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**THE GENUS *ADORETUS* DEJEAN, 1833 IN ISRAEL WITH
DESCRIPTION OF *ADORETUS (ADORETUS) LUDMILAE* SP.
NOV. AND NOTES ON RELATED WESTERN PALEARCTIC
SPECIES (SCARABAEIDAE: RUTELINAE)**

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ABSTRACT: The genus *Adoretus* Dejean, 1833 in Israel is revised, distribution and phenology are provided. *Adoretus ludmilae* previously confused with *Adoretus irakanus* Ohaus, 1928 is described from Israel and the latter is removed from the Israel Fauna. Related western palearctic *Adoretus* are discussed and paramera are illustrated.

KEY WORDS: Western Palearctic, Israel, *Adoretus*, systematics, taxonomy, morphology

According to Bodenheimer (1937) two species of the genus *Adoretus* Dejean, 1833 (for authorship see Krell, 2007 and Bousquet & Bouchard, 2013) were occurring in Israel: *Adoretus granulifrons* Fairmaire, 1882 and *Adoretus sterbae* Reitter, 1909. Chikatunov and Pavlicek in their checklist (1997) added *Adoretus irakanus* Ohaus, 1928 and they were followed by Král & Smetana (2006).

We could study 213 specimens of *Adoretus* collected in Israel, preserved in the SMTAU in other public or private collections. Three species were identified: *Adoretus sterbae* Reitter, 1909 and *Adoretus granulifrons* Fairmaire, 1882, the *Adoretus* specimens collected in Israel and identified as *irakanus* are in reality a new species here described as *Adoretus ludmilae* sp. nov.. *A. irakanus* is presently known now only from Iraq (Král & Smetana, 2006). The distribution and phenology of the *Adoretus* occurring in Israel is presented. Doing the comparative morphological analysis of the new species with the western Palearctic species of *Adoretus*, we realized that several drawing of paramera in the original descriptions are quite poor and in some cases mistakenly interpreted. Therefore in this paper we are providing photos in dorsal and lateral projection of the different species examined, excluding the species from Iraq and Iran that will be treated in another paper.

Some of the palearctic species included in the genus *Adoretus* have been grouped by Reitter (1903) and Ohaus (1934) in taxa of subgeneric rank: *Adoretus* s. str., *Lepadoretus* Reitter, 1903, *Chaetadoretus* Ohaus, 1914 and *Gemadoretus* Reitter, 1903. *Lepadoretus* is characterized only by the clothing consisting of scales instead of hairs or setae and *Chaetadoretus* by the occurrence of a few longer erect hairs placed singly amongst those on the elytra. The difference between hairs and scales in several species is quite indefinite, and the scattered erect setae make their appearance by such imperceptible degrees that they seem to us equally unsuited to provide a line of demarcation. For the present we leave the systematic situation as described but we think that at least *Adoretus* s. str. and *Lepadoretus* might be synonyms.

MATERIAL AND METHODS

This study was based on specimens preserved in SMTAU and in other public and private collections. Fresh material was also collected and examined by the authors, mainly in Tel-Aviv area (hand collecting from roses) and 'Arava Valley (using mercury and UV light traps).

External structures were observed under a Wild M5 stereoscopic microscope. Images of anatomical details/genitalia were taken with a Canon G12 digital camera and processed using licensed Adobe Photoshop CS6 software 13.0.1 x64. All measurements are in mm.

Abbreviations

CDKC = Collection Denis Keith, Chartres, France.

CGML = Collection Geoffrey Miessen, Liège, Belgium.

CGSP = Collection Guido Sabatinelli, Prévessin, France.

CORR = Collection Oz Rittner, Rishon Lezzion, Israel.

MSNG = Museum d'Histoire Naturelle de Genève, Switzerland.

SMTAU = The Steinhardt museum of natural history, Zoological department, Tel-Aviv University, Israel.

THE *ADORETUS* SPECIES IN ISRAEL

***Adoretus (Adoretus) granulifrons* Fairmaire, 1882: 68**
graniceps Reitter, 1889: 268

Material Examined. Dead Sea Area: Ne'ot haKikkar, 15.v.1999, Yarom, I. & Kravchenko V., 1 specimen. **Central Negev:** Nahal Peres, 1.vi.1998, Freidberg, A., 6 exx. **'Arava Valley:** 'En Zin, 30°53.60N 35°09.17E, 9.ix.1990 6 specimens, 25.x.1998 1 specimen, 20.vi.1999 1 specimen, 11.vi.1999 2 specimens, 9.vii.1999 6 specimens, 11.viii.1999 2 specimens, 9.ix.1999 6 specimens, 25.x.1999 2 specimens, 5.vi.2000 4 specimens, all collected by Yarom, I. & Kravchenko, V.; Nahal Gidron, 16.xi.1997, Maklakov, A., 1 specimen; Shezaf Nat. Res., 30°43N 35°16E, 18.v.1999 1 specimen, 10.x.1999 1 specimen, 2.vi.2000 2 specimens, all collected by Kravchenko, & V. Yarom, I.; 'Iddan, 4.vi.2000, Kravchenko, & V. Yarom, I., 4 specimens; Hazeva Field School, 30°46.70N 35°15.25E, 13.v.1999, Yarom, I. & Kravchenko, V. 1 specimen; Nahal Neqarot, 30°39.00N 35°10.45E, 15.viii.1999 2 specimens, 14.x.1999 1 specimen, all collected by Yarom, I. & Kravchenko, V.; Zuqim Reservoir, 30°39.20N 35°11.20E, 22.vi.1999, Yarom, I. & Kravchenko, V., 2 specimens; Gerofit, 5.ix.2002 41 specimens, 12.vi.2002 27 specimens, 15.xi.2002 6 specimens, all collected by Kravchenko, V. & Chikatunov, V.; Yotvata, 16.viii.1999, Yarom, I. & Kravchenko, V. 5 specimens. All specimens preserved in SMTAU.

Distribution. Described from Sudan (Loc. Typ. of *granulifrons*) and Egypt (Assuan, Loc. Typ. of *graniceps* Reitter). Indicated by Král & Smetana, 2006 from Israel, Jordan.

In Israel is present in the southern tip of the Dead Sea, Eastern part of the Central Negev area and along the 'Arava valley (red dots in fig. 41).

Phenology. Adults are active from May to October.

The paramera of this species are here illustrated for the first time with a photograph (fig. 26, length 1.43 mm) from a specimen from 'Arava Valley, 'En Zin.

***Adoretus (Adoretus) sterbae* Reitter, 1909: 82**

Material Examined. **Upper Galilee:** Huliot [Sede Neḥamyā], 8.viii.1943, leg. Bytinski-Salz, 1 specimen. **Jordan Valley:** Bet Alfa, 3.v.1946, leg. Bytinski-Salz, 3 specimens. **Judean Hills:** Yerushalayim, 20.i.1958, 1 specimen. All specimens preserved in SMTAU.

Distribution. Described from Turkey (Adana) and indicated by Král and Smetana (2006) also from Israel. In Israel we documented its presence in Upper Galilee, Jordan Valley and the Judean Hills (blue dots in fig. 41).

Phenology. The collecting data from the three specimens from Israel shows three very different periods of activity: January, May and August. It is possible that some records are not correct. In Turkey it was collected at in the 3rd decade of April.

The paramera of this species were illustrated for the first time in a drawing by Sabatinelli (1983) then by Baraud (1992), here reproduced (fig. 12) with an original photograph (fig. 11, length 1.7 mm) from a specimen from Jordan Valley, Bet Alfa.

***Adoretus (Adoretus) ludmilae* sp. nov. (Figs. 1-6)**

Typical Series. **Holotype** male: Israel, Tel Aviv, Park HaYarqon, 32°06'N 34°48'E, 5.VII.2010, leg. G. Sabatinelli, on roses at 21:00, deposited in SMTAU. **Allotype** female: same data as the holotype, deposited in SMTAU. **Paratypes:** **Israel, Mt. Hermon:** Har Ḥermon, 1800m., 12.vi.2003, Freidberg, A. 1 female in SMTAU. **Israel Upper Galilee:** Panyas [Banias], 30.vii.2002, Kravchenko, V. & Chikatunov, V. 1 female in SMTAU; Tel Dan, 15.vii.2002, Kravchenko, V. & Chikatunov, V. 1 female in SMTAU; Tel Dan, 20.viii.2002, Kravchenko, V. & Chikatunov, V., 1 male and 2 females in SMTAU. **Israel, Central Coastal Plain:** Herzliyya, 27.vi.2006, Freidberg, A., 17 males and 2 females in SMTAU; Herzliyya, 7.vii.2005, Freidberg, A., 1 male and 2 females in SMTAU; Tel Aviv, 6.vii.2005, Shlagman, A., 1 male in SMTAU; Tel Aviv, Park HaYarqon, 27.vi.2003, Shlagman, A., 30 males and 6 females in SMTAU; Tel Aviv, Park HaYarqon, 8.vii.2009, Rittner, O., 23 males and 17 female in SMTAU; Tel Aviv, 2.x.2002, light trap, Kravchenko, V. & Chikatunov, V., 2 males and 1 female in SMTAU; Tel Aviv, 24.vi.2003, light trap, Chikatunov, V. & Kravchenko, V., 2 males in SMTAU; Tel Aviv, Park, HaYarqon, 32°06'N 34°48'E, 5.VII.2010, leg. Sabatinelli, G. on roses at 21:00, 30 males and 30 females in CGSP, 1 male and 1 female deposited in MHNG, 10 males and 10 females in CORR. **Israel, Jordan Valley:** Hammat Gader, 15.vi.2002, light trap, Kravchenko, V., 1 male in SMTAU; Hammat Gader, 22.vii.2002, light trap, Kravchenko, V. & Chikatunov, V., 2 males in SMTAU; Hammat Gader, 23.viii.2002, Kravchenko, V. & Chikatunov, V., 1 female in SMTAU. **Jordan,** Al Jabiha, 7.v.92 [in Arabic], 1 male in CGSP.

Description.

Male. Holotype: length 12.4 mm; breadth: 5.5 mm. Habitus as in fig. 1.

Uniform red-brown-chocolate with the pronotum and head a little bit darker, evenly and closely clothed with minute decumbent grey setae. Elongate-oval and not very convex, finely punctured and not shining.

Clypeus semielliptical, transverse large 2.7 mm and width 1.2; covered with closely irregular punctures, points are mostly mixed together sometimes creating smooth horizontally layers. Each puncture bears a single short and adpressed bristle; anterior margin of reflexed; clypeal frontal suture well visible and bearing bristles.

Frons covered with closely irregular punctuation, each puncture bears a single short and adpressed bristle. The occipital area is smooth. Front of clypeus evenly broadly rounded.

Antennae lamellate. Funiculus comprises 6 segments and antennal club with 3 segments. Length of funiculus is equal to length of the club. Scape bears few erect long setae.

Canthus reach about one third of the eye and bears erect long setae.

Labrum T shaped with median process reaching between the mandibles, truncate at the end and finely serrated at the sides (fig. 6); dark colored and covered with fine punctures.

Pronotum transverse: breadth 4.6 mm, length 2.4 mm; pronotal angles visible the basal obtuse and anterior acute; with "m" shaped punctures, each one bearing a single short and adpressed bristles; pronotal margin with horizontally adpressed short bristles at its base.

Scutellum triangularly shaped with the same punctuation and bristles as the pronotum; dark colored with the center a bit brighter.

Elytra elongate, very convex and sub-parallel with the maximal breadth (5.5 mm) towards the distal part; covered with short adpressed bristles, irregular punctures and with three visible striae, each one defined by two rows of punctures.

The pygidium is clothed with erect hairs, which are short at the base and become gradually longer towards the most prominent part.

The front tibia is armed with three external teeth, with the basal teeth separated from both apical tooth and located in center of the tibia; terminal spur at the inner margin located almost in opposite to the outer median tooth; base of the tarsi located on the ventral side of the tibia, opposite to the outer median tooth. Outer edges of tibia dark colored and flattened. Tibia covered with small and shallow punctures and short bristles. The claws are very unequal, the inner front and outer middle and hind ones very long, and the first and second cleft at the tip (figs. 4 and 5).

Paramera (fig. 2, length 1.86 mm) close to those of *A. pullus* Baudi, 1870 and *A. sterbae* 1909 with who it was confused until today.

Paratypes: same characters as the holotype, length: 11-12.3 mm, max breadth: 5.5-6 mm.

Sexual dimorphism is mainly visible in the abdomen which is more is convex in the female, and straight or slightly concave in the male; the last ventral segment is large and more or less triangular in the former, and short and transverse in the latter; and the pygidium is short and oblique in the female, and larger and much more convex in the male; the club of the antenna is a little bit longer in males; the longer front and middle claws are cleft in both sexes but the two divisions are approximately equal in the female (fig. 3) and very unequal in the male (fig. 5), the cleft being at a distance from the end and sometimes almost obliterated (fig. 4).

In the male the cleft is very minute, at a little distance from the apex, and sometimes not very easily seen.

Derivatio Nominis. The species is dedicated to Ludmila Leibiusky-Rittner who kindly accompanied us several times to collect insects.

Distribution. In Israel: Mt. Hermon, North East part of Upper Galilee, Northern tip of Jordan valley and Central Coastal Plain; and Amman (Jordan) (yellow spot in fig. 41). These collection sites are very diverse in terms of climate, vegetation and height. Furthermore there is a large empty gap between these areas and it is more than possible that *A. ludmilae* will be found in the future elsewhere in Israel and its neighboring countries.

Phenology. Adults are active from mid-June to October with the peak in June-July. In Tel-Aviv adults were seen in vast numbers in a small rose garden (figs. 42-43). Activity starts in July at about 20:30, only when total darkness arrives. Outside the rose garden adults are hardly seen coming to light. In the Zoological garden of Tel-Aviv University only 2 specimens were collected near lights during a period of three years, a distance of only 1 km. from the rose garden.

NOTES ON WESTERN PALEARCTIC *ADORETUS* DEJEAN, 1833

Before deciding that *Adoretus ludmillae* was a new species we had to exclude conspecificity with all western palearctic species. In doing this exercise we realized that the aedeagus and in particular the paramera (parameral lamina) was not yet figured in any publication and in some case the original drawing in the description differed from the shape resulting from a photograph of the typus or conspecific specimens. We thought that this paper was a good opportunity to provide our observation on the matter. However the *Adoretus* of Persia-Iran will be discussed subsequently in a specific paper.

Adoretus (Adoretus) aegrotus Burmeister, 1844: 470 *millingeni* Pic, 1905: 153 (Loc. Typ.: Arabia)

Described from Nubia (Egypt-North Sudan) and reported from Algeria by Pic (as *millingeni*) and by Baraud (1885). Indicated also by Král & Smetana (2006) from Sinai ("Arabien"). We know this species, or a very closely related one, also from Arabian Peninsula.

The paramera were presented for the first time in a drawing by Baraud (1985) and here reproduced (fig. 39).

Adoretus (Adoretus) afghanus Machatschke, 1958: 178

This species was described from Afghanistan, Kabul. Machatschke compared Kabul populations of *simplex*-group with the other species from the Indian subcontinent. While at the time of the description the differences between *afghanus* and other *simplex* species-group were quite striking, the intense sampling of North Pakistan conducted by one of the authors (GS) in the recent year are weakening those differences.

The shape of paramera provided in a drawing by Machatschke and here reproduced (fig. 38) differs from those (fig. 37, length 1.86 mm) of a series of specimens from Afghanistan, North Kabul, Djebel os-Siradj (ex coll. Petrovitz,

MHNG). The value of this species needs to be reconsidered using the typical series.

***Adoretus (Adoretus) discolor* (Falderman, 1835: 276 – *Trigonostoma*)**

Described from “Persico-Armeniaca” and reported by Král & Smetana (2006) from Azerbaijan, Armenia, Georgia, and South West Russia.

The paramera of this species were presented for the first time in a drawing by Baraud (1992), here reproduced (fig. 8) and with an original photograph (fig. 7, length 2.3 mm) from a specimen from Iran, West Azerbaijan, Maku (CGSP).

***Adoretus (Adoretus) gandolphei* Guérin-Ménéville, 1859: 185**

fuscitarsis Reitter, 1903: 32 (Loc. Typ.: Algeria, Oued Deur Leur)

infissidens Pic, 1922: 17

Described from North Algeria (Chlef, formerly Orleansville) and indicated by Baraud (1885) from Morocco, Algeria and Tunisia.

The paramera of this species were presented for the first time in a drawing by Baraud (1985) here reproduced (fig. 30) and with an original photograph (fig. 29, length 1.9 mm) from a specimen from Morocco, Moyen Atlas, Qued Sebou (CGSP).

***Adoretus (Adoretus) garamas* Peyerimhoff, 1921: 235**

Described from South Algeria (Hoggar), reported by Baraud (1985) from Libya, Sahrawi, Chad and Mauritania and by Král & Smetana (2006) from Egypt.

The paramera of this species are known only from the drawing of Baraud (1985) here reproduced (fig. 33).

***Adoretus (Adoretus) geyri* Ohaus, 1917: 5**

surcoufi Peyerimhoff, 1921: 234 (Loc. Typ.: Algeria, Ghardaïa Province. El Ménia District, El Golea oasis).

Described from South East Algeria (Tig'amaïin en tisita and Tihiaout) and reported by Baraud (1985) from Morocco, Sahrawi, Algeria, by Král & Smetana (2006).

The paramera of this species were presented for the first time in a drawing by Baraud (1985) here reproduced (fig. 25) with an original photograph (fig. 24) from a specimen from Morocco, Zaoula-el-Barhnia (in CGML). The close similitude with the paramera of *A. granulifrons* Fairmaire, 1882 is striking and need to be further investigated.

***Adoretus (Adoretus) hybogeneius* Ohaus, 1930: 153**

Described from Sudan (Loc. Typ.: Shendi 150 km northeast of Khartoum on the Nile) and reported by Baraud (1985) from Morocco, Algeria and Mauritania.

The paramera of this species were figured in the original description and here reproduced (fig. 35), then by Baraud (1985) here reproduced (fig. 36) with an original photograph (fig. 34, length 2.3 mm) from a specimen from Oman Muscat (CGSP). All these images reproduce a very particular shape of paramera in the genus *Adoretus*, longitudinally fissured at the apex and densely coated with short hairs in the basal lower surface. We found that this morphology is common

to a group of *Adoretus* described with different names: *punjabensis* Arrow, 1917, *machatschkei* Petrovitz, 1965, *imitator* Benderitter, 1927, *vastus* Petrovitz, 1958, and that could represent a unique species largely distributed across Africa to India through Arabian Peninsula.

***Adoretus (Adoretus) irakanus* Ohaus, 1928: 401**

Described from Iraq (Rustam). It was reported by Chikatunov and Pavlicek (1997), followed by Král & Smetana (2006), from Israel but all the specimens from Israel previously identified as *A. irakanus* are now referred to *A. ludmilae* n.sp. and *A. irakanus* is presently known from Iraq and Iran (CGML).

The paramera of this species were figured in the original description and here reproduced (fig. 19) with an original photograph (fig. 18, length 2.52 mm) from a specimens from Irak, Al Hadr , Rawah (CDKC).

***Adoretus (Adoretus) nigriformis* (Steven, 1809: 41 – *Melolontha*) pallidulus** Motschulsky, 1860: 522

Described from Caucasus-South Russia and reported by Král & Smetana (2006) from Azerbaijan, Georgia, SW Russia, Afghanistan, Iran, Kirghizstan, Kazakhstan, Tajikistan, Uzbekistan, Xizang.

This species is the type species of the genus *Adoretus*, it is widely distributed and quite stable in its interpretation by the different authors.

The paramera of this species were presented for the first time in a drawing by Petrovitz (1958) here reproduced (fig. 23), then by Baraud (1992) and by Kalashyan (2002). Here we present an original photograph (fig. 22, length 1.85 mm) from a specimen from Afghanistan, Herat (CGSP).

***Adoretus (Adoretus) persicus* Reitter, 1889: 268**

This species was described from “Nordpersien” and it is one of the oldest species of the genus. However the interpretation of this taxon is not stable. We are reproducing here the drawing of the paramera provided by Baraud (fig. 21) in its description of *A. petrovitzi* (1975) and those (fig. 20, length 2.57 mm) from a series of specimens from Iran identified by Petrovitz (MHNG). Their shape appear quite different: while *A. persicus* sensu Petrovitz is close to *A. irakanus* Ohaus, 1928, *A. pesicus* sensu Baraud is close to *A. iranicus* Petrovitz 1958. We believe that the interpretation of Petrovitz is more close to the reality but the study of the typical series is necessary to solve this ambiguity.

***Adoretus (Adoretus) peyerimhoffi* Baraud, 1979: 222**

Described from Morocco (Erfoud, Oued Khrouf) and reported (Baraud, 1985) also from Sahrawi.

The shape of paramera of this species is known only from the drawing provided by Baraud here reproduced (fig. 28). The species is very close to *A. gandolphei* Guérin-Menéville from which can be distinguished from different shape of apical part of the labrum and from the punctuation of the clypeus and pronotum. The dorsal basal margin of paramera seems also different but we could not confirm it.

***Adoretus (Adoretus) pruinus* Ballion, 1870: 345**

Described from Uzbekistan (Chodshent, Samarkand district) and reported by Král & Smetana (2006) also from Afghanistan, Kirghizstan, Kazakhstan, Tajikistan, and Turkmenistan.

The paramera of this species were presented for the first time in a drawing by Ohaus (1930), here reproduced (fig. 14) with an original photograph (fig. 13) from a specimen from Afghanistan (MHNG).

***Adoretus (Adoretus) pullus* Baudi, 1870: 76**

Described from Cyprus and known only from there.

Paramera were illustrated first time in a drawing by Sabatinelli (1983) then by Baraud (1992) here reproduced (fig. 10) with an original photograph (fig. 9, length 1.85 mm) from a specimen from Ypsonas, Lemesos (CGML).

***Adoretus (Adoretus) quadridens* Marseul, 1878: 71**

Described from Egypt and known only from there. Baraud indicated (1985) that the type of this species disappeared and we could not trace any specimen with this particular shape of clypeus that could be attributed to this species. Although from Egypt, from the original description we believe that this species is not related to *A. ludmillae* n. sp.

***Adoretus (Adoretus) rufifrons* Reitter, 1903**

Described from China, Western Xinjiang (Maralbaschi, Kaschgar-Darja).

We could study only a single male specimen (Xinjiang, Dsungarei, Karlyk-Tag, ex coll. Petrovitz, MHNG) of this species for which we are providing for the first time the photograph of the paramera (fig. 15, length 1.34 mm). The shape of paramera is close to *A. pruinus* Ballion, 1870 but the size of the body is much smaller and integuments light coloured.

***Adoretus (Adoretus) rubenyani* Kalashyan, 2002: 76**

Described from Armenia (Etshmiadzin env., Arax vill.) and known only from there.

The paramera were figured in a drawing in the original description, here reproduced (fig. 17) with the original photograph (fig. 16). The species seems close to *A. irakanus* and *nigrifrons* with who was compared in the description.

***Adoretus (Adoretus) senescens* Walker, 1871: 12**

Described from High Egypt, known only from there and unknown by Baraud (1985). We could not trace any specimen that could be attributed to this species. Although from Egypt, from the original description we believe that this species is not related to *A. ludmillae* n. sp.

***Adoretus (Gemadoretus) clypeatus* Burmeister, 1844: 471
signatus Reitter, 1889: 268 (Loc. Typ.: Egypt, Aswan)**

Described from Kordofan (Sudan) and from Egypt (Baraud, 1985).

The paramera of this species are here figured for the first time (fig. 27, length 1.5 mm) from an historical specimen "Aegypt" (CGSP).

***Clypadoretus epistomalis* (Chobaut, 1899: 38 – *Adoretus*)**

Described from Algeria, Touggourt and know also from Algeria, Ahenet and Hoggar and Morocco in the Sahara reaching in the North Tafilalet, Erfoud (Baraud, 19885).

The paramera were figured for the first time in a drawing by Baraud and here reproduced (fig. 40).

***Pseudadoretus koechlini* (Marseul, 1867: 1xxx – *Adoretus*)
evanescens (Marseul, 1878: 72 – *Adoretus*)**

The type female described from Algeria, Biskra and the male redescribed as *evanescens* by the same Author from Algeria, Laghouat.

The species is known from several localities of Algeria but also from Morocco, Sahara reaching in the North Tafilalet and Mauritania (Baraud, 1985).

The paramera of this species were illustrated first time in a drawing by Baraud (1985) here reproduced in (fig. 32) with an original photograph (fig. 31) from a specimen from Morocco, Errachida (CGSP). It is evident that the drawing provided by Baraud is quite different from the specimen from Errachida here shown and the matter need further investigation.

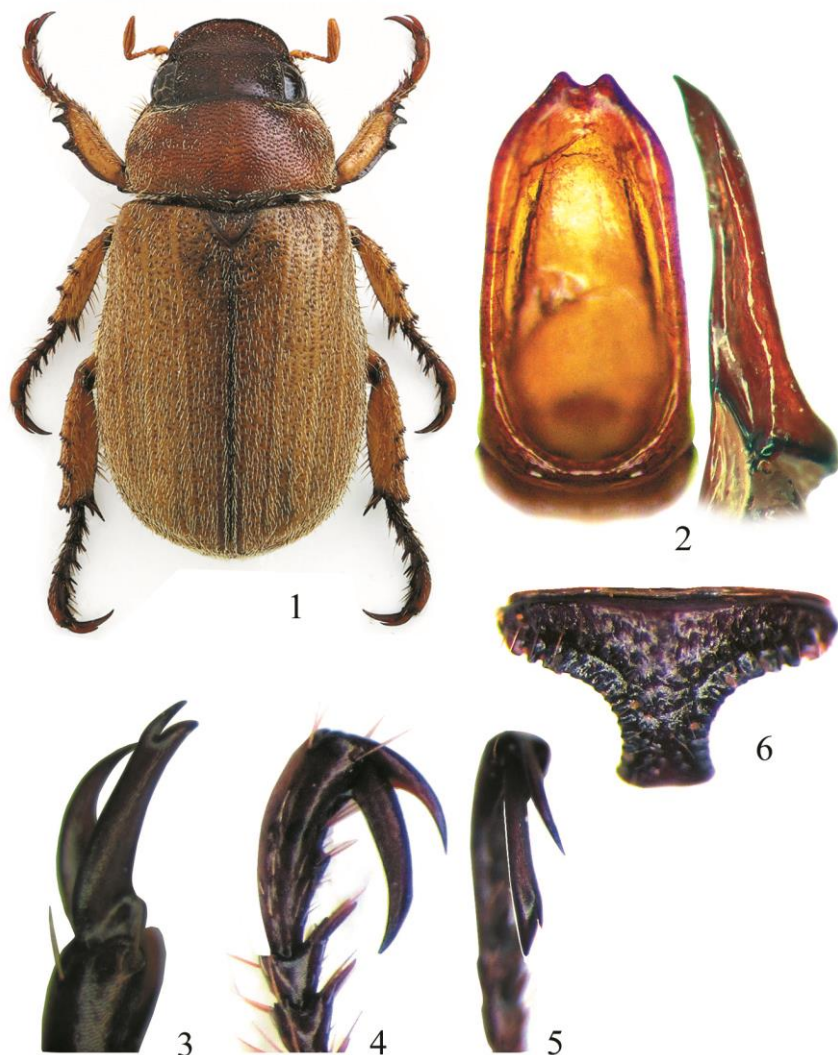
ACKNOWLEDGEMENTS

We are in debt to Marco Uliana for the photo of the typus of *A. ludmilae* n.sp., to Geoffrey Miessen and Denis Keith for providing specimens and photos from their collections, to Tigran Kredjan for the photo of the paramera of *A. rubenyani* Kalashyan, 2002 and to Giulio Cuccodoro for providing access to Petrovitz collection in the Museum d'histoire Naturelle de Genève, Switzerland.

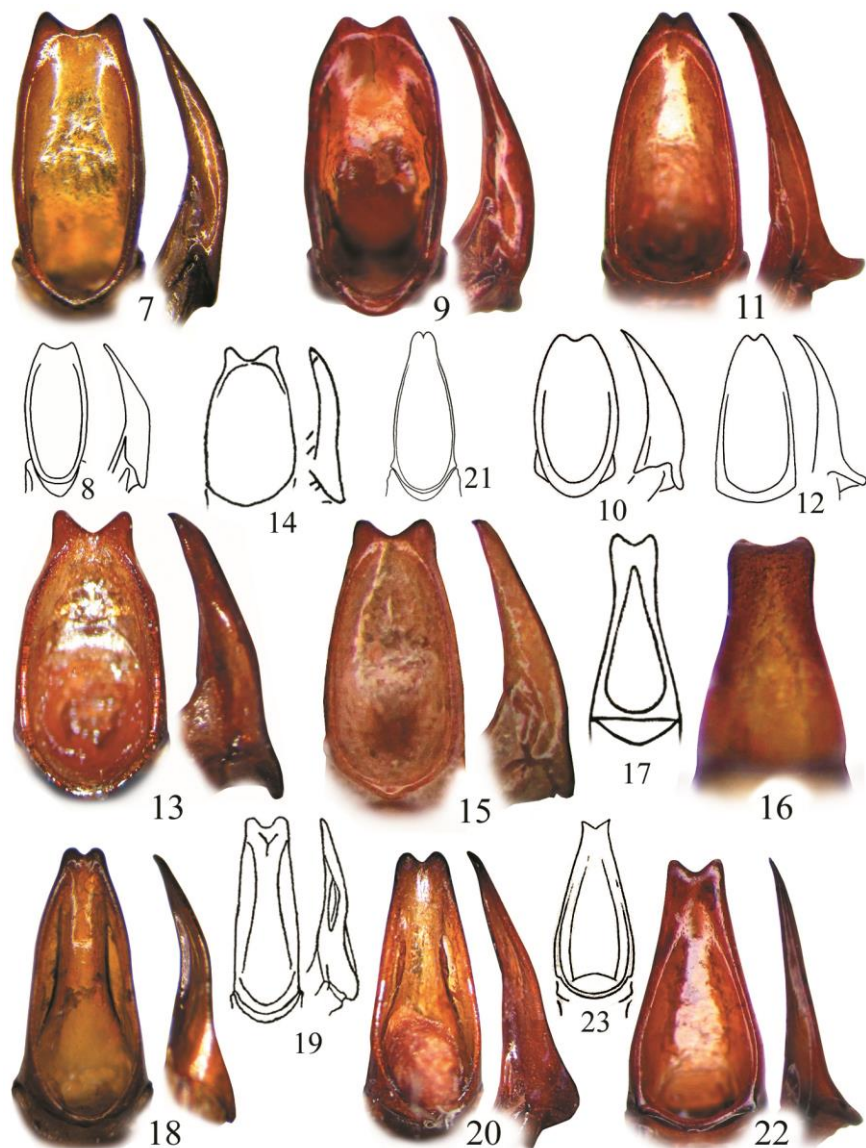
LITERATURE CITED

- Arrow, G. J.** 1917. The Fauna of British India, Including Ceylon and Burma. Coleoptera Lamellicornia part II (Rutelinae, Desmonycinae, and Euchirinae) Taylor & Francis. London: 387 pp.
- Baraud, J.** 1975. Descriptions de cinq nouvelles espèces paléarctique de Coléoptères Scarabaeoidea. Nouvelle Revue d'Entomologie. Toulouse 5 (2): 191-196.
- Baraud, J.** 1985. Coléoptères Scarabaeoidea. Faune du Nord de l'Afrique du Maroc au Sinaï. Editions Lechevalier Paris. Encyclopédie Entomologique. 650 pp.
- Baraud, J.** 1992. Coléoptères Scarabaeoidea d'Europe. Fédération Française des Sociétés de Sciences Naturelles. Faune de France. 78: 1-856.
- Baudi di Selve, F.** 1870. Coleopterorum messis in insula Cypri et Asia minore ab Eugenio Truqui congregatae recensio: de Europaeis notis quibusdam additis. Pars tertia. Berliner Entomologische Zeitschrift. Berlin, 14: 49-90 (64-78).
- Bodenheimer, F. S.** 1937. Prodrum Faunae Palaestinae. Essai sur les l'éléments Zoogéographiques et Historiques du Sud-Oest du Sous-Règne Paléarctique. Le Caire, l'Institut Français d'Archéologie Orientale. Vol. 33, 286 pp.
- Bousquet, Y. & Bouchard, P.** 2013. The genera in the second catalogue (1833–1836) of Dejean's Coleoptera collection. ZooKeys, 282: 1-219.

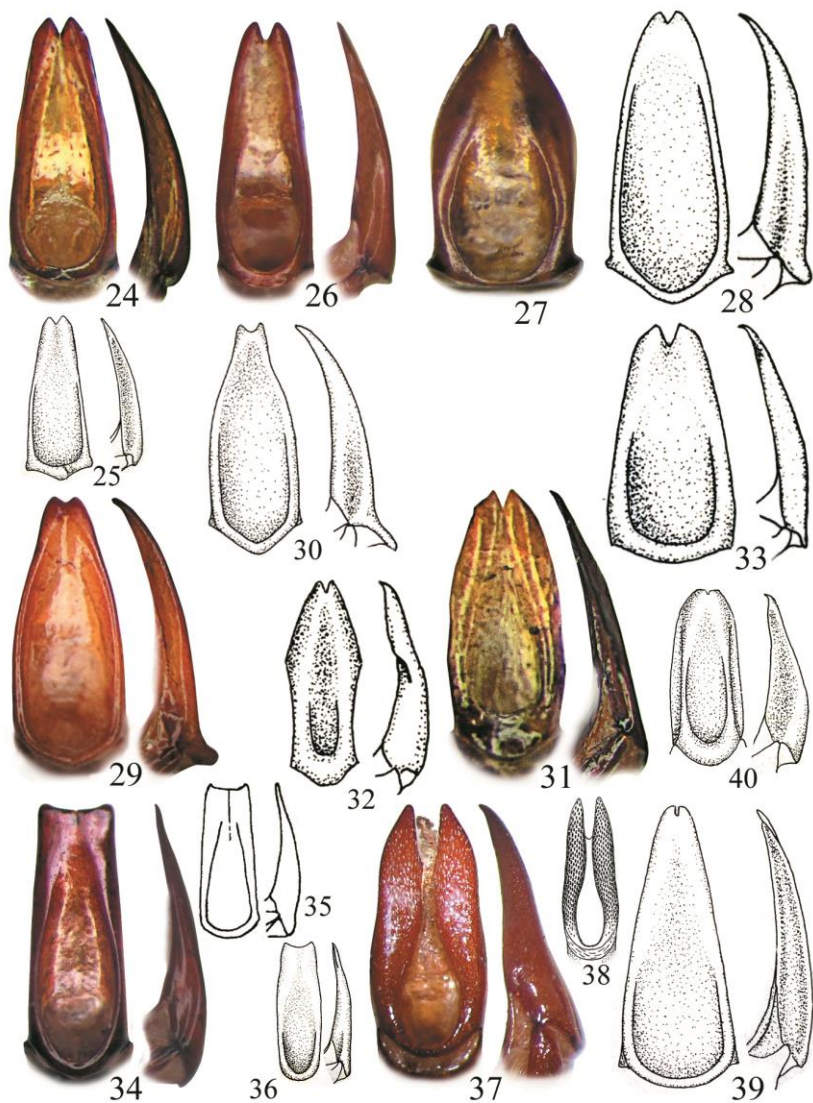
- Burmeister, H. C. C.** 1844. Handbuch der Entomologie. Coleoptera Lamellicornia, Anthob Phyllophaga systellochela. Berlin, 4 (1): 1-588.
- Chikatunov, V. & Pavlicek, T.** 1997. Catalogue of the beetles (Coleoptera) in Israel and adjacent areas: 1. Scarabaeoidea. Klapalekiana, 33: 37-65.
- Fairmaire, L.** 1882. Notes sur quelques Coléoptères du Soudan et de l'Inde boréale recueillis par MM. Stanislas et Constantin Rembielinski. Annales de la Société Entomologique de France, 6 (2): 65-68.
- Kalashian, M. Y.** 2002. New species of beetles from Armenia and Kazakhstan. Doklady Natsional'noi Akademii Nauk Armenii, 102 (1): 76-83 (76-78).
- Keith, D.** 2001. Contribution à la connaissance des Scarabaeoidea du Proche et du Moyen-Orient (9e Note): description de *Medeotrogus linnavuorii* n.gen. d'Irak et d'Iran et d'*Adoretus kashmarensis* n. sp. d'Iran. Symbioses (N.S.), 5: 75-78.
- Král, D. & Smetana, A.** 2006. Scarabaeidae: Rutelinae: Adoretini. Pp. 248–251. In: Löbl, I. & Smetana, A. 2006: Catalogue of Palaearctic Coleoptera, Vol. 3. Scarabaeoidea – Scirtoidea – Dasciloidea – Buprestoidea – Byrrhoidea. Stenstrup: Apollo Books, 690 pp.
- Krell, T.** 2007. Scientific Note, Author, date, and type species of *Adoretus* (Scarabaeidae: Rutelinae) The Coleopterists Bulletin, 61 (1): 125-126.
- Marseul, S. A.** 1878. Mélanges coléoptérologiques. Nouvelles et Faits 2 (17): 71-72.
- Ohaus, F.** 1928. Beitrag zur Kenntnis der Ruteliden. Deutsche Entomologische Zeitschrift. Berlin, 25: 385-406.
- Ohaus, F.** 1934. Genera Insectorum: Fam. Scarabaeidae, Subfam. Rutelinae ; 1. Coleoptera Lamellicornia, Volume 199, 171 pp.
- Petrovitz, R. von.** 1958. Beitrag zur Kenntnis der Scarabaeiden-Fauna des Iran. Stuttgarter Beiträge zur Naturkunde aus dem staatlichen Museum für Naturkunde in Stuttgart. Stuttgart. Ser. A. Biologie, 8: 1-12.
- Petrovitz, R. von.** 1970. Scarabaeidae aus Iran. Entomologie et Phytopathologie Appliquées. Teheran, 29: 38-45.
- Petrovitz, R. von.** 1980. Österreichischen entomologischen Expeditionen nach Persien und Afghanistan. Annalen des Naturhistorischen Museums in Wien. Wien, 83: 597-638.
- Peyerimhoff, P. de** 1921. Nouveaux Coléoptères du Nord-Africain. Trente-neuvième note: Faune saharienne. Bulletin de la Société entomologique de France, 231-236.
- Pic, M.** 1905a. Notes sur le genre *Adoretus* Lap. et description d'une espèce de ce genre. Bulletin de la Société entomologique de France. 199-201.
- Pic, M.** 1905b. Nouveaux Coléoptères d'Algérie & d'Asie occidentale. L'Échange, Revue Linnéenne. 21: 153-156.
- Reitter, E.** 1889. Uebersicht der mir bekannten *Adoretus*-Arten der palaearktischen Fauna. Entomologische Nachrichten. Berlin, 15: 267-270.
- Reitter, E.** 1903. Bestimmungs-Tabelle der Melolonthidae aus der europäischen fauna und angrenzenden ländern, enthaltend die gruppen der Rutelini, Hoplini und Glaphyrini (Schluss). Verhandlungen des Naturforschenden Vereins, Brunn (1904), 41: 28-158.
- Reitter, E.** 1909. Eine serie neuer Scarabaeiden aus der palaearktischen Fauna. Wiener Entomologische Zeitung. Wien, 28: 75-84.
- Sabatinelli, G.** 1983. Gli *Adoretus* Lap. del Mediterraneo orientale : *A. pullus* Baudi e *A. sterbae* Reitter (Coleoptera, Scarabaeidae, Rutelinae). Boll. Soc. Ent. Ital., Genova, 115 (4-7): 103-106.
- Steven, C. von** 1809. Descriptions de quelques insectes du Caucase et de la Russie méridionale. Memoires de la Societe Imperiale des Naturalistes de Moscow, 2: 31-42.
- Walker, F.** 1871. List of Coleoptera collected by J. K. Lord, Esq. in Egypt, Arabia and near the African shore of the Red Sea with characters of the undescribed species. London: 1-19.



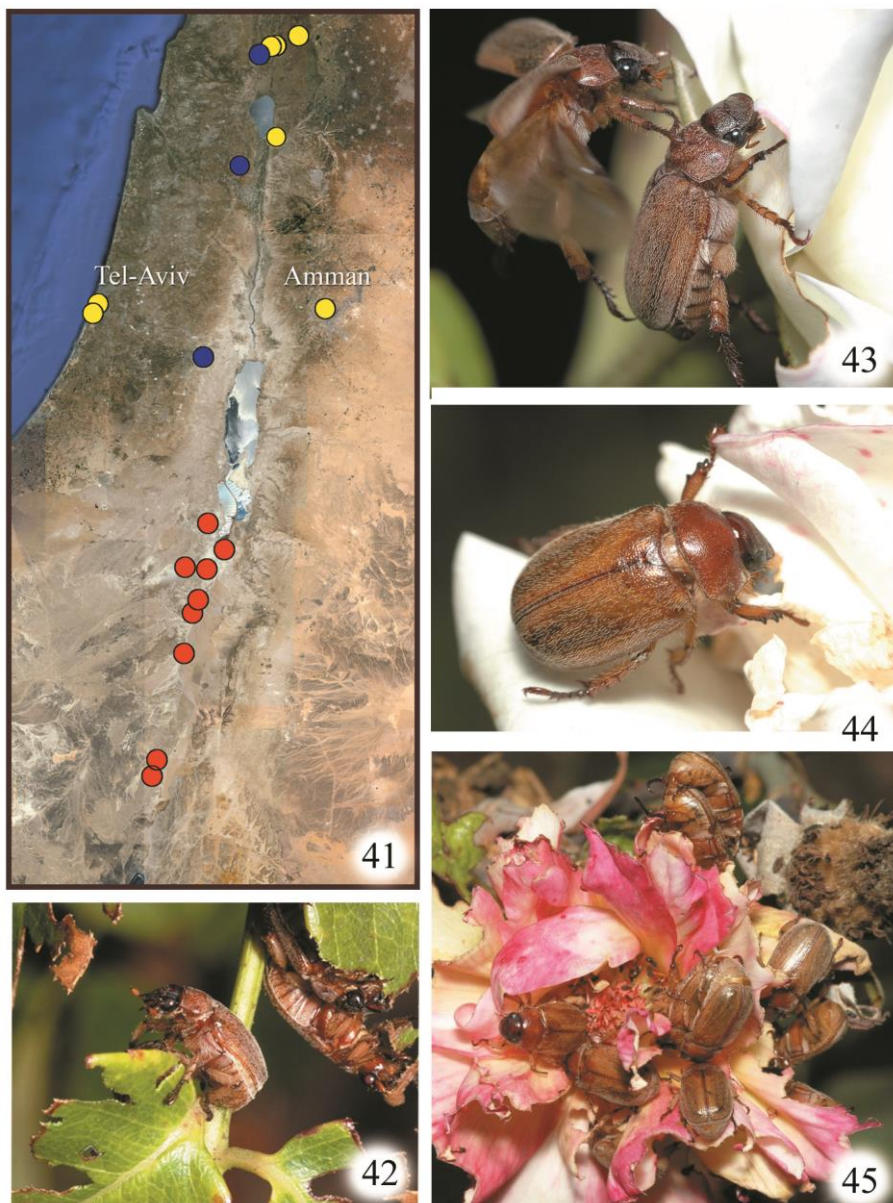
Figures 1- 5. *Adoretus (Adoretus) ludmilae* n. sp. 1: holotype male; 2: paramera in dorsal and lateral view; 3: front claws in female lateral view; 4: front claws in male lateral view; 5: front claws in male frontal view; 6: labrum.



Figures 7-23. Paramera of *Adoretus* (*Adoretus*) *discolor* (Falderman, 1835), 7: specimen from Iran; 8: according to Baraud (1992). *A. pullus* Baudi 1870, 9: specimen from Cyprus, Ipsonas; 10: according to Baraud (1992). *A. sterbae* Reitter, 1909, 11: specimen from Jordan; 12 according to Baraud (1992). *A. pruinosis* Ballion, 1870, 13: specimen from Afghanistan; 14 according to Ohaus (1930). *A. rufifrons* Reitter, 1903, 15: specimen from Xinjiang. *A. rubenyani* Kalashyan, 2002, 16: paratype; 17: according to Kalashyan (2002). *A. irakanus* Ohaus, 1928, 18: specimen from Irak; 19: according to Ohaus (1928). *A. persicus* Reitter, 1889, 20: specimen from Iran; 21: according to Baraud (1975). *A. nigrifrons* (Steven, 1809), 22: specimen from Afghanistan; 23: according to Petrovitz (1958).



Figures 24-40. Paramera of *Adoretus* (*Adoretus*) *geyri* Ohaus, 1917, 24: specimen from Morocco; 25: according to Baraud (1985). *A. granulifrons* Fairmaire, 1882, 26: specimen from Israel, 'Arava Valley. *A. (Gemadoretus) clypeatus* Burmeister, 1844, 27: specimen from "Aegypt". *A. (Adoretus) peyerimhoffi* Baraud, 1979, 27: according to Baraud (1985). *A. gandolfei* Guérin-Ménéville, 1859, 29: specimen from Morocco, Qued Sebou; 30: according to Baraud (1985). *Pseudadoretus koechlini* (Marseuil, 1867), 31: specimen from Morocco, Errachida; 32: according to Baraud (1985). *A. (Adoretus) garamas* Peyerimhoff, 1921, 33: according to Baraud (1985). *A. hybogeneius* Ohaus, 1930, 34: specimen from Oman; 35: according to Ohaus (1930); 36: according to Baraud (1985). *A. afghanus* Machatschke, 1958, 37: specimen from North Kabul; 38: according to Machatschke (1958). *A. aegrotus* Burmeister, 1844, 39: according to Baraud (1985). *Chypadoretus epistomalis* (Chobaut, 1899), 40: according to Baraud (1985).



Figures 41-45. 41: red dots: *A. granulifrons*; yellow dots: *A. ludmillae*; blue dots: *A. sterbae*. 42-45: *Adoretus (Adoretus) ludmilae* n. sp. in nature (Tel Aviv, Park HaYarqon).

A NEW SPECIES OF THE GENUS *PURPURICENUS* DEJEAN, 1821 FROM GREECE (COLEOPTERA: CERAMBYCIDAE)

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[Vartanis, J. & Ambrus, R. 2015. A new species of the genus *Purpuricenus* Dejean, 1821 from Greece (Coleoptera: Cerambycidae). *Munis Entomology & Zoology*, 10 (2): 315-318]

ABSTRACT: *Purpuricenus comenius* sp. nov. from Laconia region in the southeastern part of the Peloponnese peninsula (Greece) is described and illustrated. The new species belongs to the *Purpuricenus graecus* species group. It is compared to the three other similar species known to occur in Greece (*P. graecus graecus* Sláma, 1993, *Purpuricenus budensis* (Götz, 1783) and *Purpuricenus apiceniger* Pic, 1914).

KEY WORDS: Cerambycidae, *Purpuricenus*, new species, Greece, Palaearctic region.

Eight species of the genus *Purpuricenus* Dejean, 1821 are known from Greece. *P. kaehleri* (Linnaeus, 1758), which is widely distributed and rather common, is regarded to be represented in the area by the nominative subspecies. *P. graecus graecus* Sláma, 1993 is species endemic to Greece. It is known from the northern Greece (Grevena) to the southern Peloponnese (Taygetos Mts. near Trypi). *Purpuricenus apiceniger* Pic, 1914 is very rare species known only after single specimens from the Balkan Peninsula (from Trieste area in NE Italy to Etolia in Greece). *P. globulicollis* known from some localities in Greece, was traditionally regarded as being represented here by the nominative subspecies only. Recently (Rapuzzi & Sama, 2013) its populations from Albania, from Greece (Ossa mountain, Kokkino Nero; Eubea Island; Peloponnese, Karies), Montenegro (Morace pl.; Cetinje; Boka Kotorska), Bulgaria (Asenovgrad), were described as *P. globulicollis skypetarum* Rapuzzi & Sama, 2013. Very close to *P. globulicollis* is species *Purpuricenus schurmanni* Sláma, 1985 and, pending molecular data, it could be alternatively considered a distinct species or only a subspecies of the latter taxon (Rapuzzi & Sama, 2013). Other two species *Purpuricenus dalmatinus* Sturm, 1843 and *Purpuricenus budensis* (Götz, 1783) is widely distributed and common in Greece. Populations of *P. desfontainii*, known from many localities in Greece, are regarded as *P. desfontainii inhumeralis* Pic, 1891. It is known from continental Greece to Syria and Israel. The nominative subspecies occurs in North Africa (from Libya to Morocco) and Crete. The subspecies should be having hybridization areas at least in Greece (Peloponnese).

Recently, specimens representing a new species of *Purpuricenus* from Laconia region in the southeastern part of the Peloponnese peninsula (Greece) were discovered. The new species is described herein.

Purpuricenus comenius sp. n.

(Figs. 1-2)

Type material. Holotype, ♂: Greece-Peloponnisos, Agios Petros, 6.6.2012, lgt. D. Loupanec (coll. J. Vartanis); 6 paratypes: 1♀: Greece-Peloponnisos, Karýes,

13.6.2012 (ex larva *Quercus coccifera*), lgt. I. Martinů (coll. J. Klícha); 1♀: Greece, Peloponnese, Laconia, 2 km NE Karyes, 10.2.2013 (ex larva *Quercus coccifera*), lgt. P. Zlámál (coll. R. Ambrus); 1♀: Greece, Peloponnese, Laconia, 2.5 km NE Karyes, 18.6.2013 (on *Quercus coccifera*), lgt. P. Zlámál (coll. P. Zlámál); 1♂ and 1♀: Greece-Peloponnisos, Karýes, 18.5.2014 (ex larva *Quercus coccifera*), lgt. I. Martinů (coll. J. Vartanis); 1♂: Greece-Peloponnisos, Karýes, 18.5.2014 (ex larva *Quercus coccifera*), lgt. I. Martinů (coll. J. Klícha).

Description. Body length in males: 12.5-13.5 mm, in females: 11.0-13.5 mm; body width in males: 3.1-3.2 mm, in females: 3.3-3.6 mm. Body black; elytra and pronotum red, marked with black. Head deep punctured, with a deep groove between eyes. Front part of the head short and wide, with many erect black hairs. Antennal tubercles prominent. Pronotum globular, curvature relatively uniform, with two prominent dorsal pronotal tubercles. Lateral thoracic tubercles blunt and very small, inconspicuous. Pronotum 1.2-1.25 x wider than longer, with almost the same width as the elytra on the base; very densely and roughly punctured, gaps between dots very small and smaller than dots themselves. Several short, thin erect black hairs, denser at the sides. Shiny swelling in the middle of the pronotum, with the size of 1-2 mm, quite smooth, without dots. The shiny surface in females quite small, unlike males, whose shiny surface is larger and more visible. 2/3 of the pronotum red and 1/3 consists of a black strip in the basal portion. Pronotum of males black on lateral sides, while it is red in females. Scutellum straight on the sides with sharp angles, triangular shape. Elytra slightly long, parallel, rounded in the last 1/5. Male elytra 2.25 x longer than wide on the base, female elytra 2.10-2.20 x longer than wide on the base. Punctuation rougher, gaps between dots 2 times wider than the dots themselves. Elytra red, a black spot expands into a sharp triangular angle about 1-2 mm behind the scutellum, the angle then expands and reaches the apex, the last 1/4 completely black. Elytra glossy. Antennae dark brown to brown-black, shiny, with black adjacent hairs. 1st-3rd antennomeres dark brown, 4th-11th antennomeres darker, more brown-black. 7th-10th antennomeres quite expanded into a thorn, these antennomeres have a serrated shape. Male antennae exceed the apex of elytra by about 2.5 of antennomeres, female antennae also brown or brown-black and achieve up to 90% ends of elytra. Legs long, black, roughly punctured with several black raised hairs. 2nd and 3rd metatarsomeres together do not reach the length of the 1st metatarsomere. The width of the 2nd metatarsomere is 80- 85% of its length. Ventral side of the body sparsely pubescence, punctuation very sparse and fine.

Differential diagnosis. The described species *Purpuricenius comenius* sp. n. is related to the species *P. graecus graecus* Sláma, 1993, from which it differs in size, body shape, colour of the pronotum and elytra, length and width of antennae, shape of their antennomeres, length and width of the legs, metatarsomeres and many other smaller differences. *Purpuricenius comenius* sp. n. has a larger size, the size of male body is from 12.5 mm to 13.5 mm, of the female body from 11.0 mm to 13.5 mm. *P. graecus graecus* Sláma, 1993 is smaller, the size of the body of males is from 11.0 mm to 13.0 mm, of females around 10.0 mm in average. *Purpuricenius comenius* sp. n. has the pronotum 1.2-1.25 x wider than longer, male elytra are 2.25 x longer than wide on the base, female elytra are 2.10-2.20 x longer than wider on the base. *P. graecus graecus* Sláma, 1993 has the pronotum 1.14-1.23 x wider than long, male elytra are 2.15-2.45 x longer than

wide on the base, female elytra are 2.35 x long than wide on the base. The pronotum of *P. graecus graecus* Sláma, 1993 is predominantly black, or with two red spots in the anterior half, the pronotum of *Purpuricenius comenius* sp. n. is red from 2/3 and 1/3 consists of a black strip in the basal portion. Male pronotum is black in the sides, female pronotum is red on the sides. The black spot near the seam of the elytra of *Purpuricenius comenius* sp. n. is similar to *P. graecus graecus* Sláma, 1993, but close behind the scutellum it expands into a sharp triangular angle, which then extends and reaches the apex, the last 1/4 of elytra is completely black. Antennae of *Purpuricenius comenius* sp. n. are longer, wider and antennomeres are more serrated than in case of *P. graecus graecus* Sláma, 1993. These differences are visible especially in females. *Purpuricenius comenius* sp. n. has longer legs and 1st metatarsomere is significantly longer than 2nd and 3rd metatarsomeres together. *P. graecus graecus* Sláma, 1993 has shorter, slimmer legs and the 1st metatarsomere is almost as long as the 2nd and 3rd metatarsomeres together. Punctuation of elytra of *Purpuricenius comenius* sp. n. is rougher, the gaps between the dots are 2 times wider than the dots themselves, elytral apex is rounded. *P. graecus graecus* Sláma, 1993 whose elytra are punctured very roughly, dots are larger and sparser than in case of *Purpuricenius comenius* sp. n., elytral apex is irregular, predominantly wavelike and widely cut off.

Purpuricenius comenius sp. n. differs from similar species *Purpuricenius apiceniger* Pic, 1914 and *Purpuricenius budensis* (Götz, 1783) especially due to a small, slimmer and longer (in proportion to the width) rectangular body, arched pronotum with small blunt lateral tubercles, short scutellum, shorter antennae and many other smaller details. The black spot near the suture of the elytra of *Purpuricenius comenius* sp. n. begins not far behind the scutellum, it expands into a sharp triangular angle, which then expands and reaches the apex, the last 1/4 of elytra is completely black. *Purpuricenius budensis* (Götz, 1783) has wide common spot usually begins in the middle of elytra and expands all over their end. The black spot on the elytra of *Purpuricenius apiceniger* Pic, 1914 is in the shape of a pear and it goes from the scutellum to the end of elytra.

Remark on bionomy. *Purpuricenius comenius* sp. n. develops in *Quercus coccifera*. Females of this species preferred oviposit on living twigs of their host. Newly hatched larvae feed subcortically and they dig a spiral girdle, which interrupts the sap circulation. Finally inducing the drying of the twigs and leaves. Adults can usually be found flying around tree tops or sitting on the leaves of their host.

Etymology. A new species is dedicated to the famous Czech philosopher, pedagogue and theologian Jan Amos Komenský, who was born in Uherský Brod, on 25th March 1592. Jan Amos Komenský is considered a founder of the modern pedagogy and he has earned a nickname Teacher of Nations.

ACKNOWLEDGEMENTS

We are very grateful to Mikhail L. Danilevsky (Russian Academy of Sciences A. N. Severtzov Institute of Ecology and Evolution, Moscow, Russia), Milan Sláma (Praha, Czech Republic), Jiří Klícha (Praha, Czech Republic) and Petr Zlámál (Praha, Czech Republic) for certain valuable information and providing specimens for study. Special thanks are due to Martin Kröner (Zlín, Czech Republic) for his digital photography.

LITERATURE CITED

Danilevsky, M. L. 2007. *Purpuricen* *kaehleri* (Linnaeus, 1758) and *P. caucasicus* Pic, 1902 (Coleoptera, Cerambycidae) in Caucasus. Studies and reports of District Museum Prague East. Taxonomical Series, 3 (1-2): 31-42.

Danilevsky, M. L. 2014. Catalogue of Palaearctic Cerambycoidea. Available from: <http://cerambycidae.net/catalog.pdf> (Updated: 21.11.2014).

Rapuzzi, P. & Sama, G. 2013. Revision of the *Purpuricen* *interscapillatus* species - group and allied taxa (Coleoptera-Cerambycidae). Fragmenta entomologica, Roma, 45 (1-2): 143-171.

Sláma, M. 1993. Zwei neue Taxa aus Griechenland - *Purpuricen* *graceus* sp. n. und *Brachyleptura maculicornis ondreji* subsp. n. (Coleoptera, Cerambycidae). Folia Heyrovskyana, 1 (6): 56-62.

Sláma, M. 2001. *Purpuricen* *renyovnae* sp. n. vom Balkan (Coleoptera: Cerambycidae). Biocosme Mésogéen, 17 (2000): 225-238.

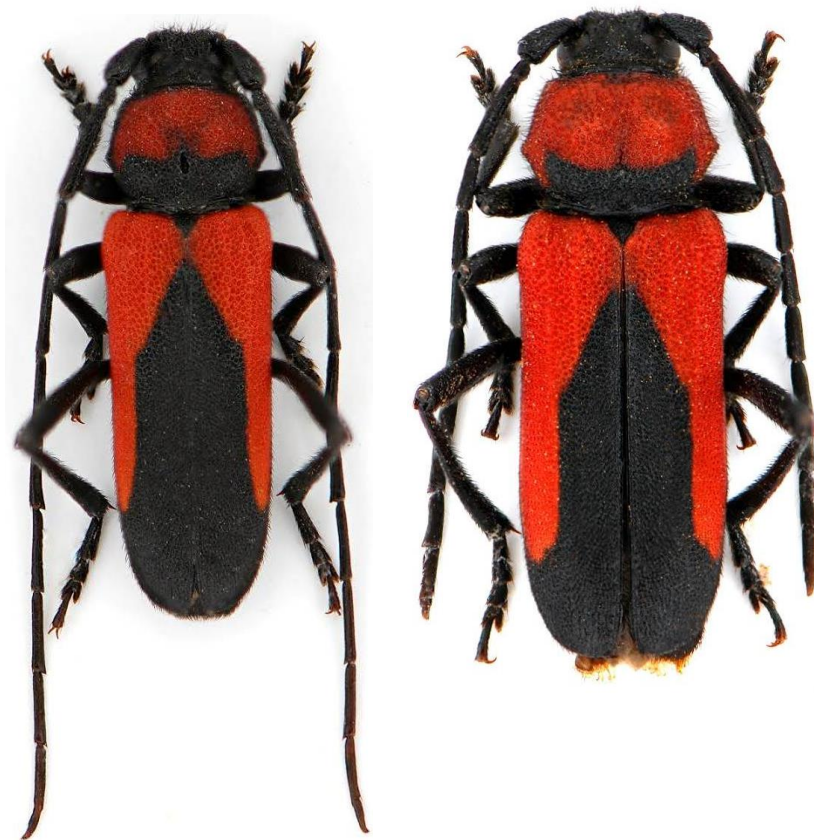


Figure 1. *Purpuricen comenius* sp. n.: Holotype, male (left) and paratype, female (right).

**A NEW SUBSPECIES OF *PSEUDOVADONIA LIVIDA* (FABRICIUS, 1777) FROM TURKEY
(CERAMBYCIDAE: LEPTURINAE)**

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[Özdikmen, H. 2015. A new subspecies of *Pseudovadonia livida* (Fabricius, 1777) from Turkey (Cerambycidae: Lepturinae). Munis Entomology & Zoology, 10 (2): 319-321]

ABSTRACT: *Pseudovadonia livida hatayensis* **ssp. nov.** is described from Hatay province in South Turkey. A key to the subspecies of *Pseudovadonia livida* (Fabricius, 1777) is also presented.

KEY WORDS: Cerambycidae, *Pseudovadonia livida*, new subspecies, Turkey.

Family Cerambycidae Latreille, 1802

Subfamily Lepturinae Latreille, 1802

Tribe Lepturini Latreille, 1802

Genus *Pseudovadonia* Lobanov, Danilevsky & Murzin, 1981: 787

[Type species *Leptura livida* Fabricius, 1777]

***P. livida* Fabricius, 1777: 233 (*Leptura*)**

The species has been represented by 5 subspecies in W Palaearctic region as *P. livida bicarinata* (N. Arnold, 1869) that is distributed in E Europe, Caucasus, NE Turkey, Iran, Kazakhstan, Kirgizia, Siberia and China, *P. livida desbrochersi* (Pic, 1891) that is distributed in Caucasus (Armenia, Azerbaijan, Georgia) and E Turkey, *P. livida livida* (Fabricius, 1777) that is distributed in Europe and European Turkey, *P. livida setosa* Danilevsky, 2013 that is distributed in E Europe, European Turkey and Western parts of Asian Turkey and *P. livida pecta* (K. Daniel & J. Daniel, 1891) that is distributed only in Italy (Löbl & Smetana, 2010; Danilevsky, 2013, 2015).

As seen above, the species has been represented by 4 subspecies except *P. livida pecta* (K. Daniel & J. Daniel, 1891) in Turkey up to now.

During the study of the collected Cerambycidae specimens, I have identified a female specimen belonging to a new subspecies that collected from Hatay province in Eastern Mediterranean Region of Turkey, of *Pseudovadonia livida* (Fabricius, 1777) which will be described in the present text.

P. livida hatayensis* **ssp. nov.* (Holotype ♀, collection H. Özdikmen, Zoological Museum of Gazi University, Ankara) [Type locality “Belen: Çakallı village” (Turkey: Hatay)] **A: TR**

Pseudovadonia livida hatayensis* **ssp. nov.*

(Figs. 1 and 2)

Type material. Holotype ♀: Turkey: Hatay prov.: Belen, Çakallı village, N 36° 28' 960'' E 36° 13' 506'', 19.V.2006, 652 m. The specimen deposited in Zoological Museum of Gazi University, Ankara (Turkey).

Body length in female (males unknown): 7 mm, width: 2.5 mm.

P. livida bicarinata (N. Arnold, 1869) is characterized by obliquely erect

dorsal pronotal setae, the nominotypical subspecies is characterized by strongly erect straight dorsal pronotal setae and generally light-yellow elytral coloration, *P. livida setosa* Danilevsky, 2013 is characterized by strongly erect and rather long dorsal pronotal setae and darker brown elytral coloration, and *P. livida pecta* (K. Daniel & L. Daniel, 1891) is characterized by strongly recumbent dorsal pronotal setae. *P. livida desbrochersi* (Pic, 1891) is easily distinguished from other subspecies by reddish abdomen and legs.

With the same reasons, the present specimen from Hatay province (S Turkey) should be a new subspecies. The new subspecies, *P. livida hatayensis* ssp. nov., is closely related to *P. livida bicarinata* (N. Arnold, 1869). It is easily distinguished from *P. livida bicarinata* by thinner, dark-yellow and weaker obliquely erect dorsal pronotal setae (dorsal pronotal setae denser, thicker, yellow or dark yellow and stronger obliquely erect in *P. l. bicarinata*), and light-brown elytral coloration (elytral coloration darker or reddish brown in *P. l. bicarinata*) chiefly.

Distribution. It is only known from South Turkey now. Probabaly it can also occur in SE Turkey, N Syria.

Etymology. From the type locality Hatay province (Turkey).

A key to the subspecies of *Pseudovadonia livida* (Fabricius, 1777)

1. Abdomen and legs completely red.....*P. livida desbrochersi*
 -. Abdomen and legs black or at most partly red.....2
2. Dorsal pronotal setae strongly erect.....3
 -. Dorsal pronotal setae obliquely erect or recumbent.....4
3. Elytral coloration light-yellow.....*P. livida livida*
 -. Elytral coloration much darker brown.....*P. livida setosa*
4. Dorsal pronotal setae recumbent.....*P. livida pecta*
 -. Dorsal pronotal setae more or less obliquely erect.....5
5. Dorsal pronotal setae thicker, yellow or dark yellow and stronger obliquely erect.....*P. livida bicarinata*
 -. Dorsal pronotal setae thinner, dark-yellow and weaker obliquely erect.....
*P. livida hatayensis* ssp. nov.

LITERATURE CITED

- Danilevsky, M. L. 2013. Six new Longicorn (Coleoptera, Cerambycidae) taxa from Russia and adjacent countries. Humanity space International almanac, 2 (Suppl. 2): 28-41.
- Danilevsky, M. L. 2015. Catalogue of Palaearctic Cerambycoidea. Available from: <http://www.cerambycidae.net/catalog.pdf> (accessed 30 January 2015)
- Löbl, I. & Smetana, A. 2010. Catalogue of Palaearctic Coleoptera, Vol. 6. Chrysomeloidea. Stenstrup: Apollo Books, 924 pp.



Figure 1. *Pseudovadonia livida hatayensis* ssp. nov. (holotype ♀).

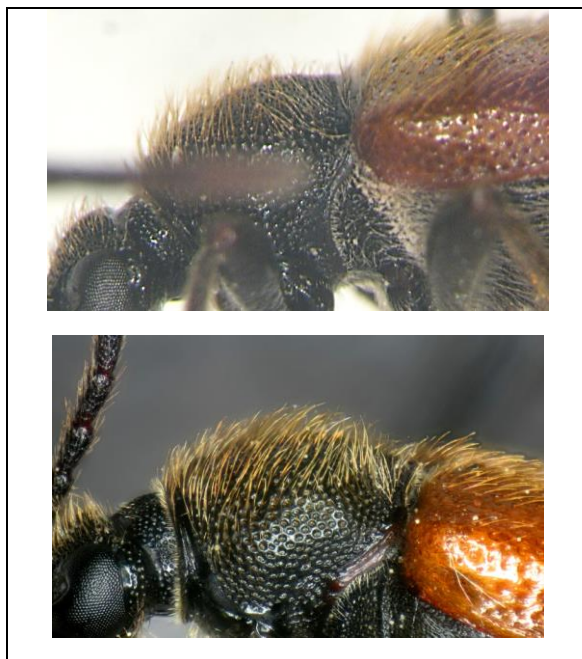


Figure 2. *Pseudovadonia livida hatayensis* ssp. nov. (above), *Pseudovadonia livida bicarinata* (below) (from M. L. Danilevsky, www.cerambycidae.net/beetles_pseudovadonia_livida_bicarinata.html).

OSTRACODS OF QUATERNARY SEDIMENTS OF THE PROVINCE OF BUENOS AIRES, ARGENTINA

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ABSTRACT: We study the benthic ostracods from the vibro-core KP60Bis (39° 08'34 .8689" S, 61° 46'10 .0278") of the estuary of Bahía Blanca, province of Buenos Aires. In the upper area of the core (Z2) the ostracofauna this domain is diverse with *Loxocythere variaculpta* Whatley, Moguilevsky, Toy, Chadwick and Ramos *Neocytherideis ruidis* Whatley, Moguilevsky, Chadwick, Toy and *Callistocythere litoralensis* (Rossi de Garcia). Within fitales and parafitales ostracods recovered *Paracytherois* sp. and *Pellucistoma elongata* Whatley, Moguilevsky, Chadwick, Toy and Feijó. Towards the top of the core is recorded species of continental origin as *Limnocythere* sp., *Ilyocypris gibba* Ramdhor, 1808 and *Cypridopsis vidua* O.F. Müller, 1776. In the middle sector (Z1) were abundant specimens of ostracods valves assigned to *Ambostracon* (*Ambostracon*) *tenuireticulata* Kotzians, 1982, *Cornucoquimba lutziana*, Zabert, 1978 and *Caudites ohmerti* Coimbra and Ornellas, 1987. Micropalaeontological analysis shows that the studied sediments were deposited in intertidal estuarine, affected by changes in sea level during the late Holocene.

KEY WORDS: Ostracodes, Holocene, Bahía Blanca, estuary.

The ostracods are microcrustaceans with a wide ecological range that inhabit marine, brackish and freshwater environments. They are very sensitive to the chemical and physical changes in the environment, introducing changes in the species composition of the community and individuals morphological level. Are recorded from the Upper Cambrian and have a shell of CaCO₃ can be preserved in the register (Horne et al., 2002). Ostracods have a high potential as a proxy (proxy-data) in Quaternary paleoecological studies (Carbonel et al., 1983, 1988). While in Argentina, this branch of Micropaleontology has advanced significantly in the last two decades: Ferrero (1996, 2005) and Bertels - Postka Laprida (1998 a,b,c); Bertels and Martínez (1990, 1997); Bertels - Psocka and Martínez (1999), Martínez (2005), Laprida (2006), the contributions made to records in estuarine environments are still rare. The aim of this study was to determine the diversity of ostracods present in Holocene sediments and provide new data for the reconstruction of paleoenvironment of the study area.

Study area

The Bahía Blanca estuary is a mesotidal system formed by a 3000 km² complex of different sized channels crossing large islands and tidal flats. Above mean sea level (m.s.l.), the intertidal areas are densely vegetated by *Spartina*. The largest freshwater contributions come from the Sauce Chico river and a smaller stream, the Napostá Grande. The temperature and salinity of the water masses are vertically homogeneous along the estuary (Fig. 1).

Lithology and radiocarbon age

The core KP60 bis (39°08'34" S - 8689 61°46'10.0278" W) is located in the external sector to Bahía Blanca estuary, at kilometer 60 of the access channel to the port system and where the km 0 corresponds to port Ingeniero White, located in the innermost portion of the estuary. The roof of this core is located 11.4 m below the level of reduction used in the charts, which is defined as the average of syzygy tides subtracted one standard deviation.

The sedimentological study found that the composition is sandy clay loam over all witness with interbedded layers of clayey silt laminated fine sands.

For the lower section (337-340 cm depth) an age of 5980 ± 70 years BP (Gra - 27128) cal age was obtained. 6616-6952 BP, for the middle section (162- 165cm): 1950 ± 60 years BP (Gra - 27127) 163- 170cm and an age of 1900 ± 40 yr BP (BETA- 216777) and section exceeds 77 -80 cm from the ceiling an age of 2220 ± 60 years BP (Gra - 27126) cal age was obtained. 2043-2332 BP.

Metodology

There was sampled the core KP60 Bis every 10cm. The samples were disintegrated in H₂O₂ to 20 % and washed by means of a sieve with an opening of Maya of 63 microns. The dried one of the samples carried out in stove to 50 ° C. From every sample the total of copies extracted to itself under magnifying glass binocular Nikon NI-150. The systematic determinations to generic level were based on the offer by Moore and Pitrat (1961), while for the specific determinations there were in use the works of Bertels and Martínez (1997); Bertels-Postka & Martínez (1999). The photographs of electronic microscopy took with microscopio electronic of sweep I read model EVO 40, of the regional center of Basic and Applied investigations of White Bay (CRIBABB). To recognize the autochthonous paleotanatocenosis and alóctonas in the different environments involved in this study, versus calculated the proportion of adult valves the total of juvenile valves (Brouwers, 1988). In addition there was calculated the index of diversity of Shannon-Wiener.

RESULTS

On the basis of the qualitative and quantitative information of the ostrácodos extracted from the samples and the fauna accompanist could divide the same one in two zones. The low section of the core, from them 390cm, turned out to be sterile. The ostrácodos met a good condition of preservation, the copies were very scanty with complete shells, that is to say with both articulated valves. There have differed, up to the moment, a total of 40 species, though for the present I work only they were considered to be those represented by adult and juvenile copies, in an approximate proportion of 1/8.

In the low sector of the core levels were registered of shells of very fragmented mollusks.

Z1 (380-240cm)

There were situated remains of the mollusks *Tagelus plebeius* (Lightfoot, 1786), *Nucula puelcha* Orbigny, 1846, *Nuculana (costelloleda) whitensis* Farinati, 1978 and bryozoos of smoothed morphology. The valves of copies were abundant of ostrácodos euhalinos assigned to *Ambostracon (Ambostracon) tenuireticulata* Kotzian, 1982, *Cornucoquimba lutziana* Zabert, 1978 (Fig. 2D) and *Caudites ohmertii* Coimbra and Ornellas, 1987 (Fig. 2C). The index of diversity of Shannon-Wiener presented values between 1 and 2,5.

Z2 (240- 235cm)

In this sector it diminishes very much the diversity and density of ostrácodos and there are very abundant the remains of valves of mollusks with high degree of fragmentation.

Z3 (235-0cm)

Recovered valves of mollusks assigned to *Nuculana (costelloleda) whitensis* Farinati, 1978 and *Paraplica* sp. and bryozoos of tree-shaped morphology. As for the present ostracofauna two subzone differ: subzone A: he presents a great diversity with domain of species eurihalinas as *Loxocythere variasculpta* Whatley, Moguilevsky, Toy, Chadwick and Branches (Fig. 2E); *Neocytherideis ruidis* Whatley, Moguilevsky, Chadwick, Toy (Fig. 2A) and *Callistocythere litoralensis* (Rossi de García) (Fig. 2F). They turn out to be exemplary adult and juvenile of *Cyprideis salebrosa hartmanni* Ramirez, 1967 (Fig. 2B). Some copies presented the development of nodules of carbonate of calcium in the external face of the valves.

Inside the ostrácodos fítales and paraquítales, those that live associated with the vegetation, registered *Paracytheroís* sp. and *Pellucistoma elongata* Whatley, Moguilevsky, Chadwick, Toy and Feijó (Fig. 2G). In addition continental species are registered as: *Limnocythere* sp. (Fig. 2J), *Cypridopsis vidua* (Fig. 2I) and *Iliocypris gibba* (Fig. 2H). The index of diversity of Shannon-Wiener presented values between 2 and 3.

Subzone B: the diversity is similar to the descripta for the subfield To but it diminishes the density.

PALEOENVIRONMENTAL INTERPRETATIONS AND DISCUSSION

The information offered to the ostrácodos and fauna accompanist allows to characterize the core KP60Bis. The low sector of the core (240-380cm) presents a low density of ostrácodos. The low values of the index of diversity Shannon-Wiener indicate an environment with low content of nutrients and a level of energy raised. This is demonstrated, in addition, by the presence of strata by numerous fragments of valves of mollusks and colonies of bryozoos of smoothed morphology. The number of individuals would have been controlled by two factors: the quantity of nutrients in the column of water and the level of energy of the environment (Carbonel, 1988). The form of the colonies of bryozoos is considered to be a warning element of the degree of stability of the environment in which they develop since the development of colonies incrustantes is observed only in environments of high energy and tree-shaped colonies only they can develop in environments of low energy due to his fragility (Moyano, 1979; Hageman et al., 1997). On the other hand, the abundant presence of copies of species euhalinas as *Ambostracon (Ambostracon) tenuireticulata*; *Cornucoquimba lutziana* and *Caudites ohmerti* demonstrate an environment submareal since these species only develop in environments submareales of the estuary in conditions of stable salinity and without air exhibition. The specimens of recovered *Tagelus plebeius* shallow. For the exposed thing it is possible to deduce that the sediments were deposited in an environment submareal by low levels of nutrients and a high level of energy. The increase of the density and high values of the index of Shannon-Wiener in the top part of the core (230-0cm) indicate conditions of minor energy with major quantity of available nutrients. The presence of bryozoos tree-shaped fragile that only can develop in environments of low energy is another indicator of the environmental conditions.

As for the present ostracofauna, the dominant species *Loxocythere variasculpta* Whatley, Moguilevsky, Toy, Chadwick and Branches; *Neocytherideis ruidis* Whatley, Moguilevsky, Chadwick, Toy characterize to current sediments submareales of little depth of the internal sector of the estuary of White Bay (Martínez et al. 2005), and *Callistocythere litoralensis* (Rossi de García), this species was found in current samples of the Channel Tres Brazas. The presence of species fiales and parafiales (*Paracytherois* sp. and *Pellucistoma elongata*) and of *Cyprideis salebrosa hartmanni* like that how the record of copies of mollusks *Nuculana (Costelloleda) whitensis* and *Paraplica* sp. permits to indicate that the studied sediments were deposited in shallow environments. The presence of nodules of CaCO₃ in specimens of the genus *Cyprideis* prove to be a character linked to the environment, and develop only under high salinity (Carbonel, 1988).

CONCLUSIONS

On the basis of the results obtained in this study they could have identified the dominant species along the core like that how his preferences to a particular habitat. Consequently, due to the sedimentological characteristics, specific composition of ostrácodos and of molluscos found, the dominancia of *Loxocythere variasculpta*; *Neocytherideis ruidis* and *Callistocythere litoralensis*; and the presence of mollusks *Nuculana (costelloleda) whitensis* and *Paraplica* sp., in the top part of the core; as well as *Ambostracon (Ambostracon) tenuireticulata*; *Cornucoquimba lutziana* and *Caudites ohmertii*, the valves of *Tagelus plebeius* and the marked decrease of the density of ostrácodos in the average sector; it is possible to infer that the commanding conditions of deposit were corresponding to subenvironments estuarinos of low depth in the area of the Bahía Blanca estuary. The ostracods are an effective tool to enhance and paleoenvironmental ecological studies.

ACKNOWLEDGEMENTS

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LITERATURE CITED

- Bertels, A. & Martínez, D. E.** 1990. Quaternary ostracodes of continental and transitional littoral-shallow marine environments. Courier Forschungs Institut Senckenberg, 123: 141-160.
- Bertels, A. & Martínez, D. E.** 1997. Ostrácodos holocenos de la desembocadura del arroyo Napostá Grande, sur de la provincia de Buenos Aires, Argentina. Revista Española de Micropaleontología, 29: 20-69.
- Bertels-Psotka, A. & Laprida, C.** 1998a. Ostrácodos (Arthropoda, Crustacea)_Holocenos del Miembro Canal 18 (Formación Las Escobas), provincia de Buenos Aires. Revista Española de Micropaleontología, 30: 129-137.
- Bertels-Psotka, A. & Laprida, C.** 1998b. Ostrácodos (Arthropoda, Crustacea) del Miembro Cerro de la Gloria, Formación Las Escobas (Holoceno), provincia de Buenos Aires, República Argentina. Revista Española de Micropaleontología, 30: 103-127.
- Bertels-Psotka, A. & Laprida, C.** 1998c. Ostrácodos (Arthropoda, Crustacea) de la Formación Las Escobas (Holoceno), Cuenca del Salado, República Argentina. Ameghiniana, 35: 81-86.
- Bertels-Psotka, A. & Martínez, D. E.** 1999. *Frenquellicythere argentinensis*, n. gen. and n. sp. from Holocene deposits of estuary of Bahía Blanca, Buenos Aires, Argentina. Micropaleontology, 45: 394-398.
- Brouwers, E.** 1988. Sediment transport detected from the analysis of ostracod population structure: an example from the Alaskan continental shelf. En: P. de Deckker, J.P. Colin y J-P. Peyrouquet (eds.), Ostracoda in the Earth Sciences, Elsevier pp. 231-245.

Carbonel, P. 1983. Ostracoda as indicators of ionic concentrations and dynamic variations: methodology (lake Bogoria, Kenya). Applications of ostracoda (R. F. Maddoks, ed.) Univ. Houston Geosc., 1983: 264-276.

Carbonel, P. 1988. Ostracods and the transition between fresh and saline waters. En: P. de Deckker, J.P. Colin y J-P. Peyrouquet (eds.), Ostracoda in the Earth Sciences, Elsevier pp. 157-173.

Ferrero, L. A. 1996. Paleoeología de ostrácodos holocenos del estuario del río Quequén Grande. Ameghiniana, 33: 209-222.

Ferrero, L. A. 2005. Foraminíferos y ostrácodos cuaternarios de dos testigos de la Plataforma continental argentina al sudeste de Mar del Plata. Reunión Anual de Comunicaciones y Simposio del 50 Aniversario de la Asociación Paleontológica Argentina, Puerto Madryn, 2005, Resúmenes, pp. 51.

Hageman, S. J., Bone, Y. & McGowran, B. 1997. Bryozoan colonial growth-forms as paleoenvironmental indicators: evaluation of methodology. Palaios, V (12): 405-419.

Hageman, S. J., Bone, Y., Bock, Ph. E. & McGowran, B. 1998. Bryozoan growth habits: Classification and analysis. Journal of Paleontology, 72 (3): 418-436.

Laprida, C. 2006. Ostrácodos continentales recientes de la llanura pampeana. Ameghiniana, 43: 181-204.

Martínez, D. 2005. Asociaciones de ostrácodos modernos del estuario de Bahía Blanca, provincia de Buenos Aires, Argentina. Ameghiniana, 42: 669-684.

Moore, R. & Pitrat, C. W. (ed.) 1961. Treatise on Invertebrate Palaeontology. Part Q. Arthropoda 3. Crustacea, Ostracoda. Geological Society of America and University of Kansas Press, Lawrence 442 pp.

Moyano, G. H. I. 1979. Bryozoa from Antarctic Bays: some ecological aspects. In: Larwood, G. P. & Abbott, M. B. (eds). Advances in Bryozoology: 383-402. Systematic Association Special Volume 13 Academic Press. London.

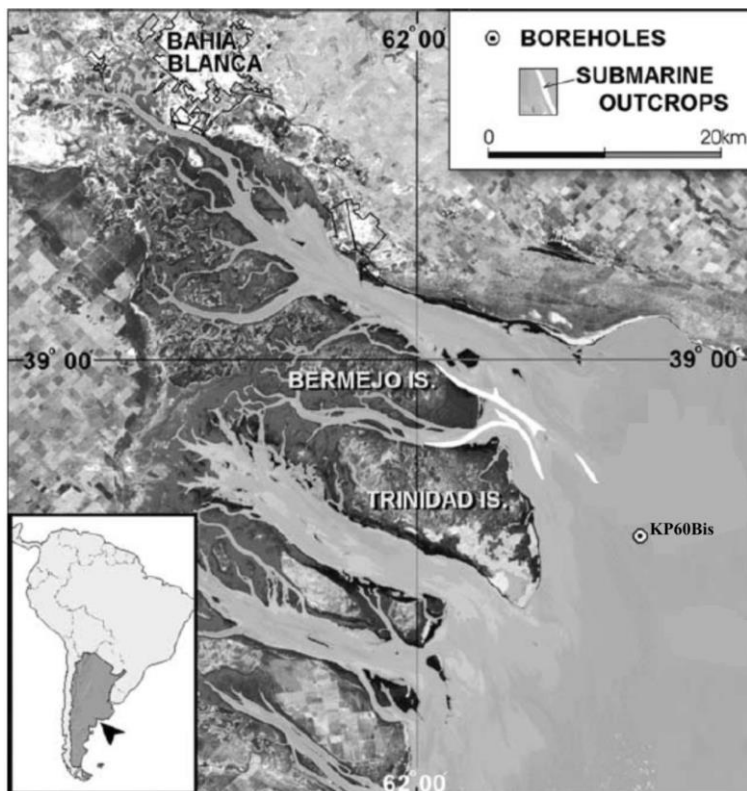


Figure 1. Studied area. Locations of the core KP60Bis in the external area of Bahía Blanca estuary.

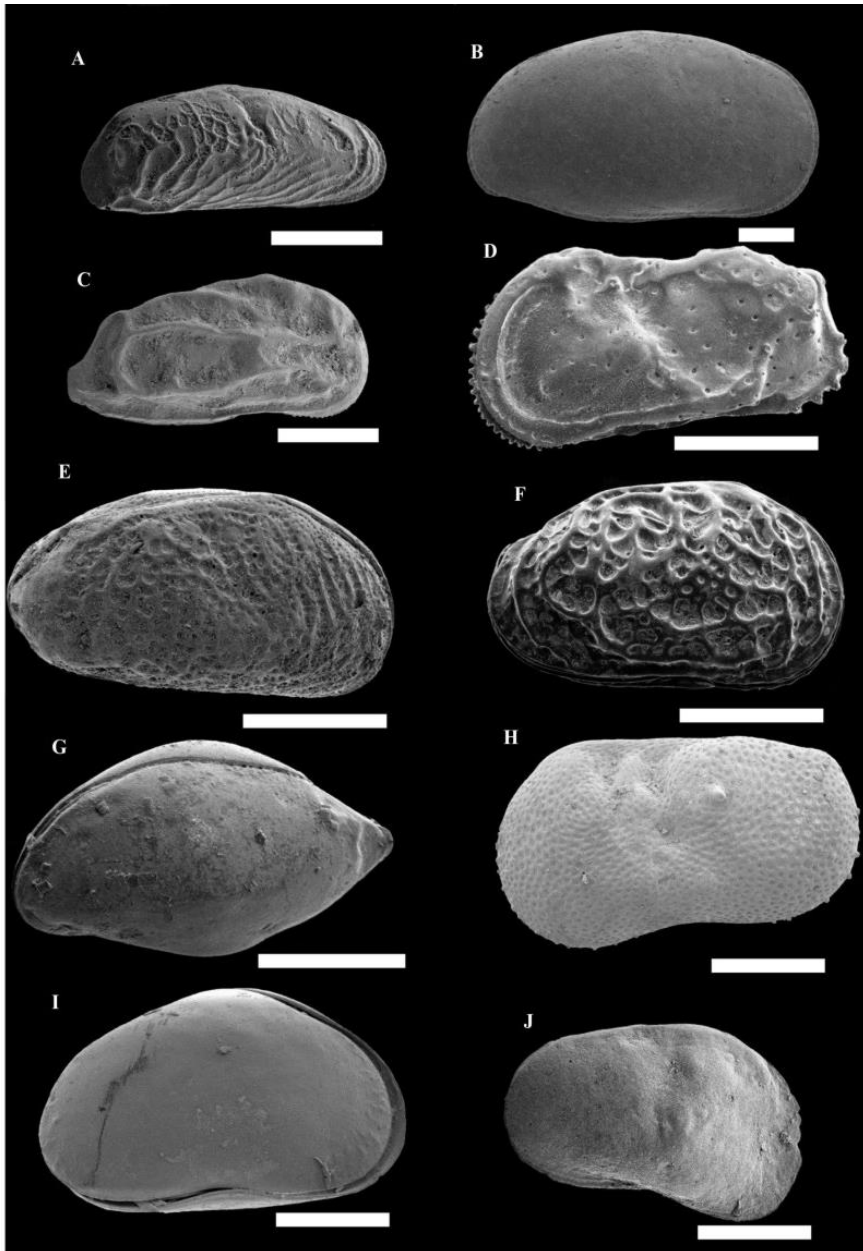


Figure 2. Ostracod species present in the estuary Bahía Blanca: A. *Neocytherideis ruidis*, B. *Cyprideis salebrosa hartmanni*, C. *Caudites ohmertii*, D. *Cornucoquimba lutziana*, E. *Loxocythere variasculpta*, F. *Callistocythere litoralensis*, G. *Pellucistoma elongata*, H. *Iliocypris gibba*, I. *Cypridopsis vidua*, J. *Limnocythere* sp. (Scale: 100μm).

CONODERINAE (ELATERIDAE) OF BUXA TIGER RESERVE, WEST BENGAL, INDIA

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[Sarkar, S., Saha, S. & Raychaudhuri, D. 2015. Conoderinae (Elaterridae) of Buxa Tiger Reserve, West Bengal, India. Munis Entomology & Zoology, 10 (2): 328-332]

ABSTRACT: Only *Heteroderes* Latreille represents the subfamily Conoderinae of Buxa Tiger Reserve, West Bengal, India. The genus includes 2 species, the endemic *H. sericeus* Candeze and the new species *H. bicoloris* that are described and illustrated. A key to species and the relationship of the proposed new species is discussed. The former species is a new report from West Bengal.

KEY WORDS: *Heteroderes*, *H. sericeus*, *H. bicoloris* sp. nov., Buxa Tiger Reserve, West Bengal, India.

Globally, the cosmopolitan subfamily Conoderinae Candeze of Elateridae includes 800 species under 14 genera (Chakraborty & Chakrabarti, 2006; Johnson & Cate, 2010). Indian counterparts on the other hand are known by 7 genera and 33 species (Vats, 1991; Vats & Chauhan, 1992, 1993; Chakraborty & Chakrabarti, 2006; Schimmel, 2007; Johnson & Cate, 2010). It appears that the Indian click beetles did not receive any serious attention till date. However we since 1994, were exploring the click beetles of Buxa Tiger Reserve, Jalpaiguri, West Bengal. In spite of our sincere effort, we could record *Heteroderus* Latreille as the only representative of the subfamily Conoderinae. The genus is found to include 2 species, an endemic *H. sericeus* Candeze reported earlier by Sarkar et al. (2012) and a new species *H. bicoloris*. Beside providing diagnosis of the genus and a key to species, both the species are suitably described and illustrated. The relationship of the proposed new species is also discussed.

MATERIAL AND METHODS

Materials were mainly collected by visual search, hand picking and UV light trap. Collected samples were preserved following Chakraborty and Chakrabarti (2006). The recorded samples were studied under Stereo Zoom Binocular Microscopes Zeiss SV11. All measurements are in millimeters, made with an eye piece graticule. Materials are in the deposition of Entomology Laboratory, Department of Zoology, University of Calcutta, Kolkata.

Abbreviation used: LT= Light Trap; BTR= Buxa Tiger Reserve.

Taxonomic account

Family: Elateridae Leach

Subfamily: Conoderinae Candeze

Genus: *Heteroderes* Latreille

Heteroderes Latreille, 1834. Annls Soc. Ent. Fr., 3: 155.

Type species: *Heteroderes fuscus* Latreille, 1834.

Diagnosis: Body pubescence of 2 types, short and long, short ones very dense and slanting, the other sparse and semi erect. Head slightly inclined, more or less convex or almost flat, frons generally convex and round in front, nasal surface much broader. Labrum entire, mandible bifurcate, last segment of maxillary palpi triangular. Antennae subserrate, 2nd segment smallest and subcylindrical, 3rd usually longer than 2nd, always shorter than 4th. Pronotum large, convex or almost flat, sides more or less arcuate, punctation double, posterior angle very elongate, uni or bicarinate, posterior margin entire or with lateral indents. Scutellum rectangular or subpentagonal. Elytra proportionately short, round at distal extremities and acuminate. Prosternum round in front, prosternal spine descending between coxae, straight posteriorly. Metacoxal plates dilated in middle. Lamellae of 4th tarsi narrow or broad.

Distribution: Cosmopolitan (Chakraborty & Chakrabarti, 2006; Johnson & Cate, 2010).

Key to species:

1. Pronotum uniformly brown black, hind angles bicarinate; elytra astigmatic; parameres longer than median lobe with apex strongly narrow.....**sericeus**
- . Pronotum bicoloured, basal 1/3rd yellow, rest dark brown, hind angles unicarinate; each elytra with 3 light brown spots; parameres as long as median lobe with apex round.....**bicoloris sp. nov.**

Heteroderes sericeus Candeze

(Figs. 1-6 & 13-14)

Heteroderes sericeus Candeze, 1859. Mem. Soc. R. Sci. Liege, 14: 357.

Description: Male.

Body length: 5.67, width: 1.51.

Body brown black, Pubescence silky white, evenly distributed.

Head brown black, pubescence silky white, dense. Punctuation double. Frons broader than long, flat. Anterior margin arcuate. Frontal carina complete across frons. Vertex slightly convex. Eyes pale brown, round, moderately large with distinct facets. Labrum brown black, broader than long, raised, anterior margin convex. Mandibles brown black, moderate, notched at the middle, tooth like. apically acute. Antennae brown, moderately long, extending just before the hind angle of pronotum, basal segment robust, longest, 2nd smallest, 3rd shorter than 4th, rest serrate and subequal, last segment constricted near apex, entirely, longitudinally carinate.

Pronotum brown black, pubescence silky white, dense, longer than broad, disc convex, punctuation double, submarginal line present, anterior margin slightly convex, with nearly acute anterior angle lateral margin weakly convex, sinuate before hind angle, hind angle long, divergent, pointed, bicarinate, outer extending upto 1/3rd of the pronotum and inner short.

Scutellum subquadrate, brown black, convex, pubescence dense.

Elytra 1.66 times longer than pronotum, brown black, striae punctuate, interstriae slightly convex, punctate with silky white pubescence, basally emarginate, apically round.

Prosternum brown black, convex, longer than broad, with distinct chin piece, punctuation double. Prosternopleural suture straight. Prosternal spine long, emarginate, longitudinally sulcate, apically round.

Only mesepimeron forming part of the margin of mesocoxal cavity.

Metacoxal plate broad, round.

Abdomen brown black, punctation double, pubescence dense.

Legs pale black, moderately long, last segment of tarsi lamellate, lamella broad, claw simple, setae present at base of claw.

Genitalia: Basal piece small, arms round at apex, anterior margin concave, posterior margin medially convex, lateral margin arcuate, uniformly sclerotized throughout; median lobe distally shorter than parameres, arms strongly sclerotized compared to rest, long, arcuate, blunt at base, not exceeding ventral posterior margin of parameres, median lobe nearly parallel sided, round at apex, furcae reaching upto the apex of median lobe; parameres uniformly sclerotized throughout, outer lateral margins weakly sinuate, basally broad, distally weakly concave, apex strongly narrow, pointed, with more than 19 hairs.

Material examined: see Sarkar et al. (2012).

Distribution: India: Uttarakhand, West Bengal (Vats & Chauhan, 1993; Johnson & Cate, 2010; Sarkar et al., 2012).

Heteroderes bicoloris sp. nov.

(Figs. 7-12 & 15-16)

Description: Male.

Body length: 3.49, width: 1.06.

Body dark brown, metallic, pubescence golden brown, evenly distributed.

Head dark brown, pubescence golden brown, dense, punctation double, frons broader than long, moderately convex, anterior margin arcuate, frontal carina complete across frons, vertex slightly convex. Eyes brown black, round moderately large with distinct facets. Labrum brown, broader than long, raised, anterior margin convex. Mandibles brown, moderate, apically acute. Antennae brown, broken.

Pronotum brown, apical $\frac{2}{3}$ rd dark, basal $\frac{1}{3}$ rd yellow, longer than broad, disc convex, pubescence golden brown, dense, punctation double, sub marginal line present, anterior margin weakly concave, with nearly acute anterior angle, lateral margin straight, hind angle long, divergent, acute, carinate.

Scutellum subquadrate, medially light brown, marginally dark, convex, pubescence dense.

Elytra 2.05 times longer than pronotum, dark brown, with 3 light brown spots on each, one basal, submarginal, 2nd median, close to suture and the 3rd apical and marginal, striae punctate, interstriae slightly convex, punctate with golden brown pubescence, basally emarginate, round, apically acute. Prosternum brown, convex, longer than broad, with distinct chin piece, punctation double. Prosternopleural suture straight. Prosternal spine long, emarginate, longitudinally sulcate, apically round.

Only mesepimeron forming part of the margin of mesocoxal cavity.

Metacoxal plate broad, round in the middle.

Abdomen brown, punctation simple, pubescence dense.

Legs pale brown, moderately long, last tarsal segment lamellate, claw simple, setae present at base of claw.

Genitalia: Basal piece short, wide, arms round at apex, both anterior and posterior margins concave, lateral margin feebly arcuate, uniformly sclerotized throughout; median lobe as long as parameres, feebly sclerotized throughout, arms long, nearly straight, pointed at base, not exceeding ventral posterior margin of parameres, median lobe basal to median little incurved, median to apical gradually narrowing, apex round, furcae reaching the anterior margin of

parameres; parameres uniformly sclerotized throughout, outer margin sinuate, basally broad, apex round with more than 5 hairs.

Remarks: The closest ally of the present species appears to be *Heteroderes lenis* Candeze but can be separated by

1. Pronotum bicoloured, basal $\frac{1}{3}$ rd yellow, rest dark brown (pronotum uniformly coloured throughout in *H. lenis*),
2. Hind angle of pronotum unicarinate (hind angle of pronotum bicarinate in *H. lenis*),
3. Each elytra with 3 light brown spots (elytra without any spot in *H. lenis*),
4. Elytra apically acute (elytra apically round in *H. lenis*),
5. Parameres apically round, directed outward (parameres apically pointed, inwardly directed, in *H. lenis*),
6. Median lobe weakly longer than parameres (median lobe shorter than parameres in *H. lenis*),
7. Furcae reaching the anterior margin of parameres (furcae not reaching the anterior margin of parameres in *H. lenis*).

The species is therefore recognized as new to science.

Etymology: The species is so named because of the bicolour nature of each part of the body.

Material examined: 1 male, Damanpur /LT, BTR, Jalpaiguri, West Bengal, India, Coll. S. Sarkar, 16.IV.2009.

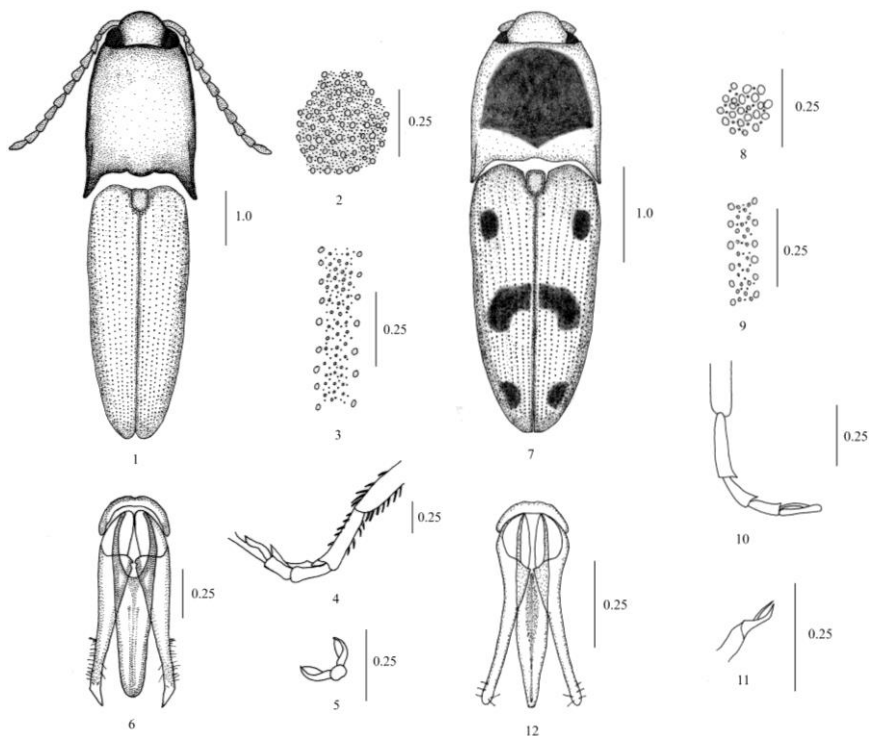
Distribution: India: West Bengal.

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LITERATURE CITED

- Chakraborty, P. & Chakrabarti, S.** 2006. A contribution to the fauna of click-beetles (Coleoptera: Elateridae) of West Bengal. Rec. Zool. Surv. India, Occ. Paper no. 254: 1-220.
- Johnson, J. & Cate, C.** 2010. Elateridae. Available from: <http://insects.tamu.edu/research/collection/hallan/test/Arthropoda/Insects/Coleoptera/Family/Elateridae.txt>. (Accessed on 12.12.2014).
- Sarkar, S., Saha, S. & Raychaudhuri, D.** 2012. On the elaterid fauna (Coleoptera) of Buxa Tiger Reserve (BTR), West Bengal, India. Munis Ent. & Zool., 7 (2): 1195-1198.
- Schimmel, R.** 2007. New records on Elateridae, and description of a new species from Westghats in India (Insecta: Coleoptera). Genus, 18 (2): 221-238.
- Vats, L. K.** 1991. Systematics of Elateridae (Coleoptera: Insecta). Final Technical Report, U.S. P.L. 480 Research Project, 346 pp.
- Vats, L. K. & Chauhan, R. L.** 1992. Species of *Conoderus* Esch. with notes on genus (Conoderinae, Elateridae: Coleoptera). Uttar Pradesh J. Zool., 12 (1): 28-36.
- Vats, L. K. & Chauhan, R. L.** 1993. Species of *Heteroderes* Latreille from North West India. Entomon, 18 (3&4): 169-173.



Figures. 1-12. 1-6: *Heteroderes sericeus* Candeze, Male: 1. Dorsal habitus; 2. Pronotal puncture; 3. Elytral puncture; 4. Leg; 5. Claw; 6. Genitalia; 7-12: *Heteroderes bicoloris* sp. nov., Male (Holotype): 7. Dorsal habitus; 8. Pronotal puncture; 9. Elytral puncture; 10. Leg; 11. Claw; 12. Genitalia.



Figures. 13-16. 13-14: Images of *Heteroderes sericeus* Candeze, Male: 13. Dorsal habitus; 14. Genitalia; 15-16: Images of *Heteroderes bicoloris* sp. nov., Male: 15. Dorsal habitus; 16. Genitalia.

LIST OF BIRD SPECIES FROM KIZILIRMAK VALLEY IN KIRIKKALE (TURKEY)

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[İliker, A. & Albayrak, İ. 2015. List of bird species from Kızılırmak Valley in Kırıkkale (Turkey). Munis Entomology & Zoology, 10 (1): 333-341]

ABSTRACT: This study is based on the bird species of the Kızılırmak Valley in Kırıkkale between the years 2010-2012. A total of 263 bird species belonging to 49 families of orders Podicipediformes, Pelecaniformes, Ciconiiformes, Phoenicopteriformes, Anseriformes, Falconiformes, Galliformes, Gruiformes, Charadiiformes, Columbiformes, Cuculiformes, Strigiformes, Apodiformes, Coraciiformes, Piciformes and Passeriformes orders were recorded in this study. Of these species, 93 are residents, 82 summer migrants, 51 winter migrants and 37 transit migrants. According to IUCN criteria; Egyptian vulture (*Neophron percnopterus*), saker falcon (*Falco cherrug*) and velvet scoter (*Melanitta fusca*) are in the endengared (EN) category; marbled teal (*Marmaronetta angustirostris*), great bustard (*Otis tarda*), aquatic warbler (*Acrocephalus paludicola*) are in the vulnerable (VU) category and ferruginous duck (*Aythya nyroca*), red kite (*Milvus milvus*), pallid harrier (*Circus macrourus*), red footed falcon (*Falco verpertinus*), great snipe (*Gallinago media*), rock partridge (*Alectoris graeca*), black tailed godwit (*Limosa limosa*), European roller (*Coracias garrulus*), semi collared flycatcher (*Ficedula semitorquata*) are in the near thretaned (NT) category.

KEY WORDS: Kızılırmak Valley, Ornithofauna, Kırıkkale, Turkey

It has been reported that 9916 bird species live in the world (Green and Moorhouse, 1995). According to the International Union for Conservation of Nature (IUCN), there are 10064 bird species in the world (Anonymous, 2012). According to the records, it has been stated that 10052 bird species live in the world (Anonymous, 2013). According to Newton and Dale (2001), the Palearctic region comprises 14% of the bird species in the world and 10% of bird types. Cox (2010) indicated that there are 9930 bird species belonging 204 families in the world, at least 2600 species from 141 families migrate and this number constitutes approximately 26.2% of all species.

According to the records, number of the bird species in Turkey differ from each other. These numbers are as follows; 403 according to Ergene (1945), 500-550 according to Kumerloeve (1962), 376 according to Baran & Yılmaz (1984), 426 according to Kızıroğlu (1989), 421 according to Turan (1990), 449 according to Bilgin (1994), 450 according to Kasperek & Bilgin (1996), 453 according to Kirwan et al. (1998), and 450 according to Kızıroğlu (2009).

The purpose of this study is to identify the local, migrant and transit migrant bird species from Kızılırmak Valley in Kırıkkale.

MATERIALS AND METHODS

This study is based on the data obtained through a research conducted in Kırıkkale for 178 days between 2010 and 2012 (Fig. 1).

The field was visited every two weeks and the observations were made in daytime generally after dawn until nightfall. Bird species in the field were

recorded with cameras, binoculars and through direct observation method. Records were kept through observations on certain spots and lines and species were determined. Identification books and voice records were used to determine the morphological characters of the species.

Bird species observed in the study area were evaluated in four groups based on their observation times. Accordingly; bird species that can be observed and reproduce all the year around are called "Resident Birds (R)", bird species arriving to spend the winter are called "Winter Migrant (WM)", bird species arriving to reproduce and spend the summer are called "Summer Migrant (SM)" and bird species observed while migrating are called "Transit Migrant (T)". Bird species observation times in the valley, habitat characteristics and Endangered (protection status) categories were specified in this study.

In addition, conservation status of the species were also specified according to the Red List published by the "International Union for Conservation of Nature" or the World Conservation Union (IUCN). Bird species were classified based on the categories "Extinct (EX)", "Critically Endangered (CR)", "Endangered (EN)", "Vulnerable (VU)", "Near Threatened (NT)", "Least Concern (LC)" and "Data Deficient (DD)" (Anonymous, 2001).

In this study, 178 field surveys were performed between the years of 2010 and 2012 (Table 1).

RESULTS

A total of 178 field surveys were conducted within the scope of this study in a period of 24 months in Kırıkkale and 263 species in total were identified in 49 families belonging to 16 orders (Podicipediformes, Pelecaniformes, Ciconiiformes, Phoenicopteriformes, Anseriformes, Falconiformes, Galliformes, Gruiformes, Charadiiformes, Columbiformes, Cuculiformes, Strigiformes, Apodiformes, Coraciiformes, Piciformes, Passeriformes), (Podicipedidae, Phalacrocoracidae, Ardeidae, Ciconiidae, Threskionithidae, Phoenicopteridae, Anatidae, Accipitridae, Falconidae, Phasianidae, Rallidae, Gruidae, Otidae, Haematopodidae, Recurvirostridae, Burhinidae, Charadriidae, Scolopacidae, Laridae, Sternidae, Pteroclididae, Columbidae, Cuculidae, Tytonidae, Strigidae, Apodidae, Alcedinidae, Meropidae, Coraciidae, Upupidae, Picidae, Alaudidae, Hirundinidae, Motacillidae, Troglodytidae, Turdidae, Sylviidae, Muscicapidae, Aegithalidae, Paridae, Sittidae, Remizidae, Oriolidae, Laniidae, Corvidae, Sturnidae, Passeridae, Fringillidae, Emberizidae). In addition to the characteristics of these species, their orders, families, names of species, migration status and protection status were also recorded (Table 2).

It has been determined that 93 of the species were resident, 82 were summer migrants, 51 were winter migrants and 37 were transit migrants.

When species were evaluated according to the criteria of IUCN; Egyptian vulture (*Neophron percnopterus*), saker falcon (*Falco cherrug*) and velvet scoter (*Melanitta fusca*) were in endangered (EN) category; marbled teal (*Marmaronetta angustirostris*), great bustard (*Otis tarda*) and aquatic warbler (*Acrocephalus paludicola*) were in vulnerable (VU) category; and ferruginous duck (*Aythya nyroca*), red kite (*Milvus milvus*), pallid harrier (*Circus macrourus*), red-footed falcon (*Falco verpertinus*), great Snipe (*Gallinago media*), rock partridge (*Alectoris graeca*), black-tailed godwit (*Limosa limosa*), European roller (*Coracias garrulus*) and semi-collared flycatcher (*Ficedula semitorquata*) were in near threatened (NT) category. Siberian stonechat (*Saxicola maurus*) was listed in the data deficient (DD) category.

DISCUSSION

263 species in 49 families from 16 orders were identified in this study. These numbers correspond to 52.4% compared to the reported number of bird species in Turkey (502), and a rate of 2.6% of bird species in the world (10064). When the studies conducted in geographical regions near the research area were examined, Çobanoğlu (2000) identified 215 species and 4 subspecies from 50 families at Seyfa Lake between the years of 1996 and 1998. The number of bird species identified in Kırıkkale Kızılırmak Valley has been found to be higher when compared to the number of bird species identified in the study conducted at Seyfa Lake near the study area.

Barış et al. (2005) reported that a total of 20806 individual birds from 100 species were put rings on between 2002 and 2004 at the Çernek bird ringing station in Samsun. Barış et al. (2010) identified 331 bird species at Kızılırmak Delta. The species identified in this study show similarity with the species identified in Kızılırmak Valley with regards of the same migratory route they use.

Kırıkkale Kızılırmak Valley is an important bird migration path. Birds must be preserved along with their habitats pursuant to the national and international regulations. In addition to the scientific researches, activities aiming at raising the public awareness should also be organised in order to eliminate the threats against bird species in Kırıkkale.

LITERATURE CITED

- Anonymous.** 2001. http://www.redlist.org/info/categories_criteria2001.html (Accessed: 10.01.2013).
- Anonymous.** 2012. <http://www.iucn.org/search> (Accessed: 29.07.2013).
- Anonymous.** 2013. <http://www.birdlife.org/datazone/species> (Accessed: 10/03/2013).
- Baran, İ. & Yılmaz, İ.** 1984. Ornitoloji Ders Notları. Ege Üniversitesi Fen Fakültesi Yayınları, Ege Üniversitesi Basımevi, İzmir, (87): 1-323.
- Barış, Y. S., Sağlam, Ö., Erciyas, K., Yavuz, N. & Özsemir, A. C.** 2010. Önemli Bir Doğa Mirası: Kızılırmak Deltası Kuşlar. Doğa ve Yaban Hayatı Koruma Derneği, Samsun. Erol Ofset Matbaacılık Yayıncılık Ambalaj Sanayi ve Ticaret Ltd. Şti., 1-169.
- Barış, S., Erciyas, K., Gürsoy A., Özsemir, C. & Nowakowski, J. K.** 2005. Çernek. A new bird ringing station in Turkey. Ring, 27 (1): 113-120.
- Bilgin, C. C.** 1994. Türkiye Avifaunası'nın tarihsel gelişimi ve son durum. XII. Ulusal Biyoloji Kongresi, 6-8 Temmuz 1994, Trakya Üniversitesi, Edirne, Zooloji Seksiyonu, 6: 259-265.
- Cox, G. W.** 2010. Bird Migration and Global Change. Islandpress, Wahington. Covelo, London, 1-291.
- Çobanoğlu, E. O.** 2000. Seyfe Gölü Avi-faunası. Gazi Üniversitesi, Fen Bilimleri Enstitüsü (Doktora Tezi), 1-145.
- Ergene, S.** 1945. Türkiye Kuşları. İstanbul Üniversitesi Fen Fakültesi Monografileri, İstanbul, (4): 1-361.
- Green, I. & Moorhouse, N.** 1995. A Birdwatchers' Guide to Turkey. Bird Watcher's Guides Prion Ltd., England, 1-122.
- Kasperek, M. & Bilgin, C. C.** 1996. Türkiye Kuşları Tür Listesi. 25-88, içinde: Türkiye Omurgahlı Tür Listesi (Kence, A. & Bilgin, C. C. eds), Nurol Matbaacılık A.Ş., Ankara, 1-183.
- Kirwan, G. M., Martins, R. P., Eken, G. & Davidson, P.** 1998. Checklist of the Birds of Turkey. OSME Sandgrouse Supplement 1, USA, 1-32.
- Kızıroğlu, İ.** 1989. Türkiye Kuşları. Orman Genel Müdürlüğü, Eğitim Dairesi Başkanlığı Yayın ve Tanıtma Şube Müdürlüğü Basım Tesisleri, Ankara, 1-312.
- Kızıroğlu, İ.** 2009. Türkiye Kuşları Cep Kitabı. Ankara Matbaacılık San. Ltd. Şti., 1-534.
- Kumerloeve, H.** 1962. Zur Kenntnis der Sumpf- und Wasservogelfauna der Türkei. J. Om., Berlin, 105: 307-325.
- Newton, I. & Dale, L.** 2001. A comparative analysis of the avifaunas of different zoogeographical regions. Journal of Zoology, 254 (2): 207-218.

Turan, N. 1990. Türkiye'nin Av ve Yaban Hayvanları, Kuşlar. Orman Genel Müdürlüğü Eğitim Dairesi Başkanlığı Yayın ve Tanıtma Müdürlüğü Matbaası, Ankara, 1-274.

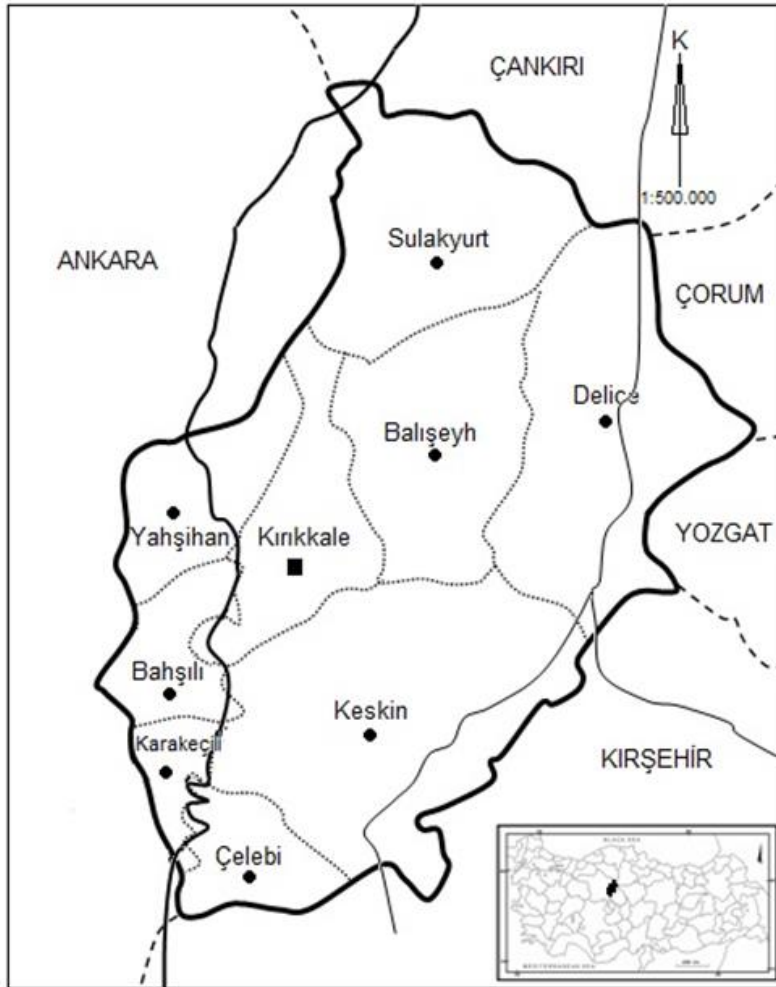


Figure 1. Map of Kırıkkale Province which the research was carried out.

Table 1. The field work in the Kızılırmak Valley in Kırıkkale.

Mounth													
Year	January	February	March	April	May	June	July	August	September	October	November	December	Total
2010	-	-	-	-	-	1	-	2	1	5	9	9	27
2011	9	9	9	8	9	9	9	9	9	9	9	9	107
2012	7	7	9	9	4	8	-	-	-	-	-	-	44
Total	16	16	18	17	13	18	9	11	10	14	18	19	178

Table 2. Systematics of the species, the species name, migration status and conservation status in Kızılırmak Valley in Kırkkale.

Number	Order	Family	Species	Common Name	Migration Status	Conservation Status
1	Podicipediformes	Podicipedidae	<i>Podiceps auritus</i>	Horned Grebe	WM	LC
2			<i>Podiceps cristatus</i>	Great Crested Grebe	R	LC
3			<i>Podiceps grisegena</i>	Red-necked Grebe	WM	LC
4			<i>Podiceps nigricollis</i>	Black-necked Grebe	R	LC
5			<i>Tachybaptus ruficollis</i>	Little Grebe	R	LC
6	Pelecaniformes	Phalacrocoracidae	<i>Phalacrocorax carbo</i>	Great Cormorant	R	LC
7	Ciconiiformes	Ardeidae	<i>Ardea cinerea</i>	Grey Heron	R	LC
8			<i>Ardea purpurea</i>	Purple Heron	SM	LC
9			<i>Ardeola ralloides</i>	Squacco Heron	SM	LC
10			<i>Botaurus stellaris</i>	Eurasian Bittern	R	LC
11			<i>Bubulcus ibis</i>	Cattle Egret	SM	LC
12			<i>Casmerodius albus</i>	Great Egret	R	LC
13			<i>Egretta garzetta</i>	Little Egret	SM	LC
14			<i>Icthyophaga minckleyi</i>	Little Bittern	SM	LC
15			<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	R	LC
16		Ciconiidae	<i>Ciconia ciconia</i>	European White Stork	SM	LC
17			<i>Ciconia nigra</i>	Black Stork	SM	LC
18		Threskionithidae	<i>Plegadis falcinellus</i>	Glossy Ibis	SM	LC
19	Phoenicopteriformes	Phoenicopteridae	<i>Phoenicopterus roseus</i>	Greater Flamingo	WM	LC
20	Anseriformes	Anatidae	<i>Anas acuta</i>	Northern Pintail	WM	LC
21			<i>Anas chryseus</i>	Northern Shoveler	R	LC
22			<i>Anas crecca</i>	Common Teal	R	LC
23			<i>Anas penelope</i>	Eurasian Wigeon	WM	LC
24			<i>Anas platyrhynchos</i>	Mallard	R	LC
25			<i>Anas querquedula</i>	Garganey	R	LC
26			<i>Anas strepera</i>	Gadwall	WM	LC
27			<i>Anser albifrons</i>	Greater White-fronted Goose	WM	LC
28			<i>Anser anser</i>	Greylag Goose	WM	LC
29			<i>Aythya ferina</i>	Common Pochard	R	LC
30			<i>Aythya fuligula</i>	Tufted Duck	WM	LC
31			<i>Aythya marila</i>	Greater Scaup	WM	LC
32			<i>Aythya nyroca</i>	Ferruginous Duck	WM	NT
33			<i>Cygnus columbianus</i>	Tundra Swan	WM	LC
34			<i>Cygnus olor</i>	Mute Swan	WM	LC
35			<i>Marmaronetta angustirostris</i>	Marbled Teal	R	VU
36			<i>Melanitta fusca</i>	White-winged Scoter	T	EN
37			<i>Mergellus albellus</i>	Smew	T	LC
38			<i>Mergus merganser</i>	Goosander	T	LC
39			<i>Netta rufina</i>	Red-crested Pochard	WM	LC
40			<i>Tadorna ferruginea</i>	Ruddy Shelduck	R	LC
41			<i>Tadorna tadorna</i>	Common Shelduck	WM	LC
42	Falconiformes	Accipitridae	<i>Accipiter gentilis</i>	Northern Goshawk	WM	LC
43			<i>Accipiter nisus</i>	Eurasian Sparrowhawk	WM	LC
44			<i>Aquila chrysaetos</i>	Golden Eagle	R	LC
45			<i>Aquila fasciatus</i>	Bonelli's Eagle	R	LC
46			<i>Buteo buteo</i>	Eurasian Buzzard	R	LC
47			<i>Buteo buteo vulpinus</i>	Steppe buzzard	R	LC
48			<i>Buteo lagopus</i>	Rough-legged Buzzard	R	LC
49			<i>Buteo rufinus</i>	Long-legged Buzzard	R	LC
50			<i>Circus gallicus</i>	Short-toed Eagle	SM	LC
51			<i>Circus aeruginosus</i>	Western Marsh Harrier	R	LC

52			<i>Circus cyaneus</i>	Northern Harrier/Hen Harrier	WM	LC
53			<i>Circus macrourus</i>	Pallid Harrier	T	NT
54			<i>Circus pygargus</i>	Montagu's Harrier	SM	LC
55			<i>Gypaetus barbatus</i>	Bearded Vulture	R	LC
56			<i>Gyps fulvus</i>	Eurasian Griffon	R	LC
57			<i>Haliaeetus albicilla</i>	White-tailed Sea Eagle	R	LC
58			<i>Hieraetus pennatus</i>	Booted Eagle	SM	LC
59			<i>Milvus migrans</i>	Black Kite	SM	LC
60			<i>Milvus milvus</i>	Red Kite	WM	NT
61			<i>Neophron percnopterus</i>	Egyptian Vulture	SM	EN
62			<i>Pandion haliaetus</i>	Osprey	R	LC
63			<i>Pernis apivorus</i>	European Honey Buzzard	SM	LC
64		Falconidae	<i>Falco cherrug</i>	Saker Falcon	WM	EN
65			<i>Falco columbarius</i>	Merlin	WM	LC
66			<i>Falco naumanni</i>	Lesser Kestrel	R	LC
67			<i>Falco peregrinus</i>	Peregrine Falcon	R	LC
68			<i>Falco subbuteo</i>	Eurasian Hobby	R	LC
69			<i>Falco tinnunculus</i>	Common Kestrel	R	LC
70			<i>Falco vespertinus</i>	Red-footed Falcon	T	NT
71	Galliformes	Phasianidae	<i>Alectoris chukar</i>	Chukar Partridge	R	LC
72			<i>Alectoris graeca</i>	Rock Partridge	WM	NT
73			<i>Coturnix coturnix</i>	Common Quail	SM	LC
74			<i>Perdix perdix</i>	Grey Partridge	R	LC
75	Gruiformes	Rallidae	<i>Fulica atra</i>	Common Coot	R	LC
76			<i>Gallinula chloropus</i>	Common Moorhen	R	LC
77			<i>Porzana parva</i>	Little Crane	SM	LC
78			<i>Porzana porzana</i>	Spotted Crane	T	LC
79			<i>Porzana pusilla</i>	Baillon's Crane	T	LC
80			<i>Rallus aquaticus</i>	Water Rail	WM	LC
81		Gruidae	<i>Grus grus</i>	Common Crane	T	LC
82		Otididae	<i>Otis tarda</i>	Great Bustard	R	VU
83	Charadiiformes	Haematopodidae	<i>Haematopus ostralegus</i>	Eurasian Oystercatcher	SM	LC
84		Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt	SM	LC
85			<i>Recurvirostra avosetta</i>	Pied Avocet	SM	LC
86		Burhinidae	<i>Burhinus oedipnemus</i>	Eurasian Stone Curlew	R	LC
87		Charadriidae	<i>Charadrius dubius</i>	Little Ringed Plover	SM	LC
88			<i>Charadrius hiaticula</i>	Common Ringed Plover	WM	LC
89			<i>Vanellus vanellus</i>	Northern Lapwing	R	LC
90		Scolopacidae	<i>Actitis hypoleucos</i>	Common Sandpiper	R	LC
91			<i>Calidris minuta</i>	Little Stint	WM	LC
92			<i>Calidris temminckii</i>	Temminck's Stint	T	LC
93			<i>Gallinago gallinago</i>	Common Snipe	WM	LC
94			<i>Gallinago media</i>	Great Snipe	T	NT
95			<i>Limosa lapponica</i>	Bar-tailed Godwit	T	LC
96			<i>Limosa limosa</i>	Black-tailed Godwit	T	NT
97			<i>Philomachus pugnax</i>	Ruff	WM	LC
98			<i>Tringa erythropus</i>	Spotted Redshank	WM	LC
99			<i>Tringa glareola</i>	Wood Sandpiper	WM	LC
100			<i>Tringa ochropus</i>	Green Sandpiper	R	LC
101			<i>Tringa stagnatilis</i>	Marsh Sandpiper	WM	LC
102			<i>Tringa totanus</i>	Common Redshank	R	LC
103			<i>Xenus cinereus</i>	Terek Sandpiper	WM	LC
104		Laridae	<i>Chlidonias leucopterus</i>	White-winged Black Tern	SM	LC
105			<i>Chlidonias niger</i>	Black Tern	T	LC
106			<i>Larus cachinnans</i>	Yellow-legged Gull	R	LC
107			<i>Larus canus</i>	Mew Gull	T	LC
108			<i>Larus genei</i>	Slender-billed Gull	R	LC
109			<i>Larus melanocephalus</i>	Mediterranean Gull	SM	LC
110			<i>Larus minutus</i>	Little Gull	T	LC
111			<i>Larus ridibundus</i>	Common Black-headed Gull	WM	LC

112			<i>Sterna hirundo</i>	Common Tern	SM	LC
113			<i>Sterna nilotica</i>	Gull-billed Tern	T	LC
114	Columbiformes	Pteroclididae	<i>Pterocles orientalis</i>	Black-bellied Sandgrouse	T	LC
115		Columbidae	<i>Columba livia</i>	Rock Dove	R	LC
116			<i>Columba oenas</i>	Stock Dove	R	LC
117			<i>Columba palumbus</i>	Woodpigeon	R	LC
118			<i>Streptopelia senegalensis</i>	Laughing Dove	SM	LC
119			<i>Streptopelia decaocto</i>	Eurasian Collared Dove	R	LC
120			<i>Streptopelia turtur</i>	European Turtle Dove	SM	LC
121	Cuculiformes	Cuculidae	<i>Clamator glandarius</i>	Great Spotted Cuckoo	SM	LC
122			<i>Cuculus canorus</i>	Common Cuckoo	SM	LC
123	Strigiformes	Tytonidae	<i>Tyto alba</i>	Barn Owl	R	LC
124		Strigidae	<i>Asio otus</i>	Long-eared Owl	R	LC
125			<i>Athene noctua</i>	Little Owl	R	LC
126			<i>Bubo bubo</i>	Eurasian Eagle-Owl	T	LC
127	Apodiformes	Apodidae	<i>Apus apus</i>	Common Swift	SM	LC
128			<i>Apus pallidus</i>	Pallid Swift	T	LC
129			<i>Tachymarptis melba</i>	Alpine Swift	T	LC
130	Coraciiformes	Alcedinidae	<i>Alcedo atthis</i>	Common Kingfisher	R	LC
131		Meropidae	<i>Merops apiaster</i>	European Bee-eater	SM	LC
132		Coraciidae	<i>Coracias garrulus</i>	European Roller	SM	NT
133		Upupidae	<i>Upupa epops</i>	Common Hoopoe	SM	LC
134	Piciformes	Picidae	<i>Dendrocopos major</i>	Great Spotted Woodpecker	R	LC
135			<i>Dendrocopos minor</i>	Lesser Spotted Woodpecker	R	LC
136			<i>Dendrocopos syriacus</i>	Syrian Woodpecker	R	LC
137			<i>Jynx torquilla</i>	Northern Wren	SM	LC
138			<i>Picus viridis</i>	Green Woodpecker	R	LC
139	Passeriformes	Alaudidae	<i>Alauda arvensis</i>	Eurasian Skylark	R	LC
140			<i>Calandrella brachydactyla</i>	Greater Short-toed Lark	R	LC
141			<i>Calandrella rufescens</i>	Lesser Short-toed Lark	R	LC
142			<i>Eremophila alpestris</i>	Horned Lark	T	LC
143			<i>Galerida cristata</i>	Crested Lark	R	LC
144			<i>Lullula arborea</i>	Woodlark	R	LC
145			<i>Melanocorypha bimaculata</i>	Bimaculated Lark	SM	LC
146			<i>Melanocorypha calandra</i>	Calandra Lark	R	LC
147		Hirundinidae	<i>Delichon urbicum</i>	Northern House Martin	SM	LC
148			<i>Hirundo daurica</i>	Red-rumped Swallow	T	LC
149			<i>Hirundo rupestris</i>	Eurasian Crag Martin	SM	LC
150			<i>Hirundo rustica</i>	Barn Swallow	SM	LC
151			<i>Riparia riparia</i>	Bank Swallow	SM	LC
152		Motacillidae	<i>Anthus campestris</i>	Tawny Pipit	SM	LC
153			<i>Anthus cervinus</i>	Red-throated Pipit	WM	LC
154			<i>Anthus hodgsoni</i>	Olive-backed Pipit	WM	LC
155			<i>Anthus pratensis</i>	Meadow Pipit	WM	LC
156			<i>Anthus spinoletta</i>	Water Pipit	WM	LC
157			<i>Anthus trivialis</i>	Tree Pipit	T	LC
158			<i>Motacilla alba</i>	White Wagtail	R	LC
159			<i>Motacilla cinerea</i>	Grey Wagtail	R	LC
160			<i>Motacilla citreola</i>	Citrine Wagtail	T	LC
161			<i>Motacilla flava</i>	Yellow Wagtail	SM	LC
162		Troglodytidae	<i>Troglodytes troglodytes</i>	Winter Wren	WM	LC
163		Muscicapidae	<i>Cercomela melanura</i>	Blackstart	T	LC
164			<i>Erithacus rubecula</i>	European Robin	WM	LC
165			<i>Erythropygia galactotes</i>	Rufous Scrub Robin	SM	LC
166			<i>Ficedula albicollis</i>	Collared Flycatcher	SM	LC
167			<i>Ficedula hypoleuca</i>	Pied Flycatcher	T	LC
168			<i>Ficedula parva</i>	Red-breasted Flycatcher	SM	LC
169			<i>Ficedula semitorquata</i>	Semi-collared Flycatcher	SM	NT
170			<i>Luscinia luscinia</i>	Thrush Nightingale	SM	LC
171			<i>Luscinia megarhynchos</i>	Common Nightingale	SM	LC

172		<i>Luscinia svecica</i>	Bluethroat	WM	LC
173		<i>Monticola saxatilis</i>	Common Rock Thrush	T	LC
174		<i>Muscicapa striata</i>	Spotted Flycatcher	SM	LC
175		<i>Oenanthe deserti</i>	Desert Wheatear	SM	LC
176		<i>Oenanthe finschii</i>	Finsch's Wheatear	SM	LC
177		<i>Oenanthe hispanica</i>	Black-eared Wheatear	SM	LC
178		<i>Oenanthe isabellina</i>	Isabelline Wheatear	SM	LC
179		<i>Oenanthe oenanthe</i>	Northern Wheatear	SM	LC
180		<i>Oenanthe pleschenka</i>	Pied Wheatear	T	LC
181		<i>Phoenicurus ochruros</i>	Black Redstart	WM	LC
182		<i>Phoenicurus phoenicurus</i>	Common Redstart	SM	LC
183		<i>Saxicola maurus</i>	Siberian stonechat	WM	NR
184		<i>Saxicola rubetra</i>	Whinchat	SM	LC
185		<i>Saxicola rubicola</i>	European stonechat	R	LC
186	Turdidae	<i>Turdus iliacus</i>	Redwing	WM	LC
187		<i>Turdus merula</i>	Eurasian Blackbird	R	LC
188		<i>Turdus philomelos</i>	Song Thrush	R	LC
189		<i>Turdus pilaris</i>	Fieldfare	WM	LC
190		<i>Turdus viscivorus</i>	Mistle Thrush	R	LC
191	Sylviidae	<i>Acrocephalus agricola</i>	Paddyfield Warbler	SM	LC
192		<i>Acrocephalus arundinaceus</i>	Great Reed Warbler	SM	LC
193		<i>Acrocephalus dumetorum</i>	Blyth's Reed Warbler	T	LC
194		<i>Acrocephalus melanopogon</i>	Moustached Warbler	R	LC
195		<i>Acrocephalus paludicola</i>	Aquatic Warbler	SM	VU
196		<i>Acrocephalus palustris</i>	Marsh Warbler	SM	LC
197		<i>Acrocephalus schoenobaenus</i>	Sedge Warbler	SM	LC
198		<i>Acrocephalus scirpaceus</i>	Eurasian Reed Warbler	SM	LC
199		<i>Cettia cetti</i>	Cetti's Warbler	R	LC
200		<i>Hippolais icterina</i>	Icterine Warbler	SM	LC
201		<i>Hippolais languida</i>	Upcher's Warbler	SM	LC
202		<i>Hippolais olivetorum</i>	Olive-tree Warbler	SM	LC
203		<i>Hippolais pallida</i>	Olivaceous Warbler	SM	LC
204		<i>Locustella fluvialis</i>	River Warbler	T	LC
205		<i>Locustella luscinioides</i>	Savi's Warbler	SM	LC
206		<i>Phylloscopus bonelli</i>	Eastern Bonelli's warbler	SM	LC
207		<i>Phylloscopus borealis</i>	Arctic Warbler	T	LC
208		<i>Phylloscopus collybita</i>	Common Chiffchaff	R	LC
209		<i>Phylloscopus sibilatrix</i>	Wood Warbler	T	LC
210		<i>Phylloscopus trochiloides</i>	Greenish Warbler	SM	LC
211		<i>Phylloscopus trochilus</i>	Willow Warbler	T	LC
212		<i>Sylvia atricapilla</i>	Blackcap	SM	LC
213		<i>Sylvia borin</i>	Garden Warbler	SM	LC
214		<i>Sylvia communis</i>	Greater Whitethroat	SM	LC
215		<i>Sylvia curruca</i>	Lesser Whitethroat	SM	LC
216		<i>Sylvia hortensis</i>	Orphean Warbler	SM	LC
217		<i>Sylvia melanocephala</i>	Sardinian Warbler	SM	LC
218	Reguliidae	<i>Regulus ignicapilla</i>	Firecrest	WM	LC
219		<i>Regulus regulus</i>	Goldcrest	T	LC
220	Aegithalidae	<i>Aegithalos caudatus</i>	Long-tailed Tit	R	LC
221	Paridae	<i>Parus ater</i>	Coal Tit	WM	LC
222		<i>Parus caeruleus</i>	Blue Tit	R	LC
223		<i>Parus cyanus</i>	Azure Tit	T	LC
224		<i>Parus major</i>	Great Tit	R	LC
225	Sittidae	<i>Sitta neumayer</i>	Western Rock Nuthatch	R	LC
226	Remizidae	<i>Remiz pendulinus</i>	Penduline Tit	SM	LC
227	Oriolidae	<i>Oriolus oriolus</i>	Eurasian Golden Oriole	SM	LC
228	Laniidae	<i>Lanius collurio</i>	Red-backed Shrike	SM	LC
229		<i>Lanius minor</i>	Lesser Grey Shrike	SM	LC

230		<i>Lanius nubicus</i>	Masked Shrike	SM	LC
231		<i>Lanius senator</i>	Woodchat Shrike	SM	LC
232	Corvidae	<i>Corvus corax</i>	Common Raven	R	LC
233		<i>Corvus corone</i>	Carion Crow	R	LC
234		<i>Corvus frugilegus</i>	Rook	R	LC
235		<i>Corvus monedula</i>	Eurasian Jackdaw	R	LC
236		<i>Garrulus glandarius</i>	Eurasian Jay	R	LC
237		<i>Pica pica</i>	Common Magpie	R	LC
238	Sturnidae	<i>Sturnus roseus</i>	Rosy Starling	SM	LC
239		<i>Sturnus vulgaris</i>	European Starling	R	LC
240	Passeridae	<i>Passer domesticus</i>	House Sparrow	R	LC
241		<i>Passer hispaniolensis</i>	Spanish Sparrow	R	LC
242		<i>Passer montanus</i>	Eurasian Tree Sparrow	R	LC
243		<i>Petronia petronia</i>	Rock Sparrow	R	LC
244	Fringillidae	<i>Carduelis cannabina</i>	Common Linnet	R	LC
245		<i>Carduelis carduelis</i>	European Goldfinch	R	LC
246		<i>Carduelis chloris</i>	European Greenfinch	R	LC
247		<i>Carduelis flammea</i>	Common Redpoll	WM	LC
248		<i>Carduelis spinus</i>	Eurasian Siskin	R	LC
249		<i>Carpodacus erythrinus</i>	Common Rosefinch	T	LC
250		<i>Coccothraustes coccothraustes</i>	Hawfinch	WM	LC
251		<i>Fringilla coelebs</i>	Chaffinch	R	LC
252		<i>Fringilla montifringilla</i>	Brambling	WM	LC
253		<i>Serinus serinus</i>	European Serin	R	LC
254	Emberizidae	<i>Emberiza caesia</i>	Cretzschmar's Bunting	SM	LC
255		<i>Emberiza cia</i>	Western Rock Bunting	WM	LC
256		<i>Emberiza cirrus</i>	Cirl Bunting	WM	LC
257		<i>Emberiza citrinella</i>	Yellowhammer	R	LC
258		<i>Emberiza hortulana</i>	Ortolan Bunting	SM	LC
259		<i>Emberiza leucocapthalos</i>	Pine Bunting	WM	LC
260		<i>Emberiza melanocephala</i>	Black-headed Bunting	SM	LC
261		<i>Emberiza schoeniclus</i>	Reed Bunting	R	LC
262		<i>Miliaria calandra</i>	Corn Bunting	R	LC
263		<i>Plectrophenax nivalis</i>	Snow Bunting	T	LC

ROLE OF FOREST BIODIVERSITY IN CONSERVATION OF NON-MULBERRY (VANYA) SILK IN INDIA

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ABSTRACT: The world's species diversity is described as 1.75 million out of the possible 12 to 100 million species and insect group comprises the largest diversity among all living organisms with 9.50 lakh described species. Biodiversity forms a still largely explored treasure that is severely endangered due to a huge amount of destructive human interventions. Changes in land use, habitat reduction and fragmentation, nutrient enrichment, and environmental stress, caused by human beings in the form of pollutants lead to reduced biological diversity on all levels (genes, species, and communities) and all functional roles. The Food and Agriculture Organization of the United Nations estimated that about 13 million hectares –an area roughly equivalent to the size of Greece, of the world's forests are cut down and converted to other land uses every year. The non-mulberry (vanya) silk industry is depending primarily on the productivity of forest eco-system. The vanya silkworm germplasm have several idotypes and wild counterparts in nature. Due to their strong endemism, the metapopulation structures of these wild silkworms are highly sensitive to the present biodiversity crisis contributed by deforestation, fragmentation of forest land, environmental pollution and climate change. The North East India is considered as the hotspot of ser-biodiversity with diverse forest based food plants and sericigenous insects which play a significant role in sustainable rural livelihood and poverty alleviation in the country. Globally India is the second largest producer of silk and contributes about 15.5 % to the total world raw silk production and generates employment to 6.8 million rural people mostly women folk. The present paper deals with the present status of wild silkworm germplasm and their food plants available in North East India and maintained at Germplasm Conservation Centre, Central Muga Eri Research & Training Institute, Chenijan (Jorhat). The prospects for commercial exploitation of some perennial forest trees such Borpat, *Ailanthus grandis*, Borkesseru, *Ailanthus excelsa* and Maiphak, *Evodia (Tetradium) meliaefolia* in eri silk sector have documented in the present study. The realistic approaches, strategies and intervention frameworks (both short term and long term) for conservation and commercial exploitation of vanya silkworm germplasm and their food plants have been discussed.

KEY WORDS: vanya silk, conservation, eri silkworm, forest, bio-resources

The present species diversity of the world is though described as 1.75 million out of the possible 12 to 100 million species (Hawksworth & Kalin-Arroyo, 1995). The insect group comprises the largest diversity among all living organisms with 9.50 lakh species out of 13.2 lakh animalia species (Fig. 1). The species richness of most groups of organisms' peaks in the tropics, with rainforests is being particularly diverse. The maximum richness of plant species is mostly found near to the equator.

Biodiversity forms a still largely explored treasure that is severely endangered due to a huge amount of destructive human actions. The current rate of species extinctions due to anthropogenic actions will result in the irreversible loss of genetic diversity, and likewise of metabolic construction plans. It can be easily

predicted that the losses for agriculture, pharmaceuticals, and many other fields of basic and applied sciences like sericulture will be severe and losses will hamper the development of future research strategies and technological innovations (Barthlott et al., 2005). Changes in land use, habitat reduction and fragmentation, nutrient enrichment, and environmental stress, caused by human beings in the form of pollutants, lead to reduced biological diversity on all levels (genes, species, and communities) and all functional roles. These accelerate the widespread extinction of bulk quantity of flora and fauna during last five centuries which are popularly known as 'the era of extinction', during which the earth has lost 200 known animal species but 400 unknown plant species each year (Koopowitz & Kaye, 1990). It is evident from reports that since 1980, the extinction rate was extraordinarily high with an annual extinction rate of 27,000 species, i.e. one species in every twenty minutes (Wilson, 1992). At this rate in 2000 AD, the number of plant species lost from the earth estimated as 40,000. The extinction of one plant species leads to extinction of several dependant animal species, which threaten the existence of human beings (Hazarika & Bhuyan, 2006). The anthropogenic actions lead to the erosion of natural forest specially the tropical forest. Till 1974, Norman Myer, a leading ecologist, estimated the loss of tropical forest ecosystem at 243200 km² per year. This might have increased manifold till date resulting in loss of habitats for many animals at the rate of 0.8 %-2 % per year (May et al., 1995), resulting in extinction of 16 million population per year or one individual in every two second (Hughes et al., 1997). The Food and Agriculture Organization of the United Nations (FAO, 2006) estimated that about 13 million hectares –an area roughly equivalent to the size of Greece- of the world's forests are cut down and converted to other land uses every year. Forest fragmentation can jeopardise the long term health and vitality of forest ecosystem. Forest fragmentation can also result in species loss as the size of a forest become too small to support a viable population of a certain plant or animal species, which is more prominent in South East Asian Countries including India (Fig. 2).

The North Eastern Region of India has got unique place in the silk map of the country producing all the four commercially exploited silk varieties namely, muga, eri tassar and mulberry silk. India is considered as hot spot of seriodiversity particularly in case of non-mulberry (vanya) silk sector and the region has emerged as its epicentre. The production and sustenance of different vanya silk varieties are directly as well as indirectly depend on forest trees, which are otherwise act as food plants for these silkworms. Hence the productivity of vanya silk depends on the health of the natural as well as artificial (cultivated) forest ecosystem. North East India including the Himalayan region is included in the 'Indo-Burma hot spot' (Myers et al., 2000), which reflects that the region is vulnerable to high rate of depletion of bio-resources. One of the important decisive factor to declare a particular region as the hotspot is the degree of threat to endemic species through habitat loss that is alarming very high in North East India (Hazarika & Bhuyan, 2006). The original extent of primary vegetation of Indo-Burma region was 2,060,000 Km², which has reduced to 100,000 km² in recent days, estimated at 4.90 % of the original vegetation (Myers et al., 2000). The data reflects that we have lost more than 95 % of our primary vegetation which includes host plants of silkworms mainly non-mulberry germplasms. It has been reported that the large scale conversion of muga food plantations (18.75 % to 32.93%) into other plantations mainly tea in three districts of Upper Assam during 2009-2012 due to environmental pollution contributed by pesticide application in tea-agro ecosystem and burning of hydrocarbons in oil fields

(Ahmed et al., 2012) causing a major threat to muga silk industry. It is needless to mention that loss of a food plant is directly related to the loss of silkworm germplasm as well. Considering the above facts, it is high time to address the conservation and commercial exploitation of non-mulberry (vanya) silk host plants and silkworm germplasm to sustainable livelihood of different stakeholders of the silk industry.

The Wild Silk Moths-An Overview

Most of the wild silkmths, under the family Saturniidae are distributed and confined with South East Asia (Peigler, 1993) and North East India is the epicentre of evolution of vanya silk moths. The food plant distribution and distinct climatic conditions of South East Asian countries impart congenial environment for occurrence and growth of the saturniid moths. Fairly good numbers of references are on record about seri-biodiversity and their potential as a source of natural silk in Indian subcontinent (Arora & Gupta 1979; Thangavelu, 1991; Nassig et al., 1996; Chinnaswamy, 2001; Thangavelu et al., 2002). Arora & Gupta (1979) estimated as many as 40 species in India alone. Jolly et al. (1975) reported about 80 species occurring in Asia and Africa to produce wild silk of economic value. Nassig et al. (1996) has mentioned that the family Saturniidae comprises of about 1200-1500 species all over the world of which the Indian subcontinent, extending from Himalayas to Sri Lanka may possess over 50 species. Out of 160 identified species of non-mulberry sericigenous insects, 100 species are found in India (Hazarika & Bhuyan, 2006). The North-Eastern Region of India makes ideal home for a number of wild sericigenous insects and is epicentre of wild silk culture including muga, *Antheraea assamensis* Helfer, eri, *Samia ricini* (Donovan) and oak tasar, *Antheraea proylei* Jolly (Peigler & Naumann 2003). About a dozen of saturniid moth species found in the Sub- Himalyan belt especially in North Eastern Region of India (Choudhury, 1981). The genus *Antheraea* is distributed within the South East Asia for its distinctive ecological requirement along with host plants in the natural forest (Hazarika & Bhuyan, 2003). Hence, the saturniid as well as *Antheraea* biodiversity exists in NE Region.

However, the diversity of wild sericigenous insects in the region is not fully explored. Given the rapid changes in land use pattern, it is pertinent to explore, characterize, conserve and document the status of these precious faunal species in the region (Ahmed & Rajan, 2011). Singh & Chakravorty (2006) enlisted 24 species of the family Saturniidae from North East India, including three species of wild silk moths namely, *Antheraea assamensis*, *Antheraea roylei* and *Attacus atlas* from Nagaland. Ahmed et al. (1996) studied detail bio-ecology of wild silk, *Cricula trifenestrata* Helfer. According to Peigler (1993) the domesticated eri silk worm, *Samia ricini* (Donovan) is not really a distinct species but a form derived from *Samia canningi* through centuries of selection for silk production which is distributed throughout the region. Kakati & Chutia (2009) recorded the presence of 14 sericigenous species belonging to 8 genera i.e. *Antheraea*, *Actias*, *Attacus*, *Archaeoattacus*, *Cricula*, *Loepa*, *Samia*, *Sonthonnaxia* and a large number of host plants. Out of the above mentioned different sericigenous saturniid silk moths, only few silk moths namely, muga, *Antheraea assamensis* Helfer, eri, *Samia ricini* (Donovan), Oak tasar, *Antheraea proylei* J. and tropical tassar, *Antheraea mylitta* D. has been commercially exploited and farmers are practising these vanya silk culture for their livelihood.

Promising unexplored wild silk moths:

It is evident from above studies that there are lots of wild silk moths are available in NE Region of India but only few have been commercially exploited for economic utilization in silk sector. However, the species which require immediate attention for utilization in silk sector or any other viable sectors such food, pharmaceuticals etc. are highlighted below.

Fagara Silk (*Attacus atlas* L.): *Attacus atlas* L. (Lepidoptera: Saturniidae), a wild silk moth which is known as *fagara* silk (Jolly et al., 1979) is the world largest lepidopteran moth in terms of its wings surface area (400 cm²) (Watson & Whally, 1983) and behind only Ghost moth, *Thysania agrippin* in terms of its wingspan, which is 32 cm in case of *T. agrippin* and 25-30 cm in case of *A. atlas* (Moucha, 1966). The caterpillar of *A. atlas* is highly polyphagous and it feeds on a variety of leaves including *Muntingia calabura*, *Annona muricata*, *Cinnamomum verum*, *Nephelium lappaceum*, *Psidium guajava*, *Sandoricum indicum*, *Citrus* sp, *Cinchona officinalis*, *Cinnamomum camphora*, *Coffea arabica*, *Curcuma longa*, *Elettaria cardamomum*, *Persea americana*, *Litsea polyantha* and other trees.

The natural incidence of *A. atlas* caterpillar on *Ailanthus excelsa* was recorded at Chenijan, Jorhat with peak incidence during May-October. The caterpillars voraciously feed on the leaves and in certain cases, the trees are completely defoliated. The average larval duration recorded 23 days during May-June period. After reaching 10-11 cm in length, the caterpillar starts pupation in the plant covering with mature leaves. The brown colored cocoons are formed by spinning a silky covering (taking around 20- 24 hours) that is interwoven with desiccated leaves. The adult emerges from the pupa in the early morning hours and total pupal period was recorded 22 days. The average cocoon weight (g) was 14.11 and 10.29 for female and male, respectively. The average shell weight of single cocoon (g) recorded 2.04 and 1.84 for female and male, respectively which is five times more than shell weight of *S. ricini*. The adult longevity was 10-12 days. The females are sexually passive, only releasing pheromones to attract a male for mating. After emergence of moths, the coupling of male and female moth continued for 4-6 hours and started egg laying on the underside of leaves or the bark of the trees. Eggs are around 2.1-2.6mm in diameter and the caterpillar hatched from the eggs after 17-22 days during summer season. The Japanese designers have developed diversified products out of the *Attacus* spun yarn in recent days.

Wild eri silk moth (*Samia canningi* Hutton): *Samia canningi* is a moth of the Saturniidae family. It is found in south-eastern Asia and China. The wingspan is 100-140 mm. The larvae mainly feed on *Ailanthus altissima*, *Prunulaurocerasus*, *Ligustrum* and *Syringa* species. It has been found highly polyphagous like domesticated *S. ricini* and found feeding on Kesseru (*Heteropanax fragrans*), Borkesseru (*Ailanthus excelsa*), Borpat (*A. grandis*), payam (*Evodia flaxifolia*) and Soalu (*Litsea polyantha*) etc. Pupation takes place in a silken cocoon on the leaves of the tree in outdoor condition. Cocoons are compact and brown in colour. The average cocoon weight and shell weight is 3.46 g and 0.446 g, respectively. The shell ratio recorded is 12.86% and fecundity in indoor condition ranges from 195-265. Hence, the economic characters at par with domesticated eri silk, *S. ricini*. The natural incidence is observed throughout the year with peak incidence during May-June.

Amphutokoni Muga (*Cricula trifenestrata* Helfer): The saturniid leaf eating caterpillar, *Cricula trifenestrata* Helfer is locally known as “*Amphutukoni muga*” was considered as serious pest of som plantation as its incidence is more during commercial muga crops i.e. Kotia (September-October). The smallest wild saturniid silk also feeds mango, cashewnut, pepper, tea, litchi and ber etc. Indonesia is well known for its silk textile derived from wild silkworm cocoon of *Cricula trifenestrata*. *C. trifenestrata* is one of the world wild species of silkworms which habitats in Java island and South East Asia. *Cricula trifenestrata* produces golden silk floss which is very luxurious and amazing. Besides, spun yarn is used for production of diverse fabrics, the use of discarded sericin of *Cricula trifenestrata* cocoon extract from the water waste of silk textile industry as biomaterials will be beneficial for the local silk textile industry and also the development of natural biomaterials as bone substitute (Sunarintyas et al., 2012).

Germplasm of Eri silkworm

Eri silkworm *Samia ricini* (Donovan) under the family Saturniidae is the only domesticated, multivoltine and polyphagous silkworm among the vanya silks. Eri silkworm is the hardiest species among commercially exploited silkworms. North East India is considered as the centre of origin for eri silkworm, *Samia ricini* (Donovan). The eri culture has recent days introduced to many non-traditional states of India like Andhra Pradesh, Gujarat, Madhya Pradesh, Chhattisgarh, Tamil Nadu, Karnataka, Maharashtra, Uttaranchal, Uttar Pradesh, Jharkhand, Bihar, West Bengal, Orissa and Sikkim. Over the period of a decade annual production of Eri raw silk has significantly increased to 3105.00MT in 2011-12 from 974 MT in 1999-2000. About 1.83 lakh families with plantation area of 26000 hectares of North East India are involved in eri culture sharing about 73% of the total raw silk production in India.

Brahmaputra valley of Assam and its adjoining foot hills in the Sub-Himalayan belt is believed to be the native place of eri. The silkworm name of 'Eri' derives from the Assamese word 'Era' which means castor the main food plant of eri silkworm. The history of silk in Brahmaputra valley can be traced back to the vedic literature (around 1600 BC). Silk from Brahmaputra valley was marketed to Mugadh, Mithila and Brahmadesh during 1340 BC. During the period of great king Bhaskar Barman of Kamrup (600-650 AD.), silk trade from Assam to North India was at peak stage. Buddhist visitor, Hieun Tsang mentioned in his writing Suvarnkusi (Sualkuchi) as an important silk producing centre. King Harsha Vardhana of Kaunuj imported silk from Assam for making his royal dresses. Later during 1492-1520 AD, the great 'Ahom' King Sarna Narayan of Sivasagar patronized silk industry of Assam.

The structure of the genitalia, wing pattern and chromosome number demonstrates that *Samia ricini* (Donovan) is derived from its wild form, *Samia canningi* (Hutton). Several eco-races like Borduar, Titabar, Khanapara, Nongpoh, Mendipathar, Dhanubhanga, Sille, Kokrajhar, Diphu, Kokrajhar, Genung etc. of eri silkworm are available in N.E. region and the germplasm conservation centre under Central Silk Board, Lahdoigarh maintains 26 numbers of ecoraces. Listing of passport data of all accessions available in the GPB is presented (Table.1). Among the presently maintained eco-races in the GPB Borduar, Genung, Diphu, Kokrajhar are showing better performance (Sarmah et al., 2012). Analysis of the growth and economic traits of cocoon of different eri silkworm races revealed that eri silkworm accession viz. SRI-001, SRI- 010 and SRI- 024 are the most promising eri silkworm races for commercial exploitation in agro climatic

condition of North eastern region of India (Sarkar, 2008). Depending upon larval colours and markings, six pure line strains were isolated from Borduar and Titabar eco races, namely, Yellow Plain (YP), Yellow Spotted (YS), Yellow Zebra (YZ), Greenish Blue Plain (GBP), Greenish Blue Spotted (GBS) and Greenish blue Zebra (GBZ).

Six pure line strains of eri silkworm had been selected and crossed following the diallel crossing technique and analyzed following Griffing's method. After combining ability studies among the six pure line strains two eri crosses viz., ES-1 (YZxGBS) and ES-2 (GBSxGBZ) have been developed (Debaraj, 2001). Field trial of two eri crosses revealed better performance in ES-1 in terms of fecundity, hatching, cocoon weight, shell weight, shell ratio, and yield (Table 2). To develop high yielding breed of eri silkworm in term of shell weight and fecundity utilizing the ecoraces like Borduar and Genung is under progress (Sinha, 2008).

Forest biodiversity and eri silkworm food plants

The total forest cover of India as per 'State of Forest Report 2003' is 678,333 km², which constitutes 20.64 % of the geographic area of the country and plays a significant role in biodiversity protection, global environment conservation, soil conservation, headwater conservation, health, recreational and cultural, material production (silk, timber, food such as mushroom etc, fertilizers, feeds, raw material for pharmaceutical and other industrial products, extracted ingredients, greening materials etc). These huge forest bio-resources may effectively be utilized for conservation and economic exploration of sericigenous insects for sustainable rural livelihood and poverty alleviation which is the major issue of developing country including India. The productivity improvement in mulberry sericulture sector is stagnant in spite of technological intervention in silkworm improvement as well as host plant management. However, growth rate of vanya silk is quite encouraging (31.16%) due to effective utilization of forest cover, improvement of rearing techniques, effective technological support in post-cocoon sectors. The North Eastern states, Jharkhand and Chattisgarh states of India are primarily dominated by tribal populations. The vanya silks are practiced mostly by these tribal and socio economically disadvantaged sections of the society.

Considering these facts, the Government of India under Forest (Conservation) Act, 1980 has issued notification in respect of vanya silk cultivation. Under this Act, the State/UT Forest Department should encourage silk cultivation in forests areas by tribals and non-tribals who live in and around the forests and are dependent on such forests for their livelihood. However, priority should be given to the tribals and to those enjoy traditional rights on such forests. The State/UT Forests Departments should permit such activities in already identified naturally grown forest areas for silk cultivation and the plantation raised for the purpose thereof in coordination with the State/UT Sericulture Department and Central Silk Board. Cultivation of trees on which vanya Silks or silk worms of Tasar, Oak Tasar, Muga, Eri and Frithi could be reared by tribals and non-tribals living in and around the forest areas for their livelihood without undertaking monoculture plantations should be traded as forestry activity. Therefore, no prior permission of the Central Government under Forests (Conservation) Act, 1980 is required.

Eri-silkworm *Samia ricini* (Donovan) is highly polyphagous in nature feeding on a number of host plants viz., Castor, *Ricinus communis* Linn; Kesseru, *Heteropanax fragrans* (Roxb.) Seem; Tapioca/Cassava, *Manihot esculanta* Crantz; Korha, *Sapium eugeniifolium* Buch-Ham; Payam, *Evodia flaxinifolia* Hook; Borpat, *Ailanthus grandis* Prain; Borkesseru, *Ailanthus excelsa* Roxb;

Gulancha, *Plumeria acutifolia* (Poir); Papaya, *Carica papaya*; Bangali era, *Jetropa curacus* Linn and several others. Further, one forest tree popularly known as 'Maiphak', *Evodia (Tetradium) meliaefolia* Benth under the family Rutaceae has been recorded as an alternative food plant of eri silkworm (Fig. 7).

Most of these plants are grown in natural forest in N.E. Region of India as well as in other parts of the country. The CMER&TI, Lahdoigarh has initiated the projects on collection, conservation and evaluation of different perennial food plants so that forest biodiversity may be utilized in eri silk industry. Some of the perennial food plants covered under the projects is highlighted below.

Tree of Heaven (*Ailanthus* species): *Ailanthus* (derived from *ailanto*, an Ambonese word probably meaning "tree of the gods" or "tree of heaven") is a genus of trees belonging to the family Simaroubaceae. The genus is native from East Asia south to northern Australasia. They are fast-growing deciduous trees growing to 25-45 m tall, with spreading branches and large (40-100 cm) pinnate leaves with 15-41 long pointed leaflets, the terminal leaflet normally present, and the basal pairs of leaflets often lobed at their bases. The number of species is disputed, with some authorities accepting up to ten species, while others accept six or fewer. There are four to five species available in India, which is distributed though out the country. A silk spinning moth, the *Ailanthus* moth, *Samia cynthia* feeds on *Ailanthus* leaves, and yields a silk more durable and cheaper than mulberry silk, but inferior to it in fineness and gloss. This type of silk is known under various names: "pongee", "eri silk" and "Shantung silk", the last name being derived from Shandong Province in China where this silk is often produced. Its production is particularly well known in the Yantai region of that province. The moth was also introduced in the United States (Li, 1993). Other Lepidoptera whose larvae feed on *Ailanthus* include *Endoclita malabaricus*. Several species of Lepidoptera utilize the leaves of *ailanthus* as food, including the Indian moon moth (*Actias selene*) and the common grass yellow (*Eurema hecabe*). In North America the tree is the host plant for the *ailanthus* webworm (*Atteva aurea*). In its native range *A. altissima* is associated with at least 32 species of arthropods and 13 species of fungi (Zheng et al., 2004).

The number of species of *Ailanthus* is disputed, with some authorities accepting up to ten species, while others accept six or fewer. The different *Ailanthus* species and their distribution are presented in the Table 2.

Chowdhury (2006) reported that four species exist in India, such as; *A. excelsa* (Borkesseru), *A. grandis* (Barpat), *A. altissima*, and *A. malabarica*. The first one is found in northern India, the second in Arunachal Pradesh, the third in Kashmir and the last one in Malabar Coast. *A. excelsa* is indigenous to India and more common in Bihar; Gujarat, Madhya Pradesh, Orissa and South India. In addition to its use as an ornamental plant, the tree of heaven is also used for its wood, medicinal properties and weed management. There are different genotypes of *Ailanthus* found in nature.

The present study on distribution of *Ailanthus* germplasm indicates that *A. excelsa* is available throughout N.E. Region i.e. Arunachal Pradesh (Papumpare district), Foothills of Nagaland, Bodo Territorial Council, Karbi Anglong and Manas reserve forest areas of Assam, Meghalaya. Further, *Ailanthus excelsa* and *A. trypsia* (syn. *malabarica*) is available in U.P., Rajasthan, Pune, Odisha, North Karnataka, Tamil Nadu, Kerala and Andhra Pradesh etc. The tree is indigenous to Southern and Central India and distributed in Western Peninsula, Rajasthan, Bihar, Orissa, Bundelkhand, throughout Madhya Pradesh, Broach and Panchamal district of Gujarat, in dry deciduous forests of Maharastra, scrace in

Deccan and Karnataka, N. Circars, forest of Tamilnadu. It is often planted along the roads (Kumar *et al.*, 2010). The present study also reflects that the distribution of *A. grandis* is restricted to N.E. Region only such as Kimin forest areas, Chessa forest and adjoining foothills and West Siang district, Tinsukia district, Manas forest area and Nambor reserve forest.

The phyto-chemical studies on *A. excelsa* demonstrated the presence of quassinoids, flavonoids, alkaloid, terpenoids, and proteins (Ogura *et al.*, 1977; Sherman *et al.*, 1980; Nag & Matai, 1994; Loizzo *et al.*, 2007). *A. excelsa* extracts and some isolated compounds have demonstrated medicinal properties such as significant antileukemic, antibacterial, antifungal and antifertility activities (Ogura *et al.*, 1977; Dhanasekaran *et al.*, 1993; Shrimali *et al.*, 2001; Joshi *et al.*, 2003). Phukan *et al.* (2006) reported that *Ailanthus grandis* Prain (Simaroubaceae-Quassia family) as an alternate food plant of eri silkworm.

Use of *A. excelsa* leaf at the last two stages save eri leaf requirement as the worm is a glutton (Chowdhury, 2006). Narayanswamy *et al.* (2006) studied the activity of amylase in digestive juice and hemolymph in eri silkworm and reported that the relationship was stronger for both castor and borkesseru than cassava. Hence, borkesseru could be exploited as suitable substitute for castor to rear eri silkworm. Saritha *et al.* (2009) also reported that the amylase activity of eri silkworm fed on Borkesseru (*Ailanthus excelsa*) was at par with those fed on castor. The present preliminary studies on evaluation of perennial food plants indicate that rearing performances (ERR, cocoon weight, shell weight and fecundity) of eri silkworm feeding on *Ailanthus grandis* (Borpat) and *Ailanthus excelsa* (Borkesseru) is better than *Heteropanax fragrans* (Kesseru) (Table 3). Further, Borpat and Borkesseru can be utilized throughout the year unlike Kesseru which shows comparative poor performance during summer crop (June-July). As castor leaf is not available throughout the year in farmer's field, the Borpat and Borkesseru are the best alternatives for sustainable eri silkworm rearing.

The data reflects that the biomass production in *Ailanthus* species is much higher than other perennial food plants and castor. Hence, utilization of *Ailanthus* plant in the eri silkworm may improve the rearing capacity of eri silkworm rearers by 2-3 times which is required for commercialization of the ericulture (Table 4). Further, *Ailanthus* species are forest based trees, so it may explored for livelihood security to the forest dwellers that are otherwise depend on tree felling causing large scale deforestation.

Strategies of conservation of sericigenous biodiversity

- ✓ Collection and maintenance of data bank on taxonomy, phenology, habitat preference, breeding system, and minimum population size of the sericigenous wild germplasms along with mapping of population, information on density within the site and interaction of species with the surrounding environments.
- ✓ Besides exploration of improved breed out of the existing eco-races of eri silkworm, it is also important of other concept of aiming at collection and maintenance of new species of eri silk moths from the field, if any, may be important from the standpoint of new concept for the future. It is well known that improvement of production and productivity of eri silk moths using existing stock in the laboratory is surely important, but

finding eri silk moths with extreme characteristics, such as having very fine filament of cocoons or having very thick filament of cocoons are also important. Because they are useful for development of new textiles with characteristic properties we cannot find elsewhere but in India or finding eri silk moths with extremely short life cycle, if any, is a source for future development.

- ✓ The genetic resources are renewable in nature or in similar *ex-situ* conservation with their proper management can fulfill human needs in larger extent.
- ✓ Proper inventorization of seri-biodiversity is need of the hour to productivity enhancement.
- ✓ Development and strengthening of *in situ* mechanism for seri-biodiversity conservation in forest and outside the protected areas.
- ✓ Collaboration among different stakeholders in national as well as regional level in the areas of policy, planning and R&D.
- ✓ Involvement of local communities, general public and scientific professionals for protection of the reserve. Further, strengthening of social capital of primary stakeholders should be emphasized for protection of seri-diversity as well as its sustainable utilization.
- ✓ Utilization of eri pupae in health and food industry is another promising filed for exploitation. Prof. Sumida had been supporting making medicinal mushrooms on Bombyx pupae to make so called 'winter insect summer grass' in a company in Japan. The company now sells the products as health foods. We believe some efforts will be needed to culture the medicinal mushrooms on eri pupae.

CONCLUSION

The concept of biodiversity conservation and gene bank maintenance have gained greater momentum in the recent times and the biodiversity wealth are considered as common heritage of mankind and sovereign rights of the nations. Seri-biodiversity refers to the variability in sericigenous insects and their host plants, which are economically and ecologically important biodiversity and by and large, forest based. There are several wild sericigenous insects and their host plants, which are abundant in the North Eastern and sub-Himalayan regions and other parts of the country. However, only five types of sericigenous insects are commercially exploited in India and there remains a great scope for producing novel silk from *Cricula trifenestrata* and *Attacus atlas* etc. The importance of these lesser known silk producing insects and their host plants should be studies and explored for betterment of mankind .In the recent times, Japan, China, Thailand and Korea have embarked on production of various other products from silkworm and their host plants, which makes sericulture more profitable

and highly sustainable. It is now essential for India to develop allied industries related to sericulture and make total use of the food plants and silkworm for different products, particularly pharmaceutical products. Being forest based, the wild silkworms contribute to the development of sustainable natural environment, which is very much required these days, since ozone layer is very much in threat due to rapid industrialization and other man made hazards.

LITERATURE CITED

- Ahmed, S. A., Goswami, D. & Mech, D.** 2012. Effect of pesticide applied in tea gardens on muga silkworm rearing. *Compendium of Seminar Papers*. National Seminar on Recent Trends in Research & Development in Muga Culture: Ideas to Action, 3-4 May 2012, Guwahati, pp: 114-121.
- Ahmed, S. A. & Rajan, R. K.** 2011. Exploration of vanya silk biodiversity in North Eastern Region of India: Sustainable livelihood and poverty alleviation. *Proceedings of International Conference on Management, Economics and Social Sciences (ICMESS'2011)*, December 23-24, 2011 at Bangkok, Thailand. pp. 485-489.
- Ahmed, S. A., Dutta, L. C. & Khound, J. N.** 1996. Biology and feeding behavior of *Cricula trifenestrata* Helf. (Lepidoptera: Saturniidae)- A pest of Som, *Machilus bombycina* King. *J. Appl. Zool. Res.*, 7 (2): 135-136.
- Arora, G. S. & Gupta, I. J.** 1979. Taxonomic studies of some of the Indian non-mulberry silk moths (Lepidoptera: Saturniidae). *Memoirs of Zoological Survey of India*, 16: 1-63.
- Barthlott, W., Linsenmiar, K. E. & Porembski, S.** 2005. Biodiversity: Structure and Function. Vol. I, *Encyclopedia of Life Support System*.
- Chinnaswamy, K. P.** 2001. Sericulture biodiversity in India. pp. 54-61. In: Balla, M. K., Rayamajhi, S. & Pradhan, N. M. B. (eds.), *Participatory Biodiversity Conservation in South Asia Region*. Fonarem, Kathmandu, Nepal.
- Chowdhury, S. N.** 2006. Host Plant species of Non-mulberry (Vanya) Silkworms. *Non-Mulberry Silkworm and Host Plants Germplasm*. pp. 67-73.
- Debaraj, Y., Sarmah, M. C., Datta, R. N., Singh, L. S., Das, P. K. & Benchamin, K. V.** 2001. Field trial of elite crosses of eri silkworm. *Indian Silk*, June: 15-16.
- Dhanasekaran, S., Suresh, B., Sethuraman, M., Rajan, S. & Dubey, R.** 1993. Antifertility activity of *Ailanthus excelsa* Linn. in female albino rats. *Indian Journal of Experimental Biology*, 31: 384-385.
- Hawksworth, D. L. & Kalin-Arroyo, M. T.** 1995. Magnitude and Distribution of Biodiversity. In: Heywood, V. H. (ed.), *Global Biodiversity Assessment*, pp. 107-191. Cambridge University Press, Cambridge.
- Hazarika, L. K. & Bhuyan, M.** 2006. Problems and prospects of non-mulberry germplasm conservation with special reference to the wild silk moths. *Non-mulberry silkworm and host plants: strategies for maintenance*, pp. 125-136.
- Hazarika, L. K. & Bhuyan, M.** 2003. Muga- the golden silk of Assam-scope for improvement of rural economy of Assam. *Souvenir, National Symposium on Biochemical Approaches for Utilization and Exploitation of Commercially Important Plants*, IX Convention and Syposium, Indian Soc. of Agril. Biochemists, Nov. 12-14, 2003, pp. 40-50.
- Hughes, J. B., Daily, G. C. & Ehrlich, P. R.** 1997. Population diversity: its extension and extinction. *Science*, 278: 689-692.
- Jolly, M. S., Sen, S. K., Sonwalkar, T. N. & Prasad, G. S.** 1979. Non-mulberry silks. *Food & Agriculture Organisation*. United Nations, Services Bulletin, Rome, 29: 178.
- Joshi, B. C., Pandey, A., Chaurasia, L., Pal, M., Sharma, R. P. & Khare, A.** 2003. Antifungal activity of the stem bark of *Ailanthus excelsa*. *Fitoterapia*, 74: 689-691.
- Kakati, L. N. & Chutia, B. C.** 2009. Diversity and ecology of wild sericigenous insects in Nagaland, India. *Tropical Ecology*, 50 (1): 137-146.
- Koopowitz, H. & Kaye, H.** 1990. *Plant Extinction—a global crisis*. Christopher Helm, London.
- Kumar, D., Bhat, Z. A., Singh, P., Shah, M. Y. & Bhujbal, S. S.** 2010. *Ailanthus excelsa* Roxb. is Really a Plant of Heaven. *International Journal of Pharmacology*, 6 (5): 535-550.
- Li, H.-L.** 1993. "Simaroubaceae". in *Editorial Committee of the Flora of Taiwan*. *Flora of Taiwan*, Volume 3: Hamamelidaceae-Umbelliferae (2nd ed.) <http://tai2.ntu.edu.tw/udth/bin/fot1.exe/browse>
- Loizzo, M. R., Said, A., Tundis, R., Rashed, K., Statti, G. A., Hufner, A. & Menichini, F.** 2007. Inhibition of Angiotensin Converting Enzyme (ACE) by Flavonoids isolated from *Ailanthus excelsa* (Roxb)(Simaroubaceae). *Phytotherapy Research*, 21: 32-36.
- May, R. M., Lawton, J. H. & Stork, N. E.** 1995. Assessing extinction rates. In: *Extension Rates* (eds. Lawton, J. H. & May, R. M.). Oxford University Press, London. pp. 1-24.

Moucha, J. 1966. Beautiful moths. Drury House, London.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Fonseca, G. A. B. & Kent, J. 2000. Biodiversity hot spots for conservation priorities. *Nature*, 403: 853-858.

Nag, A. & Matai, S. 1994. *Ailanthus excels* Roxb. (Simaroubaceae), a Promising Source of Leaf Protein. *Journal of Agriculture and Food Chemistry*, 42: 1115-1117.

Narayanswamy, K. C., Gowda, M. & Amarnatha, N. 2006. Barkesseru (*Ailanthus excelsa* Roxb.), an Ideal Substitute for Castor to rear Eri Silkworm, *Samia ricini* Boisduval.

Nassig, W. A., Lempe, R. E. J. & Kger, S. 1996. The Saturniidae of Sumatra (Lepidoptera). *Heterocera Sumatrana*, 10: 3-10.

Ogura, M., Cordell, G. A., Kinghorn, A. D. & Farnsworth, N. R. 1977. Potential anticancer agents VI. Constituents of *Ailanthus excelsa* (Simaroubaceae). *Lloydia*, 40: 579-584.

Peigler, R. S. 1993. Wild silks of the world. *American Entomologist*, 39L: 151-163.

Peigler, R. S. & Nauman, S. 2003. A Revision of the Silkmoth Genus *Samia*. University of the Incarnate World, San Antonio, Texas.

Phukan, J. C. D., Singh, K. C., Neog, K. & Chakravorty, R. 2006. *Ailanthus grandes* prain (Simaroubaceae-Quassia family) An alternate food plants of eri silkworm *Samia ricini* (DONOVAN). In: Proceeding of National workshop on Eri food plants. 2005 Guwahati, 102-110.

Saritha Kumari, S., Narayanswamy, K. C. & Gowda, M. 2009. Amylase Activity in Eri Silkworm, *Samia Cynthia ricini* Boisduval as influenced by Host Plants. *Indian J. Ecol.*, 36 (1): 71-74.

Sarmah, M. C., Ahmed, S. A. & Sarkar, B. N. 2012. Research & technology development, byproduct management and prospects in Eri culture - A review. *Munis Entomology & Zoology*, 7 (2): 1006-1016.

Sherman, M. M., Borris, R. P., Ogura, M., Cordell, G. A. & Farnsworth, N. R. 1980. 3S, 24S, 25-Trihydroxytirucall-7-ene from *Ailanthus excelsa*. *Phytochemistry*, 19: 1499-1501.

Shrimali, M., Jain, D. C., Darokar, M. P. & Sharma, R. P. 2001. Antibacterial activity of *Ailanthus excelsa* (Roxb). *Phytotherapy Research*, 15: 165-166.

Singh, K. C. & Chakrovorty, R. 2006. Seri-biodiversity of North Eastern India-an update. pp. 8-19. In: J. P. Srivastava, P. K. & K. Thangavelu (2005). *Sericulture and Seri biodiversity*. Associated Publishing Company, New Delhi.

Sinha, B. B. 2008-2009. Development of eri silkworm *Samia ricini* (Donovan) breed with higher fecundity and shell weight. Annual Report, CMER&TI, Lahdoigarh.

Sunarintyas, S., Siswomihardjo, W. & Tontowi, A. E. 2012. Cytotoxicity of *Cricula triphenestrata* Cocoon Extract on Human Fibroblasts. *International Journal of Biomaterials*, Volume 2012, Article ID 493075.

Thangavelu, K. 1991. Wild sericigenous insects of India. A need for conservation. *Wild Silk moths*, 91: 71-77.

Thangavelu, K., Rao, K. V. S. & Pandey, V. K. 2002. Wild silk moths' diversity and conservation. *International Journal of Wild Silk Moths*, 7: 87-93.

Watson, A. & Whalley, P. E. S. 1983. *The Dictionary of Butterflies and Moths in colour*. Peerage Books, London, England.

Wilson, E. O. 1992. *The Diversity of Life*. Norton, New York.

Zheng, H., Wu, Y., Ding, J., Binion, D., Fu, W. & Reardon, R. 2004. "*Ailanthus altissima*". *Invasive Plants of Asian Origin Established in the United States and Their Natural Enemies*, Volume 1. USDA Forest Service.

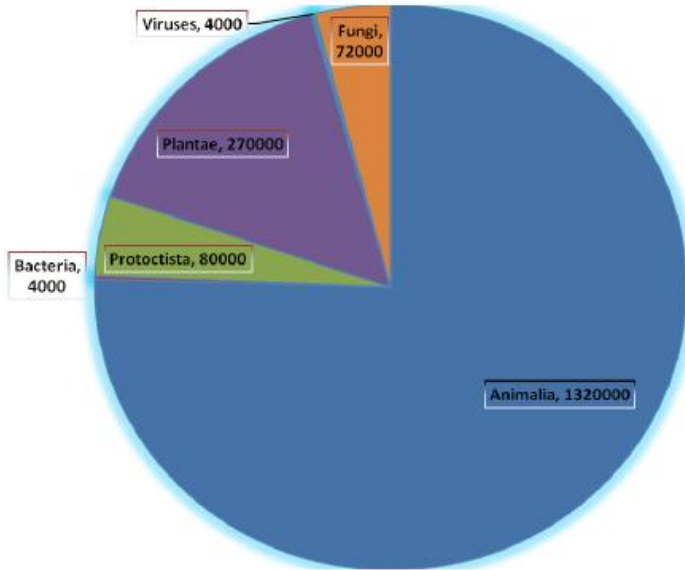


Figure 1. Number of organisms currently described (Hawksworth & Kalin-Arroyo, 1995).

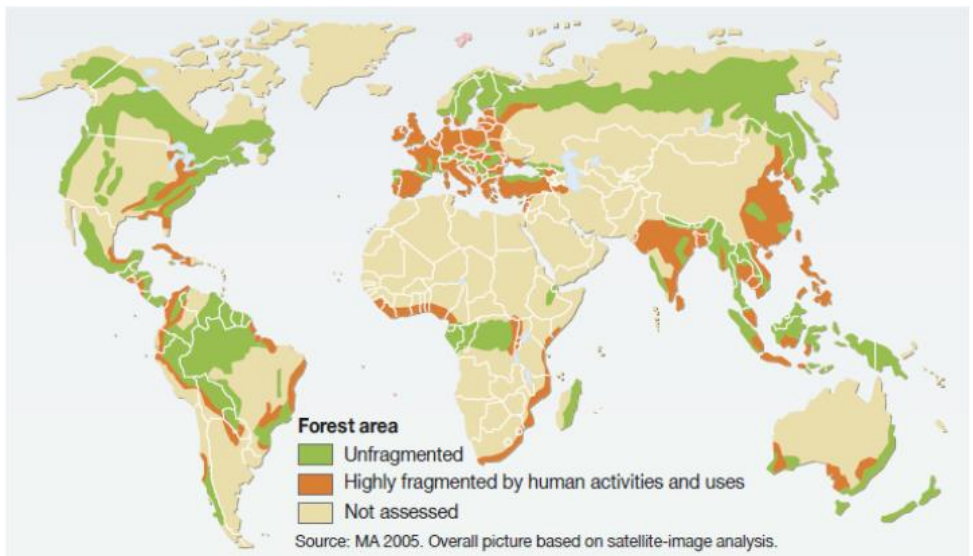


Figure 2. Global Forest Fragmentation.

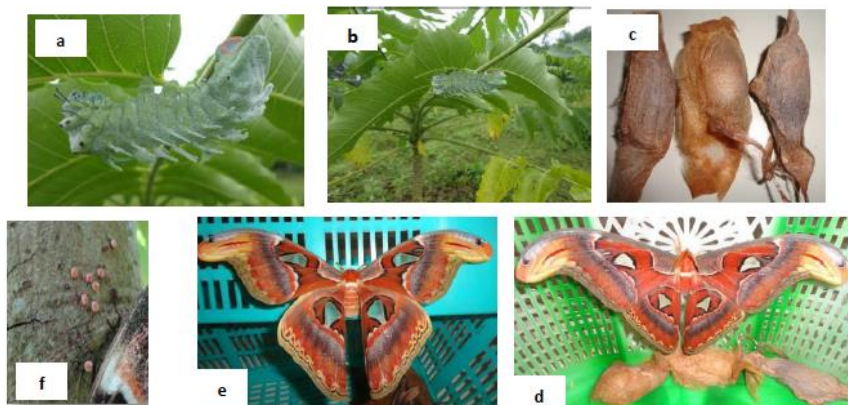


Figure 3. (a-b) *Attacus atlas* caterpillar feeding on *Ailanthus excelsa* plant (c) Cocoons of *A. atlas* (d) Male moth of *A. atlas* (e) Female moth of *A. atlas* (f) Eggs laid on bark of tree.

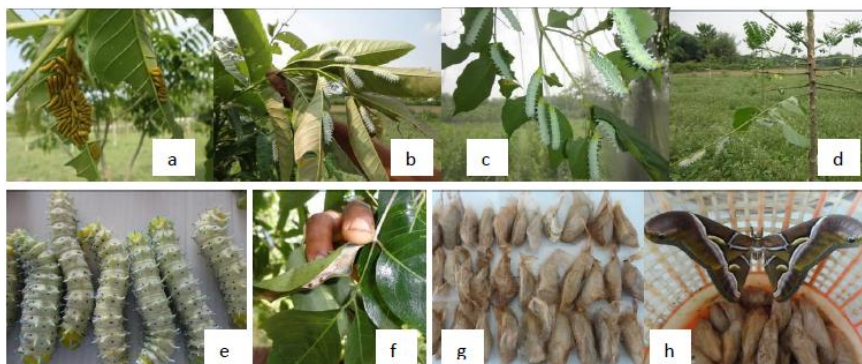


Figure 4. (a-b) *S. canningi* feeding on payam. (c) feeding on kesseru (d) feeding *A. grandis*, (e) mature larva (f) cocoon formation on leaf (g) cocoons & (h) emergence of moth.

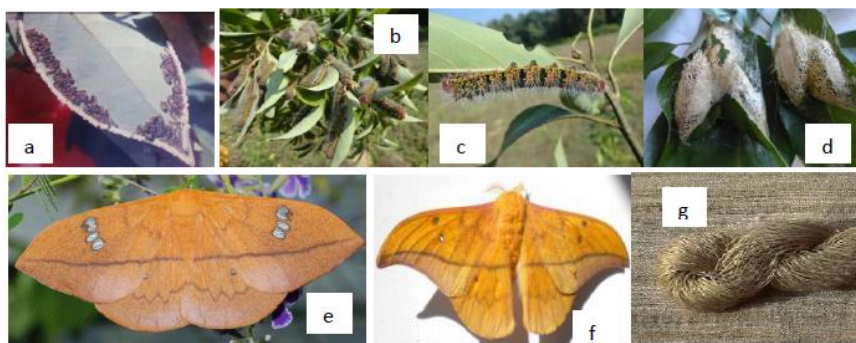


Figure 5. *Cricula trifenestrata* (a) eggs with newly hatched caterpillars (b&c) mature caterpillars (d) cocoons (e) female moth (f) male moth and (g) spun yarn.

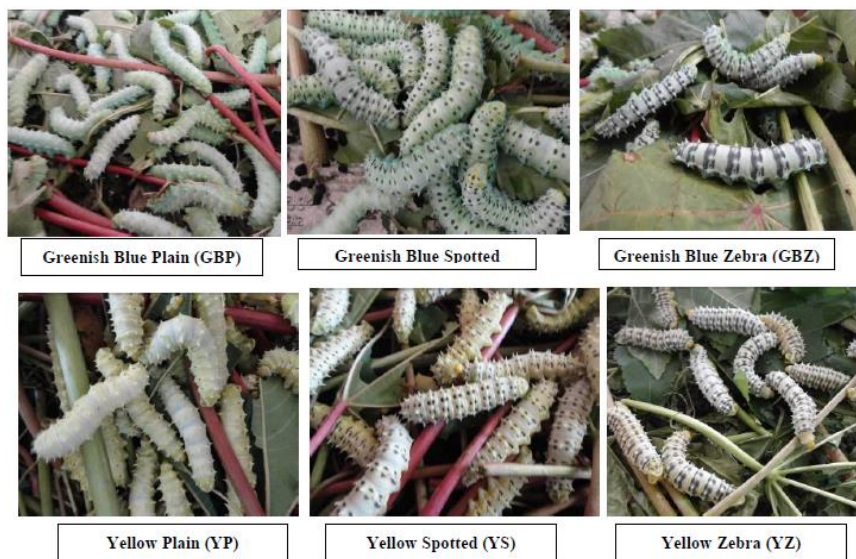


Figure 6. Different strains of eri silkworms maintained at GCC, Central Silk Board, Chenijan.



Figure 7. (a) Maiphak plant (b) Eri silkworm feeding on Maiphak.



Figure 8. *Ailanthus grandis* germplasm at GCC, CMER&TI, Chenijan.



Figure 9. *Ailanthus excelsa* germplasm in different parts of India [(a) CMER&TI, Jorhat (b) Delhi (c) Diphu, Assam (d) St. Mount park, Chennai (e) Adabari, Kokrajhar (f) Dimapur, Nagaland (g) Khurda, Odisha and (h) Chessa forest, Arunachal.



Figure 10. (a) Rearing of Eri silkworm feeding on *Ailanthus grandis*, (b) Rearing of eri silkworm feeding on *Ailanthus excels*.

Table 1. Listing of Passport data of eri silkworm accessions.

Sl. No.	Accession No.	Race name	Donor	Origin	Class	Parentage
1	SRI-001	Borduar	RERS, MEG	ASM	O(RCU)	OR
2	SRI-002	Titabar	RERS, MEG	ASM	O(RCU)	OR
3	SRI-003	Khanapara	RERS, MEG	ASM	O(RCU)	OR
4	SRI-004	Nongpoh	RERS, MEG	MEG	O(RCU)	OR
5	SRI-005	Mendipathar	RERS, MEG	MEG	O(RCU)	OR
6	SRI-006	Dhanubhanga	RERS, MEG	ASM	O(RCU)	OR
7	SRI-007	Chuchuyimlang	CMERTI, ASM	NAL	N	OR
8	SRI-008	Lahing	CMERTI, ASM	ASM	N	OR
9	SRI-009	Barpathar	CMERTI, ASM	ASM	N	OR
10	SRI-010	Diphu	CMERTI, ASM	ASM	N	OR
11	SRI-011	Adokgri	CMERTI, ASM	MEG	N	OR
12	SRI-012	Lakhimpur	CMERTI, ASM	ASM	N	OR
13	SRI-013	Dhemaji	CMERTI, ASM	ASM	N	OR
14	SRI-014	Kokrajhar	CMERTI, ASM	ASM	N	OR
15	SRI-015	Imphal	CMERTI, ASM	MAN	N	OR
16	SRI-016	Cachar	CMERTI, ASM	ASM	N	OR
17	SRI-017	Dhakuakhana	CMERTI, ASM	ASM	N	OR
18	SRI-018	Genung	RERS, MEG	MEG	N	OR
19	SRI-019	Jonai	CMERTI, ASM	ASM	N	OR
20	SRI-020	Dhansiripar	CMERTI, ASM	NAL	N	OR
21	SRI-021	Sadiya	CMERTI, ASM	ASM	N	OR
22	SRI-022	Tura	CMERTI, ASM	MEG	N	OR
23	SRI-023	Jona Kachari	CMERTI, ASM	ARP	N	OR
24	SRI-024	Barpeta	CMERTI, ASM	ASM	N	OR
25	SRI-025	Ambagaon	CMERTI, ASM	ASM	N	OR
26	SRI-026	Rongpipi	CMERTI, ASM	ASM	N	OR

SRI – *Samia ricini*, RERS – Regional Eri Research Station, CMERTI – Central Muga Eri Research & Training Institute, MEG – Meghalaya, ASM – Assam, NAL – Nagaland, MAN – Manipur, ARP – Arunachal Pradesh, O – Old, RCU – Race in current use, N – New, OR – Original Race.

Table 2. Distribution of different *Ailanthus* species.

<i>Ailanthus</i> species	Distribution
<i>Ailanthus altissima</i>	Northern and central mainland China, Taiwan, arguably the best known species
<i>Ailanthus excelsa</i>	India and Sri Lanka
<i>Ailanthus grandis</i>	India
<i>Ailanthus integrifolia</i>	New Guinea and Queensland, Australia
<i>Ailanthus malabarica</i>	Southeast Asia
<i>Ailanthus triphyssa</i>	Northern and eastern Australia
<i>Ailanthus vilmoriniana</i>	Southwest China

APHIDS SPECIES IN CITRUS ORCHARDS OF ANTALYA PROVINCE

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ABSTRACT: This study was carried out in 2012-2013 at citrus orchards in Antalya province. The aim of this study was to determine aphid species in citrus orchards. *Aphis craccivora* Koch, 1854; *Aphis fabae* Scopoli, 1763; *Aphis gossypii* Glover, 1877; *Aphis spiraeicola* Patch, 1914; *Aphis (Toxoptera) aurantii* Boyer de Fonscolombe, 1841; *Brachycaudus (Acaudus) cardui* (Linnaeus, 1758); *Rhopalosiphum maidis* (Fitch, 1856); *Myzus (Nectarosiphon) persicae* (Sulzer, 1776) species were identified. While *Aphis craccivora* was found widespread, *Brachycaudus (Acaudus) cardui* was found rarely.

KEY WORDS: Aphids, citrus, Antalya, host plant

Citrus is widely produced in Mediterranean, Aegean and Black Sea regions in Turkey. World citrus production was 123.755-750 tons in 2010. 56% of this production is oranges (FAO, 2010). The main species of citrus genus include citrus (*Citrus aurantium*), orange (*C. sinensis*), mandarin (*C. reticulata*), grapefruit (*C. paradisi*), bergamot (*C. bergamia*) and lemon (*C. limon*) which is an economical important. Fruits of citrus plant are used as food. Both their fruits are used as nutrition and their fruit shells, leaves and flowers are used for perfumery industry.

Some citrus pests are restrictive factors in citrus production. Aphids are one of the important pests of citrus. They are especially pest in nurseries. Their mouthparts are sucking and they cause a curling of the plant leaves. Aphids may also transmit viruses from plant to plant.

The aim of this study was to determine aphid species in citrus orchards of Antalya province in Turkey.

MATERIAL AND METHODS

In this study, samples were based on apterous viviparous female, alate viviparous female and sexual form of Aphidoidea species which were collected from citrus orchards of Antalya province in Turkey. Samplings were made on citrus branches, leaves and flowers between 2011-2013. Surveys were done two times in spring and summer months and a time in autumn and winter months. Samples were more frequently collected in shoot periods in different areas and orchards. Preparation procedures of aphids were made according to Hille Ris Lambers (1950).

RESULTS

Annotated list of the aphid species collected in Antalya

Tribe: Aphidini

Subtribe: Aphidina

Genus: *Aphis* Linnaeus, 1758**Species: *Aphis craccivora* Koch, 1854**

Diagnostic notes: Apterous viviparous female; body broadly pear-shaped, plump, and black in colour. There is a reticulated plate on the shiny dorsal surface of body. Eyes are blackish red, proboscis is pale greenish yellow at base and dusky colored at apex. First and 2nd antennal segments are black, 3rd and 4th segments are cream colored and 5th segment blacky and 6th segment is black. Distal of tarsus and tibia in the legs are close to dark in blackish colour and another parts are with creamy beige colour. Siphunculi, cauda and genital plate are black. Body length is about 1.88 (± 0.31) mm. Proboscis is long and a little longer than second coxa. Average length of antenna is about 1.27 (± 0.04) mm and shorter than body length. First antennal segment is wide and its length is almost as long as second segment. Other segments are thin and long. There is a primer rhinaria on 5th and 6th segments. There is not seconder rhinaria at 3rd segment. Tarsus has two segments like another aphid species and apex segment has one pair claw and there are 2-3 hairs on segments. The spinculi is cylindrical, thinning towards to apex and it makes a lip-shaped convolution. Cauda s long and with spinal structure. There are 5-8 bristle on cauda. Genital plate are also with 11-18 bristle.

Alate viviparous female; body is longly oval shaped and completely dark brownish black in colour. Eyes are close to blackish red colour, proboscis is pale greenish at basement and dusky colored at apex. Firts two segments of antenna and distal of other segments are with dark colour and other parts are with creamy beige colour. Except the distal of coxa and tibia, legs are light brown beige in colour. Tarsus, siphunculi, cauda and genital plate are black. Wing veins are blackish brown, stigma is more light brown in colour. Body length is about 1.79 (± 0.262) mm. Proboscis is long and extends to second coxa. First two segments of antenna are short, others are thin and long. Average length of antenna is about 1.19 (± 0.088) mm. The inner face of second segment of antenna is rough. Second segment of antenna is roughly appearance on inner surface. There is a primer rhinaria on 5th and 6th segments and there are 5-11 seconder rhinaria on 3rd segment. Generally, fourth segment has not seconder rhinaria but rarely it has a rhinaria. The siphunculi is cylindrical shaped and initially it thins till to middle part, then continues in same wide. Its tip is with curled. Cauda is thornlike appearance and has 4-7 bristle. Genital plate is with dark colour and 8-14 bristle (Blackman & Eastop, 1984; Stroyan, 1984) (Figs. 1a,b).

Host plants: *Acacia* sp., *Alchemilla vulgaris*, *Alhagi pseudalhagi*, *A. camelorum*, *Alhagi* sp., *Amaranthus retroflexus*, *Anagallis* sp., *Anchusa* sp., *Anthemis* sp., *Arachis hypogaea*, *Astragalus verus*, *Begonville* sp., *Brassica oleracea*, *Bromus japonicus*, *B. sterilis*, *Calendula* sp., *Calluna vulgaris*, *Camellia japonica*, *Capsicum annum*, *Capsella bursa pastoris*, *Cardaria draba*, *Catalpa* sp., *Centaurae* sp., *Chenopodium album*, *Cichorium intybus*, *Cicer arietinum*, *Cirsium* sp., *Citrus aurantium*, *Citrus nobilis*, *Colutea arborescens*, *Convolvulus arvensis*, *Crepis foetida*, *Cucumis melo*, *Cucurbita pepo*, *Cydonia vulgaris*, *Dipsacus laciniatus*, *Euphorbia* sp., *Galium aparine*, *Glycyrrhiza glabra*, *Gossypium herbaceum*, *G. hirsutum*, *Heracleum* sp., *Hibiscus esculentus*, *Lactuca sativa* var. *crispa*, *Lathyrus ochrus*, *Lens esculentum*, *Lycopersicum esculentum*, *Malus domestica*, *Malva* sp., *Medicago sativa*, *Medicago* sp., *Melilotus indicus*, *Mentha* sp., *Mespilus germanica*, *Onobrychis viciaefolia*, *Phaseolus vulgaris*, *Portulaca oleraceae*, *Prunus amygdalus*, *P. armeniaca*, *P. avium*, *P. persicae*, *P. spinosa*, *Pyrus communis*, *P. malus*, *Ranunculus glacialis*, *Ribes rubrum*, *Robinia pseudoacacia*, *Robinia* sp., *Rosa* sp., *Rumex alpinus*, *R. patientia*, *Rumex* sp., *Sanguisorba minor*, *Senecio vulgaris*, *Solanum*

lycopersicum, *S. melongena*, *S. nigrum*, *Spartium junceum*, *Syringa* sp., *Taraxacum officinale*, *Tripleurospermum decipiens*, *Tribulus terrestris*, *Trifolium* sp., *Urtica urens*, *Verbascum* sp., *Viburnum opulus sterile*, *Vicia angustifolia*, *Vigna sinensis*, *Viscaria* sp. and *Vitex agnus castus* were determined as hosts (Düzgüneş & Toros, 1978; Tuatay, 1993; Ölmez, 2000; Toros et al., 2002; Atalay & Uysal, 2005; Ayyıldız & Atlıhan, 2006; Kocadal, 2006; Kaygın et al., 2008).

Material examined: Samples were collected from *Citrus sinensis*, *Citrus paradisi*, *Citrus limon* trees.

Species: *Aphis fabae* Scopoli, 1763

Diagnostic notes: Apterous viviparous female; body is brown–greenish in colour, abdomen un-uniformly pigmented.

Alate viviparous female; body colour changes from brown to black. There are irregular dark green blackish patches on the abdomen. Alive individuals of *Aphis fabae* are matte black or very dark brown. While wingless individuals always have white pleural wax secretions, young individuals have rarely punctations. Alate individuals have sclerites on 4th and 5th segment of abdomen and cauda is dark (Blackman & Eastop, 1984; Stroyan, 1984) (Figs. 2a,b).

Aphis fabae Scopoli is a polyphagous pest and widespread all over the world. It was recorded first time on *Robinia pseudoacacia* at Florya/İstanbul in 1938 year in Turkey (Schmitschek, 1944).

Host plants: *Pimpinella anisum*, *Vitis vinifera*, *Solanum* sp., *Euonymus* sp., *Viburnum* sp. (Bodenheimer & Swirski, 1957), *Solanum dulcamara* (Tuatay & Remaudiere, 1964), *Arbitus verachne*, *A. unedo* (Çanakçıoğlu, 1967), *Solanum lycopersicum*, *Cucurbita pepo*, *Ranunculus* sp., *Zea mais* (Çanakçıoğlu, 1966, 1975), *Papaver* sp., *Nicotiana tabacum*, *Vicia fabae*, *Philadelphus coronarius*, *Matricaria* sp., *Amaranthus* sp., *Lactuca sativa* (Giray, 1974), *Foeniculum vulgare* and *Ferula* sp. (Tuatay et al., 1972; Düzgüneş et al., 1982).

In the Europe conditions, *Euonymus europaeus*, *Viburnum opulus* and *Philadelphus coronarius* are its primer hosts and they moved to seconder herbaceous hosts (Stroyan, 1984).

Material examined: Samples collected from *Citrus sinensis*, *Citrus paradisi*, *Citrus limon* in this study.

Species: *Aphis gossypii* Glover, 1877

Diagnostic notes: Apterous viviparous female; body is longish and oval, grayish black in colour. Head is small and dark, eyes are dark red and blackish red, proboscis is pale greenish yellow at base and dusky colored at apex. Antennae; light tones greenish yellow in color and last segment is dark. Thorax is grayish, greenish black. Siphunculi and cauda are black. Legs are light yellowish-grey, tarsus and end portion of the tibia black. Genital plate is usually dark brunette. Body length is about 1.64 (± 0.347). Proboscis is long and longer than second coxa. Antenna length is 1.11 (± 0.099) mm and it is shorter than body length. Antenna are 6 segments and have several short bristles. First antennal segment is wide and length almost as long as second segment. Other segments are thin and long. There is not seconder rhinaria on 3rd segment and there is one primer rhinaria on 5th and 6th segments. Tarsus have two segments and these segments has one pair claw at apex. The siphunculi is cylindrical and has patterns like tile, broaded at basement and gradually slimmed after its half and curled towards to outside at the apex part. Cauda with spinal structure and a little narrowed at middle part. Generally there are 5-6 seta on cauda and every side has 3 seta. There are 8-14

hairs on genital plate.

Alate viviparous female; head and thorax is black, eyes are blackish dark red. Proboscis is pale greenish at base and dusky colored at apex. Antenna is greyish-brown in colour. Except the distal of tibia, legs are light brownish beige and tarsi is black in colour. Abdomen is greyish, greenish black, siphunculi is black, cauda and genital plates are dusky colored. Body length is about 1.63 (± 0.277) mm. Proboscis is long and longer than second coxa and there are second hairs on last segment. Antenna is shorter than body, with 6 segments and short thin bristles. Its length is about 1.14 (± 0.144) mm. Antenna have patterns like tile, there are 5-10 second rhinaria on 3rd antennal segment. There is not any second rhinaria on 4th antennal segment or there are 1-2 rhinaria. There is one primer rhinaria on 5th and 6th antenal segments. Tarsus has two segments and first tarsus segment has irregular bristles on. There is a pair of claw at top of last tarsus segment. The siphunculi is cylindrical and broadened at the basement. After basement, it is slimmed till its half. It continues till its apex at the same width and slightly curl up towards at apex. The siphunculi has patterns like tile. Cauda has with spinal structure and a little narrowed at middle part, with 4-6 hairs. There are 8-19 seta on genital plate (Blackman & Eastop, 1984; Stroyan, 1984) (Figs. 3a,b).

Host plants: *Abutilon* sp., *Acacia* sp., *Allium cepa*, *Aquilegia vulgaris*, *Asparagus* sp., *Ageratum* sp., *Alliaria* sp., *Borago officinalis*, *Begonia* sp., *Bideus* sp., *Bromus japonicus*, *Callendula* sp., *Canna* sp., *Capsella bursa-pastoris*, *Capsicum annuum*, *C. annuum* var. *longum*, *Cardaria draba*, *Carduus* sp., *Carthamus tinctorius*, *Catalpa bignonioides*, *Chrysanthemum leucanthemum*, *Cineraria* sp., *Citrus bigardia*, *C. nobilis*, *C. sinensis*, *Citrus* sp., *Citrullus lanatus*, *C. vulgaris*, *Colocasia* sp., *Convolvulus arvensis*, *Crepis foetida*, *Cryptostegia* sp., *Cucumis flexunsus*, *C. melo*, *C. melo* var. *chate*, *C. sativus*, *Cucurbito pepo*, *Crategus* sp., *Daucus carota*, *Dipcadi* sp., *Eucaliptus camaldulensis*, *Eriobotrya japonica*, *Erodium cicutarium*, *Euphorbia* sp., *Erythaea* sp., *Ficus carica*, *Ficus sycomorus*, *Gaillardia pulchella*, *Gossypium herbaceum*, *G. hirsutum*, *Hibiscus esculentus*, *H. syriacus*, *H. japonica*, *Hypericum canariense*, *Lactuca sativa*, *Lilium* sp., *Lycopersicon esculentus*, *Mangifera indica*, *Malus communis*, *Malva* sp., *Mentha piperita*, *M. viridis*, *Musa* sp., *Nicotiana tabaccum*, *Nigella* sp., *Ocimum basilicum*, *Passiflora* sp., *Phaseolus vulgaris*, *Phoenix dactylifera*, *Pistacia palaestina*, *Portulaca oleracea*, *P. solanaceae*, *Psidium guajava*, *Pyracantha coccinea*, *Punica granatum*, *Polygonum* sp., *Preunia* sp., *Prunus amygdalus*, *P. domestica*, *Pyrus communis*, *P. malus*, *Punica granatum*, *Rhamnus* sp., *Raphanus sativus*, *Robinia pseudoacacia*, *Rosa polyantha*, *Rumex* sp., *Russelia juncea*, *Salvia splendens*, *Salix alba*, *Salix* sp., *Scorzonera cana*, *Sesamum indicum*, *Sonchus oleraceus*, *Solanum lycopersicum*, *S. melongena*, *S. tuberosum*, *Spathodea* sp., *Teucrium polium*, *Tribulus terrestris*, *Tulipa* sp., *Vicia fabae*, *Vitis vinifera*, *Vitex agnes-castus*, *Viola* sp. and *Zinnia* sp. were determined as hosts (Düzgüneş & Tuatay 1956; Bodenheimer & Swirski, 1957; Tuatay & Remaudiere, 1964; Giray, 1974; Çanakçıoğlu, 1975; Düzgüneş et al., 1982; Zeren, 1989; Tuatay, 1993; Yumruktepe & Uygün, 1994; Özdemir & Toros, 1997; Blackman & Eastop 2000; Ölmez, 2000; Toros et al., 2002; Görür, 2004; Atalay & Uysal, 2005; Kaygın et al., 2008).

It was reported first time on *Euphorbia* sp., *Hibiscus esculentus*, *Rhamnus* sp., *Citrus sinensis* in Turkey (Aegean region) at 1937 (İyriboz, 1937).

Material examined: Samples were collected on *Citrus sinensis*, *Citrus paradisi*, *Citrus limon* in this study.

Species: *Aphis spiraeicola* Patch, 1914

Diagnostic notes: Apterous viviparous female; body is plump and oval shaped, lemon yellow or apple green in color. Head is grey, compound eyes are black, proboscis is grey at base, dark at apical, antennae are usually dark. Thorax is grey. Except distal part of tibia in legs, other parts are light color, whole tarsi is dark, abdomen is yellowish green, siphunculi and cauda are black, anal plate is grey in color. Body length is 1.75 (± 0.24) mm. Proboscis is long but not reaching to second coxa. Antennae is shorter than body, 1.19 (± 0.11) mm length, with 6 segments and thin hairy on. First segment of antennae is wide and its length as long as second antennal segment, others are thin and long. There is a primer rhinaria on 5th and 6th antennal segments. Third antennal segment of apterous viviparous females is without seconder rhinaria. Fourth antennal segment has 0-5 seconder rhinaria. Tarsus is with two segments, apical segment is longer than basal segment and with two hairs and two claws. Siphunculi is pointed and tapers towards tip. Siphunculi is longer than cauda. Cauda is constricted in the middle and has 9 hairs. Anal plate is covered by hairs.

Alate viviparous female; body is longish and oval, head is dark colored, compound eyes are black, proboscis is grey at base, dark at apical, antennae are usually grey. Thorax is grey. Except distal part of tibia in legs, other parts are grey, whole tarsi is black, abdomen is yellowish with laterally dark patches, siphunculi is dark and cauda is black, anal plate is dark in color. Body length is 1.67 (± 0.23) mm. Proboscis is long but not reaching to second coxa. There are seconder hairs on last segment of proboscis. Antennae are shorter than body, with 6 segments and thin hairy on and length is about 1.16 (± 0.07) mm. First segment of antennae is wide and its length is as long as second antennal segment, others are thin and long. Antenna has two primer rhinaria, one of them is on the anterior of 5th segment, other is on apical of the basal of 6th segment. Small group of rhinaria is on lateral parts of last antenna segment. There are 4-10 seconder rhinaria on the 3rd antennal segment. There is not any seconder rhinaria on 4th antennal segment or there are 1-3. Seconder rhinaria with rounded shape, Tarsus is with two segment. Second segment is longer than first segment and it has two hair and two claws. Siphunculi is with distal section thicker than basal section. It is longer than cauda. Cauda is constricted in the middle and has 8-9 hairs, anal plate have 8-12 hairs (Blackman & Eastop, 1984; Stroyan, 1984) (Figs. 4a,b).

Host plants: *Cotoneaster franchatii*, *C. salicifolia*, *Citrus aurantium*, *C. limonum*, *C. limon*, *C. grisea*, *C. nobilis*, *C. sinensis*, *C. paradisi*, *C. reticulata*, *Cydonia oblonga*, *Eriobotrya japonica*, *Hibiscus esculentus*, *H. rosa chinensis*, *Hoya carnosa*, *Hydrangea hortensia*, *Hydrangea* sp., *Lavandula* sp., *Malus* spp., *Mespilus germanica*, *Onopordum davisii*, *Paliurus spinachristi*, *Pyracantha coccinea*, *Pyrus communis*, *Prunus domestica*, *Spiraea bumalda*, *S. vanhouetti*, *Spiraea* sp., *Viburnum opulus*, *V. tinus*, *Taraxacum officinale* were determined as hosts (Tuatay & Remaudiere, 1964; Düzgüneş et al., 1982; Tuatay, 1993; Ölmez, 2000; Toros et al., 2002; Görür, 2004; Satar & Uygün, 2007; Çota, 2007).

The species was reported on *Citrus limonum* in Adana, Turkey at 1955 for the first time (Tuatay & Remaudiere, 1964).

Material examined: Samples was collected on *Citrus sinensis*, *Citrus paradisi*, *Citrus limon* in this study.

Genus: *Aphis* Linnaeus, 1758**Species: *Aphis (Toxoptera) aurantii* Boyer de Fonscolombe, 1841**

Diagnostic notes: Apterous viviparous female; body is widely, oval shaped,

body colour changes from blackish-green to dark brown. Head is dark brown, compound eyes are wide and black. Proboscis is light color at basal and darker towards the tip. First two segment and apex parts of other segments of antenna are dark, remainders pale brown. Thorax is greenish-black. Legs are beige, tips of tibia and femure dark, tarsus is with brownish-black. Siphunculi, cauda and genital plate are usually black. Body length is about 1.82 (± 0.04) mm. Proboscis is very long and extends to third coxa. Antenna is a little short than body, with 6 segments and thin sparse hairs. First antennal segment is wide but as long as second segment. Others are thin and long. There is a primer rhinaria on 5th and 6th antennal segments and without second rhinaria. Tarsus has two segments and segment at apex has one pair claw. There are sparse hairs on tarsus segments. The siphunculi are cylindrical and longish. There is a very distinct areas at back of siphunculi on latero-ventral part of abdomen. This area contains a conspicuous pattern of ridges and they sclerotized. There is a row of peg-like, very short, thick and conical hairs on dorsal of each hind tibia. Saw like edge and conical hairs modified acts as a sonorous organ. This is an audible scraping sound by human ear. Cauda knobbed with 8-16 hairs. Genital plate has 10-14 hairs.

Alate viviparous female: body is longish, oval shaped. Head, thorax and abdomen are dark brown. Compound eyes are wide and black. First two segment and apex parts of other segments of antenna are dark, remainders light brown, beige in color. Distal of tibia except legs are pale brown and tarsi black. Siphunculi and cauda are black. Genital plate is dark. Body length is almost 1.82 (± 0.104) mm. Proboscis is long and extends to third coxa. Antenna is a little long than body and with thin short hairs. First two antennal segment is short, others are thin and long. There is one primer rhinaria on 5th and 6th antennal segments and 5-8 second rhinaria on 3th antennal segment. Tarsus has two segments and last segment at apex has one pair claw. The siphunculi are cylindrical and tapering. Alate viviparous female have a sonorous organ like apterous viviparous female but it is not developed as apterous. Cauda knobbed with 8-14 hairs. Genital plate has 13-18 hairs (Figs. 5a,b).

It was reported on *Citrus sinensis* in Içel, 1939 in Turkey for the first time (Bodenheimer & Swirski, 1957). Bodenheimer & Swirski (1957) reported that it was determined on apple and pear and it was also recorded before on *Citrus* sp. (Alkan, 1946; Yumruktepe & Uygun, 1994) and *Thea* sp. (Düzgüneş & Tuatay, 1956).

Material examined: Samples were collected on *Citrus sinensis*, *Citrus paradisi*, *Citrus limon* in this study.

Genus: *Brachycaudus* Van Der Goot, 1913

Subgenus: *Acaudus* Van Der Goot, 1913

Species: *Brachycaudus (Acaudus) cardui* (Linnaeus, 1758)

Diagnostic notes: Apterous individuals of *A. cardui* is connected with *A. caudus* which is one of the largest subgenus in *Brachycaudus* genus are green, yellow or reddish and summer generations on second hosts have a shiny, black and broad sclerotic stain on dorsal of abdomen. Color of spring generations on primer host is more mate. There is not this dark stain at *Prunus*. Sometimes, it lives under soil and on roots. Body length in apterous individuals is 1.9-2.6 mm and in alate individuals 1.6- 2.3 mm (Blackman & Eastop, 2000) (Figs. 6a,b).

Host plants: *Achillea* sp., *Amygdalus communis*, *Anchusa leptophylla*, *Anchusa* sp., *Artemisia* sp., *Carlina crymbosa*, *C. vulgaris*, *Carlina* sp., *Carduus acanthoides* *C. crispus*, *C. pycnocephalus*, *Carduus* sp., *Carthamus lacrus*, *Centaurea* sp., *Cirsium acarna*, *C. arvense*, *C. arvense* var. *inconium*, *C.*

cephalotes, *C. spinasissimum*, *Cirsium* sp., *Circus benedictus*, *Cistus crveicus*, *Convolvulus* sp., *Cynara scolymus*, *Cynoglossum creticum*, *Echinops* sp., *Eryngium compestre*, *Eryngium* sp., *Gundelia tournefortii*, *Heliotropium* sp., *Isatis glauca*, *Notobasis syriaca*, *Onopordium illyricum*, *Onopordium* sp., *Picris* sp., *Prunus armeniaca*, *P. domestica*, *P. mahaleb*, *P. spinosa*, *Salix* sp., *Silybum marianum*, *Sisymbrium altissimum*, *Sonchus asper* were determined as hosts (Bodenheimer & Swirski, 1957; Tuatay & Remaudiere, 1964; Çanakçıoğlu, 1967, 1975; Giray, 1974; Düzgüneş et al., 1982; Tuatay, 1988; Ölmez, 2000; Toros et al., 2002).

The species was reported on *Prunus domestica* and *Carduus* sp. in Ankara, Turkey at 1939 for the first time (Bodenheimer & Swirski, 1957).

Material examined: Samples were collected on *Citrus sinensis*, *Citrus paradisi*, *Citrus limon* in this study.

Genus: *Myzus* Passerini, 1860

Subgenus: *Nectarosiphon* Schouteden, 1901

Species: *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

Diagnostic notes: Body is shuttle shape, pale yellow, yellowish green, light green, pinky or greyish green in color. Eyes are blackish dark red. Proboscis is light color and middle of proxima is with pale greenish. Antennae are pale grey in color, 4th antennal segment is more dark. Siphunculi is pale beige and more dark at apex. Cauda is yellowish green in color or colorless.. Genital plate is yellowish-green, sometimes more dark in color. Legs are colorless, pale greenish and tarsus is black. Body length is about 2.23 (± 0.24) mm. There is an antennal tubercless well-devolopped on the head. Also there are numerous denticles on dorsal and ventral head surface. Proboscis is extends to second coxa. Antennae are shorter than body and average 2.12 (± 0.01) mm in length. First segment of antennae is short and widely and its lenght more than second antennal segment, others are thin and long. There is a primer rhinaria on 5th and 6th antenal segments. 3rd antennal segment is without seconder rhinaria. Antenal segments are with hair. Tarsus has two segments and the segments at apex have one pair claw. Siphunculi is cylindrical structure and it appearance as swollen because of the flange at the tip. It is curled as collar. But, generally siphunculi are long and thin. Cauda is a spiny structure and it has total 6 hairs including 3 hairs in each side. Distal section of cauda is pointy. There are 10-17 setae on genital plate.

Alate viviparous female; body is longish, yellowish green. Head is black, eyes are blackish dark red. Proboscis is pale in color with dark in apical. Antennae are generally greyish, basal section of 3rd antennal segment is more or less lihgt color. Prothorax is black, wings are colorless or pale greenish and with very dark wing veins. Tibia and tarsus in legs are grenish, other parts are more pale in color. But there is a dark part at the base of femur. Siphunculi is dark grey, cauda is pale green, yellowish-green in color. Body lenght is 2.19 (± 0.09) mm in average. Proboscis is reaching to second coxa. Antenna is shorter than body lenght and 2.05 (± 0.028) mm lenght. Antenna segments have very short hairs. There is a primer rhinaria on 5th and 6th antenal segments. Third antennal segment has 11-15 seconder rhinaria. There are indistinc numerous denticles like aptereus on dorsal head surface and short hairs. Siphunculi is thin, long, cylindrical structer and the flange at the tip. Cauda is with spinal structure and towards the distal end. it has total 6 hairs including 3 hairs in each side. There are 10-14 setae on genital plate (Düzgüneş & Tuatay, 1956; Blackman & Eastop, 1984) (Figs. 7a,b).

Host plants: *Allium sativum*, *Althea rosa*, *Amygdalus* sp., *Antirrhinum majus*, *Antirrhinum* sp., *Asparagus* sp., *Atropa belladonna*, *Begonia* sp., *Beta*

vulgaris, *B. vulgaris altissima*, *B. vulgaris* var. *cicla*, *Boreava orientalis*, *Bougainvillea* sp., *Brassica oleraceae*, *B. napus*, *B. rapa*, *B. campestris*, *Capsella bursa-pastoris*, *Capsicum annuum*, *C. annuum* var. *longum*, *Cardaria draba*, *Carduus pycnocephalus*, *Carthamus tinctorius*, *Chrysanthemum* sp., *Cirsium arvense*, *Cirsium* sp., *Citrus nobilis*, *Citrus* sp., *Coleus* sp., *Convolvulus* sp., *Crataegus* sp., *Cucurbita pepo*, *Cucumis melo*, *C. sativus*, *Cydonia vulgaris*, *Cynara scolymus*, *Daucus carota*, *Dianthus* sp., *Duranta repens*, *Foeniculum vulgare*, *Fuchsia* sp., *Gazania* sp., *Gossypium* sp., *Hedera* sp., *Helianthus annuus*, *Hibiscus* sp., *Hordeum vulgare*, *Hordeum* sp., *Lactuca sativa*, *Linaria genistifolia*, *Lycopersicon esculentum*, *Maclura pomifera*, *Malus communis*, *Malva neglecta*, *M. sylvestris*, *malva* sp., *Mentha* sp., *Mercurialis annua*, *Nicandra physaloides*, *Nicotiana tabacum*, *Onopordos armenum*, *Petroselinum hortense*, *Petunia hybrida*, *Phaseolus vulgaris*, *Portulago oleraceae*, *Prunus avium*, *P. amygdali*, *P. domestica*, *P. persicae*, *Pyrus communis*, *Ranunculus chius*, *R. marginatus* var. *trachycarpus*, *Rhaphanus raphanistrum*, *R. sativus*, *Rubus* sp., *Rumex obtusifolius*, *Scorzonera* sp., *Senecio vulgaris*, *Senecio* sp., *Sesamum indicum*, *Sisymbrium* sp., *Solanum melongena*, *S. tuberosum*, *Sonchus oleraceae*, *Spinacia oleracea*, *Triticum* sp., *Tulipa* sp., *Verbana* sp., *Veronica* sp., *Vicia* sp., *Viola tritocolar* and *Zea mays* were recorded as host plants (Düzgüneş & Tuatay, 1956; Bodenheimer & Swirski, 1957; Tuatay & Remaudiere, 1964; Giray, 1974; Çanakçıoğlu, 1975; Düzgüneş & Toros 1978; Düzgüneş et al., 1982; Karaat & Göven, 1986; Zeren, 1989; Tuatay, 1991; Önuçar & Ulu, 1992; Kıran, 1994; Akkaya & Uygün, 1996; Toros et al., 1996; Özdemir & Toros, 1997; Ölmez, 2000; Çobanoğlu, 2000; Toros et al., 2002; Ayyıldız & Atlıhan, 2006; Kocadal, 2006).

Myzus (Nectarosiphon) persicae was reported on *Spinacia oleraceae* in Ankara, Turkey at 1938 for the first time (Bodenheimer & Swirski 1957).

Material examined: Samples were collected on *Citrus sinensis*, *Citrus paradisi* in this study.

Genus: *Rhopalosiphum* Koch, 1854

Species: *Rhopalosiphum maidis* (Fitch, 1856)

Diagnostic notes: Antenna of aptereus viviparous individuals is short, body is long, its color is change from yellowish-green to dark olive green or bluish-grey. Sometimes it is covered by a thin dusty material. Basal of cornicle is shadow by a dusky circle stain. Abdomen of alate viviparous is dirty yellowish-green. There is a lateral dusky stain on 2nd, 3rd and 4th abdomen segments and a widely dusky stain at basal of cornicle, a transversal dusky band on apical segments. Width of aptereus viviparous is 1.23 ± 0.16 (1-1.6) mm and height is 2.47 ± 0.08 (2.35-2.60) mm. Width and length of alate viviparous are 1.01 ± 0.04 (0.9-1.1) mm and 2.32 ± 0.09 (2.05-2.45) respectively. Antennal tubercles are at aptereus and alate viviparous both small. There are 6 segment on antenna and its length is as half of body. Processus terminal smooth and twice as long as base of last antennal segment. There is not second sensoria at 3rd antennal segment of aptereus viviparous but there are 14-18, 0-8 and 0-3 second sensoria at 3rd, 4th and 6th antennal segments of alate viviparous respectively. Cornicles are slindirical and rude pattern. Cauda is spinal structure and finger shape and slightly constricted at proximal half. There are two pairs dorso-lateral setae and middle part slightly constricted at alate (Figs. 8a,b).

Blackman & Eastop (1984) reported that *R. maidis* is a cosmopolitan species and fed on more than 30 genus of gramineae. As first record in Turkey reported by İyriboz (1937) that it is important pest of corn and wheat.

Host plants: *Zea mays* L., *Triticum* sp., *Hordeum* sp., *Secale cereale* L.,

Avena sativa L., *Lolium* sp., *Hordeum murinum* L.

Material examined: Samples were collected on *Citrus sinensis*, *Citrus paradisi*, *Citrus limon* in this study.

DISCUSSION

8 aphids species on citrus orchards in Antalya province, *Aphis craccivora* Koch, 1854; *Aphis fabae* Scopoli, 1763; *Aphis gossypii* Glover, 1877; *Aphis spiraeicola* Patch, 1914; *Aphis (Toxoptera) aurantii* Boyer de Fonscolombe, 1841; *Brachycaudus (Acaudus) cardui* (Linnaeus, 1758); *Myzus (Nectarosiphon) persicae* (Sulzer, 1776); *Rhopalosiphum maidis* (Fitch, 1856) were found. Within these species, it was observed that *Aphis craccivora* is most widespread and *Brachycaudus (Acaudus) cardui* is rare species.

Note: This study is part of a master thesis at Suleyman Demirel University, Plant Protection Department, Institute of Natural and Applied Science.

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LITERATURE CITED

- Akkaya, A. & Uygun, N.** 1996. Diyarbakır ve Şanlıurfa İlleri Yazlık Sebze Ekosistemindeki Insecta Faunası. Türkiye 3. Entomoloji Kongresi Bildirileri, Ankara, s. 423-431.
- Ayyıldız, Y. & Athhan, R.** 2006. Balıkesir İli Sebze Alanlarında Görülen Yaprakbiti Türleri ve Doğal Düşmanları Yüzyüncü Yıl Üniversitesi, Ziraat Fakültesi, Tarım Bilimleri Dergisi (J. Agric. Sci.), 2006, 16 (1): 1-5.
- Blackman, R. L. & Eastop, V. F.** 1984. Aphids on The World's Crops: An Identification guide. A Wiley. Interscience Publication, pp: 466.
- Blackman, R. L. & Eastop, V. F.** 1994. Aphids on The World's Trees. An Identification ve information guide CAB International, pp: 986+16.
- Blackman, R. L. & Eastop, V. F.** 2000. Aphids on The World's Crops: An Identification guide. Second Edition. A Wiley. Interscience Publication, pp: 414.
- Bodenheimer, F. S. & Swirski, E.** 1957. The Aphidoidea of the Middle East. The Weizmann Science Press of Israel, Jerusalem, pp: 378.
- Çanakçıoğlu, H.** 1966. Türkiye'de orman ağaçlarına arız olan bitki bitleri (Aphidoidea) üzerine araştırmalar (A study of the Forest Aphidoidea of Turkey). İstanbul Üniversitesi Orman Fakültesi Dergisi Seri A, XVI (2): 131-90 (English, pp.172-85), İstanbul.
- Çanakçıoğlu, H.** 1967. Türkiye'de Orman Ağaçlarına Arız Olan Yaprakbitleri (Aphidoidea) Üzerine Araştırmalar. T.C. Tarım Bakanlığı, Orman Genel Müdürlüğü Yayınlarından, 466, 22, VIII. pp: 151.
- Çanakçıoğlu, H.** 1975. The Aphidoidea of Turkey. İstanbul Üniversitesi Orman Fakültesi Yayınları, O.F.Yayın Seri A, XXII, 1.
- Çobanoğlu, S.** 2000. Aphididae (Hom.) Species of Edirne Province (Thrace part of Turkey). Entomologist's monthly magazine. 45-52s.
- Çota, F.** 2007. Investigation on Aphidoidea Species in Bartın District, Zonguldak Karaelmas Üniversitesi, Bartın Faculty of Forestry, M.Sc. Thesis, pp. 120 Bartın.
- Düzgüneş, Z. & Tuatay, N.** 1956. Türkiye Aphidleri. Ziraat Vekaleti, Ankara Zirai. Enstitü Müdürlüğü, 4 pp: 63.
- Düzgüneş, Z. & Toros, S.** 1978. Ankara İli ve Çevresinde Elma Ağaçlarında Bulunan Yaprakbiti Türleri ve Kısa Biyolojileri Üzerinde Araştırmalar. Türkiye Bitki Koruma Dergisi, 1 (3): 151-175.
- Düzgüneş, Z., Toros, S., Kılınçer, N. & Kovancı, B.** 1982. Ankara İlinde Bulunan Aphidoidea Türlerinin Parazit ve Predatörlerinin Tespiti. Tarım ve Orman Bakanlığı Zirai Mücadele ve Zirai Karantina Genel Müdürlüğü Yayın Şub., 251 pp.

FAO, 2010. www.fao.org. Erişim Tarihi 23.05.2012.

Gıray, H. 1974. İzmir İli Çevresinde Aphididae (Homoptera) Familyası Türlerine Ait İlk Liste ile Bunların Konukçu ve Zarar Şekilleri Hakkında Notlar. Ege Üniversitesi Ziraat Fakültesi Dergisi, 11 Sayı:1, 39-69.

Görür G. 2004. Aphid Species of Niğde Region (Insecta: Homoptera:Aphidoidea). Nigde University Press, No: 17 (Turkish, with English summary).

Hille Ris Lambers, D. 1950. On Mounting Aphids and Other Softskinned Insects. Entomologische Berichten, XIII, 55-58.

İyriboz, N. 1937. Pamuk Hastalıkları. Ziraat Vekaleti Neşriyatı U.S. 237, Pamuk Bürosu S.1, pp: 85.

Kaygın, A. T., Görür, G. & Çota, F. 2008. Contribution to the Aphid (Homoptera: Aphididae) Species Damaging on Woody Plants in Bartın, Türkiye. International Journal of Engineering Sciences, 2 (1): 83-86.

Kıran, E. 1994. Güneydoğu Anadolu Bölgesi Hububat Ekiliş Alanlarında Görülen Yaprakbiti Türleri ve Doğal Düşmanları Üzerinde Çalışmalar. 3. Biyolojik Mücadele Kongresi Bildirileri, Ankara, s.29-37.

Kocadal, E. 2006. The determination of aphidoidea (homoptera) species and their host plants, parasitoids and predators in the Turkish Republic of Northern Cyprus. Çukurova Üniversitesi. Adana. 82 pp.

Ölmez, S. 2000. Diyarbakır İlinde Aphidoidea (Homoptera) Türleri ile Bunların Parazitoit ve Predatörlerinin Saptanması. (Yüksek Lisans Tezi). Çukurova Üniversitesi Fen Bilimleri Enstitüsü pp: 109.

Özdemir, I. & Toros, S. 1997. Ankara Parklarında Mevsimlik Süs Bitkilerinde Zararlı Aphidoidea (Hom.) Türleri. Türkiye Entomoloji Dergisi, 21 (4): 283-298.

Schimitschek, E. 1944. Forstinsekten der Türkeiveigre Umwelt. Volk., Reich, Prag, Berlin, 371 pp.

Stroyan, H. L. G. 1984. Aphids–Pterocommatinae and Aphidinae (Aphidini) Homoptera: Aphididae. Handbooks for The Identification of British Insects. V, II, 6. Royal Entom. Soc. of London, pp: 232.

Toros, S., Yaşar, B., Özgökçe, M. S. & Kasap, İ. 1996. Van İlinde Aphidoidea (Homoptera) Üst familyasına Bağlı Türlerin Saptanması Üzerine Çalışmalar. Türkiye 3. Entomoloji Kongresi, 24-28 Eylül 1996, Ankara Üniversitesi Basımevi, Ankara-Türkiye, pp: 549-556.

Toros, S., Uygun, N., Ulusoy, R., Satar, S. & Özdemir, I. 2002. Doğu Akdeniz Bölgesi Aphidoidea Türleri. T.C. Tarım ve Köyişleri Bakanlığı, Tarımsal Araştırmalar Genel Müdürlüğü, 108 s.

Tuatay, N. 1988. Türkiye Yaprakbitleri (Homoptera: Aphididae): I. Aphidinae: Macrosiphini (I. Kısım). Bitki Koruma Bülteni, 28 (1-2): 1-28.

Tuatay, N. 1991. Türkiye Yaprakbitleri (Homoptera: Aphididae) III. Aphidinae: Macrosiphini (III. Kısım). Bitki Koruma Bülteni, 31 (1-4): 3-18.

Tuatay, N. 1993. Türkiye Yaprakbitleri (Homoptera: Aphididae) IV. Aphidinae: Macrosiphini (I. Kısım). Bitki Koruma Bülteni, 33 (3-4): 83-106.

Tuatay, N., Kalkandelen, A. & Aysev, N. 1972. Nebat Koruma Müzesi Böcek Kataloğu (1961-1971). T.C. Tarım Bakanlığı Zırai Mücadele Zırai Karantina Genel Müdürlüğü Yayınları, Mesleki Kitaplar Serisi. Yenigün Matbaası, Ankara, pp: 119.

Yumruktepe, R. & Uygun, N. 1994. Doğu Akdeniz Bölgesi Turuncgil Bahçelerinde Saptanan Yaprakbiti (Hom., Aphididae) Türleri ve Doğal Düşmanları.

Zeren, O. 1989. Çukurova Bölgesinde Sebzelerde Zararlı Olan Yaprakbitleri (Aphidoidea) Türleri, Konukçuları, Zararları ve Doğal Düşmanları Üzerinde Araştırmalar. Tarım Orman ve Köyişleri Bakanlığı Araştırma Yayınları Serisi, 59, 205 s.

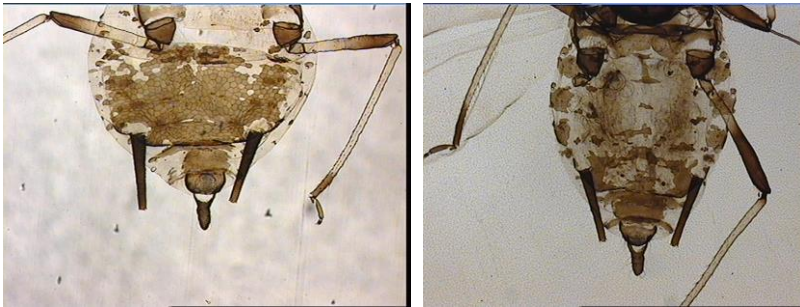


Figure 1. *Aphis craccivora* Koch a: Apterous and b: Alate



Figure 2. *Aphis fabae* Scopoli a: Aptereus and b: Alate



Figure 3. *Aphis gossypii* Glover a: Aptereus and b: Alate



Figure 4. *Aphis spiraecola* Patch a: Aptereus and b: Alate



Figure 5. *Aphis (Toxoptera) aurantii* (Boyer de Fonscolombe) a: Aptereus and b: Alate



Figure 6. *Brachycaudus (Acaudus) cardui* (Linnaeus) a: Aptereus and b: Alate

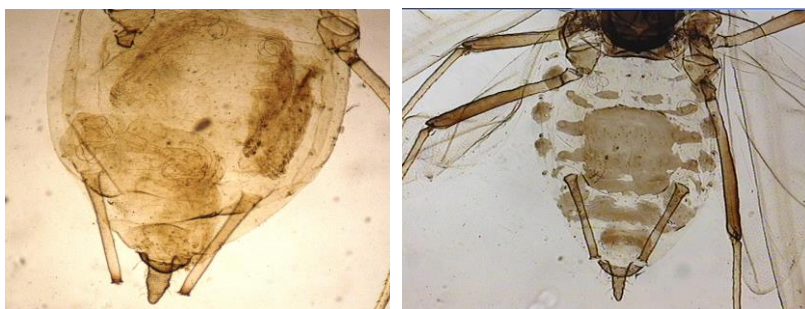


Figure 7. *Myzus (Nectarosiphon) persicae* (Sulzer) a: Aptereus and b: Alate



Figure 8. *Rhopalosiphum maidis* (Fitch) a: Aptereus and b: Alate

***MALLOSIA IMPERATRIX TAURICOLA* K. DANIEL, 1904
STAT. NOV. (CERAMBYCIDAE: LAMIINAE)**

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[**Özdikmen, H.** 2015. *Mallosia imperatrix tauricola* K. Daniel, 1904 stat. nov. (Cerambycidae: Lamiinae). Munis Entomology & Zoology, 10 (2): 370-371]

ABSTRACT: With the present work, *Mallosia imperatrix tauricola* K. Daniel, 1904 rest. nov. is discussed and regarded as a subspecies of *Mallosia imperatrix* Abeille de Perrin, 1885.

KEY WORDS: *Mallosia imperatrix tauricola* K. Daniel, 1904, stat. nov., Cerambycidae, Turkey.

***Mallosia imperatrix tauricola* K. Daniel, 1904 stat. nov.**

Firstly, *Mallosia imperatrix tauricola* was described by K. Daniel (1904) from Taurus (Turkey) as a morpha of *Mallosia imperatrix* Abeille de Perrin, 1885.

Mallosia imperatrix m. *tauricola* K. Daniel, 1904 was given by Löbl & Smetana (2010) and Danilevsky (2015) as a synonym of *Mallosia imperatrix* Abeille de Perrin, 1885 with *Mallosia robusta* Pic, 1901 that was described from Syria.

Turkish distribution patterns of the species, *Mallosia imperatrix*, were given by Özdikmen & Aytar (2012) as follows:

Old records from Turkey: Taurus (K. Daniel, 1904; Aurivillius, 1921); Nur Mt. (Demelt, 1967); Osmaniye prov.: Nurdağı pass, Bingöl prov. (Adlbauer, 1988); Turkey (Lodos, 1998; Löbl & Smetana, 2010); Adıyaman prov.: Karadut village, Nemrut Mt. (Rejzek & Hoskovec, 1999); Hakkari prov.: Suvari Halil (Tauzin, 2000); Bingöl prov.: Central, Bitlis prov.: Central, Erzurum prov.: Pasinler (Çalıcı) (Tozlu et al., 2003); Van prov.: Van-Bahçeşaray road (Narlıca) (Özdikmen, 2006).

The SW-Asiatic species, *Mallosia imperatrix*, is distributed in Iran, Iraq, Lebanon, Syria and Turkey.

According to original description of *Mallosia imperatrix tauricola*, it is quite different from the typical form by sparser, smaller elytral punctuation and broadly curved narrowed elytra near shoulders chiefly.

Original description of K. Daniel (1904):

1" Die dorsalen Tomentbinden nur sehr spärlich von kleinen Kahlpunkten durchbrochen, gelblich weiss, mit dem pechschwarzen Deckengrund scharf contrastirend, im Basalviertel in einzelne, ziemlich zerstreute Fleckchen aufgelöst; Flügeldecken hinter den etwas mehr vortretenden Schultern breit geschweift verengt; Fühler einfarbig pechschwarz, das Apicalviertel der Flügeldecken überragend, Beine schlank, die Mittel- und Hintertibien immer dicht büstenartig behaart. Durchschnittlich etwas grössere Easse vom hohen Taurus.....*imperatrix tauricola* m.

Consequently, I propose *Mallosia imperatrix tauricola* K. Daniel, 1904 should be a separate subspecies that is distributed only in Turkey now.

Besides, with respect to the original description of *Mallosia robusta* Pic, 1901, it should be remained as a synonym of *Mallosia imperatrix* Abeille de Perrin, 1885 that was described from Syria (Rif Dimashq (Anti-Liban): Bloudan).

Original description of Pic (1901):

J'ai reçu dernièrement une femelle de Mallosia, provenant de Syrie, voisine de Herminae Reitt., mais distincte, à première vue, par son écusson bien plus large, subéchancré au sommet, très déprimé au milieu, la forme du corps encore plus robuste, les bandes blanches des élytres très irrégulièrement interrompues, etc. Long, 40 mill. J'ai nommé cette espèce robusta; je la décrirai plus longuement dans une étude synoptique du genre que je prépare.

Finally, the new arrangement of *Mallosia imperatrix* is presented as follows:

Genus MALLOSIA Mulsant, 1863: 399

[Type species *Saperda graeca* Sturm, 1843]

Subgenus EUMALLOSIA Danilevsky, 1990: 364

[Type species *Mallosia herminae* Reitter, 1890]

imperatrix Abeille de Perrin, 1885: cxl

imperatrix imperatrix Abeille de Perrin, 1885: cxl (Holotype ♂, ex collection Abeille de Perrin, Muséum National d'Histoire Naturelle, Paris) [type locality "Rif Dimashq (Anti-Liban): Bloudan" (Syria)] **A:** IN IQ LE SY *robusta* Pic, 1901: 19 [Syria]

imperatrix tauricola K. Daniel, 1904: 308 (Holotype, ex collection K. Daniel, Deutsches Entomologisches Institut, Eberswalde) [type locality "Taurus" (Turkey)] **A:** TR

LITERATURE CITED

Daniel, K. 1904. Die Cerambyciden-Gattung *Mallosia* Muls.. Münchener Koleopterologische Zeitschrift, 2: 301-314.

Danilevsky, M. L. 2015. Catalogue of Palaearctic Cerambycoidea. Available from: <http://www.cerambycidae.net/catalog.pdf> (accessed 30 January 2015)

Löbl, I. & Smetana, A. 2010. Catalogue of Palaearctic Coleoptera, Vol. 6. Chrysomeloidea. Stenstrup: Apollo Books, 924 pp.

Özdikmen, H. & Aytar, F. 2012. Subgeneric arrangement of *Mallosia* Mulsant, 1862 with three new subgenera, and a new species from Turkey (Coleoptera: Cerambycidae). Munis Entomology & Zoology, 7 (2): 653-662.

Pic, M. 1901. Notes diverses. Matériaux pour servir à l'étude des Longicornes, 3 (3): 15-19.

A NEW RECORD OF *JOHNSTONIANA* GEORGE, 1909 (ACARI: JOHNSTONIANIDAE) FROM TURKEY

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[Adil, S., Sevsay, S., Doğan, S. & Dilkaraoğlu, S. 2015. A new record of *Johnstoniana* George, 1909 (Acari: Johnstonianidae) from Turkey. Munis Entomology & Zoology, 10 (2): 372-376]

ABSTRACT: *Johnstoniana rapax* Wendt et Eggers, 1994 is described based on active postlarval forms. This is the second species of *Johnstoniana* from Turkey. Also, morphological features and zoogeographical distributions are given here.

KEY WORDS: Acari, Johnstonianidae, *Johnstoniana*, Turkey.

The family Johnstonianidae created by Thor, 1935 and Newell, 1957 occurred two subfamilies; Charadracarinae Newell, 1960 and Johnstonianinae Thor, 1935. *Johnstoniana* genus has 13 species and five of these species nomen dubium (Makol & Wohltmann, 2012). This genus has been reported only one species from Turkey (Sevsay & Özkan 2005).

In this paper adults and deutonymphs of *Johnstoniana rapax* Wendt et Eggers, 1994 described and illustrated which is collected from Giresun, Turkey.

MATERIAL AND METHODS

Active postlarval forms were collected directly from the soil surface and extracted using Berlese funnels. The material was preserved in 70% ethyl alcohol. Specimens for light microscope studies 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. For morphological terminology see by Wohltmann et al. (2004) followed in the text. All measurements are given in micrometers (µm). All specimens examined are deposited in the Biology Department of Erzincan University, Turkey.

RESULTS

Family Johnstonianidae Thor, 1935

Subfamily Johnstonianinae Thor, 1935

Genus *Johnstoniana* George, 1909

Type sp. *Johnstoniana errans* (Johnston, 1852)

Johnstoniana rapax Wendt et Eggers, 1994

Adult. Standard measurements in Table 1. Relatively large Johnstonianidae. Colour in life light to dark red or brown. Body length is 400-410 and width 230-248.

Gnathosoma. Palp tibia with odontus and bifid basidont (Fig. 1). Palp tarsus with 3-5 solenidia, 3-7 eupathidia and lots of nonspecialized setae (Fig. 2). Chelicera is typical and internal edge of cheliceral nude and with protrusion close to end (Fig. 3).

Idiosoma. Ovoid, scutum triangular with anterior naso, bears anterior (ASens) and posterior (PSens) sensillae. 6-18 non-specialized setae placed laterally to posterior sensillae. Crista metopica widened at level of sensillae (Fig. 4). Two pairs of stalked eyes placed on level of posterior sensillae. Anterior lens slightly larger than posterior lens. Dorsal setae (DS) uniform, curved and pointed to the end, set on rounded, slightly asymmetrical tubercles (Fig. 5).

Genital opening with three pairs of acetabula surrounded by epivalves and centrovalves with smooth setae (Fig. 6). Anal sclerites with smooth setae.

Legs with completely separated basifemur and telofemur. All non-specialized setae smooth and short barbs. Eupathidia and solenidia present on all leg segments except for coxa I-IV. Tarsus I have not barbed setae (Fig. 7). Tarsus II with 2-4 club-shaped solenidia (ω) (Fig. 8-9).

Male. As female, but genital opening differentiated and shorter than female.

Deutonymph. Similar to adult, but smaller than adult. Scutum with 6-14 non-specialized setae and 2 pairs of trichobothria. Dorsal setae (DS) as in adults uniform, curved, pointed to the end and set on flat, asymmetrical sclerites. Genital opening with two pairs of acetabula. Tarsus I have not barbed setae. Tarsus II with 1-2 club-shaped solenidia (ω).

Specimens examined. 24.11.2013. 1 adult, 1 female, 3 deutonymph. Mossy soil, N40° 43' 28" E39° 02' 40" 730 m. Taşlıca village, Doğankent, Giresun, Turkey. Leg. S. Adil. 15.03.2014, 1 adult, 1 male. Mossy-lungwort soil. N40° 56' 35" E38° 51' 13" 100 m. Tirebolu, Giresun, Turkey. Leg. S. Adil.

Distribution. Finland, Germany, Poland, The Netherlands (Makol & Wohltmann, 2012). New for Turkish fauna.

DISCUSSION

Johnstoniana rapax easily distinguished from other species of the genus by having 1-2 eupathidia on basifemur IV and absent setulose setae on tarsus I. Turkish specimens are similar to European specimens crista metopica's structure and number of solenidia on tarsus II.

Turkish specimens differs from European specimens (Wohltmann et al., 2004) some morphological property: PaTi/CpPp ratio (adult) (Turkish specimens 5.2-6, European specimens 3.8-4.6); Dorsal setae (DS) structure (while in European specimens dorsal setae tiny setulae, Turkish specimens nude) and length (Turkish specimens 36-70, European specimens 52-76). We suppose that these morphological differences base on geographical properties.

ACKNOWLEDGEMENTS

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LITERATURE CITED

- George, C. F. 1909. Some British earthmites. Trombididae. Naturalist (London), 635: 423-424.
- Johnston, G. 1852. The Acarides of Berwickshire. Historical Berwickshire Nature Club III, (X): 113-115.
- Krantz, G. W. & Walter, D. E. 2009. A Manual of Acarology, Texas Tech University Press, 1-326.
- Makol, J. & Wohltmann, A. 2012. An Annotated Checklist of Terrestrial Parasitengona (Actinotrichida: Prostigmata) of the World, Excluding Trombiculidae and Walchiidae. Ann. Zool., 62 (3): 359-562.

Newell, I. M. 1957. Studies on the Johnstonianidae (Acari, Parasitengona). Pacific Science, 11 (4): 396-466.

Sevsay, S. & Özkan, M. 2005. A new species of *Johnstoniana* (Acari: Trombidiidae) from Turkey: *Johnstoniana hakani* n. sp. G.U. Journal of Science, 18 (2): 187-191.

Thor, S. 1935. Übersicht und Einteilung der Familie Trombidiidae W. E. Leach 1814 in Unterfamilien. Zoologischer Anzeiger, 109 (5-6): 107-112.

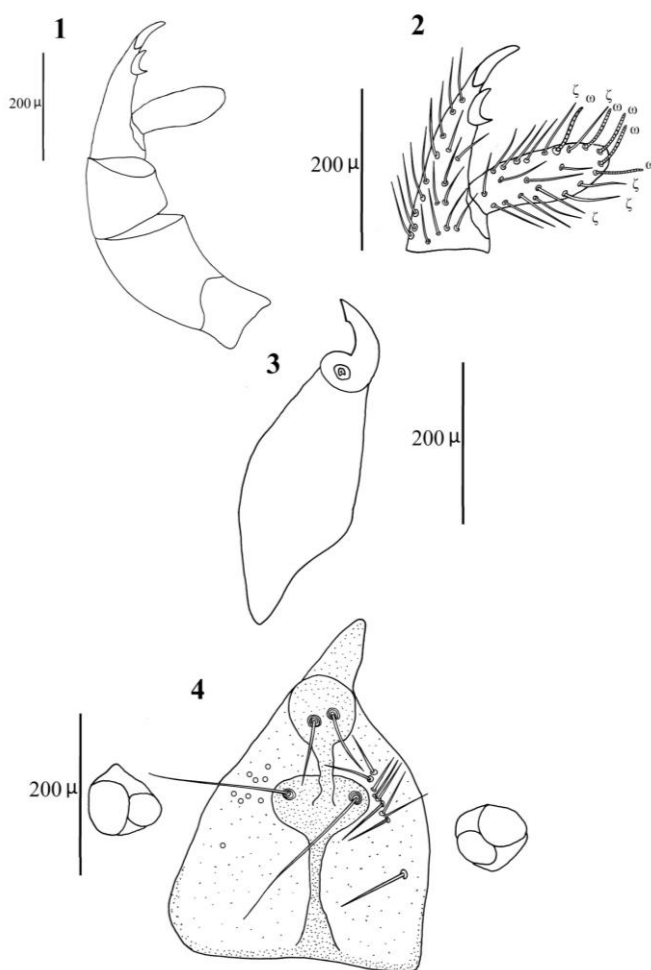
Wendt, F. E. & Eggers, A. 1994. *Johnstoniana rapax* n. sp., a new species of the Johnstonianidae from Europe including a description of all active instars (Acari: Parasitengonae: Trombidia). Mitteilungen aus dem Hamburgischem Zoologischen Museum und Institut, 91: 113-126.

Wohltmann, A., Małkol, J. & Gabryś, G. 2004. A revision of European Johnstonianinae (Acari: Prostigmata: Parasitengona: Trombidoidea). Annales Zoologici, 54 (3): 595-630.

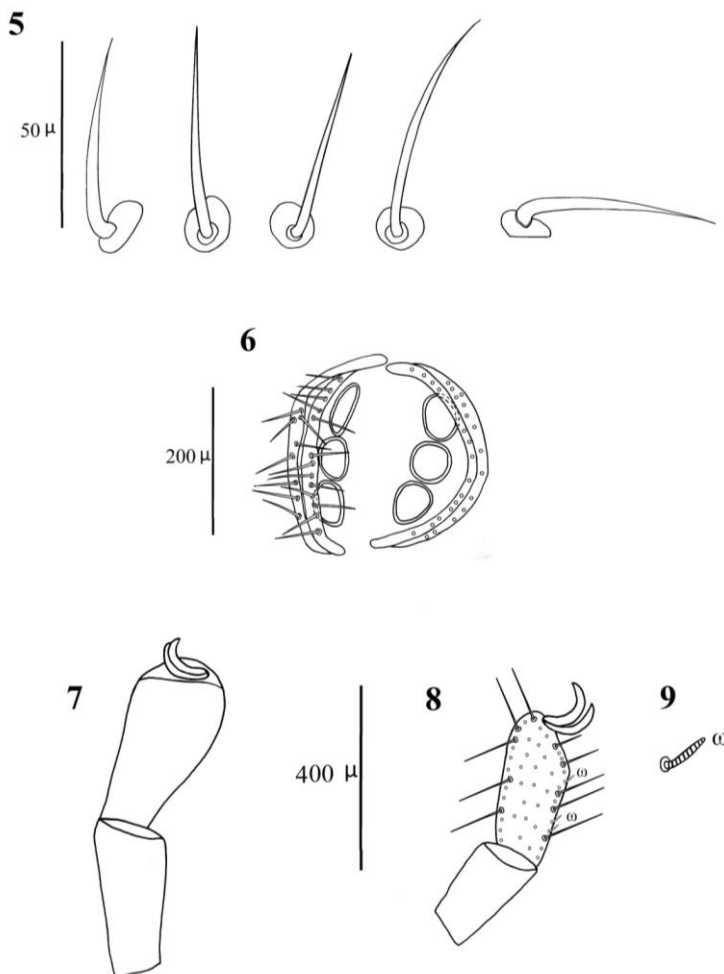
Table 1. Morphometric data on postlarval forms of *Johnstoniana rapax*.

Characters	<i>J. rapax</i> Female (n=1)	<i>J. rapax</i> Adult (n=1)	<i>J. rapax</i> Male (n=1)	<i>J. rapax</i> Deutonymph (n=3) min.-max.
L Scutum	346	410	285	210-261
W Scutum	271	248	233	140-204
A Sens	95	72	77	60-77
P Sens	183	182	165	122-160
SBA	27	24	19	21-24
SBP	82	83	70	23-54
ISD	83	101	68	59-71
DS mn.-mx.	35-60	36-70	30-50	40-65
VS mn.-mx.	33-50	35-65	35-60	30-50
L Gop	274	273	230	83-88
Cx I	222	264	204	151-162
Tr I	137	148	115	90-105
Bf I	245	283	212	133-171
Tf I	220	280	187	129-162
Ge I	258	328	221	143-188
Ti I	306	363	259	133-196
Ta I	381	408	320	171-247
Cx II	223	289	198	164-175
Tr II	106	134	92	74-95
Bf II	188	215	148	124-141
Tf II	147	200	111	92-112
Ge II	161	211	133	112-129
Ti II	200	250	158	125-134
Ta II	297	326	250	203-224
Cx III	263	250	208	164-257
Tr III	140	139	105	87-138
Bf III	208	234	162	114-136
Tf III	174	205	144	106-133
Ge III	200	232	166	115-148
Ti III	260	283	221	130-155
Ta III	337	378	286	211-232
Cx IV	316	301	250	176-190
Tr IV	238	288	144	142-159
Bf IV	273	293	231	144-155
Tf IV	281	275	216	125-138
Ge IV	317	329	265	148-176
Ti IV	414	413	364	194-210
Ta IV	423	442	365	243-270

PaFe	274	246	225	144-156
PaGe	129	143	97	74-83
PaTi	199	241	170	137-146
PaTa	147	176	127	96-106
CpPp	38	46	28	23-29
PaTi/CpPp	5:2	5:2	6	5-5.9
odontus	81	70	65	49-58
basidont	58	50	48	30-35



Figures: 1-4: *Johnstoniana rapax* Adult 1. Palp general view setae omitted 2. Palp tibial-tarsus 3. Cheliser 4. Crista metopica region.



Figures 5-8: *Johnstoniana rapax* Adult 5. Dorsal setae (DS) 6. Genital opening 7. Leg I tibia-tarsus setae omitted 8. Leg II tibia-tarsus 9. Club-shaped solenidia(ω).

IMPACT OF ISOLATED DIETS ON THE GROWTH RATE OF *CHRYSOMYA MEGACEPHALA* (DIPTERA)

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[Alexander, D., Christudhas, A. & Mathai, M. T. 2015. Impact of isolated diets on the growth rate of *Chrysomya megacephala* (Diptera). Munis Entomology & Zoology, 10 (2): 377-383]

ABSTRACT: The association of *C. megacephala* with decomposing carrion is of particular interest in the field of forensic entomology. The impact of different isolated diets influence the larval weight and length including head capsule which accounts on its fine articulated cephalopharyngeal sclerites. The larval feeding duration highly influence the duration of life cycle in *C. megacephala*.

KEY WORDS: Forensic Entomology, Carrion, Blow flies, Morphometrics.

The most important dipteran group associated with animal carrion both in terms of number as well as the role that they play in decomposition, are the green and blue bottles commonly known as carrion blowflies, these necrophages and sarcophages species feeding on corpse tissue include the genera *Chrysomya*, *Lucilia*, *Calliphora* and *Sarcophaga*, which are cosmopolitan in distribution (Putman, 1977). The association of *Chrysomya megacephala* (Fabricius) with the decomposing carrion is of particular interest in the field of forensic entomology (Keh, 1985; Catts & Goff, 1992). Age determination of these insects usually is the basis for making post mortem interval estimations (Marchenko, 1980; Nainis et al., 1982). As decomposition progresses, the insect and other vertebrates that colonize corpses, can provide valuable information concerning the time and manner of death.

Early historical documented accounts on forensic entomology are almost nonexistent. A documented account appeared first in thirteenth century (McKnight, 1981). The age of the maggots and the development of *C. megacephala* determines the period of corpse exposure (Goff et al., 1986). "A manual of forensic entomology" (Smith, 1986) provides a series of 19 cases submitted by European Forensic Entomologist and "Entomology and Death" (Catts & Haskell, 1991), is a procedural guide attempting to familiarize death investigations as well as entomologists with procedures and analysis in handling entomological data in death investigations.

In the ecosystem, the insect reproductive biology is governed by both biotic and abiotic factors. The primary necessity for reproduction is the abundant availability of food materials, from which the larvae and adults derive energy for their growth and development. Almost all organic materials in nature serve as food for insects (Brues, 1946). The quality and quantity of the food is also a primary factor which influence the biology of the insects (Shahein, 1986).

A decomposing carrion is a highly temporary habitat available for a limited duration of time, compared to other habitats hence, the biology of blowflies are well synchronized with the host availability. In *C. megacephala*, the life cycle, fecundity, size and weight of the life stages are under the influence of the host availability (Bhuvaneswari & Daniel, 1994). Though *C. megacephala* feed, breed

and oviposit randomly on the carrion, noticeable aggregation was recorded on certain regions like brain, clotted blood and decomposing meat.

The association of *C. megacephala* with the decomposing carrion is of particular interest in the field of forensic entomology apart from its economic importance as an effective pollinator of mangoes (Hu et al., 1995). The length of the oldest maggots recovered from the corpse often provide an accurate estimate of the time of death hence, the study is to understand the impact of three isolated diets on the size and weight of the pupal forms along with the adult emergence and the details in the structure of cephalopharyngeal sclerites, including the recording of the size of the head capsule.

MATERIAL AND METHODS

The live adult individuals of *C. megacephala* were trapped using rotten beef, etherized, and reared under captivity en mass on beef diet. The individuals were grouped to 10 at the sex ratio (3:1) of female to male from mass culture as the males are promiscuous and reared on the isolated diets like bovine brain tissue, blood clot and decomposing meat under controlled conditions. The development of *C. megacephala* was examined at 30°C.

Following emergence, the larvae were reared in batches of 15 to 25 and observed at different feeding durations with 24hrs extended feeding range up to 288hrs. After each feeding duration, 30 larvae were randomly removed from the different cultures for morphometrics. The pupae were undisturbed and observed till their emergence, based on which the number of viable pupae on different diet was calculated. Statistical analysis was computed to determine the mean and standard deviation of the various parameters of the larvae, pupae and adult.

RESULTS

The studies on the impact of the larval feeding duration in the biology of *C. megacephala* reveal that it produced variations in the size of the larvae and pupae with differential feeding time. Under normal conditions the emerging larvae pupate after a period of 72hrs of feeding. This study reveals that the feeding by larvae less than 72hrs fails to pupate. The larvae after 144hrs of feeding starts shrinking in its total body length.

The focus on the influence of the isolated food materials: the brain, the blood and the meat on the rate of larval growth and the time of pupal formation after different larval feeding durations reveals that the rate of growth of larvae is comparatively greater in the brain tissues, where the larvae attained a length of 8.520.1031mm when compared to the other two meals, the blood and the meat, where the length are 7.980.0258mm and 8.230.1204mm respectively. The comparative growth of the larval forms on the three isolated food materials up to a feeding duration of 288hrs is tabulated (Table 1). Correspondingly the pupation with the different larval feeding duration was also recorded (Table 1 & 2). The pupation occurred very late on the brain diet, only after 120hrs of feeding but, in the case of meat the pupation occurs immediately after 48hrs of feeding. In all this diets the length of the pupae gradually increase towards the maximum feeding duration almost all larvae pupated after 120-240hrs of feeding on the diets blood and meat. The maximum recorded pupal length was when fed with the brain diet (9.940.0376mm).

The first instar was muscoid shaped and composed of 12 segments. The cephalic segment possess a pair of terminal organs, a pair of multi-branched oral

hooks situated at mid-dorsal region of the mouth and three oral grooves at each side of the mouth. Each oral hook contains 3-4 rows of single, curved spines with sharp tips. The anterior spiracle is not apparent in this instar. The prominent features of the caudal segment are a pair of posterior spiracular discs and a pair of circular, deep depressions ventral to the spiracular disc. Each spiracular disc contains two straight spiracular slits that coalesce ventrally and are interspaced with bundles of relatively thin and multi-branched spiracular hairs (Plate 1).

The general morphology of the second instar larva is very similar to that of the first instar. The dorsal and terminal organs still remain with minimal change, but the ventral organ and grooves are more extensive and well developed. The labium appears as a trilobed structure. The ventral organ appears as C-shaped with four short spines appearing on the anterior side of the inner curvature of the organ. Prothoracic anterior spiracles become well developed. The caudal segment bears the posterior spiracular discs having two separated straight slits encircled by four multi-branched spiracular hairs. The button or cedysial scar appears as a hole ventro-medially on the posterior spiracular discs.

Cephalopharyngeal skeleton: In *Cyclorrhapha*, the typical mouthparts undergo atrophy in correlation with the reduction of the head, the maxillae and labium are scarcely recognizable other than papillae representing their palp. In *C. megacephala* there is a very characteristic framework of articulated sclerites, known as cephalopharyngeal skeleton (Thompson, 1938) Plate 2. This is a secondary development and is composed in the mature larva of the following principle sclerites. The most anterior are the mouth-hooks or mandibular sclerites which articulate basally with hypostomal or intermediate sclerites. The latter is H-shaped, its halves being joined by a transverse bar: the hypostomal sclerites receive the opening of the salivary duct. Behind this sclerite is the much larger basal or pharyngeal sclerite. The latter is formed of two lateral, vertical lamellae which unite ventrally forming a trough in which is lodged the pharynx. In many species, circular dentate sclerite units the bases of the mandibular sclerites: various other small accessory sclerites are frequently present, notably in carnivorous species.

In saprophagous larvae (Keilin, 1915) the floor of the pharyngeal sclerite is beset with longitudinal ridges which project into the cavity of the pharynx: larvae feeding on living animal or vegetable tissues are devoid of pharyngeal ridges or, if latter be present (as in *Pegomyia*) they are reduced. Furthermore, in phytophagous larvae the mandibular sclerites are usually toothed, and in carnivorous larvae they are sharply pointed: in the parasitic forms the buccal armature undergoes marked reduction. The size of the larval head capsule of *C. megacephala* is measured in mm on three different diets (Table 3). The size of the head capsule is influenced by the duration of feeding.

DISCUSSION

No other order of insects presents so great a diversity of larval habits as Diptera. Only four families have the majority of their species phytophagous in the larval stage: cecidomyiidae, tephritidae, agromyzidae and chloropidae. While the mycetophilidae and platypezidae are fungivorous. The saprophagous habit is largely in evidence among the anthomyiidae. Other notable scavengers are the bibionidae, sepsidae, phoridae, heleomyzidae and scatophaginae. Next to the parasitic hymenoptera, the dipteral constitute the most important natural controlling agency over the increase of other insects.

The trapping materials used: vinegar and brown-sugar mixture and the decomposing meat, the maximum attraction of the flies were noticed only on the decomposing meat. The attractivity of decomposing fish, human faeces and fermenting banana as bait to female calliphoridae and sarcophagidae in different stages of ovarian development was that the former undergoing intense vitellogenesis was attracted to fish and mature flies with eggs are attracted to banana and the latter at the beginning of vitellogenesis found fish and faeces most attractive (D'Almedia & Lima, 1995).

The duration of the larval feeding influence the size at different life stages and the duration of the lifecycle of *C. megacephala*. Correspondingly there is variation in the internal reproductive organs of the adults. Food can influence the growth in terms of the body length of the adults depending upon the nutritive value. In *C. megacephala* the sexual dimorphism is not well expressed.

The mating behavior in *C. megacephala* shows that the males are promiscuous, mating with several females and the mating takes place in "male above female position. The pheromones play an important role in sexual attraction like lepidopteran (Tinbergen, 1989). The position of contact during mating behavior is venter-venter in *C. megacephala* and it varies in other orders of insects (Richards, 1927).

Dipterans of forensic importance can be powerful tool in investigation of homicide and other deaths; particularly care is taken to collect specimens and record information. Many of direct observation of blowflies on or in corpse are reported by medical pathologists. With rare exceptions, experimental studies having forensic implications are carried out on carcasses rather than on corpses. Not only an animal size and species produce results that differ in some respects from those one would expect. If the experiments were carried out on man, the condition of the experiment may differ from those observed in forensic investigations. Efforts to adopt entomological data obtained for economic, medical or other purposes may in some cases be only partially successful, since critical elements are either unexplored or unreported.

The larval morphological description using SEM suggest that when first instar larvae are collected from a corpse, they should be reared to the second instar in order to easily differentiate between *C. megacephala* and *C. rufifacies*. However, rearing the third instar is required to definitely separate these two species from other closely related blowflies that may be found in a corpse, up to 42 calliphorid species are recorded (Tumrasvin et al., 1979). Thus the SEM results are beneficial for specific identification of larva in forensic investigations. Similarly low levels of variation between species of the same genus are diagnosed by sequencing the mitochondrial DNA (Harvey et al., 2003).

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LITERATURE CITED

- Bhuvaneswari, & Daniel, M. 1994. Impact of larval feeding duration on the viable pupal production in *C. megacephala* F. (Diptera: Insecta). Proceedings of the IX All India Symposium on Invertebrate Reproduction, Sivakasi.
- Brues, C. T. 1946. Insect dietary. An account of the food habits of insects. Harvard University Press, Cambridge.
- Catts, E. P. & Goff, M. L. 1992. Forensic entomology in criminal investigations. Annual Review of Entomology, 37: 253-272.

Catts, E. P. & Haskell, N. H. 1991. Entomology and death: a procedural guide. Joyce's print shop, Clemson South Carolina.

D'Almedia, J. M. & Lima, S. F. 1995. Attractiveness of different baits and its relationship with phases of ovarian development in Calliphoridae and Sarcophagidae (Insecta: Diptera). *Revista Brasileira de Zoologia*, 11 (2): 177-186.

Goff, M. L., Odom, C. B. & Early, M. 1986. Estimation of postmortem interval by entomological techniques: a case study from Oahu, Hawaii. *Bulletin of the Society Vector Ecology*, 11: 242-246.

Harvey, M. L., Dadour, I. R. & Gaudieri, S. 2003. Mitochondrial DNA cytochrome oxidase I gene: Potential for distinction between immature stages of some forensically important fly species Diptera in western Australia. *Forensic Science International*, 131: 134-139.

Hu, T., Len, C. H. & Lee, B. S. 1995. The laboratory rearing and radiation effects of gamma ray on the pupae of *C. megacephala* Fabricius. *Chinese Journal of Entomology*, 152: 103-111.

Keh, B. 1985. Scope and Applications of Forensic Entomology. *Annual Review of Entomology*, 30: 137-154.

Keilin, D. 1915. Recherchessur les larves de Diptere scyclorhaphes. *Bulletin Scientifique de la Belgique*, 49: 15-198.

Marchenko, M. J. 1980. Classifying of cadaveric entomofauna. *Biology of flies: The forensic medical role*. Sudebno-MeditsinskaiaEkspertiza, 23: 17-20.

McKnight, B. E. 1981. The washing away of wrongs: forensic medicine in thirteen-century China. University of Michigan Press.

Nainis, I. V. J., Marchenko, M. I. & Kazak, A. N. 1982. A calculation method for estimating by entomofauna the period during which the body had remained in the place where it was found. *Sudebno-MeditsinskaiaEkspertiza*, 25: 21-23.

Putman, R. J. 1977. Dynamics of the blow fly, *Calliphora erythrocephala* within carrion. *Journal of Animal Ecology*, 46: 853-866.

Richards, O. W. 1927. Sexual selection and allied problems in the insects. *Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society*, 298-360.

Shahein, A. 1986. Effect of intra specific competition between larvae of *Calliphora erythrocephala* Meig. Calliphoridae: Diptera. *Beitrag zur Entomologie*, 36 (2): 233-235.

Smith, K. G. V. 1986. A manual of forensic entomology. British Museum, London.

Thompson, W. R. 1938. A dipterous parasite of mycetophylids. *Parasitology*, 30: 176-180.

Tinbergen, N. 1989. The study of instinct. Oxford University Press, London.

Tumrasvin, W., Kurahashi, H. & Kano, R. 1979. Studies on medically important flies in Thailand 7. 42 species of Calliphorid flies including the taxonomic keys (Diptera: Calliphoridae). *Bulletin of Tokyo Medical and Dental University*, 26 (4): 242-272.

Table 1. Larval and pupal length (in mm) of *Chrysomya megacephala* on three different diets.

Duration (Hours)		24	48	72	96	120	144	168	192	216	240	264	288
Larvae	Bra in	8.52±0.1031	9.10±0.0079	12.72±0.1923	15.29±0.1884	17.17±0.052	18.58±0.0698	16.39±0.0554	15.61±0.0831	14.47±0.0676	13.38±0.0554	12.92±0.0397	-
	Blood	7.98±0.0258	8.61±0.046	12.4±0.5431	14.12±0.1032	15.8±0.079	15.99±0.0952	14.19±0.0722	13.77±0.0641	12.57±0.5594	11.55±0.0353	-	-
	Meat	8.23±0.1204	8.76±0.0389	12.64±0.114	14.8±0.079	16.64±0.0962	17.88±0.0609	15.81±0.134	14.6±0.0715	13.47±0.0622	12.5±0.0721	-	-
Pupae	Bra in	-	-	-	-	8.95±0.0376	9.04±0.0316	9.28±0.032	9.42±0.0808	9.63±0.0349	9.78±0.038	9.82±0.0316	9.94±0.0376
	Blood	-	-	-	8.07±0.0469	8.64±0.0316	8.83±0.0414	8.98±0.1283	9.1±0.038	9.28±0.032	9.45±0.0414	9.36±0.0303	-
	Meat	-	-	8.21±0.0685	8.52±0.0622	8.87±0.0303	8.95±0.0376	9.16±0.0378	9.28±0.032	9.45±0.0414	9.66±0.0808	9.78±0.0469	-

Table 2. Larval and pupal weight (in grams) of *Chrysomya megacephala* on three different diets.

Duration (Hours)		24	48	72	96	120	144	168	192	216	240	264	288
Larvae	Brain	0.009±0.0003	0.0193±0.0019	0.0345±0.0019	0.0572±0.0015	0.0769±0.003	0.1032±0.0001	0.0913±0.0005	0.0877±0.0012	0.086±0.0005	0.0855±0.0007	0.0812±0.0007	-
	Blood	0.0061±0.0005	0.0079±0.0002	0.0314±0.0037	0.0456±0.0069	0.0635±0.0008	0.0875±0.0008	0.0723±0.0005	0.0613±0.0005	0.0594±0.0003	0.058±0.0007	-	-
	Meat	0.0077±0.0003	0.0128±0.0003	0.0321±0.0032	0.0498±0.0017	0.0687±0.0042	0.0942±0.0026	0.083±0.0008	0.0815±0.0008	0.078±0.0016	0.072±0.0003	-	-
Pupae	Brain	-	-	-	-	0.0348±0.0004	0.0386±0.0006	0.0415±0.0003	0.0452±0.0002	0.0487±0.0004	0.0491±0.0003	0.0506±0.0005	0.0515±0.0004
	Blood	-	-	-	0.0316±0.0003	0.0329±0.0007	0.0352±0.0005	0.0389±0.0003	0.0419±0.0003	0.0446±0.0002	0.0462±0.0001	0.0478±0.0003	-
	Meat	-	-	0.0302±0.0001	0.0326±0.0001	0.0336±0.0002	0.0373±0.0003	0.0405±0.0004	0.0443±0.0004	0.0467±0.0004	0.0487±0.0004	0.0492±0.0008	-

Table 3. Larval head capsule (in mm) of *Chrysomya megacephala* on three different diets.

Duration (Hours)	Brain	Blood	Meat
24	0.6±0.0158	0.48±0.0258	0.58±0.0207
48	0.69±0.087	0.56±0.0559	0.65±0.036
72	0.75±0.0396	0.67±0.0414	0.74±0.0371
96	0.8±0.0291	0.71±0.024	0.79±0.0286
120	0.86±0.0602	0.78±0.0568	0.82±0.0349
144	0.9±0.0595	0.82±0.043	0.87±0.0396
168	0.82±0.0316	0.79±0.0303	0.77±0.0316
192	0.76±0.024	0.7±0.037	0.73±0.0316
216	0.7±0.0255	0.61±0.0316	0.63±0.0158
240	0.65±0.0414	0.59±0.024	0.6±0.0192
264	0.54±0.0319	-	-



Plate 1. Cephalopharyngeal skeleton of *C. megacephala* after larval treatment with KOH for 15 minutes. A) Cephalopharyngeal skeleton B) showing mandibular sclerite, dentate sclerite, hypostomal sclerite, pharyngeal sclerite and Lateral organ C) Cuticular armature at the region of cephalic capsule.

A NEW SUBSPECIES
PHYTOECIA (HELLADIA) HUMERALIS
FROM TURKEY (CERAMBYCIDAE: LAMIINAE)

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[Özdikmen, H. & Turgut, S. 2015. A new subspecies *Phytoecia (Helladia) humeralis* from Turkey (Cerambycidae: Lamiinae). Munis Entomology & Zoology, 10 (2): 384-387]

ABSTRACT: A new subspecies, *Phytoecia (Helladia) humeralis caneri* ssp. n. is described from S Turkey (Hatay, Osmaniye, Gaziantep provinces).

KEY WORDS: *Phytoecia (Helladia) humeralis*, new subspecies, Lamiinae, Cerambycidae, Coleoptera, Turkey.

Phytoecia (Helladia) humeralis caneri was firstly described by Ozdikmen & Turgut (2010) from S Turkey (Hatay, Osmaniye, Gaziantep provinces). Unfortunately, type material was not designated in the work. So it was invalid. Özdikmen (2015) designated type material for *Phytoecia (Helladia) humeralis caneri*. It is still invalid. Therefore, we have to describe the subspecies again.

***Phytoecia (Helladia) humeralis caneri* ssp. n.**
(Fig. 1B)

Type materials: Holotype ♂: Hatay prov.: Kırkhan–Belen road, Kıcı, N 36 28 E 36 16, 481 m, 31.03.2007. Paratypes: Osmaniye prov.: Yaylalık–Türkoğlu road, N 36 17 E 36 37, 701 m, 18.05.2006, 1 specimen; Zorkun road, Çiftmazi, N 37 01 E 36 17, 223 m, 20.05.2006, 1 specimen; Entry of Yarpuz, N 37 03 E 36 25, 930 m, 18.05.2006, 5 specimens; Hasanbeyli, N 37 07 E 36 32, 711 m, 21.04.2007, 3 specimens; Toprakkale, N 37 03 E 36 08, 107 m, 23.04.2007, 3 specimens; Bahçe, Kızlaç village, Aslanlı, N 37 10 E 36 38, 768 m, 21.04.2007, 1 specimen; Hatay prov.: Kırkhan–Belen road, Kıcı, N 36 28 E 36 16, 481 m, 31.03.2007, 7 specimens; Hassa–Kırkhan road, 10 km to Kırkhan, N 36 33 E 36 23, 31.03.2007, 5 specimens; Hassa–Kırkhan road 20th km, N 36 35 E 36 24, 145 m, 31.03.2007, 1 specimen; Serinyol, N 36 21 E 36 13, 115 m, 30.03.2007, 2 specimens; Alahan castle, N 36 19 E 36 11, 147 m, 30.03.2007, 7 specimens; Akbez, N 36 50 E 36 32, 464 m, 22.04.2007, 9 specimens; Akbez, Gülpınarı plateau, N 36 51 E 36 30, 617 m, 19.05.2006, 1 specimen; Samandağı, Hüseyinli village, N 36 09 E 36 04, 149 m, 20.04.2007, 1 specimen; Samandağı, Üzengili village, N 36 09 E 36 04, 141 m, 20.04.2007, 1 specimen; Gaziantep prov.: Fevzipaşa–İslahiye road, N 37 05 E 36 38, 542 m, 31.03.2007, 26 specimens (Fig. 2). The specimens are deposited in Gazi University (Turkey: Ankara).

Mainly, the new subspecies *Phytoecia (Helladia) humeralis caneri* is a color form of *Phytoecia (Helladia) humeralis*. It is close to the nominotypical subspecies by reddish-yellow pubescence and to the species *Phytoecia (Helladia) insignata* Chevrolat, 1854 by coloration of the legs.

The new subspecies, *Phytoecia (Helladia) humeralis caneri* can be easily distinguished from *Phytoecia (Helladia) humeralis humeralis* (Waltl, 1838),

which is widely distributed in SW-Asiatic area by following characters: Middle and hind tibiae are reddish entirely (Fig. 1B). Sometimes, middle and hind femora in the exception of their black colored inner parts are reddish. The apexes of middle femora are also reddish.

Also the new subspecies, *Phytoecia (Helladia) humeralis caneri* can be easily distinguished from *Phytoecia (Helladia) insignata* Chevrolat, 1854, which is distributed in S Syria, Israel, Lebanon and Jordan by following characters: Head, pronotum and scutellum have reddish-yellow pubescence like nominotypical subspecies. In sp. *insignata*, they have white pubescence.

The new subspecies probably distributes only in Central parts of Southern Anatolian region [Hatay to Adiyaman provinces (especially in Amanos Mountains and its northern parts) of Turkey. The hybridization areas of the new subspecies observed as Gaziantep and Hatay provinces. According to present materials, 5 different localities which are in S, SE and E of Amanos Mountains are determined for the hybridization areas of the new subspecies as Hatay prov.: Kırkhan–Belen road, Kıcı, N 36 28 E 36 16; Serinyol, N 36 21 E 36 13; Alahan castle, N 36 19 E 36 11; Akbez, N 36 50 E 36 32 and Gaziantep prov.: Fevzipaşa–İslahiye road, N 37 05 E 36 38. All specimens from Osmaniye province belong to the new subspecies only.

It is clear that the picture of *H. humeralis* from Adiyaman prov. (Turkey) given by Hoskovec & Rejzek (2015) and the Adiyaman record of Rejzek & Hoskovec (1999) should be belong to the new subspecies, *Phytoecia (Helladia) humeralis caneri*. Kahramanmaraş records of Özdikmen & Okutaner (2006) belong to the new subspecies. Besides, status of the old Turkish records of *Phytoecia (Helladia) humeralis* from near Amanos Mountains need to be clarified. So now, according to the present data, *Phytoecia (Helladia) humeralis caneri* ssp. n. is distributed in Hatay, Osmaniye, W Gaziantep, Kahramanmaraş and Adiyaman provinces as its distribution area.

On the other side, some color forms of *Phytoecia (Helladia) humeralis* have been described by different authors (Mulsant, Pic, Heyrovsky and Breuning). Two of them, *Helladia scapulata* var. *mersinensis* Pic, 1900 and *Phytoecia (Helladia) humeralis* m. *flavoreducta* Breuning, 1951, were described from Anatolia. However, the closest forms to coloration of the new subspecies among them are *Phytoecia scapulata* Mulsant, 1851 that described from Syria and *Helladia scapulata* var. *mersinensis* Pic, 1900. *Phytoecia humeralis* ab. *bytinskii* Heyrovsky, 1948 that described from Israel (Jerusalem) and *Phytoecia (Helladia) humeralis* m. *flavoreducta* Breuning, 1951 are less resemble to the new subspecies.

According to Pic (1900), Mulsant stated that first 2 (print error, should be 4) segments of antennae black and middle femora dark or almost dark, etc. as the distinguishing characters in the description of *P. scapulata* from Syria. Pic (1900) mentioned that “I captured a variety of this species with the 4 (print error, should be 2) hind legs more or less clear and first segment of antennae testaceous in Mersin (=İçel) and Karaman provinces (long. 9-10 mm.); I shall indicate it under the name of var. *mersinensis* var. nov.. This variety corresponds almost in var. *scapipicta* Reitt. of *adelpha* Ganglb.”.

The description of *P. scapulata* of Ganglbauer (1884) as follows:

Der Ph. humeralis Waltl. ebenfalls sehr nahe stehend, aber die Stirne, die zwei Längsbinden auf dem Scheitel, das Schildchen und überdies noch die vier ersten Fühlerglieder lebhaft roth tomentirt, die grosse rothe Medianmakel auf dem Halsschild vorne winkelig erweitert, an den Beinen auch die Spitze der

Mittelschenkel und die Mittelschienen mit Ausnahme ihrer Kante und Spitze rötlichgelb. Long. 9-11 mm. — Syrien.

Finally, the new subspecies clearly differs from other described infrasubspecific taxa of *Phytoecia* (*Helladia*) *humeralis*.

Variations: The new subspecies is characterized by reddish middle and hind femora and tibiae chiefly. Middle and hind femora has usually reddish area in all examined specimens. At least middle femora has always reddish area in all specimens. The reddish area of middle tibiae and hind femora and tibiae variable. The variation observed from the most parts reddish of middle and hind legs to hind legs black completely.

Etymology: The new name “*caneri*” is dedicated to Caner Gören (Turkey) who collected some specimens of the new subspecies.

A short key for related taxa on the base of Breuning (1951)

1. Pygidium black.....2
- Pygidium red.....4
2. The subhumeral spot is very large. It stretches over the disc of the elytron and exceeds behind the basal one third of elytra.....*Phytoecia humeralis* ab. *bytinskii* Heyrovsky, 1948
- The subhumeral spot is smaller. It barely reach the disc of elytra.....3
3. The design of head, pronotum and scutellum white.....*Phytoecia* (*Helladia*) *insignata* Chevrolat, 1854
- The design of head, pronotum and scutellum yellow or ocraceous-red.....*Phytoecia frontalis* Chevrolat, 1882
4. First four antennal segments black.....5
- First four antennal segments red.....7
5. Middle and hind tibiae always black.....6
- Middle and hind tibiae usually at least partly red.....*Phytoecia* (*Helladia*) *humeralis caneri* ssp. n.
6. Frons and vertex with clear drawings.....*Phytoecia* (*Helladia*) *humeralis humeralis* (Waltl, 1838)
- Frons and vertex without clear drawings.....*Phytoecia* (*Helladia*) *humeralis m. flavoreducta* Breuning, 1951
7. Hind tibiae black.....*Phytoecia scapulata* Mulsant, 1851
- Hind tibiae red.....*Helladia scapulata* var. *mersinensis* Pic, 1900

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LITERATURE CITED

- Breuning, S.** 1951. Revision du genre *Phytoecia* Muls. (Coleoptera Cerambycidae). Entom. Arbeiten aus dem Museum G. Frey 2: 1-103, 353-460.
- Ganglbauer, L.** 1884. Bestimmungs-Tabellen der europäischen Coleopteren. VIII. Cerambycidae.-Verhandlungen der kaiserlich-königlichen zoologisch.-botanischen Gesellschaft in Wien, 33: 437-586.
- Hoskovec, M. & Rejzek, M.** 2015. Longhorn beetles (Cerambycidae) of the West Palaearctic Region . Available from: <http://www.cerambyx.uochb.cz/> (Last updated 20 January 2014).

Özdikmen, H. & Okutaner, A. Y. 2006. The longhorned beetles fauna (Coleoptera, Cerambycidae) of Kahramanmaraş province. G. U. Journal of Science 19 (2): 77-89.

Özdikmen, H. & Turgut, S. 2010. An overview on the W-Palaeartic subgenus *Phytoecia* (*Helladia*) Fairmaire, 1864 with a new subspecies *Phytoecia* (*Helladia*) *humeralis caneri* ssp. n. from Turkey (Coleoptera: Cerambycidae: Lamiinae). Munis Entomology & Zoology, 5 (2): 317-343.

Özdikmen, H. 2015. Holotype and paratypes designations of *Phytoecia* (*Helladia*) *humeralis caneri* Ozdikmen & Turgut, 2010 (Cerambycidae: Lamiinae). Munis Entomology & Zoology, 10 (1): 300-300.

Pic, M. 1900. Note sur des *Phytoecia* du sous-genre *Helladia* (Col.). Bulletin de la Société Entomologique de France, 1900: 139-140.

Rejzek, M. & Hoskovec, M. 1999. Cerambycidae of Nemrut Dağı National Park (Anatolia, South-East Turkey). Biocosme Mésogéen, Nice 15 (4): 257-272.

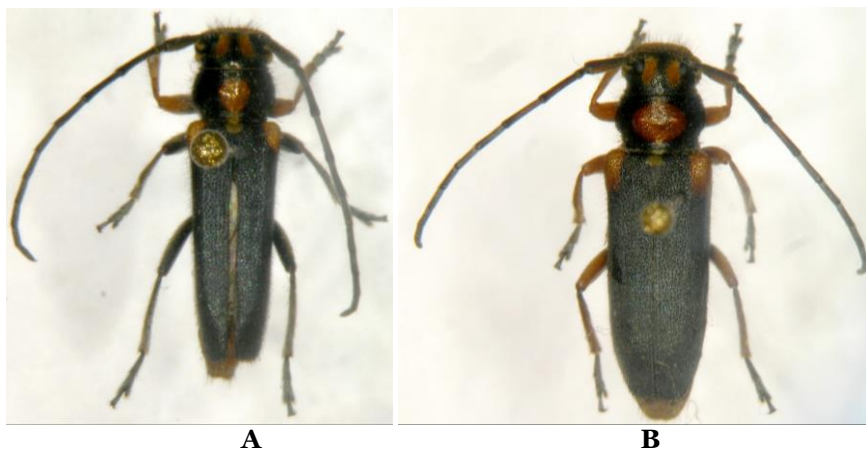


Figure 1. A. Habitus of *Phytoecia* (*Helladia*) *humeralis humeralis* (Waltl, 1838), B. Habitus of *Phytoecia* (*Helladia*) *humeralis caneri* ssp. n..

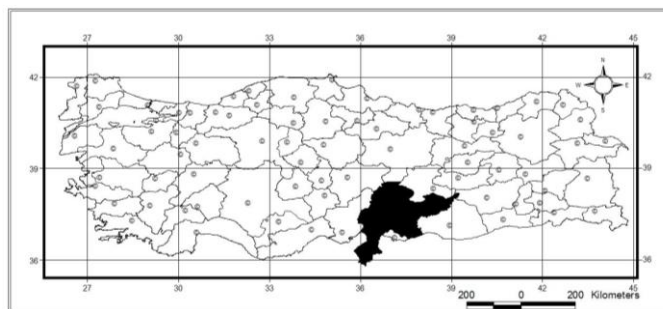


Figure 2. The distribution of *Phytoecia* (*Helladia*) *humeralis caneri*.

LIFE HISTORY OF *APHIS POMI* DE GEER (GREEN APPLE APHID) ON APPLE PLANTATIONS IN JAMMU PROVINCE, J&K, INDIA

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[Gupta, R. & Tara, J. S. 2015. Life history of *Aphis pomi* De Geer (green apple aphid) on apple plantations in Jammu Province, J&K, India. Munis Entomology & Zoology, 10 (2): 388-391]

ABSTRACT: In the present study, life history of green apple aphid was studied during July to November months on apple host and the data on total life period (pre reproductive, reproductive and post reproductive periods) was recorded. Total progeny produced and total nymphal period was also calculated. The detailed biology of the pest has been recorded for the first time in Jammu province of J&K state on apple plants.

KEY WORDS: *Aphis pomi* De Geer, life history, green apple aphid.

Jammu and Kashmir has thus been more favourably located for growth of apples and other temperate fruits since times immemorial. Jammu and Kashmir probably is the most ideal unparalleled area in the world with respect to soil, climate and environment that suits the culture and preservation of temperate fruits.

Aphid pests cause considerable loss to horticultural crops by sucking their sap and transmitting many diseases (Kennedy et al., 1962) Aphids have adapted their life cycle to different geographical regions depending upon the environmental conditions prevailing in the area of study. Though sufficient work with regard to biology of *Aphis pomi* has been done by earlier workers in some parts like Baker & Turner (1916) in North America and Gautam & Kumari (2004) in Shimla, but detailed information on the biology of this pest in Jammu province of Jammu and Kashmir State is not yet known.

In the present investigation, the life history of green apple aphids was studied on the red delicious cultivar of apple plantations from August to October months as heavy infestation of the pest was recorded in the fields during the said period. Present studies by the author may prove useful in ascertaining the adaptability of this aphid *Aphis pomi* to its host plant in the area of present study.

MATERIALS AND METHODS

Aphis pomi is economically important and widely distributed pests of apple plantations in Jammu province. During present study, a stock culture aphid was maintained on apple nursery plants grown in the fields. Colonies were established on excised twigs under laboratory conditions from adult apterous morphs (nymphs) collected from the field. From the laboratory colonies, individual aphids were taken to be reared individually. This was done by placing a single apterous parthenogenetic adult on a damaged portion of an excised delicious apple twig confined within a sleeve cage.

The twigs with caged aphids were kept in plastic vials half filled with water and placed in a jar. Each caged aphid was examined every 24 hours and the adult female and excess nymphs removed, leaving a single nymph on each twig. The

development of each nymph was then studied daily under a microscope and exuvae were removed after each moult. However aphids were also preserved in 80% alcohol for further morphometric studies. Morphological characters were measured using an ocular micrometer attached to a binocular microscope. Observations were made on nymphal period, pre reproductive, reproductive and post reproductive periods from July to October months.

RESULTS AND DISCUSSIONS

Green apple aphid populations build slowly on apples in early spring (bloom, petal, fall), which increases rapidly with the rise in temperature. Their number is more during July and early August. Depending on weather conditions, one life cycle takes two to three weeks in the area of author on apple plantations. There are many generations per year.

Green apple aphids usually remain on apple plants throughout the summer. The infestation of green apple aphid was found to be more in the apical parts of the plants (Fig. 1-1,2). Both nymphs and adults suck the sap from leaves, twigs, branches and young fruits, as a result of which the affected leaves curl up, blossoms shed and the young fruits drop prematurely and the quality of fruits is greatly impaired. Severely infected plants show stunted growth.

First generation usually consists of wingless individuals but eventually winged individuals appear which also migrates to other adjoining host plants like pear, peach etc growing in the vicinity of apple trees in the study area and the reproductive process continues rapidly thereby building enormous populations of aphids in a relatively short span of time.

Aphids generally overwinter in the egg stage which hatches in the spring into the females that reproduce parthenogenetically and give birth to young ones. Several generations of the pest are being produced during the season in this way. Baker & Turner (1916) and Gautam & Kumari (2004) during their studies had reported that the aphids passed through a complex life cycle involving polymorphism, viviparity and telescoping of generations. The present author during her studies has seen that green apple aphids have a number of stages like eggs, stem mothers, wingless viviparous females, winged viviparous females, males and oviparous females in the study area.

All the newly hatched nymphs are females who begin to feed immediately on growing leaves, and are initially seen on terminal shoots, moving later to older cluster leaves. After feeding for about two weeks and moulting several times, nymphs mature into wingless adults that reproduce without mating. These adults give birth to live young, with populations building rapidly.

Parthenogenetic wingless and winged forms were recorded from the fields. Wingless forms are parthenogenetic viviparous and their progeny also consisted of only parthenogenetic viviparous females. The average nymphal duration of this species is 13.50 ± 0.38 days which ranged from a minimum of 10.0 days to a maximum of 14.0 days. The average pre-reproductive, reproductive and post-reproductive periods of this aphid are 12.95 ± 0.27 , 17.50 ± 0.47 and 1.45 ± 0.17 days respectively (Table 1). The reproductive period starts with the laying of young ones and the progeny produced by a female varied from 19-79 aphids and averaged 47.80 ± 4.39 aphids (Table 1).

Maximum number of nymphs laid in a day averaged 5.00 ± 0.39 from a minimum of 4.0 nymphs to a maximum of 7.0 nymphs (Table 1). However, Baker & Turner (1916) also reported that the wingless viviparous females begin reproduction about 24 hrs after becoming mature and the average reproduction

varied greatly with season. According to these workers, the maximum reproduction was more than 16 for one day. These variations in number of nymphs in a day may be attributed to different prevailing weather conditions in different study areas.

In the present studies by the author in Jammu province *Aphis pomi*, the green apple aphid takes an average of 31.22 ± 0.10 days to complete one life cycle on apple plants as host (Table 1) whereas earlier workers like Baker & Turner (1916) and Gautam & Kumari (2004) reported that the average total duration of lifecycle of this pest for the entire season was 30.9 days in North America and 24.15 to 42.35 days in Himachal Pradesh. During these observations by the present investigator, only apterous parthenogenetic viviparous morphs were studied in detail however winged forms of this pest also exist in the study area but their biology could not be studied in detail.

Further extensive studies are required to study the biology of different morphs as well as their cytology and ecology in this region to minimize the infestation and also to devise the strategies of IPM for effective control of green apple aphid.

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LITERATURE CITED

- Baker, A. C. & Turner, W. F.** 1916. Morphology and biology of the Green Apple aphid (*Aphis pomi*). Journal of Agricultural Research, 5: 955-993.
- Bhalla, O. P.** 1972. Ensure quality of apple fruit by adopting measures against insect pests. Himachal Horticulture, 9 (2): 24-28.
- Gautam, D. C. & Kumari, M.** 2004. Biology of Green apple aphid (*Aphis pomi* De Geer) on Apple host. Indian Journal of Horticulture, 61 (3): 229-231.
- Kennedy, J. S., Day, M. F. & Eastop, V. F.** 1962. A Conspectus of Aphids as vectors of plant viruses. London Comm. Inst. Entomology, 1: 114.

Table 1. Life cycle (Pre-reproductive, reproductive and post-reproductive periods) of green apple aphid (*Aphis pomi* de Geer) on apple plantations in Jammu region.

Particulars	Range (in days)		Mean \pm SE
	Min.	Max.	
Total nymphal period (in days)	10.00	14.00	13.50 \pm 0.38
Period between last moult and beginning of reproduction (in days)	1.00	2.00	1.35 \pm 0.13
Total pre-reproductive period (in days)	12.5	14.0	12.95 \pm 0.27
Total reproductive period (in days)	16.0	20.0	17.50 \pm 0.47
Total post-reproductive period (in days)	1.00	2.5	1.45 \pm 0.17
Total life period (in days)	30.0	38.5	31.22 \pm 0.10
Total progeny produced	19.0	79.0	47.80 \pm 4.39
Max. no. of nymphs laid in one day	4.00	7.00	5.00 \pm 0.39

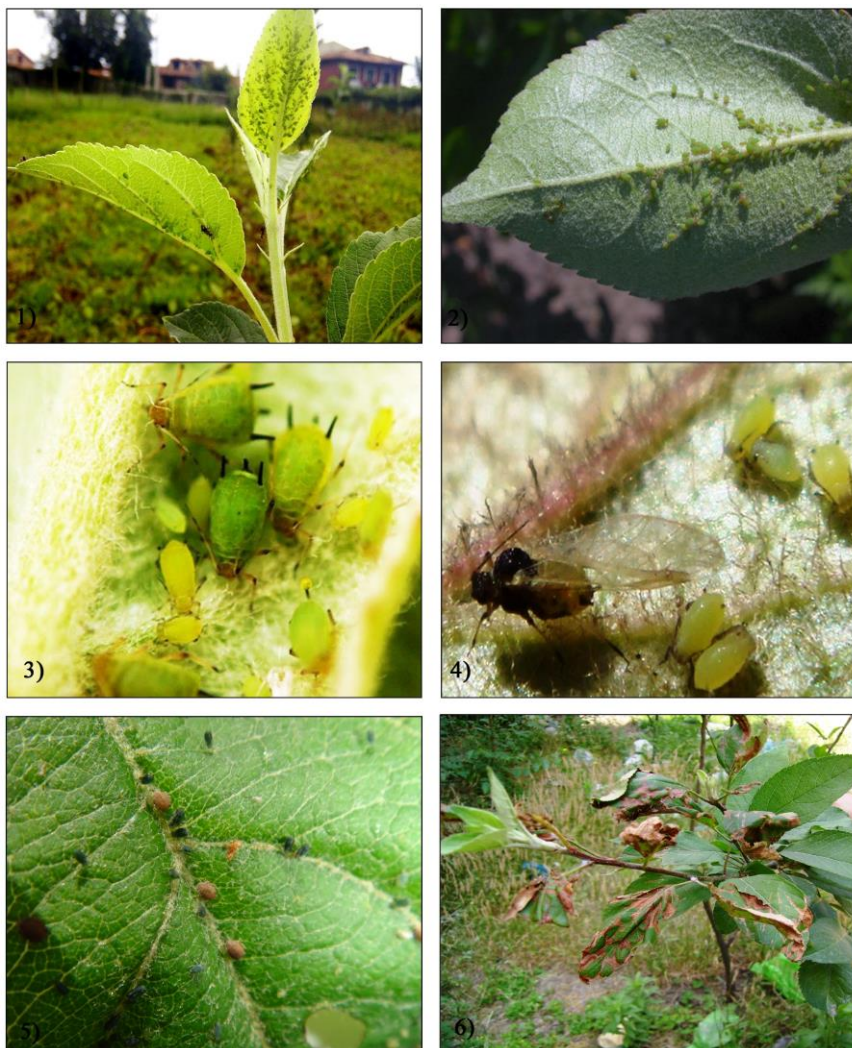


Figure I. 1-6. Infestation of green apple aphid (1,2. Aphid colonied on leaves, 3. Parthenogenetic apterous nymphs, 4. Alate morph).

**THREE NEW SPECIES OF THE GENUS *PACHYRHYNCHUS*
GERMAR, 1824 FROM LUBANG ISLAND (PHILIPPINES)
(CURCULIONIDAE: ENTIMINAE: PACHYRHYNCHINI)**

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[Bollino, M. & Sandel, F. 2015. Three new species of the genus *Pachyrhynchus* Germar, 1824 from Lubang Island (Philippines) (Curculionidae: Entiminae: Pachyrhynchini). Munis Entomology & Zoology, 10 (2): 392-401]

ABSTRACT: In the present paper three new species of Pachyrhynchini Schoenherr, 1826 (Curculionidae: Entiminae) *Pachyrhynchus mohagani* n. sp., *P. tilikensis* n. sp., and *P. lubanganus* n. sp. from Lubang Island (Philippines) are described and habitus and genitalia are illustrated.

KEY WORDS: Philippines, Lubang I., *Pachyrhynchus*, PIAP.

After the contributes by Heller (1934) and Schultze (1934), our knowledge about Philippine members of the tribe Pachyrhynchini (Curculionidae: Entiminae) remained unchanged for nearly eighty years, except for few contributions given by Janczyk (1957; 1959). In the last few years only few more taxa have been described (Yoshitake, 2011, 2012). These new species all came from previously entomologically almost unexplored areas of Mindanao, confirming our own belief that several new taxa will be discovered as soon as new areas and new habitats will be sampled. No members of the tribe Pachyrhynchini have ever been recorded from Lubang island, so, when we received a small assortment of such beetles collected there, we were not surprised to find three new *Pachyrhynchus* that will be described hereinafter.

MATERIAL AND METHODS

This study was based on specimens deposited in the Museum für Tierkunde, Dresden, Germany (MTD), and in private collections of Maurizio Bollino, Lecce, Italy (MBLI) and Franco Sandel, Miane, Italy (CFS). Holotypes will be deposited in MTD.

External structures were observed under a Nikon SMZ745T stereoscopic microscope. Stacked digital habitus images were taken with a Nikon D90 digital camera and AF-S DX Micro NIKKOR 85mm f/3.5G ED VR lens, and processed using a licensed version of software Zerene Stacker 1.04. Images of anatomical details/genitalia were drawn by tracing photographic images of the single parts, and adding details by observation under stereomicroscope. All measurements are in mm. Label data are given verbatim, with slash sign parting lines.

Abbreviations

LB = length of the body, from the apical margin of pronotum to the apices of clothed elytra

LE = length of the elytra, from the level of the basal margins to the apices of the clothed elytra

LP = length of the pronotum, from the base to apex along the midline

LR = length of the rostrum

WE = maximum width across the elytra
WP = maximum width across the pronotum
WR = maximum width across the rostrum

Taxonomy

Pachyrhynchus mohagani sp. nov.

(Figs. 1a-d, 2-8)

Holotype (male): Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, presently in MBLI, will be deposited in MTD.

Paratypes (1 male, 4 females): 3 females, Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, all in MBLI; 1 male, 1 female, Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, all in CFS.

Description.

Male. Holotype: LB: 11.25; LR: 1.55; WR: 1.50; LP: 3.65; WP: 4.15; LE: 7.10; WE: 5.60. Dorsal habitus as shown in Fig. 1, lateral habitus as shown in Fig. 2.

Integument of head, scape and funicular segments, prothorax, all femora, tibiae and tarsi black; elytra dark chestnut-brown. Very few scattered small, cobalt-blue recumbent scales on elytra, mostly along striae. Body surface strongly shiny except elytra and underside. Body subglabrous, with few glossy cobalt-blue recumbent round to elliptic scales. Rostrum nearly as long as wide (length/wide 1.1) very minutely pubescent on dorsum, with shallow obovate concavity on basal half, weakly bulging on apical half; apical bulge flattish dorsally, but faintly depressed in middle of basal half; dorsal contour of forehead and rostrum interrupted by a weak transverse groove; each side of rostrum covered with short hair-like scales on lateroventral part basad of antennal scrobe, covered with pale blue linear long hair-like scales on lateral part apicad of it, and furnished with long golden hairs near apex. Antennal scape short and stout, strongly clavate, slightly shorter than funicle; funicle relatively stout; club subellipsoidal, nearly twice as long as wide. Head glabrous, minutely and sparsely punctured; forehead with trace of furrow along midline, furrow deeper at base of rostrum; eyes relatively large, moderately prominent from outline of head. Prothorax subspherical (width/length 1.1), maximum transverse diameter just basad of middle, shiny, finely and sparsely punctured, without scales on disc; a patch of scattered cobalt-blue recumbent round scales on anterior portion of lateral edge. Elytra glabrous, each elytron with few scattered cobalt-blue round scales along lateral margin, mostly on anterior and median portions (Fig. 1d). Elytra broadly subobovate, convex dorsally, wider than prothorax (elytral/pronotal width 1.4), nearly twice as long as prothorax (elytral/pronotal length 1.9), dull due to irregular leathery wrinkles (Fig. 1c); dorsal convexity highest at posterior 3/5; sides gradually dilated from base, widest just before middle, then strongly narrowed to faint subapical constrictions, and then gently rounded at apices. Legs stout; femora rather strongly clavate; tibiae strongly latero-laterally flattened, serrate along internal margins, incurved apically, mucronate at apices; tibial mucrones well-developed on all legs. Anterior part of coxae with short light-coloured hairs. Femora with short light-coloured hairs near base, thinly covered by scattered short hairs, with hair-like scales along posterior margins, and a patch of pale blue hairs on anterior subapical part. Tibiae sparsely minutely pubescent;

each tibia fringed with long hairs along internal margin. Basisternum with few elliptical scales, and sternellum with a large scaly patch. Intercoxal part of mesosternum with few elliptical cobalt-blue scales. Venter subglabrous. Ventrite V truncate at apex. A large circular depression on disc of posterior half of metasternum and anterior half of ventrite I.

Genitalia as illustrated in Figs. 2-8. Spiculum gastrale (Fig. 4) slender, nearly twice as long as aedeagal body, strongly curved leftward. Aedeagal body (Figs. 2-3) stout, in lateral view moderately curved ventrally in the subbasal part, and gradually attenuated in the apical sixth in a narrow plate. In frontal vision (Fig. 2) little or barely sinuate in subbasal part, apical sixth moderately narrowed and then gradually so toward the conical apical plate. Aedeagal apodemes slender, nearly 1.6 times as long as aedeagal body. Tegmen (Fig. 5) with very slender apodeme, nearly 1.9 times as long as diameter of tegminal ring.

Female. Sternite VIII in ventral view (Fig. 7): body of sternite with a longitudinal impression, and with many hairs, more dense and long near the apex, apodeme slender, curved leftward at apical quarter, nearly 4.5 times as long as body of sternite.

Diagnosis. *Pachyrhynchus mohagani* shows an unusual pattern, being easily distinguishable from nearly all other *Pachyrhynchus* species by the shiny integument of head, pronotum and legs in contrast with the weaker luster of integument of elytra. This quite unconventional combination of character within the genus is shared with few species, all belonging to the *orbifer* species group, namely *P. rugicollis* Waterhouse, 1841, *P. infernalis* Fairmaire, 1897, and another yet undescribed taxon (Bollino & Sandel, in prep.). *Pachyrhynchus mohagani* can be distinguished from similar species also for the strongly flattened meta and mesotibiae.

Distribution. Lubang Island.

Etymology. The new species is named after Noel Mohagan (Del Pilar, Naujan, Or. Mindoro) for his contribution to a better knowledge of this interesting group of weevils.

Pachyrhynchus tilikensis sp. nov.

(Figs. 1e-f, 9-15)

Holotype (male): Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, presently in MBLI, will be deposited in MTD.

Paratypes (7 males, 9 females): 6 males, 5 female, Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, all in MBLI; 1 male, 4 females, Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, all in CFS.

Description.

Male. Holotype: LB: 14.25; LR: 2.05; WR: 2.05; LP: 4.85; WP: 5.10; LE: 9.40; WE: 7.05. Dorsal habitus as shown in Fig. 7, lateral habitus as shown in Fig. 8.

Integument black. Body surface weakly shiny except underside which has a weaker luster, subglabrous, with glossy sea-green markings of recumbent round to elliptic scales. Rostrum as long as wide (length/width 1.00), dorsum very

minutely pubescent; basal half with a subtriangular depression with apical base, roughly bulging on apical half, and two small admedian patches of scales on base of apical half; apical bulge flattish dorsally; dorsal contour of forehead and rostrum interrupted by a weak transverse depression; lateral side of rostrum with a deep furrow just below the margin and in front of antennal scrobe; long hair-like scales and a scaly patch in front of antennal scrobe, and a scaly patch with short hair-like scales behind it; rostrum with long golden hairs near apex and scaly patches on sides of basal subtriangular depression. Antennal scape short and stout, strongly clavate and slightly shorter than funicle; funicle relatively stout; club subellipsoidal, nearly twice as long as wide. Head glabrous, minutely and sparsely punctured; forehead with triangular patch of loose scales; eyes relatively large, moderately prominent from outline of head. Prothorax subspherical (width/length 1.1), maximum transverse diameter just behind the middle, finely and sparsely punctured; dorsally a basal linear scaly patch along midline; a central small scaly spot in the middle of pronotum; two scaly patches below middle of pronotum, one before the anterior edge, and one behind posterior edge; a broad scaly patch on lateroventral part above fore coxa. Elytra obovate, moderately convex dorsally, wider than prothorax (elytral/pronotal width 1.4), nearly twice as long as prothorax (elytral/pronotal length 1.9), weakly shiny with thick irregular leathery wrinkles; dorsal convexity highest at central 1/3; sides gradually dilated from base, widest just before middle, then moderately narrowed to faint subapical constrictions, and then gently rounded at apices. Elytra glabrous, each elytron with the following eleven scaly markings: an elliptic postmedian patch along suture, an small elliptic subapical patch along suture, a subbasal para-sutural elliptic patch, a median para-sutural round small patch, a median and a postmedian discal round patches, an elliptic subbasal, round median patch, and a small postmedian lateral patches, a postmedian and a subapical marginal stripes. Legs stout; femora rather strongly clavate; tibiae serrate along internal margins, incurved apically, mucronate at apices; tibial mucrones well developed on all legs. Anterior parts of fore coxae covered with few scales. Femora very minutely pubescent, each with a subapical subanular scaly patch which is dorsally interrupted. Tibiae sparsely minutely pubescent; each tibia fringed with long hairs along internal margin. Prosternum with very few scales on the sternellum, and a large scaly patch nearly covering proepisternum. A scaly patch on posterior part of metepisternum. Venter sparsely minutely pubescent; ventrite I and II with a pair of scaly patches on sides along posterior margin; ventrites III and IV subglabrous; ventrite V with suberect hairs on apical third, and truncate at apex. A circular depression on anterior two-thirds of disc of ventrite I, extended to posterior edge of metasternum.

Genitalia as illustrated in Figs. 9-15. Spiculum gastrale (Fig. 11) slender, nearly 1.5 times as long as aedeagal body, regulary curved leftward. Aedeagal body (Figs. 9-10) very short and stout, strongly curved ventrally, subparallel-sided in dorsal view, then gradually convergent to apex. Aedeagal apodemes very long, nearly 2.4 times as long as aedeagal body, strongly flattened laterally and regulary curved leftward. Tegmen (Fig. 12) with slender apodeme curved leftward at apical quarter, nearly 1.7 times as long as diameter of tegminal ring.

Female. Sternite VIII in ventral view (Fig. 13) with a large central depression at the truncated apex, somewhat bilobed, apodeme very slightly curved leftward, nearly 3,3 times as long as body of sternite.

Diagnosis. *Pachyrhynchus tilikensis* is similar in general appearance to *P. smaragdinus* Behrens, 1887 and related species, but differs at first glance by

having a basal linear scaly patch along midline of pronotum, thus approaching to the *congestus* species group *sensu* Schultze (1924).

Distribution. Lubang Island.

Etymology. The name is derived from the village of Tilik (~ 13°48'N 120°12'E), near which the type series was collected.

***Pachyrhynchus lubanganus* sp. nov.**

(Figs. 1g-h, 16-22)

Holotype (male): Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, presently in MBLI, will be deposited in MTD.

Paratypes (3 males, 1 female): 3 males, Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, all in MBLI; 1 female, Philippines – Lubang Is. / South-West of Tilik / (MIMARO - Occidental Mindoro) / IV 2014 / Ex Noel Mohagan, in CFS.

Description.

Male. Holotype: LB: 14.00; LR: 2.05; WR: 1.95; LP: 4.65; WP: 4.80; LE: 8.90; WE: 6.10. Dorsal habitus as shown in Fig. 5, lateral habitus as shown in Fig. 6.

Integument black. Body surface shiny except underside which has a weaker luster, subglabrous, with glossy pale blue markings of recumbent round to elliptic scales. Rostrum nearly as long as wide (length/width 1.1) very minutely pubescent on dorsum, with shallow obovate concavity on basal half, weakly bulging on apical half, and a sagittal groove along midline, apical bulge flattish dorsally, but faintly depressed in middle of basal half; dorsal contour of forehead and rostrum subcontinous; lateral side of rostrum with long hair-like scales and a scaly patch in front of antennal scrobe, and a scaly patch with short hair-like scales behind it; rostrum with long golden hairs near apex. Antennal scape short and stout, strongly clavate, slightly shorter than funicle; funicle relatively stout; club subellipsoidal, nearly twice as long as wide. Head glabrous, minutely and sparsely punctured, with elliptic scaly patch along midline which extends from vertex to apex of forehead; eyes relatively large, moderately prominent from outline of head. Prothorax subspherical (width/length 1.00), with maximum transverse diameter just behind the middle, shiny, finely and sparsely punctured; dorsally a basal elongated triangular scaly patch along midline; a pair of ovate scaly spots on both sides of middle of pronotum; two small dots on each side, below middle of pronotum, one before the anterior edge, and one behind posterior edge; each side with broad scaly patch on lateroventral part above fore coxa. Elytra obovate, moderately convex dorsally, wider than prothorax (elytral/pronotal width 1.3), nearly twice as long as prothorax (elytral/pronotal length 1.9), moderately striate-punctured, with intervals evenly flattish; dorsal convexity highest at central 1/3; sides gradually dilated from base, widest just before middle, then moderately narrowed to faint subapical constrictions, and then gently rounded at apices. Elytra glabrous, each elytron with the ten following scaly markings: a median round patch on interval II united with the median patch on interval III, a subbasal elliptic patch, a median round patch, a postmedian round patch and an apical round spot on interval III, a median and a postmedian round patches on interval V, a subbasal and a median elongate patches on interval VII, a postmedian

marginal stripe. Legs stout; femora rather strongly clavate; tibiae serrate along internal margins, incurved apically, mucronate at apices; tibial mucrones well developed on all legs. Anterior parts of fore coxae covered with scales, mingled with short light-coloured hairs. Profemora covered with short hairs, each with scaly patch on ventral subapical part; meso and metafemora with short hairs, and on subapical part with a larger ventral scaly patch, and a smaller dorsolateral one. Tibiae sparsely minutely pubescent; each tibia fringed with long hairs along internal margin. Both basisternum and sternellum with a patch of scales, and a large scaly patch nearly covering proepisternum. Intercoxal part of mesosternum with a patch of scales. Metasternum with a scaly patch in the middle, behind the posterior edge, and another large patch on metepisternum. Venter sparsely minutely pubescent; ventrite I and II with a pair of scaly patches on sides along posterior margin, that on ventrite II being larger than that on ventrite I; ventrites III and IV subglabrous; ventrite V with suberect hairs on apical third and truncate at apex. A large circular depression on disc of posterior half of metasternum and anterior third of ventrite I.

Genitalia as illustrated in Figs. 16-22. Spiculum gastrale (Fig. 18) slender, nearly 1.5 times as long as aedeagal body, strongly curved leftward. Aedeagal body (Figs. 16-17) stout, in lateral view moderately curved ventrally in the subbasal part, and gradually attenuated to form a keel before the ventral apical blade. In frontal vision (Fig. 16) sides sinuate, rather strongly narrowed from base to basal half, then subparallel to subapical part, and then strongly convergent to conical apex. Aedeagal apodemes slender, of the same length as aedeagal body, in lateral view strongly laterally flattened and curved leftward to apical 1/3. Tegmen (Fig. 19) with slender apodeme, nearly 1.7 times as long as diameter of tegminal ring.

Female. Sternite VIII in ventral view (Fig. 21): body of sternite without impression, with some sparse hairs more long at apex, apodeme slender, not curved, nearly 3.2 times as long as body.

Diagnosis. *Pachyrhynchus lubanganus* is similar in general appearance to *P. tilikensis* n.sp., but it is easily distinguishable from the latter by the unique scaly markings.

Distribution. Lubang Island.

Etymology. The name is derived from that of the island of Lubang.

DISCUSSION

Lubang (Map 1) is an oceanic island about 40 km off the southwestern coast of Luzon. The island, with several smaller nearby islands, is well isolated from Luzon and Mindoro by depths exceeding the levels to which sea level dropped during the Pleistocene (Heaney et al., 2014). As consequence, even if small, being about 125 square kilometres (48 sq mi), it is considered by biogeographers as a Pleistocene Aggregate Island Complex (PAIC), i.e. the Lubang PAIC (Heaney, 2004), thus a major center of biodiversity and endemism, with distinctive flora and fauna (Ong et al., 2002; Gaulke et al., 2007; Brown & Diesmos, 2009; Diesmos & Brown, 2011).

At best of our knowledge, nearly no data are available about the entomological fauna of the Island but a list of Papilionidae (Lepidoptera) given by Page & Treadaway (2011), which includes the description of two endemic taxa from the island. Some researches were recently carried out about its mammalian fauna,

leading to the description of one endemic species of Philippine forest mice of the genus *Apomys* Mearns, 1905 (Muridae, Rodentia) (Heaney et al., 2014). It is quite interesting to note that such *Apomys* species has strict phylogenetic relationships with two species endemic to Zambales Range (Zambales and Bataan Provinces, Western Central Luzon), demonstrating a faunal affinity between Lubang and Luzon, and matching the similar pattern observed in either *Pachyrrhynchus rugicollis*, which is apparently restricted to Zambales Range, and *P. mohagani* n. sp. Moreover the, although tentative, attribution of *P. tilikensis* n. sp. to the *congestus* species group *sensu* Schultze (which is restricted to central and northern Luzon) further confirms the faunal affinity between Lubang and Luzon.

ACKNOWLEDGEMENTS

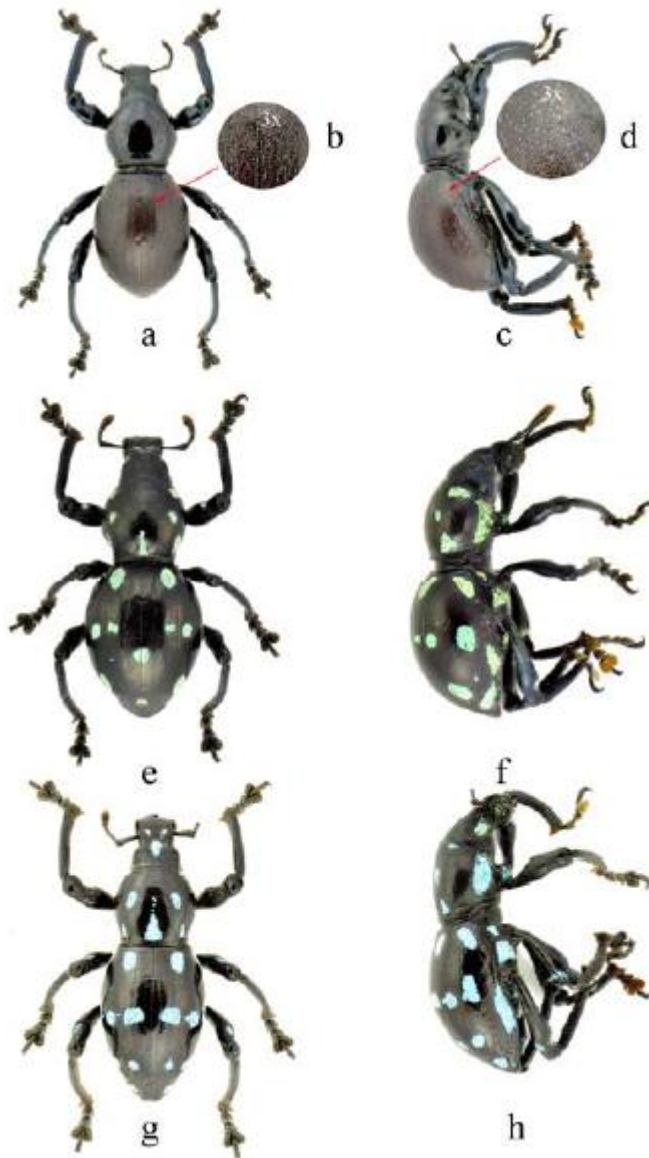
Thanks are given to Olaf Jäger and Matthias Nuss (Museum für Tierkunde, Dresden, Germany) for their kind assistance during our stay in Dresden on September 2009, Enzo Colonnelli (Rome, Italy) for the revision of the text and precious suggestions, Lawrence R. Heaney (Field Museum of Natural History, Chicago, USA) for the bibliographical support, and to Enrico Ruzzier (The Natural History Museum, London, England) and Marco Uliana (Natural History Museum, Venice, Italy) for their help in various ways.

LITERATURE CITED

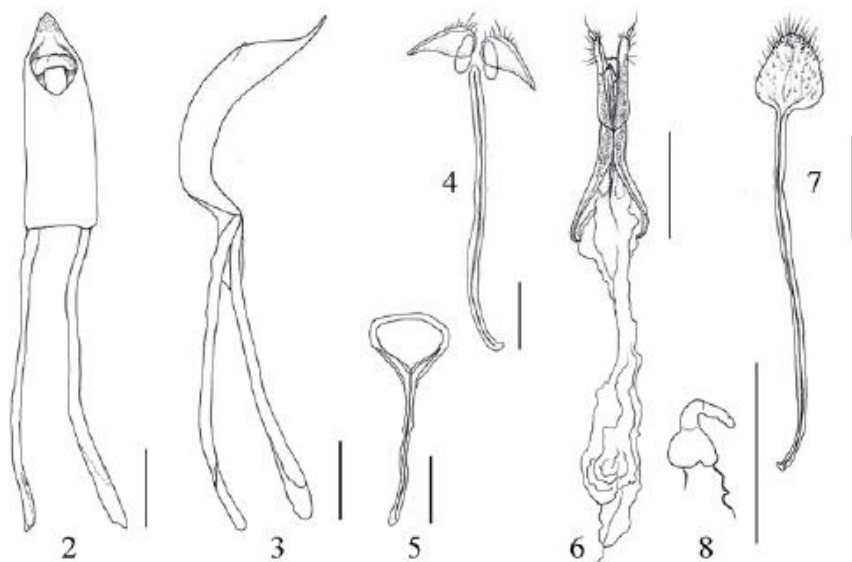
- Brown, R. & Diesmos, A.** 2009. Philippines, Biology. pp. 723-732. In: A. Gillespie, R. & Clague, D. (eds.), *Encyclopedia of Islands*. University of California Press.
- Diesmos, A. & Brown, R.** 2011. Diversity, biogeography and conservation of Philippine amphibians. pp. 26-49. In: *Biology and Conservation of Tropical Asian Amphibians*. Proceedings of the Conference "Biology of the Amphibians in the Sunda Region, South-east Asia". Organized by University Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia, 28–30 September 2009.
- Gaulke, M., Roesler, H. & Brown, R.** 2007. A New Species of *Luperosaurus* (Squamata: Gekkonidae) from Panay Island, Philippines, with Comments on the Taxonomic Status of *Luperosaurus cumingii* (Gray, 1845). *Copeia*, 2007 (2): 413-425.
- Heaney, L. R.** 2004. Conservation Biogeography in an Oceanic Archipelago, pp. 345-360. In: M. V. Lomolino & L. R. Heaney (eds.), *Frontiers of Biogeography, New Directions in the Geography of Nature*. Sinauer Associates, Sunderland.
- Heaney, L., Balete, D., Veluz, M., Steppan, S. J., Esselstyn, J., Pfeiffer, A. & Rickart, E.** 2014. Two new species of Philippine forest mice (*Apomys*, Muridae, Rodentia) from Lubang and Luzon Islands, with a redescription of *Apomys sacobianus* Johnson, 1962. *Proc. Biol. Soc. Washington*, 126 (4): 395-413.
- Heller, K.** 1934. New and little known Philippine Coleoptera. *Philippine Journal of Science*, 54 (2): 279-307.
- Janczyk, F.** 1957. Neue Curculioniden der Zoologischen Sammlung des Naturhistorischen Museums (1. Beitrag zur Kenntnis der Curculionidae). *Annalen des Naturhistorischen Museums in Wien*, 61: 241-248.
- Janczyk, F.** 1959. Neue Curculioniden der Zoologischen Abteilung des Naturhistorischen Museums. *Annalen des Naturhistorischen Museums in Wien*, 63: 430-435.
- Ong, P. S., Afuang, L. E. & Rosell-Ambal, R. G. (eds.)** 2002. Philippine biodiversity conservation priorities: A second iteration of the National Biodiversity Strategy and Action Plan. Department of Environment and Natural Resources - Protected Areas and Wildlife Bureau, Conservation International Philippines, Biodiversity Conservation Program - University of the Philippines Center for Integrative and Development Studies, and Foundation for the Philippine Environment, Quezon City, Philippines, 113 pp.
- Page, M. & Treadaway, C.** 2011. New subspecies of Papilionidae from South-east Asia (Lepidoptera: Papilionidae). *Nachrichten des entomologischen Verheins Apollo*, 31 (4): 201-205.
- Schultze, W.** 1924. A monograph of the pachyrrhynchid group of the Brachyderinae, Curculionidae. Part I. The genus *Pachyrrhynchus* Germar (concluded). *Philippine Journal of Science*, 24: 309-366.
- Schultze, W.** 1934. Thirteenth Contribution to the Coleoptera Fauna of the Philippines. *Philippine Journal of Science*, 53 (3): 311-338.

Yoshitake, H. 2011. A new species of the subgenus *Artapocyrtus* of the genus *Metapocyrtus* (Coleoptera: Curculionidae: Entiminae) from Mindanao, the Philippines. *Esakia*, (50): 115-119.

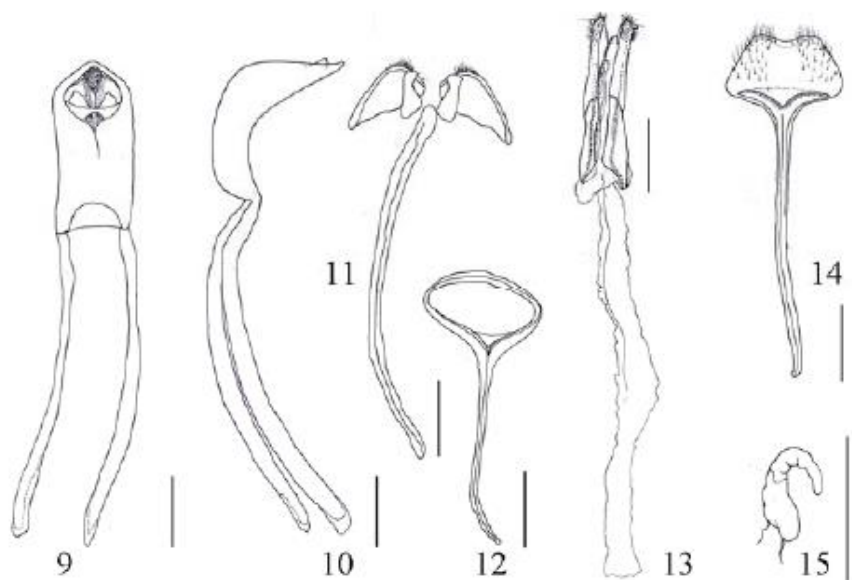
Yoshitake, H. 2012. Nine new species of the genus *Pachyrhynchus* Germar (Coleoptera: Curculionidae) from the Philippines. *Esakia*, 52: 17-34.



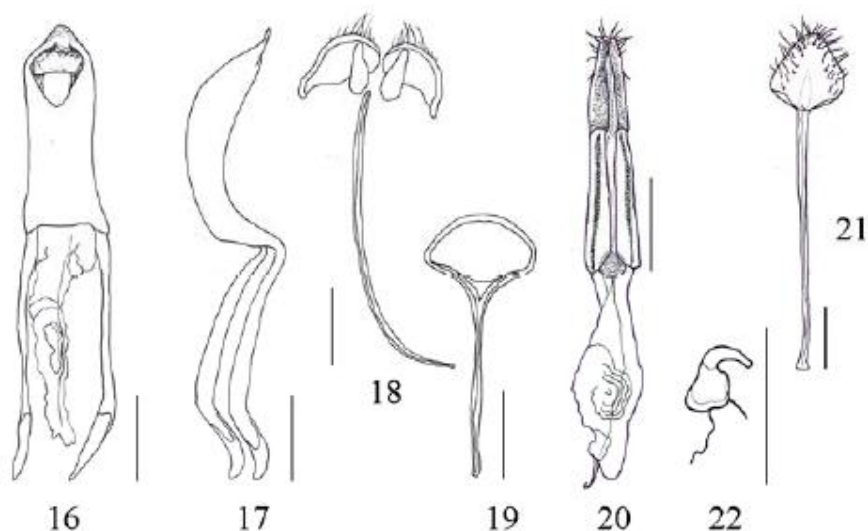
Figures 1a-h. *Pachyrhynchus mohagani* n. sp. holotype - a: dorsal habitus; b: magnification 3x of dorsal integument of elytra; c: lateral habitus; d: magnification 3x of lateral integument of elytra; *Pachyrhynchus tilikensis* n.sp. holotype - e: dorsal habitus; f: lateral habitus; *Pachyrhynchus lubanganus* n.sp. holotype - g: dorsal habitus; h: lateral habitus.



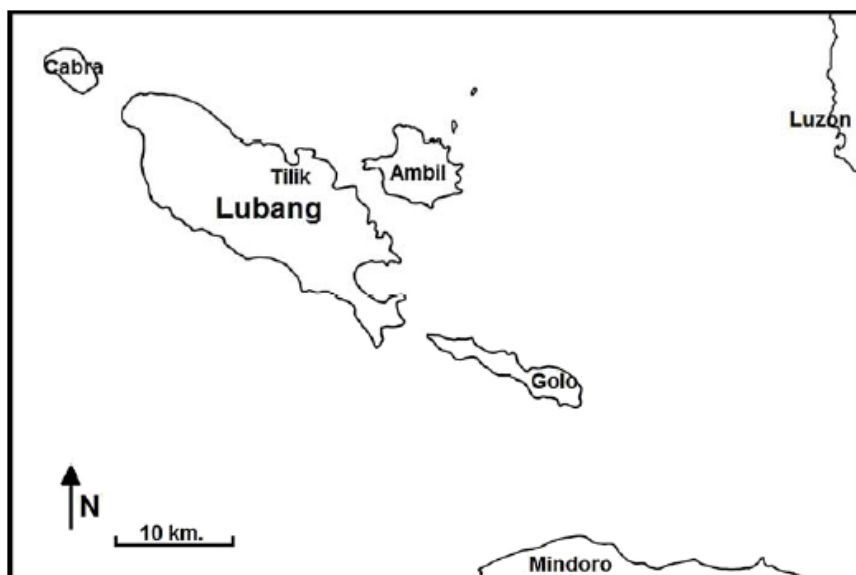
Figures 2-8. Male and female genitalia of *Pachyrhynchus mohagani* n. sp. 2: aedeagus in dorsal view; 3: aedeagus in lateral view; 4: sternite IX in dorsal view; 5: tegmen in dorsal view; 6: ovipositor in dorsal view; 7: sternite VIII in ventral view; 8: spermatheca. Scale: 1 mm.



Figures 9-15. Male and female genitalia of *Pachyrhynchus tilikensis* n. sp. 9: aedeagus in dorsal view; 10: aedeagus in lateral view; 11: sternite IX in dorsal view; 12: tegmen in dorsal view; 13: ovipositor in dorsal view; 14: sternite VIII in ventral view; 15: spermatheca. Scale: 1 mm.



Figures 16-22. Male and female genitalia of *Pachyrhynchus lubanganus* n. sp. 16: aedeagus in dorsal view; 17: aedeagus in lateral view; 18: sternite IX in dorsal view; 19: tegmen in dorsal view; 20: ovipositor in dorsal view; 21: sternite VIII in ventral view.



Map 1. Map of Lubang archipelago, and neighbouring islands.

IMPACT OF INTEGRATED CHAWKI REARING TECHNOLOGY ON COCOON PRODUCTION IN MUGA SILKWORM *ANTHRAEA ASSAMENSIS* HELFER

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[Goswami, D., Ibotombi Singh, N., Mustaq Ahmed, Senapati, M. D. & Giridhar, K. 2015. Impact of integrated chawki rearing technology on cocoon production in Muga Silkworm *Antheraea Assamensis* Helfer. Munis Entomology & Zoology, 10 (2): 402-406]

ABSTRACT: In muga culture, high mortality of larvae occurred particularly in the early stage of rearing to the tune of 15 to 25 %. The present paper examines the impact of adoption of integrated chawki (1st to 3rd instar larvae) rearing technology as a strategy for improving muga cocoon production in India. During Jethua Crop (May-June), the cocoon yield of the farmers who adopted the technology ranged from 4552 to 6178 per 100 disease free laying (dff) while in the traditional lot, it ranged from 4020 to 5490 per 100 dff. It was observed that increase in cocoon yield in the technology adopted lots over that of control lot ranged from 8.07 % to 17.02 %. Similarly, during Kotia crop (October-November), the cocoon yield of the farmers who adopted the technology ranged from 4367 to 6215 per 100 disease free laying(dff) while in the control lot, it ranged from 3970 to 5624 per 100 dff. During this crop, increase in cocoon yield of the treated lot over that of control ranged from 6.70 % to 18.62 %. Significant improvement in cocoon production was observed due to the adoption of the chawki rearing technology in muga culture.

KEY WORDS: *Antheraea assamensis* Helfer, chawki rearing technology.

Sericulture is a labour oriented, low investment, agrarian small scale industry which suits both marginal and small land holders because of its high returns, short gestation period, and it creates opportunity for own family employment round the year. Sericulture serves as an important tool for rural reconstruction, benefiting the weaker sections of the society (Lakshmanan et al., 1998). Muga culture like other forms of sericulture, is an industry that is characterized by a three-step process, the cultivation of food plants- som (*Machilus bombycina* Kost) and Soalu (*Litsea monopetala*) trees, the rearing of silkworms on these leaves to produce cocoons and the production of silk threads and fabrics. North east India- the indigenous home of muga silkworm, *Antheraea assamensis* Helfer has a long history in muga cocoon and silk production but muga silk productivity in the country is low due to lack of adoption of improved technologies. Lack of awareness of new technologies at the farmers' level has been one of the main lacunae in the development of this industry. Muga silkworm, *Antheraea assamensis* Helfer is a multivoltine insect. Muga silkworm completes 5-6 crop cycles in a year, of which, spring (May-June) and Autumn (October-November) are considered as commercial crops and remaining four crops as pre-seed or seed crops. In the crop cycle, each commercial crop is preceded by one seed crop and each seed crop is preceded by one pre seed crop, as such, autumn commercial crop (October-November) is preceded by late summer seed crop (August-September) which is preceded by summer pre-seed crop (June-July). Due to outdoor nature of rearing high mortality larvae occurred particularly in the early stage of rearing to the tune of 15 to 25 %. Farmers adopted age old traditional technologies of host plant management and rearing technologies (Thangavellu et

al., 1988; Sarmah et al., 2010). A number of farmers' friendly new technologies have been innovated by the scientists of Central Muga Eri Research and Training Institute, Jorhat, Assam (India) which is boon for the development of muga industry. In order to enhance the muga silk production, to meet the future demands, adoption of new technologies at the farmers' field is needed. This study examines the impact of adoption of integrated chawki (1st to 3rd instar larvae) rearing technologies as a strategy for improving muga cocoon production in India.

MATERIALS AND METHODS

Five villages of Assam (India) were identified and 20 muga farmers were selected from each village for the present study. Each farmer was supplied 100 disease free layings (dfils) of muga silkworm and rearing was conducted in outdoor for two commercial crops on the foliages of Som, *Machilus bombycina* Kost. In each village, 10 farmers conducted rearing without adopting the chawki rearing technology (control) while 10 farmers adopted the integrated chawki rearing technology (treatment) as detailed as detailed below.

- a) **Pruning and defoliation:** The main objective of this component is the proper management of the food plants to produce disease free nutritious leaves suitable for the young age silkworms and effective management during rearing. About 20% of the total plants were pruned to the height of 6-7 ft. before 4-5 months of rearing and remove the old leaves (Fig. 1A). Clean the base of the food plants and garden by cutting all unwanted weeds. Mixture of slaked lime and bleaching powder (9:1) was sprayed in the field on bright sunny days after cleaning to kill the disease germs available in the food plants as well as on the ground.
- b) **Application of manure and fertilizer:** The main objective of this component is to produce nutritious leaves suitable for the chawki larvae. After pruning and defoliation, 2 cft of farm yard manure (FYM) was applied to each plant in two split doses. When the plants attained 5 years, 80 g urea, 120 g phosphate and 30 g potash per year is applied per plant to produce quality foliage. Manure and fertilizer are applied by digging ring of 6"- 8" depth with a radius of 2 ft around the food plant and immediately the ring is filled up with soil.
- c) **Pre-brushing care and management:**
 - i. *Incubation of eggs before brushing:* Hatching of muga eggs also depends upon the care taken incubation/preservation. Eggs were incubated at 25-26 °C and 80-85 % relative humidity. However, if incubation facility is not available in farmer's field, eggs were preserved in single layer in bamboo tray in well aerated and disinfected thatch house where normally temperature remains at 26 °C- 28 °C. Before 2 days of hatching, eggs were transferred to small paper packets @2 g per packet for convenience of brushing. Before one day of hatching, 2/3 tender food plant leaves were put inside the egg packet in the evening time so that in the following morning just after hatching tiny larvae may crawl over the leaves and eat the leave.
 - ii. *Selection of plant for brushing:* In the already prepared chawki rearing plot, all plants will be ready for brushing with semi tender nutritious foliage (Fig. 1B). For winter season, brushing plants were selected towards sunlight and for summer plants were selected opposite to the direct sunlight.
 - iii. *Pre-brushing care of plants:* The plants were covered with nylon nets before one day of brushing to protect the chawki larvae from pest and predators (Fig. 2). The selected plants were disinfected by spraying 0.02 % sodium

hypo chloride solution before 2 days of brushing. The rearing was conducted fully under nylon net cover till 3rd instar. After brushing all used food plans were wrapped with polythene sheet or banana leaf as a barrier on the tree trunk above 1.5–2 ft from the ground to obstruct the geo-negative movement of the larvae up to the ground.

- iv. *Care during rearing*: The newly larvae were reared in outdoor condition on the foliages of som. 0.01% sodium hypo chloride solution were sprayed in the foliages along with the worms once in each instar to protect the larvae from bacterial and viral attack. During rainy day, slaked lime was dusted in the chawki plot with full care so that lime powder may not come in contact with the muga larvae.

After completion of the rearing, data of cocoon harvest were collected from the farmers and compared with the control lots.

RESULTS AND DISCUSSION

The cocoon production data for two commercial crops are shown in table 1 and table 2. During Jethua Crop (May-June), the cocoon yield in the treated lot ranged from 4552 to 6178 per 100 disease free laying(dfl) while in the control lot, it ranged from 4020 to 5490 per 100 dfl. It was observed that increase in cocoon yield of the treated lots over that of control lots ranged from 8.07 % to 17.02 %. Similarly, during Kotia crop (October-November), the cocoon yield in the treated lot ranged from 4367 to 6215 per 100 (dfl) while in the control lot, it ranged from 3970 to 5624 per 100 dfl. During this crop, increase in cocoon yield of the treated lots over that of control lots ranged from 6.70 % to 18.62 %. The cocoon production data before the adoption of technology and after the adoption of technology were subjected to Student's "t" test and compare with the table value. It is clear from Table 1 and 2 that the calculated "t" values of the cocoon production of the ten farmers in each village were significantly higher than the table value during these two crops which evinced that the adoption of the technology significantly increased cocoon production.

The increase in cocoon yield is due to the increase in the nutritional quality of the leaves after adoption of the technology. The production of good cocoon crop is totally dependent on the quality of leaves and maintenance of hygienic condition in rearing field. In *Bombyx mori*, the nutritional elements of mulberry leaves determine the growth and development of the larvae and cocoon production (Nagaraju, 2002; Seidavi et al., 2005). The quality of the leaves has a profound effect on the superiority of silk produced. Leaves of superior quality enhance the chances of good cocoon crop (Ravikumar, 1988). It has also been demonstrated that the dietary nutritional management has a direct influence on quality and quantity of silk production in *B. mori* (Murugan et al., 1998). Adoption of improved technologies of rearing and food plant management increased cocoon production (Priyadarshini & Vijaya Kumari, 2013).

Disinfection and maintenance of hygienic condition during rearing are essential factors for preventing occurrence of diseases. Sodium hypochlorite acts as a leave surface disinfectant. Sodium hypochlorite is effective against bacteria, viruses and fungi and it disinfects the same way as chlorine does. When sodium hypochlorite dissolves in water, two substances viz. hypochlorous (HOCl) and the less active hypochlorite ion (OCl⁻) are formed, which play a role for oxidation and disinfection. The efficacy of Sodium hypochlorite in controlling mortality due to bacterial and viral diseases has been reported in tasar and muga silkworms (Alok Sahay et al., 2008; Ibotombi et al., 2014). The application of sodium hypochlorite solution to the

foliages before the rearing and during the rearing reduces the mortality due to bacterial and viral diseases thereby contributing in increasing the cocoon productivity.

The result of the present study shows that the integrated “chawki rearing technology” is effective in increasing the cocoon production and therefore this technology should be percolated to all the muga farmers for increasing the cocoon production. The extension activities should be taken up in such a way that the farmers should get convinced about the benefits of following improved techniques.

LITERATURES CITED

- Alok Sahay, Ojha, N. G., Kulshrestha V., Singh, G. P., Roy, D. K. & Suryanarayana, N.** 2008. Application of sodium hypochlorite for controlling virosis and bacteriosis in tasar silkworm, *Antheraea mylitta* D.. *Sericologia*, 48 (1): 71-79.
- Ibotoombi Singh, N., Goswami, D., Mustaque, A. & Giridhar, K.** 2014. Efficacy of sodium hypochlorite in controlling viral and bacterial diseases in muga silkworm, *Antheraea assamensis* Helfer. *J. App. Biol. & Biotechnology*, 2 (2): 12-15.
- Lakshmanan, S. & Geethadevi, R. G.** 2005. Studies on economics of sericulture under dry farming condition in Chama raja nagardistrict of Karnataka. *Indian J. Seric.*, 40 (2): 183-185.
- Murugan, K., Jeyabalan, D., Senthil, K. N., Senthil, N. S. & Sivaprakasan, N.** 1998. Growth promoting effects of Plant products on Silk worm. *J. Sci. Ind. Res.*, 57: 740-745.
- Nagaraju, J.** 2002. Application of genetic principles in improving silk production. *Current Science*, Vol. 83, No. 4.
- Nguku, E. K., Muli, E. M. & Raina, S. K.** 2007. Larvae, cocoon and post-cocoon characteristics of *Bombyx mori* L. (Lepidoptera: Bombycidae) fed on mulberry leaves fortified with Kenyan royal elly. *J. Appl. Sci. Environ. Manage*, 11 (4): 85-89.
- Priyadarshini, M. B. & Vijaya Kumari, N.** 2013. A study on the knowledge and adoption level of improved sericulture practices by the farmers of Chittoor district. *International Journal of Agricultural Science and Research*, 3 (2): 43-46.
- Ravikumar, C.** 1988. Western ghat as a bivoltine region prospects, challenges and strategies for its development. *Indian Silk*, 26 (9): 39-54.
- Sarmah, M. C., Rahman, S. A. S. & Barah, A.** 2010. Traditional practices and terminologies in muga and eri culture. *Indian J. Traditional Knowledge*, 9 (3): 448-452.
- Seidavi, A. R., Bizhannia, A. R., Sourati, R. & Mavvajpour, M.** 2005. The nutritional effects of different mulberry varieties on biological characters in silkworm. *Asia Pac. J. Clin. Nutr.*, 14 (Suppl): 122.
- Thangavellu, K., Chakroborty, A. K., Bhagowati, A. K. & Isa Md.** 1988. *Handbook of Muga Culture*. Pp. 1-103. Published by Central Silk Board, Bangalore, India.



Figure 1. A. Pruning of Som to get quality leave. B. Good quality foliage of Som after pruning.



Figure 2. A. Brushing of larvae under nylon net. B. Good harvest after adopting technology.

Table 1. Cocoon production at farmers, field during Jethua crop per 100 dfl.

Village		Farmers										t-value
		1	2	3	4	5	6	7	8	9	10	
Sonowal	Control	4880	5221	4975	4789	4120	4800	4525	4879	4112	5334	3.945
	Treatment	5423	5854	5532	5433	4615	5424	5068	5482	4605	5854	
	Improvement(%) over control	11.12	12.12	11.19	13.44	12.01	13.00	12.00	12.36	12.00	9.75	
Tambulbari	Control	4221	3989	4570	5120	5030	4780	4760	4367	4967	4970	3.106
	Treatment	4812	4587	5105	5656	5635	5423	5474	4892	5464	5645	
	Improvement(%) over control	14.00	14.99	11.70	10.46	12.02	11.85	15.00	12.02	10.00	13.58	
Thaura	Control	4020	4330	3890	4480	4987	4690	4380	5080	4890	5221	5.424
	Treatment	4583	4893	4552	5018	5665	5244	4906	5651	5513	5728	
	Improvement(%) over control	14.99	13.00	17.02	12.00	13.59	11.81	12.01	11.20	12.74	9.71	
Duwarisinga	Control	4500	4220	4980	4338	4898	5110	4976	5078	4990	4280	6.508
	Treatment	4950	4853	5617	4816	5444	5603	5872	5927	5709	4708	
	Improvement(%) over control	10.00	15.00	12.79	11.02	11.14	9.64	18.00	16.72	14.40	10.00	
Humhumia	Control	4400	5278	4980	5623	5190	5080	4978	5490	5056	5012	3.853
	Treatment	4840	5801	5778	6178	5609	5570	5795	6170	5862	5453	
	Improvement(%) over control	10.00	9.91	16.02	9.87	8.07	9.64	16.41	12.38	15.94	8.40	

*Table value of "t" at 5% = 1.83, and at 1% = 2.82

Table 2. Cocoon production at farmers, field during Kotia crop per 100 dfl.

Village		1	2	3	4	5	6	7	8	9	10	t-value
		1	2	3	4	5	6	7	8	9	10	
Sonowal	Control	5200	4980	3970	5200	4879	5012	4689	5020	5345	4978	4.880
	Treatment	5624	5478	4367	5720	5513	5432	5345	5522	5729	5326	
	Improvement(%) over control	8.15	10.00	10.00	10.00	12.99	11.03	13.99	10.00	6.70	6.99	
Tambulbari	Control	4500	5230	4980	4565	3988	5023	4980	4890	5010	4990	4.882
	Treatment	5530	5892	5478	5250	4546	5675	5678	5628	5411	5688	
	Improvement(%) over control	18.62	12.65	10.00	15.00	13.98	12.98	14.01	15.09	8.00	13.98	
Thaura	Control	4565	4780	5020	4980	4565	5120	5070	4880	4050	4289	4.045
	Treatment	5113	5354	5372	5478	5022	5478	5476	5624	4455	4632	
	Improvement(%) over control	12.00	12.01	7.01	10.00	10.01	7.00	8.00	15.24	10.00	8.00	
Duwarisinga	Control	5010	4560	4980	5030	5470	4720	4868	5230	5260	4980	3.400
	Treatment	5510	5198	5577	5382	5944	5286	5524	5865	5628	5828	
	Improvement(%) over control	10.00	13.99	11.98	7.00	8.66	11.99	13.47	12.14	7.00	17.02	
Humhumia	Control	4880	5490	4536	5130	5090	4878	4560	5120	4878	5467	5.870
	Treatment	5515	5965	5080	5892	5697	5415	5016	5776	5602	6215	
	Improvement(%) over control	11.51	8.47	11.99	14.85	11.90	11.00	10.00	12.81	14.84	13.68	

*Table value of "t" at 5% = 1.83, and at 1% = 2.8

BIOLOGICAL SCREENING OF *CLERODENDRON INERME* LEAF EXTRACTS FOR REPELLENCY AND TOXICITY POTENTIALS AGAINST STORED PRODUCT INSECTS

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ABSTRACT: Botanicals have been used traditionally as grain and legume protectants against stored product insects. The objective of this study was to evaluate the repellent and insecticidal activity of different solvent extracts of *Clerodendron inerme* (L.) leaf against the red flour beetle *Tribolium castaneum* (Herbst), the lesser grain borer *Rhyzopertha dominica* (F.), and the cowpea weevil *Callosobruchus chinensis* (L.). The area preference method and dose-mortality was used to determine repellency rate and insecticidal activity. The average repellency of 0.02 μ l, 0.04 μ l, 0.08 μ l of the methanol, petroleum ether and ethyl acetate extract concentrate per cm² of *C. inerme* leaves totally achieved class II, III, class IV and class V respectively at different intervals (2, 4, 8 hours) of time. The order of repellent activity was *Callosobruchus chinensis* < *Rhyzopertha dominica* < *Tribolium castaneum*. The concentrate of methanol- extract of *Clerodendron inerme* leaves was found to be more effective than the commercial product teflubenzuron (No: SZBB291XV) and also more effective than other solvent extracts. The order of repellent activity was *Callosobruchus chinensis* < *Rhyzopertha dominica* < *Tribolium castaneum*. The dose-mortality test of methanolic extracts of *C. inerme* leaf indicates that the LD₅₀ (1.74 mg/cm²) and LD₉₉ (3.01 mg/cm²) was very high in *C. chinensis* compared to the other two beetles. Our result indicates that the repellent activity was dose and extract dependent in different intervals of time and dose-mortality of the methanolic extract varied depending on the insect species.

KEY WORDS: Phytochemicals, Repellency, *Rhyzopertha dominica*, *Tribolium castaneum*, *Callosobruchus chinensis*, Teflubenzuron.

Insects are the major threat for stored grain products throughout the world due to the qualitative, quantitative, commercial and agronomic losses they cause. It is estimated that more than 20,000 species of field and storage pests destroy approximately one-third of the world's food production, valued annually at more than \$ 100 billion among which the highest losses (43%) occurring in the developing world (Jacobson 1982, Ahmed & Grainge 1986). The quantitative and qualitative damage to stored grain and grain products from the insect pests may amount to 20-30% in the tropical zone and 5-10% in the temperate zone (Talukder, 2006). Although synthetic chemical pesticides have been commonly used to reduce losses, there is great risk of negative effects such as the development of insecticide-resistant strains, environmental pollution, serious public health hazards, and pesticide residues in food and increase of the cost of application. The continuous application and dependence on chemical pesticides have also resulted in potential toxicity hazards for non target organisms and users (Amanda et al., 2012; Silva et al., 2002; Regnault-Roger et al., 2004). The increase in the above problems and contamination of the biosphere associated with large-scale use of broad spectrum synthetic pesticides have led to the need for effective biodegradable pesticides with greater selectivity. This awareness has created a world-wide interest in the development of alternative strategies,

including the discovery of new insecticides (Sharma & Meshram, 2006). Therefore, there is an urgent need for new alternative approaches to control stored product insects by eco-friendly organic sources that are easily available, affordable, less toxic to mammals and less detrimental to the environment.

In recent years, studies have been focused on plant materials and their bio-active chemical constituents as a rich source of natural substances which can be used to develop ecologically safer methods for Insect control (Cloyd, 2004, Arnason et al., 1989). Insecticidal activities of many plants against insect pests have been well demonstrated (Jilani & Su 1983, Isman, 2000, Rajesh Kumar et al., 2008; Regnault-Roger et al., 2004; Karina Caballero-Gallardo et al., 2012). The deleterious effects of plant extracts or pure compounds on insects can be manifested in several manners including toxicity (Dubey et al., 2007; Park et al., 2003; Jouda et al., 2012; Tripathi et al., 2000a,b, 2001c,d), mortality (Jouda et al., 2012; Kim et al., 2011), repellent activity (Mc Donald et al., 1970; Xie et al., 1995; Fields et al., 2001; Mohan & Fields, 2002, Hou et al., 2004; Kumar et al., 2004; Tapondjou et al., 2005; Isman, 2006; Nerio et al., 2009; Amanda et al., 2010; Olivero-Verbel et al., 2011; Karina Caballero-Gallardo et al., 2012, Lu & Shi 2012), antifeedent, growth inhibitor, suppression of reproductive behavior and reduction of fertility and fecundity (Metcalf & Metcalf, 2002, Rajasekaran & Kumaraswami, 1985; Papachristos & Stamapoulos, 2002) on stored product insects. Natural plant products such as essential oils (Isman, 2000) mixtures of volatile terpenes and alkaloids, polyphenols, steroids and other components isolated mostly from plants (Liu & Su, 1999; Prajapati et al. 2001; Regnault-Roger et al., 2004, Arthur et al., 2011; Hamid et al. 2011) are being extensively studied as repellents and insecticidal compounds which are biodegradable. There is a considerable importance for phytochemicals because of their repellent effect, which is highly species - specific and generally advantageous being specific and having low mammalian toxicity (Malik & Naqvi, 1984). The repellent properties of Neem leaves on the insect pests of both stored products and field crops have also been extensively studied (Nakanishi, 1975; Radwanski, 1977).

Many authors also reported the grain protectant activity of some plant materials against insect pests due to their repellent properties (Malik & Naqvi, 1984, Quersi et al., 1988; Jalini et al. 1994; Bekele et al., 1996; Othira et al., 2009). A number of workers stated the gustatory repellent properties of the seed kernel extracts of neem against different insects (Pradhan et 1963, Jotwani & Sircar 1965). The *Clerodendron inerme* (L.) Gaertn belongs to (Verbenaceae) and its bio-efficacy on the public health flies like *Musca domestica* have been studied by Periera and Gurudutt, 1999 but there is no attempt made to study bio-efficacy on stored-product insects. Therefore the present work has been carried out to evaluate the repellent and insecticidal activity of *Clerodendron inerme* (L.) leaf extract on the lesser grain borer *Rhyzopertha dominica* (F.), the red flour beetle *Tribolium castaneum* (Herbst) and the cowpea weevil *Callosobruchus chinensis* (L.).

MATERIALS AND METHODS

Collection and Extraction of plant material

Fresh plant leaves of *Clerodendron inerme* belongs to (L.) Gaertn. (Verbenaceae) were collected during August-October 2012 from the ICMR regional centre, Belgaum campus (N15.88668; E74.523653) Karnataka, India and authenticated by Dr. Harsh V Hegde Scientist. Regional Medical Research Centre, Belgaum. Approximately 500 gms harvested leaves of *Clerodendron inerme* were

washed, air-dried in shade for 2 days and lyophilized. The dried leaves were ground to powder using electric grinder. The resulting powder was passed through a 25-mesh sieve to obtain a fine powder. This powder was soaked with 1 liter of methanol, petroleum ether and ethyl acetate solvents separately and stirred for 30 minutes using a magnetic stirrer and then filtered through Whatman No. 1 filter paper (Rahman and Talukder 2006). After 2 days solvents from the pooled filtrated solution was concentrated to dryness using a rotary flash evaporator at 70°C. The yield of final crude extracts was 5.2 gms and they were preserved in sealed bottles in a refrigerator at 5°C until used for further insect repellent bioassays. Sample specimens of these plants were deposited in form of herbarium in the FPIC Department, under the following codes *C. inerme* Geartn0012.

Rearing of test insects

The lesser grain borer *R. dominica*, the red flour beetle *T. castaneum* and the cowpea weevil *C. chinensis* were reared for the present study. A small population of these insects was obtained from the entomology laboratory stock, Food Protectants and Infestation Control Department, CSIR-CFTRI, India. The rearing of above insect was done on whole wheat, wheat flour and cow pea seeds (food media) inside a growth chamber at $27 \pm 2^\circ\text{C}$, L : D 12:12 and with $70 \pm 5\%$ RH (Rahman & Talukder, 2006).

100 numbers of 1-2 days old adult insects were placed in a glass jar (1.5-L) containing 500 gms of food media in glass containers covered by muslin cloth. Maximum of 7 days were allowed for mating and oviposition. Then the parent stocks were removed and food media containing eggs were incubated in a temperature/humidity controlled cabinet ($27 \pm 2^\circ\text{C}$ and RH $70 \pm 5\%$) in darkness to obtain same aged insects (Rahman & Talukder, 2006). Thus subsequent progenies of the insects were used for assays.

Repellency bioassay

Repellency assay was carried using paper strip method described by McDonald et al., 1970, Tapondjou et al., 2005; Nerio et al., 2009; Olivero-Verbel et al., 2010; Karina Caballero-Gallardo et al., 2011; Lu & Shi, 2012). Test solutions were prepared by dissolving different volumes of the plant leaf extract with acetone (0.02 μl , 0.04 μl , 0.08 μl of the extracts per cm^2). Each Whatman filter paper (18 cm in diameter) was cut into two halves to fit into glass petri dish (18 cm in diameter) and each volume of plant extract was applied to a half filter paper as uniform as achievable using a pipette. The other half was treated only with acetone and it served as control. The plant-extract treated and acetone treated halves were air-dried to evaporate the solvent completely for 10 minutes. Each treated strip was attached lengthwise, edge to edge with cellophane tape. A filter paper was placed on the bottom of the glass petri-dish. Twenty five unsexed adult insects of *T. castaneum* (6 days old) *R. dominica* (6 days old) and *C. cinensis* (3 days old) were released at the center of each filter paper disc, and then petri dishes were covered and placed in darkness at $27 \pm 2^\circ\text{C}$ with relative humidity of $70 \pm 5\%$. The numbers of *T. castaneum* specimens on treated and untreated portions of the experimental paper halves were counted for each dish after 2, 4, 8 hours exposure. Percentage repellency (PR) for a given treatment time was obtained using the formula: $\text{PR} = [(\text{Nc}-\text{Nt})/(\text{Nc}+\text{Nt})] \times 100$, where Nc= the number of insects in the untreated (control) and Nt = treated areas, respectively (Karina Caballero-Gallardo et al. 2012). Positive values expressed repellency and negative values attractancy (Karina Caballero-Gallardo et al. 2012). Along with this standard repellent Teflubenzuron from Sigma-Aldrich batch no: SZBB291XV was used as positive control (Saeideh Loni et al. 2011), utilizing the same

experimental conditions as the extracts. The averages were then assessed to different class using the following scale. Percent repulsion >0.01 to <0.1 = class 0; $0.1-20$ = class I; $20.1-40$ = class II; 40.1 to 60 = class III; 60.1 to 80 = class IV; $80.1-100$ = class V (Mc Govern et al. 1977). Five replicates were performed for each test concentrations of plant leaf extract and also for positive control.

For dose-mortality calculation, surface film assay method was used. The stock solution of *Clerodendron inerme* leaf extract was prepared at 100 mg/ml concentration level. This stock was serially diluted with acetone to give a concentration of 0.2 , 0.4 , 0.8 , 1.0 , 1.4 mg/cm². Then 1 ml of each of the solutions was poured onto the Whatman No. 1 filter circle in each of the petri-plate (6 cm diameter) and allowed for about 10 minutes in a hood for the solvent to evaporate. 30 unsexed insects (6 days old *T. castaneum*, 6 day old *R. dominica* and 3 days old *C. chinensis* (due to less life span) were released separately into each petri-plate. Dead insects were counted after 24 hours of exposure. The mortality (%) was calculated using the Abbott's formula (Abbott 1925) in treated filter papers in comparison with the control ones.

Statistical analysis

The mean number and standard deviation of insects on the treated and untreated area of the filter paper was calculated for average repellency rate. The Duncan's Multiple Range Test was used to compare percentages of mean repellency at different intervals of time. Probit analysis for dose-mortality was performed according to Finney (1947) and Busvine (1971) to find out the LD_{50} and LD_{99} values using STATS plus software.

RESULTS

The results of repellency rate assays are presented in Table 1. The different solvent extracts of *C. inerme* leaf and teflubenzuron (standard repellent) were tested to determine their repellency against *T. castaneum*, *R. dominica* and *C. chinensis*. The methanol extract exhibited strong repellent effect to the red flour beetle, *T. castaneum* and *R. dominica* at all the doses showing the repellency of class IV and class V in different dose and intervals of time. However, there is slight less effectiveness in case of *C. chinensis* at lowest dose (0.020 μ l/cm²). All the concentrations of petroleum ether extracts were found to be moderately repellent to *T. castaneum* and *C. chinensis* showing (only class III) but in case of *R. dominica* repellency rate goes to class III at 0.020 μ l/cm² and class IV at 0.080 μ l/cm² concentrations respectively. The repellency rate of ethyl acetate showed least effective result to *C. chinensis* depicting class 0 and class 1 with negative results in lower concentrations and class II in higher doses of extract compared to *T. castaneum* and *R. dominica*. The standard repellent teflubenzuron was less effective with class III (58.1 ± 5.8 for *T. castaneum* and 51.6 ± 6.8 ; 59.2 ± 4.4 ; 63.4 ± 5.6 at 0.020 μ l/cm², 0.040 μ l/cm² and 0.080 μ l/cm² respectively for *R. dominica*) and II, but not even class IV in any of three stored-product beetles. The results showed a dose, different extract concentration and time dependent repellent effects of *C. inerme* against *T. castaneum*, *R. dominica* and *C. chinensis* respectively.

The methanolic extract of *Clerodendron inerme* leaf offered dose-mortality action against *T. castaneum*; *R. dominica* and *C. chinensis* adults and the results were found to be promising as presented in Table 2. The LD_{50} and LD_{99} values for methanol leaf extract were 0.65 mg/cm² and 1.50 mg/cm² for *R. dominica* which is lower compared to *T. castaneum* ($LD_{50}=1.28$ and $LD_{99}=2.20$ mg/cm²). At the same time the LD_{50} and LD_{99} doses against *C. chinensis* reached LD_{50} (1.74

mg/cm²) and LD₉₉ (3.01mg/cm²) respectively. The methanolic extract of *C. inerme* significantly affected survival of all three stored product beetles according to Chi-Square values depicted in Table 2, Figure 1a, 1b, and 1c along with R² values.

DISCUSSION

Currently, botanicals constitute 1% of world insecticide market, despite the knowledge that plants constitute a rich source of bioactive chemicals and provide alternatives to regular insect control agents (Kim et al. 2003). Several species from the various plant families have been tested for their insecticidal potency (Abida et al., 2010; Belmain et al., 2001; Khanam et al. 2008; Ogendo et al., 2004). The present work revealed the effective repellent activity of three solvent extracts of *C. inerme* leaf, along with a standard repellent teflubenzuron and insecticidal activity of methanolic plant extract on three stored product insects. Significant repellent activity against *T. castaneum*, *R. dominica* and *C. chinensis* adults was observed with crude methanol extract from *C. inerme* leaf, followed by petroleum ether and ethyl acetate as given in Table 1.

The careful scrutiny of Table 1 indicates that repellent activity of the *C. inerme* plant methanolic extract varied depending on the insect species with different solvent system in intervals of time. The order of repellent activity was *C. chinensis* < *R. dominica* < *T. castaneum*. The concentrate of methanol-extract of *C. inerme* leaves was found to be more effective than other solvent extract (ethyl acetate, petroleum ether) of the same plant according to the repellency class (Mc Govern et al., 1977) in all the doses and in various intervals of time. For this purpose methanolic extract was selected to determine the dose mortality test for all the three stored-product insects. Further results showed that adults of *T. castaneum* were more susceptible to the plant methanolic extract and higher dose is required to achieve higher repellency rate. The consideration of the time exposure effect of methanolic extract dose is directly proportional to the time taken for the repellency activity in all three beetles. This is in contrast to the other solvent extracts (petroleum ether and ethyl acetate) and also for teflubenzuron standard repellent (Saeideh Loni et al., 2011), where the repellent activity is uneven in time and dose.

Further, our findings suggest that there may be different compounds in different solvent extracts possessing different bioactivities. Previous works by (Talukder & Howse, 1993) on repellent effect of different solvent extracts of Pitraj seed on *T. castaneum* showed that the acetone extract exhibited 88 and 93% repellency at 0.5% and 1% concentrations respectively to the beetles. The result is in agreement with Jilani & Su (1983) who reported that petroleum ether extract of neem leaf acted as repellent to *T. castaneum*. The garlic extracts were shown to be repellent to stored product insects by Ho & Ma (1995). Interestingly, repellent properties of the methanolic extract were better than those registered for the standard repellent teflubenzuron, which showed modest repellency rate with class II and III, but not even class IV in any of the three stored-product insects which is the contrast to work of (Saeideh Loni et al., 2011). These findings receive support from the result of Karina Caballero-Gallardo et al., (2012) who reported natural oils from *Cymbopogon martinii*, *Cymbopogon flexuosus* and *Lippia origanoides* were more effective as repellents than the commercial product IR3535 and Nerio et al., 2009 showing activity of repellency from seven aromatic plants. According to Table 2 and figure 1a, 1b, 1c the dose-mortality test of methanolic extracts of *C. inerme* leaf suggest that LD₅₀ and LD₉₉ was very high in case of *C. chinensis* and

low in *R. dominica* compared to *T. castaneum*. This reflects *C. chinensis* is less sensitive to insecticidal activity of methanolic extract, which is also similar in the order of repellent behavior exhibited by the above three stored product insects. Based on the present findings, the plant extracts examined pose potential in controlling and chasing stored product pests. This study provides an interesting opportunity to develop bio-insecticides and repellent formulations based on the extracts from lesser known plants. Along with this our findings confirms the results of Karina Caballero-Gallardo et al., 2012. Since plant-derived pesticides are biodegradable and safer to higher animals, they offer a viable alternative to synthetic agrochemicals. Although this study has verified the scientific principle for use of *C. inerme* in controlling stored product insects, further research on mechanism of action of bioactive compounds extracted from *C. inerme* is necessary.

CONCLUSION

Evaluation of repellent activity by area preference method can be used for preliminary screening of plant products for their insecticidal activity on stored product insects. This will help to save time in identifying the insecticidal activity of plant products. Regarding the side effects of synthetic pesticides, the study suggests that these plant extracts which are eco-friendly, play an important role in protection of storage commodities. Therefore, these extracts may be potential candidates for their use in the formulation of commercial repellents and toxic agents that could be effective control options, in the management of stored product insects which are responsible for huge loss of food commodities in the world.

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LITERATURE CITED

- Abbott, W. S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology*, 18: 265-267.
- Abida, Y., Tabassum, S., Zaman, S., Chhabi, S. B., & Islam, N. 2010. Biological screening of *Curcuma longa* L. for insecticidal and repellent potentials against *Tribolium castaneum* (Herbst) adults. *University Journal of Zoology Rajshahi University*, 28: 69-71.
- Ahmed, S. S. & Grainge, M. 1986. Potentials of the Neem tree (*Azadirachta indica*) for pest control and rural development. *Economic Botany*, 40 (2): 126-135.
- Amanda, H., Italo, C., Karla, P., Fernando, A. & Jaime, E. A. 2010. Toxicity and repellence of aqueous and ethanolic extracts from *Schinus molle* on elm leaf beetle *Xanthogaleruca luteola*. *Crop Protection*, 29: 1118-1123.
- Arnason, J. T., Philogene, B. J. R. & Morand, P. 1989. Insecticides of plant origin. *ACS Symposium Series*. 387.
- Arthur, F. H., Emily, A. F. & Campbell, J. F. 2011. Evaluation of catmint oil and hydrogenated catmint oil as repellents for the flour beetles, *Tribolium castaneum* and *Tribolium confusum*. *Journal of Insect Science*, 11: 1-9.
- Bekele, A. J., Obeng-Ofori, D., & Hassanali, A. 1996. Evaluation of *Ocimum suave* (Wild) as a source of repellents, toxicants and protectants in storage against three stored product insect pests. *International Journal of Pest management*, 42 (2): 139-142.
- Belmain, R. S., Neal, E. G., Roy, D. E. & Golob, P. 2001. Insecticidal and vertebrate toxicity associated with ethnobotanicals used as post-harvest protectants in Ghana. *Food Chemistry and Toxicology*, 39 (3): 287-291.

- Busvine, J. R.** 1971. A critical review of the techniques for testing insecticides. Commonwealth Agricultural Bureau, London, 345.
- Cloyd, R.** 2004. Natural instincts: Are natural insecticides safer and better than Conventional insecticides? American Nurseryman 200: 38-41.
- Dubey, S. C., Suresh, M. & Singh, B.** 2007. Evaluation of *Trichoderma* species against *Fusarium oxysporum* f. sp. *ciceris* for integrated management of chickpea wilt. Biological Control, 40 (1): 118-127.
- Fields, P. G., Xie, Y. S. & Hou, X.** 2001. Repellent effect of pea (*Pisum sativum*) fractions against stored-product insects. Journal of Stored Products Research, 37: 359-370.
- Finney, D. J.** 1947. In Probit Analysis: A statistical treatment of the sigmoid response curve. Cambridge University Press London. 333.
- Hamid, A. A., Aiyelaagbe, O. O. & Usman, L. A.** 2011. Essential oils: its medicinal and pharmacological uses. International Journal of Current Research, 33: 086-098.
- Ho, S. H. & Ma, Y.** 1995. Repellence of some plant extracts to the stored product beetles *Tribolium castaneum* (Herbst) and *Sitophilus zeamais* Motsch. paper presented at the Symposium on pest management for stored food and feed. SEMEO-BIOTROP, BOGER, Indonesia. 5-7. Septmeber.
- Hou, X., Fields, P. G. & Taylor, W.** 2004. The effect of repellents on penetration into packaging by stored product insects. Journal of Stored Products Research, 40: 47-54.
- Isman, M. B.** 2000. Plant essential oils for pest and disease management. Crop Protection, 19: 603-608.
- Isman, M. B.** 2006. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annual Review of Entomology, 51: 45-66.
- Jacobson, M.** 1982. Plants, insects and man-their interrelationships. Economic Botany, 36 (3): 346-354.
- Jouda, M. B. J., Nesrine, T., Karima, T. T. & Mohamed, L. K.** 2012. Insecticidal activities of essential oils from leaves of *Laurus nobilis* L. from Tunisia, Algeria and Morocco and comparative chemical composition. Journal of Stored Products Research, 48: 97-104.
- Jilani, G. & Su, H. C. F.** 1983. Laboratory studies on several plant materials as insect repellents for protection of cereal grains. Journal of Economic Entomology, 76: 154-157.
- Jotwani, M. G. & Sircar, P.** 1965. Neem seed as a protectant against stored grain pests infestation wheat seed. Indian Journal of Entomology, 27: 160-164.
- Karina, C. G., Jesus, O. V., Elena, E. & Stashenko, E. E.** 2012. Repellency and Toxicity of essential oils from *Cymbopogon martini*, *Cymbopogon flexuosus* and *Lippie origanoides* cultivated in Colombia against *Tribolium castaneum*. Journal of Stored products Research, 50: 62-65.
- Khanam, L. A. M., Rahman, M. S. & Mahfuz, I.** 2008. Repellency of *Tribolium castaneum* Herbst and *Tribolium confusum* Duval (coleopteran: Tenebrionidae to the Rhizome and leaf extracts of *Zingiber cassumunar* Roxb. Bangadesh. Journal of Scientific industry Research, 43 (2): 251-258.
- Kim, S. L., Chae, S. H., Youn, H. S., Yeon, S. H. & Ahn, Y. J.** 2011. Contact and fumigant toxicity of plant essential oils and efficacy of spray formulations containing the oils against of B- and Q-biotypes of *Bemisia tabaci*. Pest Management Science, 67: 1093-1099.
- Kumar, P. K., Mohan, S. & Balasubramanian, G.** 2004. Effect of whole pea flower and a protein rich fraction as repellents against stored product insects. Journal of Stored Products Research, 40: 547-552.
- Liu, Z. & Ho, S.** 1999. Bioactivity of the essential oil extracted from *Evodia rutaecarpa* Hook f. et Thomas against the grain storage insects, *Sitophilus zeamais* (Motsch.) and *Tribolium castaneum* (Herbst). Journal of Stored Products Research, 35: 317-328.
- Lu, J. H. & Shi, Y. L.** 2012. The bioactivity of essential oils from *Allanthus altissima swingle* (Sapindales: Simaroubaceae) bark on *Lasioderma serricorne* (Fabricius) (Coleoptera: Anobiidae). Advanced Materials Research, 365: 428-432.
- Malik, M. M. & Naqv, S. H. M.** 1984. Screening of some indigenous plants as repellants or antifeedents for stored grain insects. Journal of Stored Products Research, 20 (1): 41-44.
- Mc Donald, L. L., Guy, R. H. & Speirs, R. D.** 1970. Preliminary evaluation of new candidate materials as toxicants, repellents and attractants against stored product insects. USDA Marketing Research Report No. 882.
- McGovern, T. P., Gillenwater, H. B. & McDonald, L. L.** 1977. Repellents for adult *Tribolium confusum*: mandelates. Journal of Entomoloical Society, 12: 79-84.
- Metcalf, R. & Metcalf, E.** 1992. Plant kairomones in insect ecology and control Chapman and Hall, New York.
- Mohan, S. & Fields, P. G.** 2002. A simple technique to assess compounds that are repellent or attractive to stored-product insects. Journal of Stored Products Research, 38: 23-31.

- Nakanishi, K.** 1975. Structure of the insect antifeedent Azadirachtin. Recent Advancement of Phytochemistry, 9: 283-298.
- Nerio, L., Olivero-Verbel, J. & Stashenko, E. E.** 2009. Repellent activity of essential oils from seven aromatic plants grown in Colombia against *Stiphilus Zeamais* Motschulsky (Coleoptera). Journal of Stored Products Research, 45: 212-214.
- Ogendo, J. O., Deng, A. L., Belmain, S. R., Walker, D. J. & Musandu, A. A. O.** 2004. Effects of insecticidal plants materials, *Lantana camara* L. and *Tephrosia vogelii* Hook, on the quality parameters of stored maize grains. Journal of Food Technology Africa, 9 (1): 29-35.
- Olivero-Verbel, J., Nerio, L. S. & Stashenko, E. E.** 2010. Bioactivity against *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae) of *Cymbopogon citratus* and *Eucalyptus citriodora* essential oils grown in Colombia. Pest Management Science, 66: 664-668.
- Othira, J. O., Onek, L. A., Deng, A. L. & Omolo, E. O.** 2009. Insecticidal potency of *Hyptis spicigera* preparations against *Sitophilus zeamais* (L.) and *Tribolium castaneum* (Herbst) on stored maize grains. African Journal of Agricultural research, 4 (3): 187-192.
- Papchristos, D. P. & Stamopoulos, D. C.** 2002. Repellent, Toxic and Reproduction inhibitory effects of essential oil vapours on *Acanthoscelides obtectus* (Say) (Coleoptera: Bruchidae). Journal of Stored Products Research, 38: 117-128.
- Park, I. K., Lee, S. G., Choi, D. H., Park, J. D. & Ahn, Y. J.** 2003. Insecticidal activities of constituents identified in the essential oil from leaves of *Chamaecyparis obtusa* against *Callosobruchus chinensis* (L.) and *Sitophilus oryzae* (L.). Journal of Stored Products Research, 39: 375-384.
- Pereira, J. & Gurudutt, S. N.** 1999. Growth inhibition of *Musca domestica* (L.) and *Culex quinquefasciatus* (say) by delta-3- epicaryoptin isolated from leaves of *Clerodendron inerme* (Gaertn) (Verbenaceae). Journal of Chemical Ecology, 16 (7): 2297-2306.
- Pradhan, S., Jotwani, M. G. & Rai, B. K.** 1963. The repellent properties of neem products. Bulletin of Regional Research Laboratory, Jammu, 1 (2): 147-151.
- Prajapati, V., Tripathi, A. K., Aggarwal, K. K., Khanuja, S. P. S. & Sushil Kumar.** 2001. Screening of some synthetic aroma chemicals for toxicity on the stored grain pest, *Callosobruchus maculatus* (F.). Journal of Medicinal and Aromatic Plant Sciences, 23 (4): 624-629.
- Quershí, S. A., Mohiuddín, S. & Quershí, R. A.** 1998. Repellent values of some common indigenous plants against red flour beetle *Tribolium castaneum* (Herbst). Pakistan Journal of Zoology, 20 (3): 201-208.
- Radwanski, S.** 1977. Neem tree: Further uses and potential uses. World Crops and Live stock. 29: 67-168.
- Rahman, A. & Talukder, F. A.** 2006. Bioefficacy of some plant derivatives that protect grain against the pluse beetle *Callosobruchus maculatus*. Journal of Insect Science, 6 (3): 1-10.
- Rajasekaran, B. & Kumarswami, T.** 1985. Studies on increasing the efficacy on neem seed kernel extract in Behavioural and Physiological Approaches in Pest management, A. Ragupathy and S. Jayaraj (eds.), 29-30, Khadi and Village Industries Commission, Pune, India.
- Rajeshkumar, Ashok, K., Chandra Shekar, P., Dubey, N. K. & Raju, S.** 2008. Insecticidal activity *Aegle marmelos* (L.) Correa essential oil against four stored grain insect pests. Internet Journal of Food Safety, 10: 39-49.
- Regnault-Roger, C., Staff, V., Philogene, B., Terron, P. & Vincent, C.** 2004. Biopesticides de origen vegetal, Ediciones Mundi-Prensa, Madrid.
- Saeideh, L., Maryam, M., Hossain, F. & Esmaeile, K.** 2011. The effect of regulating compounds on the growth of *Tribolium confusum* Du Val (Coleoptera: Tenebrionidae). Munis Entomology and Zoology, 6 (1): 377-385.
- Sharma, K. & Meshram, N. M.** 2006. Bioactivity of essential oils from *Acorus calamus* and *Syzygium aromaticum* against *Sitophilus oryzae* (L.) in stored wheat. Biopesticide International, 2: 144-152.
- Silva, S., Lagunes A., Rodriguez, J. & Rodriguez, D.** 2002. Insecticidas vegetales: una vieja y nueva alternative para el manejo de plagas. Manejo Integrado de Plagas y Agroecología (Costa Rica), 66: 4-12.
- Talukder, F. A. & Howse, P. E.** 1993. Deterrent and insecticidal effects of extracts of pitraj, *Aphanamixis polystachea* (Meliaceae). against *Tribolium castaneum* in storage. Journal of Chemical Ecology, 19 (11): 2463-2471.
- Talukder, F. A.** 2006. Plants products as potential stored product insect management agents- a mini review. Emirates Journal of Agricultural Science, 18: 17-32.
- Tapondjou, A. L., Adler, C., Fontem, D. A., Bouda, H. & Reichmuth, C.** 2005. Bioactivities of cymol; and essential oils of *Cupressus sempervirens* and *Eucalyptus saligna* against *Stiphilus Zeamais* (Motschulsky) and (*Tribolium Confusum* du val). Journal of Stored Products Research, 41: 91-102.
- Tripathi, A. K., Prajapati, V., Aggarwal, K. K., Khanuja, S. P. S. & Sushil Kumar.** 2000a. Repellency and toxicity of oil from *Artemisia annua* to certain stored product beetles. Journal of Economic Entomology, 93: 43-47.

Tripathi, A. K., Prajapati, V., Aggarwal, K. K., & Sushil Kumar. 2000b. Effect of volatile oil constituents of mentha species against the stored pests, *Callosobruchus maculatus* and *Tribolium castaneum*. Journal Medicinal Aromatic Plant Sciences, 22/1B: 549-556.

Tripathi, A. K., Prajapati, V., Aggarwal, K. K. & Kumar, S. 2001c. Toxicity, anti-feedant and effect of activity of 1, 8-cineole from *Artemisia annua* on progeny production of *Tribolium castaneum* (Herbst) (Coleoptera;Tenebrionidae). Journal of Economic Entomology, 94 (4): 979-983.

Tripathi, A. K., Prajapati, V., Aggarwal, K. K., Khanuja, S. P. & Kumar, S. 2001d. Toxicity of fractionated essential oil from *Anethumsowa* seed towards *Tribolium castaneum* (Herbst.) Journal of Medicinal Aromatic Plant Sciences, 22/4A, 23/1A, 146-150.

Xie, Y. S., Fields, P. G. & Isman, M. B. 1995. Repellency and Toxicity of Azadarachtin and neem concentrates to three stored products beetles. Journal of Economic Entomology, 88 (4): 1024-103.

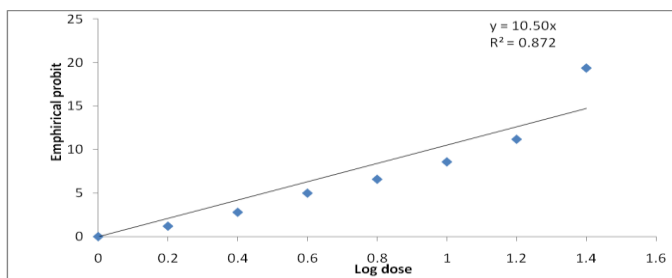


Figure 1a. Effect of dose mortality of *Clerodendron inerme* on *T. castaneum* adults.

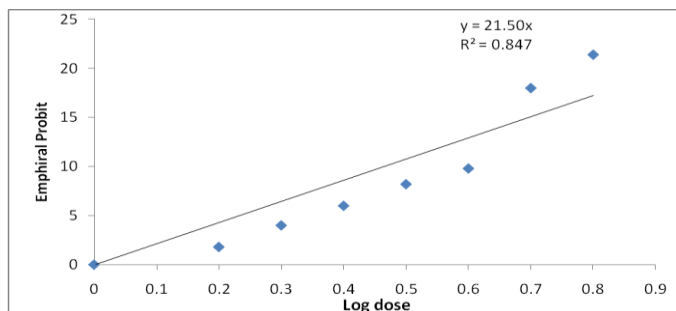


Figure 1b. Effect of dose mortality of *Clerodendron inerme* on *R. dominica* adults.

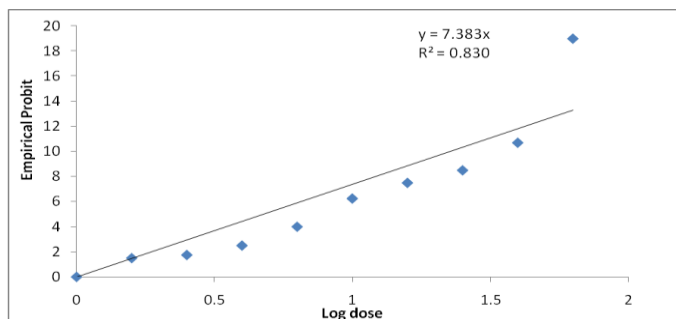


Figure 1c. Effect of dose mortality of *Clerodendron inerme* on *C. chinensis* adults.

Table 1. Percentage and rate of repellency of *Clerodendron inerme* leaf extracts on three stored product insects.

Insect species	Solvent used	Concentration of extract $\mu\text{g cm}^{-2}$	*Average repellency (%) after treatment (hours)			Mean	Repellency rate (class)
			2	4	8		
<i>T. castaneum</i>	Methanol	0.020	60.7 \pm 2.6 ^a	71.3 \pm 3.5 ^b	75.4 \pm 3.1 ^c	69.1	IV
		0.040	75.4 \pm 2.9 ^a	79.3 \pm 5.2 ^b	85.6 \pm 4.5 ^c	80.1	V
		0.080	90.3 \pm 3.8 ^a	93.2 \pm 3.4 ^b	95.3 \pm 2.8 ^c	92.9	V
	Petroleum ether	0.020	41.4 \pm 1.4 ^a	42.3 \pm 5.2 ^{ab}	40.7 \pm 3.2 ^a	41.4	III
		0.040	48.1 \pm 4.1 ^a	45.6 \pm 2.5 ^b	43.4 \pm 1.6 ^c	45.7	III
		0.080	49.6 \pm 4.4 ^a	50.2 \pm 3.1 ^b	53.1 \pm 2.1 ^c	50.8	III
	Ethyl acetate	0.020	24.1 \pm 1.7 ^a	26.6 \pm 2.5 ^b	23.4 \pm 2.6 ^c	24.7	II
		0.040	46.7 \pm 4.1 ^a	39.7 \pm 4.4 ^b	40.1 \pm 2.3 ^c	42.1	III
		0.080	48.5 \pm 2.1 ^a	46.1 \pm 6.5 ^a	41.2 \pm 4.8 ^c	45.2	III
	Teflubenzuron	0.020	40.5 \pm 6.7 ^a	32.7 \pm 5.8 ^b	21.4 \pm 4.3 ^c	31.5	II
		0.040	50.3 \pm 4.2 ^a	41.1 \pm 6.5 ^b	30.3 \pm 5.2 ^c	40.5	II
		0.080	58.1 \pm 5.8 ^a	60.8 \pm 3.4 ^b	34.2 \pm 4.7 ^c	51.1	III
<i>R. dominica</i>	Methanol	0.020	60.1 \pm 6.2 ^a	63.4 \pm 5.8 ^b	70.3 \pm 4.4 ^c	64.6	IV
		0.040	69.3 \pm 9.4 ^a	79.3 \pm 7.1 ^b	81.2 \pm 5.1 ^c	76.6	IV
		0.080	81.7 \pm 6.4 ^a	89.2 \pm 4.6 ^b	90.4 \pm 3.9 ^c	87.1	V
	Petroleum ether	0.020	43.4 \pm 8.1 ^a	40.1 \pm 7.1 ^b	39.7 \pm 6.2 ^{cb}	41.2	III
		0.040	53.2 \pm 4.3 ^a	50.3 \pm 6.3 ^b	40.5 \pm 5.4 ^c	48.0	III
		0.080	79.1 \pm 6.7 ^a	74.4 \pm 7.1 ^b	69.2 \pm 6.7 ^c	74.2	IV
	Ethyl acetate	0.020	20.1 \pm 7.1 ^a	29.3 \pm 3.4 ^b	30.6 \pm 6.3 ^{cb}	26.6	II
		0.040	35.4 \pm 8.6 ^a	41.5 \pm 4.7 ^b	39.3 \pm 4.6 ^c	38.7	II
		0.080	50.6 \pm 6.4 ^a	49.8 \pm 4.1 ^{ab}	38.2 \pm 5.1 ^c	46.2	III
	Teflubenzuron	0.020	51.6 \pm 6.8 ^a	44.1 \pm 5.2 ^b	40.8 \pm 3.7 ^c	45.5	III
		0.040	59.2 \pm 4.4 ^a	64.1 \pm 6.8 ^b	34.4 \pm 5.4 ^c	52.5	III
		0.080	63.4 \pm 5.6 ^a	54.2 \pm 6.5 ^b	42.1 \pm 6.9 ^c	53.2	III
<i>C. chinensis</i>	Methanol	0.020	65.3 \pm 8.2 ^a	50.4 \pm 6.2 ^b	58.4 \pm 6.1 ^c	58.0	III
		0.040	61.7 \pm 6.4 ^a	62.3 \pm 5.7 ^{ab}	70.2 \pm 5.3 ^c	64.7	IV
		0.080	65.6 \pm 7.3 ^a	70.3 \pm 7.1 ^{bc}	71.2 \pm 3.2 ^c	69.1	IV
	Petroleum ether	0.020	41.2 \pm 6.4 ^a	39.4 \pm 4.1 ^{ab}	40.3 \pm 4.6 ^c	40.3	III
		0.040	49.6 \pm 7.1 ^a	41.2 \pm 3.6 ^b	39.4 \pm 4.1 ^c	43.3	III
		0.080	51.9 \pm 6.4 ^a	50.1 \pm 8.1 ^{ab}	40.7 \pm 7.4 ^c	47.5	III
	Ethyl acetate	0.020	20.3 \pm 7.2 ^a	-7	-12	00	00
		0.040	31.5 \pm 7.1 ^a	-11	-12	18	I
		0.080	49.5 \pm 3.2 ^a	31.8 \pm 4.3 ^b	28.5 \pm 3.9 ^c	36.6	II
	Teflubenzuron	0.020	30.1 \pm 4.3 ^a	20.1 \pm 4.2 ^b	10.2 \pm 2.7 ^c	20.1	II
		0.040	41.2 \pm 2.1 ^a	40.1 \pm 5.4 ^{ab}	39.1 \pm 5.2 ^{cb}	40.1	III
		0.080	50.6 \pm 3.5 ^a	48.1 \pm 3.2 ^b	46.2 \pm 6.4 ^c	48.3	III

*values are averages of five replicates and mean \pm SD; Means within same rows followed by same letter aren't significantly different according to DMRT ($P < 0.05$)

Table 2. Dose-mortality effects of *Clerodendron inerme* methanol extracts against stored product insects.

	Exposure (h)	LD ₅₀ value (mg/cm ²)	LD ₉₉ value (mg/cm ²)	χ^2 value (df)
<i>T. castaneum</i>	24	1.28	2.20	15.36 (4)
<i>R. dominica</i>	24	0.65	1.50	13.7 (4)
<i>C. Chinensis</i>	24	1.74	3.01	30.01 (4)

ESTIMATING WEALTH OF VISITORS FLORAL (INSECTA) BOTANICAL GARDEN THE FACULTY OF AGRICULTURE, UNLPAM, IN THE PROVINCE OF LA PAMPA, ARGENTINA

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ABSTRACT: The arthropods, whole organisms are larger and more diversified biological success of all animals that have occurred in the planet evolutionarily. They get food from various modes, and many of them are that feed on nectar, visiting flowers, contributing to pollination. Currently, particularly in Argentina, the work on the use of floral resources by insects are scarce. The study was conducted in 30 plants of the Botanical Garden of the Faculty of Agriculture, National University of La Pampa (UNLPam) (36° 28" S; 64° 35" W) (Province of La Pampa, Argentina) which conducted a survey of insect floral visitors. Sampling was done every 15 days, between 11 and 14 hours a day for three months: 2011 and 2012. Arthropods were captured trawls and hand harvested, they were fixed in 70% alcohol, and beetles were identified to morphospecies level, the formicids to species and other arthropods collected, to the taxonomic order. The parts of the plant, is herborizaron and identified using dichotomous keys. The order Coleoptera, 150 copies were obtained. The order Hymenoptera, of Fam. Formicidae, recorded 199 specimens belonging to 18 species. Other arthropods collected belong to the following orders: Araneae, Coleoptera, Hymenoptera, Hemiptera, Lepidoptera, Orthoptera, Diptera and Phasmida.

KEY WORDS: Coleoptera, Formicidae, biodiversity, *Hyalis argentea*, *Santolina chamaecyparissus* and *Commelina erecta*.

Arthropods constitute the set of broader, more diversified and biological success, of all arthropods.

They are found inhabiting from polar to equatorial peak and from deep sea to the highest mountain peaks, also colonizing the soil media and also dominate the middle air.

Among Insecta are several orders, of which the Coleoptera, were more than 370,000 described species. They have colonized and invaded all media: soil, water and air. This order includes family groups, some of which are aquatic, others include semi-aquatic forms, there are also ways that are closely related to man, living in wool, leather, furniture, libraries or stored products. The Coleoptera are insects of varying size, have two pairs of wings on which the first is not adapted to the flight but is transformed into leathery elytra acting as a protection element. The second pair of wings is the flight body and are membranous. The mouth parts of these insects are chewing type. They have a large and endowed with freedom of movement prothorax, while the mesothorax is greatly reduced. Undergo complete metamorphosis (holometabolous). Their larvae are generally eruciformes campodeiformes or, very rarely legless, and pupae are adécticas or exaradas.

Insecta are located within the Orders Hymenoptera and Coleoptera, among others. The Hymenoptera are economically important for pest control and for pollination and beekeeping. It also includes the Fam. Formicidae, comprising species that use floral resources for their livelihoods.

Floral resources correspond to any derivative of flowers that are used by animals to meet their energy needs. The adult beetles and larvae in some Hymenoptera certain species and use nectar, pollen, oils and fruit exudates.

Currently we began to investigate the presence of floral visitors and potential pollinators in *Opuntia ficus-indica* (L) Mill (Lo Green and La Mantia, 2011).

In Argentina the work on the use of floral resources by insects are scarce: refer to Chaco Serrano de Córdoba (Sosa, Manfrini & Brewer, 2008) and sunflower (Torretta et al., 2010).

Whereas the biological characteristics, considering the richness and abundance of Coleoptera and Hymenoptera on flowers, we expect: 1) the presence of greater wealth of Coleoptera and Hymenoptera plants in the Botanical Gardens, where representatives of other insect orders, as well as, 2) that are more abundant Coleoptera.

Because many species of ants use floral resources for their livelihoods, 3) is expected to find greater wealth of the subfamilies of Formicidae Formicinae and Myrmicinae in the study area.

Therefore, the aim of this study was to survey flower visiting insects (particularly beetles and watching Hymenoptera Formicidae) to estimate biodiversity (richness and abundance) in plants of the Botanical Garden of the Faculty of Agriculture, UNLPam.

MATERIALS AND METHODS

Study area:

The study area was the Botanical Garden of the Faculty of Agronomy (36 ° 33 '19.60" S), where the floral visitors of thirty plant species (Table N° 1) were collected.

The Botanical Garden of the Faculty of Agriculture, UNLPam., Was created in 1973 to 1974 in an area belonging to the field of education at the University.

It has an area of 4 hectares. Of which approximately 70% is occupied by the Botanic Garden itself, and the rest dedicated to experimental works.

At present it has an estimated number ranging in 700 copies. As these species distributed in three layers: Arboretum, Garden Educational and Ecological Garden: with native species distributed according to the three phytogeographic provinces of La Pampa grassland and shrubland caldenal.

A total of 30 samples were collected every fortnight during the period between the months of November, December 2011 and February 2012, between 11 am and 14 pm in the Botanical Garden of the Faculty of Agriculture, UNLPam of Santa Rosa, La Pampa, Argentina, relieving five plant sample and to a height of 1.50 m.

The collected samples were taken to the laboratory Invertebrate Biology II lecture for further processing, which consisted fixed in 70% alcohol and separation of biological material in Coleoptera, Hymenoptera and others. Insects were identified beetles to morphospecies (CSIRO, 1991) and Hymenoptera Formicidae, to species level (Bolton et al., 2007). Other arthropods also were fixed in 70% alcohol for later identification to Order level (CSIRO, 1991). Parts of the plants where they held the capture of arthropods for identification to species level is herborized. Environmental parameters were recorded during the days of sampling were: temperature in °C; % humidity, wind direction, sunny, cloudy, whose data are presented in Table 2.

Data Analysis:

To determine the diversity among the sampled stakeholders, Coleoptera and Formicidae Simpson Index (Dominance) and Shannon-Wiener Index (Equity) (Moreno, E. C. 2001). For analysis of means between Coleoptera and Formicidae, he made a Test F and variances Student t test.

Statistic:

For the review and discussion of the results of the statistical program was used.

RESULTS

In the study period 571 arthropods distributed in different orders, of these, 150 belong to the Order Coleoptera Order Hymenoptera and the 258, of which 199 are of the family Formicidae were collected.

Within the Order Coleoptera, the Coccinelidae, Chrysomelidae, Tenebrionidae and Cantaridae families were those that showed a greater number of copies and the Scarabaeidae family that the highest number of morphospecies, whose payroll is presented in Table 3.

Formicidae, Vespidae and Apidae, whose payroll is presented in Table 4. Within the Order Hymenoptera specimens belonging to three families were collected.

The Family Formicidae including the most representative specimens belonging to 199 different species.

The commands identified in the other captured insects are presented in Table 5 and in Fig 2.

The Family Formicidae (Hymenoptera) included representatives of three subfamilies, whose payroll is presented in Table 6 and in Fig 3.

As for the diversity of Family Formicidae, were:

Subfamily Myrmicinae Species ----- 5 = 28%

Subfamily Dolichoderinae Species ----- 5 = 28%

Subfamily Formicinae ----- 8 Species = 44%.

The analysis was carried out to determine dominance ("Simpson index") indicated no significant differences between the mean total populations sampled Formicidae and Coleoptera, but were among the variances:

Test F = 6, 28995433 , p = 0.000290.

Student t test = -0.59776431 ; g.l. = 19 , p = 0.557056.

Regarding Equity (Shannon-Wiener index), the analysis revealed that there were significant differences in mean total between populations of Coleoptera and Formicidae, but there were not between the variances:

Test F = 1 , 2911807 , p = 0.304801.

Student t test = 9.649435863 , sp = 0.01070892 , p = 0.000000.

The most visited plant species was *Hyalis argentea*, with 38 specimens of insects and the number of species collected per plant were: *Santolina chamaecyparissus* and *Commelina erecta*, with 8 taxa (Table 7).

DISCUSSION

In the work in the Chaco Serrano (Sosa, Manfrini and Brewer, 2008) 14 families of beetles were obtained, whereas in the present work 9 families were identified, of which the Fam. Cantharidae, Chrysomelidae, Elateridae and Curculionidae match in its finding.

As noted by Torretta et al. (2010) in sunflower, numerous species of insects as day visitors, including the honeybee (*Apis mellifera*) was the main pollinator of this species at all sites surveyed were recorded.

In flowers of *Opuntia* spp., Hymenoptera were always the richest group with more than 100 species, with *Apis mellifera* (Apidae) the most abundant, followed by Coleoptera (Scarabaeoidea, Melyridae and Nitidulidae) and Lepidoptera. (Lo Green & La Mantia, 2011).

CONCLUSIONS

According to the results it is concluded that there are no significant differences between populations Dominance Formicidae and Coleoptera (Test $t = -0.59776431$, $df = 19$, $p = 0.557056$), while Equity Analysis (Test $t = 9.649435865$; $sp = 1.03 \times 10^{-1}$, $p = 0.000000$) significant difference between them, so that the hypothesis is rejected No. 2 arise.

The order Coleoptera was represented by 150 copies of the following families: Carabidae, Scarabaeidae, Elateridae, Curculionidae, Staphylinidae, Coccinellidae, Chrysomelidae, Tenebrionidae and Cantaridae.

The Order Hymenoptera was represented by 258 copies of the following families: Vespidae, Apidae and Formicinae, allowing accept Hypothesis 1.

The subfamily Formicinae has more species, while Myrmicinae and Dolichoderinae subfamilies, and are approximated with a similar number of both species, the following: *Pheidole bergi* Mayr, *Crematogaster quadriformis* Roger, *Acromyrmex striatus* Roger, *Acromyrmex lobicornis* Emery, *Solenopsis patagonica* Emery, *Dorymyrmex* sp Mayr, *Linepithema humile* Mayr, *Araucomyrmex tener* Mayr, *Conomyrma wolffhügeli* Forel, *Conomyrma carettei* Forel, *Camponotus crassus* Mayr, *Camponotus bonariensis* Mayr, *Camponotus borelli* Emery, *Camponotus rufipes* Fabricius, *Camponotus mus* Roger, *Camponotus punctulatus* Mayr, *Brachymyrmex patagonicus* Mayr and *Forelius minor* Forel; so lets accept Hypothesis 3.

The plant species *Hyalis argentea* (Asteraceae) was the most visited in the number of specimens of insects, while *Santolina chamaecyparissus* (Asteraceae) and *Commelina erecta* (Commelinaceae) were as in the number of registered species of both groups.

This work represents a contribution to the knowledge of the biodiversity of floral visiting insects of plants of the Botanical Garden, Faculty of Agronomy UNLPam and is an exploratory analysis from which new questions are generated, that will deepen interaction man and his environment.

ACKNOWLEDGEMENTS

I want to thank the Faculty of Natural Sciences, UNLPam for their support, my colleagues in the Laboratory of Biology of Invertebrates II and Ing. Oscar Martinez for the information provided on the Botanical Garden and for helping with the identification of plant species.

LITERATURE CITED

Bolton, B., Alpert, G., Ward, P. S. & Naskrecki, P. 2007. Bolton's Catalogue of Ants of the World: 1758-2005. Harvard University Press.

Csiro (Eds). 1991. The Insects of Australia: A textbook for students and researchs works. 2nd edition. 2 volúmenes. 560 + 600 pp. Melbourne. University Press. Carlton.

Lo Green, G. & La Mantia, T. 2011. The role of native flower visitors in pollinating *Opuntia ficus-indica* (L.) Mill., naturalized in Sicily. *Acta Oecologica*, 37: 413-417.

Moreno, C. E. 2001. Métodos para medir la biodiversidad. M&T–Manuales y Tesis SEA, vol. 1. Zaragoza, 84 pp.

Sosa, M. C. & Manfrini de Brewer, M. 2008. Uso de recursos florales por Coleoptera en una Sección del Chaco Serrano de Córdoba (Argentina). In: VII Congreso Argentino de Entomología, Octubre 2008, Huerta Grande, Córdoba. Pp. 302.

Torretta, J. P., Medan, D., Roig Alsina, A. & Montaldo, N. H. 2010. Visitantes florales diurnos del girasol (*Helianthus annuus*, Asterales: Asteraceae) en la Argentina. *Rev. Soc. Entomol. Argent.*, 69 (1-2): 17-32.



Figure 1. Satellite image: La Pampa, Faculty of Agriculture, Botanical Garden ($36^{\circ}33'19.60''$ S), 2012.



Figure 2. Representation of orders captured in the Botanical Garden, Faculty of Agriculture, UNLPam, November-December 2011 and February 2012.

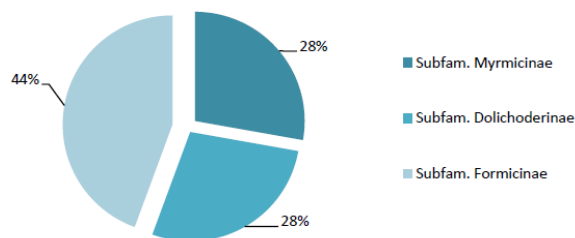


Figure 3. Representation of the different subfamilies of Formicidae Fam the tract.

Table 1. List of plant species in the Faculty of Agronomy, UNLPam Botanical Garden, November-December 2011 and February 2012.

Planta N°	Familia	Especie "nombre vulgar"
1	Liliaceae	<i>Yucca gloriosa</i> "yucca"
2	Rosaceae	<i>Photinia fraseri</i>
3	Fabaceae	<i>Spartinum junceum</i> "retama de españa"
4	Asteraceae	<i>Coreopsis grandiflora</i>
5	Rosaceae	<i>Rosa sp.</i>
6	Brassicaceae	<i>Hirschfeldia incana</i> "mostacilla"
7	Asteraceae	<i>Santolina chamaecyparissus</i> "santolina"
8	Boraginaceae	<i>Echium plantagineum</i> "flor morada"
9	Commelinaceae	<i>Commelina erecta</i> "flor de santa lucia"
10	Oxalidaceae	<i>Oxalis articulata</i> "vinagrillo"
11	Asteraceae	<i>Hyalis argentea</i> "olivillo"
	Caprifoliaceae	<i>Abelia grandiflora</i> "abelia"

12		
13	Apocynaceae	<i>Nerium oleander</i> "laurel de jardín" morado
14	Fabaceae	<i>Prosopis humilis</i>
15	Cariophyllaceae	<i>Saponaria officinalis</i> "yerba jabonera"
16	Amaryllidaceae	<i>Crinum variable</i> "azucena"
17	Asteraceae	<i>Centaurea solstitialis</i> "abrepuño amarillo"
18	Liliaceae	<i>Bulbine frutescens</i> "bulbine"
19	Bignoniaceae	<i>Campsis radicans</i> "trompeta"
20	--	---
21	Solanaceae	<i>Solanum elaeagnifolium</i> "revienta caballo"
22	Asteraceae	<i>Heterotheca subaxillaris</i> "falsa alcanfor"
23	Amaryllidaceae	<i>Tulbaghia violacea</i> "tulbaghia"
24	Commelinidaceae	<i>Commelina erecta</i> "flor de santa lucia"
25	Asteraceae	<i>Conyza bonariensis</i> "rama negra"
26	Asteraceae	<i>Solidago chilensis</i> "vara de oro"
27	Bignoniaceae	<i>Macfadyena dentata</i> "corneta"
28	Zigophyllaceae	<i>Tribulus terrestris</i> "roseta francesa"
29	Liliaceae	<i>Bulbine frutescens</i> "bulbine"
30	Apocynaceae	<i>Nerium oleander</i> "laurel de jardín" blanco

Table 2. Details of environmental parameters. Botanical Garden, Faculty of Agriculture, UNLPam, November-December 2011 and February 2012, the Meteorological Service of the Faculty of Agronomy, UNLPam.

	T°C	% H	DV	S	N
SAMPLING 1 15/11/2011	14 - 22 °C	37%	northwest	X	
SAMPLING 2 29/11/2011	16 - 30 °C	36%			X
SAMPLING 3 15/12/2011	18 - 32 °C	34%	northwest	X	
SAMPLING 4 27/12/2011	21 - 35 °C	33%	the northern sector	X	partially
SAMPLING 5 06/02/2012	23 - 33 °C	31%		X	
SAMPLING 6 23/02/2012	19 - 26 °C	30%		X	partially

Table 3. Payroll morphospecies of Coleoptera captured in the Faculty of Agronomy, UNLPam Botanical Garden, November-December 2011 and February 2012.

Families de Coleoptera	Morphospecies	Number of individuals
Carabidae	1	2
Scarabaeidae	2	2
	3	1
	4	2
	5	1
Elateridae	6	6
	7	1
Curculionidae	8	4
Staphylinidae	9	3
Coccinellidae	10	45
	11	14
Chrysomelidae	12	11
Tenebrionidae	13	32
	14	6
Cantaridae	15	20

Table 4. List of Families collected in the Order Hymenoptera, Faculty of Agriculture, UNLPam, November-December 2011 and February 2012 Botanic Garden.

Orden	Families	Number of individuals
Hymenoptera	Vespidae	37
	Apidae	22
	Formicidae	199

Table 5. Payroll Orders of insects captured in the Faculty of Agronomy, UNLPam Botanical Garden, November-December 2011 and February 2012.

Ordens	Number of individuals
Araneae	18
Coleoptera	150
Hymenoptera	258
Hemiptera	72
Lepidoptera	3
Orthoptera	29
Diptera	36
Fasmida	1

Table 6. List of species of the family Formicidae (Hymenoptera) caught in the Faculty of Agronomy, UNLPam Botanical Garden, November-December 2011 and February 2012.

Subfamilies/ Species de Formicidae	Number of individuals
Myrmicinae	
<i>Pheidole bergi</i>	32
<i>Crematogaster quadriformis</i>	5
<i>Acromyrmex striatus</i>	38
<i>Acromyrmex lobicornis</i>	1
<i>Solenopsis patagonica</i>	16
Dolichoderinae	
<i>Dorymyrmex sp.</i>	3
<i>Linepithema humile</i>	1
<i>Araucomyrmex tener</i>	1
<i>Conomyrma wolffhügeli</i>	9
<i>Conomyrma carettei</i>	19
Formicinae	
<i>Camponotus crassus</i>	7
<i>Camponotus bonariensis</i>	19
<i>Camponotus borelli</i>	1
<i>Camponotus rufipes</i>	13
<i>Camponotus mus</i>	1
<i>Camponotus punctulatus</i>	5
<i>Brachymyrmex patagonicus</i>	22
<i>Forelius minor</i>	6

Table 7. Floral Visitors of the plants of the Botanical Garden, Faculty of Agriculture, UNLPam, November-December 2011 and February 2012.

Plant N°	flower visitors			
	Coleoptera	quantity	Formicidos	quantity
1	Morpho 10	4	<i>Pheidole bergi</i>	4
	Morpho 11	1		
	Morpho 12	1		
2	Morpho 8	1	<i>Camponotus crassus</i>	3
	Morpho 10	1		
	Morpho 13	3		
3	Morpho 8	1	<i>Camponotus bonariensis</i>	2
	Morpho 10	1		
	Morpho 11	2		
	Morpho 12	2		
	Morpho 15	6		
4	Morpho 10	1	<i>Brachymyrmex patagonicus</i>	4
	Morpho 13	1		
	Morpho 15	1		
5	Morpho 6	1		
	Morpho 10	1		
	Morpho 11	3		
	Morpho 12	1		
	Morpho 15	6		
6	Morpho 13	4	<i>Camponotus borelli</i>	1
	Morpho 15	2		
7	Morpho 6	5	<i>Pheidole bergi</i>	1
	Morpho 8	1	<i>Camponotus crassus</i>	4
	Morpho 13	1	<i>Brachymyrmex patagonicus</i>	7
	Morpho 15	1	<i>Dorymyrmex sp.</i>	3
8	Morpho 8	1	<i>Camponotus bonariensis</i> <i>Crematogaster quadriformis</i>	6
	Morpho 10	6		3
	Morpho 12	2		
	Morpho 13	3		
	Morpho 15	1		
9	Morpho 10	1	<i>Pheidole bergi</i>	3
	Morpho 11	1		
	Morpho 14	3		
10	Morpho 10	2		
	Morpho 12	1		
	Morpho 14	2		
11	Morpho 10	19	<i>Crematogaster quadriformis</i>	1
	Morpho 11	7		
	Morpho 13	10		
	Morpho 15	1		
12	Morpho 13	1		
13	Morpho 10	1	<i>Camponotus bonariensis</i>	1
	Morpho 13	1	<i>Acromyrmex striatus</i>	1
14			<i>Camponotus bonariensis</i>	1
			<i>Acromyrmex lobicornis</i>	1

15	Morpho 10 Morpho 13 Morpho 15	8 1 2	<i>Pheidole bergi</i>	3
16	Morpho 13	1	<i>Camponotus bonariensis</i> <i>Camponotus rufipes</i>	1 3
17	Morpho 7		<i>Camponotus rufipes</i> <i>Forelius minor</i>	1 6
18			<i>Camponotus rufipes</i>	2
19			<i>Conomyrma wolffhügelii</i> <i>Linepithema humile</i> <i>Camponotus rufipes</i>	9 1 7
20				
21	Morpho 9 Morpho 13	1 1	<i>Acromyrmex striatus</i> <i>Pheidole bergi</i> <i>Camponotus bonariensis</i>	7 1 1
22			<i>Acromyrmex striatus</i> <i>Camponotus mus</i> <i>Araucomyrmex tener</i> <i>Pheidole bergi</i> <i>Brachymyrmex patagonicus</i> <i>Camponotus punctulatus</i>	2 1 1 1 1 5
23	Morpho 2 Morpho 13	1 2	<i>Pheidole bergi</i> <i>Conomyrma carettei</i>	9 1
24	Morpho 1 Morpho 3 Morpho 9 Morpho 13	1 1 2 1	<i>Solenopsis patagonica</i> <i>Brachymyrmex patagonicus</i> <i>Conomyrma carettei</i> <i>Camponotus bonariensis</i>	7 2 1 3
25	Morpho 2 Morpho 12	1 1	<i>Pheidole bergi</i> <i>Crematogaster quadriformis</i> <i>Conomyrma carettei</i> <i>Acromyrmex striatus</i>	4 1 1 1
26			<i>Acromyrmex striatus</i>	20
27	Morpho 12	1	<i>Pheidole bergi</i> <i>Conomyrma carettei</i>	2 6
28	Morpho 4 Morpho 5	2 1	<i>Pheidole bergi</i> <i>Acromyrmex striatus</i> <i>Brachymyrmex patagonicus</i> <i>Camponotus bonariensis</i> <i>Conomyrma carettei</i>	2 3 6 2 9
29			<i>Brachymyrmex patagonicus</i> <i>Conomyrma carettei</i> <i>Acromyrmex striatus</i> <i>Pheidole bergi</i> <i>Camponotus bonariensis</i>	2 1 4 2 1
30	Morpho 1 Morpho 12 Morpho 13 Morpho 14	1 2 2 1	<i>Solenopsis patagonica</i> <i>Camponotus bonariensis</i>	9 1

PSEUDOSCORPIONS (ARACHNIDA: PSEUDOSCORPIONES) FOUND IN BIRD NESTS AND IN BAT GUANO IN SLOVAKIA AND GERMANY

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ABSTRACT: First data about pseudoscorpions found in open nests of *Turdus merula* Linnaeus, 1778 for Germany are presented. The species *Neobisium* sp., *Chernes hahnii* (C.L. Koch, 1839), *Chernes vicinus* (Beier, 1932) and *Lamprochernes nodosus* (Schränk, 1803) were identified in examined nests. In Slovakia, the species *Dactylochelifer latreillii* (Leach, 1817), *C. hahnii* and *Allochernes wideri* (C.L. Koch, 1843) were found in open nests of *T. merula* and *Turdus philomelos* Brehm, 1831. New data on pseudoscorpions living in bat guano from Slovakia are reported. Altogether three pseudoscorpion species were found in guano collected from bat boxes and from tree hollows – *C. hahnii*, *Dinocheirus panzeri* (C.L. Koch, 1837) and *A. wideri*. None of the recorded species showed specific relationship to the host; the built type of nests and their certain location in the environment influenced pseudoscorpion occurrence in the nest.

KEY WORDS: Pseudoscorpions, *Turdus*, Chiroptera, guano, nest, tree hollow, Central Europe.

Pseudoscorpions are an important group of predators, which occupies virtually every terrestrial habitat, including nests of birds and mammals. The pseudoscorpion fauna of Slovakia includes 55 species, which belong to eight families (Christophoryová et al., 2011a,c; Christophoryová et al., 2012a,b). The German fauna is presently known by 50 species from eight families (Blick et al., 2004; Harvey, 2013).

The first recorded pseudoscorpion species from the nests of *Turdus merula* Linnaeus, 1758 in Slovakia was identified as *Chelifer cancroides* (Linnaeus, 1758) (Nosek & Lichard, 1962). Christophoryová (2010) and Christophoryová et al. (2011b) later reported the presence of *Dactylochelifer latreillii* (Leach, 1817) and *Chernes hahnii* (C.L. Koch, 1839) in *T. merula* nests. In the nests of *Turdus philomelos* Brehm, 1831 pseudoscorpions *Neobisium sylvaticum* (C.L. Koch, 1835), *D. latreillii* and *C. hahnii* were recorded (Christophoryová, 2010; Christophoryová et al., 2011b). The species *C. hahnii* was also found in nests of *Turdus pilaris* Linnaeus, 1758 (Christophoryová et al., 2011b).

Only a few records about pseudoscorpions from bat guano are known from Slovakia. Verner (1959) published the first record of *Diplotemnus insolitus* Chamberlin, 1933 from guano of *Myotis myotis* Borkhausen, 1797 and *Myotis oxygnathus* Monticelli, 1885. Until then, *D. insolitus* have been recorded only from Africa and Asia, from where it was introduced probably by bats to Slovakia. On the same locality, the species *C. cancroides* was collected from bat guano (Verner, 1959; Christophoryová et al., 2014). Both of the species were found in a church loft. Kováč et al. (2007) found pseudoscorpion *Neobisium carcinoides* (Hermann, 1804) in guano of bat colony in a cave.

In Germany, species *Cheiridium museorum* (Leach, 1817), *C. cancroides*, *Dinocheirus panzeri* (C.L. Koch, 1837), *Allochernes powelli* (Kew, 1916), *Allochernes wideri* (C.L. Koch, 1843) and *Pselaphochernes scorpioides* (Hermann, 1804) have been recorded from bird nests (Helversen, 1966; Jost, 1982; Droglá & Lippold, 2004). No records about pseudoscorpions from *Turdus* nests were published.

Turienzo et al. (2010) published a global checklist of pseudoscorpions living in bird nests. The species *Chthonius fuscimanus* Simon, 1900, *C. ischnocheles* (Hermann, 1804), *N. sylvaticum*, *C. cancroides*, *D. latreillii* and *D. panzeri* were found in common blackbird nests in Europe (Turienzo et al., 2010; Christophoryová et al., 2011b). From song thrush nests, the species *N. sylvaticum*, *D. latreillii* and *C. hahnii* were collected in Europe (Turienzo et al., 2010; Christophoryová et al., 2011b).

The present paper provides original data about pseudoscorpions found in bat guano for Slovakia. The paper also provides new data about pseudoscorpions inhabiting *Turdus* nests in Slovakia. Pseudoscorpions occurrence in *Turdus* nests is documented from Germany for the first time.

MATERIALS AND METHODS

The research about pseudoscorpions from bird nests was carried out in 2011 in Slovakia and in 2012 in Germany (leg. Terézia Lučeničová, Zlatica Országhová). Altogether, 13 open nests of *T. merula* (Fig. 1) and one open nest of *T. philomelos* were collected immediately after the fledging of chicks in Slovakia. In Germany, four open nests of *T. merula* were examined; one of them was collected about two weeks after the fledging of chicks.

The guano was collected from bat boxes, in which the bats *Nyctalus noctula* (Schreber, 1774) and *Pipistrellus pipistrellus* (Schreber, 1774) were determined; and from tree hollows with guano of bats *Myotis daubentoni* (Kuhl, 1817) and *N. noctula* (Fig. 1). Bat boxes were installed on trees in a high about 2–3 meters above the ground. The studied locality with occurrence of bats was the City Park in Nitra, Slovakia (leg. Jana Christophoryová, Peter Fendá, Katarína Krajčovičová, Martin Ševčík).

The bird nests and guano were heat extracted in Tullgren funnels. The material was studied as permanent slide mounts using Leica DM1000 microscope. All specimens were identified using the key Christophoryová et al. (2011d) (det. Christophoryová, Krajčovičová). The pseudoscorpions on Figure 2 were photographed using a Leica ICC50 camera connected to a Leica DM1000 microscope, using Leica LAS EZ 1.8.0 software. Digital images were montaged using the "CombineZP" image stacking software. Nomenclature for all taxa follows Harvey (2013). The whole material is deposited in the zoological collection of the Comenius University, Bratislava.

List of collecting sites:

Slovakia

T. merula: Bratislava – Chorvátske rameno: [1] 20.4.2011, 48°06'32.78", 17°06'46.86", 132 m a.s.l.; [2] 2.6.2011, 48°06'10.66", 17°06'14.65", 133 m a.s.l.; Bratislava – Sad Janka Kráľa: [3] 21.6.2011, 48°08'09.36", 17°06'44.40", 138 m a.s.l.; [4] 5.7.2011, 48°08'10.20", 17°06'40.02", 139 m a.s.l.; Bratislava – Malý Draždiak: [5] 13.5.2011, 48°07'29.46", 17°07'23.22", 133 m a.s.l.; [6] 16.5.2011, 48°07'29.46", 17°07'23.22", 133 m a.s.l.; [7] 10.6.2011, 48°06'37.68", 17°07'06.60", 134 m a.s.l.; [8] 8.7.2011, 48°06'36.66", 17°07'00.96", 137 m a.s.l.;

Bratislava – Botanical garden: [9] 11.5.2011, 48°08'44.97", 17°04'28.23", 147 m a.s.l.; [10] 25.5.2011, 48°08'46.98", 17°04'28.08", 147 m a.s.l.; Stupava – Borník (Fig. 1): [11] 25.4.2011, 48°16'28.68", 17°02'24.60", 210 m a.s.l.; [12] 23.5.2011, 48°16'28.32", 17°02'27.12", 211 m a.s.l.; Stupava: [13] 25.4.2011, 48°16'33.72", 17°01'58.98", 183 m a.s.l.

T. philomelos: Stupava: [14] 8.7.2011, 48°15'32.10", 17°02'28.20", 170 m a.s.l.

Guano: Nitra – New City Park (Fig. 1): [15] 28.9.2012, 48°19'01", 18°04'52", 143 m a.s.l.; Nitra – Old City Park: [16] 28.9.2012, 48°19'14", 18°05'03", 142 m a.s.l.

Germany

T. merula: Leipzig – Centre: [17] 19.7.2012, 51°20'34.86", 12°22'49.68", 113 m a.s.l.; [18] 24.7.2012, 51°20'35.88", 12°22'15.77", 111 m a.s.l.; Leipzig – Park: [19] 25.5.2012, 51°19'33.36", 12°21'15.18", 119 m a.s.l.; [20] July 2012, 51°19'37.15", 12°21'07.36", 121 m a.s.l.

RESULTS AND DISCUSSION

Altogether, six pseudoscorpion species from three families were identified from 18 *Turdus* nests. In Slovakia, the species *D. latreillii*, *C. hahnii* and *A. wideri* were found in examined nests. In Germany, the species *Neobisium* sp., *C. hahnii*, *Chernes vicinus* (Beier, 1932) and *Lamprochernes nodosus* (Schrank, 1803) were collected from *Turdus* nests. The most abundant family was the Chernetidae in both of the studied countries. The species *C. hahnii*, *D. panzeri* (C.L. Koch, 1837) and *A. wideri* were recorded in bat guano in Slovakia.

Neobisiidae Chamberlin, 1930

Neobisium sp.

Germany: *T. merula*: [19] open nest on the ground, 1 protonymph.

Neobisiidae species are typical inhabitants of forest leaf litter and soil (Beier, 1963).

The finding of one protonymph in the nest on the ground corresponds to known family preferences; *Neobisium* sp. occurred in nest probably accidentally.

Cheliferidae Risso, 1827

Dactylochelifer latreillii (Leach, 1817)

Slovakia: *T. merula*: [1] open nest 2 m above the ground, 1♂, 1 deutonymph; [2] open nest 1.4 m above the ground, 1♂, 1 tritonymph; [3] open nest 1.4 m above the ground, 1♂; [5] open nest 1.4 m above the ground, 1♂; [6] open nest 1.7 m above the ground, 1 deutonymph; [8] open nest 1 m above the ground, 1 tritonymph; [10] open nest 2.2 m above the ground, 1♂; [13] open nest 1.2 m above the ground, 1 tritonymph. *T. philomelos*: [14] open nest 1 m above the ground, 1 tritonymph.

The species *D. latreillii* is distributed in Europe, Africa and Asia (Harvey, 2013). It was recorded abundantly from bird nests, in mould of tree hollows and under the tree bark (Krumpál & Cyprich, 1988; Droglá & Lippold, 2004; Christophoryová, 2010; Krajčovičová & Christophoryová, 2014). Christophoryová et al. (2011b) characterised *D. latreillii* as species frequently occurring in all types of bird nests, except the ones situated in burrows. *D. latreillii* was less commonly found in forest litter and compost heaps; it was found as well in Malaise trap and wood decay fungi (Droglá, 1988; Droglá & Lippold, 2004; Krajčovičová & Christophoryová, 2014).

During the present study, this pseudoscorpion occurred in *Turdus* nests in Slovakia.

Chernetidae Menge, 1855***Chernes hahnii* (C.L. Koch, 1839)**

Slovakia: *T. merula*: [4] open nest 1 m above the ground, 1♀; [9] open nest 1.5 m above the ground, 4♀♀, 2♂♂, 3 tritonymphs, 4 deutonymphs, 2 protonymphs; [11] open nest 2.3 m above the ground, 1♂; [12] open nest 2.3 m above the ground, 1♀. Guano: [15] bat boxes with *N. noctula*, 1♀, 1♂, 2 tritonymphs; [16] old guano and wasp sheets from bat boxes without bats, 2♀♀, 1♂, 2 tritonymphs, 1 deutonymph. Germany: *T. merula*: [17] open nest 2 m above the ground 1♂, 1 deutonymph; [18] open nest 2.2 m above the ground 1♀.

Pseudoscorpion *C. hahnii* (Fig. 2) is distributed in Europe and Asia (Harvey, 2013). The species prefers the microhabitats under the tree bark, mould of tree hollows and bird nests (Helvesen, 1966; Krumpál & Cyprich, 1988; Droglá & Lippold, 2004; Christophoryová, 2010; Krajčovičová & Christophoryová, 2014). Christophoryová et al. (2011b) characterised *C. hahnii* as species found in all bird nest types, except the ones in synanthropic habitats and burrows. *C. hahnii* was also recorded in tree trunk and ground photoelectors, in wood decay fungi and Malaise traps (Blick et al., 2003; Krajčovičová & Christophoryová, 2014).

During the present study, it was found in *T. merula* nests; moreover this is the first record of *C. hahnii* in bird nests for Germany. The findings in guano represent its first records in this microhabitat type in Slovakia.

***Chernes vicinus* (Beier, 1932)**

Germany: *T. merula*: [18] open nest 2.2 m above the ground, 1♀.

Pseudoscorpion *C. vicinus* is recorded only from Austria, Belgium, Czech Republic, Germany, Slovakia and Sweden (Harvey, 2013). The species was found in anthills (Helvesen, 1966; Droglá & Lippold, 2004). Krumpál & Cyprich (1988) recorded *C. vicinus* in bird boxes and Beier (1963) from leaf litter.

During the present study, *C. vicinus* occurred in *T. merula* nest situated on the ground.

***Dinocheirus panzeri* (C.L. Koch, 1837)**

Slovakia: Guano: [15] old guano of *M. daubentoni* and *N. noctula* and mould from tree hollow, 1♀.

Pseudoscorpion *D. panzeri* was mostly recorded from tree hollows (Helvesen, 1966; Jost, 1982; Šťáhlavský, 2001; Droglá & Lippold, 2004; Christophoryová, 2010; Krajčovičová & Christophoryová, 2014). It was also found in bird nests situated in tree hollows and bird boxes (Helvesen, 1966; Křišťofík et al., 2002; Christophoryová, 2010).

During the present study, *D. panzeri* occurred in guano collected from tree hollow that responds to the known microhabitat preference of the species.

***Allochernes wideri* (C.L. Koch, 1843)**

Slovakia: *T. merula*: [7] open nest in open-fronted bird box 1.1 m above the ground, 1♀. Guano: [15] old guano of *N. noctula* and mould from tree hollow, 2♂♂, 1 tritonymph, 1 deutonymph; [16] old guano and wasp sheets from bat boxes without bats, 1♀; [16] guano from bat boxes with *P. pipistrellus*, 1♀.

The species *A. wideri* (Fig. 2) prefers microhabitats of tree hollows and it was occasionally found under the tree bark (Šťáhlavský, 2001; Droglá & Lippold, 2004; Christophoryová, 2010; Krajčovičová & Christophoryová, 2014). There are known records from anthills and Malaise traps (Droglá & Lippold, 2004;

Krajčovičová & Christophoryová, 2014) and also from bird nests (Helversen, 1966; Christophoryová, 2010). According to Christophoryová et al. (2011b) and Krumpál & Cyprich (1988) *A. wideri* occurs frequently in nests situated in burrows, tree hollows and boxes; it occurs only accidentally in open nests.

During the present study, one *A. wideri* female was collected from *T. merula* nest and from bat guano. Observed results correspond to known microhabitat preferences of the species.

***Lamprochernes nodosus* (Schrank, 1803)**

Germany: *T. merula*: [20] open nest on the ground, 1♂, 1 tritonymph, 9 deutonymphs, 1 protonymph.

The species *L. nodosus* was numerous found in compost heaps (Drogla & Lippold, 2004; Christophoryová et al., 2014). The phoresy of *L. nodosus* was recorded in Europe (for example: Ressler & Beier, 1958; Helversen, 1966; Drogla & Lippold, 2004). This pseudoscorpion was less commonly found in buildings, bird nests, under the tree bark and in wood decay fungi (Drogla & Lippold, 2004; Christophoryová, 2010; Krajčovičová & Christophoryová, 2014).

During the present study, *L. nodosus* was recorded for the first time in bird nests in Germany.

Many authors have discussed whether pseudoscorpions arrive accidentally to the nests or are regular visitors (for example: Krumpál & Cyprich, 1988; Christophoryová, 2010; Turienzo et al., 2010; Christophoryová et al., 2011b). We incline to the view that the pseudoscorpion presence in nests is caused by suitable microclimatic conditions, which also offer potential prey. Therefore a lot of species were regularly collected from nests and even were represented by all nymphal stages. The most dominant regular visitors are certainly species from the Chernetidae family (Christophoryová et al., 2011b). The latest detailed studies have found out that the built type of nests and their certain location in the environment influenced the presence of one or another pseudoscorpion species (Krumpál & Cyprich, 1988; Christophoryová, 2010; Turienzo et al., 2010; Christophoryová et al., 2011b). The obtained results of the present study confirmed the aforementioned assumptions.

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LITERATURE CITED

- Beier, M. 1963. Ordnung Pseudoscorpionidea (Afterskorpione). Bestimmungsbücher zur Bodenfauna Europas. Verlag, Berlin, 313 pp.
- Blick, T., Muster, C. & Ducháč, V. 2004. Checkliste der Pseudoskorpione Mitteleuropas. Checklist of the pseudoscorpions of Central Europe (Arachnida: Pseudoscorpiones). Version 1. Oktober 2004. Available from: http://arages.de/wp-content/uploads/2013/05/checklist2004_pseudoscorpiones.pdf (02 February 2015).
- Blick, T., Weiss, I. & Burger, F. 2003. Spinnentiere einer neu angelegten Pappel-Kurzumtriebsfläche (Energiewald) und eines Ackers bei Schwarzenau (Lkr. Kitzingen, Unterfranken, Bayern). Arachnologische Mitteilungen, 25: 1-16.
- Christophoryová, J. 2010. Štúriky (Pseudoscorpiones) pod kôrou stromov, v dutinách a hniezdach na Slovensku. Folia faunistica Slovaca, 15 (1): 1-12.
- Christophoryová, J., Gardini, G. & Enékesová, E. 2012a. *Withius hispanus* new to the fauna of Slovakia (Pseudoscorpiones: Withiidae). Arachnologische Mitteilungen, 44: 10-13.

- Christophoryová, J., Gardini, G. & Korenko, S.** 2011a. *Allochernes powelli* new to the fauna of Slovakia (Pseudoscorpiones: Chernetidae). *Folia faunistica Slovaca*, 16 (2): 67-70.
- Christophoryová, J., Krumpálová, Z., Křištofik, J. & Országhová, Z.** 2011b. Association of pseudoscorpions with different type of bird nests. *Biologia*, 66 (4): 669-677.
- Christophoryová, J., Mock, A. & Luptáček, P.** 2011c. *Chthonius (Chthonius) carinthiacus* and *Chthonius (Ephippiochthonius) tuberculatus* new to the fauna of Slovakia (Pseudoscorpiones: Chthoniidae). *Arachnologische Mitteilungen*, 42: 23-28.
- Christophoryová, J., Štáhlavský, F. & Fedor, P.** 2011d. An updated identification key to the pseudoscorpions (Arachnida: Pseudoscorpiones) of the Czech Republic and Slovakia. *Zootaxa*, 2876: 35-48.
- Christophoryová, J., Štáhlavský, F. & Krajčovičová, K.** 2014. Štúriky (Pseudoscorpiones) Pohoria Burda (NPR Kováčovské kopce). *Folia faunistica Slovaca*, 19 (2): 161-167.
- Christophoryová, J., Štáhlavský, F., Krumpál, M. & Fedor, P.** 2012b. Pseudoscorpiones of Czech Republic and Slovakia: An annotated and revised checklist (Arachnida: Pseudoscorpiones). *North-Western Journal of Zoology*, 8 (1): 1-21.
- Drogla, R.** 1988. Pseudoskorpione aus dem Naturschutzgebiet „Ostufer de Münitz“ – Aberrationen und eine für die DDR neue Art (Arachnida, Pseudoscorpiones). *Zoologischer Rundbrief Bez. Neubrandenburg*, 5: 10-15.
- Drogla, R. & Lippold, K.** 2004. Zur Kenntnis der pseudoskorpion-fauna von Ostdeutschland (Arachnida, Pseudoscorpiones). *Arachnologische Mitteilungen*, 27/28: 1-54.
- Harvey, M. S.** 2013. Pseudoscorpions of the World. Version 3.0. Western Australian Museum, Perth. Available from: <http://museum.wa.gov.au/catalogues-beta/pseudoscorpions>. (02 February 2015).
- Helversen, O.** 1966. Pseudoskorpione aus dem Rhein-Main-Gebiet. *Senckenbergiana biologica*, 47: 131-150.
- Jost, G.** 1982. Zum Vorkommen und zur Verbreitung von Pseudoskorpionen (Arachnida, Pseudoscorpionidea) im Naturpark Hoher Vogelsberg. *Bericht der Naturwissenschaftlicher Verein Darmstadt*, 6: 2-12.
- Kováč, L., Luptáček, P., Višňovská, Z. & Mock, A.** 2007. Bezstavovce (Evertebrata) Liskovskej jaskyne. *Aragonit*, 12: 47-51.
- Krajčovičová, K. & Christophoryová, J.** 2014. Faunistic survey of pseudoscorpions (Arachnida: Pseudoscorpiones) collected from trees and using Malaise traps in Slovakia and the Czech Republic. *Klapalekiana*, 50: 167-180.
- Křištofik, J., Šustek, Z. & Mašán, P.** 2002. Arthropods (Pseudoscorpionida, Acari, Coleoptera, Siphonaptera) in the nests of red-backed shrike (*Lanius collurio*) and lesser grey shrike (*Lanius minor*). *Biologia*, 57 (5): 603-613.
- Krumpál, M. & Cyprih, D.** 1988. O výskytu štúrikov (Pseudoscorpiones) v hniezdach vtákov (Aves) v podmienkach Slovenska. *Zborník Slovenského národného múzea, Prírodné vedy*, 34: 41-48.
- Nosek, J. & Lichard, M.** 1962. Beitrag zur Kenntnis der Vogelnebstfauna. *Entomologische Probleme II*, 8 (6): 29-51.
- Ressl, F. & Beier, M.** 1958. Zur Ökologie, Biologie und Phänologie der heimischen Pseudoskorpione. *Zoologische Jahrbücher, Abteilung für Systematik, Ökologie und Geographie der Tiere* 86: 1-26.
- Štáhlavský, F.** 2001. Štúri (Arachnida: Pseudoscorpiones) Prahy. *Klapalekiana*, 37: 73-121.
- Turienzo, P., Di Iorio, O. & Mahnert, V.** 2010. Global checklist of pseudoscorpions (Arachnida) found in birds' nests. *Revue Suisse de Zoologie*, 117 (4): 557-598.
- Verner, P. H.** 1959. Ein interessanter Fund eines Pseudoscorpions in der Tschechoslowakei (Pseudoscorpionidea). *Acta Faunistica Entomologica Musei Nationalis Pragae*, 5: 61-63.



Figure 1. Collecting sites and microhabitat types with pseudoscorpion occurrence. A. Stupava – Borník. B. Nest of *Turdus merula*. C. City Park in Nitra. D. Bat boxes. Photos: Jana Christophoryová, Peter Fenda, Terézia Lučeničová.



Figure 2. Recorded pseudoscorpions from Slovakia. A. *Chernes hahnii*. B. *Allochernes wideri*. Scale: 1 mm. Photos: Jana Christophoryová.

**A COMPARATIVE STUDY OF THE SPIDER (ARANEAE)
FAUNA IN KEOLADEO NATIONAL PARK (KNP),
NAHARGARH WILDLIFE SANCTUARY (NWS) AND
SUR-SAROVAR BIRD SANCTUARY (SBS), INDIA.**

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[Lawania, K. K. & Trigunayat, M. M. 2015. A comparative study of the spider (Araneae) fauna in Keoladeo National Park (KNP), Nahargarh Wildlife Sanctuary (NWS) and Sur-sarovar Bird Sanctuary (SBS), India. Munis Entomology & Zoology, 10 (2): 435-440]

ABSTRACT: Spiders are the highly diverse group of invertebrates and occupy various habitats. A preliminary checklist of spiders of the three reserve areas namely, KNP, NWS and SBS is provided based on a comparative study undertaken during March 2012 to February 2014. A total of 88 species belonging to 54 genera and 17 families were recorded from the said areas. In all these areas, Salticidae (Ground runner), Araneidae (Orb web weaver), Lycocidae (Ground-active runner) and Oxyopidae (Foliage runner) families were most diverse families. The present study was undertaken to establish a relationship in similar climatic zone.

KEY WORDS: Comparative diversity, spider fauna, KNP, NWS, SBS.

India is the home of thousands of species of wild animal, viz. mammals, birds, reptiles, fishes, amphibians and invertebrates. They live in and around the country's diverse vegetation that varies from the open thorny forest with dessert of Rajasthan in the west to the evergreen forest of Kerala in the south; the rain forest of northeast India and the alpine pastures of Kashmir in north and also in the inland and marine waters, swamps and marshes.

Spiders comprise one of the largest order of animals. The spider fauna of India has never been studied its entirety despite of contribution by many arachnologists (Pocock, 1900a,b; Tikader, 1980, 1982, 1987). Although spider diversity in temperate regions has been well studied, tropical areas however, have received relatively little attention and their study had always remained largely neglected. They have, however, largely been ignored because of the human tendency to favor some organism over others of equal importance because they lack a universal appeal. Spiders are the most diverse and abundant invertebrate predators in terrestrial ecosystems (Wise, 1993; Nyffeler, 2000). They regulate the terrestrial arthropod population (Riechert & Bishop, 1990; Coddington & Levi, 1991). The global list of spider fauna is approximately 39,882 species belonging to 3676 genera and 108 families (Platnick, 2011). Tikader (1987) published the first comprehensive list of Indian spiders which included 1067 species belonging to 249 genera in 43 families. Rajasthan and Uttarpradesh states have not been studied extensively for its spider diversity; fragmentary reports however, are available (Bastawade & Khandal, 2006; Saini et al., 2012; Anjali & Santprakash, 2012; Lawania & Trigunayat, 2013a,b,c,d,e,f,g,h; Kaur et al., 2014). The aims of this study were to investigate the comparative diversity of spiders in said areas and reveal the species richness, endemism, affinity and similarity with other

geographic faunas. This study is focused on the comparison of spider fauna and providing base line information for further studies.

MATERIALS AND METHODS

Study area

The study area includes three reserve areas, namely Keoladeo National Park (KNP, 29sq.km.), Nahargarh Wildlife Sanctuary (NWS, 52.40 sq.km.), Sursarovar Bird Sanctuary (SBS, 7.97 sq.km.).

Keoladeo National Park (KNP) – Keoladeo National park is situated in Indo-Gangetic flood plains at 174 m MSL between longitude 77°-29'5" to 77°-33'9" E. and longitude 27°-7'6" to 27°-12'2" N in Bharatpur district of Rajasthan. It is a man made wetland. The park covers 29 Sq.km. areas out of which 12 sq. km. forms the wetland zone. It is flat with a gentle slope towards the centre forming a depression of about 8.5 Sq.km. which is the submersible area of the park providing shelter to the water fowls and other aquatic animals. This park is commonly called Ghana means thick forest.

Nahargarh Wildlife Sanctuary (NWS) – Nahargarh Wildlife Sanctuary is a small sanctuary and situated at Northeastern part of Aravalli hills and Northern outskirts of Jaipur city (Rajasthan) and mean sea level above 1,219 m. It is confined between 26°15' to 28°45'N and 75°45' to 77°05'E. The Aravalli ranges (oldest hills of the World) traverse through sanctuary and the forest type is subsidiary edaphic type of dry tropical thorn forest.

Sursarovar Bird Sanctuary (SBS) – Sursarovar bird Sanctuary was declared as national bird Sanctuary on 27 March 1991 by Uttar Pradesh Forest Department. The Sanctuary is situated between 27.57°N Latitude, 80.09°E Longitude at 300m. MSL. Sursarovar Bird Sanctuary located close to Keetham Lake / Sursarovar (Latitude – 27.25 'N, Longitude – 77.89 E) Sursarovar Bird Sanctuary spread over an area of 7.97 Sq. Km. it sanctuary comprises a large lake covering area of 2.25 Sq Km. The depth of lake varies from 4 Meters to 8 Meters. The riverine belt of Yamuna surrounds the area of Sursarovar. The climatic condition of the Sanctuary area is typical of Uttar Pradesh plains with hot windy summers and extremely cold winters. The average temperature range between 1.5°C to 49°C. The monsoon season occurs during July to August.

Collection

The Study was undertaken from March 2012 to February 2014. Bushes tree trunks, forest floor, foliage and grass lands were searched for spiders and collected by using various methods such as hand picking, pitfall trapping, sweep netting, and cryptic searching.

Identification

The identification of spiders was done following Tikader (1980, 1982, and 1987), Murphy (2000), as well as pictorial guide Levi (2002), Sebastian & Peter (2009). The Collected specimens were preserved in 70% ethyl alcohol with a few drops of glycerin (Prasad, 1985).

RESULTS AND DISCUSSION

A total of 88 species represented by 53 genera and 17 families were recorded from in these reserve areas. The family composition of the spider fauna for the three study areas is shown in table-I. In all study area Salticidae (Ground

runners), Oxyopidae (Foliage runners), Araneidae (Orb web builders), and Lycosidae (Ground dweller) accounted for the largest population of spider species. NWS recorded higher species abundance (68 species belonging to 49 genera and 17 families) than SBS (54 species belonging to 36 genera and 14 families) and KNP (68 species belonging to 49 genera and 13 families). The Salticidae (22 species), Araneidae (18 species), Oxyopidae (10 species) and Lycosidae (8 species) families made up the biggest proportion of species in these habitats. A total of 88 species were recorded and 42 species were common in these reserve areas. 13 species are well represent in only NWS but are known to be absent from SBS and KNP. 11 species are well represented is only in SBS but absent from NWS and KNP, and 03 Species are well represented from KNP but absent from NWS and SBS.

CONCLUSION

Spider community structure is closely related to variation in habitat structure, food abundance, microclimatic changes and spatial variation. In this study area we compared the spider fauna of three reserve areas (KNP, NWS, SBS) in India. The conclusion drawn as the difference in spider species richness among the three areas will depend to some extent on how complete the sampling effort was in each. It is assumed that the difference in spider species richness between NWS, KNP and SBS is real rather than an artifact of under sampling, some factors might account for the difference. These areas have a similar climatic conditions and difference mean sea level (KNP- 174 m. MSL, SBS- 300 m. MSL and NWS- 1,219 m. MSL) and difference mean rainfall (2012-2014) (KNP- 768 mm., SBS- 813mm. and NWS- 844mm.). There are at least three possible explanations, none of which are necessarily mutually exclusive: a) spider diversity exists, with highest diversity at the increasing mean sea level (MSL); b) spider diversity is related to mean annual rainfall, with higher diversity in wetter areas; c) there are unique differences in the regional pools of available spider species in the three regions which determines the diversity in each area. There is some support for the concept of a latitudinal gradient of diversity of spiders.

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LITERATURE CITED

- Anjali & Santprakash** 2012. Diversity of spiders (araneae) from semi-arid habitat of agra(India). Indian society of arachnology, 1 (2): 66-72.
- Bastawade, D. B. & Dharmendra Khandal** 2006. Fauna of Sanjay Gandhi National Park (Invertebrate). Zool. Surv. India, conservation Area series, 26: 139-184.
- Coddington, J. A. & Levi, H. W.** 1991. Systematic and evaluation of spiders (Araneae). Annual Review of Ecology and Systematic, 22: 565-592.
- Kaur et al.** 2014. Preliminary checklist of spiders of Keoladeo National Park, Bharatpur, Rajasthan with first record of *Ptocosius strupifer* Simon 1901 (Araneae: Salticidae) from India, Mun. Ent. Zool., 9 (1): 501-509.
- Lawania, K. K., Sant Prakash & Trigunayat, M. M.** 2013a. Biodiversity of Spider in and around Agra, Souvenir of National Conference on forest and wildlife: Present Status, Future needs and challenges ahead, Pp. 12.
- Lawania, K. K. & Trigunayat, M. M.** 2013b. Baseline studies on the spider fauna (Araneae) of Braj Region (Brajbhoomi) India. International journal of Biotechnology and Bioengineering Research, 4: 16-19.

- Lawania, K. K. & Trigunayat, M. M.** 2013c. Web pattern and architecture in some spiders (Araneae) from Central India. *International journal of Biotechnology and Bioengineering Research*, 4: 20-22.
- Lawania, K. K. & Trigunayat, M. M.** 2013d. On the diversity of spiders in and around Sur-sarovar Bird sanctuary, Agra (UP) India. *International journal of Engineering Research and Technology*, 6: 99-104.
- Lawania, K. K. & Trigunayat, M. M.** 2013e. Diversity and distribution of spiders in and around Vrindavan, Mathura (UP) India. *International journal of Engineering Research and Technology*, 6: 105-110.
- Lawania, K. K., Kritika Trigunayat & Trigunayat, M. M.** 2013f. Spider in mosquito control, *International journal of Biotechnology and Bioengineering Research*, 4 (6): 609-616.
- Lawania, K. K., Kritika Trigunayat & Trigunayat, M. M.** 2013g. On the diversity in and around Deeg-Town bharatpur (raj.). *Indian society of arachnology*, 2 (2): 609-616.
- Lawania, K. K. & Trigunayat, M. M.** 2013h. Studies on the spiders (Araneae) diversity of Mewat region, India. *International journal of environmental science*, 4: 159-163.
- Levi, L. R.** 2002. Spider and their kin. St.martins press, Newyork.
- Murphy, J. F.** 2000. an introduction to the spider of South East Asia. Kuala- Lampur, Malaysia. Malaysian Nature Society, 625 pp.
- Nyffeler, M.** 2000. Ecological impact of spider predation: a critical assessment of Bristowe's and Turnbull's estimates. *Bull. Br. arachnol. Soc.*, 11: 367-373.
- Pocock, R. I.** 1900a. The fauna of British India, Arachnida. Taylor and Francis, London. 279 pp.
- Pocock, R. I.** 1900b. The fauna of British India, including Ceylon and Burma. Arachnida. London.
- Prasad, B.** 1985. Setting and preservation of spiders. *Entomologists' news letter*, 1 (8): 2-3.
- Platnick, N. I.** 2011. The World Spider Catalog, version 12.0. American Museum of Natural History. <http://research.amnh.org/entomology/spiders/catalog/index.html>
- Riechert, S. E. & Bishop, L.** 1990. Prey Control By assemblage Generalists' predators: Spider in garden test system. *Ecology*, 71: 1441-1450.
- Saini et al.** 2012. Analysis of spider density across Shekhawati region of Rajasthan, India. *Indian society of arachnology*, 1 (2): 30-38.
- Sebastian, P. A. & Peter, K. V. 2009. Spiders of India, University Press publication.
- Tikader, B. K.** 1980. Thomisidae (Crab-spiders) - Fauna of India (Araneae). *Zoological Survey of India*, 1: 1-247.
- Tikader, B. K.** 1982. Family Araneidae Argiopidae) typical orb weavers. *Fauna of India (Araneae)*, 2: 1-293.
- Tikader, B. K.** 1987. Handbook of Indian Spiders. *Zool. Surv. India, Calcutta*, 251 pp.
- Wise, D. A.** 1993. Spiders in ecological webs. Cambridge, UK: Cambridge University Press.

Table 1. Shown spider species, recorded from three conserve areas (KNP, NWS and SWS) of India.

Family	Species	Guild	Distribution of species		
			KNP	NWS	SBS
Agelenidae	(i) <i>Agelendia</i> sp.	Funnel Web builders	--	++	--
	(ii) <i>Teganiaria domestica</i>	Funnel Web builders	--	++	--
Araneidae	(i) <i>Acusilas indicus</i>	Orb web builders	--	++	--
	(ii) <i>Araneus mitificus</i>	Orb web builders	--	++	--
	(iii) <i>Argiope aemula</i>	Orb web builders	++	++	++
	(iv) <i>Argiope anasuja</i>	Orb web builders	++	++	++
	(v) <i>Argiope pulchella</i>	Orb web builders	++	++	++
	(vi) <i>Cylosa insulana</i>	Orb web builders	++	++	++
	(vii) <i>Cyclosa</i> sp.	Orb web builders	--	++	++
	(viii) <i>Cyrtarachne keralayensis</i>	Orb web builders	--	++	--
	(ix) <i>Cyrtophora cicatrosa</i>	Orb web builders	++	++	++
	(x) <i>Cyrtophora citricola</i>	Orb web builders	++	++	--
	(xi) <i>Cyrtophora faei</i>	Orb web builders	--	--	++
	(xii) <i>Cyrtophora molucensis</i>	Orb web builders	--	++	++
	(xiii) <i>Eriovixia excelsa</i>	Orb web builders	++	--	--
	(xiv) <i>Larinia emertoni</i>	Orb web builders	++	--	--
	(xv) <i>Leucauge decorata</i>	Orb web builders	++	++	++
	(xvi) <i>Larinia chlorus</i>	Orb web builders	++	++	++
	(xvii) <i>Neoscona mukerjai</i>	Orb web builders	++	++	++
	(xviii) <i>Zygella indica</i>	Orb web builders	++	++	++
Corinnidae	(i) <i>Castianeira</i> sp.	Ground runner	--	++	++
Clubionidae	(i) <i>Chiracanthium</i> sp.	Foliage runner	--	++	--
Dictynidae	(i) <i>Nigma shiprai</i>	Irregular web builders	--	++	--
Gnaphosidae	(i) <i>Callilepis lambai</i>	Ground runner	--	++	++
	(ii) <i>Callilepis rukminiae</i>	Ground runner	--	--	++
	(iii) <i>Drassodes</i> sp.	Ground runner	++	++	++
Hersiliidae	(i) <i>Hersilia savignyi</i>	Foliage runner	++	++	++
Linyphiidae	(i) <i>Linyphia</i> sp.	Sheet web builders	++	++	++
Lycosidae	(i) <i>Geolycosa urbana</i>	Ground runner	--	++	++
	(ii) <i>Hippasa madhuae</i>	Ground runner	++	--	--
	(iii) <i>Hippasa pisaurina</i>	Ground runner	++	--	++
	(iv) <i>Lycosa mackenziei</i>	Ground runner	--	++	--
	(v) <i>Lycosa pictula</i>	Ground runner	++	++	++
	(vi) <i>Pardosa birmanica</i>	Ground runner	++	++	++
	(vii) <i>Perdosa sangosa</i>	Ground runner	++	--	++
	(viii) <i>Pardosa pseudomulata</i>	Ground runner	--	--	++
	(i) <i>Nephila</i> sp.	Orb web builders	--	--	++
	(ii) <i>Nephila kuhlli</i>	Orb web builders	--	++	--
	(iii) <i>Nephila pilipes</i>	Orb web builders	++	++	++
Oxyopidae	(i) <i>Oxyopes assamesis</i>	Foliage runner	--	++	++
	(ii) <i>Oxyopes biramanicus</i>	Foliage runner	++	++	++
	(iii) <i>Oxyopes javanus</i>	Foliage runner	++	++	++
	(iv) <i>Oxyopes ratanae</i>	Foliage runner	++	++	++
	(v) <i>Oxyopes shweta</i>	Foliage runner	++	++	++
	(v) <i>Oxyopes</i> sp.	Foliage runner	--	--	++
	(vi) <i>Oxyopes pankaji</i>	Foliage runner	++	++	++
	(vii) <i>Oxyopes rufisternum</i>	Foliage runner	--	++	--
	(viii) <i>Oxyopes sertatus</i>	Foliage runner	--	--	++
	(ix) <i>Oxyopes retani</i>	Foliage runner	++	++	++
	(x) <i>Oxyopes viridana</i>	Foliage runner	++	--	++
Pholcidae	(i) <i>Artema atlanta</i>	Irregular web builders	++	++	++
	(ii) <i>Crosspriza lyoni</i>	Irregular web builders	++	++	++

	(iii) <i>Pholcus phalangiodes</i>	Irregular web builders	++	++	++
	(iv) <i>Pholcus</i> sp.	Irregular web builders	++	++	++
Salticidae	(i) <i>Acemonea tenuipes</i>	Ground runner	--	--	++
	(ii) <i>Bavia</i> sp.	Ground runner	--	++	--
	(iii) <i>Binor albobimaculatus</i>	Ground runner	++	++	++
	(iv) <i>Binor pseudomaculatus</i>	Ground runner	++	++	++
	(vi) <i>Cosmophasis umbortia</i>	Ground runner	--	++	--
	(vi) <i>Hasarius andersoni</i>	Ground runner	++	--	++
	(vii) <i>Hyllus semicupreus</i>	Ground runner	++	++	--
	(viii) <i>Myrmaracne mathewei</i>	Ground runner	--	--	++
	(ix) <i>Myrmaracne orientalis</i>	Ground runner	--	++	--
	(x) <i>Neoscona</i> sp.	Ground runner	--	++	++
	(xi) <i>Phintella vittella</i>	Ground runner	++	--	++
	(xii) <i>Plexippus paykuli male</i>	Ground runner	++	++	++
	(xiii) <i>Plexippus paykuli female</i>	Ground runner	++	++	++
	(xiv) <i>Phidippus pateli</i>	Ground runner	++	++	++
	(xv) <i>Phidippus yashdharae</i>	Ground runner	++	++	++
	(xvi) <i>Salticus runjitus</i>	Ground runner	++	++	++
	(xvii) <i>Phidippus indicus</i>	Ground runner	++	++	++
	(xviii) <i>Portia assamensis</i>	Ground runner	++	++	++
	(xix) <i>Portia</i> sp.	Ground runner	++	++	++
	(xx) <i>Ptocasius strupifer</i>	Ground runner	++	++	--
	(xxi) <i>Selenops</i> Sp.	Ground runner	--	--	++
	(xxii) <i>Telamanata dimidiata</i>	Ground runner	++	++	++
Tetragnathidae	(i) <i>Leucauge decorata</i>	Orb web builders	++	++	++
	(ii) <i>Tetragnatna chamberlini</i>	Orb web builders	++	++	--
	(iii) <i>Leucauge</i> sp.	Orb web builders	++	--	++
Theridiidae	(i) <i>Achaeuranea mundula</i>	Single line snare web	--	++	++
	(ii) <i>Chrysso nigra</i>	Single line snare web	--	--	++
	(iii) <i>Chrysso pulcherrimus</i>	Single line snare web	--	++	--
	(iv) <i>Steatoda</i> sp.	Single line snare web	++	++	++
Thomisidae	(i) <i>Philodromus</i> sp.	Ambusher	--	--	++
	(ii) <i>Thomisus lobosus</i>	Ambusher	++	++	++
	(iii) <i>Thomisus projectus</i>	Ambusher	++	++	++
	(iv) <i>Xysticus minutes</i>	Ambusher	--	++	++
Uloboridae	(i) <i>Uloborus donoliui</i>	Dome shape horizontal web	++	++	++

FAUNISTIC STUDY ON NOTERIDAE AND DYTISCIDAE (COLEOPTERA: ADEPHAGA) IN RAMSAR SITE KUYUCUK LAKE (TURKEY), WITH FURTHER DISTRIBUTIONAL NOTES

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[**Darılmaz, M. C., Polat, A., İncekara, Ü. & Taşar, G. E.** 2015. Faunistic study on Noteridae and Dytiscidae (Coleoptera: Adephaga) in Ramsar Site Kuyucuk Lake (Turkey), with further distributional notes. *Munis Entomology & Zoology*, 10 (2): 441-445]

ABSTRACT: In this study we established the presence of 10 aquatic beetle (Coleoptera: Adephaga) species belonging to 2 families (Noteridae and Dytiscidae) in Ramsar site Kuyucuk Lake, Kars. The specimens were collected between 2010 and 2011. Two species from Eastern Anatolian Region, and eight species from research area were recorded for the first time, and distributions in Turkey of these newly recorded species are presented.

KEY WORDS: Coleoptera, aquatic beetles, Adephaga, new records, Kuyucuk Lake.

The family Dytiscidae, known as the largest family into the suborder Adephaga with about 4000 species in 175 genera in the world, represented with 137 species and nine subspecies from Turkey in 885 species from Palearctic Region (Balke et al., 2004; Jach & Balke, 2008; Darılmaz & Kıyak, 2009; Taşat et al., 2012).

The family Noteridae, known 3 species from Turkey, represented 250 species in the world which include about 30 species from Palearctic region (Darılmaz & Kıyak, 2009).

Aim of this study is to determine the Adephaga in Ramsar site Kuyucuk Lake and make a contribution to the Turkish aquatic Coleoptera fauna.

MATERIAL AND METHODS

In summer seasons between 2010 and 2011, specimens were collected by means of a sieves that having 3,15 x 1 mm pores from the Kuyucuk Lake (map of Kuyucuk Lake is shown in Fig. 1). Firstly collected samples were killed with ethyl acetate and were stored in small bottles in the research area. Specimens were cleaned with brush before identification, and then aedeagus of the beetles were dissected under a stereo microscope in the laboratory. All samples have been deposited in the Zoological Museum, Atatürk University, Science Faculty, Department of Biology, Erzurum, Turkey. On the other hand, number of total individuals of each species is shown in Fig. 2.

RESULTS

In the Kuyucuk Lake, 10 aquatic beetle species belonging to Dytiscidae and Noteridae were recorded. One species (*Noterus clavicornis*) belonging to Noteridae and one species (*Hydaticus ponticus*) belonging to Dytiscidae recorded from Eastern Anatolian Region for the first time. And 8 species (*Rhantus*

suturalis, *Graphoderus cinereus*, *Hydroglyphus geminus*, *Scarodytes halensis halensis*, *Hygrotus impressopunctatus*, *H. parallelogrammus*, *H. inaequalis*, *Laccophilus minutus*) belonging to Dytiscidae are recorded from the research area for the first time. Number of species collected in different locations is given in Table 1.

Noteridae

Noterus clavicornis (De Geer, 1774)

Material examined: Kars; Kuyucuk Lake, 40°44'54N 43°27'17E, 1634m, 03.08.2010, 1ex.; 40°44'53N 43°27'05E, 1635m, 15.10.2011, 5ex.; 40°44'53N 43°27'03E, 1631m, 03.08.2010, 60ex.; 40°45'06N 43°27'23E, 1647m, 03.08.2010, 16ex.; 40°44'53N 43°27'03E, 1639m, 28.05.2011, 11ex.; 40°44'23N 43°27'15E, 1636m, 28.05.2011, 10ex.; 40°44'55N 43°29'58E, 1635m, 28.05.2011, 1ex.; 40°44'50N 43°27'23E, 1636m, 03.08.2010, 8ex.

Distribution in Turkey: Aksaray, Ankara, Antalya, Aydın, Balıkesir, Bilecik, Bolu, Çorum, Düzce, Eskişehir, Isparta, İzmir, Kayseri, Konya, Manisa, Sakarya, Samsun, Trabzon (Darılmaz & Kiyak, 2009; Darılmaz et al., 2010; Topkara & Balık, 2010).

Remark: New record of Eastern Anatolia.

Dytiscidae

Rhantus suturalis (W.S. MacLeay, 1825)

Material examined: Kars; Kuyucuk Lake, 40°44'53N 43°27'03E, 1631m, 03.08.2010, 2ex.; 40°44'23N 43°27'15E, 1636m, 28.05.2011, 1ex.; 40°44'50N 43°27'23E, 1636m, 03.08.2010, 1ex.

Distribution in Turkey: Aksaray, Ankara, Çorum, Erzurum, Kayseri, Konya, Manisa, Rize, Trabzon (Darılmaz & Kiyak, 2009; Darılmaz et al., 2010; Hızarcıoğlu et al., 2010; İncekara et al., 2010).

Remark: New record of research area.

Graphoderus cinereus (Linnaeus, 1758)

Material examined: Kars; Kuyucuk Lake, 40°44'54N 43°27'17E, 1634m, 03.08.2010, 3ex.; 40°44'53N 43°27'05E, 1635m, 15.10.2011, 1ex.; 40°44'53N 43°27'03E, 1631m, 03.08.2010, 2ex.; 40°44'55N 43°29'58E, 1635m, 28.05.2011, 2ex.

Distribution in Turkey: Afyon, Agri, Ankara, Erzurum (Darılmaz & Kiyak, 2009; Hızarcıoğlu et al., 2010).

Remark: New record of research area.

Hydaticus ponticus Sharp, 1882

Material examined: Kars; Kuyucuk Lake, 40°44'55N 43°29'58E, 1635m, 28.05.2011, 6ex.

Distribution in Turkey: Aydın, Burdur (Darılmaz & Kiyak, 2009).

Remark: New record of Eastern Anatolia.

Hydroglyphus geminus (Fabricius, 1792)

Material examined: Kars; Kuyucuk Lake, 40°44'53N 43°27'05E, 1635m, 15.10.2011, 3ex.; 40°44'53N 43°27'03E, 1639m, 28.05.2011, 1ex.; 40°44'55N 43°29'58E, 1635m, 28.05.2011, 18ex.; 40°44'50N 43°27'23E, 1636m, 03.08.2010 9ex.

Distribution in Turkey: Adana, Afyon, Aksaray, Ankara, Antalya, Artvin, Aydın, Balıkesir, Bolu, Bursa, Çorum, Edirne, Erzurum, Eskişehir, Gümüşhane, Isparta, İçel, İzmir, Kastamonu, Kayseri, Konya, Kilis, Manisa, Muğla, Rize, Samsun, Trabzon, Yozgat (Darılmaz & Kiyak, 2009; Darılmaz et al., 2010).

Remark: New record of research area.

Scarodytes halensis halensis (Fabricius, 1787)

Material examined: Kars; Kuyucuk Lake, 40° 44'53N 43°27'05E, 1635m, 15.10.2011, 1ex.

Distribution in Turkey: Aksaray, Ankara, Antalya, Artvin, Bursa, Çorum, Erzurum, Eskişehir, Gümüşhane, Isparta, İçel, İzmir, Kayseri, Van, Trabzon, Yozgat (Darılmaz & Kiyak, 2009; Darılmaz et al., 2010).

Remark: New record of research area.

***Hygrotus impressopunctatus* (Schaller, 1783)**

Material examined: Kars; Kuyucuk Lake, 40°44'53N 43°27'03E, 1631m, 03.08.2010, 5ex.; 40°44'53N 43°27'03E, 1639m, 28.05.2011, 2ex.; 40°44'23N 43°27'15E, 1636m, 28.05.2011, 2ex.

Distribution in Turkey: Çorum, Erzurum, Konya (Darılmaz & Kiyak, 2009; Darılmaz et al., 2010).

Remark: New record of research area.

***Hygrotus parallelogrammus* (Ahrens, 1812)**

Material examined: Kars; Kuyucuk Lake, 40°44'53N 43°27'03E, 1631m, 03.08.2010, 2ex.; 40°45'06N 43°27'23E, 1647m, 03.08.2010, 1ex.; 40°44'53N 43°27'03E, 1639m, 28.05.2011, 6ex.

Distribution in Turkey: Afyon, Ankara, Erzurum, Konya, Kütahya, Samsun, Tuz Lake, Toros Mountains (Darılmaz & Kiyak, 2009).

Remark: New record of research area.

***Hygrotus inaequalis* (Fabricius, 1777)**

Material examined: Kars; Kuyucuk Lake, 40°44'54N 43°27'17E, 1634m, 03.08.2010, 5ex.; 40°44'53N 43°27'05E, 1635m, 15.10.2011, 8ex.; 40°44'53N 43°27'03E, 1631m, 03.08.2010, 8ex.; 40°44'53N 43°27'03E, 1639m, 28.05.2011, 2ex.; 40°44'23N 43°27'15E, 1636m, 28.05.2011, 7ex.; 40°44'50N 43°27'23E, 1636m, 03.08.2010, 1ex.

Distribution in Turkey: Afyon, Ankara, Artvin, Bolu, Çorum, Erzurum, Isparta, Kayseri, Konya, Manisa, Samsun (Darılmaz & Kiyak, 2009; Darılmaz et al., 2010; Hızarcıoğlu et al., 2010; İncekara et al., 2010).

Remark: New record of research area.

***Laccophilus minutus* (Linnaeus, 1758)**

Material examined: Kars; Kuyucuk Lake, 40°44'53N 43°27'05E, 1635m, 15.10.2011, 24ex.; 40°44'53N 43°27'03E, 1631m, 03.08.2010, 22ex.; 40°45'06N 43°27'23E, 1647m, 03.08.2010, 6ex.; 40°44'53N 43°27'03E, 1639m, 28.05.2011, 2ex.

Distribution in Turkey: Afyon, Aksaray, Ankara, Antalya, Artvin, Aydın, Balıkesir, Bolu, Burdur, Bursa, Çorum, Erzurum, Eskişehir, Gümüşhane, Isparta, İzmir, Kastamonu, Kayseri, Konya, Manisa, Rize, Samsun, Sinop, Sivas, Trabzon, Toros Mountains Yozgat (Darılmaz & Kiyak, 2009; Darılmaz et al., 2010; Topkara & Balık, 2010).

Remark: New record of research area.

LITERATURE CITED

Balke, M., Jäch, M. A. & Hendrich, L. 2004. "Order Coleoptera", Freshwater Invertebrates of the Malaysian Region. In: Yule, C. M., Yong, H. S., Academy of Sciences Malaysia, Selangor, 555-609.

Darılmaz, M. C. & Kiyak, S. 2009. Checklist of Gyrinidae, Haliplidae, Noteridae and Dytiscidae of Turkey (Coleoptera: Adephega). Journal of Natural History, 43 (25-26): 1585-1636.

Darılmaz, M. C., Salur, A. & Mesci, S. 2010. Aquatic Coleoptera fauna of Çorum and Yozgat Provinces (Turkey). Biological Diversity and Conservation, 3 (2): 89-96.

Hızarcıoğlu, R., Kiyak, S. & Darılmaz, M. C. 2010. Some aquatic Coleoptera from Ankara province, Turkey. Munis Entomology & Zoology, 5 (1): 278-282.

İncekara, Ü., Polat, A., Darılmaz, M. C., Mart, A. & Taşar, G. E. 2010. Aquatic Coleoptera fauna of Ramsar site Sultan Sazlığı (Kayseri Turkey) and surroundings, with new distribution records of four species from the southern limit of its ranges. Archives of Biological Sciences, Belgrade, 62 (4): 1181-1191.

Jäch, M. A. & Balke, M. 2008. Global diversity of water beetles (Coleoptera) in freshwater. Hydrobiologia, 595: 419-442.

Taşar, G. E., Polat, A., Darılmaz, M. C., Türken, H., Aydoğan, Z., İncekara, Ü. & Kasapoğlu, A. 2012. A Good Sample to Concurrent Fauna: Study on Aquatic Coleoptera Fauna (Adephega and Polyphaga) of Lake Van Basin (Turkey), with some Zoogeographic Remarks. J. Entomol. Res. Soc., 14 (2): 27-37.

Topkara, E. T. & Balık, S. 2010. Contribution to the Knowledge on Distribution of the Aquatic Beetles (Ordo: Coleoptera) in the Western Black Sea Region and Its Environs of Turkey. Turkish Journal of Fisheries and Aquatic Sciences, 10 (3): 323-332.

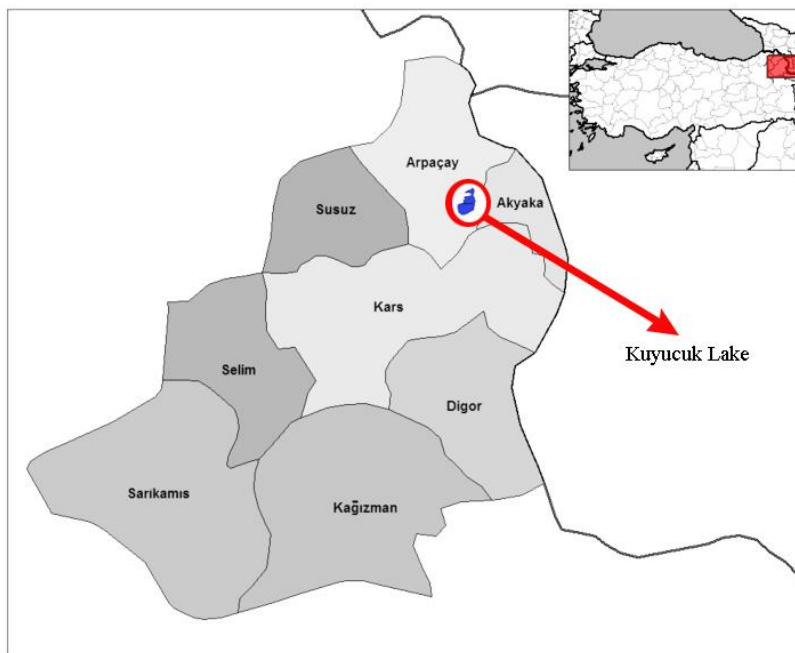


Figure 1. Map of research area.

Table 1. Collected species and locations. **1:** 40°44'54N 43°27'17E, 03.08.2010, 1634m; **2:** 40°44'50N 43°27'23E, 03.08.2010, 1636m; **3:** 40°44'53N 43°27'03E, 03.08.2010, 1631m; **4:** 40°45'06N 43°27'23E, 03.08.2010, 1647m; **5:** 40°44'53N 43°27'03E, 28.05.2011, 1639m; **6:** 40°44'23N 43°27'15E, 28.05.2011, 1636m; **7:** 40°44'55N 43°29'58E, 28.05.2011, 1635m; **8:** 40°44'53N 43°27'05E, 15.10.2011, 1635m.

Species	Localities							
	1	2	3	4	5	6	7	8
<i>Noterus clavicornis</i>	1 ex.	8 ex.	60 ex.	16 ex.	11 ex.	10 ex.	1 ex.	5 ex.
<i>Rhantus suturalis</i>		1 ex.	2 ex.			1 ex.		
<i>Graphoderus cinereus</i>	3 ex.						2 ex.	1 ex.
<i>Hydaticus ponticus</i>							6 ex.	
<i>Hydroglyphus geminus</i>		9 ex.			1 ex.		18 ex.	3 ex.
<i>Scarodytes halensis halensis</i>								1 ex.
<i>Hygrotus impressopunctatus</i>			5 ex.		2 ex.	2 ex.		
<i>Hygrotus parallelogrammus</i>			2 ex.	1 ex.	6 ex.			
<i>Hygrotus inaequalis</i>	5 ex.	1 ex.	8 ex.		2 ex.	7 ex.		8 ex.
<i>Laccophilus minutus</i>			22 ex.	6 ex.	6 ex.			24 ex.

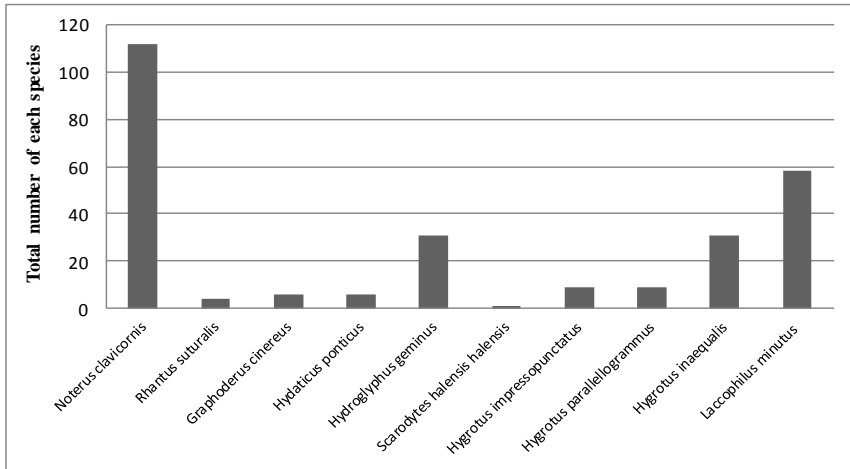


Figure 2. Comparison of total individuals of the species.

**BIOCHEMICAL STUDIES ON TOTAL PROTEIN,
CARBOHYDRATE AND LIPIDS CONTENT LEVEL DURING
THE INFECTION BY FUNGI WHITE MUSCARDINE DISEASE
OF SILKWORM, *BOMBYX MORI* L.**

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[Nirupama, R. 2015. Biochemical studies on total protein, carbohydrate and lipids content level during the infection by fungi white muscardine disease of silkworm, *Bombyx mori* L. Munis Entomology & Zoology, 10 (2): 446-454]

ABSTRACT: The changes of protein, carbohydrate and lipids (pcl) metabolism were studied in haemolymph and whole larval tissues during the 5th instar larval development on 1st, 2nd, 3rd, 4th and 5th day after inoculation with fungi *Beauveria bassiana* (white muscardine) of conidial suspension,. The concentration level of pcl showed a similar trend of increasing in multivoltine and bivoltine silkworm breeds of control batches and reducing level was noticed in the infected batches, due to effect of fungal infection in both the breeds. The progressive concentration was found to be day by day reach peak level in healthy/control breeds, the bio-molecules are correlated to the degree of their absorption, inter-conversion and utilization in control batches. The biochemical results presumed on the basis of these major changes in protein, carbohydrate and lipid content level in infected batches causes for high toxicity of the silkworm larvae showing significant variation in their concentration. Two different varieties of silkworm breeds multivoltine 2000H and bivoltine CSR6 were utilized and bio-physiological status were discussed in relation to the 5th instar larvae under inoculated and control conditions.

KEY WORDS: *Beauveria bassiana*, Haemolymph and whole larval tissues, Protein (P), Carbohydrate (C), Lipids (L), 5th instar silkworm larvae.

The silkworm, *Bombyx mori* is a manophagous and holometabolous lepidopteron insect and its growth, development and metabolism mainly depends on its nutritional requirements and environmental conditions. Generally insects acquire infection, parasitized or become diseased in many routes, they manifest there conditions in variety form of actions, appearances and signs. The manifestations known as symptoms are most useful in the detection or diagnosis of disease (Steinhanus, 1963). The silkworm larvae accumulate large quantity of fuel reserves in various tissues, and it is endowed with a unique bio-chemical adaptation to conserve nutritional resources available during the active larval stage. The lepidopteron insects maintain relatively higher level of heamolypmh sugar compared to other insects (Roeder, 1953). Haemolymph sugar levels in the larvae of *B. mori* have been worked by many entomologists (Hemmingsen, 1924; Weing & Joachin, 1936; Kawana, 1937). Carbohydrates and proteins are very essential for adult larva and pupal development and are obtained from the fat body and haemolymph stored during the 5th instar larval stage. The concentration of bio-molecules like proteins, carbohydrates, lipids, amino acids, nucleic acid, enzymes etc., may vary significantly during the life cycle of all living organisms. The carbohydrates are stored in the fat body as glycogen, which is converted into simple sugar and trehalose before it is released in to the haemolymph for its utilization. Carbohydrate plays a polysaccharides and free sugars of a tissue and its size dynamics is a good indication of metabolic status of the tissue. The quantitative variation of these bio-molecules in the body of insects depends upon

the nutritional status of the food and their utilization during growth and metamorphosis stated by (Nagata & Yashitake, 1989). The major sources of bio-molecules are carbohydrate, protein and lipids which play a pertinent role in the development and morphogenesis in almost all the intermediary metabolic pathways of insects (Wyatt, 1978). The haemolymph proteins serve as the important source for other tissue proteins as well as reserve energy in the adult during starvation (Buck, 1953). Carbohydrate is a major part of the total caloric intake of the organism and serves as a temporary store of glucose. Lipids are important constituents of cuticle and help in acylation of glucose-6-phosphate during chitin synthesis (Wyatt, 1967). Lipids serve as a source of metabolic energy and essential for structural components of cells. The lipid in the fat body is an energy reserve, which can be mobilized rapidly during starvation, oogenesis, embryogenesis and moulting and is used to sustain continuous muscular activity (Gilbert & Chino, 1974). The multiplication of pathogen in the host system is often reflected by specific metabolic variations along with gradual changes in the infected tissues and susceptibility to a disease differs according to the physiological status of the host. Studies on the changes in various biochemical constituents in haemolymph and whole tissues in relation to entomo-pathogenic fungi of *B. bassiana* (white muscardine) is very scanty and several biochemical work reports indicates only on viral and bacteria disease. There are only two literatures available regarding biochemical changes in silkworm haemolymph infection by fungi (Mallikarjuna et al., 2002). In the present study, an investigation was conducted to understand the patho-physiological changes of major biochemical quantitative in protein, carbohydrates and lipids activity in haemolymph and whole larval tissues were examined in the identified resistant multivoltine silkworm breed 2000H and susceptible bivoltine breed CSR6 under inoculated/treated and control/healthy conditions during different days of progressive infection.

MATERIAL AND METHODS

The entomopathogenic fungi of *Beauveria bassiana* (white muscardine) was cultured on potato dextrose agar medium and isolated. The conidial suspension of fungus prepared, inoculation was done on newly ecdysed 4th moult-out larvae of 5th instar per cutaneous. Dosage of 1×10^6 conidial suspension/ml/100 larvae sprayed on the body of multivoltine 2000H and bivoltine CSR6 breeds. Treated batches were kept under temperature $25 \pm 1^\circ\text{C}$ and humidity $90 \pm 95\%$, along with control batches of same breeds larvae reared under normal temperature and humidity without any inoculation.

Sample collection method: The haemolymph or blood and whole larval tissues were collected after 24h of inoculation 1st, 2nd, 3rd, 4th and 5th day (24, 48, 72, 96 and 120 h) from the silkworm breeds of 2000H and CSR6. Three samples of five larvae each randomly selected every day from both in infected/inoculated and healthy/control batches. Haemolymph was collected by cutting of thoracic-legs in pre-chilled eppendorf tubes which contained a few crystals of phenyl thiourea (PTU) followed by (Joy & Gopinathan, 1995) and immediately frozen at -80°C , the same larvae were dissected gut wall debris was removed and crushed thoroughly with the help of sterilized mortar and pestle and stored at -80°C till processed for analysis of various organic compounds.

Estimation process: 1000ul of haemolymph was homogenized with 5ml of 15% Trichloroacetic acid (TCA) and 250mg larval tissues was homogenized with 5ml of 15% TCA individually and centrifuged at 6000rpm for 20 minutes. The supernatant was transferred to another test tube individually for the estimation of carbohydrates. The residues were washed twice with cold 80% acetone followed by cold diethyl ether and finally suspended in 5ml of 1N NaOH (Sodium hydroxide pellets) solution for tissues and haemolymph respectively and again centrifuged, supernatant was used for protein estimation.

Protein estimation method: Soluble total Protein was estimated according to the methods of Lowry et al., (1951) by Folin-phenol methods, using BSA as standard. For 100ul samples of haemolymph and tissues were taken separately, to that 5ml of alkaline copper-sulphate reagent C was added, [**Reagent A:** 2% sodium carbonate mixed with 50ml of 1N NaOH solution. **Reagent B:** 5ml of 0.5% copper sulphate mixed with 5ml of 1% sodium potassium tartrate. **Reagent C:** prepared by (50:1 ratio) 100ml of Reagent A and 2ml of Reagent B] contents were mixed well after 10 minutes, 1:1 ratio of 0.5ml folin-phenol reagent was added and tubes were shaken well. The blank sample contained 100ul of distilled water, 5ml of alkaline copper reagent and 0.5ml folin-phenol reagent. The colour intensity (light blue) was read at 660nm in a spectrophotometer against blank after 30minutes. The protein content was recorded from the standard curve prepared by bovine serum albumin (BSA) (10-100ug). The total protein content values were expressed as mg protein/ml of haemolymph and for whole tissues mg/g. wet wt. of tissue.

Carbohydrate estimation method: Total Carbohydrate was followed Carroll et al. (1956) by Anthrone method and Glucose was used as standard. For 100ul each supernatant haemolymph and whole tissues sample taken individually in a test tube, to that 4ml of anthrone reagent (200mg of anthrone powder dissolved in 72 % of 100ml of sulphuric acid) solution was added and contents mixed well. All tubes kept in a boiled how water bath for 10 min, then tubes were cooled at room temperature. The developed colour intensity (light green) was read at 620nm in a spectrophotometer using a blank sample. The total carbohydrates present in sample was expressed as mg/ml of haemolymph and for tissues expressed as mg/gm of wet wt. of tissues.

Lipid estimation method: Lipids were carried out gravimetrically of Folch's et al. (1957) by chloroform and methanol mixture. For 1000ul of haemolymph in 10ml of chloroform methanol mixture (2:1 ratio) was added and homogenized with the help of mortar, pestle and transferred to test tube. 250mg of crushed tissues was thoroughly macerated with 10ml of chloroform methanol mixture, and transferred to test tube, kept it over night under normal room temperature and next day morning centrifuged at 5000rpm for 20 min. Then 4ml of 0.9% Sodium chloride solution were added all tubes and vortexing for few seconds and centrifuged again at low speed at 2500rpm for 10 min to separate the two phases of upper and lower layer. After centrifugation, remove the upper siphoning solution (white) and lower chloroform phase (yellow) containing lipid was collected into a pre-weighed plastic vial. The lipid fraction was air dried and the weight of the vials was noted, the differences between in initial and final weight of the plastic vials were recorded and quantity of lipid content was expressed as mg/ml of haemolymph and mg/g wet wt. for tissues.

RESULTS

Biochemical changes brought out by the two varieties of samples, haemolymph and whole larval tissues and changes in the haemolymph are mainly caused by diseases, the basic components of protein, synthesis involving in the regulation of ionic balance for energy rescuing operations. Variation in the content of soluble total protein, carbohydrates and lipids in haemolymph and whole larval tissues during 5th instars development in the multivoltine and bivoltine silkworm breeds were studied. Significant difference in protein, carbohydrate, and lipids concentration between healthy and infected/diseased was recorded. As the disease progresses haemolymph and larval tissues pcl content was disturbed and significant variations was noticed in infected batches. Although in case of healthy/control larvae of pcl increased steadily as the age of the larvae increases their protein, carbohydrate and lipids respectively. The inoculated batches of protein content level in the haemolymph was found maximum (63.00mg/ml) on third day in 2000H followed by 57.46 mg/ml in CSR6 and decreased gradually towards the end of 4th and 5th day 56.50 to 52.25 mg/ml and 52.32 to 49.46 mg/ml due to muscardine infection. In the control batches of 2000H, protein level increased simultaneously day by day 64.29 to 81.35 mg/ml from 1st to 5th day, and 59.58 to 78.00 mg/ml in CSR6. Similarly, the larval tissues protein content ranged from 43.42 to 57.90mg/gm in 2000H to 40.23 to 55.30 mg/gm in CSR6 in the control batches. Whereas treated batches of 2000H showed 40.10 to 38.60 mg/g followed by 34.75 to 33.31 mg/gm in CSR6, Table 1.

Total carbohydrates or sugar content level in the haemolymph showed normal in the 1st day was found 22.70 and 20.42mg/ml and decreased gradually towards the end of 5th day 21.50 mg/ml in inoculated batches, same trend was observed in the larval tissues. Significant variation was also noticed in the control batches carbohydrates level of concentration gradually increased day by day both in haemolymph and whole tissues and same trend was also exhibited in lipids profiles, Table 2.

The treated batches lipid concentration level in the haemolymph was 56.70 and 55.35 mg/ml in 2000H followed by 53.47 and 51.45 mg/ml in CSR6 breed. Higher concentration level was found 67.18 to 77.58 mg/ml and 59.00 to 73.25 mg/ml under both the control breeds respectively. Similarly the whole tissues of lipid content level ranged from 36.76 to 42.26 mg/g up to 3rd day and simultaneously decreased their level to 35.00 at the end of 5th day in inoculated batches and gradually increased 39.44 to 53.50 mg/g under the control of 2000H multivoltine breed. Same trend was observed in CSR6 larval tissues under inoculated and control batches, Table 3.

The results presumed on the basis of these major changes in protein, carbohydrates and lipids content level showed a similar trend of reducing and increasing in infected batches in both the breeds, and it was found to be progressive concentration day by day reach peak level in health/control breeds values have been presented in the Table 1, 2 and 3.

The change of biochemical constituents in the tissues reflects the physiological status at different stages of development of an insect. The increase and decrease in the pcl content of haemolymph and whole larval tissues from the 1st day of 5th instars up to 5th day after inoculated/treated batches due to infection by white muscardine and pathogen of fungi utilized the host organic profiles for its growth and development. Whereas in the control batches the pcl level gradually ranged day by day due to by accumulation of proteins that are transported to other

tissues through the haemolymph for further physiological activities in the larva, the active secretion of protein by other tissues like fat bodies.

The patho-biochemical progressive variation in the infected and control batches have been presented in the Graphs. 1, 2, 3, 4, 5 and 6. The changes in the concentration of these bio-molecules are correlated to the degree of their absorption, inter-conversion and utilization in the control batches and cause for high toxicity of the silkworm larvae under infected batches.

DISCUSSION

Proteins are one of the important macromolecule organic substances and their role is compensatory mechanisms, especially during the stress (infection) conditions in silkworm which occupies the pivotal role both in structural and dynamic aspects of living systems. The total protein content consists of structural and soluble proteins involved in the architecture and metabolism of cells respectively. In the present study, biochemical changes after inoculation of fungi *Beauveria bassiana* showed major changes in the total protein, carbohydrate and lipid content in the haemolymph and whole larval tissues during the course of white muscardine infection. The physiological anomalies and infection by pathogens are responsible for altered metabolism in any organisms. Fluctuation in blood protein concentrations during metamorphosis are known since many years (Heller, 1924). The carbohydrates and lipids both constitute important source of energy during larval development and increased physical activities (Chino & Gilbert, 1965). Pathogenic infections are reported to induce several biochemical and physiological alterations in insect tissues (Martignoni, 1964; Shigematsu & Noguchi, 1969). The decrease of protein, carbohydrate and lipids content level under infection condition, as well as it was increased simultaneously in the control conditions. The increase in protein content from first day to third day clearly indicated that the digestive activities are high during the early part of 5th instars development, which results in increased accumulation of proteins that are then transported to other tissues through the haemolymph for further physiological activities in the healthy larva (Horie et al., 1982). The study of biochemical constituents was elevated by under control conditions, where in the worms were healthy and not subjected to infection by fungus *Beauveria bassiana*. Carbohydrates serve as main source of energy of insect species (Chino & Gilbert, 1965), as energy plays a vital force in the biological system, a break down of organic constituents mainly carbohydrates is required to meet the energy under stress condition (Manohar Reddy, 2004). The decreased pcl level in haemolymph and tissues can be attributed to the excessive utilization of carbohydrates to meet the demand of energy of fungi *Beuveria bassiana* infection. The percentage level of protein, carbohydrate and lipids variation in the silkworm larvae under infected and control have been presented in the Graphs. 1, 2, 3, 4, 5 and 6. The infection by fungi white muscardine seems to be a reflection of stepped-up demand for energy in the host to combat the disease as a natural response and maximum significant reduction of total protein, carbohydrate and lipids concentrations in the whole tissues were observed in the infected/inoculated batches. This decrease was suggested to be due to reduction in the level of pcl in the haemolymph of diseased larvae which in-turn affects the formation of silk protein in the glands.

The infected larval protein, carbohydrate and lipid content level was decreased significantly in the haemolymph and whole larval tissues cause under stress condition to meet the energy demands or due to increased synthesis. Similarly the

carbohydrate content might have been actively mobilized towards glucose under stress to provide maximum energy. The total lipid content also increased as the age of the larvae increased both in control and decreased under inoculated batches of both the breeds. Fungi might have stimulated the protein, carbohydrate and lipid utilization in order to meet requirements of toxic stress, where as the pcl content level was gradually increased under healthy/control batches, data have been presented in the Tables 1, 2 and 3.

In conclusion of this results of the study clearly indicated that, white muscardine caused a severe disturbance in the protein metabolism, that cause for decrease in major organic compounds of protein, carbohydrate and lipids contents under highly toxic relation by fungus produced ammonium and magnesium oxalate has a toxins impact on silkworm, The degradation products may in-turn be fed into tricarboxylic acid (TCA) cycle through the amino-transferase system to cope up with the high energy demands augmented during stress conditions reported by (Nath et al., 1997). Protein depletion in tissues may constitute a role of compensatory mechanism under the influence of toxins of chemical reactions. The higher and lower level of organic compounds in silkworm breeds may be due to its susceptible and resistant nature also their polygenic characters, resistant breed feeding activity is normal compared to susceptible breed after infection.

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LITERATURE CITED

- Buck, J. B.** 1953. Physical properties and chemical composition of insect blood. Insect physiology (Ed. K. W. Roeder), John Wiley and Sons Inc., New York.
- Carroll, N. V.; Longely, N. V. & Roe, J. H.** 1956. J. Biol. Chem., 220-583.
- Chino, H. & Gilbert, L. I.** 1965. Lipid release and transport in insect. Biochem. Bio Phys. Acta., 98: 94-110.
- Folch, J. M., Less, P. & Stane-Stanely, G. H.** 1957. A simple methods for the isolation and purification of total lipids from animal tissues. J. Bio. Chem., 226: 497-509.
- Gilbert, L. I. & chino, P.** 1974. Transport of lipids in insects. J. Lipid Res., 15: 439-456.
- Hemmingsen, A. M.** 1924. Sband. Arch. Physiol., 45: 204.
- Horie, Y., Watanabe, K. & Sakamoto, E.** 1982. Evidence of stepwise digestion of protein in the digestive system of the silkworm, *Bombyx mori*. App. Ent. Zool., 17: 358-363.
- Heller, J.** 1924. Compt. Rend. Soc. Biol., 90: 1360.
- Kawana, Z.** 1937. Japan J. Zool., 7: 203-273.
- Lowry, O. H., Rosebrough, N. J., Farr, A. L. & Randall, R. J.** 1951. Protein measurement with Folin Phenol reagent. J. Bio. Chem., 193: 265-275.
- Mallikarjuna, M., Balavenkatasubbaiah, M., Nataraju, B. & Thiagarajan, V.** 2002. Effect of systemic fungicides on total haemocyte count and haemolymph biochemical changes in silkworm, *Bombyx mori* L. infected with *Beauveria bassiana*. Int. J. Entomol., 5 (2): 189-194.
- Manohar Reddy, B.** 2004. Metabolic modulations in various tissues of pre spinning silkworm *Bombyx mori* (L) Larvae during grasserie (BmNPV) disease. Ph.D. Thesis, Sri Venkateswara University, Tirupathi, India.
- Martignoni, E.** 1964. Pathophysiology in the insect. Ann. Rev. Entomol., Pp. 179-206.

Nagata, M. & Yashitake, N. 1989. Protein metabolism in the larval development of silkworm, *Bombyx mori*. Protein reutilization at the IV moult. J. Seric. Jpn., 58 (3): 221-233.

Nath, B. S., Suresh, A., Varma, B. M. & Kumar, R. P. S. 1997. Changes in protein metabolism in haemolymph and fat body of the silkworm, *Bombyx mori* (Lepidoptera: *Bombycidae*) in response to organophosphorus insecticides toxicity. Ecotoxicol. Environ. Saf., 36: 169-173.

Shigematsu, H. & Noguhi, A. 1969. Biochemical studies on the multiplication of a nuclear polyhedrosis virus in the silkworm, *Bombyx mori*. II. Protein synthesis in the larval tissue after infection. J. Invertebr. Pathol., 14: 301-307.

Steinhouse, E. A. (ed). 1963. Insect Pathology, Vols. 1 and 2. Academic Press, New York. Pp. 661-689.

Roeder, K. D. (ed) 1953. Insect Physiology. John. Wiley & Sons, Inc., New York. Pp. 147-190.

Weing, K. & Joachim, J. 1936. Biochem. Zeitschr., 285: 98.

Wyatt, G. R. 1967. The biochemistry of sugar and polysaccharides in insects. Adv. Insect Physiol., 4: 287-360.

Wyatt, G. R. & Pan, M. L. 1978. Insect plasma protein. Ann. Rev. Entomol., 47: 779-817.

Table 1. Protein concentration in the breeds of 2000H and CSR6.

Larval days	Treated He(2H) (mg/ml)	Control He (2H) (mg/ml)	Treated Lt(2H) (mg/g)	Control Lt(2H) (mg/g)	Treated He (C6) (mg/ml)	Control He (C6) (mg/ml)	Treated Lt(C6) (mg/g)	Control Lt(C6) (mg/g)
1 st	55.17	64.29	40.10	43.42	50.41	59.58	34.75	40.23
2 nd	59.95	69.42	44.57	46.55	53.29	65.17	37.85	44.57
3 rd	63.00	73.00	49.50	51.88	57.46	69.52	40.95	49.88
4 th	56.50	78.49	42.27	53.45	52.32	73.25	36.72	52.73
5 th	52.25	81.35	38.60	57.90	49.46	78.00	33.31	55.30

Table 2. Carbohydrate level in the breeds of 2000H and CSR6.

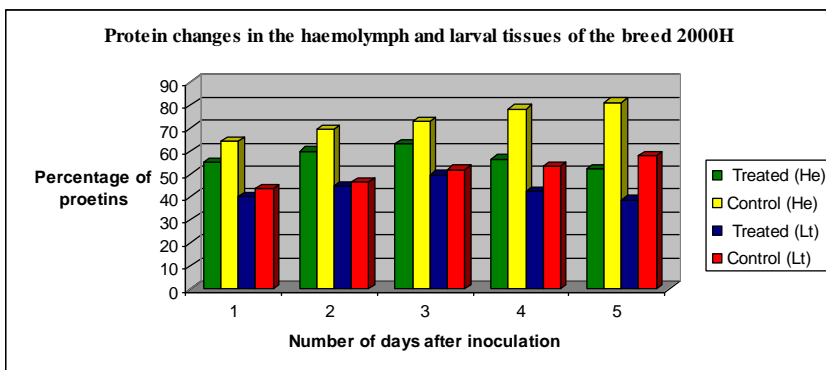
Larval days	Treated He(2H) (mg/ml)	Control He(2H) (mg/ml)	Treated Lt (2H) (mg/g)	Control Lt (2H) (mg/g)	Treated He(C6) (mg/ml)	Control He(C6) (mg/ml)	Treated Lt(C6) (mg/g)	Control Lt(C6) (mg/g)
1 st	22.70	28.92	19.89	22.42	20.42	26.52	17.30	21.38
2 nd	27.30	33.97	22.73	25.73	24.29	30.92	21.26	24.35
3 rd	32.60	41.26	25.88	29.36	29.31	35.41	25.00	27.50
4 th	26.88	47.92	21.19	32.68	25.10	39.70	21.25	31.94
5 th	21.50	52.64	18.75	35.71	21.50	43.75	18.05	34.15

Table 3. Lipid content in the breeds of 2000H and CSR6.

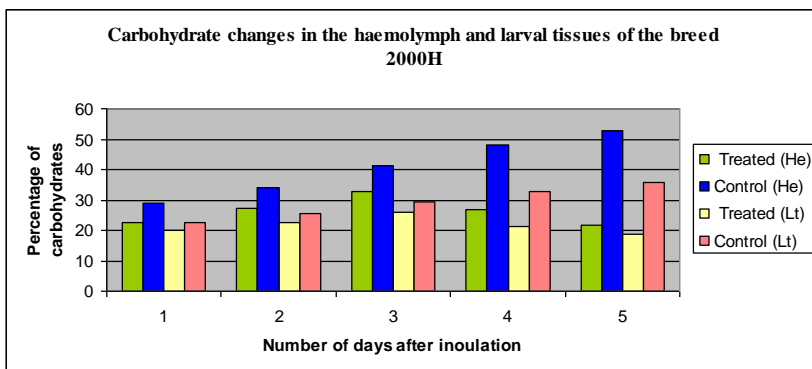
Larval days	Treated He(2H) (mg/ml)	Control He (2H) (mg/ml)	Treated Lt (2H) (mg/g)	Control Lt (2H) (mg/g)	Treated He(C6) (mg/ml)	Control He(C6) (mg/ml)	Treated Lt (mg/g)	Control Lt(C6) (mg/g)
1 st	56.70	67.18	36.76	39.44	52.47	59.00	33.69	36.57
2 nd	59.44	69.36	39.57	43.02	55.60	62.35	37.33	41.15
3 rd	63.35	73.85	42.26	48.23	61.19	66.57	40.92	45.78
4 th	58.00	75.43	37.35	50.73	57.78	70.29	35.73	49.30
5 th	55.35	77.58	35.00	53.50	51.45	73.25	32.00	51.10

He- haemolymph and Lt- larval tissues. (2H), (C6) indicates breeds name

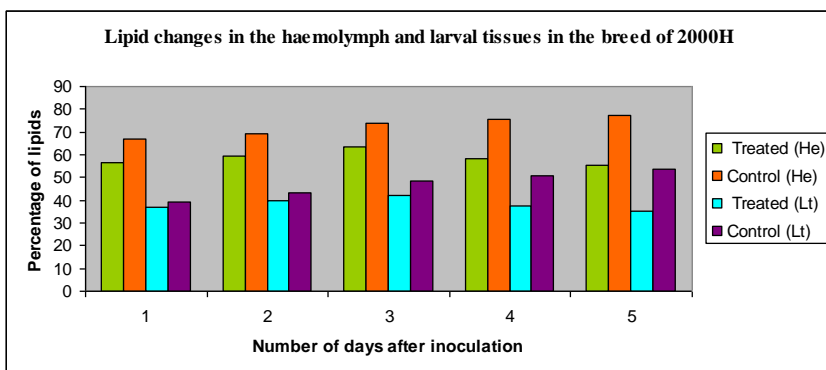
Biochemical Progress changes in the infected and control silkworm *Bombyx mori* L.



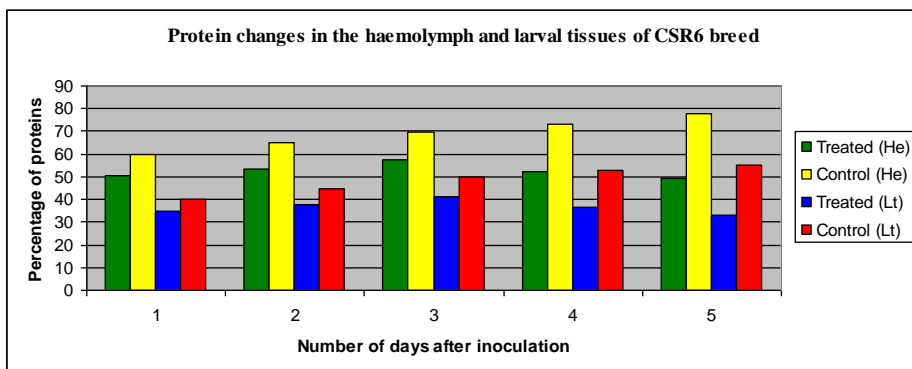
Graphs 1.



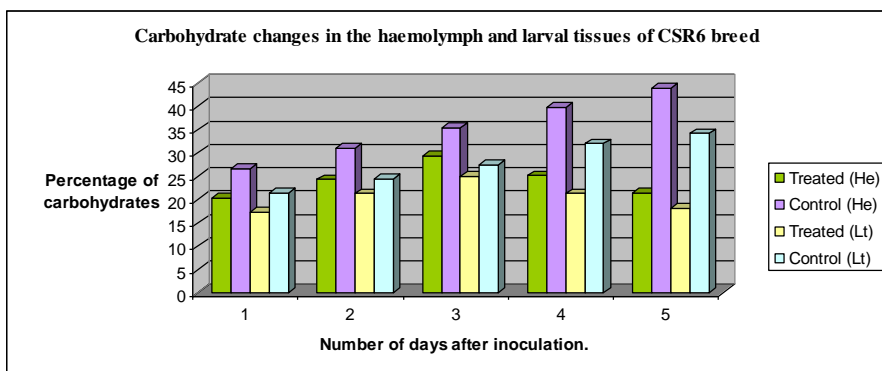
Graphs 2.



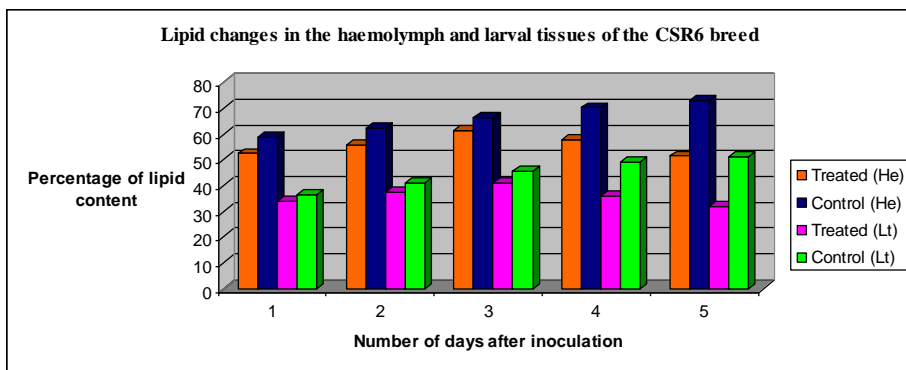
Graphs 3.



Graphs 4.



Graphs 5.



Graphs 6.

**A NEW SPECIES OF *ECTINOHOPLIA* FROM LAOS
WITH NOTES ON SOME OTHER SPECIES
(COLEOPTERA: SCARABAEIDAE)**

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[Prokofiev, A. M. 2015. A new species of *Ectinohoplia* from Laos with notes on some other species (Coleoptera: Scarabaeidae). Munis Entomology & Zoology, 10 (2): 455-459]

ABSTRACT: *Ectinohoplia ctenicera* sp. nov. from Laos is described. The new synonyms (*Spinohoplia* Sabatinelli, 1997 = *Ectinohoplia* Redtenbacher, 1868; *Ectinohoplia hispidula* Reitter, 1903 = *Ectinohoplia davidis* Fairmaire, 1889; *Ectinohoplia tonkinensis* Moser, 1912 = *Ectinohoplia guttaticollis* Fairmaire, 1900) and combinations (*Spinohoplia ahrensis* = *Ectinohoplia ahrensis* (Sabatinelli, 1997) comb. nov.; *Ectinohoplia dalatella* = *Hoplia dalatella* (Prokofiev, 2012) comb. nov.; *Ectinohoplia pictipes* = *Hoplia pictipes* (Fairmaire, 1889) comb. nov.) are proposed. The validity of *E. guttaticollis* is confirmed.

KEY WORDS: *Ectinohoplia*, *Hoplia*, taxonomy, South-East Asia.

The taxonomy and faunistics of the Oriental Hopliine beetles are extremely poorly known. During a revisional study of the Hopliines of East Indochina I had an opportunity to examine a wide set of material from South-East Asia including the all survived types of Fairmaire, Brenske, Nonfried and Moser. Within the other undescribed taxa I discovered a very peculiar specimen belonging to a new species of *Ectinohoplia* Redtenbacher, 1868. As this species can not be covered in my currently submitted review of Indochinese *Hoplia* Illiger, 1806, I present its formal description in this separate publication. In addition, the taxonomy and nomenclature of some inadequately known Oriental and Chinese species of *Ectinohoplia* are discussed.

The holotype from my reference collection will be housed in the Zoological Museum, Moscow State University. The body length was measured from the anteriormost point of the clypeus to the apical point of the elytra.

***Ectinohoplia ctenicera* Prokofiev, sp. nov.**
(Figs. 1-5)

Type material: Holotype male: Laos, Khammouane province, Pakhhene, 01-16.06.2013.

Description: Male (Fig. 1): Length 6.5 mm, greatest width 3.5 mm. Integument black, outer half of clypeus and legs reddish-orange. Round to weakly diamond-shaped shining golden scales (many with bluish or greenish glistening) forming the following pattern: a broad band along the side margins and in the lateral thirds of anterior margin of pronotum, a spot-like aggregation on each side of the pronotal base inward from the posterior angles and a narrow band in the bottom of the medial pronotal sulcus; a broad band along the lateral and apical margins of elytra, being curved anteriorly inward from the apical umbones, a narrow irregular streak along the sutural margin, a friable aggregation at the sides of scutellum and a narrow transverse band at mid-length of elytra; isolated scales distributed here and there on the disc of elytra; distal half of propygidium,

pygidium and abdominal sternites fully covered by the closely packed scales; scales on strerna are present on the peripheral parts only; legs only partially scaled with scales not closely packed (but probably partially worn here). Tibiae with elongated scales, femora like the body with round scales.

Antennae 10-articulated, with club 3-articulated, short and broad, slightly shorter than the combined length of 2-7th joints and approximately 1.5 times longer than broad; 3-7th joints strongly comb-like, i.e. with a sharp process on their anterior margin (Fig. 2). Clypeus weakly transverse, trapezoidal, with sides converging antieriad and broadly rounded toward the almost straight anterior margin, lacking anterior angles; basis of clypeus smoothly passing into ocular canthus. Head and pronotum bearing sparse short pale setae. Pronotum convex, with moderately deep medial sulcus and shallow rounded depressions on sides at the level of its greatest width, with greatest width at middle, with sides weakly crenulated, crenulations setigerous. Anterior margin of pronotum conspicuously and uniformly concave, anterior angles sharp; sides of pronotum somewhat more convergent antieriad than posteriad, weakly sinuated in anterior half, but much more conspicuously sinuated in posterior half before posterior angles. Basal margin of pronotum almost uniformly convex, but smoothly concave near well-marked posterior angles; thus, posterior angles becoming almost straight. Scutellum triangular, flat, with bluntly pointed apex. Elytra almost parallel-sided, 1.3 times as long as broad; humeral and apical umbones well-marked; humeral umbones long, rib-like; sides of elytra forming a deep vertical plate below the humeri; side margin of elytra moderately concave. Elytra with few rows of sparse short adpressed setae laterally, and with a single long and strong and few short dark setae at the apical sutural angle. Propygidium completely exposed; pygidium flat, vertical, with sparse and very short pale erect setae; each abdominal sternite with a transverse row of very short sparse pale setae.

Fore tibiae with three obtuse teeth, basal tooth rounded and slightly more spaced than the medial and distal teeth; fore tarsi attached on the level of the anteriormost point of the basis of the medial tooth. Upper internal angle of the hind tibiae not produced; distal margin of hind tibiae almost straight; hind tibiae not dilated and not curved; hind tarsi slightly longer than hind tibiae. All claws including posterior ones splitting; long claws of fore and middle tarsi broadened.

Aedeagus, as on Figs 3-5; parameres long, weakly broadened at tips, with hooked inner apical angles and triangular outer apical margin.

Female unknown.

Differential diagnosis: This new species sharply differs from the all known *Ectinohoplia* species in the strongly comb-shaped, saw-like joints 3-7 of the antennal funicle (vs. all joints quadrangular or only joints 5-7 more or less weakly comb-like). In the other characters the new species is most similar to *E. obducta* (Motschulsky, 1857) from Japan and China, but differs in the clypeus trapezoidal (vs. almost semicircular), the sides of the pronotum sinuated before the straight posterior angles (vs. non-sinuated, with the posterior angles obtuse), the head and thorax sparsely (vs. densely) scaled, and in presence of one long and few short modified setae near the apical sutural angle of the elytra (vs. several setae of an unequal length).

Etymology: The species is named after its comb-like antennae.

On the taxonomy and nomenclature of some *Ectinohoplia* species

The last revision of the genus *Ectinohoplia* was published by Arrow (1921); however, this treatment has not covered all the species described at that time and the types of the species described by French and German authors apparently were not studied. As a consequence, some of the names used for the valid species and some synonymies are incorrect according to my data.

Ectinohoplia davidis Fairmaire, 1889 = *Ectinohoplia hispidula* Reitter, 1903, syn. nov. I was unable to examine the types of *E. hispidula*; however, this species is characterized by two characters unique within the other *Ectinohoplia* species: the middle transverse band of elytra is angulate and the firm black setae are distributed along most of the sutural margin of elytra (Reitter, 1903; Arrow, 1921; Medvedev, 1952). A single type specimen of *E. davidis* from Sichuan studied by me possesses all the characters typical for *E. hispidula*; thus, the aforementioned synonymy can be established.

Ectinohoplia guttaticollis Fairmaire, 1900, bona sp. = *Ectinohoplia tonkinensis* Moser, 1912, syn. nov. Arrow (1921: 268) treated *E. variegata* De Borre, 1886, *E. variabilis* Reitter, 1903, *E. nigrotincta* Fairmaire, 1897, *E. guttaticollis* and *E. tonkinensis* as the synonyms of *E. paivae* (Wollaston, 1859). A direct comparison of the types of *E. guttaticollis* and *E. tonkinensis* confirms their synonymy; however, this species can be easily distinguished from *E. paivae* in the pronotal pattern (a pair of round patches and a medial longitudinal streak of scales on the disc of pronotum, absent in *E. paivae*); in the total absence of greenish scales above and below, and in the presence of the rather long and numerous erect hairs on the pygidium. I agree with Arrow's synonymy of *E. variegata* and *E. nigrotincta* (= *E. variabilis*) with *E. paivae*, although all three species were cited as valid in the Catalogue of Palaearctic Coleoptera (Smetana, 2006).

Recently I described *Ectinohoplia dalatella* from Vietnam, a diminutive species having the completely exposed propygidium and golden-blue glistening scales but lacking a specialized setation at the apical sutural angle of elytra (Prokofiev, 2012a). A more thorough study of the group reveals that this is a member of a probably monophyletic association including also *Hoplia albomaculata* Moser, 1912, *H. coerulesignata* Moser, 1916, *H. grisea* Moser, 1912, *H. montana* Moser, 1921, *H. viridisignata* Moser, 1912, *H. viridissima* Brenske, 1894, *H. viridula* Brenske, 1899, probably few other Indian and Thai species and almost all the Taiwanese species. This group is characterized by the small sizes of beetles, the presence of partially or completely exposed pygidium lacking an interlocked mechanism, brilliant glistening scales on underside of body, more or less concave lateral margin of elytra with the sides of elytra below the humeral umbones forming a rather deep vertical plate. All of these characters except the small sizes unite this group with *Ectinohoplia*; however, its representatives possess no specialized setosity at the apical sutural angle of the elytra, which is only real feature for separation *Ectinohoplia*, as I can conclude now (although it shows considerable variations in degree of development and in structure of the setae). Before a phylogenetic analysis of the Oriental Hoplines I feel that it is more correctly to retain this group within *Hoplia* sensu lato; as a result, the following new combination should be proposed: *Ectinohoplia dalatella* = *Hoplia dalatella* (Prokofiev, 2012) comb. nov.

Ectinohoplia pictipes Fairmaire, 1889 also resembles the members of *Ectinohoplia* in the body shape, but lacks a specialized setosity at the apical sutural angles of elytra; thus, this species should be also treated as *Hoplia pictipes*

(Fairmaire, 1889) comb. nov. It can be easily distinguished from the other externally similar species by the deeply excavated sides of pronotum before its hind angles.

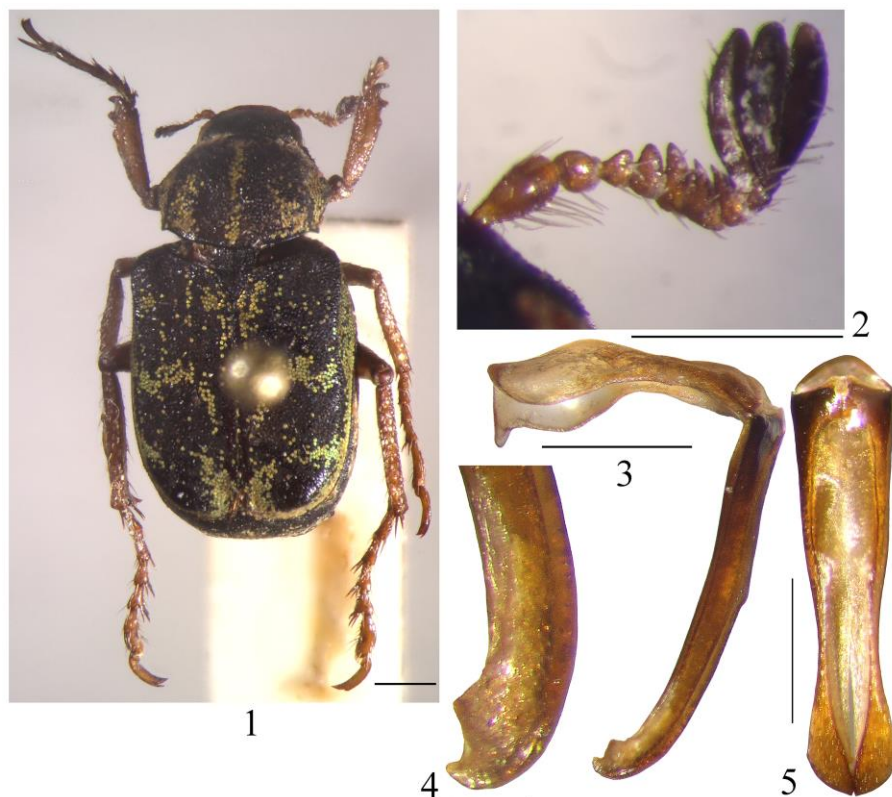
The monotypic Himalayan genus *Spinohoplia* Sabatinelli, 1997 was said to be different from *Ectinohoplia* in the presence of a single long bristle at the apical sutural angle of the elytra, 9-articulated antennae and parameres with a ventral tip (Sabatinelli, 1997). Although Sabatinelli listed the hollowed scutellum as a generic character of *Spinohoplia*, this feature is also known for some *Ectinohoplia* and one undescribed *Hoplia* species. Though my previous report (Prokofiev, 2012b) on the 9-articulated antennae in *Ectinohoplia* was based on the strongly worn specimens of *Hoplia aureola* (Pallas, 1781) with misplaced abdomen, this character has the wide intraspecific, sexual and even individual variations in *Hoplia*. In some *Ectinohoplia* the basis of propygidium is also covered by the elytra on a short distance, like in *S. ahrensis*. *E. harpagon* (Fairmaire, 1887) possess a single long bristle at the apical sutural angle of the elytra like *S. ahrensis*, and *E. ctenicera* bears a single long and few short bristles here. *E. ctenicera* represents a morphological intermediate link between *Spinohoplia* and typical *Ectinohoplia* in the shape of the parameres. Thus, there are no clear differences between the aforementioned genera; as a result, I synonymize *Spinohoplia* with *Ectinohoplia* (syn. nov.) and propose a new combination: *Spinohoplia ahrensis* = *Ectinohoplia ahrensis* (Sabatinelli, 1997) comb. nov.

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LITERATURE CITED

- Arrow, G. J.** 1921. A revision of the melolonthine beetles of the genus *Ectinohoplia*. Proceedings of the Zoological Society of London, 19: 267-276.
- Medvedev, S. I.** 1952. Fauna SSSR. Coleoptera. V. 10. N. 2. Plastintshatousye (Scarabaeidae). Subfam. Melolonthinae. Pt. 2. Izdatelstvo Akademii Nauk SSSR, Moscow–Leningrad: 276 p.
- Prokofiev, A. M.** 2012a. A new species of *Ectinohoplia* Redtb. (Coleoptera, Scarabaeoidea, Hopliini) from central Viet Nam. Euroasian Entomological Journal, 11 (6): 529-532.
- Prokofiev, A. M.** 2012b. New and noteworthy pleurostict scarab beetles (Coleoptera: Scarabaeidae). Calodema, 220: 1-33.
- Reitter, E.** 1903. Bestimmungs-Tabelle der Melolonthidae aus der europäischen fauna und angrenzenden ländern, enthaltend die gruppen der Rutelini, Hoplini und Glaphyrini (Schluss). Verhandlungen des Naturforschenden Vereins, 41: 28-158.
- Sabatinelli, G.** 1997. Descrizione di *Hoplia testudinis* n. sp. e *Spinohoplia* n. gen. *ahrensis* n. sp. del Nepal. Lambillionea, 97 (1): 64-71.
- Smetana, A.** 2006. Tribe Hopliini Latreille, 1829. In: Löbl, I., Smetana, A. (Eds.), Catalogue of Palaearctic Coleoptera. V. 3. Apollo Books, Stenstrup: 184-189.



Figures 1-5. *Ectinohoplia ctenicera* sp. nov. (holotype): 1. dorsal habitus; 2. antenna; 3. aedeagus, lateral view; 4. distal tip of parameres, lateral view; 5. parameres, frontal view. Scale bars: 1 = 1.0 mm; 2, 3, 5 = 0.5 mm; 4 = 0.1 mm.

**ELASMUS WESTWOOD (HYMENOPTERA:
CHALCIDOIDEA: EULOPHIDAE: EULOPHINAE:
ELASMINI) OF MAHARASHTRA, INDIA**

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[Kazmi, S. I. & Girish Kumar, P. 2015. *Elasmus* Westwood (Hymenoptera: Chalcidoidea: Eulophidae: Eulophinae: Elasmmini) of Maharashtra, India. Munis Entomology & Zoology, 10 (2): 460-467]

ABSTRACT: The present paper deals with the study of subfamily Eulophinae of Maharashtra which includes 14 female species. Out of one *Elasmus flavescens* Verma & Hayat is new records from Maharashtra. A key to Maharashtra species is also given.

KEY WORDS: New record, Parasitic wasps, Chalcidoidea, Eulophidae, Elasmmini, Maharashtra.

Indian genus *Elasmus* Westwood was reviewed by Verma et al. (2002) and Narendran et al. (2008). The genus *Elasmus* contains 54 species from India; out of which 14 species are represented from the state of Maharashtra. In the present paper one species *Elasmus flavescens* Verma & Hayat, is recorded for the first time from Maharashtra. Besides, new records, diagnosis, hosts and distribution of all known species are provided. The key to species are adopted from Verma et al. (2002) and Narendran et al. (2008).

An asterisk (*) marked after the name of the species indicates that it is a new record from the state Maharashtra. The species studied are deposited in the National Zoological collections of Northern Regional Centre, Zoological Survey of India, Dehradun, India.

The following abbreviations are used: F1-F3 = first, second and third funicle segments; TI – TVII = gastral terga 1 to 7; F = female; M = male; BMNH = The Natural History Museum, London; QMB = Queensland Museum, Brisbane; USNM = The U. S. National Museum, Washington, D.C.

Genus *Elasmus* Westwood

Elasmus Westwood, 1833: 343 [Type species *Elasmus flabellatus* Fonscolombe, by monotypy]

Aneure Nees, 1834: 194 [Type species *Aneure nuda* Nees, designated by Gahan & Fagan, 1923: 12.

Synonymy by Westwood, 1839: 74]

Heptocondyla Rondani, 1877: 182 [Type species *Heptocondyla unicolor* Rondani, by monotypy.

Synonymy by Bouček, 1974: 252, 279]

Cyclopleura Cameron, 1913: 96 [Type species *Cyclopleura fumipennis* Cameron (*Elasmus cameroni* Verma & Hayat as replacement name), designated by Gahan & Fagan, 1923: 41. Synonymy by Waterston, in Mahdihasan, 1925]

Austelasmus Riek, 1967: 148 [Type species *Elasmus trifasciiventris* Girault, by original designation. Synonymy by Burks, in Krombein et al., 1979: 1020]

Diagnosis:

Female. The *Elasmus* are easily recognized by the enlarged body, yellowish, and brown to black in colour, with metallic luster. Antenna with funicle 3-segmented and a conspicuous anellus, scutellum with a triangular apical projection, notaular

lines incomplete, fore wings elongate and narrow, densely covered with setae, with a very long marginal vein, hind coxae compressed and disc like; hind tibiae with diamond-shaped or wavy lines patterns of setae, tarsi four-segmented.

Male. Similar to female except antennal formula (1143) with F1 to F3 each with a dorsal ramus.

Biology. *Elasmus* are mainly primary parasitoids of the larvae of Lepidoptera or hyperparasitoids on them through various Hymenoptera, in particular the Ichneumonidae and Braconidae. Some species develop regularly both as primary and hyperparasitoids. They are usually gregarious. In India, *Elasmus nephandidis* on coconut black headed caterpillar and *Elasmus zehntneri* on sugarcane top borer are commonly collected.

Distribution. *Elasmus* have been distributed all over major zoogeographical regions but they are not particularly abundant.

Statistics. Number of world genera one and species nearly 226 (from Indian region 54, Nearctic 16, Neotropical 20).

Key to Maharashtra species of *Elasmus* (Female)

(Adopted from Verma et al., 2002 and Narendran et al., 2008)

1. Mesothoracic dorsum (also prothorax and propodeum) dark brown to black; occasionally mesoscutum with a whitish or yellowish spot on each side near tegulae and or scutellum with a longitudinal yellowish band on each side or with a transverse yellowish band at apex.....2
- Mesothoracic dorsum not completely dark.....10
2. Hind coxa completely dark brown to black, at most with extreme apex yellowish (Mid coxa largely dark brown to black).....3
- Hind coxa yellow at least apical third.....8
3. F1 slightly shorter than pedicel and at most slightly longer than broad, F2 and F3 broader than long; body blackish; gaster completely black or apices of TI and TII and occasionally also TIII, and basal four sternites, honey yellow.....*brevicornis* Gahan
- F1-3 usually elongate, F1 almost sub-equal in length to pedicel; F3 at most quadrate, usually larger than broad, if pedicel longer than F1 then F2 and F3 quadrate, usually clearly longer than broad.....4
4. Gaster entirely dark brown to black, at most ventre yellowish.....5
- Gaster with apical half of TI and basal half or so of TII yellowish; pedicel shorter than F1; F1-3 each slightly more than 2.5X as long as broad.....*indicus* Rohwer
5. Mesoscutum with yellowish spot on each side near tegulae; pedicel 1.5X as long as broad; scape about 4X as long as broad; fore femur brownish in basal half and yellowish in apical half.....*anticles* Walker
- Mesoscutum without such spot; scutellum completely dark.....6
6. Hind tibia (also mid tibia) yellow to pale yellow.....7
- Hind tibia (also mid tibia) brownish, at most with both ends pale; Pedicel shorter than F1; F1-3 relatively longer; F3 1.5X as long as broad; forewing 3.5 X as long as broad.....*johnstoni* Ferriere
7. F1-3 subequal in length, each about 1.5X as long as broad; clava longer shorter than preceding two funicle segments combined.....*krishnagiriensis* Mani & Saraswat

- Funicle segments shorter, F3 slightly longer than broad; clava longer than preceding two funicle segments combined.....**mahabali Mani & Saraswat**

8. Mesoscutum with a yellowish spot on each side near tegulae.....

.....**punctulatus Verma & Hayat**

- Mesoscutum completely dark, without such yellow spots.....9

9. Gaster with narrow, dusky yellow stripes at apices of TI-TIV; pedicel only slightly shorter than F1 which is at most 2.5X as long as broad; forewing hyaline; Hind femur yellowish with blackish margins; mid coxa and femur largely yellow.....

.....**viridiscutellatus Verma & Hayat**

- Gaster reddish, orange, or honey yellow, at most with dark spots or bands, but apical two terga more or less completely dark; pedicel about 2X as long as broad and only slightly shorter than F1; F1 about 2.5X as long as broad; gaster with T1 about 3X as long as TII; head entirely blackish.....**zehntneri Ferriere**

10. Either mesoscutum (save axillae) or scutellum not entirely yellow; mesoscutum yellowish-brown with a black transverse band posteriorly; F1-3 each about 3X as long as broad, and each about 1.5X as long as pedicel; gaster yellowish-brown with base of T1 and apical fourth, blackish.....**khandalus Mani & Saraswat**

- Mesoscutum (save axillae) and scutellum entirely yellow.....11

11. Mid coxa more or less blackish in basal half.....**punensis Mani & Saraswat**

- Mid coxa wholly or almost wholly yellow.....12

12. Gaster, except for the blackish band in basal half of T1, orange yellow to honey- yellow.....

.....**queenslandicus Girault**

- Gaster, apart from basal half of TI, with some terga with blackish spots or bands.....13

13. Gaster with TVI largely blackish, TVII yellow; scape 3.5X as long as broad; ovipositor with exerted part about 1/9th of gaster.....**flavescens Verma & Hayat**

- Gaster with TIV-VII blackish; scape 4.5X as long as broad; ovipositor with exerted part 1/12th of gaster.....**cavicolous Verma & Hayat**

***Elasmus brevicornis* Gahan**

Elasmus brevicornis Gahan, 1922: 50, M, F. Type F: Indonesia: Java, Buitenzora (USNM).

Diagnosis: Body dark brown to black; head, pronotum and mesoscutum with bluish shine; tegula brownish, yellowish at base, gaster blackish with the venter except at apex, apices of TI and TII somewhat honey yellow; antennal radicle and scape pallid, flagellum yellowish brown; wings hyaline. Legs: coxae dark brown except yellowish at apex of fore coxa; fore femur with brownish infuscation at base; middle and hind femora dark brown, yellowish at base and tip; all trochanters, tibiae and tarsal segments yellowish.

Hosts: *Biloba subsecivela*; *Cnaphalocrocis medinalis*; *Diaphania indica*; *Hapalia machaeralis* on *Tectona grandis*; *Lamprosema indicata*; *Lygropia quarternalis* defoliating *Helictares isora*; *Marasma suspicalis*; *Nausinoe geometralis*. Braconid, *Apanteles machaeralis*.

Distribution: India: Andhra Pradesh, Kerala, Punjab, Chhattisgarh, Uttar Pradesh, Delhi, Goa, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttarakhand, West Bengal.

Specimen examined: 2 females, INDIA: Maharashtra, Ratnagiri, Chiplun, Kapsar, 17.iii.2009 (S. I. Kazmi), Regd. No.A-11407, A 11410; 1 female, INDIA, Maharashtra, Satara, Soangaon, 8.iii.2009 (S. I. Kazmi), Regd. No. A-11409.

***Elasmus johnstoni* Ferriere**

Elasmus johnstoni Ferriere, 1929: 258, F, M. Type F: Sudan, Wad Medani (BMNH).

Elasmus valparaicus Mani & Saraswat, 1972: 481, F.: India (USNM). Synonymy by Narendran et al., 2008: 12.

Diagnosis: Body dark brownish with bluish green shine on propodeum and base of TI of gaster; tegulae brownish; antennal radicle and scape dusky; flagellum brownish; wings hyaline; legs concolourous with body, except sometimes trochanters, base and apex of all femora, base and extreme apex of hind tibia and tibial spurs yellowish.

Hosts: *Earias insulana*; *E. cupreoviridis*; *E. fabia*; *Hapalia machaeralis*; *Hyblaea pueria*; *Nephanteryx rhodobasalis*; *Pectinophora gossypiella*; *Sylepta derogate*; Braconidae: *Apanteles impartunus*; *A. machaeralis*; *A. malevolus*.

Distribution: India: Haryana, Jharkhand, Maharashtra, Rajasthan, Uttarakhand, Uttar Pradesh, Madhya Pradesh, Tamil Nadu, Chhattisgarh, West Bengal.

Specimen examined: None. Specimen examined is based on Verma et al., 2002.

***Elasmus viridiscutellatus* Verma & Hayat**

Elasmus viridiscutellatus Verma & Hayat, 2002: 270-271, F. Type F: India: Maharashtra, Elephanta, caves off Mumbai (BMNH).

Diagnosis: Body blackish with greenish blue shine on frontovertex, pronotum and mesoscutum, more intense on scutellum, propodeum less bluish; tegulae dark, appear metallic; posterior extension of metanotum hyaline except at base yellowish; gaster blackish dorsally with bluish green shine at base of TI; apex of TI-IV with transverse dusky yellow strips; antennal pedicel yellow, dorsal margin slightly brownish; flagellum dark brown covered with short black setae; wings hyaline; legs yellowish except extreme base of fore coxa, sides of middle coxa at base, dorsal and ventral margin in middle of middle femur, brownish; slightly less than basal half of hind coxa blackish with bluish shine, dorsal margin of hind femur and a spot on ventral margin, brownish.

Hosts: *Cnephalocrosis medinalis*, larvae.

Distribution: India: Andhra Pradesh, Bihar, Maharashtra, Tamil Nadu, West Bengal.

Specimen examined: None. Specimen examined is based on Verma et al., 2002.

***Elasmus zehntneri* Ferriere**

Elasmus sp. Zehntner, 1900: 1 (by Ferriere, 1929).

Elasmus zehntneri Ferriere, 1929: 417, F, M. Type F: Indonesia, West Java (BMNH).

Elasmus mahabaleswarensis Mani & Saraswat, 1972: 475-476, F: India (USNM). Synonymy by Narendran et al., 2008: 13.

Diagnosis: Head and thorax blackish with bluish green shine on frontovertex, pronotum and mesoscutum; less bluish on scutellum; gaster honey yellow with brownish spots as follows: faint brownish spots at base of TI; bases of TII-V slightly extending on lateral side with triangular brownish spots; TVI to apex completely dark brown to blackish; antennal radicle dusky; scape yellowish, dorsal margin slightly brownish; flagellum brownish; wings hyaline; legs yellowish; basal third of hind coxa metallic black, basal third or so of middle femur broadly brownish; tibia and tarsal segments of all legs yellowish.

Hosts: *Bissetia steniella*; *Chilo infuscatellus*; *Pectinophora gossypiella*; *Scirpophaga* sp. *S. auriflua*; *Tryporyza monostigma*; *T. novella*; *T. rhodoproctalis*.

Distribution: India: Andhra Pradesh, Bihar, Delhi, Karnataka, Maharashtra, Tamil Nadu, Punjab, Kerala, West Bengal.

Specimen examined: None. Specimen examined is based on Verma et al., 2002.

***Elasmus khandalus* Mani & Saraswat**

Elasmus khandalus Mani & Saraswat, 1972: 471-472, F. Holotype F: India, Khandala (USNM).

Diagnosis: Yellowish brown; legs including coxae light brown; mesoscutum with a transverse black band posteriorly; hind coxa narrowly above, TI baso-dorsal part and last 1/4th of gaster black.

Host: Unknown.

Distribution: India: Kerala, Maharashtra, West Bengal.

Specimen examined: None. Specimen examined is based on Kazmi & Girish Kumar, 2013.

***Elasmus punensis* Mani & Saraswat**

Elasmus punensis Mani & Saraswat, 1972: 479, F. Holotype F: India, Pune, Khandakwasla Sinhagarh Fort (USNM).

Diagnosis: Body yellowish brown; flagellum dark brown; head with ocellar triangle, a conspicuous narrow transverse band on posterior margin of mesoscutum, propodeum, basal third of mid coxa, a narrow patch above near base on hind coxa, a spot on base of first abdominal tergite, ovipositor sheath brownish black; fore wing sub hyaline; head with fine setigerous punctures; antennal scape about 5X as long as broad; all funicle segments longer than broad; scape about 2X as long as pedicel; propodeum without transverse carina and smooth shiny; gaster short, conical; ovipositor slightly exerted.

Host: Unknown.

Distribution: India: Karnataka, Kerala, Andhra Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh.

Specimen examined: None. Specimen examined is based on Verma et al., 2002.

***Elasmus queenslandicus* Girault**

Elasmus queenslandicus Girault, 1913: 82, F. Holotype F: Australia, Queensland, Kuranda (QMB). Synonyms given in Riek 1967: 159.

Diagnosis: Body orange yellow except a spot above foramen continued on to frontovertex surrounding ocelli and extending on front of anterior ocellus; a large convex spot on basal half of pronotum with slight greenish shine; axillae blackish; tegulae dark violet; a spot on side of metanotum; propodeum dark brown in middle and light brown infusate area surrounding spiracle; a blackish band with greenish shine in basal half of TI of gaster, in some specimens a brown small spot in middle of TIV; antennal radicle yellow; scape slightly dusky; flagellum brown with some orange tinge; fore wing hyaline; legs yellowish except dorsal margin of hind coxae in distal half or so, dorsal margin of middle femur narrowly; most of dorsal margin of hind femur, tarsal segments of all legs brownish.

Host: Unknown.

Distribution: India: Karnataka, Kerala, Tamil Nadu, Odisha, Uttar Pradesh, Uttarakhand, Jharkhand, Delhi, Chhattisgarh, West Bengal.

Specimen examined: None. Specimen examined is based on Kazmi & Girish Kumar, 2013.

***Elasmus indicus* Rohwer**

Elasmus indicus Rohwer, 1921: 123-124, F. M. Holotyp F, India, Coimbatore (USNM).

Diagnosis: Head and thorax blackish; posterior extension of metanotum hyaline; gaster dark brown, apical half of TI, basal half or more of TII slightly extending on sides, reddish yellow; legs dark brown except fore leg beyond basal half of coxa, basal third or so of fore femur, distal fourth or so of middle femur, tibiae, tarsi and tibial spurs of all legs yellow.

Hosts: *Anomalococcus* sp.; *A. indicus*; coccids on *Acacia* sp. *Diaphania* (*Margaronia*) *indica*; *Lamprosema indicate*; *Eublemma* sp. predaceous on *A. indicus*; probably parasitic on larvae of *Eublemma* sp.; *Sylepta derogate*.

Distribution: India: Karnataka, Tamil Nadu, Uttarakhand, Maharashtra.

Specimen examined: 1 female, INDIA: Maharashtra, Sindhudurg, Kudal, 13.iii, 2009 (S. I. Kazmi), Regd No. A-11412.

Elasmus anticles Walker

Elasmus anticles Walker, 1846: 181, F. Type F, India, Mumbai (=Bombay) (BMNH).

Elasmus albomaculatus Gahan, 1920: 347, F. Holotype F, Philippines, Manila, Luzon (USNM). Synonymy by Kerrich, 1970: 89-91.

Elasmus ricinus Husain & Kudeshia, 1984: 363-365, F, India, Aligarh (Type lost?).

Synonymy by Narendran et al., 2008: 15.

Diagnosis: Black with green refringence on head, thorax dorsum and on sides of basal TI (in some specimens body dark brown); tegulae dark brown; mesoscutum with a yellow or pale yellow or whitish yellow spot on each side near tegulae; scutellum black with slightly metallic refringence; metanotum yellow at base of posterior hyaline extended part; legs black or dark brown with trochanters, apical half of fore femur, apices and middle of hind femur and tibiae of all legs pale yellow; gaster slightly longer than head and thorax combined.

Hosts: *Apanteles malevolus* Rolston through *Hyblaea puera* Cramer, *Bracon* sp. and *Cheionus* sp. through *Epicephala pulcherrima* (Linn.) in Philippines. *Inglisia bivalvata* Green (Coccidae) on Sandalwood.

Distribution: India: Karnataka, Kerala, Tamil Nadu, Uttar Pradesh, Uttarakhand, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra.

Specimen examined: 1 female, INDIA: Maharashtra, Alibag, Naogaon Forest, 19.iii, 2009 (S. I. Kazmi), Regd No A-11405 ; 1 female, INDIA: Maharashtra, Ahmadnagar, Vilad Ghat, 6.iii, 2009 (S. I. Kazmi), Regd No A-11406.

Elasmus krishnagiriensis Mani & Saraswat

Elasmus krishnagiriensis Mani & Saraswat, 1972: F. Holotype F, 474-475, India, Mumbai (=Bombay), Krishnagiri (USNM).

Diagnosis: Black with metallic green refringence; head metallic green; fore leg pale yellow except black basal part of fore coxa, obscure basal part of femur; middle coxa black with apex pale yellow; middle femur black or dark brown with apex pale yellow; hind femur black with base and apex pale yellow; gaster mostly black with ventral part mostly yellowish brown; fore wing with an obscure and faint infuscation behind stigmal vein.

Hosts: Unknown.

Distribution: India: Kerala, Maharashtra.

Specimen examined: None. The above account is based on the original description of Mani & Saraswat 1972.

Elasmus mahabalii Mani & Saraswat

Elasmus mahabalii Mani & Saraswat, 1972: F., M. Holotype F, 477. India, Mahabalipuram (USNM).

Diagnosis: Black with metallic blue refringence; basal half of fore coxa, basal half of fore femur, whole of middle and hind coxae and femora black, rest of legs

pale brown; gaster dorsally and apically brownish black to black; posterior borders of tergites and venter brown.

Hosts: Unknown.

Distribution: India: Kerala, Karnataka, Tamil Nadu, Maharashtra.

Specimen examined: None. The above account is based on the original description of Mani & Saraswat 1972.

***Elasmus punctulatus* Verma & Hayat**

Elasmus punctulatus Verma & Hayat, 2002: 267-268, F. Type F: India: Tamil Nadu (BMNH).

Diagnosis: Body blackish with bluish refringence; tegulae brownish with base yellowish; mesoscutum with two yellow spots, one on each side near tegulae; posterior extension of metanotum hyaline with base dark brown; gaster dark brown or black dorsally, with bluish refringence on sides of T₁, yellowish brown laterally and ventrally, brownish stripes at apex of T₁, T_{III}, T_{IV} and T_V, faintly on T_{II}; legs yellowish, with brownish as follows: basal half or so of fore coxa, basal 2/3 or so of hind coxa, and base of mid coxa, dorsal and ventral margins at base of fore femur, tip of middle and basal half of hind femora.

Hosts: Unknown.

Distribution: India: Kerala, Karnataka, Tamil Nadu, Maharashtra.

Specimen examined: None. Specimen examined is based on Verma et al., 2002.

Elasmus flavescens* Verma & Hayat

Elasmus flavescens Verma & Hayat, 2002: 284-285, F. Type F: India: Karnataka (BMNH).

Diagnosis: Body yellow to honey yellow, following parts brown to blackish: a large area above foramen continued on to frontovertex surrounding ocelli and extending in front of anterior ocellus; head behind up to middle with a large area between eyes except on sides above; pronotum largely brownish, on sides and narrowly at apex, yellowish; mesoscutum with a faint brownish middle area extending from base up to middle and a blackish spot on sides below notauli; axillae and tegulae brownish; metanotum dark brown or black; propodeum with metallic blue refringence; gaster yellow with following parts as follows: basal half of T_I black with metallic bluish refringence, dark brown median patch or spot on T_{III} to T_V; T_{VI} black except basal part; legs yellow with a dark brown or black spot at base of hind coxa.

Hosts: Unknown.

Distribution: India: Kerala, Karnataka, Maharashtra.

Specimen examined: 1 female, INDIA: Maharashtra, Ratnagiri, Chiplun, Kapsar, 17.iii.2009 (S. I. Kazmi) Regd. No. A-11408.

***Elasmus cavicolous* Verma & Hayat**

Elasmus cavicolous Verma & Hayat, 2002: 285-286, F. Type F: India: Maharashtra (BMNH).

Diagnosis: Body yellowish with following parts as follows: a black spot on head below, between eyes; axillae and tegulae dark brown; gaster honey yellow with T_{VI} and T_{VII} black; fore wing faintly infuscated; hind wing hyaline; legs mostly yellowish, with dorsal margin of hind femur narrowly brown.

Hosts: Unknown.

Distribution: India: Maharashtra.

Specimen examined: 1 female, INDIA: Maharashtra, Sindhudurg, Kudal, 13.iii.2009 (S. I. Kazmi) Regd. No. A-11411.

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LITERATURE CITED

- Ferriere, C.** 1929. The Asiatic and African species of *Elasmus* Westwood (Hymenoptera: Chalcidoidea). Bull. Ent. Res., 20: 411-423.
- Gauthier, N., La Salle, J., Quicke, D. L. J. & Godfray, H. C. J.** 2000. Phylogeny of Eulophidae (Hymenoptera: Chalcidoidea), with a reclassification of Eulophinae and the recognition that Elasmidae are derived eulophids. Syst. Ent., 25: 521-539.
- Kazmi, S. I. & Girish Kumar, P.** 2013. The species of *Elasmus* Westwood (Hymenoptera: Eulophidae: Eulophinae) from West Bengal, India, Prommalia, 1: 79-92.
- Kazmi, S. I., Sheela, S. & Girish Kumar, P.** 2008. The Species of *Elasmus* Westwood (Hymenoptera: Eulophidae: Eulophinae) from Uttar Pradesh, India. Columban J. Life Sci., 9 (1&2): 124-129.
- Khan, F. R. & Hayat, M.** 2011. Record of some species of *Elasmus* from India (Hymenoptera: Chalcidoidea: Eulophidae). Bionotes, 13 (1): 7-10.
- Mani, M. S.** 1989. Fauna of India. Chalcidoidea Part II. Zoological Survey of India, Government of India. [Elasmidae: 1158-1205 pp].
- Mani, M. S. & Saraswat, G. G.** 1972. On some *Elasmus* (Hymenoptera: Chalcidoidea) from India. Oriental Ins., 6: 459-506.
- Narendran, T. C., Sheeba, M. & Kulkarni, H.** 2008. A review on the taxonomy of the Indian species of *Elasmus* Westwood (Hymenoptera: Chalcidoidea: Eulophidae: Eulophinae: Elasmmini). Biospectra, 3 (1): 1-25.
- Riek, E. F.** 1967. Australian Hymenoptera Chalcidoidea, family Eulophidae, subfamily Elasmidae. Aust. J. Zool., 15 : 146-199.
- Verma, M. & Hayat, M.** 1985. 'Family Elasmidae': pp. 233-234. In B. R. Subba Rao & M. Hayat (eds): The Chalcidoidea (Insecta: Hymenoptera) of India and the adjacent countries. Part I. Oriental Ins., 19: 163-310.
- Verma, M. & Hayat, M.** 1986. 'Family Elasmidae': pp. 173-178. In B. R. Subba Rao & M. Hayat (eds): The Chalcidoidea (Insecta: Hymenoptera) of India and the adjacent countries. Part II. Oriental Ins., 20: 1-430.
- Verma, M., Hayat, M. & Kazmi, S. I.** 2002. The species of *Elasmus* from India (Hymenoptera: Chalcidoidea: Eulophidae). Oriental Ins., 36: 245-306.

FIRST RECORD OF GENUS *LASIOBELBA* AOKI, 1959 (ACARI: ORIBATIDA) FROM TURKEY

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[Yaşa, M., Ayyıldız, N. & Baran, Ş. 2015. First record of genus *Lasiobelba* Aoki, 1959 (Acari: Oribatida) from Turkey. *Munis Entomology & Zoology*, 10 (2): 468-473]

ABSTRACT: In this study the genus *Lasiobelba* is firstly recorded from Turkey with the species *Lasiobelba* (*L.*) *kuehnelti* (Csiszár, 1961). Redescription and SEM images have been given on the basis of specimens collected from Sakarya province.

KEY WORDS: Acari, Oribatida, *Lasiobelba*, new record.

The subfamily Oppiinae Sellnick, 1937 has 23 genera and 161 species (Subías, 2015) all over the world. To date, only one genus and one species *Oppia nitens* Koch, 1836 have been assigned to the subfamily Oppiinae from Turkey (Özkan et al., 1988, 1994; Baran & Ayyıldız, 2004; Erman et al., 2007). The genus *Lasiobelba* in the subfamily Oppiinae is newly recorded from Turkey.

The genus *Lasiobelba* has two subgenera and thirty one species (Subías, 2015). To date there were 17 known species of the subgenus *Lasiobelba* (*Lasiobelba*) Aoki, 1959 worldwide and no record for the Turkish fauna. *Lasiobelba* is characterized by large size (more than 400 µm), absence of lamellar line or costula, laceolate or setiform sensillus.

MATERIAL AND METHODS

Mites were extracted by a Tullgren funnel apparatus from the soil and litter samples collected from Sakarya province between October 2009 and February 2011. They were fixed and stored in 70% ethanol. Mites were sorted from the samples under a stereomicroscope (Olympus SZX51) and mounted on slides in modified Hoyer's medium (30 g gum Arabic, 50 ml distilled water, 200 gr chloral hydrate, 16 ml glycerol) or 35% lactic acid for microscopic observation. The scanning electron microscopic (SEM) images were taken by JEOL JSM 6060 LV. Drawings were made with the aid of a camera lucida attached to a compound microscope (Leica DM1000LED). All measurements are given in micrometers (µm).

The terminology used in this paper follows Balogh (1983) and Subías & Balogh (1989). Examined materials are deposited in the Acarological Collection of the last author, Sakarya University, Sakarya, Turkey.

RESULTS

Lasiobelba (*Lasiobelba*) *kuehnelti* (Csiszár, 1961)

Synonyms. *Oppia yodai* Aoki, 1965; *Oppia yodai africana* Kok, 1967; *Cilioppia pori* Vasiliu e Ivan, 1995, *Lasiobelba arabica* Mahunka, 2000, *Lasiobelba neonominata* Subías, 2004.

Material examined: Sakarya: Adapazarı, 1605 m, 8.VII.2013, 3♀♀, in soil with *Quercus* sp. litter, and 8.VII.2014, 1♀, in soil from hazelnut grove.

Measurements and color: body in 535 (520-549) µm in length and 265 (263-267) µm in width (n=4). Color light brown.

Prodorsum (Figs. 1 & 2): Elongated, representing approximately 37 % of total body length. Rostrum conical, rostral setae (*ro*) about 30 µm. Average length of lamellar setae (*le*) 73 µm, interlamellar setae (*in*) 78 and exobothridial setae, 55 µm. Setae *le* closer to setae *ro* than the setae *in*. Sensillus 84 µm in length and slightly fusiform, apically pointed and finely ciliated (Fig. 2). Ratio of prodorsal setae as setae *ss* > *in* > *le* > *ex* > *ro*. Three pairs of sigilla between interlamellar setae.

Notogaster (Figs. 1 & 3): oval, anterior border of notogaster convex. Ten pairs of heterotrichous setae present. Setae *c*₂ very fine and hardly visible, rest of nine notogastral setae long, baciliform and ciliated (Fig. 3). Setae *p*₁ and *p*₃ shorter than the others.

Ventral region (Figs. 4-7): Epimeral regions separated medially. Apodema II hardly visible, rest of the apodems (apodema sejugal and apodema IV) well developed. Epimera III+IV elongated, discidium small. Epimeral setae finely ciliated and epimeral setal formula 3:1:3:3. Genital plate 61 µm in length and 46 µm in width. Anal plate 103 µm in length and 93 µm in width. 5 pairs of genital, 1 pair of aggenital, 2 pairs of anal and 3 pairs of adanal setae present. Genital setae minute (11 µm), aggenital adanal and anal ones longer and (26, 22 and 20 µm respectively). Anal, aggenital and genital setae rarely ciliated, adanal ones densely ciliated.

Legs: All legs monodactylous.

DISCUSSION

Hitherto only one genus and species belonging to subfamily Oppiinae *Oppia nitens* was known from Turkey. The genus *Oppia* Koch, 1836 and *Lasiobelba* Aoki, 1959 differentiated from each other by the shape of sensillus. In the genus *Oppia* sensillus fusiform or spindle-lanceolate and dilated less than its distal half on the other hand sensillus lanceolate or lanceolate-setiform and dilated at least in its distal half (Subías & Arillo 2001).

Lasiobelba arabica Mahunka, 2000, *Lasiobelba neonominata* Subías, 2004, *Cilioppia pori* Vasiliu & Ivan, 1995, *Oppia yodai* Aoki, 1965 and *Oppia yodai africana* Kok, 1967 are given as the synonyms of *Lasiobelba* (*L.*) *kuehnelti* (Csizsár, 1961) by Subías (2015).

Body dimensions of this species have been determined by other authors as follows size of this species previously given as 414-619 / 228-338 µm (Mahunka, 2000; Subías & Arillo, 1997; Vasiliu & Ivan, 1995; Kok, 1967; Csizsár, 1961). In our specimens body dimensions 535 (520-549) µm in length and 265 (263-267) µm. According to the above data, our measurements are found in the known range of the body dimensions. Our specimens only differs from previously described ones by sharp pointed rostrum (Fig. 7).

ACKNOWLEDGEMENTS

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LITERATURE CITED

- Balogh, J.** 1983. A partial revision of the Oppiidae Grandjean, 1954 (Acari: Oribatei). Acta Zoologica Academiae Scientiarum Hungaricae, 29: 1-79.
- Baran, S. & Ayyıldız, N.** 2004. *Oppia nitens* C.L. Koch, 1836, a New Species for the Turkish Fauna (Acari, Oribatida, Oppiidae). Turkish Journal of Zoology, 28 (2004): 111-113.
- Erman, O., Özkan, M., Ayyıldız, N. & Doğan, S.** 2007. Checklist of the mites (Arachnida: Acari) of Turkey, Second Supplement. Zootaxa, 1532: 1-21.
- Özkan, M., Ayyıldız, N. & Soysal, Z.** 1988. Türkiye Akar Faunası. Doğa-Türk Zooloji Dergisi, 12 (1): 75-85.
- Özkan, M., Ayyıldız, N. & Erman, O.** 1994. Check list of the Acari of Turkey, First Supplement. EURAAC News Letter, 7 (1): 4-12.
- Subías, L. S.** 2015. Listado sistemático, sinónimo y biogeográfico de los ácaros oribátidos (Acariformes: Oribatida) del mundo. Available from: http://escalera.bio.ucm.es/usuarios/bba/cont/docs/RO_1.pdf (15 March 2015).
- Subías, L. S. & Arillo, A.** 1997. Datos sobre la subfamilia Oppiinae en el sur de España. Primera cita del género *Lasiobelba* en la Península Ibérica (Acari, Oribatida: Oppiidae). Boln. Asoc. esp. Ent., 21 (1-2): 89-96.
- Subías, L. S. & Arillo, A.** 2001. Fauna Iberica 15: Acari Oribatei, Gymnionota II., Museo Nacional de Ciencias Naturales, CSIC, Madrid, p. 289.
- Subías, L. S. & Balogh, P.** 1989. Identification keys to the genera of Oppiidae Grandjean, 1951 (Acari: Oribatei). Acta Zoologica Academiae Scientiarum Hungaricae, 35: 355-412.

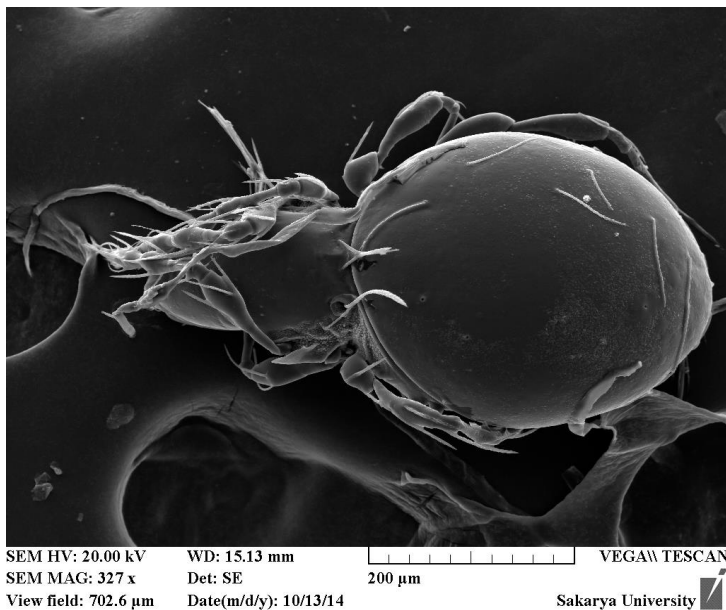


Figure 1. *Lasiobelba (L.) kuehnelti* dorsal view of adult Scanning electron microscopy image.

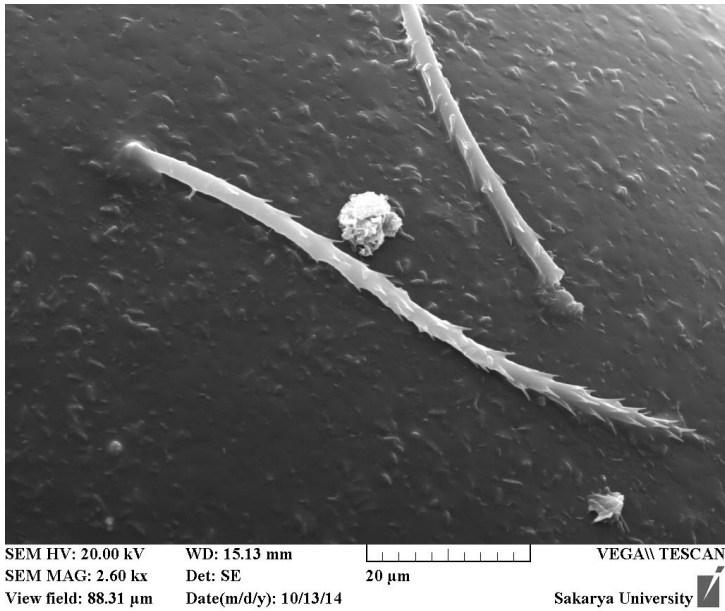


Figure 2. *Lasiobelba (L.) kuehnelti* prodorsum, Scanning electron microscopy image.

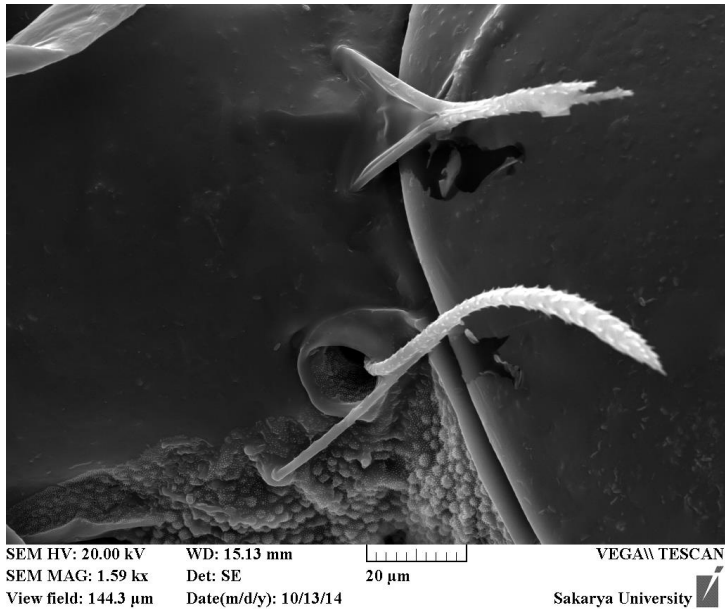


Figure 3. *Lasiobelba (L.) kuehnelti* notogastral setae, Scanning electron microscopy image.

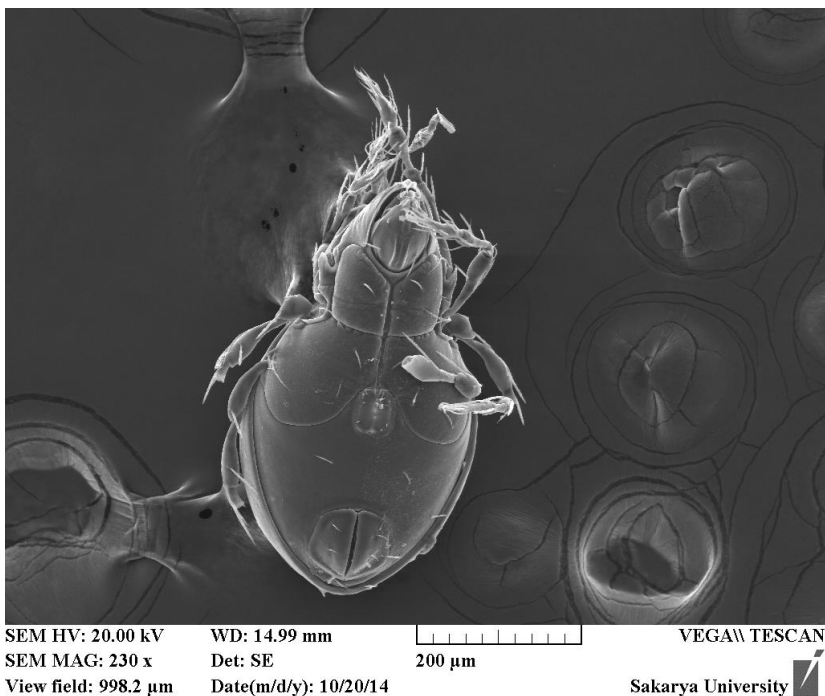


Figure 4. *Lasiobelba (L.) kuehnelti* ventral region, Scanning electron microscopy image.

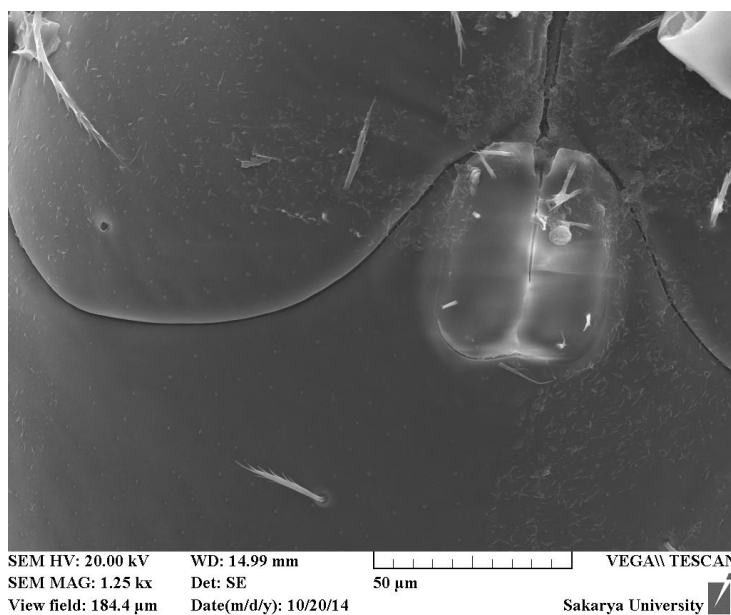


Figure 5. *Lasiobelba (L.) kuehnelti* genital plate, Scanning electron microscopy image.

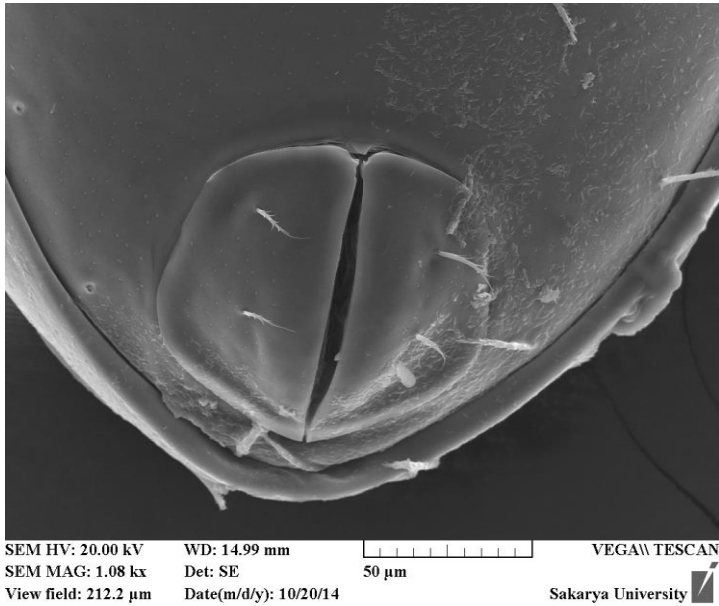


Figure 6. *Lasiobelba (L.) kuehnelti* anal plate, Scanning electron microscopy image.

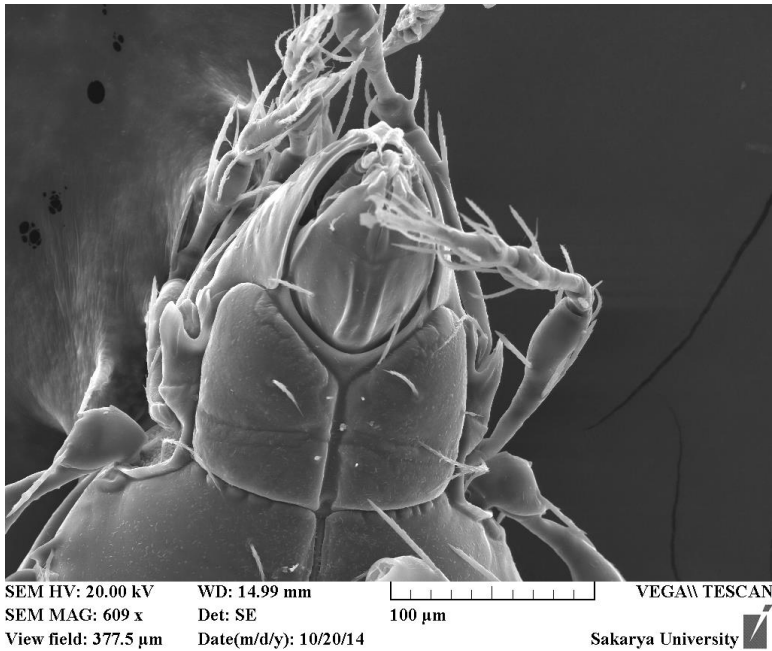


Figure 7. *Lasiobelba (L.) kuehnelti* epimeral region and ventral view of rostrum, Scanning electron microscopy image.

DIVERSITY OF PYRRHOCOROIDEA (HEMIPTERA: HETEROPTERA) OF MADHYA PRADESH, INDIA

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[Chandra, K. & Kushwaha, S. 2015. Diversity of Pyrrhocoroidea (Hemiptera: Heteroptera) of Madhya Pradesh, India. Munis Entomology & Zoology, 10 (2): 474-477]

ABSTRACT: The present paper deals with the study of 11 species pertaining to two families Largidae and Pyrrhocoridae of the superfamily Pyrrhocoroidea from Madhya Pradesh. Of these, two species of the family Largidae and three species of the family Pyrrhocoridae are new addition to the fauna of the state.

KEY WORDS: Pyrrhocoroidea, Largidae, Pyrrhocoridae, Madhya Pradesh, New records.

Pyrrhocoridae is one of the smaller families of the order Hemiptera having around 446 species under 46 genera throughout the world (Henry, 2009) and nearly 45 species under 15 genera from India (Saha & Bal, 2010). They are red coloured and are known as red bugs and some species of the genus *Dysdercus* are also called as cotton strainers. The family is characterized by the large robust body with brighter in colour, corium broader without appendix, membrane generally with minimum four and maximum five veins. Most of the members of this family are phytophagous.

Southwood (1956) studied the eggs of the Heteroptera and suggested that the families Largidae and Pyrrhocoridae together formed a separate superfamily Pyrrhocoroidea with two families *i.e.* Largidae and Pyrrhocoridae. Largidae can be distinguished from Pyrrhocoridae by the pronotum laterally reflexed and the abdominal sternum seven of female split medially, whereas pronotum is laterally reflexed and the abdominal sternum seven entire in female in case of Pyrrhocoridae. Previously Chandra (2008, 2009), Chandra and Kushwaha (2013) and Chandra et al. (2010, 2012) reported 6 species from Madhya Pradesh.

Altogether 11 species of the superfamily Pyrrhocoroidea belonging to two families viz. Largidae (5 species) and Pyrrhocoridae (6 species) are reported from Madhya Pradesh. Of these, two species of the family Largidae and three species of the family Pyrrhocoridae are new record to the fauna of the state.

MATERIAL AND METHODS

The specimens of the superfamily Pyrrhocoroidea are collected either by sweeping or light trap methods from various districts and protected areas of Madhya Pradesh. Collected specimens are killed by using of benzene in killing jars and after that those insects are set and pinned and preserved in the laboratory. The pinned and labelled specimens are identified with the help of various literatures as well as Distant (1902). Photography and morphology of bug was studied by Leica microscope M 205-A (Plate- 1).

Abbreviations used: PBR- Pachmarhi Biosphere Reserve; SWLS- Singhori Wildlife Sanctuary; VDWS- Veerangana Durgavati Wildlife Sanctuary; PTR-

Pench Tiger Reserve; RH- Rest House; ZSI-Zoological Survey of India; * -New record to state.

RESULTS

Altogether 11 species were identified belonging to two families of superfamily Pyrrhocoroidea from Madhya Pradesh are reported from Madhya Pradesh. Of these, 2 species of family Largidae and 3 species of family Pyrrhocoridae are new addition to state fauna.

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LITERATURE CITED

- Chandra, K.** 2008. Insecta: Hemiptera, Faunal Diversity of Jabalpur District, M. P. Conservation Area Series, (Published by Zoological Survey of India, Kolkata). Pp. 141-157.
- Chandra, K.** 2009. Insecta: Hemiptera. Fauna of Pachmarhi Biosphere Reserve, Conservation Area Series, (Published by Zoological Survey of India, Kolkata). 39: 247-257.
- Chandra, K. & Kushwaha, S.** 2013. Distribution and Diversity of Hemiptera Fauna of Singhori Wildlife Sanctuary, Raizen District, Madhya Pradesh, India. Munich Journal of Entomology, 8 (2): 677-681.
- Chandra, K., Kushwaha, S., Sambath, S. & Biswas, B.** 2012. Distribution and diversity of Hemiptera fauna of Veerangana Durgavati Wildlife Sanctuary, Damoh, Madhya Pradesh (India). Biological Forum-An International Journal, 4 (1): 68-74.
- Chandra, K., Sharma, R. M. & Ojha, P.** 2010. A Compendium on the faunal resources of Narmada river basin in Madhya Pradesh. Rec. zool. Surv. India, Occ. Paper No. 310, pp. 42-43.
- Distant, W. L.** 1902. The fauna of British India including Ceylon and Burma. Rhynchota. volume 2, Taylor and Francis, London. Pp. 1-97.
- Henry, T. J.** 2009. Biodiversity of Heteroptera in Insect Biodiversity edited by R. Foottit and P. Alder, Science and Society pub.: 223-268.
- Saha, P. C. & Bal, A.** 2010. Pyrrhocoroidea: Heteroptera. Fauna of Uttaranchal: State Fauna Series, 18 (2): 245-253.
- Southwood, T. R. E.** 1956. The structure of the eggs of the terrestrial Heteroptera and its relationship to the classification of the group. Transactions of the Royal Entomological Society of London, 108: 163-221.

Table 1. List of superfamily Pyrrhocoroidea studied from Madhya Pradesh.

S. N.	Suborder / Superfamily / Family / Species	No. of exs.	Collection localities (Area / WLS / National Park / Biosphere Reserve)	Districts	Date of Collection
Order : HEMIPTERA					
Suborder: HETEROPTERA					
Superfamily: PYRRHOCOROIDEA					
Family: LARGIDAE					
1	<i>Physopelta quadrigutta</i>	1	PBR	Hoshangabad	07.vi.2099
	(Bergr.,1894)	2	PBR	Hoshangabad	06.iv.2001
		5	ZSI Quarters Colony	Jabalpur	12.iv.2012
2	<i>Physopelta schlanbuschi</i> (Fabr.,1787)*	10	SWLS	Raisen	14.iv.2011
3	<i>Physopelta trimaculata</i> Stehlik, 2008	1	SWLS	Raisen	10.iv.2011
4	<i>Physopelta gutta</i> (Burmeister,1834)	1	VDWLS	Damoh	13.iii.2011
		2	SWLS	Raisen	10.iv.2011
		1	PBR	Hoshangabad	06.iv.2001
5	<i>Antilochus coqueberti</i> Fabr.,1803	8	SWLS	Raisen	01.iv.2011
		2	VDWLS	Damoh	23.vi.2009
		8	ZSI office	Jabalpur	14.ii.2010
		3	PBR	Hoshangabad	10.iv.2001
		10	RH Sarsala	Narsinghpur	08.iii.2014
Family: PYRRHOCORIDAE					
6	<i>Euscopus albatu</i> s Distant, 1909*	1	VDWLS	Damoh	11.iii.2011
			Vijay Nagar	Jabalpur	11.iv.2010
7	<i>Deltocephalus infirmus</i> Melichar, 1903	1	Chandia Village	Shahdol	03.xi.2007
8	<i>Dysdercus koenigii</i> (Fabr.,1775)	5	SWLS	Raisen	11.ii.2010
		2	VDWLS	Damoh	18.xi.2009
		1	PBR	Hoshangabad	25.x.2002
		3	Vijay Nagar	Jabalpur	15.ii.2012
		2	RH Sarsala	Narsinghpur	12.iii.2014
9	<i>Scantius pallens</i> (Distant, 1903)	1	Barha	Katni	08.vi.2009
10	<i>Scantius volucris</i> Gerstaecker, 1873*	1	Karmajhiri, PTR	Seoni	23.vi.2001
11	<i>Dermatinus lugubris</i> Distant,* 1903	1	SWLS	Raisen	21.ix.2011

Plate 1



Physopelta trimaculata Stehlik



Physopelta gutta (Burmeister)



Physopelta schlanbuschi (Fabr.)



Euscopus albus Distant



Antilochus coqueberti Fabricius



Dysdercus koenigii (Fabricius)

ANALYSIS OF PHENOTYPIC DIVERSITY AND PROTEIN POLYMORPHISM IN SOME SILKWORM BREEDS OF *BOMBYX MORI* L.

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[Moorthy, S. M. & Chandrakanth, N. 2015. Analysis of phenotypic diversity and protein polymorphism in some silkworm breeds of *Bombyx mori* L. Munis Entomology & Zoology, 10 (2): 478-485]

ABSTRACT: The assessment of genetic variation is a major aspect in silkworm improvement programmes. It distinguishes different genotypes for designing the breeding programmes and population-genetic analysis. It also estimates the amount of variation within genotypes and between genotypes for predicting potential genetic gain in a breeding programme. Variations in three qualitative traits and nine quantitative traits along with protein polymorphism were studied in ten silkworm genotypes. The results showed significant variation ($P < 0.05$) in the quantitative traits of silkworm genotypes studied. Cluster analysis based on phenotypic variation revealed three clusters separating high, moderate and low silk producers according to the silk producing ability of silkworms. The results of Principle Co-ordinate analysis was in agreement with the dendrogram. Protein profiling divided ten silkworm genotypes into two clusters. The dendrogram deduced from phenotypic data clearly indicates the dominant role of environment on quantitative traits. However, expression of quantitative traits depends on the genotypes and their place of origin. The phenotypic data depicted substantiate amount of diversity among the silkworm genotypes and hence, these breeds can be utilized for improving the silk yielding traits.

KEY WORDS: Genetic diversity, Quantitative traits, Qualitative traits, Protein polymorphism.

The Silkworm (*Bombyx mori*) is the most domesticated lepidoptera with economic significance, attributed to its silk secreting ability. In the long history of domestication, several thousand silkworm strains have been developed and maintained. Currently, more than 4000 strains are available in the germplasm of *B. mori* (Nagaraju, 2002; Kumaresan et al., 2007), which includes uni-, bi- and multi-voltine. Among them, some different genotypes are similar in morphological characters (e.g., larval markings, cocoon shape) although they were collected from different parts of the world revealing morphological divergence between them (Li et al., 2005).

Genetic variability is a prerequisite for an effective selection of any economically important organism and an essential factor in developing high yielding varieties (Akanda et al., 1998). Such genetic diversity studies involving similarities and differences of relationship and genotypes in various pure lines are involved in breeding programs for crossing and hybridization to maximize heterosis. Thus, there must be specified relationships between different pure lines (Nezhad et al., 2010). But the researchers emphasize that the high genetic variation might not give always a high genetic diversity in the inbreeding population, such as silkworm. This is further confirmed that the genetic diversity is not always related with geographical diversity (Rao & Nakada, 1998).

The proteins are the “working horses of the cell”, their expression and abundance leaves a footmark of their functional role in different developmental stages of an organism. The understanding of such variations at protein level not

only helps in the identification of genotypes in the germplasm but also unveil the loci governing the changed phenotype of the pure genotypes (Bakkappa & Subramanya, 2010). The protein polymorphism gives a clue on the heterotic expression for selected traits and can be used as an index in silkworm breeding (Telebi et al., 2011). Perusal of literature indicated haemolymph protein as one of the most extensively studied banding profiles and with wide overlapping substrate specificities and pattern of inhibition and protein polymorphism occurring in numerous forms, which are expressed by distinct gene loci having a high degree of genetic variability (Takasusuki et al., 2006). The importance of similar study relevant to animal and plant breeding (Frey et al., 1983) and conservation of genetic resource (Zeng et al., 2003), genetic variability in mosquitoes (Pushpalatha & Vijayan, 1999) and in silkworms (Moorthy et al., 2007; Doddaswamy & Subramanya, 2007; Akkad et al., 2008; Anuradha et al., 2010) are clearly established.

The selection of best genotypes depends on a number of characters and diversity among them. Therefore, a clear understanding and knowledge of association and contribution of various yield components is essential for any selection programme aimed at yield improvement. Hence, the present study was undertaken to estimate the phenotypic variation and protein polymorphism among ten silkworm genotypes.

MATERIALS AND METHODS

Silkworm genotypes

For the present study ten silkworm genotypes consisting of five bivoltines (CSR2, CSR50, CSR51, BHR3 and SK4C) and five multivoltines (Pure Mysore, ND7, Nistari, Cambodge and L14) were used. Rearing of these silkworm genotypes was conducted by adopting standard technique suggested by Krishnaswamy (1978). At the end of 5th instar, the spinning larvae were collected manually and mounted on plastic collapsible mountages. Data on qualitative characters (morphological) like larval marking, cocoon colour, cocoon shape and data on the economically important quantitative traits, such as fecundity (no), larval weight (g), cocoon yield/ 10000 larvae by number (no.), yield/ 10000 larvae by weight (g), cocoon weight (g), shell weight (g), shell ratio (%), filament length (m) and filament size (d) were collected. The experiment was performed in triplicate with 250 larvae each. Morphological characters of the silkworm genotypes are presented in Table 1.

Collection of Haemolymph

Haemolymph of different silkworm genotypes were collected from the 5th instar 3rd day larvae in a precooled eppendorf tube coated with 0.1M phenylthiourea by cutting the prolegs. The haemolymph samples were centrifuged for 10 min at 3000 rpm and the supernatant was transferred to fresh tubes. The samples were stored at -80°C until use.

Qualitative analysis of haemolymph proteins

A discontinuous gel with 5% of stacking gel and 12% of resolving gel was prepared separately as described by Janarthanan & Vincent (2007). After electrophoresis the gels were removed and stained with coomassie brilliant blue solution for 3 hours and destained with acidic methanol. The destained gels were fixed with 7% acetic acid solution.

Statistical and cluster analysis

The data of quantitative traits were subjected for one way analysis of variance (ANOVA) and cluster analysis using Euclidean distance with complete linkage. Protein bands were scored in a binary code as '1' for presence and '0' for absence. The dendrogram was constructed based on Unweighted Pair Group Method with Arithmetic Mean (UPGMA). All the analysis was performed on Statistical Package for Social Sciences (SPSS) version 10/11.5 and GenAlEx 6.5 (Peakall & Smouse, 2012).

RESULTS AND DISCUSSION

Details of three qualitative traits (morphological) and nine quantitative traits in five bivoltine and five multivoltine silkworm genotypes are shown in Table 1 and 2. Analysis of variance revealed significant differences between the quantitative traits studied. Fecundity, larval weight, shell % and filament length ranged from 563 to 410, 46.41 to 23.28 g, 23 to 14.26 % and 1052 to 352.29 m respectively. CSR2 showed highest fecundity, larval weight, cocoon weight and shell %. CSR50 and SK4C showed highest filament length and filament size, respectively. Nistari showed the lowest fecundity, larval weight, shell % and filament length followed by Pure Mysore. Among multivoltines, L14 had high cocoon weight and shell%. For characters like fecundity, larval weight, shell % and filament length the genotypes ND7 and L14 had moderate values that is higher than the other multivoltines and lower than the bivoltines. Variance component was higher in filament length with 65155.822 followed by fecundity (3050.409), larval weight (71.658) and shell % (10.45 %) (Table 2 & 3).

Phenotypic diversity

The cluster analysis based on phenotypic data clearly indicated that the genotypes are grouped on the basis of their silk yielding ability. Ten silkworm genotypes were grouped into three clusters, of which cluster I contained all the three high silk yielders (CSR2, CSR50 and CSR51) and Cluster II had two bivoltines (BHR3 and SK4C) developed at Eastern India with two multivoltine genotypes (ND7 and L14) developed from Southern India, which were grouped together based on their moderate values for most of the quantitative traits. Cluster III had three multivoltine genotypes namely Nistari, Cambodge and Pure Mysore, which are low silk yielders (Fig. 1).

Phenotypic differences between silkworm genotypes were completely dependent on silk yielding quantitative traits. In cluster II, BHR3 and SK4C were close and shared moderately higher values for all the quantitative traits, that is lesser than other bivoltine genotypes, but greater than multivoltines. The other two multivoltine genotypes, ND7 and L14 were also found close to each other as they shared some of the quantitative traits with intermediate number, especially yield/10000 larvae in weight, cocoon weight, shell % and filament length. Another common factor among them was morphological characters, even though Pure Mysore also shared the qualitative traits with ND7 and L14 (Table 1), but it was grouped with Nistari and Cambodge as their quantitative traits are very similar. It also proves that the base for dendrogram classification was quantitative characters. The relationship between Nistari and Pure Mysore is consistent with the previous reports of Talebi and Subramanya (2009). Nistari and Cambodge may be nearer because of their common biological and developmental performances. These findings are further confirmed by PCoA analysis, which was concurrent with the results of dendrogram by clearly separating the high,

moderate and low silk yielding silkworm genotypes (Fig. 2). Our results demonstrate the dominant role of environmental conditions prevailing in different geographical regions on the variations in the quantitative traits in silkworm as they are varying with the genotypes from different geographical regions (Table 2).

Protein polymorphism in haemolymph

Protein profiling of haemolymph of ten silkworm genotypes under study revealed 15 bands ranging from 11 to 211 kDa, of which one band with molecular weight ~24kDa was polymorphic and it was expressed only in CSR2 and BHR3. Cluster analysis based on protein polymorphism revealed two clusters, cluster I contained eight genotypes and cluster II had two genotypes (Figs. 3 and 4).

Protein analysis was able to generate a minimum level of polymorphism with a single polymorphic protein band and hence, could be used as supplementary criteria for characterization. Approximately, 24kDa protein was expressed in CSR2 and BHR3 genotypes; though the geographic origin is not same for the genotypes, they were able to generate identical protein profiles, indicating a definite role of this protein in their biological and metabolic process.

In silkworm, *Bombyx mori*, the silk yield is contributed by more than 21 traits (Thiagarajan et al., 1993) and there exists an interrelationship between multiple traits in silkworm. Any effort to improve the yield requires consideration of cumulative effect of the major traits which influences the silk yield. It has also been established that selection pressure applied for one character results in correlated changes in other quantitative traits of economic importance (Moorthy et al., 2011). Hence, classification of silkworm genotypes is very important in breeding programs. Commercial rearing of this insect is based on hybrids crossed from pure lines. Due to the presence of many genotypes and continuous production of new lines, furnishing all the possible crosses to obtain the best hybrids and hybrid vigour using heterosis is impossible (Etebari et al., 2005). Hence, phenotypic diversity is of utter importance in silkworm as it is economically important insect; in which most of the commercial traits are quantitative.

These findings are important for breeding programs, as diversity between silkworm genotypes is vital for selection of suitable parents required for successful development of improved variety and hybrids of silkworm that have the potential to adapt to the fluctuating environments and management systems for realising stable and sustainable yields.

LITERATURE CITED

- Akanda, M. A. L., Alam, M. S. & Uddin, M. M. 1998. Genetic variability, correlation and path analysis in composite maize. Bangladesh J. Agril. Res., 23 (1): 107-113.
- Anuradha, J. H., Somasundaram, P., Vishnupriya, S. & Manjula, A. 2012. Storage protein-2 as a dependable biochemical index for screening germplasm stocks of the silkworm *Bombyx mori* (L). Albanian J. agric. sci., 11: 141-148.
- Bakkappa, S. K. & Subramanya, G. 2010. Electrophoretic haemolymph protein pattern in a few bivoltine races of the silkworm, *Bombyx mori*. The Bioscan, 5 (4): 541-544.
- Doddaswamy, M. S. & Subramanya, G. 2007. Haemolymph protein profiles in three pure races and their hybrids of the silkworm, *Bombyx mori* L. through SDS-PAGE. The Bioscan, 2 (3): 189-193.
- Etebari, K., Mirhosseini, S. Z. & Matindoost, L. 2005. A study on interspecific biodiversity of eight groups of silkworm (*Bombyx mori*) by biochemical markers. Insect Sci., 12: 87-94.
- Frey, K. J., Cox, T. S., Rodgers, D. M. & Cox P. M. 1983. Increasing cereal yields with gene from wild and weedy species. Proceedings of XV Intl. Cong. Genetics, 4: 51-68.

Janarthanan, S. & Vincent, S. 2007. Practical Biotechnology: Methods and protocols, Universities press Pvt. Ltd., India, pp. 79-84.

Krishnaswamy, S. 1978. New technology of silkworm rearing, in Bulletin No.2, Central Sericultural Research and Training Institute, Mysore, Central Silk Board, Govt. of India, pp. 1-23.

Kumaresan, P., Sinha, R. K. & Raje Urs, S. 2007. An analysis of genetic variation and divergence in Indian tropical polyvoltine silkworm (*Bombyx mori* L.) genotypes. *Caspian J. Env. Sci.*, 5 (1): 11-17.

Li, M., Shen, L., Xu, A., Miao, X., Hou, C., Sun, P., Zhang, Y. & Huang, Y. 2005. Genetic diversity among silkworm (*Bombyx mori* L., Lep., Bombycidae) germplasm revealed by microsatellites. *Genome*, 48: 802-810.

Moorthy, S. M., Das, S. K., Rao, P. R. T, Raje Urs, S. & Sarkar A. 2007. Evaluation and selection of potential parents based on selection indices and isozyme variability in silkworm. *Bombyx mori*, L., *Int. J. Indust. Entomology*, 14: 1-7.

Moorthy, S. M., Mandal, K., Kar, N. B. & Das, S. K. 2011. Identification of suitable bivoltine foundation cross for sustainable bivoltine silkworm seed crop in tropics. *The Bioscan*, 6 (4): 697-700.

Nagaraju, J. 2002. Application of genetic principles for improving silk production. *Current Science*, 83: 409-414.

Nezhad, S. M., Mirhosseini, S. Z., Gharahveysi, S., Mavajpour, M. & Seidavi, A. R. 2010. Evaluation of 37 economically important traits from 51 strains of the silkworm *Bombyx mori* and their relationships. *Journal of Food, Agriculture & Environment*, 8 (2): 924-929.

Peakall, R. & Smouse, P. E. 2012. GenALEx 6.5: Genetic Analysis in Excel - Population genetic software for teaching and research-an update. *Bioinformatics*, 28: 2537-2539.

Pushpalatha, N. & Vijayan, V. A. 1999. Isozyme profiles in relation to ecological status in two Japanese encephalitis vectors, *Culex vishnui* and *Culex fuscescens* (Diptera: culicidae), *Entomol.*, 24: 297-306.

Ramamohana Rao, P. & Nakada, T. 1998. Clustering of polyvoltine strains of the silkworm *B. mori* by image processing method: Significance of cocoon size and weight variables. *Indian J. Seric.*, 37: 33-39.

Takasusuki, M. C. R., Viana, L. H. D., Baitala, T. V., Nicolin, K. C. & Toledo V. A. A. 2006. Characterization of esterases in *Tetragonisca angustula* and *Tetragona clavipes*, *Broc. J. morphol. Sci.*, 23 (3&4): 431-434.

Talebi, E. & Subramanya, G. 2009. Genetic distance and heterosis through evaluation index in the silkworm, *Bombyx mori* L. *World Applied Journal*, 7 (9): 1131-1137.

Telebi, E., Khadami, M. & Subramanya G. 2011. A molecular approach for estimating of genetic identify and relationship in sixteen genotypes of mulberry silkworm. *Advances in Environmental biology*, 5 (6): 1209-1217.

Thiagarajan, V., Bhargava, S. K., Ramesh Babu, M. Z. & Nagaraj, B. 1993. Difference in seasonal performance of 26 strains of silkworm *Bombyx mori* (Bombycidae). *J. Lep. Soc.*, 47: 321-337.

Zeng, Z., Wang, J., Zhou, S., Bai, J. & Zheng, H. 2003. Allozyme variation and population genetic structure of *Betula alnoides* from Guangxi, China, *Biochemical Genetics.*, 41: 61-75.

Table 1. Details of the morphological traits in the silkworm genotypes.

Sl No.	Breeds	Voltinism	Larval Marking	Cocoon colour	Cocoon shape
1	Pure Mysore	Multivoltine	Plain	Light greenish yellow	Spindle
2	ND7	Multivoltine	Plain	Light greenish yellow	Elongated oval
3	Nistari	Multivoltine	Marked	Yellow	Spindle
4	Cambodge	Multivoltine	Plain	Yellow	Spindle
5	L14	Multivoltine	Plain	Light greenish yellow	Elongated oval
6	CSR2	Bivoltine	Plain	White	Oval
7	CSR50	Bivoltine	Plain	White	Oval
8	CSR51	Bivoltine	Marked	White	Dumbbell
9	BHR3	Bivoltine	Marked	White	Dumbbell
10	SK4C	Bivoltine	Marked	White	Dumbbell

Table 2. Details of quantitative traits studied in silkworm genotypes.

Genotypes	Fecundity	Larval weight (g)	Yield/10000 larvae by no.	Yield/10000 larvae by wt.(kg)	Cocoon weight (g)	Shell weight (g)	Shell (%)	Filament length (m)	Filament size
Pure Mysore	425	23.45	9254	9.427	1.053	0.16	15.11	402	2.1
ND7	422	25.56	9207	13.537	1.456	0.27	18.77	636	2.45
Nistari	410	23.28	9495	12.689	1.182	0.618	14.26	352.29	2.87
Cambodge	450	25.66	9420	9.641	1.23	0.179	14.54	402.16	2.88
L14	510	34.24	9142	13.203	1.446	0.26	17.98	724	2.06
CSR	563	46.41	9077	15.498	1.782	0.41	23	1050	2.82
CSR50	544	44.11	9040	15.757	1.715	0.389	22.6	1052	2.86
CSR51	538	42.45	8847	15.22	1.71	0.367	21.4	975	2.82
BHR3	517	34.33	9226	12.638	1.525	0.297	19.45	622.83	2.93
SK4C	524	34.42	9226	14.362	1.627	0.334	20.51	704.9	2.99

Table 3. ANOVA and summary statistics of the nine quantitative traits measured in 10 silkworm genotypes.

Traits	Mean	Standard Deviation	Range	F-value	P-value
Fecundity	490.3	57.42831	410 – 563	1369.280	0.0001
Larval weight	33.391	8.763985	23.28 - 46.41	1099.936	0.0001
Yield/10000 larvae in no.	9193.4	184.995	8847 – 9495	3.113	0.016
Yield/10000 larvae in Wt.	13.1972	2.232143	9.427 - 15.757	496.356	0.0001
Cocoon weight	1.4726	0.248949	1.053 - 1.782	777.019	0.0001
Shell weight	0.3284	0.131434	0.16 - 0.618	258.937	0.0001
Shell %	18.762	3.252704	14.26 -23	247.007	0.0001
Filament length	692.118	264.6746	352.29 – 1052	153383.75	0.0001
Filament size	2.678	0.346404	2.06 - 2.99	25.894	0.0001

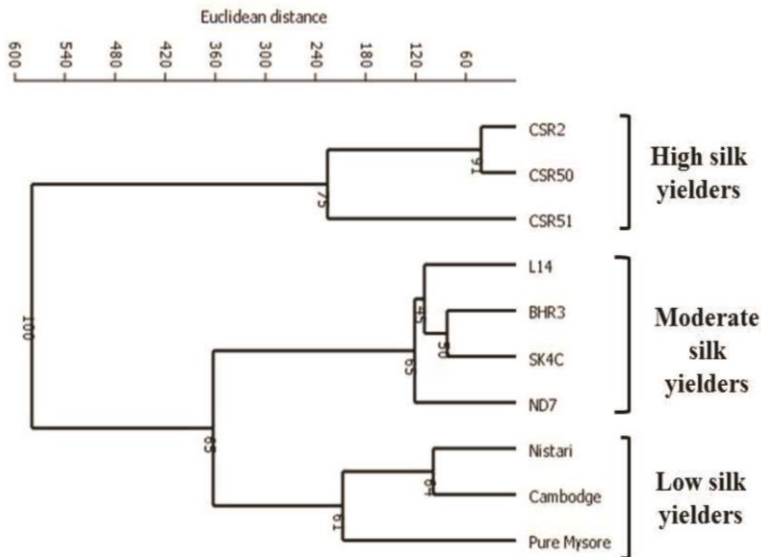


Figure 1. Dendrogram based on the phenotypic data of ten silkworm genotypes elucidated by using Euclidean distance with complete linkage.

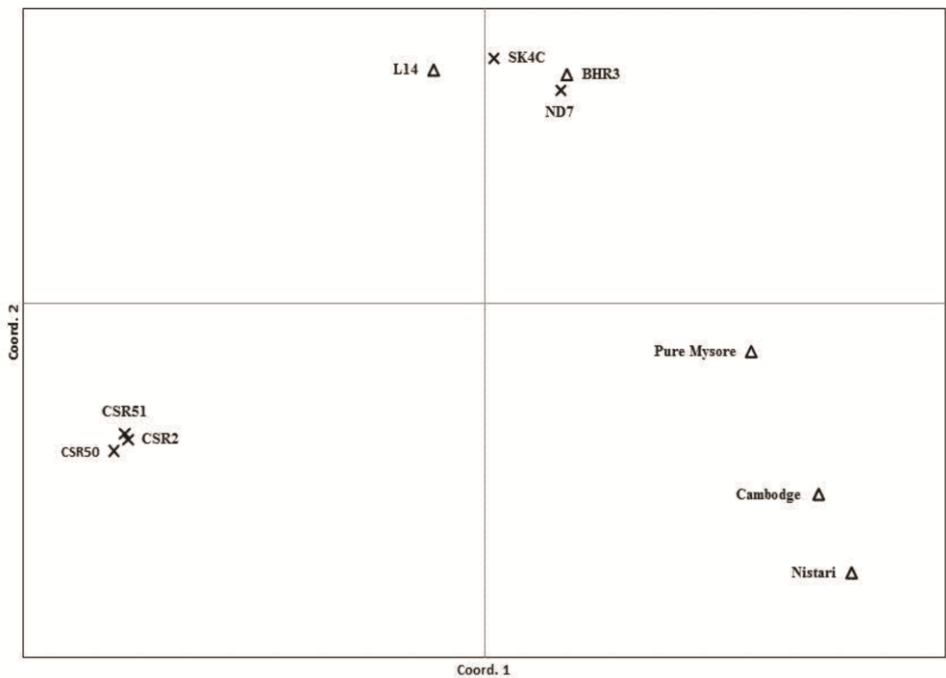


Figure 2. PCoA based on phenotypic data of ten silkworm genotypes.

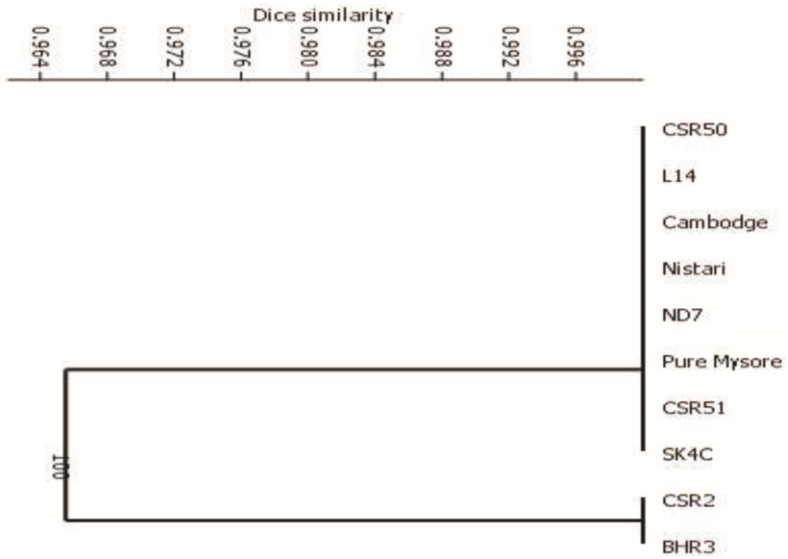


Figure 3. Dendrogram based haemolymph proteins of ten silkworm genotypes elucidated by using Dice similarity.

**ON A COLLECTION OF TRUE BUGS
(INSECTA: HEMIPTERA) FROM RALAMANDAL
WILDLIFE SANCTUARY, MADHYA PRADESH, INDIA**

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[Chandra, K., Bhandari, R. & Kushwaha, S. 2015. On a collection of true bugs (Insecta: Hemiptera) from Ralamandal Wildlife Sanctuary, Madhya Pradesh, India. Munis Entomology & Zoology, 10 (2): 486-488]

ABSTRACT: Present investigation deals with the Hemiptera fauna of the Ralamandal Wildlife sanctuary Madhya Pradesh, after a deep observation of the surveyed area of the WLS there were 34 species belonging to 30 genera under 12 families reported. All the species are new to RWLS.

KEY WORDS: Hemiptera, RWLS, Madhya Pradesh.

The state of Madhya Pradesh was created in 1956, total covering about 14.5% of the total area of India. The elevation is largely 305 to 610 m. As per records total forest area is 308,245 km² annual rainfall is 1800 mm and temperature is 22.5°- 25°C. Ralamandal WLS situated 15 km from Indore-Tillore road and covers 234.55 ha, notified as WLS of Madhya Pradesh in the year 1982 (Diwedi, 2003). Order Hemiptera is the one of the largest group with more than 35000 species of bugs from all over the world, Suborder Heteroptera being the largest group with more than 35000 species (Slater, 1982).

Detailed account on Hemiptera of central India was describe in the '*Fauna of British India*' Distant (1902, 1904 and 1906). Later on investigation on Order Hemiptera of Madhya Pradesh were done by Chandra (2008, 2009), Chandra et al. (2010, 2012) and Chandra, Kushwaha (2013, 2014a,b) and (Chandra et al. 2014).

These bugs were collected by sweeping over vegetation with a net. Some specimens found under stones, leaf axils and loose bark were collected by picking with forceps or small ones with a hairbrush dipped in spirit. Night collection was also carried out with using white cloth sheet and mercury bulb. The identification of specimens up to species level was done using reference collection present in ZSI, Jabalpur.

This observational survey deals with the study of 34 species belonging to 30 genera under 12 families of order Hemiptera reported first time from Ralamandal Wildlife Sanctuary.

Abbreviation used: VH-Very high; H-High; L-Low; R-Rare; VR-Very Rare; FRH-Forest Rest House; RWLS- Ralamandal Wildlife Sanctuary.

Table 1. List of Hemiptera studied from Ralamandal Wildlife Sanctuary, Madhya Pradesh.

S. No.	Scientific Name	WLS/NP/ Locality	Status	Date of Observation
	Order: Hemiptera			
	Suborder: Heteropterodea			
	Infraorder: Cimicomorpha			
	Superfamily: Cimicoidea			
	Family: Reduviidae			
1	<i>Tribelocephala indica</i> (Walker)	RWLS/Water tank	H	18.vi.2013
2	<i>Ectomocoris cordiger</i> Stal	Near Museum wall	L	19.vi.2013
3	<i>Catantarius brevipennis</i> (Serv.)	Near Museum wall	L	19.vi.2013
4	<i>Prostemma carduelis</i> Dohrn	Village boundary	VH	20.vi.2013
5	<i>Ectrychotes dispar</i> Reuter	Water tank	H	21.vi.2013
6	<i>Oncoccephalus annulipes</i> Stal	RWLS/FRH	L	22.vi.2013
7	<i>Prostemma carduelis</i> Dohrn	RWLS/Near Water tank	L	21.vi.2013
8	<i>Polididus armatissimus</i> Stal	RWLS/FRH	VH	22.vi.2013
9	<i>Scadra annulipes</i> Reuter	Village boundary	H	20.vi.2013
10	<i>Rhynocoris marginatus</i> (F.)	RWLS/FRH	L	22.vi.2013
	Infraorder: Pentatomorpha			
	Superfamily: Lygaeoidea			
	Family: Lygaeidae			
11	<i>Spilostethus pandurus militaris</i> (F.)	Near Museum wall	H	19.vi.2013
12	<i>Spilostethus hospes</i> (F.)	RWLS/Near Water tank	L	21.vi.2013
	Superfamily: Pyrrhocoroidea			
	Family: Largidae			
13	<i>Antilochus coqueberti</i> , (F.)	Near Museum wall	VH	19.vi.2013
	Family: Phyllorhynchidae			
14	<i>Dysdercus koenigii</i> (F.)	RWLS/Near Water tank	VH	21.vi.2013
	Superfamily: Coreoidea			
	Family: Coreidae			
15	<i>Serinetia abdominalis</i> (F.)	RWLS/FRH	L	22.vi.2013
16	<i>Anoplocnemis phasiana</i> (F.)	RWLS/Near Water tank	R	21.vi.2013
17	<i>Homocerus signatus</i> Walker	Near Museum wall	R	19.vi.2013
18	<i>Notobitus meleagris</i> (F.)	RWLS/FRH	R	22.vi.2013
	Family: Alydidae			
19	<i>Riptortus fuscus</i> (F.)	Village boundary	VH	20.vi.2013
20	<i>Leptocoris varicornis</i> (F.)	RWLS/FRH	VH	22.vi.2013
	Superfamily: Pentatomoidea			
	Family: Plataspidae			
21	<i>Megacopta cribraria</i> Hsiao and Ren	RWLS/Near Water tank	VH	21.vi.2013
	Family: Cydnidae			
22	<i>Aethus indicus</i> (Westwood)	Village boundary	VH	20.vi.2013
	Family: Pentatomidae			
23	<i>Antestiopsis cruciata</i> (F.)	RWLS/Near Water tank	H	21.vi.2013
24	<i>Eusarcocoris ventralis</i> (Westwood)	RWLS/FRH	H	22.vi.2013
25	<i>Eusarcocoris montivagus</i> Distant	Near Museum wall	R	19.vi.2013
26	<i>Eocanthecona furcellata</i> (Wolff)	Village boundary	R	20.vi.2013
27	<i>Halys dentatus</i> Fabricius	RWLS/FRH	VH	22.vi.2013
28	<i>Nezara viridula</i> Linnaeus	Village boundary	R	20.vi.2013
29	<i>Plautia fimbriata</i> Fabricius	RWLS/Near Water tank	R	21.vi.2013
30	<i>Acrosternum graminea</i> (F.)	RWLS/FRH	R	22.vi.2013
31	<i>Erthesina fullo</i> (Thunberg)	Village boundary	H	20.vi.2013
	Family: Dinidoridae			
32	<i>Cyclopelta siccifolia</i> (Westwood)	RWLS/FRH	L	22.vi.2013
	Family: Scutelleridae			
33	<i>Poecilocoris interruptus</i> (Westwood)	Near Museum wall	VR	19.vi.2013
34	<i>Chrysocoris purpureus</i> (Westwood)	RWLS/FRH	VR	22.vi.2013

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LITERATURE CITED

- Chandra, K.** 2008. Insecta: Hemiptera, *Faunal Diversity of Jabalpur District*, M. P Conservation Area Series, (Published by Zoological Survey of India, Kolkata): 1-157 pp.
- Chandra, K.** 2009. Insecta: Hemiptera. *Fauna of Pachmarhi Biosphere Reserve*, Conservation Area Series, (Published by Zoological Survey of India, Kolkata): 1-257 pp.
- Chandra, K. & Kushwaha, S.** 2013. Distribution and Diversity of Hemiptera Fauna of Singhori Wildlife Sanctuary, Raisen District, Madhya Pradesh, India. *Munis Entomology & Zoology*, 8 (2): 677-681.
- Chandra, K. & Kushwaha, S.** 2014a. Ground bugs (Hemiptera: Lygaeidae) of Madhya Pradesh, with their distribution in India. *Munis Entomology & Zoology*, 9 (1): 535-539.
- Chandra, K. & Kushwaha, S.** 2014b. Superfamily Coreoidea (Hemiptera) from Madhya Pradesh. *Bionotes*, 16 (1): 9-11.
- Chandra, K., Kushwaha, S., Sambath, S. & Biswas, B.** 2012. Distribution and diversity of Hemiptera fauna of Veerangana Durgavati Wildlife Sanctuary, Damoh, Madhya Pradesh (India). *Biological Forum-An International Journal*, 4 (1): 68-74.
- Chandra, K., Sharma, R. M. & Ojha, P.** 2010. A Compendium on the faunal resources of Narmada river basin in Madhya Pradesh. *Rec. zool. Surv. India, Occ. Paper No. 310*: 42-43.
- Distant, W. L.** 1902. The fauna of British India including Ceylon and Burma, Rhynchota Vol. II, Taylor and Francis, London: 1-503 pp.
- Distant, W. L.** 1904. The fauna of British India including Ceylon and Burma, Rhynchota Vol. I, Taylor and Francis, London: 1-438 pp.
- Distant, W. L.** 1906. The fauna of British India including Ceylon and Burma, Rhynchota Vol. III, Taylor and Francis, London: 1-502 pp.
- Diwedi, A. P.** 2003. Protected area of Madhya Pradesh, Published by PCCF Bhopal: 1-218 pp.
- Slater, J. A.** 1982. Hemiptera. In: Parker, Sp. P. (Ed.), *synopsis and classification of living organisms*. McGraw-Hill, New York. pp. 417-447.

SOME TAXONOMICAL AND BIOLOGICAL CHARACTERISTICS OF *MYOTIS EMARGINATUS* (MAMMALIA: CHIROPTERA) IN TURKEY

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[Albayrak, İ. 2015. Some taxonomical and biological characteristics of *Myotis emarginatus* (Mammalia: Chiroptera) in Turkey. Munis Entomology & Zoology, 10 (2): 489-494]

ABSTRACT: This study is based on some records and observations concerning *Myotis emarginatus* obtained during the field works carried out between 1977 and 2012. Diagnostic characters, habitat, fur color, measurements and collection localities of the specimens were recorded. Specimens were represented by adult groups and compared to the literature in terms of statistical data, and fur colour and it was concluded that our specimens represented the nominative form, *M. e. emarginatus*.

KEY WORDS: *Myotis emarginatus*, taxonomy, bioecology, Vespertilionidae, Turkey.

Of 5416 mammalian species in the world, 1116 species belong to bats (Wilson and Reeder, 2005). Up to date, it was determined that one species belonging to Megachiroptera and 37 species belonging to Microchiroptera lives in Turkey. One of the these species, *Vespertilio murinus* was recorded by means of faeces, the other one, *Otonycteris hemprichi* was recorded by using sound detector and the remaining was recorded basing on sample. These species are represented by the families of Pteropodidae, Emballonuridae, Rhinolophidae, Vespertilionidae and Molossidae.

Of 407 species belonging to the family Vespertilionidae in the world, 30 species are distributed in Turkey. One of them, *Myotis emarginatus* is distributed in Europe, Northern Africa, İran and Turkmanistan in Palaearctic Region. Çağlar (1961) gave the first record of *Myotis emarginatus* from Kırklareli Province in Turkish Thrace and stated that Thracian specimens represented the nominate form. Çağlar (1965, 1969) pointed out that *Myotis emarginatus* occurred in Kırklareli. *Myotis emarginatus* was recorded from Konya and Antalya Provinces (Helversen, 1989). Albayrak (1990) has determined *Myotis emarginatus* from Adıyaman, Hatay and Samsun. Albayrak (1993) also pointed out the existing of *Myotis emarginatus* in İzmir and Manisa Provinces and recorded some morphometric values. Obuch (1994) recorded *Myotis emarginatus* from Adıyaman. Benda & Horacek (1998) gave the records of this species from Antalya, Yalova (Yalova was a district of İstanbul before 1995. Howbeit, they showed Yalova in Çanakkale Province by mistake), Hatay, Kırklareli and Kocaeli provinces. Irmak and Sözen (2014) recorded this species from Zonguldak Province (Figure 1).

The purpose of this study is to determine some biological and taxonomical characteristics of *Myotis emarginatus* which has a discontinuous distribution in Turkey.

MATERIAL AND METHOD

This study is based on 70 *Myotis emarginatus* specimens obtained during the field works between 1977 and 2012. Specimens were caught by hand and using

aerial net. Specimens were represented as adult according to Anderson (1917), Menzies (1973) Young (1975) and Baagoe (1977). Weight, 18 external and 19 cranial measurements were taken from each specimens according to Ognev (1928), Harrison (1964) and Çağlar (1968). Compared data were also shown using box-plot. Diagnostic characters, habitat, pelage colour, measurements and collection localities of *Myotis emarginatus* were given. The statistical values of specimens were compared to the literature and an assessment was made in subspecies level. Whether group averages were equal or not was tested by Kruskal-Wallis Anova with significancy values at the probability level of 0.05.

RESULTS

Family Vespertilionidae is represented with 30 species and one of these species is *Myotis emarginatus*, which is represented by the nominate form, *Myotis emarginatus emarginatus*.

Species: *Myotis emarginatus* (Geoffroy, 1806) (Geoffroy's bat)
1806. *Vespertilio emarginatus* Geoffroy, Ann. Mus. Hist. Nat., 8: 198-199.

Type locality: Ardenes, Givet, Charlemont, Fransa
1900. *Myotis emarginatus*, Méhely, Monogr. Chiropt. Hungariae, Budapest, 170-178.

Subspecies: *Myotis emarginatus emarginatus* (Geoffroy, 1806)
1918. *Myotis emarginatus emarginatus*, Bobrinski, Zametki o letuchikh myshakh dobytykh Materialy k poznaniyu fauny i flory Rossii, 15: 17.

Diagnostic characters: There is a very distinct notch on the outer edge of the ear. The wing membrane reaches to the bottom of the outer finger of foot. The pattern of the interfemoral membrane of *M. emarginatus* has densely scattered dots. In 58 specimens, condylobasal length was 14.3 (14.8) 15.5 and mandibul length was 11.5 (11.9) 12.6 mm; in 54 specimens, zygomatic breadth was 9.2 (9.7) 10.3 mm.

Habitat: This species, which usually lives in caves, was found in the high cliffs shaded with leafy forest trees such as linden, beech and elm trees in summer months. In whelping period coinciding with the end of May, a small colony consisting of 15 females was found and in other months of the year only small colonies with 5-6 individuals consisting of males and females were found. In a formerly operated mine on a hillside with pine trees, 200 female individuals were found to have created a breeding colony. There were also colonies of *Rhinolophus ferrumequinum*, *Rhinolophus hipposideros* and *Miniopterus schreibersi* species in that mine. In another small artificial cave where people used to host in a rocky pine forest, a small colony with 30 individuals living sympatricly with *Rhinolophus ferrumequinum* was detected. An embryo or a pup was found with adult females.

Pelage colour: In summer the dorsal colour of *M. emarginatus* varies from somewhat redish gray to brownish gray tinged light henna colour; ventral colour varies from yellowish gray to brownish gray. Hair on dorsal has three colorations; base of hair is brown, middle of hair is yellowish dirty white and tip of hair has general dorsal coloration. Hair on ventral has two colorations; base of hair varies from light brown gray to dark brown gray and tip of hair has general ventral coloration. While the coloration of wing and tail membranes and ears of adults

are gray brown, those of young are either the same with adults or blackish brown.

Measurements: All specimens were females. No statistical significant differences between youngs and adults were found. Therefore statistical data of youngs and adults were pooled and given in Table 1.

Karyology: In this species the diploid number was 44, the fundamental number 56, and the number of autosomal arms 52 (Zima & Král, 1984).

Specimen examined. Total number, 60 (53 adult females, 5 juvenile females, 1 male and 1 female infants) from following localities: Adana Province, Karaisalı, 8 (♀♀, 23 May 1985); Adıyaman Province, İndere (Zey) village, 3 (♀♀, 17 May 1977); Hatay Province, Altınözü, Kozkalesi köyü, 4 (♀♀, 25 May 1979); Samsun Province, Kelkaya mahallesi (Asarağaç village), 9 (7 ♀♀, 13 July 1978; 2 ♀♀, 19 June 1980); İzmir Province, Gümüldür, 28 (27 ♀♀, 1 ♂ 10 June 1983); Manisa Province, Demirci, 8 (♀♀, 21 June 1977).

DISCUSSION

Our morfometric data were not compared to those in the literature because of insufficient characteristics given in the original description of *Myotis emarginatus emarginatus*. However, our material were comparable with the nominate form recorded from Holland, Austria, Hungary and Italy by Miller (1912). Besides, there is not any difference between our material and European population in terms of color, measurement and other features.

Recording the measurements of an adult specimen collected from Turkish Thrace, Çağlar (1961) included the Turkish Thrace into the distribution area of nominative subspecies.

Ognev (1928) stated that *M. e. desertorum* had steeper tragus than that of nominative form, and dorsal colour varied from light gray straw yellow to rusty or yellowish gray. *M. e. desertorum* (the specimen from Belucistan) was evaluated as species by Dobson (1865) and as subspecies by Bobrinski (1918). Colour variation of our specimens collected in may and june were not within the colour variation of *M. e. desertorum* specimens collected in june and july given by Ognev (1928) and thus, our specimens appear to be different from *M. e. desertorum*. Diagnostic character given for tragus was not evaluated because of absence of *M. e. desertorum* specimens for the visual examination.

It is known that internal characters are more reliable than external characters being more susceptible to the errors during applications. Of these internal characters, the condylobasal length, zygomatic breadth, upper toothrow length values were included in the analysis because data of those were almost fully available in all records and thus met statistical assumptions for reliable comparison. European values were quoted from Miller (1912) and Russian values quoted from Ognev (1928). No significant difference was found statistically between our specimens and European specimens, but statistically significant ($P < 0.05$) difference was detected between our specimens and Russian specimens. Despite their less reliability, the data of ear and hindfoot lengths, which were also available from Russia and Turkey and appropriate to examine statistically, showed statistically significant ($P < 0.05$) differences (Figure 2).

As a result it was concluded that Anatolian specimens differ from *M. e. desertorum* and represented the nominate form.

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LITERATURE CITED

- Albayrak, İ.** 1990. Doğu Anadolu Yarasaaları ve Yayılışları (Mammalia: Chiroptera). Doğa Tr. of Zoology, 14 (2): 214-228.
- Albayrak, İ.** 1993. Batı Türkiye Yarasaaları ve Yayılışları (Mammalia: Chiroptera). Doğa Tr. J. of Zoology, 17 (2): 237-257.
- Anderson, J.** 1917. On the determination of age in bats. J. Bombay Nat., Hist., Soc., 25: 249-259.
- Baagoe, H. J.** 1777. Age determination in bats (Chiroptera). Vid. Med. Dansk nat. For., 140: 53-92.
- Benda, P. & Horacek, I.** 1998. Bats (Mammalia: Chiroptera) of the Eastern Mediterranean. Part 1. Review of Distribution and Taxonomy of bats in Turkey. Acta Soc. Zool. Bohem., 62: 255-313.
- Çağlar, M.** 1961. Türkiye'de bulunduğu tespit edilen bir *Myotis* türü hakkında. İstanbul Üniversitesi Fen Fakültesi Mecmuası, Seri B, 26 (3-4): 107-109.
- Çağlar, M.** 1965. Türkiye'nin yarasaları I. İ. Ü. Fen Fakültesi Mecmuası, Seri B, 30 (3-4): 125-134.
- Çağlar, M.** 1968. Bats of Turkey-I. Türk Biyoloji Dergisi, Türk Biyologlar Cemiyeti'nin Yayın Organı, İstanbul, 18 (1): 5-18.
- Dobson, G. E.** 1865. Descriptions of New Mammalia from Persia and Baluchistan. In Blandfort, 16 (4): 309-313.
- Harrison, D. L.** 1964. The Mammals of Arabia. Insectivora, Chiroptera, Primates, London, 1: 1-192.
- Helversen, O. Von.** 1989. New records of bats (Chiroptera) from Turkey. Zoology in the Middle East, 3: 5-17.
- Irmak, S. & Sözen, M.** 2014. Zonguldak İlinde Yayılış Gösteren Yarasa Türleri. 55-66, in: Türkiye Yarasaaları Sempozyum I. 25-26 Ekim 2014, Basım ve Foto-Film Şube Müdürlüğü, 1-108.
- Menzies, J. I.** 1973. A study of leaf-nosed bats (*Hipposideros cafer* and *Rhinolophus landeri*) in a cave in northern Nigeria. J. Mam., 54 (4): 930-946.
- Miller, G. S.** 1912. Catalogue of the Mammals of Western Europe (Europe exclusive of Russia) in the collection of the Museum. Brit. Mus. Nat. Hist., London, 1-1019.
- Ognev, S. I.** 1928. Mammals of Eastern Europe and Northern Asia, Vol. I, Insectivora and Chiroptera. Moskva-Leningrad (Israel Program for Scientific Translations. Jerusalem 1962), 1-487.
- Wilson, D. E. & Reeder, D. A. M.** 2005. Mammal species of the world. Smithsonian Institution Press. Washington and London, 1-1206.
- Young, R. A.** 1975. Aging criteria, pelage colour polymorphism and Moulting in *Rhinolophus megaphyllus* (Chiroptera) from Sout-eastern Queensland, Australia. Mammalia, Paris, 39 (1): 75-113.
- Zima, J. & Král, B.** 1984. Karyotypes of European Mammals I. Acta Sc. Nat. Brno, 18 (7): 1-51.

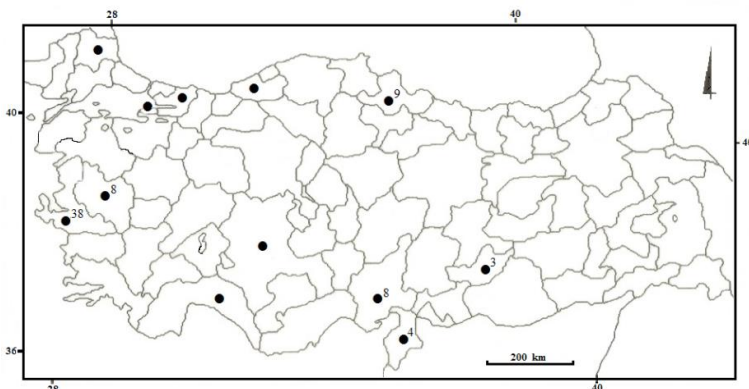


Figure 1. Map of Turkey showing the localities of *Eptesicus serotinus* (•) (Figures indicates the number of the obtained specimens concerning this study).

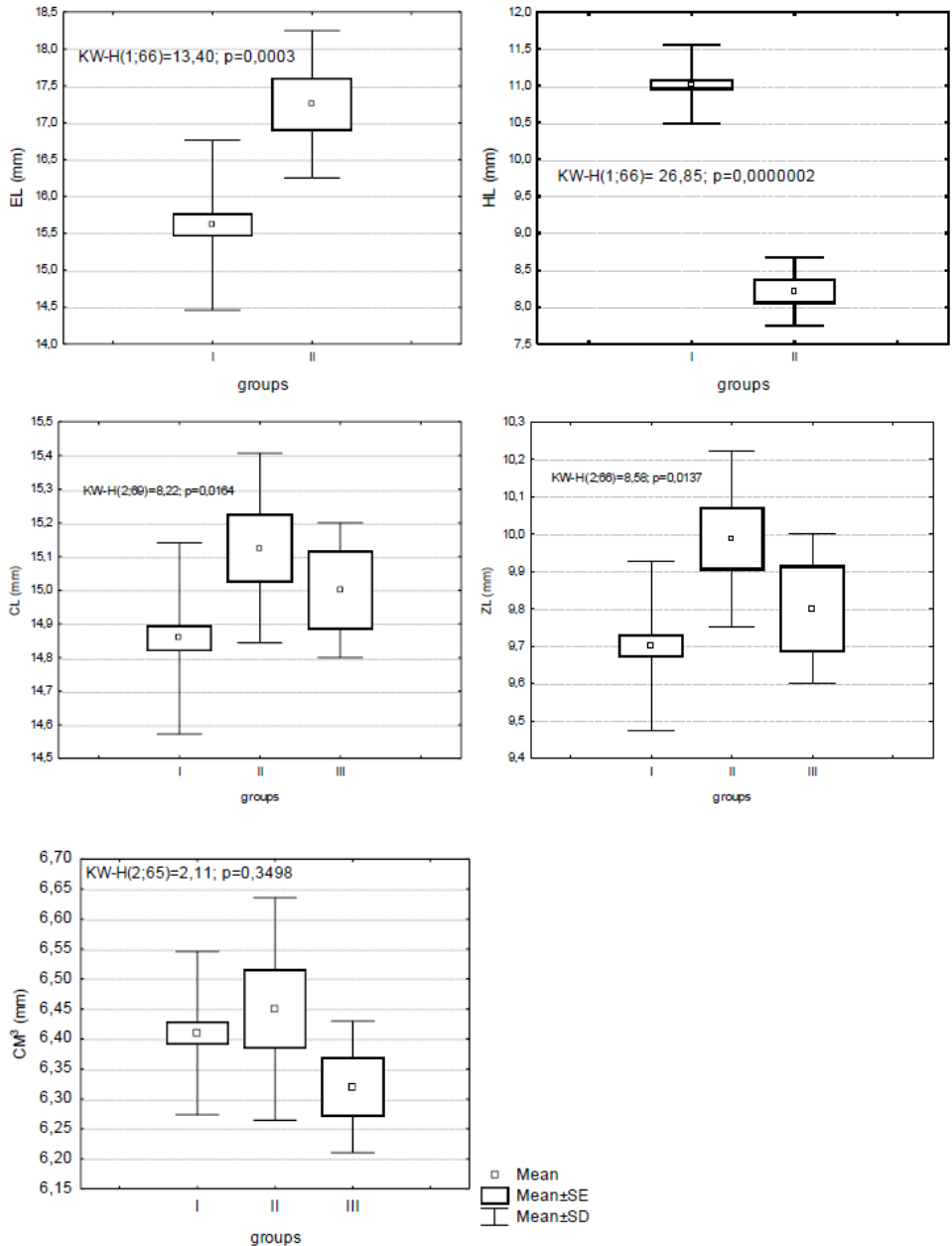


Figure 2. Comparison of some external and cranial measurements of *Myotis emarginatus* from Hungary, Holand and Italy (Miller, 1912); Buhara, Askhabad, Turkmania (Ognev, 1928) and present study. KW: Kruskal-Wallis Anova, I: Turkey (Present study); II=USSR (Ognev, 1928; III=Europa (Miller, 1912).

Table 1. Statistical data on weight external and cranial measurements of adult *Myotis emarginatus*: number of individuals (n), range (r), mean (m), standart deviation (\pm Sd).

Measurements	n	r	m	\pm Sd
Total length	57	86-101	93.8	3.77
Total body length	57	44-62	52.2	3.78
Tail length	57	34-45	39.6	2.34
Hindfoot length	58	10-12	11.0	0.53
Ear length	58	10-18	15.6	1.15
Weight	58	4.5-9.5	7.1	1.16
Tragus length	15	7.5-8.9	8.4	0.41
Forearm length	58	35.4-41.4	38.1	1.31
Tibia length	16	15.7-18.3	17.2	0.61
2nd digit metacarpal length	16	31.1-35.8	33.1	1.27
3rd digit metacarpal length	16	33.8-36.5	35.0	0.77
3rd digit 1st phalanx length	16	13.0-14.8	13.8	0.53
3rd digit 2nd phalanx length	16	10.0-11.4	10.7	0.47
4th digit metacarpal length	16	32.8-36.0	34.4	0.85
4th digit 1st phalanx length	16	9.4-10.8	10.1	0.40
4th digit 2nd phalanx length	16	7.3-8.9	8.1	0.54
5th digit metacarpal length	16	33.7-36.1	34.9	0.79
5th digit 1st phalanx length	16	9.1-10.7	10.0	0.46
5th digit 2nd phalanx length	16	6.4-7.4	6.9	0.37
Greatest skull length	55	15.7-17.0	16.1	0.29
Total skull length	58	15.1-16.5	15.7	0.30
Condylbasal length	58	14.3-15.5	14.8	0.28
Basal length	16	13.4-14.3	13.7	0.26
Palatal length	16	6.3-7.1	6.8	0.24
Rostrum length	16	3.8-4.7	4.1	0.29
Zygomatic breadth	55	9.2-10.3	9.7	0.22
Interorbital breadth	57	3.5-4.0	3.6	0.11
Braincase breadth	15	7.1-7.4	7.3	0.11
Mastoid breadth	55	7.5-9.0	7.9	0.22
Rostral breadth	12	3.9-4.4	4.1	0.14
Infraorbital breadth	15	3.9-4.5	4.1	0.15
Skull height	42	6.8-7.4	7.1	0.16
Maxillary toothrow length	52	6.1-6.7	6.4	0.13
Upper molar length	16	3.4-3.7	3.6	0.09
Tympanic bullae diameter	15	2.3-3.0	2.6	0.18
Mandibular toothrow length	57	6.5-7.2	6.8	0.13
Lower molar length	16	3.9-4.2	4.0	0.08
Mandible length	58	11.5-12.6	11.9	0.27

KARYOLOGICAL ANALYSES OF TWO WOLF SPIDER (ARANEAE: LYCOSIDAE) FROM TURKEY

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[Türker, H., Demir, H. & Seyyar, O. 2015. Karyological analyses of two wolf spider (Araneae: Lycosidae) from Turkey. Munis Entomology & Zoology, 10 (2): 495-498]

ABSTRACT: In this study, the karyotype analysis of two wolf spider, *Alopecosa pulverulenta* (Clerck, 1757) and *Alopecosa accentuata* (Latreille, 1817) were made based on the samples from Turkey. The chromosome diploid number (2n) and the sex chromosome system in males of both species were found in the same, $2n = 28 (26 + X_1X_2)$. Two species have telocentric chromosomes.

KEY WORDS: Araneae, Lycosidae, Karyotype, sex chromosome, Turkey.

Lycosidae is one of the big spider families, which contains worldwide 2399 species from 120 (Platnick, 2015). However, only 85 species belonging to 15 genera are listed in Turkey (Topçu et al., 2005; Bayram et al., 2015). Many lycosids are diurnal and very active and therefore easy to find and observe. As the females carry the egg sacs attached to the spinnerets, these are easily collected during the reproductive season (Jocque, Alderweireldt, 2005). Although wolf spiders are one of the best explored families of entelegyne spiders, cytogenetic studies with them are scarce. Most of the analyzed species have only telocentric or acrocentric chromosomes; the sex chromosome system $X_1X_2\sigma/X_1X_1X_2X_2\phi$ occurs in 94% of lycosids (Chemisquy et al., 2008).

In the present study, we have reported the results on the karyotypes of two wolf spider species in Lycosidae.

MATERIALS AND METHODS

Adult males of *A. pulverulenta* (Clerck, 1757) and *A. accentuata* (Latreille, 1817) were collected by hand in Central Anatolia of Turkey. All the individuals were collected between April and June in 2013. The specimens were deposited in NUAM (Niğde University Arachnology Museum).

It is selected the most suitable subadult and/or adult males for this type of analysis. Chromosome preparations were made according to the procedure described by TRAUT (1976), with some modifications. Testes were dissected out in a hypotonic solution (0.075 M KCl) and then transferred into a new hypotonic solution, and they were hypotonized for 20 min in total. Tissues were moved in 2 changes of freshly prepared Carnoy fixative (ethanol, chloroform, and glacial acetic acid, 6:3:1) for 35 min in total. A piece of tissue was suspended in a drop of 60% acetic acid on a slide using a pair of tungsten needles. The slide was dried on a histological plate (surface temperature 42 °C) and stained with a 5% Giemsa solution in Sørensen phosphate buffer (pH 6.8) for 27 min. The cells were investigated under an Olympus CX31 microscope and the best metaphase figures were photographed with an Olympus DP 25 digital camera and the DP2-BSW program (Olympus). Karyotypes of *A. pulverulenta* (Clerck, 1757) and *A. accentuata* (Latreille, 1817) were constructed by arranging chromosomes in pairs according to size using images of spermatogonial metaphases. Relative

chromosome lengths (RCLs) of each chromosome pair were calculated from 10 metaphase plates obtained from each species. Chromosome morphology was classified according to the method of Levan et al. (1964).

RESULTS

Alopecosa pulverulenta (Clerck, 1757)

The male karyotype consisted of 28 chromosomes (Figure 1). All autosome pairs were telocentric. Autosome pairs gradually decreased in size. Relative lengths of autosome pairs ranged from 5.06% to 3.01% (Table 1). The sex chromosome system was of the $X_1X_2\sigma$ type. The X_1 and X_2 sex chromosomes were telocentric and their relative lengths were 3.38% and 2.70%, respectively.

Alopecosa accentuata (Latreille, 1817)

The male karyotype consisted of 28 chromosomes (Figure 2). All autosome pairs were telocentric. Autosome pairs gradually decreased in size. Relative lengths of autosome pairs ranged from 5.34% to 2.81% (Table 1). The sex chromosome system was of the $X_1X_2\sigma$ type. The X_1 and X_2 sex chromosomes were telocentric and their relative lengths were 4.66% and 3.20%, respectively.

DISCUSSION

Despite the high diversity of lycosids (120 genera, 2399 species), they are poorly known from the cytogenetic point of view. As of today, 100 species have been examined. Diploid chromosome numbers in these species ranges varied from 18 to 30 and $2n\sigma = 28$ in 48% of all studied species (Kumbıçak et al., 2009).

Cytogenetic studies on the majority of males of lycosids have similar characteristics: acrocentric or telocentric chromosomes, sex chromosome system in male $X_1X_2\sigma$. Until now, only three species belonging to the genus *Alopecosa* has been studied cytogenetically (Table 2).

As a result, in this study we are studied on two *Alopecosa* species. First species, *A. accentuata* was investigated for the first time as by examining karyological characters, and other species *A. pulverulenta* was studied previously, the karyotypes consist of acrocentric chromosomes and the sex chromosome system is $X_1X_2\sigma$ (Hackman, 1948; Kumbıçak et al., 2009). Telocentric chromosome form of this species was found for the first time in this study.

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LITERATURE CITED

Bayram, A., Kunt, K. B. & Danişman, T. 2015. The Checklist of the Spiders of Turkey, version (online) at <http://www.spidersofturkey.com> 2015, (Version 2014).

Chemisquy, M. A., Rodriguez-Gil, S. G., Scioscia, C. L. & Mola, L. M. 2008. Cytogenetic studies of three Lycosidae species from Argentina (Arachnida, Araneae). Genetics and Molecular Biology, 31: 857-867.

Gorlova, O. Y., Gorlov, I. P., Nevo, E. & Logunov, D. V. 1997. Cytogenetic studies on seventeen spider species from Israel. Bulletin of the British Arachnological Society, 10 (7): 249-252.

Hackman, W. 1948. Chromosomenstudien an Araneen mit besonderer Berücksichtigung der Geschlechtschromosomen. Acta Zoologica Fennica, 54: 1-101.

Jocque, R. & Alderweireldt, M. 2005. Lycosidae: the grassland spiders. Acta Zoologica Bulgarica, 1: 125-130.

Kumbıçak, Z., Ergene, S. & Saygıdeğer, S. 2009. Chromosomal data on six araneomorph spiders belonging to the families Lycosidae and Gnaphosidae (Araneae: Araneomorphae). Zoology in the Middle East, 48: 89-96.

Levan, A., Fredga, K. & Sandbergh, A. A. 1964. Nomenclature for centromeric position on chromosomes. Hereditas, 52 (2): 201-220.

Platnick, N. I. 2015. The world spider catalog, version 16. American Museum of Natural History (online) at <http://research.amnh.org/iz/spiders/catalog/Lycosidae>. (04.V.2015).

Traut, W. 1976. Pachytene mapping in the female silkworm *Bombyx mori* L. (Lepidoptera). Chromosoma, 58: 275-284.

Topçu, A., Demir, H. & Seyyar, O. 2005. A Checklist of the spiders of Turkey. Serket, 9 (4): 109-140.

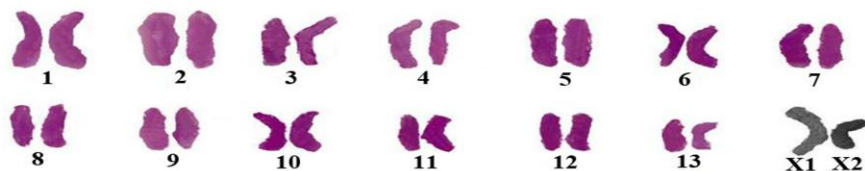
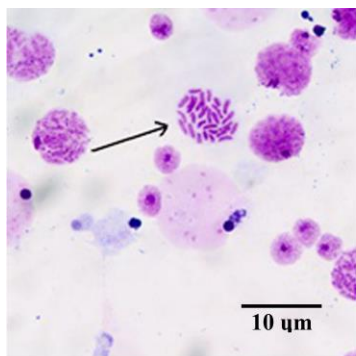


Figure 1. Male karyotype of *Alopecosa pulverulenta* ($2n = 28, X_1X_2\sigma$) (scale = 10 μm).

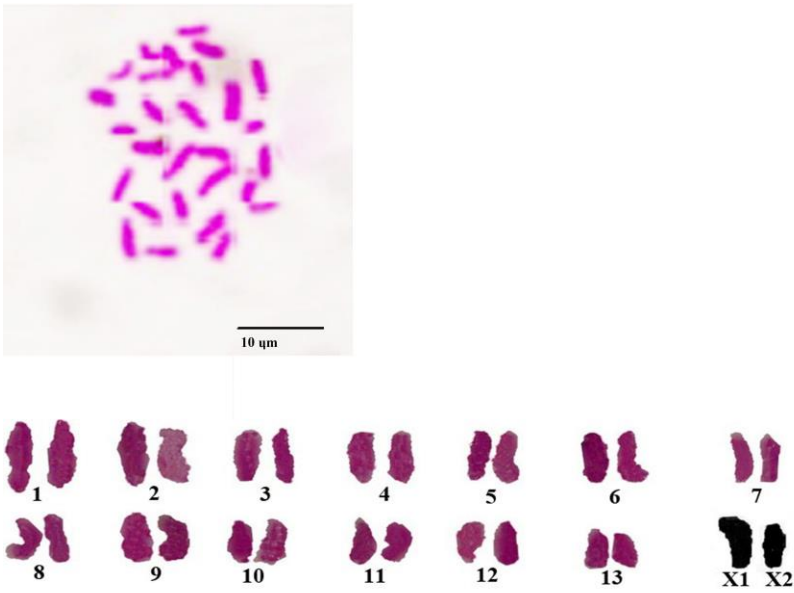


Figure 2. Male karyotype of *Alopecosa accentuata* ($2n = 28, X_1X_2\sigma$) (scale = 10 μm).

Table 1. Relative length of chromosome pairs (RCL) and chromosome morphology (CM) of *Alopecosa pulverulenta* and *A. Accentuata* based on spermatogonial metaphase cells (t: telocentric).

<i>Alopecosa pulverulenta</i>			<i>Alopecosa accentuata</i>		
Pair no.	RCF%	CM	Pair no.	RCF%	CM
1	5.06	t	1	5.34	t
2	4.76	t	2	4.49	t
3	4.57	t	3	4.29	t
4	4.29	t	4	3.99	t
5	3.97	t	5	3.99	t
6	3.83	t	6	3.95	t
7	3.81	t	7	3.85	t
8	3.75	t	8	3.80	t
9	3.60	t	9	3.56	t
10	3.12	t	10	3.48	t
11	3.10	t	11	3.26	t
12	3.00	t	12	3.11	t
13	3.01	t	13	2.81	t
X1	3.38	t	X1	4.66	t
X2	2.70	t	X2	3.20	t

Table 2. List of karyotyped species of the genera *Alopecosa*.

Species	2n	Haploid (σ)	References
<i>A. pulverulenta</i>	28	13+X1X2	Hackman, 1948; Kumbıçak et. al., 2009; In this study
<i>A. albofasciata</i>	28	13+X1X2	Gorlova et. al., 1997
<i>A. aculeata</i>	28	13+X1X2	Hackman, 1948
<i>A. accentuata</i>	28	13+X1X2	In this study

**OCCURRENCE OF ROOT APHID, *FORDA ORIENTALIS*
GEORGE ON A HIGH ALTITUDE PLANT, *ARENARIA*
FESTUCOIDES BENTH IN WESTERN HIMALAYA**

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[Nadda, G. 2015. Occurrence of root aphid, *Forda orientalis* George on a high altitude plant, *Arenaria festuroides* Benth in Western Himalaya. Munis Entomology & Zoology, 10 (2): 499-501]

ABSTRACT: The root aphid, *Forda orientalis* is recognized for the first time from the roots of *Arenaria festuroides* Benth growing at an altitude of 3263 m amsl (latitude-32°33'58.8" N, longitude-76°58'21.8" E) in Lahaul and Spiti district of Himachal Pradesh, India. This is the first report of *F. orientalis* from Indian Himalayan region.

KEY WORDS: Root aphid, *Forda orientalis*, *Arenaria festuroides*, Himalaya.

Arenaria festuroides Benth (Caryophyllaceae) commonly known as “Fescue Sandwort” is a densely tufted perennial plant growing at high altitudes. It is found on rocks and stony ground in the Himalayas, from Pakistan to Uttar Pradesh in India and western Tibet, at an altitude of 3600-4500 m (Flowers of India, 2014). In India, it has been reported from Nilang valley in Uttarakhand (Rawat, 2008), Lahaul and Spiti (Srivastava, 2012) Bharmour forest division, Chamba, HP (Thakur et al., 2014). It has been reported as an endemic plant from Kinnaur, Himachal Pradesh (HP), India (Chawla et al., 2012). It has a short stem (2.5-15 cm) covered with long, soft, transparent and glandular hairs. Stem bears bristle-like, shining, spine-tipped leaves and short erect flowering stems with white flowers. It is commonly called as “mumri” in Chamba area (HP) and is considered as the best fodder for sheep in the region (Thakur et al., 2014). The whole plant is reported to be used in Tibetan medicine.

During our survey, we have found *A. festuroides* growing in the wild area near Centre for High Altitude Biology (CeHAB-a CSIR-Institute of Himalayan Bioresource Technology Centre) at Ribling, Keylong, Lahaul & Spiti (HP) at an altitude of 3263 m amsl (latitude-32°33'58.8" N, longitude-76°58'21.8" E) in the month of October 2013 (Fig. 1A). Some of the *A. festuroides* plants showing stunted growth were uprooted. Their roots were found to be infested with the colonies of root aphids, *Forda orientalis* George (Pemphiginae: Eriosomatinae) (Fig. 1B). Adults and nymphal stages were present. These aphids were very active after uprooting the plants and started dispersing from the colonies. Adult aphids were globose, smooth and yellowish white (Fig. 1C). This is the first record of the occurrence of root aphid, *F. orientalis* on *A. festuroides* and also from Indian Himalayan region. However, root aphids have been reported to occur in ant attended colonies on roots of Poaceae (*Botriochloa*, *Pennisetum*, *Saccharum*, *Sorghum*, *Triticum*) in Israel, Iran, Kazakhstan, India, Pakistan and east Siberia (Aphidsonworldsplants, 2014). It is reported on roots of *Oryza sativa* L. (NBAIL, 2014) and sorghum from southern India. It is an important soil arthropods infesting sugarcane in Coimbatore, Tamil Nadu (Jasmine & Ananthanarayana, 1975; Edwards & Veeresh, 1976). *F. orientalis* are confined to the root zone and presence of aphids is rarely noticed until the plant show symptoms of wilting,

excess tillering, stunted growth and early maturity (Musthak Ali & Sharatchandra, 1986).

To the best of our knowledge and available literature, the root aphid, *F. orientalis* has been reported for the first time from the roots of *A. festucoides* and also from Indian Himalayan region. Further investigations are required to be conducted in order to study the life cycle and population dynamics of these root aphids at the high altitudes of Indian Himalayan region.

ACKNOWLEDGEMENTS

I thank the Director, CSIR-IHBT, Palampur for providing necessary facility for conducting the experiments. I also thank Dr. Sunil Joshi, Principal Scientist, National Bureau of Agriculturally Important Insects, Bangalore, Karnataka, India for kindly identifying the aphids. I thank Mr. Vikrant Awasthi for helping in collection of aphids during the survey and the CSIR-India for providing the funds to complete this study.

LITERATURE CITED

- Aphidsonworldsplants** 2014. http://www.aphidsonworldsplants.info/d_APHIDS_F.htm#Forda (Accessed on 7th July 2014).
- Chawla, A., Parkash, O., Sharma, V., Rajkumar, S., Lal B., Gopichand, Singh R. D. & Thukral, A. K.** 2012. Vascular plants, Kinnaur, Himachal Pradesh, India. Check List, 8: 321-348.
- Edwards, C. A. & Veeresh, G. K.** 1976. Soil biology and ecology in India. In Proceedings of the First All India Symposium held at UAS, Bangalore.
- Flowers of India.** 2014. <http://www.flowersofindia.net/catalog/slides/Fescue%20Sandwort.html>. (Accessed on 7th July 2014).
- Jasmine, P. N. & Ananthanarayana, K.** 1975. A new root aphid on sugarcane in south India. Current Science, 44: 780.
- Musthak Ali, T. M. & Sharatchandra, H. C.** 1986. Role of ants in the establishment of root aphid (*Forda orientalis* George) on finger millet (*Eleusine coracana* Beauv.) and its management. In: Agarwala, B. K. (Eds). Aphidology in India. Proceedings of National Symposium, Agartala (Tripura), 2-4 November 1985. XI. A.R. Printers, Calcutta, pp. 75-80.
- NBAII.** 2014. <http://www.nbaii.res.in/Aphids/Forda-orientalis.php>. (Accessed on 7th July 2014).
- Rawat, G. S.** 2008. Special habitats and threatened plants of India. ENVIS Bulletin: Wildlife and Protected Areas, Vol. 11 (1). Wildlife Institute of India, Dehradun, India, 239.
- Srivastava, D. K.** 2012. Cytomorphological diversity in species of labiatae and scrophulariaceae from Lahaul Spiti and adjoining areas. Ph.D. Thesis, Punjabi University, Patiala.
- Thakur, K. S., Kumar, M., Bawa, R. & Busmann, R.W.** 2014. Ethnobotanical study of herbaceous flora along an altitudinal gradient in Bharmour forest division, district Chamba of Himachal Pradesh, India. Evidence Based Complementary and Alternative Medicine, 1-7.

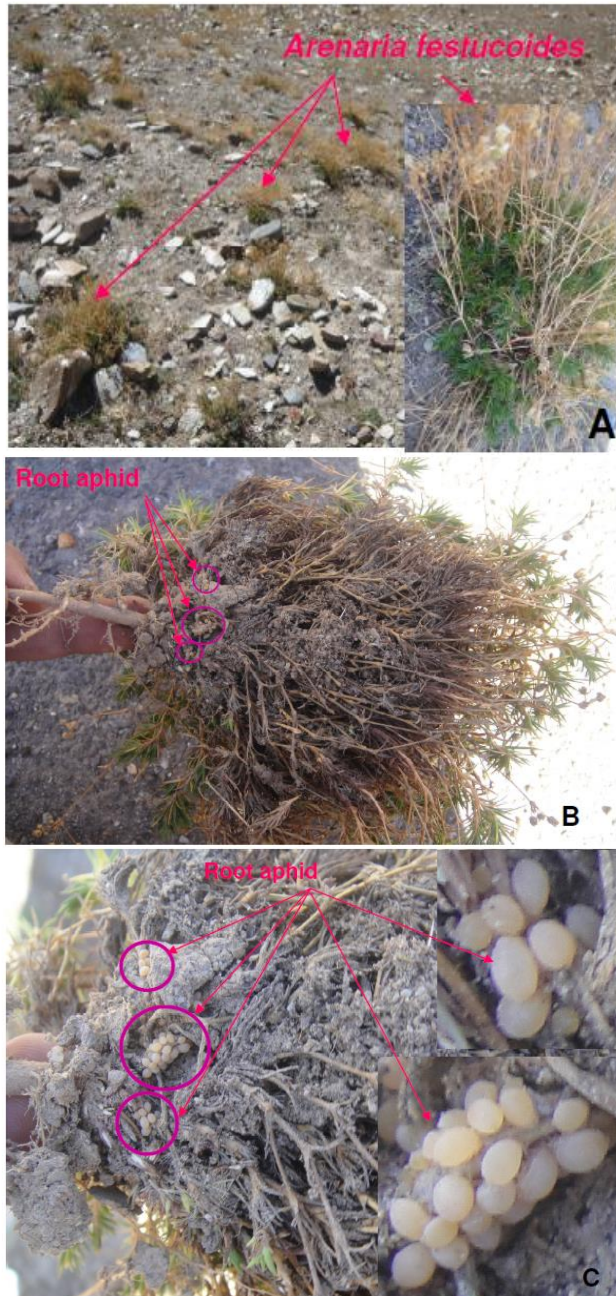


Figure 1. (A). *Arenaria festucoides* Benth in the field; (B). Uprooted plant showing colonies of root aphid, *Forda orientalis* George; (C). Enlarged view of root aphid colonies.

**A NEW RECORD OF *BIBASIS GOMATA* (LEPIDOPTERA:
HESPERIIDAE) ON KESSERU, *HETEROPANAX FRAGRANS*
(ROXB.) FROM INDIA**

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[Krajčovičová, K., Christophoryová, J. & Lučeničová, T. 2015. A new record of *Bibasis gomata* (Lepidoptera: Hesperiiidae) on kesseru, *Heteropanax fragrans* (Roxb.) from India. Munis Entomology & Zoology, 10 (2): 502-505]

ABSTRACT: *Bibasis gomata* Moore (1865) is belongs to the family Hesperiiidae in order Lepidoptera was noticed feeding on kesseru plant, *Heteropanax fragrans* (Roxb.) Seem (Family: Araliaceae) during 2013 and analysis of literature indicates that this is the first record of *B. gomata* Moore on kesseru plantation crop at Farm No. 3, Central Muga Eri Research and Training Institute, Central Silk Board, Ministry of Textiles, Govt. of India, Lahdoigarh, Assam. In the manuscript the host range of *B. gomata* and taxonomy and morphological characters are presented.

KEY WORDS: *Bibasis gomata*, new record, kesseru, Assam, India.

Kesseru, *Heteropanax fragrans* (Roxb.) Seem (Family: Araliaceae) is primary host plant for Eri Silkworm, *Samia ricini*, Helfer (Lepidoptera: Saturniidae) in whole Assam and other North Eastern Region of India where the eri silkworm rearing occurs. This tree usually attacked by many pests, leaf eating weevil, sucking pests, mealy bugs etc. Recently, *Bibasis gomata* Moore (1865) (Lepidoptera: Hesperiiidae) was noticed feeding on the leaves of *H. fragrans* during the year 2013. North eastern region of India is abode to endemic insect biodiversity. Kesseru plantation is available in North Eastern India and eri silkworm is grown to get silk for making fabric and pupae for eating. The purpose of this paper is to highlight important observations of *B. gomata* found feeding on leaves of kesseru.

MATERIALS AND METHODS

All the specimens were collected and preserved in well fumigated wooden boxes. Prior to collection, the beetles were photographed in the field condition during the year 2013 at Farm No. 3, Central Muga Eri Research and Training Institute, Central Silk Board, Ministry of Textiles, Govt. of India, Lahdoigarh, Assam. For field observations specimens and damage symptoms were photographed by Nikon 14.0 mega pixel. The photographs were edited using software ACDSee 9.0 Photo Manager and prepared plate in 600 dpi using software Adobe Photoshop 7.0.

RESULTS AND DISCUSSION

***Bibasis gomata* (Lepidoptera: Hesperiiidae)**

Bibasis gomata Moore, 1865

Ismene gomata Moore (1866)

Choaspes gomata

Burara gomata

Burara gomata gomata

Type Locality: Darjeeling

LARVAL CHARACTERS (Figs. 1-3)

26 mm last instar. 6 black spots are present at head on last instar of larva. First instar larva 4 mm in size.

PUPAL CHARACTERS (Figs. 4-6)

Pupa forms upperside of leaves. Pinkish and brown in color, cremaster present at the last segment. Wings and thorax are light grey. Laterally, black spots are present extending to last segment. Ventrally, two black spots present in head. Thorax contains one spindle shaped black spot on dorsal side.

ADULTS (Figs. 7-13)

Male: Wing span 46 mm, Upperside pale vinaceous brown ; both wings with pale brownish yellow streaks longitudinally between the veins. Abdomen blackish brown with yellowish bands. Cilia yellow, underside dark brown, with the veins and longitudinal streaks between them greyish green, the brown showing only along each side of the veins; posterior margin of forewing broadly pale vinaceous; exterior margin of both wings defined by a brown line. Labial palpus three segmented and third segment turns down and brown in color, the rest is yellow. Thorax, legs and abdomen beneath orange are yellow.

Female: Wing span 40 mm, Upperside very dark glossy bronzygreen, shading off into glossy indigo-blue at the apex and outer margin. Forewing with a pale green spot in the second median interspace, with a larger one in the interspace below it, in the male these spots are merged in a large patch of the ochreous ground-colour from the inner margin. The green markings everywhere more restricted and of a darker shade. Labial palpus three segmented and third segment turns down and brown in color, the rest is yellow. Thorax, legs and abdomen beneath orange are yellow.

Male Genitalia: Uncus broad and sclerotized; valvae symmetrical, and harpae sclerotized present on both the valvae. Juxta less sclerotized. Vinculum present and membranous; saccus V-shaped and less sclerotized. Sclerotized spiny cornutii present in aedeagus and vesica present.

Female Genitalia: Anterior apophysis and posterior apophyses present, but short. Ostium bursae sclerotized and ductus bursae long. Corpus bursae balloon shaped, long contains hard denticulate sclerotized brown color signum.

Host plants: *Schefflera octophylla* (Lour.) Harms (Family Araliaceae) (oldhks.org/info-b_gomata.html); *Schefflera lurida*, *Trevesia sundaica*, *Embelia graciniaefolia*, *Horsfieldia* sp. (Corbet and Pendlebury, 1992) Corbet *et al.*, (1992). New record on kesseru plant, *Heteropanax fragrans* (Roxb.) Seem (Family: Araliaceae).

Distribution: Hong Kong, China, Mala peninsula, Philippines, Indonesia archipelago, India (Assam, Sikkim, West Bengal, South India and Himalayan Belt of India) (Wikipedia).

Damage Symptoms: Larvae always feed after folding the leaves.

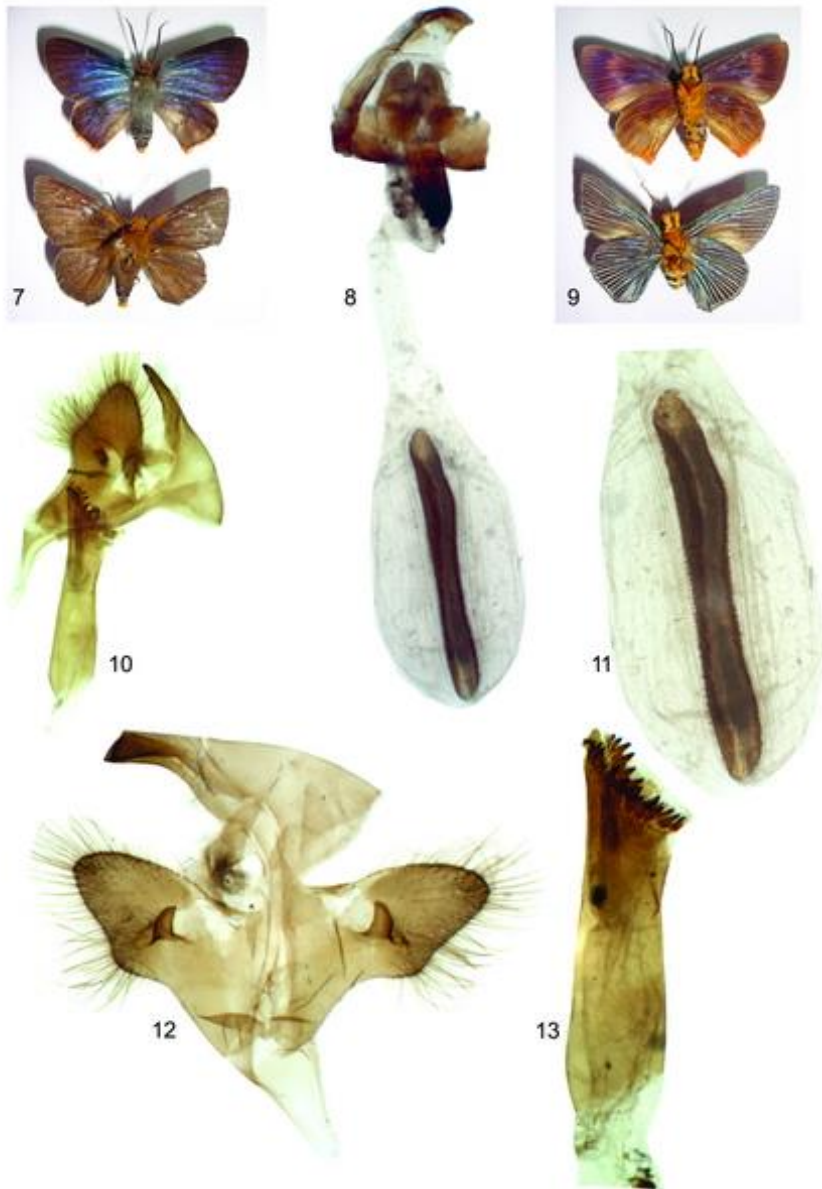
Material Examined: 3 ♂♂, 29.09.2013, 06.10.2013, 29.09.2013. 4 ♀♀, 10.10.2013, 10.04.2013, 10.10.2013, 15.11.2013. Farm No. 3, CMERTI, Lahdoigarh, Jorhat, Assam (India) leg. P. Chutia and Rajesh Kumar feeding on *Heteropanax fragrans* (Roxb.) Seem (Family: Araliaceae).

LITERATURE CITED

Corbet, A. S., Pendlebury, H. M. & Eliot, J. N. 1992. The butterflies of the Malay Peninsula, 4th Edition, ISBN 983-9681-05-2 Kuala Lumpur Malayan Nature Soc., 595 pp.
Web address: oldhks.org/info-b_gomata.html
Wikipedia, 2014. En.wikipedia.org/wiki/Bibasis_gomata



Figure 1-5. *Bibasis gomata*- 1-2. Prepupal stage of larva, 3. Head capsule of larvae, 4. Dorsal side of pupa, 5. ventral view of pupa, 6. Lateral view of pupa.



Figures 7-13. *Bibasis gomata* – 7. Dorsal view of male & female, 8. Female genitalia, 9. Ventral view of male & female, 10. Lateral view of male genitalia along with aedeagus, 11. Signum in corpus bursae of female genitalia, 12. Ventral view of male genitalia, 13. Aedeagus.

SUBSTITUTIONAL NAMES AND NEW COMBINATIONS FOR TAXA OF OSTRACODA (ARTHROPODA: CRUSTACEA)

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[Kempf, E. K. 2015. Substitutional names and new combinations for taxa of Ostracoda (Arthropoda: Crustacea). Munis Entomology & Zoology, 10 (2): 506-517]

ABSTRACT: For junior primary homonyms of ostracod genera the following substitutional names are proposed: *Uralinova* nom. nov. for *Uralina* Rozhdestvenskaya, 1962; *Vanalabia* nom. nov. for *Vania* Kruta & Siveter, 1998; *Kunluniacypris* nom. nov. for *Kunlunia* Jiang & Lin, 1995. For junior primary homonyms of ostracod species the following substitutional names are proposed: *Cypris methueni* nom. nov. for *Cypris tuberculata* Methuen, 1910; *Procytherura erichbrandi* nom. nov. for *Procytherura reticulata* Brand, 1990; *Paradoxostoma mostafawii* nom. nov. for *Paradoxostoma ensiformis* (recte: *ensiforme*) Mostafawi, Nabavi & Moghaddasi, 2010; *Paradoxostoma lucasae* nom. nov. for *Paradoxostoma cuneata* (recte: *cuneatum*) Lucas, 1931; *Trachyleberis abkhaziana* nom. nov. for *Trachyleberis quadrata* Imnadze, 1975; *Agrenocythere ciampoi* nom. nov. for *Agrenocythere bensoni* Ciampo, 1981. In addition, 77 new combinations for ostracod species are proposed.

KEY WORDS: Ostracoda, nomenclatural changes, junior homonyms, replacement names, new combinations.

Class Ostracoda Latreille, 1802
Order Kloedenellocopida Scott, 1961
Suborder Kloedenellocopina Scott, 1961
Superfamily Kloedenelloidea Ulrich & Bassler, 1908
Family Gotlandellidae Sarv, 1978

Genus *Uralinova* nom. nov.

Uralina Rozhdestvenskaya, 1962. Srednedeviskie ostrakody zapadnogo sklona yuzhnogo Urala ...: 208. (Crustacea: Ostracoda). Preoccupied by *Uralina* Schuchert & LeVene, 1929. American Journal of Science, series 5, 17 (98): 122. (Brachiopoda).

Remarks on nomenclatural change: The genus name *Uralina* was coined by Schuchert & LeVene (1929) as a nomen novum for *Uralia* Licharew, 1925 (Brachiopoda), an invalid junior homonym of *Uralia* Mulsant & Verreaux, 1866. Subsequently, the genus *Uralina* was erected by Rozhdestvenskaya (1962) for a fossil ostracod.

Thus the genus name *Uralina* Rozhdestvenskaya, 1962 is a primary junior homonym of the valid genus name *Uralina* Schuchert & LeVene, 1929. Herewith I propose to replace *Uralina* Rozhdestvenskaya, 1962 with the new substitutional name *Uralinova*.

Actually known species (according to Kempf 1986, 1995, 2008, and in preparation a):

Type species: *Uralinova uralica* (Rozhdestvenskaya, 1960) **comb. nov.**

Original binomen: *Endolophia ? uralica* Rozhdestvenskaya, 1960

Additional species:

Uralinova grandis (Rozhdestvenskaya, 1959) **comb. nov.**

Original binomen: *Endolophia grandis* Rozhdestvenskaya, 1959

Uralinova scrobiculata (Polenova, 1952) **comb. nov.**

Original binomen: *Evlanella scrobiculata* Polenova, 1952

Etymology: To remain similar in meaning, the original name *Uralina* is changed to *Uralinova*. Gender feminine.

Family ? Kloedenellitinae Abushik, 1990

Genus *Vanalabia* nom. nov.

Vania Kruta & Siveter, 1998. Stereo-Atlas of Ostracod Shells, 25 (11): 53-56 (Crustacea: Ostracoda). Preoccupied by *Vania* Sirel & Gündüz, 1985. Bulletin of the Mineral Research and Exploration Institute of Turkey, 101-102 (1983-1984): 20-24 (Foraminiferida).

Already in 1911 (page 756) a name *Vania* was introduced by Clark for a group of species within the typical subgenus *Comanthus* of the genus *Comanthus* (Echinodermata: Crinoidea). That name seems to be treated as a synonym of *Comanthus* at present.

Remarks on nomenclatural change: In 1985 the name *Vania* was introduced by Sirel & Gündüz for a genus of larger Foraminifera from the early Tertiary of eastern Turkey. Subsequently, the name *Vania* was validated by Kruta & Siveter (1998) for a genus of fossil Ostracoda from the Upper Silurian of Bohemia, a name that had already been used as a nomen nudum since 1988.

As a consequence, the genus name *Vania* Kruta & Siveter, 1998 is a primary junior homonym of *Vania* Sirel & Gündüz, 1985. Herewith I propose to replace *Vania* Kruta & Siveter, 1998 with the new substitutional name *Vanalabia*.

Actually known species (according to Kempf 1986, 1995, 2008, and in preparation a):

Type species: *Vanalabia perdita* (Kruta & Siveter, 1998) **comb. nov.**

Original binomen: *Vania perdita* Kruta & Siveter, 1998

Additional species:

Vanalabia vera (Schallreuter, 2001) **comb. nov.**

Original binomen: *Vania vera* Schallreuter, 2001

Etymology: The name *Vania* of Kruta & Siveter, as now also *Vanalabia*, was coined in honour of M. Vana, Laboratory of the Institute of Geology, Academy of Sciences, Czech Republic, Prague. Gender feminine.

Family ? Barychilinidae Ulrich, 1894

Genus *Keslingolophia* Özdikmen, 2009

2009 *Keslingolophia* Özdikmen, Munis Entomology & Zoology, 4 (2): 614.

Remarks on nomenclatural change: This new substitutional genus name was published for the primary junior homonym *Endolophia* Kesling, 1954 (preoccupied by *Endolophia* Hampson, 1899), but without citing any names of species.

Actually known species (according to Kempf 1986, 1995, 2008, and in preparation a):

Type species: *Keslingolophia chariessa* (Kesling, 1954) **comb. nov.**

Original binomen: *Endolophia chariessa* Kesling, 1954

Additional species:

Keslingolophia secunda (Lethiers, 1981) **comb. nov.**

Original binomen: *Endolophia secunda* Lethiers, 1981

Remarks: The species *Endolophia uralica* Rozhdestvenskaya, 1960 and *Endolophia grandis* Rozhdestvenskaya, 1959 had been transferred to the new genus *Uralina* Rozhdestvenskaya, 1962 which turned out to represent a primary junior homonym which above is substituted by the new name *Uralinova*.

Order Platycopida Sars, 1866 Family Cavellinidae Egorov, 1950

Genus *Bektasia* Özdikmen, 2010

2010 *Bektasia* Özdikmen, Munis Entomology & Zoology, 5 (1): 316.

Remarks on nomenclatural change: This new substitutional genus name was published for the primary junior homonym *Reubenella* Sohn, 1968 (preoccupied by *Reubenella* Lochman, 1966), but without citing any names of species.

Actually known species (according to Kempf 1986, 1995, 2008, and in preparation a):

Type species: *Bektasia avnimelechi* (Sohn, 1968) **comb. nov.**

Original binomen: *Reubenella avnimelechi* Sohn, 1968

Additional species:

Bektasia amnechoroshevi (Gramm, 1970) **comb. nov.**

Original binomen: *Recytella amnechoroshevi* Gramm, 1970

Bektasia angulata (Monostori, 1995) **comb. nov.**

Original binomen: *Reubenella angulata* Monostori, 1995

Bektasia gibbera (Kristan-Tollmann, 1973) **comb. nov.**

Original binomen: *Reubenella gibbera* Kristan-Tollmann, 1973

Bektasia gracilisculpta (Kristan-Tollmann, 1991) **comb. nov.**

Original binomen: *Reubenella gracilisculpta* Kristan-Tollmann, 1991

Bektasia ivisensis (Kristan-Tollmann, 1973) **comb. nov.**

Original binomen: *Reubenella ivisensis* Kristan-Tollmann, 1973

Bektasia khanehkatensis (Crasquin-Soleau & Teherani, 1995) **comb. nov.**

Original binomen: *Reubenella khanehkatensis* Crasquin-Soleau & Teherani, 1995

Bektasia kramtchanini (Gramm, 1969) **comb. nov.**

Original binomen: *Cavussurella kramtchanini* Gramm, 1969

Bektasia ovata (Hou & Gou, 1977) **comb. nov.**

Original binomen: *Reubenella ovata* Hou & Gou, 1977

Bektasia picardi (Sohn, 1968) **comb. nov.**

Original binomen: *Reubenella picardi* Sohn, 1968

Bektasia sandbergeri (Coryell, 1963) **comb. nov.**

Original binomen: *Cytherella sandbergeri* Coryell, 1963

Order Podocopida G.O.Sars, 1866
Superfamily Cypridoidea Baird, 1845
Family Cyprididae Baird, 1845
Genus *Cypris* O.F.Müller, 1776

***Cypris methueni* nom. nov.**

Cypris tuberculata Methuen, 1910. Proceedings of the Zoological Society of London, 1910 (1): 156. Preoccupied by *Cypris tuberculata* Sowerby, 1836. Transactions of the Geological Society of London, series 2, 4 (2): 345, plate XXI: figs. 2b and 2c.

Remarks on nomenclatural change: At least since the publication of the first volume of "Index and bibliography of nonmarine Ostracoda" (Kempf, 1980) that old case of homonymy is known, but until now there is not registered an appropriate replacement name in the Kempf Database Ostracoda.

Comparison of the published descriptions and figures of *Cypris tuberculata* Sowerby, 1836, discovered in Wealden sediments from Seabrook near Hythe in England, with the modern *Cypris tuberculata* Methuen, 1910 from the shallow littoral water of Lake Chrissie in South Africa reveals that in addition to the great contrariety in age and space also their shells look quite different.

Consequently, according to the International Code of Zoological Nomenclature (1999) *Cypris tuberculata* Methuen, 1910 represents a junior primary homonym, for which *Cypris methueni* nom. nov. is herewith introduced as a substitutional new name.

In the course of time *Cypris tuberculata* Sowerby, 1836 has been transferred to another genus and was combined as *Cypridea tuberculata* (Sowerby, 1836) Jones, 1878. Similarly *Cypris tuberculata* Methuen, 1910 was informally combined as *Sclerocypris tuberculata* (Methuen, 1910) by Klie (1939). Under that name the species has been reported upon several times and furthermore has experienced an additional extended description (Martens, 1991). Now its name has to be changed to *Sclerocypris methueni* (Kempf, 2015) **comb. nov.**

In 1971 *Megalocypris tuberculata* Sars, 1924 was combined as *Sclerocypris tuberculata* (Sars, 1924) by McKenzie. As it was regarded to be a junior subjective homonym of *Sclerocypris tuberculata* (Methuen, 1910), *Sclerocypris sarsi* Martens, 1986 was later published as a substitutional name. This name is no longer needed, as *Sclerocypris tuberculata* (Sars, 1924) McKenzie, 1971 can be used again, because this name is no homonym of *Sclerocypris methueni* (Kempf, 2015).

Etymology: The new name is honouring Paul Ayshford Methuen in recognition of his valuable contributions to zoology.

Genus *Kunhuniacypris* nom. nov.

Kunlunia Jiang & Lin, 1995 in Jiang, Zhou, Lin et al. 1995. Stratigraphy and ostracods of Xinjiang in China: 203, 489, plate 62: 17a-b, 18a-b (Crustacea:

Ostracoda). Preoccupied by *Kunlunia* Wang, 1983 in Zhang et al. 1983. Palaeontological Atlas of northwestern China: 308 (Brachiopoda: Productida).

Remarks on nomenclatural change: In 1983 the genus name *Kunlunia* was introduced by Wang in Zhang et al. for a brachiopod from the Permian of China. Subsequently, the name *Kunlunia* was coined by Jiang & Lin (1995) for a genus of fossil Ostracoda from the non-marine Upper Permian of the Tarim Basin, China.

Thus, the genus name *Kunlunia* Jiang & Lin, 1995 is a primary junior homonym of *Kunlunia* Wang, 1983. Herewith I propose to replace *Kunlunia* Jiang & Lin, 1995 with the new substitutional name *Kunluniacypris*.

Actually known species (according to Kempf 1986, 1995, 2008, and in preparation a):

Type species: *Kunluniacypris haoae* (Jiang & Lin, 1995) **comb. nov.**

Original binomen: *Kunlunia haoae* Jiang & Lin, 1995

Etymology: The new name is composed of *Kunlunia* and the suffix "cypris" in order to maintain a similarity to the original name. Gender feminine.

Superfamily Cytheroidea Baird, 1850

Family Cytheruridae G. W. Müller, 1894

Genus *Procytherura* Whatley, 1970

***Procytherura erichbrandi* nom. nov.**

Procytherura reticulata Brand, 1990. Geologisches Jahrbuch, Reihe A, 121: 166. Preoccupied by *Procytherura reticulata* Ainsworth, 1986. Geological Survey of Ireland Bulletin, 3: 305.

Remarks on nomenclatural change: In July 1993 I informed Dr. Erich Brand of that case of homonymy. He expressed his intention to publish a replacement name, but until now such a substitutional name could not be registered for the Kempf Database Ostracoda.

Comparison of the published descriptions and figures of *Procytherura reticulata* Ainsworth, 1986 from Late Toarcian to Aalenian sediments of the Fastnet Basin with those of *Procytherura reticulata* Brand, 1990 from Upper Bathonian sediments of Northwest Germany reveals that both with a length of about 0.3 mm are very small ostracods of nearly equal size. However, with the triangular outline and the flattened anterior and posterior ends of the shell *Procytherura reticulata* Brand, 1990 shows significant differences.

Consequently, according to the International Code of Zoological Nomenclature (1999) *Procytherura reticulata* Brand, 1990 represents a junior primary homonym, for which *Procytherura erichbrandi* nom. nov. is herewith introduced as a necessary new name.

Etymology: The new name is honouring Dr. Erich Brand (1914–2011) in recognition of his valuable contributions to micropalaeontology, especially ostracodology, but also in remembrance of his biostratigraphical work for the benefit of the oil industry.

Family Paradoxostomatidae Brady & Norman, 1889
Genus *Paradoxostoma* Fischer, 1855

***Paradoxostoma mostafawii* nom. nov.**

Paradoxostoma ensiformis (recte: *ensiforme*) Mostafawi, Nabavi & Moghaddasi, 2010. Revista Española de Micropaleontología, 42 (2): 260, plate 3, figs. 19-20. Preoccupied by *Paradoxostoma ensiforme* Brady, 1868. Transactions of the Linnean Society London, 26 (2): 460, plate 35, figs. 8-11.

Remarks on nomenclatural change: In January 2011 I informed Dr. Mostafawi of that case of homonymy, but until now there could not be registered a replacement name in the Kempf Database Ostracoda.

Comparison of the published descriptions and figures of the two species reveals that they are not synonymous. The valves of *Paradoxostoma ensiforme* Brady, 1868 from the North Atlantic are about 15% longer and differ considerably in outline, especially in the posterior part.

Consequently, according to the International Code of Zoological Nomenclature (1999) *Paradoxostoma ensiforme* Mostafawi, Nabavi & Moghaddasi, 2010 from the Strait of Hormuz represents a junior primary homonym, for which *Paradoxostoma mostafawii* nom. nov. is herewith introduced as a necessary new name.

Etymology: The new name is honouring Dr. Nasser Mostafawi in recognition of his valuable contributions to ostracodology.

***Paradoxostoma lucasae* nom. nov.**

Paradoxostoma cuneata (recte: *cuneatum*) Lucas, 1931. Contributions to Canadian Biology and Fisheries, 6 (1): 409, fig. 6. Preoccupied by *Paradoxostoma cuneatum* Brady & Robertson, 1874. Annals and Magazine of Natural History, series 4, 13 (74): 117, plate 5, figs. 6, 7.

Remarks on nomenclatural change: At least since the publication of the first volume of "Index and bibliography of marine Ostracoda" (Kempf, 1986) that old case of homonymy is known, but until now a replacement name is not yet registered in the Kempf Database Ostracoda.

Comparison of the published descriptions and figures of the two species reveals that they are not synonymous. The valves of *Paradoxostoma cuneatum* Lucas, 1931 are larger and in side view they differ considerably in outline, as anterior and posterior margins are more narrowly rounded.

Consequently, according to the International Code of Zoological Nomenclature (1999) *Paradoxostoma cuneatum* Lucas, 1931 represents a junior primary homonym of *Paradoxostoma cuneatum* Brady & Robertson, 1874 for which *Paradoxostoma lucasae* nom. nov. is herewith introduced as a necessary new name.

Etymology: The new name is honouring Verna Z. Lucas, in later years Verna Z. Smith, for her contributions to ostracodology.

Family Trachyleberididae Sylvester-Bradley, 1948
Genus *Trachyleberis* Brady, 1898

***Trachyleberis abkhaziana* nom. nov.**

Trachyleberis quadrata Imnadze, 1975 in Vekua, 1975: Ostrakody Kimmeriyskikh i Kuyalnitskikh otlozheniy Abkhazii.: 97, plate 15: 6. Preoccupied by *Trachyleberis quadrata* Howe & Howe, 1973. Journal of Paleontology, 47 (4): 645, plate 4: 14-15.

Remarks on nomenclatural change: Since the publication of the first volume of "Index and bibliography of marine Ostracoda" (Kempf, 1986) that case of homonymy is known, but until now there is not registered a replacement name in the Kempf Database Ostracoda.

Comparison of the published descriptions and figures of those two species reveals that they cannot be synonymous, as there are distinct differences of their shells in size, outline, and surface sculpturing.

Consequently, according to the International Code of Zoological Nomenclature (1999) *Trachyleberis quadrata* Imnadze, 1975 from Kuyalnikian (Upper Pliocene) deposits represents a junior primary homonym of *Trachyleberis quadrata* Howe & Howe, 1973 from Upper Eocene deposits, for which *Trachyleberis abkhaziana* nom. nov. is herewith introduced as a substitutional new name.

Etymology: The new name refers to Abkhazia, the geographical region where this species was detected near the village Pokveshi for the first time.

Genus *Agrenocythere* Benson, 1972

***Agrenocythere ciampoi* nom. nov.**

Agrenocythere bensoni Ciampo, 1981. Bollettino della Societa Paleontologica Italiana, 20 (1): 64. Preoccupied by *Agrenocythere bensoni* Pokorný, 1977. Casopis pro mineralogii a geologii, 22 (4): 384.

Remarks on nomenclatural change: Since the publication of the first volume of "Index and bibliography of marine Ostracoda" (Kempf, 1986) that case of homonymy is made known, but until now there is not registered a replacement name in the Kempf Database Ostracoda.

Comparison of the published descriptions and figures reveals that the Upper Oligocene species *Agrenocythere bensoni* Ciampo, 1981 from Sicily and the Eocene species *Agrenocythere bensoni* Pokorný, 1977 from Moravia are not conspecific. There are differences in outline and sculpturing. Moreover, in length and height the Upper Oligocene species is about one third larger.

Consequently, according to the International Code of Zoological Nomenclature (1999) *Agrenocythere bensoni* Ciampo, 1981 represents a junior primary homonym, for which *Agrenocythere ciampoi* nom. nov. is herewith introduced as a substitutional new name.

Etymology: The new name is honouring Dr. Giuliano Ciampo in recognition of his many valuable contributions to ostracodology.

Family Hemicytheridae Puri, 1953**Genus *Aysegulina* Özdikmen, 2010**

2010 *Aysegulina* Özdikmen, Munis Entomology & Zoology, 5 (1): 315.

Remarks on nomenclatural change: This new substitutional genus name was published for the primary junior homonym *Limburgina* Deroo, 1966 (preoccupied by *Limburgina* Laurentiaux, 1950), but without citing any names of species.

Actually known species (according to Kempf 1986, 1995, 2008, and in preparation a):

Type species: *Aysegulina ornata* (Bosquet, 1847) **comb. nov.**

Original binomen: *Cypridina ornata* Bosquet, 1847

Additional species:

Aysegulina alveolalata (Sharapova, 1937) **comb. nov.**

Original binomen: *Cythereis alveolalata* Sharapova, 1937

Aysegulina arabica (Al-Furaih, 1983) **comb. nov.**

Original binomen: *Limburgina arabica* Al-Furaih, 1983

Aysegulina ariyalurensis (Jain, 1977) **comb. nov.**

Original binomen: *Limburgina ariyalurensis* Jain, 1977

Aysegulina astrei (Blanc & Colin, 1975) **comb. nov.**

Original binomen: *Limburgina astrei* Blanc & Colin, 1975

Aysegulina aurora (Neale, 1975) **comb. nov.**

Original binomen: *Limburgina aurora* Neale, 1975

Aysegulina bhatiai (Jain, 1977) **comb. nov.**

Original binomen: *Limburgina bhatiai* Jain, 1977

Aysegulina binkhorsti (Veen, 1936) **comb. nov.**

Original binomen: *Cythereis binkhorsti* Veen, 1936

Aysegulina briarti (Marliere, 1958) **comb. nov.**

Original binomen: *Bradleya ? briarti* Marliere, 1958

Aysegulina calciporacea (Deroo, 1966) **comb. nov.**

Original binomen: *Limburgina calciporacea* Deroo, 1966

Aysegulina castanea (Deroo, 1966) **comb. nov.**

Original binomen: *Limburgina castanea* Deroo, 1966

Aysegulina cauditeiformis (Margerie, 1968) **comb. nov.**

Original binomen: *Limburgina cauditeiformis* Margerie, 1968

Aysegulina chapeltonensis Puckett & Colin, 2012 in Puckett, Colin & Mitchell

Aysegulina damottae (Babinot, 1980) **comb. nov.**

Original binomen: *Limburgina damottae* Babinot, 1980

Aysegulina eopacifica (Malz, 1981) **comb. nov.**

Original binomen: *Limburgina eopacifica* Malz, 1981

Aysegulina foncirquensis (Tambareau, 1972) **comb. nov.**

Original binomen: *Limburgina foncirquensis* Tambareau, 1972

Aysegulina foresterae (J.K.Smith, 1978) **comb. nov.**

Original binomen: *Limburgina ? foresterae* J.K.Smith, 1978

Aysegulina formosa (Bate, 1972) **comb. nov.**

Original binomen: *Limburgina formosa* Bate, 1972

Aysegulina frescoensis (Apostolescu, 1961) **comb. nov.**

Original binomen: *Bradleya frescoensis* Apostolescu, 1961

- Aysegulina furoi* (Colin & Lauverjat, 1974) **comb. nov.**
Original binomen: *Limburgina* ? *furoi* Colin & Lauverjat, 1974
- Aysegulina galvensis* (Bremán, 1976) **comb. nov.**
Original binomen: *Rehacythereis galvensis* Bremán, 1976
- Aysegulina gerryi* (Rosenfeld, 1974) **comb. nov.**
Original binomen: *Limburgina* ? *gerryi* Rosenfeld, 1974
- Aysegulina gowdai* (Mallikarjuna & Nagaraja, 1996) **comb. nov.**
Original binomen: *Limburgina gowdai* Mallikarjuna & Nagaraja, 1996
- Aysegulina grekovi* (Damotte, 1962) **comb. nov.**
Original binomen: *Cythereis grekovi* Damotte, 1962
- Aysegulina guhai* (Mallikarjuna & Nagaraja, 1996) **comb. nov.**
Original binomen: *Limburgina guhai* Mallikarjuna & Nagaraja, 1996
- Aysegulina hellenica* (Babinot, 1988) **comb. nov.**
Original binomen: *Limburgina hellenica* Babinot, 1988
- Aysegulina indica* (Sastry & Mamgain, 1972) **comb. nov.**
Original combination: *Cythereis binkhorsti indica* Sastry & Mamgain, 1972
- Aysegulina karcevae* (Lev, 1983) **comb. nov.**
Original binomen: *Cythereis karcevae* Lev, 1983
- Aysegulina khoslai* (Mallikarjuna & Nagaraja, 1996) **comb. nov.**
Original binomen: *Limburgina khoslai* Mallikarjuna & Nagaraja, 1996
- Aysegulina longiporacea* (Deroo, 1966) **comb. nov.**
Original binomen: *Limburgina longiporacea* Deroo, 1966
- Aysegulina mannikerii* (Mallikarjuna & Nagaraja, 1996) **comb. nov.**
Original binomen: *Limburgina mannikerii* Mallikarjuna & Nagaraja, 1996
- Aysegulina mauritsi* (Marliere, 1958) **comb. nov.**
Original binomen: *Bradleya* ? *mauritsi* Marliere, 1958
- Aysegulina mbassisensis* Sarr, 2014
- Aysegulina miarensis* (Honigstein, 1984) **comb. nov.**
Original binomen: *Limburgina miarensis* Honigstein, 1984
- Aysegulina octofera* (Veen, 1936) **comb. nov.**
Original binomen: *Cythereis octofera* Veen, 1936
- Aysegulina oertlii* Sauvagnat & Colin, 2014
- Aysegulina ornatella* (Deroo, 1966) **comb. nov.**
Original binomen: *Limburgina ornatella* Deroo, 1966
- Aysegulina ornatoidea* (Deroo, 1966) **comb. nov.**
Original binomen: *Limburgina ornatoidea* Deroo, 1966
- Aysegulina ornatoidea* (Deroo, 1966) **comb. nov.**
Original binomen: *Limburgina ornatoidea* Deroo, 1966
- Aysegulina papillata* Sarr, 2014
- Aysegulina pectinata* (Babinot, 1980) **comb. nov.**
Original binomen: *Limburgina pectinata* Babinot, 1980
- Aysegulina pegnolaensis* (Rodríguez-Lazaro, 1988) **comb. nov.**
Original binomen: *Limburgina pegnolaensis* Rodríguez-Lazaro, 1988
- Aysegulina pokornyj* (Jain, 1977) **comb. nov.**
Original binomen: *Limburgina pokornyj* Jain, 1977
- Aysegulina postaurora* (Dingle, 2009) **comb. nov.**
Original binomen: *Limburgina postaurora* Dingle, 2009
- Aysegulina pseudosemicancellata* (Veen, 1936) **comb. nov.**
Original binomen: *Cythereis pseudosemicancellata* Veen, 1936
- Aysegulina quadrazea* (Hornibrook, 1952) **comb. nov.**
Original binomen: *Quadracythere quadrazea* Hornibrook, 1952
- Aysegulina riominhoensis* Puckett & Colin, 2012 in Puckett, Colin & Mitchell

- Aysegulina sagitta* Puckett & Colin, 2012 in Puckett, Colin & Mitchell
Aysegulina santamariae (Andreu, 1983) **comb. nov.**
 Original binomen: *Limburgina* ? *santamariae* Andreu, 1983
Aysegulina santonia (Honigstein, 1984) **comb. nov.**
 Original binomen: *Limburgina* ? *santonia* Honigstein, 1984
Aysegulina sarlatensis (Colin, 1973) **comb. nov.**
 Original binomen: *Limburgina* ? *sarlatensis* Colin, 1973
Aysegulina semicancellata (Bosquet, 1854) **comb. nov.**
 Original binomen: *Cythere semicancellata* Bosquet, 1854
Aysegulina senonensis (Damotte, 1964) **comb. nov.**
 Original binomen: *Cythereis senonensis* Damotte, 1964
Aysegulina seuvensis (Andreu, 1983) Sauvagnat & Colin, 2014
 Original binomen: *Limburgina seuvensis* Andreu, 1983
Aysegulina spinosareticulata (Margerie, 1968) **comb. nov.**
 Original binomen: *Limburgina spinosareticulata* Margerie, 1968
Aysegulina uberata (Apostolescu, 1961) Sarr, 2014
 Original binomen: *Bradleya uberata* Apostolescu, 1961
Aysegulina uhlenbroeki (Deroo, 1966) **comb. nov.**
 Original binomen: *Limburgina uhlenbroeki* Deroo, 1966
Aysegulina utrioides (Tambareau, 1972) **comb. nov.**
 Original binomen: *Limburgina* ? *utrioides* Tambareau, 1972
Aysegulina ventrocurva Puckett & Colin, 2012 in Puckett, Colin & Mitchell
Aysegulina venusta (Damotte, 1964) **comb. nov.**
 Original binomen: *Cythereis venusta* Damotte, 1964
Aysegulina verricula (Butler & Jones, 1957) **comb. nov.**
 Original binomen: *Cythereis verricula* Butler & Jones, 1957
Aysegulina villabasilensis (Rodriguez-Lazaro, 1988) **comb. nov.**
 Original binomen: *Limburgina* ? *villabasilensis* Rodriguez-Lazaro, 1988

Genus *Hartmannosa* Özdikmen, 2009

2009 *Hartmannosa* Özdikmen, Munis Entomology & Zoology, 4 (2): 614.

Remarks on nomenclatural change: This new substitutional genus name was published for the primary junior homonym *Palaciosa* Hartmann, 1959 (preoccupied by *Palaciosa* Bolivar, 1930), but without citing any names of species.

Actually known species (according to Kempf 1986, 1995, 2008, and in preparation a):

Type species: *Hartmannosa vandenboldi* (Hartmann, 1959) **comb. nov.**

Original binomen: *Palaciosa vandenboldi* Hartmann, 1959

Additional species:

Hartmannosa chilensis (Hartmann, 1962) **comb. nov.**

Original binomen: *Hemicythere chilensis* Hartmann, 1962

Hartmannosa cracenta (Bate, Whittaker & Mayes, 1981) **comb. nov.**

Original binomen: *Palaciosa cracenta* Bate, Whittaker & Mayes, 1981

Hartmannosa minuta (Edwards, 1944) **comb. nov.**

Original binomen: *Hemicythere minuta* Edwards, 1944

LITERATURE CITED

(For many of the new combinations of taxa the publications containing their first description are not cited here. All those references may be looked up in my bibliographies (Kempf 1988, 1996, 2008 b, in preparation b) published together with the different index volumes from the "Kempf Database Ostracoda", the genuine and original "World Ostracoda Database" which is entirely based on about 20,000 original publications on ostracod genera and species.)

Ainsworth, N. R. 1986. Toarcian and Aalenian Ostracoda from the Fastnet Basin, offshore south-west Ireland. Geological Survey of Ireland Bulletin, 3: 277-336.

Brady, G. S. 1868. A Monograph of the Recent British Ostracoda. Transactions of the Linnean Society of London, 26 (2): 353-495, 19 plates.

Brady, G. S. & Robertson, D. 1874. On Ostracoda taken amongst the Scilly Islands, and on the anatomy of *Darwinella stevensoni*. Annals and Magazine of Natural History, series 4, 13 (74): 114-119, 2 plates.

Brand, E. 1990: Biostratigraphische Untergliederung des Ober-Bathonium im Raum Hildesheim, Nordwestdeutschland, mittels Ostracoden und Korrelation ihrer Vertikalreichweiten mit Ammoniten-Zonen. Geologisches Jahrbuch, Reihe A, 121: 119-274.

Ciampo, G. 1981. Ostracodi fossili (Oligocene superiore - Serravalliano) del monte Cammarata (Sicilia centro-occidentale) e del Ragusano (Sicilia sud-orientale). Bollettino della Società Paleontologica Italiana, 20 (1): 53-72.

Clark, A. H. 1911. The Recent Crinoids of Australia. Australian Museum Memoir, 4 (15): 705-804.

Howe, R. C. & Howe, H. J. 1973. Ostracodes from the Shubuta Clay (Tertiary) of Mississippi. Journal of Paleontology, 47 (4): 629-656, 5 plates.

International commission of zoological nomenclature. 1999. International Code of Zoological Nomenclature. Fourth Edition. The International Trust for Zoological Nomenclature, London. I-XXIX, 1-306.

Jiang Xianting, Zhou Weifen, Lin Shupan et al. 1995. Xinjiang di ceng ji jie xing lei hua shi. (Stratigraphy and Ostracods of Xinjiang in China). I-IV, 1-577, 122 unpaginated plates, Beijing (In Chinese with English summary).

Kempf, E. K. 1980. Index and Bibliography of Nonmarine Ostracoda 1, Index A. Sonderveröffentlichungen, Geologisches Institut der Universität zu Köln, 35: 1-188.

Kempf, E. K. 1986. Index and Bibliography of Marine Ostracoda 1, Index A. Sonderveröffentlichungen, Geologisches Institut der Universität zu Köln, 50: 1-766.

Kempf, E. K. 1988. Index and Bibliography of Marine Ostracoda 4, Bibliography A. Sonderveröffentlichungen, Geologisches Institut der Universität zu Köln, 53: 1- 454.

Kempf, E. K. 1995. Index and Bibliography of Marine Ostracoda 6, Index A, Supplement 1. Sonderveröffentlichungen, Geologisches Institut der Universität zu Köln, 100: 1-244.

Kempf, E. K. 1996. Index and Bibliography of Marine Ostracoda 9, Bibliography C. Sonderveröffentlichungen, Geologisches Institut der Universität zu Köln, 103: 1-198.

Kempf, E. K. 2008 a. Index and Bibliography of Marine Ostracoda 11, Index A, Supplement 2. CD-ROM publication by the author.

Kempf, E. K. 2008 b. Index and Bibliography of Marine Ostracoda 14, Bibliography E. CD-ROM publication by the author.

Kempf, E. K. in preparation a. Index and Bibliography of Marine Ostracoda 11, Index A, Supplement 2, Second edition. CD-ROM publication by the author.

Kempf, E. K. in preparation b. Index and Bibliography of Marine Ostracoda 14, Bibliography E, Second edition. CD-ROM publication by the author.

Klie, W. 1939. Ostracoden aus dem Kenia-Gebiet, vornehmlich von dessen Hochgebirgen. Internationale Revue der gesamten Hydrobiologie und Hydrographie, 39 (1-2): 99-161.

Kruta, M. & Siveter, D. J. 1998. On *Vania perditia* Kruta and Siveter gen. et sp. nov. Stereo-Atlas of Ostracod Shells, 25 (11) 53-56.

Lucas, V. Z. 1931. Some Ostracoda of the Vancouver island region. Contributions to Canadian Biology and Fisheries, 6 (1): 397-416.

Mallikarjuna, U. B. & Nagaraja, H. M. 1996. Ostracodes from the Ariyalur Group (Late Cretaceous), Cauvery Basin, Southern India. Journal of the Geological Society of India, 48 (2): 189-201.

- Martens, K.** 1986. Taxonomic Revision of the Subfamily Megalocypridinae Rome, 1965 (Crustacea, Ostracoda). Verhandeligen van de Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België, Klasse der Wetenschappen, 48 (Nr.174): 1-146.
- Martens, K.** 1991. Description of the male of *Sclerocypris tuberculata* (Methuen, 1910) (Crustacea, Ostracoda, Megalocypridinae). Hydrobiologia, 218 (2): 127-131.
- McKenzie, K. G.** 1971. Species list of South African freshwater Ostracoda with an appendix listing museum collections and some further determinations. Annals of the South African Museum 57 (9): 157-213.
- Methuen, P. A.** 1910. On a collection of freshwater Crustacea from the Transvaal. Proceedings of the Zoological Society of London, 1910 (1): 148-166, 11 plates.
- Mostafawi, N., Nabavi, S. M. B. & Moghaddasi, B.** 2010. Ostracods from the Strait of Hormuz and Gulf of Oman, Northern Arabian Sea. Revista Española de Micropaleontología, 42 (2): 243-265.
- Özdikmen, H.** 2009. Substitute names for two genera of Ostracoda (Crustacea). Munis Entomology & Zoology, 4 (2): 614-615.
- Özdikmen, H.** 2010. Substitute names for three genera of Ostracoda (Crustacea). Munis Entomology & Zoology, 5 (1): 315-316.
- Pokorný, V.** 1977. The genus *Agrenocythere* (Ostracoda, Crust.) in the Paleogene of Moravia, Czechoslovakia. Casopis pro mineralogii a geologii, 22 (4): 383-393.
- Puckett, T. M., Colin, J.-P. & Mitchell, S.** 2012. New species and genera of Ostracoda from the Maastrichtian (Late Cretaceous) of Jamaica. Micropaleontology, 58 (5): 397-455.
- Rozhdstvenskaya, A. A.** 1962. Srednedevonskie ostrakody zapadnogo sklona yuzhnogo Urala, preduralskogo progiba i platformennoy chasti Bashkirii (Middle Devonian Ostracoda from the western slope of the southern Urals, Pre-Uralian trough and platform parts of Bashkiria). in: Tyazheva, A. P., Rozhdstvenskaya, A. A. & Chibrikova, E. V. 1962. Brakhiopody, ostrakody i spory srednego i verkhnego devona Bashkirii (Brachiopoda, Ostracoda and spores from the Middle and Upper Devonian of Bashkiria): 169-349 [In Russian].
- Sarr, R.** 2014. Ostracodes nouveaux du Paléogène du Sine-Saloum (Sénégal, Afrique de l'Ouest): biostratigraphie, paléoenvironnement. Revue de Paléobiologie, 32 (2013) (2, 2014): 569-588.
- Sauvagnat, J. & Colin, J.-P.** 2014. Ostracodes de l'Albien des Landes (Sud-Ouest de la France): taxonomie, biostratigraphie et paléobiogéographie. Revue de Paléobiologie, 32 (2013) (2, 2014): 541-556.
- Schallreuter, R. E. L.** 2001. Ostrakoden aus dem Ostrakodenkalk (Silur) der Lindener Mark bei Gießen (Hessen). Paläontologische Zeitschrift 74 (4): 517-531.
- Schuchert, C. & LeVene, C. M.** 1929. New Names for Brachiopod Homonyms. American Journal of Science, series 5, 17 (98): 119-122.
- Sirel, E. & Gündüz, H.** 1985. *Vania*, a new foraminiferal genus from the Thanetian of the Van region (East Turkey). Bulletin of the Mineral Research and Exploration Institute of Turkey, 101-102 (1983-1984): 20-24, 3 plates.
- Sirel, E. & Gündüz, H.** 1985. Van bölgesi (Doğu Türkiye) Tanesiyeinde bulunan yeni bir foraminifer cinsi, *Vania* n. gen. Maden Tetkik ve Arama Dergisi, 101-102 (1983-1984): 68-71, 3 levhalar.
- Sowerby, J. de C.** 1836. Descriptive notes respecting the shells figured in plates XI to XXIII. Transactions of the Geological Society of London, series 2, 4 (2): 335-349.
- Vekua, M. L.** 1975. Ostrakody Kimmeriyskikh i Kuvalnitskikh otlozheniy Abkhazii i ikh stratigraficheskoe znachenie. 1-137, 20 plates.
- Zhang Chuan, Zhang Fong-Ming, Zhang Zhi-Xing & Wang, Zhi** 1983. (Brachiopoda). 262-383, 712-737, plates 86-145. in: (Palaeontological Atlas of north-western China (Xinjiang Part), Palaeozoic, part 2), 1-747, 180 plates (in Chinese).

SCIENTIFIC NOTES

OCCURRENCE OF ENTOMOPATHOGENIC FUNGUS ON MUGA SILKWORM IN JORHAT DISTRICT OF ASSAM**Aparupa Borgohain*, Ranjana Das and Kalyan Dutta**

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[Borgohain, A., Das, R. & Dutta, K. 2015. Occurrence of entomopathogenic fungus on muga silkworm in Jorhat district of Assam. Munis Entomology & Zoology, 10 (2): 518-520]

The North eastern region of India is endowed with large natural wealth of both fauna and flora especially in case of sericigenous insects and their food plants which have given a unique outlook to the region (Choudhuri, 1983; Thangavelu, 1991). Natural silk is the product of a group of sericigenous Lepidoptera insects and muga silk is a wonderful gift of nature which is produced by muga silk worm *Antheraea assamensis* Helfer. It is a semi domesticated endemic sericigenous insect of North East India, especially in Assam. It is a multivoltine, polyphagus insect generally in six crop i.e Jarua (November-January), Chatua (February-March), Jethua (April-May), Aherua (June-July), Bhodia (August-September) and Katia (October-November) in a year. Due to outdoor nature of rearing, muga silkworm are exposed to various rigors of changing environment of the region of varied topography and thus the rearing is prone to numbers of disease and leading to crop loss (Choudhury, 1981; Thangavelu et al., 1988; Das et al., 2005). Silkworm crop loss due to outbreak of disease is one of the major constraints uncounted by the farmers, it accounts for 35% of crop loss (Kakoti, 2002). The most common diseases of muga silkworm are flacherie, grasserie, muscardine and pebrine (Thangavelu, 1988). The present study carried on late Aherua crop during July-August.

MATERIALS AND METHOD

The infected Muga cadavers were collected from fields at CMER&TI, Lahdoigarh, Jorhat district, Assam during the late Aherua crop (August, 2012). The dead cadavers were observed morphologically and observation was recorded. The samples were surface sterilized with 0.1% mercuric chloride solution and washed thrice with distilled water. After sterilization the silkworm were dissected and serial dilution was carried out in PDA (Hi-media, Mumbai) for the isolation of fungi and control also maintained from healthy larva. The plates were incubated for 5 days at 28°C in BOD. The pure culture of the fungus was obtained by hyphal tip transfer techniques to obtain monotype culture for future use (Fig. 2) (Vishunavat & Kolte, 2005) and then maintained for further evaluation. The morphological and cultural characterisation of the culture grown on PDA was studied. Isolated colonies were identified as per description of "A Manual of Soil Fungi" by Gilman (1995), "Illustrate Genera of Imperfect fungi" by Burnet & Hunter (1987), and "Introductory Mycology" by Alexopoulos et al. (1986).

Pathogenicity Test: Pathogenicity test of the isolates was done in the 5th instar larva in august 2012 using Single Hyphal Tip technique (Puzari et al., 1994; Vishunavat & Kolte, 2005) obtained from 8d old cultures on PDA, onto healthy

host plant of *Antheara assamensis*. Inoculated endo- rearing potted plant and controls were covered with net for a week and kept under room temperature conditions. In pathogenicity test disease symptoms started developing after 5 days. The re-isolation invariably yielded the same fungus from the infected worm.

Observation: After spore inoculation in foliar host plant and silkworm surface, the fungi started to develop within 5 to 7 days and then after taking the food the larva is infected after 5 days. The infected larva stops feeding within hours and also stops the movement. The larvae lose appetite and the body colour change to pale and later the body became hard and secrete some juicy part. After infection the larva will die within 5 to 7 days.

RESULT AND DISCUSSION

The disease was found during the last stage of worms i.e. 4th and 5th instars before spinning. Fungal isolates were identified on the basis of cultural, morphological and microscopic characteristics of the isolates. The mycelial and spore characters of the fungi were studied under phase Contrast microscope (Leica, Germany) and photograph was also taken for the work. Cultural and morphological characters such as colony colour, type of growth, texture were studied on PDA medium. Initially young hyphae were pink white with floppy dense mycelia which then finally appeared as dark pink with slight white regular periphery. During microscopic observation it is observed that the mycelium is septate and right angled branching. The fungal hyphae give rise to simple conidiophores, which produce two types of conidia i.e. micro and macro. Microconidia are single celled and ovoid/oblong with blunt end in shape. Macroconidia are hyaline, elongated, filiform and multisepted with pointed ends, measuring 14.3X5.02µm. Each macro-conidia gives rise to several germ tubes (Gupta et al., 1998). In the reverse side also the colony is observed as pink colour. The infected hypodermis and fat bodies may also be infected. The infected & isolated fungus is identified as *Fusarium solani*.

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LITERATURE CITED

- Alexopoulos, C. J. & Mims, C. W. 1986. Introductory Mycology. Wiley Eastern Limited, New Delhi, pp. 1-566.
- Burnett, H. L. & Hunter, B. B. 1987. Illustrated genera of imperfect fungi. (Fourth Edition) Macmillan Publishing Campus N.Y., collar Macmillan Publishers London, pp. 216.
- Choudhury, A., Guha, A., Yadav, A., Kumara, J., Unni, B. G. & Roy, M. K. 2002. Casual organism of flacherie in the silkworm *Antheraea assama* Ww: Isolation, characterisation and inhibition by garlic extract. *Phytotherapeutic Research*, 16: 89-90.
- Choudhury, S. N. 1983. Eri silk industry. Directorate of seric. Weaving, Government of Assam, India, 1-23.
- Das, K., Borah, A., Yadav, A. & Chakravarty, R. 2005. Seasonal incidence of diseases in muga silkworm in the different muga growing belts. In: Proceedings of 20th congress of the International Sericultural Commission: 259-263.
- Gilmah, C. J. 1995. A manual of Soil fungi Printwell Jaipur (India), 1-256.

Govindhan, R., Narayanaswamy, T. K. & Devaiah, M. C. 1998. Principles of silkworm pathology. Seri. Scientific publishers, Baglalore, 420.

Gupta, V. P., Raju, H. V., Kumar, V. & Govindaiah. 1998. surface ultrastructure of infection process of *Alternaria alternata* and *Fusarium pallidoroseum* on mulberry. Arch. Phytopathol. Pflanzenschutz, 31: 429-434.

Kakoti, P. K. 2002. Adoption of prophylactic measures to contain muga silkworm diseases. Indian silk., 41 (1): 19-21.

Majumder, A., Boetel, M. A. & Jaronski, S. T. 2008. Discovery of *Fusarium solani* as a naturally occurring pathogen of sugarbeet root maggot (Diptera: Ulidiidae) pupae: prevalence and baseline susceptibility. J. Inverte. Pathol., 97 (1): 1-8.

Puzari, K. C., Hazarika, L. K. & Deka, N. 1994. Pathogenicity of *Beauveria bassiana* (Bals.) vuill on development stages of rice hispa. J. Biol. Control., 8: 133-135.

Samson, M. V., Baig, M., Sharma, S. D., Balavenkatasubbaiah, M., Sasidharan, T. O. & Jolly, M. S. 1990. Survey on the relative incidence of silkworm diseases in Karnataka, India. Journal of Sericulture, 29 (2): 248-25.

Thangavelu, K., Chakravarti, A. K. & Bhagabati, A. K. 1988. Hand book of muga culture, 75-84.

Thangavelu, N. 1991. Wild ericigenous insects of India: A need for conservation. In: Wild Silkworm 1991. Inter. Society for wild silkworms: Japan, 71-77.

Vishunavat, K. & Kolte, S. J. 2005. Essentials of Phytopathological Technique (Eds), Kalyani Publisher, India. 217.

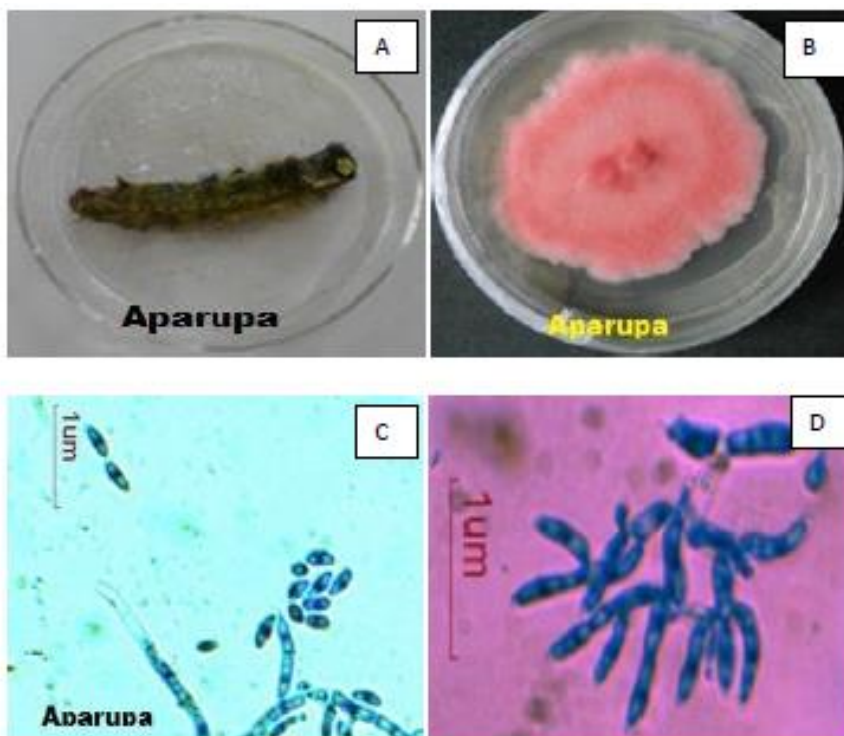


Figure 1. Fungal spore and conidiophore of *Fusarium solani*: (A) Infected Larva; (B) Colony culture; (C) Microconidia; (D) Macroconidia.