This volume is dedicated to the lovely memory of the chief-editor Hüseyin Özdikmen’s khoja

ŞA’BAN-I VELİ

MUNIS

ENTOMOLOGY & ZOOLOGY

Ankara / Turkey
II

Scope: Munis Entomology & Zoology publishes a wide variety of papers on all aspects of Entomology and Zoology from all of the world, including mainly studies on systematics, taxonomy, nomenclature, fauna, biogeography, biodiversity, ecology, morphology, behavior, conservation, paleobiology and other aspects are appropriate topics for papers submitted to Munis Entomology & Zoology.

Submission of Manuscripts: Works published or under consideration elsewhere (including on the internet) will not be accepted. At first submission, one double spaced hard copy (text and tables) with figures (may not be original) must be sent to the Editors, Dr. Hüseyin Özdikmen for publication in MEZ. All manuscripts should be submitted as Word file or PDF file in an e-mail attachment. If electronic submission is not possible due to limitations of electronic space at the sending or receiving ends, unavailability of e-mail, etc., we will accept “hard” versions, in triplicate, accompanied by an electronic version stored in a floppy disk, a CD-ROM.

Review Process: When submitting manuscripts, all authors provide the name, of at least three qualified experts (they also provide their address, subject fields and e-mails). Then, the editors send to experts to review the papers. The review process should normally be completed within 45-60 days. After reviewing papers by reviewers: Rejected papers are discarded. For accepted papers, authors are asked to modify their papers according to suggestions of the reviewers and editors. Final versions of manuscripts and figures are needed in a digital format.

Preparation of Manuscripts

All manuscripts must be typed in English, using Microsoft Word. Entire manuscript must be double-spaced, with margins of at least 2-3 cm on all sides of the page (A4). Pages should be numbered consecutively. Authors whose native language is not English are encouraged to have their manuscripts read by a native English-speaking colleague before submission. Nomenclature must be in agreement with the International Code of Zoological Nomenclature (4th edition 1999). Author(s) of species name must be provided when the scientific name of any animal species is first mentioned (the year of publication needs not be given; if you give it, then provide a full reference of this in the reference list). Authors of plant species name need not be given. Metric systems should be used. If possible, use the common font Times New Roman (12 pt) and use as little formatting as possible (use only bold and italics). Special symbols (e.g. male or female sign) should be avoided.
Title and Name(s) of Author(s): The title should be informative and as possible as brief, in boldface capital letters, not exceed twenty words. The higher taxa containing the taxa dealt with in the paper should be indicated in parentheses. Full name(s) of author(s) should come underneath the title with full address, each on a separate line. The author(s) name(s) should be given in boldface lower case.

Abstract: The abstract should be concise and should draw attention to the significant contents of the paper and the author's main conclusions. It should normally not exceed 200 words and should contain no uncommon abbreviations or references. Any new names or new combinations proposed in the paper should be mentioned. The abstract should be followed by a list of key words. Up to seven keywords should be suggested by the author.

Text: Regular papers include as the main sections (except in Book Reviews and Scientific Notes etc.); Introduction, Material & Methods, Results, Discussion, Acknowledgments and Literature Cited. The section introduction should be written without a title. However, the main sections may be varies with different types of papers. According to types of papers, main section can be changed. All scientific names (only genus and species group names) should be italicized throughout the paper, including literature cited. References should be cited in the text as Turgut (2003), Turgut & Turgut (2000) or Turgut et al. (2001) (3 or more authors), or alternatively in a parenthesis (Turgut, 2003; Turgut & Turgut, 2000 or Turgut et al., 2001). All literatures in the text must be listed alphabetically in the literature cited in the following format.

Journal paper:

Book chapter:

Book:
Turgut, A., Turgut, B. & Turgut, C. 2001. Title of Book, Publisher name and location, number of pages (e.g. 123 pp).

Internet resources:
Turgut, S. 2002. Title of website, database or other resources, Publisher name and location (if indicated), number of pages (if known). Available from: http://xxx.xxx.xxx/ (Date of access).
Tables, Illustrations and Photographs: Tables, illustrations and photographs should be submitted in a separate file, not embedded in the text. They should be given at the end of the manuscript. Please use the table function in your word processor to build tables so that the cells, rows and columns can remain aligned when font size and width of the table are changed. Illustrations should be clean, sharp, with good contrast. Small illustrations should be grouped into plates. For species illustration, line drawings are preferred, although good quality B&W photographs are also acceptable. Maximum size of printed illustration, including all legends, is 12 x 16 cm. Images must be submitted either in .tif, .jpg, or .pdf (PC compatible format strongly preferred). Digital versions of illustrations should be prepared as follows: photographs should be saved as .pdf or .tif format at 300 dpi. Line figures should be saved in .tif or .jpg at 300 dpi. All illustrations must be numbered consecutively using Arabic numerals. They should be cited “Fig. 1” or “Figs. 1–4” in sequential order. Photographs must be of exceptional quality, good contrast.

Scientific Notes and Book Reviews. These are usually short contributions, typically not exceeding one (Book Review) or two (Scientific Notes) printed pages. Scientific notes and book reviews lack an abstract and most of the main headings, except for the acknowledgements and the literature cited sections.

Page Charge: There is no page charge for publishing with MEZ.

MEZ is indexed in Zoological Record, Biological Abstract, Biosis Preview, Agricola, ......
THE GENUS ADORETUS DEJEAN, 1833 IN ISRAEL WITH DESCRIPTION OF *ADORETUS (ADORETUS) LUDMILA* SP. NOV. AND NOTES ON RELATED WESTERN PALEARCTIC SPECIES (SCARABAEIDAE: RUTELINAE)

Guido Sabatinelli* and Oz Rittner**

* 493, Route de la Fontaine, Le Grand Pré, Villa 12, 01280 Prééssin, FRANCE. E-mail: g.sabatinelli@hotmail.com
** The Steinhardt museum of natural history, Zoological department Tel-Aviv University. 69978 Tel Aviv, ISRAEL. E-mail: israelbutterflies@gmail.com

[Sabatinelli, G. & Rittner, Oz. 2015. The genus *Adoretus* Dejean, 1833 in Israel with description of *Adoretus (Adoretus) ludmilae* sp. nov. and notes on the western palearctic species (Coleoptera, Scarabaeidae, Rutelinae). Munis Entomology & Zoology, 10 (2): 301-314]

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


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 form Iraq and Iran that will 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 Lezziyon, 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


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**


**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)**


**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-Menéville, 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


Described from South East Algeria (Tig’amaain en tsita and Tihilhaout) 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 were 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

**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) nigriforns (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. petrovitzii* (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) pruinosus 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. pruinosus 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, 1985).

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 Cuccodor0 for providing access to Petrovitz collection in the Museum d’histoire Naturelle de Genève, Switzerland.

**LITERATURE CITED**


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 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)

Janis Vartanis* and Richard Ambrus**

* Luhanova 1825, CZ-688 01 Uherský Brod, CZECH REPUBLIC. E-mails: akimerus@seznam.cz, giannisv@seznam.cz
** Trnkovo nám. 1112/1, CZ-152 00 Praha 5, CZECH REPUBLIC. E-mail: ambrus@centrum.cz


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 schurrmanni 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-Peloponnese, Agios Petros, 6.6.2012, lgt. D. Loupanec (coll. J. Vartanis); 6 paratypes: 1♀: Greece-Peloponnese, Karýes,
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 Purpuricenus 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. Purpuricenus 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. Purpuricenus 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 *Purpuricenus 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 *Purpuricenus 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 *Purpuricenus 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. *Purpuricenus 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 *Purpuricenus 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 *Purpuricenus comenius* sp. n., elytral apex is irregular, predominantly wavelike and widely cut off.

*Purpuricenus comenius* sp. n. differs from similar species *Purpuricenus apiceniger* Pic, 1914 and *Purpuricenus 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 *Purpuricenus 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. *Purpuricenus 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 *Purpuricenus apiceniger* Pic, 1914 is in the shape of a pear and it goes from the scutellum to the end of elytra.

**Remark on bionomy.** *Purpuricenus 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. Severtsov Institute of Ecology and Evolution, Moscow, Russia), Milan Sláma (Praha, Czech Republic), Jiří Klícha (Praha, Czech Republic) and Petr Zlámal (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


Figure 1. *Purpuricenus comenius* sp. n.: Holotype, male (left) and paratype, female (right).
A NEW SUBSPECIES OF PSEUDOVADONIA LIVIDA (FABRICIUS, 1777) FROM TURKEY (CERAMBYCIDAE: LEPTURINAE)

Hüseyin Özdikmen*

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


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)


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. Probability 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**


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

R. G. Kihn* and E. A. Gómez**

* IADO (Instituto Argentino de Oceanografía), Florida 8000 (Camino La Carrindanga km 7,5), 8000 Bahía Blanca, Buenos Aires, ARGENTINA. E-mail: rgkihn@gmail.com
** Instituto Argentino de Oceanografía (CONICET/UNS), CC 804, 8000 Bahía Blanca, Argentina/UTN, Facultad Regional Bahía Blanca, 11 de Abril 461, B8000LMI. Bahía Blanca, ARGENTINA. E-mail: gmgomez@criba.edu.ar


ABSTRACT: We study the benthic ostracods from the vibro-core KP60Bis (39° 08'34 .8689'' S, 61° 46'10 .0278'' W) 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 variasculpta Whatley, Moguilevsky, Toy, Chadwick and Ramos Neocytherides ruidis Whatley, Moguilevsky, Chadwick, Toy and Callistoxythere 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 Cypriodopsis viridua O.F. Müller, 1776. In the middle sector (Z1) were abundant specimens of ostracods valves assigned to Ambostracon (Ambostracon) tenuireticulata Kotzias, 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 - Psotka and Martinez (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 - 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 (162-165 cm): 1950 ± 60 years BP (GRA-27127) 163-170 cm 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 10 cm. 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 photographies 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 390 cm, 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 briozoos of smoothed morphology. The valves of copies were abundant of ostrácodos euhalinos assigned to Ambosbracon (Ambosbracon) tenuireticulata Kotzian, 1982, Cornucoquimba lutiziana Zabert, 1978 (Fig. 2D) and Caudites ohmerti 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 briozoos 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 fitales and parafitales, those that live associated with the vegetation, registered *Paracytherois* 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 *Iliocypsis 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 ostrácods 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 briozoos 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 briozoos 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 *Ambrostracon (Ambrostracon) tenuireticulata; Cornuocoquimba 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 briozoos 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 to. 2005), and *Callistocythere litoralensis* (Rossi de García), this species was found in current samples of the Channel *Tres Brazas*. The presence of species fitales and parafitales (*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 mollusces 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 ohmerti*, 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**

We thank Lic. José Luis Pall for critical reading of the manuscript. This study was supported by the National Council of Scientific and Technical Research, Argentina (CONICET).

**LITERATURE CITED**


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 ohmerti, D. Cornucoquimba lutziana, E. Loxocythere variasculpta, F. Callistocythere litoralensis, G. Pellucistoma elongata, H. Iliocypris gibba, I. Cypridopsis vidua, J. Limnoocythere sp. (Scale: 100µm).
CONODERINAE (ELATERIDAE) OF BUXA TIGER RESERVE, WEST BENGAL, INDIA

Sutirtha Sarkar*, Sumana Saha** and Dinendra Raychaudhuri*

*Entomology Laboratory, Department of Zoology, University of Calcutta, 35, Ballygunge Circular Road, Kolkata-700019, INDIA. E-mails: sutirthaento@gmail.com; dinendrarccu@gmail.com
** Department of Zoology, Darjeeling Govt. College, Govt. of West Bengal, INDIA. E-mail: sahasumana2010@gmail.com


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  
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, punctuation 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 dialated 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)


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 mesocular cavity.
Metacoxal plate broad, round.
Abdomen brown black, punctuation 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, punctuation double, frons broader than long, moderately convex, anterior margin arcute, 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, punctuation 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, \( 2^{nd} \) median, close to suture and the \( 3^{rd} \)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, 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 in the middle.
Abdomen brown, punctuation 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 \(1/3\)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.

**ACKNOWLEDGEMENTS**

Authors are indebted to West Bengal Biodiversity Board (Sanction no. 326/5k(Bio)-3/2007 dt. 11.12.2008 & 21/5k(Bio)-3/2007 dt. 14.01.2009) for sponsoring the project and the Head, Department of Zoology, University of Calcutta for necessary support. The first author is also thankful to UGC, New Delhi, for awarding RFSMS fellowship (Sanction no.F.4-1/2006(BSR)/7-45/2007 (BSR) dated 25.10.2011).

**LITERATURE CITED**


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

Ayşegül İliker* and İrfan Albayrak**

* Aşağı Öveçler Mahallesi 1066, Cadde 1292. Sokak No:10/3 Çankaya, Ankara, TÜRKİYE.
** Kırıkkale Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, 71450, Yahşihan, Kırıkkale, TÜRKİYE. E-mail: iralbayrak@yahoo.com


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, Charadriiformes, 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 endangered (EN) category; marbled teal (Marmoronette 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 vespertinus), 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 threatened (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 Kumerloev (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 Kasparek & 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, Gruiformes, Charadriiformes, Columbiformes, Cuculiformes, Strigiformes, Apodiformes, Coraciiformes, Piciformes, Passeriformes), (Podicipedidae, Phalacrocoracidae, Ardeidae, Ciconiidae, Threskiornithidae, Phoenicopteridae, Anatidae, Accipitridae, Falconidae, Phasianidae, Gallidae, Pelecanidae, Gruiformes, Charadriiformes, Columbiae, Cuculidae, Scolopacidae, Laridae, Sternae, Pteroclididae, Ciconiidae, Tytonidae, Strigidae, Apodidae, Alcedinidae, Meropidae, Coraciidae, Upupidae, Picidae, Alaudidae, Hirundinidae, Motacillidae, Tyrannidae, Turdidae, Sylvidae, 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 (Marmorona angustirostris), greater 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 parrtridge (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 Seyfe 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

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

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

<table>
<thead>
<tr>
<th>Year</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>2011</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>107</td>
</tr>
<tr>
<td>2012</td>
<td>7</td>
<td>7</td>
<td>9</td>
<td>4</td>
<td>8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>44</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>16</td>
<td>18</td>
<td>17</td>
<td>13</td>
<td>18</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>14</td>
<td>18</td>
<td>19</td>
<td>178</td>
</tr>
</tbody>
</table>
Table 2. Systematics of the species, the species name, migration status and conservation status in Kızılırmak Valley in Kırıkkale.

<table>
<thead>
<tr>
<th>Number</th>
<th>Order</th>
<th>Family</th>
<th>Species</th>
<th>Common Name</th>
<th>Migration Status</th>
<th>Conservation Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Podiceps anas</td>
<td>Horned Grebe</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>2</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Podiceps cristatus</td>
<td>Great Crested Grebe</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>3</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Podiceps grisegena</td>
<td>Red-necked Grebe</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>4</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Podiceps minor</td>
<td>Black-necked Grebe</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>5</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Podiceps nigricollis</td>
<td></td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>6</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Podilodius ridibundus</td>
<td>Little Grebe</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>7</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax carbo</td>
<td>Great Cormorant</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>8</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax auritus</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>9</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Purple Heron</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>10</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax carbo</td>
<td>Great Cormorant</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>11</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>12</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax carbo</td>
<td>Great Cormorant</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>13</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>14</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>15</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>16</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>17</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>18</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>19</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>20</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>21</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>22</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>23</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>24</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>25</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>26</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>27</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>28</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>29</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>30</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>31</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>32</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>33</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>34</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>35</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>36</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>37</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>38</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>39</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>40</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>41</td>
<td>Podicipediformes</td>
<td>Podicipedidae</td>
<td>Phalacrocorax ardesia</td>
<td>Grey Heron</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>42</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Accipiter gentilis</td>
<td>Northern Goshawk</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>43</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Accipiter nisus</td>
<td>Eurasian Sparrowhawk</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>44</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Aquila chrysaetos</td>
<td>Golden Eagle</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>45</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Aquila fasciata</td>
<td>Bonelli’s Eagle</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>46</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Buteo buteo</td>
<td>Eurasian Buzzard</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>47</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Buteo buteo vulpinus</td>
<td>Steppe buzzard</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>48</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Buteo buteo vulpinus</td>
<td>Steppe buzzard</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>49</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Buteo buteo vulpinus</td>
<td>Steppe buzzard</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>50</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Circus cyaneus</td>
<td>Short-toed Eagle</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>51</td>
<td>Falconiformes</td>
<td>Accipitridae</td>
<td>Circus sparrowius</td>
<td>Western Marsh Harrier</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>No.</td>
<td>Species Name</td>
<td>scientific name</td>
<td>family</td>
<td>order</td>
<td>conservation status</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>--------------</td>
<td>-----------------</td>
<td>--------</td>
<td>-------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td><em>Circus pygargus</em></td>
<td><em>Circus pygargus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>LC</strong></td>
</tr>
<tr>
<td>53</td>
<td><em>Circus macrourus</em></td>
<td><em>Circus macrourus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>NT</strong></td>
</tr>
<tr>
<td>54</td>
<td><em>Circus hudsonius</em></td>
<td><em>Circus hudsonius</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>NT</strong></td>
</tr>
<tr>
<td>55</td>
<td><em>Haliaeetus leucocephalus</em></td>
<td><em>Haliaeetus leucocephalus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>NT</strong></td>
</tr>
<tr>
<td>56</td>
<td><em>Gypaetus barbatus</em></td>
<td><em>Gypaetus barbatus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>LC</strong></td>
</tr>
<tr>
<td>57</td>
<td><em>Haliaeetus leucocephalus</em></td>
<td><em>Haliaeetus leucocephalus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>NT</strong></td>
</tr>
<tr>
<td>58</td>
<td><em>Haliaeetus leucocephalus</em></td>
<td><em>Haliaeetus leucocephalus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>NT</strong></td>
</tr>
<tr>
<td>59</td>
<td><em>Pandion haliaetus</em></td>
<td><em>Pandion haliaetus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>NT</strong></td>
</tr>
<tr>
<td>60</td>
<td><em>Falco peregrinus</em></td>
<td><em>Falco peregrinus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>61</td>
<td><em>Falco subbuteo</em></td>
<td><em>Falco subbuteo</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>62</td>
<td><em>Falco tinnunculus</em></td>
<td><em>Falco tinnunculus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>63</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>64</td>
<td><em>Falco lagopus</em></td>
<td><em>Falco lagopus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>65</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>66</td>
<td><em>Falco peregrinus</em></td>
<td><em>Falco peregrinus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>67</td>
<td><em>Falco tinnunculus</em></td>
<td><em>Falco tinnunculus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>68</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>69</td>
<td><em>Falco tinnunculus</em></td>
<td><em>Falco tinnunculus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>70</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>71</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>72</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>73</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>74</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>75</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>76</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>77</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>78</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>79</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>80</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>81</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>82</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>83</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>84</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>85</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>86</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>87</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>88</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>89</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>90</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>91</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>92</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>93</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>94</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>95</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>96</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>97</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>98</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>99</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>100</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>101</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>102</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>103</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>104</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>105</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>106</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>107</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>108</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>109</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>110</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>111</td>
<td><em>Falco rusticolus</em></td>
<td><em>Falco rusticolus</em></td>
<td><strong>Falconidae</strong></td>
<td><strong>Falconiformes</strong></td>
<td></td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>112</td>
<td>Sterna hirundo</td>
<td>Common Tern</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>Sterna hirundo</td>
<td>Gull-billed Tern</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>Columbiformes</td>
<td>Pteroclididae</td>
<td>Pterocles orientalis</td>
<td>Black-bellied Sandgrouse</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>115</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Columba tenuis</td>
<td>Rock Dove</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>116</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Columba oenas</td>
<td>Stock Dove</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>117</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Columba palumbus</td>
<td>Woodpigeon</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>118</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Streptopelia decaocto</td>
<td>Eurasian Collared Dove</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>119</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Streptopelia turtur</td>
<td>European Turtle Dove</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>120</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Clamator glandarius</td>
<td>Great Spotted Cuckoo</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>121</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Cuculus canorus</td>
<td>Common Cuckoo</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>122</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Tyto alba</td>
<td>Barn Owl</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>123</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Asio otus</td>
<td>Long-eared Owl</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>124</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Athene noctua</td>
<td>Little Owl</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>125</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Bufo bufo</td>
<td>Eurasian Eagle-Owl</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>126</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Apus pallasii</td>
<td>Pallid Swift</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>127</td>
<td>Columbiformes</td>
<td>Columbidae</td>
<td>Tachymarptis melba</td>
<td>Alpine Swift</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>128</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Alcedo atthis</td>
<td>Common Kingfisher</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>129</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Alcedo atthis</td>
<td>European Bee-eater</td>
<td>SM</td>
<td>NT</td>
</tr>
<tr>
<td>130</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Carcina garrulus</td>
<td>European Roller</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>131</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Upupa epops</td>
<td>Common Hoopoe</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>132</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Dendrocopos major</td>
<td>Great Spotted Woodpecker</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>133</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Dendrocopos minor</td>
<td>Lesser Spotted Woodpecker</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>134</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Dendrocopos medius</td>
<td>Svisca Woodpecker</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>135</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Lasiopicus torquilla</td>
<td>Northern Wheatear</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>136</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Picus viridis</td>
<td>Green Woodpecker</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>137</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Alauda arvensis</td>
<td>Eurasian Skylark</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>138</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Calandra bridgwoodi</td>
<td>Greater Short-toed Lark</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>139</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Calandra rubeculoides</td>
<td>Lesser Short-toed Lark</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>140</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Emberiza alpina</td>
<td>Horned Lark</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>141</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Gasteria cristata</td>
<td>Crested Lark</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>142</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Linaria arborescens</td>
<td>Woodlark</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>143</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Mecocorypha bimaculata</td>
<td>Hume Lark</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>144</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Mecocorypha calandra</td>
<td>Calandra Lark</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>145</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Delichon urbicum</td>
<td>Northern House Martin</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>146</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Hirundo rustica</td>
<td>Red-rumped Swallow</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>147</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Hirundo rustica</td>
<td>Eurasian Crag Martin</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>148</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Hirundo rustica</td>
<td>Barn Swallow</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>149</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Riparia riparia</td>
<td>Bank Swallow</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>150</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Anthus campestris</td>
<td>Tawny Pipit</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>151</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Anthus cervinus</td>
<td>Red-throated Pipit</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>152</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Anthus hodgsoni</td>
<td>Olive-backed Pipit</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>153</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Anthus pratensis</td>
<td>Meadow Pipit</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>154</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Anthus spinolletta</td>
<td>Water Pipit</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>155</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Anthus trivialis</td>
<td>Tree Pipit</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>156</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Motacilla alba</td>
<td>White Wagtail</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>157</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Motacilla cinerea</td>
<td>Grey Wagtail</td>
<td>R</td>
<td>LC</td>
</tr>
<tr>
<td>158</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Motacilla cinerea</td>
<td>Cetti’s Wagtail</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>159</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Motacilla cinerea</td>
<td>Yellow Wagtail</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>160</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Motacilla cinerea</td>
<td>Blackstart</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>161</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Motacilla cinerea</td>
<td>European Robin</td>
<td>WM</td>
<td>LC</td>
</tr>
<tr>
<td>162</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Eriithacus rubecula</td>
<td>Ruff</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>163</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Ficedula albicollis</td>
<td>Collared Flycatcher</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>164</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Ficedula hypoleuca</td>
<td>Pied Flycatcher</td>
<td>T</td>
<td>LC</td>
</tr>
<tr>
<td>165</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Ficedula hypoleuca</td>
<td>Red-breasted Flycatcher</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>166</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Ficedula albicollis</td>
<td>Semi-collared Flycatcher</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>167</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Ficedula hypoleuca</td>
<td>Thrush Nightingale</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>168</td>
<td>Columbiformes</td>
<td>Alcedinidae</td>
<td>Ficedula albicollis</td>
<td>Common Nightingale</td>
<td>SM</td>
<td>LC</td>
</tr>
<tr>
<td>172</td>
<td>Loxia curvirostra</td>
<td>Blue Grosbeak</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>173</td>
<td>Ammodramus ocaxillaris</td>
<td>Common Rock Thrush</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>174</td>
<td>Mnemiops eunostus</td>
<td>Spotted Flycatcher</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>175</td>
<td>Oenanthe deserti</td>
<td>Desert Wheatear</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>176</td>
<td>Oenanthe fusca</td>
<td>Finsch's Wheatear</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>177</td>
<td>Oenanthe hispanica</td>
<td>Black-eared Wheatear</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>178</td>
<td>Oenanthe isabellina</td>
<td>Isabelline Wheatear</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>179</td>
<td>Oenanthe oenanthe</td>
<td>Northern Wheatear</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td>Oenanthe pleschanka</td>
<td>Red Wheatear</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>181</td>
<td>Phoenicurus ochruros</td>
<td>Black Redstart</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>182</td>
<td>Phoenicurus phoenicurus</td>
<td>Common Redstart</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>183</td>
<td>Saxicola montana</td>
<td>Siberian Stonechat</td>
<td>WM</td>
<td>NR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>184</td>
<td>Saxicola rubetra</td>
<td>Whinchat</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>185</td>
<td>Saxicola rubetra</td>
<td>European Stonechat</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>186</td>
<td>Turdus iliacus</td>
<td>Redwing</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>187</td>
<td>Turdus merula</td>
<td>Eurasian Blackbird</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>188</td>
<td>Turdus philetus</td>
<td>Song Thrush</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>189</td>
<td>Turdus pilaris</td>
<td>Fieldfare</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>190</td>
<td>Turdus viscivorus</td>
<td>Mistle Thrush</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>191</td>
<td>Sylvia atricapilla</td>
<td>Paddyfield Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>192</td>
<td>Sylvia atricapilla</td>
<td>Great Reed Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>193</td>
<td>Sylvia borin</td>
<td>Blyth's Reed Warbler</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>194</td>
<td>Sylvia melanocephala</td>
<td>Moustached Warbler</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>195</td>
<td>Sylvia paludicola</td>
<td>Aquatic Warbler</td>
<td>SM</td>
<td>VU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>196</td>
<td>Sylvia paludicola</td>
<td>Marsh Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>197</td>
<td>Sylvia svecica</td>
<td>Sedge Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>198</td>
<td>Sylvia atricapilla</td>
<td>Eurasian Reed Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>199</td>
<td>Cetti cetti</td>
<td>Cetti's Warbler</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>Hippolais icterina</td>
<td>Icterine Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>201</td>
<td>Hippolais icterina</td>
<td>Upland Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>202</td>
<td>Hippolais icterina</td>
<td>Olive-tree Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>203</td>
<td>Hippolais icterina</td>
<td>Olivaceous Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>204</td>
<td>Locustella luteola</td>
<td>River Warbler</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>205</td>
<td>Locustella luteola</td>
<td>Savin's Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>206</td>
<td>Phylloscopus bonelli</td>
<td>Eastern Bonelli's warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>207</td>
<td>Phylloscopus borealis</td>
<td>Arctic Warbler</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>208</td>
<td>Phylloscopus collybita</td>
<td>Common Chiffchaff</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>209</td>
<td>Phylloscopus collybita</td>
<td>Wood Warbler</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>210</td>
<td>Phylloscopus trochiloides</td>
<td>Greenish Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>211</td>
<td>Phylloscopus trochiloides</td>
<td>Willow Warbler</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>212</td>
<td>Sylvia atricapilla</td>
<td>Blackcap</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>213</td>
<td>Sylvia atricapilla</td>
<td>Garden Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>214</td>
<td>Sylvia atricapilla</td>
<td>Greater Whitethroat</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>215</td>
<td>Sylvia atricapilla</td>
<td>Lesser Whitethroat</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>216</td>
<td>Sylvia atricapilla</td>
<td>Orphean Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>217</td>
<td>Sylvia atricapilla</td>
<td>Sardinian Warbler</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>218</td>
<td>Regulus dauricus</td>
<td>Firecrest</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>219</td>
<td>Regulus regulus</td>
<td>Goldcrest</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>220</td>
<td>Aegithalos caudatus</td>
<td>Long-tailed Tit</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>221</td>
<td>Passer domesticus</td>
<td>Coal Tit</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>222</td>
<td>Passer domesticus</td>
<td>Blue Tit</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>223</td>
<td>Passer domesticus</td>
<td>Azure Tit</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>224</td>
<td>Passer domesticus</td>
<td>Great Tit</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>225</td>
<td>Sitta europaea</td>
<td>Western Rock Nuthatch</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>226</td>
<td>Remiz pendulinus</td>
<td>Penduline Tit</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>227</td>
<td>Orieolus origo</td>
<td>Eurasian Golden Oriole</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>228</td>
<td>Lanius collurio</td>
<td>Red-backed Shrike</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>229</td>
<td>Lanius minor</td>
<td>Lesser Grey Shrike</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family</td>
<td>Species</td>
<td>Common Name</td>
<td>Type</td>
<td>Classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td>---------------------</td>
<td>------</td>
<td>----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lanius ictus</td>
<td>Masked Shrike</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lanius senator</td>
<td>Woodchat Shrike</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cercopsis cana</td>
<td>Common Raven</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cercopsis cana</td>
<td>Carrion Crow</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cercopsis cana</td>
<td>Rock</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cercopsis cana</td>
<td>Eurasian Jackdaw</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cercopsis cana</td>
<td>Eurasian Jay</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pica pica</td>
<td>Common Magpie</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sturnus roseus</td>
<td>Rosy Starling</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sturnus vulgaris</td>
<td>European Starling</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passer domesticus</td>
<td>House Sparrow</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passer hispaniolensis</td>
<td>Spanish Sparrow</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passer montanus</td>
<td>Eurasian Tree Sparrow</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parus major</td>
<td>Rock Sparrow</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fringilla cannabina</td>
<td>Common Linnet</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carduelis carduelis</td>
<td>European Goldfinch</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carduelis chloris</td>
<td>European Greenfinch</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carduelis flammea</td>
<td>Common Redpoll</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carduelis spinus</td>
<td>Eurasian Siskin</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carpodacus erythrinus</td>
<td>Common Rosefinch</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coccothraustes coccothraustes</td>
<td>Hawfinch</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fringilla coelebs</td>
<td>Chaffinch</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fringilla montifringilla</td>
<td>Brambling</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Serinus serinus</td>
<td>European Serin</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza citrata</td>
<td>Cretzschmar’s Bunting</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza caesia</td>
<td>Western Rock Bunting</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza ceca</td>
<td>Cur Bunting</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza citrinella</td>
<td>Yellowhammer</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza hortulana</td>
<td>Ortolan Bunting</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza leucophaea</td>
<td>Pine Bunting</td>
<td>WM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza melanophrys</td>
<td>Black-headed Bunting</td>
<td>SM</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emberiza schoeniclus</td>
<td>Reed Bunting</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mincita calandra</td>
<td>Corn Bunting</td>
<td>R</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ectophasma mystax</td>
<td>Snow Bunting</td>
<td>T</td>
<td>LC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ROLE OF FOREST BIODIVERSITY IN CONSERVATION 
OF NON-MULBERRY (VANYA) SILK IN INDIA

S. A. Ahmed*, N. I. Singh and C. R. Sarkar**

* Central Muga Eri Research & Training Institute, Central Silk Board, Govt. of India Lahdoigarh, Jorhat-785700, INDIA. E-mail: saahmed31@gmail.com
** University of Science & Technology, Meghalaya, Techno City, Kling Road, Ri-Bhoi district, Meghalay-793101, INDIA.


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 idiotypes 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) meliaeifolia 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 seribiodiversity 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 silkmoths, 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 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 cm$^2$) (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 murricata, 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 hardest 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 3105.00 MT 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. Budhist 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, Kahanapara, Nongpoh, Mendiopathar, Dhanubhang, 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 curucus Linn and several others. Further, one forest tree popularly known as ‘Maiphak’, Evodia (Tetradium) meliaeifolia 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, Laikoiagrh 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 are 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. trypisia (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 Maharashtra, 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 seric biodiversity is need of the hour to productivity enhancement.
- Development and strengthening of in-situ mechanism for seric 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 seric-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. Seric biodiversity refers to the variability in sericogenous insects and their host plants, which are economically and ecologically important biodiversity and by and large, forest based. There are several wild sericogenous 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 sericogenous insects are commercially exploited in India and there remains a great scope for producing novel silk from Cricula trifenesstrata 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


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.

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


Table 2. Distribution of different *Ailanthus* species.

<table>
<thead>
<tr>
<th>Ailanthus species</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ailanthus altissima</em></td>
<td>Northern and central mainland China, Taiwan, arguably the best known species</td>
</tr>
<tr>
<td><em>Ailanthus excelsa</em></td>
<td>India and Sri Lanka</td>
</tr>
<tr>
<td><em>Ailanthus grandis</em></td>
<td>India</td>
</tr>
<tr>
<td><em>Ailanthus integrifolia</em></td>
<td>New Guinea and Queensland, Australia</td>
</tr>
<tr>
<td><em>Ailanthus malabarica</em></td>
<td>Southeast Asia</td>
</tr>
<tr>
<td><em>Ailanthus triphysa</em></td>
<td>Northern and eastern Australia</td>
</tr>
<tr>
<td><em>Ailanthus vilmoriniana</em></td>
<td>Southwest China</td>
</tr>
</tbody>
</table>
APHIDS SPECIES IN CITRUS ORCHARDS OF ANTALYA PROVINCE

İşıl Saraç*, İşıl Özdemir** and İsmail Karaca*

* Süleyman Demirel University, Faculty of Agriculture, Department of Plant Protection, 32260 Isparta, TURKEY.
** Plant Protection Central Research Institute Gayret Mahallesi, Fatih Sultan Mehmet Bulvari, No.: 66, P.K.49 06172 Yenimahalle/Ankara TURKEY. E-mail: isilozdemir70@gmail.com


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 spiraecola 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 spiniculi is cylindirical, 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 roughy 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 cylinrdierical 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).

lycopersicum, S. melongena, S. nigrum, Spartium junceum, Syringa sp., Taraxacum officinale, Tripleurospermum decipiens, Tribulus terrestris, Trifolium sp., Urtica urens, Verbacum 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 & Athhan, 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 irreguler 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 sclerits 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/Istanbul in 1938 year in Turkey (Schmitschek, 1944).


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 then 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 cylindirical 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 midle 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 seconder 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 seconder rhinaria on 3rd antennal segment. There is not any seconder rhinaria on 4th antennal segment or there are 1-2 rhinaria. There is one primer rhinaria on 5th and 6th antennal segments. Tarsus has two segments and first tarsus segment has irregular bristles on. There is a pair of clav at top of last tarsus segment. The siphunculi is cylindirical and broaded 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 midle part, with 4-6 hairs. There are 8-19 seta on genital plate (Blackman & Eastop, 1984; Stroyan, 1984) (Figs. 3a,b).


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 paradisi, Citrus limon in this study.
Species: *Aphis spiraecola* 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 then 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 antenal segments. Third antenal segment of aperous viviparous females is without seconder rhinaria. Fourth antenal 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 then 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 sekonder rhinaria on the 3rd antennal segment. There is not any seconder rhinaria on 4rd antenal 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. grveis, 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 davisi, Paliurus spinaci, 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; Düzgün, 1982; Tuatay, 1993; Ölmez, 2000; Toros et al., 2002; Göür, 2004; Satar & Uygun, 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 antenal segments and without seconder 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 scleroted. 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 knobbled 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 lenght 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 antenal segments and 5-8 seconder rhinaria on 3th antenal 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 developped as apterous. Cauda knobbled 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. (Düzgünüş & 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: Aptereus 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 seconder 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 lenght in aptereus individuals is 1.9-2.6 mm and in alate individuals 1.6- 2.3 mm (Blackman & Eastop, 2000) (Figs. 6a,b).

cephalotes, C. spinasissimum, Cirsium sp., Circus benedicus, Cistus creveicus, Convolvulus sp., Cynara scolymus, Cynoglossum creticum, Echinops sp., Eryngium compeste, Eryngium sp., Gundelia tournefortii, Heliotropium sp., Isatis glauca, Notobasis syriaca, Onapordium illyricum, Onopordium sp., Picris sp., Prunus armeniaca, P. domestica, P. mahalep, 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 midle 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-developed 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 length more than second antennal segment, others are thin and long. There is a primer rhinaria on 5th and 6th antennal segments. 3rd antennal segment is without second 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 light color. Prothorax is black, wings are colorless or pale greenish and with very dark wing veins. Tibia and tarsus in legs are greenish, 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 length is 2.19 (±0.09) mm in average. Proboscis is reaching to second coxa. Antenna is shorter than body length and 2.05 (±0.028) mm length. Antenna segments have very short hairs. There is a primer rhinaria on 5th and 6th antennal segments. Third antennal segment has 11-15 seconder rhinaria. There are indistinct numerous denticles like aptereus on dorsal head surface and short hairs. Siphunculi is thin, long, cylindrical strucrer 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 belladona, Begonia sp., Beta

Myzus (Nectarosiphon) persicae was reported on Spinacia oleracea 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 apterous viviparious individuals is short, body is long, ist 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 sircle stain. Abdomen of alate viviparious 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 apterus viviparious is $1.23\pm 0.16$ (1-1.6) mm and height is $2.47\pm 0.08$ (2.35-2.60) mm. Width and length of alate viviparious are $1.01\pm 0.04$ (0.9-1.1) mm and $2.32\pm 0.09$ (2.05-2.45) respectively. Antennal tubercles are at apterus and alate viviparious 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 antenal segment. There is not second sensoria at 3rd antennal segment of apterus viviparious but there are 14-18, 0-8 and 0-3 second sensoria at 3rd, 4th and 6th antennal segments of alate viviparious respectively. Cornicles are slender and rude pattern. Cauda is spinal structure and finger shape and slightly constricted at proximal half. There are two pairs dorso-lateral setae and midle 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 spiraeola* 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.

**ACKNOWLEDGEMENTS**

The authors wish to thank the Research and Technology Department of Suleyman Demirel University in Isparta, Turkey for financial support (Project No: 3392-YL1-12).

**LITERATURE CITED**


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. (CERAMBYCIDAEE: LAMIINAE)

Hüseyin Özdikmen*

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


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 (Çalıyazı) (Tozlu et al., 2003); Van prov.: Van-Bahçesaray road (Narhca) (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 schlanke, die Mittel- und Hintertibien immer dicht bürstenartig 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 female 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 décritrai 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**


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

Sezai Adil*, Sevgi Sevsay*, Salih Doğan* and Sibel Dilkaraoğlu*

* Department of Biology, Science and Literature Faculty, Erzincan University, 24030, Erzincan, TURKEY. E-mails: sezaiadil@gmail.com, sadil@erzincan.edu.tr


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 occured two subfamilies; Charadracarinae Newell, 1960 and Johnstonianinae Thor, 1935. Johnstoniana genus has 13 species and five of these species nomen dobitum (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. Standart 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 basidon (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, asimetrical 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 lenght (Turkish specimens 36-70, European specimens 52-76). We suppose that these morphological differences base on geographical properties.

ACKNOWLEDGEMENTS

This study was supported by the Scientific and Technological Research Council of Turkey (TUBITAK project number: 113Z094). We are grateful to Prof. Dr. Andreas Wohltmann for giving some of the references. This study is a part of the first author’s Ph.D. thesis.

LITERATURE CITED


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

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>J. rapax</em></th>
<th><em>J. rapax</em></th>
<th><em>J. rapax</em></th>
<th><em>J. rapax</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female (n=1)</td>
<td>Adult (n=1)</td>
<td>Male (n=1)</td>
<td>Deutonymph (n=3) min.-max.</td>
</tr>
<tr>
<td>L Scutum</td>
<td>346</td>
<td>410</td>
<td>285</td>
<td>210-261</td>
</tr>
<tr>
<td>W Scutum</td>
<td>271</td>
<td>248</td>
<td>233</td>
<td>140-204</td>
</tr>
<tr>
<td>A Sens</td>
<td>95</td>
<td>72</td>
<td>77</td>
<td>60-77</td>
</tr>
<tr>
<td>P Sens</td>
<td>183</td>
<td>182</td>
<td>165</td>
<td>122-160</td>
</tr>
<tr>
<td>SBA</td>
<td>27</td>
<td>24</td>
<td>19</td>
<td>21-24</td>
</tr>
<tr>
<td>SBP</td>
<td>82</td>
<td>83</td>
<td>70</td>
<td>23-54</td>
</tr>
<tr>
<td>ISD</td>
<td>83</td>
<td>101</td>
<td>68</td>
<td>59-71</td>
</tr>
<tr>
<td>DS mn.-mx.</td>
<td>35-60</td>
<td>36-70</td>
<td>30-50</td>
<td>40-65</td>
</tr>
<tr>
<td>VS mn.-mx.</td>
<td>33-50</td>
<td>35-65</td>
<td>35-60</td>
<td>30-50</td>
</tr>
<tr>
<td>L Gop</td>
<td>274</td>
<td>273</td>
<td>230</td>
<td>83-88</td>
</tr>
<tr>
<td>Cx_I</td>
<td>222</td>
<td>264</td>
<td>204</td>
<td>151-162</td>
</tr>
<tr>
<td>Tr_I</td>
<td>137</td>
<td>148</td>
<td>115</td>
<td>90-105</td>
</tr>
<tr>
<td>Bf_I</td>
<td>245</td>
<td>283</td>
<td>212</td>
<td>133-171</td>
</tr>
<tr>
<td>Tf_I</td>
<td>220</td>
<td>280</td>
<td>187</td>
<td>129-162</td>
</tr>
<tr>
<td>Ge_I</td>
<td>258</td>
<td>328</td>
<td>221</td>
<td>143-188</td>
</tr>
<tr>
<td>Ti_I</td>
<td>306</td>
<td>363</td>
<td>259</td>
<td>133-196</td>
</tr>
<tr>
<td>Ta_I</td>
<td>381</td>
<td>408</td>
<td>320</td>
<td>171-247</td>
</tr>
<tr>
<td>Cx_II</td>
<td>223</td>
<td>289</td>
<td>198</td>
<td>164-175</td>
</tr>
<tr>
<td>Tr_II</td>
<td>106</td>
<td>134</td>
<td>92</td>
<td>74-95</td>
</tr>
<tr>
<td>Bf_II</td>
<td>188</td>
<td>215</td>
<td>148</td>
<td>124-141</td>
</tr>
<tr>
<td>Tf_II</td>
<td>147</td>
<td>200</td>
<td>111</td>
<td>92-112</td>
</tr>
<tr>
<td>Ge_II</td>
<td>161</td>
<td>211</td>
<td>133</td>
<td>112-129</td>
</tr>
<tr>
<td>Ti_II</td>
<td>200</td>
<td>250</td>
<td>158</td>
<td>125-134</td>
</tr>
<tr>
<td>Ta_II</td>
<td>297</td>
<td>326</td>
<td>250</td>
<td>203-224</td>
</tr>
<tr>
<td>Cx_III</td>
<td>263</td>
<td>250</td>
<td>208</td>
<td>164-257</td>
</tr>
<tr>
<td>Tr_III</td>
<td>140</td>
<td>139</td>
<td>105</td>
<td>87-138</td>
</tr>
<tr>
<td>Bf_III</td>
<td>208</td>
<td>234</td>
<td>162</td>
<td>114-136</td>
</tr>
<tr>
<td>Tf_III</td>
<td>174</td>
<td>205</td>
<td>144</td>
<td>106-133</td>
</tr>
<tr>
<td>Ge_III</td>
<td>200</td>
<td>232</td>
<td>166</td>
<td>115-148</td>
</tr>
<tr>
<td>Ti_III</td>
<td>260</td>
<td>283</td>
<td>221</td>
<td>130-155</td>
</tr>
<tr>
<td>Ta_III</td>
<td>337</td>
<td>378</td>
<td>286</td>
<td>211-232</td>
</tr>
<tr>
<td>Cx_IV</td>
<td>316</td>
<td>301</td>
<td>250</td>
<td>176-190</td>
</tr>
<tr>
<td>Tr_IV</td>
<td>238</td>
<td>288</td>
<td>144</td>
<td>142-159</td>
</tr>
<tr>
<td>Bf_IV</td>
<td>273</td>
<td>293</td>
<td>231</td>
<td>144-155</td>
</tr>
<tr>
<td>Tf_IV</td>
<td>281</td>
<td>275</td>
<td>216</td>
<td>125-138</td>
</tr>
<tr>
<td>Ge_IV</td>
<td>317</td>
<td>329</td>
<td>205</td>
<td>148-176</td>
</tr>
<tr>
<td>Ti_IV</td>
<td>414</td>
<td>413</td>
<td>304</td>
<td>194-210</td>
</tr>
<tr>
<td>Ta_IV</td>
<td>423</td>
<td>442</td>
<td>365</td>
<td>243-270</td>
</tr>
</tbody>
</table>
Table:

<table>
<thead>
<tr>
<th></th>
<th>274</th>
<th>246</th>
<th>225</th>
<th>144-156</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaFe</td>
<td>129</td>
<td>143</td>
<td>97</td>
<td>74-83</td>
</tr>
<tr>
<td>PaGe</td>
<td>199</td>
<td>241</td>
<td>170</td>
<td>137-146</td>
</tr>
<tr>
<td>PaTi</td>
<td>147</td>
<td>176</td>
<td>127</td>
<td>96-106</td>
</tr>
<tr>
<td>PaTa</td>
<td>38</td>
<td>46</td>
<td>28</td>
<td>23-29</td>
</tr>
<tr>
<td>CpPp</td>
<td>5,2</td>
<td>5,2</td>
<td>6</td>
<td>5-5,9</td>
</tr>
<tr>
<td>odontus</td>
<td>81</td>
<td>70</td>
<td>65</td>
<td>49-58</td>
</tr>
<tr>
<td>basidont</td>
<td>58</td>
<td>50</td>
<td>48</td>
<td>30-35</td>
</tr>
</tbody>
</table>

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

D. Alexander, Anulin Christudhas* and Manu Thomas Mathai

* Department of Zoology, Madras Christian College, Tambaram, Chennai-600059, INDIA.
E-mail: anulindhas@yahoo.com

[ 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 promiscus 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 pocess 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 units 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: cocidomyidae, tephritidae, agromyzidae and chloropidae. While the mycetophilidae and platypezidae are fungivorous. The saprophagous habit is largely in evidence among the anthomyidae. Other notable scavengers are the bibionidae, sepsidae, phorididae, heleomyzidae and scatophaginae. Next to the parasitic hymenoptera, the dipteran 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).

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Department of Zoology, Madras Christian College, Tambaram, for permitting to conduct the research.

LITERATURE CITED


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


Table 1. Larval and pupal length (in mm) of Chrysomya megacephala on three different diets.
Table 2. Larval and pupal weight (in grams) of *Chrysomya megacephala* on three different diets.

<table>
<thead>
<tr>
<th>Duration (Hours)</th>
<th>24</th>
<th>48</th>
<th>72</th>
<th>96</th>
<th>120</th>
<th>144</th>
<th>168</th>
<th>192</th>
<th>216</th>
<th>240</th>
<th>264</th>
<th>288</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larvae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain</td>
<td>0.009±0.003</td>
<td>0.019±0.001</td>
<td>0.034±0.009</td>
<td>0.057±0.015</td>
<td>0.076±0.003</td>
<td>0.103±0.001</td>
<td>0.091±0.005</td>
<td>0.087±0.002</td>
<td>0.086±0.005</td>
<td>0.055±0.007</td>
<td>0.081±0.007</td>
<td></td>
</tr>
<tr>
<td>Blood</td>
<td>0.006±0.005</td>
<td>0.007±0.002</td>
<td>0.031±0.007</td>
<td>0.045±0.009</td>
<td>0.063±0.008</td>
<td>0.087±0.008</td>
<td>0.073±0.005</td>
<td>0.061±0.005</td>
<td>0.059±0.003</td>
<td>0.058±0.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td>0.007±0.003</td>
<td>0.012±0.003</td>
<td>0.012±0.003</td>
<td>0.048±0.004</td>
<td>0.068±0.002</td>
<td>0.094±0.006</td>
<td>0.081±0.008</td>
<td>0.078±0.001</td>
<td>0.072±0.003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupae</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain</td>
<td></td>
<td></td>
<td></td>
<td>0.034±0.004</td>
<td>0.038±0.006</td>
<td>0.0415±0.0003</td>
<td>0.0452±0.0002</td>
<td>0.0487±0.0004</td>
<td>0.0491±0.0003</td>
<td>0.0500±0.0005</td>
<td>0.0515±0.0004</td>
<td></td>
</tr>
<tr>
<td>Blood</td>
<td></td>
<td></td>
<td></td>
<td>0.032±0.003</td>
<td>0.0352±0.0007</td>
<td>0.038±0.0003</td>
<td>0.0419±0.0003</td>
<td>0.046±0.0002</td>
<td>0.0462±0.0001</td>
<td>0.047±0.0003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td></td>
<td></td>
<td></td>
<td>0.032±0.001</td>
<td>0.0356±0.0002</td>
<td>0.037±0.0003</td>
<td>0.04±0.0004</td>
<td>0.044±0.0004</td>
<td>0.047±0.0004</td>
<td>0.048±0.0004</td>
<td>0.049±0.0008</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Duration (Hours)</th>
<th>Brain</th>
<th>Blood</th>
<th>Meat</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>0.6±0.0158</td>
<td>0.48±0.0256</td>
<td>0.58±0.0207</td>
</tr>
<tr>
<td>48</td>
<td>0.69±0.087</td>
<td>0.56±0.0555</td>
<td>0.65±0.036</td>
</tr>
<tr>
<td>72</td>
<td>0.75±0.0396</td>
<td>0.67±0.0414</td>
<td>0.74±0.0371</td>
</tr>
<tr>
<td>96</td>
<td>0.8±0.0291</td>
<td>0.71±0.024</td>
<td>0.79±0.0286</td>
</tr>
<tr>
<td>120</td>
<td>0.86±0.0602</td>
<td>0.78±0.0568</td>
<td>0.82±0.0349</td>
</tr>
<tr>
<td>144</td>
<td>0.9±0.0595</td>
<td>0.82±0.043</td>
<td>0.87±0.0396</td>
</tr>
<tr>
<td>168</td>
<td>0.82±0.0316</td>
<td>0.79±0.0303</td>
<td>0.77±0.0316</td>
</tr>
<tr>
<td>192</td>
<td>0.7±0.024</td>
<td>0.7±0.037</td>
<td>0.73±0.0316</td>
</tr>
<tr>
<td>216</td>
<td>0.7±0.0255</td>
<td>0.61±0.0316</td>
<td>0.63±0.0158</td>
</tr>
<tr>
<td>240</td>
<td>0.65±0.0414</td>
<td>0.59±0.024</td>
<td>0.6±0.0192</td>
</tr>
<tr>
<td>264</td>
<td>0.54±0.0319</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
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 (CERAMBYCIDAЕ: LAMIINAE)

Hüseyin Özdikmen* and Semra Turgut*

* Gazi Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü, 06500 Ankara / TÜRKİYE. E-mails: ozdikmen@gazi.edu.tr and semraturgut@gmail.com


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 Özdikmen & 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.: Kırıkhan–Belen road, Kıcı, N 36 28 E 36 16, 481 m, 31.03.2007. Paratypes: Osmaniye prov.: Yaylalı–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.: Kırıkhan–Belen road, Kıcı, N 36 28 E 36 16, 481 m, 31.03.2007, 7 specimens; Hassa–Kırıkhan road, 10 km to Kırıkhan, N 36 33 E 36 23, 31.03.2007, 3 specimens; Hassa–Kırıkhan 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; Aşağı İstiklal castle, N 36 19 E 36 11, 147 m, 30.03.2007, 7 specimens; Akbez, Gülpınar 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 Adıyaman 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.: Kırıkhan–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–Islahiye 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 Adıyaman prov. (Turkey) given by Hoskovec & Rejzek (2015) and the Adıyaman record of Rejzek & Hoskovec (1999) should be belong to the new subspecies, *Phytoecia (Helladia) humeralis caneri*. Kahramanmaraş records of Öz dikmen & 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 Adıyaman 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 Karahantepe 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 Längsbünden 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*
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............................................................................................................2
2. The subhumeral spot is very large. It stretches over the disc of the elytron and exceeds behind the basal one third of elytra..........................................................4
   - The subhumeral spot is smaller. It barely reach the disc of elytra.........................3
3. The design of head, pronotum and scutellum white..................................................3
   - The design of head, pronotum and scutellum yellow or ocraceous-red...................3
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....................................................6
6. Frons and vertex with clear drawings........................................................................6
   - Frons and vertex without clear drawings...............................................................6
7. Hind tibiae black...........................................................................................................7
   - Hind tibiae red..........................................................................................................7

**ACKNOWLEDGEMENT**

The authors wish to thank to Gérard Tavakilian (France) for notice and comments on validity of the subspecies.

**LITERATURE CITED**


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

Ruchie Gupta* and J. S. Tara

* Department of Zoology, University of Jammu, Jammu (Tawi) - 180006, J & K, INDIA. E-mail: ruchiegupta18@gmail.com

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 aperterous 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 aperterous 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 exuviae 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 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.

**ACKNOWLEDGEMENTS**

The authors are highly thankful to Head, Dept. of Zoology, University of Jammu for necessary help.

**LITERATURE CITED**


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.

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

Maurizio Bollino* and Franco Sandel**

* c/o Museo di Storia naturale del Salento, 73021 Calimera (Lecce), ITALY. E-mail: m.bollino@tin.it
** Via Fontanelle 30, 31050 Miane (Treviso), ITALY. E-mail: francosandel@libero.it


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 parasutural elliptic patch, a median parasutural 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. Prefemora 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 propisternum. 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 *Pachyrhynchus 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**


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.


Map 1. Map of Lubang archipelago, and neighbouring islands.
IMPACT OF INTEGRATED CHAWKI REARING TECHNOLOGY ON COCOON PRODUCTION IN MUGA SILKWORM
ANTHERAEA ASSAMENSIS HELFER

D. Goswami, N. Ibotombi Singh*, Mustaq Ahmed, M. D. Senapati and K. Giridhar

* Central Muga Eri Research & Training Institute, Central Silk Board, Lahdoigarh, Jorhat, Assam, INDIA. E-mail: ibotombisingh@yahoo.co.in

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 (dfl) while in the traditional lot, it ranged from 4020 to 5490 per 100 dfl. 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(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 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 bombicina 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
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 (dfls) 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 foliage of som. 0.01% sodium hypo chloride solution were sprayed in the foliage 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 leaf 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


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.

<table>
<thead>
<tr>
<th>Village</th>
<th>Control</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>T value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sonawal</td>
<td>4800</td>
<td>3975</td>
<td>4200</td>
<td>4800</td>
<td>5023</td>
<td>4879</td>
<td>4112</td>
<td>3334</td>
<td></td>
<td></td>
<td>3.945</td>
</tr>
<tr>
<td></td>
<td>5400</td>
<td>5834</td>
<td>5532</td>
<td>5433</td>
<td>4615</td>
<td>5424</td>
<td>5068</td>
<td>5438</td>
<td>4605</td>
<td>3854</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.75</td>
</tr>
<tr>
<td>Tamuliari</td>
<td>4221</td>
<td>3989</td>
<td>4570</td>
<td>5120</td>
<td>5030</td>
<td>4780</td>
<td>4670</td>
<td>4367</td>
<td>4967</td>
<td>4970</td>
<td>3.106</td>
</tr>
<tr>
<td></td>
<td>4812</td>
<td>4587</td>
<td>5105</td>
<td>5656</td>
<td>5635</td>
<td>5423</td>
<td>5144</td>
<td>4892</td>
<td>5644</td>
<td>5645</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.58</td>
</tr>
<tr>
<td>Thara</td>
<td>4020</td>
<td>3390</td>
<td>3890</td>
<td>4080</td>
<td>4078</td>
<td>4069</td>
<td>4030</td>
<td>5080</td>
<td>4890</td>
<td>5221</td>
<td>5.424</td>
</tr>
<tr>
<td></td>
<td>4583</td>
<td>4893</td>
<td>4352</td>
<td>5018</td>
<td>5665</td>
<td>5244</td>
<td>4906</td>
<td>4591</td>
<td>5173</td>
<td>5728</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.74</td>
</tr>
<tr>
<td>Thavaisings</td>
<td>4500</td>
<td>4884</td>
<td>4567</td>
<td>4320</td>
<td>5013</td>
<td>5432</td>
<td>4879</td>
<td>5023</td>
<td>5729</td>
<td>5728</td>
<td>6.808</td>
</tr>
<tr>
<td></td>
<td>4950</td>
<td>4983</td>
<td>5617</td>
<td>4816</td>
<td>5444</td>
<td>5603</td>
<td>5872</td>
<td>5927</td>
<td>5909</td>
<td>4708</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14.40</td>
</tr>
<tr>
<td>Harshana</td>
<td>4400</td>
<td>4980</td>
<td>5023</td>
<td>5190</td>
<td>5080</td>
<td>4978</td>
<td>4590</td>
<td>4506</td>
<td>5012</td>
<td>3853</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4840</td>
<td>5081</td>
<td>5778</td>
<td>6178</td>
<td>5609</td>
<td>5730</td>
<td>5792</td>
<td>6710</td>
<td>5862</td>
<td>5453</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.89</td>
</tr>
</tbody>
</table>

*Table value of “T” at 5% = 1.93, and at 1% = 2.82

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

<table>
<thead>
<tr>
<th>Village</th>
<th>Control</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>T value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sonawal</td>
<td>5200</td>
<td>4890</td>
<td>3970</td>
<td>4200</td>
<td>4879</td>
<td>5012</td>
<td>4869</td>
<td>5020</td>
<td>5345</td>
<td>4978</td>
<td>4.880</td>
</tr>
<tr>
<td></td>
<td>5624</td>
<td>5478</td>
<td>4567</td>
<td>3720</td>
<td>5313</td>
<td>5432</td>
<td>5357</td>
<td>5352</td>
<td>5729</td>
<td>5728</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.79</td>
</tr>
<tr>
<td>Tamuliari</td>
<td>4500</td>
<td>5280</td>
<td>4890</td>
<td>4565</td>
<td>4398</td>
<td>5022</td>
<td>4908</td>
<td>5010</td>
<td>4900</td>
<td>4.882</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4950</td>
<td>4983</td>
<td>5617</td>
<td>4816</td>
<td>5444</td>
<td>5603</td>
<td>5872</td>
<td>5927</td>
<td>5909</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.98</td>
</tr>
<tr>
<td>Thara</td>
<td>4565</td>
<td>4780</td>
<td>5020</td>
<td>4980</td>
<td>4565</td>
<td>5120</td>
<td>5070</td>
<td>4880</td>
<td>4590</td>
<td>4289</td>
<td>4.045</td>
</tr>
<tr>
<td></td>
<td>5113</td>
<td>5554</td>
<td>5372</td>
<td>5478</td>
<td>5020</td>
<td>5478</td>
<td>5478</td>
<td>5020</td>
<td>5455</td>
<td>4632</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10.00</td>
</tr>
<tr>
<td>Thavaisings</td>
<td>5010</td>
<td>4590</td>
<td>4980</td>
<td>5030</td>
<td>5470</td>
<td>4720</td>
<td>4868</td>
<td>5230</td>
<td>5260</td>
<td>4900</td>
<td>3.400</td>
</tr>
<tr>
<td></td>
<td>5510</td>
<td>5198</td>
<td>5577</td>
<td>5382</td>
<td>5944</td>
<td>5386</td>
<td>5354</td>
<td>5865</td>
<td>5638</td>
<td>5838</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.72</td>
</tr>
<tr>
<td>Harshana</td>
<td>4880</td>
<td>5400</td>
<td>4556</td>
<td>5130</td>
<td>5090</td>
<td>4878</td>
<td>4960</td>
<td>5120</td>
<td>4878</td>
<td>5467</td>
<td>5.870</td>
</tr>
<tr>
<td></td>
<td>5515</td>
<td>5965</td>
<td>5080</td>
<td>5982</td>
<td>5979</td>
<td>5415</td>
<td>5016</td>
<td>5796</td>
<td>5502</td>
<td>6015</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Improvement (%) over control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13.65</td>
</tr>
</tbody>
</table>

*Table value of “T” at 5% = 1.98, and at 1% = 2.82
BIOLOGICAL SCREENING OF CLERODENDRON INERME LEAF EXTRACTS FOR REPELLENCY AND TOXICITY POTENTIALS AGAINST STORED PRODUCT INSECTS

B. R. Guruprasad* and Akmal Pasha*

* Food Protectants and Infestation Control Department, CSIR-Central Food Technological Research Institute, Mysore-570 020, INDIA. E-mails: akmalpasha@cftri.res.in; drguruprasad28@gmail.com


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 0.02µl, 0.04µl, 0.08µl 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 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 bioactive 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 (McDonald 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., 2010; 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 & Kamaraswami, 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 ± 2°C, L : D 12:12 and with 70 ± 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 ± 2°C and RH 70 ± 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 Mc Donald 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 (0.02µl, 0.04µl, 0.08µl of the extracts per cm²). 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. 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. chinensis (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 ± 2°C with relative humidity of 70 ± 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: PR = [(Nc-Nt)/(Nc+Nt)] ×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; 60.1to 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 1ml of each of the solutions
was poured onto the Whatman No. 1 filter circle in each of the peri-
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 LD99 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
bettle, 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 (0.020µl/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 µl/cm² and class IV at 0.080
µl/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 µl/cm², 0.040 µl/cm² and 0.080 µl/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 LD50 and LD99 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 (LD50=1.28 and LD99=2.20 mg/cm²). At the
same time the LD50 and LD99 doses against C. chinensis reached LD50 (1.74
mg/cm$^2$) and LD$_{99}$ (3.01mg/cm$^2$) 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 R$^2$ 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 repellant activity of three solvent extracts of C. inerme leaf, along with a standard repellant teflubenzuron and insecticidal activity of methanolic plant extract on three stored product insects. Significant repellant 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 Table1 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 martini, 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 LD$_{50}$ and LD$_{99}$ 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 Caballer-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.

**ACKNOWLEDGEMENTS**

The authors are thankful to Prof. Ram Rajasekharan Director, CSIR-CFTRI for the facilities and encouragement. We are also thankful to the Department of Science and Technology, SERB, New Delhi, India for financial support and fellowship to one of the author.

**LITERATURE CITED**


Ho, S. H. & Ma, Y. 1995. Repellence of some plant extracts to the stored product beetles Tribolium castaneum (Herbst) and Sitophilus granarius Motsch. paper presented at the Symposium on pest management for stored food and feed. SEMEO-BIOTROP, BOGER, Indonesia. 5-7, September.


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.


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.

<table>
<thead>
<tr>
<th>Insect species</th>
<th>Solvent used</th>
<th>Concentration of extract g/100ml</th>
<th>*Average repellency (%) after treatment (hours)</th>
<th>Mean</th>
<th>Repellency rate (class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. castaneum</td>
<td>Methanol</td>
<td>0.020</td>
<td>60.7 ± 2.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>71.3 ± 3.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>75.4 ± 3.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>75.4 ± 2.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>79.3 ± 5.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>85.6 ± 4.5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>90.3 ± 3.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>93.2 ± 3.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>95.3 ± 2.8&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Petroleum ether</td>
<td>0.020</td>
<td>41.4 ± 1.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.3 ± 5.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.7 ± 3.2&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>48.1 ± 4.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>45.6 ± 2.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>43.4 ± 1.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>49.6 ± 4.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50.2 ± 3.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.1 ± 2.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Ethyl acetate</td>
<td>0.020</td>
<td>24.1 ± 1.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.6 ± 2.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>23.4 ± 2.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>46.7 ± 4.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.7 ± 4.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.1 ± 2.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>48.5 ± 2.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.1 ± 6.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>41.2 ± 4.8&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Tefubenzuron</td>
<td>0.020</td>
<td>40.5 ± 6.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.7 ± 5.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21.4 ± 4.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>50.3 ± 4.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.1 ± 6.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.3 ± 5.2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>58.1 ± 5.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>60.8 ± 3.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>34.2 ± 4.7&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>R. dominica</td>
<td>Methanol</td>
<td>0.020</td>
<td>60.1 ± 2.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>63.4 ± 5.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>70.5 ± 4.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>69.3 ± 9.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>79.3 ± 7.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>81.2 ± 5.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>81.7 ± 6.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>89.2 ± 4.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>90.4 ± 3.9&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Petroleum ether</td>
<td>0.020</td>
<td>43.4 ± 8.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.1 ± 7.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.7 ± 6.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>53.2 ± 4.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50.3 ± 6.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.5 ± 5.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>79.1 ± 6.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>74.7 ± 7.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>69.2 ± 6.7&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Ethyl acetate</td>
<td>0.020</td>
<td>20.1 ± 7.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>29.3 ± 3.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.6 ± 6.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>35.4 ± 8.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.5 ± 4.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.3 ± 4.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>50.6 ± 6.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49.8 ± 4.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>38.2 ± 5.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Tefubenzuron</td>
<td>0.020</td>
<td>51.6 ± 6.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44.1 ± 5.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.8 ± 3.7&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>59.2 ± 4.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>64.1 ± 6.8&lt;sup&gt;b&lt;/sup&gt;</td>
<td>34.4 ± 5.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>63.4 ± 5.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>54.2 ± 6.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>42.1 ± 6.9&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>C. chinensis</td>
<td>Methanol</td>
<td>0.020</td>
<td>65.3 ± 8.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50.4 ± 6.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>58.4 ± 6.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>61.7 ± 6.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>62.3 ± 5.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>70.2 ± 5.3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>65.6 ± 7.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>70.3 ± 7.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>71.2 ± 3.2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Petroleum ether</td>
<td>0.020</td>
<td>41.2 ± 6.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.4 ± 4.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.3 ± 4.6&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>49.6 ± 7.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.2 ± 3.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.4 ± 4.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>51.9 ± 6.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50.1 ± 8.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>40.7 ± 7.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Ethyl acetate</td>
<td>0.020</td>
<td>20.3 ± 7.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-7</td>
<td>-12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>31.5 ± 7.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-11</td>
<td>-12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.080</td>
<td>49.5 ± 3.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>31.8 ± 4.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>28.5 ± 3.9&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Tefubenzuron</td>
<td>0.020</td>
<td>41.2 ± 2.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.1 ± 5.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>39.1 ± 5.2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.040</td>
<td>50.6 ± 3.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>48.1 ± 3.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>46.2 ± 6.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

*values are averages of five replicates and mean ± 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.

<table>
<thead>
<tr>
<th>Insect species</th>
<th>Exposure (h)</th>
<th>LD&lt;sub&gt;50&lt;/sub&gt; value (mg/cm&lt;sup&gt;2&lt;/sup&gt;)</th>
<th>LD&lt;sub&gt;90&lt;/sub&gt; value (mg/cm&lt;sup&gt;2&lt;/sup&gt;)</th>
<th>χ&lt;sup&gt;2&lt;/sup&gt; value (df)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. castaneum</td>
<td>24</td>
<td>1.28</td>
<td>2.20</td>
<td>15.36 (4)</td>
</tr>
<tr>
<td>R. dominica</td>
<td>24</td>
<td>0.65</td>
<td>1.50</td>
<td>13.7 (4)</td>
</tr>
<tr>
<td>C. chinensis</td>
<td>24</td>
<td>1.74</td>
<td>3.01</td>
<td>30.01 (4)</td>
</tr>
</tbody>
</table>
ESTIMATING WEALTH OF VISITORS FLORAL (INSECTA) BOTANICAL GARDEN THE FACULTY OF AGRICULTURE, UNLPAM, IN THE PROVINCE OF LA PAMPA, ARGENTINA

Gimena B. Suppo* and Estela Quirán*

* Facultad de Ciencias Exactas y Naturales, UNLPam, Uruguay 151, CP 6300, Santa Rosa, La Pampa, ARGENTINA. E-mail: gimesuppo_86@hotmail.com


ASTRACT: 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 Coccinellidae, 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* = 9.649 435 865; *sp* = 1, 03 x 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, Cynolestidae, and Tenebrionidae.

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


The plant species *Hyalis argentea* (Asteraceae) was the most visited in the number of specimens of insects, while *Santolina chamaecyparissus* (Asteraceae) and *Commelina erecta* (Commelinidaceae) 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**


Figure 1. Satellite image: La Pampa, Faculty of Agriculture, Botanical Garden (36°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.

<table>
<thead>
<tr>
<th>Planta N°</th>
<th>Familia</th>
<th>Especie “nombre vulgar”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Liliaceae</td>
<td><em>Yucca gloriosa</em> “yucca”</td>
</tr>
<tr>
<td>2</td>
<td>Rosaceae</td>
<td><em>Photinia fraseri</em></td>
</tr>
<tr>
<td>3</td>
<td>Fabaceae</td>
<td><em>Spartium junceum</em> “retama de españa”</td>
</tr>
<tr>
<td>4</td>
<td>Asteraceae</td>
<td><em>Coreopsis grandiflora</em></td>
</tr>
<tr>
<td>5</td>
<td>Rosaceae</td>
<td><em>Rosa sp.</em></td>
</tr>
<tr>
<td>6</td>
<td>Brassicaceae</td>
<td><em>Hirschfeldia incana</em> “mostacilla”</td>
</tr>
<tr>
<td>7</td>
<td>Asteraceae</td>
<td><em>Santolima chamaecyparissus</em> “santolina”</td>
</tr>
<tr>
<td>8</td>
<td>Boraginaceae</td>
<td><em>Echium plantagineum</em> “flor morada”</td>
</tr>
<tr>
<td>9</td>
<td>Commelinaceae</td>
<td><em>Commelina erecta</em> “flor de santa lucia”</td>
</tr>
<tr>
<td>10</td>
<td>Oxalidaceae</td>
<td><em>Oxalis articulata</em> “vinagrillo”</td>
</tr>
<tr>
<td>11</td>
<td>Asteraceae</td>
<td><em>Hyalis argentea</em> “olivillo”</td>
</tr>
<tr>
<td></td>
<td>Caprifoliaceae</td>
<td><em>Abelia grandiflora</em> “abelia”</td>
</tr>
<tr>
<td>12</td>
<td>Apocynaceae</td>
<td>Nerium oleander “laurel de jardín” morado</td>
</tr>
<tr>
<td>----</td>
<td>----------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>13</td>
<td>Fabaceae</td>
<td>Prosopis humilis</td>
</tr>
<tr>
<td>14</td>
<td>Carophyllaceae</td>
<td>Saponaria officinalis “yerba jabonera”</td>
</tr>
<tr>
<td>15</td>
<td>Amaryllidaceae</td>
<td>Crinum variabile “azucena”</td>
</tr>
<tr>
<td>16</td>
<td>Asteraceae</td>
<td>Centaurea solstitialis “abrepuño amarillo”</td>
</tr>
<tr>
<td>17</td>
<td>Liliaceae</td>
<td>Bulbine frutescens “bulbine”</td>
</tr>
<tr>
<td>18</td>
<td>Bignoniaceae</td>
<td>Campsis radicans “trompeta”</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>---</td>
</tr>
<tr>
<td>20</td>
<td>Solanaceae</td>
<td>Solanum elaeagnifolium “revienta caballo”</td>
</tr>
<tr>
<td>21</td>
<td>Asteraceae</td>
<td>Heterotheca subaxillaris “falsa alcanfor”</td>
</tr>
<tr>
<td>22</td>
<td>Amaryllidaceae</td>
<td>Tulbaghia violacea “tulbaghia”</td>
</tr>
<tr>
<td>23</td>
<td>Commelinidaceae</td>
<td>Commelina erecta “flor de santa lucia”</td>
</tr>
<tr>
<td>24</td>
<td>Asteraceae</td>
<td>Conyza bonariensis “rama negra”</td>
</tr>
<tr>
<td>25</td>
<td>Asteraceae</td>
<td>Solidago chilensis “vara de oro”</td>
</tr>
<tr>
<td>26</td>
<td>Bignoniaceae</td>
<td>Macfadyena dentata “cometa”</td>
</tr>
<tr>
<td>27</td>
<td>Zygophyllaceae</td>
<td>Tribulus terrestris “roseta francesa”</td>
</tr>
<tr>
<td>28</td>
<td>Liliaceae</td>
<td>Bulbine frutescens “bulbine”</td>
</tr>
<tr>
<td>29</td>
<td>Apocynaceae</td>
<td>Nerium oleander “laurel de jardín” blanco</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Sampling</th>
<th>Temperature</th>
<th>Humidity</th>
<th>Direction</th>
<th>Shade</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>15/11/2011</td>
<td>14 - 22 °C</td>
<td>37%</td>
<td>northwest</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>29/11/2011</td>
<td>16 - 30 °C</td>
<td>36%</td>
<td>northwest</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>15/12/2011</td>
<td>18 - 32 °C</td>
<td>34%</td>
<td>the northern sector</td>
<td>X</td>
<td>partially</td>
</tr>
<tr>
<td>27/12/2011</td>
<td>21 - 35 °C</td>
<td>33%</td>
<td>northwest</td>
<td>X</td>
<td>partially</td>
</tr>
<tr>
<td>06/02/2012</td>
<td>23 - 33 °C</td>
<td>31%</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>23/02/2012</td>
<td>19 - 26 °C</td>
<td>30%</td>
<td></td>
<td>X</td>
<td>partially</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Familles de Coleoptera</th>
<th>Morphospecies</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carabidae</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Scarabaeidae</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Elateridae</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Curculionidae</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Staphylinidae</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Coccinellidae</td>
<td>10</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Chrysomelidae</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Tenebrionidae</td>
<td>13</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Cantaridae</td>
<td>15</td>
<td>20</td>
</tr>
</tbody>
</table>
Table 4. List of Families collected in the Order Hymenoptera, Faculty of Agriculture, UNLPam, November-December 2011 and February 2012 Botanic Garden.

<table>
<thead>
<tr>
<th>Orden</th>
<th>Families</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hymenoptera</td>
<td>Vespidae</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Apidae</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Formicidae</td>
<td>199</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Orders</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Araneae</td>
<td>18</td>
</tr>
<tr>
<td>Coleoptera</td>
<td>150</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>258</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>72</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>3</td>
</tr>
<tr>
<td>Orthoptera</td>
<td>29</td>
</tr>
<tr>
<td>Diptera</td>
<td>36</td>
</tr>
<tr>
<td>Fasmida</td>
<td>1</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Subfamilies/ Species de Formicidae</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myrmicinae</td>
<td></td>
</tr>
<tr>
<td><em>Phidole bergi</em></td>
<td>32</td>
</tr>
<tr>
<td><em>Crematogaster quadriformis</em></td>
<td>5</td>
</tr>
<tr>
<td><em>Acromyrmex stritus</em></td>
<td>38</td>
</tr>
<tr>
<td><em>Acromyrmex lobicornis</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Solenopsis patagonica</em></td>
<td>16</td>
</tr>
<tr>
<td>Dolichoderinae</td>
<td></td>
</tr>
<tr>
<td><em>Dorymyrmex sp.</em></td>
<td>3</td>
</tr>
<tr>
<td><em>Linepithema humile</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Araucomyrmex tener</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Conomyrmex wolffhügel</em></td>
<td>9</td>
</tr>
<tr>
<td><em>Conomyrmex carettei</em></td>
<td>19</td>
</tr>
<tr>
<td>Formicinae</td>
<td></td>
</tr>
<tr>
<td><em>Camponotus crassus</em></td>
<td>7</td>
</tr>
<tr>
<td><em>Camponotus bonariensis</em></td>
<td>19</td>
</tr>
<tr>
<td><em>Camponotus borelli</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Camponotus rufipes</em></td>
<td>13</td>
</tr>
<tr>
<td><em>Camponotus mus</em></td>
<td>1</td>
</tr>
<tr>
<td><em>Camponotus punctulatus</em></td>
<td>5</td>
</tr>
<tr>
<td><em>Brachymyrmex patagonicus</em></td>
<td>22</td>
</tr>
<tr>
<td><em>Forelius minor</em></td>
<td>6</td>
</tr>
</tbody>
</table>
Table 7. Floral Visitors of the plants of the Botanical Garden, Faculty of Agriculture, UNLPam, November-December 2011 and February 2012.

<table>
<thead>
<tr>
<th>Plant N°</th>
<th>Coleoptera</th>
<th>quantity</th>
<th>Formicidae</th>
<th>quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Morpho 10</td>
<td>4</td>
<td>Phaethus bergi</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Morpho 11</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 12</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Morpho 8</td>
<td>1</td>
<td>Camponotus crassus</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Morpho 10</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 13</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Morpho 8</td>
<td>1</td>
<td>Camponotus bonariensis</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Morpho 10</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 11</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 12</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 15</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Morpho 10</td>
<td>1</td>
<td>Brachymyrmex patagonicus</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Morpho 13</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 15</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Morpho 6</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 10</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 11</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 12</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 15</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Morpho 13</td>
<td>4</td>
<td>Camponotus borelli</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Morpho 15</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Morpho 6</td>
<td>5</td>
<td>Phaethus bergi</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Morpho 8</td>
<td>1</td>
<td>Camponotus crassus</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Morpho 13</td>
<td>1</td>
<td>Brachymyrmex patagonicus</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Morpho 15</td>
<td>1</td>
<td>Doromyrmex sp.</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Morpho 8</td>
<td>1</td>
<td>Camponotus bonariensis</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Morpho 10</td>
<td>6</td>
<td>Crematogaster quadriformis</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Morpho 12</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 13</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 15</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Morpho 10</td>
<td>1</td>
<td>Phaethus bergi</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Morpho 11</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 14</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Morpho 10</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 12</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 14</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Morpho 10</td>
<td>19</td>
<td>Crematogaster quadriformis</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Morpho 11</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 13</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Morpho 15</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Morpho 13</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Morpho 10</td>
<td>1</td>
<td>Camponotus bonariensis</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Morpho 13</td>
<td>1</td>
<td>Acromyrmex striatus</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>Morpho 10</td>
<td>1</td>
<td>Camponotus bonariensis</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Morpho 13</td>
<td>1</td>
<td>Acromyrmex lobicornis</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Morpho 10</td>
<td>Morpho 13</td>
<td>Morpho 15</td>
<td>Pheidole borgi</td>
</tr>
<tr>
<td>----</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------------</td>
</tr>
<tr>
<td>15</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>Pheidole borgi</td>
</tr>
</tbody>
</table>

|    | Morpho 13 | | | Canponentus bonariensis | 1 |
|----|-----------| | | Canponentus rufipes | 3 |

|    | Morpho 7 | | | Canponentus rufipes | 1 |
|----|----------| | | Forelius minor | 6 |

|    | Morpho 7 | | | Canponentus rufipes | 2 |

|    | | | Conomyrma wolffiogeli | 9 |
|----| | | Linepithema humile | 1 |
|    | | | Canponentus rufipes | 7 |

|    | | | Acromyrmex striatus | 7 |
|----| | | Pheidole borgi | 1 |
|    | | | Canponentus bonariensis | 1 |

|    | | | Acromyrmex striatus | 2 |
|----| | | Canponentus mus | 1 |
|    | | | Araucanomyrnx tener | 1 |
|    | | | Pheidole borgi | 1 |
|    | | | Brachymyrmex patagonicus | 1 |
|    | | | Canponentus punctulatus | 5 |

|    | Morpho 2 | Morpho 13 | | 1 | Pheidole borgi | 9 |
|----|----------|-----------| | | 2 | Conomyrma caretei | 1 |

|    | Morpho 1 | Morpho 3 | Morpho 9 | Morpho 13 | | Solenopsis patagonica | 7 |
|----|----------|----------|----------|----------| | | Brachymyrmex patagonicus | 2 |
|    | | | | | | Conomyrma caretei | 1 |
|    | | | | | | Canponentus bonariensis | 3 |

|    | Morpho 2 | Morpho 12 | | Pheidole borgi | 4 |
|----|----------|-----------| | | 1 |
|    | | | Crematogaster quadriforinis | 1 |
|    | | | Conomyrma caretei | 1 |
|    | | | Acromyrmex striatus | 1 |

|    | Morpho 12 | | | Acromyrmex striatus | 20 |
|----|-----------| | | Conomyrma caretei | 6 |

|    | Morpho 4 | Morpho 5 | | Pheidole borgi | 2 |
|----|----------|----------| | | 3 |
|    | | | Acromyrmex striatus | 3 |
|    | | | Brachymyrmex patagonicus | 6 |
|    | | | Canponentus bonariensis | 2 |
|    | | | Conomyrma caretei | 9 |

|    | | | Brachymyrmex patagonicus | 2 |
|----| | | Conomyrma caretei | 1 |
|    | | | Acromyrmex striatus | 4 |
|    | | | Pheidole borgi | 2 |
|    | | | Canponentus bonariensis | 1 |

|    | Morpho 1 | Morpho 12 | Morpho 13 | Morpho 14 | | Solenopsis patagonica | 9 |
|----|----------|-----------|-----------|-----------| | | Canponentus bonariensis | 1 |
PSEUDOSCORPIONS (ARACHNIDA: PSEUDOSCORPIONES) FOUND IN BIRD NESTS AND IN BAT GUANO IN SLOVAKIA AND GERMANY

Katarína Krajčovičová*, Jana Christophoryová* and Terézia Lučeničová

* Department of Zoology, Faculty of Natural Sciences, Comenius University, Mlynská dolina B–1, SK–842 15 Bratislava, SLOVAKIA. E-mails: krajcovic.katarina@gmail.com; christophoryova@gmail.com; t.lucenicova@gmail.com

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 Lamprocheres nodosus (Schrank, 1803) were identified in examined nests. In Slovakia, the species Dactylochelifer latreillii (Leach, 1817), C. hahnii and Allocheres 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 Monticolli, 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 carcinooides (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; Droglé & 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. hahni* 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, Zlatícia 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 daubentonii* (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 Krajevičová, 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, Krajevičová). 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**

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; Drogla & 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 (Drogla, 1988; Drogla & 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 (Helversen, 1966; Krumpál & Cyprich, 1988; Drogla & 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 (Helversen, 1966; Drogla & 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)


Pseudoscorpion D. panzeri was mostly recorded from tree hollows (Helversen, 1966; Jost, 1982; Štáhlavský, 2001; Drogla & Lippold, 2004; Christophoryová, 2010; Krajčovičová & Christophoryová, 2014). It was also found in bird nests situated in tree hollows and bird boxes (Helversen, 1966; Kríštofík 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)


The species A. wideri (Fig. 2) prefers microhabitats of tree hollows and it was occasionally found under the tree bark (Štáhlavský, 2001; Drogla & Lippold, 2004; Christophoryová, 2010; Krajčovičová & Christophoryová, 2014). There are known records from anthills and Malaise traps (Drogla & 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 numerously found in compost heaps (Drogla & Lippold, 2004; Christophoryová et al., 2014). The phoresy of L. nodosus was recorded in Europe (for example: Ressl & 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.

**ACKNOWLEDGEMENTS**

We are grateful to all collectors of pseudoscorpion material used in this paper and Alica Christophoryová for technical assistance with figures. The study was financially supported by the project VEGA 2/0035/13 and VEGA 1/0191/15.

**LITERATURE CITED**


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 Fendá, 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.

Krishna Kant Lawania* and M. M. Trigunayat**

* Research scholar, Department of Life Sciences, IIS University, Jaipur-302020, INDIA. E-mail: kklawania23@gmail.com
** Head department of Zoology, Govt. R. D. Girls PG College Bharatpur-321001, INDIA. E-mail: drmmt@rediffmail.com


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 desert 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 outskirt 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 represented in only NWS but are known to be absent from SBS and KNP. 11 species are well represented in only 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- 813 mm. and NWS- 844 mm.). 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.

ACKNOWLEDGEMENTS

We are thankful to Prof. N.P. Singh, Head, Department of zoology, University of Rajasthan, Jaipur and Prof. P. Bhatnagar, Dean of life science, IIS University, Jaipur (Raj.) for encouragement.

LITERATURE CITED


Table 1. Shown spider species, recorded from three conserve areas (KNP, NWS and SWS) of India.

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Guild</th>
<th>Distribution of species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>KNP</td>
</tr>
<tr>
<td>Agelenida</td>
<td>(i) Agelenius sp.</td>
<td>Funnel Web builders</td>
<td>--</td>
</tr>
<tr>
<td>Araneida</td>
<td>(ii) Tegenaria domestica</td>
<td>Funnel Web builders</td>
<td>--</td>
</tr>
<tr>
<td>Araneida</td>
<td>(i) Acresilus indicus</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(ii) Araneus nitidus</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(iii) Argiope aemula</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(iv) Arigiope anasiu</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(v) Arigiope pulchella</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(vi) Cyclosa insulana</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(vii) Cyclosa sp.</td>
<td>Orb web builders</td>
<td>--</td>
</tr>
<tr>
<td>Araneida</td>
<td>(viii) Cyrtarachne keralayensis</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(ix) Cyrtophora cicatrosa</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(x) Cyrtophora citricola</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xi) Cyrtophora fadii</td>
<td>Orb web builders</td>
<td>--</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xii) Cyrtophora molacens</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xiii) Erenovisa excelsa</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xiv) Larinia emorni</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xv) Leucanopus decorata</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xvi) Larinia chlorus</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xvii) Neoscona mushera</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Araneida</td>
<td>(xviii) Zygella indica</td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Corinnidae</td>
<td>(i) Castanapia sp.</td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td>Clubionidae</td>
<td>(i) Chiracanthium sp.</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Dictynidae</td>
<td>(i) Nigma shiprai</td>
<td>Irregular web builders</td>
<td>--</td>
</tr>
<tr>
<td>Gnaphosida</td>
<td>(i) Callilepis lambai</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Gnaphosida</td>
<td>(ii) Callilepis rubrinia</td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td>Hesperiida</td>
<td>(iii) Dressodes sp.</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Linyphiida</td>
<td>(i) Linyphia sp.</td>
<td>Sheet web builders</td>
<td>++</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(i) Geolycosa urbana</td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(ii) Hippasa madhuiae</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(iii) Hippasa pisaurina</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(iv) Lycosa mackenziei</td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(v) Lycosa pictula</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(vi) Parasa birmanica</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(vii) Perelosia sangosa</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Lycosida</td>
<td>(viii) Parasa pseudomurata</td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Nephilida</td>
<td>(i) Nephila sp.</td>
<td>Orb web builders</td>
<td>--</td>
</tr>
<tr>
<td>Nephilida</td>
<td>(ii) Nephila kuhlii</td>
<td>Orb web builders</td>
<td>--</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(i) Oxyopes assamensis</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(ii) Oxyopes bhamaniceus</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(iii) Oxyopes javanus</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(iv) Oxyopes tarsanae</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(v) Oxyopes shiwata</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(vi) Oxyopes pankaji</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(vii) Oxyopes ryfisernum</td>
<td>Foliage runner</td>
<td>--</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(viii) Oxyopes serfatus</td>
<td>Foliage runner</td>
<td>--</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(ix) Oxyopes retani</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Oxyopidae</td>
<td>(x) Oxyopes viridana</td>
<td>Foliage runner</td>
<td>++</td>
</tr>
<tr>
<td>Pholcidae</td>
<td>(i) Artemia atlanta</td>
<td>Irregular web builders</td>
<td>++</td>
</tr>
<tr>
<td>Pholcidae</td>
<td>(ii) Crossopra lyont</td>
<td>Irregular web builders</td>
<td>++</td>
</tr>
<tr>
<td>Family</td>
<td>Species</td>
<td>Behavior Type</td>
<td>++</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------------------</td>
<td>----------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>Salticidae</td>
<td>(i) <em>Acemonea tenipes</em></td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(ii) <em>Bavia sp.</em></td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(iii) <em>Biton albopictus</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(iv) <em>Biton pseudobitum</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(v) <em>Cossaphis umborta</em></td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(vi) <em>Hassius ansensis</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(vii) <em>Hyllus seminispina</em></td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(viii) <em>Myrmecina matthewi</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(ix) <em>Myrmecina orientalis</em></td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(x) <em>Neoconus sp.</em></td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(xi) <em>Pintella vitella</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xii) <em>Plexippus paykulli</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xiii) <em>Plexippus paykulli</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xiv) <em>Phidippus patell</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xv) <em>Phidippus yashchake</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xvi) <em>Salticus runjites</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xvii) <em>Phidippus tindicus</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xviii) <em>Portia assamensis</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xix) <em>Portia sp.</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xx) <em>Ptococcus strupifer</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(xxi) <em>Seleneops Sp.</em></td>
<td>Ground runner</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(xxii) <em>Telamantista dimidiata</em></td>
<td>Ground runner</td>
<td>++</td>
</tr>
<tr>
<td>Tetragenathidae</td>
<td>(i) <em>Leucauge decorata</em></td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(ii) <em>Tetragenathina chamberlini</em></td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(iii) <em>Leucauge sp.</em></td>
<td>Orb web builders</td>
<td>++</td>
</tr>
<tr>
<td>Theridiidae</td>
<td>(i) <em>Achaeranae minutia</em></td>
<td>Single line saare web</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(ii) <em>Chrysochaeta nigra</em></td>
<td>Single line saare web</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(iii) <em>Chrysochaeta pulcherrima</em></td>
<td>Single line saare web</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(iv) <em>Steatoda sp.</em></td>
<td>Single line saare web</td>
<td>++</td>
</tr>
<tr>
<td>Thomisidae</td>
<td>(i) <em>Philodromus sp.</em></td>
<td>Ambusher</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(ii) <em>Thomisus labosus</em></td>
<td>Ambusher</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(iii) <em>Thomisus projectus</em></td>
<td>Ambusher</td>
<td>++</td>
</tr>
<tr>
<td></td>
<td>(iv) <em>Xysticus minutus</em></td>
<td>Ambusher</td>
<td>++</td>
</tr>
<tr>
<td>Uloboridae</td>
<td>(i) <em>Uloborus donolius</em></td>
<td>Dome shape horizontal web</td>
<td>++</td>
</tr>
</tbody>
</table>
FAUNISTIC STUDY ON NOTERIDAE AND DYTISCIDAE (COLEOPTERA: ADEPHAGA) IN RAMSAR SITE KUYUCUK LAKE (TURKEY), WITH FURTHER DISTRIBUTIONAL NOTES

Mustafa Cemal Darılmaz*, Ahmet Polat**, Ümit İncekara** and Gani Erhan Taşar***

* Aksaray University, Science and Art Faculty, Department of Biology, Aksaray, TURKEY.
** Atatürk University, Science Faculty, Department of Biology, Erzurum, TURKEY. E-mail: ahmetpolat@atauni.edu.tr
*** Adıyaman University, Kahta Vocational High School, Adıyaman, TURKEY.

[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, Hygrothrus impressopunctatus, H. parallellogrammus, 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 clavicorinis* (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 & Kıyak, 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 & Kıyak, 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°44’53N 43°27’03E, 1631m, 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, Ağrı, Ankara, Erzurum (Darılmaz & Kıyak, 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 & Kıyak, 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, Aşkale, Ankara, Antalya, Artvin, Aydın, Balıkesir, Bolu, Bursa, Çorum, Edirne, Erzurum, Eskişehir, Gümüşhane, Isparta, Içel, İzmir, Kastamonu, Kayseri, Konya, Kilis, Manisa, Mugla, Rize, Samsun, Trabzon, Yozgat (Darılmaz & Kıyak, 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, Içel, İzmir, Kayseri, Van, Trabzon, Yozgat (Darılmaz & Kıyak, 2009; Darılmaz et al., 2010).

**Remark:** New record of research area.
**Hygrotus impressopunctatus (Schaller, 1783)**

Materials examined: Kars; Kuyucuk Lake, 40°44'53"N 43°27'03"E, 1631m, 03.08.2010, 5ex.; 40°44'53"N 43°27'03"E, 1639m, 28.05.2011, 2ex.; 40°44'23"N 43°27'15"E, 1636m, 28.05.2011, 2ex.

**Distribution in Turkey:** Çorum, Erzurum, Konya (Darılmaz & Kıyak, 2009; Darılmaz et al., 2010).

**Remark:** New record of research area.

**Hygrotus parallelogrammus (Ahrens, 1812)**

Materials examined: Kars; Kuyucuk Lake, 40°44'53"N 43°27'03"E, 1631m, 03.08.2010, 2ex.; 40°45'06"N 43°27'23"E, 1647m, 03.08.2010, 1ex.; 40°44'53"N 43°27'03"E, 1639m, 28.05.2011, 6ex.

**Distribution in Turkey:** Afyon, Ankara, Erzurum, Konya, Kütahya, Samsun, Tuz Lake, Toros Mountains (Darılmaz & Kıyak, 2009).

**Remark:** New record of research area.

**Hygrotus inaequalis (Fabricius, 1777)**

Materials examined: Kars; Kuyucuk Lake, 40°44'54"N 43°27'17"E, 1634m, 03.08.2010, 5ex.; 40°44'53"N 43°27'05"E, 1635m, 15.10.2011, 8ex.; 40°44'53"N 43°27'03"E, 1631m, 03.08.2010, 8ex.; 40°44'53"N 43°27'03"E, 1639m, 28.05.2011, 2ex.; 40°44'23"N 43°27'15"E, 1636m, 28.05.2011, 7ex.; 40°44'50"N 43°27'23"E, 1636m, 03.08.2010, 1ex.

**Distribution in Turkey:** Afyon, Ankara, Artvin, Bolu, Çorum, Erzurum, Isparta, Kayseri, Konya, Manisa, Samsun (Darılmaz & Kıyak, 2009; Darılmaz et al., 2010; Hızarcıoğlu et al., 2010; İncekara et al., 2010).

**Remark:** New record of research area.

**Laccophilus minutus (Linnaeus, 1758)**

Materials examined: Kars; Kuyucuk Lake, 40°44'53"N 43°27'05"E, 1635m, 15.10.2011, 24ex.; 40°44'53"N 43°27'03"E, 1631m, 03.08.2010, 22ex.; 40°45'06"N 43°27'23"E, 1647m, 03.08.2010, 6ex.; 40°44'53"N 43°27'03"E, 1639m, 28.05.2011, 2ex.

**Distribution in Turkey:** Afyon, Aksaray, Ankara, Antalya, Artvin, Aydin, Balıkesir, Bolu, Burdur, Bursa, Çorum, Erzurum, Eskişehir, Gümüşhane, Isparta, İzmir, Kastamonu, Kayseri, Konya, Manisa, Rize, Samsun, Sinop, Sivas, Trabzon, Toros Mountains Yozgat (Darılmaz & Kıyak, 2009; Darılmaz et al., 2010; Topkara & Balık, 2010).

**Remark:** New record of research area.

**LITERATURE CITED**


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 Environments 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. 40º44'54N 43º27'17E, 03.08.2010, 1634m; 2: 40º44'50N 43º27'23E, 03.08.2010, 1636m; 3: 40º44'53N 43º27'03E, 03.08.2010, 1631m; 4: 40º45'06N 43º27'23E, 03.08.2010, 1647m; 5: 40º44'53N 43º27'03E, 28.05.2011, 1639m; 6: 40º44'23N 43º27'15E, 28.05.2011, 1636m; 7: 40º44'55N 43º29'58E, 28.05.2011, 1635m; 8: 40º44'53N 43º27'05E, 15.10.2011, 1635m.

<table>
<thead>
<tr>
<th>Species</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noterus clavicornis</td>
<td>1 ex.</td>
<td>8 ex.</td>
<td>60 ex.</td>
<td>16 ex.</td>
<td>11 ex.</td>
<td>10 ex.</td>
<td>1 ex.</td>
<td>5 ex.</td>
</tr>
<tr>
<td>Rhantus suturalis</td>
<td>1 ex.</td>
<td>2 ex.</td>
<td></td>
<td></td>
<td></td>
<td>1 ex.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graphoderus cinereus</td>
<td>3 ex.</td>
<td></td>
<td></td>
<td>2 ex.</td>
<td></td>
<td>1 ex.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydaticus ponticus</td>
<td></td>
<td>6 ex.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydroglyphus geminus</td>
<td>9 ex.</td>
<td>1 ex.</td>
<td>18 ex.</td>
<td>3 ex.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scarodytes halensis halensis</td>
<td></td>
<td></td>
<td></td>
<td>1 ex.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hygrotus impressopunctatus</td>
<td>5 ex.</td>
<td>2 ex.</td>
<td>2 ex.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hygrotus parallelogrammus</td>
<td>2 ex.</td>
<td>1 ex.</td>
<td>6 ex.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hygrotus inaequalis</td>
<td>5 ex.</td>
<td>1 ex.</td>
<td>8 ex.</td>
<td>2 ex.</td>
<td>7 ex.</td>
<td>8 ex.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laccophilus minutus</td>
<td>22 ex.</td>
<td>6 ex.</td>
<td>6 ex.</td>
<td></td>
<td>24 ex.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 2. Comparision 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.

R. Nirupama*

* Central Sericultural Research and Training Institute, Mysore-570008, Karnataka, INDIA.
E-mail: nirupama_mail@rediffmail.com

[ 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 haemolymph 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 biomolecules 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 1x10⁶ conidial suspension/ml/100 larvae sprayed on the body of multivoltine 2000H and bivoltine CSR6 breeds. Treated batches were kept under temperature 25±1°C and humidity 90±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 an anthrone solution (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 g/m 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/g 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 form 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 *Beauveria 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.

ACKNOWLEDGEMENTS

The author wishes to express her gratitude to Science and Engineering Research Board, New Delhi for project and financial assistance, and to the Director of Central Sericultural Research & Training Institute, Mysore for providing laboratory facilities, and Scientist-D, SSTL, kodathi, Banglore.

LITERATURE CITED


Table 1. Protein concentration in the breeds of 2000H and CSR6.

<table>
<thead>
<tr>
<th>Larval days</th>
<th>Treated He(2H) (mg/ml)</th>
<th>Control He(2H) (mg/ml)</th>
<th>Treated Lt(2H) (mg/g)</th>
<th>Control Lt(2H) (mg/g)</th>
<th>Treated He(C6) (mg/ml)</th>
<th>Control He(C6) (mg/ml)</th>
<th>Treated Lt(C6) (mg/g)</th>
<th>Control Lt(C6) (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>55.17</td>
<td>64.29</td>
<td>40.10</td>
<td>43.42</td>
<td>59.58</td>
<td>34.75</td>
<td>40.23</td>
<td>44.57</td>
</tr>
<tr>
<td>2nd</td>
<td>59.95</td>
<td>69.42</td>
<td>44.57</td>
<td>53.29</td>
<td>65.17</td>
<td>37.85</td>
<td>44.57</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>63.00</td>
<td>73.00</td>
<td>49.50</td>
<td>57.46</td>
<td>69.52</td>
<td>40.95</td>
<td>49.88</td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td>56.50</td>
<td>78.49</td>
<td>42.27</td>
<td>52.32</td>
<td>73.25</td>
<td>36.72</td>
<td>52.73</td>
<td></td>
</tr>
<tr>
<td>5th</td>
<td>52.25</td>
<td>81.35</td>
<td>38.60</td>
<td>49.46</td>
<td>78.00</td>
<td>33.31</td>
<td>55.30</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Carbohydrate level in the breeds of 2000H and CSR6.

<table>
<thead>
<tr>
<th>Larval days</th>
<th>Treated He(2H) (mg/ml)</th>
<th>Control He(2H) (mg/ml)</th>
<th>Treated Lt(2H) (mg/g)</th>
<th>Control Lt(2H) (mg/g)</th>
<th>Treated He(C6) (mg/ml)</th>
<th>Control He(C6) (mg/ml)</th>
<th>Treated Lt(C6) (mg/g)</th>
<th>Control Lt(C6) (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>22.70</td>
<td>28.92</td>
<td>19.89</td>
<td>22.42</td>
<td>26.52</td>
<td>17.30</td>
<td>21.38</td>
<td></td>
</tr>
<tr>
<td>2nd</td>
<td>27.30</td>
<td>33.97</td>
<td>22.73</td>
<td>25.73</td>
<td>30.92</td>
<td>21.26</td>
<td>24.35</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>32.60</td>
<td>41.26</td>
<td>25.88</td>
<td>29.36</td>
<td>35.41</td>
<td>25.00</td>
<td>27.50</td>
<td></td>
</tr>
<tr>
<td>4th</td>
<td>26.88</td>
<td>47.92</td>
<td>21.19</td>
<td>32.68</td>
<td>39.70</td>
<td>21.25</td>
<td>31.94</td>
<td></td>
</tr>
<tr>
<td>5th</td>
<td>21.50</td>
<td>52.64</td>
<td>18.75</td>
<td>35.71</td>
<td>43.75</td>
<td>18.05</td>
<td>34.15</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Lipid content in the breeds of 2000H and CSR6.

<table>
<thead>
<tr>
<th>Larval days</th>
<th>Treated He(2H) (mg/ml)</th>
<th>Control He(2H) (mg/ml)</th>
<th>Treated Lt(2H) (mg/g)</th>
<th>Control Lt(2H) (mg/g)</th>
<th>Treated He(C6) (mg/ml)</th>
<th>Control He(C6) (mg/ml)</th>
<th>Treated Lt(C6) (mg/g)</th>
<th>Control Lt(C6) (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>59.70</td>
<td>67.18</td>
<td>36.76</td>
<td>39.44</td>
<td>52.47</td>
<td>59.00</td>
<td>33.69</td>
<td>36.57</td>
</tr>
<tr>
<td>2nd</td>
<td>59.44</td>
<td>69.36</td>
<td>39.57</td>
<td>43.02</td>
<td>55.60</td>
<td>62.35</td>
<td>37.33</td>
<td>41.15</td>
</tr>
<tr>
<td>3rd</td>
<td>63.35</td>
<td>73.85</td>
<td>42.26</td>
<td>48.23</td>
<td>61.19</td>
<td>66.57</td>
<td>40.92</td>
<td>45.78</td>
</tr>
<tr>
<td>4th</td>
<td>58.00</td>
<td>75.43</td>
<td>37.35</td>
<td>50.73</td>
<td>57.78</td>
<td>70.29</td>
<td>35.73</td>
<td>49.30</td>
</tr>
<tr>
<td>5th</td>
<td>55.35</td>
<td>77.58</td>
<td>35.00</td>
<td>53.50</td>
<td>51.45</td>
<td>73.25</td>
<td>32.00</td>
<td>51.10</td>
</tr>
</tbody>
</table>

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.
Protein changes in the haemolymph and larval tissues of CSR6 breed

Graphs 4.

Carbohydrate changes in the haemolymph and larval tissues of CSR6 breed

Graphs 5.

Lipid changes in the haemolymph and larval tissues of the CSR6 breed

Graphs 6.
A NEW SPECIES OF ECTINOHOPLIA FROM LAOS
WITH NOTES ON SOME OTHER SPECIES
(COLEOPTERA: SCARABAEIDAE)

Artem M. Prokofiev*

* Institute for Ecology and Evolution, Russian Academy of Sciences, Leninsky prospect 33, Moscow 119071, RUSSIA. E-mail: prokartster@gmail.com


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 Hopline beetles are extremely poorly known. During a revisional study of the Hoplines 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, Pakhhen, 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 anteriad 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 sternum 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 anteriad 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 anteriad 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. coeruleosignata* 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 Hopliines 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.

ACKNOWLEDGEMENTS

I am sincerely indebted to Drs. Johannes Frisch and Joachim Willers (Museum für Naturkunde, Berlin, Germany), Olivier Montreuil and Antoine Mantilleri (Muséum National d’Histoire naturelle, Paris, France) for the possibility of examination of the type specimens in the collections under their care and numerous assistances during the museum work.

LITERATURE CITED


Figures 1-5. *Ectinohopia 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: CHALCIDOIDAEA: EULOPHIDAE: EULOPHINAE: ELASMINI) OF MAHARASHTRA, INDIA

Sarofrazul Islam Kazmi* and P. Girish Kumar**

* Northern Regional Centre, Zoological Survey of India, Dehradun (Uttarakhand), INDIA. E-mail: kazmizsi@gmail.com
** Zoological Survey of India, M-Block, New Alipore, Kolkata (West Bengal), INDIA.


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, Elasmini, 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; TT – 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, 1859: 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 trifasciatiiventris 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 nephantidis* 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)

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>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</td>
<td>brevicornis Gahan</td>
</tr>
<tr>
<td>2.</td>
<td>Mesothoracic dorsum not completely dark</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Hind coxa completely dark brown to black, at most with extreme apex yellowish (Mid coxa largely dark brown to black)</td>
<td>indicus Rohwer</td>
</tr>
<tr>
<td>4.</td>
<td>Hind coxa yellow at least apical third</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>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</td>
<td>krishnagiriensis Mani &amp; Saraswat</td>
</tr>
<tr>
<td>6.</td>
<td>Gaster entirely dark brown to black, at most ventre yellowish; pedicel shorter than F1; F1-3 each slightly more than 2.5X as long as broad</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Hind tibia (also mid tibia) yellow to pale yellow</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Mesoscutum without such spot; scutellum completely dark</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Hind tibia (also mid tibia) yellow to pale yellow</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>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</td>
<td>johnstoni Ferriere</td>
</tr>
<tr>
<td>15.</td>
<td>F1-3 subequal in length, each about 1.5X as long as broad; clava longer shorter than preceding two funicle segments combined</td>
<td></td>
</tr>
</tbody>
</table>
- 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......
- Gaster, apart from basal half of TII, with some terga with blackish spots or bands………………queenslandicus Girault

13. Gaster with TVI largely blackish, TVII yellow; scape 3.5X as long as broad; ovipositor with exserted part about 1/9th of gaster………………………………………………………………………………flavescens Verma & Hayat
- Gaster with TIV-VII blackish; scape 4.5X as long as broad; ovipositor with exserted 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; Lamprosoema indicate; 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.


Elasmus johnstoni Ferriere

Elasmus johnstoni Ferriere, 1929: 258, F, M. Type F: Sudan, Wad Medani (BMNH).

**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 concolorous 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 puera; Nephantes rhodobasalis; Pectinophora gossypiella; Sylepta derogate; Braconidae: Apanteles imparatus; 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**


**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).


**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. auriflue; 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


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


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 exserted.

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


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 infuscate 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

**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 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 (Margaronta) 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**


**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**


**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 infusion 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**


**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**


**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, TIII, TIV and TV, faintly on TII; 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**


**Diagnosis:** Body yellow to honey yellow, following parts brown to blackish: a large area above foramen continued on to frontovertext 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 T1 black with metallic bluish refringence, dark brown median patch or spot on TIII to TV; TVI 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**


**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 TVI and TVII 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.
ACKNOWLEDGEMENTS

We are grateful to Dr. K. Venkataraman, Director, Zoological Survey of India, Kolkata, for providing facilities. We are also grateful to Dr. Kailash Chandra, Additional Director & Officer-in-Charge of Entomology Division (A), Zoological Survey of India, Kolkata and Dr. P. C. Tak, Officer-in-Charge, Northern Regional Centre, Zoological Survey of India, Dehradun, for his useful suggestions in the preparation of the manuscript.

LITERATURE CITED


FIRST RECORD OF GENUS LASIOBELBA AOKI, 1959 (ACARI: ORIBATIDA) FROM TURKEY

Merve Yaşa, Nusret Ayyıldız and Şule Baran*

* Sakarya University, Department of Biology, 54187 Sakarya, TURKEY. E-mail: sbaran@sakarya.edu.tr


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 form 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)

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 *c2* very fine and hardly visible, rest of nine notogastral setae long, bacilliform and ciliated (Fig. 3). Setae *p1* and *p3* 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 seate 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).


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; Csiszár, 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

This study was partly produced from the postgraduate thesis of the first author and supported by Sakarya University Scientific Research Project Unit (Project no: FBYLTEZ 2014-50-01-055). We wish to thank Prof. Dr. Fatih Üstel, Garip ERDOĞAN, Fatih Erdem BAŞTAN and Semih YÜCEL from Sakarya University, Thermal Spray Technology Laboratory (TESLAB) with for the Scanning Electron Microscopy investigations.

LITERATURE CITED


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.) kuehnetli* ventral region, Scanning electron microscopy image.

Figure 5. *Lasiobelba (L.) kuehnetli* 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

Kailash Chandra* and Sandeep Kushwaha**

* Zoological Survey of India, 'M' Block New Alipore Kolkata, West Bengal, INDIA. E-mail: kailash611@rediffmail.com
** Zoological Survey of India, Central Zone Regional Centre, Scheme No. 5, Plot No. 168-169, Vijay Nagar, Jabalpur-482 002 Madhya Pradesh, INDIA. E-mail: sandeepkushwaha_17@yahoo.com


ABSTRACT: The 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; VDWLS- 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 superfamly 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.

ACKNOWLEDGEMENT

The authors are thankful to Dr. K. Venkataraman, Director, Zoological Survey of India for providing necessary facilities and encouragement.

LITERATURE CITED


Table 1. List of superfamily Pyrrhocoroidea studied from Madhya Pradesh.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Suborder / Superfamily / Family</th>
<th>Species</th>
<th>No. of exs.</th>
<th>Collection localities (Area / WLS / National Park / Biosphere Reserve)</th>
<th>Districts</th>
<th>Date of Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td><em>Physopelta quadrigutta</em> (Bergr., 1894)</td>
<td>1</td>
<td>PBR</td>
<td>Hoshangabad</td>
<td>07.vi.2009</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>2</td>
<td>PBR</td>
<td>Hoshangabad</td>
<td>06.iv.2001</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>5</td>
<td>ZSI Quarters Colony</td>
<td>Jabalpur</td>
<td>12.iv.2012</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td><em>Physopelta schlanbuschi</em> (Fabr., 1787)</td>
<td>10</td>
<td>SWLS</td>
<td>Raisen</td>
<td>14.iv.2011</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td><em>Physopelta trimaculata</em> Stehlik, 2008</td>
<td>1</td>
<td>SWLS</td>
<td>Raisen</td>
<td>10.iv.2011</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>1</td>
<td>VDWLS</td>
<td>Damoh</td>
<td>13.iii.2011</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>2</td>
<td>SWLS</td>
<td>Raisen</td>
<td>10.iv.2011</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>1</td>
<td>PBR</td>
<td>Hoshangabad</td>
<td>06.iv.2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>SWLS</td>
<td>Raisen</td>
<td>01.iv.2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>VDWLS</td>
<td>Damoh</td>
<td>23.vi.2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>ZSI office</td>
<td>Jabalpur</td>
<td>14.ii.2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>RH Sarsala</td>
<td>Narsinghpur</td>
<td>08.iii.2014</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td><em>Euscoscopus albatus</em> Distant, 1909*</td>
<td>1</td>
<td>VDWLS</td>
<td>Damoh</td>
<td>11.iii.2011</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>1</td>
<td>Vijay Nagar</td>
<td>Jabalpur</td>
<td>11.iv.2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>SWLS</td>
<td>Raisen</td>
<td>11.ii.2010</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td><em>Deltocophalus infimus</em> Melichar, 1903</td>
<td>2</td>
<td>VDWLS</td>
<td>Damoh</td>
<td>18.xi.2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>PBR</td>
<td>Hoshangabad</td>
<td>25.x.2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>Vijay Nagar</td>
<td>Jabalpur</td>
<td>15.ii.2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>RH Sarsala</td>
<td>Narsinghpur</td>
<td>12.iii.2014</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td><em>Scantius pallens</em> (Distant, 1903)</td>
<td>1</td>
<td>Barha</td>
<td>Kami</td>
<td>08.vi.2009</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td><em>Scantius volucris</em> Gerstäcker, 1873*</td>
<td>1</td>
<td>Karmajhir, PTR</td>
<td>Seoni</td>
<td>23.vi.2001</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td><em>Dermatius lugubris</em> Distant,* 1903</td>
<td>1</td>
<td>SWLS</td>
<td>Raisen</td>
<td>21.ix.2011</td>
</tr>
</tbody>
</table>
ANALYSIS OF PHENOTYPIC DIVERSITY AND PROTEIN POLYMORPHISM IN SOME SILKWORM BREEDS OF BOMBYX MORI L.

Shunmugam Manthira Moorthy* and Nalavadi Chandrakanth

* Central Sericultural Research and Training Institute, Mysore-570 008, Karnataka, INDIA.
E-mail: moorthysm68@gmail.com


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 Li4) 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 -80ºC 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 coommossie 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 (Moorothy 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**


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.


Table 1. Details of the morphological traits in the silkworm genotypes.

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Breeds</th>
<th>Voltinism</th>
<th>Larval Marking</th>
<th>Cocoon colour</th>
<th>Cocoon shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pure Mysore</td>
<td>Multivoltine</td>
<td>Plain</td>
<td>Light greenish yellow</td>
<td>Spindle</td>
</tr>
<tr>
<td>2</td>
<td>ND7</td>
<td>Multivoltine</td>
<td>Plain</td>
<td>Light greenish yellow</td>
<td>Elongated oval</td>
</tr>
<tr>
<td>3</td>
<td>Nistari</td>
<td>Multivoltine</td>
<td>Marked</td>
<td>Yellow</td>
<td>Spindle</td>
</tr>
<tr>
<td>4</td>
<td>Cambodge</td>
<td>Multivoltine</td>
<td>Plain</td>
<td>Yellow</td>
<td>Spindle</td>
</tr>
<tr>
<td>5</td>
<td>L14</td>
<td>Multivoltine</td>
<td>Plain</td>
<td>Light greenish yellow</td>
<td>Elongated oval</td>
</tr>
<tr>
<td>6</td>
<td>CSR2</td>
<td>Bivoltine</td>
<td>Plain</td>
<td>White</td>
<td>Oval</td>
</tr>
<tr>
<td>7</td>
<td>CSR50</td>
<td>Bivoltine</td>
<td>Plain</td>
<td>White</td>
<td>Oval</td>
</tr>
<tr>
<td>8</td>
<td>CSR51</td>
<td>Bivoltine</td>
<td>Marked</td>
<td>White</td>
<td>Dumbbell</td>
</tr>
<tr>
<td>9</td>
<td>BHR3</td>
<td>Bivoltine</td>
<td>Marked</td>
<td>White</td>
<td>Dumbbell</td>
</tr>
<tr>
<td>10</td>
<td>SK4C</td>
<td>Bivoltine</td>
<td>Marked</td>
<td>White</td>
<td>Dumbbell</td>
</tr>
</tbody>
</table>
Table 2. Details of quantitative traits studied in silkworm genotypes.

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Fecundity</th>
<th>Larval weight (g)</th>
<th>Yield/10000 larvae by no.</th>
<th>Yield/10000 larvae by wt. (kg)</th>
<th>Cocoon weight (g)</th>
<th>Shell weight (g)</th>
<th>Shell (%)</th>
<th>Filament length (m)</th>
<th>Filament size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Mysore</td>
<td>425</td>
<td>23.45</td>
<td>9254</td>
<td>9.427</td>
<td>1.053</td>
<td>0.16</td>
<td>15.11</td>
<td>402</td>
<td>2.1</td>
</tr>
<tr>
<td>ND7</td>
<td>422</td>
<td>25.56</td>
<td>9207</td>
<td>13.537</td>
<td>1.456</td>
<td>0.27</td>
<td>18.77</td>
<td>636</td>
<td>2.45</td>
</tr>
<tr>
<td>Nistari</td>
<td>410</td>
<td>23.28</td>
<td>9495</td>
<td>12.689</td>
<td>1.182</td>
<td>0.618</td>
<td>14.26</td>
<td>352.29</td>
<td>2.87</td>
</tr>
<tr>
<td>Cambodge</td>
<td>450</td>
<td>25.66</td>
<td>9420</td>
<td>9.641</td>
<td>1.23</td>
<td>0.179</td>
<td>14.54</td>
<td>402.16</td>
<td>2.88</td>
</tr>
<tr>
<td>L14</td>
<td>510</td>
<td>34.24</td>
<td>9142</td>
<td>13.203</td>
<td>1.446</td>
<td>0.26</td>
<td>17.98</td>
<td>724</td>
<td>2.06</td>
</tr>
<tr>
<td>CSR</td>
<td>563</td>
<td>46.41</td>
<td>9077</td>
<td>15.498</td>
<td>1.782</td>
<td>0.41</td>
<td>23</td>
<td>1050</td>
<td>2.82</td>
</tr>
<tr>
<td>CSR50</td>
<td>544</td>
<td>44.11</td>
<td>9040</td>
<td>15.757</td>
<td>1.715</td>
<td>0.389</td>
<td>22.6</td>
<td>1052</td>
<td>2.86</td>
</tr>
<tr>
<td>CSR51</td>
<td>538</td>
<td>42.45</td>
<td>8847</td>
<td>15.22</td>
<td>1.71</td>
<td>0.367</td>
<td>21.4</td>
<td>975</td>
<td>2.82</td>
</tr>
<tr>
<td>BHR3</td>
<td>517</td>
<td>34.33</td>
<td>9226</td>
<td>12.638</td>
<td>1.525</td>
<td>0.297</td>
<td>19.45</td>
<td>622.83</td>
<td>2.93</td>
</tr>
<tr>
<td>SK4C</td>
<td>524</td>
<td>34.42</td>
<td>9226</td>
<td>14.362</td>
<td>1.627</td>
<td>0.334</td>
<td>20.51</td>
<td>704.9</td>
<td>2.99</td>
</tr>
</tbody>
</table>

Table 3. ANOVA and summary statistics of the nine quantitative traits measured in 10 silkworm genotypes.

<table>
<thead>
<tr>
<th>Traits</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
<th>F-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecundity</td>
<td>490.3</td>
<td>57.42831</td>
<td>410 - 563</td>
<td>1369.280</td>
<td>0.0001</td>
</tr>
<tr>
<td>Larval weight</td>
<td>33.391</td>
<td>8.763985</td>
<td>23.28 - 46.41</td>
<td>1099.936</td>
<td>0.0001</td>
</tr>
<tr>
<td>Yield/10000 larvae in no.</td>
<td>9193.4</td>
<td>184.995</td>
<td>8847 - 9495</td>
<td>3.113</td>
<td>0.016</td>
</tr>
<tr>
<td>Yield/10000 larvae in Wt.</td>
<td>13.1972</td>
<td>2.232143</td>
<td>9.427 - 15.757</td>
<td>496.356</td>
<td>0.0001</td>
</tr>
<tr>
<td>Cocoon weight</td>
<td>1.4726</td>
<td>0.248949</td>
<td>1.053 - 1.782</td>
<td>777.019</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shell weight</td>
<td>0.3284</td>
<td>0.131434</td>
<td>0.16 - 0.618</td>
<td>258.937</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shell %</td>
<td>18.762</td>
<td>3.252704</td>
<td>14.26 - 23</td>
<td>247.007</td>
<td>0.0001</td>
</tr>
<tr>
<td>Filament length</td>
<td>692.118</td>
<td>264.6746</td>
<td>352.29 - 1052</td>
<td>153383.75</td>
<td>0.0001</td>
</tr>
<tr>
<td>Filament size</td>
<td>2.678</td>
<td>0.346404</td>
<td>2.06 - 2.99</td>
<td>25.894</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
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

Kailash Chandra*, Reeta Bhandari*** and Sandeep Kushwaha**

* Zoological Survey of India, ‘M’ Block New Alipore Kolkata, West Bengal, INDIA. E-mail: kailash611@rediffmail.com
** Zoological Survey of India, Central Zone Regional Centre, Scheme No. 5, Plot No. 168-169, Vijay Nagar, Jabalpur-482 002 Madhya Pradesh, INDIA. E-mail: sandeepkushwaha_17@yahoo.com
*** Govt. Science College Jabalpur Madhya Pradesh, INDIA.


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.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Scientific Name</th>
<th>WLS/NP/ Locality</th>
<th>Status</th>
<th>Date of Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Order: Hemiptera</strong>&lt;br&gt;<strong>Suborder: Heteropteroidea</strong>&lt;br&gt;<strong>Infraorder: Cimicomorpha</strong>&lt;br&gt;<strong>Superfamily: Cimicoidea</strong>&lt;br&gt;<strong>Family: Reduviidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Tribelocephala indica (Walker)</td>
<td>RWLS/Water tank</td>
<td>H</td>
<td>18.vi.2013</td>
</tr>
<tr>
<td>2</td>
<td>Ectomocoris cordiger Stal</td>
<td>Near Museum wall</td>
<td>L</td>
<td>19.vi.2013</td>
</tr>
<tr>
<td>3</td>
<td>Catamiaurus brevipennis (Serv.)</td>
<td>Near Museum wall</td>
<td>L</td>
<td>19.vi.2013</td>
</tr>
<tr>
<td>4</td>
<td>Prostemma carduelis Dohrn</td>
<td>Village boundary</td>
<td>VH</td>
<td>20.vi.2013</td>
</tr>
<tr>
<td>5</td>
<td>Ectrychotes dispar Reuter</td>
<td>Water tank</td>
<td>H</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td>6</td>
<td>Oncocephalus annulipes Stal</td>
<td>RWLS/Near Water tank</td>
<td>L</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td>7</td>
<td>Prostemma carduelis (Dohrn)</td>
<td>RWLS/Near Water tank</td>
<td>L</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td>8</td>
<td>Polididus armatissimus Stal</td>
<td>RWLS/FRH</td>
<td>VH</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td>9</td>
<td>Scadra annulipes Reuter</td>
<td>Village boundary</td>
<td>H</td>
<td>20.vi.2013</td>
</tr>
<tr>
<td>10</td>
<td>Rhynocoris marginatus (F.)</td>
<td>RWLS/FRH</td>
<td>L</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td><strong>Infraorder: Pentatomorpha</strong>&lt;br&gt;<strong>Superfamily: Lygaeoidea</strong>&lt;br&gt;<strong>Family: Lygaeidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Spilostethus hospes (F.)</td>
<td>RWLS/Near Water tank</td>
<td>L</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td><strong>Superfamily: Pyrrhocoroidea</strong>&lt;br&gt;<strong>Family: Largidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Family: Phyrrocoridae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Dysdercus koenigii (F.)</td>
<td>RWLS/Near Water tank</td>
<td>VH</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td><strong>Superfamily: Coreoidea</strong>&lt;br&gt;<strong>Family: Coreidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Serinetha abdominalis (F.)</td>
<td>RWLS/FRH</td>
<td>L</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td>16</td>
<td>Anoplocnemis phasiana (F.)</td>
<td>RWLS/Near Water tank</td>
<td>R</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td>17</td>
<td>Homoeurus signatus Walker</td>
<td>Near Museum wall</td>
<td>R</td>
<td>19.vi.2013</td>
</tr>
<tr>
<td>18</td>
<td>Notobitus meleagris (F.)</td>
<td>RWLS/FRH</td>
<td>R</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td><strong>Family: Alydidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Giptortus fusci (F.)</td>
<td>Village boundary</td>
<td>VH</td>
<td>20.vi.2013</td>
</tr>
<tr>
<td>20</td>
<td>Leptocorisa varicornis (F.)</td>
<td>RWLS/FRH</td>
<td>VH</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td><strong>Superfamily: Pentatomoidea</strong>&lt;br&gt;<strong>Family: Plataspidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Megacopta cribraria Hsiao and Ren</td>
<td>RWLS/Near Water tank</td>
<td>VH</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td><strong>Family: Cydnidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Aethus indicus (Westwood)</td>
<td>Village boundary</td>
<td>VH</td>
<td>20.vi.2013</td>
</tr>
<tr>
<td><strong>Family: Pentatomidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Antestiopsis cruciata (F.)</td>
<td>RWLS/Near Water tank</td>
<td>H</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td>24</td>
<td>Eusarcoecis ventralis (Westwood)</td>
<td>RWLS/FRH</td>
<td>H</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td>26</td>
<td>Eoanthecina furcellata (Wolff)</td>
<td>Village boundary</td>
<td>R</td>
<td>20.vi.2013</td>
</tr>
<tr>
<td>27</td>
<td>Halys dentatus Fabricius</td>
<td>RWLS/FRH</td>
<td>VH</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td>28</td>
<td>Nezara viridula Linnaeus</td>
<td>Village boundary</td>
<td>R</td>
<td>20.vi.2013</td>
</tr>
<tr>
<td>29</td>
<td>Plautia simbriata Fabricius</td>
<td>RWLS/Near Water tank</td>
<td>R</td>
<td>21.vi.2013</td>
</tr>
<tr>
<td>30</td>
<td>Acrosterium gramineum (F.)</td>
<td>RWLS/FRH</td>
<td>R</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td>31</td>
<td>Erthesina fullo (Thunberg)</td>
<td>Village boundary</td>
<td>H</td>
<td>20.vi.2013</td>
</tr>
<tr>
<td><strong>Family: Dinidoridae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Ciclopetla sicifolia (Westwood)</td>
<td>RWLS/FRH</td>
<td>L</td>
<td>22.vi.2013</td>
</tr>
<tr>
<td><strong>Family: Scutelleridae</strong>&lt;br&gt;<strong>Family: Pentatomidae</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Poecloricorius interruptus (Westwood)</td>
<td>Near Museum wall</td>
<td>VR</td>
<td>19.vi.2013</td>
</tr>
<tr>
<td>34</td>
<td>Chrysocoris purpurus (Westwood)</td>
<td>RWLS/FRH</td>
<td>VR</td>
<td>22.vi.2013</td>
</tr>
</tbody>
</table>
ACKNOWLEDGEMENT

The authors are thankful to Dr. K. Venkataraman, Director, Zoological Survey of India for providing necessary facilities and encouragement.

LITERATURE CITED


SOME TAXONOMICAL AND BIOLOGICAL CHARACTERISTICS OF MYOTIS EMARGINATUS (MAMMALIA: CHIROPTERA) IN TURKEY

İrfan Albayrak*

* University of Kirikkale, Faculty of Science and Arts, Department of Biology, 71450 Yahşihan, Kirikkale, TURKEY. E-mail: iralbayrak@yahoo.com


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 color and it was concluded that our specimens represented the nominative form, M. e. emarginatus.

KEYWORDS: 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, Iran and Turkmanistan in Palaearctic Region. Çağlar (1961) gave the first record of Myotis emarginatus from Kirklareli Province in Turkish Thrace and stated that Thracian specimens represented the nominate form. Çağlar (1965, 1969) pointed out that Myotis emarginatus occurred in Kirklareli. 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, Kirklareli 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 significance 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*.


**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 reddish 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 youngs 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, Karaisah, 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 ligh 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.
ACKNOWLEDGEMENT

I wish to thank Dr. İlhami TÜZÜN for his contribution on statistical analysis and critically reviewing of this manuscript.

LITERATURE CITED


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, Holland 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 (±Sd).

<table>
<thead>
<tr>
<th>Measurements</th>
<th>n</th>
<th>r</th>
<th>m</th>
<th>±Sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total length</td>
<td>57</td>
<td>86-101</td>
<td>93.8</td>
<td>3.77</td>
</tr>
<tr>
<td>Total body length</td>
<td>57</td>
<td>44-62</td>
<td>52.2</td>
<td>3.78</td>
</tr>
<tr>
<td>Tail length</td>
<td>57</td>
<td>34-45</td>
<td>39.6</td>
<td>2.34</td>
</tr>
<tr>
<td>Hindfoot length</td>
<td>58</td>
<td>10-12</td>
<td>11.0</td>
<td>0.53</td>
</tr>
<tr>
<td>Ear length</td>
<td>58</td>
<td>10-18</td>
<td>15.6</td>
<td>1.15</td>
</tr>
<tr>
<td>Weight</td>
<td>58</td>
<td>4.5-9.5</td>
<td>7.1</td>
<td>1.16</td>
</tr>
<tr>
<td>Tragus length</td>
<td>15</td>
<td>7.5-8.9</td>
<td>8.4</td>
<td>0.41</td>
</tr>
<tr>
<td>Forearm length</td>
<td>58</td>
<td>35.4-41.4</td>
<td>38.1</td>
<td>1.31</td>
</tr>
<tr>
<td>Tibia length</td>
<td>16</td>
<td>15.7-18.3</td>
<td>17.2</td>
<td>0.61</td>
</tr>
<tr>
<td>2nd digit metacarpal length</td>
<td>16</td>
<td>31.1-35.8</td>
<td>33.1</td>
<td>1.27</td>
</tr>
<tr>
<td>3rd digit metacarpal length</td>
<td>16</td>
<td>33.8-36.5</td>
<td>35.0</td>
<td>0.77</td>
</tr>
<tr>
<td>3rd digit 1st phalanx length</td>
<td>16</td>
<td>13.0-14.8</td>
<td>13.8</td>
<td>0.53</td>
</tr>
<tr>
<td>3rd digit 2nd phalanx length</td>
<td>16</td>
<td>10.0-11.4</td>
<td>10.7</td>
<td>0.47</td>
</tr>
<tr>
<td>4th digit metacarpal length</td>
<td>16</td>
<td>32.8-36.0</td>
<td>34.4</td>
<td>0.85</td>
</tr>
<tr>
<td>4th digit 1st phalanx length</td>
<td>16</td>
<td>9.4-10.8</td>
<td>10.1</td>
<td>0.40</td>
</tr>
<tr>
<td>4th digit 2nd phalanx length</td>
<td>16</td>
<td>7.3-8.9</td>
<td>8.1</td>
<td>0.54</td>
</tr>
<tr>
<td>5th digit metacarpal length</td>
<td>16</td>
<td>33.7-36.1</td>
<td>34.9</td>
<td>0.79</td>
</tr>
<tr>
<td>5th digit 1st phalanx length</td>
<td>16</td>
<td>9.1-10.7</td>
<td>10.0</td>
<td>0.46</td>
</tr>
<tr>
<td>5th digit 2nd phalanx length</td>
<td>16</td>
<td>6.4-7.4</td>
<td>6.9</td>
<td>0.37</td>
</tr>
<tr>
<td>Greatest skull length</td>
<td>55</td>
<td>15.7-17.0</td>
<td>16.1</td>
<td>0.29</td>
</tr>
<tr>
<td>Total skull length</td>
<td>58</td>
<td>15.1-16.5</td>
<td>15.7</td>
<td>0.30</td>
</tr>
<tr>
<td>Condylaral length</td>
<td>58</td>
<td>14.3-15.5</td>
<td>14.8</td>
<td>0.28</td>
</tr>
<tr>
<td>Basal length</td>
<td>16</td>
<td>13.4-14.3</td>
<td>13.7</td>
<td>0.26</td>
</tr>
<tr>
<td>Palatal length</td>
<td>16</td>
<td>6.3-7.1</td>
<td>6.8</td>
<td>0.24</td>
</tr>
<tr>
<td>Rostrum length</td>
<td>16</td>
<td>3.8-4.7</td>
<td>4.1</td>
<td>0.29</td>
</tr>
<tr>
<td>Zygomatic breadth</td>
<td>55</td>
<td>9.2-10.3</td>
<td>9.7</td>
<td>0.22</td>
</tr>
<tr>
<td>Interorbital breadth</td>
<td>57</td>
<td>3.5-4.0</td>
<td>3.6</td>
<td>0.11</td>
</tr>
<tr>
<td>Braincase breadth</td>
<td>15</td>
<td>7.1-7.4</td>
<td>7.3</td>
<td>0.11</td>
</tr>
<tr>
<td>Mastoid breadth</td>
<td>55</td>
<td>7.5-9.0</td>
<td>7.9</td>
<td>0.22</td>
</tr>
<tr>
<td>Rostral breadth</td>
<td>12</td>
<td>3.9-4.4</td>
<td>4.1</td>
<td>0.14</td>
</tr>
<tr>
<td>Infraorbital breadth</td>
<td>15</td>
<td>3.9-4.5</td>
<td>4.1</td>
<td>0.15</td>
</tr>
<tr>
<td>Skull heighth</td>
<td>42</td>
<td>6.8-7.4</td>
<td>7.1</td>
<td>0.16</td>
</tr>
<tr>
<td>Maxillary toothrown length</td>
<td>52</td>
<td>6.1-6.7</td>
<td>6.4</td>
<td>0.13</td>
</tr>
<tr>
<td>Upper molar length</td>
<td>16</td>
<td>3.4-3.7</td>
<td>3.6</td>
<td>0.09</td>
</tr>
<tr>
<td>Tymanpic bullae diameter</td>
<td>15</td>
<td>2.3-3.0</td>
<td>2.6</td>
<td>0.18</td>
</tr>
<tr>
<td>Mandibular toothrown length</td>
<td>57</td>
<td>6.5-7.2</td>
<td>6.8</td>
<td>0.13</td>
</tr>
<tr>
<td>Lower molar length</td>
<td>16</td>
<td>3.9-4.2</td>
<td>4.0</td>
<td>0.08</td>
</tr>
<tr>
<td>Mandible length</td>
<td>58</td>
<td>11.5-12.6</td>
<td>11.9</td>
<td>0.27</td>
</tr>
</tbody>
</table>
KARYOLOGICAL ANALYSES OF TWO WOLF SPIDER (ARANEAE: LYCOSIDAE) FROM TURKEY

Hüseyin Türker, Hakan Demir* and Osman Seyyar

* Department of Biology, Faculty of Science and Arts, Niğde University, TR–51100 Niğde, TURKEY. E-mail: ozyptila@gmail.com


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 + X1X2). 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 X1X2♂/X1X1X2♀ 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 Sörensen 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 X1X0♂ type. The X1 and X2 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 X1X0♂ type. The X1 and X2 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♂ = 28 in 48% of all studied species (Kumbiçak et al., 2009).

Cytogenetic studies on the majority of males of lycosids have similar characteristics: acrocentric or telocentric chromosomes, sex chromosome system in male X1X0♂. 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 X1X0♂ (Hackman, 1948; Kumbiçak et al., 2009). Telocentric chromosome form of this species was found for the first time in this study.

ACKNOWLEDGEMENTS

The authors are indebted to the Niğde University Scientific Research Project Unit (Project No.FBE 2013/38- BAGEP) for financial support of this work. This paper includes some datas extracted from the master thesis of the first author. We also thank to Dr. Zübeyde Kumbiçak from Nevşehir University for her help and comments.

LITERATURE CITED


Figure 1. Male karyotype of Alopecosa pulverulenta (2n = 28, X1X2♂) (scale = 10 µm).
Figure 2. Male karyotype of *Alopecosa accentuata* (2n = 28, X1X2♂) (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).

<table>
<thead>
<tr>
<th>Pair no.</th>
<th>RCF%</th>
<th>CM</th>
<th>Pair no.</th>
<th>RCF%</th>
<th>CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.06</td>
<td>t</td>
<td>1</td>
<td>5.34</td>
<td>t</td>
</tr>
<tr>
<td>2</td>
<td>4.76</td>
<td>t</td>
<td>2</td>
<td>4.49</td>
<td>t</td>
</tr>
<tr>
<td>3</td>
<td>4.57</td>
<td>t</td>
<td>3</td>
<td>4.29</td>
<td>t</td>
</tr>
<tr>
<td>4</td>
<td>4.29</td>
<td>t</td>
<td>4</td>
<td>3.99</td>
<td>t</td>
</tr>
<tr>
<td>5</td>
<td>3.97</td>
<td>t</td>
<td>5</td>
<td>3.99</td>
<td>t</td>
</tr>
<tr>
<td>6</td>
<td>3.83</td>
<td>t</td>
<td>6</td>
<td>3.95</td>
<td>t</td>
</tr>
<tr>
<td>7</td>
<td>3.81</td>
<td>t</td>
<td>7</td>
<td>3.85</td>
<td>t</td>
</tr>
<tr>
<td>8</td>
<td>3.75</td>
<td>t</td>
<td>8</td>
<td>3.80</td>
<td>t</td>
</tr>
<tr>
<td>9</td>
<td>3.60</td>
<td>t</td>
<td>9</td>
<td>3.56</td>
<td>t</td>
</tr>
<tr>
<td>10</td>
<td>3.12</td>
<td>t</td>
<td>10</td>
<td>3.48</td>
<td>t</td>
</tr>
<tr>
<td>11</td>
<td>3.10</td>
<td>t</td>
<td>11</td>
<td>3.26</td>
<td>t</td>
</tr>
<tr>
<td>12</td>
<td>3.00</td>
<td>t</td>
<td>12</td>
<td>3.11</td>
<td>t</td>
</tr>
<tr>
<td>13</td>
<td>3.01</td>
<td>t</td>
<td>13</td>
<td>2.81</td>
<td>t</td>
</tr>
<tr>
<td>X1</td>
<td>3.38</td>
<td>t</td>
<td>X1</td>
<td>4.66</td>
<td>t</td>
</tr>
<tr>
<td>X2</td>
<td>2.70</td>
<td>t</td>
<td>X2</td>
<td>3.20</td>
<td>t</td>
</tr>
</tbody>
</table>

Table 2. List of karyotyped species of the genera *Alopecosa*.

<table>
<thead>
<tr>
<th>Species</th>
<th>2n</th>
<th>Haploid (♂)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A. pulverulenta</em></td>
<td>28</td>
<td>13+X1X2</td>
<td>Hackman, 1948; Kumbiçak et. al., 2009; In this study</td>
</tr>
<tr>
<td><em>A. albofasciata</em></td>
<td>28</td>
<td>13+X1X2</td>
<td>Gorlova et. al., 1997</td>
</tr>
<tr>
<td><em>A. aculeata</em></td>
<td>28</td>
<td>13+X1X2</td>
<td>Hackman, 1948</td>
</tr>
<tr>
<td><em>A. accentuata</em></td>
<td>28</td>
<td>13+X1X2</td>
<td>In this study</td>
</tr>
</tbody>
</table>
OCCURRENCE OF ROOT APHID, *FORDA ORIENTALIS* GEORGE ON A HIGH ALTITUDE PLANT, *ARENARIA FESTUCOIDES* BENTH IN WESTERN HIMALAYA

Gireesh Nadda*

* Entomology and Pesticide Residue Analysis Laboratory, Hill Area Tea Science Division, CSIR-Institute of Himalayan Bioresource Technology, Post Box No. 6, Palampur, Kangra, HP India 176 061, INDIA. E-mail: girish@ihbt.res.in; girish_nadda@yahoo.co.in


ABSTRACT: The root aphid, *Forda orientalis* is recognized for the first time from the roots of *Arenaria festucoides* 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 festucoides*, Himalaya.

*Arenaria festucoides* 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. festucoides* 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. festucoides* 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. festucoides* 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. (NBAII, 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,

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


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

Rajesh Kumar*, Preetirekha Chutia, Binita Gogoi, Mustaq Ahmed and G. Rajkhowa

* Central Muga Eri Research & Training Institute, Central Silk Board, Ministry of Textiles (Govt. of India), Central Silk Board, Lahdoigarh 785700, Assam, INDIA. E-mail: rajesh.ento@gmail.com


ABSTRACT: *Bibasis gomata* Moore (1865) is belongs to the family Hesperiidae 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, Lahdoigarah, 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: Hesperiidae) 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, Lahdoigarah, 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: Hesperiidae)

*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 aphophyses 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) (oldhkls.org/info-b_gomata.html); *Schefflera lurida*, *Trevesia sundaica*, *Embelia gracinaefolia*, *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.

LITERATURE CITED

Web address: oldhkl.org/info-b_gomata.html

SUBSTITUTIONAL NAMES AND NEW COMBINATIONS FOR TAXA OF OSTRACODA
(ARTHROPODA: CRUSTACEA)

Eugen Karl Kempf*

* University at Cologne, Faculty of Mathematics and Natural Sciences, Institute of Geology and Mineralogy, Zuelpicher Str. 49a, D-50674 Koeln, GERMANY. E-mail: kempf@uni-koeln.de


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; *Procyclherura erichbrandi* nom. nov. for *Procyclherura 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.


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 ? Kloedenellitinidae Abushik, 1990**

**Genus Vanalabia nom. nov.**


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**

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**


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 annekhoroshevi* (Gramm, 1970) **comb. nov.**

  Original binomen: *Recytella annekhoroshevi* 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.**


**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 Kunlunia cypris nom. nov.**


**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) \textit{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**

\textit{Procytherura erichbrandi} nom. nov.


**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 \textit{Procytherura reticulata} Ainsworth, 1986 from Late Toarcian to Aalenian sediments of the Fastnet Basin with those of \textit{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 \textit{Procytherura reticulata} Brand, 1990 shows significant differences.

Consequently, according to the International Code of Zoological Nomenclature (1999) \textit{Procytherura reticulata} Brand, 1990 represents a junior primary homonym, for which \textit{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.


**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.


**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.


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.


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 Pokorny, 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


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 alveoloalata* (Sharapova, 1937) **comb. nov.**
  Original binomen: *Cythereis alveoloalata* 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 binkhorstii* (Veen, 1936) **comb. nov.**
  Original binomen: *Cythereis binkhorstii* Veen, 1936
*Aysegulina briarti* (Marliere, 1958) **comb. nov.**
*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.**
*Aysegulina foncirquensis* (Tambareau, 1972) **comb. nov.**
  Original binomen: *Limburgina foncirquensis* Tambareau, 1972
*Aysegulina foresterae* (J.K.Smith, 1978) **comb. nov.**
*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 furoni (Colin & Lauverjat, 1974) **comb. nov.**
Original binomen: Limburgina ? furoni Colin & Lauverjat, 1974

Aysegulina galvensis (Breman, 1976) **comb. nov.**
Original binomen: Rehacythereis galvensis Breman, 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: Limburgina gowdai Mallikarjuna & Nagaraja, 1996

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 ornatoida (Deroo, 1966) **comb. nov.**
Original binomen: Limburgina ornatoida Deroo, 1966

Aysegulina ornatoidella (Deroo, 1966) **comb. nov.**
Original binomen: Limburgina ornatoidella Deroo, 1966

Aysegulina papillata Sarr, 2014

Aysegulina pectinata (Babinot, 1980) **comb. nov.**
Original binomen: Limburgina pectinata Babinot, 1980

Aysegulina pegnolaensis (Rodriguez-Lazaro, 1988) **comb. nov.**
Original binomen: Limburgina pegnolaensis Rodriguez-Lazaro, 1988

Aysegulina pokornyi (Jain, 1977) **comb. nov.**
Original binomen: Limburgina pokornyi 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: Cythere semicancellata Bosquet, 1854
Aysegulina semicancellata (Bosquet, 1854) comb. nov.
   Original binomen: Cythere semicancellata Bosquet, 1854
Aysegulina senonensis (Damotte, 1964) comb. nov.
   Original binomen: Cythereis senonensis Damotte, 1964
   Original binomen: Limburgina seuensis 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.

Genus Hartmannosa Özdikmen, 2009


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.)


Kempf, E. K. 1980. Index and Bibliography of Nonmarine Ostracoda 1, Index A. Sonderveröffentlichungen, Geologisches Institut der Universität zu Köln, 35: 1-188.


Rozhdestvenskaya, A. A. 1962. Srednedevonskie ostrarakody 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 Bashkoria). in: Tyazheva, A. P., Rozhdestvenskaya, A. A. & Chibrikova, E. V. 1962. Brachiopoda, ostrakody i spory srednego i verkhnego devona Bashkirii (Brachiopoda, Ostracoda and spores from the Middle and Upper Devonian of Bashkoria): 169-349 [In Russian].


SCIENTIFIC NOTES

OCCURRENCE OF ENTOMOPATHOGENIC FUNGUS ON MUGA SILKWORM IN JORHAT DISTRICT OF ASSAM

Aparupa Borgohain*, Ranjana Das and Kalyan Dutta

* Silkworm Pathology Section, Central Muga Eri Research & Training Institute, Lahdoigarh, Jorhat, Assam, INDIA. E-mail: aborgohaino@gmail.com

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, polyphagous 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; Thangavela 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).

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 color 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. 4\textsuperscript{th} and 5\textsuperscript{th} 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*.

**ACKNOWLEDGEMENTS**

Authors are thankful to the Director CMER&TI, Lahdoigarh, Assam for providing necessary facilities during course of study and DBT, New Dehli for financial assistance under the project “Establishment of Institutional of Biotech hubs.”

**LITERATURE CITED**


Figure 1. Fungal spore and conidiophore of Fusarium solani: (A) Infected Larva; (B) Colony culture; (C) Microconidia; (D) Macroconidia.