



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2015; 3 (1): 295-301

© 2015 JEZS

Received: 03-12-2014

Accepted: 01-01-2015

Toheed IqbalDepartment of Entomology,
The University of Agriculture,
Peshawar, Pakistan.**Mian Inayatullah**Department of Entomology,
The University of Agriculture,
Peshawar, Pakistan.

Two Species of Genus *Antrocephalus* Kirby (Chalcididae: Chalcidoidea: Hymenoptera): New Records for Province Khyber Pakhtunkhwa, Pakistan

Toheed Iqbal and Mian Inayatullah**Abstract**

Two new records of genus *Antrocephalus* Kirby belonging to Family Chalcididae (Chalcidoidea: Hymenoptera) were identified from the collection of 200 specimens collected with insect collection sweep net and Malaise Trap from different ecological zones of Khyber Pakhtunkhwa, Pakistan for two consecutive years in 2012-13. These species were comprised of *A. mitys* and *A. nicus*. Diagnostic characters, host record and worldwide distribution of the species are also provided with the description of the species. Key to the species of genus *Antrocephalus* of Khyber Pakhtunkhwa, Pakistan is also provided along with illustrations of important characters.

Keywords: *Antrocephalus*, Khyber Pakhtunkhwa, New records, Pakistan, Parasitoids and Taxonomy.

1. Introduction

Chalcididae are medium to large sized insects varying in size from 1.5mm to 27mm in length. Distinctive characters are coarse setiferous punctures on head and thoracic dorsum, enlarged and swollen metafemur with denticulate or toothed ventral margins, larger metapleuron and arched metatibia (Gibson *et al.*, 1997) [15]. Chalcididae are similar to Leucospidae in numerous physical features including body size, coarse setiferous punctures on head and thorax, arched metatibia and enlarged and toothed metafemur. However, Chalcididae differs from them by having flat forewing instead of folded lengthwise, poorly developed labiomaxillary complex, usually exposed labrum, tegulae more or less broad and oval, modified apex of scutellum and simple dorsellum (Bouček, 1974) [7]. Subfamily Podagrioninae of Family Torymidae is also similar to chalcids but they lack setiferous punctures and long ovipositor. Members of family Chalcididae are endoparasites of insects belonging to order Coleoptera, Diptera, Lepidoptera and Hymenoptera. All these orders have several pests of economic importance, therefore chalcids are generally beneficial to humans as a group and many of its species have been used to control insect pests. They play significant role in the ecosystems of various economically important crops and thus, their importance cannot be underestimated (Cowan, 1979 [11]; Ubaidillah, 1996) [53]. Linnaeus (1767) [32] was the first who studied chalcids and reported species of *Spex sispes* (*Chalcis sispes*), *Vespa minuta* (*Brachymeria minuta*) etc. Linnaeus (1767) [32] was followed by Fabricius (1787) [12], Spinola (1811) [50], Westwood (1829) [60], Kirby (1883) [30]. Later on, Ashmead (1897, 1904) [3, 4], Cameron (1904) [10], Girault (1911) [16], Masi (1929) [36], Walker (1834) [54], Schmitz (1946) [47], Bouček (1952) [6], Nikol'skaya (1952) [41], Mani (1935) [34], Habu (1960, 1962) [22, 23] and Narendran (1989) [40] made significant contribution to the knowledge of Chalcididae. In Pakistan, Khokhar *et al.*, [29] described *Brachymeria bicolorata* as pupal parasite of *Earias spp.* on cotton from Sind province. *Brachymeria ocellata* was recorded as pupal parasite of fruit fly *Dacus ferrugineus* in Karachi by Samad *et al.*, (1971) [45]. Additionally, Ahmed *et al.*, (1987) [2], Rafi *et al.*, (1987) [44], Ishrat & Mailk (1987) [28] and Sheikh *et al.*, (1987) [48] contributed to chalcidid fauna of Pakistan. According to Noyes (2014) [42], 29 species under seven genera are reported from Pakistan. Irshad (2003) [27] reported 14 species in four genera from Pakistan out of which 3 genera with six species are from Khyber Pakhtunkhwa. Iqbal *et al.*, (2013) [26] reported 3 species of genus *Hockeria* from Khyber Pakhtunkhwa. He has also provided key for the identification of genera along with illustrations of important characters. Keeping in view importance of taxonomic study of Chalcididae, current study was conducted

Correspondence:**Toheed Iqbal**Department of Entomology,
The University of Agriculture,
Peshawar, Pakistan.

in which we report 2 species of genus *Antrocephalus* Kirby new to Pakistan. Key to the species along with illustrations of the important characters is also given.

2. Materials and Methods

Different specimens were collected from diverse ecological zones of province Khyber Pakhtunkhwa, Pakistan. This area has variable climate due to different ecological zones. These zones included hilly areas in the North to dry sandy lands in the south, whereas from east to West this province is mainly composed of plain areas except for western dry mountains, which serve as border of Afghanistan.

Insect collection was done for two consecutive years 2012-2013. During each collection process, few members of Chalcididae were found. Among Chalcididae, species of genus *Antrocephalus* were collected from plain areas of the province and none of the species is reported from the hilly areas of the province. Collection of insects was generally carried out with the help of sweep net. However, Malaise traps were also installed in low vegetation especially grasses.

Literature shows that some chalcidids of genus *Antrocephalus* are natural enemies of stored product moth pests such as *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae) (Sastry & Appanna (1960) [46], Gates (1993) [13], Konishi *et al.*, (2004) [31]), *Ephestia cautella* (Walker) (Lepidoptera: Pyralidae) (Pereira *et al.*, 2013) [43], *Galleria mellonella* L. (Lepidoptera: Pyralidae) (Subba, 1955) [52] and *Opisina arenosella* Walker (Lepidoptera: Xylorctinae) (Abdurahiman *et al.*, 1983 [1], Mohandas & Abdurahiman 1992, 1995) [38, 39]. Potential hosts were also reared in the laboratory at Entomology Museum, The University of Agriculture, Peshawar, Pakistan. Collected specimen were first preserved in 70% ethanol and subsequently transferred to 97% ethanol for 5 hours before mounting on point cards. Chalcididae are too small to pin, therefore specimen were mounted on point cards. Gibson *et al.*, (1979) [15] was followed for morphological terms whereas Harris (1979) [24] was followed for terminology of surface sculpturing.

Literature followed include, Habu (1960, 1962) [22, 23], Zdenek Bouček (1988) [8], Narendran (1989) [41], Grissel and Schauff (1990) [21], Bouček & Delvare (1992) [9], Medvedev, (English translation (1995)) [38] and Gibson *et al.*, (1997) [15].

All specimens were compared with paratypes available at Bohart Museum of Entomology, The University of California, Davis, USA. Microscope Nikon SMZ 745T was used for observation and identification of specimens. Important characters of insects were drawn with the help of Camera (Lucida). Key to the important characters of the species is also provided.

Identified species were deposited in the Insect Museum of the Department of Entomology, The University of Agriculture, Peshawar, Pakistan.

Terminology and abbreviations used in the description are:

Metasoma: The abdomen in Apocrita (Hymenoptera)

Petiole: First metasomal segment.

T₁: Abdominal segment 1

OOL: Ocello-Ocular Length

POL: Posterior Ocellar Length

BMNH: British Museum of Natural History

USNM: United States National Museum

ZDAMU: Zoology Department Aligarh Muslim University

3. Results

3.1 Genus *Antrocephalus* Kirby, 1883 [30]

Genotype: *Haltichella fascicornis* Walker (Original designation)

Antrocephalus Kirby (1883) [30]. Journ. Linn. Soc. London, Zool. 17:54, 63.

Dilla Strand (1911) [51]. Arch. Naturges. 77: 210.

Genotype: *Antrocephalus rufipes* Kieffer.

Sabatiella Masi (1929) [37]. Boll. Lab. Ent. Bologna 2:167-168. Syn. novo

Genotype: Masi.

Dillisca Ghesquiere (1946) [14]. Rev. Zool. Bot. Afr. 39:367. (For *Dilla* strand, nec Fischer De W Aldheim).

The known synonyms of *Antrocephalus* are: *Coelochalcis* Cameron (1904) [10], *Stomatoceroide* Girault (1913) [17], *Metarretocera* Girault (1927) [19], *Tainania* Masi (1929) [37], *Sabatiella* Masi (1929) [37], *Stomatocerella* Girault (1930) [20], *Uxa* Girault (1930) [20], *Dillisca* Ghesquiere (1946) [14] and *Uda* Girault (1930) [20].

Published records show *Apis cerana*, *Ceratovacuna lanigera*, *Contheylea rotunda*, *Corcyra cephalonica*, *Cydia pomonella*, *Dactylethrella candida*, *Grapholita molesta*, *Hapalia machaeralis*, *Homona coffearia*, *lasiocampid*, *Pimpla albipalpis*, *Siriocauta testulalis* and *Sitotroga cerealella* as the hosts of genus *Antrocephalus*.

This genus is perhaps the most difficult one among Chalcididae to study taxonomically. Bouček (1988) [8] has discussed in detail the variation as well as the various synonymy involved in this genus. Members of this genus can be recognized by combination of the following characters; structure of preorbital carinae and their relation to the genal or post orbital carina; presence or absence of a distinct glabrous temporal furrow behind the eyes; development of lateral carinae on the pronotum, either stout or nearly joining themselves in the proximity of the apical margin of prothorax; presence or absence of a longitudinal furrow on the scutellum; presence or absence of two parallel carinae at the base of T₁, metafemur without lobes or uni, bi or trilobed; metacoxae with or without an inner basal tooth and presence or absence of external carina on metatibia.

Genus *Antrocephalus* Kirby has been identified as a new genus not only for the record of parasitic Hymenoptera in Pakistan but it also adds 2 new species to the records of Khyber Pakhtunkhwa in our current study. Key to the main features of *Antrocephalus* species is provided as under, illustrations of important characters are also provided with the key.

3.2 Key to the species of genus *Antrocephalus* in province Khyber Pakhtunkhwa

3.2.1 Fore wing with postmarginal vein subequal to or shorter than marginal vein, never longer than marginal vein (Fig. 2); propodeum with distinct lateral teeth (Fig. 5); metafemur with an inner basal tooth; legs rufous; gaster rufous or blackish *mitys* (Walker).

3.2.2 Forewing with postmarginal vein longer than marginal vein (Fig. 7); propodeum without lateral teeth (Fig. 8); metafemur without an inner basal tooth; legs rusty brown; gaster shining black *nicus* Narendran.

(a) *Antrocephalus mitys* (Walker, 1846) ^[55]

Haltichella mitys Walker 1846 ^[55]. Part 1, Chalcidites: 81, ♀, Mauritius (BMNH).

Chalcis pandens Walker 1860 ^[56]. Ann. Mag. Nat. Hist. 6:357, ♀, Sri Lanka, (BMNH) Narendran.

Haltichella simplex Walker (1862) ^[57].

Haltichella divisiicornis Walker (1871) ^[58].

Stomatocera sulcata Ashmead 1905 ^[5]. Proc. US. Natn. Mues. xxiii: 401. ♂. Philippines, Manila, (USNM No. 8954), Narendran.

Antrocephalus mahensis Masi (1917) ^[35].

Stomatocera bergeraci Girault (1921) ^[18].

Antrocephalus humilis Waterson 1922 ^[59]. Ind. For. Rec. 9: 22. ♀. India, Dehra Dun (BMNH), Narendran.

Antrocephalus aethiopicus Masi (1926) ^[36].

Antrocephalus vitatus Husain & Agarwal 1982 ^[25]. Oriental Ins. 16:327. ♀. India, Aligarh, (ZDAMU) Narendran.

More details about synonymy and biology of genus *Antrocephalus* is provided by Bouček (1992) ^[9] in his book Australasian Chalcidoidea.

Diagnosis

The species can be identified by having a longitudinal furrow in the scutellum forming two apical tubercles (Fig. 1); abdominal segments with small punctations or shagreened appearance; forewing with a brown spot under marginal and stigma vein, not under the postmarginal vein (Fig. 2); pre and postorbital carina present (Fig. 3); frontogenal sulcus distinct and carinate (Fig. 3); genotemporal margin with a deep furrow (Fig. 4); propodeum with lateral teeth (Fig. 5); metafemur with an inner basal tooth and a series of small teeth in one or two lobes (Fig. 6).

Description of the Female (n=10, 6♀, 4♂)

Length: 5.5 - 6.2 mm

Colour

Black. Head, thorax and propodeum completely black with narrow punctuation and silvery pubescence; abdomen dark brown to blackish brown; tegulae dark brown; eyes rusty brown, antennae, fore, mid and hind coxae, trochanter, femur and tibia dark brown with apices of tibia light brown; anteriorly metatibia blackish; forewings with slightly brownish tinge and a slight brown colour below the marginal and stigmal vein; postmarginal vein almost equal to the length of marginal vein; underside of abdomen light brown; antennal club and interantennal projection rusty brown.

Head

Slightly broader than thorax; OOL 3 times POL; preorbital carina coming up behind the anterior ocellus and meets the auricular carina at the base (Fig. 3); scrobe and scape reaching the anterior ocelli; genotemporal margin with a deep groove; pre and post orbital carina present; frontogenal carina carinate and distinct; antennae just above the clypeus; antennal scape reaching the anterior ocellus, the length of which is equal to first 5 funicular segments of the antennae.

Thorax

Slightly narrow than head; anterior margin of pronotum with distinct carina but they do not form a tubercle when meet in the middle; scutellum with a furrow starting from anterior margin and reaching to the posterior margin forming two slightly upturned tubercles at the apex of scutellum (Fig. 1); propodeum (Fig. 5) without a median carina, submedian carinae distinct with small cross carinae between them; accessorial carina distinctly forming a raised point of attachment with several cross carinae to the submedian carinae, sublateral carina meeting with lateral costae at anterior end and joins the lower part of propodeum; semi horizontal spiracles are present between the sublateral carinae and the lateral costae; tarsi are 5 segmented in fore, mid and hindleg, both fore and midfemur are swollen at the top and narrow at the base.

Abdomen

Abdomen longer than thorax, pointed posteriorly with ovipositor; base of abdomen with a small fovea between two very small ridges and without carina; T₁ larger in size than combined length of T₂-T₅;

Type material Examined

India. Cherangode, Nilgiri Hills, 3500ft. 1 ♀. 1987. P. S. Nathan Collection. DET T.C. Narendran, 2002. **Pakistan.** KPK. Peshawar. 1♀. 34° 1.3'N, 71° 28.5'E. 12.iv.2009. Inayatullah. 1♀, 1♂. 1.v.2008. Inayatullah. 1♀, 2♂. 19.xi.2007. Inayatullah. 1♀. 12.iv.2009. Inayatullah. 1♂. 8.viii.2008. Toheed Iqbal. Swabi. 1♀. 34° 1.3'N, 71° 28.5'E. 20.viii.2004. Inayatullah.

Male

Similar to female except the abdominal end which is round in male and pointed due to presence of ovipositor in female.

Distribution

Australia (Queensland), Afrotropical, Brazil, India (Kerala, Tripura, Uttar Pradesh), Israel, Kenya, Malaysia, Mauritius, Philippines, Senegal, Seychelles, Sierra Leone, Somalia, Sri Lanka, Thailand (Noyes, 2014) ^[43] and Pakistan (Peshawar and Swabi, New Records).

Host

Lepidoptera: *Corcyra cephalonica* (Stainton) (Pyralidae), *Lamida moncusalis* Walker (Pyralidae), *Chilo partellus* (Swinhoe) (Crambidae), *Ectomyelois ceratoniae* (Zeller) (Pyralidae) (Noyes, 2014) ^[43] and *Ephesia cautella* (Walker) (Pyralidae) (Pereira *et al.*, 2013) ^[44]

Yponomeutidae: *Ypsolophus ocropane*. (Noyes, 2014) ^[43]

Plant Associates

Family Fabaceae: *Arachis hypogaea*, *Cerantonia siliqua*, *Pisum sativum* (Noyes, 2014) ^[43]

Family Poaceae: *Oryza sativa*, *Sorghum sp.*, *Zea mays* (Noyes, 2014) ^[43]

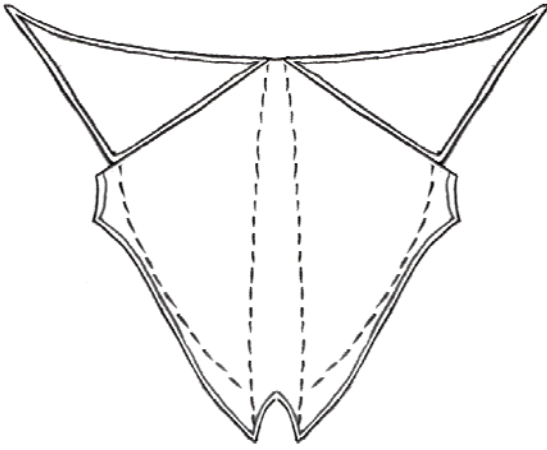


Fig 1: Apex of scutellum. *A. mitys*

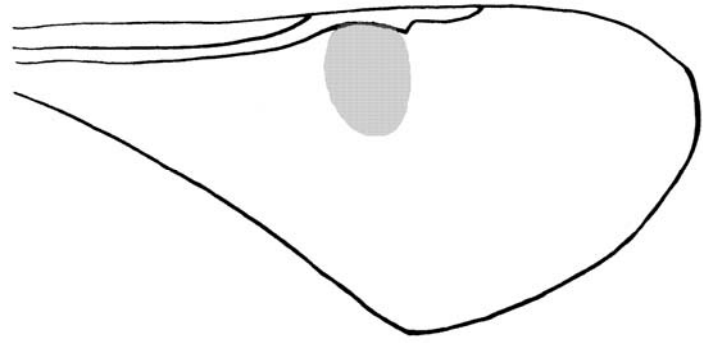


Fig 2: Forewing. *A. mitys*

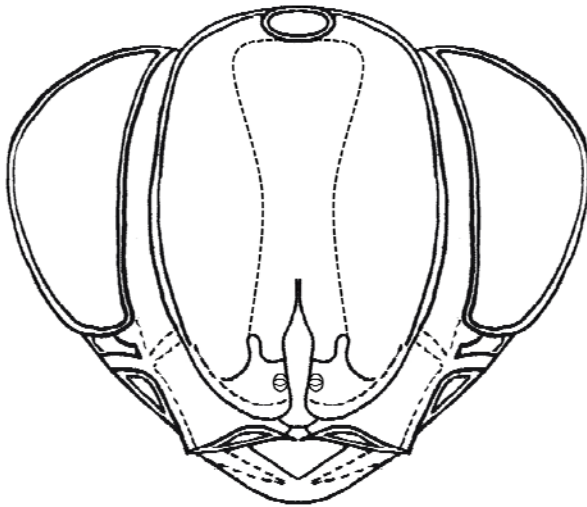


Fig 3: Head. *A. mitys*

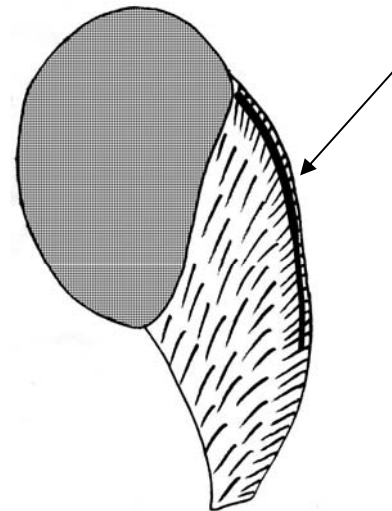


Fig 4: Genotemporal margin of head. *A. mitys*

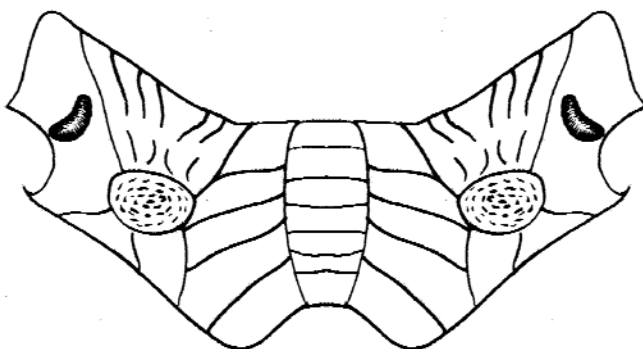


Fig 5: Propodeum. *A. mitys*

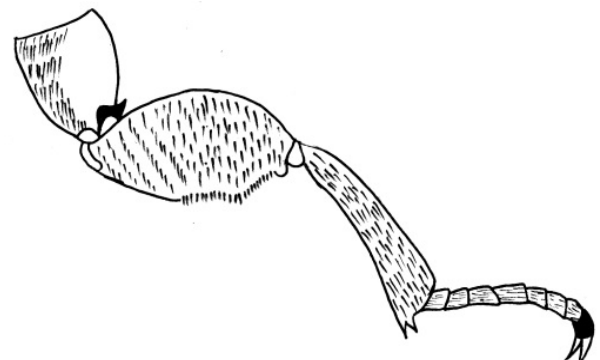


Fig 6: Metafemur. *A. mitys*

(b) *Antrocephalus nicus* Narendran, 1989 ^[41]

Diagnosis

The species can be identified by having convex metanotum, without longitudinal furrow (Fig. 9); forewing without any brown patch below the marginal or post marginal vein, however wings have brown tinge (Fig. 7); preorbital carina narrowly meets auricular carina, postorbital carina absent (Fig. 10); frontogenal sulcus distinct in lower half, apical half indistinct (Fig. 10); propodeum without lateral teeth (Fig. 8); metafemur with an outer ventral margin weakly bilobed with a row of teeth that starts mid femur and ends till the base, no basal tooth present on metafemur; basal 2 segment of antennal

flagellum rusty brown, remaining segments dark brown.

Description of the Female (n=26, 7♀, 19♂)

Length: 5.6 - 6.5mm

Colour

Black. Head and thorax dull black; with small impunctations and gaps between the impunctations; tegulae rust brown, abdomen shining black when viewed from above; abdomen blackish dorsally; eyes pale blackish yellow; all legs rust brown, basal segments of antennae rust brown, apical 7 segments dark brown; forewing with brownish tinge and dark

brown marginal and post marginal vein; coxa, trochanter, femur, and tibia of fore leg, mid leg and hind leg rust brown, tarsi of these legs light brown with a claw at end; propodeum with long silver pubescence on the lower side.

Head

Head slightly wider than longer; scrobe and scape reaching the front ocelli (Fig.10), POL almost 4 times the OOL; vertex slightly depressed in middle when viewed from front; preorbital carina narrowly meets the auricular carina; post orbital carina absent (Fig.10); frontogenal sulcus distinct in lower half, apical half indistinct; genotemporal furrow shallow; scape length almost equal to the combined length of pedicel and 3 anterior segments; length of club 2.3 time the proceeding segment; antennal toruli just above the clypeus.

Mesosoma

Thorax convex, with close pits on the dorsum, interstices narrow, rugose and carinate; prothorax with lateral carina that reach up the middle and meet in the center forming two carinae moving towards head; scutellum jetting over the propodeum; post marginal vein $1.25 \times$ marginal vein, marginal and post marginal veins at wing margin (Fig. 7); hind coxa with a well developed dorso basal tooth; metafemur without an inner basal tooth, outer ventral margin weakly bilobed with a row of comb of teeth; propodeum with deep pits, and well developed post spiracular pit on either side, spiracles almost vertical in position (Fig. 8); thorax sub equal to abdomen.

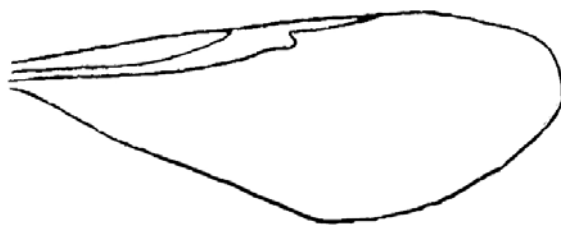


Fig 7: Forewing. *A. nicus*

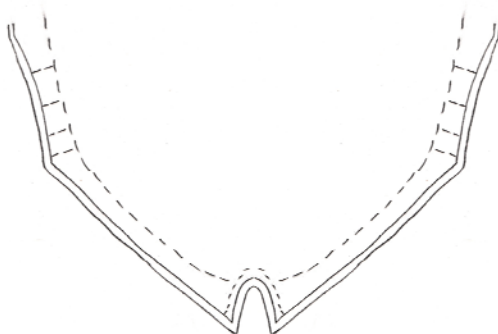


Fig 9: Scutellum. *A. nicus*

Abdomen

T₁ with a shallow pit covered by two small ridges on both the sides of the pit; T₂ with small pits and rugae laterally; T₃ with a smooth anterior and rough posterior part covered with slight lateral pubescence; T_{4, 5} entirely rough with small rugae laterally and dorsally; T₆ larger in size from T_{4,5} but smaller than T₃ with sparse punctations and rugae.

Material Examined

Pakistan. KPK. Peshawar. 1♂. 34° 1.3'N, 71° 28.5'E. 23.viii.2013. Inayatullah. 1♂. 20.ix.2013. Inayatullah. 1♀. 10.vii.2003. Inayatullah. 1♀. 16.vii.2012. Inayatullah. 1♀. 19.xi.2007. Inayatullah. 2♂. 22.vi.2012. Toheed Iqbal. 1♂. 09.vi.2012. Toheed Iqbal. Charsadda. 2♀, 1♂. 34° 5.06'N, 71° 50.1'E. 5.vii.2011. Toheed Iqbal. 10♂. 5.vii.2011. Toheed Iqbal. 1♀, 1♂. 13.vi.2012. Toheed Iqbal. Nowshehara. 1♂. 34° 0.37'N, 71° 56.2'E. 22.v.2012. Toheed Iqbal. Swabi. 1♂. 34° 11.0'N, 72° 19.5'E. 15.vii.2000. Inayatullah. 1♀. 14.vii.2000. Inayatullah.

Male

Males are similar to the females except the abdominal end which is rounded in males.

Distribution

Philippines and Pakistan (Swabi, Peshawar, Charsadda and Nowshehara, New Record).

Host

Not Known

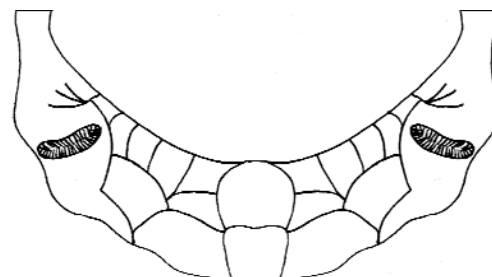


Fig 8: Propodeum. *A. nicus*

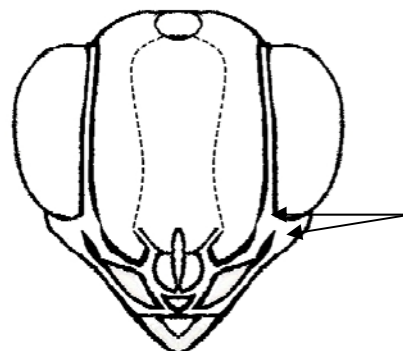


Fig 10: Head. *A. nicus*

4. Discussion

Diagnosis characters of *A. mitys* show that this species can be identified with the help of following character, i.e, by having a longitudinal furrow in the scutellum forming two apical tubercles; forewing with a brown spot under marginal and

stigma vein, not under the postmarginal vein; pre and postorbital carina present; frontogenal sulcus distinct and carinate; genotemporal margin with a deep furrow; propodeum with lateral teeth; metafemur with an inner basal tooth and a series of small teeth in one or two lobes. According to

Narendran (1989) ^[41], T₁ with basal carinae on both sides of the median fovea. In our case, there is a small median fovea between two lateral ridges, but without any carina, however remaining characters meet his description. Moreover, the specimen at Bohart Museum of Entomology was also studied and compared with Narendran's (1989) ^[41] description and the current description therefore adds more to his findings. The species distribution shows that it is widely distributed species. Host record also shows that the species is restricted to only one Lepidopterous family, Pyralidae. No host from other families has been reported till date. Research needs to be done to find out the host range of this species. Specimens in current research were collected from the grasses and alfalfa fields during spring season which shows that these parasitoids attack their hosts only in a specific time of the year.

A. nicus can be identified by having convex metanotum, without longitudinal furrow; forewing without any brown patch below the marginal or post marginal vein, however wings have brown tinge; preorbital carina narrowly meets auricular carina, postorbital carina absent; frontogenal sulcus distinct in lower half, apical half indistinct; propodeum without lateral teeth; metafemur with an outer ventral margin weakly bilobed with a row of teeth that starts mid femur and ends till the base, no basal tooth present on metafemur; basal 2 segment of antennal flagellum rusty brown, remaining segments dark brown. Narendran (1989) ^[41] mentioned that this species is different from rest of the species by having convex thoracic notum, and with a broad pit on the base of gaster. Our specimen is similar to the description provided by ^[36] and we did not find any difference from the description he provided. Distribution record of the species shows that it is reported from Philippines only. However current record adds to the knowledge of the species to be distributed in Peshawar, Swabi, Charsadda and Nowshera areas of Khyber Pakhtunkhwa province of Pakistan. Host record of the species is not available.

5. References

- Abdurahiman UC, Mohamed UVK, Remadevi OK. Studies on the biology of *Antrocephalus hakonensis* (Hymenoptera: Chalcididae), a pupal parasitoid of *Opisina arenosella*, the coconut caterpillar. Cocos 1983; 1:11-16.
- Ahmed SM, Malik KF, Ahmed M. Three species including two new chalcidid parasites on insect pests of grain crops in lower Sind, Pakistan. Proc. 5th Pakistan Congress of Zoology 1987, 90-91.
- Ashmead WH. California bees and their parasites. Proceedings of the South California Academy of Sciences 1897; 1(3):3-6.
- Ashmead WH. Classification of Chalcid Flies of the Superfamily Chalcidoidea with description of new species in Carnegie Museum, collected in South America by Herbert H. Smith. Memoirs of the Carnegie Museum. 1904; 1(4):1-11, 1-551.
- Ashmead WH. New genera and species of Hymenoptera from the Philippines. Proceedings of the United States National Museum 1905; 29(1424):401.
- Bouček Z. The first revision of the European species of the family Chalcididae (Hymenoptera). Sborník Entomologického Oddělení Národního Muzea v Praze 27. (Supplement, 1). 1952; 1-108.
- Bouček Z. A revision of the Leucospidae (Hymenoptera: Chalcidoidea) of the world. Bulletin of the British Museum of Natural History 1974; 23:241.
- Bouček Z. (Ed.). Australasian Chalcidoidea (Hymenoptera). A biosystematic revision of genera of fourteen families, with a reclassification of species. CAB International, Wallingford, Oxon, U.K., Cambrian News Ltd; Aberystwyth, Wales 1988; 832 pp.
- Bouček Z, Delvare G. The New World genera of Chalcididae. Memoirs of the American Entomological Institute 1992; 53:1-466.
- Cameron P. Descriptions of new genera and species of Hymenoptera from Mexico. Trans. Am. Entomological Society 1904; 30: 251-267.
- Cowan DP. The function of enlarged hind legs in oviposition and aggression by *Chalcis canadensis* (Hymenoptera: Chalcididae). Great Lakes Entomologist 1979; 12(3): 133-136.
- Fabricius JC. Mantissa Insectorum sistens species nuper detectas 1787; 1(20):1-348.
- Gates S. Self and conspecific superparasitism by the solitary parasitoid *Antrocephalus pandens*. Ecological Entomology 1993; 18: 303-309.
- Ghesquière J. Contribution à l'étude de microhyménoptères du Congo Belge. X-XI. Revue de Zoologie et de Botanique Africaines. 1946; 39:367-373.
- Gibson GAP, Huber JT and Woolley JB. (Eds.). Annotated keys to the genera of Nearctic Chalcidoidea (Hymenoptera). National Research Council of Canada, NRC Research Press, Ottawa, Canada 1997; 794 pp.
- Girault AA. Notes on the Hymenoptera Chalcidoidea with descriptions of several new genera and species. J. New York Entomological Society 1911; 19(3):175-189.
- Girault AA. On several new genera and species of Australian Hymenoptera Chalcidoidea. Canadian Entomologist 1913; 45:101-106
- Girault AA. Miscellaneous species of chalcid-flies from Australia (Hymenoptera, Chalcididae). Insector Inscitiae Menstruus 1921; 9:187.
- Girault AA. Notes on and descriptions of chalcid wasps (Chalcididae) in the South Australian Museum. Records of the South Australian Museum 1927; 3:309-338.
- Girault AA. New pests from Australia. Private Publication Brisbane 1930; 8:1-5.
- Grissell EE, Schauff ME. (Eds.). A handbook of the families of Nearctic Chalcidoidea (Hymenoptera). Entomological Society Washington 1990; 12: 22-23.
- Habu A. (Ed.). A revision of the Chalcididae (Hymenoptera) of Japan with description of sixteen new species. Bulletin. National Institute of Agricultural Sciences 1960; 11:131-363.
- Habu A. (Ed.). Chalcididae, Leucospidae and Podagrionidae (Insecta: Hymenoptera). Fauna Japonica 1962; 1-232.
- Harris RA. A glossary of surface sculpturing. Occasional Papers in Entomology, Sacramento, California 1979; 28:1-31.
- Husain T, Agarwal MM. Taxonomic studies on Haltichellinae of India (Hymenoptera: Chalcididae) P.T.I. Haltichellini. Oriental Insects 1982; 16:327-329.
- Iqbal T, Inayatullah M and Ahmed S. New records and a key to the species of genus *Hockeria* Walker (Hymenoptera: Chalcididae) from Khyber Pakhtunkhwa, Pakistan. Pakistan journal of Zoology 2013; 45(5): 1279-1284.
- Irshad M. (Ed.). Parasitoids, predators & pathogens of Agriculture and Forest insect Pests of Pakistan. National IPM Programme, NARC, Islamabad, Pakistan 2003; 1-78. pp.

28. Ishrat G, Malik KF. Two new species of pupal parasites of the genus *Brachymeria* Westwood (Chalcididae: Hymenoptera) on spotted bollworms in Karachi, Pakistan. Karachi University Journal of Science 1987; 14(1-2):75-77.
29. Khokhar KF, Qadri MAH, Ahmed M. Systematics and biology of *Brachymeria bicolorata* new species (Chalcididae: Hymenoptera). A pupal parasite of *Earias spp.* in Sind, Pakistan. Pakistan Journal of Scientific and Industrial Research 1971; 14(3):261-264.
30. Kirby WF. Remarks on the genera of the subfamily Chalcidinae, with synonymic notes and descriptions of new species of Leucospidinae and Chalcidinae. Journal of the Linnean Society of Zoology 1883; 17:53-78.
31. Kirby WF. Remarks on the genera of the subfamily Chalcidinae, with synonymic notes and descriptions of new species of Leucospidinae and Chalcidinae. J. Linnean Society of Zoology 1883; 17:53-78.
32. Konishi K, Narendran TC, Imamura T, Visarath AP. Chalcididae (Hymenoptera) from rice stores in Thailand, with description of two new species. Entomological Sciences 2004; 7:31-38.
33. Linnaeus C. (Ed.) Systema naturae 1(2):533-1327-1365.
34. Mani MS. 1935 New Indian Chalcidoidea (Parasitic Hymenoptera). Records of the Indian Museum 1767; 37:241-258.
35. Masi L. Chalcididae of the Seychelles islands. (With an appendix by J. J. Kieffer). Novitates Zoologicae 1917; 24:133.
36. Masi L. Descrizione di un nuovo *Antrocephalus* della Somalia italiana (Hymen. Chalcididae). Bollettino della Società Entomologica Italiana 1926; 58(7):116.
37. Masi L. Contributo alla conoscenza dei Chalcididi Orientali della Sottofamiglia Chalcidinae. Bollettino del Laboratorio di Entomologia del R.Istituto Superiore Agrario di Bologna 1929; 2:155-188.
38. Medvedev LN. (Ed.). Nasekomye V'etnama. (Insects of Vietnam). Nauka, Moscow, USSR 1985, 1-182.
39. Mohandas TP, Abdurahiman UC. Longevity and its relevance to fecundity in *Antrocephalus hakonensis* (Hymenoptera: Chalcididae), a pupal parasitoid of *Opisina arenosella* (Lepidoptera: Xylorictidae). Entomon 1992; 17:21-27.
40. Mohandas TP, Abdurahiman UC. Behavioural responses to humidity gradient by *Antrocephalus hakonensis* and other parasitoids of *Opisina arenosella*, the caterpillar pest of coconut. Entomon 1995; 20:67-71.
41. Narendran TC. (Ed.). Oriental Chalcididae (Hymenoptera: Chalcidoidea). Published by Department of Zoology, University of Calicut, Kerala, India 1989, 1-440.
42. Nikol'skaya MN. The Chalcid fauna of the U.S.S.R. Chalcidoidea 1952, 85-89.
43. Noyes JS. Universal Chalcidoidea Database. World Wide Web electronic publication. <http://www.nhm.ac.uk/chalcidoids>. Page visited on: 30.viii.2014.
44. Pereira AIA, Tiago GP, Francisco SR, Sagadai M, José ES, José CZ. *Antrocephalus mitys* (Hymenoptera: Chalcididae) in laboratory cultures of *Tenebrio molitor* (Coleoptera: Tenebrionidae), and possible role in biological control of *Ephestia cautella* (Lepidoptera: Pyralidae). Florida Entomologist 2013; 96(2):634-637.
45. Rafi MA, Malik KF and Ahmed M. Chalcid parasites, *Brachymeria dentata*, new species and *B. kafimu*, new species, and a new record on cotton bollworms in Lower Sind, Pakistan. Proc. 5th Pakistan Congress of Zoology 1987, 187-188.
46. Samad K, Khokhar FF, Qadri MAH. A note on the *Brachymeria ocellata* (a new species Chalcididae: Hymenoptera) a pupal parasite of fruit flies in West Pakistan. Journal of Science, Karachi 1971; 1(1):216-218.
47. Sastry KSS, Appanna M. Observations on the biology and habits of *Antrocephalus sp.*, the pupal parasite of *Corcyra cephalonica* Stainton. Mysore Agricultural Journal 1960; 35:80-85.
48. Schmitz G. Chalcididae de l'Afrique Central. Exploration du Parc National Albert, Mission G.F. de Witte Fas. 17 plates Congo Belge, Inst. Parcs. Nat. Albert, Mission G.F. de Witte 1946; 48:1-191.
49. Sheikh MU, Malik KF, Ahmed M. Two new and one known species of the genus *Brachymeria* Westwood on Insect pests of Grasses in Lower Sind, Pakistan. Proc. 5th Pakistan Congress of Zoology 1987, 171-175.
50. Spinola M. Essai d'une nouvelle classification générale des Diplolépaires. Annales du Muséum National d'Histoire Naturelle. Paris 1811; 17:138-152.
51. Strand E. Neue exotische Chalcididen der Gattungen Phasgonophora Westw., Heptasmicra Ashm. Anacryptus Kby., Antrocephalus Kby., Aperilampus Wlk and Chryseida Spin. (Schluss) Fauna Exotica 1911; 1(3):9-10.
52. Subba RBR. A new species of *Antrocephalus* Kirby. Journal of Bombay Natural History Society 1955; 52: 948-950.
53. Ubaidillah RR. A new Species of *Brachymeria* parasitic on cocoa husk borer, *Cryptopheles encarpa* (Lepidoptera: Tortricidae) in Malaysia. Bulletin of Entomological Research 1996; (86)-4: 481-484.
54. Walker F. Monographia Chalciditum. Entomological Magazine 1834; 2(1-4): 13-39.
55. Walker F. 1846. List of the specimens of Hymenopterous insects in the collection of the British Museum. Part 1 Chalcidites. 84-85 London.
56. Walker F. Characters of some apparently undescribed Ceylon insects. Annals and Magazine of Natural History 1860; 6(35):357.
57. Walker F. Notes on Chalcidites, and characters of undescribed species. Transactions of the Entomological Society of London 1862; (3) 1:366.
58. Walker F. Part III. Torymidae and Chalcididae. Notes on Chalcidiae. E.W. Janson, London 1871; 44pp.
59. Waterston J. On Chalcidoidea. (Mainly bred at Dehra Dun, U.P., from pests of Sal, Toon, Chir and Sundri). Indian Forest Records 1922; 9(2):22
60. Westwood JO. On the Chalcididae. Zoological Journal, London 1829; 4:3-31.