

Taxonomic Studies of the Genus *Megachile* from Coniferous Forests of Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

Very little is known about the Megachilid bee diversity from Pakistan. In this context, a study primarily focused on Genus *Megachile* Latreille 1802 from grassland and meadows of coniferous forests of Khyber Pakhtunkhwa Province was conducted. Eight species were recorded, two species (*Megachile albifrons*, Smith 1853, *Megachile pseudodisjuncta*, Kumari 2018) are new record to Pakistan, whereas all the eight species are new record to Khyber Pakhtunkhwa Province. Brief description together with illustrations and distributional range of each of these *Megachile* species is also provided. A diagnostic key for identification of the female species of Genus *Megachile* Latreille 1802 for Pakistan is provided for ready reference.

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Authors' Contribution

NA conceived and conducted the study. AU supervised and supported the study.

Key words

Megachile, Bee, Megachilid bees, Conifer forest

INTRODUCTION

Megachilidae being third largest and diverse family of bees, containing more than 4000 described species worldwide (Michener, 2007; Ascher and Pickering, 2020). The Megachilid are long-tongued bees having the scopa (pollen collecting hairs) under the metasoma except parasitic Megachilid bees. Among Megachilid bees the Genus *Megachile* Latreille 1802, being diverse bee genera, with more than 1525 described valid bee species and with more than 50 subgenera worldwide (Ascher and Pickering, 2020). This genus consists of leafcutter bees, mason bees and resin bees (Sardar et al., 2021). Currently more than 150 species of Genus *Megachile* in a several subgenera are recognized as valid Southeast Asian species (Ascher and Pickering, 2020). Taxonomic studies on Genus *Megachile* Latreille, 1802 bear a lot of significance, because of their role as main pollinators in agro-landscape ecosystems. Taxonomic studies provide information on the identification, classification as well as their diversity and also provide floral association which will contribute to

the better understanding of pollination biology in relation to important crop plants. So far, the study of bees fauna of Pakistan has been poorly studied, thus the identification of Megachilids from grassland and meadows of coniferous forests of Khyber Pakhtunkhwa is important. The conifer forests in Pakistan play a significant role in the natural ecosystem, because of their role as watershed protection, supplying timber, habitat for biodiversity and non-timber forest produce and also grazing land for domesticated animals (Ahmad et al., 2012; Ahmed et al., 2006). The specific objectives of this research study were to explore the diversity and distribution of Megachilid bees from coniferous forests of Khyber Pakhtunkhwa Province.

MATERIALS AND METHODS

The present study is restricted to the species of the Genus *Megachile* Latreille, 1802 from coniferous forests of Khyber Pakhtunkhwa Province. While bees were visiting on the flowers, they were collected. Then bees were killed with ethyl acetate. After collection, bees properly stretched and then followed for preservation. Keys known for eminent workers of Oriental region like Bingham (1897), Gupta (1993) and Michener (2007) were followed. The morphological terminology and classification used in the descriptions follows Michener (2007).

Descriptions are provided for all species present in the current list. *Megachile* specimens were investigated by using a Nikon Stereo Zoom Microscope SMZ 18 (Nikon, Minato City, Tokyo, Japan). Digital images were acquired by employing camera DS-Fi2 (Nikon) attached

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to the stereo zoom microscope; images were refined with Helicon Focus image stacking software and then finely tuned by Adobe Photoshop software.

Genus *Megachile* Latreille, 1802

Megachile Latreille, 1802. Histoire naturelle de fourmis: 413.

Diagnosis

Body black and robust, covered with white, yellowish-grey or reddish-brown, short or long pubescence. Head rounded, female mandibles 3-5 teeth seldom with 6 teeth; mandibles with or without cutting edges, cutting edges if present than at the base of one or more interspace; in males mandibles narrower, 2-3 dentate, with a long triangular process ventrally, scutellum without prominent axillary spines. Arolia absent, in female scopa (pollen collecting hairs) present on Sternum S2-S5, sometimes on S6, entirely absent on hind tibia. In males tergum 6 with a narrow ventral tooth laterally or without it.

Diagnostic Key of the Females of the Genus *Megachile* Latreille, 1802 from Pakistan

(Modified from the key by Bingham, 1897; Michener, 2000)

1. Mandibles without cutting edges.....2
Mandibles with cutting edges.....6
2. Mandible carina largely shiny and smooth, not dulled by microsculpturing, apical margin of clypeus markedly produced over labral base.....3
Mandible carina dulled by microsculpturing, apical margin or clypeus weakly produced over labral base.....4
3. Basal abdominal segments covered with fulvous hairs, orange red pubescence on the face, mesosoma, and first 2 abdominal tergites, white apical bands of setae on 3rd to 5th terga.....*Megachile lanata*
Basal abdominal segments covered with pale yellow or white hairs.....5
4. Scopa pale white, basal two abdominal segments covered with fulvous pubescence, white fasciae on third, fourth and fifth abdominal segments.....*Megachile lerma*
Scopa fulvous brown or white6
5. Mandible tridentate long and curved, clypeus subtriangular, transverse white fascia at the base of 1st 2nd and 3rd abdominal segments, scopa white*Megachile cephalotes*
Mandible tridentate narrow and looped, first abdominal segment with mixtures of white

and fulvous hairs, tergites 2-6 with erect black hairs on lateral aspect, scopa fulvous brown.....*Megachile pseudodisjuncta*

6. Metasoma covered with fulvous hairs7
Metasoma covered with black and/ or fringed with white hairs.....8
7. Mandible 4 dentate with two incomplete cutting edges on 3rd and 4th interspace, abdomen with fulvous pubescence above.....*Megachile bicolor*
Head, thorax and anterior metasoma clothed with orange red hairs, white hair bands on lateral sides of abdominal segments 2 to 4 *Megachile laticeps*
8. Mandible six toothed with incomplete cutting edge in 2nd and 3rd interspace, both sides of the basal abdominal segments with a square patch of white pubescence, legs black..... *Megachile albifrons*
Mandibles quadridentate with very small cutting edge in second interspace and complete cutting edges in third interspace, mid and hind trochanter and femora entirely dull orange..... *Megachile femoratella*

1. *Megachile* (*Creightonella*) *albifrons* (Smith, 1853)

Megachile albifrons, Smith, Cat. i, p. 180.

Creightonella albifrons Michener 1965: p. 206.
Female (Fig. 1)

Description

Body length 14.25-17.82mm; clypeus convex, rounded anteriorly and hidden under thick pubescence, clypeus with median longitudinal impunctate line, mandible 6 dentate with incomplete cutting edge on 2nd and 3rd interspace; dense white pubescence on face, thorax covered with white pubescence on lateral sides, forewing is dark fuscous apically and subhyaline basally, anterior leg with fuscous pubescence mixed with few white hairs, intermediate and posterior legs with few white hairs, tarsi fuscous on posterior side, scutellum coarsely and finely punctured, abdomen slightly metallic, on both sides of the basal abdominal segments a square patch of white pubescence, apical margins of the segments T2- T3 with a transverse fasciae, complete fasciae present on T3-T5; tegulae black in colour; T6 disc clothed with black hairs; scopa S2-S5 with white hairs, S6 with erect black hairs.

Material examined

Pakistan. Abbottabad. Havalian. 4♀, 11.vi.2020, sweep net, Naveed; 1♂, 8.iv.2019, 2♀, 15.iii.2020; sweep net, collected by Farhat; 4♀, 5.xi.2019, sweep net, Naveed; Haripur, 1♂, 7.x.2020, sweep net, Naveed. 1♂, 29.vii.2019; 1♂, 30.viii.2018; 1♂, 31.vii.2022, sweep net, collected by Naveed.

Distribution

Oriental region (Veereshkumar, 2015). New record to Pakistan.

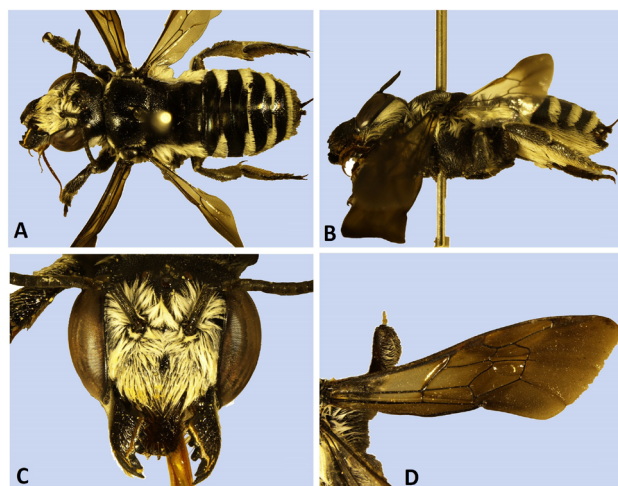


Fig. 1. *M. albifrons*. A: Habitus, Dorsal view; B: Habitus, Lateral view, C: Habitus, Head view, D: Forewing view.

2. *Megachile (Pseudomegachile) lanata* (Fabricius, 1775)

Apis lanata, Fabr. Ento.Syst. ii.p. 335.

Megachile lanata Latreille, 1809: p.166

Megachile (Archimegachile) *lanata* Mitchell, 1962

Trachusa lanata Jurine, 1809: p.251

Megachile proxima, Smith, Trans. Zool. Soc. vii. P.192.

Female (Fig. 2)

Description

Body length 12.17-16.58 mm; face with red fulvous pubescence, clypeus apical margin slightly emarginated medially, anteriorly transverse, mandibles quadridentate without cutting edges, mesosoma pubescence, first 2 terga is orange or with fulvous pubescence, 3rd to 5th terga have white apical bands and sparsely lined with erect black hairs, tegulae orange yellow; scutellum rounded; wings flavo-hyaline, legs black with fulvous pubescence; scopa on S2-S5 pale white, S6 is dominated with short black hairs.

Material examined

3♀, 7.vi.2020, sweep net, Naveed; Farhat, 5♀, 1.v.2022, sweep net, Naveed; Raiz, 3♀, 21.vii.2022; 1♂, 2.ix.2019, sweep net, collected by Farhat; Upper Dir, 1♀, 23.vii.2019, sweep net; Naveed, Swat, 1♀, 29.vi.2020, sweep net, Naveed; Haripur, 1♂, 5.iii.2019; 1♂, 17.iii.2019, sweep net, collected by Naveed.

Distribution

Oriental region, Palearctic region and Afrotropical regions (Gonzalez *et al.*, 2019; Genaro, 1996; Moure *et al.*, 2007; Raw, 2007; Meurgey, 2016; Ascher and Pickering 2020). New record to Pakistan.

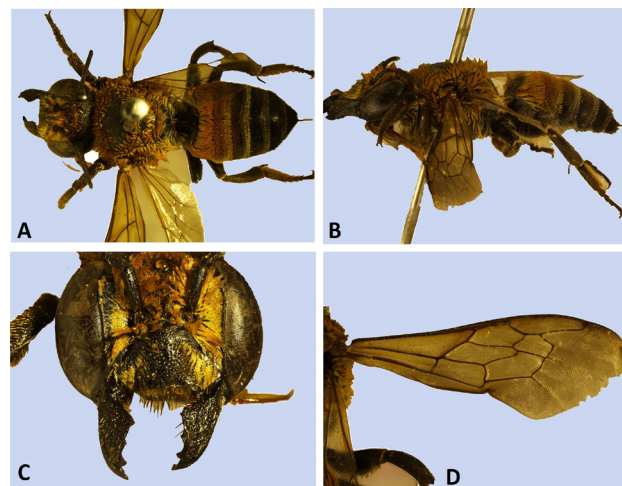


Fig. 2. *M. lanata*. A: Habitus, Dorsal view; B: Habitus, Lateral view, C: Habitus, Head view, D: Forewing view.

3. *Megachile (Eutricharaea) femoratella* (Cockerell, 1918)

Megachile femorata Smith 1879, New Sp. Hym. B.M., p. 68.

Megachile femorata Dalla Torre 1894a, Cat. Hym. Vol. X., p. 430.

Megachile femorata Bingham 1897, Fauna of Brit. Ind. Vol. I, p. 488.

Female (Fig. 3)

Description

Body length 4.5-6.1mm; body black, head and thorax finely punctured, white pubescence on face, clypeus slightly convex with a median longitudinal line, clypeus anterior margin slightly arched, mandibles quadridentate with very small cutting edge in second interspace and complete cutting edges in third interspace; abdomen cordate; wings hyaline with fuscous along the apical margin; fascia of abdominal segments yellowish white; scopa pale white from S2-S5 except S6 where it is black in colour; mid and hind trochanter and femora entirely dull orange, posterior tibia and tarsi with pale whitish hair; white transverse bands on apical margins of abdominal segments T1-T5.

Material examined

1♀, 7.vi.2020, sweep net, Naveed; Farhat, 1♀,

1.v.2022, sweep net, Naveed.

Distribution

Oriental region (Gupta, 1993; Kumari *et al.*, 2019).

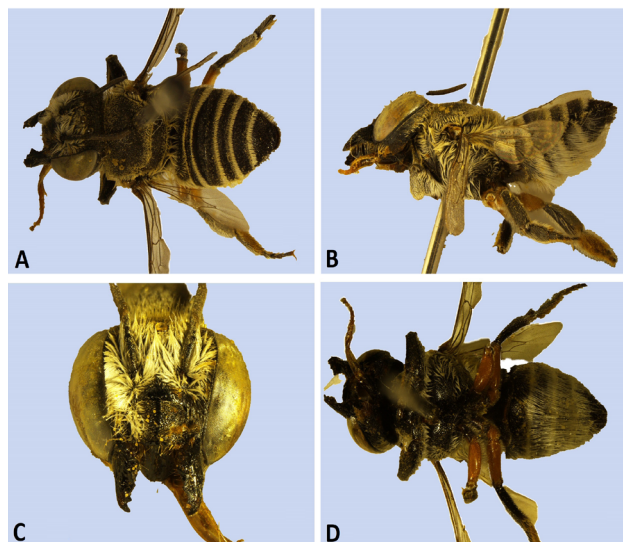


Fig. 3. *M. femoratella*. A: Dorsal view; B: Lateral view, C: Head view, D: Ventral view.

4. *Megachile (Callomegachile) lerma* (Cameron, 1908)

Megachile domesticum Perkins, 1899;

Megachile lerma Cameron, 1908: p.654;

Cressoniella (Neomegachile) *lerma* (Cameron, 1908)

Female (Fig. 4)

Description

Body length 11.5-13.80 mm; Black pubescence on face and body, base of the clypeus and supra clypeal area strongly convex; mandible broad, quadridentate without cutting edges; head and thorax punctured and coarsely pitted; tegulae orange yellow; white pubescence on dorsal surface of legs; wing reddish brown basally, fuscous apically, tarsal spine orange red, anterior and lateral margins of thorax, first abdominal tergite (T1) and fasciae of T2 with fulvous pubescence; T3, T4 and T5 with white fasciae; white fasciae of T3 mixed with fulvous pubescence; lateral aspect of T3–T6 with erect black hairs; T6 disc covered with black pubescence, scopa pale white from S2-S5; apical S5 and disc of S6 covered with black hairs.

Material examined

Khyber Pakhtunkhwa: Shinkairi, 2♀, 26.v.2019, sweep net, Farhat; Swat, Kalam, 2♀, 17.VII.2020; 3♀,

1.x.2018; 1♀, 17.vii.2021, sweep net, collected by Naveed; Shangla, 1♀, 28.v.2019, sweep net, Farhat.

Distribution

Oriental region (Gupta, 1993; Veereshkumar, 2015).

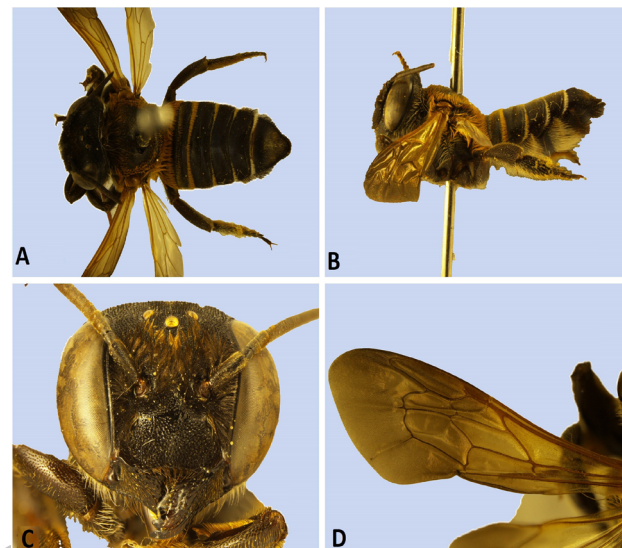


Fig. 4. *M. lerma*. A: Dorsal view; B: Lateral view, C: Head view, D: Forewing view.

5. *Megachile (Callomegachile) pseudodisjuncta* (Kumari, 2018)

Female (Fig. 5)

Description

Body length 13.15-14.83 mm; clypeus convex, arched anteriorly, mandible tridentate without cutting edges, mandible with prominent carina at the base, face with black pubescence, lateral aspect of thorax with mixture of black and white hairs, scutum slightly convex, bare, scutellum with carinate on lateral side, swollen pronotal lobe, tegula black, wings hyaline. T1 with mixtures of white and fulvous hairs, T2-T6 long erect black hairs on lateral aspect, scopa bright fulvous from S2-S5, S6 with black hairs, mid and hind tibia with white hairs on posterior side, red hairs on anterior side of tarsal segments.

Material examined

Khyber Pakhtunkhwa: Shankari, 2♀, 26.v.2019, sweep net, Farhat; Haripur, Ghazi, 2♀, 17.VII.2020; Farhat.

Distribution

Oriental region (Kumari and Kumar, 2018). New record to Pakistan.

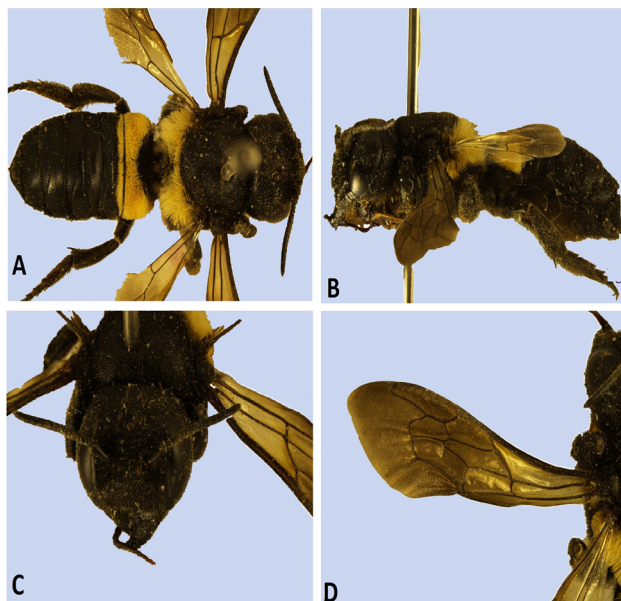


Fig. 5. *M. pseudodisjuncta*. A: Dorsal view; B: Lateral view, C: Head view, D: Forewing view.

6. *Megachile (Aethomegachile) laticeps* (Smith, 1853)

Megachile laticeps, [Smith 1853](#), Cat. Hym. Brit. Mus., 1: 183
Female ([Fig. 6](#))

Description

Head wider than the thorax, head and thorax strongly punctate, clypeus slightly emarginate, mandible with 5 teeth, incomplete or rudimentary cutting edge in the 2nd interspace and concealed cutting edges in the 3rd interspace, supraclypeal region with carinate, Head, thorax and anterior metasoma clothed with orange hairs, white hair bands on lateral aspect of abdominal segments T2 to T4, but fulvous on T1, forewing red at base, fulvo-hyaline at apical side, posterior tarsi fringed with long white pubescence, first four abdominal segments have entire fulvous hair-bands, scopa pale white from S2-S5, black on S6.

Material examined

Khyber Pakhtunkhwa: Upper Dir, 3♀, 26.iv.2019, sweep net, Farhat; Abbottabad, Nathia Gali, 2♀, 17.ix.2020; 3♀, 1.x.2020; 1♀, 17.vii.2021, sweep net, collected by Farhat; Haripur, 1♀, 28.v.2020, sweep net, Naveed.

Distribution

Oriental region ([Pauly and Munzinger, 2003](#); [Ascher et al., 2016](#)) (New record to Pakistan).

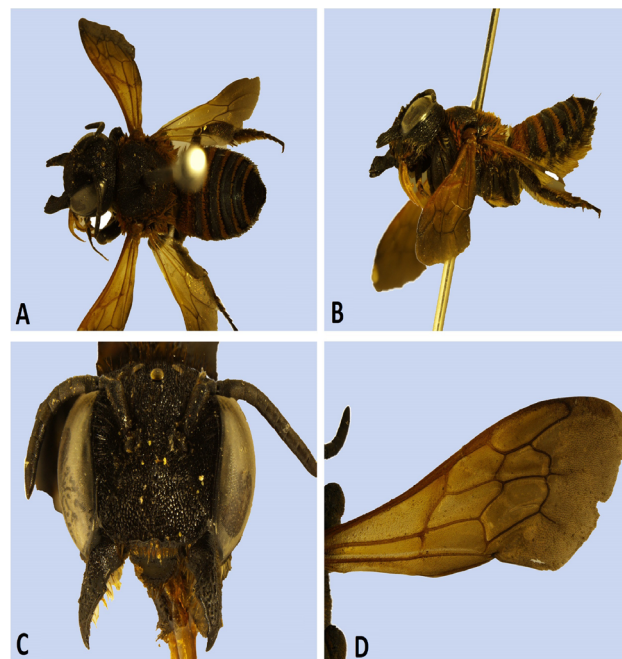


Fig. 6. *M. laticeps*. A: Habitus, Dorsal view; B: Habitus, Lateral view, C: Habitus, Head view, D: Forewing view.

7. *Megachile (Amegachile) bicolor* (Fabricius, 1781)

Megachile bicolor, [Lepel. Hym, ii, p.342](#).
Apis bicolor, [Fabr. Mant. Ins. I, p. 304](#),
Female ([Fig. 7](#))

Description

Body length 14.16-16.56 mm; clypeus subtriangular, mandible 4 dentate with two cutting edges on 3rd and 4th interspace, supra clypeal area medially flattened and sloping at the sides, scutellum finely punctate and rounded, slightly overhanging on metanotum; wings fusco-hyaline, abdomen above with rich fulvous red, T6 disc covered with suberect dark greyish pubescence, Intermediate and posterior tarsi fulvous red on the underside, Scopa white from S2 to S6, S6 sparsely covered with black hairs.

Material examined

Pakistan. Mansehra. Shinkari. 7♀, 17.v.2019; 1♂, 19.v.2019, sweep net, collected by Naveed; Abbottabad, 2♀, 22.vi.2020, sweep net, 1♀, 21.vii.2021, sweep net, Naveed; Swat, 2♀, 19.ix.2022, sweep net, Naveed.

Distribution

A widespread species in Oriental region ([Gupta, 1993](#); [Aslam et al., 2020](#)).

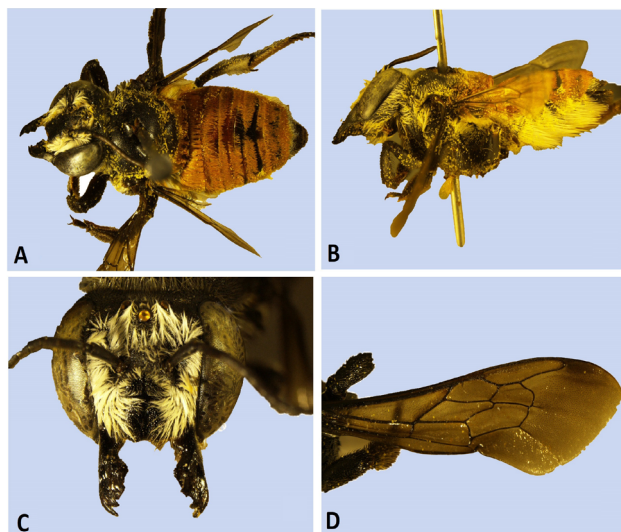


Fig. 7. *M. bicolor*: A: Dorsal view; B: Lateral view, C: Head view, D: Forewing view.

8. *Megachile (Callomegachile) cephalotes* Smith, 1853

Megachile cephalotes, Smith, Cat.i.p, 179.

Chalicodoma (Callomegachile) *cephalotes*

Michener, 1965: p.191.

Female (Fig. 8)

Description

11.75-13.82mm; clypeus strongly convex, slightly emarginated, apical margin truncate, mandible tridentate long, narrow and curved, first and second teeth same in length and also same and equal in interspace distance, 2nd interspace distance long, incurved to 3rd tooth, lower margin of mandible with short but stout submedian process, head and thorax with coarse punctures, rounded scutellum, tegulae black, wings flavohyaline, legs black, 1st, 2nd and 3rd abdominal segments with transverse white fascia, T2-T6 with suberect black hairs on lateral sides, scopa without white apical fasciae, scopa pale white from S2-S5.

Distribution

Oriental region (Aslam *et al.*, 2020; Gupta, 1993; Veereshkumar, 2015).

Material examined

5♀, 20.vi.2020, sweep net, Naveed; 7♀, 1.v.2022, sweep net, Naveed; 3♀, 21.vii.2022; 1♂, 2.ix.2019, sweep net, collected by Farhat; Mangora, 1♀, 23.vii.2019, sweep net; Naveed, Swat, 1♀, 29.vi.2020, sweep net, Naveed; Haripur, 1♂, 5.iii.2019; 1♂, 17.iii.2019, sweep net, collected by Naveed.

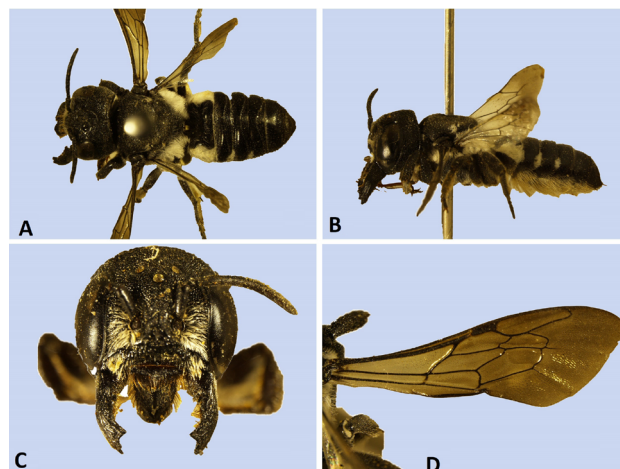


Fig. 8. *M. cephalotes*. A: Dorsal view; B: Lateral view, C: Head view, D: Forewing view.

Early records of Megachilid bees from Indian Sub-Continent were summarized by Bingham (1897) in his monograph of the Bee Fauna of British India reported 53 species under 8 genera; Smith (1853) recorded 4 genera with 26 species; Radoszkowski (1882) reported five species under one genus; Cameron (1897) reported 8 genera with 36 species; Nurse (1904) reported 6 genera with 12 species; Friese (1904) reported 2 genera with 6 species; soon after Nurse (1904) conducted detailed studies on Megachilid bees in what is now Pakistan, describing numerous endemic species. Cockerell (1907, 1910) reported 8 genera with 19 species.

In Pakistan majority of the researchers focused their studies on the role of bees in crop pollination rather than taxonomic or faunistic approaches such as Ahmad (1976) reported non-Apis bee's species while studying alfalfa pollinators. Fiaz (1977) studied non-apis bees on citrus. Ascher and Rasmussen (2010) reported 250 bee species from Pakistan, out of which 45 species belong to family Megachilidae, without describing their distribution detail. Rehman *et al.* (1990) studied bees fauna concerned with mango pollination whereas Jasra and Rafi (2003) studied pollinator fauna of apricot from Gilgit-Baltistan.

From India, Gupta (2003) reported 25 genera of family Megachilidae with 225 species; whereas Ghorpade (2009) reported 53 genera, however some of the genera have been synonymized. Wu (2005) recorded fourteen new species of *Megachile* Latreille belonging to 7 subgenera which were collected from Yunnan, China. Wu (2006) recorded and redescribed five species from China, with a key to them in her Fauna sinica.

The knowledge on the Megachilid fauna of Pakistan is insufficient and poorly explored, due to lack of field surveys

and taxonomic works, which highlights the need for proper exploration of this region and further conservation of this important pollinator group. Summarizing knowledge of Pakistani *Megachile* is the first step towards more thorough description and characterization of the regional fauna.

CONCLUSIONS

Exploring wild bee fauna is a vital step for assessing their role as crop pollinators. This will ensure the achievability of pollination services in future. In order to accomplish these targets comprehensive studies on wild and native bees particularly in Megachilidae in Pakistan are still lacking. Despite their diversity and economic importance, leafcutter bees are taxonomically poorly studied in Pakistan. Therefore, a gap in the knowledge of Megachilid bee in the country needs to be filled. Thus, this study will highly improve our knowledge of Megachilinae fauna.

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Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

- Ahmad, R., 1976. A note on insect pollinators of alfalfa in Pakistan. *N. Z. Entomol.*, **6**: 190-191. <https://doi.org/10.1080/00779962.1976.9722243>
- Ahmad, S.S., Abbasi, Q.U.A., Jabeen, R. and Shah, M.A., 2012. Decline of conifer forest cover in Pakistan. *Pak. J. Bot.*, **44**: 511-514.
- Ahmed, M., Hussain, T., Sheikh, A.H. and Siddiqui, M.F., 2006. Phytosociology and structure of Himalayan forests from different climatic zones of Pakistan. *Pak. J. Bot.*, **38**: 361-383.
- Ascher, J.S. and Rasmussen, C., 2010. *Bee species list for Pakistan*. FAO, Rome.
- Ascher, J.S. and Pickering, J., 2020. *Discover life's bee species guide and world checklist*. Available in: <http://www.discoverlife.org> (accessed 3 July, 2022).
- Ascher, J.S., Risch, S., Soh, Z.W.W., Lee, J.X.Q. and Soh, E.J.Y., 2016. Megachile leaf-cutter and resin bees of Singapore (Hymenoptera: Apoidea: Megachilidae). *Raffles Bull. Zool.*, **32**: 33-55.
- Aslam, S., Rafi, M.A., Zia, S.A., Munir and Saljoki, A.U.R., 2020. Faunistic study of Non-Apis bees (Hymenoptera: Apoidea) from Potohar Plateau of Pakistan. *Int. J. Biosci.*, **16**: 221-230.
- Bingham, C.T., 1897. Hymenoptera wasps and bees. In: *The Fauna of British India, including Ceylon and Burma* (ed. W.T. Blandford). Vol. 1. Taylor and Francis, London, pp. 1-579. <https://doi.org/10.5962/bhl.title.100738>
- Cameron, P., 1897. Hymenoptera Orientalia, or contributions to knowledge the Hymenoptera of the Oriental Zoological region. *Mem. Manch. Soc.*, **41**: 1-144.
- Cockerell, T.D.A., 1907. On a collection of Australian and Asiatic bees. *Annls Mag. Nat. Hist.*, **23**: 221-236.
- Cockerell, T.D.A., 1910. Some bees from high altitudes in the Himalaya. *Entomologist*, **43**: 238-242. <https://doi.org/10.5962/bhl.part.28542>
- Fiaz, M., 1977. *Role of insects in the pollination of sun flower*. M.Sc. thesis, Department of Entomology, University of Agriculture, Faisalabad.
- Friese, H., 1904. Ueber Megachile Heteroptera Sich. (Hym.). *Zeits. Hym. Dipt.*, **4**: 327-230.
- Genaro, J.A., 1996. Key to the genus *Megachile*, *Chalicodoma* group (Hymenoptera: Megachilidae) in Cuba. *Rev. Biol. Trop.*, **44**: 193-198.
- Ghorpade, K., 2009. Identification and study of Indian bees (Hymenoptera Apoidea): A scenario of the taxonomic status quo in our subregion. *Colemania*, **19**: 1-26.
- Gonzalez, V.H., Guevara, D.A., Jaramillo-Silva, J. and Ospina, R., 2019. Discovery of *Megachile* (*Pseudomegachile*) *lanata* (Fabricius, 1775) (Hymenoptera, Megachilidae) in Colombia, an adventive bee species from the old world. *Check List*, **15**: 45-48. <https://doi.org/10.15560/15.1.45>
- Gupta, R.K., 1993. *Taxonomic studies on the Megachilidae of North-western India (Insecta, Hymenoptera, Apoidea)*. India Council of Agricultural Research. New Dehli. Reprint: 1999, Scientific Publishers (India) Jodhpur: pp. 1-294.
- Gupta, R.K., 2003. *The diversity of bees (Hymenoptera: Apoidea) in India*. Adv. in Insect Biodiver. Agribios (India), Jodhpur.
- Jasra, A.W. and Rafi, M.A., 2003. Cash crop farming in

- the northern Pakistan: The importance of pollinator diversity and managed pollination in apricots. *Int. Cen. Integ. Moun. Dev. Kathmandu Nepal*, pp. **60**: 7263-7269.
- Kumari, P. and Kumar, N.R., 2018. A new species from Genus *Megachile* Subgenus *Callomegachile* (Hymenoptera, Megachilidae) from Chandigarh and Punjab plains. *J. appl. nat. Sci.*, **10**: 454-458. <https://doi.org/10.31018/jans.v10i1.1650>
- Kumari, P., Kumar, N.R., Kaur, A. and Chandra, K., 2019. Taxonomic studies on species belonging to subgenus *Eutricharaea* Thomson of the genus *Megachile* (Hymenoptera: Megachilidae). *J. appl. nat. Sci.*, **11**: 612- 618.
- Meurgey, F., 2016. Bee species and their associated flowers in the French West Indies (Guadeloupe, Les Saintes, La Désirade, Marie Galante, St Barthelemy and Martinique) (Hymenoptera: Anthophila: Apoidea). *Annls Soc. Ent. Fr.*, **52**: 209–232. <https://doi.org/10.1080/00379271.2016.1244490>
- Michener, C.D., 2000. *The bees of the world*, 1st edn. The Johns Hopkins University Press, Baltimore, USA, pp. 913.
- Michener, C.D., 2007. *The bees of the Word*, 2nd edn. Johns Hopkins University Press, Baltimore. pp. 953.
- Moure, J.S., Melo, G.A.R. and DalMolin, A., 2007. *Megachilini* Latreille, 1802. In: *Catalogue of bees (Hymenoptera, Apoidea) in the Neotropical region* (eds. J.S. Moure, D. Urban and G.A.R. Melo). Sociedade Brasileira de Entomologia, Curitiba, Brazil. pp. 917–1001.
- Nurse, C.G., 1904. New species of Indian Hymenoptera. *J. Asiatic Soc. Bengal*, **70**: 146-154.
- Pauly, A. and Munzinger, J., 2003. Contribution à la connaissance des Hymenoptera Apoidea de Nouvelle-Calédonie et de leurs relations avec la flore butinée. *Annls Soc. Ent. Fr.*, **39**: 153–166. <https://doi.org/10.1080/00379271.2003.10697370>
- Radoszkowski, O., 1882. Opisanie nowych gatunków Błonkoskrzydłych (Hymenoptera). *Waidom. Z. nauk. Przyrodz. Warsaw*, **2**: 72-81.
- Raw, A., 2007. An annotated catalogue of the leafcutter and mason bees (Genus *Megachile*) of the Neotropics. *Zootaxa*, **1601**: 1–127. <https://doi.org/10.11646/zootaxa.1601.1.1>
- Rehman, K., Husain, T., Soomro, A.H. and Khuhro, R.D., 1990. *Pollinator's activity on mango inflorescence*. Proc. 10th Congress of Zoology.
- Sardar, S., Warrit, N., Rameshkumar, A. and Kazmi, S.I., 2021. New distributional records of *Megachile* Latreille, 1802 (Apoidea: Megachilidae) from Indian States. *Rec. Zool. Surv. India*, **121**: 23-29.
- Smith, F., 1853. *Catalogue of Hymenopterous insects in the collection of the British Museum part I* London. British Museum, pp. 133-197.
- Veereshkumar, 2015. *Taxonomic studies on leaf cutter bees (Hymenoptera: Megachilidae) of Karnataka*. Ph.D. thesis, University of Agricultural Sciences, Karnataka, India.
- Wu, Y.R., 2006. *Fauna Sinica, Insecta Vol. 44. Hymenoptera. Megachilidae*. Science Press, Beijing. xvi+474 pp., 4 plts.
- Wu, Y.R., 2005. A study on the genus *Megachile* latreille from China with descriptions of fourteen new species (Apoidea, Megachilidae). *Acta Zoot. Sin.*, **30**: 155–165.