

INSECT POLLINATORS ASSOCIATED WITH APPLE ORCHARDS AT DISTRICT CHITRAL, KHYBER PAKHTUNKHWA-PAKISTAN

Muhammad Sohail Khan¹, Muhammad Israfil Khan², Muhammad Arabi Awan*¹, Arsalan Ali³, Abdul Mujeeb¹, Tahir Zaman¹, Muhammad Junaid¹, Hizar Ali¹, and Naveed Ul Haq⁴

1. Department of Entomology, The University of Agriculture, Peshawar-Pakistan.
2. Department of Plant Protection, The University of Agriculture, Peshawar-Pakistan.
3. Directorate of Non-Timber Forest Products, Khyber Pakhtunkhwa.
4. Department of Food Science, The University of Guelph, Canada.

ABSTRACT

A study was carried out to explore the insect pollinators in apple orchards at three different areas (Seenlast, Balach and Shoghor) of District Chitral Pakistan, in 2018-19. The insect pollinators were collected by using hand net and pan traps of yellow, blue and white colour. During the study 4 genera i.e., *Melitta* Kirby, *Dasygaster* Latreille, *Stelis* Panzer and *Megachile* Latreille were recorded. These genera were reported as new to the fauna of Khyber Pakhtunkhwa and Pakistan. Diagnostic characters and colored photographs of the specimens also provided.

Key Words: Chitral, Pollinators, Genera, Fauna, Diagnostic characters.

INTRODUCTION

Family Rosaceae comprises apple (*Malus domestica*), which contain about 100 genera and 300 species worldwide. Apples are distributed worldwide. They are commonly present in temperate areas (Velasco *et al.*, 2010). There is various size of apple trees, ranges from small to medium several-branched, these are deciduous having a single stem and have generally a scattering shade. Apple trees are commonly 2-5m in height while the wild apple trees are 10-15m in height. It is most extensively developed species and is cultivated worldwide as a fruit tree. Apple has much bacterial fungal and insect pest problems, which can be controlled through inorganic and organic sources. Apples contain many essential features for a healthier body as they contain large amount of phenolic compounds. These compounds are very useful against astringent, oxidant, cancer, inflammation, and bacterial activity. *Malus domestica* are effective

and compete against inflammation, Diabetes mellitus, heart diseases, constipation and asthma (Mazed, 2009).

Among the fruit crops, the best essential moderate fruit crop is apple and has been cultured in Europe and Asia from the time immemorial. Moderate weather is the best habitat of apple fruit and it is intrinsic to many parts of Asia and Europe (Sandor, 2008). Apple is distributed worldwide in above 94 countries, the apple fruit yield is 69.60 million metric tons, obtained from land of 4.85 million hectares (Velasco *et al.*, 2010). At Pakistan the yield of apple was 564693 tons, recorded from 88589 hectares of land, while in Khyber Pakhtunkhwa the yield of apple was 69287 tons, recorded from 7540 hectares of land (Statistics of Pakistan 2017-18).

Pollination is very effective due to its need for certifying human food security as well as keeping the output of agricultural and natural ecosystems (Eardley *et al.*, 2006; Ollerton, 2011). It is estimated that about 80% of plants and three-quarters of world food crops depend on animal pollinators for example bees, flies, etc. (Eardley *et al.*, 2006; Klein *et al.*, 2007). Pollinators improve the quality and quantity of fruit crops, and increasing genetic changes among species of crops due to which extent of pollination profits have diversity among the crops (Hajjar *et al.*, 2008).

It is estimated that the annual contribution of pollinators to agricultural crops worldwide is about US\$ 206 billion (Gallai *et al.*, 2009). Though, the hilly regions of South Asia, specially the Hindu Kush–Himalayan areas, which contains Pakistan, Afghanistan, India, Nepal, China, Bangladesh, Myanmar and Bhutan. The absence of awareness and knowing about the importance of crop pollination to conserve crop production of cross-pollinated crops and the deficiency of official and farmers' activities to encourage succeeded crop pollination is still a collective feature (Partap and Partap 1997). Pollinators recorded on apple (*Malus domestica* or *Malus sylvestris*) are honey bees, orchid mason bee, bumble bees, solitary bees and hover flies.

Insects are the main source of pollination in the ecosystem service results to sustain them in both agro-ecosystems and in nature (Buchmann and Nabhan, 1996). It is estimated that about 75% crop species worldwide are pollinated through, insects that is why the insect pollinators are very important to agro ecosystem most of the crop species are depended on them for to improve the yield of seed set or fruits (Klein *et al.*, 2007). Worldwide contribution of pollinators is about

35% of food volume and provide essential nutrients for human survival (Gallai *et al.*, 2009). Pollination requirements are different for different crops species due to which their dependency on insect pollinators is also different (Morse and Calderone, 2000).

MATERIALS AND METHODS

Collection of insect pollinators was started during blooming period of apple flora in April 2019 at Seenlasht, Balach and Shoghore of District Lower Chitral. Each orchard was sampled 3 days (From 9.00 am to 4.00 pm) sequentially. Collection was done by using hand net and pan traps.

Between 9.00 am and 4.00 pm netting was done (90mins in the morning before 12.00 pm and 90mins in the afternoon). Netting was made in whole orchard with optimum speed. After collection pollinators were put immediately into the killing jar for killing purpose. Data from all the trees in entire area was recorded at equal interval.

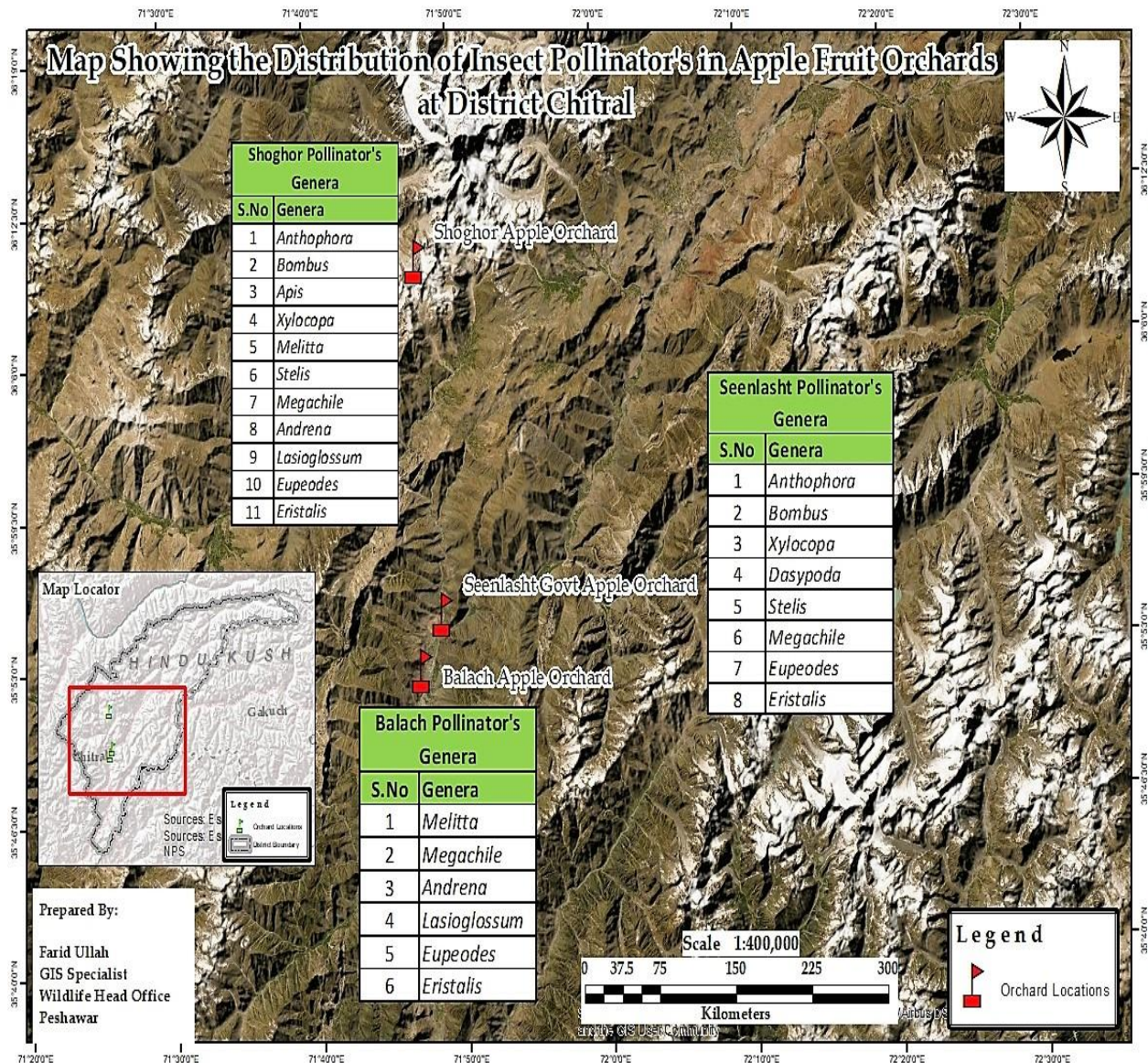
The pan traps of white, blue and yellow colour were kept in the field in morning with water mixed with detergents. After 4pm the water was removed from the traps with the help of muslin cloth and the specimens were collected.

Preservation

The collected pollinators were moved to alternative jar having tissue paper, which absorbed fluids created by pollinators. This fluid absorption helping in the control of colors changing process of pollinators specimens. The pollinators were then transferred in to the collection box. For the protection of specimens from the attack of museum pest, naphthalene balls were kept in the box and to guard the specimens from the attack of fungus small packets of silica gel were putted to absorb the moisture around the box.

Identification

The specimens were identified with the help of Nikon SMZ 754T stereo microscope. The identified specimens were deposited to the Insect Museum, Department of Entomology, The University of Agriculture, Peshawar.



RESULTS AND DISCUSSION

In the current study 4 genera are reported from district Chitral. These genera were recorded new to the insect fauna of Khyber Pakhtunkhwa and Pakistan.

Genus *Melitta* Kirby, 1802 (Figure, 1-5)

Melitta Kirby 1802: 117-119. Type species: *Melitta tricincta* Kirby, 1802 (designated by Richards 1935).

Diagnostic Characters: Genus *Melitta* can be distinguished from other genera of bees by the following characteristics including: Bees with tongue short, pointed or occasionally bilobed (Fig.

17); hind wing with jugal lobe somewhat shorter than half of the length of claval lobe (Fig. 17a); antenna with last segment truncate squarely (Fig. 17b); face with only one groove running towards the clypeus from antennal socket (Fig. 17c); male and female lacking depressed area next to the inner margin of eyes.

Description of female

Body length: 10-12 mm

Body Color: Color mainly brownish to blackish

Head: Head 3.1 mm in length; integument and antennal segments black; mandibles with reddish brown patches in the middle; antenna with flagellum ventrally curved slightly; compound eyes with inner margins parallel, sometimes converging; clypeus convex and wide; face with white and silver hairs, densely punctate; vertex punctate with dark hairs scattered; galae with outer surface sculptured and slightly shiny.

Mesosoma: Mesosoma 3-4 mm long and 2-3 mm wide; cuticle black in color; scutellum and mesoscutum punctate densely; lateral part of scutellum and central part of mesoscutum with large dots; propodeum and mesosoma with white and silver pubescence at the sides; triangle of propodeum sculptured and shiny on the ribs; thorax covered dorsally with yellowish grey or yellowish brown hairs; legs black except pre-tarsi with brown color, covered with white pubescence; 1st segment of tarsi and tibia with white and silver pubescence on the outer surface and on the inner surface with black hairs; tibia with proximal part below the meta- tibial plate also with black hairs; wings dark slightly; front wing with 3 submarginal cells; 3rd submarginal cell of forewing elongate.

Metasoma: Metasoma 5-7 mm long and 3-5 mm wider; all the terga punctate densely and black, shiny and smooth between the punctures; terga with apical margin black; margins of tergite 2 and 3 laterally slightly depressed; tergite 1-4 apically with white and erect hairs, twice as broad as width of apical margins; sterna with apical parts yellowish; gonostylus short with ventral part having a flattened hemispherical protrusion in the middle.

Distribution: The genus *Melitta* is generally distributed in Nearctic region, East and Southern Africa and Palaearctic region (Eardley and Kuhlmann, 2006; Wu 2000; Snelling and Stage,

1995; Michener, 1979 and 1981 and Warncke, 1973b). Mostly the genus *Melitta* is species-rich in Palearctic region (Michener, 2000).

Material Examined: (n=22♀) Pakistan: KP, Chitral, Balach. 10♀. 35.8765 N, 71.7904 E. Shoghor. 12♀. 36.0151 N, 71.7630 E. 28.IV.2019. M. Sohail Khan.

Comments: This genus was reported for the first time by Kirby in 1802 later on synonymized by Leach (1815), Lepelletier (1841), Radoszkowski (1891) and Viereck (1909, 1909). This genus can be separated from other genera of bees by the following characters: tongue short, pointed or occasionally bilobed; hind wing with jugal lobe somewhat shorter than half of the length of claval lobe; antenna with last segment truncate squarely; face with only one groove running on the clypeus from antennal socket; male and female lacking felty and depressed area next to the inner margin of eyes. This genus is identified for the first time from Balach and Shoghor, District Chitral, Khyber Pakhtunkhwa.

Genus *Dasypoda* Latreille, 1802 (Figure, 6-10)

Dasypoda Latreille, 1802: 424. Type species: *Andrena hirtipes* Fabricius, 1793.

Diagnostic Characters: This genus has the following diagnostic characters: Face with only 1 groove extended from antennal socket to the clypeus; tongue pointed but occasionally bilobed, short (Fig. 18); forewing with basal vein curved gently, marginal cell narrow, submarginal cells are 2 in numbers (Fig. 18a); hind wing with jugal lobe short, less than half of claval lobe length (Fig. 18b); gaster with strong hairs white in female but in male with golden brown bands (Fig. 18c); hind leg of female with dense scope; thorax pale at sides, with brown hairs (Fig. 18d); face black; body hairy, without yellow or white spots except clypeus with yellow color.

Description of female

Body Length: 11-17 mm

Body Color: Body black

Head: Clypeus polished and smooth without punctures; cuticle with shiny, smooth and non-punctured area at the sides and front of ocelli; pubescent of vertex with short black brown hairs, in the middle fused with long silver white hairs; face covered with silver white hairs; genae with

inner part and occiput with curved and long silver hairs fused with short brown hairs; malar space 4.5 x shorter than basal width of mandibles; mandibles black in color with red apical parts; galeae covered with square shaped tubercles and roughly punctured apical part; antenna 11-12 segmented with flagellomeres densely covered with short setae.

Mesosoma: Mesoscutum densely punctate; propodeum with median area marked with prominent ribs in the form of fine shallow mesh; thorax with long and erect silver white hairs at lateral and ventral parts; scutum with sides punctured densely with same hairs fused with dark brown hairs; scutum in the middle smooth, between the points shiny and covered with short dark brown hairs; tegula in front black and at the lateral and back side yellow brown, not punctured; leg black in color with silver white hairs long, bent at prothorax and profemur; hind tibia at distal part thickened and at the outside convex; basitarsi with dense silver white hairs except hind basitarsi with light brown hairs; hind leg with tibial light yellow; wings at the top slightly shaped and transparent.

Metasoma: Terga with marginal parts at the sides depressed, at the top colorless and enlightened widely; tergite 1 with horizontal part short; terga with basal part bear brown scattered hairs; tergite 4-7 in the middle punctate; tergite 3-5 with short narrow bands of silver white hairs; tergite 7 in the middle with longitudinal keel; sternite 2-4 covered with short yellow white hairs; marginal part with apex semi-transparent, thinly striated covered with short narrow band of white hairs; sternite 5 with long white hair on marginal and short hairs on the basal part; genitalia with long and narrow penis valves; gonostylus with inner side bears spiky, long protuberance.

Distribution: The genus *Dasygaster* is widely distributed in palaeartic region from canary Island and Portugal to Japan and is usually widespread in Mediterranean basin of the world. This genus is also reported from west palaeartic region (Warncke, 1973a), Spain (Quilis, 1928), China (Wu, 1978) and European Russia (Radchenko and Pesenko, 1989).

Material Examined: (n=8♀) Pakistan: KP, Chitral, Seenlasht. 8♀. 35.12 N, 71.20 E. 23.IV.2019. M. Sohail Khan.

Comments: This genus was for the first time described by Latreille in 1802 and later on synonymized by different authors. It has the following diagnostic characters: basal vein of front wing curved; tongue short and pointed; forewing with 2 submarginal cells; jugal lobe short;

female with hind leg having scope; face black in color. This genus was described for the first time from District Chitral, Khyber Pakhtunkhwa, Pakistan.

Genus *Stelis* Panzer, 1806 (Figure, 11-15)

Stelis Panzer, 1806: 246. Type species; *Apis ateniina* Panzer, 1798, not Christ, 1791 = *Apis punctulatissima* Kirby, 1802, monobasic. Isotypic with *Trachusa* Jurine, *Gywdroma* Klug, *Gyinnus*. And *Ceraplastes*.

Diagnostic Characters: This genus has the following diagnostic characters; forewing with 2 sub-marginal cells; vein 2M-Cu joined vein M at sub-marginal cell 2 at outer end; tongue long compared to other mouthparts (Fig. 21); hindwing with jugal lobe shorter than claval lobe and reduced (Fig. 21a); metasoma with pale whitish spots or bands at tergites (Fig. 21b); metasoma with no spines at the apex; scopa absent.

Description of female

Body Length: 4-14mm

Body Color: Black to richly marked with orange, yellow or cream markings.

Head: Head broader than long slightly; eyes convergent below slightly, 2.5 x as long as broad; paraocular carina complete; malar space wider, linear, posteriorly produced slightly; clypeus with distal margin medially sinuous, without tubercles, 2x as broad as long; scape 3.4x as long as wide; outer mandibular surface on basal half shiny, coarsely punctate with tubercles shiny and smooth; distal half of mandibles dull, unevenly punctate; integument smooth, between punctures shiny.

Metasoma: Mesosoma shiny and smooth, coarsely punctate; mesepisternum and mesoscutellum slightly with sparse and large punctures; propodeum with lateral surface, pronotum and mesepisternum antero-dorsally with sparse and small punctuation; tegula with scattered, minute and fine punctuation; axila with punctures smaller than scutellum; legs with dense and fine punctures; hind leg with punctures sparse and large; lateral and anterolateral margins of mesoscutum with continuous bands; mesoscutellum with distal margins, metepisternum dorsally and axila with diffuse bands; propodeum with lateral surface and metepisternum with dense

setae; wings usually light brown, forewing with costal margin dark; prestigma, terostigma and veins brown.

Metasoma: Tergites of metasoma imbricate weakly to shiny and smooth with punctures small; terga distally with dense and large punctuation; punctures on tergite 7 form transversal rows mid-apically; sterna imbricate with small punctuation; sternum 6 usually with contiguous and large punctures; sterna 2-5 with diffuse bands; terga with bands complete, tergum 2 with small spot laterally; sterna and terminal terga with dense and long setae.

Distribution: The genus *Stelis* is generally distributed in Holarctic region extends to Kenya, Malaysia and Costa Rica. This genus is also been reported from South Africa (Griswold and Parker, 2003) and Caribbean Region (Gonzalez *et al.*, 2012).

Material Examined: (n=23♀)

Pakistan: KP, Chitral, Seenlasht. 14♀.35.12N, 71.20E. Shoghor.9♀.36.0151N,71.7630E. 27.IV.2019. M. Sohail Khan.

Comments: This genus was first described by Panzer in 1806 and later on synonymized by different authors. It has the following important morphological characters: Metasoma with no spines at the apex; scopa absent; metasoma with pale whitish spots or bands at tergites; hindwing with jugal lobe shorter than claval lobe and reduced; Forewing with 2 sub-marginal cells; vein 2M-Cu joined vein M at sub-marginal cell 2 at outer end; tongue long compared to other mouthparts. This genus is newly recorded from District Chitral, Khyber Pakhtunkhwa, Pakistan.

Genus *Megachile* Latreille, 1802 (Figure, 16-20)

Megachile Latreille, 1802a:434. Type species: *Apis centiinciliaris* Linnaeus, 1758, by designation of Curtis, 1828: 1.

Diagnostic Characters: The genus *Megachile* has the following important morphological characters: Arolium absent in apical tarsal joints; tergite 1 with front face concave; forewing with 2 sub-marginal cells; vein 2M-Cu join the vein M in 2nd sub-marginal cell of forewing; hind wing with jugal lobe reduced; jugal lobe shorter than claval lobe about 0.5 x (Fig. 20c).

Description of female**Body Length:** 6-9.5mm**Body Color:** Black in color; galae transparent orange; claws and distal tarsal segments yellow brown; pterostigma and wing veins dark brown.**Head:** Compound eyes 4.0 x as long as wide, slightly overlapping base of the mandible; antennal socket slightly close to apex than to the vertex; face 1.8-2.0mm in length and 1.9-2.1mm wide, as a whole abstemiously shiny; supra-clypeus slightly protuberant, extending from perimeter mound evenly rounded, most of protuberant aspect around halfway between a line through supra-clypeus lower margin and antennal sockets upper margin, with punctures larger centrally and around perimeter medium sized; vertex and frons with punctures medium to large in size; paraocular area with irregular, small and very close punctuation; clypeus very short and re-curved slightly; lower edge emerginate shallowly and smooth; longitudinal median area impunctate narrowly; mandibles with 4 massive distinct teeth; galae shiny and smooth; gena shiny, in lateral view little-bit wider than eyes with irregular, large and close punctuation.**Mesosoma:** Pronotum shagreened moderately with punctures medium in size and obscured; scutellum and scutum similar to vertex and frons; metanotum narrow with irregular, close and small punctures; propodeal triangle curved slightly in lateral view, posterior face dull, tessellated densely and narrow; propodeum with lateral surface shiny with close and large punctures; metapisternum with punctures closely spaced and large; hind tibial spur ciliate; forewing 4.5-4.9mm in length; pterostigma about 2x as long as wide and small; 1st M-Cu vein joined sub-marginal cell 2 about 1/8 length of cell from proximal end.**Metasoma:** Metasoma with 1st tergum anteriorly broadly concave, lower half shagreened moderately with small punctures, lateral area and upper half shiny and smooth; 2nd tergum with elongated and transversely aligned pear shaped area dull, impunctate and finely tessellated, posterior to gradulus; terga 2-5 with anterior margin lightly and narrowly tessellated; terga 1-5 shiny with medium to large sized punctured closely spaced, size of punctures increased with succeeding terga; tergum 6 shiny with closely spaced medium size punctuation; 1st sternum apically emerginate shallowly, shagreened lightly, with small punctures medially widely but

laterally closely spaced; sterna 2-5 with sculptures similar to terga 3-5; sternum 6 shagreened lightly with small punctures medium sized.

Distribution: The genus *Megachilidae* is generally distributed in every continent of the world except in Antarctica and is one of the largest family in term of species on every continent except Antarctica, and is one of the largest families in terms of the number genera (77) and species (4037) (Ascher and Pickering 2011). From Japan this genus was recorded by Hiroshima and Maita (1974).

Material Examined: n = 33♀

Pakistan: KP, Chitral, Seenlasht. 13♀. 35.12N, 71.20E. 22. Balach. 11♀. 35.8765N, 71.7904E. 25. IV.2019, M. Sohail Khan.

Comments: This genus was first described in 1802 by Laterielle and later on synonymized by Schulz in 1906. It has the following diagnostic characters: Tergite 1 with front face concave; hind wing with jugal lobe reduced; jugal lobe shorter than claval lobe about 0.5 x; forewing with 2 sub-marginal cells; vein 2M-Cu join the vein M in 2nd sub-marginal cell of forewing; Arolia absent. This genus is reported for the first time from District Chitral, Khyber Pakhtunkhwa-Pakistan.

REFERENCES

- Ascher, J. S. and J. Pickering. Report: 2011. Discover Life's bee species guide and world checklist.
- Eardley, C. D. and M. Kuhlmann. 2006. Southern and East African *Melitta* Kirby (Apoidea: Melittidae). Afri. Entomol. 14: 293-305.
- Eardley, C., D. Roth, J. Clarke, S. Buchmann and B. Gemmill. 2006. Pollinators and Pollination: A resource book for policy and practice. African Pollinator Initiative, South Africa.
- Gallai, N., J.M. Salles, J. Settele and B.E. Vaissiere. 2009. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. Ecological Economics. 68: 810–821.

- Gonzalez, V.H., J.S. Ascher and M.S. Engel .2012. A new *Stelis* (*Dolichostelis*) from northern Colombia (Hymenoptera: Megachilidae): first records for South America and a synopsis of the bee fauna from the Caribbean region of Colombia. *J. Nat. Hist.* 46: 47-48.
- Griswold, T. and F.D. Parker. 2003. *Stelis rozeni*, new species, the first record of the parasitic bee genus *Stelis* from Southern Africa (Hymenoptera: Megachilidae). *J. Kan. Ento. Soc.* 76: 282-285.
- Hajjar, R., D.I. Jarvis and B.H. Gemmill. 2008. The utility of crop genetic diversity in maintaining ecosystem services. *Agriculture, Ecosystems and Environment.* 123 (4): 261- 270.
- Hirashima, Y. and Y. Maeta. 1974. Bees of the genus *Megachile* sensu lato of Hokkaido and Tohoku District of Japan. *Kontyu, Tokyo,* 42: 157–173.
- Klein, M.A., B.E. Vaissiere, H.C.I. James, S.A. Cunningham, C. Kremen and T. Tscharntke. 2007. Importance of pollinators in changing landscapes for world crops. *Proceeding biological sciences.* 274: 303–313.
- Mazed, M.A. and S. Mazed. U.S. Patent No. 20100021533A1. Washington, DC: U.S. Patent and Trademark Office. 2009. pp. 1–31.
- Michener, C.D. 1979. Biogeography of the bees. *Annals of the Missouri Botanical Garden.* 66: 277-342.
- Michener, C.D. 1981. Classification of the bee family Melittidae with a review of species of Meganomiinae. *Contribution of the American Entomological Institute.* 18: 1-135.
- Michener, C.D. 2000. *The bees of the world.* The Johns Hopkins University Press, Baltimore. pp. 913.
- Morse, R.A. and N.W. Calderone. 2001. The value of Honey bees as pollinators of US crops. *Bee Culture.* 128: 1–15.
- Ollerton, J., R. Winfree and S. Tarrant. 2011. How many flowering plants are pollinated by animals. *Oikos.* 120: 321-326.

- Partap, U. and T. Partap. 1997. Managed crop pollination. The missing dimension of mountain agricultural productivity. Discussion paper series no. MFS 97/1, ICIMOD, Kathmandu, Nepal.
- Quilis, P.M. 1928. Estudio monografico de las Dasypoda Latr. Eos4: 173-241, pls. III-V.
- Radchenko, V.G. and Y.A. Pesenko. 1989. A key to the bees of the genus *Dasypoda* Latreille (Hymenoptera, Melittidae) of the European part of the USSR. Trudy Zoologicheskova Instituta, Akademii Nauk SSSR. 188: 114-121. [In Russian.]
- Sandor, F. 2008. Apple Production. Perennial Crop Support Series Jalalabad, Afghanistan. Manual produced by Roots of Peace, USAID, Afghanistan, California. Alternative Livelihood Program-Eastern Region ALP/E. Publication No. 2008-004-AFG, info@rootsofpeace.org Slingo.
- Snelling, R. R. and G. I. Stage. 1995. A revision of the Nearctic Melittidae: the subfamily Melittinae (Hymenoptera: Apoidea). Contributions in Science - Natural History Museum of Los Angeles County. 451: 19-31.
- Statistics of Pakistan. 2017-18. Area, Production of Fruit, Vegetables and Condiments.
- Velasco, R., A. Zharkikh and J. Affourtit. 2010. The genome of the pumilated apple (*Malus pumila*). Nature Genetics. 42(10): 833–839.
- Warncke, K. 1973a. Die westpaläarktischen Arten der Bienenfamilie Melittidae. Polskie Pismo Entomologiczne 43: 97-126.
- Warncke, K. 1973b. Die westpaläarktische Arten der Bienen Familie Melittidae (Hymenoptera). Polskie Pismo Entomologiczne. 43: 97-126.
- Wu, Y.R. 2000. Hymenoptera, Melittidae and Apidae. Academia Sinica, Beijing. Pp. 442. [In Chinese with English abstract].
- Wu, Y.R. 1978. A study of Chinese Melittidae with descriptions of new species. Acta Entomologica Sinica 21: 419-428. [In Chinese, English summary.]



Figure 1. Mouthparts, *Melitta*



Figure 2. Jugal lobe, *Melitta*



Figure 3. Antenna truncate, *Melitta*



Figure 4. Face with groove, *Melitta*



Figure 5. lateral view, *Melitta*



Figure 6. Head, *Dasyпода*



Figure 7. Forewing, *Dasyпода*



Figure 8. Metasoma, *Dasyпода*



Figure 9. Mesosoma, *Dasyпода*



Figure 10. Lateral view, *Dasyпода*



Figure 11. Forewing, *Stelis*



Figure 12. Metasoma, *Stelis*



Figure 13. Mouthparts, *Stelis*

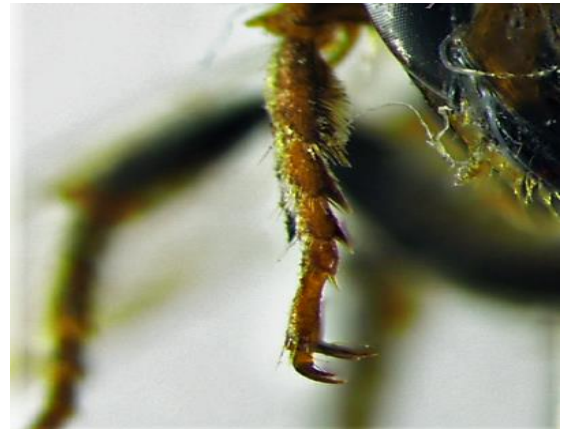


Figure 14. Leg without Arolium, *Stelis*



Figure 15. lateral view, *Stelis*



Figure 16. Metasoma, *Megachile*



Figure 17. Forewing, *Megachile*



Figure 18. Arolium absent, *Megachile*



Figure 19. Jugal lobe, *Megachile*



Figure 20. Lateral View, *Megachile*