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Morphology and Food Plants of Cuckoo Bees (Apidae: Hymenoptera) From Indian Himalayas

Rifat H. Raina*, Malkiat S. Saini

Department of Zoology and Environmental Sciences Punjabi University Patiala, INDIA
* Corresponding author: rifat72001@yahoo.co.in; rifat72001@rediffmail.com

Abstract. Cuckoo bees belong to the genus *Bombus* (Apidae: Hymenoptera) under **s**ub genus *Psythrus* Lepeletier and is widely distributed subgenus from the oriental region represented by 17 valid species. This subgenus is represented by eight valid species from Indian Himalayas viz. *B. ferganicus B. novus*, *B. morawatizianus*, *B. cornutus, B. branickii*, *B. skorikovi, B. tibetanus* and *B. turneri*. Due emphasis has been laid on their altitudional distribution, food plants, taxonomy, synonymy, and illustrations. Being their parasitic nature these species lack worker caste and has negligible role in pollination ecology although they have got preference to forage on different host plants. The species were observed feeding sluggishly on flower heads of *Rosa weibbiana*, *Cirsium* spp. and *Trifoium* spp. Many new food plants of these species have been recorded for the first time from the area under study. During the present studies six species of the cuckoo bees were collected and identified and one species *viz. B. turneri* which could not found during the present study were procured on exchanged from BMNH, London.

Key words: Morphology, food plants, Cuckoo bees, Indian Himalayas.

Abbreviations used in the text:
BMB – breadth mandible at its base, LF – length of flagellum, LHB – length of head breadth, LM – lamella, LOB – length of basitarsus, LS – length of scape, MBB – breadth of metabasitarsus, MF – median furrow, MS – length of malar space, OOL – ocello ocular length, POC – post-ocular line, POL – post-ocellar length, * – new record.

Introduction

The world bumblebee fauna consists of approximately 250 known species, and it is reasonable to assume that the majority of species have now been discovered (WILLIAMS, 1985; 1994; 1998; PEDERSEN, 1996). Recent classifications place all of the known species in a single genus *Bombus*. The majorities of these species are known as 'true' bumblebees, and have a social worker caste which is more or less sterile (they cannot mate but can lay unfertilized eggs that develop into males). The remaining 45 or so species are known as cuckoo bumblebees, and were formerly placed in a separate genus *Psithyrus*. These are inquilines that live within the nests of the true bumblebees. It is now clear that cuckoo bees have a monophyletic ancestry and belong within the genus *Bombus*, so that *Psithyrus* is now regarded as one of many *Bombus* subgenera (PLOWRIGHT & STEPHEN, 1973; PEKKARINEN *et al.*, 1979; ITO, 1985; PAMILO *et al.*, 1987; WILLIAMS, 1985, 1994; CAMERON *et al.*, 2007). All the species of Cuckoo bees have annual life cycles similar to those of typical temperate bumblebee species, except that instead of founding their own nest and rearing workers, they steal a nest from a 'true' bumblebee. The females are especially powerful, and force their way into the nests of their bumblebee hosts. They

kill or evict the queen and take over her workers as their own, using them to rear their own offspring. The *Psithyrus* female lays eggs that develop into either new breeding females or males. Mate location behaviour and hibernation are similar to other *Bombus* species. After emergence the female *Psithyrus* spends some time foraging on flowers while their ovaries develop. They then search for nests of their host species, probably at least in part using scent (FRISON, 1930). *Psithyrus* often resemble their hosts in coloration. Most authors agree that this is probably not to aid entry in to the nest, but that the *Psithyrus* and their hosts are members of Müllerian mimicry groups (ALFORD, 1975; PRYS-JONES & CORBET, 1991). Since Psithyrus do not have a worker caste, all of the offspring are males or future breeding females. The invading Psithyrus may eat host eggs and young larvae, but older ones are allowed to develop to add to the work force. Nests that have been invaded produce few or no host queens or males, although workers do lay eggs and a few of the resulting male off-spring may survive (FREHN & SCHWAMMBERGER, 2001). The frequency of invasion of bumblebee nests by *Psithyrus* (Cuckoo bees) is highly variable both between localities and years. In most other respects the life cycle of *Psithyrus* is rather similar to that of their hosts. Mating occurs in mid to late summer, and only females hibernate. Males are far more frequently seen than females, and they are very commonly observed feeding sluggishly on flower heads. The female *Psithyrus* also has a number of morphological adaptations, such as larger mandibles and a larger venom sac that increases her chances of taking over a nest. Upon hatching, the male and female Psithyrus disperse and mate. Like non-parasitic bumblebee queens, female *Psithyrus* finds suitable locations to spend the winter and enter diapause upon being mated.

Material and Methods

The research material for the present studies was collected from the last eight years (2007-2014) during different collection cum survey tours in various localities situated in the State's of Jammu and Kashmir and Himachal Pradesh falling in an altitudinal range of 1000-5500 m. These cuckoo bees were collected with sweeping hand net and the collected insect material was first sorted out in the field and latter brought to the laboratory for further identification and analysis. Distributional data including date of collection, number of specimens examined and locality with altitude was appended to each specimen to facilitate comparison. The microscopic examination of various morphological features was performed with the help of binocular microscope fitted with an ocular grid. The photographs of collected specimens were taken with Canon 18 MP LOS 5D. All the food plants of this species were collected side by side and got identified from the Centre of Plant Taxonomy, University of Kashmir. The following characters have been found trust worthy, stable and unambiguous while dealing with taxonomy of species. Shape and sculpturing of labrum and clypeus, length of malar space, mandibles, antennal segments, position of ocelli, Ocello-ocular areas of the vertex, Relative length of the pubescence and different parts of male genitalia. The terminology proposed by (WILLIAMS, 1991) for male genitalia have generally been adopted. Pictorial key for both males and females has been prepared. Temporary slides of different parts *viz.*, male genitalia, labrum, antenna, meso and meta basitarsal segments, 7th and 8th sternites etc were prepared in glycerin and alcohol. Some of its important features like penis valve, gonostylus, gonocoxites, gonobase, volsella and spatha hold a great taxonomic significance. The type specimens are deposited in the Museum of the Department of Zoology & Environmental Sciences, Punjabi University, Patiala, India for future references. The species were re described on the basis of the own material after confirmation /comparision with the type material at Natural History Musuem, London.

Results and Discussion

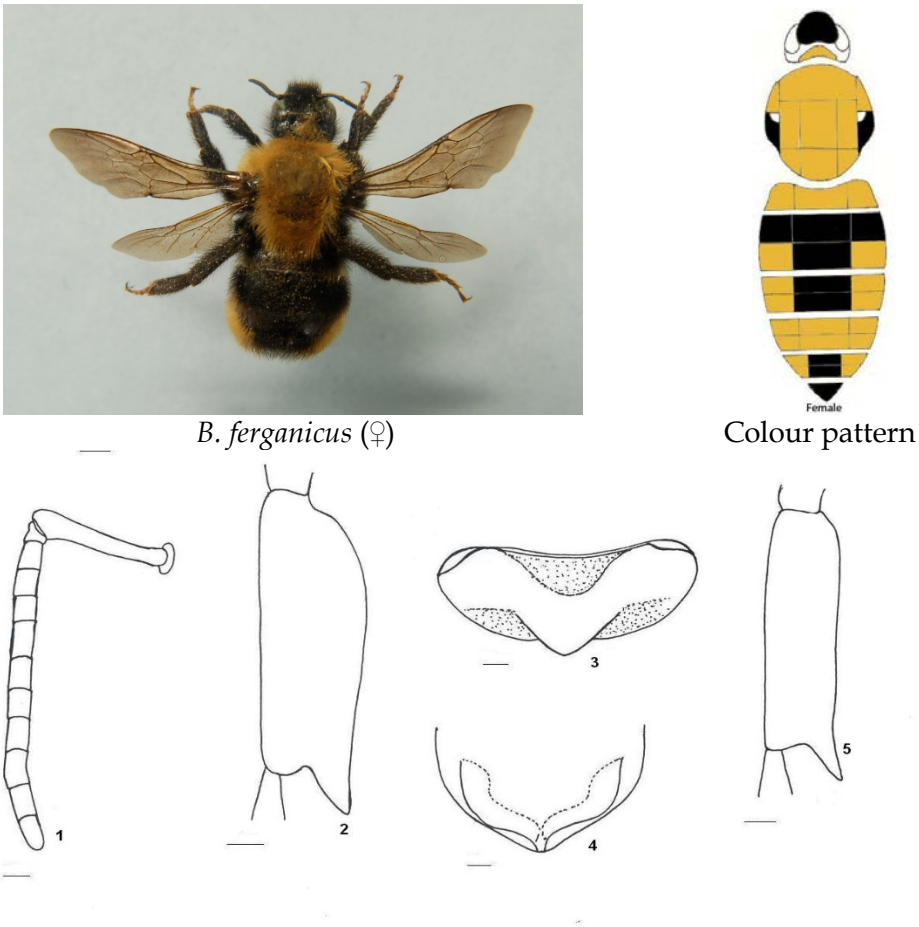
***Bombus* (*Psithyrus*) *ferganicus* RADOSZKOWSKI, 1893**

Bombus ferganicus RADOSZKOWSKI, 1893:241, Lectotype female USSR (MNHU) designated by TKALCU, 1969:206.

Synonymy: Apathus ochraceus MORAWITZ, 1894:5; *Psithyrus indicus* RICHARDS, 1929:139.

Diagnostic features

Female (Fig.1)*:* Pubescence on head, lateral aspects of mesonotum black; yellow are malar space, thorax, abdominal tergites 1 and 4; abdominal tergum 2 black with dirty yellow posterior corners; abdominal tergum 3 and 5 medially black with dirty yellow sides. Head covered with thick pubescence except malar space, clypeus, an area lateral to and in front of ocelli and narrow stripes on inner and post orbits. Labrum with basal transverse depression extending apically as a deep median furrow between pronounced lateral tubercles, displacing ridge between them to form a lamella that overhangs apical margins (Fig. 1-3). Clypeus nearly uniformly flat, only apico lateral corners curved back strongly towards occiput. MS: BMB=2:3. Antennal segments 3:4:5=1:1:1.0; LF: LS: LHB= 9:5:10.50 (Fig. 1-1). Band of punctures along eye margin in ocello-ocullar area opposite lateral ocellus, occupying half of distance between lateral ocellus and eye. The lateral ocelli just below POC. OOL: POL=2:2.5. The distoposterior corner of mesobasitarsus spinosely produced (Fig. 1-5). Basal depression shallow and with punctures, apex of lamella broadly rounded. Lateral keels of sternite 7 declining from near their mid points so that strongly swollen parts are separated by more than their own breadths (Fig. 1-4). Outer surface of meta-tibia convex, moderate to long hair throughout, but without a comb of stout spines along inner distal margin. Meta basitarsus (Fig. 1-2) with its posterior margin concave having a distoposterior corner spinosely produced and longer than distoanterior corner. Apex of tergite 7 triangularly notched, surface sculptured, but shining, no median furrow present.



B. ferganicus (♀) Colour pattern

Fig. 1. *B. ferganicus* (♀) – photograph, colour pattern and morphology. Legend: 1 – antenna, 2 – metabasitarsus, 3 – labrum, 4 – 7th sternite, 5 – mesobasitarsus, Scale bar = 0.5 mm.

B. ferganicus (♂)

Colour pattern

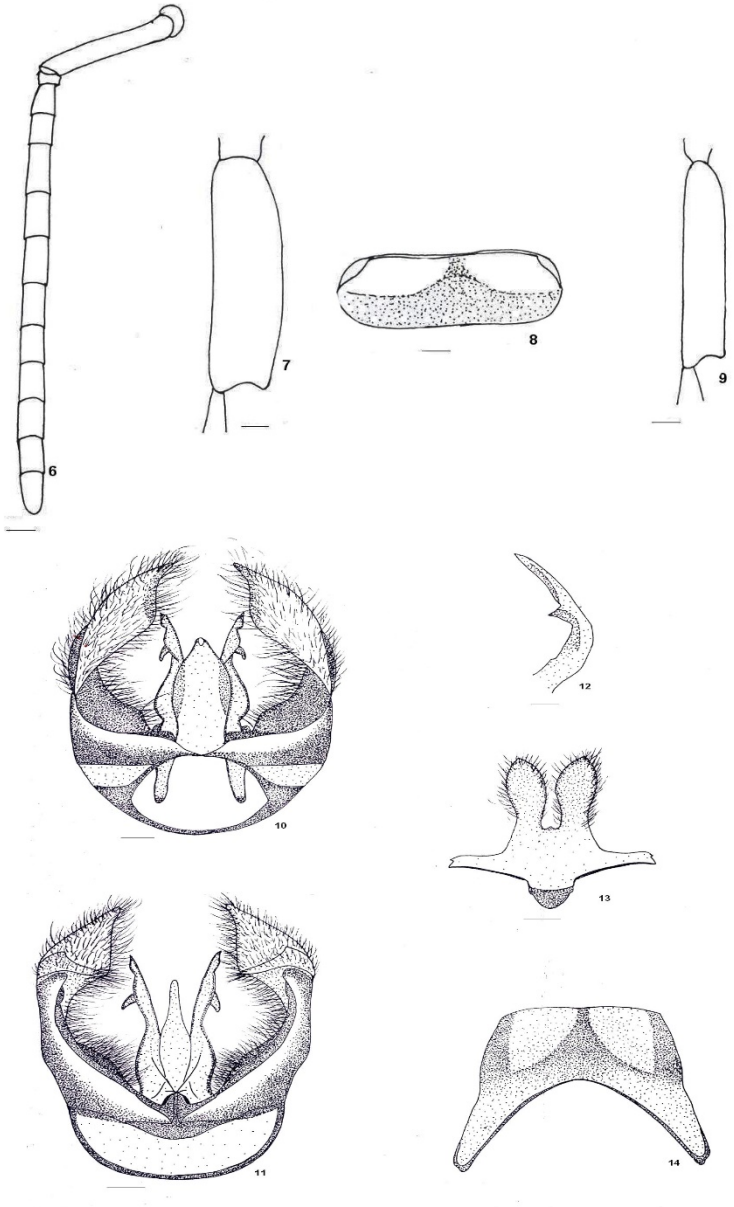


Fig 2. *B. ferganicus* (♂) – photograph, colour pattern and morphology. Legend: 6 – antenna, 7 – metabasitarsus, 8 – labrum, 9 – mesobasitarsus, Male genitalia: 10 – ventral aspect, 11 – dorsal aspect, 12 – penis valve, 13 – 8th sternite, 14 – 7th sternite. Scale bar = 0.5 mm.

Male: Head and mesonotum black, yellow are malar space, pronotum, metanotum and abdominal tergum 1; abdominal tergum 2 black with dirty yellow posterior corners; abdominal tergum 3-5 medially black with dirty yellow sides. Lateral tubercles raised, sloping inward, not meeting each other due to broad but shallow depression. Excepting a few large punctures close to top of tubercles, rest of the labrum with micropunctures. Anterior margin of labrum entire (Fig. 2-8). Area lateral to lateral ocellus in the ocello-ocular region unpunctured equal to the diameter of lateral ocellus. A band of punctures along eye margin covering half the area between lateral ocellus and eye margin. OOL: POL=2:3. The lateral ocelli are at the level of POC. Antennal segments 3:4:5=1:1.10:2.10; LF: LS: LHB=10:2.5:6.25 (Fig. 2-6). Head of penis valve nearly straight from dorsal aspect, not strongly curved but shaped like a slender arrow head from lateral apsect. Gonostylus broadly triangular with much long hair around interiobasal process. Inner corner of volsella well defined, strongly produced for some individuals without any inwardly directed hooks, nearly triangular in distal section, weakly sclerotised. Ventrobasal angle of penisvalve strongly and broadly produced ventrally and outwardly, so as to be clearly visible from dorsal aspect (Figs.2-10 to 2-14).

Material examined: Himachal Pradesh: Lahaul-Spiti, Gramphoo, 3800 m, 1 ♀, 2 ♂♂, 2.VIII.2003., 12.VIII.2013. Jammu and Kashmir: Bandipora, Achoora, 3300 m, 8 ♀♀ , 12 ♂♂, 28.VI.2009., 22.VI.2013.; Izmarg, 2500 m, 19 ♀♀, 20.VI.2007, 9.VII.2008, 25.VI.2012, 29.VII.2013, 14.VIII.2014 (Fig. 4); Baramulla: Affarwatt, 4000 m, 4 ♂♂, 21.VII.2009; Khilanmarg, 3300 m, 5 ♀♀, 9 ♂♂, 2.IX.2008, 3.VIII.2014.; Ganderbal: Baltal, 3350 m, 9 ♂♂, 11.VIII.2008, 23.VIII.2009, 13.VII.2012.; Kargil: Batalik, 3385 m, 2 ♀♀ (q), 7 ♂♂, 4.VIII.2008; Padam, 3650 m, 2 ♂♂, 31.VII.2008.; Leh: Hunder, 3600 m, 2 ♂♂, 5.VIII.2008. Budgam: Yousmarg, 2600 m; 16 ♀♀, 18♂♂, 21.V.2007, 22.VI.2008, 9.VIII.2014.

Distribution worldwide: India, Afghanistan, Pakistan and Kazakhstan, Kyrgyzstan and northwestern China (WILLIAMS, 2004).

Distribution within India: Kashmir, Himachal Pradesh, Uttarakhand and Sikkim (WILLIAMS, 1991; SAINI *et al.*, 2011).

Holotype depository: NHM, London.

Stratification: 2500-4000 m a.s.l.

Population variation: No variation.

Food plants: **Cirsium falconeri* (Hook.f.) Petrak, **C. wallichii* DC., *Cirsium* sp. (Fig. 3-2), **Echinops cornigerus* DC. (Asteraceae); **Brassica campestris* L. (Brassicaceae); *Dracocephalum heterophyllum* Benth. (Lamiaceae); **Trifolium pratense* L. (Fig. 3-1), *T. repens* L. (Papilionaceae); **Acantholimon lycopodioides* (Girard.) Bioss (Plumbaginaceae).

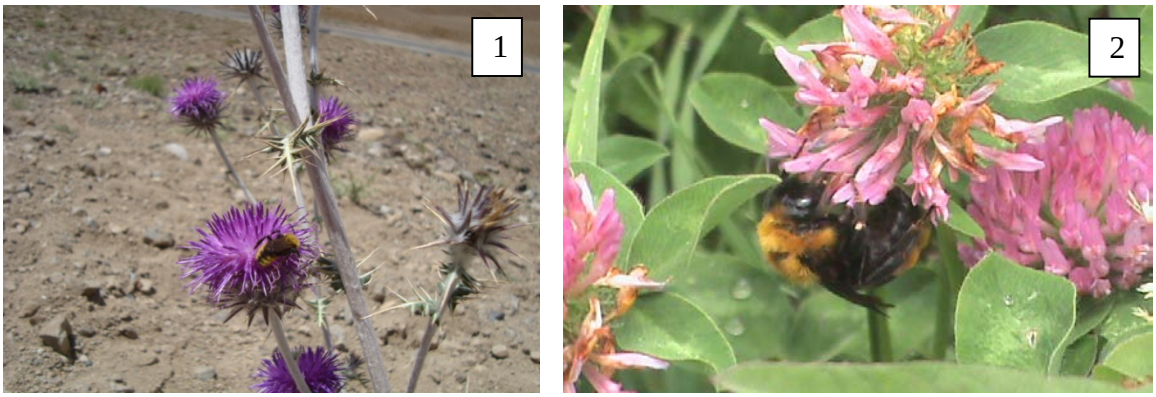


Fig. 3. 1 - *B. ferganicus* (♀) on *Trifolium pratense*. 2 - *B. ferganicus* (♂) on *Cirsium* sp.

Fig. 4. Collection locality (Izmarg), 2500 m.

***Bombus* (*Psithyrus*) *cornutus* FRISON, 1933**

Bombus Psithyrus cornutus FRISON, 1933: 338: Holotype female, India (ZSI); WILLIAMS, 1991: 45; YAO, 1995: 580; 1998: 404; YAO & LUO, 1997: 1694.

Synonymy: Psithyrus (*Psithyrus*) *pyramideus* MAA, 1948: 19; *Psithyrus acutisquameus* MAA, 1948: 21; *Psithyrus* (*Ceratopsithyrus*) *klapperichi* PITTIONI, 1949: 273; *Psithyrus* (*Eopsithyrus*) *cornutus* ssp. *canus* TKALCU, 1989: 42.

Diagnostic features

Female: Not recorded.

Male: Pubescence of head and abdominal tergum 4 black; lemon yellow are pronotum, metanotum, abdominal tergum 1 and 3; abdominal tergum 5 brick red; mesonotum lemon yellow with a median black patch; abdominal tergum 2 anteriorly black and posteriorly lemon yellow. Anterior margin of labrum weakly concave (Fig. 5-18). Tubercles meeting in centre at same level without any interruption. No median groove. Surface of tubercles covered with macropunctures. Rest of area with a mixture of macro and micropunctures. Area equal to the diameter of lateral ocellus situated in the ocello-ocular region, unpunctured. A broad band of punctures along eye margin covering two-third of the area between lateral ocellus and eye margin. OOL: POL=2:2.5. The lateral ocelli are just above the POC. Antennal segments 3:4:5=2:1.25:2.5; LF: LS: LHB=11.5:3.5:8 (Fig. 5-15); MS: BMB=2:1.75; MBB: LOB=2:9. Genitalia with the gonostylus and volsella moderately sclerotised, pale, and not thickened and the gonostylus densely hairy narrowing gradually from near its inner projection towards its outer margin, penis valve with the ventro-lateral angle strongly projecting and broad, forming almost a right angle distally, volsella near its midpoint marked only by a broad curve, not strongly produced inwards as an inner projection (Figs. 5-19 to 5-23).

Material examined: Himachal Pradesh: Kulu, Jalaori Pass, 3200 m, 8 ♂♂, 11.VIII.2004, 7.VIII.2013. Jammu and Kashmir: Leh, Hundur (Nobra valley), 3600 m, 1 ♂, 5.VIII.2008.

Distribution worldwide: India (Himalaya), Nepal, southwestern and central China. (WILLIAMS *et al.*, 2010).

Distribution within India: Himachal Pradesh, Uttarakhand and Kashmir (Ladakh) (WILLIAMS, 2004; SAINI *et al.*, 2011).

Holotype depository: ZSI, Kolkata.

Population variation: No variation.

Food plants: **Carduus nutans* L., **Cirsium falconeri* (Hook.f.) Petrak, **C. wallichii* DC., **Echinops cornigerus* DC., * *E. niveus* Wall., **Tanacetum* sp. (Asteraceae).

Stratification: 3600-4200 m a.s.l.

***Bombus* (*Psithyrus*) *novus* FRISON, 1933**

Bombus novus FRISON, 1933: 340, Holotype female, India: Kashmir, Nagaberan, (Bion) Kolkata (ZSI); BURGER *et al.*, 2009: 460.

Synonymy: *Psithyrus* (*Psithyrus*) *novus* subsp. *nepalensis* TKALCU, 1974: 318

Diagnostic features

Female: Pubescence of head, abdominal tergites 3-4 black; malar space white; yellow are pronotum, mesonotum, metanotum and abdominal tergites 1 and 2; abdominal tergum 5 with an anterior narrow black and posterior wide brick red bands. Outer surface of hind tibia convex, with moderate to long hair throughout, but without a comb of stout spines along inner distal margin; gastral sternum 6 with a pair of ventro-lateral keels, clypeus nearly uniformly flat, only apico-lateral corners curved back strongly towards occiput, crests of lateral keels of sternum 6, beyond projecting angle of mid-point, almost straight; sternum 2 with transverse ridge rounded and curved unevenly towards anterior margin in middle; labral furrow wide, about a third of total basal breadth of labrum, most of clypeus with scattered large punctures spaced more widely than their own widths, Mandible as illustrated (Fig. 6-27). Labrum with basal transverse depression extending apically as a deep median furrow between pronounced lateral tubercles, displacing ridge between them to form a lamella that overhangs apical margin; lateral furrow wide, about a third of total basal breadth of labrum (Fig. 6-28). MS: BMB=3:4. Antennal segments 3:4:5=1.50:1:1.25; LF: LS: LHB=8:4:10 (Fig. 6-24). The distoposterior corner of mesobasitarsus spinosely pointed (Fig. 6-25); and its length is longer than that of distoanterior corner. Metabasitarsus with its half of distoposterior margin concave (Fig. 6-25), outer surface of metatibia convex with moderate to long hair throughout but without a comb of stout spines along inner distal margin. Apex of tergite 7 having slightly raised boss, shallowly notched, with longitudinal median groove (Fig. 6-26).

Male: Pubescence black, white are: outer margin of pronotum, metanotum and abdominal tergite first and second, abdominal tergite third black whereas 4 to 5 are brick red. Anterior margin of labrum roundly, subtriangularly produced (Fig. 7-33); Lateral tubercles meeting in centre at same level, central area with some scattered punctures. Rest of the labrum with a mixture of macro and micropunctures. Area lateral to lateral ocellus in the ocello-ocular region unpunctured equal to the diameter of lateral ocellus. A broad band of punctures along eye margin covering two third of OOL; OOL: POL= 2:3. The lateral ocelli are just above the POC. Antennal segments 3:4:5= 1.25:1:1.35; LF:LS: LHB=16:5:12.5 (Fig. 7-31); MS:BMB=2:2.75; MBB:LOB=3:13. Gonostylus usually with many long hairs around interiobasal process. Distal section of volsella about as long as its maximum breadth from ventral aspect. Volsella weakly sclerotised yellowish in colour with a pronounced interiobasal process, associated with many long branched hairs. Ventrobasal angle of penisvalve strongly and broadly produced ventrally and outwardly so as to be clearly visible from dorsal aspect. Head of penisvalve, less than a quarter of total length, not strongly curved but shaped like a slender arrow head from lateral apsect. Head of penisvalve nearly straight from dorsal aspect. (Figs. 7-34 to 7-38).

Material examined: Jammu and Kashmir: Baramulla, Kongdori, 3000 m (Fig. 9); 1 ♀, 1 ♂, 10.VI.2007.; Razdan Pass, 3800 m; 16 ♂♂, 21.VIII.2011,06.IX.2011, 15.IX.2013, 4.IX.2014.

Distribution worldwide: India, Nepal and Pakistan (WILLIAMS *et al.*, 2010).

Distribution within India: Kashmir, Himachal Pradesh and Uttarakhand (WILLIAMS, 2004; SAINI *et al.*, 2011).

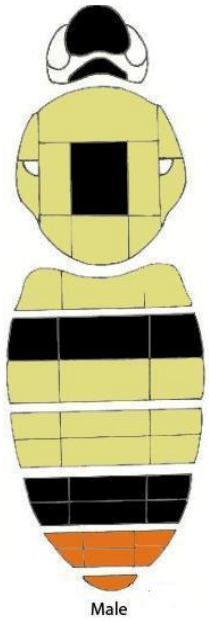
Holotype depository: ZSI, Kolkata.

Population variation: No variation.

Food plants: **Carduus edelbergii* (Fig. 8-1), *Circium* sp., **Saussurea lappa* C.B. Clarke, **Saussurea costus*, *Taraxacum officinale* (Asteraceae); *Swertia petiolata* D.Don (Gentianaceae); **Hyssopus officinalis* L., **Marrubium vulgare* (Lamiaceae); *Aconitum laeve* Royle, **Caltha alba* Camb., *Delphinium roylei* (Ranunculaceae) (Fig. 8-2); *Scrophularia*

pauciflora Benth. (Scrophulariaceae). *Stratification:* 2900-3900 m a.s.l.

B. cornutus (♂)



Colour pattern

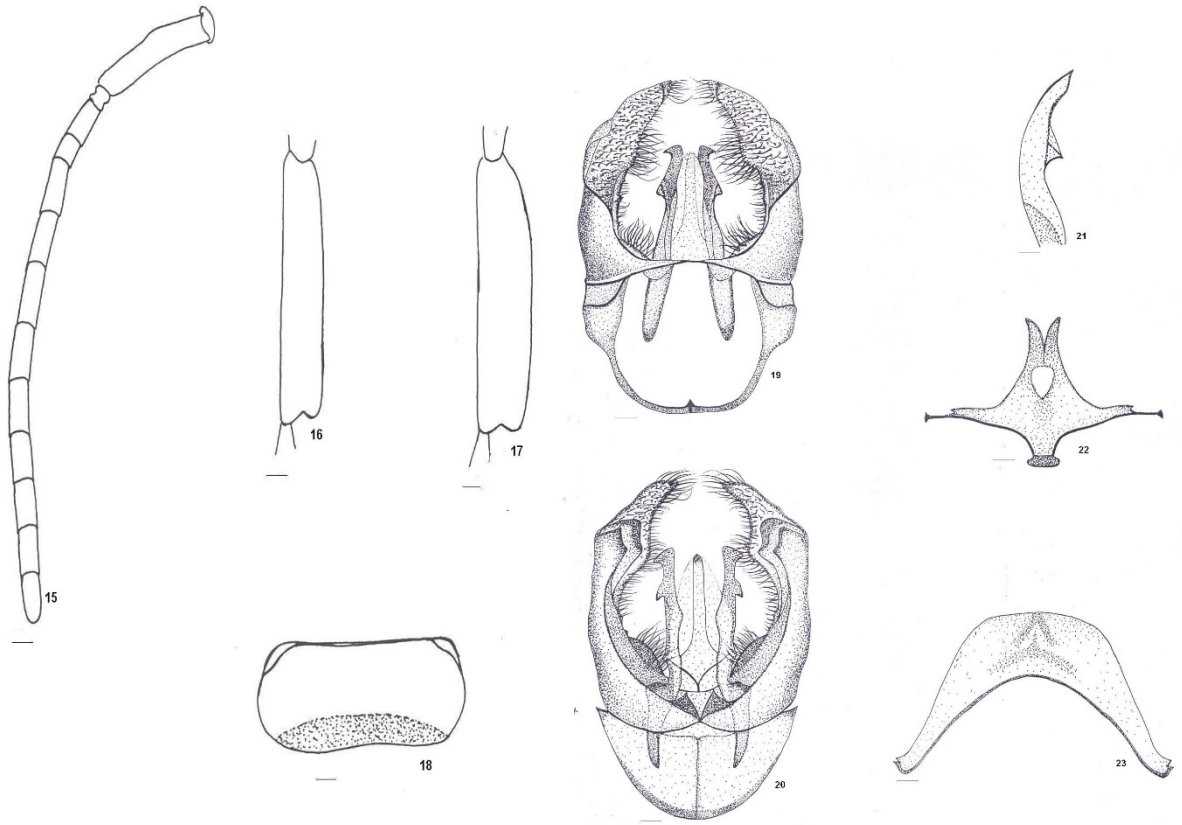
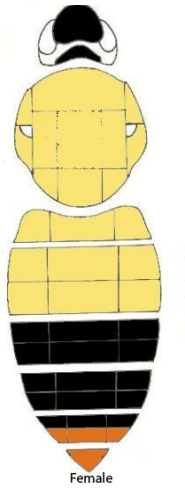


Fig. 5. *B. cornutus* (♂) – photograph, colour pattern and morphology. Legend: 15 – antenna, 16 – mesobasitarsus, 17 –metabasitarsus, 18 – labrum, Figs. 19-23. Male genitalia: 19 – ventral aspect, 20 – dorsal aspect, 21 – penis valve, 22 – 8th sternite, 23 – 7th sternite. Scale bar = 0.5 mm.

B. novus (♀)



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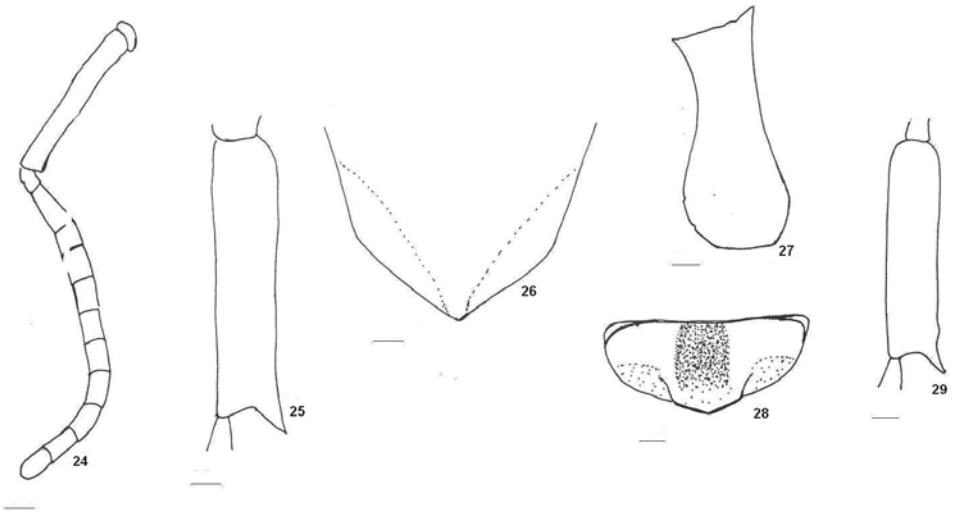
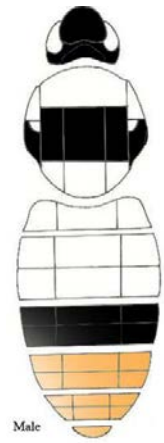


Fig 6. *B. novus* (♀) – photograph, colour pattern and morphology. Legend: 24 – antenna, 25 – metabasitarsus, 26 – 7th sternite, 27 – mandible, 28 – labrum, 29 – mesobasitarsus, Scale bar = 0.5 mm.

B. novus (♂)



Colour pattern

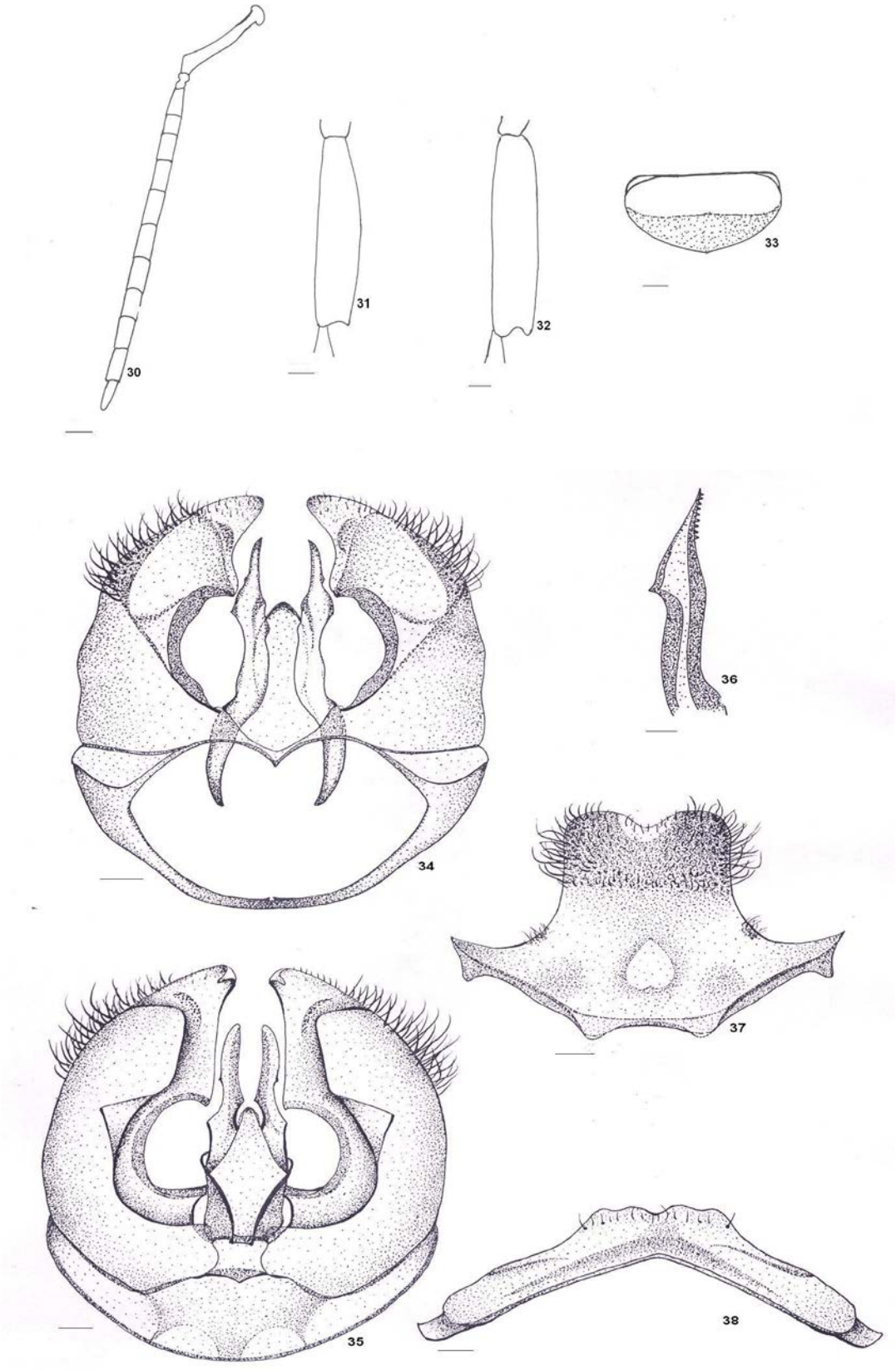


Fig 7. *B. novus* (♂) - photograph, colour pattern and morphology. Legend: 30 – antenna, 31 – mesobasitarsus, 32 –metabasitarsus, 33 – labrum, Figs. 34-38. Male genitalia: 34– ventral aspect, 35 – dorsal aspect, 36 – penis valve, 37 – 8th sternite, 38 – 7th sternite. Scale bar = 0.5 mm.

Fig. 8. 1 - *B. novus* (♀) on *Carduus edelbergii,* 2 - *B. novus* (♂) on *Delphinium roylei.*

Fig. 9. Collection locality - Kongdori, 3000 m.

***Bombus* (*Psithyrus*) *branickii* (RADOSZKOWSKI, 1893)**

Psithyrus branickii RADOSZKOWSKI, 1893: 241, Lectotype female, USSR, Kirgiziya (MNHU); TKALCU, 1969: 204; PESENKO, 2000: 8; WILLIAMS, 1991: 48.

Synonymy: Apathus chloronotus MORAWITZ, 1894: 6; *Psithyrus rupestris* var. *eriophoroides* REINIG, 1930: 110; *Psithyrus* (*Psithyrus*) *rupestris* subsp. *elisabethae* REINIG 1940: 231; *Psithyrus branichi* KIM & LTO, 1987.

Diagnostic features

Female: Pubescence of head and abdominal tergum 4 black; malar space and thorax yellow; abdominal tergum 5 brick red; abdominal tergites 2 and 3 black with yellow posterior corners; wings light brown. Mandible as illustrated (Fig. 10-43). Labrum with basal transverse depression extending apically as a deep median furrow between pronounced lateral tubercles, displacing ridge between them to form a lamella that overhangs apical margin (Fig. 10-41); labral furrow narrow, about fifth of total basal breadth of labrum; clypeus with many large punctures spaced more closely than their own widths, except in a well-defined narrowly unpunctured mid apical area; antennal segments 3:4:5=1.80:1:1.40; LF: LS: LHB=10:6:13 (Fig. 10-39). Outer surface of meta tibia convex with long hair throughout but without a comb of stout spines along inner distal margin. Crests of lateral keels of sternite 7, beyond projecting angle of mid-point, with a strongly concave margin (Fig. 10-42). Meta basitarsus with its posterior

margin nearly concave with a distoposterior corner spinosely produced and longer than distoanterior corner (Fig. 40). The distoposterior corner of mesobasitarsus spinosely produced. The length of this corner longer than the length of distoanterior corner (Fig. 10-44). Apex of tergite 7 slightly raised, with no boss and no median furrow.

Male: Pubescence of head, mesonotum and abdominal tergum 3 black; yellow are malar space, pronotum, metanotum, lateral aspects of mesonotum and abdominal tergites 1 and 2; abdominal tergites 4 and 5 are brick red. Anterior margin of labrum apically produced, lateral tubercles low lying meeting at centre at same level, entire area micropunctured (Fig. 48). Area lateral to lateral ocellus in the ocello-ocular area unpunctured equal to one and half times the diameter of lateral ocellus. A band of punctures along eye margin covering almost half of the area between lateral ocellus and eye margin. OOL: POL= 2:2.5. The lateral ocelli are above the POC. Antennal segments 3:4:5=1.5:1:1.75; LF: LS: LHB=9.5:3.25:7 (Fig. 45). Genitalia with the gonostylus and volsella weakly sclerotised and pale, the gonostylus densely hairy; penis valve with the ventro-lateral angle strongly projecting and distally narrowed so that it is almost spinose, volsella in the distal part extending inwards broadly towards the inner corner and almost twice as long as its maximum breadth from the ventral aspect (Figs. 49-53).

Material examined: Jammu and Kashmir: Kargil, Zanskar, 3600 m, 1 ♀, 1 ♂, 30.VII.2007.

Distribution worldwide: India, Afghanistan, Pakistan, Tibet, China, Kazakhstan, Kyrgyzstan, Mongolia, Russia and Tajikistan (WILLIAMS *et al.*, 2010).

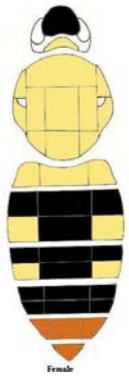
Distribution within India: Kashmir, Himachal Pradesh, Uttarakhand and Sikkim. (WILLIAMS, 2004; SAINI *et al.*, 2011).

Holotype depository: ZS, Munich.

Population Variation: No variation.

Food plants: Allium cepa (Amaryllidaceae); *Gypsophila cerastioides* (Caryophyllaceae); *Rhodiola crenulata* (Crassulaceae); **Hyssopus officinalis* L. (Lamiaceae); *Caragana versicolor* Wall., **Hedysarum* sp. (Papilionaceae); **Aconitum* sp. (Ranunculaceae).

B. branickii (♀)



Colour pattern

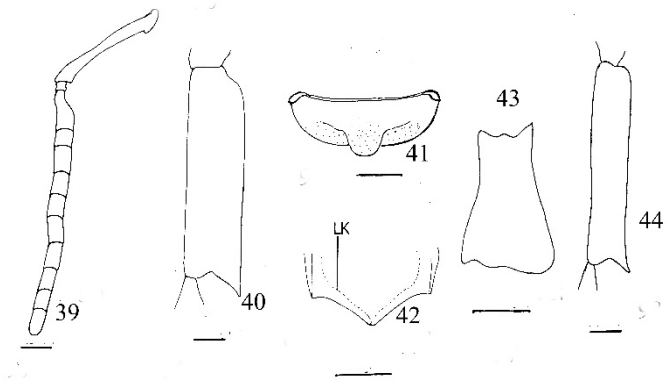
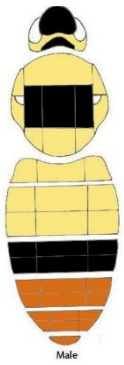


Fig. 10. *B. branickii* (♀) - photograph, colour pattern and morphology. Legend: 39 – antenna, 40 – metabasitarsus, 41 – labrum, 42 – 7th sternite, 43 – mandible, 44 – mesobasitarsus, Scale bar = 0.5 mm.

B. branickii (♂)



Colour pattern

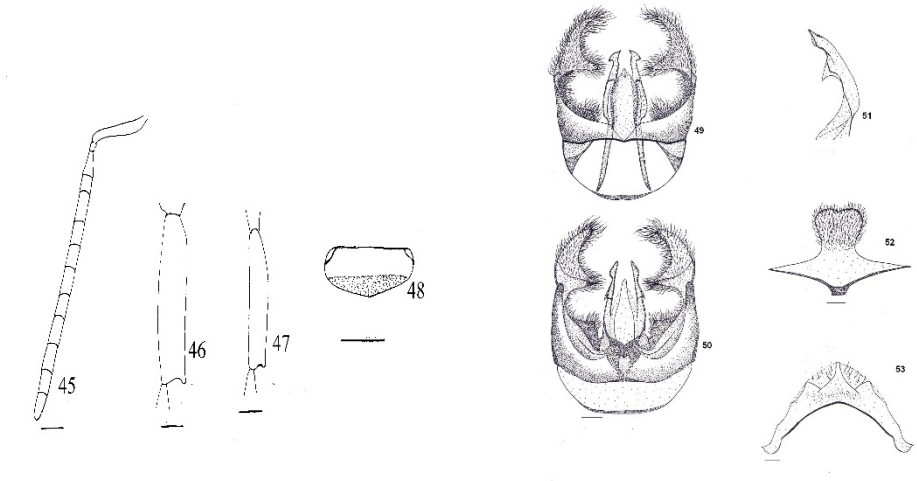


Fig. 11. *B. branickii* (♂) - photograph, colour pattern and morphology. Legend: 45 – antenna, 46 – metabasitarsus, 47–mesobasitarsus, 48 – labrum, Figs. 49-53. Male genitalia: 49– ventral aspect, 50 – dorsal aspect, 51– penis valve, 52 – 8th sternite, 53 – 7th sternite. Scale bar = 0.5 mm.

***Bombus* (*Psithyrus*) *skorikovi* POPOV, 1927**

Psithyrus skorikovi POPOV, 1927: 267, Holotype female, China: Gansu (ZI); (*Grum Grzhimailo*); WILLIAMS, 1991: 50, MACIOR & TANG, 1997: 3; BURGER *et al.*, 2009: 461.

Synonymy: Psithyrus skorikovi var. *mesoxanthus* RICHARDS, 1928: 360; *Psithyrus* (*Fernaldaepsithyrus*) *gansuensis* POPOV, 1931: 168, 202; *Psithyrus* (*Fernaldaepsithyrus*) *kuani* TKALCU, 1961: 362.

Diagnostic features

Female: Not recorded.

Male: Pubescence on head black; thorax, abdominal tergites 1 to 3 dark yellow; black are: last three abdominal tergites (Fig. 12). Genitalia with the gonostylus and volsella weakly sclerotised and pale, the gonostylus densely hairy; penis valve with the ventro-lateral angle strongly projecting and narrow, distally pointed; volsella in the distal half narrowed into an elongate finger.

Material examined: Razdan Pass, 3800 m (Fig. 14); 9 ♂♂, 06.IX.2011, 13.IX.2014 (very rare species).

Distribution worldwide: India, Pakistan, Nepal, China and Tibet (WILLIAMS *et al.*, 2010).

Distribution within India: Kashmir, Himachal Pradesh Uttarakhand and Sikkim (WILLIAMS, 2004; SAINI *et al.*, 2011).

Holotype depository: BMNH.

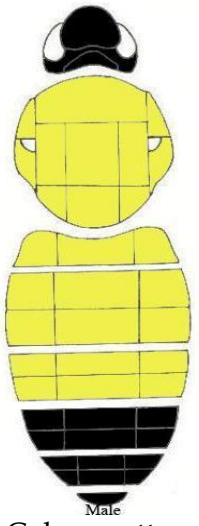
Population variation: No variation.

Food plants: *Aster* sp., *Cirsium* sp., **Saussurea costus* F. (Fig. 13-1), **Taraxacum officinale* (Asteraceae) (Fig. 13-2); **Swertia*

petiolata D.Don (Gentianaceae); *Prunella vulgaris* L. (Lamiaceae); **Trifolium pratense* L., **T. repens* L., (Papilionaceae); *Scrophularia pauciflora* Benth. (Scrophulariaceae).

Startification: 2700–4300 m a.s.l.

B. skorikovi (♂)



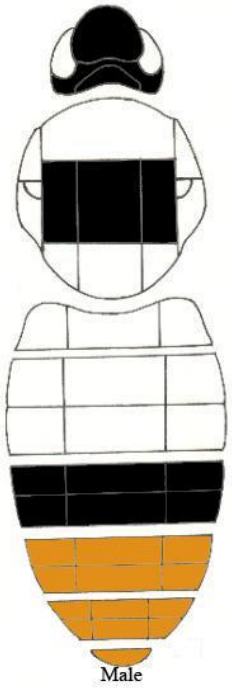
Colour pattern

Fig. 12. *B. skorikovi (♂)* – photograph and colour pattern.

Fig. 13. 1 - *B. skorikovi* (♂) on *Saussurea costus;* 2 - *B. skorikovi* (♂) on *Taraxacum officinale.*

Fig. 14. Collection locality: Razdan Pass, 3800 m.

B. turneri (♂)



Colour pattern

Fig. 15. *B. turneri* (♂) – photograph and colour pattern.

Bombus* (*Psithyrus*) *turneri RICHARDS, 1929

B. (*Psithyrus*) *turneri* RICHARDS, 1929:141, Holotype male BMNH India.; WILLIAMS, 1991:52; YAO & LUO, 1997: 1695.

Synonymy: Psithyrus monozonus FRIESE, 1931:304; *Psithyrus* (*Eopsithyrus*) *decoomani* MAA, 1948:26; *Psithyrus* (*Eopsithyrus*) *martensi* TKALCU, 1974:314.

Diagnostic features:

Female: not recorded

Male: (length 12–14 mm) with the hair of the thorax and tergum 3 black, sometimes with greyish bands on the anterior, posterior, and lateral aspects of the thorax, terga 1–2 white, 4–7 orange-red; genitalia with the gonostylus and volsella weakly sclerotised and pale, the gonostylus densely hairy, narrowing gradually from near its outer margin towards its inner projection; penis valve with the ventro-lateral angle strongly projecting and narrowed and pointed, like a shark's fin; volsella proximally with a large inwardly projecting swelling that is irregular but nearly rectangular, volsella near its mid-point marked only by a broad curve, not strongly produced inwards as an inner projection (Fig. 15).

Material examined: 1♂, procured on exchange basis from British Museum (Natural History), London, UK. The species was not found under the present study. Photograph of adult male supplied by Dr. Norton, Sr. Curator, British Museum (Natural History), London, UK.

Distribution worldwide: India, Himalaya, Nepal, Bhutan, eastern Tibetan plateau, Taiwan and south-western China (WILLIAMS *et al.*, 2010).

Distribution within India: Sikkim and Arunachal Pradesh (WILLIAMS, 2004).

Food plants (based on literature): Carduus sp., *Centaurea* sp., *Cirsium* sp. (Asteraceae); *Rosa* sp. (Rosaceae).

Stratification: 3300-3800 m a.s.l.

***Bombus* (*Psithyrus*) *morawitzianus* (POPOV, 1931)**

This description of this species has not been included in this paper as the same is published by the RAINA *et al.*, (2013) in Entomological News.

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