

TAXONOMY AND FOOD PLANTS OF SOME BUMBLE BEE SPECIES OF LAHAUL AND SPITI VALLEY OF HIMACHAL PRADESH

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ABSTRACT

A list of seven species of bumble bees, viz., *Bombus waltoni*, *B. keriensis*, *B. himalayanus*, *B. asiaticus*, *B. personatus*, *B. rufofasciatus* and *B. tunicatus* found in the Lahaul-Spiti valley of Himachal Pradesh is provided. Due emphasis has been laid on their detailed taxonomic descriptions, synonymy, host/food plants, distribution pattern and illustrations.

KEYWORDS

Bombus, bumble bee, Himachal Pradesh, Lahaul-Spiti, taxonomy

ABBREVIATIONS

AD - Apical depression; AS-III - IIIrd antennal segment; AS-IV - IV antennal segment; AS-V - V antennal segment; AU - Auricle; BD - Basal depression; BMB - Breadth of mandible at its base; BT - Basitarsus; CA - Corbicular area; DAC - Distoanterior corner; DP - Depression; DPC - Distoposterior corner; DPM - Distal posterior margin; GB - Gonobase; GC - Gonocoxite; GS - Gonostylus; LF - Length of flagellum; LHB - Length of head breadth; LK - Lateral keels; LM - Lamella; LOB - Length of basitarsus; LS - Length of scape; LT - Lateral tubercle; MBB - Breadth of metabasitarsus; MF - Median furrow; MS - Length of malar space; MT - Mandibular teeth; OOL - Ocello ocular length; OOL - Ocello ocular length; POC - Post ocular line; POL - Post ocellar length; PPC - Proximoposterior corner; PV - Penis valve; SP - Spatha; TB - Tibia; TR - Transverse ridge; VL - Volsella

Bumble bees (Hymenoptera: Bombidae) constitute a large assemblage of highly valuable category of anthophilous insects. They are important pollinators of a bewildering variety of cultivated as well as wild flowering plants in the high altitude regions of Himalaya thereby playing a major role in conserving a fabulous tapestry of plant diversity particularly confined to an inhospitable environment of alpine meadows and snow clad mountain tracts. Bumble bee fauna inventory of the region of Lahaul and Spiti, an isolated area of Himachal Pradesh was conducted in 2002-2004. Seven species were recorded along with their host plants. For the final list, systematics, distribution within and outside India and enlisting of various host plants (in addition to those recorded by the present authors), Williams (1991, 1998) was consulted. Works of Macior (1990) and Macior and Sood (1992) also gave indirect hints regarding the pollination ecology of some bumble bee species.

MATERIALS AND METHODS

Seven-hundred-and-twenty-five (725) adult Bumble bee specimens belonging to all the three casts, i.e., queen, drones and workers, constituted the material for the present studies. This material was collected mainly with the help of hand nets whereas, at some appropriate places Malaise's traps were also used. For the collection of this material different localities of Lahaul and Spiti areas along with some adjoining parts of Himachal Pradesh were repeatedly visited for three years (2002-2004) during the months of July, August and September. The material so collected was pinned, stretched and dried before storing in sterilized insect cabinets. Most of the species were identified with the help of available literature and for confirmation the material was sent to Dr. Williams at BMNH, London. The host

plants were collected, pressed, dried and after proper identification these were deposited in the nationally recognised herbarium of the Department of Botany, Punjabi University, Patiala. Line drawings of various taxonomically important morphological features, including female and male genitalia were drawn under the binocular microscope fitted with an ocular grid. Terminology used is the same as that of Williams (1991, 1998). Most of the host plant records and the distribution of various species within and outside India are after Williams (1991).

Bombus waltoni Cockerell, 1910

(Figs. 1-14) *B. waltoni* Cockerell, 1910: 239; Williams 1998: 100.; *B. mendax* subsp. *chinensis* Skorikov, 1910a: 330.

Material examined: 8 females, 1 male, 19.viii.2003, Kaza, Himachal Pradesh, 3500m, coll. M.S. Saini and H.S. Ghattor.

Distribution: Outside India: Tibet (Southwestern China). India: Himachal Pradesh: Kaza (3200m); Sikkim

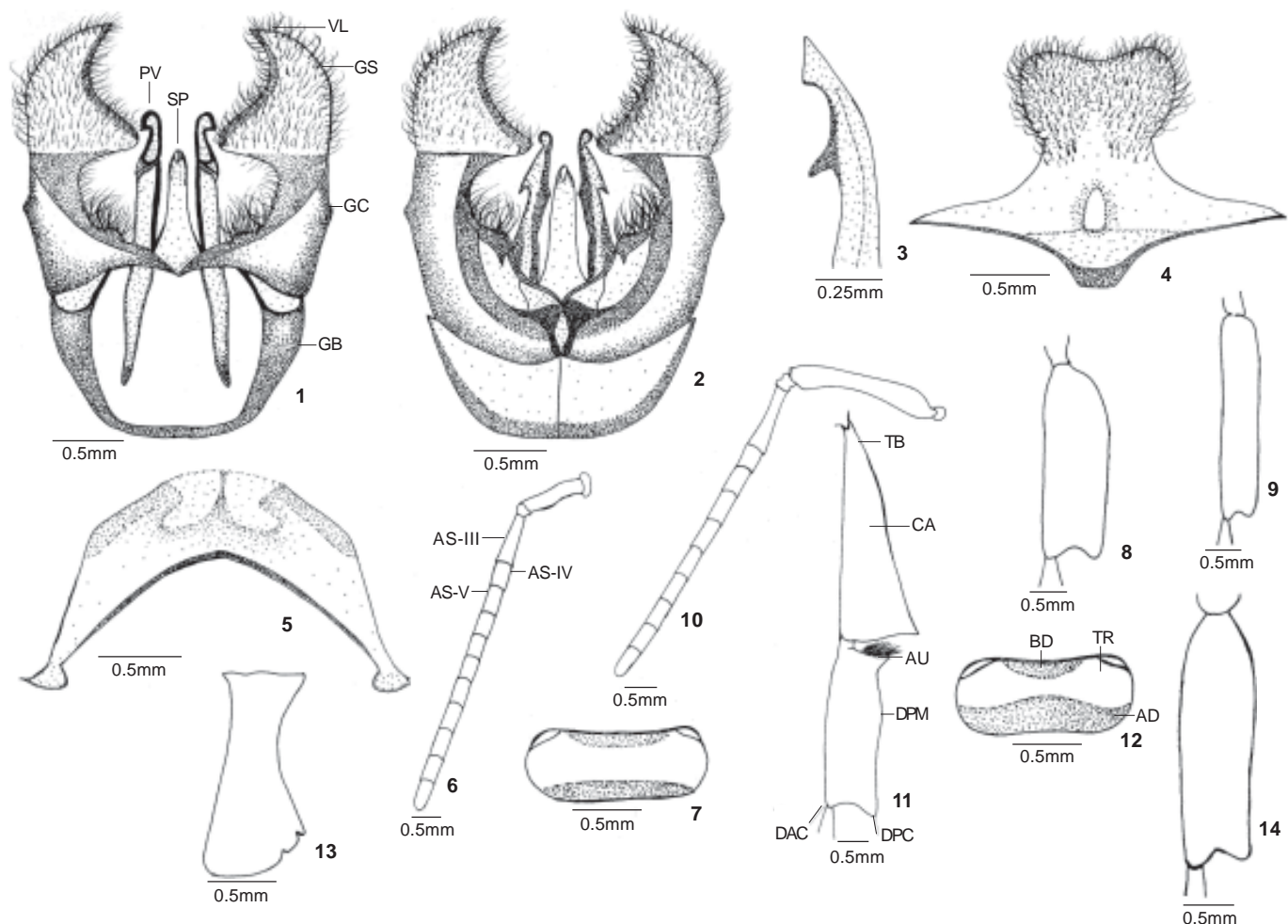
Host plants: *Taraxacum officinale* Wigg (Asteraceae); *Melilotus officinalis* (L.) Pall (Fabaceae).

Holotype depository: NH Museum, London.

Female: Pubescence black, orange red are: last 5 abdominal tergites. Head covered with thick pubescence except malar space, labrum, clypeus, an area lateral to and in front of ocelli and narrow stripes on inner and post orbits. Thorax and abdomen uniformly covered with thick pubescence except middle areas of all abdominal tergites where it is sparse. Wings uniformly infumated. Mandible as illustrated in Fig. 13. Labrum with bluntly raised tubercles, subsiding towards the middle to form a ridge. Ridge between labral tubercles is at its midpoint almost equal to basal depression with few punctures. Lamella absent (Fig. 12). Clypeus strongly protuberant with lateral and basal margin curved back to join gena and supraclypeal area respectively. MS: BMB - 4:3. Antennal segments 3:4:5 - 2.4:1:1.3; LF: LS: LHB - 13:6:13.75 (Fig. 10). Area lateral to lateral ocellus unpunctured for almost equal to diameter of ocellus. Band of micro punctures along eye margin in ocello-ocular area opposite lateral ocellus, occupying half of OOL. The lateral ocelli are below the POC. OOL:POL - 2:3.5. The distoposterior corner of mesobasitarsus bluntly rounded (Fig. 14). The length of distoposterior corner clearly shorter than the length of distoanterior one. Meta basitarsus with dense pubescence of proximal margin (auricle) continuing on to the outer surface of proximoposterior projection as just few sparse hairs, length of projection shorter than its breadth at its base; distal half of its posterior margin concave with a distoposterior corner bluntly pointed and longer than distoanterior corner (Fig. 11). Outer (corbicular) surface of meta tibia punctate, rough, with long stout hairs arising from outer surface below upper or proximal quarter. Apex of tergite VII rounded, subacute.

Male: Pubescence black, last 2 abdominal tergites whitish on

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Figures 1-14. *Bombus waltoni* Cockerell, 1910

1 - Male genitalia (ventral aspect); 2 - Male genitalia (dorsal aspect); 3 - Penisvalve (lateral aspect); 4 - 8th sternite (male); 5 - 7th sternite (male); 6 - Antenna (male); 7 - Labrum (male); 8 - Metabasitarsus (male); 9 - Mesobasitarsus (male); 10 - Antenna (female); 11 - Metabasitarsus (female); 12 - Labrum (female); 13 - Mandible (female); 14 - Mesobasitarsus (female)

margin. Anterior margin of labrum entire. Lateral tubercles meeting each other in the middle uninterruptedly at the same level (Fig. 7). Top of the tubercles sparsely punctured, polished, rest of the area densely punctured. Area anterior and lateral to lateral ocellus in the ocello-ocular region is unpunctured and equal to half of the diameter of lateral ocellus. A band of punctures along eye margin covering half of the OOL. OOL : POL = 75:2. The lateral ocelli are much below the POC, even more than the diameter of lateral ocellus. Antennal segments 3:4:5 - 3.5:1.5:2; LF:LS:LHB - 12:3:10 (Fig. 6); MS:BMB - 2:1.5; MBB: LOB - 5:13.5.

Male genitalia (Figs. 1-5): Penis valve dorsally almost straight, its tip directed outward. Dorsolaterally it is flattened with a prominent median tooth, almost in its middle. Volsella almost triangular in outline with its inner corner strongly produced inward. Entire body studded with setae. Gonostylus with its apical margin almost straight. The interioapical corner sharp and pointed. Inner basal angle produced into a rounded projection. Entire later margins of spatha almost free.

Remarks: *B. waltoni* was first recorded from Tibet and later on from Sikkim (India). It was considered to be confined to the north eastern part of himalayan belt only. However, in the present study, it has been recorded from Himachal Pradesh and stands as first report

from northwestern India. It has a very low population in the field and is limited to very high altitudes of Lahaul Spiti valley. It is of medium size and feeds mainly on small bushy flowers. There is a considerable sexual dichromatism. Due to its very distinct colour pattern *B. waltoni* can be easily identified in the field itself.

Bombus keriensis Morawitz, 1887

(Figs. 15-28) *Bombus keriensis* Morawitz, 1887: 199; William, 1991: 96, 1998: 134; *B. separandus* Vogt. 1909: 61; *B. kohli* Vogt, 1909: 61; *B. kazlovi* Skorikov, 1910b: 413; *B. lapidarius* var. *tenellus* Friese, 1913: 66; *B. keriensis* f. *richardsi* Reinig, 1935: 341; *B. tenellus* subsp. *tibetensis* Wang, 1982: 439; *B. trilineatus* Wang, 1982: 441.

Material examined: 20.viii.2003, 4300m, 30 females, 10 males, Chandertal, Himachal Pradesh, coll. H.S. Ghattor; Rohtangpass; 3980m, 12 females, 5.viii.2002, coll. H.S. Ghattor; Sarchu, 4200m, 11 females, 6.viii.2002, coll. H.S. Ghattor, M.S. Saini; Kaza, 3500m, 17 males, 19.viii.2003, coll. H.S. Ghattor; Losar, 3500m, 20 males, 17.viii.2003, M.S. Saini; Ataragu (Pin Valley), 3600m, 22 males, 19.viii.2003, coll. H.S. Ghattor.

Population variation: White of pro and metanotum and 1st abdominal tergite may be replaced by bright to dull yellow.

Distribution: Outside India: Afghanistan, Pakistan, Nepal, Bhutan, Tibet Western and Southwestern China, Iran, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkey. India: Arunachal Pradesh; Himachal Pradesh: Chandertal, Sarchu, Rohtang Pass, Baralacha Pass, Losar, Kaza, Pin Valley; Kashmir; Sikkim; Uttaranchal

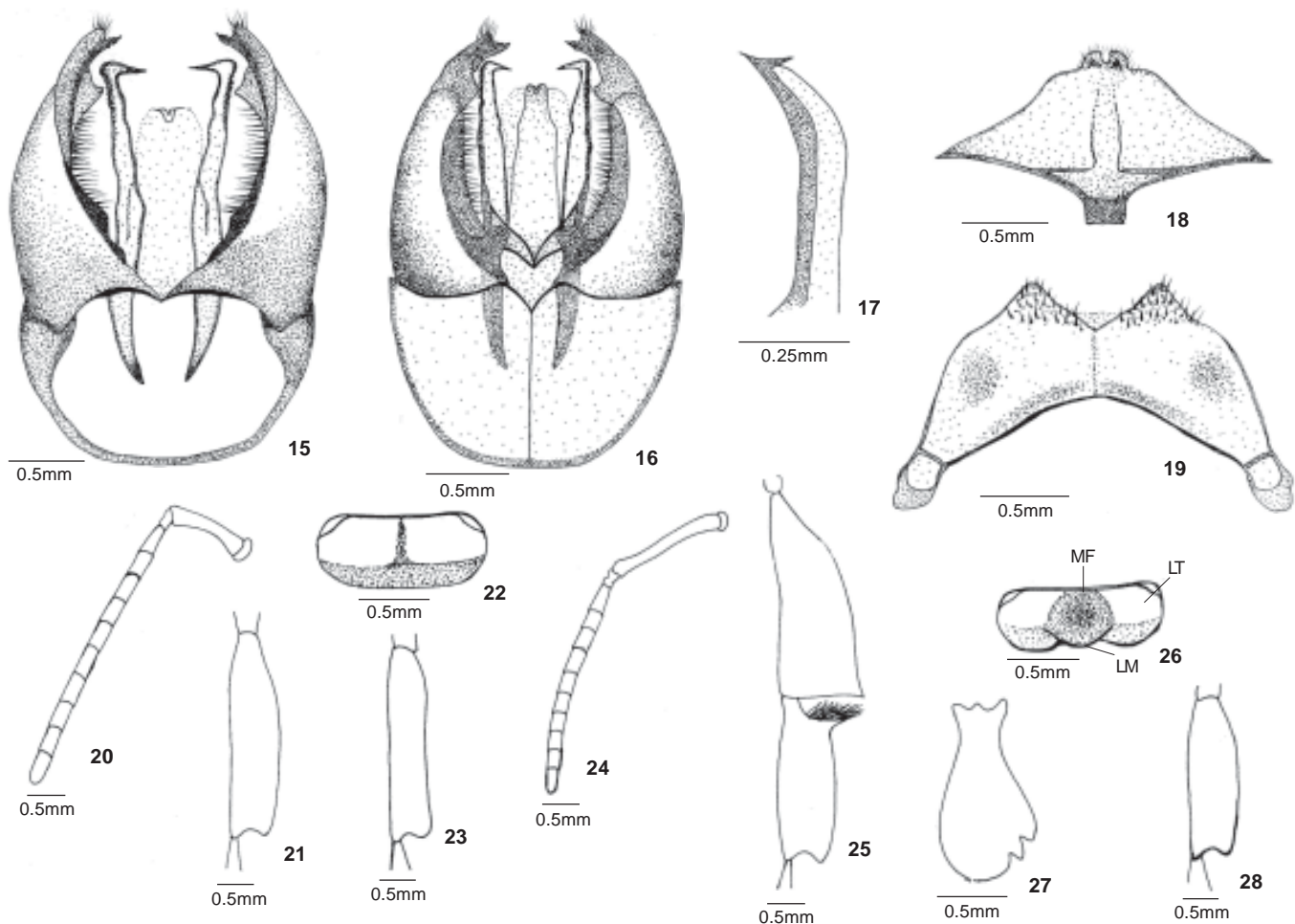
Host plants: *Aconitum hookeri* Stapf. (Ranunculaceae); *Impatiens glandulifera* Royle (Balsaminaceae); *Cirsium falconeri* (Hook. f.) Petrak (Asteraceae); *Swertia petiolata* D. Don. (Gentianaceae); *Picrorhiza kurroa* Royle ex. Benth (Scrophulariaceae); *Caragana versicolor* (Wallich) Benth (Fabaceae); *Stachys tibetica* Vatke (Lamiaceae); *Pedicularis pectinata* Wall. (Scrophulariaceae); *Thymus serpyllum* Linn. (Lamiaceae).

Holotype depository: ITZ, Amsterdam.

Female: Pubescence black, creamish yellow are: clypeus, pro & metanotum and 2nd & 3rd abdominal tergites. Last 3 abdominal tergites are brick red. 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. Thorax and abdomen uniformly covered with thick pubescence. Mandible as illustrated in fig. 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

(Fig. 26). Clypeus strongly protuberant, with lateral and basal margins curved back to join gena and supraclypeal area respectively. MS:BMB - 2:2.40. Antennal segments 3:4:5 - 1.60:1:1.20; LF:LS:LHB - 13.5:7:14 (Fig. 24). Area lateral to lateral ocellus unpunctured for more than the diameter of an ocellus. Band of punctures along eye margin in ocellocular area opposite lateral ocellus is occupying one third of distance between lateral ocellus and eye. The lateral ocelli are slightly below the POC. OOL:POL - 2:3. The distoposterior corner of mesobasitarsus rounded (Fig. 28). The length of distoposterior corner smaller than the length of distoanterior corner. Metabasitarsus with dense pubescence of proximal margin (auricle) continuing on to the outer surface of proximoposterior projection as just few sparse hairs; length of projection longer than breadth at its base; distal half of its posterior margin convex with a distoposterior corner bluntly rounded and longer than distoanterior corner (Fig. 25). Outer (corbicular) surface of meta tibia smooth, shining; without any long stout hairs arising from outer surface below upper or proximal quarter. Apex of tergite VII broadly but shallowly notched, weakly sculptured, with median ridge and moderately raised boss.

Male: Pubescence lemon yellow, mesonotum and first three abdominal tergites are black. Last four segments are brick red. Anterior



Figures 15-28. *Bombus keriensis* Morawitz, 1887

15 - Male genitalia (ventral aspect); 16 - Male genitalia (dorsal aspect); 17 - Penis valve (lateral aspect); 18 - 8th sternite (male); 19 - 7th sternite (male); 20 - Antenna (male); 21 - Metabasitarsus (male); 22 - Labrum (male); 23 - Mesobasitarsus (male); 24 - Antenna (female); 25 - Metabasitarsus (female); 26 - Labrum (female); 27 - Mandible (female); 28 - Mesobasitarsus (female)

margin of labrum entire (Fig. 22). Lateral tubercles not meeting in centre due to a median longitudinal groove and a depression. Top of tubercles unpunctured, rest of area punctured with a mixture of micro and macro punctures. Area lateral to lateral ocellus in the oculo-ocular area unpunctured equal to the diameter of lateral ocellus. A broad band of punctures along eye margin covering two third of the area between lateral ocellus and eye margin. OOL:POL-2:3. The lateral ocelli are at the level of POC. Antennal segments 3:4:5-1:1:1.10; LF:LS:LHB-10:3.5:8 (Fig. 20); MS:BMB-1:1; MBB: LOB-2:8.5.

Male genitalia: (Figs. 15-19) Free recurved hook of penisvalve head about two thirds as long as more apical part of penisvalve head, penisvalve shaft narrower at its mid point from lateral aspect than spatha at its midpoint from dorsal aspect. Gonostylus with its apical margin broadly convex. It is shorter than its greatest breadth excluding interobasal process, which is reduced to a small rounded projection or a right angled corner. Volsella extending beyond gonostylus by about its own breadth at the point where it emerges from beneath gonostylus from dorsal aspect. Seventh and 8th sternites are as in Figs. 18 & 19.

Remarks: *B. keriensis* is widely distributed in the Oriental region. In India, it extends from N.W. to North-eastern Himalayas. In north-western himalayas, it is a very common species of Ladakh valley and is confined to high altitude cold, dry and arid conditions. It is generally found foraging on the flowers of small bushes. On account of its large population size, it seems to be a dominant species of this region. Its worker's size is very small whereas queens are comparatively large and brightly coloured. On account of almost similar ecological conditions, it is also a very common species in Lahaul and Spiti valley. During the present survey, its colony was found near Chandertal Lake from where a queen and several workers were collected.

***Bombus himalayanus* (Skorikov, 1914)**

(Figs. 29-42) *Mendacibombus mendax* subsp. *himalayanus* Skorikov, 1914: 127; Williams 1991: 41, 1998: 99; *Mendacibombus varius* Skorikov, 1914: 125.

Material examined: 20.viii.2003, 3800m, 3 females, 1 male, Gramphoo, Himachal Pradesh, coll. H.S. Ghattor; Losar, 3500m, 6 females, 17.viii.2003, coll. H.S. Ghattor; Chandertal, 4300m, 4 females, 16.viii.2003, coll. H.S. Ghattor; Baralacha Pass, 4500m, 12 females, 6.viii.2002, M.S. Saini.

Distribution: Outside India: Pakistan (Williams, 1998). India: Himachal Pradesh: Gramphoo, Chandertal, Losar, Baralacha Pass; Kashmir.

Host plants: *Cirsium falconeri* (Hook. f.) Petrak (Asteraceae); *Swertia petiolata* D. Don. (Gentianaceae); *Picrorhiza kurroa* Royle ex Benth (Scrophulariaceae); *Thymus linearis* Benth ex Benth (Lamiaceae); *Caragana versicolor* (Wallich) Benth (Fabaceae); *Gypsophila cerastoides* D. Don (Caryophyllaceae); *Thymus serpyllum* Linn. (Lamiaceae).

Holotype depository: ZI, U.S.S.R.

Female: Pubescence black, pro and metanotum & 4th abdominal tergite are white; 2nd and 3rd abdominal tergites light yellow with admixture of white where as last three are orange red. 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. Thorax and abdomen uniformly covered with thick pubescence. Mandible as illustrated in fig. 40. Labrum with a narrow transverse basal depression leaving a ridge between tubercles, no lamella, no median furrow. Ridge between lateral tubercles subsiding towards middle, where there are many punctures (Fig. 41). Clypeus strongly

protuberant, with lateral and basal margin curved back to join gena and supraclypeal area respectively. MS:BMB-3:4. Antennal segments 3:4:5-2.15:0.75:1; LF:LS:LHB-12:6:13 (Fig. 38). Area lateral to lateral ocellus unpunctured for nearly equal to the diameter of ocellus. Band of punctures along eye margin in oculo-ocular area opposite lateral ocellus, occupying less than half of distance between lateral ocellus and eye. The lateral ocelli are below the POC. OOL:POL-2:3.5. The distoposterior corner of mesobasitarsus roundly pointed, never produced as a spine (Fig. 42). The length of distoposterior corner shorter than the length of distoanterior one. Meta basitarsus with dense pubescence of proximal margin (auricle) continuing onto outer surface of proximo posterior projection as just a few sparse hairs, length of projection shorter than its breadth at its base; distal half of its posterior margin nearly straight with a distoposterior corner roundly pointed (Fig. 39). Outer (corbicular) surface of meta tibia coarsely sculptured (imbricate) appearing rough, with widely spaced long stout hairs or bristles arising from near middle of outer surface throughout upper or proximal half. Apex of tergite VII rounded, subacute with a boss.

Male: Pubescence black, clypeus, pro and metanotum and 2nd abdominal tergite are white; 3rd abdominal tergites intermixed with yellow, rest of tergites rusty red.

Anterior margin of labrum (Fig. 35) narrowly but deeply notched, lateral tubercles raised, not meeting in the centre and are separated from one another by about three times the diameter of each tubercle. Excepting the convexity of tubercle, rest of the area macropunctured with micropunctures in between. Area lateral to lateral ocellus in the oculo-ocular area, unpunctured equal to half the diameter of lateral ocellus. A band of punctures present along eye margin covering one third the area between lateral ocellus and eye margin. OOL : POL- .5:2. The lateral ocelli are much below POC almost equal to one and a half times the diameter of lateral ocellus. The ratio of antennal segments 3:4:5-2:1:1.2; LF:LS:LHB-11.5:3:10 (Fig. 34); MS:BMB-2:1.5; MBB :LOB-3:7.

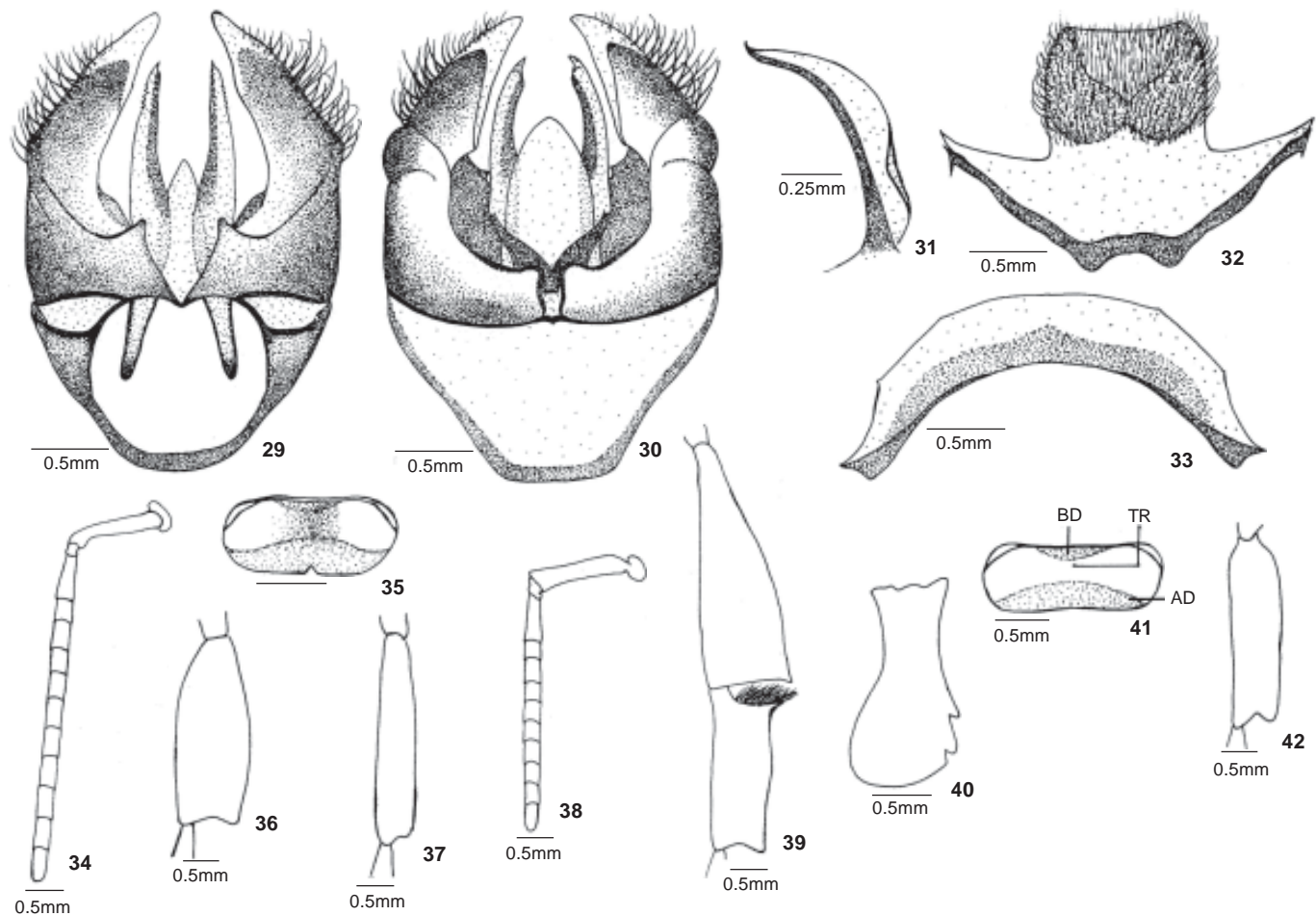
Male genitalia (Figs. 29-33): Volsella strongly sclerotised, dark brown in colour, inner corner located near midpoint of its length without any inwardly directed hooks, nearly triangular in distal section. Gonostylus from outer dorsolateral aspect with a distinct, though broadly rounded, exterior apical corner. Gonostylus stout and not strongly flattened, without hairs. Penisvalve nearly tubular. Head of penisvalve, ventrally curved and sabre shaped from lateral aspect (Fig. 31). 7th & 8th sternites are as in Figs. 33 & 32.

Remarks: *B. himalayanus* is confined to Pakistan Himalaya in the Oriental region. In Indian region, it is only restricted to north western Himalayan hills. It is very common in higher altitude arid regions of Ladakh valley and was found foraging on flowers of small bushes at the base of barren slopes of mountains. Its population in the field is normal and it is a medium size species. On the basis of colour pattern it is very close to *B. avinoviellus*.

***Bombus asiaticus* Morawitz, 1875**

(Figs. 43-56) *Bombus hortorum* var. *asiaticus* Morawitz in Fedtschenko, 1875: 4; Williams 1991: 87, 1998: 135; *B. regeli* Morawitz, 1880: 337; *B. regeli* [subsp.] *miniataudatus* Vogt, 1911: 61; *B. heicens* Wang, 1982: 430; *B. huangcens* Wang, 1982: 430; *B. flavicollis* Wang, 1985: 163; *B. baichengensis* Wang, 1985: 164.

Material examined: 9.viii.2002, 7.viii.2002, 4200m, 20 males, Sarchu, Himachal Pradesh, coll. M.S. Saini; Nokila pass, 4800m, 12



Figures 29-42. *Bombus himalayanus* Skorikov, 1914

29 - Male genitalia (ventral aspect); 30 - Male genitalia (dorsal aspect); 31 - Penisvalve (lateral aspect); 32 - 8th sternite (male); 33 - 7th sternite (male); 34 - Antenna (male); 35 - Labrum (male); 36 - Metabasitarsus (male); 37 - Mesobasitarsus (male); 38 - Antenna (female); 39 - Metabasitarsus (female); 40 - Mandible (female); 41 - Labrum (female); 42 - Mesobasitarsus (female)

females, 14 males, 7.viii.2002, coll. M.S. Saini; Gramphoo, 3800m, 12 females, 9 males, 20.viii.2003, coll. H.S. Ghattor; Chandertal, 4300m, 27 females, 13 males, 17.viii.2003, coll. H.S. Ghattor; Kaza, 3500m, 10 males, 19.viii.2003, coll. M.S. Saini. 8.viii.2002, 3500m, 3 females, 12 males, Upshi, Jammu & Kashmir; coll. H.S. Ghattor; Srinagar 1200m, 11 females, 18.vii.2003, coll. M.S. Saini.

Population variation: Yellow of mesonotum may be replaced by a black band between wing bases, black of first 2 abdominal tergite may be replaced by yellow.

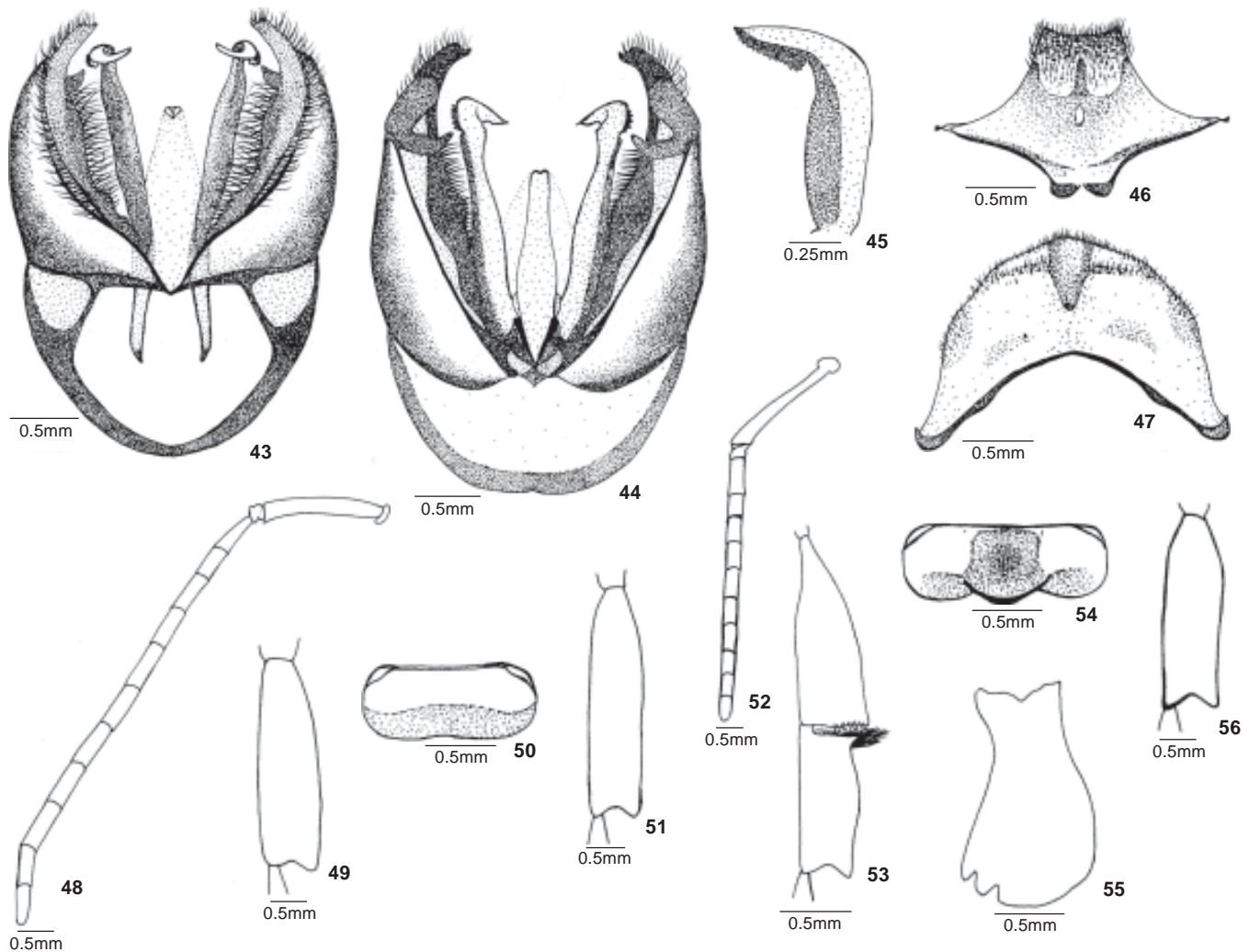
Distribution: Outside India: Afghanistan, Pakistan, Nepal, Tibet (Western and Southwestern China), Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan (Williams, 1998). India: Kashmir: Ladakh region-Nokila Pass, Lachungla Pass, Tanglangla Pass, Gulmarg, Khilenmarg; Himachal Pradesh; Sikkim; Uttaranchal

Host plants: *Impatiens glandulifera* Royle (Balsaminaceae); *Trifolium repens* L. (Fabaceae); *Cirsium faldoneri* (Hook.f.) Petrok (Asteraceae); *C. wallichii* DC (Asteraceae); *Digitalis lanata* Ehrh (Scrophulariaceae); *Mentha longifolia* Huds. (Lamiaceae); *Hyocymus niger* Linn. (Solanaceae).

Holotype depository: ZMMU, U.S.S.R.

Female: Pubescence black; thorax, and first 2 abdominal tergites are dirty yellow; last 3 tergites are brick red. Head covered with thick pubescence except malar space, most of the clypeus, an area lateral to

and in front of ocelli and narrow stripes on inner and post orbits. Visible parts of thorax and abdomen uniformly covered with thick pubescence. Wings clear, transparent. Mandible as illustrated (Fig. 55). 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. 54). Clypeus strongly protuberant, with lateral and basal margin curved back to join gena and supraclypeal area respectively. MS: BMB-3:2.25, ocello-malar area with many widely spaced moderate to large punctures. Antennal segments 3:4:5-1.90:1:1.15; LF:LS:LHB-11.25:6:13 (Fig. 52). Area lateral to lateral ocellus unpunctured equal to the diameter of ocellus. Band of punctures along eye margin in ocello-ocular area occupying half of OOL. The lateral ocelli are much below the POC. OOL: POL-2:2.5. The distoposterior corner of mesobasitarsus bluntly pointed (Fig. 56). Length of distoposterior corner equal to the length of distoanterior corner. Metabasitarsus with dense pubescence on proximal margin (auricle) continuing on to the outer surface of proximoposterior projection as dense long brush; length of projection longer than its breadth at the base (Fig. 53); distal half of its posterior margin concave with a distoposterior corner bluntly pointed and longer than distoanterior corner. Outer (corbicular) surface of meta tibia smooth, shining, without any long stout hairs arising



Figures 43-56. *Bombus asiaticus* Morawitz, 1875

43 - Male genitalia (ventral aspect); 44 - Male genitalia (dorsal aspect); 45 - Penisvalve (lateral aspect); 46 - 8th sternite (male); 47 - 7th sternite (male); 48 - Antenna (male); 49 - Metabasitarsus (male); 50 - Labrum (male); 51 - Mesobasitarsus (male); 52 - Antenna (female); 53 - Metabasitarsus (female); 54 - Labrum (female); 55 - Mandible (female); 56 - Mesobasitarsus (female)

from outer surface below upper or proximal quarter. Apex of tergite VII truncate, coarsely sculptured but without a median groove.

Male: Pubescence black; dirty yellow is thorax. Last four abdominal tergites orange red.

Anterior margin of labrum slightly concave, tubercles meeting in the centre without any groove and excepting top of tubercles rest of area is covered with macropunctures (Fig. 50). Area lateral to lateral ocellus in the ocello-ocular area unpunctured equal to half the diameter of lateral ocellus. A band of punctures along eye margin is covering half of OOL. OOL: POL-1:2.5. The lateral ocelli are much below the POC almost equal to 2 times the diameter of lateral ocellus. Antennal segments 3:4:5-2:1.30:2; LF:LS:LHB-11.25:3:7.5 (Fig. 48); MS:BMB-2:2.5; MBB: LOB-3:10.

Male genitalia (Figs. 43-47): Gonostylus just longer than its greatest breadth excluding interior basal process, which is pronounced as a broad shelf and broadening apically. Volsella strongly sclerotised, narrowed apically with its interior apical process narrow and elongate but exterior apical corner scarcely acute; penisvalve turned inwards. Shaft of penis valve more than three quarters as broad from lateral

aspect as greatest breadth of gonostylus excluding its interior basal process. Spatha beyond basal fusion with penisvalves more than three times longer than its breadth midway along this length, sides nearly parallel in proximal half.

Remarks: *B. asiaticus* is widely distributed in Oriental as well as in the Indian region. It is found in abundance in the Ladakh region falling in the states of Jammu & Kashmir and in different parts of Himachal Pradesh. It has a lot of population variation. It was found foraging on the flowers of small bushes growing on the slopes of mountains. The size of its workers may vary from small, medium up to large.

***Bombus personatus* Smith, 1879**

(Figs. 57-61) *Bombus personatus* Smith, 1879 : 132; Bingham 1897, Williams 1991 : 64, 1998 : 121; *B. rohorozskyi* Morawitz, 1887 : 197.

Material examined: 7.viii.2002, 5000m, 12 females, Lachungla Pass, Himachal Pradesh, coll. H.S. Ghattor; 7.viii.2002, 4800m, 4 females, Nokila pass, coll. H.S. Ghattor; 19.viii.2003, 3500m, 8 females, Losar, coll. M.S. Saini.

Distribution: Outside India: Nepal, Tibet (Southwestern China) (Williams, 1998).

India: Himachal Pradesh: Lachungla Pass, Nokila Pass, Losar; Kashmir; Sikkim; Uttaranchal;

Host plants: *Caragana versicolor* (Wallich) Benth (Fabaceae); *Stachys tibetica* Vatke (Lamiaceae); *Cyanthus lohatus* Wall. (Campanulaceae); *Gypsophila cerastioides* D. Don. (Caryophyllaceae).

Holotype depository: NH Museum, London.

Female: Pubescence black, pro and metanotum and first two abdominal tergites are dirty yellow. 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. Visible parts of thorax and abdomen uniformly covered with thick pubescence. Wings infumated towards tips. Mandible as illustrated (Fig. 61). 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. 59). Clypeus strongly protuberant, with lateral and basal margin curved back to join gena and supraclypeal area respectively. Central area of clypeus with many fine punctures, often separated by a distance of about twice their own diameter. MS:BMB-4:2.50. Antennal segments 3:4:5-2.10:1:1.40; LF: LS:LHB-14:7.5:15 (Fig. 57). Area anterior and lateral to lateral ocellus unpunctured almost equal to the diameter of ocellus. Band of punctures along eye margin in ocello-ocular area opposite lateral ocellus, occupying more than half of OOL. The lateral ocelli are on the level of POC. OOL:POL-2:3. The distoposterior corner of mesobasitarsus spinosely pointed. The length of distoposterior corner is equal to the length of distoanterior corner (Fig. 60). Meta basitarsus with dense pubescence of proximal margin (auricle) continuing on to the outer surface of proximoposterior projection as just few sparse hairs, length of projection longer than the breadth at its base; distal half of its posterior margin convex with a distoposterior corner spinosely pointed and almost equal to distoanterior corner (Fig. 58). Outer (corbicular) surface of meta tibia smooth, shining, without any long stout hairs arising from outer surface below upper or proximal quarter. Apex of tergite VII rounded, subacute, with a boss; area sculptured, median furrow present.

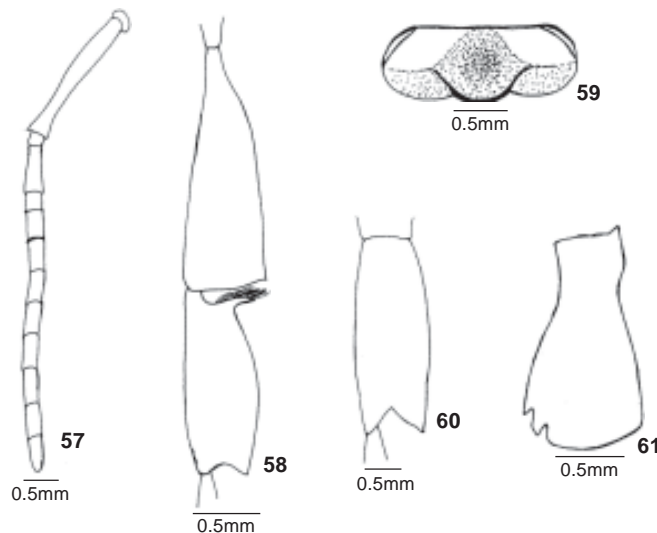
Male: Not recorded.

Remarks: *B. personatus* is a high altitude species and mostly found in Tibet and Nepal in the Oriental region. In India, it is mainly found in the north western Himalaya. In the present study, it was found from very higher altitudes in Ladakh valley. It is medium in size and resembles *B. melanurus* in colour pattern. Its population density in the field is high and found foraging on small flowers of bushes growing on arid mountain slopes.

***Bombus rufofasciatus* Smith, 1852**

(Figs. 62-75) *Bombus rufofasciatus* Smith, 1852: 48; Bingham, 1897: 547; Williams, 1991: 105, 1993: 127, 1998: 133; *B. prshewalskyi* Morawitz, 1880: 342; *B. rufocinctus* Morawitz, 1880: 343; Cresson, 1864: 106; *B. chinensis* Dalla Torre, 1890: 139; *B. waterstoni* Richards, 1934: 88.

Material examined: Himachal Pradesh: 5.viii.2002, 15.viii.2003, 3200m, 10 females, Koksar; 5.viii.2002, 20.viii.2003, 10.ix.2004, 3000m, 21 females, 19 males, Gulaba; 4.viii.2002, 2500m, 1 female, Kothi; 6.viii.2002, 3100m, 9 females, Sissu; 6.viii.2002, 10.viii.2002, 20.viii.2003, 3500m, 43 females, Marhi; 15.viii.2003, 4000m, 13 females, Chotta dara; 15.viii.2003, 4000m, 8 females, Chattru;



Figures 57-61. *Bombus personatus* Smith, 1879
57 - Antenna (female); 58 - Metabasitarsus (female);
59 - Labrum (female); 60 - Mesobasitarsus (female);
61 - Mandible (female)

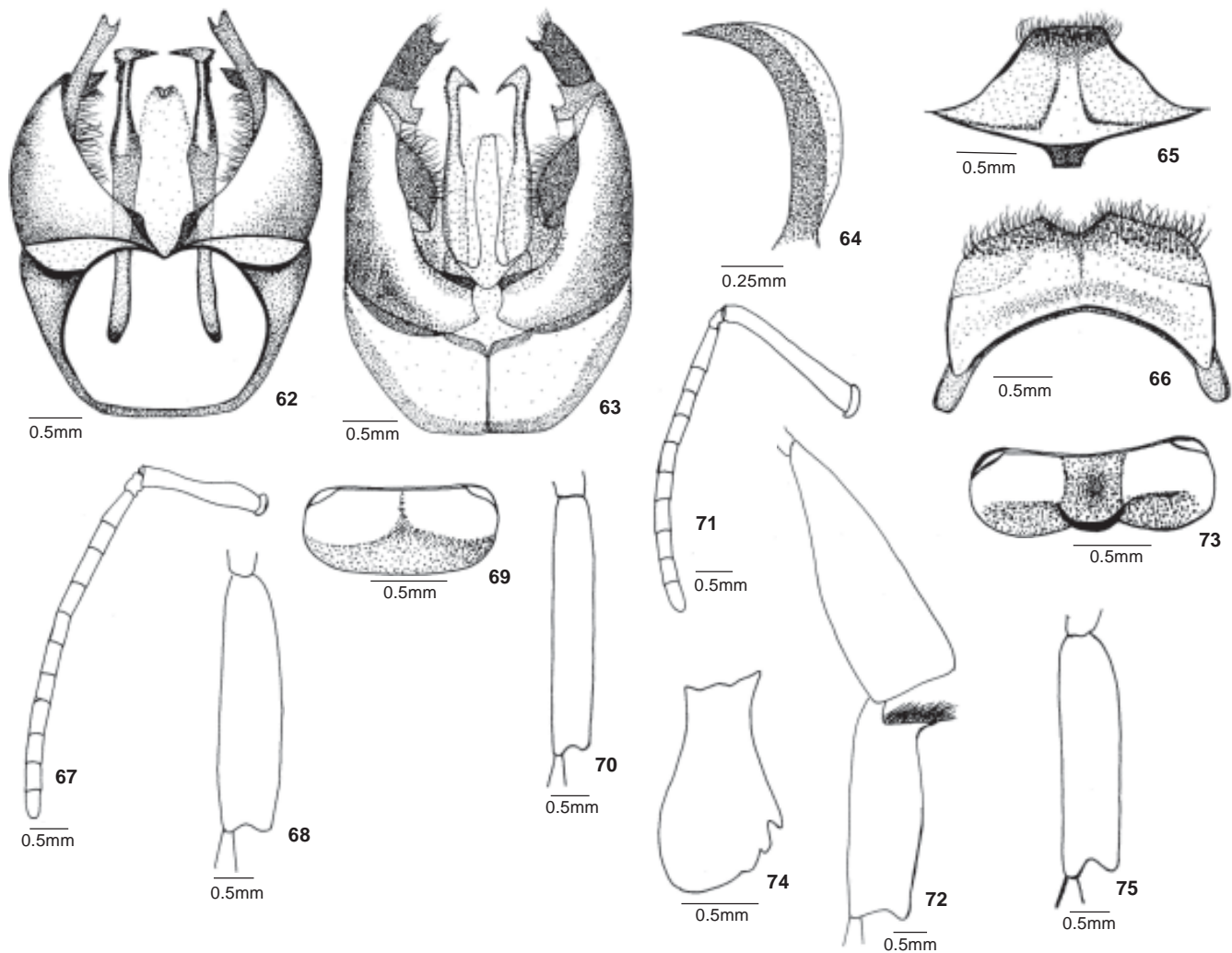
5.viii.2002, 3200m, 1 male, Khangsar; 20.viii.2003, 3200m, 13 females, 15 males, Gramphoo; 6.viii.2002, 4500m, 1 female, 1 male, Baralacha Pass; 5.viii.2002, 10.viii.2002, 20.viii.2003, 3890m, 29 females, 1 male, Rohtang Pass; 10.viii.2002, 3500m, 1 queen, Marhi; 19.viii.2003, 3500m, 1 female, Kaza; 19.viii.2003, 3200m, 2 females, Pin Valley, coll. M.S. Ghattor. Uttarakhand: 26.vii.2002, 3000m, 3 females, Lanka; 27.viii.2002, 2800m, 1 females, Gobind Dham; 26.vii.2002, 3100m, 1 female, Harsil; 28.viii.2002, 13.ix.2003, 4300m, 21 females, 17 males, Valley of Flowers; 30.viii.2002, 4 females, 1 male, Badrinath coll. M.S. Saini. Jammu & Kashmir: 19.vii.2003, 2800m, 13 females, Khilanmarg, coll. H.S. Ghattor.

Distribution: Outside India: Pakistan, Nepal, Bhutan, Myanmar, Tibet (Southwestern China) (Williams, 1998). India: Arunachal Pradesh (Williams, 1991); Himachal Pradesh: Koksar, Gulaba, Kothi, Sissu, Marhi, Chotta dara, Chattru, Khangsar, Gramphoo, Baralacha Pass, Pin Valley, Rohtang Pass, Keylong, Gramphoo, Kaza; Jammu & Kashmir: Khilanmarg, Gulmarg; Sikkim; Uttaranchal: Lanka, Gobind Dham, Harsil, Valley of Flowers, Badrinath.

Host plants: *Aconitum laeve* Royle (Ranunculaceae); *A. heterophyllum* Wallich ex Royle (Ranunculaceae); *A. violaceum* Jacquem ex Stapf (Ranunculaceae); *Impatiens glandulifera* Royle (Balsaminaceae); *Lonicera quenquelocularis* Hardw (Sambucaceae); *Cirsium falconeri* (Hook.f.) Petrak (Asteraceae); *C. wallichii* DC. (Asteraceae); *Rhododendron anthopogon* D. Don. (Ericaceae); *Swertia petiolata* D. Don (Gentianaceae); *Scrophularia pauciflora* Benth (Scrophulariaceae); *Phlomis bracteosa* Royle ex Benth (Lamiaceae); *Impatiens sulcata* Wall (Balsaminaceae); *Dipsacus inermis* Wall (Dipsacaceae)

Holotype depository: ZSI, Kolkata.

Female: Pubescence black, pro and meta notum, 2nd and last two abdominal tergites are white; 4th and 5th abdominal tergites brick red, whereas, anterior half of 3rd is brownish-yellow. However, in queen, the brownish-yellow of 3rd abdominal tergite is replaced with black. Head covered with thick pubescence except malar space, top of clypeus, an area lateral to and in front of ocelli and narrow stripes on inner and post orbits. Visible parts of thorax and abdomen uniformly covered with thick pubescence. Wings uniformly lightly infumated. Mandible



Figures 62-75. *Bombus rufofasciatus* Smith, 1852

62 - Male genitalia (ventral aspect); 63 - Male genitalia (dorsal aspect); 64 - Penis valve (lateral aspect); 65 - 8th sternite (male); 66 - 7th sternite (male); 67 - Antenna (male); 68 - Metabasitarsus (male); 69 - Labrum (male); 70 - Mesobasitarsus (male); 71 - Antenna (female); 72 - Metabasitarsus (female); 73 - Labrum (female); 74 - Mandible (female); 75 - Mesobasitarsus (female).

as illustrated (Fig. 74). 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. 73). Clypeus strongly protuberant, with lateral and basal margin curved back to join gena and supraclypeal area respectively. MS:BMB -2.1:2. Antennal segments 3:4:5-1:1.50: 65; LF : LS : LHB -11.5:11.2 (Fig. 71). Area anterior and lateral to lateral ocellus unpunctured almost, equal to the diameter of ocellus. Band of punctures along eye margin in ocello-ocular area opposite lateral ocellus, occupying half of OOL. The lateral ocelli are slightly below the POC. OOL: POL-2:3. The distoposterior corner of meso-basitarsus bluntly pointed. The length of distoposterior corner is less than the length of distoanterior corner (Fig. 75). Meta basitarsus with dense pubescence of proximal margin (auricle) continuing on to the outer surface of proximoposterior projection as just a few sparse hairs, length of projection is equal to its breadth at its base; distal half of its posterior margin weakly concave with a distoposterior corner roundly pointed and equal to distoanterior corner (Fig. 72). Outer (corbicular) surface of meta tibia smooth, shining with only a few

short branched hairs, which are confined to margins near distoposterior corner, and without any long stout hairs arising from outer surface below upper or proximal quarter. Apex of tergite VII with a boss nearly circular and evenly convex, only narrowly pointed adjacent to apex of tergum.

Male: Pubescence black, clypeus, pro & meta notum, 2nd and last two abdominal tergites are white, 3rd tergite bright yellow, whereas 5th and 6th are brick red. Anterior margin of labrum almost truncate (Fig. 69). Lateral tubercles not meeting in the centre, interrupted by a shallow depression. Excepting tubercles, rest of the area densely punctured. Area lateral to lateral ocellus in the ocello-ocular area unpunctured equal to half the diameter of lateral ocellus. A band of punctures along eye margin covering one third of OOL. OOL : POL-1:2.5. The lateral ocelli are below the POC almost equal to half the diameter of ocellus. Antennal segments 3:4:5-1.25:1:1.25; LF:LS:LHB-11:4:10.5 (Fig. 67); MS:BMB-1:1.5; MBB : LOB-3:12.5.

Male genitalia (Figs. 62-66): Interobasal process of gonostylus with apex forming nearly a right angle, interioapical process with sides diverging towards apex, which is broadly bilobed. Volsella

strongly sclerotised and extending beyond gonostylus apically by at least nearly twice its own breadth at the point where it emerges from beneath gonostylus from dorsal aspect. Penis valve from dorsal aspect turned inwards before apex and dorsoventrally flattened as a sickle. Spatha beyond fusion with penis valves more than three times longer than its breadth midway along this length, sides nearly parallel in proximal half. Sternites 7th and 8th as in Figs. 66, 65.

Remarks: *B. rufofasciatus* is one of the most abundantly available species in the field. Due to its large scale availability in the field, a large number of host plants is recorded. Males and females are similar in colour pattern while queen is a little different. It prefers open high altitude mountain slopes and is found in abundance at high altitude open meadows like Valley of flowers (Uttarakhand) and Rohtang pass (Himachal Pradesh). It is one of the dominant species existing there.

***Bombus tunicatus* Smith, 1852**

(Figs. 76-89) *Bombus tunicatus* Smith, 1852: 43; Bingham, 1897: 549, Frison, 1933 : 333, Williams, 1991: 79, 1998: 129; *B. gilgitensis* Cockerell, 1905: 223.

Material examined: Himachal Pradesh: 10.ix.2004, 3200m, 25 males, Jalaori Pass; 11.ix.2004, 2500m, 13 males, Narkanda; 8.vii.2002, 2500m, 15 females, Kufri; 14.ix.2003, 2500m, 8 females, Bharmour; 27.vi.2001, 2000m, 5 females, Manali; 12.vii.2001, 2500m, 6 females, Jibhi, Coll. H.S. Ghattor. Uttarakhand: 26.vii.2002, 2200m, 22 females, Harsil; 30.viii.2002, 3200m, 28 females, Badrinath; 9.viii.2001, 2400m, 6 females, Ranachatti; 9.viii.2001, 2400m, 5 females, Hanuman Chatti; 8.viii.2001, 2500m, 8 females, Chakrata, coll. M.S. Saini.

Distribution: Outside India: Afghanistan, Pakistan, Nepal (Williams, 1998). India: Himachal Pradesh: Kufri, Narkanda, Jalaori Pass, Manali, Solang, Bharmour, Jibhi; Kashmir: Srinagar, Tangmarg; Sikkim; Uttarakhand: Badrinath, Harsil, Chakrata, Rana Chatti, Hanuman Chatti.

Host plants: *Aconitum heterophyllum* Wallich ex Royle (Ranunculaceae); *A. hookeri* Stapf. (Ranunculaceae); *Impatiens glandulifera* Royle (Balsaminaceae); *Lypinus* sp. (Fabaceae); *Lonicera quinquelocularis* Hardw (Sambucaceae); *Cirsium falconeri* (Hook. f.) Petrak (Asteraceae); *C. wallichii* DC. (Asteraceae); *Swertia petiolata* D. Don. (Gentianaceae); *Digitalis lanata* Ehrh. (Scrophulariaceae); *D. purpurea* L. (Scrophulariaceae); *Pteracanthus urticifolius* (Kuntze) Bremek (Acanthaceae); *Dipsacus inermis* Wall. (Dispacaceae); *Stachys serecia* Wall. ex. Benth. (Lamiaceae).

Holotype depository: NH Museum, London.

Female: Pubescence black, pro and metanotum and first 2 abdominal tergites are white; 5th and 6th abdominal tergites brick red. However, in queen, the white of 2nd abdominal tergite is replaced with chocolate brown. 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. Visible parts of thorax and abdomen uniformly covered with thick pubescence. Mandible as illustrated in Fig. 88. 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. 87). Lamella narrow, only about a third of basal breadth of labrum. Clypeus strongly protuberant, with lateral and basal margin curved back to join gena and supraclypeal area respectively. Presence of many large punctures scattered on

flattened central areas of clypeus. MS : BMB-2:4.5. Antennal segments 3:4:5-1.5:1.1:4.0; LF :LS:LHB-12:6.5:13 (Fig. 85). Area lateral to lateral ocellus unpunctured for more than the diameter of an ocellus. Band of punctures along eye margin in ocello-ocular area opposite lateral ocellus, occupying nearly half of OOL. The lateral ocelli are at the level of POC; OOL:POL-2:3. The distoposterior corner of mesobasitarsus bluntly rounded, never produced as a spine. The length of distoposterior corner is longer than the length of distoanterior corner (Fig. 89). Metabasitarsus with dense pubescence of proximal margin (auricle) continuing on to the outer surface of proximoposterior projection as just few sparse hairs, length of projection longer than its breadth at its base; distal half of its posterior margin convex with a distoposterior corner roundly pointed and longer than distoanterior corner (Fig. 86). Outer (corbicular) surface of meta tibia smooth, shining, without any long stout hairs arising from outer surface below upper or proximal quarter. Apex of tergite VII round, subapically nearly flat, without a rounded boss, surface sculptured, with no median groove.

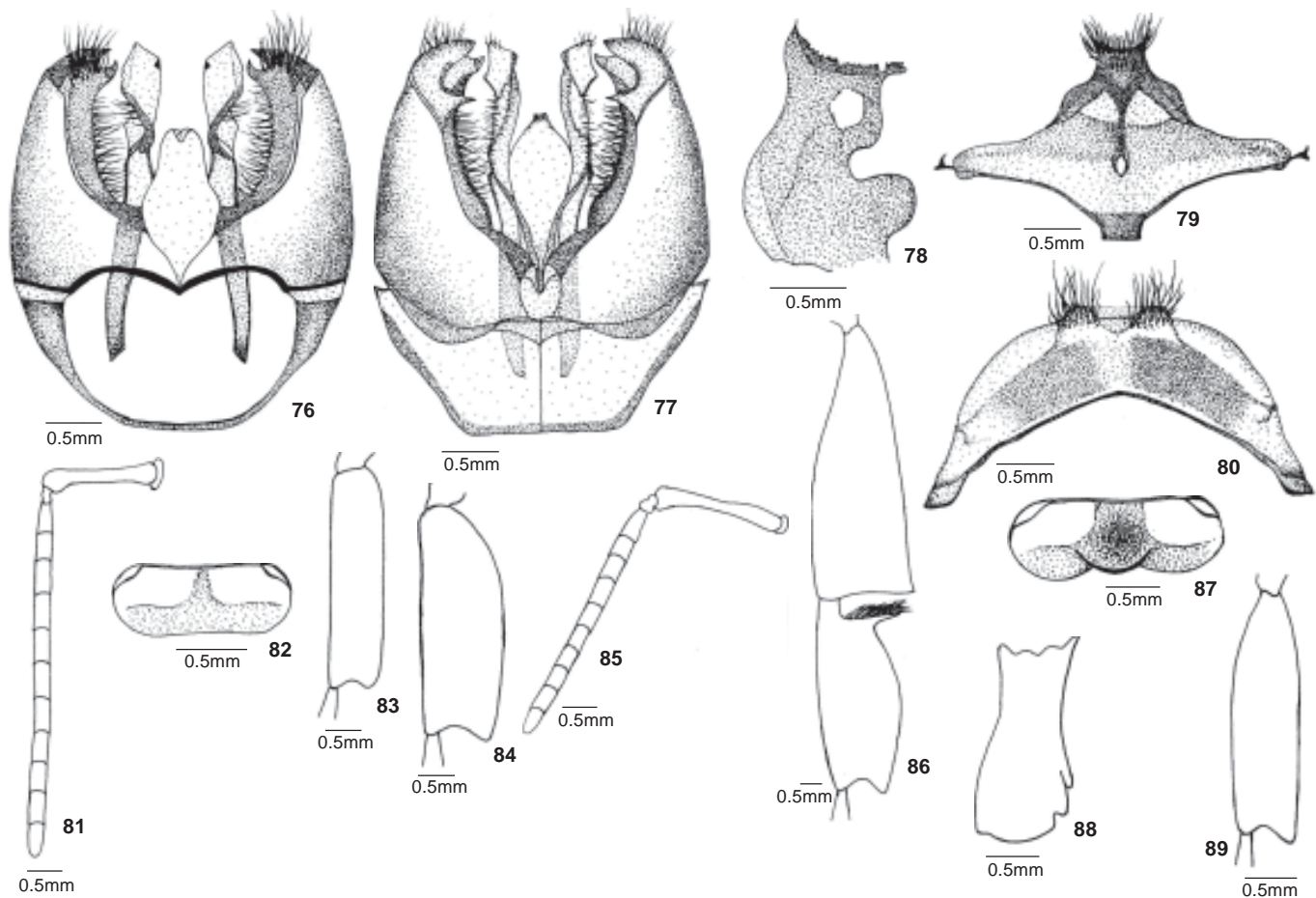
Male: Pubescence black, pro and meta notum and 2nd abdominal tergite are white, 3rd tergite brownish whereas, last 4 are orange red. Anterior margin of labrum slightly concave (Fig. 82). Tubercles low lying, bean shaped, interrupted by broad median groove. Whole of labrum including tubercles covered with macropunctures. Area lateral to lateral ocellus in the ocello-ocular area 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 3:4:5-1.25:1:1.5; LF:LS:LHB-11.5:4.5:10.5 (Fig. 81); MS:BMB-2:3; MBB:LOB-4:13.

Male genitalia (Figs. 76-80): Gonostylus with interioapical process but without long hairs. Penisvalve from dorsal aspect turned outwards and flattened as a sickle. Penisvalves strongly broadened in dorso ventral plane so as to form 2 halves of a tube ends displayed outwards as a broad funnel. Volsella strongly sclerotised and forms an interioapical corner. 7th and 8th sternites as in Figs. 80, 79-3.

Remarks: *B. tunicatus* is one of the most frequently found species in the field. It has a wide range and could be found at different altitudes. It is found in Afghanistan, Pakistan, and Nepal in the Oriental region. It is a common species of N.W. Himalayan region and was recorded from almost every area that was visited above an altitude of 2000m. The species has a wide range of distribution. The worker size of this species is variable with one having a size of a peanut and others have much larger size. The colour pattern is very similar to *B. simillimus*, with difference in having a black band between the wing bases.

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Figures 76-89. *Bombus tunicatus* Smith, 1852

76 - Male genitalia (ventral aspect); 77 - Male genitalia (dorsal aspect); 78 - Penisvalve (lateral aspect); 79 - 8th sternite (male); 80 - 7th sternite (male); 81 - Antenna (male); 82 - Labrum (male); 83 - Mesobasitarsus (male); 84 - Metabasitarsus (male); 85 - Antenna (female); 86 - Metabasitarsus (female); 87 - Labrum (female); 88 - Mandible (female); 89 - Mesobasitarsus (female)

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