Indian Journal of Agricultural Sciences **84** (10): 1217–24, October 2014/Article

Morphology and food plants of subgenus *Bombus* sensu stricto (Hymenoptera: Apidae: Apinae) from Indian Himalaya

RIFAT H RAINA[1], MALKIAT S SAINI[2] and Z H Khan[3]

Punjabi University, Patiala, Punjab 147 002

Received: 10 January 2013; Revised accepted: 16 July 2014

ABSTRACT

Subgenus *Bombus* sensu stricto is represented by two species, viz. *Bombus tunicatus* Smith and *B. lucorum* L from the Oriental region including Indian Himalayan belt. Morphology of 8 variants, synonymy and illustrations of this subgenus from Indian Himalayan belt is given. Besides this, new plants visited by them are also enumerated. Samples collected from Kashmir Himalayas showed great variation in the colour pattern of both species were noted. The worker size of *B. tunicatus* is variable with one having a size of a peanut and others having much larger size. *B. tunicatus* queens show different shades of white and brown colour on pronotum; white, brown and black on metanotum; abdominal tergum 1and 2 white and black. The colour pattern is very similar to *B. simillimus* with difference in having a black band between the bases of wings on the thorax. Females (queens) of *B. lucorum* show different shades of pale brown and yellow on pronotum and abdominal tergum 2; abdominal tergum 1 is pale brown, black and yellow; abdominal tergum 5 is white and yellow.

Key words: Bumblebees, Food plants, India, Morphometry, Population variation, Subgenus *Bombus* sensu stricto.

Amongst high altitude insects that play a pivotal role in the sustenance of a wide variety of cultivated as well as wild flowering plants, bumble bees form a major component. These anthophilous pollinators thrive well in very harsh and inhospitable environment which is characteristic of such regions. At some of the secluded hill terrains, slopes and gorges these bees are the sole pollinators to maintain the vivid tapestry of vegetation. Many important medicinal herbs and shrubs of high altitude regions owe their existence to these bees. These also serve as pollinators of cultivated crops and orchards in these areas. Earlier, 29 species of bumble bees had been described from Kashmir Himalaya including parts of Pakistan occupied Kashmir (William 1991). To begin with, Linneaus (1758, 1761) comes out to be the first name that got indirectly associated with the Indian bumble bees. He recorded two species of Bumble bees from outside India but after a gap of about two centuries the same were reported from Indian faunistic limits. The major works of similar nature concerning Indian bumble bees include: Fabricius (1781), 1 species; Illigir (1806), 1 species; Lepeletier (1836), 1 species; Smith (1852a, b, 1854, 1861, 1878 and 1879), 19 species ; Morawitz (1875, 1880, 1883, 1886, 1894), 13 species; Dalla torre (1890), 1 species; Gribodo (1882, 1892), 3 species; Radoszkowski (1893), 2 species; Bingham (1897), 3 species; Ashmead (1905), 1 species; Friese (1905, 1909, 1913, 1916, 1918, 1924 and 1931), 19 species; Vogt (1909, 1911), 4 species; Skorikov (1910, 1912, 1914a, b, 1933 and 1938), 25 species; Pendlebury (1923), 3 species; Popov (1927, 1931), 2 species; Richard (1928, 1929, 1930, 1931 and 1934), 18 species; Bischoff and Hedicke (1931), 1 species; Frison (1933 and 1935), 6 species; Bischoff (1935, 1936), 2 species; Reining (1935, 1940), 3 species; Pittioni (1939, 1949), 2 species; Maa (1948), 3 species; Sakagami and Yoshikawa (1961), 1 species; Tkalcu (1961, 1968, 1974, 1989), 12 species; Wang (1979, 1982, 1985), 14 species and Williams (1991), 1 species. All these works make a total of 172 species from India up to 1991. Most of these species were based on the differences in the colour pattern and some morphological features. Workers at that time never used the structure of genitalia for species differentiation. Since there is lot of population variation as far as the pubescence colour pattern and the morphological features amongst workers, queens and males are concerned. The reason being most of the species were erected merely on the basis of unstable morphological features and some differences in colour pattern. Due to lot of colour variations even males and females of the same species were put under different species. However, Williams (1998) made a detailed studies and taking male genitalia, sculpture, labrum and clypeus and some other stable ratios and synonymized most of the

[1]E mail: rifat72001@rediffmail.com; rifat72001@yahoo.co.in, [2]Department of Zoology and Environmental Sciences, [3]Division of Entomology SKUAST-K Shalimar, J&K

species thus reducing the number of valid species to only 47. He confirmed his findings still further by making the molecular analysis of different variants. After 1991 there is only one new record from this continent (Raina *et al*. 2013).

Globally, 250 valid species of bumble bees are documented (Williams 2008), whereas only 48 species of these bees are known from Indian Himalaya (Saini *et al.* 2011, 2012a, 2012b; Raina *et al.* 2013). On the basis of morphological features, sex, caste and colour pattern, there is lot of intra-specific population variation in both the species of this sub genus. In the present communication 8 variants of sub genus *Bombus* sensu stricto are discussed with some new food plants. Of which 5 variants are of *B. tunicatus* queen and 3 variants are of *B. lucorum* queen. These variants are recorded for the first time from study area. These variants are distinguished each other by their different colour pattern on abdominal segments.

MATERIALS AND METHODS

The research material comprised of bumble bee specimens collected during extensive survey undertaken between 2006 and 2012 in various localities of Jammu and Kashmir, Himachal Pradesh and Uttarakhand falling in an altitudinal range of 1000-5500m. These collections were made by sweeping hand net and occasionally with the help of malaise trap.

The live photography was done with Olympus camera equipped with different macro lenses to authenticate host plant association. The collected bumble bees were first sorted out in the field and latter brought to the laboratory for further identification and analysis. Sorting of sex and species was done on the basis of distinct and constant colour pattern. Insects were pinned, stretched and dried before transporting them from field station to laboratory. Specimens were identified upto the species level with the available keys, records and literature. However, some doubtful material was sent to UK for final confirmation A label depicting the date of collection, number of specimens examined and locality with altitude was appended to each specimen. Material was roughly sorted out into species. It was mostly based on colour pattern. The microscopic examination of various morphological features was done with the help of binocular microscope fitted with an ocular grid. Drawings were made with the help of ocular grid and the measurements were made with the help of slide micrometer and ocular meter.

The photographs of collected specimens were taken with Canon 18 MP LOS 5D. All the plants visited by the bumble bees were collected simultaneously and got identified from the Centre of Plant Taxonomy, University of Kashmir, (J & K). The following characters have been found trust worthy, stable and unambiguous while dealing with taxonomy of this subgenus. 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, Corbicula and different parts of male genitalia. Two major keys which were helpful and repeatedly consulted in this connection were by Bingham (1897) and Williams (1991). The terminology proposed by Williams (1991) for male genitalia have been adopted. Pictorial key for both males and females were prepared with the help of Adobe Photoshop as per the colour pattern of the abdominal segments of specimens.

Colours were put in a standard figure with the help of computer keeping in front the specimens.

Abbreviations used in the text are:

LF = Length of flagellum, POC = Postocular line, POL = Post ocellar length, HB = Head breadth, MS = Length of malar space, BMB = Breadth of mandible at its base, LOB = Length of basitarsus, OOL = Ocelloocular length, LS = Length of scape, MBB = breadth of metabasitarsus.

DESCRIPTION

Bombus (*Bombus*) *tunicatus* (Smith 1852)

B. tunicatus Smith 1852: 43, Lectotype queen; North: India (BMNH); Tkalcu 1974: 324; Burger *et al.* 2009: 46.

Synonymy

B. vallestris Smith 1878:168
B. gilgitensis Cockerell 1905: 223
B. terrestris var *simlaensis* Friese 1909: 674
B. terrestris var *fulvocinctus* Friese 1909: 674

Diagnostic features

Female: In queen pubescence on head, mesonotum and abdominal tergum 3 black; pronotum, metanotum and abdominal tergum 1 white; abdominal terga 4 and 5 brick red, well-developed black band between wings. Worker with white pronotum and metanotum; head, mesonotum and abdominal tergum3; abdominal terga 4 and 5 brick red. Visible parts of thorax and abdomen uniformly covered with thick pubescence. Mandible with two teeth one with deep furrow and second forming a shallow cavity like structure. 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. Anterior margin of labrum entire; lateral tubercles bean shaped, not meeting in the centre with a median depression of the length of each tubercle abdominal tergum red. 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 = 1.5:1:1.40; LF:LS:LHB = 12:6.5:13 Antenna has three segments but the flagellum consists of many flagellomeres which are mostly considered as segments of flagellum. The distoposterior corner of mesobasitarsus bluntly rounded, never produced as a spine. The distoposterior corner is longer than the distoanterior corner. Meta basitarsus with dense pubescence of proximal margin (auricle) continuing on to the outer surface of proximoposterior projection as just few sparse hair, length of projection longer than its

Material examined: Jammu and Kashmir, Himachal Pradesh and Uttarakhand

District	Locality	Altitude amsl	Material examined	DOC
Bandipora	Achoora	3000 m	1 female (q)	28.06.2009
	Bagtore	2467 m	2 males	06.09.2010
	Dainala	2400 m	1 female (q)	18.06.2007
	Dasi	2471 m	3 males	06.09.2010
	Dawar	2434m	1female (q), 2 females, 3 males	18.06.2007, 08.07.2008, 28.06.2009
	Gosianala	3000 m	4 males	8.09.2010
	Gujran	3001 m	2 males	06.09.2010
	Izmarg	2500 m	3 females (q), 7 males	27.06.2007, 05.09.2010
	Kanzalwan	2600 m	2 females (q)	27.06.2009
	Razdhan Pass	3500 m	3 males	08.09.2010
	Tarbal	2600 m	1 female (q)	29.06.2009
Baramulla	Affarwatt	4000 m	2 females (q), 11 females, 15 males	27.06.2009
	Gulmarg	3000 m	1 female (q), 4 females, 6 males	08.07.2008
	Kongdori	3300 m	1 female, 8 males	02.09.2008
	Tangmarg	2400 m	3 males	03.09.2008
Anantnag	Aru	2700 m	1 female (q), 4 females, 7 males,	30.08.2008, 10.09.2008, 1309.2010
	Baisan	2533 m	1 female(q), 9 males	29.08.2008
	Chandanwari	3385 m	9 males	1.09.2008, 14.08.2010
	Kullar	2100 m	5 males	28.08.2008
	Lidderwatt	3500 m	1 female, 9 males,	14.07.2008
	Mahagunus Top	4200 m	1 male	19.08.2010
	Mandlan	2900 m	1 female, 7 males	30.08.2008
	Pishugati	3400 m	3 males	15.08.2010
	Sheeshnag	3500 m	1 female, 4 males	17.08.2010
	Tarsar Marsar	3700 m	4 females (q), 5 females,	1.07.2010
Ganderbal	Baltal	3000 m	1 female (q), 5 females, 19 males	14.07. 2008, 11.08.2008, 23.08.2009
	Thajiwas	2900 m	1 female(q)	03.09.2008
Kargil	Batalik	3385 m	5 males	04.08.2008
	Drass	3350 m	4 females, 2 males	11.08.2008, 08.07.2010
	Gumri	3544 m	2 females	06.07.2010
	Kargil,	2950 m	1 female (q), 23 females, 19 males,	8.09.2007, 29.07.2008, 29.09.2009, 09.07.2010
	Padam valley/Zanskar	3605 m	5 females	17.07. 2010
	Rungdum, ,	4000 m	2 females	15.07.2010
Budgam	Doodpather,	2900 m	2 females(q), 7 females, 7 males	04.06.2007, 15.06.2008, 4.07.2009, 20.06.2010
	Yousmarg	2600 m	4 females (q), 1 male	27.06.2008, 27.08.2008
Leh	Hunder	3300 m	1 female (q), 6 females, 4 males	5.07.2008
	Leh	3600 m	1 female, 6 males	14.09.2007, 10.07.2010
	Stakna	3385 m	5 females, 4 males,	5.08.2008
Srinagar:,	Kashmir Botanical Garden	1627 m	6 females (q)	10.06.2008, 21.06.2007
Kupwara	Sadnapass	3500 m	2 females (q)	03.07.2009
Lahaul-Spiti	Sarchu	4200 m	12 males	07.08.2007, 09. 08.2007,
	Nakeela Pass	4800 m	9 females , 11 males	07.08.2007
Uttarakhand	Valley of Flowers	4300 m	8 males	28.08.2006, 13.09.2007

breadth at its base; distal half of its posterior margin convex with a distoposterior corner roundly pointed and longer than distoanterior corner. Queens of *B. tunicatus* can be recognized by their large size and by the short ocular malar distance and by the strongly arched posterior margin of the hind basitarsius.

Male: Head, mesonotum and abdominal tergum 2 black, white is pronotum, metanotum and abdominal tergum first; abdominal tergum 3-5 brick red. Anterior margin of labrum slightly concave. Whole of labrum including tubercles covered with macropunctures. Punctures (Punctuation) can be micro or macro. Antennal segments 3:4:5 = 1.25:1:1.5; LF:LS:HB = 11.5:4.5:10.5; MS:BMB = 2:3; MBB:LOB = 4:13. 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. Gonostylus with interioapical process but without long hair. Penis valve from dorsal aspect turned outwards and flattened as a sickle, penis valves 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.

Global distribution: India, Afghanistan, Pakistan and Nepal (Williams 2004 and Williams *et al.* 2010).

Distribution within India: Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Calcutta. (Saini *et al.* 2011).

Holotype depository: NH Museum, London.

Population variants: B. tunicatus queens show different shades of white and brown colour on pronotum; white, brown and black on metanotum; abdominal tergum 1and 2 white and black.

Food plants:

Family	Food plants
Acanthaceae	*Pteracanthus urticifolius* (Kuntze) Bremek*
(Araliaceae)	*Hedera nepalensis* K. Koch
Asteraceae	*Aster himalicus, Antirrhinum majus* L. *Artemisia absinthium* L., *Artemisia* sp., *Carduus edelbergii* Rech. f., *Centaurea ibérica* Trevir ex Spreng*, *Cichorium intybus* L., *Cirsium falconeri* (Hook.f.) Petrak*, *Cirsium arvense* (L.) Scop., *C. wallichii* DC. *, *Cosmos* spp., *Cynara scolymus* L., *Helianthus annuus* L., *Rudbeckia laciniata* L., *Rudbeckia* sp., *Saussurea albescence* (DC.) Sch. Bip., *S. costus* (Falc.) Lipschitz, *S. lappa* C.B. Clarke, *Scorzonera virgata* DC., *Tagetes patula* L., *Tagete* spp., *Zinnia elegans* Jacq.
Balsaminaceae	*Impatiens balsamina* L.*, *I. edgeworthii* Hook. f., *I. glandulifera* Royle
Campanulaceae	*Campanula* spp.
Caprifoliaceae	*Lonicera quinquelocularis* Hardw.
Chenopodiaceae	*Chenopodium botrys* L.
Convolvulaceae	*Convolvulus arvensis* L.
Dipsacaceae	*Dipsacus inermis* Wall
Gentianaceae	*Gentiana* sp., *Swertia petiolata* D.Don.*
Geraniaceae	*Geranium* sp., *G. wallichianum* D.Don
Lamiaceae	*Nepeta cataria* L., *Prunella vulgaris* L., *Stachys sericea* Wall. ex Benth.*
Leguminosae	*Lupins* sp.
Malvaceae	*Lavatera cashmeriana* Camb.
Papilionaceae	*Astragalus* sp., *Indigofera heterantha* Wall. ex Brand., *Lupinus polyphyllus* Lindl., *Robinia pseudoacacia* L., *Trifolium pratense* L.
Ranunculaceae	*Aconitum heterophyllum* Wall. *, *Aconitum hookeri* Stapf*., *Aconitum* sp., *Delpinium* sp.
Rosaceae	*Althea rosea* L., *Potentilla atrosanguinea* Lodd., *Rosa webbiana* Wall.
Sambucaceae	*Lonicera quinquelocularis* Hardw.
Scrophulariaceae	*Digitalis lanata* Ehrh. *, *D. purpurea* L. *, *Pedicularis punctata* Decne*, *Pedicularis* spp.

*food plants documented earlier (Williams 1991)

These host plants are not new from this area but are associated with this species for the first time. Some of the food plants documented earlier (Williams 1991) are marked with * mark.

Stratification: 1650m to 5500m amsl.

DESCRIPTION

Bombus (*Bombus*) *lucorum* (Linnaeus 1761)

Bombus (*Apis*) *lucorum* Linnaeus 1761:425, Lectotype male (Sweden); Day 1979:66 ; Fabricius 1804:350; Skorikov 1933:57; Wang 1982:429, 1985:160, 1987:1380, 1988:555, 1992:1423; Williams 1991:81; Williams 2000:15; Wang and Yao 1996:305; Burger *et al.* 2009:460.

Synonymy

Apis cryptarum Fabricius 1775:379
B. modestus Cresson 1863:99
B. modratus Cresson 1863:109
B. monozonus Friese 1909:674
B. lucorum ab. *mongolicus* Vogt 1909:42
B. (*Terrestribombus*) *lucorum* forma *magnus* Vogt 1911:56
B. (*Terrestribombus*) *lucorum mongolicus* Vogt 1911:56
B. lucorum subsp. *jacobsoni* Skorikov 1912:610
B. terrestris var. *lucocryptarum* Ball 1914:82
B. pratorum var. *longipennis* Friese 1918:83
B. (*Terrestribombus*) *lucorum* var. *alaiensis* Reinig 1930:107
B. (*Terrestribombus*) *magnus* Rasse *mongolicus* Kruger 1954:276
B. magnus Kruger 1954:276
B. burjaeticus Kruger 1954:277
B. florilegus Panfilov 1956:1334
B.reinigi Tkalcu 1974:322

Diagnostic features

Female: In queen pubescence on head, mesonotum, metanotum, abdominal terga 1, 3 and 4 black; yellow is pronotum and abdominal terga 2 and 5; long orange hair around the clypeus and short grey feathered hair on the face around the antennal base, wings light brown. Worker with black head, mesonotum, metanotum and abdominal terga 3 and 4; pronotum, abdominal terga 1 and 2 yellow; abdominal tergum 5 white. meso basitarsus with the distal posterior corner forming rounded right angle; meta basitarsus with the posterior margin strongly arched, oculo-malar distance approximately 0.9 times the proximal breadth of the

mandible; the thorax with a yellow band anteriorly extending half way down the sides of the thorax.

Male: Head and mesonotum black, yellow is pronotum, metanotum and abdominal terga 1 and 2; abdominal tergum 3 black anteriorly and yellow posteriorly; abdominal tergum 4 anteriorly black and posteriorly white; abdominal tergum 5 white. Compound eyes unenlarged relative to that of female and the antenna reaching posteriorly only just to the wing bases anterior area of labrum entire. Lateral tubercles meeting at same level in the middle with macropunctures confined to entire remaining surface, entire surface covered with macro and micropunctures including tubercles. A band of punctures along eye margin covering one third of the area between lateral ocellus and eye margin. OOL:POL = 2.5:3. The lateral ocelli are at the level of POC. Antennal segments 3:4:5 = 1.25:1:1.25; LF:LS:LHB = 12:5:11; MS:BMB = 2:2.5; MBB:LOB = 3:14. Genitalia with the penis valve greatly broadened and flared outwards to form half of a funnel. Gonostylus with interioapical process but without long hair. Volsella strongly sclerotised and forms an interioapical corner; penisvalve from dorsal aspect turned outwards and flattened as a sickle, strongly broadened in dorso ventral plane so as to form 2 halves of a tube, ends displayed outwards as a broad funnel.

Distribution worldwide: India, Afghanistan, Bhutan Pakistan, Myanmar, Nepal, Tibet, Yunnan, Sichuan, Gansu, Hokkaido in Japan and Kamchatka. (Williams *et al.* 2010).

Distribution within India: Kashmir, Sikkim, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. (Williams 1991, Saini *et al.* 2011).

Holotype depository: MNHU, Berlin.

Population variants: Queens of *B. lucorum* show different shades of pale brown and yellow on pronotum and abdominal tergum 2; abdominal tergum 1 is pale brown, black and yellow; abdominal tergum 5 is white and yellow. Majority of the males are extensively yellow but some males are darker with a broad black band on thorax and another on abdominal tergum 3 and 4.

Food plants:

Family	Food plants
Amaryllidaceae	*Allium* sp.
Asteraceae	*Artemisia absinthium* L., *Artemisia* spp., *Aster thomsonii* C. B. Clarke, *Carduus edelbergii* Rech. f., *Cirsium falconeri* (Hook. f.) Petrak.*, *C. wallichii* DC.*, *Cirsium* sp., *Cosmos* sp., *Cousinia thomsonii* Clarke., *Cremanthodium* sp., *Ligularia* sp., *Senecio chrysanthemoides* DC., *Tagetes patula* L. *Taraxacum officinale* Weber
Balsaminaceae	*Impatiens balsamina* L., *I. sulcata* Wall.
Boraginaceae	*Arnebia benthamii* (Wall. ex G.Don) Johns, *Microula* sp.
Crassulaceae	*Lonicera* sp. *(Caprifoliaceae); Sedum* sp.
Gentianaceae	*Swertia petiolata* D.Don*
Lamiaceae	*Geranium wallichianum* D. Don, *Labium album, Nepeta cataria* L., *Nepeta* sp., *Prunella vulgaris* L.*, *Stachys sericea* Wall. ex Benth., *Salvia morcroftiana* Wall. ex Benth.
Malvaceae	*Lavatera cashmeriana* Camb.
Papilionaceae	*Hedysarum* sp., *Trifolium repens* L.*
Onagraceae	*Epilobium angustifolium* L.
Polygonaceae	*Bistoria affinis* Greene
Ranunculaceae	*Aconitum* sp., *Anemone obtusiloba* D. Don., *Anemone* sp.,

Material examined: Jammu and Kashmir, Himachal Pradesh and Uttarakhand

District	Locality	Altitude amsl	Material examined	Date of collection
Baramulla	Allapather	4200 m	3 males	21. 08. 2009
	Kangdori	3300 m	7 males,	02.09.2008
Ganderbal	Baltal	3385 m	2 females (q), 6 females, 6 males	11.08.2008
				23.08.2009
Kargil	Batalik	3350 m	1 female	23.08.2009
	Drass	3265 m	5 females, 5 males	10.08.2008
	Kargil	2950 m	1 female (q), 2 females, 4 males	29 .07.2008
	Padam	3650 m	4 females, 5 males	31.07.2008
	Rungdum	4000 m	1 male	30 .07.2008
Bandipora	Dawar	2434 m	3 females (q), 8 females, 3 males	1006.2007
				08.07.2008
Leh	Hunder	3350 m	4 females, 4 males	05.08.2008
	Panamic	3265 m	5 females, 4 males	07. 08.2008
Anantnag	Pishugati	3300 m	1 female (q), 1 female, 4 males	01.09.2008
Lahaul-Spiti	Sarchu	4200 m	5 males	07.08. 2007
				09. 08. 2007
	Nakeela Pass	4800 m	4 females, 8 males	07.08.2007
Chamoli	Valley of Flowers	4300 m	9 males	28.08. 2006
				13.09.2007

	Clematis tibetica, Clematis sp.,
Rosaceae	*Potentilla atrosanguinea* Lodd.
Scrophulariaceae	*Digitalis lanata* Ehrh. *, *Pedicularis roylei* Maxim., *P. siphonantha* D.Don., *Pedicularis punctata* Decene*, *Pedicularis* spp.

*food plants documented earlier (Williams 1991)

These food plants are not new from this area but are associated with this species for the first time.

Stratification: 2100m to 4800m amsl.

RESULTS AND DISCUSSION

The overall distributional pattern of the species, their foraging activities with the altitude on Nakeela pass and Sarchu is quite similar to that found in other mountains around the valley of Kashmir (e.g. Mahagunus top and Affarwatt) and the Ladakh valley (e.g. Rungdum and Zanskar) respectively. The bees of this group from north western Kashmir resemble to some of those from central Asia and whereas those from south eastern Kashmir resemble those from the eastern Himalaya. The male genitalia of all the species of the subgenus Bombus have the sub apical inner margin of the penis valve concave in dorsal aspect, the gonostylus has the interio-apical corner produced beyond the exterior-apical corner by a distance that is much less than the breadth of volsella. Within the subgenus *Bombus* species of the terrestris group have the ventro-basal angle of the penis valve marked with a strongly pronounced right angle in lateral aspect. It is one of the least well understood bumblebee taxa at present and application of the name has been the matter of opinion. There is broad set of individuals of *B. lucorum* that appears to be discrete. There is a variation in the colour of pubescence and morphology. Females of *B. lucorum* are distinctive in their appearances among the fauna of North-west Himalaya. Some of the females from North West Himalaya broadly resemble British *B. lucorum* in colour pattern, but have the yellow bands across the anterior of thorax extending down the sides of thorax from third to nearly half of the distance to the leg base. *B. tunicatus* is very unique among the old world species of the subgenus *Bombus* for the combination of reduced projection of the interio apical corner of the gonostylus and a broadly obtuse form of the ventro basal angle of the penis valve. The queens can be distinguished by a distinct band of fine punctures in a slight groove at the mid line of the clypeus. They can be easily recognized by their large size, by the short oculo-malar distance and by the strongly arched posterior margin of the hind basitarsus. Workers of this species lacks a black band on thorax and closely resemble to *B. simillimus* but can usually be recognized by tergum I white rather than chocolate brown which is very rare for *B. simillimus.* Males of this species can be recognized by their outwardly flared heads of the penis valve. With the present effort some new variants were observed of this subgenus and their association with newly recorded host plants has also been enumerated which will way pave way for future workers working on this group.

REFRENCES

Ashmead W H. 1905. Additions to the recorded Hymenopterous fauna of Philippine Islands with descriptions of new species. *Proceedings of the United States National Museum* **28**: 957–71.

Ball F J. 1914. Les bourdons dela Belgique. *Annales de La Socit Gologique de Belgique* **58**: 77–108.

Bingham C T. 1897. The fauna of British India, including Ceylon and Burma. Hymenoptera, Vol. 1. Wasps and bees. Taylor and Francis, London, UK, xxix + 579 pp.

Bischoff H. 1935. (in) *Genus Bombus (Apidae, Hymen)*, p 255. Visser Ph C and visser J (Eds). Brand I A Brockhaus, Leipzig.

Bischoff H and Hedicke H. 1931. Uber einige von Illiger beschriebene Apiden (Hym.). Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin **1930**: 385–92.

Burger F, Creutzburg F and Hartmann M. 2009. Die hummeln von Nepal (Insecta: Hymenoptera: Apidae: Bombus). (*In*) Biodiversity und Naturausstattung im Himalaya III. Hartmann M and Weipert J (eds). Eufurt: Verein der Freunde und forderer des Naturkundemuseums Erfurt, pp 455–62.

Cockerell T D A. 1905. Descriptions and records of bees I. *Annals and Magazine of Natural History* **16**(7): 216–25.

Cresson E T. 1863. List of the North American species of *Bombus* and *Apathus. Proceedings of Entomological Society of Philadelphia* **2**: 83–116.

Dalla Torre KW von 1890. Hymenopterologische Notizen. *Wiener entomologische Zeitung* **9**: 139.

Day M C. 1979. The species of Hymenoptera described by Linnaeus in the genera Sphex, Chrysis, Vespa, Apis and Mutilla. *Biological Journal of Linnean Society* **12**: 45–84.

Fabricius J C. 1775. *Systema entomologiae, sistens insectorvm classes, ordines, genera, species, adiectis synonymus, locis, descriptionibvs, observcationibvs.* Metcalf Collection, North Carolina State University: Flensbvrgi and Lipsiae, 832 pp.

Fabricius J C. 1781. *Species insectorvm exhibentes Borum differentias specificas, synonyma avctorvm, loca natalia, metamorphosin adietis observationibvs, descriptionibvs. Impensis Carol Ernest Bohnii: Hamburgi et Kilonii.*

Fabricius J C. 1804. *Systemapiezatorum secundum ordines, genera, species adiectis synonymis, locis, observationibus, descriptionibus.* Carolum Reichard: Brunsvigae.

Friese H. 1905. Neue oder wenig bekannte Hummeln des russischen Reiches (Hymenoptera). *Ezhegodnik Zoologicheskago muzeya* **9**: 507–23.

Friese H. 1909. Neue Varietaten van *Bombus* (Hym.). *Deutsche Entomologische Zeitschrift* **1909**: 673–6.

Friese H. 1913. Uber einige neue Apiden (Hym.). *Archiv fiir Naturgeschichte* **78**: 85–89.

Friese H. 1918. Uber Hummelformen aus dem Himalaja. *Deutsche Entomologische Zeitschrift* **1918**: 81–6.

Friese H. 1916. Uber einige neue Hummelformen (Bombus), besonders aus Asien (Hym.). *Deutsche entomologische Zeitschrift* **1916**: 107–10.

Friese H. 1918. Uber Hummelformen aus dem Himalaja. *Deutsche entomologische Zeitschrift* **1918**: 81–6.

Friese H. 1924. Uber auffallende Hummelformen. (Hym. Apid.). *Deutsche entomologische Zeitschrift* **1924**: 437–9.

Friese H. 1931. Uber Bombus unci Psithyrus. *Konowia* **10**: 300–4.

Frison T H. 1933. Records and descriptions of Bremus and

Psithyrus from India (Bremidae: Hymenoptera). *Record of the Indian Museum* **38**: 331–42.

Frison T H. 1934. Records and descriptions of Bremus and Psithyrus from Formosa and the asiatic mainland. *Transactions of the Natural History Society of Formosa* **24**: 150–185.

Frison TH. 1935. Records, notes and descriptions of Bremus from Asia (Bremidae: Hymenoptera). *Record of the Indian Museum* **37**: 339 -63.

Gribodo G. 1882. Alcune nuove speice e nuove genere di imenotteri aculeati. *Annali del Museo civico di stona naturale Giacomo Doria* **18**: 261-268.

Gribodo G. 1892. Contribuzioni imenotterologiche. Sopra alcune specie nuove poco conosciute di imenotteri antofili (generi Ctenoplectra, Xyloco pa, Centris, Psithyrus, Trigona, eBombus). *Bolletino della Societa Entomologica Italiana* **23**:102–19.

Illiger J C W. 1806. William Kirby's Familien der bienenartigen Insekten, mit Zusat Zen, Nachweisungen und Bemerkungen. *Magazin ftlr Insektenkunde* **5**: 28-175.

Kruger E. 1954. Phaenoanalytische Studien an einigen Arten der Untergattung *Terrestribombus* O. Vogt (Hymenoptera, Bombidae). II. Teil. *Tijdschrift voor Entomologie* **97**: 263-298.

Lepeletier de Salnt-Fargeau ALM. 1836. Histoire naturelle des insectes. *Hymenopteres* **1**: 547.

Linneaus C. 1761. *Fauna svecica sistens ammalia svecia regni* : *Mammalia, Aves, Amphibia, Pisces, Insecta, Vermes, Distributa per classes and ordines, genera and species, cum differentiis specierum, synonymis auctorum, no minibus incolarum, locis natalium, descriptionibus insectorum*. Stockholmiae: Laurentii Salvii.

Maa T. 1948. On some eastern asiatic species of the genus Psithyrus Lepel. (Hymenoptera: Bombidae). *Notes d'entomologie chinoise* **12**: 17–37.

Morawitz F. 1875. (in) *Bees*, p 303. A Fedtschenko (Ed). Walter de Gruyter und Co, Berlin.

Morawitz F. 1880. Ein Beitrag zur Bienen-Fauna Mittel-Asiens. *Izvestiya Imperatorskoi akademii nauk* **26**: 337–79.

Morawitz F. 1883. Neue russisch-asiatische Bombus-Arten. Trudy *Russkago entomologicheskago obshchestva* **17**: 235–45.

Morawitz F. 1886. Insecta in itinere el. N. Przewalskii in Asia centrali novissime lecta. I: Apidae. Trudy *Russkago entomologicheskago obshchestva* **20**: 195–29.

Morawitz F. 1894. Supplement zur Bienenfauna Turkestans. Trudy *Russkago entomologicheskago obshchestva* **28**: 1–87.

Panfilov D V. 1956 Contribution to the taxonomy of bumblebees (Hymenoptera, Bombinae), including the description of new forms. *Zoologicheskii Zhurnal* **35**: 1 325–34.

Pendlebury H M. 1923. Four new species of Bombus from the Malay Peninsular. *Journal of the Federated Malay States Museums* **11**: 64–7.

Pittioni B. 1939. Die Hummeln unci Schmarotzerhummeln der Balkan Halbinsel. II. Spezieller Teil. *Izvestiya na Tsarskite prirodonauchni instituti v Sofiya* **12**: 49–115.

Pittioni B. 1949. Beitrage zur Kenntnis der Bienenfauna SO-Chinas. Die Hummeln unci Schmarotzerhummeln der Ausbeute J. Klapperich (1937/38). (Hym., Apoidea, Bombini). *Eos Madrid* **25**: 241–84.

Popov V B. 1927. New forms of the genus *Psithyrus* Lep. *Konowia* **6**: 267–74.

Popov V B. 1931. Zur Kenntnis der paläarktischen Schmarotzerhummeln (Psithyrus Lep.). *Eos Madrid* **7**: 131–209.

Radoszkowski O. 1893. Descriptions d'hymenopteres nouveaux. *Revue d'entomologie* **12:** 241–5.

Raina R H, Saini M S and Khan Z H. 2013. *Bombus morawitzianus* (Popov) a new addition to the genus Bombus (Apidae: Hymenoptera) from Indian Himalaya. Entomological News **122**(1): 25–31.

Reinig W F. 1930. Untersuchungen zur Kenntnis der Hummelfauna des Pamir-Hochlandes. Zoologische Ergebnisse der deutch-russischen Alai-Pamir-Expedition der Notgemeinschaft der Deutschen Wissenschaft und der Akademie der Wissenschaften der U.S.S.R. *Zeitschriftftir Morphologie und Okologieder Tiere* **17**: 68–123.

Reinig W F. 1935. On the variation of Bombus lapidarius L. and its cuckoo, Psithyrus rupestris Fabr., with notes on mimetic similarity. *Journal of Genetics* **30**: 321–56.

Reinig W F. 1940. Beitrage zur Kenntnis der Hummelfauna von Afghanistan (Hym., Apid.). Ergebnisse der Reise von H. und E. Kotzsch in den Hindukusch in Jahre 1936. *Deutsche entomnologische Zeitschrift* **1940**: 224–35.

Richards O W. 1928. Bombus and Volucella in the Himalayas. *Entomological Monthly Magazine* **64**:107-8.

Richards O W. 1929. A revision of the bumble-bees allied to *Bombus orientalis*, Smith with the description of a new subgenus. *Annals and Magazine of Natural History* **3**(10): 378–86.

Richards O W. 1930. The bumble bees captured on the expeditions to Mt. Everest (Hymenoptera, Bombidae). *Annals and Magazine of Natural History* **5**(10): 633–58.

Richards O W. 1931. A new species of India bumble bee in the Collection of the British Museum (Hymenoptera, Bombidae). *Annals and Magazine of Natural History* **8**(10): 529–33.

Richards O W. 1934. Some new species and varieties of oriental bumble bees (Hym., Bombidae). *Stylops* **3**: 87–90.

Sakagami S F and Yoshikawa K. 1961. Bees of Xylocopinae and Apinae collected by the Osaka City University Biological Expedition to Southeast Asia 1957–58, with some biological notes. Nature and Life in Southeast Asia.

Saini M S, Raina R H and Khan Z H. 2011. A Check list of Bumblebees (Hymenoptera: Apidae) from Indian Himalaya. *Journal of Insect Science* **24**: 326–52.

Saini M S, Raina R H and Khan Z H. 2012 *a.* Species diversity of Bumblebees (Hymenoptera: Apidae) from different mountains regions of Kashmir Himalayas. *Journal of Scientific Research* **4**(1): 263–72.

Saini M S, Raina R H and Khan Z H. 2012 *b*. Food plants and stratification of Bumblebees (Apidae: Hymenoptera) from Indian Himalayas. *Annals of Entomology* **30** (1): 81–9.

Skorikov A S. 1910. New forms of bumblebees (Hymenoptera, Bombidae). *Russkoe entomol ogicheskoe Obozrenie* **9**: 409–13.

Skorikov A S. 1912. Neue Hummelformen (Hymenoptera, Bombidae). IV. *Russkoe Entomologicheskoe Obozrenie* **12**: 606–10.

Skorikov A S. 1914a. Les formes nouvelles des bourdons (Hymenoptera, Bombidae). VI. *Russkoe entomologicheskoe Obozrenie* **14**: 119–29.

Skorikov A S. 1914b. Pratobombus leucopygos sic (F. Mor.) et ses variations (Hymenoptera, Bombidae). *Russkoe entomologicheskoe Obzorenie* **14**: 293–4.

Skorikov A S. 1933. Zur Hummelfauna Japans und seiner Nachbarl¨ander. *Mushi* **6**: 53–65.

Skorikov A S. 1938. Vorlaufige Mitteilung über die Hummelfauna Burmas. *Arkiv for zoology* **30**: 1–3.

Smith F. 1852a. Descriptions of some new and apparently undescribed species of hymenopterous insects from north China, collected by Robert Fortune, Esq. *Transactions of the Entomological Society of London* **2**: 33–45.

Smith F. 1852b. Descriptions of some hymenopterous insects from northern India. *Transactions of the Entomological Society of London* **2**: 45–8.

Smith F. 1854. Catalogue of hymenopterous insects in the collection of the British Museum. Part II. Apidae. London: British Museum.

Smith F. 1861. Descriptions of new genera and species of exotic Hymenoptera. *Journal of Entomology* **1**: 146–55.

Smith F. 1869. Descriptions of Hymenoptera from Japan. *Entomologist* **4**: 205–8.

Smith F. 1878. List of the Hymenoptera obtained by Mr. Ossian Limborg east of Maulmain, Tenasserim Provinces, during the months of December 1876, January, March and April 1877, with descriptions of new species. *Journal of the Asiatic Society of Bengal* **47:** 167–9.

Smith F. 1879. Descriptions of new species of Hymenoptera in the collection of the British Museum. Trustees of the British Museum, London.

Tkalcu B. 1961. Zur Hummelfauna der Umgebung Kuku-Nors (Hymenoptera, Bombinae). *Casopis Ceskoslovenské spolecnosti entomologické* **58**: 344–79.

Tkalcu B. 1968. Revision der Arten derUntergattung Tricornibombus Skorikov (Hymenoptera: Apoidea, Bombinae). Ac Rer Natur Mus Nat Slov. *Bratislava* **14**: 79–94.

Tkalcu B. 1974. EineHummel-Ausbeute aus dem Nepal-Himalaya (Insecta, Hymenoptera, Apoidea, Bombinae). *Senckenbergiana Biologica* **55:** 311–49.

Tkalcu B. 1989. Neue Taxa asiatischer Hummeln (Hymenoptera, Apoidea). *Acta entomologica bohemoslovaca* **86**: 39–60.

Vogt O. 1909. Studien iiber das Artproblem. 1. Mitteilung. Ober das Variieren der Hummeln. 1. Teil. *Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin* **1909**: 28–84.

Vogt O. 1911. Studien iiber das Artproblem. 2. Mitteilung. Ober das Variieren der Hummeln. 2. Teil. (Schluss). *Sitzungsberichte der Gesellschaft naturforschender Freunde zu Berlin* **1911**: 31–4.

Wang S. 1979. Three new species of bumble [sic] bees from Tibet. *Acta entom ologicasinica* **22**: 188–91.

Wang S. 1982. *Insects of Xizang*. Beijing: Geological *Publishing* House.

Wang S. 1985. (In) *Organisms of the Tumuefeng region of Tienshan.* F Huang (Ed.).Yunnan: Yunnan Science and Technology Press, Yunnan.

Wang S. 1987. (In) *Forest Insects of Yunnan*. F Huang (Ed.). Yunnan Science and Technology Press, Yunnan.

Wang S. 1988. (In) *Insects of Mt. Namjagbarwa region of Xizang*. F Huang (Ed.). Science Press, Beijing.

Wang S. 1992. *The series of the scientific expedition to the Hengduan Mountains region of Qinghai-Xizang Plateau, vol. 2. Chinese Academy of Sciences China.*

Wang S and Yao J. 1996. (in) *Insects of the Karakorum-Kunlun mountains. The Scientific Expedition to the Qinghai-Xizang Plateau*. Science Press, Beijing.

Williams P H. 1991. The bumble bees of the Kashmir Himalaya (Hymenoptera: Apidea; Bombinae): *Bulletin of the British Museum of Natural History* **60**: 1–204.

Williams P H. 1998. An annotated checklist of bumblebees with an analysis of patterns of description (Hymenoptera: Apidae, Bombini). *Bulletin of Natural History Musuem London* **67**: 79–152.

Williams P H. 2004. Genus Bombus Latreille. (In) An annotated catalogue of the bee species of the Indian Region. Jodhpur: Jai Narain Vyas University. web page providing a list of bumblebees of India and adjacent countries with common synonyms and a summar of their distributions within the region. Gupta, R K. (ed.). (www.nhm.ac.uk/research-curation/research/projects/bombus/william04_india.pdf accessed 2010).

Williams P H, Cameron S A, Hines H M, Cederberg B and Rasmont P. 2008. A simplified subgeneric classification of the bumblebees (genus *Bombus*). *Apidologie* **39**: 46–74.

Williams P H, I to M, Matsumura T and Kudo I. 2010. The Bumblebees of the Nepal Himalaya (Hymenoptera: Apidae). *Insecta Matsumurana* **66**: 115–51.

Williams P H. 2000. Are *Bombus lucorum* and *magnus* separate species? BWARS Newsletter **2000:** 15–7.