



DISTRIBUTIONAL PATTERN AND FOOD PLANTS OF WESTERN HIMALAYAN BUMBLE BEES FROM NANDA DEVI BIOSPHERE RESERVE

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ABSTRACT

The present work incorporates new distributional records of the genus *Bombus* (Hymenoptera: Apoidea) from Nanda Devi Biosphere Reserve (NDBR) of Western Himalaya covering some major habitats/localities. A total of nine species were collected viz. *B. albopileus*, *B. asiaticus*, *B. festivus*, *B. jacobsoni*, *B. keriensis*, *B. melanurus*, *B. rufofasciatus*, *B. simillimus* and *B. tunicatus* distributed over five subgenera with elevation ranging from 2500-3500 masl. Out of nine species *B. tunicatus* was already recorded from the study area (Gupta, 1997). The remaining eight species were documented for the first time; *B. tunicatus* was observed to be the most prominent species with respect to number of males. The identified species comprised individuals of worker and male castes. In addition, some food plants of these bees were also recorded for the first time.

Key words: *Bombus*, distribution, documentation, taxonomy, food plants, altitudinal stratification, Nanda Devi, new record, Uttarakhand, Western Himalaya, pollination, abundance, castes, males, cold and arid habitats

Bumble bees are eusocial insects inhabiting in cooler and highland areas with large body size having soft and colorful usually banded hairs on dorsal side. They possess polylectic and phytophagous capabilities which helps them to pollinate highland wild and medicinal plants including some endangered plants available at high altitude region of IHR (Singh et al., 2019 and Sinha et al., 2019) and survive in the harsh and extreme environmental condition. Bees generally show high pollination services with more than 25% increase in pollination rate in the agricultural crops (Fijen et al., 2018). These characteristics separate them from other insects. In India, the species of the genus *Bombus* Latreille (1802) are found predominantly in the Himalaya and the northeast. Of the 62 species of genus *Bombus* recognized from entire Himalayan region, 56 species were described from the Indian region (Williams, 2022). Previous exploration on bee fauna of Nanda Devi Biosphere Reserve (NDBR) was carried out in the last century (Gupta, 1997), which showed only three species of Hymenoptera (Apidae)- *Apis laboriosa* Smith, *Bombus tunicatus* Smith, *B. flavescens* Smith; Kishore et al. (2019) observed the distribution of two species which were already recorded (Gupta, 1997). The current study evaluates the distribution of bumble bees in the Niti valley, stretched buffer region of NDBR representing cold, and arid habitats.

MATERIALS AND METHODS

Survey was undertaken during July, 2022 in the

foremost habitats in buffer zone of NDBR of Chamoli district in Uttarakhand, India. The biosphere is situated in three districts of Uttarakhand and divided into three zones (Core, buffer and transition) and comprises two national parks, Nanda Devi National Park and Valley of Flowers National Park, respectively. The total area of the biosphere is 6407.03 km², including the core (712.12 km²), buffer (5148.570 km²) and transition zone (546.60 km²). The study sheds light on the diverse habitats of the biosphere reserve, including Niti Valley, Gamshali and the Auli-Gurson trail of NDBR, which differ from an altitudinal upsurge from grassland to cold, arid environment. Geographical coordinates of different collection sites were verified using Garmin GPS 64SC receivers. Collection of bumble bee samples was done using random and opportunistic sampling methods. The flowers that could be found anywhere were observed along the walking trail and alongside roads. The moment when a bumble bee was seen foraging, it was first photographed along with the host plant to authenticate host relationship. The fresh collection of bees was done simultaneously with sweep-nets and killed in a glass bottle filled with ethyl acetate fumes and later stored in airtight containers containing tissue papers and naphthalene to avoid mold growth during transportation. These were later dry-mounted using entomological pins. Concurrently, images of live pollinating species, habitats, topography, and host flowering plants were captured using a DSLR camera (Nikon Coolpix P1000) with telephoto lens.

Identification of collected specimens was done at laboratory with available literature (Williams, 1991, 2022; Saini et al., 2015).

RESULTS AND DISCUSSION

Order HYMENOPTERA; Superfamily APOIDEA; Family APIDAE; Subfamily APINAE; Tribe **Bombini**; Genus **Bombus** Latreille, 1802

1. *Bombus (Megabombus) albopleuris* Friese, 1916 (Fig. 1a)

B. haemorrhoidalis var. (subsp.) *albopleuris* Friese, 1916: 108

Diagnostics: Male- Head, abdominal tergite T3 black with lateral side is white coloured; abdominal tergites T2-T3 yellowish and T3-T4 is brick-red coloured. Antennae elongated and ratio of 3:4:5 flagellomeres are 1.5:1:2.

Material examined: India, Uttarakhand, Chamoli, Auli village, 1 ♂, N 30°42'10.38", E 79°36'32.96", 2591 masl, 01.vii.2022, (Regd. No. 12728/A); Chamoli, Gurson bugyal, 1 ♂, N 30°31'10.30", E 79°33'39.57", 3038 masl, 02.vii.2022, (Regd. No. 12739/A)

Distribution: India: Arunachal Pradesh, Himachal Pradesh, Uttarakhand, Kashmir, Manipur, Meghalaya, Sikkim, and West Bengal (Williams, 1991, 2004; Saini et al., 2015); Elsewhere: Nepal, Bhutan, Malaysia, Laos, Pakistan, Thailand, Taiwan, Vietnam, Afghanistan, Myanmar (Williams et al., 2010)

Host plants: *Polygonum macrophylla* D. Don, *Trifolium repens* L., *T. pratense* L.

Remarks: New record from Nanda Devi Biosphere Reserve, Chamoli.

2. *Bombus (Sibricobombus) asiaticus* Morawitz, 1875 (Fig. 1b)

B. asiaticus Morawitz, 1875: 4

Diagnostics: Male- Head, mesonotum and abdominal tergites T1-T4 black coloured; lateral side of thorax, pronotum and metanotum having straw coloured; abdominal tergite T5 brick red coloured. Antennae very long and ratio of 3:4:5 flagellomeres are 2:1.30:2.

Material examined: India, Uttarakhand, Chamoli, Gamshali, 6 ♂♂, N 30°31'18.49", E 79°33'43.45", 3284 masl, 05.vii.2022, (Regd. No. 13298/A)

Distribution: India: Kashmir, Sikkim, Himachal Pradesh, Uttarakhand; Elsewhere: Afghanistan,

Southwestern China, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Tajikistan, Tibet (Saini et al. 2015)

Host plants: *Thymus linearis* Benth., *Cirsium wallichii* D. C., *Cynoglossum wallichii* G. Don, *Allium stacheyi* Baker, *Gentiana argentea* (Royal ex D. Don)

Remarks: New record from Nanda Devi Biosphere Reserve, Chamoli.

3. *Bombus (Melenobombus) festivus* Smith, 1861 (Fig. 1c)

B. festivus Smith, 1861: 152

Diagnostics: Female- Thick black pubescence in head; thorax and abdominal tergites T5-T6 white; apart this all abdominal tergites covered with thick black pubescence. Ratio of 3:4:5 flagellomeres are 1.50:1:1.25. Male- Head covered in black pubescence; light orange coloured thorax; black coloured abdominal tergites T1-T3 and T4-T6 white coloured; Ratio of 3:4:5 flagellomeres are 1:1:1.40.

Material examined: India, Uttarakhand, Chamoli, Auli village, 1 ♂, N 30°42'10.38", E 79°36'32.96", 2591 masl, 01.vii.2022, (Regd. No. 12731/A); Chamoli, Gurson bugyal, 2 ♂♂, N 30°30'37.04", E 79°33'57.07", 3370 masl, 02.vii.2022, (Regd. No. 12736/A); Chamoli, Gurson bugyal, 5 ♂♂, 1 ♀, N 30°32'06.99", E 79°34'11.54", 2914masl, 02.vii.2022, (Regd. No. 12738/A); Chamoli, Gurson top, 5 ♂♂, 1 ♀, N 30°30'35.45", E 79°33'55.60", 3260masl, 03.vii.2022, (Regd. No. 12741/A); Chamoli, Gurson top, 19 ♂♂, N 30°30'35.92", E 79°33'55.79", 3136masl, 03.vii.2022, (Regd. No. 12743/A)

Distribution: India: Arunachal Pradesh, Himachal Pradesh, Sikkim, West Bengal (Darjeeling), Uttarakhand (Saini et al. 2015); Elsewhere: Bhutan, Myanmar, Nepal, Southern China (Williams, 2004).

Host plants: *Bistorta affinis* (D. Don) Greene, *Polygonum macrophylla* D. Don, *Trifolium repens* L., *T. pratense* L.

Remarks: New record from Nanda Devi Biosphere Reserve, Chamoli.

4. *Bombus (Bombus) jacobsoni* Skorikov, 1912 (Fig. 1d)

B. lucorum subsp. *jacobsoni* Skorikov, 1912: 610

Diagnostic characters: Male- Black pubescence in head and mesonotum; pronotum, metanotum and abdominal tergites T1-T2 yellow; T3 and T4 anterior

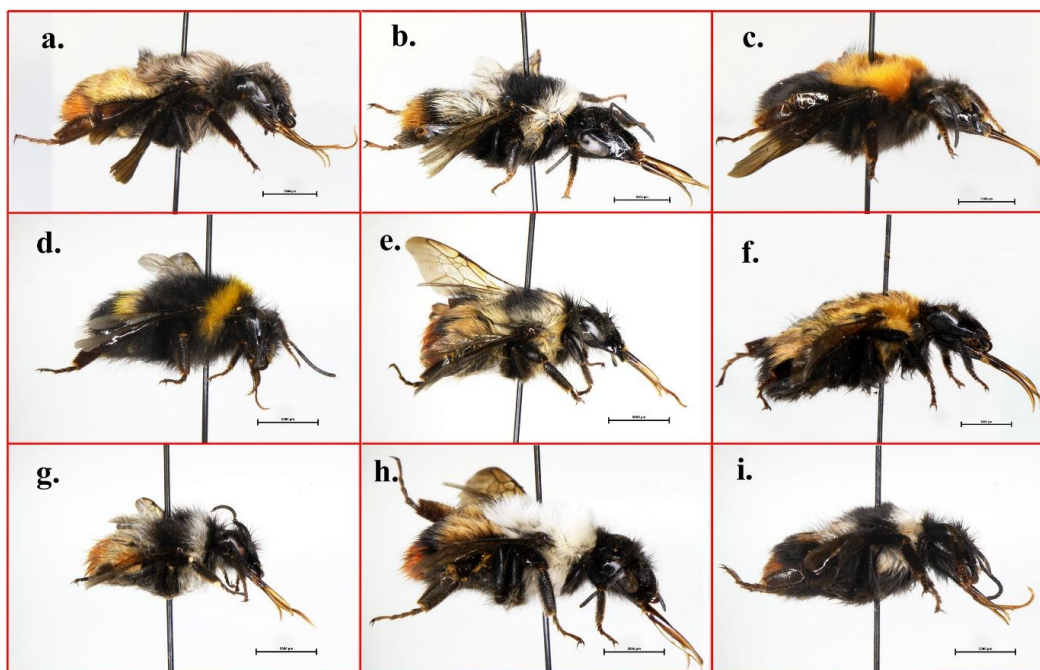


Fig. 1. Identified bumble bee species (a) *Bombus albopleuralis* Friese, 1916; (b) *B. asiaticus* Morawitz, 1875; (c) *B. festinus* Smith, 1861; (d) *B. jacobsoni* Skorikov, 1912; (e) *B. keriensis* Morawitz, 1817; (f) *B. melanurus* Lepeletier, 1835; (g) *B. rufofasciatus* Smith, 1852; (h) *B. simillimus* Smith, 1852; (i) *B. tunicatus* Smith, 1853

portion black and posterior portion yellow and white respectively; pubescence in T5 white coloured. Ratio of 3:4:5 flagellomeres are 1.25:1:1.25.

Material Examined: India, Uttarakhand, Chamoli, Niti village, 1 ♂, N 30°45'40.09", E 79°51'05.82", 3507 masl, 06.vii.2022, (Regd. No.12825/A); Chamoli, Niti Valley, 1 ♂, N 30°45'42.55", E 79°51'07.21", 3496 masl, 06.vii.2022, (Regd. No.12827/ A)

Distribution: India: Kashmir, Ladakh, Sikkim, Arunachal Pradesh, Himachal Pradesh, Uttarakhand (Williams, 1991, 2004; Saini et al., 2015); Elsewhere: Pakistan, Afghanistan, Nepal, Bhutan, Myanmar, Europe, Canada, Japan, North Korea, China (including Tibet), Japan, Iran, Kamchatka, Kazakhstan, Korea, Kyrgyzstan, Tajikistan, Turkey, and Russia (Williams, 2004; Williams et al., 2010).

Host Plants: *Thymus linearis* Benth., *Hyssopus officinalis* L., *Cynoglossum wallichii* G. Don, *Cirsium wallichii* D.C., *Gentiana argentea* Royal ex D. Don., *Allium stracheyi* Baker

Remarks: New record from NDBR, Chamoli.

5. *Bombus (Melenobombus) keriensis* Morawitz, 1887 (Fig. 1e)

B. keriensis Morawitz, 1887: 199

Diagnostic characters: Male- Head, mesonotum and abdominal tergite T3 black pubescence; yellow pubescence in pronotum, metanotum and abdominal tergites T1-T2; orange-red in T4-T5. Ratio of 3:4:5 flagellomeres are 1:1:1.10.

Material Examined: Chamoli, Niti valley, 1 ♂, 20 N 30°45'40.04", E 79°51'05.81", 3457 masl, 06.vii.2022, (Regd. No. 13297/A)

Distribution: India: Himachal Pradesh, Uttarakhand, Sikkim, Kashmir and Ladakh (Kargil), Arunachal Pradesh (Williams 1991, 2022; Saini et al., 2015); Elsewhere: Afghanistan, Bhutan, China (including Tibet), Mongolia, Kyrgyzstan, Kazakhstan, Nepal, Pakistan, Tajikistan, Turkey, Iran (Williams, 1991).

Host Plants: *Thymus linearis* Benth., *Hyssopus officinalis* L., *Cirsium wallichii* D.C., *Cynoglossum wallichii* G. Don, *Pedicularis longifolia* var. *tubiformis* (Klotzsch) Tsoong

Remarks: New record from Nanda Devi Biosphere Reserve, Chamoli.

6. *Bombus (Subterraneobombus) melanurus* Lepeletier, 1835 (Fig. 1f)

B. melanurus Lepeletier (1835): 469

Diagnostic characters: Male- Head and abdominal

tergites T3-T5 black coloured; whole thorax and T1 dirty yellow; anterior part is dirty yellow and posterior is black in T2 tergite. Ratio of 3:4:5 flagellomeres are 1.5:1:2

Material Examined: India, Uttarakhand, Chamoli, Niti village, 2 ♂♂, N 30°45'40.09", E 79°51'05.82", 3507 masl, 06.vii.2022, (Regd. No. 12824/A); Chamoli, Niti valley, 3 ♂♂, N 30°45'40.04", E 79°51'05.81", 3457 masl, 06.vii.2022, (Regd. No. 12428/A)

Distribution: India: Himachal Pradesh, Kashmir, Sikkim, Uttarakhand (Williams, 2004; Saini et al. 2015); Elsewhere: Afghanistan, China, Armenia, Nepal, Kazakhstan, Kyrgyzstan, Mongolia, Europe, Lebanon, Iran, Uzbekistan, Pakistan, Russia, Syria, Turkey (Williams, 2004; Williams et al. 2010; Saini et al. 2015).

Host Plants: *Cirsium wallichii* D.C., *Thymus linearis* Benth., *Cynoglossum wallichii* G. Don, *Allium stracheyi* Baker, *Gentiana argentea* Royle ex D. Don

Remarks: New record from Nanda Devi Biosphere Reserve, Chamoli.

7. *Bombus (Melanobombus) rufofasciatus* Smith, 1852 (Fig. 1g)

B. rufofasciatus Smith, 1852a: 48

Diagnostic characters: Female- Head is black coloured; pronotum, metanotum white and mesonotum black coloured; abdominal tergites T1 white, T2 black, T3 entirely radish, T4-T5 white coloured; Ratio of 3:4:5 flagellomeres are 1:50:65.

Male- Same as female worker. Ratio of 3:4:5 flagellomeres are 1.25:1:1.25.

Material examined: India, Uttarakhand, Chamoli, Gamshali, 17 ♂♂, 14 ♀♀, N 30°31'18.49", E 79°33'43.45", 3001 masl, 05.vii.2022, (Regd. No. 12820/A); Chamoli, Gamshali, 26 ♂♂, 7 ♀♀, N 30°31'18.49", E 79°33'43.45", 3284 masl, 05.vii.2022, (Regd. No. 12822); Chamoli, Niti village, 5 ♀♀, N 30°45'40.09", E 79°51'05.82", 3507 masl, 06.vii.2022, (Regd. No. 12823/A); Chamoli, Niti Valley, 3 ♂♂, N 30°45'42.55", E 79°51'07.21", 3496 masl, 06.vii.2022, (Regd. No. 12826/A); Chamoli, Niti valley, 3 ♂♂, 1 ♀, N 30°45'40.04", E 79°51'05.81", 3457 masl, 06.vii.2022, (Regd. No. 12829/A)

Distribution: India: Himachal Pradesh, Uttarakhand, Sikkim, Kashmir, Ladakh (Kargil), and Arunachal Pradesh (Williams, 1991, 2022; Saini et al., 2015); Elsewhere: Nepal, Pakistan, Bhutan, China (including Tibet), Myanmar (Williams, 2004, 2022).

Host Plants: *Cirsium wallichii* D.C., *Cynoglossum wallichii* G. Don., *Thymus linearis* Benth, *Gentiana argentea* Royle ex D. Don, *Allium stracheyi* Baker

Remarks: New record from Nanda Devi Biosphere Reserve, Chamoli.

8. *Bombus (Melanobombus) simillimus* Smith, 1852 (Fig. 1h)

B. simillimus Smith, 1852a: 48

Diagnostic characters: Male- Head black coloured; thorax and abdominal tergite T1 covered with white pubescence; T2 anterior portion brown and posterior white, T3 anterior black and posterior white, T4-T5 brick red coloured. Ratio of 3:4:5 flagellomeres are 1.5:1:1.5.

Material examined: India, Uttarakhand, Chamoli, Auli village, 1 ♂, N 30°42'10.38", E 79°36'32.96", 2591 masl, 01.vii.2022, (Regd. No. 12729/A); Chamoli, Gurson bugyal, 1 ♂, N 30°30'37.04", E 79°33'57.07", 3370 masl, 02.vii.2022, (Regd. No. 12735/A); Chamoli, Gurson top, 1 ♂, N 30°30'35.92", E 79°33'55.79", 3136 masl, 03.vii.2022, (Regd. No. 12747/A)

Distribution: India: Kashmir, Ladakh, Sikkim, Himachal Pradesh, Uttarakhand, West Bengal; Elsewhere: Pakistan (Williams, 1991, 2022; Saini et al., 2015)

Host Plants: *Trifolium repens* L., *T. pratense* L., *Polygonum macrophylla* D. Don, *Prunella vulgaris* L.

Remarks: New record from Nanda devi biosphere reserve, Chamoli, Uttarakhand.

9. *Bombus (Bombus) tunicatus* Smith, 1853 (Fig. 1i)

B. tunicatus Smith, 1852b: 43

Diagnostic characters: Female- Head and mesonotum black pubescence; pronotum and metanotum white coloured pubescence; abdominal tergites T3 black, T4-T5 brick red coloured. Ratio of 3:4:5 flagellomeres are 1.5:1:1.40.

Male- Black pubescence on head; pronotum, metanotum and abdominal tergite T1 covered in white pubescence; mesonotum, abdominal tergites T2 black, T3-T5 brick red coloured. Ratio of 3:4:5 flagellomeres are 1.25:1:1.5.

Material examined: India, Uttarakhand, Chamoli, Auli village, 14 ♂♂, N 30°42'10.38", E 79°36'32.96", 2591 masl, 01.vii.2022, (Regd. No. 12727/A); Chamoli, Gurson bugyal, 13 ♂♂, 1 ♀, N 30°30'37.04", E 79°33'57.07", 3370 masl, 02.vii.2022, (Regd. No.

13734/A); Chamoli, Gurson bugyal, 15 ♂♂, 2 ♀♀, N 30°32'06.99", E 79°34'11.54", 2914 masl, 02.vii.2022, (Regd. No. 12737/A); Chamoli, Gurson bugyal, 22 ♂♂, N 30°31'10.30", E 79°33'39.57", 3038 masl, 02.vii.2022, (Regd. No. 12740/A); Chamoli, Gurson top, 18 ♂♂, N 30°30'35.45", E 79°33'55.60", 3260 masl, 03.vii.2022, (Regd. No. 12742/A); Chamoli, Gurson top, 27 ♂♂, 4 ♀♀, N 30°30'35.92", E 79°33'55.79", 3136 masl, 03.vii.2022, (Regd. No. 12744/A); Chamoli, Gurson top, 13 ♂♂, 7 ♀♀, N 30°30'35.92", E 79°33'55.79", 3000 masl, 03.vii.2022, (Regd. No. 12745/ A)

Distribution: India: Kashmir, Ladakh, Sikkim, Himachal Pradesh, Uttarakhand, West Bengal (Williams, 1991, 2022; Saini et al., 2015); Elsewhere: Afghanistan, Nepal, Pakistan (Williams et al. 2010)

Host Plants: *Bistorta affinis* (D. Don) Greene, *Trifolium repens* L., *T. pratense* L., *Polygonum macrophylla* D. Don, *Prunella vulgaris* L., *Potentilla lineata* Trevir, *P. argyrophylla* Wall. ex. Lehm.

Remarks: Previously recorded by Gupta, 1997 from the study area.

The field survey revealed occurrence of nine species belonging to five sub-genera viz. *Bombus*, *Megabombus*, *Melanobombus*, *Sibricobombus* and *Subterraneobombus* are first time observed from the study area. The present study also updates the bee fauna of NDBR with newly recorded species i.e., *B. albopilealis* Friese, *B. asiaticus* Morawitz, *B. festivus* Smith, *B. jacobsoni* Skorikov, *B. melanurus* Lepeletier, *B. keriensis* Morawitz, *B. rufofasciatus* Smith, and *B. simillimus* Smith. The dominating species in terms of number of individuals were *B. tunicatus* Smith followed by *B. rufofasciatus* Smith and *B. festivus* Smith. Male and female of all the bumblebee species first time reported from this region are now deposited in NZC, DRC, ZSI, Jodhpur for future reference. The Bumblebee species recorded are the efficient pollinators of the plant families especially, Asteraceae, Fabaceae, Polygonaceae, Lamiaceae, Boraginaceae, Gentianaceae, Rosaceae, Orobanchaceae, Ranunculaceae etc. *Thymus linearis* Benth., *Cirsium wallichii* D.C., *Cynoglossum wallichii* G. Don., *Trifolium repens* L. and *Polygonum macrophylla* D. Don. observed in bulky patches of flowers and preferred by the presented bumblebee species. The Biosphere Reserve needs more extensive surveys to identify the plant pollinator relationships and occurrence of other indigenous bees and to study their role in pollination ecology.

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AUTHORS CONTRIBUTION STATEMENT

The present study first conceptualized and designed by the RR. and TJ executed the field survey under the guidance of RR and IS. RR identified the presented bumblebee species. PC prepare the GIS maps of the survey locations. RR and TJ wrote the manuscript with significant involvement from all the authors. All authors have reviewed and approved the final manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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