

## Diversity of bumble bee (Bombini, Aphidae: Hymenoptera) in Chitwan district of Nepal

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### Abstract

Chitwan Districts provide a variety of climatic settings for bumblebees. So, an experiment was carried out in different sites of Agriculture and Forestry (AFU) University, Chitwan, Nepal during April to August in 2018 to study and determine diversity of bumble species. Species within sub-genus were analyzed in the laboratory. A total of 150 bumble bee specimens were collected where 5 species from 4 subgenera were identified. Altitude, abundance, host-plant interaction, and habitat were detected for each five species. Lower species were found in the study site. Type of flower (size, architecture), height of plant, altitude, habitat distance, behavior of insect species, size, and body make-up of bumble bee determined the species richness and diversity in the research area. The *Bombus festivus* (subgenus: *Festivobombus*) was the most common species in the research area. *Bombus* (*Melanobombus*) *eximus*, *Bombus* (*festivobombus*) *Festivus*, *Bombus haemorrhoidalis*, *Bombus rotundiceps* and *Bombus lepidus* Skorikov were five species diversity found within the sub-genera of bumble bee. It was analyzed that Chitwan district has limited species and sub-genera of bumble bees visiting different habitats or flowers in variable altitude.

**Keywords:** Abundance, bees, diversity, genera, species

### Introduction

Bumble bees (*Bombus*) (Bombini, Aphidae: Hymenoptera) are native bees mainly found in global temperate region (Corbet *et al.* 1991; C Kremen *et al.* 2002; Memmott and Waser, 2004; Fontaine *et al.* 2006; Hegland and Totland, 2008) [8, 18, 20, 21] and their importance has been understood with alternative of honeybee as pollinator in communities (Delaplane and Mayer 2000) [9]. Their robust body size, heavy hairs, and buzz-pollination behavior (high-frequency buzzing to release pollen from flowers) have greatly contributed to pollen transfer for major crops such as tomatoes and berries. Disturbing reports of bumble bee population minimization in Europe have recently knocked over into North America, fueling environmental and economic concerns of global decline (Committee on the Status of Pollinators in North America 2007; Goulson *et al.* 2008; Williams and Osborne 2009) [7, 15, 35]. However, the proper justification for large-scale range reductions across North America is lacking.

Bumblebees (Hymenoptera, Apidae, Latreille, 1802) are crucial friendly insects that pollinate in both wild and agricultural plants. Bumble bee population was originated from Central Asian Mountains where temperate alteration can be observed (Williams 1985) [30]. Since they can absorb the heat, bumblebees are greatly adapted than most other bees to their activity in cool climates (Williams 2007) [33]. Bumble bee can resist at the freezing temperature specially during foraging time. The bumblebee's foraging activities are associated to nectar gathering (Goulson 2010) [16], whilst the selection of food plants or flowers are based on the pollen's characteristics or traits (Roger *et al.* 2016). It is observed that old bumble bee has better skills in pollen collection (Raine and Chittka 2007) [25]. However, the tongue, body size and weight also determine their foraging characteristic. Species with Long- tongue are more specialized in their choice of food plants and are the pollinators of deep nectar flowers based on the length of their tongues (Kawakita *et al.* 2004; Goulson, *et al.* 2006)

[14, 19]. Once the plants are visited by some bees, other bees avoid visiting the same bloom since because their feet smell and leave a scent after they have fed (Bumblebee Conservation Trust 2014). Bumble bee have distinguishing ability to determine other visitors in the flowers and if the nectar is removed. According to Chacoff *et al.* (2010) [6] and Bommarco *et al.* (2012) [3], bumblebees considered as imperative part of ecosystem because they provide buzz pollination for seed production or in seed breeding process, making them significant pollinators of agricultural production and natural ecology (Sabir *et al.* 2011).

According to the recent taxonomy, all bumblebees are subjected under the genus *Bombus*, which contains 250 species worldwide and 34 species from Nepal (Cameron *et al.* 2007; Williams *et al.* 2010) [4, 36]. The diversity of bumble bee is higher in cooler climate than compared with warmer (Goulson *et al.* 2005; Peat *et al.* 2005) [13, 24]. Bumble bees are abundant in Himalaya (1000-56000 meters above sea level) (Williams 1985) [30]. The species richness has been noted higher in the mountains of central Asia and the mountains to the east of Tibet (Williams 1994) [32]. However, a typical species is observed in the lowland tropics of Southeast Asia, Central America, and South America, they are majorly restricted to the Northern Hemisphere (Williams 2007; Goulson 2010) [16, 33]. In the Himalayas, they are typically located between 1,000 and 5,600 meters above sea level.

The environmental factors influence the diversity of flora and fauna (Williams *et al.* 2010; Rawat 2017) [26, 36]. Due to low annual rainfall West Himalaya has temperate broad leaf forests, parched alpine meadows, and pastures at high elevations (Rawat, 2017) [26]. As a result of the preparation of moist alpine meadows at higher elevations and subtropical broad leaf forests at the eastern part, which feels high annual precipitation of up to 5,000 mm (Dhar and Nandargi 2006), global hotspot for biodiversity is found with significant biodiversity in the East Himalaya (Myers *et al.* 2000) [23]. Most of the study in bumble bee abundance

and diversity (Williams *et al.* 2010) [36] have been carried in the Central and the West Himalaya (Williams 1991; Saini *et al.* 2015) [31]. In these area *Bombus miniatus*, *B. albopileatus* and *B. genalis* are greatly distributed.

In the Central Himalaya, highest loads of bumble bee are studied mainly from Nepal and the Indian state of Sikkim (Williams *et al.* 2010, Saini *et al.* 2015) [36]. Both the eastern and western species reach the limits of their ranges, and the overlap of these two faunal zones may be a factor in the region's high bumble bee diversity in Nepal (Williams *et al.* 2010) [36].

There is still a knowledge gap on the bumblebee's relationship with its host plant, feeding habits, and ecology. Therefore, to preserve, protect, and document Nepal's natural ecosystem, a complete species inventory is still required. So, the study was only focused in collecting diversity of species, relationship of flora & fauna including ecology of bumble bee in Chitwan district of Nepal.

## Materials and Methods

### 1. Study location

The experiment was conducted in the periphery of Agricultural and Forestry University (AFU) Rampur, Chitwan. Geographically it is located at 27°37' N latitude 84° 25' E longitude and at an altitude of 260-315 meter above sea level. According to the geographical classification of the country, the experimental location falls in the Terai region of Central Development Region.

### 2. Methods

Within the various agricultural and non-agricultural sites, the bumble bee populations were studied by opportunistic method (Goulson 2010) [16]. Species were identified by using identification key developed by Williams *et al.* (2010) [36], An *et al.* (2014) [1] and Saini *et al.* (2015). Field sampling was conducted in suitable timing for Bumblebees i.e. April to August in 2018. In the field frequency of bumblebees, host plant, temperature and humidity were recorded.

### 3. Statistical analysis

The recorded data were all tabulated and systematically arranged treatment wise under three replications using Ms-Excel which were subjected to Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT-0.05 level) for mean separations using Gen stat software (Gomez & Gomez, 1984) [12].

## Results

### 1. Diversity of species

Among 387 individual 5 species of 4 subgenera were analyzed. Species were detected applying identification key developed by Williams *et al.* (2010) [36], An *et al.* (2014) and Saini *et al.* (2015). Each subgenera & species including their characteristics are described hereunder. In addition, the study describes habitat, altitude, and host-plant characters.

#### 1.1. Sub genus – Melanobombus, *Bombus* (Melanobombus) *eximus*

##### Features

Color-thorax with black hairs, orange hairs in its mid and hind tibiae & basitarsus.

Body-three segmented, queens measuring 28-30 mm long, worker male 18-19 mm and female workers 14-19 mm long.

Female labrum with lamella irregular and almost straight & about half of the labrum.

### Diversity

Females 2, habitat-agricultural plots, altitude-300.

#### 1.2. Sub genus - Festivobombus

##### *Bombus* (festivobombus) *festivus*

##### Features

Length of queen 22-25 mm and 12-17 mm-worker length. Thick pubescence is evenly present on the visible thorax and abdomen. Strongly infuscated wings. The lateral and basal margins of the clypeus are extremely protuberant, and they curve back to join the gena and supraclapeal region. The mesobasi tarsus' distoposterior is entirely spherical. The meta tibia's outer corbicular surface is shiny, smooth, and devoid of any long, stout hairs that protrude from the surface.

##### Distribution

Place-Rampur, altitude-300, Female-2, habitat-agricultural field, hp -*Allium sativum*. Female-2, habitat-home garden, hp- *Canna indica*, altitude-300.

Female-2, habitat - agricultural field, hp - *Solanum tuberosum*, Altitude- 250.

Female-1, habitat-forest, hp - *Jasminum humile*, Altitude-255. Female 1, habitat-agricultural field, hp- *Solanum tuberosum*.

Female-2, habitat- home garden, hp - *Dahlia pinnata*, Altitude -290.

#### 1.3. Sub genus - Orientalibombus

##### *Bombus* haemorrhoidalis

##### Features

They are a large species with totally black queen pubescence on the head and thoracic dorsum, white abdominal tergites 1 and 2, black abdominal tergum 3, and brick red tergites 4-5; worker with head, thorax, and abdominal tergum 3 totally black, yellow; abdominal tergites 1 and 2; abdominal tergites 4 and 5 are brick red; wings are firmly infuscated; pubescence is short and extremely even. Except for the malar space, the clypeus, a region laterals to and in front of the ocelli, and narrow stripes on the inner and post orbits, the head is completely covered in pubescence. Labrum having lateral tubercles that are prominent, a lateral lamella that is broad and takes up more than half of the labrum's basal width, and a basal transverse depression that extends apically as a deep median furrow between them.

##### Distribution

Altitude-300, female-2, habitat-agricultural land, hp-*Lantana sp.*

Altitude-310, female-1, habitat- agricultural field, hp *Aster karvinkianus*.

Altitude- 300, female-1, habitat-garden, hp -*Lavatera cachemiriana*.

Altitude- 307, female-1, habitat-garden, hp- *Lavatera cachemiriana*.

#### 1.4. Sub genus - Pyrobombus

##### a. *Bombus lepidus* Skorikov,

##### Features

Female- Head, pronotum, metanotum, abdominal tergites 1 and 2 is yellow, mesonotum, malar space, and tergum 3 is

black, and abdominal tergites 4-5 is brick red. Truncate, bean-shaped lateral tubercles on the anterior labrum's edge are divided in the middle by a shallow median depression that is the same length as the tubercle. The rest of the labrum is macro perforated, except for the raised section of the lateral tubercle. Unpunctured area adjacent to the lateral ocellus in the ocello-ocular region that is the same size as the lateral ocellus. One-fourth of the space between the lateral ocellus and the eye margin is covered by a band of punctures along the eye margin.

### Distribution

Altitude- 300, female-1, habitat - grassland, hp - *Trifolium repens*.

Altitude- 310, female-1, habitat- grassland, hp-*Anemone elongate*.

Altitude-300, female-2, habitat-forest, hp- *Jasminum humile*.

### b. *Bombus rotundiceps*

Female- The first three abdominal tergites pubescence are black and dingy yellow. Brick red describes the final 3. Except for the malar space, clypeus, the region laterals to and in front of the ocelli, and the short stripes on the inner and post orbits, the head is covered in heavy pubescence. Thick pubescence is evenly seen on the thorax and abdomen. Labrum with pronounced lateral tubercles that are slightly bluntly elevated and a deep median furrow between them that displaces the ridge between them to form a lamella that overhangs the apical border. The lateral and basal margins of the clypeus are substantially protuberant, and they curve back to connect the gena and the supraclypeal area, respectively.

### Distribution

Altitude- 300, female-1, habitat- agricultural field, hp - *Eiden Pilosa*.

Altitude-290, female-1, habitat-agricultural field, hp-*Stribilianthes tomentosa*.

Altitude-310, female-1, habitat-agricultural field, hp-*Impatiens glandulifera*.

Altitude- 312, female-1, hab-forest, hp - *Jasminum humile*

### Discussion

Species variation in the study sites were related to the local microhabitats, floral composition, and land use change. Due to the different microhabitat such as grassland, agricultural land, forest, and home garden of three sample sites, the distribution pattern of bumblebees' species was variable. Bumble bees have specific foraging limitation, they require proximity between landscape elements that provide nesting sites, foraging habitats, and undisturbed structures for hibernation (Diekotter *et al.* 2006) <sup>[10]</sup>.

The species richness, abundance, and foraging activities of bumble bees were affected by the diversity and abundance of flowering plant species, as well as vegetation architecture and height. Many *Bombus* species move to different foraging site as per their need of foraging, nesting, and nature (Carvell *et al.* 2002) <sup>[5]</sup>. The size, color, and shape of the flowers, the amount and making of pollen, the weather and time including the location are some of the variables that affect the floral composition of host plants (Tai *et al.* 2020) <sup>[28]</sup>. Different species of bumble bee have their own traits of foraging and flower visits. Shape of flower is most

important factor for these bees to visit the flower and site. Flowers have funnel-shaped that facilitate direct movement and make it easier to collect pollen and nectar. Symmetrical shape of flowers is mostly visited by the bumble bees (Moler 1995; Vaudo 2016) <sup>[29]</sup>. Instead of color and categories, host plant selection was heavily influenced by host plant families, plant height, shape of flower, and flower types (Bhusal *et al.* 2019) <sup>[2]</sup>.

During several field survey in the Chitwan district, over 150 bumble bee specimens were collected, belonging to 5 species. Out of 4 subgenera of *Bombus*, *B. festivus* was most abundant as the species of this subgenus inhabit in high alpine grassland, open grassland, semi-desert, and tropical site, short, medium or may have long tongue-length visiting shallow to deep flowers while subgenus *Melano Bombus* was least abundant as most species of this subgenus inhabit in higher altitude of the country (Williams *et al.* 2008) <sup>[34]</sup>. *Bombus festivus* was found more abundant because of its nature in visiting different flowers at lower altitude (Williams 1991; Streinzer *et al.* 2018) <sup>[31]</sup>.

### Conclusion

Chitwan Districts provide a variety of climatic settings for bumblebees. The research was carried out in different sites of Agriculture and Forestry (AFU) University, Chitwan, Nepal during April to August in 2018. A total of 150 bumble bee specimens were collected, and 5 species from 4 subgenera were identified. The *Bombus festivus* (subgenus: *Festivobombus*) was the most common species in the research area. *Bombus* (*Melanobombus*) *eximus*, *Bombus* (*festivobombus*) *Festivus*, *Bombus haemorrhoidalis*, *Bombus rotundiceps* and *Bombus lepidus* Skorikov were five species diversity studied in the research.

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