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Foraging Discrepancy of *Bombus* Species with Native Versus Non–native Flora in Chitwan Annapurna Landscape, Nepal

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ABSTRACT

We compared the foraging frequency of bumblebee (*Bombus* spp) with native versus non-native flowring plants in Chitwan Annapurna Landscape (CHAL). Specimens were collected using a sweeping net along the altitudinal gradients following an accessible walking trail between 600 to 3500 m asl. The random sampling was carried in different habitat types (agriculture, forest, grassland and home garden) along the transects. The relative frequency of *Bombus* species was significantly vary with the flowering plant (native types and non native cultivated, non native naturalized and invasive) in sampling rout along the altitudinal gradients. Some *Bombus* species were found to be foraged only to the specific plants within the study sites indicating that the specific flowering preference. The overall results indicated the differential foraging choice of *Bombus* species with native and non-native plant communities in the study area.

Key words: pollinators, foraging, host plants, *Bombus* spp, CHAL

INTRODUCTION

Many studies documented declines in insect pollinators, including bumblebees Bombus spp., globally (Goulson et al. 2015, Potts et al. 2016). Many factors are known to be driving this decline: land use change, habitat loss, pesticide use, biological invasion, pathogens; and possibly climate change (Goulson et al. 2005, 2015). Insect pollinators exhibit flower-visiting behaviors that influence on pollen dispersal and reproductive success of many plants. The spatial distribution, diversity and abundance of floral resources may also be important for maintaining community composition of insect pollinators including bumblebees (Osborne et al. 1999, Walther-Hellwig and Frankl 2000, Bhusal et al. 2019). Many ecological factors and plant features have been explained regarding the relationship between bee communities and the foraging host plants that crucial factors to alter the species richness, species diversity and abundance of the bumblebees (Potts et al. 2010) in the different habitats. The impacts of exotic plants on the pollination and reproductive success of natives have been widely reported; however, in spite of its importance for the invasive process, the role of native plants in the pollination and reproduction of exotic plants has been explored in different by different researchrs. However, knowledge is limited how the choice of flowers, foraging time, and the number of flowers visited by pollinators is determined to the success of pollination. In the current global change scenario, it is critical to understand how insect pollinators are affected by plant invasions (Carvallo et al. 2013) and vice versa.

Bumblebees forage in a very complex and and highly dynamics environment, where they obtain nectar and pollen vary widely among plant species. These resources are accompanied by myriad floral cues, including odors, color of flower, morphology, and spatiotemporal availability of host plants that may influence on foraging decisions(Brunet et al. 2015, Vaudo et al. 2015). It is known that the nonnative plants have the potential to cause direct and indirect impacts on those species, as well as the functioning of ecosystems (Mack et al. 2000). Some previous studies suggested that invasive plant species generally reduce the abundance and diversity of local and native plant species, which may affect alterations of pollinator communities (Biesmeijer et al 2006, Geib and Galen 2012, Geib et al. 2015). Bumblebees (*Bombus* spp) are widespread, efficient pollinators that are important for many native plant species and the reproductive success of many local crop species. The foraging relation of bumblebees is often difficult to investigate since it might be affected by range shifts of native flora, change of floral composition, and phenology under the current climate change scenario (Ogilvie 2017, Woodard 2017, Suzuki-Ohno et al. 2020). However, the mechanism of these interactions is not fully understood. The morphology, colour of the flower, and the foraging Bombus species are also important for the determination of the foraging behavior and the flower choice by bumblebees (Inouye 1980, Simonds and Plowright 2004, Raine and Chittka 2005). For example: the presence of pollen baskets on the hind legs, mandibles and a long tongue used to remove pollen grain from anther and to moisten the pollen grains with regurgitated droplet of nectar are some specific adaptive features of true pollinators community for the pollination success. Foraging behavior and preference by different bumblebee to a specific plants species with the particular evolutionary features such as shape and size of corolla and plant functional features also play a key feature in predicting reproductive success (Gomez et al. 2008, Ordano et al. 2008, Córdoba and Cocucci 2011). Many other ecological factors, the diversity and abundance of flora locally available to bumblebees, the distance between the nesting sites and foraging plants (Dramstad 1996, Walther-Hellwig and Frankl 2000, Goulson and Stout 2001) are also the notable factors for the foraging choice of many Bombus species. The foraging patterns of bumblebees especially focusing on native versus non-native flowering plants across altitudinal gradients is poorly studied theme from Hindu Kush Himalaya (Bhusal 2020) region including central Himalaya, Nepal. In this context, the exploration regarding the foraging choice of bumblebees is crucial especially with limited historical and current occurrence data from this region.

The floral abundance and density also affect the species-specific foraging patterns especially in alpine bumblebees (Shibata and Kudo 2020). There might be a functional relationship between flower characters and colour and particular bumblebee species. The Bombus species were significantly affected by the families of the host plants in both (open and closed) type of floral structures under high pressure of urbanization and land use change (Hulsmann et al. 2015, Bhusal et al. 2019). There is a growing debate on the benefit of native and non-native plants in landscapes levels especially for the pollinator's management concerns It is generally suggested that native plants support greater faunal diversity and biomass than non-native planting (Burghardt et al. 2008). It is known that non native species have many advantages over native species, such as faster growth and reproduction rates, higher ecological tolerance, or more effective dispersal mechanisms (Sladonja et al. 2018). The correlations between floral traits and pollen reward affected pollinator preferences and may facilitate selection of floral traits by specific bumblebee (Brunet et al. 2015). The outward preference of native fauna for native flora is often explained based on the long history of the association, the two having coevolved over millions of years While plants have evolved a variety of physical and chemical means to attract pollinators, those insects that have co-evolved with them are believed to be much more likely to have the specialized behavioral and physiological adaptations (Tallamy 2004). The co-evolutionary explanation may again partly support the apparent differences in pollinator preference between native and non-native plant species. The foraging response of Bombus species depends upon the colour, morphology and adaptation of flower-and bumblebee. With respect to the qualitative and quantitative changes in floral resources, bumblebees extensively forage multiple plant species. In general, studies of impacts of nonnative plant species on bumblebees' communities are much harder to perform It is suggested that non-native plants are a novel resource for the resident pollinator community, but may not be able to successfully attract pollinators if they have a specialized floral morphology (Bode et al. 2020). Some non-native provides benefits (including the economic and environmental benefits of increased pollination services) but others have negative impacts on native pollinators (Stout and Morales 2009). Impacts of invasive alien species on specialist and generalist bee taxa may differ and probably vary according to landscape context. Pollinator limitation may limit invasion success, but a plant able to attract many pollinators in different conditions will be a successful invasive species.

In this context, we hypothesized in this study that the foraging preference of Bumblebees (*Bombus* species) vary with native versus non-native plant species in the human-dominated heterogeneous Chitwan annapurna landscape (CHAL) Nepal.

MATERIALS AND METHODS

Study area

This study (Fig. 1) was carried out along an altitudinal gradient (from 500 to 3500 m asl) in three river valleys of the Chitwan Annapurna Landscape (CHAL) following Kaligandaki (west site), Marsyangdi (mid site), and Budhigandaki (east site) in central Nepal. These sites host diverse habitat types (agriculture, forest, grassland, and human settlements). The study area is rich in biodiversity and includes the Annapurna conservation area which is an important transit route for bird's migration, as well as for many endangered species including the snow leopard, red panda, and the Himalayan black bear (Oli et al. 1994, Adhikari et al 2019, Chetri et al. 2019). The landscape has a rich cultural heritage that harbors millions of people who have a high dependency on forest resources and ecosystem services especially on agriculture production and destruction of natural habitat by infrastructure development and land-use change. This area is particularly facing many threats under current climate change and facing the rapid invasion of some notorious invasive plants (Pandey et al. 2020, Bhusal et al. 2020) that might be affecting on native floral composition in term of reproductive success and competition for natural resources affecting on physiological and morphological abnormality that ultimately distressing on pollination process. In the long run, this competition adversely affecting on the maintenance of plant-pollinators interaction and ecosystem service of this landscape.

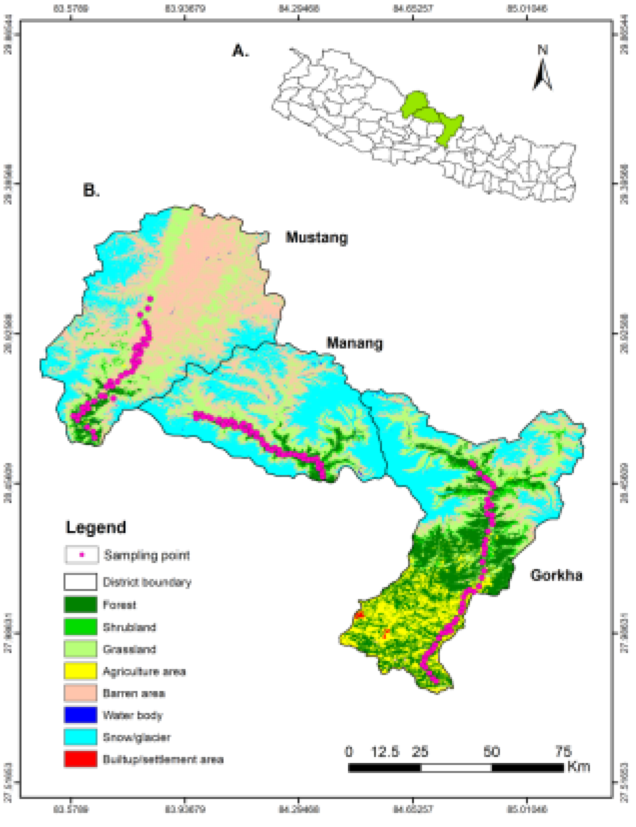

Figure 1. Study area showing GPS points of bumblebee collection

Bumblebee surveying and identification

Field surveys were conducted throughout the entire flowering season between April and November 2019. We followed three accessible walking routes (transects) along with the river valley sites (Kaligandaki, Marsyangdi, and Budhigandaki) of the study area. Extensive surveys were conducted along the three walking transects from 500 to 3500 m asl. Whenever a foraging bumblebee was detected at a particular point along the walking route, we observed around the flowering plants present there and the bumblebees on the site were collected and recorded. The survey was carried out between 9 hrs and 18 hrs (especially morning and afternoon time) when rain was absent and wind speeds were low. *Bombus* species were captured using an entomological net and immediately killed using ethyl acetate. During the survey, we also noted habitat types (agriculture, human settlement, and forest) altitude, and GPS location of the collection points were recorded. Specimens were stored in airtight containers with a few layers of tissue and the addition of a few drops of ethyl alcohol to prevent the growth of mold during transport. Specimens were subsequently dry-mounted using standard insect pins and deposited in the Entomological Museum of the Central Department of Zoology, Tribhuvan University, and Kathmandu (www.cdztu.edu.np). We collected 600 individuals workers and collected specimens were observed under a stereoscopic microscope and identified using published identification keys for adjacent regions (Williams 1991, Williams et al. 2009, 2010, An et al. 2014), and India (Saini et al.

2015)

Data analyses

The relative frequency composition of identified *Bombus* species was analyssed. We also, identificed plant species and were cataegorised: native type (NAT) and non native type. The non native species were further categoried into non native cultivated (CUL), non native invasive (INV) and non native naturalized (NNU). Similarly, the habitat types (forest, home garden, agriculture and grassland) were classified. We further divided the nature of the flower into open and close types of flowers. The number of foraging observation (response variables) of particular *Bombus* species with their host plants across the walking transit was analysised by performing linear mix effective model (lmm) in lme4 package in R. The category, habitat and nature of flower were applied and explanatory variables. A crosstab (two-way contingency table) was prepared between *Bombus* species (at the row) and category of plants and habitat types (at the Column). Meanwhile, the Chi-square (χ^2) level of significance (<005) was observed for each contingency table. Thus prepared data were subjected for cluster analysis and corresponding analysis (CA) to explore how closely *Bombus* species related to the particular habitat types and categories of foraging plants in the study area. Similarly, we calculated relative foraging presence of *Bombus* species in different flowering plant. If *Bombus* species were recorded more than 20 times in our sample categoried as very common (VC), if it is 10 to 20 categoried as common (C), if it is between 5 to 10 that it is categoried as rare (R), and if it is less than 5 categoried as very rare (VR) (Supplementary table 1).

RESULTS

We catagoried all the identified plants native and non native (INV, CUL, NNU) types of plants. The sum of the relative frequency conservation within non

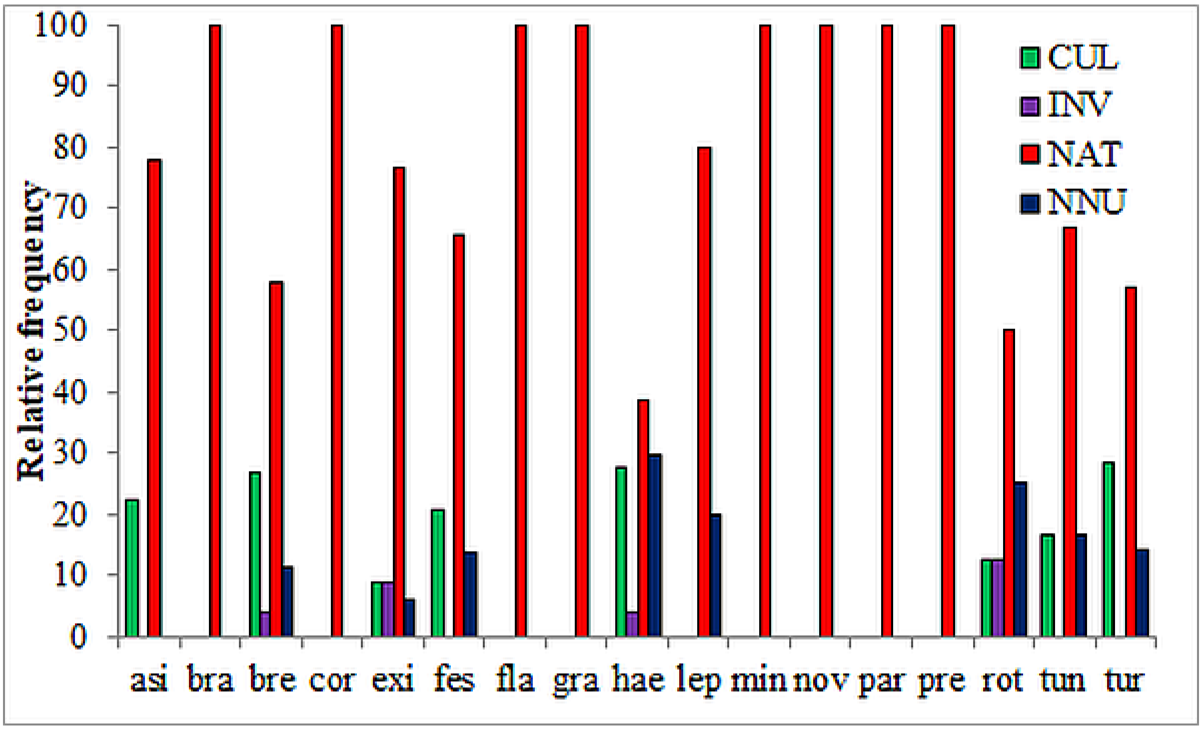

Figure 2. Relative abundance of *Bombus* species in different categories of plants: Native type (NAT), nonnative cultivated type (CUL), nonnative invasive type (INV) and nonnative naturalized (NNU); *Bombus asiaticus* – asi, *B. branickii*- bra, *B. breviceps* - bre, *B. cornutus*- cor, *B. eximius*- exi, *B. festivus*- fes, *B. grahami* - gra, *B. haemorrhoidalis*- hae, *B. lepidus*- lep, *B. miniatus*-min, *B. novus*- nov, *B. parthenius* - par, *B. pressus*-pre, *B. rotundiceps*- rot, *B. tunicatus*- tun, *B. turneri*- tur

native floral versus native flora was determioned. We resulted the frequency observation of identified bumblebees (χ^2 = 40.383, df = 16, p-value = 0.0006844) were significantly vary with native (NAT) and sum of the non native (CUL, INV, NNU) flowering plants (Fig. 2). In our study most of the species were found to be foraged in native type of flora. Whereas, only one species for example: *B. haemorrhoidalis* was found to be foraged relatively higher in non native group. Similarly, *B. rotudinceps* was found to be reported almost equally in both (native and non native) types of flora. Meanwhile, we carried out the frequency observation (Chi square value = 50.141, df = 16, p-value = 0.00002177) within the catagories of native and non native plants (Fig. 3). Similarly, we performed cluster analysis of the catagories of plants based on the relative foraging frequency of identified Bombus species, The corresponding analysis (CA) between foraging records of Bombus species versus categories of plants showed the well ordination (Fig. 4). We found most of the Bombus species were ordinate towards the native types of plants rather than non native types.

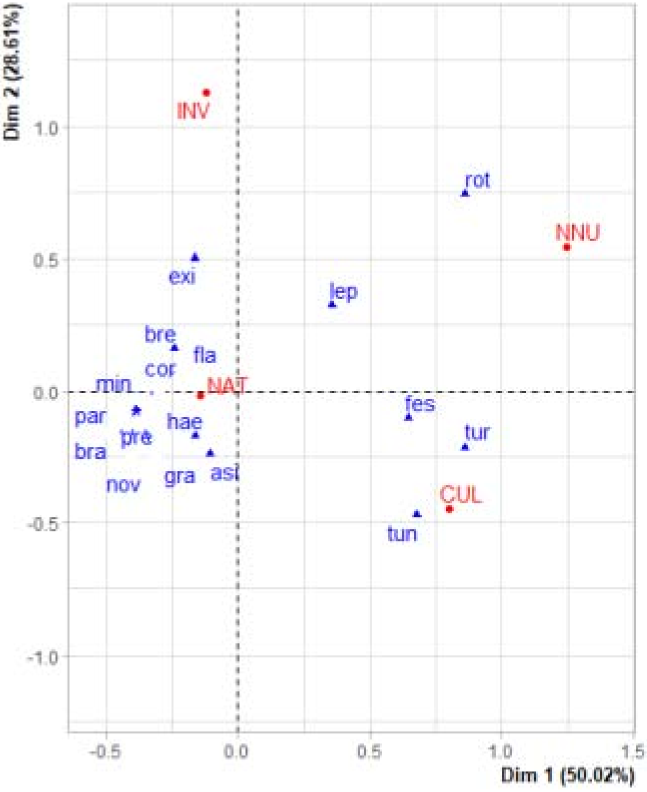

Figure 4. Corresponding analysis (CA) between plant categories and foraging records of *Bombus* species

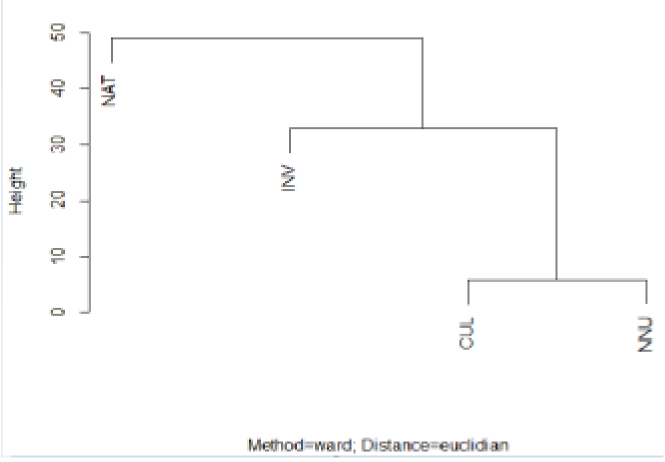

Figure 3. Cluster analysis plant categories of the basis of bumblebee foraging records

Effect of category of host plants, habitat types and nature of plants on foraging frequency of *Bombus* species

To find the effect of catagories, habitat types (Forest, seminatural, agricultural, home garden) and nature of flowers (open and close types of floweres) we performed linear mixed model (lmm) fitted by maximum likehood ['lmerMod']. We fitted the frequency (n= 248) of *Bombus* species observed along the transet with nature of flower as random factor whereas, category and habitate types were as fix explanatory factors in this model (Table 1). There was significant variation of category of foraged plants whereas no significant variation was observed within habitat types.

Table 1. Summary of Linear mixed model between number of bunblebee caught, plant categories and habitat fit by maximum likelihood ['lmerMod']

Fixed factors	**Estimate**	**Std. Error**	**t value**
(Intercept)	4.8261	0.7077	6.819
INV	1.9391	1.7319	1.12
NAT	2.0392	0.993	2.054
NNU	4.277	1.2085	3.539
Forest	-2.0791	1.0561	-1.969
Grassland	-1.8566	1.1028	-1.684
Home garden	-0.4548	1.0337	-0.44

Relative foraging frequency of *Bombus* species with flowering plant

We analysed the foraging preference based on our foraging records of *Bombus* species in different flowering plant in our samples. On the basis of relative foraging records of *Bombus* species in different flowering plant during the study we analysed as more very common (VC), Common (C), Rare(R) and very rare (VR). we found that certain *Bumbus* species were highly specific for the specific plant species and some were commonly found to be foreged in many types of host plants. The highest relative frequency of bumblebees has been found foraging the host plants were *Anemone elongate, Jasminum humile, Rosa brunonii, Solanum tuberosum* and *Trifolium repens*. In this study, *Bombus asiaticus* was generally foraged on wide range of plant species such as *Anemone elongata, Solanum tuberosum, Rosa brunonii, Jasminum humile, Impatiens stenantha, Glycine max, Cucurbita* sp., *Cirsium arvense, Cirsium falconeri*. Similarly, *B. branickii* was seen to be foraged only on *Rosa brunonii* in our study areas. *B. brevicep* was like to forage on *Clinopodium* sp., *Cucurbita pepo, Cirsium falconeri*. Other species such as *B. cornutus* was seen foraging on *Anemone elongata, Chirita bifolia, Jasminum humile*. In this study *B. eximus* was observed to be foraging mostly on *Jasminum humile* and *Bidens pilosa*. *B. festivus* was also seen to be foraging specially on *Jasminum* and *Trifolium* species. *B. flevesens* recorded on *Clinopodium* sp., *Cirsium arvense* and *Cirsium falconeri*. *B. graham* was mostly foraged on *Anemone elongata, Chirita bifolia, Colquhounia coccinea, Corydalis casimiriana, Gaultheria fragrantissima* during our field study. *B. haemorrhoidalis* was most commonly foraged on *Solanum viarum, Cuphea procumbens, Ipomoea purpurea*. *B. lepidus* foraged on *Jasminum humile, Anemone elongate* and *Cotoneaster frigidus*. We observed *B. miniatus* was only foraging on *Aconogonum molle*. *B. novus* was found to be mostly foraging on *Anemone elongata* in our field areas while *B. parthenius* was seen on the host plant of *Jasminum humile, Colquhounia coccinea* and *Imatiens scabrida*. Similarly, we found, *Rosa brunonii* was specific foraging host plant for *B. pressus*. *Bombus rotundiceps* was commonly found to be foraging on *Trifolium repens*, *Jasminum humile*, *Ophiopogon* sp., *Rosa brunonii*, *Solanum tuberosum*. *B. tunicatus* visited on *Anemone elongate* and *Anaphalis contorta*. Similarly *B. turneri* frequently foraged on *Rosa brunonii,* and *Solanum tuberosum*.

DISCUSSION

Overall foraging response of bumblebees community differed significantly between native and non native flora. Some Bombus species were found to be foraged only to the specific flowers within the study sites indicating that the specific flowering preference of certain bumblebees in the study area. In this study, most of the *Bombus* species were recorded to be foraged at native plants, while relatively few species were observed in non natives types. This result indicated that the native plants can benefit native pollinators rather that non native types of plant species. It is suggested, the flowers of non native plants are foraged on by native bees (Williams et al. 2011, Drossart et al. 2017), but whether they prefer native or non native plants is still unclear. In our study, the most foraging plant under the families were Rosaceae, Oleaceae, Ranunculaceae, Fabaceae and Asteraceae whereas, least foraging like Apocynaceae, Cactaceae, Cannabaceae, Iridaceae, Lauraceae, Liliaceae, Ophiopogon, Papaveraceae, Verbenceae and Viburnaceae. However, some previous studies (Westphal et al. 2003, Hanley et al. 2008) suggested that the plants under the certain selective families such as Fabaceae and Verbenaceae were the most attractive plants to visit the bumblebee workers. There is long debate about the spatial foraging preference of different insect pollinators including bumblebees with the local flora. Many researchers suggested, the foraging preference of *Bombus* species between native and non native type of flowers is probably assouciuated with the many ecological and evolutionary relation. Some The floral characters such as morphology, color and scent are probably associated with the attraction of the bumblebee (Stone et al. 2003, Cnaani et al. 2006, Fornoff et al. 2017) with their foraging plants. Moreover, it is linked with flower resources, structure of flower, and other adaptational relationship (Dotterl et al. 2005, Dobson 2006, Knudsen et al. 2006).

Beside this, the foraging distance (Elliott 2009), flower availability, flower cover and types of host plants (Williams and Osborne 2009) are the major determining factors for the plant -bumblebees (Goulson et al. 2008, Krishna and Keasar 2019) foraging relation. The effect of complexity of morphological characters of many non native flower species such as corolla length and of length of proboscis (Inouye 1980, Smithson and Macnair 1996, Dhzono et al. 2011) might be important for the rate of flower vistitation and flower use by native bumblebees species (Inoue and Yokoyama 2006) of this region. Moreover, the spatial foraging relation of the Bombus species depending on their behavioral plasticity and nutritional requirements (Delaplane and Mayer 2000, Shafir et al. 2003, Drossart et al. 2020). So the flowers of the host plants of these families being symmetrical with higher availability of nectar for foraging might be preferred more by bumblebee than the flowers from (Kells and Goulson 2003, Sepp et al. 2004, Bhusal et al. 2019). In the other hand, the occurrence of more feeding generalist *Bombus* species might be linked with foreging strength in native types of flora. Another reason can be more specialized interactions of generalist species with the native types of flora in our study sites. Therfore, their foraging patterns can vary with the range of plants available (Seitz et al. 2020). In the other hand, the regular flowering of (perennial) wildflower and the seasonal cultivated flowers and therefore bumblebees rely on additional floral resources that may have the some foraging biases in the local habitats with native and non native flora. Similarly, In case of non native flowers, had a few plant species in the early establishment phase might affect on the foraging patterns of bumblebee species in this area. The change in plant species composition from native to non native in the particular habitats may impacted on foraging patterns of bumblebees in this human dominated heterogenous landscape. The pollinator friendly plantings are often used to enrich habitats in bumblebee conservation efforts. More research that experimentally compares native versus non native pollinator friendly plants in this landscape, at different scales is essential. Thus, we recommend the bumblebees visitation to the particular native and non native flora be considered in future studies to ensure precise and accurate interpretations of foraging preference by different bumblebee species that can be implemented for the conservation point of view in this landscape.

In sum up, our findings suggest that the higher foraging frequency of *Bombus* species within native flora in our sampling effort. some *Bombus* species were found to be foraged only to the specific flowers within the native and non native categories indicating that the specific flowering preference of certain bumblebees. The future changes in land use pattern and climate change might affect on the future floral composition especially on native flora that will be the survival risk for many native species of Bombus from this region. For the more conclusive thought, detail study especially plant-bumblebees interaction will be necessary in furure.

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Supplementary table 1. Relative frequency of *Bombus* species in sampling sites with foraging in flowering plant. Frequency on more than 20 = very common (VC), 10 to 20 = common (C), 5 to 10 = rare (R), Less than 5= very rare (VR)

Plant species

Allium sativum (CUL), B. fes $^{(VR)}$
Abelmoschus esculentus (CUL), B. hae $^{(VR)}$
Anaphalis busua (NAT), B. exi $^{(VR)}$, B. fes $^{(R)}$
Anaphalis contorta (NAT) B. tun $^{(C)}$
Anaphalis griffithii (NAT) B. hae $^{(VR)}$
Anemone elongate (NAT), B. asi $^{(C)}$, B. cor $^{(VC)}$, B. exi$^{(VR)}$, B. fes$^{(VR)}$, B. gra $^{(C)}$, B. lep $^{(C)}$, B. nov $^{(VC)}$, B. tun $^{(C)}$, B. tur $^{(C)}$
Antirrhinum majus (NNU) B. exi$^{(VR)}$ n=1, B.tun$^{(C)}$
Bidens pilosa (INV), B. bre$^{(VR)}$, B. exi$^{(VR)}$, B. hae$^{(VR)}$, B. rot$^{(C)}$
Canna hybrid (CUL), hae$^{(VR)}$
Canna indica (CUL), fes$^{(VR)}$
Cannabis sativa (CUL), exi$^{(VR)}$
Cascabela thevetia (CUL), B. hae$^{(VR)}$
Cirsium verutum (NAT), B. bre$^{(VR)}$, B. exi$^{(VR)}$
Chrysojasminum humile (NAT), B. asi$^{(C)}$, B. bre$^{(VR)}$, B. cor$^{(VC)}$, B. exi$^{(C)}$, B. fes$^{(VC)}$, B. hae$^{(VR),}$ B. lep$^{(VC)}$, B. par$^{(VC)}$, B. rot$^{(C)}$, B. tun$^{(C)}$
Cirsium arvense (NAT), B. asi$^{(C)}$, B. exi$^{(R)}$, B. fla$^{(VC)}$, B. hae$^{(R)}$
Cirsium falconeri (NAT), B. asi$^{(C)}$, B.bre$^{(C)}$, B. exi$^{(VR)}$, B. fla$^{(VC)}$, B. hae$^{(VR)}$
Clinopodium umbrosum (NAT) B. bre$^{(VC)}$, B. fla$^{(VC)}$, B. hae$^{(VR)}$
Colquhounia coccinea (NAT), B. exi$^{(VR)}$, B. gra$^{(VC)}$
Corydalis casimiriana (NAT), B. gra$^{(VR)}$
Cotoneaster frigidus (NAT), B. hae$^{(VR)}$, B. lep$^{(VC)}$
Cucumis melo (NAT), B. hae$^{(VR)}$
Cucumis sativus (NAT), B. hae$^{(VR)}$
Cucurbita pepo (CUL), B. asi$^{(C)}$, B. bre$^{(VR)}$, B. exi$^{(R)}$, B. hae$^{(R)}$
Cuphea procumbens (NNU), B. bre$^{(VR)}$), B. hae$^{(R)}$
Dahlia pinnata (CUL), B. fes$^{(VR)}$, B. hae$^{(VR)}$
Duranta erecta (NNU), B. hae$^{(VR)}$
Elsholtzia fruticosa (NAT), B. hae$^{(VR)}$
Fagopyrum cymosum (NAT), B. fes$^{(VR)}$, B. hae$^{(VR)}$
Gaultheria fragrantissima (NAT) B. fes$^{(VR)}$, B. gra$^{(VC)}$
Glycine max (NAT), B. asi$^{(C)}$
Helianthus annuus (CUL), B. hae$^{(VR)}$
Henckelia bifolia (NAT), B. cor$^{(VC)}$, B. exi$^{(VR)}$, B. gra$^{(VR)}$
Hibiscus rosa-sinensis (NAT), B. hae$^{(VR)}$
Impatiens glandulifera (NAT), B. rot$^{(C)}$
Impatiens scabrida (NAT), B. bre$^{(R)}$, B. exi$^{(R)}$, B. hae$^{(R)}$, B. par$^{(VC)}$
Impatiens stenantha (NAT), B. asi$^{(C)}$, B.exi$^{(VR)}$
Ipomoea nil (NNU), B. hae$^{(VR)}$
Ipomoea purpurea (NNU), B. bre$^{(VR)}$, B. hae$^{(R)}$
Iris domestica (NAT), B. hae$^{(VR)}$
Koenigia mollis (NAT) B. min$^{(VC)}$
Lantana camara (INV), B. hae$^{(VR)}$
Lindera pulcherrima (NAT), B. exi$^{(VR)}$
Malva cachemiriana (NAT), B. fes$^{(R)}$, B. hae$^{(VR)}$
Neillia rubriflora (NAT), B. exi$^{(VR)}$
Ophiopogon parviflorus (NAT), B. rot$^{(C)}$
Opuntia orbiculata (NNU), B. ror$^{(C)}$
Parochetus communis (NAT), B. fes$^{(C)}$
Persicaria nepalensis (NAT), B. fes$^{(R)}$
Phaseolus vulgaris (NNU), B. fes$^{(R)}$, B. hae$^{(VR)}$
Prinsepia utilis (NAT), B. exi$^{(VR)}$, B. tur$^{(C)}$
Rosa brunonii (NAT), B. asi$^{(C)}$, B. bra$^{(VC)}$, B. bre$^{(VR)}$, B. fes$^{(VR)}$, B. pre$^{(VC)}$, B. rot$^{(C)}$, B. tur$^{(VC)}$
Rubus nepalensis (NAT), B. exi$^{(VR)}$, B. fes$^{(VR)}$, B. hae$^{(VR)}$
Scutellaria discolor (NAT) B. hae$^{(VR)}$
Solanum betaceum (CUL) B. hae$^{(VR)}$
Solanum lycopersicum (CUL), B. hae$^{(R)}$
Solanum melongena (CUL), B. hae$^{(VR)}$
Solanum tuberosum (CUL), B. asi$^{(C)}$, B. fes$^{(R)}$, B. hae$^{(VR)}$, B. rot$^{(C)}$, B. tun$^{(C)}$, B. tur$^{(VC)}$
Solanum viarum (NNU), B. hae$^{(R)}$
Strobilanthes attenuate (NAT), B. exi$^{(VR)}$, B. hae$^{(VR)}$
Trifolium repens (NNU), B. bre$^{(VR)}$, B. exi$^{(VR)}$, B. fes$^{(C)}$, B. lep$^{(VR)}$, B. rot$^{(C)}$, B. tur$^{(C)}$
Viburnum erubescens (NAT), B. exi$^{(R)}$, B. hae$^{(VR)}$
Vigna unguiculata (CUL), B. bre$^{(VR)}$, B. hae$^{(VR)}$