doi: http://dx.doi.org/10.3126/botor.v8i0.5558 © 2011 Central Department of Botany, Tribhuvan University http://www.nepjol.info/index.php/BOTOR

Research

Bee flora in mid hills of Central Nepal

Subodh Adhikari^{1†*} and Nar B. Ranabhat²

¹Amrit Campus, Tribhuvan University, Kathmandu, Nepal; ²University of Hohenheim, 70593; Stuttgart, Germany [†]Current address: Wichita State University, 1845 Fairmount, Wichita, KS 67260, USA

Abstract

Beekeeping is one of the promising ventures for economically poor families in Nepal. Knowledge about the bee flora of a certain area is very crucial for the farmers. A study was conducted in mid hills of Central Nepal during 2003-04 and 2008-09 to monitor the common plant species visited by bees with their visiting time and seasons. The flowering period of those plant species were also observed. Observations were made on the bees' activities on flowers of different plant species. Relevant information was also collected through informal key informant interviews. The plant species visited by the bees and the bee species (mainly Apis cerena with some Apis melifera) themselves were collected, preserved and identified. Plants were categorized as major, medium and minor sources of pollen and/or nectar. The pollen and nectar statuses in different plants were also determined. A total of 158 plant species were identified as main bee flora in the study area. Among them, 19 species were horticultural plants, 42 species were crop plants, 15 species were ornamental plants and 82 species were wild plants. In total, 38 species were recognized as major, 35 as medium and 30 as minor sources for both nectar and pollen. Months from March to May and August to October were the honey flow periods. Species of Brassica, Citrus, Pyrus, Berberis, Rubus, Callistemon, Bombox and Artemisia were some of the important plants which bloomed during those months. Winter (mid November to January) and rainy (June and July) seasons were identified as the dearth periods for bees to collect honey. Some of the plants that bloom during winter were Pisum sativum, Ipomoea batata and Eupatorium sp. Similarly, Lagerstroemia sp., Impatiens balsamina, Sesamum indicum, Zea mays and many cucurbits bloomed during rainy season. Study has shown that mid-hills of Central Nepal is rich in bee flora and has great potential for beekeeping as many plants bloomed even in dearth periods.

Key-words: beekeeping, dearth period, Honey flow, honey dew, nectar source, pollen source.

Introduction

Beekeeping is one of the promising ventures for economically poor families in Nepal. Owing to massive geographical variations enriched with biodiversity, several species of bees have been noticed (Joshi 1999). Similarly, the quality of the honey produced depends on the seasons and timing of the bees visiting diverse plant species. Many of the farmers engaged in beekeeping enterprise since long times have

enriched indigenous knowledge on plant species and quality of honey (Ranabhat 2010).

Bee floras are the major sources of nectar and pollen for the bees (Partap 1997). Knowledge about the bee flora of a certain area is very crucial for the beekeepers (farmers). Considerable research has been carried out in improved production of crops and fruits. However, the major aspect of crop production, the pollination system of bee flora, has been neglected. Pollination is even more important than quality of seeds, fertilizer and irrigation for better and higher production (Joshi 1999; Adhikari 2003). Bee pollination not only helps to produce seeds but also enhances quality and yield of seeds

e-mail: subodh.adhikari1@gmail.com, tel: 01-316-347-6753

and fruits of bee flora (Joshi 1999). Decline in fruits and seed production of different important plant species in the Hindukush Himalayan Region has been reported due to the decline of bee pollinators (Partap 1997; Partap and Partap 2001). About one third of the total human diet comes from bee pollinated crops and pollination value worth about 143 times more than honey production (Mishra 1989). Average global value of pollination system is \$ 117 ha⁻¹ yr⁻¹ (Costanza et al. 1997). Bee floras and their pollinators are greatly affected by environmental variables (Kearns and Inouye 1993). Flower development and opening, nectar secretion, anther dehiscence and seed development are all dependent on ambient temperature. Similarly, air temperature affects the activity of flower-visitors. Bees, the most important pollinators, can't go outside their hive in cold, foggy and rainy weathers (Adhikari 2003, 2010). Some evolutionary co-adaptation can also be seen between flowers and their bee pollinators (Macior 1990, Macior and Ya 1997). The present study was carried out to identify the existing bee flora and to prepare floral calendar for central region of Nepal.

Materials and Methods

STUDY AREA

This study was carried out during 2003 to 2004 in areas of three Village Development Committees (VDCs) of Kaski District (83°40' to 84°12' longitude and 28°06' to 28°36' latitude) viz. Kristi Nachne Chour, Nirmal Pokhari and Pumdi Bhumdi, and during 2008 to 2009 in areas of three VDCs of Lamjung District (82°41' longitude and 28°23' latitude) viz. Duradanda, Chandreswor and Neta. The altitude of the study area in Kaski ranges from 840 to 1525 m above mean sea level (m asl) and in Lamjung from 1050 to 1560 m asl (Ranabhat 2010). This altitudinal variation has created the environmental heterogeneity and ultimately the variation in biodiversity, especially the large varieties of flowering plants in different seasons. The climate is monsoonal. Normally, the monsoon begins in the month of June and attains a maximum in July. Kaski district receives the highest rainfall among all other districts of Nepal. About 70% of the annual rainfall takes place during the rainy season from June to August (Figure 1). The period September to November is dry and warm, December to February is cold and March to June is dry and hot (Figure 2). The climate in these regions is strongly

influenced by the Annapurna Range with Mount (Mt.) Annapurna (8091 m asl), Mt. Machhapuchhre (6993 m asl), Mt. Dhaulagiri (8167 m asl) and Mt. Lamjung (6983 m asl) (NTB 2010).

METHODS

The first field data were collected during September, October and December of 2003, and January, April and May of 2004; the second field data were collected during June, July, August and November of 2008, and February and March of 2009. Field data were collected through survey, which included observation of bees' activities on flowers of different plant species, and the collection and preservation of plant and bee

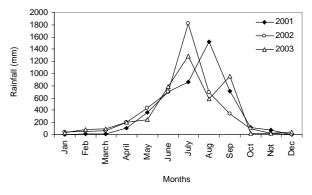


Figure 1. Rainfall measured during the different months taken consecutively for three years (2001 to 2003) (source: DHM 2004).

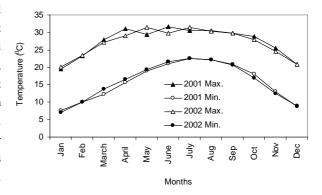


Figure 2. Temperature during the different months taken consecutively for three years (2001 to 2003) (source: DHM 2004).

specimens. The specimens of plants were identified at Tribhuvan University Central Herbarium (TUCH), and the specimens of bees at the Central Department of Zoology and Natural History Museum of Tribhuvan University, Kathmandu Nepal. The location of hive and the surrounding flora were also examined. The major bee foraging plants were further verified by direct observation. The foraging plants were marked and observed on three seasons in Sep/Oct, Dec/ Jan, April/May and Jun/July. The observations on nectar and pollen source were based on activities performed by honeybees on different flowers. The flowers where the honey bees extended their proboscis into the deep region were considered as sources of nectar, and the flower on which bees were observed with pollens on their hind legs were considered as sources of pollens (Bista and Shivakoti 2000-2001). Honeydew plants were considered to those plants from which honey bees collected propolis (a waxy resinous substance that comes from buds and useful in making bee hive).

The sources and their status were determined by the time invested by bees on the flowers (<5 seconds or 5-20 seconds or >20 seconds), frequency of bees' visits (<2 times/ 30 minutes or 2-5 times/30 minutes or >5 times/30 minutes) and flowering duration (time up to when a flower blooms) of source plant (<2 days or 2-5 days or >5 days). The plant species were categorized into major (designated as N1P1), medium (N2P2) and minor (N3P3) sources of pollen and/or nectar depending upon their resource potentials (presence and abundance of pollen, nectar and honeydew).

Additional information like most visited plant species by bees and their flowering time were obtained from the beekeepers of the nearest village through interview with structured questionnaire individually. Ninety beekeepers (50 from Kaski and 40 from Lamjung), out of total 230, were randomly selected and interviewed.

Results

NECTAR AND POLLEN SUPPLY

The plant species were mostly visited by Apis cerena with some Apis melifera. A total of 158 plant species were identified as important bee flora in the study area. Among them, 76 plant species were cultivated (19 horticultural species, 42 crop species and 15 ornamental species) and 82 species were wild (Table 1). Out of 158, 38 species were recognized as the major (N1P1), 35 as medium (N2P2) and 30 as minor (N3P3) sources for both nectar and pollen. Similarly, 52 species were identified as major sources of nectar (N1), 52 medium (N2) and 44 minor (N3). Similarly, 54 species were identified as major sources of pollen (P1), 54 medium (P2) and 48 minor (P3) (Table 1). Out of 158 species, plants having both nectar and pollen with their same status (i.e. N1P1, N2P2 and N3P3) were more (65.19%) than the plants having unequal status (N1P2, N1P3, N2P1, N2P3, N3P1 and N3P2) of pollen and nectar. N1P1 (major pollen and nectar sources) was found to be proportionately higher in horticultural plants (57.89%) than in other plants (23.81% in crops, 13.33% in ornamental and 18.29% in wild species). Similarly, N2P2 (medium sources) was proportionately higher in wild plants (26.83%) than in other plants (20% in ornamentals, 19.05% in crops, and 10.53% in horticultural plants); whereas, N3P3 (minor source) was higher in ornamental plants (40%) than in other plants (28.57% in crops, 12.20% in wild and 10.53% in horticultural plants) (Table 1).

Citrus spp., Litchi chinensis, Prunus persica, Psidium guajava, Pyrus communis among horticultural plants; Brassica spp., Cucumis sativus, Cucurbita maxima, Guizotia abyssinica, Helianthus annus, Raphanus sativus and Sesamum indicum among agricultural crops; Callistemon citrinus, Grevillea robusta and Impatiens sp. among ornamental plants and Aesandra butyracea, Bombax ceiba, Dalbergia sissoo, Elaeagnus parvifolia, Engelhardia spicata, Eucalyptus sp., Grewia optiva, Lagerstroemia parviflora, Myrica esculenta, Prunus cerasoides, Rhododendron arboreum, Syzygium cumini and Trifolium repens among wild plants were the important bee floras of the study area as they were identified as the major sources of both nectar and pollen (Appendix 1-4).

The honeydew plants identified were Berberis aristata, Fraxinus floribunda, Juniperus sp., Phyllanthus emblica, Pinus roxburghii, Rubus ellipticus, Saccharum officinarum, Sapium insigne and Syzygium cumini. Honeydew was a less important floral cue compared to pollen and nectar as the honeydew was present in very limited plant species (less than 8% of the total plants examined) (Table 1). Plant species like Alnus nepalensis, Ricinus communis, Shorghum vulgare and Zea mays were visited by bees only for pollen; whereas, Mentha spicata was visited only for nectar (Appendix 1-4). However, honey from some plants, like Lyonia ovalifolia, according to farmers, is poisonous to human health. Same results were

Table 1. Nectar and pollen statuses of different plants found in study area.

Plants							Source	es and s	tatuses	of poll	en and	necta	r					
	N1	N2	N3	P1	P2	Р3	N1 P1	N2 P2	N3 P3	N1 P2	N1 P3	N2 P1	N2 P3	N3 P1	N3 P2	H1	Н2	НЗ
Horticultural plants (19 species)	11	4	3	13	2	3	11	2	2	0	0	1	1	1	0	1	0	0
Crop plants (42 species)	13	10	17	13	11	17	10	8	12	1	2	0	1	1	2	0	0	0
Ornamental plants (15 species)	5	3	7	3	5	7	2	3	6	2	1	0	0	1	0	0	0	0
Wild plants (82 species)	23	35	17	25	35	21	15	22	10	5	3	6	7	2	5	1	6	4
Total plants (158 species)	52	52	44	54	54	48	38	35	30	8	6	7	9	5	7	2	6	4

Note: N1 = major nectar source, N2 = medium nectar source, N3 = minor nectar source, P1 = major pollen source, P2 = medium pollen source, P3 = minor pollen source, H1 = major honey dew source, H2 = medium and H3 minor honey dew source.

also reported by Bista and Shivakoti (2000-2001) and Kafle (1992).

HONEY FLOW AND DEARTH PERIODS

The period from March to May and then from August to October were the main honey flow periods because most of the plants bloomed in these months and environment was also favorable for bees' activities (Table 2). Among these months too, March-April was the most favorable period for honey production. The plant species Berberis aristata, Bombax ceiba, Brassica spp., Callistemon citrinus, Citrus spp., Mangifera indica, Rubus ellipticus were some of the major sources of honey during these months. The period from November to February (the colder months) was the dearth period i.e. not favorable for the honey bees. The species bloomed during this time were Euphorbia pulcherrima, Fagopyrum esculentum, Solanum tuberosum, Pogostemon glaber, Hypericum spp. and Brassica spp. Similarly, June and July (the rainy months) were also not favorable for the bees (Figure 3). Though relatively more flowers were bloomed during rainy season, due to heavy and continuous rain, bee foraging was found to be limited. Horticultural plants mainly flowered during March-April, crops during July-September, ornamental plants throughout the year (mainly August-September and April-May), and wild plants during April-May. Some ornamental plants like Malvaviscus sp., Salvia sp. and Verbena sp. bloomed throughout year.

Discussion

Altogether 158 plant species were identified as bee flora in the study area, and they bloomed in different seasons. Out of which, plants having both nectar and pollen with their same status were more than the plants having unequal status of pollen and nectar indicating a positive relationship of the presence of two major floral cues, i.e. nectar and pollen in the flowering plants. Our results indicated that if a plant species is a major source of nectar, it is likely that the same plant species would also be major source of pollen. Horticultural species were more important as sources of nectar and pollens than other categories. Therefore, plantation of horticultural species seems to be more effective than the other kinds of plant species for bee keeping.

March and April has been identified as the main honey flow season. Similarly, the winter season, with low temperature, short sunshine period and availability very few flowering plants, has been identified as the critical dearth period. Study has already revealed that the rainy and cold weather mostly reduces bees' activity (Adhikari 2003, 2010; Kearns and Inouye 1993). However, there were some plants which bloomed during winter, including Pisum sativum, Ipomoea batata and Eupatorium sp. Similarly, Lagerstroemia sp., Impatiens balsamina, Sesamum indicum, Zea mays and many cucurbits bloomed during rainy season.

The inevitable and obligate role of pollination makes it clear that the conservation of pollination systems is an important priority for all (Adhikari 2003). The declining apple

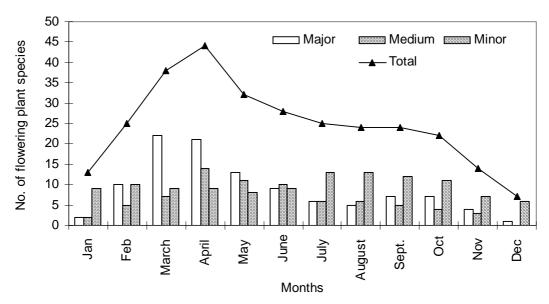


Figure 3. Different plants flowering in different months of the year.

Table 2. Number of species of different categories in bloom during different months.

Plants	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Horticultural plants (fruits)	3	8	14	11	5	2	1	1	2	2	1	1
Crops (cereals, vegetables, pulses)	5	12	13	8	6	12	18	14	17	12	9	6
Ornamental plants	4	4	7	9	9	7	7	10	9	6	4	4
Wild plants	4	16	28	36	34	30	27	25	25	18	11	2
Total	16	40	62	64	54	51	53	50	53	38	25	13

production in the Hindukush Himalaya has been attributed to the loss of local/wild pollinators and consequently to the inadequate crop pollination (Partap and Partap 2001; Ahmad *et al* 2002; Adhikari 2003, 2010). Managed/controlled pollination of crops has been a largely neglected part of our agriculture system. By exploring the knowledge about bee flora and conserving them, the production of honey and the agri-products can be increased to a larger amount (Partap 1997). Encouraging farmers for horticultural farming of extremely important bee flora, as reported in this study, can help to increase the socio-economic status of farmers; the more bees, the more honey and fruit production.

The present study has shown that the mid-hills of Central Nepal is rich in bee flora and has great potential for beekeeping as many plants bloomed even in dearth periods. However, the results presented here are only preliminary. In the future studies, the use of sophisticated methods to understand the co-evolution of bees and bee floras, and to measure relative

importance of plant species as sources of pollen and nectar would generate more reliable data. Pollination ecology of each plant would give more clear and valid picture of bee flora.

Acknowledgements

The authors are highly grateful to the local farmers of the study area for sharing their valuable knowledge. Thanks are also due to two anonymous reviewers for their valuable comments on the earlier versions of the manuscript.

References

Adhikari S. 2003. Floral Phenology and Pollination Ecology of Pedicularis dendrothauma R. R. Mill and D J Allard in Sikles (ACAP) Kaski, Nepal. M.Sc. Thesis, Central Department of Botany, Tribhuvan University, Kathmandu, Nepal.

- Adhikari S. 2010. Floral phenology and pollination ecology of Punica granatum L. in Kathmandu, Nepal. Nepal Journal of Science and Technology 11: 115-124.
- Ahmad F., Partap U., Joshi S.R. and Gurung M.B. 2002. Why The Hindu Kush Himalayan (HKH) Region Needs the Native Hive Honeybee Apis cerana? Briefing Paper, International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.
- Bista S. and Shivakoti C.P. 2000-2001. Honey bee flora at Kabre, Dolakha District. Nepal Agriculture Research Journal 4-5: 18-25.
- Costanza R., d'Arge R., de Groot R., Farberk S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neill R.V., Paruleo J., Raskin R.G., Sutton P. and van den Belt M. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 253-260.
- DHM 2004. Climatological Records of Nepal. Department of Hydrology and Metrology, Babarmahal, Kathmandu, Nepal.
- Joshi S.R. 1999. Physico-chemical and Melisso-palynological Characteristics of Nepalese Honey. Ph.D. Dissertation, University of Agricultural Sciences, Vienna, Austria.
- Kafle G.P. 1992. A general survey of bee flora in and around Kathmandu valley. Nepalese Journal of Agriculture 15: 89-

- Kearns C.A. and Inouye D.W. 1993. Techniques for Pollination Biologists. University Press of Colorado, Niwot, Colorado, USA.
- Macior L.W. and Ya T. 1997. A preliminary study of the pollination ecology of Pedicularis in the Chinese Himalaya. Plant Species Biology 12: 1-7.
- Macior L.W. 1990. Pollination ecology of Pedicularis punctata Decne. (Scrophulariaceae) in the Kasmir Himalaya. Plant Species Biology 5: 215-223.
- Mishra R.C., Kumar J. and Gupta J.K. 1989. A new approach to the control of predatory wasps (Vespa spp.) of the honey bees Apis mellifera L. Journal of Apiculture Research 28: 126-131.
- NTB 2010. Himalayan Peaks of Nepal. Nepal Tourism Board, Kathmandu, Nepal.
- Partap U. 1997. Bee Flora of the Hindukush-Himalayas. Inventory and Management. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.
- Partap V. and Partap T. 2001. Declining Apple Production and Worried Himalayan Farmers: Promotion of Honeybees for Pollination. Issues in Mountain Development Vol. 1. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.
- Ranabhat N.B. 2010. Beekeeping: Indigenous Practice in the Mid-hills of Nepal. LAP LAMBERT Academic Publishing AG & Co. KG., Germany.

Appendix 1. Bee floral calendar for horticultural plants (19 species).

N	Scientific name	Common name	Local/Nenali name	Sources					Flowering months	nom su	ths				
				and status	Jan	Feb	Mar Apr	May	unſ	Jul	Aug	Sep	0ct	Nov	Dec
⊣	Artocarpus heterophyllus	jackfruit	rukhakatar	N3P3											
2	Carica papaya	papaya	mewa	N1P1											
3	Citrus aurantifolia	lime	kagati	N1P1					Ī						
4	Citrus grandis	shad dock	bhogate	N1P1											
2	Citrus limon	lemon	nibuwa	N1P1											
9	Citrus medica	citron	bimiro	N1P1											
7	Citrus sinensis	sweet orange	mansum	N1P1											
8	Citrus reticulata	mandarin orange	suntala	N1P1											
6	Litchi chinensis	litchi	litchi	N1P1				Ì							
10	Mangifera indica	mango	aanp	N2P2											
11	Morus alba	mulberry	kimbu	N2P2				Ì							
12	Musa paradisiaca	banana	kera	N2P3											
13	Prunus domestica	mnld	aarubakhada	N2P1											
14	Prunus persica	peach	aaru	N1P1											
15	Psidium guajava	guava	belauti	N1P1											
16	Punica granatum	pomegranate	anar	N3P1						Ì					
17	Pyrus communis	pear	naspati	N1P1					Ī					İ	
18	Saccharum officinarum	sugarcane	ukhu	H1											
19	Vitis vinifera	grape	aangur	N3P3											

Note: N1= major nectar source, N2= medium nectar source, N3= minor nectar source, P1= major pollen source, P2= medium pollen source, P3= minor pollen source, H1= major honey dew source, H2= medium and H3 minor honey dew source.

Appendix 2. Bee floral calendar for crops (vegetables, cereals, pulses and others; 42 species).

Flowering months	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec																														
Sources	status	N2P2	N2P3	N3P3	N1P1	N1P1	N1P1	N1P1	N2P2	N2P2	N2P2	N3P3	N3P3	N1P3	N3P2	N1P1	N1P1	N2P3	N1P2	N3P3	N1P1	N1P1	N2P2	N3P2	N3P3	N1P3	N2P2	N3P3	N3	N3P3	N3P3
Local/Nepali name		chiple vindi	piyaj	lasun	tori	sarsyun	rayo	kalo tori	cauli	banda gobi	salgam	rahar	khursani	chana	dhania	kakro	pharsi	gajar	phapar	bhattmas	jhuse til	suryamukhi	sakharkhanda	chamsur	lauka	moosuro	ghiroula	golbheda	pudina	karela	silam
Common name		lady's finger	onion	garlic	mustard	sarson	leaf mustard	black mustard	cauliflower	cabbage	turnip	pigeon pea	chilli	gram	coriander	cucumber	pumpkin	carrot	buckwheat	soyabean	niger	sunflower	sweet potato	lettuce	bottle gourd	lentil	spongegourd	tomato	mint	bitter gourd	perila
Scientific name		Abelmoschus esculentus	Allium cepa	Allium sativum	Brassica campestris	Brassica campestrisvar. sarson	Brassica juncea	Brassica nigra	Brassica oleracea var. botrytis	Brassica oleracea var. capitata	Brassica rapa	Cajanus cajan	Capsicum annum	Cicer arietinum	Coriandrum sativum	Cucumis sativus	Cucurbita maxima	Daucus carota	Fagopyrum esculentum	Glycine max	Guizotia abyssinica	Helianthus annus	Ipomoea batata	Lactuca sativa	Lagenaria siceraria	Lens culinaris	Luffa cylindrica	Lycopersicum esculentum	Mentha spicata	Momordica charantia	Perilla frutescens
S.N		1	2	3	4	2	9	7	8	6	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	53	30

Appendix 2. contd...

N	0		I amon ilonol/ lea - I	5				E		2 44				
N.	Scientific name	common name	Local/ Nepan name	Sources				FIC	Flowering months	ntns				
				status	Jan Feb	Mar	Apr	May]un Jul	l Aug	Sep	Oct	Nov	Dec
31	Phaseolus mungo	black gram	mash	N3P3								m		
32	Pisum sativum	pea	kerau	N3P3								5		
33	Raphanus sativus	radish	mula	N1P1										
34	Sechium edule	chayote	Iskush	N2P2										
35	Sesamum indicum	sesame	seto til	N1P1				,,,,,,,						
36	Shorghum vulgare	sorghum	jau	P1										
37	Solanum tuberosum	potato	aalu	N3P3					-					
38	Trichosanthes anguina	snake gourd	chichindo	N3P3				******				m		
39	Vicia faba	broad bean	bakulla	N3P1								3		
40	Vigna sinensis	cow pea	bodi	N3P3				#2222						
41	Vigna umbellata	red bean	masyang	N2P2				4						
42	Zea mays	maize	makai	P1				4444						-
S.N	Scientific name	Common name	Local/Nepali name	Sources				Ē	Flowering months	onths				Ì
					Jan Feb	Mar	Apr	May	lul nul	ıl Aug	Sep	Oct	Nov	Dec
1	Amaranthus cruentus	garden amaranth	lattephool	N3P3										
2	Callistemon citrinus	bottle brush	kalkiphool	N1P1									13333	
3	Chrysanthemum morifolium	chrysanthemum	godawari	N3P3									ı	
4	Euphorbia pulcherrima	poinsettia	lalupate	N3P3								l		
2	Grevillea robusta	silky oak	kainyo phool	N1P1										
9	Hibiscus rosa- sinensis	chinese rose	ghantiphool	N1P2										
7	Impatiens balsamina	pink balsam	tigre phool	N1P2								1		
8	<i>Impatiens</i> sp.	balsam	rangi phool	N2P2		•								
6	Jacaranda mimosifolia	jacaranda tree	nil phool	N3P3								ı		
10	Malvaviscus arboreus	malva	khursaniphool	N2P2										
11	Ocimum sanctum	tulasi	tulsi	N2P2		'								
12	Rosa hybrida	rose	gulab	N3P1										
13	<i>Salvia</i> sp.	salvia	ramtulasa	N1P3										
14	Tagetes erecta	marigold	sayapatri	N3P3										

Appendix 4. Bee floral calendar for wild plants (82 species).

	Sep Oct Nov Dec																															
Flowering months	Feb Mar Apr May Jun Jul Aug																															
ces	and Jan status	N1P1	N3P3	N3P2	N3P2	P1	P2	N2P2	N2P2	N3P3	N1P3	N3P2	N2P2H2	N3P2	N1P1	N2P3	N2P1	N2P2	N2P2	N2P2	N2P2	N3P3	P3	N3P3	N1P1	P2	N1P1	N3P3	N1P1	N1P1	N1P2	N1P1
Local/Nepali	name	chiuri	ketuki	gande jhar	siris	uttis	seto ekli ghans	sarpa makai	titepati	jhar	neem	tanki	chutro	kuro	simal	gayo	simtaro	ganja	katush	lapsi	bohori	chinchine	oqnp	jibre jhar	sissoo	bhringe raj	gunyali	rudrakhsha	mauwa	tindu	phaledo	masala
Common name		indian butter tree	century plant	common weed	albizia	alder	•	cobra lily	mug wort	starwort	margosa	geranium tree	barberry	spanish needle	silk cotton	gayo	butterfly bush	hemp	chestnut	hog plum	bohori	sanhemp	dub grass	hounds tongue	sissoo			bead tree		,	coral tree	eucalyptus
Scientific name		Aesandra butyracea	Agave americana	Ageratum conyzoides	Albizia sp.	Alnus nepalensis	Anaphalis busua	Arisaema sp.	Artemisia indica	Aster sp.	Azadirachta indica	Bauhinia purpurea	Berberis aristata	Bidens sp.	Bombax ceiba	Bridelia retusa	Budleja asiatica	Cannabis sativa	Castanopsis indica	Choerospondias axillaris	Cordia dichotoma	Crotalaria juncea	Cynodon dactylon	Cynoglossum sp.	Dalbergia sissoo	Eclipta prostrata	Elaeagnus parvifolia	Elaeocarpus sphaericus	Engelhardia spicata	Eriobotrya sp.	Erythrina stricta	Eucalyptus sp.
S.N		1	2	3	4	2	9	7	8	6	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	53	30	31

Appendix 4. contd...

Flowering months	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec																																
Sources	and status	N2P2	N1P3H3	N2P3	N1P1H2	N3P3	N3P1	N2P1	N3P3	Н3	N2P2	N1P1	N3P1	N3P3	N2P2	N2P2	N2P2	N2P3	N2P2	N2P2	N3P2	N2P2	N1P1	N2P2	N2P2	N2P2	N2P2H2	P1H3	N2P1	N2P2	N1P1	N2P2	N2P1
Local/Nepali	name	bhui ainselu	lankuri	gyanjak	shyal phusre	ghottapre	aareli	pyauli phul	sajiwan	dhupi	asuro	asare phool	epilepil	kutmero	angeri	damaru	bilaune	Tapre jhar	bakaino	chanp	lazzawati	dhobini	kafal	siundi	chari aamilo	bhuin amala	amala	sallo	ishabgol	rudilo	painyu	mayal	bhalayo
Common name		alpine strawberry	ash tree	gentiana	bhemal		hypericum		jatropha	juniper	basak	crape myrtle	epilepil	meda	lyonia		ı	ı	china berry	chap	touch me not	paper chase	bay-berry	prickly pear	creeping sorrel		gooseberry	pine	plantago	pogestemon	wild cherry	wild pear	nepal sumac
Scientific name		Fragaria nubicola	Fraxinus floribunda	Gentiana pedicellata	Grewia optiva	Hydrocotyle nepalensis	Hypericum cordifolium	Hypericum sp.	Jatropha curcas	Juniperus spp.	Justicia adhatoda	Lagerstroemia indica	Leucaena leucocephala	Litsea monopetala	Lyonia ovalifolia	Maclura cochinchinensis	Maesa chisia	<i>Mazus</i> sp.	Melia azederach	Michelia champaca	Mimosa pudica	Mussaenda roxburghii	Myrica esculenta	Opuntia monacantha	Oxalis corniculata	Phyllanthus virgatus	Phyllanthus emblica	Pinus roxburghii	Plantago major	Pogostemon glaber	Prunus cerasoides	Pyrus pashia	Rhus wallichi
S.N		33	34	32	36	37	38	39	40	41	42	43	44	45	46	47	48	49	20	21	52	23	54	22	26	22	28	26	09	61	62	63	64

Appendix 4. contd...

Flowering months	Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec																		
Sources	and status	P2	N1P1	N1P2H1	N2P1	N2P3H2	N1P2	N1P2	N3P3	N2P3	N2P3	N1P1H3	N1P1	N2P3	N2P2	N1P1	N3P3	N1P2	N1P3
Local/Nepali	name	ader	laliguras	ainselu	bainsh	khirro	chilaune	sal	mulapate	tike jhar	kyamun	jamun	barro	tooni	aankhi tare	tinpate	rahune jhar	simali	bayar
Common name		caster oil	rododendron	raspberry	willow plant		needle wood	sal		•		jam bolan	myrobalan			clover		indian privet	jujube
Scientific name		Ricinus communis	Rododendron arboreum	Rubus ellipticus	Salix babylonica	Sapium insigne	Schima wallichii	Shorea robusta	Sonchus asper.	Stellaria vestita	Syzigium operculata	Syzygium cumini	Terminalia belerica	Toona ciliata	Trichilia connaroides	Trifolium repens	Vernonia sp.	Vitex negundo	Zizyphus sp.
S.N		92	99	29	89	69	70	71	72	73	74	75	9/	77	78	79	80	81	82

Note: N1= major nectar source, N2= medium nectar source, N3= minor nectar source, P1= major pollen source, P2= medium pollen source, P3= minor pollen source, H1= major honey dew source, H2= medium and H3 minor honey dew source.