

Preparation of a Floral Calendar of Honey Plants of Kangra and Adjoining Areas of Himachal Pradesh

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Abstract: Beekeeping industry, one of the important agricultural and forest based rural industries in India, is mainly involved in production of commercial quantities of honey, using essentially colonies of the Indian hive bee, *Apis cerana*. Beekeeping is entirely dependent on the types of flowering plants available in any given area. It is not only the total abundance, that is only important, but also the duration of time for which bee forage is available. Nectar and pollen are the raw materials of beekeeping industry. Pollen analysis of honey shows the possibility of determining the botanical, geographical and ecological origin of honey from the pollen grains they contain. Therefore, microscopic analysis of some honeys conducted from Kangra and adjoining areas of Himachal Pradesh so as to identify important pollen and nectar sources of this region. *Centaureacynus*, *Helianthusannus*, *Taraxacumofficinale*, *Bombaxceiba*, *Brassica* sp., *Erucasativa*, *Raphanussativus*, *Rhododendron arboreum*, *Carica papaya*, *Cucurbita* spp., *Terminalia* spp., *Kalanchoeintegrata*, *Cucumis* spp., *Delbergiasissoo*, *Trifolium* spp., *Acaciacatechu*, *Aesculusindica*, *Woodfordiafruticosa*, *Moringaoleifera*, *Callistemoncitrinus*, *Eucalyptuscaldulensis*, *Psidiumgaujara*, *Syzygiumcumini*, *Sesamumindicum*, *Grevillearobusta*, *Eriobotryajaponica*, *Prunusamygdalus*, *prunusarmeniaca*, *Pyruspersica*, *Citrus* spp., *Litchichinensis*, *Sapindusmukorosii*, *Camelliasinensis* and *Grewiaoptiva* were major sources of pollen and nectar to honeybee in Kangra and its adjoining areas, whereas, *Adhatodavastica*, *Justiciapubigera*, *Acer* spp., *Carissa caranda*, *Asclepiascurassavica*, *Cardusonopardios*, *Dahlia pinnata*, *Zinnia elegans*, *Impatiensglandulifera*, *Berberis* spp., *Brassica* spp., *Cardamine* spp., *Opuntiaspp.*, *Cannabissativa*, *Benincasa* spp., *Emblicaofficinale*, *Acacia arabica*, *Cassiafistula*, *Erythrinasuberosa*, *Delonixregia*, *Indigoferasp.*, *Salvia* spp., *Lagerstroemiaindica*, *Abelomoshusculentus*, *Althaearosea*, *Hibiscus rosa-sinensis*, *Malvaviscusarboreus*, *Epilobium* spp., *Clematis* spp., *Prinsepiautilis*, *Pyruspashia*, *Rubus* spp., *Murrayakoenigii*, *Aeglemarmelos*, *Antirrhinummajus* and *Origanumvulgare* were medium nectar and pollen resources. Whereas, Minor nectar and pollen sources were: *allium sativum*, *Allium cepa*, *Mangifera indicia*, *Salvia* sp., *Foeniculumvulgare*, *Heracleum* sp., *Ageratum conyzoides*, *Calendula officinalis*, *Eupatorium* sp., *Jacaranda mimosifolia*, *Cynoglossum* sp., *Albizziapulibrissin*, *Albizzialebek*, *Albizziastipulata*, *Glycine max*, *Rumexhestatus* etc. and other members belonged to families *Acantheaceae*, *Agavaceae*, *Amaryllidaceae*, *Anacardiaceae*, *Apiaceae*, *Apocynaceae*, *Arecaceae*, *Asteraceae*, *Bignoniaceae*, *Boraginaceae*, *Caprifoliaceae*, *Chenopodiaceae*, *Convolvulaceae*, *Cucurbitaceae*, *Euphorbiaceae*, *Fabaceae*, *Fagaceae*, *Geraniaceae*, *Lamiaceae*, *Liliaceae*, *Linaceae*, *Malvaceae*, *Meliaceae*, *Moraceae*, *Musaceae*, *Papaveraceae*, *Plantaginaceae*, *Poaceae*, *Polygonaceae*, *Portulacaceae*, *Punicaceae*, *Ranunculaceae*, *Rhamnaceae*, *Rosaceae*, *Rubiaceae*, *Solanaceae*, *Verbenaceae*, *Violaceae* and *Vitaceae*. Minor nectar and pollen sources were: *Mangiferaindica*, *Coriandrumsativum*, *Sonchus* spp., *Tagetes erectus*, *Cichoriumintybus*, *Eupatorium* spp., *Senecio* spp., *Bidenspilosa*, *Foeniculumvulgare*, *Ageratum conyzoides*, *Calendula officinalis*, *Eupatorium* sp., *Jacaranda mimosifolia*, *Ipomoea* spp., *Albizzia* spp., *Glycine max*, *Rumexhestatus*, *Papaverrhoeasete*. and other members belonged to families as *Acantheaceae*, *Agavaceae*, *Amaryllidaceae*, *Anacardiaceae*, *Apiaceae*, *Apocynaceae*, *Arecaceae*, *Asteraceae*, *Bignoniaceae*, *Boraginaceae*, *Caprifoliaceae*, *Chenopodiaceae*, *Convolvulaceae*, *Cucurbitaceae*, *Euphorbiaceae*, *Fabaceae*, *Fagaceae*, *Geraniaceae*, *Lamiaceae*, *Liliaceae*, *Linaceae*, *Malvaceae*, *Meliaceae*, *Moraceae*, *Musaceae*, *Papaveraceae*, *Plantaginaceae*, *Poaceae*, *Polygonaceae*, *Portulacaceae*, *Punicaceae*, *Ranunculaceae*, *Rhamnaceae*, *Rosaceae*, *Rubiaceae*, *Solanaceae*, *Verbenaceae*, *Violaceae* and *Vitaceae*. Based on present melissopalynological studies in Kangra and adjoining areas and those of earlier investigators, it is proposed that there is an urgent need to conduct such studies on following important aspects by future workers in this field. To produce a computer assisted pollen data bank of honey plant resources of the Himalayan region; to generate a complete database on the diversity and abundance of various melliferous resources of Himalayan region; pollen analysis of honey samples from different parts of the Himalayan region; identification of major, medium and minor sources of pollen and nectar to honeybees and preparation of floral calendars; to recommend measures for the conservation of depleting melliferous flora;

Keywords: Beekeeping, Honey, Pollen, Nectar, Bee forage

1. Introduction

Insects and plants are mutually dependent upon each other. Many insects including honey bees depend upon the plants for energy to maintain their activities, whereas, plants in turn depend for pollination on insects. This energy relationship between plants and nectar gathering insects is a necessary basis for studying the foraging behaviour, crop pollination and honey production. Honey bees while foraging on the flowers of different entomophilous plants for collecting nectar, also gather some pollen with it. This pollen is retained in the ripened honey which is subsequently stored in the honey combs. The microscopical examination of these pollen grains in the honey is known as 'melissopalynology' and any final confirmatory evaluation of bee plants is incomplete without the study of melissopalynology.

Melissopalynology is helpful in both quantitative and qualitative pollen analysis of honey samples. Quantitative analysis is used for confirming the botanical sources of unifloral and multifloral honeys, whereas, qualitative analysis helps in the identification of geographical origin of honey samples because local floras have characteristic plant associations that are reflected in the corresponding spectrum of pollen types represented in the local honeys.

2. Materials and Methods

Microscopical analysis was conducted on different honey samples of honeybees viz., *A. cerana* F., *A. dorsata* L. and *A. mellifera* L. collected from Kangra and adjoining areas of Himachal Pradesh. Himachal Pradesh is predominantly a hill state presents varied climate, topography and geology

resulting in diversified flora. Climate is the main factor which determines the composition of the flora of any other areas. There are four major agro-climatic zones in Himachal Pradesh which can be classified as sub-tropical (low lying hills), sub-temperate (mid hills), temperate (high hills and interior valley) and dry cold zone (trans- Himalaya). Flowering Plants (wild and ornamental) which were visited by honeybees to collect pollen and nectar were collected from different zones of Kangra and adjoining areas of

Himachal Pradesh during different seasons from 2014 to 2015. These plants were identified with the help of local floras and taxonomists from Department of Biosciences, Himachal Pradesh University, Shimla and CSIR-Institute of Himalayan Bioresource Technology, Palampur, Himachal Pradesh. A floral calendar of honey yielding plants of Kangra hills indicating their taxonomic status, geographic location, honey potentiality and period of flowering have been prepared.

Table 1: Major, medium and minor honey plants of Kangra and adjoining areas of Himachal Pradesh

<i>Family/Plant species</i>	<i>Common name</i>	<i>Honey Potentiality</i>	<i>Flowering period</i>	<i>Distribution</i>	<i>Nature/Economic importance</i>
1	2	3	4	5	6
Acanthaceae					
<i>Adhatodavasica</i> Nees	Basuti	N ² P ²	Apr-Nov	Throughout	Shrub(w)
<i>Justiciapubigera</i> Nees	Bankas	N ² P ²	Aug-Oct	Mid & high hills	Herb(w)
<i>Rungiaparvijflora</i> Nees	Rungia	N ³ P ³	Jul-Aug	Valley, low & mid hills	Herb, Weed(w)
Aeraceae					
<i>Acer</i> spp.	Great maple	N ² P ²	Mar-Apr	Mid & high hills	Avenue tree, Timber(w/c)
Agavaceae					
<i>Agave Americana</i> L.	Century plant	N ³ P ³	Sept-Nov	Valley, low & mid hills	Shrub(c)
Amaranthaceae					
<i>Amaranthuspaniculatus</i> L.	Amaranth	P ²	Jun-Jul	Throughout	Herb, Crop(c)
Amaryllidaceae					
<i>Allium cepa</i> L.	Onion	N ³ P ³	May-Jun	Throughout	Herb, Vegetable(c)
<i>Allium sativum</i> L.	Garlic	N ³ P ³	May-Jun	Throughout	Herb, Vegetable(c)
Anacardiaceae					
<i>Mangiferaindica</i> L.	Mango	N ³ P ³	Mar-Apr	Valley & low hills	Fruit tree, Fuel & Timber(c)
<i>Rhus</i> spp.	Sumac	N ³ P ³	May-Jun	Mid & high hills	Tree/Shrub(w)
Apiaceae					
<i>Coriandrumsativum</i> L.	Corriander	N ³ P ³	May-Jun	Throughout	Herb, Condiment(c)
<i>Daucuscarota</i> L.	Carrot	N ² P ³	Mar-May	Throughout	Herb, Vegetable(c)
<i>Foeniculumvulgare</i> Mill.	Funnel	N ³ P ³	Aug-Sept	Throughout	Herb, Condiment(c)
<i>Heracleum</i> spp.	Hogweed	N ³ P ³	May-Jul	Throughout	Herb(w)
Apocynaceae					
<i>Carissa caranda</i> L.	Karandas	N ² P ²	Apr-May	Throughout	Shrub, preservation(w/c)
Areaceae					
<i>Phoenix</i> spp.	Wild date plam	N ² P ³	May-Jul	Valley & low hills	Shrub, Fruit tree(w)
Asclepiadaceae					
<i>Asclepiascurassavica</i> L.	Milkweed	N ² P ²	Apr-Jun	Valley, low & mid hills	Shrub, Fibre(w)
Asteraceae					
<i>Ageratum conyzoides</i> L.	Ageratum or Goat weed	N ³ P ³	Jul-Sept	Throughout	Herb, Ornamental(w/c)
<i>Artemisia</i> spp.	Mugwort	N ³ P ³	Aug-Oct	Mid & high hills	Herb, Ornamental(w/c)
<i>Aster</i> spp.	Star-wort	N ³ P ³	Oct-Nov, Jul-Sept	Throughout	Herb, Ornamental(w/c)
<i>Bidenspilosa</i> L.	Badi-gumbri	N ³ P ³	Jun-Sept	Throughout	Herb(w)
<i>Calendula officinalis</i> L.	Marigold	N ³ P ³	May-Jul	Valley, low & mid hills	Herb, Ornamental(w/c)
<i>Cardusonopardiodes</i> Fisch.	Musk thistles	N ² P ²	May-Aug	Throughout	Herb, Weed(w)
<i>Centaureacyanus</i> L.	Cornflower	N ¹ P ¹	Feb-Apr	Throughout	Herb, Ornamental(c)
<i>Chrysanthemum</i> spp.	Chrysanthemum	N ³ P ³	May-Sept	Throughout	Herb, Ornamental(w/c)
<i>Cichoriumintybus</i> L.	Chichory	N ³ P ³	May-Aug	Throughout	Herb, Weed(w)
<i>Cosmos sulphureus</i> Cav.	Cosmos	N ³ P ²	Sept-Nov	Throughout	Herb, Ornamental(w/c)
<i>Dahlia pinnata</i>	Dahlia	N ² P ²	Jul-Jan	Throughout	Herb, Ornamental(c)
<i>Eupatorium</i> spp.	Throughwort	N ³ P ³	Jul-Sept	Throughout	Herb(w)
<i>Helianthus annuus</i> L.	Sunflower	N ¹ P ¹	Jul-Sept	Throughout	Herb, Oilseed, Ornamental, Fodder(w/c)
<i>Helichrysumarenarium</i>	Paper flower	N ² P ³	Feb-Jun	Valley, low & mid hills	Herb, Ornamental(c)
<i>Senecio</i> spp.	Ragwort	N ³ P ³	Jun-Sept	Throughout	Herb, Weed(w)
<i>Solidagolongifolia</i> Schrad.	Golden rod	N ² P ³	Jun-Sept	Throughout	Herb, Ornamental(w/c)
<i>Sonchus</i> spp.	Sow thistle	N ³ P ³	Jun-Oct	Throughout	Herb, Weed(w)
<i>Tagetes erectus</i> L.	Marigold	N ³ P ³	Jul-Oct	Throughout	Herb, Aromatic, Ornamental(w/c)

<i>Taraxacum officinale</i> Weber.	Dandelion	N ¹ P ¹	Mar-Sept	Throughout	Herb, Juicy weed(w)
<i>Tussilago farfara</i> L.	Coltsfoot	N ³ P ³	Apr-Jun	Valley, low & mid hills	Herb, Medicinal(w)
<i>Zinnia elegans</i> Jacq.	Zinnia	N ² P ²	Jun-Sept	Valley, low & mid hills	Herb, Ornamental(c)
Balsaminaceae					
<i>Impatiens balsamina</i> L.	Pink balsam	N ¹ P ²	Jul-Sept	Throughout	Herb, Ornamental(c)
<i>Impatiens glandulifera</i> Royle	Balsam	N ² P ²	Jul-Sept	Throughout	Herb, Aromatic, Medicinal(w/c)
Berberidaceae					
<i>Berberis balsamina</i> L.	Berberis	N ² P ²	Apr-Jun	Throughout	Shrub, Fruit, Dye, Medicinal (w)
<i>Berberis lycium</i> Royle	Raisin Berberis	N ² P ²	Apr-Jun	Throughout	Shrub, Fruit, Medicinal (w)
Bignoniaceae					
<i>Campsis grandiflora</i>	Trumpet vine	N ² P ³	May-Aug	Valley, low & mid hills	Climber, Ornamental(c)
<i>Tachomastans</i> L.	Sonpatti	N ² P ³	Apr-June	Valley, low & mid hills	Ornamental(c)
<i>Jacaranda mimosifolia</i> D. Don	Jacaranda	N ³ P ³	May-Jun	Valley, low & mid hills	Tree, Ornamental(w/c)
Bombacaceae					
<i>Bombax ceiba</i> L.	Silk cotton tree	N ¹ P ¹	Feb-Mar	Throughout	Fodder tree, fibre, Timber (w)
Boraginaceae					
<i>Cordiadi chotoma</i> Forster F.	Lasora	N ¹	Mar-Apr	Valley, low & mid hills	Edible, Medicine(w/c)
<i>Cynoglossum</i> spp.	Hounds Tongue	N ³ P ³	Jun-Sept	Valley, low & mid hills	Herb(w)
<i>Ehretia acuminata</i> R. Br. Prodr.	Ivory Wood	N ¹ P ²	Feb-Apr	Valley, low & mid hills	Avenue tree, Fruit, Fodder, Timber(w/c)
Brassicaceae					
<i>Brassica campestris</i> L.	Mustard	N ¹ P ¹	Dec-May	Throughout	Herb, Oilseed(c)
<i>B. campestris</i> var. sarson	Sarson	N ¹ P ¹	Sept-Mar	Throughout	Herb, Oilseed, Vegetable(c)
<i>Brassica juncea</i> (L.) Cosson	Indian mustard	N ¹ P ¹	Feb-Mar	Throughout	Herb, Oilseed(c)
<i>Brassica napus</i> L. Var. glauca (Roxb.) Schutz	Rape	N ¹ P ¹	Dec-Mar	Throughout	Herb, Oilseed, Vegetable(c)
<i>Brassica napus</i> var. toria L.	Toria	N ¹ P ¹	Dec-Mar	Throughout	Herb, Oilseed, Vegetable(c)
<i>Brassica regusa</i> (Roxb.) Bailey	Rai	N ¹ P ¹	Dec-Mar	Throughout	Herb, Vegetable(c)
<i>B. oleracea capitata</i> L.	Cabbage	N ² P ²	Feb-Mar	Throughout	Herb, Vegetable(c)
<i>B. oleracea botrytis</i> L.	Cauliflower	N ² P ²	Feb-Mar	Throughout	Herb, Vegetable(c)
<i>Brassica rapa</i> L.	Turnip	N ² P ²	Feb-Apr	Throughout	Herb, Vegetable(c)
<i>Cardamine</i> spp.	Cardamine	N ² P ²	Jan-Feb	Throughout	Herb, Medicinal(w)
<i>Eruca sativa</i> Mill	Rocket Salad	N ¹ P ¹	Dec-Mar	Throughout	Herb, Oilseed, Fodder(c)
<i>Raphanus sativus</i> L.	Radish	N ¹ P ¹	Feb-Mar	Throughout	Herb, Vegetable(c)
Cactaceae					
<i>Opuntia</i> spp.	Prickly Pear	N ² P ²	Apr-May	Throughout	Shrub, Weed (w)
Cannabinaceae					
<i>Cannabis sativa</i> L.	Hemp	N ² P ²	Jun-sept	Throughout	Weed, Alkaloid fibre (w/c)
Capparidaceae					
<i>Crataeva religiosa</i> Forst.	Barna	N ² P ³	Apr-May	Valley, low & mid hills	Tree (w/c)
Caprifoliaceae					
<i>Dianthus caryophyllus</i> L. Lonicera spp.	Carnation	N ³ P ³	Apr-Jun	Throughout	Herb, Ornamental(c)
Caricaceae					
<i>Carica papaya</i> L.	Papaya	N ¹ P ¹	May	Valley & low hills	Tree, fruit edible (c)
Chenopodiaceae Combretaceae					
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	Bahera	N ¹	Mar-june	Valley, low & mid hills	Timber, Fuel, Medicine(w/c)
<i>Terminalia chebula</i> Retz.	Harada	N ¹	Apr-Aug	Valley, low & mid hills	Fodder, Edible, Medicine(w/c)
<i>Terminalia</i> spp.	Myrobalan	N ¹ P ¹	Apr-May	Valley, low & mid hills	Tree, Timber, Fruit, Medicinal, Fuel, Tanning, Dyeing (w/c)
<i>Quisqualis indica</i> L.	Malti	N ²	May-Oct	Valley, low & mid hills	Ornamental(c)
Convolvulaceae					
<i>Convolvulus arvensis</i> L.	Convolvulus	N ³ P ³	Apr-Sept	Throughout	Weed(w)
<i>Ipomoea batatas</i> Lam.	Sweet Potato	N ² P ³	Aug-Nov	Throughout	Herb, Vegetable, Climber(c)
<i>Ipomoea pulchella</i> Roth.	Railway Creeper	N ³ P ³	Aug-Nov	Throughout	Herb, Climber (w)
<i>Cuscuta reflexa</i> Roxb.	Amar-Bel	P ³	Jul-Oct	Throughout	Herb, Parasitic, Succulent, Medicinal (w)
Crassulaceae					
<i>Kalanchoe integrifolia</i> (Medik.) Kuntz	Biskhapra	N ¹ P ¹	Sept-Dec	Throughout	Medicine(w/c)
Cucurbitaceae					

<i>Benincasa</i> spp.	Petha	N ² P ²	Apr-May	Valley, low & mid hills	Climber, Vegetable(c)
<i>Cocciniagrandsis</i> (L.)Voigt	Kundururu	N ²	Jan-July	Throughout	Climber, Vegetable, Medicine(c)
<i>Cucumis</i> spp.	Cucumber	N ¹ P ¹	Jul-sept	Valley, low & mid hills	Climber(c)
<i>Cucurbitapepo</i> L.	Pumpkin	N ¹ P ¹	Apr-May	Throughout	Climber, Vegetable(c)
<i>Cucurbita maxima</i> L.	Great Pumpkin	N ¹ P ¹	Feb-Apr	Throughout	Climber, Vegetable(c)
<i>Luffacylindrica</i> L.	Ridged Gourd	N ³ P ³	Jul-sept	Throughout	Climber(c)
<i>Momordicacharantia</i> L.	Bitter Gourd	N ³ P ³	Jun-sept	Throughout	Climber, Vegetable (c)
<i>Sechiumedule</i> SW.	Chayote	N ² P ²	JULY-NOV	Throughout	Climber, Vegetable (C)
Ericaceae					
<i>Rhododendron arboreum</i> Smith	Alpine Rose	N ¹ P ¹	Mar-May	Mid & high hills	Tree (w)
Euphorbiaceae					
<i>Emblicoefficialis</i> Gaertn.	Indian Gooseberry	N ² P ²	Mar-May	Valley, low & mid hills	Tree, Medicinal (c)
<i>Euphorbia royleana</i> Bros.	Euphorbia	N ³ P ³	Apr-May	Valley, low & mid hills	Shrub, Juicy, Hedge plant (w/c)
<i>Heveabrsiliensis</i> Muell. Arg.	Rubber tree	N ¹ P ³	May-Jul	Valley, low & mid hills	Tree, Ornamental(c)
<i>Mallotusphilippensis</i> (Lam.)Mwell.-Arg.	Kamala	N	Sept-Nov	Valley, low & mid hills	Medicine, Fuel-wood (w)
<i>Ricinuscommunis</i> L.	Castor oil plant	P ²	May-Aug	Valley, low & mid hills	Shrub, Oilseed, Soft wood (w/c)
Fabaceae					
<i>Acacia arabica</i> Willd.	Acacia	N ² P ²	May-Jul	Valley, low & mid hills	Tree, Fodder, Medicinal, Tanning industry, Dyeing, Ornamental (w/c)
<i>Acacia catechu</i> (L.f.) Willd.	Acacia	N ¹ P ¹	Apr-Jul	Valley, low & mid hills	Tree, Timber, Fodder, Fuel (w/c)
<i>Albizziajulibrissin</i> Durazz.	Pink Siris	N ³ P ³	Apr-May	Valley, low & mid hills	Timber, Fuel-wood (w/c)
<i>Albizzialebbek</i> Benth.	Siris	N ³ P ³	Apr-May	Valley, low & mid hills	Tree, Timber, Fodder, Fuel (w/c)
<i>Albizzia stipulata</i> Roxb.	Oai	N ³ P ³	May-June	Valley, low & mid hills	Tree, Timber, Fodder, Fuel (w/c)
<i>Bauhinia vahlii</i> Wight & Arn.	Camel's foot	N ² P ³	Mar-May	Throughout	Tree, Fodder, Fuel, Vegetable (w)
<i>Bauhinia variegata</i> L.	Kachnar	N ² P ³	Feb-Apr	Throughout	Tree, Fodder, Fuel, Vegetable, Ornamental (w)
<i>Bauhinia purpurea</i> L.	Geranium tree	N ² P ³	Mar-Apr	Throughout	Tree, Fodder, Fuel, Vegetable, Ornamental (w)
<i>Buteamonosperma</i> (Lam.) Kuntze	Palas	N ³ P ³	May-Sept	Valley, low & mid hills	Tree, Fodder, Fuel, Food for lac insect, Medicinal (w)
<i>Caesalpinia decalpetala</i> (Roth.) Alston	Kingari	N ²	Feb-Sept	Valley, low & mid hills	Fodder, Medicinal (w)
<i>Cassia fistula</i> L.	Indian laburnum	N ² P ²	Apr-Jul	Valley, low & mid hills	Avenue tree (w)
<i>Cajanuscajan</i> L.	Pigeon Pea	N ³ P ³	May-Sept	Valley, low & mid hills	Jhynh.k,
<i>Dalbergiasissoo</i> Roxb.	Sissoo	N ¹ P ¹	Mar-May	Valley, low & mid hills	Tree, Timber, Fodder, Fuel, Shade (w)
<i>Erythrinasuberosa</i> Roxb.	Coral tree	N ² P ²	May-Jun	Valley, low & mid hills	Tree (w/c)
<i>Delonixregia</i> Raf.	Gulmohr	N ² P ²	May-Jun	Valley, low & mid hills	Avenue tree (w/c)
<i>Glycinemax</i> Merr (L.)	Soyabean	N ³ P ³	Jul-Aug	Throughout	Herb, Oilseed(c)
<i>Indigofera</i> spp.	Indigofera		Jun-Aug	Throughout	Shrub (w)
<i>Leucaenaleucocephala</i> (Lam.) De Wit	Ipil-Ipil	N ³ P ¹	May-Oct	Valley& low hills	Small tree, Fodder, Fuel (w/c)
<i>Medicago sativa</i> L.	Alfalfa	N ¹ P ²	May-Aug	Throughout	Herb, Fodder (w/c)
<i>Melilotus</i> spp.	Mellilot	N ¹ P ²	Mar-Jul	Throughout	Herb, Fodder (c)
<i>Pisumsativum</i> L.	Garden Pea	N ³ P ³	Mar-Jul	Throughout	Herb, Vegetable (c)
<i>Robiniapseudoacacia</i> L.	Black locust	N ¹ P ²	Apr-Jun	Throughout	Tree, Fuel, Ornamental, Timber (w/c)
<i>Tamarindusindica</i> L.	Tamarind	N ³ P ³	Mar-May	Valley, low & mid hills	Avenue tree, Condiment, Fruit, Oil (c)
<i>Trifoliumalexandrinum</i> L.	Egyptian clover	N ¹ P ¹	Apr-Jul	Throughout	Herb, Fodder (w/c)
<i>Trifoliumpratense</i> L.	Red clover	N ¹ P ²	Apr-Jul	Throughout	Herb, Fodder (w/c)
<i>Trifoliumrepens</i> L.	White clover	N ¹ P ¹	Apr-Jul	Throughout	Herb, Fodder, Cover crop (w/c)
<i>Vicia</i> spp.	Field beans	N ³ P ¹	Apr-Aug	Throughout	Crop, Edible, Fodder (w/c)
Fagaceae					
<i>Castanea sativa</i> Mill	Sweet Chestnut	N ³ P ³	May-Sept	Throughout	Tree, Timber, Seed, Nuts, Edible (w/c)
<i>Quercus</i> spp.	Oak	N ² P ³	Apr-Jul	Throughout	Timber tree (w/c)
Geraniaceae					
<i>Geranium</i> spp.	Geranium	N ³ P ³	May-Sept	Throughout	Herb, Ornamental(c)

Hypericaceae					
<i>Hypericum</i> spp.	Hypericum	P ¹	Apr-Oct	Throughout	Shrub, Twigs used as toothbrush, seed as Condiment for flavoring curry (w)
Juglandaceae					
<i>Juglansregia</i> L.	Walnut	P ²	Mar	Mid & high hills	Tree, furniture, dyeing & Tanning industry (w/c)
Lamiaceae					
<i>Menthaviridis</i> L.	Mint	N ³	Jul-Oct	Throughout	Aromatic herb (w/c)
<i>Ocimumbasilicum</i> L.	Basil	N ² P ³	Jun-Sept	Valley, low & mid hills	Herb (w/c)
<i>Ocimum sanctum</i> L.	Tulsi	N ²	Apr-Nov	Throughout	Aromatic herb, Medicinal (w/c)
<i>Origanumvulgare</i> L.	Marjoram	N ² P ²	Jul-Sept	Valley, low & mid hills	Aromatic herb, Oil (w)
<i>Plectranthuscoesta</i> Buch. Ham.	Shain	N ¹ P ²	Sept-Oct	Mid & high hills	Under shrub (w)
<i>Plectranthusgerardianus</i> Wall. Ex Benth.	Shain	N ¹ P ²	Aug-Oct	Mid & high hills	Under shrub (w)
<i>Plectranthusrugosus</i> Wall. Ex Benth.	Shain	N ¹ P ²	Aug-Nov	Mid & high hills	Shrub (w)
<i>Salvia</i> spp.	Red Sage	N ² P ²	Jul-Oct	Throughout	Herb, Medicinal(w)
<i>Stachys</i> spp.	Woundwort	N ² P ³	Jun-Sept	Throughout	Herb (w)
Liliaceae					
<i>Asphodelustenuifolius</i> Cav.	Piazi	N ³ P ²	Jul-Oct	Throughout	Herb (w)
<i>Lilium</i> spp.	Lilium	P ³	May-Jun	Valley, low & mid hills	Herb, Ornamental (c)
Linaceae					
<i>Linum</i> spp.	Flax	N ³ P ³	Feb-Mar	Throughout	Herb, Oilseed, Fibre (w/c)
Lythraceae					
<i>Lagerstroemia indica</i> L.	Pride of India	N ² P ²	Jul-Sept	Throughout	Timber, Ornamental (w/c)
<i>Woodfordiafruticosa</i> (L.) Kurz	Dhawi	N ¹ P ¹	Mar-Apr	Throughout	Shrub, Dye, Medicinal, Fodder, Fuel (W)
Malvaceae					
<i>Abelmoschusesculentus</i> L.	Lady's finger	N ² P ²	Jul-Sept	Throughout	Herb, Vegetable (c)
<i>Althaearosea</i> Cav.	Hollyhock	N ² P ²	Jul-Oct	Valley, low & mid hills	Herb, Ornamental (c)
<i>Gossypiumarboresum</i> L.	Cotton	N ¹ P ²	Jul-Sept	Valley, low & mid hills	Shrub (c)
<i>Hibiscus rosinensis</i> L.	Chinese Rose	N ² P ²	Mar-Apr	Valley, low & mid hills	Shrub, Ornamental (c)
<i>Malvasylvestris</i> L.	Mallow	N ² P ³	Jun-Oct	Valley, low & mid hills	Herb, Ornamental (c)
<i>Malvaviscusarboresum</i>	Malvaviscus	N ² P ²	Whole Year	Valley, low & mid hills	Shrub, Ornamental (c)
Meliaceae					
<i>Azadirachtaindica</i> A. Juss.	Mangosa	N ² P ³	May-Sept	Valley & low hills	Avenue tree, Forest tree (w)
<i>Cedrelatoona</i> Roxb. Ex Rottl. & Willd	Cedrela	N ¹ P ²	Mar-Jun	Valley, low & mid hills	Tree, Woody, Furniture (w)
Moraceae					
<i>Morus alba</i> L.	Mulberry	P ²	Mar-Apr	Throughout	Tree, Silkworm rearing, Fruit edible (w/c)
Moringaceae					
<i>Moringaoleifera</i> Lam.	Drumstick tree	N ¹ P ¹	Jan-Mar	Low & mid hills	Tree, Perfumes & Lubricants, Fertilizer, Gum, Fodder, Vegetable, Antibacterial properties (c)
Musaceae					
<i>Musa sapientum</i> L.	Banana	N ² P ³	Mar-Dec	Valley, low & mid hills	Giant herb, Fruit (c)
Myrtaceae					
<i>Callistemon citrinus</i> (Curt) Skeels	Bottle Brush	N ¹ P ¹	Mar-Oct	Valley & low hills	Tree, Ornamental (c)
<i>Eucalyptus camaldulensis</i> Dehn.	Eucalyptus	N ¹ P ¹	May-Jun	Valley & low hills	Avenue tree, Fuel wood, Charcoal, Paper pulp, Termite resistant timber, Medicinal (w/c)
<i>Psidiumguajava</i> L.	Guava	N ¹ P ¹	May-Jun	Valley, low & mid hills	Tree, Fruit (c)
<i>Syzygiumcumini</i> (L.) Alston	Jambolan	N ¹ P ¹	Apr-Jun	Valley, low & mid hills	Avenue tree, Fruit (w/c)
Ongraceae					
<i>Epilobium</i> spp.	Willow Herb	N ² P ²	Jun-Sept	Throughout	Herb (w)
Papaveraceae					
<i>Argemone Mexicana</i> L.	Prickly Poppy	P ³	May-Jul	Valley, low & mid hills	Herb (w)
<i>Eschscholziacalifornica</i>	Californian Poppy	N ³ P ¹	Mar-Jun	Valley, low & mid hills	Herb, Ornamental (c)
<i>Papaverrhoeas</i> L.	Poppy	N ³ P ³	Mar-May	Throughout	Herb, Ornamental (c)
Pedaliaceae					
<i>Sesamumindicum</i> L.	Sesamum	N ¹ P ¹	Jul-Sept	Throughout	Crop, Oilseed (c)
Plantaginaceae					

<i>Plantago</i> spp.	Plantago	N ² P ¹	Mar-Sept	Throughout	Herb (w)
Poaceae					
<i>Bambusabambos</i> (L.) Voss	Bamboo	N ³ P ³	Nov-Dec	Valley, low & mid hills	Tree, Forest, Wood, Furniture (w)
<i>Cynodondoctylon</i> L.	Dub Grass	P ³	May-Sept	Throughout	Fodder (w)
<i>Sorghum vulgare</i> Pers.	Sorghum	P ¹	May-Jun	Throughout	Crop, Grain, Fodder (c)
<i>Zea mays</i> L.	Maize	P ¹	Jul-Aug	Throughout	Grain, Fodder (c)
Polygonaceae					
<i>Fagopyrumsagittatum</i> Moench.	Buck Wheat	N ¹ P ²	Jun-Sept	Throughout	Herb, Grain, Fodder (c)
<i>Polygonum</i> spp.	Polygonum	N ³ P ³	Jun-Sept	Throughout	Herb, Weed (w/c)
<i>Rumexhastatus</i> D. Don	Almor	N ³ P ³	Jun-Oct	Throughout	Herb (w)
<i>Rumexnepalensis</i> Spreng	Halhaley	N ³ P ³	Jun-Oct	Mid hills	Herb (w)
<i>Rumex</i> spp.	Rumex	N ³ P ³	Jun-Oct	Throughout	Herb (w)
Portulacaceae					
<i>Portulacagrandiflora</i> Hook	Portulaca	N ² P ¹	Jun-Sept	Throughout	Herb, Ornamental (c)
Proteaceae					
<i>Grevillearobusta</i> A. Cunn. Ex. R.Br.	Silky Oak	N ¹ P ¹	Apr-May	Valley, low & mid hills	Avenue tree, Timber, Ornamental (c)
Punicaceae					
<i>Punicagranatum</i> L.	Pomegranate	N ² P ¹	Apr-May	Valley, low & mid hills	Shrub/Tree, Fruit (c)
Punica nana L.					
Ranunculaceae					
<i>Anemone</i> spp.	Wood anemone	P ³	Apr-Jun	Valley, low & mid hills	Ornamental (w/c)
<i>Caltha</i> spp.	Marsh marigold	N ³ P ²	Apr-Jul	High hills	Herb (w)
<i>Clematis</i> spp.	Clematis	N ² P ²	Mar-May	Valley, low & mid hills	Climber, Medicinal (w)
<i>Delphinium roylei</i> Munz.	Larkspur	N ³ P ³	Mar-May	Valley, low & mid hills	Herb, Ornamental (c)
<i>Ranunculus arvensis</i> L.	Butter cup	N ³ P ³	May-Jun	Throughout	Herb (w)
Rhamnaceae					
<i>Zizyphusjuzuba</i> Mill.	Chinese date	N ¹ P ³	Jul-Sept	Valley, low & mid hills	Tree, Fruit, Fodder, Oilseed (w/c)
Rosaceae					
<i>Eriobotrya japonica</i> Thunb. Lindley	Loquat	N ¹ P ¹	Feb-Mar & Sept-Oct	Valley, low & mid hills	Fruit tree (c)
<i>Fragariavesca</i> L.	Strawberry	N ² P ²	May-Sept	Mid & high hills	Herb, Fruit, Ornamental (c)
<i>Prinsepiautilis</i> Royle	Bekhal	N ² P ²	Sept-Nov	Mid & high hills	Shrub (w)
<i>Prunusamygdalus</i> Batsch.	Almond	N ¹ P ¹	Mar-Apr	Mid & high hills	Fruit tree (c)
<i>Prunusarmeniaca</i> L.	Apricot	N ¹ P ¹	Mar-Apr	Mid & high hills	Fruit tree (c)
<i>Prunusavium</i> L.	Cherry	N ¹ P ¹	Mar-Apr	Mid & high hills	Fruit tree (c)
<i>Prunuscerasoides</i> D. Don.	Wild Cherry	N ¹ P ¹	Oct-Nov	Mid & high hills	Fruit tree (w/c)
<i>Prunusdomestica</i> L.	Plum	N ² P ¹	Feb-Mar	Mid & high hills	Fruit tree (c)
<i>Pyruspashia</i> Buch-Ham. Ex D. Don	Wild Pear	N ² P ²	Feb-Mar	Mid & high hills	Fruit tree (w)
<i>Pyruspersica</i> (L.) Batsch	Peach	N ¹ P ¹	Feb-Mar	Mid & high hills	Fruit tree (c)
<i>Pyruscommunis</i> L.	Pear	N ² P ¹	Feb-Apr	Mid & high hills	Fruit tree (c)
<i>Rosa macrophylla</i> Lindley	Rose	N ³ P ¹	Mar-May	Throughout	Shrub, Ornamental (c)
<i>Rosa moschata</i> Miller	Wild Rose	N ³ P ¹	Apr-Jun	Throughout	Shrub, Ornamental (w/c)
<i>Rubus</i> spp.	Berries	N ² P ²	Apr-Jun	Throughout	Shrub, Climber, Hedges, Fruit (w/c)
Rubiaceae					
<i>Wendlandiaexserta</i> (Roxb.) DC	Chanlai	N ² P ¹	Nov-Feb	Valley, low & mid hills	Tree, Toothbrush, Fodder, Medicinal (w)
<i>Wendlandiaheynei</i> Sant & Merch.	Pansara	N ² P ¹	Apr-June	Valley, low & mid hills	Fodder (w)
Rutaceae					
<i>Aeglemarmelos</i> L. Correa	Bel	N ² P ²	Mar-June	low & mid hills	Edible, Medicinal (w)
<i>Citrus aurantifolia</i> (Christm) Swingle	Lemon	N ¹ P ¹	Mar-Apr	Throughout	Fruit tree (c)
<i>Citrus grandis</i> (L.) Osbeck	Pumelo	N ¹ P ¹	Mar-Apr	Throughout	Fruit tree (c)
<i>Citrus jambhiri</i> Lush.	Jambhiri	N ²	Sep-Oct	low & mid hills	Edible (c)
<i>Citrus limetta</i> Riso	Sweet lemon	N ¹ P ¹	Mar-Apr	Throughout	Fruit tree (c)
<i>Citrus medica</i> L.	Citron	N ¹ P ¹	Mar-Apr	Throughout	Fruit tree (c)
<i>Citrus reticulata</i> Blanco	Mandarin orange	N ¹ P ¹	Mar-Apr	Throughout	Fruit tree (c)
<i>Citrus sinensis</i> L.	Sweet orange	N ¹ P ¹	Mar-Apr	Throughout	Fruit tree (c)
<i>Murrayakoenigi</i> Spreng	Curry leaf plant	N ² P ²	Mar-Apr	Valley, low & mid hills	Shrub, Ornamental, Medicinal (w/c)
Scrophulariaceae					
<i>Antirrhinum majus</i> L.	Antirrhinum	N ² P ²	May-Jun	Valley, low & mid hills	Herb, Ornamental (c)

<i>Scrophularia</i> spp.	Fig figwort	N ¹ P ²	Jul-Sept	Throughout	Herb, Weed (w/c)
Salicaceae					
<i>Salix babylonica</i> L.	Weeping willow	N ¹ P ¹	Feb-Mar	Throughout	Tree, Timber(w/c)
Sapindaceae					
<i>Aesculusindica</i> Colebr.	Horse Chestnut	N ¹ P ¹	May-Jun	Mid & high hills	Timber, Fodder, Medicinal (w/c)
<i>Litchi chinensis</i> Sonner	Litchi	N ¹ P ¹	Feb-Mar	Valley, low & mid hills	Fruit tree (c)
<i>Sapindusmukorosii</i> Gaertn.	Soap nut	N ¹ P ¹	May-Jun	Valley, low & mid hills	Avenue tree, Fruit used as Soap, Timber (w/c)
Solanaceae					
<i>Capsicum</i> spp.	Chillies	N ³ P ³	Jul-Aug	Throughout	Herb, Vegetable (c)
<i>Daturastramonium</i> L.	Thorn apple	P ³	Jun-Sept	Throughout	Herb, Medicinal (w)
<i>Lycopersicumesculentum</i> Mill.	Tomato	N ³ P ³	Mar-Oct	Throughout	Herb, Vegetable (c)
<i>Solanummelongena</i> L.	Brinjal	N ³ P ³	Jun-Aug	Throughout	Shrub, Ornamental (c)
Theaceae					
<i>Camellia sinensis</i> (L.) Kuntze	Tea	N ¹ P ¹	Oct-Nov	Valley, low & mid hills	Shrub, Coloring material, Beverage ©
Tiliaceae					
<i>Grewiaoptiva</i> Dumm. Ex Burret	Beol or Bhemal	N ¹ P ¹	May-Jul	Throughout	Tree, Fruit, Fodder, Timber (w/c)
<i>Tilia</i> spp.	Limeb basswood	N ¹	Jun-Aug	Throughout	Avenue tree, Ornamental, Timber (w/c)
Verbenaceae					
<i>Caryopteris</i> spp.	Caryopteris	N ² P ³	Mar-Apr	Throughout	Shrub (w)
<i>Durantarepens</i> L.	Duranta	N ²	Jul-Sept	Throughout	Ornamental(c)
<i>Vitexnegundo</i> L.	Indian privet	N ¹ P ²	May-Jun	Throughout	Shrub, Insect repellent, Medicinal (w)
Violaceae					
<i>Viola odorata</i> L.	Sweet violet	N ³ P ³	Jun-Aug	Throughout	Herb, Ornamental, Medicinal (w/c)
Vitaceae					
<i>Vitisvinifera</i> L.	Grapes	N ³ P ³	May-Jun	Throughout	Shrub,Fruit (c)

N¹ = Major nectar source P¹ = Major pollen source
N² = Medium nectar source P² = Medium pollen source
N³ = Minor nectar source P³ = Minor pollen source
W = Wild Throughout = Valley, low, mid & high hills
C = Cultivated

3. Result and Discussion

Insects and plants are mutually dependent upon each other. Many insects including honey bees depend upon the plants for energy to maintain their activities, whereas, plants in turn depend for pollination on insects. This energy relationship between plants and nectar gathering insects is a necessary basis for studying the foraging behaviour, crop pollination and honey production. Honey bees while foraging on the flowers of different entomophilous plants for collecting nectar, also gather some pollen with it. Present melissopalynological and bee botanical investigations in Kangra and adjoining areas revealed a total of 219 plants species as nectar and pollen sources. Of these, 49 were major; 39 were medium and 55 plants were minor pollen source. Present studies indicated that Kangra and adjoining areas of Himachal Pradesh contained pollen grains of both entomophilous and anemophilous types. The anemophilous types were: *Psidiumguajava* Sudher and Bundla, *Pinus* sp. in Kangra, and Poaceous members in Jwalamukhi of summer season. All other morpho types like *Eucalyptus* sp., *Brassica* sp., *Cedrella* sp., *Taraxacum* sp. and *Trifolium* sp. etc. as recorded in various honey samples belonged to entomophilous types.

4. Future Scope

Based on present melissopalynological studies in Kangra and adjoining areas and those of earlier investigators, it is proposed that there is an urgent need to conduct such studies on following important aspects by future workers in this field. To produce a computer assisted pollen data bank of honey plant resources of the Himalayan region; to generate a complete database on the diversity and abundance of various melliferous resources of Himalayan region; pollen analysis of honey samples from different parts of the Himalayan region; identification of major, medium and minor sources of pollen and nectar to honeybees and preparation of floral calendars; to recommend measures for the conservation of depleting melliferous flora; to work out the honey potentials of different melliferous resources present in the Himalayan region; to strengthen research and development activities at institutional level; to enhance capacity building among researchers/ extension workers, farmers and other stakeholders; to take up studies on pollinator-plant interactions; to study the pollination requirement of economically important crops; to encourage farmers and private sector including NGOs for creating awareness

regarding the importance of melliferous resources and apiforestry programmes.

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