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# Frequency Distribution of Pollen Types in Honey Samples of *Apiscerana* F. Collected from Different Areas of Shiwalik Hills

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**Abstract:** ***Most of the flowering plants are pollinated by insects and many insects are specific to certain species of plants. Honey bees; on the other hand have no such restriction of pollen and nectar. There are at least four hundred species of plants which are either major or minor sources of pollen and nectar to Indian hive bee, ApisceranaF. It is obvious that all the plant species are not available in any one locality and a given plant species may also show variations in its utility to bees in different localities or during different years. Information on the utility of each of these plants species, its distribution, abundance and preferences for any climate or soil etc. is of great importance to beekeepers. Therefore, melissopalynological studies were conducted on twelve honey samples and pollen loads collected from different localities of Shiwalik hills. Analysis of pollen types in honey was carried using standard methods of melissopalynology. These investigations revealed that predominant sporomorphs were: Brassica sp., Raphanus sp., Murraya sp., Eucalyptus sp. etc. whereas, calendula sp., Mangiferasp, Eruca sp., Trifolium sp., Woodfordiasp.. Psidium sp., Grewia sp., Phoenix sp., Hibiscus sp., Syzygium sp., Melia sp., Grewia sp., Acacia sp., Adhatoda sp., Citrus sp., Azadirachta sp. etc. were secondary pollen types. The important minor and minor pollen components represented in these honey samples were: Acacia sp., Adhatoda sp., Ageratum sp., Allium sp., Bauhinia sp., Berberis sp., Bidens sp., Callistemon sp., Carissa sp., Cassia sp., Chenopodium sp., Dalbergia sp., Dianthus sp., Gossypium sp., Grevillea sp., Grewia sp., Helianthus sp., Lagerstroemia sp., Lilium sp., Medicago sp., Murraya sp., Rubus sp., Salvia sp., Sapindus sp., Syzygium sp., Zea sp., Zizyphus sp., Bauhinia sp., Cestrum sp., Citrus sp., Litchi sp., Raphanus sp.Bombax sp., Embilica sp., Pisum sp., Rosa sp., Woodfordia sp. Aegle sp., Albizzia sp., Berberissp., Calendula sp., Cedrella sp., Dianthus sp., Leucaenasp., Ocimum sp., Pisum sp., Polygonumsp., Punica sp., Ricinus sp., Robiniasp., Taraxacum sp., Sonchus sp., Syzygium sp., Vitis sp., Bombax sp., Litchisp and members of families Boraginaceae, Convolvulaceae, Euphorbiaceae, Fabaceae, Meliaceae, Asteraceae, CucurbitaceaeMyrtaceaeAcanthaceae, Apiaceae, Apocynaceae, Boraginaceae, Brassicaceae, Cannabinaceae, Lamiaceae, Malvaceae, Papaveraceae, Poaceae, Rosaceae, Sapindaceae and Rutaceae. Most of the honey samples had pollen of entomophilous plants with a small percentage of anemophilous types. These investigations also revealed both uniflorality and multiflorality in different honey samples. On the basis of present melissopalynological and bee botanical investigations, a floral calendar of honey plant resources of Shiwalik hills indicating their taxonomic status, geographic location, honey potentiality, periods of flowering and economic uses has been prepared. Present studies thus suggest that this region offers very rich potential for the development of beekeeping due to the multiplicity of bee flora available throughout the year. Such investigations can be helpful in setting up new apiaries, in migratory beekeeping practices and application of modern bee management technology.***

**Keywords:** Beekeeping, Honey, Melissopalynology, Pollen, Nectar, Bee pasturase

## 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 (Seeley, 1985). This energy relationship between plants and nectar gathering insects is a necessary basis for studying the foraging behavior, crop pollination and honey production (McGregor, 1976; Free, 1993). 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 (Deodikar, 1965; Louveaux*et al*., 1978; Nair, 1985; Sharma, 1989).

In view of increased application of honey pollen analysis and bee botany to apiculture, the present investigations were undertaken to determine the frequency distribution of pollen types in honey samples of Apiscerana F. collected from different areas of Shiwalik hills.

## 2. Material & Methods

Melissopalynogical studies were conducted on different honey samples collected from various altitudes of Shiwalik hills. These hills symbolize one of the most fragile ecosystems which extend from $29^0$ -$33^0$ N latitude to $74^0$-$80.5^0$ E longitude. These studies were conducted by collecting a total of 12 honey samples and pollen loads form A. cerana colonies in different parts of Shiwalik hills. These collections were made mainly during the major honey flow seasons (i.e. September to October and February to June) of the years 2008 and 2009 respectively. Collection sites (and elevation in meters) are shown in Table1. Reference pollen slides of honey samples were prepared according to the method of Louveaux et al. (1978), modified by Iwama and Melhem (1979). Pollen grains recovered from the honey samples were identified with the help of reference pollen slides and counted using a haemocytometer. The absolute pollen count and percentage of pollen types were then calculated and pollen spectra constructed on the basis of those percentages.

For pollen load analysis, the pollen pellets were dispersed in water and the solution acetolysed according to the method of Erdtman (1969).

**Table: 1:** Frequency distribution of pollen types in honey samples of *Apiscerana* F. collected from different areas of Shiwalik hills of (expressed as percentage of total number of pollen grains)

| *Plant species* | *Kumarhatti* | *Plasare* | *Ropar* | *Panchkula* | *Ramshahar* | *Mittian* | *Diggal* | *Una Proper* | *Gagret* | *Pinjore* | *Chandigarh* | *Derabassi* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| *Acacia sp.* | - | - | - | 4.75 | - | - | - | - | - | 19.95 | - | - |
| **Acanthaceae** | - | - | - | - | 1.95 | - | - | - | 2.89 | - | - | - |
| *Adhatoda sp.* | - | - | 8.59 | - | - | - | - | - | - | 20.47 | - | - |
| *Aegle sp.* | - | - | - | - | - | - | - | 1.04 | - | - | - | - |
| *Ageratum sp.* | - | - | - | - | - | - | - | - | - | 4.15 | - | - |
| *Albizzia sp.* | - | - | - | - | - | - | 0.98 | - | - | - | - | - |
| *Allium sp.* | - | - | - | - | - | - | 6.85 | - | - | - | - | - |
| **Apiaceae** | - | - | - | - | - | - | - | 2.90 | - | - | - | - |
| **Apocynaceae** | - | - | - | - | - | - | 1.99 | - | - | - | - | - |
| **Asteraceae** | 1.67 | 1.53 | - | - | - | 1.89 | - | 2.99 | - | - | 3.99 | 2.63 |
| *Azadirachta sp.* | - | - | - | - | - | - | - | 16.95 | - | - | - | - |
| *Bauhinia sp.* | - | 4.87 | - | - | - | 3.95 | 6.30 | - | - | - | - | 8.54 |
| *Berberis sp.* | - | - | - | - | 7.74 | - | 2.83 | - | - | 2.69 | - | - |
| *Bidens sp.* | - | - | - | - | - | - | - | 3.0 | 4.1 | - | - | - |
| *Bombax sp.* | 3.25 | - | - | - | - | - | - | - | - | - | 0.92 | 2.09 |
| **Boraginaceae** | - | - | - | - | - | - | - | 5.90 | - | 1.09 | - | - |
| *Brassica sp.* | 17.58 | 16.45 | - | - | 18.59 | 45.23 | - | - | - | - | 46.06 | 30.32 |
| **Brassicaceae** | - | - | - | - | - | - | 2.99 | - | - | - | - | - |
| *Calendula sp.* | - | - | 16.35 | - | 2.99 | - | - | - | - | - | - | - |
| *Callistemon sp.* | - | - | - | - | - | - | 8.68 | - | - | - | - | - |
| **Cannabinaceae** | - | - | - | - | - | - | - | - | 2.89 | - | - | - |
| *Carissa sp.* | - | - | - | - | - | - | - | - | 6.99 | - | - | - |
| *Cassia sp.* | - | - | - | 3.93 | - | - | - | 4.30 | - | - | - | - |
| *Cedrella sp.* | - | - | - | - | - | - | 2.98 | 9.11 | - | - | 2.50 | - |
| *Cestrum sp.* | - | - | - | - | - | - | - | - | - | - | - | 6.48 |
| *Chenopodium sp.* | - | - | - | - | 4.0 | - | - | - | - | - | - | - |
| *Citrus sp.* | 16.86 | 8.01 | - | - | - | - | - | - | - | - | 16.01 | - |
| **Convolvulaceae** | - | - | - | - | - | - | - | - | - | 7.94 | - | - |
| **Cucurbitaceae** | 1.66 | 2.01 | - | - | - | 1.99 | - | - | - | - | 1.92 | - |
| *Dalbergia sp.* | - | - | - | 5.06 | - | - | - | - | - | - | - | - |
| *Dianthus sp.* | - | - | - | - | 0.63 | - | - | - | 3.69 | - | - | - |
| *Emblica sp.* | 4.0 | - | 3.90 | - | - | - | - | - | - | - | 3.0 | - |
| *Eruca sp.* | - | 16.93 | - | - | 16.73 | 16.93 | - | - | - | - | - | 35.82 |
| *Eucalyptus sp.* | - | - | - | 47.16 | - | - | - | 16.83 | - | - | - | - |
| **Euphorbiaceae** | - | - | - | - | - | - | - | 8.93 | - | - | - | - |
| **Fabaceae** | - | - | 12.45 | - | - | - | - | - | 9.93 | - | - | - |
| *Gossypium sp.* | - | - | - | - | - | - | - | - | - | 6.49 | - | - |
| *Grevillea sp.* | - | - | - | - | - | - | 4.02 | - | - | - | - | - |
| *Grewia sp.* | - | - | - | 16.95 | - | - | 4.69 | - | 23.99 | - | - | - |
| *Helianthus sp.* | - | - | - | - | - | - | - | - | - | 4.69 | - | - |
| *Hibiscus sp.* | - | - | - | - | - | - | 16.18 | - | - | - | - | - |
| *Lagerstroemia sp.* | - | - | - | - | - | - | - | - | - | 3.05 | 3.27 | - |
| **Lamiaceae** | - | - | - | 0.9 | - | - | - | - | - | - | - | - |
| *Leucaena sp.* | - | - | - | - | - | - | 1.99 | - | - | - | - | - |
| *Lilium sp.* | - | - | - | - | - | - | -- | - | 8.94 | - | - | - |
| *Litchi sp.* | - | 3.21 | - | - | - | 4.80 | - | - | - | - | - | 2.25 |
| ***Malvaceae*** | - | - | - | - | - | - | 2.98 | - | - | - | - | - |
| *Mangifera sp.* | - | - | 21.19 | - | - | - | - | - | - | - | - | - |
| *Malea sp.* | - | - | - | - | - | - | - | 16.71 | - | - | - | - |
| *Medicago sp.* | - | - | - | - | - | - | - | - | - | 5.68 | - | - |
| **Meliaceae** | - | - | 5.45 | - | - | - | - | - | - | - | 3.22 | - |
| *Murraya sp.* | 46.15 | - | 3.96 | - | 7.98 | - | - | - | - | - | - | - |
| **Myrtaceae** | - | - | - | - | - | - | - | - | - | 4.32 | - | - |
| *Ocimum sp.* | - | - | - | - | - | - | - | - | - | 2.99 | - | - |
| **Papaveraceae** | - | - | - | 0.98 | - | - | - | - | - | -- | - | - |
| *Phoenix sp.* | - | - | - | 17.95 | - | - | - | - | - | - | - | - |
| *Pisum sp.* | - | - | - | - | - | - | - | - | 2.09 | - | 3.06 | - |
| **Poaceae** | - | - | - | - | - | - | - | 2.98 | - | - | - | - |
| *Polygonum sp.* | - | - | - | - | - | - | - | - | - | 1.73 | - | - |
| *Psidium sp.* | - | - | 16.12 | - | - | - | - | - | - | - | - | - |
| *Punica sp.* | - | - | 6.43 | - | - | - | 2.69 | - | - | - | - | - |
| *Raphanus sp.* | - | 46.99 | - | - | - | 3.89 | - | - | - | - | 16.05 | 11.87 |
| *Ricinus sp.* | - | - | - | - | - | - | - | - | 2.76 | - | - | - |
| *Robinia sp.* | - | - | - | - | - | - | - | - | - | 1.93 | - | - |
| *Rosa sp.* | 4.38 | - | - | - | - | - | - | - | - | - | - | - |
| **Rosaceae** | - | - | 0.99 | - | - | 4.38 | - | - | - | - | - | - |
| *Rubus sp.* | - | - | - | - | - | - | - | - | 8.99 | - | - | - |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rutaceae** | - | - | - | - | - | - | 8.06 | - | - | - | - | - |
| *Salix sp.* | - | - | - | - | - | 5.85 | - | - | - | - | - | - |
| *Salvia sp.* | - | - | - | - | - | - | - | - | - | 3.64 | - | - |
| **Sapindaceae** | - | - | - | - | - | - | - | - | 2.80 | - | - | - |
| *Sapindus sp.* | - | - | - | - | 3.25 | - | - | - | - | - | - | - |
| *Solaum sp.* | - | - | - | 2.23 | - | - | - | - | - | - | - | - |
| *Sonchus sp.* | - | - | - | - | - | - | - | 2.68 | 1.93 | - | - | - |
| *Syzygium sp.* | - | - | 2.64 | - | - | - | 24.12 | 5.68 | 16.02 | - | - | - |
| *Taraxacum sp.* | - | - | - | - | 2.09 | - | 1.05 | - | - | - | - | - |
| *Trifolium sp.* | - | - | - | - | - | 16.11 | - | - | - | - | - | - |
| **Violaceae** | - | - | - | 0.09 | - | - | - | - | - | - | - | - |
| *Vitis sp.* | - | - | 1.93 | - | - | - | 0.62 | - | 1.99 | - | - | - |
| *Woodfordia sp.* | 4.45 | - | - | - | 17.94 | - | - | - | - | - | - | - |
| *Zea sp.* | - | - | - | - | - | - | - | - | - | 4.13 | - | - |
| *Zizyphus sp.* | - | - | - | - | - | - | - | - | - | 5.06 | - | - |

**Percentage contribution of different plant species to honey samples from different areas of Shiwalik hills**

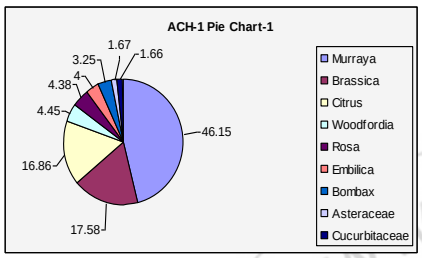



**Figure A:** Kumarhatti honey

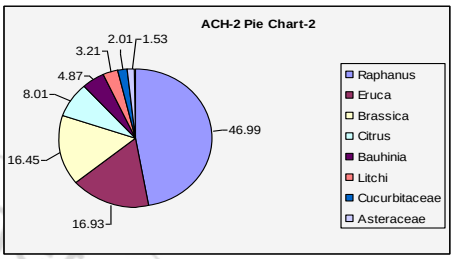



**Figure B:** Plasare honey

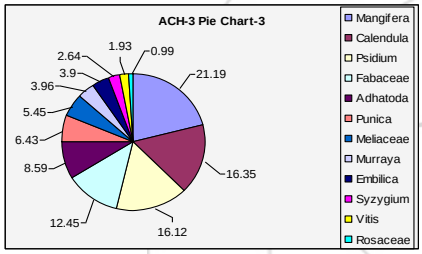



**Figure C:** Ropar honey

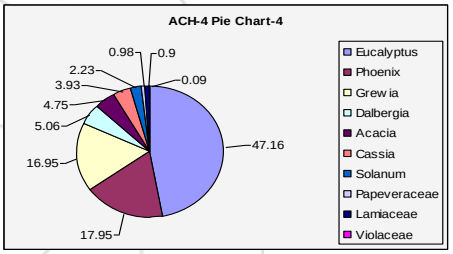



**Figure D:** Panchkula honey

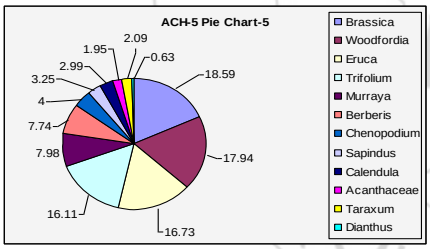



**Figure E:** Ramshahar honey

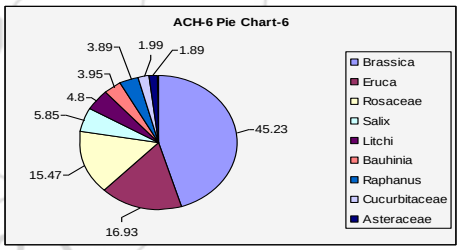



**Figure F:** Mittian honey

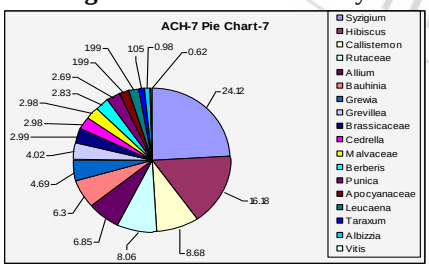



**Figure G:** Diggal honey

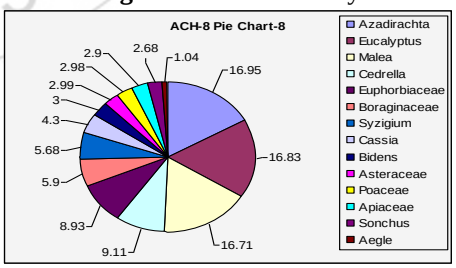



**Figure H:** Una proper honey

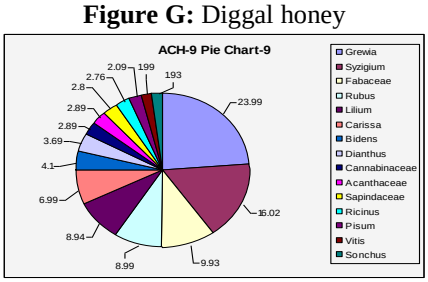



**Figure I:** Gagret honey

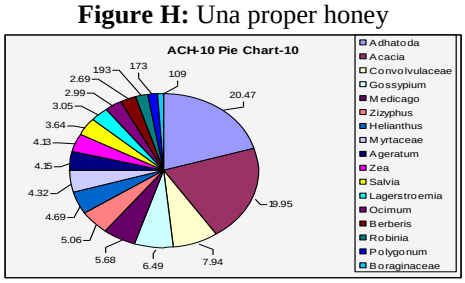
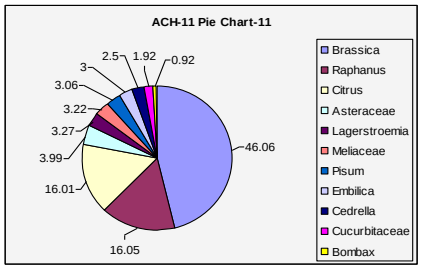
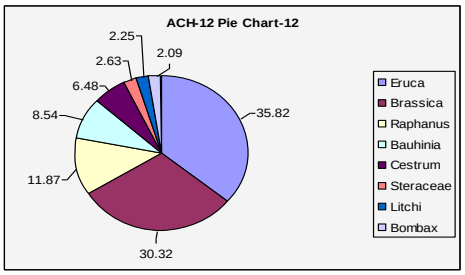



**Figure J:** Pinjore honey




**FigureK:** Chandigarh honey




**FigureL:** Derabassi honey

**Table 2:** Pollen spectrum of honey samples of *Apiscerana* F. collected from different areas of Shiwalik hills

| *Locality* | *Season* | *Month of Collection* | *Colour of honey* | *Unifloral or Multifloral* | *Predominant pollen type* | *Secondary pollen type* | *Important minor pollen types* | *Minor pollen types* |
|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| Kumarhatti | Spring | April | Light amber | Unifloral | *Murraya sp.* | Citrus sp., Brassica sp. | Bombax sp., Woodfordia sp., Rosa sp., Embilica sp. | *Cucurbitaceae Asteraceae* |
| Plasare | Winter | February | Watery white | Unifloral | Raphanus sp. | *Brassica sp., Eruca sp.* | *Bauhinia sp., Litchi sp., Citrus sp.* | Asteraceaecucurbitaceae |
| Ropar | Summer | May | Light amber | Multifloral | - | *Mangifera sp., Psidium sp., Calendula sp.* | *Adhatoda sp., Murraya sp., Meliaceae, Embilica sp., Punica sp., Fabaceae* | *RosaceaeSyzygium sp., Vitis sp.* |
| Panchkula | Summer | June | Light amber | *Unifloral* | Eucalyptus sp. | *Phoenix sp., Grewia sp.* | Acacia sp., Dalbergia sp., Cassia sp. | *Violaceae, Lamiaceae, Papaveraceae* |
| Ramshahar | Summer | May | Amber | Multifloral | - | *Brassica sp., Trifolium sp., Woodfordia sp., Eruca sp.* | Berberis sp., Sapindus sp., Murraya sp., Chenopodium sp. | *Taraxum sp., Dianthus sp., Calandula sp., Acanthaceae sp.* |
| Mittian | Winter | February | Light Amber | Unifloral | Brassica sp. | *Eruca sp., Rosaceae* | Bauhinia sp., Raphanus sp., Salix sp., Lithi sp. | *Asteraceae, Cucurbitaceae* |
| Diggal | Summer | May | Light Amber | Multifloral | - | Syzygium sp., Hibiscus sp. | Grevillea sp., Rutaceae sp., Allium sp., Bauhinia sp., Grewia sp., Callistemon sp. | *Albizzia sp., Apocyanaceae, Vitis sp., Brassicaceae, Punica sp., Lucaena sp., Malvaceae, Cedrella sp., Taraxum sp.* |
| Una Proper | Summer | June | Light Yellow | Multifloral | - | *Eucalyptus sp., Melia sp., Azadirchta sp.* | Syzygium sp., Cedrella sp., Cassia sp., Euphorbiaceae, Boraginaceae, Bidens sp. | *Aegle sp., Asteraceae, Apiaceae, Sonchus sp., Poaceae.* |
| Gagret | Summer | June | Light Amber | Multifloral | - | *Grewia sp., Syzygium sp.* | Dianthus sp., Fabaceae, Lilium sp., Rubus sp., Bidens sp., Carissa sp. | *Acanthaceae, Cannabinacee, Sonchus sp., Vitis sp., Sapindaceae, Pisun sp., Ricinus sp.* |
| Pinjore | Summer | July | Amber | Multifloral | - | *Adhadota sp., Acacia sp.* | Medicago sp., Ageratum, Zizyphus sp., Gossypium sp., Myrtaceae, Helianthus sp., Zea sp., Salvia sp., Convolvulaceae, Lagerstroemia sp. | *Berberis sp., Robinia sp., Boraginaceae, Ocimum sp., Polygum sp.* |
| Chandigarh | Spring | March | Watery white | Unifloral | *Brassica sp.* | *Raphanus sp., Citirus sp.* | Pisum sp., Meliaceae sp., Asteraceae sp., Embilica sp. | *Cedrellasp., Cucurbitaceae, Bombaxsp.* |
| Derabassi | Winter | February | Light Yellow | Multifloral | - | *Eruca sp., Brassica sp.* | Raphanus sp., Bauhinia sp., Cestrum sp. | *Litchi sp., Bombax sp., Asteraceae.* |

Predominant pollen type = 45 % and above Important minor pollen type = 3 to 15 %
Secondary pollen type = 16 to 45 % and Minor pollen type = < 3 %

## 3. Results

The system adopted by Louveaux et al. (1970) was used for the presentation of frequencies of pollen grains in the honey samples. The following terms were used to describe the samples: 'predominant pollen grains' (45% or more pollen grains present), 'secondary pollen grains' (16-45%), 'important minor pollen grains' (3-15%) and 'minor pollen grains' (less than 3%). Honey samples having 45 or more grains of a single pollen type are termed 'unifloral honeys' and those having several pollen types in considerable percentage are termed 'multifloral honeys' (Iwama&Melhem 1979; Chaturvedi 1983).

The pollen types found are shown in table 2:

**Predominant pollen types (45% or more):** In the honey samples of Shiwalik hills, Murraya sp., Raphaumus sp., Eucalyptus sp., Brassica sp., were the predominant sporomorphs.

**Secondary pollen types (16-45%):-** The following secondary pollen sources were present in honey; Citrus sp., Brassica sp., Mangifera sp., Psidium sp., Eruca sp., Calendula sp., Phoenix sp., Grewia sp., Trifolium sp., Woodfordia sp., Syzygium sp., Hibiscus sp., Eucalyptus sp., Melia sp., Azadirachta sp., Grewia sp., Adhatoda sp., Raphanus sp., and members of family Rosaceae.

**Important minor and minor pollen types (up to 15%):-** Pollen analysis of honey samples revealed Bombax sp.,

Woodfordia sp., Rosa sp., Emblica sp., Bauhinia sp., Litchi sp., Citrus sp., Adhatoda sp., Murraya sp., Punica sp., Emblica sp., Acacia sp., Cassia sp., Berberis sp., Sapindus sp., Chenopodium sp., Bauhinia sp., Raphanus sp., Saix sp., Grevillea sp., Allium sp., Grewia sp., Callistemon sp., Cedrella sp., Syzygium sp., Bidens sp., Dianthus sp., Lilium sp., Rubus sp., Bidens sp., Carissa sp., Medicago sp., Ageratum sp., Zizyphus sp., Gossypium sp., Helianthus sp., Zea sp., Salvia sp., Pisum sp., Cesttrum sp., Bombax sp., Robinia sp., Ocimum sp., Albizzia sp., Vitis sp., Lucaena sp., Taraxacum sp., Aegle sp., Sonchus sp., Calendula sp., Dianthus sp., Ricinus sp., and members of families Cucurbitaceae, Asteraceae, Rosaceae, Violaceae, Lamiaceae, Papaveraceae, Acanthaceae, Apocyanaceae, Brassicaceae, Apiaceae, Cannabinaceae, Sapindaceae, Boraginaceae, Convolvulaceae, Meliaceae, Myrtaceae, Euphorbiaceae, Fabaceae, Rutaceae. Of the 12 honey samples 5 were unifloral and 7 were of multifloral origin.

## 4. Discussion

Present studies indicated that there are two honey flow seasons in Shiwalik hills, alternated by comparative dearth periods when there are floral gaps and to some extent bee colonies may experience nectar and pollen shortage. Present investigations suggest that different parts of Shiwalik hills have vast potential for the development of beekeeping due to multiplicity of bee flora available throughout the year. Pollen analysis also revealed a number of anemophilous pollen in different honey and pollen samples. They are Chenopodium sp., Zea sp., Psidium sp., members of families Euphorbiaceae and Poaceae.

## 5. Conclusion

Present melissopalynological and bee botanical investigations revealed that *Centaureacyanus*, *Helianthus annus*, *Taraxacumofficinale*, *Bombaxceiba*, *Brassica* spp., *Eruca sativa*, *Raphanussativus*, *Carica papaya*, *Terminalia* sp., *Cucumis* sp., *Cucurbita* sp., *Acacia catechu*, *Dalbergiasissoo*, *Trifoliumalexandrinum*, *Trifoliumrepens*, *Woodfordiafructicosa*, *Moringaoleifera*, *Callistemon citrinus*, *Eucalyptus camaldulensis*, *Psidiumguajava*, *Syzygiumcumini*, *Sesamumindicum*, *Grevillea robusta*, *Eriobotrya japonica*, *Citrus* spp., *Salix babylonica*, *Litchi chinensis*, *Sapindusmukorosii*, *Camellia sinensis* and *Grewiaoptiva* were major sources of pollen and nectar to honey bees in Shiwalik hills. Whereas, *Adhatodavasica*, *Carissa caranda*, *Asclepiascurassavica*, *Cardusonopardiodes*, *Dahlia pinnata*, *Zinnia elegans*, *Impatiens glandiflora*, *Berberis* spp., *Brassica* sp., *Opuntia* spp., *Cannabis sativa*, *Benincasa* spp., *Embilicaofficinalis*, *Acacia arabica*, *Cassia fistula*, *Erythrinasuberosa*, *Delonixregia*, *Indigofera* spp., *Salvia* spp., *Lagerstroemia indica*, *Abelmoschusesculentus*, *Althaea rosea*, *Hibiscusrosa-sinensis*, *Malvaviscusarboreus*, *Epilobium* spp., *Clematis* spp., *Prinsepiautilis*, *Rubus* spp., *Murrayakoenigii* and *Antirrhinum majus* were the medium plant resources.

Besides the above major and medium soruces other plant species which were identified as minor sources belonged to families Acanthaceae, Agavaceae, Amaryllidaceae, Anacardiaceae, Apiaceae, Arecaceae, Asteraceae, Bignoniaceae, Boraginacae, Caprifoliaceae, Chenopodiaceae, Convolvulaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Fagaceae, Geraniaceae, Lamiaceae, Liliaceae, Linaceae, Malvaceae, Meliaceae, Maraceae, Musaceae, Papaveraceae, Plantiaginaceae, Poaceae, Polygonaceae, Portulacaceae, Punicaceae, Ranunculaceae, Rhamnaceae, Rosaceae, Rubiaceae, Solanaceae, Verbenaceae, Violaceae and Vitaceae.

Present studies indicated that there are two honey flow seasons in Shiwalik hills, alternated by comparative dearth periods when there are floral gaps and to some extent bee colonies may experience nectar and pollen shortage. Present investigations suggest that different parts of Shiwalik hills have vast potential for the development of beekeeping due to multiplicity of bee flora available throughout the year. For successful beekeeping floral calendars can prove to be excellent information sources of honey plants. This would be of great importance to bee keepers, extension of horticulture, agriculture and forest departments as its not only increases honey production but fruit quality is also greatly improved through such kind of apicultural investigations.

## 6. Future Scope

Assessment of bioresources including honey plant resources and their utilization pattern for hilly and plain area of North-West Himalayas. Floral maps should be prepared for whole of the Himalayan region. Detailed ecological and biochemical studies should be conducted on excellent nectar sources. Assessment of bioresources including honey plant resources and their utilization pattern for hilly and plain area of North-West Himalayas. For double-fold benefit, area based scientific beekeeping should be encouraged among the farmers. Need based research activities should be taken up.

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