

Chapter Six

Summary

The present study incorporates a qualitative and quantitative pollen analysis with biochemical investigation of 67 natural (squeezed and extracted) honey samples from the forests nearby agricultural areas of Sikkim and Sub-Himalayan West Bengal during the period of 1995 to 1998. Of the 67 samples, 65 included honeys of *Apis cerana indica* F. and rest 2 were of *Apis florea* F. The investigation was undertaken in order to identify the chief bee foraging plants, to recognise types of honey viz. unifloral or multifloral, quality of honey and to identify areas suitable for bee keeping industry where most of the economically backward tribal people like Lepcha, Tamang, Sherpa and others live. The study may also serve to indicate the geographical source of the honey samples collected widely from different areas with rich and characteristic flora.

The quantification of the pollen types and categorisation of the honeys were carried out according to the methodology recommended by the International Commission for Bee Botany (Louveaux *et al.*, 1978). Four frequency classes were recognised by the commission viz. predominant pollen types (> 45 %), secondary pollen types (16 - 45 %), important minor pollen types (3 - 15 %). and minor pollen types (< 3 %). The honey dew elements were studied from unacetolysed honey samples. The absolute pollen count of the honey samples were determined following the method adopted by Suryanarayana *et al.* (1981).

Of the 65 *Apis cerana indica* F. samples 7 were of Winter honeys (Honey Flow Period I during the months from November to February), 40 were of Summer honeys (Honey Flow Period II during the months from March to June) and the rest 18 were of Autumn/Monsoon honeys (Honey Flow Period III during the months from July to October). Rest two samples (No. 66 & 67) of *Apis florea* F. were of Summer honeys.

Of the 40 summer honeys of *Apis cerana indica* F. 15 were found to be unifloral and rest 25 were found to be multifloral. The dominant pollen taxa representing the unifloral honeys during summer were *Citrus* spp. (54.22 % in Dzongu honey), *Rosa* spp. (66.66 % in Damthang honey),

Ageratum conyzoides (50 % in Jaldhaka honey), *Rubus* spp. (52.15 % in Kagay honey), *Buddleja asiatica* (51.09 % in Lingee honey), *Prunus* spp. (56.79 % in Mitiali honey and 88.8 % in Tendrabong), *Milletia* spp. (70.73 % in Makum Busty honey), *Primula* spp. (51.21 % in Soreng Busty honey), *Calendula officinalis* (55.94 % in Sumbuk honey and 66 % in Sumbaria honey), *Schima wallichii* (57.7 % in Solak Busty honey), *Trifolium repens* (51.5 % in Dudhia Tea Estate honey), *Fragaria* spp. (54.91 % in Seed Farm honey) and *Potentilla* spp. (45.06 % in Todey honey). Pollen taxa in unifloral honeys during winter were *Aristolochia* spp. (52 % in Ecchey Busty honey) and *Rosa* spp. (78.5 % in Samsing honey). Unifloral samples during autumn consisted of the pollen taxa like *Michelia* spp. (85.36 % in Khamdong honey), *Brassica* spp. (58.29 % in Rabitar honey), *Sedum multicaule* (50 % in Rimbick honey), *Schima wallichii* (51.63 % in Sangsay honey, 65 % in Sakyone honey and 60.15 % in Dr. Graham's Homes area honey), *Prunus* spp. (50.22 % in Payong honey) and *Ageratum conyzoides* (55 % in Chibo busty honey).

Of the two summer honey samples of *Apis florea* F., one was unifloral with *Trifolium repens* as the dominant pollen source (82.7 % in Pabong honey) and another was multifloral in nature.

A total of 166 pollen types referable to 78 families were recovered from the honey samples of which 142 pollen types, represented the summer honeys, 60 the winter honeys and 91 the autumn honeys.

On the whole 310 (approx.) bee forage plants were recognised of which ± 262 were entomophilous, ± 44 were amphiphilous (pollinated by both insect and air) and ± 7 were anemophilous in nature.

Of the 65 honey samples of *Apis cerana indica* F. 51 samples were graded as Group I (APC, < 20000/10 gm honey), 13 samples as Group II (APC, 20000 – 100000/10 gm honey) and rest one sample of seed farm area of Kalimpong as Group III (APC, 100000 – 500000/10 gm honey).

Of the two *Apis florea* F. honey samples the Pabong sample (PABH) was graded as Group III (APC, 463767/10 gm) and the other from Lathpancher (LPH) as Group II (APC, 25862/10 gm honey) honey.

Physicochemical characterisation of 25 honey samples of *Apis cerana indica* F. and 2 honey samples of *Apis florea* F. were made adopting standard analytical methods. Samogyi, 1945) and were estimated. Specific gravity and pH of the honey samples were measured using hydrometer and pH meter (digital) respectively. Of the 25 samples of *Apis cerana indica* F. total sugar (both levulose and dextrose) was found to be highest in the seed farm honey sample of Kalimpong (762.5 mg/gm) and lowest in the Khamdong sample (130.0 mg/gm). Total amino acid was found to be highest in Rimbick sample (14.0 mg/gm), total proteins was found to be highest in Damthang honey (102.5 mg/gm). Both the honey samples of *Apis florea* F. showed highly acidic in nature having low pH (3.42 – 3.73) value and high amount of total amino acids 14.2 mg/gm in Lathpanchar honey and 13.6 mg/gm in Pabong honey).

The total water soluble protein and unidentified matters in both the samples were also found to be higher in comparison to those of *Apis cerana indica* F.

Intoxicating nature of a few honey samples was recognised due to presence of some intoxicating pollens like *Gynocardia odorata* (eg. 28.81 % in Sangsay honey, 5.19 & 12.8 % in two Pedong honeys etc.), *Bassia butyracea* (eg. 4.8 % in Fifth Mile honey, 3.4 % in Middle Bong busy honey etc.), *Bauhinia* spp. (eg. 10.5 % in Suruk honey, 9.78 % in Gangtok honey etc.) and *Leucosceptum canum* (eg. 1.35 % in Hill top honey)

A few honeys were found to have probable toxic effect due to the presence of certain percentages of toxic pollen like *Rhododendron* spp. (eg. 1.0 % each in Damthang and Payong honeys), *Papaver* spp. (eg. 17.7 % in Eleventh Mile honey, 8.5% in Monsong honey etc.), *Aesculus indica* (eg. 0.5 % in Monsong honey and *Croton* spp. (eg. 1 % in Mitiali honey).

Atomic absorption spectrometry was carried out taking three honey samples from three different target zones from pesticidal poisoning of honey point of view. Presence of traces of heavy metals were tested following nitric acid digestion technique and using the model varian AA 575 ABQ. Zinc, Copper, and Manganese were found to be higher than the normal quantity of the same in honey as denoted by Crane in 1975.

Ethnic use of honey was also investigated from qualitative, medicinal and ritual points of view. It was found that local herbalists, ('Jhankri'/'Gunin') give the 'Putka honey' of *Apis florea* F. more importance medicinally than the honey of *Apis cerana indica* F.

So, the present melissopalynological investigation of the honey samples and overall survey regarding the uses of honey and its importance near the local people favour the possibility of utilizing the rich flora of Sikkim and Sub-Himalayan West Bengal in developing apiary industry for good quality of honey and some honey based ancillary industries. This will create not only employment opportunities for the economically backward classes of this zone but also will help to maintain ecological balance through planting more and more bee plants which will also enhance the crop production through cross pollination by bees.