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Palynocontents of Bee-Collected Pollen Loads of Autumn Season in Bhimal, India.

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ABSTRACT : Melittopalynological investigations of honey bee (*Apis cerana indica* Fabr.) pollen loads for autumn season (September-October) from Bhimtal (near Nainital) in the Kumaon Himalaya, U.P., India were made. All the loads were unifloral representing 15 families and 18 taxa of both entomophilous and anemophilous angiosperms. The taxa belonging to the family Compositae were most dominant (34.7%) followed by Gramineae, Labiatae and Leguminosae (10% each). Besides, eleven minor sources of alternate bee flora have been highlighted in order to provide information on bee pasture to maintain continuous pollen/nectar or both pollen and nectar flow to the beehive for successful thriving of apiaries which is a prerequisite for lavish honey production.

KEY WORDS : **Honey bee, Pollen loads, Autumn season, Bhimtal, India.**

INTRODUCTION

Bee forage includes nectar and pollen. Nectar is the basic raw material from which honeybees make honey, whereas pollen rich in proteins, amino acids, carbohydrates, vitamins and hormones is an essential ingredient for bee nutrition and development of the brood and is therefore essential for the maintenance of a healthy bee colony. The pollen loads gathered by honeybees are moistened with regurgitated honey or nectar, and finally packed in the form of small pellets in their corbiculae or pollen baskets situated in their hind legs and are utilized for their protein requirements (chiefly during the larval stage) thereby serving as bee bread. During the process of collection and packing of pollen the honeybees transfer pollen to the pistil bringing about pollination of the flowers inadvertently.

Pollen analysis of honeys and bee collected pollen loads for their pollen contents provide valuable information regarding plants preferred by the bees for nectar/pollen or both nectar and pollen. It further reflects upon the characteristic local flora and vegetational assemblage of the area studied. It also furnishes information on major and minor sources of nectar and pollen and helps in identifying areas with possibilities of having a high potential for organizing apiary gardens for commercial honey production.

Earlier studies made in India on the floral origin of honeybee pollen loads were based on the color shade of individual pollen loads by Deodikar (1964), Phadke (1964), Suryanarayana and Thakar (1966). Later, pollen loads were analysed on the basis of pollen

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morphological characters by Sharma (1970), Chaturvedi (1976), Chaudhry (1977) and Garg and Nair (1994a). These workers have listed important bee forage plants of different regions in India.

Previous investigations made on honeybee pollen loads of Bhimtal region have elucidated 24 families of significant bee forage plants of spring season such as the taxa of Rosaceae and Fabaceae among the entomophilous types and Poaceae of the anemophilous type. The other important taxa were those of Asteraceae, Cucurbitaceae, Rutaceae, Cruciferae, Apiaceae Rhamnaceae, Aceraceae, Combretaceae, Mimosaceae, Polygonaceae, Ulmaceae, Chenopodiaceae, Potamogetonaceae, Primulaceae, Solanaceae, Amaranthaceae, Cannabinaceae, Cornaceae, Liliaceae type, Myrtaceae and Salicaceae. A pollen calender of honey bee preferred plants of the area and valuable information on apiary management has also been provided (Garg and Nair, 1994b). Following this, the present attempt is made on pollen load analysis of autumn season of the area covering the months of September and October.

Bhimtal is situated on the outer hills of Kumaon Himalayas at an altitude of 1371 m and 22 Km from Nainital (Fig.1). The place is identified by a lake ('Tal') and surrounded by hills which form a part of the central Himalayan range.

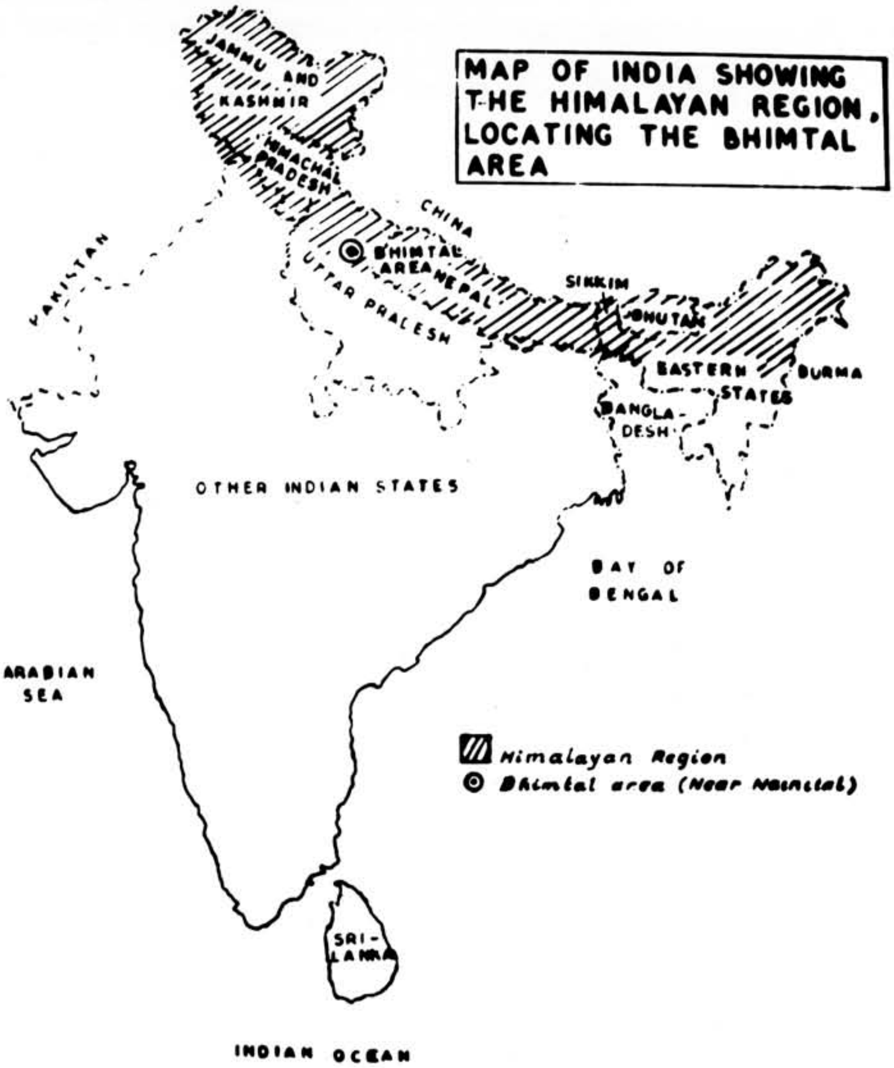

Fig.1. Map showing location of the study site (Bhimtal) in Kumaon Himalaya in Uttar Pradesh (Altitude: 1371 m)

MATERIALS AND METHODS

A total number of 49 pollen loads were procured from the Central Bee Research Institute, Pune, representing the months of September and October (autumn season), in the form of small pellets trapped from hind legs of the bees by means of a 5-mesh hardware metal sheet with 4.7 mm holes and a receptacle to collect the dislodged pellets placed at the hive entrance when the worker bees return to the hive. These collections were made at weekly intervals or after a fortnight during heavy rainfall considering that the ground flora is consistent for at least 10-15 days.

In laboratory the pollen analysis was made by the method described in the previous study (Garg & Nair, 1994 a, b). For these studies the individual pollen contained in the pellets were first dispersed in water, subsequently acetolysed by the standard acetolysis method (Erdtman, 1952; Nair, 1970). The acetolysed pollen was divided in two parts. One part was mounted on slides in glycerine jelly for light microscopy (LM) and the other part was mounted on brass stubs, coated with gold and photographed under JEOL-JSM 35 C Scanning Electron Microscope (SEM).

For the identification of pollen, observations on the phenology of the ground flora, reference pollen slide made from the flowering plants of the region, and the Flora Nainitalensis (Gupta, 1968) formed the basis. For calculating the percentages of various pollen types, all the grains contained in the pollen load samples were examined. Following the recommendations of International Comission for Bee Botany (ICBB) (1970), samples with 45% or more pollen of a single type are termed as 'unifloral'. The terminology used for describing pollen morphology is based on that of Erdtman *et al.* (1961) and modified by Nair (1970).

RESULTS

The pollen types and their frequencies in the honeybee pollen loads for the entire autumn season are elucidated in Table 1 and Fig. 2 and the scanning electron micrographs of the pollen grains are provided in Plates I-III.

Pollen Morphology

1. Aquifoliaceae (Pl. I, Fig. 1)

Grains 63 x 42 μm; prolate; 3-zonocolporate, colpus long, endocolpium lalongate, 8 x 12 μm. Exine 4 μm thick; surface retipilate, muri simplibaculate.

2. Betulaceae : *Alnus nepalensis* D. Don. (Pl. I, Fig. 2, 3)

Grains 17 x 26 μm; suboblate; 4-5 zonoporate, subaspidote, angulaperturate, pore oval, 3 x 2.2 μm. Exine 1.5 μm thick (3 μm thick at aspis); surface psilate.

3. Bignoniaceae : *Jacaranda mimosaefolia* D. Don. (Pl. I, Fig. 4)

Grains 59 x 50 μm; prolate spheroidal; 5-zonocolpate. Exine 4 μm thick; surface finely reticulate.

Table 1. Palynocontents of bee-collected pollen loads of autumn season

date	SEPTEMBER				OCTOBER				
Family	2	16	23	30	7	14	21	28	%
Aquifoliaceae		1							2.04
Betulaceae								1	2.04
Bignoniaceae	1								2.04
Cannabinaceae			1						2.04
Compositae		3	3	5		2	4		34.70
Cucurbitaceae		1							2.04
Gramineae			1	2	1	1			10.20
Labiatae					2	1		2	10.20
Leguminosae		1			1	2	1		10.20
Liliaceae type	2			1					6.12
Myricaceae	2								4.08
Polygonaceae	2								4.08
Smilacaceae	1								2.04
Solanaceae		1	1				1		6.12
Urticaceae		1							2.04

Numbers represent the number of pollen loads

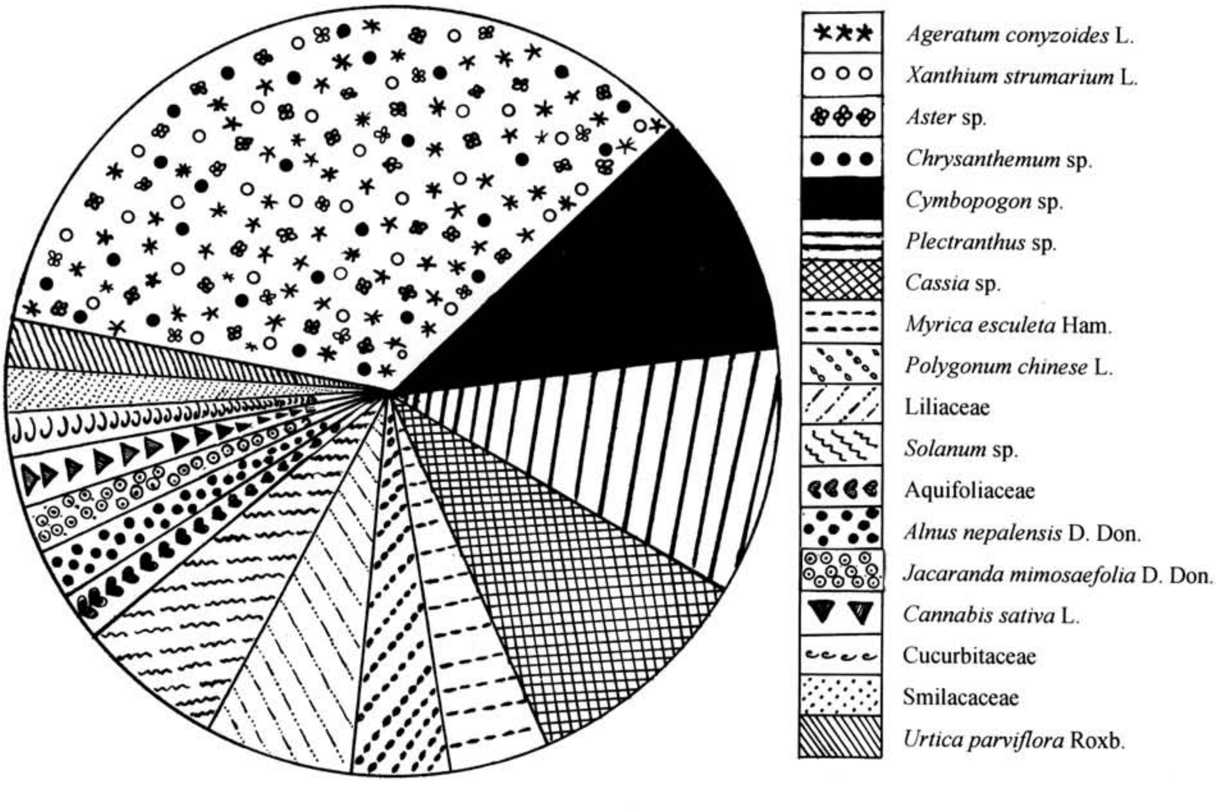

Fig. 2. Palynogram showing pollen frequency in the honey bee pollen loads of autumn season.

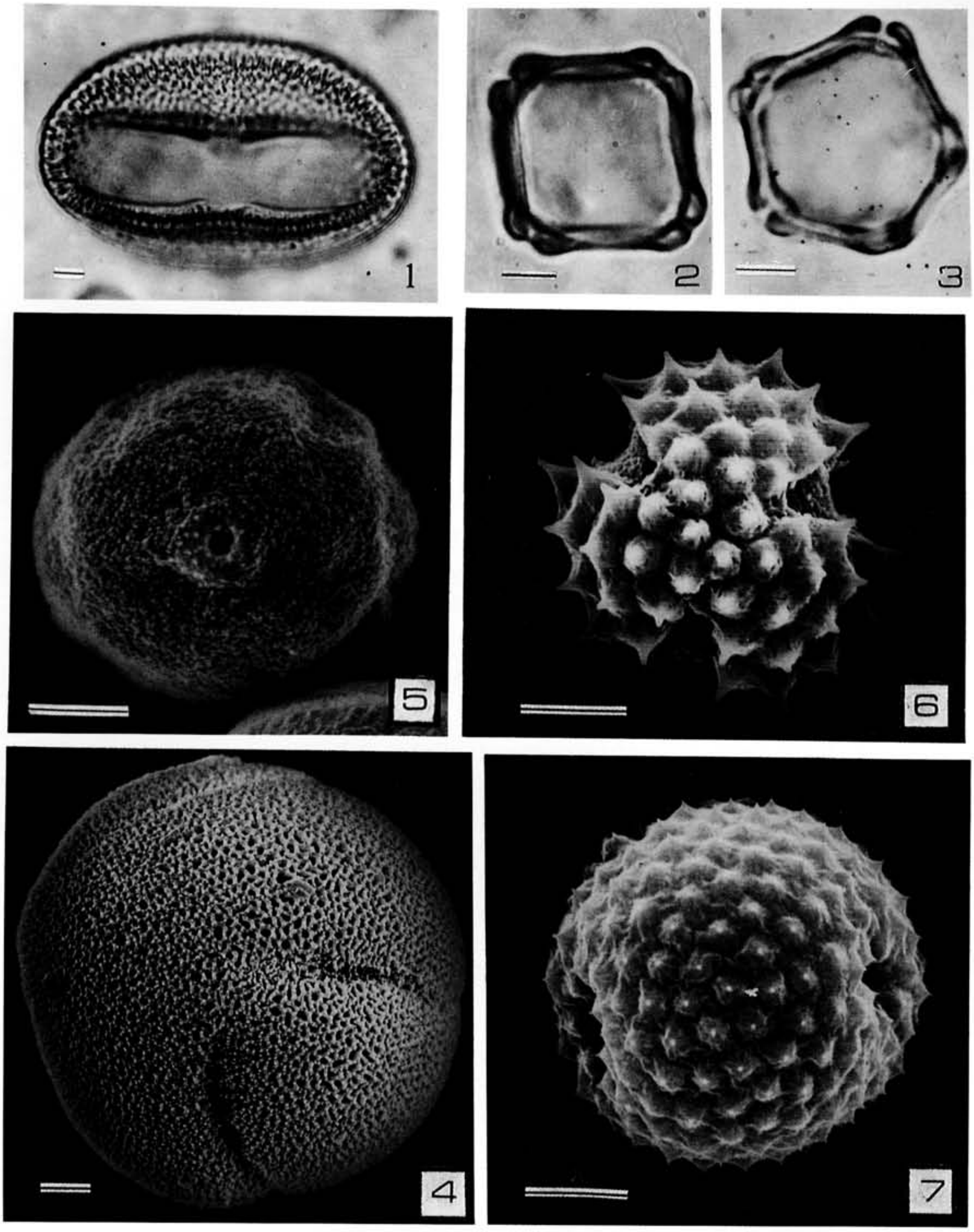

Plate I. Pollen micrographs . Scale lines = 5 μm.
Fig. 1: LM, Aquifoliaceae, equatorial view. 2, 3: LM, *Alnus nepalensis*, polar view showing aspidote grains. 4: SEM, *Jacaranda mimosaefolia*, slightly oblique polar view. 5: SEM, *Cannabis sativa*, equatorial view showing one pore. 6: SEM, *Ageratum conyzoides*, polar view. 7: SEM, *Xanthium strumarium*, equatorial view showing brevicolpate aperture.

4. Cannabinaceae : *Cannabis sativa* L. (Pl. I, Fig. 5)

Grains 24.3 μm; spheroidal; 3-zonoporate. Exine 1 μm thick; surface minutely granulate.

5. Compositae :

(i) *Ageratum conyzoides* L. (Pl. I, Fig. 6)
Grains 19 x 21 μm; oblate-spheroidal, 3-zonocolporate; endocolpium lalongate, broad elliptical, 3 x 9 μm. Exine 5 μm thick; surface spinulate.

(ii) *Xanthium strumarium* L. (Pl. I, Fig. 7)
Grains 22 x 25 μm; oblatespheroidal; 3 zonocolporate, apertures brevicolpate, colpi 5 x 2 μm. Exine 4.5 μm thick; surface spinulate, wavy.

(iii) *Aster* sp. (Pl. II, Fig. 8)
Grains 30 x 31 μm;oblate-spheroidal; 3-4 zonocolporate, endocolpium lalongate, 3 x 10 μm. Exine 9 μm thick; surface spinate, spine 6 μm long.

(iv) *Chrysanthemum* sp. (Pl. II, Fig. 9)
Grains 33 x 34 μm; prolate-spheroidal;3-zonocolporate, endocolpium lalongate, oval, 7 x 3 μm. Exine 9 μm thick, differentiated into basal root zone and distal column zone, root zone forming a dome shaped profusely punctate exposed basal cushion.; surface spinate, spines 6 μm long.

6. Cucurbitaceae (Pl. II, Fig. 10)
Grains 59 x 42 μm; prolate; 3-zonocolporate, endocolpium lolongate 12 x 5 μm, oval. Exine 3.5 μm thick; surface finely striato-reticulate.

7. Gramineae : *Cymbopogon* type (Pl. II, Fig. 11)
Grains 30.8 μm diam; spheroidal; monoporate, pore operculate, annulate, annulus diam 9 μm, pore diam 3 μm. Exine 1 μm thick; surface psilate.

8. Labiatae : *Plectranthus* sp. (Pl. III, Fig. 14)
Grains 48 x 35.5 μm; prolate; 6-zonocolpate. Exine 3 μm thick, surface reticulate with simple reticulum.

9. Leguminosae : *Cassia* sp. (Pl. II, Fig. 12)
Grains 50 x 40 μm; subprolate; 3-zonocolporate, endocolpium lolongate, oval 7 x 4 μm. Exine 3-4 μm thick; surface foveolate.

10. Liliaceae type (Pl. III, Fig. 15)
Grains 27 x 49.8 x 38 μm; planoconvex; ellipsoidal; monocolpate. Exine 1.5 μm thick; surface granulose and finely punctate.

11. Myricaceae : *Myrica esculenta* Ham. (Pl. II, Fig. 13)
Grains19 x 25μm;suboblate; 3-zonopororate, angulaperturate, aspidote, aspis diam 9 μm, pore diam 3 μm. Exine 1.5 μm thick; surface densely granulose.

12. Polygonaceae : *Polygonum chinense* L. (Pl. III, Fig. 16)
Grains 55 μm; spheroidal; 3-zonocolpate, colpus long. Exine 6 μm thick; surface heavily sculptured with large reticulum, brochi irregular with number of piloid elements.

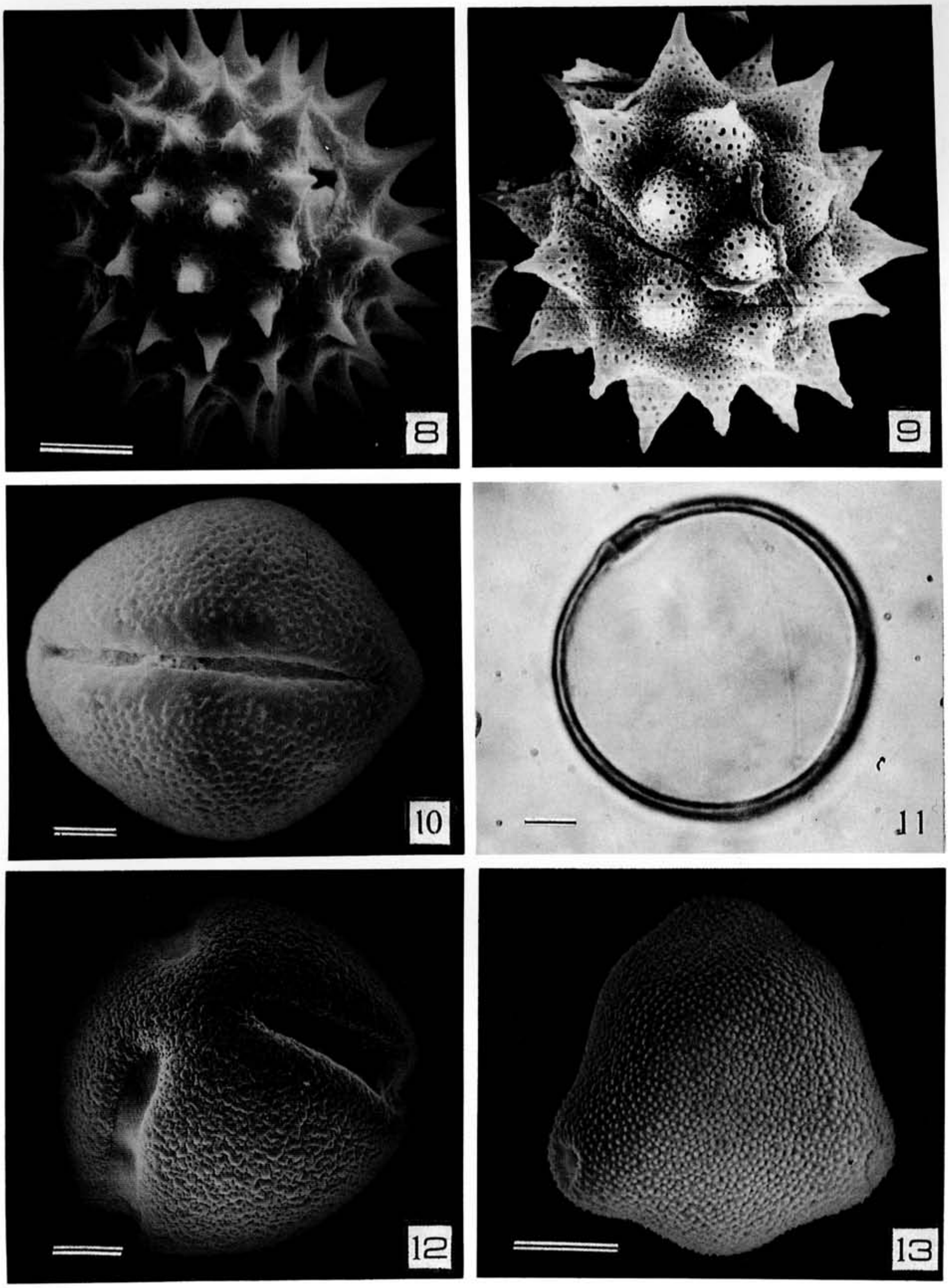

Plate II. Pollen micrographs. Scale lines = 5 μm.
Fig 8: SEM, *Aster* sp., slightly oblique equatorial view. 9: SEM, *Chrysanthemum* sp., slightly oblique polar view showing dome shaped spine complex. 10: SEM, Cucurbitaceae, equatorial view. 11: LM, *Cymbopogon* type. 12: SEM, *Cassia* sp., slightly oblique polar view showing broad colpi. 13: SEM, *Myrica esculenta*, polar view showing angulaperturate aspidote grains.

13. Smilacaceae (Pl. III, Fig. 17)

Grains 12 x 21 μm; 3-zonocolpate; ellipsoidal. Exine 1 μm thick; surface psilate with few scattered minute perforations.

14. Solanaceae : *Solanum* sp. (Pl. III, Fig. 18)

Grains 36.5 x 35 μm; subspheroidal; 3-4 zonocolporate, colpi margo thickened, endocolpium lalongate, lip-shaped, 4 x 20 μm. Exine 3 μm thick; surface foveolate.

15. Urticaceae : *Urtica parviflora* Roxb. (Pl. III, Fig. 19)

Grains spheroidal; 15 μm diam; pantopororate with 5-7 pores, pore diam 2.5 μm. Exine 1.5 μm thick; surface granulate.

DISCUSSION

The pollen analysis of bee loads has revealed the occurrence of all unifloral pollen loads reflecting the characteristic " floral fidelity " trait of the honeybees. The percentage purity of these loads was as high as 75 - 100%. Out of 49 loads, 17 are of Compositae (Table 1) representing 34.7% of the entire bee forage, and are constituted of *Ageratum conyzoides* L., *Xanthium strumarium* L., *Aster* and *Chrysanthemum* species. These are followed by *Cassia* sp. (Leguminosae), *Cymbopogon* type (Gramineae), and *Plectranthus* sp. (Labiatae) in equal numbers, together forming 30.6% loads (10.2% each; see Fig. 2). Significantly, these four important families together constitute 65.3% of the bee preferred plants suggesting that an apiary garden possessing these floral constituents can serve as a healthy vegetational unit sufficient enough for the bees to feed upon and rear a strong colony which is a prerequisite to a luxuriant honey harvest during the short autumn season. Other pollen types represented in the loads are Liliaceae type, *Solanum* sp. (Solanaceae), 6.12% each, *Myrica* (Myricaceae) and *Polygonum chinense* (Polygonaceae), 4.08% each, and Aquifoliaceae, *Alnus nepalensis* D. Don. (Betulaceae), *Jacaranda mimosaefolia* D. Don. (Bignoniaceae), *Cannabis sativa* L. (Cannabinaceae),Cucurbitaceae, Smilacaceae and *Urtica parviflora* Roxb. (Urticaceae), 2.04% each (Fig. 2).

The Compositae pollen were represented throughout the season in a more or less uniform pattern and contributed significantly to the bee flora (Table 1). Although each load was unifloral in nature, but on any specific day more than one type of loads were also obtained.

The diverse collection of pollen from different species of flowering plants in a day reflects the possibility of existence of a division of labour among the worker bees of a colony. The number of taxa representing each week were few indicating a greater availability of pollen from a single healthy source, the Compositae in particular and the Gramineae, Labiatae and Leguminosae in general.

The high dominance of anemophilous pollen of Gramineae constituting one of the major promising bee pastures is of special significance reflecting the behavioural character of the honey bees in frequenting nectarless anemophilous flowers for foraging on pollen exclusively, as also reported earlier (Sharma, 1970; Chaturvedi, 1976).

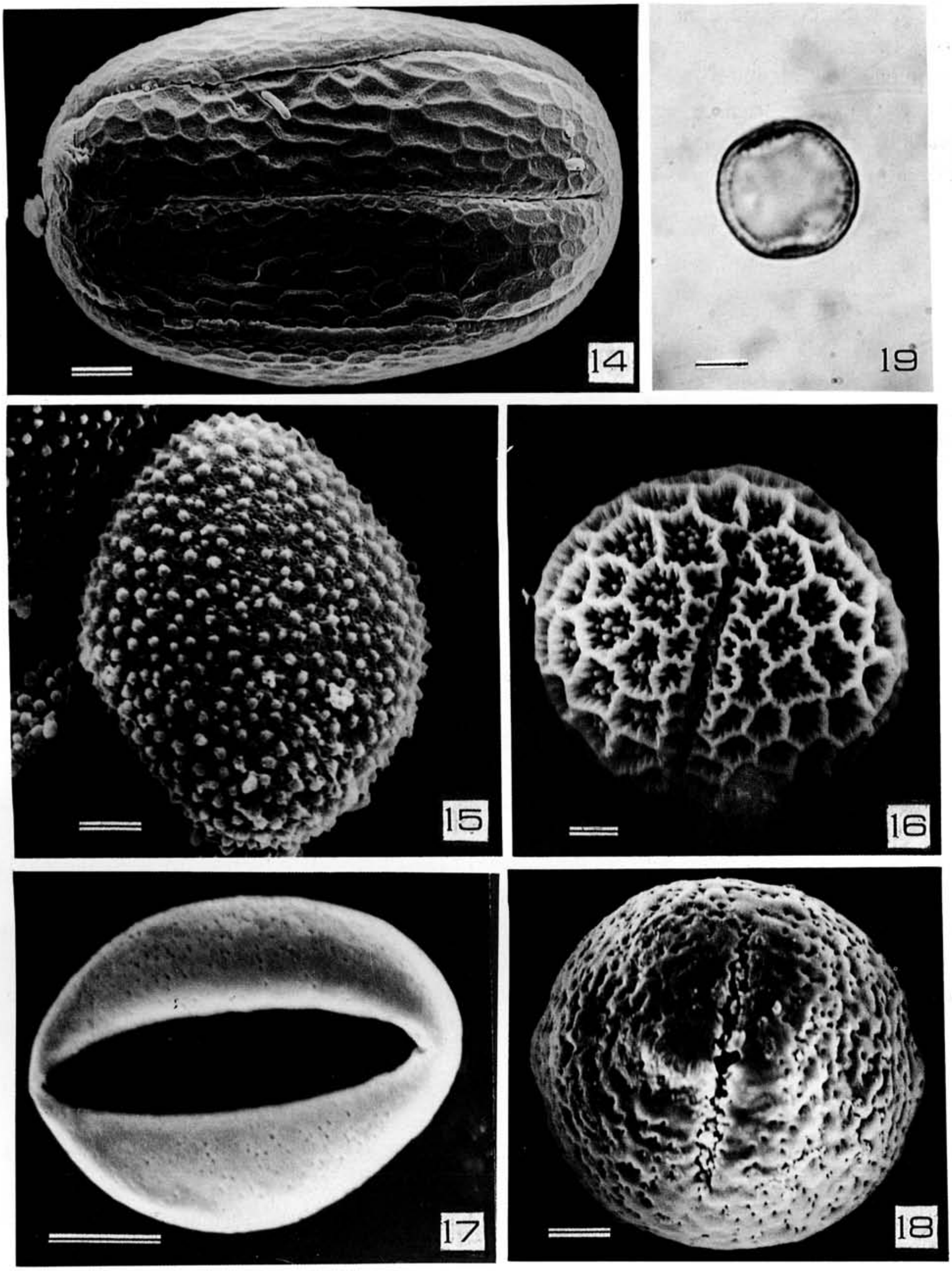

Plate III. Pollen micrographs. Scale lines = 5 μm.
Fig 14: SEM, *Plectranthus* sp., equatorial view showing 3 colpi. 15: SEM, Liliaceae type, surface view. 16: SEM, *Polygonum chinensis*, oblique equatorial view showing large reticula. 17: SEM, Smilacaceae, equatorial view showing broad colpus. 18: SEM, *Solanum* sp., equatorial view. 19: LM, *Urtica parviflora*, polar view.

It may therefore be concluded that the investigation of local bee forage in Bhimtal area during the autumn season has identified 4 important sources of pollen namely Compositae, Gramineae, Labiatae and Leguminosae and 11 other promising nectar and pollen sources for the bees, in order to provide a continuous chain of bee forage plants for autumn season management of apiary gardens (see Table 1 and Fig.2) in the area, thus opening new vistas for obtaining luxuriant honey harvest and enhancing the planter's income.

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印度 Bhimal 地區秋季蜜蜂採集花粉團之組成

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摘　　要

Bhimal 位於印度 Kumaon Himalaya 區，該地區印度蜂 (*Apis cerana indica* Fabr.) 於秋季 (九月至十月) 採集之花粉團之組成分析。結果所有花粉團皆屬於單花花粉團，花粉的種類包括風媒和蟲媒被子植物花粉，分屬於 15 個科和 18 個分類群。菊科花粉佔 34.7%，為最優勢，其次為禾本科、唇形科和豆科 (各佔 10%)。充足粉源及蜜源對於維持蜂產品的量是非常重要的，本實驗提及優勢花粉及 11 種次要的花粉，可做為選取設置蜂箱的參考。

關鍵詞：印度，Bhimal，秋季，蜜蜂花粉團。

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