Himachal Journal of Agricultural Research 45(1&2) : 66-75 (2019)

Palynological study of pollens of some important bee floral plants in Kangra district of Himachal Pradesh

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Manuscript Received: 29.06.2019; Accepted: 26.07.2019

Abstract

Shivalik region of Himachal Pradesh has a great diversity of pollen and nectar sources and good potential for commercial beekeeping. Studies on the morphological characteristics of pollen grains were carried out at Bee Research Station, Nagrota Bagwan of CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh during the year 2018- 2019. This study was opined to explore 60 blooming plants of different group *viz.,* oilseed crops, forest & fruit trees, vegetables and ornamental plants. Fresh and matured pollens were collected at the time of anthesis, washed with 70% ethyl alcohol and slides were prepared using DPX mountant. With an aid of Phase Contrast Microscope both polar and equatorial lengths of pollen as morphological features of 60 pollen types were described. The dominant pollen type belonged to family Rosaceae (8) followed by Brassicaceae (6), Asteraceae (4) and Verbenaceae (3).

Key words: Pollen, morphological characteristics, polar, equatorial.

Pollination; the transfer of pollen grains from anther to stigma is an essential pre-requisite for fertilization and for fruit or seed set. Inadequate pollination causes poor fertilization, uneven fruit or seed set, non-symmetrical fruits and high rates of fruit drop (Fell 2005; Thakur and Mattu 2014). Insects are main asset of essential ecosystem service in pollination dependent crops (Bhalla *et al.* 1983). Honeybees have been designated as excellent pollinators and suffice the purpose up to 16% of 400 blooming crops worldwide (Crane and Walker 1984).

Profitable beekeeping is resultant of better strain of honeybees' availability of pollen and nectar yielding resources. A tiny pollen grain is a product evolved by flowering plants to continue their generation and pollinators as external agents act along for co-evolution and mutualism (Dutta 1970). The study of pollen is important for gaining an understanding of bee behaviour with particular reference to their plant preferences (Nair 1985; Garg & Nair 1993; Baum *et al.* 2004; Jones and Bryant 2004). The morphological study of pollen grains helps to identify the potentialities like foraging resources, pollination mechanisms, migration routes of a locality for beekeeping and to ascertain the proportion contribution of various flora in honey production (Jones & Bryant 1996; Jones and Jones 2001; Barth 2004; Noor *et al.* 2004; Teper 2005; Singh and Mall 2017). Kangra district of the state is a hub of beekeepers and hence has the potential for commercial beekeeping (Kumar and Kundal 2016; Singh *et al.* 2017). The research on study of pollens in different parts of the country has been carried out but available knowledge and published research on the pollen study in this area is scanty (Carol 1999; Taha 2005; Sajwani *et al.* 2014; Taha 2015). Keeping all this in view, the present investigation was undertaken to determine pollen resources for honeybees in Palampur, Baijnath, Nagrota Bagwan and adjoining areas. Therefore, knowledge of bee important plants is of prime concern for the growth and progress of the apiculture in the state.

Materials and Methods

Fresh and matured pollens were collected at the time of anthesis which later cleaned with 70% ethyl alcohol and slides prepared using DPX mountant (Avetisjan 1950; Singh *et al.* 2018). Mounted slides were kept in hot air oven (40-45°C) for 72 hours. The extra dried medium was scrapped off with a razor blade and cover glass was ringed with transparent nail paint to avoid drying of medium. With an aid of Phase Contrast Microscope both polar and equatorial lengths

of pollen as their size in µm were measured. Different criteria for measurement of pollen grains of various shapes were followed. The size of round pollens was measured from one end to another end while the triangular, tri-lobed and round triangular pollen grain size was taken as average of perpendicular distances between each arm and the opposite angle. The length of both equatorial and polar axis were recorded along with their P/E ratio. The longer axis was considered as length while smaller as breadth of the pollen grain (Singh 2015). These pollen grains were then divided into five categories according to their size *i.e.,* <20 µm very small, 20-30 µm small, 30-50 µm medium, 50-100 µm large and >100 µm very large as per classification given by Sawyer (1981).

Results and Discussion

Morphological characteristics of pollens of 60 blooming plant species considered as bee flora for honeybees belonging to 31 botanical families throughout the season during 2018-2019 were recorded and have been presented in Table 1. The study revealed that dominant pollen type belonged to family Rosaceae (8), Brassicaceae (6), Asteraceae (4) and Verbenaceae (3). These pollen types were distributed to 40% ornamental plants, 20% vegetable crops, 18.33% forest plantations, 16.66% fruit crops, 3.33% oilseed crops and 1.66% cereal crop. Singh *et al.* (2017) also have reported 68 pollen types that served as pollen sources for bees from fruit trees, medicinal plants, ornamentals, vegetables and wild plants. As it is apparent from the plate 1 to plate 5 representing the shape and size of pollen grains that pollen morphology varied among different plant species. Similar report has also been documented on pollen morphology of 360 species belonging to 67 families by Qaiser and Praveen (1991). It is also evident from the Table 1 that the pollens of family Brassicaceae showed variation in their symmetry, exine surface and sculpture. Mustard was recorded with the largest pollen 1.82 µm in Brassicaceae family. The pollen types belonging to families Asteraceae and Malvaceae were spinolous and okra was observed with largest pollen of size 1.01 µm among all the vegetable crops. *Impatiens balsamina*, *Gaillardia pulchella*, *Phlox paniculata*, *Pyrus persica*, *Prunus domestica*, *Pyrus pashia*, *Punica granatum* and *Melia azedarach* pollens were long and had bilateral symmetry. The smallest pollen (1.09 µm) among all the forest trees was of kachnar. Among the fruit trees investigated peach was recorded with the largest pollen (2.14 µm) and kiwifruit the smallest (1.26 µm).The study also showed that pollen grains of family Cucurbitaceae were very large, round and rounded triangular while those of *Verbena bonariensis* were boat shaped and bilateral. Zinnia was observed with largest pollen size of 1.00 µm among all the ornamental plants. Wei (1991) also revealed that pollen grain of *Brassica campestris* was sub spherical to prolate and there had been great variation in the size of the pollen grains of different plant species. The pollen morphology so determined and described in the present investigation would help the beekeepers to utilize the flora, students to know the discrimination in sizes of pollens and researchers to plan further molecular studies.

Table 1. Morphological characteristics of pollen of some bee floral plants

Sr. No.	Common Name	Scientific Name	Family	Pollen Length (µm)		Size (P/E) (µm)	Color	Pollen Description
				Polar length (P)	Equatorial length (E)			
Oilseed crops								
1	Toria	*Brassica campestris* var. *toria*	Brassicaceae	23.77	21.89	1.08	Yellow	Oval, small, bilateral symmetry
2	Mustard	*Brassica juncea*	Brassicaceae	138.59	75.79	1.82	Yellow	Round, very large, radial symmetry
Fruit trees								
1	Peach	*Prunus persica*	Rosaceae	196.41	91.57	2.14	Reddish yellow	Long, very large, bilateral symmetry
2	Nectarin	*Prunus persica* var. *nucipersica*	Rosaceae	47.82	28.68	1.66	Reddish yellow	Triangular, medium, bilateral symmetry
3	Pear	*Pyrus pashia*	Rosaceae	37.09	23.62	1.57	White	Long, medium, bilateral symmetry
4	Apple	*Malus pumila*	Rosaceae	30.36	28.21	1.07	White	Rounded triangular, small, radial symmetry

5	Strawberry	*Fragaria vesca*	Rosaceae	23.51	18.78	1.25	Yellow	Round, small, radial symmetry
6	Plum	*Prunus domestica*	Rosaceae	36.94	23.42	1.57	Yellow	Long, medium, bilateral symmetry
7	Blueberry	*Vaccinium corymbosum*	Ericaceae	42.05	37.61	1.11	White	Triangular, medium, bilateral symmetry
8	Kiwifruit	*Actinidia deliciosa*	Actinidiaceae	21.97	17.37	1.26	White	Round and very small
9	Pomegranate	*Punica granatum*	Lythraceae	26.64	16.02	1.66	Yellow	Long, small, bilateral symmetry
10	Citrus	*Citrus sinensis*	Rutaceae	30.24	20.05	1.50	Yellow	Long, medium, bilateral symmetry
Forest plantations								
1	Kamala	*Mallotus philippensis*	Euphorbiaceae	19.03	18.68	1.01	Reddish Brown	Round, very small, radial symmetry
2	Safeda	*Eucalyptus camaldulensis*	Myrtaceae	21.29	19.47	1.09	White	Triangular, very small, bilateral symmetry
3	Tahli	*Dalbergia sissoo*	Fabaceae	19.32	18.39	1.05	Yellow	Round, very small, radial symmetry
4	Aonla	*Phyllanthus emblica*	Phyllanthaceae	23.38	19.06	1.22	Yellow	Long, small, bilateral symmetry
5	Cury leaf Plant	*Murraya koenigii*	Rutaceae	58.46	28.46	2.05	White	Long, medium, bilateral symmetry
6	Dharek	*Melia azedarach*	Meliaceae	34.02	25.24	1.34	White	Long, medium, bilateral symmetry
7	Kachnar	*Bauhinia variegate*	Fabaceae	17.79	16.22	1.09	White	Round, very small, radial symmetry
8	Wild roses	*Rosa moschata*	Rosaceae	51.52	20.52	2.51	Yellow	Long, large, bilateral symmetry
9	Jacaranda	*Jacaranda mimosifolia*	Bignoniaceae	70.58	31.65	2.23	White	Long, large, bilateral symmetry
10	Silver oak	*Grevillea robusta*	Proteaceae	49.85	40.37	1.23	White	Triangular, medium, bilateral symmetry
11	Pajja	*Prunus puddum*	Rosaceae	40.07	25.67	1.56	White	Oval, medium, bilateral symmetry
Vegetable crops								
1	Chinese Cabbage	*Brassica rapa* subsp. *chinensis*	Brassicaceae	33.10	18.57	1.78	White	Long, small, bilateral symmetry
2	Cabbage	*Brassica oleraceae* var. *capitata*	Brassicaeae	24.48	17.91	1.36	Light yellow	Round, small, radial symmetry
3	Broccoli	*Brassica oleraceae* var. *italica*	Brassicaeae	32.55	18.26	1.78	Light yellow	Oval, small, bilateral symmetry
4	Cauliflower	*Brassica oleraceae* var. *botrytis*	Brassicaeae	32.65	16.84	1.93	Light yellow	Long, small, bilateral symmetry
5	Coriander	*Coriandrum sativum*	Apiaceae	65.89	58.90	1.11	Pink	Round, large, radial symmetry
6	Tomato	*Lycopersicum esculentum*	Solanaceae	33.54	15.62	2.14	Yellow	Long, small, bilateral symmetry
7	Brinjal	*Solanum melongena*	Solanaceae	33.83	30.47	1.110	Yellow	Oval, medium, radial symmetry
8	Okra	*Abelmoschus esculentus*	Malvaceae	223.22	220.98	1.010	Light yellow	Round, very large, echinate, radial symmetry
9	Ridge gourd	*Luffa cylindrica*	Cucurbitaceae	159.41	155.56	1.024	Yellow	Rounded triangular, very large, bilateral symmetry
10	Chilli	*Capsicum annuum*	Solanaceae	37.33	33.94	1.099	White	Oval, medium, radial symmetry
11	Pumpkin	*Cucurbita pepo*	Cucurbitaceae	201.13	190.12	1.057	Yellow	Round, very large, radial symmetry
12	Radish	*Raphanus sativus*	Brassicaeae	32.29	15.30	2.110	White	Long, small, bilateral symmetry

Cereal crop								
1	Maize	*Zea mays*	Poaceae	134.57	131.50	1.023	Light yellow	Round, very large, radial symmetry
Ornamentals								
1	Marigold	*Calendula officinalis*	Asteraceae	33.76	33.31	1.014	White	Oval, medium, radial symmetry
2	Morning glory	*Ipomoea purpurea*	convolvulaceae	150.11	145.88	1.029	White	Round, very large, radial symmetry
3	Lantana	*Lantana camara*	Verbenaceae	28.33	27.73	1.022	White	Round, small, radial symmetry
4	Azalea	*Rhododendron arboreum*	Ericaceae	44.02	40.20	1.095	White	Triangular, medium, bilateral symmetry
5	Trailing daisy	*Wedelia trilobata*	Asteraceae	29.91	23.67	1.263	Yellow	Oval, small, bilateral symmetry
6	Calla lily	*Zantedeschia aethiopica*	Aeraceae	64.37	64.33	1.001	White	Round, large, radial symmetry
7	Big leaf hydrangea	*Hydrangea macrophylla*	Hydrangeaceae	31.30	31.12	1.005	White	Oval, small, bilateral symmtetry
8	Garden dahlia	*Dahlia pinnata*	Asteraceae	33.16	30.42	1.090	Light yellow	Round, medium, bilateral symmetry
9	Bottlebrush	*Callistemon citrinus*	Myrtaceae	19.22	18.04	1.065	Yellow	Triangular, small, bilateral symmetry
10	Fall phlox	*Phlox paniculata*	Polemoniaceae	68.68	38.56	1.781	White	Long, large, bilateral symmetry
11	Cuphea	*Cuphea hyssopifolia*	Lythraceae	24.34	13.21	1.842	White	Oval, very small, bilateral symmetry
12	Bougainvillea	*Bougainvillea spectabilis*	Nyctaginacaeae	29.76	27.90	1.066	White	Round, small, radial symmetry
13	Purple top Vervain	*Verbena bonariensis*	Verbenaceae	32.75	27.48	1.191	White	Boat shaped, medium, bilateral symmetry
14	Spider plant	*Cleome hassleriana*	Cleomaceae	82.94	80.06	1.036	White	Round, large, radial symmetry
15	Cosmos	*Cosmos bipinnatus*	Asteraceae	43.99	38.48	1.143	Yellow	Round, medium, radial symmetry
16	Blanket flower	*Gaillardia pulchella*	Asteraceae	29.57	28.34	1.043	White	Round, small, spiny, radial symmetry
17	Abelia	*Abelia grandiflora*	Caprifoliaceae	85.95	77.89	1.103	White	Rounded triangular, large, bilateral symmetry
18	Zinnia	*Zinnia elegans*	Asteraceae	195.08	195.02	1.000	Yellow	Round, very large, spiny, radial symmetry
19	Cockscomb	*Celosia spicata*	Amaranthaceae	28.99	26.43	1.097	White	Round, small, spiny, radial symmetry
20	Garden balsam	*Impatiens balsamina*	Balsaminaceae	37.42	19.13	1.956	White	Long, small, bilateral symmetry
21	Amaranth	*Gomphrena globosa*	Amaranthaceae	21.85	21.20	1.031	White	Round, small, Irregular ornamentations
22	Duranta	*Duranta repens*	Verbenaceae	37.68	32.14	1.172	White	Oval, medium, radial symmetry
23	Musk mallow	*Hibiscus abelmoschus*	Malvaceae	152.4	147.6	1.035	White	Round, very large, echinate, radial symmetry
24	Tulsi	*Ocimum sanctum*	Lamiaceae	78.60	73.13	1.074	brown	Oval, large, bilateral symmetry

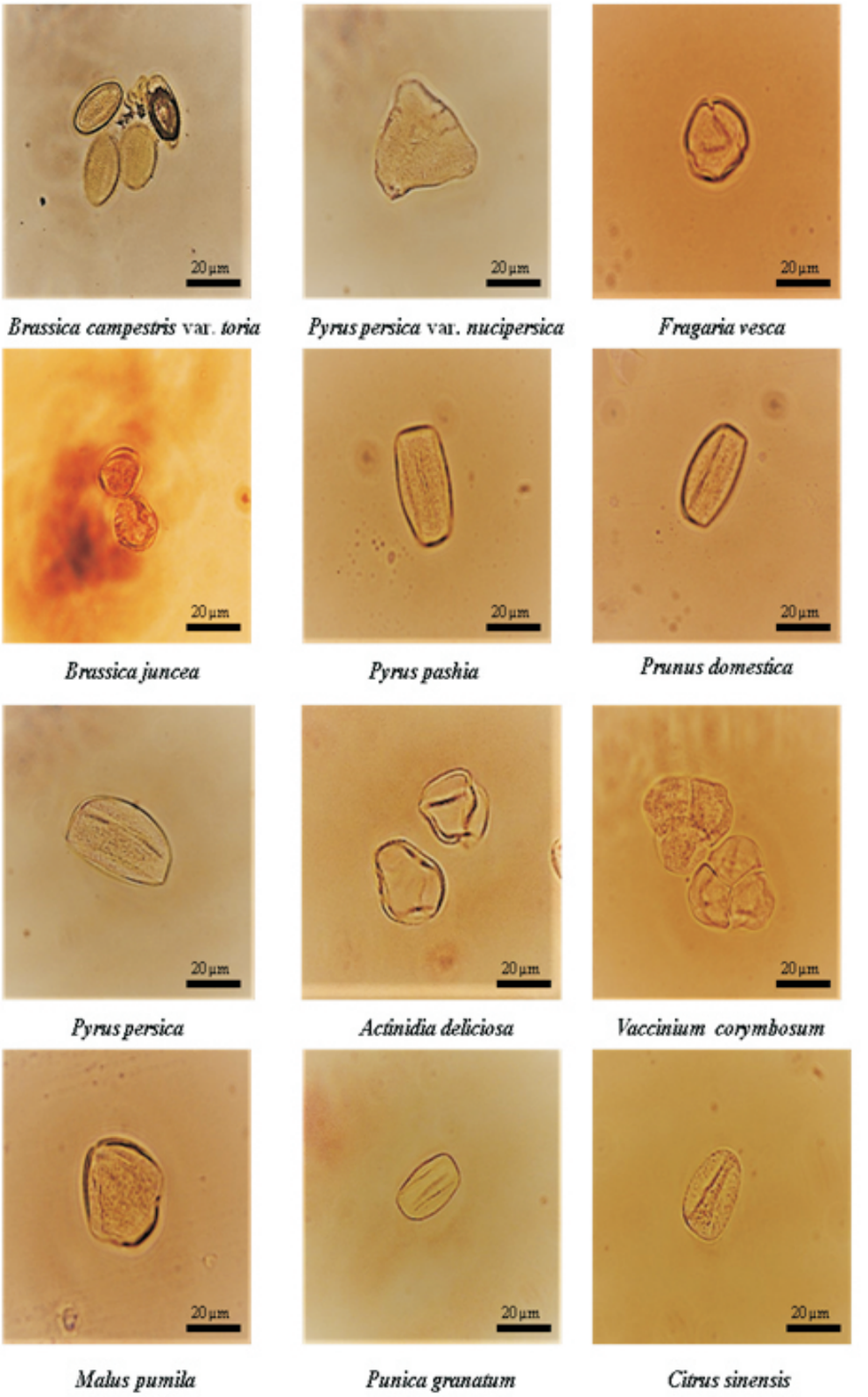

Plate 1. Pollens of some bee floral plants

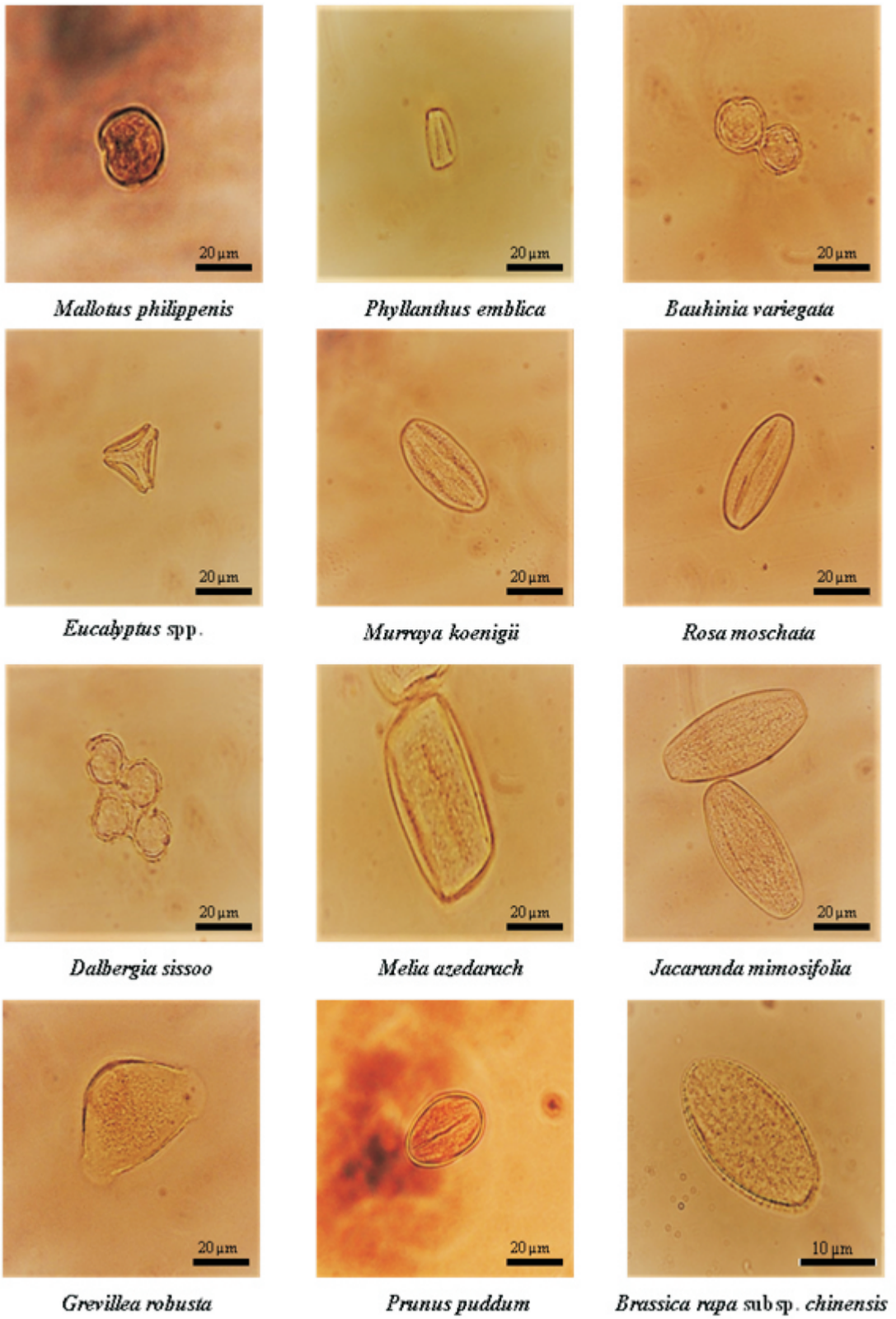

Plate 2: Pollens of some bee floral plants

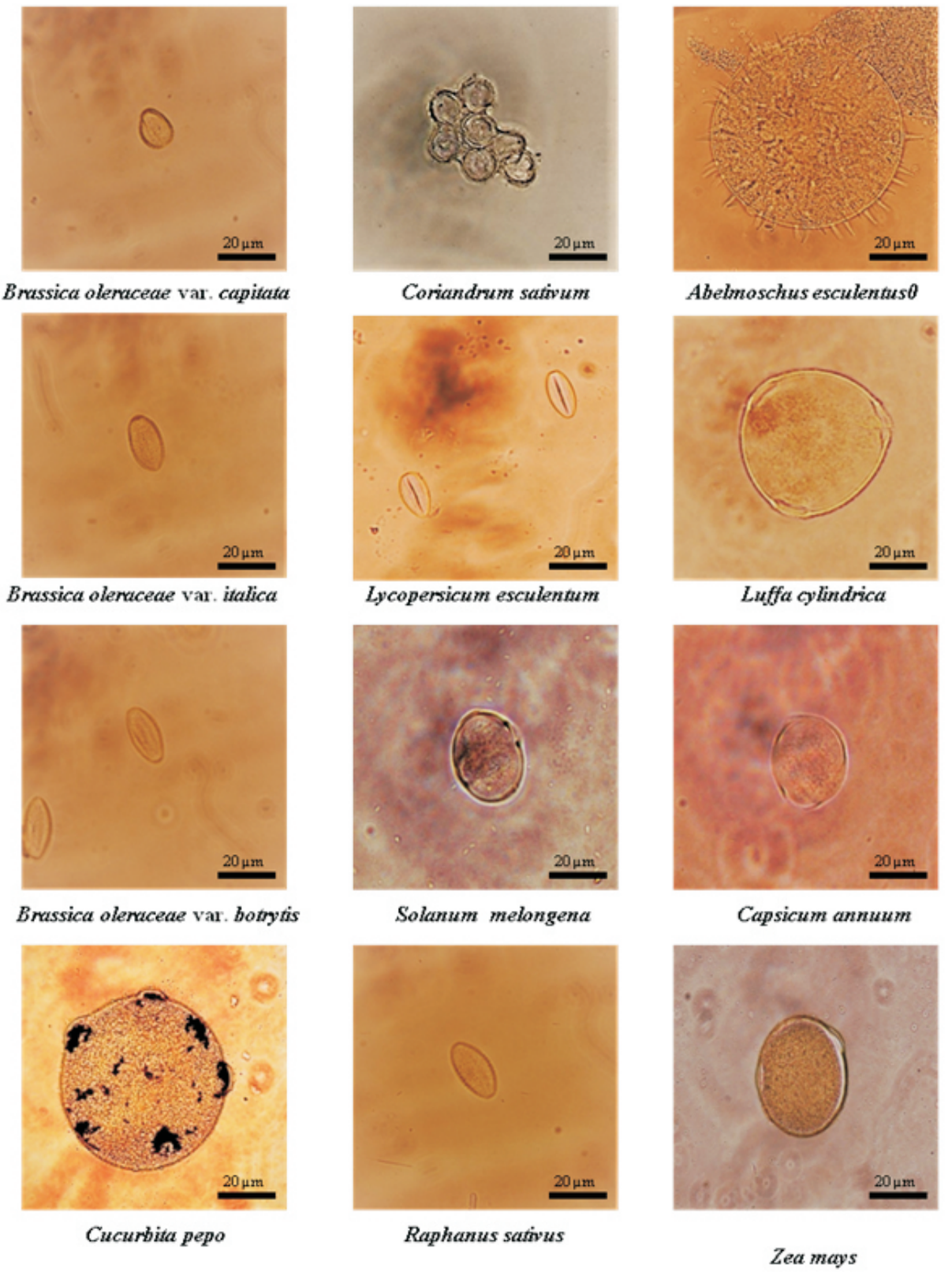

Plate 3: Pollens of some bee floral plants

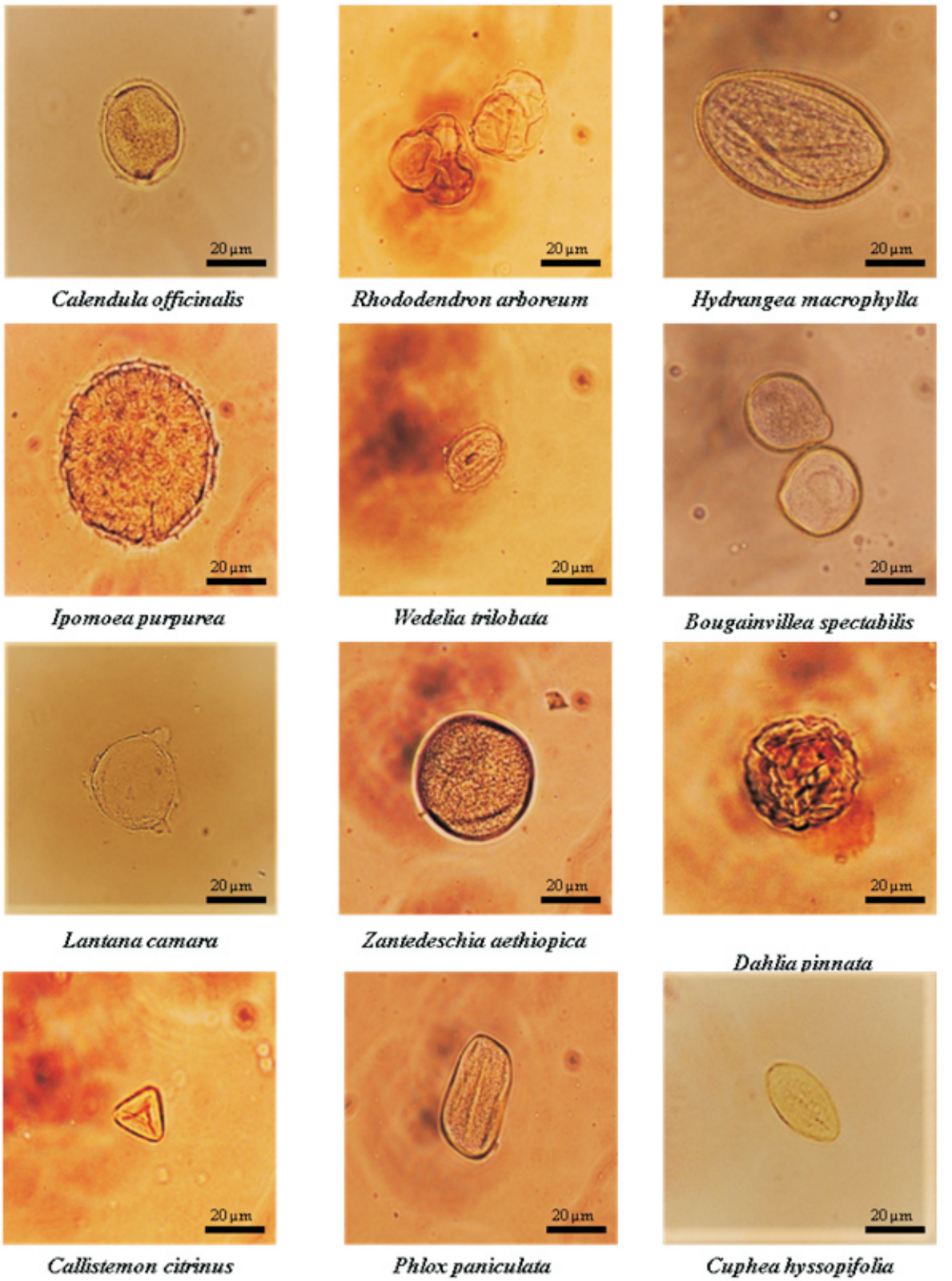

Plate 4: Pollens of some bee floral plants

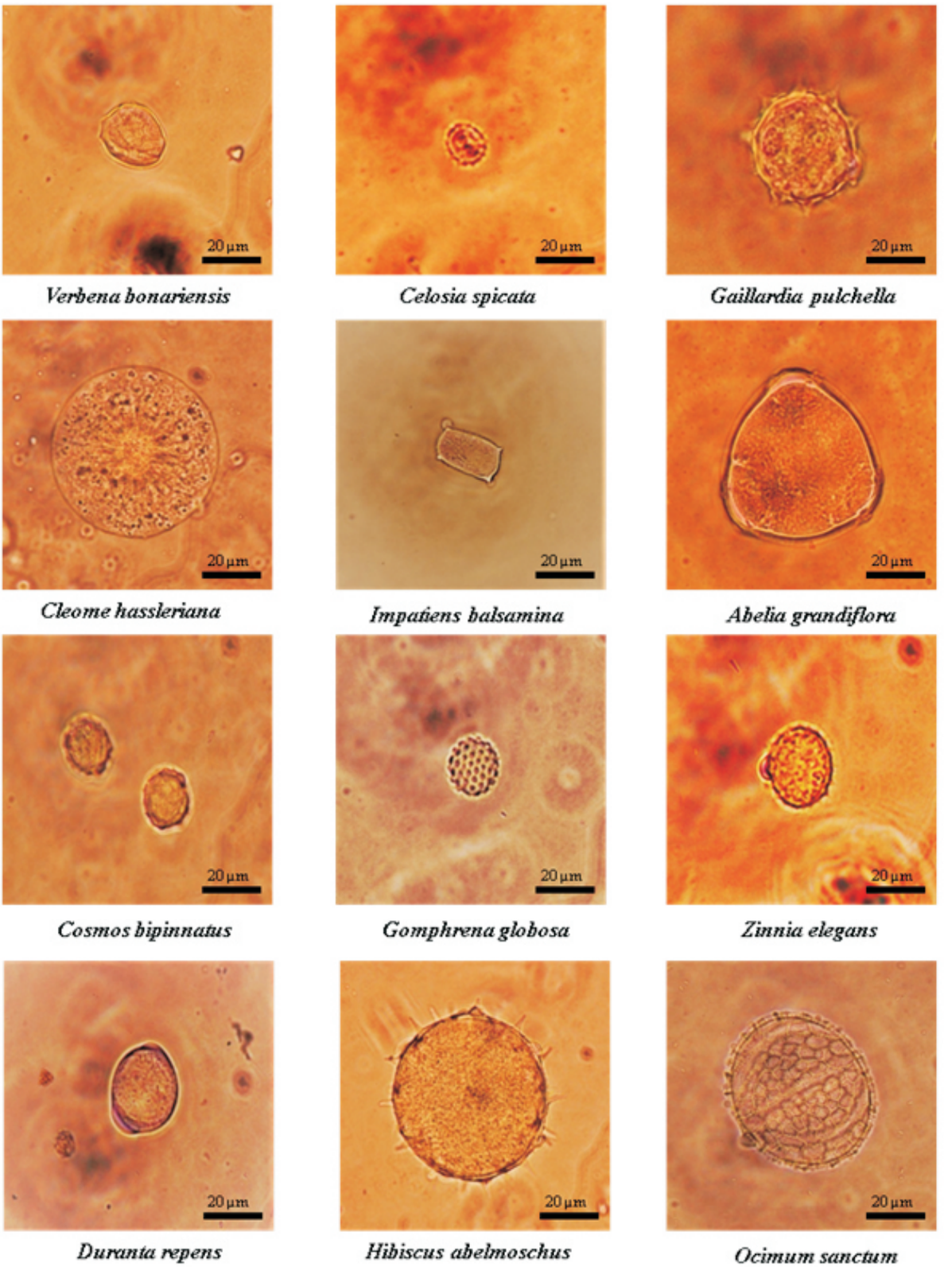

Plate 5: Pollens of some bee floral plants

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