

MELITOPALYNOLOGICAL STUDY IN TAIWAN (I)⁽¹⁾

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Abstract: Eighty-eight honey samples collected from Middle and South Taiwan between April and May were investigated. Totally, pollen of 53 taxa belonging to 35 families were identified. Both pollen from entomophilous and anemophilous plants were presented in the honey samples. The major honey source plants in the spring are *Euphoria longana* and *Litchi chinensis*. Pollen of Myrtaceae (*Psidium guajava* or *Syzygium javanicum*) is sometimes dominant. Other anemophilous plants, such as Compositae, Ulmaceae (*Trema* and *Celtis*), Euphorbiaceae (*Macaranga tanarius*, *Mallotus japonicus* and *Sapium sebiferum*), Moraceae, Gramineae and Polygonaceae (*Rumex*) are also considerable amount of pollen in the honey. Pollen of Leguminosae (*Acacia confusa*), Rutaceae (*Citrus*), etc., also are present frequently.

Of the 88 samples, 10 are multifloral honey, 78 are unifloral honey. Among the unifloral honeys, 72 are of Longan honey, 2 of Lychee honey, 3 of *Psidium* honey and one of Compositae honey. The absolute pollen frequency per gram honey was counted.

INTRODUCTION

Honeybees collect their foods from plants, especially from such plants that offer higher concentration or large quantity of nectar. Besides nectar they also collect honeydew secreted from leaves or other parts of plants. Honeybees store surplus of the collected sugar-containing juice as honey for the time of necessity (Straka, 1975). Besides honey collecting, honeybees also gather large quantity of pollen directly from entomophilous and anemophilous flowers for the feeding of bee larvae. Pollen grains are usually collected together with nectar, but transported and stored separately from the latter (Vorwohl, 1978). However, a small amount of this pollen may get into honey and thus provide an important aid to indicate the honey origin and furthermore the honey quality (Straka, 1975).

A pollen analysis of honey has been done previously by Chen (1979) in Taiwan. The purpose of this investigation is to identify the honey source plants and to find out a suitable method for the evaluation of honey quality in Taiwan.

MATERIALS AND METHODS

The eighty-eight honey samples collected between April and May 1983 were procured from different apiaries in Middle and South Taiwan. Among them 85

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samples were noted by the beekeepers as Longan honey and 3 as Lychee honey. Sample number, sort of honey, locality and data of collection are given by the suppliers (Table 1).

The usual acetolysis method (Erdtman, 1966) was followed to prepare pollen slides after centrifuging the pollen from 50 g honey by dilution in hot water. Abundance of pollen was calculated by dilution method. The acetolysed pollen were suspended in 10 ml H₂O. The absolute pollen number in 1 g honey was then calculated according to the absolute counts in 10 μ l diluted suspension. Percentages of each pollen species in honey were calculated in virtue of the frequency of presence encountered in 500 counts. For observation by scanning electron microscopy (SEM) the acetolysed pollen grains were coated with gold after treating with a series of alcohol (Chen, 1984).

In the course of identification, the local Pollen Flora (Huang, 1972) and fresh materials are consulted. The abundance of pollen in honey was classified according to Zander (1935) and Lieux (1972): dominant pollen contains over 45%; secondary pollen 16-45%; minor pollen 1-15; trace pollen less than 1%. A dominant pollen denotes an unifloral honey.

Pollen slides and honey samples are preserved in the Laboratory of Palynology, Institut of Botany, National Taiwan University.

RESULTS

The frequencies of the presence of pollen in each honey sample are given in Table 2. Of the 88 honey samples studied, 10 samples with 11.4% had less than 2,000 grains per gram honey, 70 samples with 79.5% had 2,000-10,000 grains and 8 samples with 9.1% had more than 10,000 grains (Table 3).

53 taxa belonging to 35 families of pollen types were identified (Table 4). Neither fern spores nor pollen of gymnosperm were found. The pollen spectra showing the percentages of the common and important pollen types are illustrated in Fig. 1 and 2 for Longan honey and Lychee honey respectively. The 85 samples of the so-called Longan honey are arranged in the order of percentage of *Euphoria longana* pollen. Those samples from the same supplier, locality and collected-date are grouped together. The mean percentages of the pollen appeared in Longan- and Lychee honey are given in Table 5.

According to the results showed above, of the 88 samples, 10 are multifloral and 78 unifloral honeys: seventy-two Longan honey (*Euphoria longana* 45-88%), two Lychee honey (*Litchi chinensis* 75-86%), one Compositae honey (Compositae 73%) and three *Psidium* honey (*Psidium guajava* 53-63%).

An unifloral Longan honey of sample 94 is shown in Fig. 3 with SEM. Some common pollen species of honey are presented in Plates 1-5 with light microscopy (LM) and in Plates 6-8 with SEM.

DISCUSSION

The absolute pollen frequency as well as relative counting of different species in a sample may be influenced by the preparation method of honey. The value of absolute pollen frequency in the honey varies usually in the range between 2,000 and 10,000 grains per gram honey when the honey is acquired by centrifugation.

Table 1. List of 88 honey samples

Sample number	Sort of honey	Locality	Date of collection
1	Longan honey	Changhua	Apr. 12, 1983
2	Longan honey	Changhua	Apr. 12, 1983
3	Longan honey	Changhua	Apr. 12, 1983
4	Longan honey	Taichung: Chelungpu	Apr. 12, 1983
5	Longan honey	Taichung: Chingshuykeng	May 21, 1983
6	Lychee honey	Taichung: Chelungpu	Apr. 12, 1983
7	Longan honey	Taichung: Wufeng	Apr. 21, 1983
8	Longan honey	Taichung: Wufeng	Apr. 21, 1983
9	Longan honey	Taichung: Wufeng	Apr. 21, 1983
10	Longan honey	Tainan: Nanhsi	Apr. 18, 1983
11	Longan honey	Tainan: Nanhsi	Apr. 14, 1983
12	Longan honey	Tainan: Nanhsi	Apr. 14, 1983
13	Longan honey	Tainan: Nanhsi	Apr. 17, 1983
16	Longan honey	Tainan: Nanhsi	Apr. 15, 1983
17	Longan honey	Tainan: Nanhsi	Apr. 15, 1983
18	Longan honey	Tainan: Nanhsi	Apr. 15, 1983
19	Longan honey	Nantou: Puli	Apr. 20, 1983
20	Longan honey	Nantou: Puli	Apr. 20, 1983
21	Longan honey	Nantou: Puli	Apr. 20, 1983
22	Longan honey	Chiayi	Apr. 25, 1983
23	Longan honey	Chiayi	Apr. 25, 1983
24	Longan honey	Chiayi	Apr. 25, 1983
25	Longan honey	Chiayi	Apr. 18, 1983
26	Longan honey	Chiayi	Apr. 18, 1983
27	Longan honey	Chiayi	Apr. 18, 1983
28	Longan honey	Tainan: Yushan	Apr. 15, 1983
29	Longan honey	Tainan: Yushan	Apr. 25, 1983
30	Longan honey	Tainan: Lungchi	Apr. 24, 1983
31	Longan honey	Tainan: Lungchi	Apr. 24, 1983
32	Longan honey	Tainan: Lungchi	Apr. 24, 1983
33	Longan honey	Tainan: Hsinhua	Apr. 15, 1983
34	Longan honey	Tainan: Hsinhua	Apr. 15, 1983
35	Longan honey	Tainan: Hsinhua	Apr. 15, 1983
36	Longan honey	Taichung: Chutzekeng	
37	Longan honey	Tainan: Hsinhua	
38	Longan honey	Tainan: Hsinhua	
39	Longan honey	Taichung: Taiping	
40	Longan honey	Taichung: Taiping	
41	Lychee honey	Taichung: Taiping	

42	Longan honey	Kaohsiung: Takangshan
43	Longan honey	Kaohsiung: Takangshan
44	Longan honey	Kaohsiung: Tashu
45	Longan honey	Kaohsiung: Heishan
46	Longan honey	Kaohsiung: Heishan
47	Lychee honey	Kaohsiung: Heishan
56	Longan honey	Nantou: Chungliao
57	Longan honey	Nantou: Chungliao
58	Longan honey	Nantou: Chungliao
59	Longan honey	Nantou: Chungliao
60	Longan honey	Tainan: Tungshan
61	Longan honey	Tainan: Tungshan
62	Longan honey	Tainan: Tungshan
63	Longan honey	Tainan: Tungshan
64	Longan honey	Tainan: Nanhsi
65	Longan honey	Tainan: Nanhsi
66	Longan honey	Tainan: Hsientsau
67	Longan honey	Tainan: Hsientsau
68	Longan honey	Tainan: Nanhsi
69	Longan honey	Tainan: Nanhsi
70	Longan honey	Tainan: Nanhsi
71	Longan honey	Tainan: Nanhsi
72	Longan honey	Taichung: Toupienkeng
73	Longan honey	Taichung: Toupienkeng
74	Longan honey	Taichung: Toupienkeng
75	Longan honey	Tainan: Hsinhua
76	Longan honey	Tainan: Hsinhua
77	Longan honey	Tainan: Hsinhua
78	Longan honey	Tainan: Hsinhua
79	Longan honey	Tainan: Hsinhua
80	Longan honey	Tainan: Hsinhua
81	Longan honey	Nantou
82	Longan honey	Nantou
83	Longan honey	Nantou
84	Longan honey	Taichung: Wufeng
85	Longan honey	Taichung: Wufeng
86	Longan honey	Taichung: Wufeng
87	Longan honey	Kaohsiung: Chiahsien
88	Longan honey	Kaohsiung: Chiahsien
89	Longan honey	Kaohsiung: Chiahsien
90	Longan honey	Kaohsiung: Chiahsien
91	Longan honey	Kaohsiung: Chiahsien
92	Longan honey	Kaohsiung: Chiahsien

93	Longan honey	Changhua: Yuanlin	Apr. 20, 1983
94	Longan honey	Changhua: Yuanlin	Apr. 20, 1983
95	Longan honey	Changhua: Yuanlin	Apr. 24, 1983
96	Longan honey	Changhua: Yuanlin	Apr. 24, 1983
97	Longan honey	Changhua: Yuanlin	Apr. 24, 1983
98	Longan honey	Changhua: Yuanlin	Apr. 24, 1983

Table 2. Frequency of absolute pollen number in honey samples

Sample number	No. of pollen/g	Sample number	No. of pollen/g	Sample number	No. of pollen/g
1	8060	33	7740	70	1500
2	4980	34	6740	71	2720
3	5040	35	5260	72	3720
4	4740	36	2900	73	3000
5	5780	37	3360	74	6500
6	22120	38	6800	75	7980
7	22140	39	1640	76	2780
8	20240	40	4200	77	9320
9	3400	41	1600	78	9940
10	6360	42	8040	79	6740
11	4840	43	2120	80	12140
12	4120	44	7340	81	1740
13	3160	45	3020	82	3480
16	6540	46	2800	83	3220
17	9180	47	1260	84	5960
18	7400	56	14800	85	2780
19	4280	57	13980	86	5700
20	3340	58	8400	87	11780
21	8140	59	6700	88	6660
22	9120	60	9520	89	8000
23	3140	61	5280	90	9560
24	2320	62	3680	91	1700
25	2520	63	3760	92	8660
26	6900	64	3400	93	7500
27	2840	65	2300	94	20260
28	1140	66	6500	95	8280
29	1700	67	2540	96	8360
30	3380	68	9920	97	3440
31	6120	69	1880	98	1280
32	5080				

Table 3. The distribution of absolute pollen number in honey samples

Number of pollen/g	Number of samples	Number of pollen/g	Number of samples
<2,000	10	9,000—10,000	7
2,000—3,000	12	10,000—11,000	0
3,000—4,000	14	11,000—12,000	1
4,000—5,000	6	12,000—13,000	1
5,000—6,000	7	13,000—14,000	1
6,000—7,000	11	14,000—15,000	1
7,000—8,000	6	>20,000	4
8,000—9,000	7		

Table 4. Taxa of honey pollen

Actiniaceae	<i>Euphorbia</i> sp.	Polygonaceae
<i>Saurauja oldhamii</i>	<i>Jatropha panduræfolia</i>	<i>Polygonum</i> sp.
Amaryllidaceae	<i>Macaranga tanarius</i>	<i>Rumex</i> sp.
<i>Narcissus</i> sp.	<i>Mallotus japonicus</i>	Rubiaceae
Caricaceae	<i>Phyllanthus simplex</i>	<i>Randia spinosa</i>
<i>Carica papaya</i>	<i>Sapium sebiferum</i>	Rutaceae
Capparidaceae	Gramineae	<i>Citrus</i> sp.
<i>Gynandropsis gynandra</i>	Labiatae	Salicaceae
Caprifoliaceae	<i>Hyptis rhomboides</i>	<i>Salix</i> sp.
<i>Lonicera japonica</i>	<i>Salvia</i> sp.	Sapindaceae
Casuarinaceae	Lardizabalaceae	<i>Euphoria longana</i>
<i>Casuarina</i> sp.	<i>Stauntonia hexaphylla</i>	<i>Litchi chinensis</i>
Chenopodiaceae	Leguminosae	Saxifragaceae
<i>Chenopodium</i> sp.	<i>Acacia confusa</i>	<i>Hydrangea</i> sp.
Combretaceae	<i>Leucaena glauca</i>	<i>Parnassia palustris</i>
<i>Terminalia catappa</i>	Moraceae	Scrophulariaceae
Compositae	Mysinaceae	<i>Torenia</i> sp.
Convolvulaceae	<i>Ardisia</i> sp.	Solanaceae
<i>Ipomoea</i> sp.	Myrtaceae	<i>Solanum nigrum</i>
Cruciferae	<i>Psidium guajava</i>	<i>Solanum</i> sp.
Elaeocarpaceae	<i>Syzygium javanicum</i>	Theaceae
<i>Elaeocarpus</i> sp.	Oleaceae	<i>Thea</i> sp.
Ericaceae	<i>Ligustrum</i> sp.	Ulmaceae
<i>Rhododendron</i> sp.	<i>Osmanthus</i> sp.	<i>Celtis</i> sp.
Euphorbiaceae	Passifloraceae	<i>Trema</i> sp.
<i>Bridelia monoica</i>	<i>Passiflora suberosa</i>	Umbelliferae
<i>Claoxylon brachyandrum</i>	Polygalaceae	<i>Pimpinella diversifolia</i>
<i>Codiaeum variegatum</i>	<i>Polygala</i> sp.	<i>Torilis japonica</i>

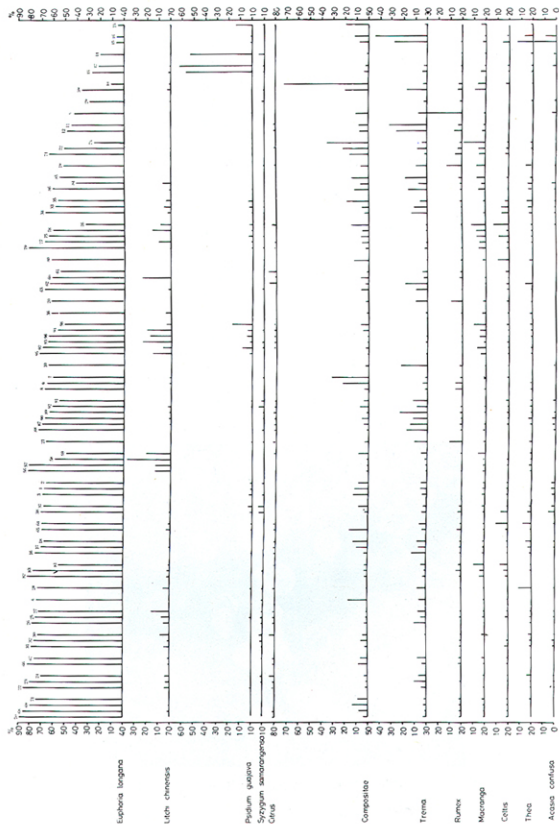


Fig. 1. Pollen spectra of 85 Longan honey samples.

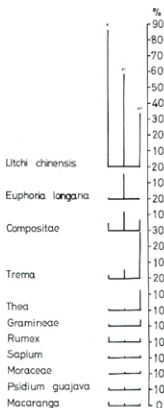


Fig. 2. Pollen spectra of 3 Lychee honey samples.

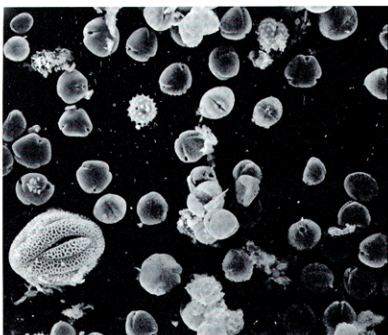


Fig. 3. The unifloral honey of sample 94 shows the pollen grains from Longan honey from Taiwan.

E=*Euphoria longana*, C=Compositae, P=*Passiflora suberosa*.

Table 5. The mean percentages of pollen types for honey samples from Longan- (85 samples) and Litchi-honey (3 samples) of Taiwan

Taxa	Longan honey	Lychee honey
<i>Euphoria longana</i> (Sapindaceae)	61.0	5.1
<i>Litchi chinensis</i> (Sapindaceae)	4.0	59.6
Compositae	8.0	7.4
<i>Trema</i> (Ulmaceae)	7.3	12.1
<i>Psidium guajava</i> (Myrtaceae)	3.1	0.7
<i>Macaranga tanarius</i> (Euphorbiaceae)	2.6	0.7
<i>Ricinus</i> (Polygonaceae)	2.0	1.8
<i>Celtis</i> (Ulmaceae)	1.6	0.5
<i>Ardisia</i> (Myrsinaceae)	1.6	0.3
<i>Thea</i> (Theaceae)	1.4	0.5
Moraceae	1.0	0.8
Gramineae	1.0	1.5
<i>Acacia confusa</i> (Leguminosae)	0.8	1.1
<i>Sapium sebiferum</i> (Euphorbiaceae)	0.8	0.7
<i>Syzygium javanicum</i> (Myrtaceae)	0.6	0.2
<i>Mallotus japonicus</i> (Euphorbiaceae)	0.6	—
<i>Citrus</i> (Rutaceae)	0.6	—
<i>Bridelia monoica</i>	0.5	—
<i>Euphorbia</i> (Euphorbiaceae)	0.5	0.3
<i>Saurauja oldhamii</i> (Actinidiaceae)	0.3	—
<i>Terminalia catappa</i> (Combretaceae)	0.1	—
Labiatae	0.1	—
<i>Stauntonia hexaphylla</i> (Lardizabalaceae)	0.1	0.4
<i>Casuarina</i> (Casuarinaceae)	*	—
<i>Randia spinosa</i> (Rubiaceae)	*	—
<i>Osmunthus</i> (Oleaceae)	*	—
<i>Torenia</i> (Scrophulariaceae)	*	—
<i>Passiflora suberosa</i> (Passifloraceae)	*	—
<i>Ligustrum</i> (Oleaceae)	*	—
<i>Chenopodium</i> (Chenopodiaceae)	*	—
<i>Jatropha pandurafolia</i> (Euphorbiaceae)	*	—
<i>Elaeocarpus</i> (Elaeocarpaceae)	*	—
<i>Solanum</i> (Solanaceae)	*	—
<i>Parnassia palustris</i> (Saxifragaceae)	*	—
<i>Phyllanthus simplex</i> (Euphorbiaceae)	*	—
<i>Lonicera japonica</i> (Caprifoliaceae)	*	—
<i>Hydrangea aspexa</i> (Saxifragaceae)	*	—
<i>Polygonum</i> (Polygonaceae)	*	—

Cruciferae	*	0.1
<i>Polygala</i> (Polygalaceae)	*	—
<i>Salix</i> (Salicaceae)	*	—
<i>Torilis japonica</i> (Umbelliferae)	*	—
<i>Rhododendron</i> (Ericaceae)	*	—
<i>Pimpinella diversifolia</i> (Umbelliferae)	*	—
<i>Carica papaya</i> (Caricaceae)	*	—
<i>Gynandropsis gynandra</i> (Capparidaceae)	*	—
<i>Hyptis rhomboides</i> (Labiatae)	*	—
<i>Claoxylon</i> cf. <i>brachyandrum</i> (Euphorbiaceae)	*	—
<i>Narcissus</i> (Amaryllidaceae)	*	—
<i>Leucaena glauca</i> (Leguminosae)	*	—
<i>Codiaeum variegatum</i> (Euphorbiaceae)	*	—
<i>Ipomoea</i> (Convolvulaceae)	*	—
<i>Rhododendron</i> (Ericaceae)	*	—

*: the mean value <0.1%

—: pollen not found in 500 counts

The pollen frequency may be higher than 100,000 grains per gram when they are prepared by press or heating (Maurizio, 1939). There are ten samples whose pollen frequency are less than 2,000 grains per gram (Table 3). These honeys may probably be either adulterated with artificial products or obtained from a sugar-feeding honeybees (Maurizio, 1951).

The species of pollen presented in the honey are classified into 53 taxa belonging to 35 families. These species are predominantly the constituents of the vegetation of Middle and South Taiwan. Although the predominant part of pollen are of those from entomophilous plants, such as *Euphoria longana*, *Litchi chinensis*, *Psidium guajava*, *Syzygium javanicum*, *Citrus*, *Thea*, *Acacia confusa*..... etc., some of those from anemophilous plants, such as Compositae, *Macaranga tanarius*, *Rumex*, *Celtis*, *Trema*, *Moraceae*, *Sapium sebiferum*, *Mallotus japonicus*, *Casuarina*..... etc., also present in the honey. Furthermore, pollen from some nectarless flowers, such as Gramineae, also are present in the honey samples.

As shown above, the commercially named honey, such as Longan honey, Lychee honey, Citrus honey,..... etc., does not contain sole pollen species. In other word, some other nectar and pollen are admixed in a given honey. The relative frequency of the presence of these pollen may indicate in this case the extent of admixture and also the quality of honey.

The results of pollen analysis do not agree well with beekeepers' notes. For example, sample 13 was noted by beekeeper as Longan (*Euphoria longana*) honey. This sample contains however *Bridelia* (35.2%), Compositae (19.2%) and *Psidium guajava* (14.2%) rather than *Euphoria longana*, which appears only in low percentage (5.2%). Due to the absence of dominant pollen species, this sample can be denoted as multifloral honey. Another example is the case by sample 42, 43 and 44 noted by beekeepers also as Longan honey. They contain however *Psidium guajava* pollen (53.6-62.6%) as dominant pollen and *Euphoria longana* as secondary pollen. Actually they are *Psidium* honey.

Pollen analysis of honey reveals that in the spring the leading plants contributing to honey are *Euphoria longana* and *Litchi chinensis*. The other leading pollen are *Psidium guajava* and Compositae, although they are present only in a few samples.

The previously melittopalynological work in Taiwan (Chen, 1979) shows that pollen of Sapindaceae (only *Euphoria longana* presented) appear in honey samples only in low percentage, usually less than 20%. This is quite different from the results shown above. One of the possible reasons might be that pollen of *Litchi chinensis* was misidentified in Chen's paper. Therefore he concludes that plants of *Litchi chinensis* offer only nectar instead of pollen in the honey samples.

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臺灣蜂蜜花粉之研究 (I)

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摘 要

從 88 個在 1983 年 4 月及 5 月期間於本省中、南部所收集到的蜂蜜樣品所做花粉分析的結果顯示，蜂蜜中的花粉，蟲媒花和風媒花植物均有。由各種花粉出現的百分比得知，本省春天之主要蜜源植物為蟲媒花的龍眼和荔枝，次為蕃石榴和蓮霧，其次為風媒花植物如菊科，榆科（山黃麻、朴樹），大戟科（血桐、梧桐、烏桕）、桑科、禾本科、蓼科（酸模屬）等。此外，茶科，豆科（香思樹）芸香科（柑橘屬）等之花粉，亦常在蜂蜜中出現。

本研究共鑑定 44,000 粒花粉，計 53 種分屬於 35 科。樣品中有 10 個為雜花蜜，78 個為單花蜜。單花蜜中，72 個為龍眼蜜，2 個為荔枝蜜，3 個為蕃石榴蜜，1 個為菊花蜜。由計算每克蜂蜜所含花粉數量的結果顯示，88 個樣品中，有 10 個樣品之花粉個數少於 2,000 個，此可能是蜂蜜被換假或蜜蜂被餵糖漿所致。

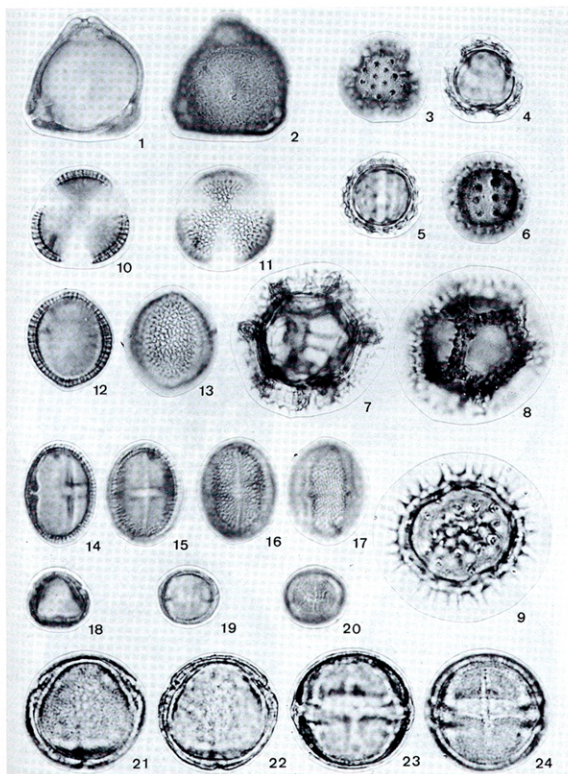


Plate I. 1-2, Casuarinaceae: *Casuarina* sp.; 3-6, Compositae Type 1; 7-8, Compositae Type 2; 9, Compositae Type 3; 10-13, Cruciferae; 14-17, Euphorbiaceae; 14-17, *Bridelia monoica*; 18-20, *Macaranga tanarius*; 21-24, *Mallotus japonicus*. 1-24, $\times 1000$.

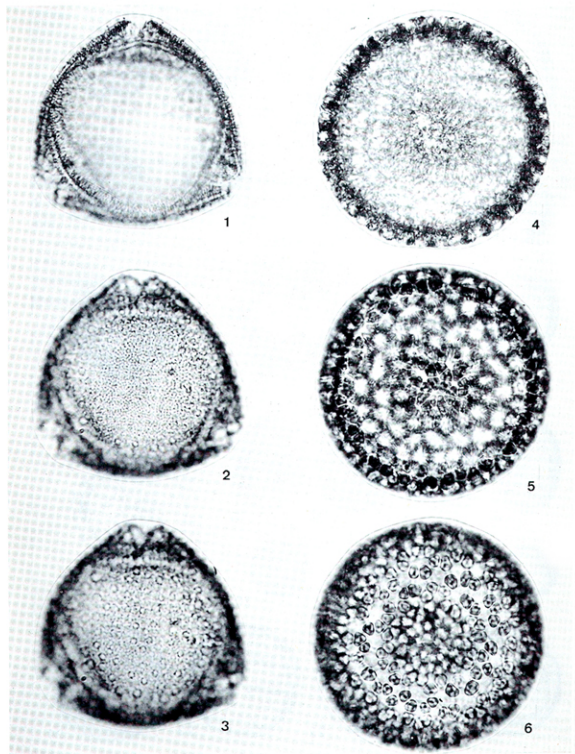


Plate 2. 1-3, Caprifoliaceae: *Lonicera japonica*; 4-6, Euphorbiaceae: *Jatropha pandurifolia*.
1-6, $\times 800$.

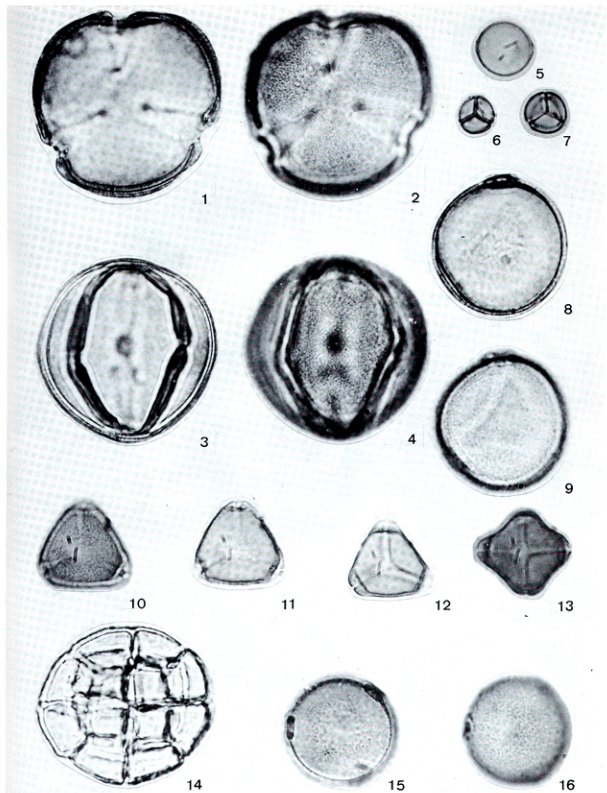


Plate 3. 1-4, Euphorbiaceae: *Sapium sebiferum*; 5, Moraceae; 6-7, Myrsinaceae: *Ardisia* sp.; 8-9, Gramineae; 10-13, Myrtaceae: 10-11, *Psidium guajava*; 12-13, *Syzygium javanicum*; 14, Leguminosae: *Acacia confusa*; 15-16, Rubiaceae: *Randia spinosa*. 1-16, $\times 1000$.

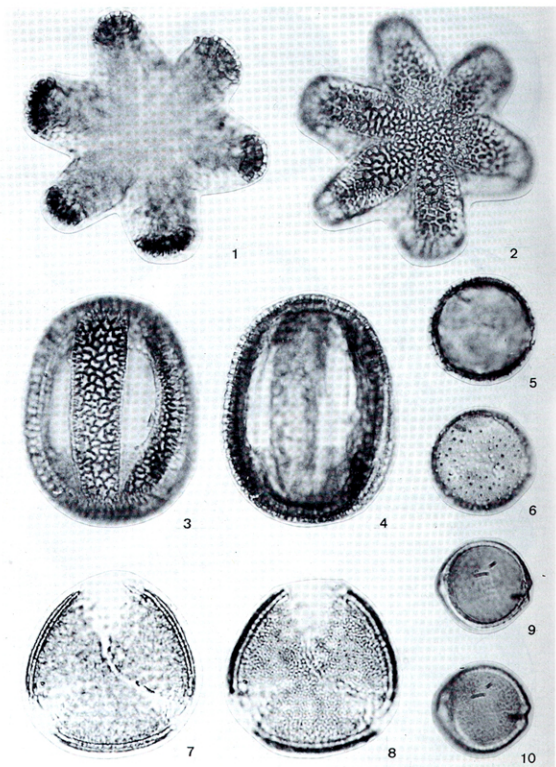


Plate 4. 1-4, Passifloraceae: *Passiflora suberosa*; 5-6, Campanulaceae; 7-8, Scrophulariaceae; 9-10, Ulmaceae: *Trema* sp. 1-10, $\times 1000$.

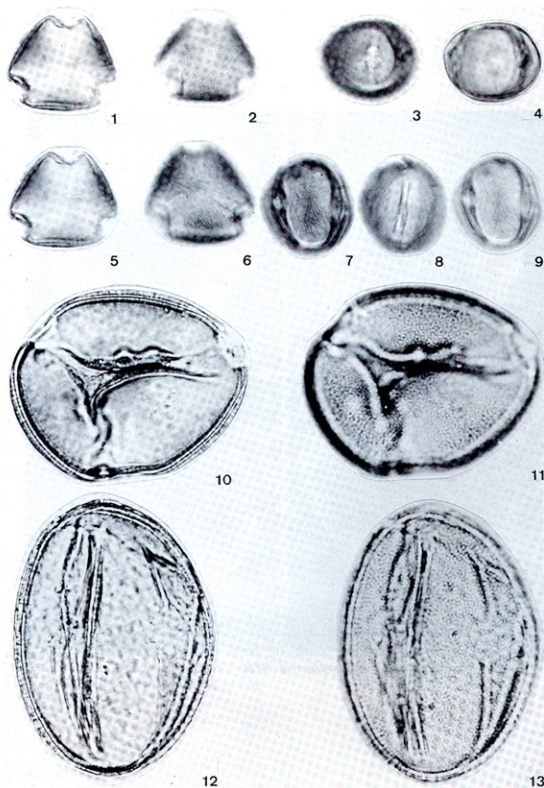


Plate 5. 1-9, Sapindaceae: 1-4, *Euphoria longana*; 5-9, *Litchi chinensis*; 10-13, Theaceae: *Thea* sp. 1-13, $\times 1000$.

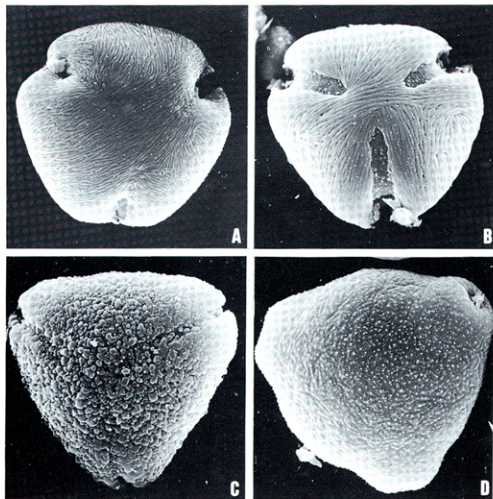


Plate 6. A, *Euphoria longana*, SEM, $\times 3000$; B, *Litchi chinensis*, SEM, $\times 3000$; C, *Psidium guajava*, SEM, $\times 3750$; D, *Casuarina* sp., SEM, $\times 2250$.

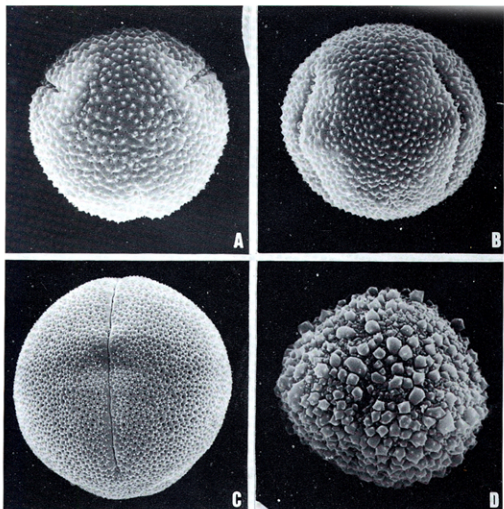


Plate 7. A & B, *Macaranga tanarius*, SEM, $\times 3750$; C, *Ricinus communis*, SEM, $\times 2250$; D, *Codiaeum variegatum*, SEM, $\times 4500$.

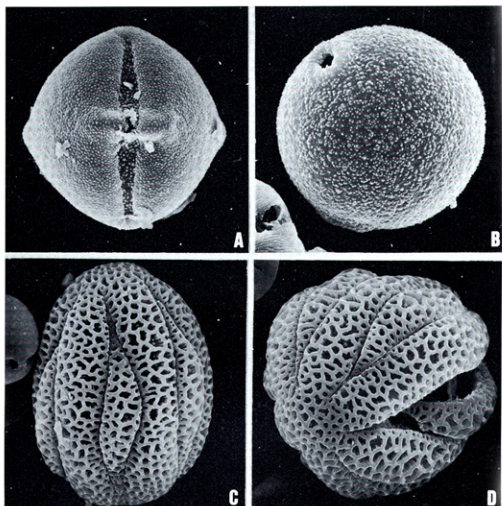


Plate 8. A, *Solanum* sp., SEM, $\times 3000$; B, *Trema* sp., SEM, $\times 3000$; C & D, *Passiflora suberosa*, SEM, $\times 1275$.