AN ULTRASTRUCTURAL STUDY OF FORMOSAN HONEY POLLEN (I)

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Abstract: The morphology of pollen from those plants contributing as nectar sources were observed with scanning electron microscopy (SEM). The pollen samples were subjected to acetolysis, fixation, dehydration, critical point drying and subsequently coating with gold. The ultrastructure of pollen of thirty-one species belonging to sixteen families were described. The results can provide with more information about the honey pollen and criteria for identification of honey species precisely.

INTRODUCTION

In general, most of the pollen found in ripe honey falls into raw nectar while it is still in the flower. Thus, the raw nectar with its characteristic pollen is taken back to the hive in the bee's honey stomach and eventually appears in the ripe honey (Lieux, 1975). The analysis of pollen in honey therefore may provides a basis for identifying the origin of honey in terms of localities and floral sources of nectar contributors. The information obtained from pollen analysis may be used as an important reference for diagnosing the quality of a product (Moar, 1985).

The analysis of honey pollen in Taiwan had been done previously (Chen, 1979; Chen *et al.*, 1984). The information from the analysis has successfully provided a basis not only for the identification of honey source plants, but also for the evaluation of honey quality (Chen *et al.*, 1984). A general investigation of the distribution and flowering period of 134 honey plants in Taiwan (Jeng *et al.*, 1986) has confirmed the results of honey pollen analysis.

The identification of pollen grains by light microscopy (LM) has some limitations. In many cases it can not precisely enough to determine the kind of honey pollen, when it was observed by LM. The use of SEM for observation of ultrafine structure is necessary for pollen identification (Dustmann & Bote, 1985)· For instance, the use of SEM makes it possible to distinguish 9 apple and 6 crabapple varieties just from the ultrastructure of their pollen grains (Dustmann and Bote, 1987). It is therefore necessary and of great value to study the ultrastructure of pollen appeared in honey. An observation of the ultrastructure of 31 important honey pollen in Taiwan was thus conducted. After acetolysis, the entire exinous surfaces of the grains were free from "pollenkitt" or other materials which might obscure significant features. Therefore the acetolysed pollen grains were used in this study.

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Table 1. Specimen used in this study, especially for microphotographs

Family	Scientific name	Specimen No.	Locality	Collected date
Anacardiaceae	*Rhus orientalis* (Green) Schn.	381	Chiayi	May 22, 1984
Caprifoliaceae	*Lonicera japonica* Thunb.	268	Miaoli	Apr. 27, 1984
Casuarinaceae	*Casuarina equisetifolia* L.	242	Taipei	Apr. 19, 1984
Compositae	*Blumea balsamifera* (L.) DC. var. *microcephala* Kitamura	855	Tainan	May 13, 1986
Compositae	*Chrysanthemum coronarium* L.	067	Taipei	Mar. 7, 1984
Convolvulaceae	*Ipomea pes-caprae* (L.) Sweet subsp. *brasiliensis* (L.) Ooststr.	552	Pingtong	Nov. 12, 1984
Euphorbiaceae	*Aleurites montana* E. H. Wilson	253	Taipei	Apr. 24, 1984
Euphorbiaceae	*Bridelia balansae* Tutch.	350	Taipei	May 15, 1984
Euphorbiaceae	*Codiaeum variegatum* (L.) Blume	256	Taipei	Apr. 25, 1984
Euphorbiaceae	*Euphorbia formosana* Hayata	601	Taipei	Mar. 24, 1985
Euphorbiaceae	*Macaranga tanarius* (L.) Muell-Arg.	264	Ilan	Apr. 27, 1984
Euphorbiaceae	*Mallotus japonicus* (Thunb.) Muell-Arg.	387	Taipei	May 24, 1984
Euphorbiaceae	*Ricinus communis* L.	329	Hsinchu	May 10, 1984
Leguminosae	*Acacia confusa* Merr.	270	Hsinchu	Apr. 27, 1984
Leguminosae	*Leucaena glauca* (L.) Benth.	319	Taipei	May 9, 1984
Leguminosae	*Mimosa pudica* L.	760	Tainan	Oct. 10, 1985
Lythraceae	*Lagerstroemia indica* L.	455	Taipei	Jun. 20, 1984
Lythraceae	*Lagerstroemia subcostata* Koehne	448	Taipei	Jun. 18, 1984
Moraceae	*Morus australis* Poir.	064	Taipei	Feb. 23, 1984
Myrtaceae	*Eucalyptus robusta* Smith	507	Taipei	Sep. 5, 1984
Myrtaceae	*Psidium guajava* L.	263	Ilan	Apr. 27, 1984
Myrtaceae	*Syzygium samarangense* (Blume) Merr. & Perry	386	Ilan	May 24, 1984
Passifloraceae	*Passiflora suberosa* L.	H94		
Rosaceae	*Rhaphiolepis umbellata* (Thunb.) Makino var. *integerrima* (Hook. & Arn.) Masamune	128	Taipei	Mar. 30, 1984
Rutaceae	*Citrus sinensis* Osbeck	825	Tainan	Apr. 5, 1986
Sapindaceae	*Euphoria longana* Lam.	832	Pingtong	Apr. 5, 1986
Sapindaceae	*Litchi chinensis* Sonner.	838	Tainan	May 13, 1986
Solanaceae	*Solanum melongena* L.	567	Taipei	Dec. 15, 1984
Theaceae	*Camellia japonica* L.	557	Taipei	Dec. 8, 1984
Theaceae	*Camellia oleifera* Abel.	558	Taipei	Dec. 8, 1984
Theaceae	*Camellia sinensis* (L.) Ktze.	664	Taipei	Dec. 15, 1985

MATERIALS AND METHODS

Thirty-one fresh pollen grains of honey pollen were collected from plants listed in Table 1. The species of plants was determined according to the Flora of Taiwan (Li *et al.*, 1979).

Pollen grains were first acetolysed (Erdtman, 1966). After fixing, dehydrating, drying with critical point dryer and coating with gold (Chen, 1988), pollen grains were then examined with a Hitachi S-520 SEM and photographed. The terminology of pollen description of Erdtman (1966) and Huang (1972) is followed in this study. Voucher specimens are deposited in the Palynological Laboratory, Department of Botany, National Taiwan University.

DESCRIPTION OF POLLEN MORPHOLOGY

Anacardiaceae

1. **Rhus orientalis** (Green) Schn. (Fig. 1A–C)

Pollen grains 3-colporate, isopolar; subprolate to prolate (P/E=1.15-1.64) in equatorial view, 26-31.5×17.5-24 μ, circular in polar view, 21-28 μ wide.

Colpi as long as P axes, 2.5 μ wide, narrow in equator. Ora transversally parallel, 2.5 μ wide.

Exine 1.5-2.5 μ thick. Sexine striate to striato-reticulate. Striae (ridges) 3 μ wide, grooves 2-3 μ wide.

Caprifoliaceae

2. **Lonicera japonica** Thunb. (Fig. 1D–F)

Pollen grains 3-colporate, brevicolpate, isopolar; usually spheroidal or more or less flattened, oblate spheroidal to prolate spheroidal (P/E=0.79-0.96) in equatorial view, 47.5-70×60-77.5 μ, circular in polar view, 67.5-77.5 μ wide.

Colpi relatively short, 12.5-21.5 μ long, the same length as ora or a slightly longer distance from colpi apices to poles, 1.5-2.5 μ wide. Ora transversally elliptic.

Exine 2.5-4 μ thick in mesocolpia, 3.5-4.5 μ thick at the vicinity of apertures. Sexine distinctly echinate, tegillate. Echini 4-4.5 μ high, 3-4.8 μ wide in base.

Casuarinaceae

3. **Casuarina equisetifolia** L. (Fig. 1G–I)

Pollen grains 3-porate, isopolar; suboblate in equatorial view, 22-33×25-37 μ, semiangular in polar view, 25-36 μ wide.

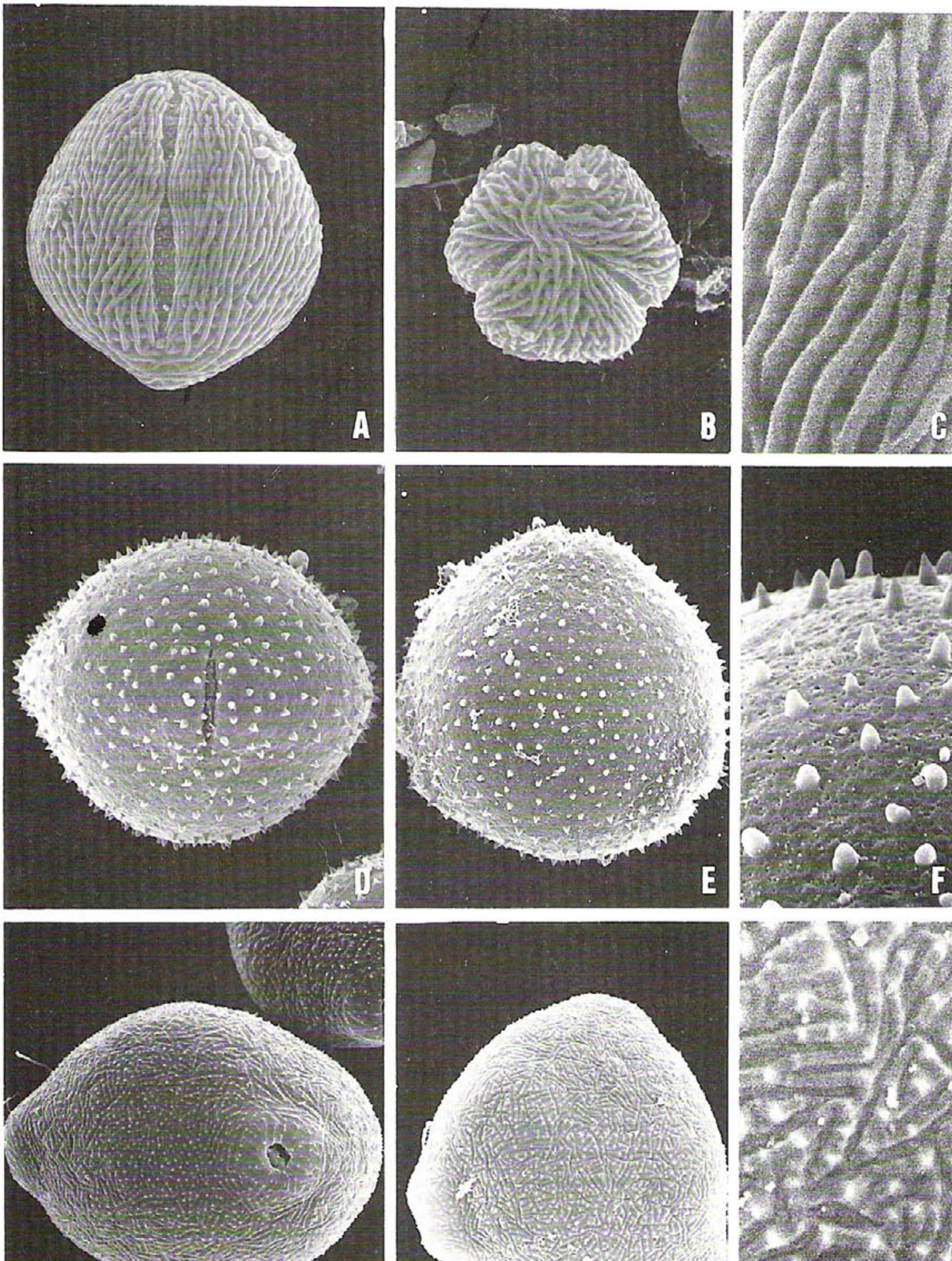
Pores circular, 2-4 μ wide in diameter. Annulus 6 μ wide.

Exine 1-2.5 μ thick. Sexine with supratectal ridges, often in parallel arrangement, ridges with minute processes.

Compositae

4. **Blumea balsamifera** (L.) DC. var. **microcephala** Kitamura (Fig. 2A)

Pollen grains 3-colporate, isopolar; spheroidal (P/E=1) in equatorial view, 21-25×21-25 μ, inter-subangular to circular in polar view, 21-25 μ wide.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Colpi 19 μ long, 3.5-5 μ wide. Ora transversally elliptic, 2-2.5×7.5-11.5 μ.

Exine 2-2.5 μ thick. Sexine distinctly echinate, tectate, spiniferous around the echini. Echini 2-2.5 μ high, 3.5-5 μ wide in base.

5. **Chrysanthemum coronarium** L. (Fig. 2B)

Pollen grains 3-colporate, isopolar; prolate spheroidal to subprolate (P/E=1-1.23) in equatorial view, 37.5-47.5×32.5-44 μ, inter-subangular in polar view, 37.5-42.5 μ wide.

Colpi 20-25 μ long, 2-3 μ wide. Ora circular, 5-6 μ wide.

Exine 3.5-5 μ thick (exclude echini). Sexine distinctly echinate. Echini 6 μ high, 3.5-6 μ wide in base.

Convolvulaceae

6. **Ipomea pes-caprae** (L.) Sweet subsp. **brasiliensis** (L.) Ooststs. (Fig. 2C-D)

Pollen grains pantoporate, unpolar; spheroidal, 81-106 μ wide. Pores 6-9 μ wide, crassinexinous.

Exine 4-5 μ thick. Sexine echinate, more or less rod-like elements often coalescing to form basal rootlets of echini and to form reticulate sculpture around echini. Echini 10-16 μ high, 6-16 μ wide.

Euphorbiaceae

7. **Aleurites montana** E. H. Wilson (Fig. 3A-B)

Pollen grains inaperturate, unpolar; spheroidal, 58-100 μ wide.

Exine 5-6 μ thick (including the gemmate processes). Sexine "Croton-pattern", the processes triangular in surface view, 2.5-4 μ wide.

8. **Bridelia balansae** Tutch. (Fig. 2E-G)

Pollen grains 3-colporate, isopolar; prolate spheroidal to subprolate (P/E=1-1.25) in equatorial view, 22.5-30×22.5-30 μ, circular to semiangular in polar view, 23.5-32.5 μ wide.

Colpi as long as P axes, 1-1.5 μ wide. Ora transversally parallel, 3 μ wide.

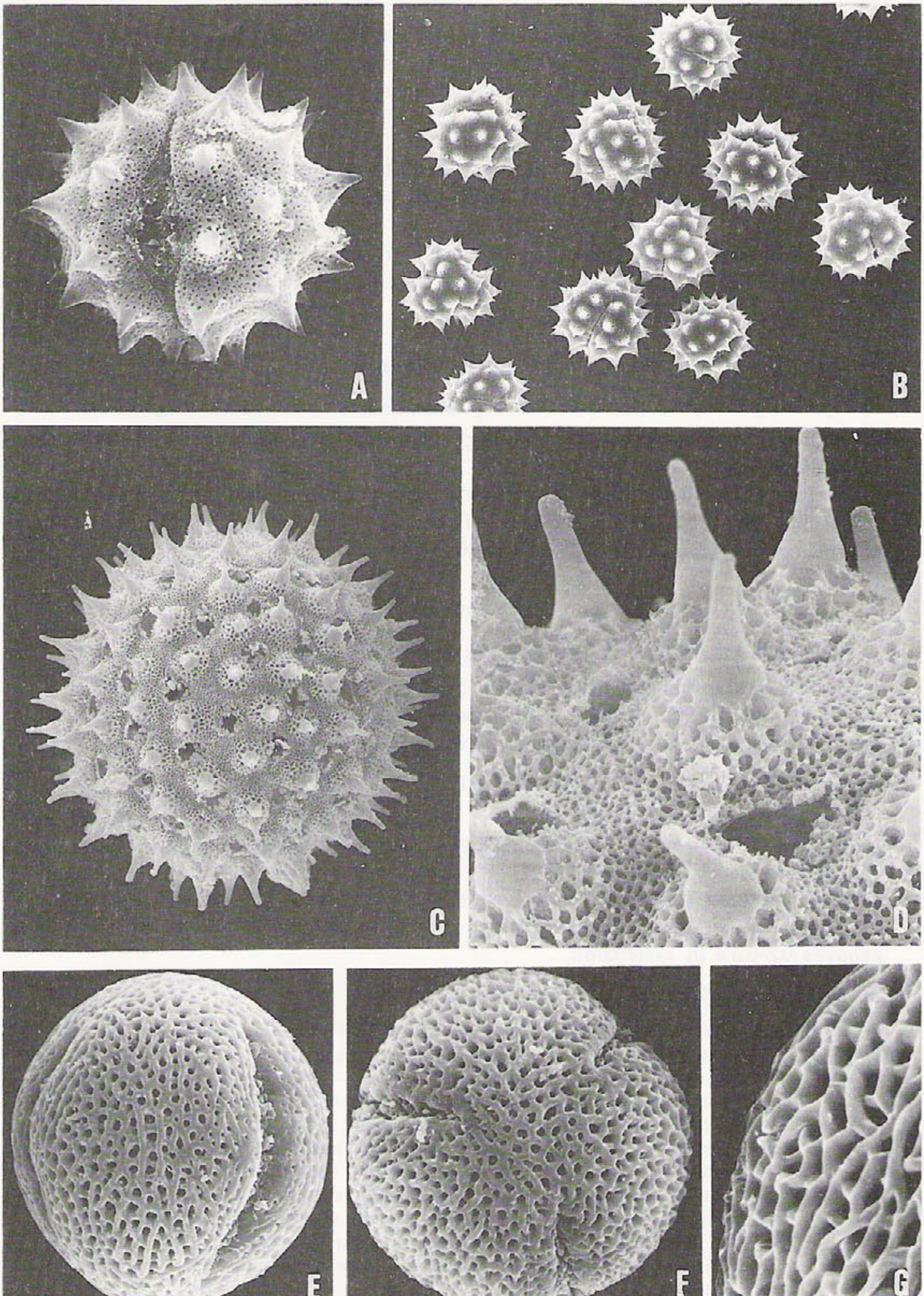
Exine 2.5-3 μ thick. Sexine striato-reticulate to reticulate. Striae 0.2 μ wide, grooves 0.2-0.5 μ in dimension.

9. **Codiaeum variegatum** (L.) Blume (Fig. 3C-D)

Pollen grains inaperaturate, unpolar; spheroidal, 40-55 μ wide.

Exine 3-5 μ thick. Sexine with irregular processes.

Fig. 1. (A-C) *Rhus orientalis* (Green) Schn.: (A) A grain in equatorial view, ×2,300; (B) A grain in polar view, ×2,300; (C) Detail of striate exine surface, ×10,000. (D-F) *Lonicera japonica* Thunb.: (D) A grain in equatrial view, showing short colpus, ×1,000; (E) A grain in polar view, ×1,000; (F) Detail of short echini on exine surface, ×3,300. (G-I) *Casuarina equisetifolia* L.: (G) A grain in equatorial view showing two of three pores, ×2,000; (H) A grain in polar view, ×2,000; (I) Detail of exine surface showing supratectal ridges with microprocesses on them, ×10,000.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10. **Euphorbia formosana** Hayata (Fig. 3E-G)

Pollen grains 3-colporate, isopolar; oblate spheroidal to prolate spheroidal (P/E=0.88-1.13) in equatorial view, 37.5-45×37.5-45 μ, inter-subangular in polar view, 35-45 μ wide.

Colpi 27.5-39 μ long, 6-8.5 μ wide. Colpus membranes smooth. Ora transversally parallel, 10-12.5 μ wide.

Exine 3-5 μ thick. Sexine reticulate. Muri keeled, 0.4-0.5 μ wide, lumina regular, 0.3-0.6 μ in dimension.

11. **Macaranga tanarius** (L.) Muell.-Arg. (Fig. 4A-C)

Pollen grains 3-colporate, isopolar; suboblate to prolate spheroidal (P/E=0.82-1.13) in equatorial view, 13.5-17×15-18 μ, circular in polar view, 14-18 μ wide.

Colpi 11-13 μ long, 1 μ wide. Colpus membranes granulate. Ora anastomosing to form a contiunous equatorial oral zone (zonorate).

Exine 1-1.5 μ thick, thicker at aperture margins. Sexine densely spinulate. Spinulae 0.15 μ in dimension.

12. **Mallotus japonicus** (Thunb.) Muell.-Arg. (Fig. 4D-F)

Pollen grains 3-colporate, isopolar; suboblate to prolate spheroidal (P/E=0.88-0.96) in equatorial view, 23-27×25-29 μ, circular in polar view, 22-28 μ wide.

Colpi 16-19 μ long, 1 μ wide. Colpus membranes granulate. Ora zonorate.

Exine 2-3 μ thick, thicker at aperture margins. Sexine spinulate/punctate.

13. **Ricinus communis** L. (Fig. 4G-I)

Pollen grains 3-colporate, isopolar; spheroidal (P/E=1) in equatorial view, 23.5-32×23.5-32 μ, circular to semiangular in polar view, 25-34 μ wide.

Colpi as long as P axes, very narrow (1-1.5 μ wide). Ora transversally elliptic.

Exine 1-1.5 μ thick. Sexine finely reticulate.

Leguminosae

14. **Acacia confusa** Merr. (Fig. 5E)

Pollen grains polyads, 16-celled, flat, longest diameters 33-50 μ. Single grains 4-5-porate.

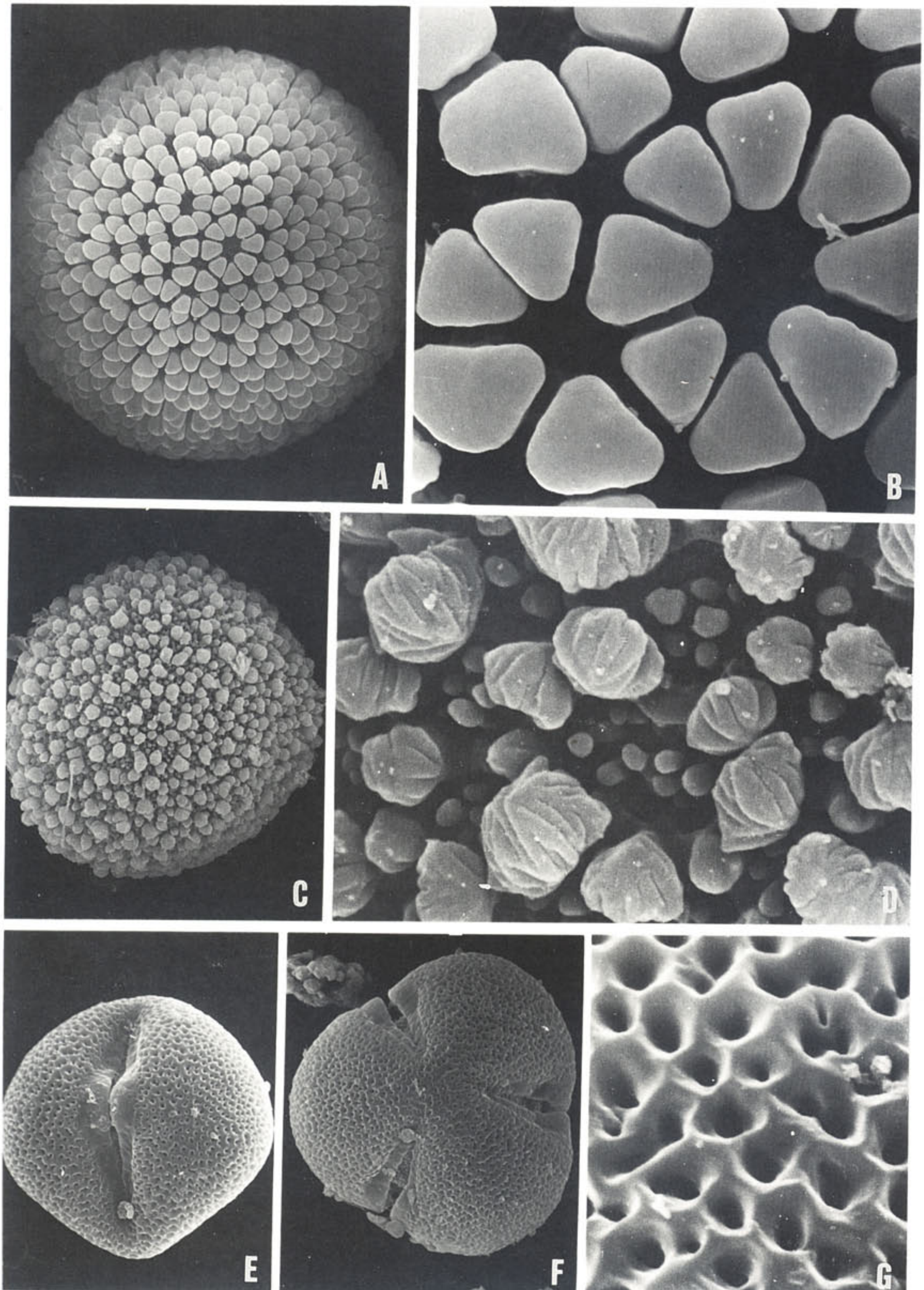
Exine 1-1.5 μ thick. Sexine broadly reticulate.

15. **Leucaena glauca** (L.) Benth. (Fig. 5A-B)

Pollen grains 3-colporate, isopolar; subprolate (P/E=1.13-1.33) in equatorial view, 52-59×45-52 μ, circular in polar view, 47-56 μ wide.

Colpi as long as P axes, 7-10 μ wide. Colpus membranes broad and smooth. Ora circular, 6-10 μ wide.

Fig. 2. (A) *Blumea balsamifera* (L.) DC. var. *microcephala* Kitamura, a 3-colporate grain in equatorial view, ×2,300. (B) *Chrysanthemum coronarium* L., an over view of 3-colporate grains, ×500. (C & D) *Ipomea pes-caprae* (L.) Sweet subsp. *brasiliensis* (L.) Oostst.: (C) a pantoporate grain with distinctaly echinate processes, ×700; (D) Detail exine surface with reticulate sculpture around echini ×3,000. (E-G) *Bridelia balansae* Tutch.: (E) A grain in equatorial view with two of three colpores, ×2,700; (F) A grain in polar view, ×2,700; (G) Detail of reticulate exine surface, ×6,600.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Exine 2.5 μ thick. Sexine punctate.

16. **Mimosa pudica** L. (Fig. 5C-D)

Pollen grains very small, tetrad, spheroidal, 6-8 μ wide.

Exine very thin. Sexine areolate. Areolae ca. 0.5 μ in dimension.

Lythraceae

17. **Lagerstroemia indica** L. (Fig. 5F-G)

Pollen grains 3-colporate with 6 pseudocolpi which parallel the colpi, isopolar; prolate spheroidal to subprolate (P/E=1.03-1.17) in equatorial view, 35-44×31-43 μ, inter-semiangular in polar view, 35-41 μ wide.

Colpi 22-26 μ long, 5 μ wide, pseudocolpi shorter than colpi. Colpus membranes granulate. Ora longitudinally elliptic, 6×3.5 μ.

Exine 1.5-3 μ thick, exine at mesocolpial area thicker than that in colpus vicinity. Three undulating sexinal crests covered on the mesocolpi and fused together at the poles. Sexine verrucate.

18. **Lagerstroemia subcostata** Koehne (Fig. 5H)

Pollen grains 3-colporate with 6 pseudocolpi which parallel the colpi, isopolar; prolate spheroidal to subprolate (P/E=1.03-1.30) in equatorial view, 32-47×32-42 μ, inter-semiangular in polar view, 36-43 μ wide.

Colpi 29 μ long, 2 μ wide. Ora 5-6 μ wide.

Exine 1-3 μ thick, the thickness of exine and the sexinal crests similar to that of *L. indica*. Sexine verrucate.

Moraceae

19. **Morus australia** Poir. (Fig. 5I-J)

Pollen grains 2-porate (3-porate in one grain per 100 counts), isopolar; spheroidal, view, 17-25 μ in diameter.

Pores circular, 3 μ in diameter, incrassimarginate. Pore membranes beset with an operculum.

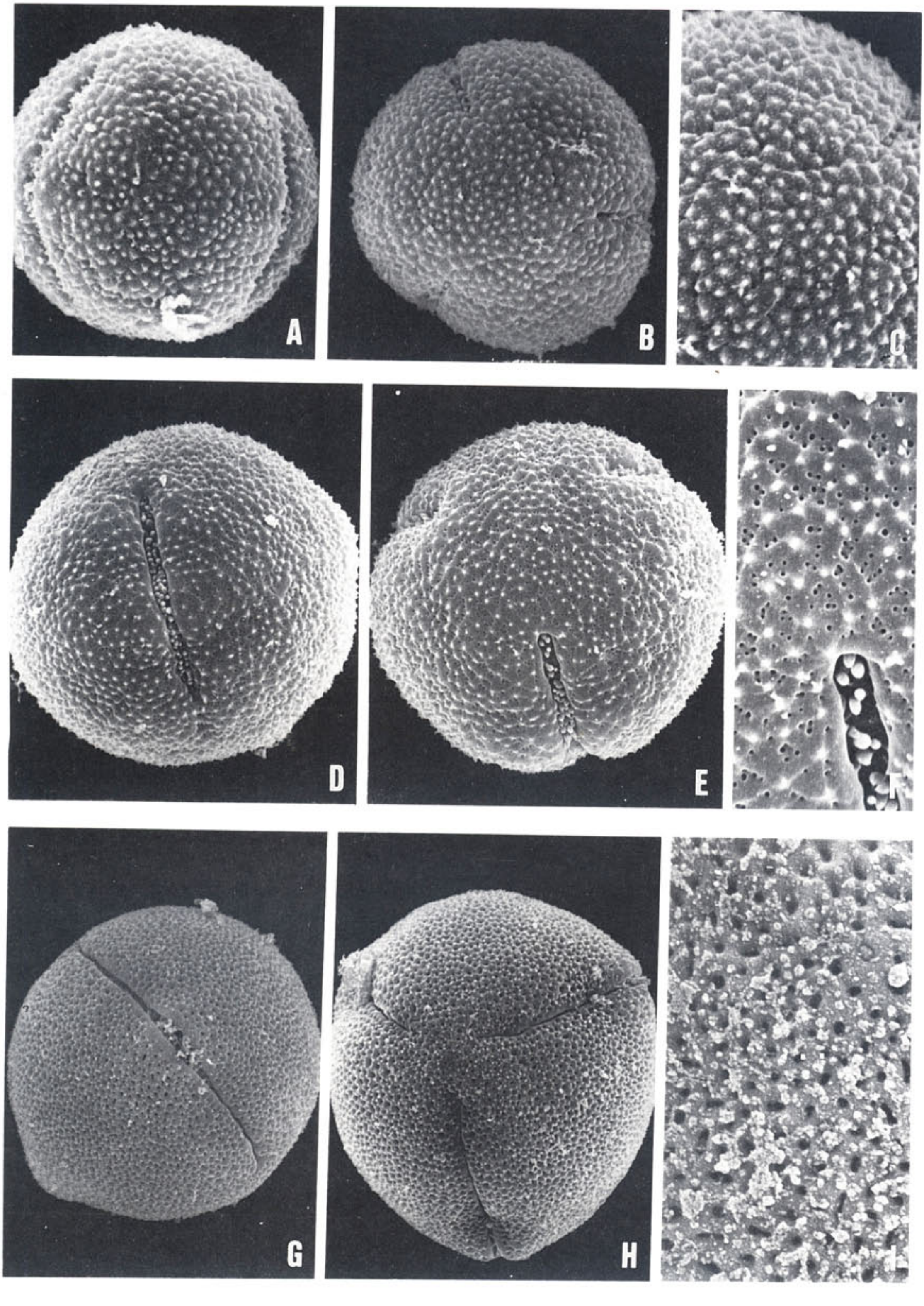
Exine thinner than 1 μ thick. Sexine sparsely spinulate, spinulae 0.2-0.3 μ in dimension.

Myrtaceae

20. **Eucalyptus robusta** Smith (Fig. 6A)

Pollen grains syncolporate, isopolar; oblate in equatorial view, 13-17×23-28 μ, subangular in polar view, 22.5-25 μ wide.

Fig. 3. (A & B) *Aleurites montana* E. H. Wilson: (A) An inaperturate grain with croton sculpture, ×1,200; (B) Detail of croton pattern, ×7,000. (C & D) *Codiaeum variegatum* (L.) Blume: (C) An inaperaturate grain, ×1,300; (D) Detail of various elements on exine surface, ×10,000. (E-G) *Euphorbia formosana* Hayata: (E) A 3-coloporate grain in equatorial view showing distinct colpus membrane, ×1,300; (F) A grain in polar view, ×1,300; (G) Detail of reticulate exine surface with keeled muri, ×10,000.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Colpus membranes smooth. Ora transversally elliptic, 0.8–1.5 μ wide.
Exine 1–1.5 μ thick. Sexine smooth.

21. **Psidium guajava** L. (Fig. 6B)

Pollen grains 3-colporate, seldomly 4-colporate, isopolar; oblate (P/E=0.56–0.71) in equatorial view, 11–14×17–21 μ, triangular in polar view, 17.5–20 μ wide.

Colpi very long, apocolpia small. Colpus membranes granulate. Ora circular, 1–2 μ wide.

Exine 1–1.5 μ thick, thinner at mesocolpia, thicker near colpi, indistinguished two layer walls separated each other at ora. Sexine granulate with irregular size, 0.4–1.2 μ in dimension.

22. **Syzygium samarangense** (Blume) Merr. & Perry (Fig. 6C)

Pollen grains syncolporate, isopolar; oblate to suboblate (P/E=0.6–0.8) in equatorial view, 10–15×15–21 μ, triangular (some rectangular) in polar view, sometimes with slightly concave sides, 15–20 μ wide.

Colpi narrow, wider towards apocolpia. Ora transversally parallel or lalongate, 1 μ wide.

Exine 1–1.5 μ thick. Sexine as thick as nexine, separated each other at ora. Sexine smooth around colpus margins and granulate on the mesocolpia and apocolpia.

Passifloraceae

23. **Passiflora suberosa** L. (Fig. 6D)

Pollen grains 6-colporate, isopolar; subprolate in equatorial view, 52×44 μ, circular in polar view.

Colpi very long. Ora longitudinally elliptic, slightly shorter than colpi. Spindle shaped opercula peeled off frequently.

Exine 4 μ thick. Sexine reticulate. Sculpture of opercula same as the other sexine surface.

Rosaceae

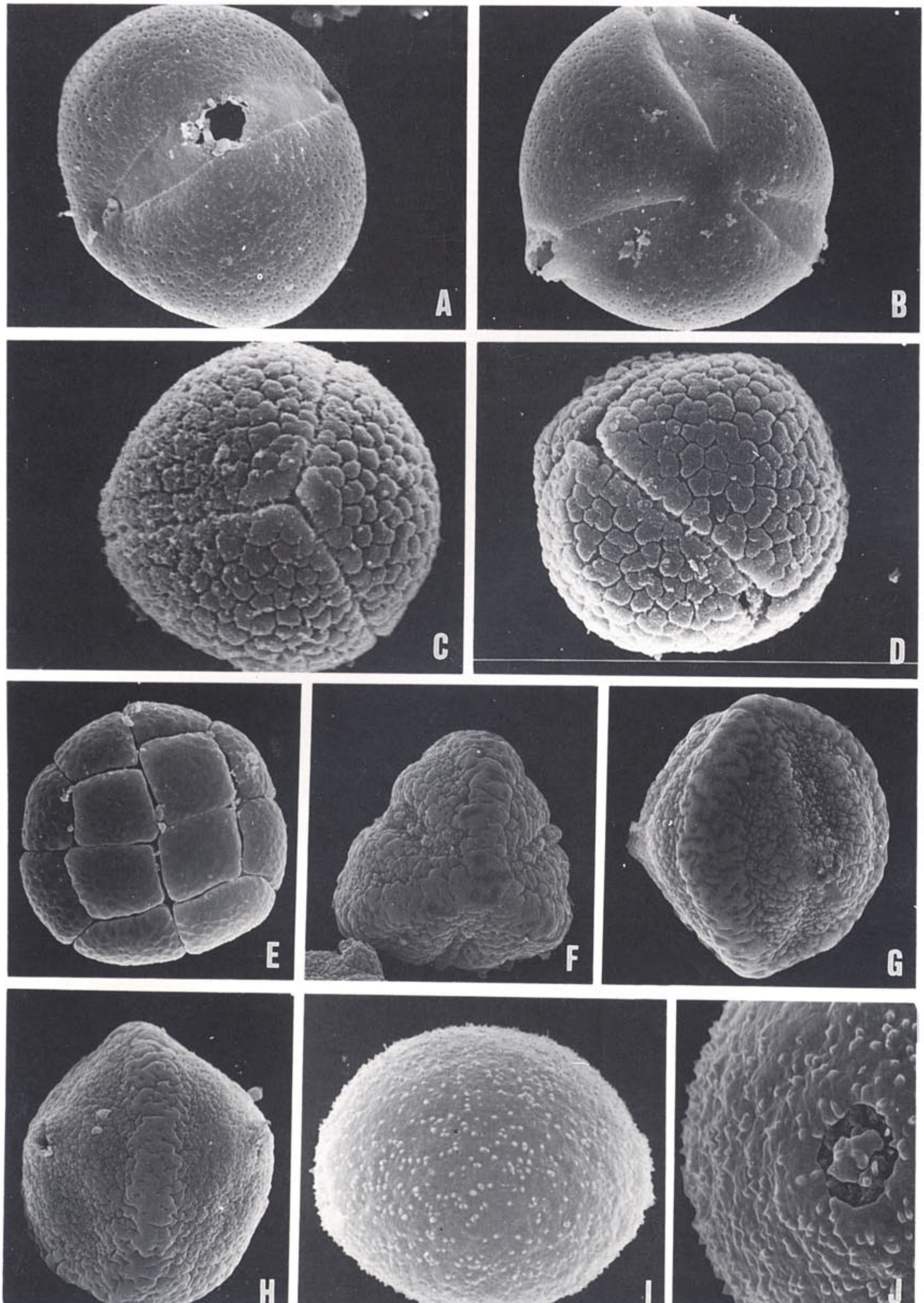
24. **Rhaphiolepis umbellata** (Thunb.) Makino var. **integerrima** (Hook. & Arn.) Masamune (Fig. 6E–F)

Pollen grains 3-colporate, isopolar; oblate spheroidal to subprolate (P/E=0.88–1.30) in equatorial view, 27–38×25–34 μ, circular in polar view, 27–38 μ wide.

Colpi and ora broken.

Exine 1–2.5 μ thick. Sexine densely striate.

Fig. 4. (A–C) *Macaranga tanarius* (L.) Muell-Arg.: (A) A 3-colporate grain in equatorial view, ×4,000; (B) A grain in polar view, ×4,000; (C) Detail of exine surface with spinulate elements, ×6,600. (D–F) *Mallotus japonicus* (Thunb.) Muell-Arg.: (D) A 3-colporate grain in equatorial view, colpus membrane with granulate processes, ×2,700; (E) A grain in slightly oblique polar view, ×2,700; (F) Detail of spinulate/punctate exine surface, ×6,600. (G–I) *Ricinus communis* L.: (G) A 3-colporate grain in equatorial view showing sharp colpus and slight protruding on ora, ×2,300; (H) A grain in polar view, ×2,300; (I) Detail of finely reticulate exine surface, ×10,000.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Rutaceae

25. **Citrus sinensis** Osbeck (Fig. 7A)

Pollen grains 4-colporate, isopolar; oblate spheroidal to subprolate (P/E=0.95-1.16) in equatorial view, 24-31×23-30 μ, round-rectangular in polar view, 25-30 μ wide.

Colpus 16 μ long, 2 μ wide. Ora 1-2 μ wide.

Exine 2-3 μ thick. Sexine foveo-reticulate, ±crassimurate. Muri 0.5-1.0 μ wide, lumina circular to oval, 0.3-1.0 μ in dimension.

Sapindaceae

26. **Euphoria longana** Lam. (Fig. 7B-C)

Pollen grains 3-colporate, isopolar; oblate to subprolate (P/E=0.65-1.28) in equatorial view, 15-25×14-26 μ, triangular in polar view, 16-26 μ wide.

Colpus membranes granulate, sometimes fragmented. Ora circular, varying in size, 1-5 μ wide.

Exine 1.5-3 μ thick. Sexine striate, some specimen with ridges parallel to each other and to colpi, some with shorter ridges and intersected, some with 3-5 ridges gathered together.

27. **Litchi chinensis** Sonner. (Fig. 7D-E)

Pollen grains 3-colporate, isopolar; oblate to subprolate (P/E=0.98-1.28) in equatorial view, 21-25×18-25 μ, circular to round triangular in polar view, 21-26 μ wide.

Colpi 14-16 μ long, 2 μ wide; apocolpia small. Colpus membranes verrucate. Ora circular or elliptical, 2-5 μ wide.

Exine 1-1.5 μ thick, thinner towards the colpi. Sexine striate, the ridges parallel to each other and to colpi around the colpi, but intersected in the middle of mesocolpia and forming small isodiametric lumina, 0.3 μ wide.

Solanaceae

28. **Solanum melongena** L. (Fig. 7F-H)

Pollen grains 3-colporate, isopolar; prolate spheroidal to subprolate (P/E=1-1.21) in equatorial view, 26-34×26-32.5 μ, semi-angular or circular in polar view, 25-31.5 μ wide.

Colpi 18.5-31 μ long, 1.5-2.5 μ wide, the margins pouting and narrow at equator, up to 16 μ wide. Colpus membranes faintly granulate. Ora transversally elliptic,

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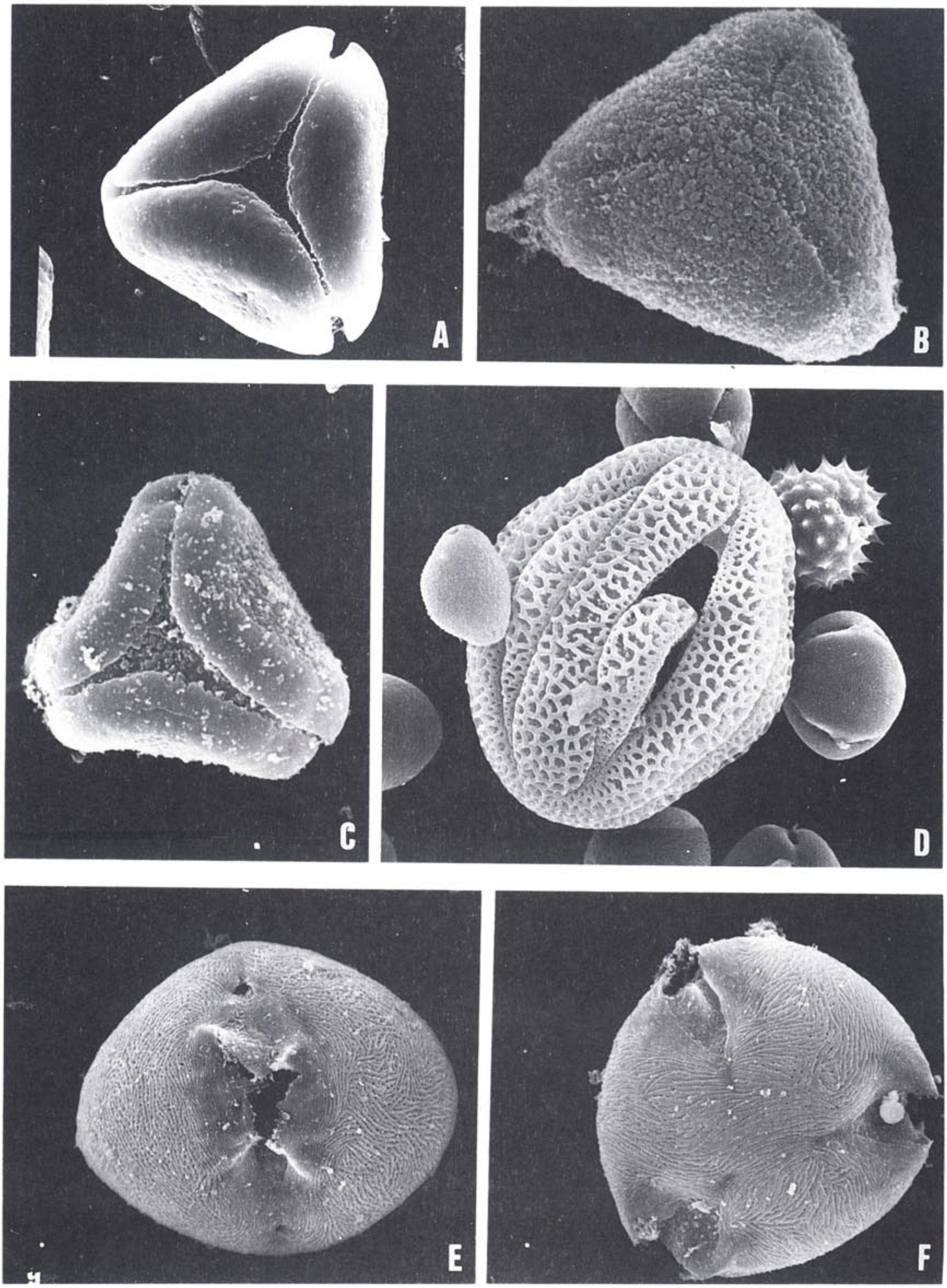
Fig. 5. (A & B) *Leucaena glauca* (L.) Benth.: (A) A 3-colporate grain in equatorial view showing smooth colpus membrane and a round os; ×1,300; (B) A grain in slightly oblique polar view showing protruding colpus membrane, ×1,300. (C & D) *Mimosa pudica* L.: (C) A tetrahedral grain showing three of four, ×6,600; (D) Another view of tetrahedral grain, ×6,600. (E) *Acacia confusa* Merr., a 16-celled polyad grain, ×1,300. (F & G) *Lagerstroemia indica* L.: (F) A grain in polar view showing three colpi and a trilete ridge in mesocolpia, ×1,500; (G) A grain in equatorial view, ×1,500. (H) *Lagerstroemia subcostata* Koehne, a grain in equatorial view showing an os in the left hand, ×1,700. (I & J) *Morus australia* Poir.: (I) A 2-porate grain, ×3,000; (J) Detail of exine surface and a pore with protruding on the pore membrane, ×6,600.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15×2.5-3 μ.

Exine 1-2.5 μ thick. Sexine densely blunt spinulate, 0.1 μ wide.

Theaceae

29. **Camellia japonica** L. (Fig. 8A-C)

Pollen grains 3-colporoidate, isopolar, suboblate to oblate spheroidal (P/E=0.75-1.0) in equatorial view, 40-62×42-70 μ, circular in polar view, 37-70 μ wide.

Colpi very long. Colpus membranes granulate. Ora obscure or circular.

Exine 2.5-5 μ thick. Sexine rugulate. Rugulae consisting of very densely spaced pila.

30. **Camellia oleifera** Abel. (Fig. 8D-F)

Pollen grains 3-colporoidate, isopolar; oblate to suboblate (P/E=0.61-0.88) in equatorial view, 27-40×37-48 μ, subangular in polar view, 32-45 μ wide.

Colpi 25-35 μ long, 5 μ wide. Ora obsucre.

Exine 2-3 μ thick. Sexine rugulate. Rugulae cansisting of very densely spaced pila.

31. **Camellia sinensis** (L.) Ktze. (Fig. 8G-I)

Pollen grains 3-colporoidate, isopolar, suboblate to oblate spheroidal (P/E=0.81-1.0) in equatorial view, 60-75×62-79 μ; semiangular in polar view, 72-92 μ wide.

Colpi long. Ora obscure.

Exine 3.5-5 μ thick. Sexine vermiculate.

DISCUSSION

In Taiwan, *Euphoria longana, Litchi chinensis, Psidium guajava* and Compositae are dominant pollen species in honey (Chen *et al.*, 1984). These plants usually contributed over 45% of the total pollen grains counted in honey samples which are so-called unifloral honey. These plants are the major nectar contributors during spring in central and southern Taiwan.

Both *E. longana* and *L. chinensis* are cultivated orchard plants. The plants of *E. longana* are rather complicated in genotype as well as phenotype, because they are obtained from series of breeding. There exists a great variation in pollen morphology among different cultivars (Chen, 1986). This makes the distinguishment between them very difficult, even using the ultrastructure observed under SEM. A further study on them is necessary.

It is difficult to distinguish pollen of Myrtaceae under LM. However, observation with SEM provides a good solution to this problem. As shown in Figure

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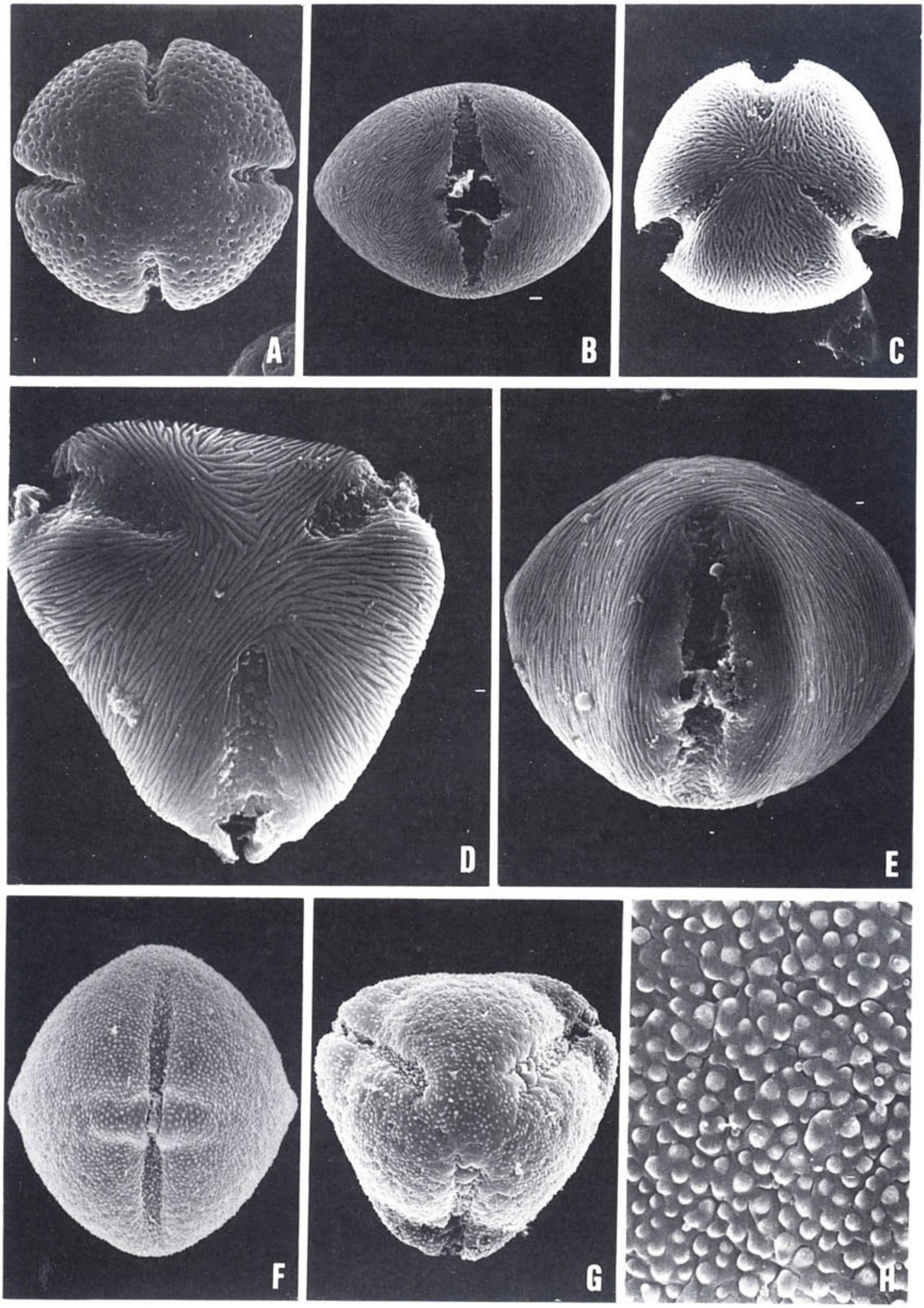
Fig. 6. (A) *Eucalyptus robusta* Smith, a syncolporate grain in polar view, ×2,300. (B) *Psidium guajava* L., a 3-colporate grain in polar view, ×3,300. (C) *Syzygium samarangense* (*Blume*) Merr. & Perry, a syncolporate grain in polar view, ×3,300. (D) *Passiflora suberosa* L., a 6-colporate grain in equatorial view, ×1,200. (E & F) *Rhaphiolepis umbellata* (Thunb.) Makino var. *integerrima* (Hook. & Arn.) Masamune: (E) A 3-colporate grain in equatorial view showing broken os, ×2,000; (F) A grain in polar view, ×2,000.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6 (A-C), the ultrastructure of those pollen of *Eucalyptus*, *Psidium* and *Syzygium* can be easily distinguished from each other.

There are five non-edaphic species of *Passiflora* in Taiwan. The most common pollen found in honey is of *P. suberosa* (Fig. 6D) rather than fruit plants of *P. edulis* and *P. foetida* var. *hispida* (Jeng *et al.* 1986). Pollen of *P. suberosa* is 6-colporate with six spindle-shaped opercula in pollen morphology. This is however different from that described by Huang (1972). A check of this should be done.

Honeybees gather large quantity of pollen directly not only from entomophilous but also from anemophilous flowers for feeding the bee larvae (Vorwohl, 1978). Seven of thirty-one investigated honey pollen were also found as air borne pollen (Chen, 1984; 1988). They are *Casuarina equisetifolia*, *Macaranga tanarius*, *Mallotus japonicus*, *Lagerstroemia indica*, *L. subcostata*, *Morus australis* and *Eucalyptus robusta.*

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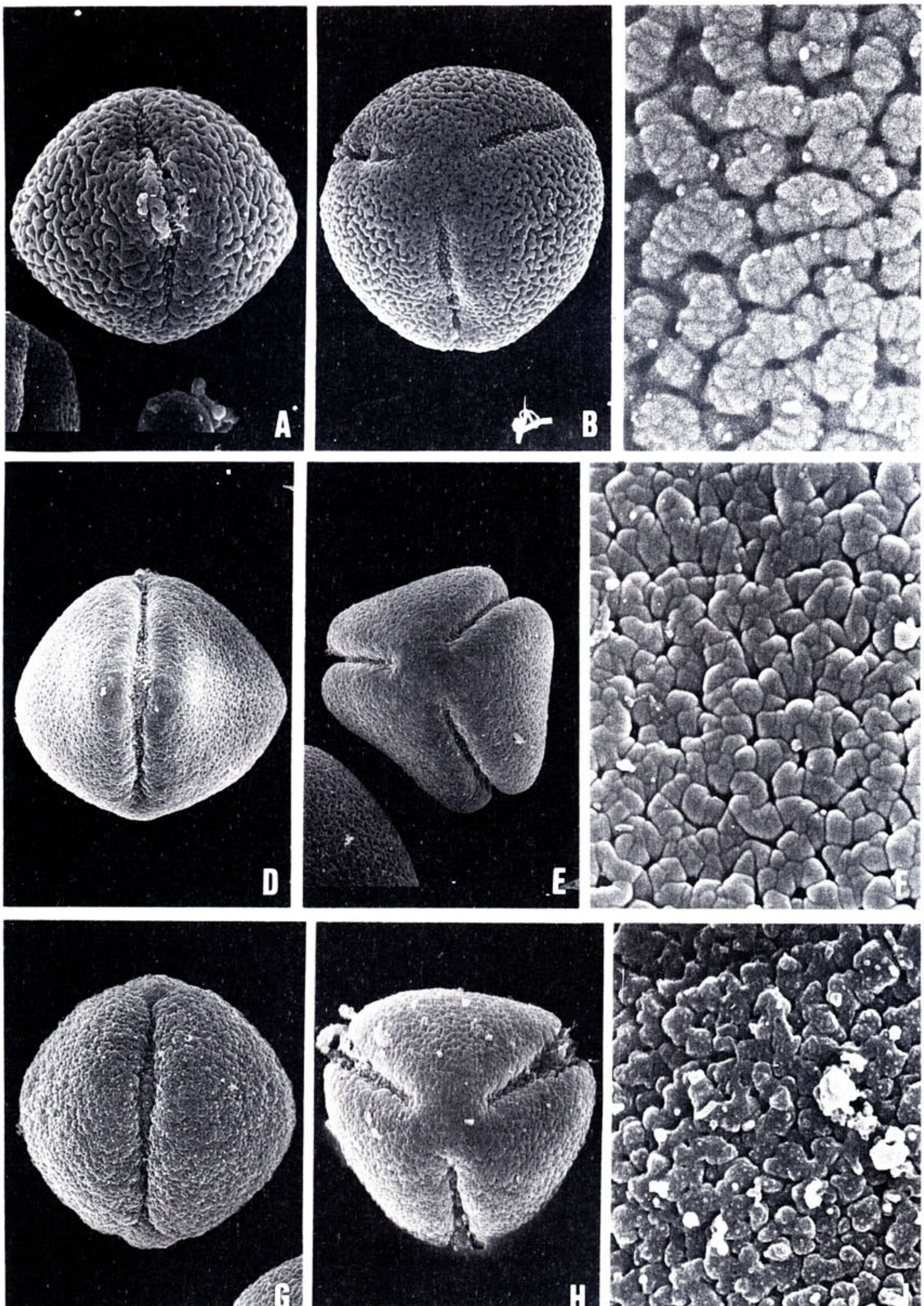
Fig. 7. (A) *Citrus sinensis* Osbeck, a 4-colporate grain in polar view, ×2,000. (B & C) *Euphoria longana* Lam.: (B) A 3-colporate grain in equatorial view, ×2,700; (C) A grain in polar view, ×2,700. (D & E) *Litchi chinensis* Sonner.: (D) A 3-colporate grain in polar view showing striate exine surface, ×4,000; (E) A grain in slightly oblique equatorial view, ×4,000. (F-H) *Solanum melongena* L.: (F) A 3-colporate grain in equatorial view showing pouting margins at equator, ×2,000; (G) A grain in polar view, ×2,000; (H) Detail of spinulate exine surface, ×6,600.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臺灣蜂蜜花粉之掃描電子顯微鏡研究(一)

陳 淑 華　　沈　　琪

摘　　要

本文採集 31 種，分屬於 16 科之蜜源植物之花粉，先以濃硫酸及無水醋酸處理，再經固定、脫水、臨界點乾燥及金屬離子覆膜後，以掃描式電子顯微鏡觀察其表面之微細構造。本文對蜂蜜花粉形態提供更詳細的描述，並對蜂蜜種類之鑑定提供更精確之資料。

Fig. 8. (A-C) *Camellia japonica* L.: (A) A grain equatorial view, ×1,500; (B) A grain in polar view, ×1,500; (C) Detail of rugulate exine surface, ×10,000. (D-F) *Camellia oleifera* Abel.: (D) A grain in equatorial view, ×1,700; (E) A grain in polar view, ×1,700; (F) Detail of rugulate exine surface, ×10,000. (G-I) *Camellia sinensis* (L.) Ktze.: (G) A grain in equatorial view, ×1,300; (H) A grain in polar view, ×1,300; (I) Detail of vermiculate exine surface, ×7,000.