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Pollen Morphology of the *Ipomoea* (Convolvulaceae) in Taiwan

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ABSTRACT: Pollen of 18 species of *Ipomoea* in Taiwan was examined in LM and SEM. Light microscope study of pollen morphology has shown that all examined species share common pollen morphological characters - spherical shape, pantoporate apertures and tectum with spinulate processes. On the basis of exine stratification, two different groups of this genus were defined : The Group 1 pollen include *I. acuminata* and 9 other species, possess spines, extraporal regions and tetragonal to hexagonal areas . The pores are surrounded by an extraporal region, and the spines and the ridges of the bacula form a tetragonal to hexagonal area around each extraporal region . Each pore is covered with an operculum which is peeled off after acetolysis. Fine reticula are present all over the surface of the grain. The reticula consist of very minute lumina. The Group 2 pollen include *I. obscura* and 7 other species. The extraporal regions and tetragonal to hexagonal areas are absent. Minute lumina are also present all over the surface of the grain. A key for distinguishing Taiwan's various species of *Ipomoea*, based on exine stratification and spinal characteristics, was made.

KEY WORDS: *Ipomoea*, Convolvulaceae, Pollen morphology, SEM.

INTRODUCTION

Pollen morphology is a useful tool for the study of the taxonomy and pollination biology of flowering plants (Grayum, 1986; Nilsson, 1986). Erdtman felt the purposes of taxonomic classification could be advanced by further morphological investigation of the pollen of certain families. He included Convolvulaceae among these families because the pollen grain of genus *Ipomoea* has very distinct features. He felt it would be useful to study its overall morphology, sporoderm stratification and fine structure (Erdtman, 1963).

The Convolvulaceae is a widely distributed family of about 50 genera and 1500-1800 species, in which, *Ipomoea* is a dominant genus comprising approximately 400 species (Woodland, 1991). In Taiwan the Convolvulaceae genus is represented by 12 genera and 40 species. Twenty species of *Ipomoea*, including cultivated and introduced plants, have been recorded in Flora of Taiwan (Chang, 1978).

Erdtman (1952) separated the pollen grains of Convolvulaceae into two groups, *Ipomoea*-type and Other-type, pointing out that the morphology of *Ipomoea* pollen is very different from that of other genera within the family Convolvulaceae.

Huang (1972) studied the pollen morphology of 14 species of *Ipomoea* under a light

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microscope, and observed that the pollen of each species possessed several unique morphological characteristics (with the exception of exine thickness, spine length and bacula).

Sengupta performed an extensive investigation of the pollen morphology of the Convolvulaceae, in which, nine Indian species of *Ipomoea* (Sengupta, 1966) and numerous taxa of Convolvulaceae were studied (Sengupta, 1972). He recognized four main types of Convolvulaceae pollen grains, and that the dominant type in *Ipomoea* is the Group I pantoporate type. He also found that spine feature could be used as a diagnostic feature in constructing a pollen key for the *Ipomoea* genus.

In this paper, *Ipomoea* pollen from Taiwan is examined using LM and SEM, and a pollen morphology-based key is constructed.

MATERIALS AND METHODS

Anthers were removed from fresh specimens and pollen slides were prepared in accordance with the Huang method (Huang, 1972), then mounted with Entellan. All measurements except sexine and nexine thickness were made with these fresh pollen samples.

Some anthers were dried in an oven at 40 ℃ and stored for uses of SEM and thick sectioning for LM observation.

Pollen materials for SEM and thick section were acetolyzed with acetic acid for 15 min, dehydrated with absolute alcohol twice (15 min each time) and with absolute acetone twice (15 min each time). Then, the materials for SEM were dried in a Critical Point Dryer (CPD), coated with gold-palladium evaporated in a Hitachi E102 ion sputter coater, and photographed with a Hitachi S-2500 SEM. The materials for thick section were infiltrated and embedded in Spurr's medium (Spurr, 1969). After sectioning with glass knives (1 μm), the sections were stained with Toluidine Blue O, and photographed with a Zeiss MC80 microscope.

In this study, the diameter of the grains is measured excluding the length of the spines. The length of the spines excludes that of the basal rootlet. The thickness of the sexine does not include the length of the spine (Fig. 1). The measurements, as a rule, are based on ten readings. Since they are considered to be important, the suprategillar process types have been illustrated in Figure 2.

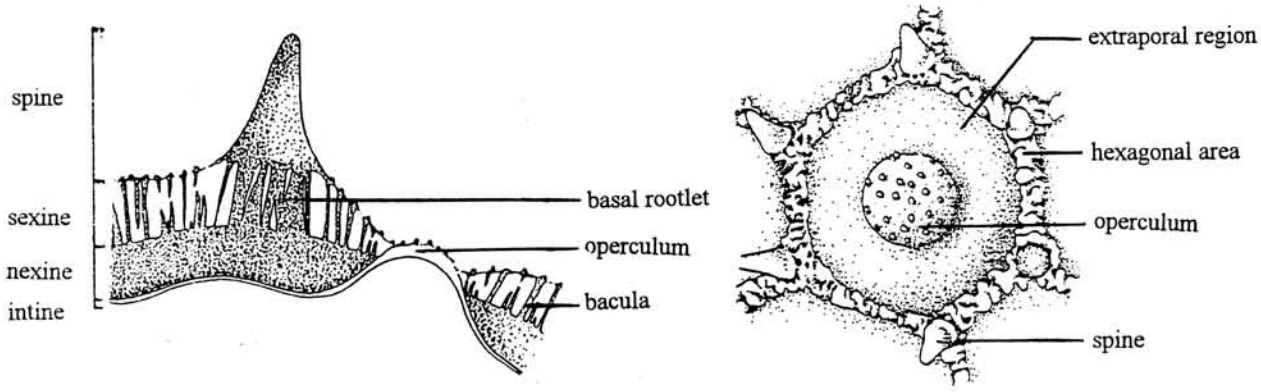


Fig. 1. The exine stratification and exine pattern used for references of measurement.

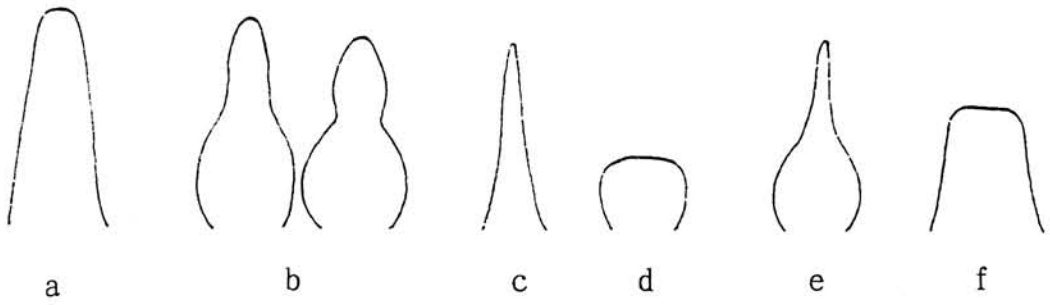


Fig. 2. Spine process types. a. broad at base, gradually tapering towards the apex with a blunt tip. b. broad and bulbous at base, gradually tapering towards the apex with a blunt tip and a faint, constricted neck. c. broad at base, gradually tapering towards the apex with a more or less acute tip. d. globular knob-like structure. e. broad and bulbous at base, gradually tapering towards the apex with a more or less acute tip and a faint, constricted neck. f. broad at base, cylinder-shaped, the apex with a flattened tip.

RESULTS

The relevant data and measurements of the pollen grains of *Ipomoea* are represented in Table 1. Detailed descriptions are as follows :

Group 1: Spines and the ridges of bacula around the extraporal region form a distinct tetragonal to hexagonal area; fine reticula are present all over the surface.

Ipomoea acuminata (Vahl) Roem. & Schult. 銳葉牽牛 Figs. 3-5

Grains pantoporate, spherical, 75-109 μm wide; pore diameter 5-7.2 μm; operculum finely granulate. Each pore surrounded by an extraporal spinulose ring-shaped area; nexine 2.8-3 μm thick; sexine (excluding spines) 1.5-2 μm thick; tectum with spines and granules, the spines 6-14 μm long, broad at base, gradually tapering towards the apex with a blunt tip (Fig.2a), the spines and the ridges of the bacula around each extraporal region forming a distinct hexagonal area, the bacula different in size, those towards the pore much smaller than those forming the ridges of the hexagon; the downward basal projections (basal rootlet) of the spines and bacula forming a slightly undulating surface at the base of the spine; fine reticulum present all over the surface of the grain; lumina very small. The ratio between pore diameter and width of extraporal area is 2:1.

Ipomoea nil (L.) Roth. 牽牛花 Figs. 6-8

Grains pantoporate, spherical, 91-109 μm wide. Pore diameter 4.2-4.4 μm, operculum finely granulate. Each pore surrounded by an extraporal spinulose ring-shaped area. Nexine 5 μm thick, sexine (excluding spines) 0.8-2 μm thick. Tectum with spines and granules, the spines 7.4-9.9 μm long, broad and bulbous at base, gradually tapering towards the apex with

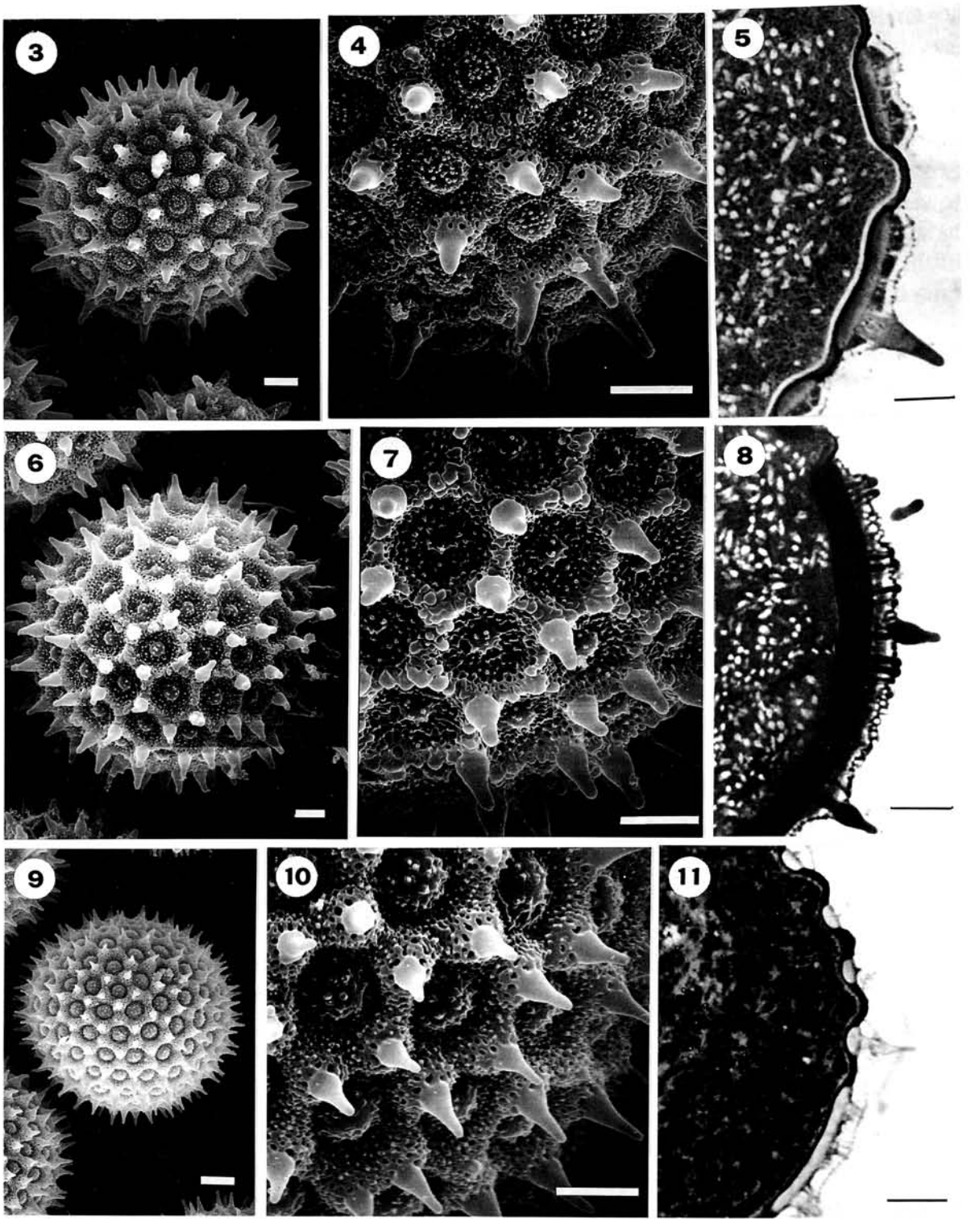
Table 1. Measurements of pollen (μm)

Name of the plant	Grain diameter	Spine length	Pore diameter	Sexine thickness	Nexine thickness	Locality	Collection date
Group 1							
I. acuminata	75-109	6-14	5-7.2	1.5-2	2.8-3	Tai-nan Shih	Aug.
I. nil	91-109	7.4-9.9	4.2-4.4	0.8-2	5	A-li Shan	Oct.
I. aquatica	64-82	4.7-7	3.7-3.8	1-2	1.5-2	Tai-chung	May
I. quamoclit	102-126	4.8-8.6	3.3-3.9	0.8-2	6.9-7.2	Tai-nan	Aug.
I. hederacea	84-119	6-16	6-7.6	1.5-2	3.5-4.5	Tai-nan Shih	Aug.
I. batatas	79-101	5.6-8	4.2-5.8	2-2.5	3.8-4	Chung-li	Sep.
I. alba	112-145	5-8	9.2-11	2-2.2	4-4.3	Tai-chung Shih	Sep.
I. stolonifera	79-96	7-12	3.6-4	1.5-2	3.8-4	Feng-ch'ui-sha	Aug.
I. gracilis	59-79	7.9-10.9	4.7-6.9	2.9-4.4	2-3	Feng-ch'ui-sha	Aug.
I. triloba	57-82	5-7	2.8-4	0.5-0.9	1.1-2.1	Tai-nan	Oct.
Group 2							
I. obscura	57-69	5-7.4	6	0.7-1.1	2.1-2.4	Tai-nan	May
I. pes-caprae subsp brasiliensis	63-91	9.6-12	4.6-6.3	0.8-1.5	2.2-3	Tai-nan Ssu-ts'ao	Nov.
I. cairica	59-79	6-10	3.5-4.8	1-1.2	1.6	Tai-nan Shih	Feb.
I. crassicaulis	64-77	7.4-12.4	4.5-5.1	1-1.2	2	Kao-hsiung	Aug.
I. tuba	80-114	6.7-12	5.9-7.6	1.7-3	2.1-2.8	Ping-tung	Aug.
I. sinensis	54-74	5-7	5.9-9.2	0.1-0.8	1.5-2.5	Peng-hu	July
I. sinensis cv. aurea-reticulate	54-77	5.5-7.4	6.7-10	0.1-0.9	1.5-2	Kao-hsiung Hsien	Aug.
I. pes-tigridis	50-77	4-7	5.5-7	0.1-0.2	1-1.5	Tai-nan	July

a blunt tip and a faint constricted neck (Fig.2b). The spines and the ridges of the bacula around each extraporal region forming a distinct hexagonal area. The bacula different in size, those towards the pore much smaller than those forming the ridges of the hexagon. The downward basal projections of the spines and bacula seeming to form a slightly undulating surface at the base of the spine. Fine reticulum present all over the surface of the grain. Lumina very small. The ratio between pore diameter and width of extraporal area is 1:1.

Ipomoea aquatica Forsk. 蕹菜 Figs. 9-11

Grains pantoporate, spherical, 64-82 μm wide. Pore diameter 3.7-3.8 μm, operculum finely granulate. Each pore surrounded by an extraporal spinulose ring-shaped area. Nexine 1.5-2 μm thick, sexine (excluding spines) 1-2 μm thick. Tectum with spines and fine granules, the spines 4.7-7 μm long, broad at base, gradually tapering towards the apex with a more or less acute tip (Fig.2c). The spines and the ridges of the bacula around each extraporal region forming a distinct hexagonal area. The bacula different in size, those towards the pore much smaller than those forming the ridges of the hexagon. The downward basal projections of the spines and bacula seeming to form an undulating surface at the base of the spine. Fine reticulum present all over the surface of the grain. Lumina very small. The ratio between pore diameter and width of extraporal area is 6:1.



Figs. 3-11. Pollen morphology. 3-5. *I. acuminata*. 6-8. *I. nil*. 9-11. *I. aquatica*. Bar=10μm, except Fig. 10 in which Bar=5μm. (5,8,11 under LM; others under SEM)

Ipomoea quamoclit L. 鳶蘿 Figs. 12-14

Grains pantoporate, spherical, 102-126 μm wide. Pore diameter 3.3-3.9 μm, operculum less granulate. Each pore surrounded by an extraporal spinulose ring-shaped area. Nexine 6.9-7.2 μm thick; sexine (excluding spines) 0.8-2 μm thick. Tectum with spines, the spines 4.8-8.6 μm long, broad and bulbous at base, gradually tapering towards the apex with a blunt tip and a faint constricted neck (Fig.2b). The spines and the ridges of the bacula around each extraporal region forming a distinct hexagonal area. The bacula different in size, those towards the pore much smaller than those forming the ridges of the hexagon. The downward basal projections of the spines and bacula seeming to form an undulating surface at the base of the spine. Fine reticulum present all over the surface of the grain. Lumina very small. The ratio between pore diameter and width of extraporal area is 2:3.

Ipomoea hederacea (L.) Jacq. 碗仔花 Figs. 15-17

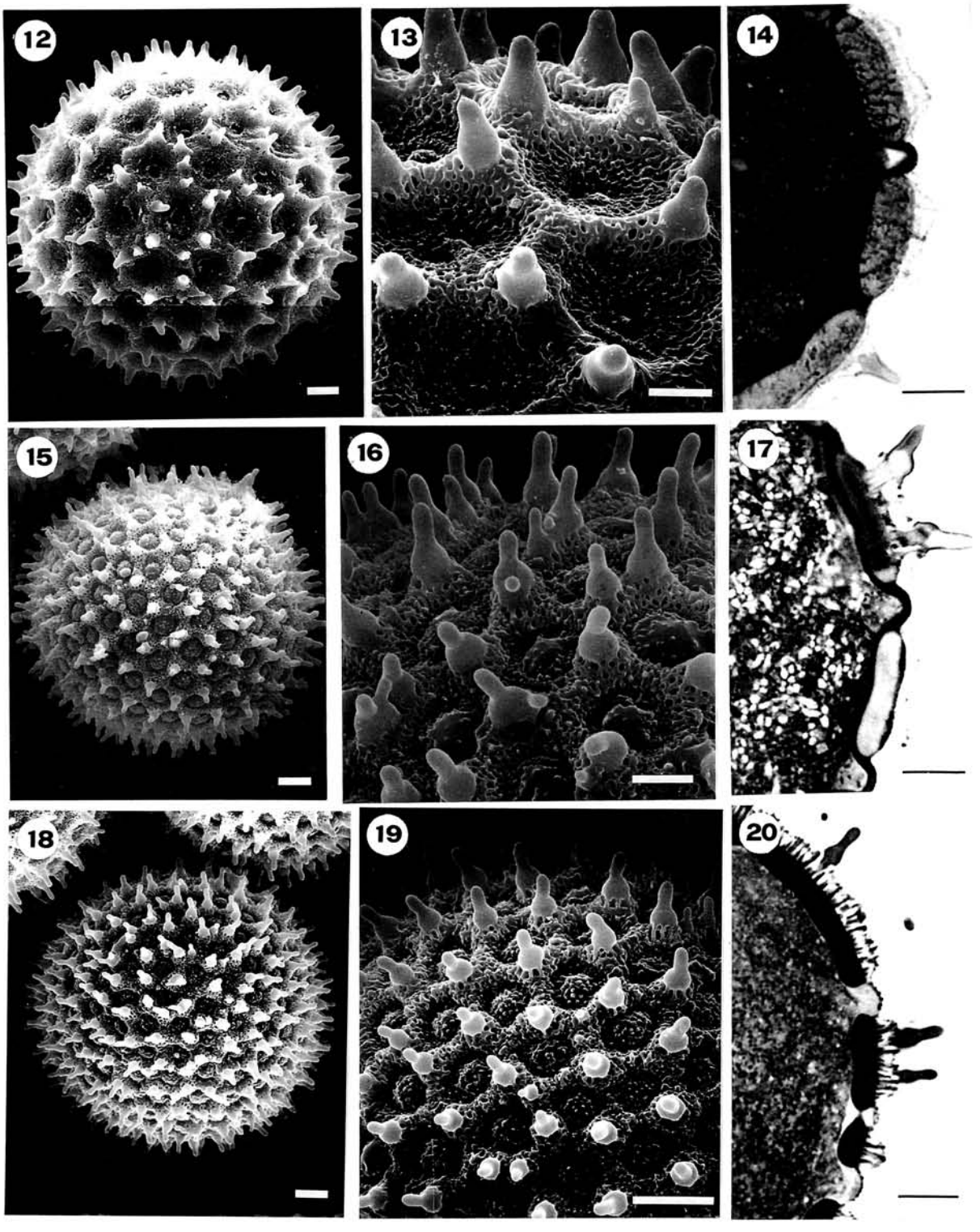
Grains pantoporate, spherical, 84-119 μm wide. Pore diameter 6-7.6 μm, operculum finely granulate. Each pore surrounded by an extraporal spinulose ring-shaped area. Nexine 3.5-4.5 μm thick, sexine (excluding spines) 1.5-2 μm thick. Tectum with spines and granules, the spines 6-16 μm long, broad and bulbous at base, gradually tapering towards the apex with a blunt tip and a faint constricted neck (Fig.2b). The spines and the ridges of the bacula around each extraporal region forming a distinct hexagonal area. The bacula different in size, those towards the pore much smaller than those forming the ridges of the hexagon. The downward basal projections of the spines and bacula seeming to form an undulating surface at the base of the spine. The bacula loose when seen in optical section (Fig.17). Fine reticulum present all over the surface of the grain. Lumina very small. The ratio between pore diameter and width of extraporal area is 4:1.

Ipomoea batatas (L.) Lam. 甘藷 Figs. 18-20

Grains pantoporate, spherical, 79-101 μm wide. Pore diameter 4.2-5.8 μm, operculum finely granulate. Each pore surrounded by an extraporal spinulose ring-shaped area. Nexine 3.8-4 μm thick, sexine (excluding spines) 2-2.5 μm thick. Tectum with spines and granules, the spines 5.6-8 μm long, broad and bulbous at base, gradually tapering towards the apex with a blunt tip and a distinct constriction at the neck region (Fig.2b). The spines and the ridges of the bacula around each extraporal region forming a distinct hexagonal area. The bacula different in size, those towards the pore much smaller than those forming the ridges of the hexagon. The downward basal projections of the spines and bacula seeming to form an undulating surface at the base of the spine. The bacula dense when seen in optical section(Fig.20). Fine reticulum present all over the surface of the grain. Lumina small. The ratio between pore diameter and width of extraporal area is 4:1.

Ipomoea alba L. 天茄兒 Figs. 21-23

Grains pantoporate, spherical, 112-145 μm wide. Pore diameter 9.2-11 μm, operculum finely granulate. Each pore surrounded by an extraporal gemmate ring-shaped area. Nexine



Figs. 12-20. Pollen morphology. 12-14. *I. quamoclit*. 15-17. *I. hederacea*. 18-20. *I. batatas*. Bar=10μm, except Figs. 13,16 in which Bar=5μm. (14,17,20 under LM; others under SEM)

4-4.3 μm thick, sexine (excluding spines) 2-2.2 μm thick. Tectum with gemmate processes and granules, the gemmaes 5-8 μm long, with a globular knob-like structure (Fig.2d). The gemmaes and the ridges of the bacula around each extraporal region forming a distinct hexagonal area. The bacula different in size, those towards the pore much smaller than those forming the ridges of the hexagon. The downward basal projections of the spines and bacula seeming to form a more or less even surface at the base of the gemmae. Fine reticulum present all over the surface of the grain. Lumina very small. The ratio between pore diameter and width of extraporal area is 4:1.

Ipomoea stolonifera (Cyrill.) J. F. Gmel. 厚葉牽牛 Figs. 24-26

Grains pantoporate, spherical, 76-96 μm wide. Pore diameter 3.6-4 μm, operculum finely granulate. Each pore surrounded by an extraporal spinulose ring-shaped area. Nexine 3.8-4 μm thick, sexine (excluding spines) 1.5-2 μm thick. Tectum with spines and fine granules, the spines 7-12 μm long, broad at base, gradually tapering towards the apex with a more or less acute tip (Fig.2c). The spines and the ridges of the bacula around each extraporal region forming a tetragonal area. The bacula different in size, those towards the pore much smaller than those forming the ridges of the tetragon. The downward basal projections of the spines and bacula seeming to form an undulating surface at the base of the spine. Fine reticulum present all over the surface of the grain. Lumina very small. The extraporal area obscure.

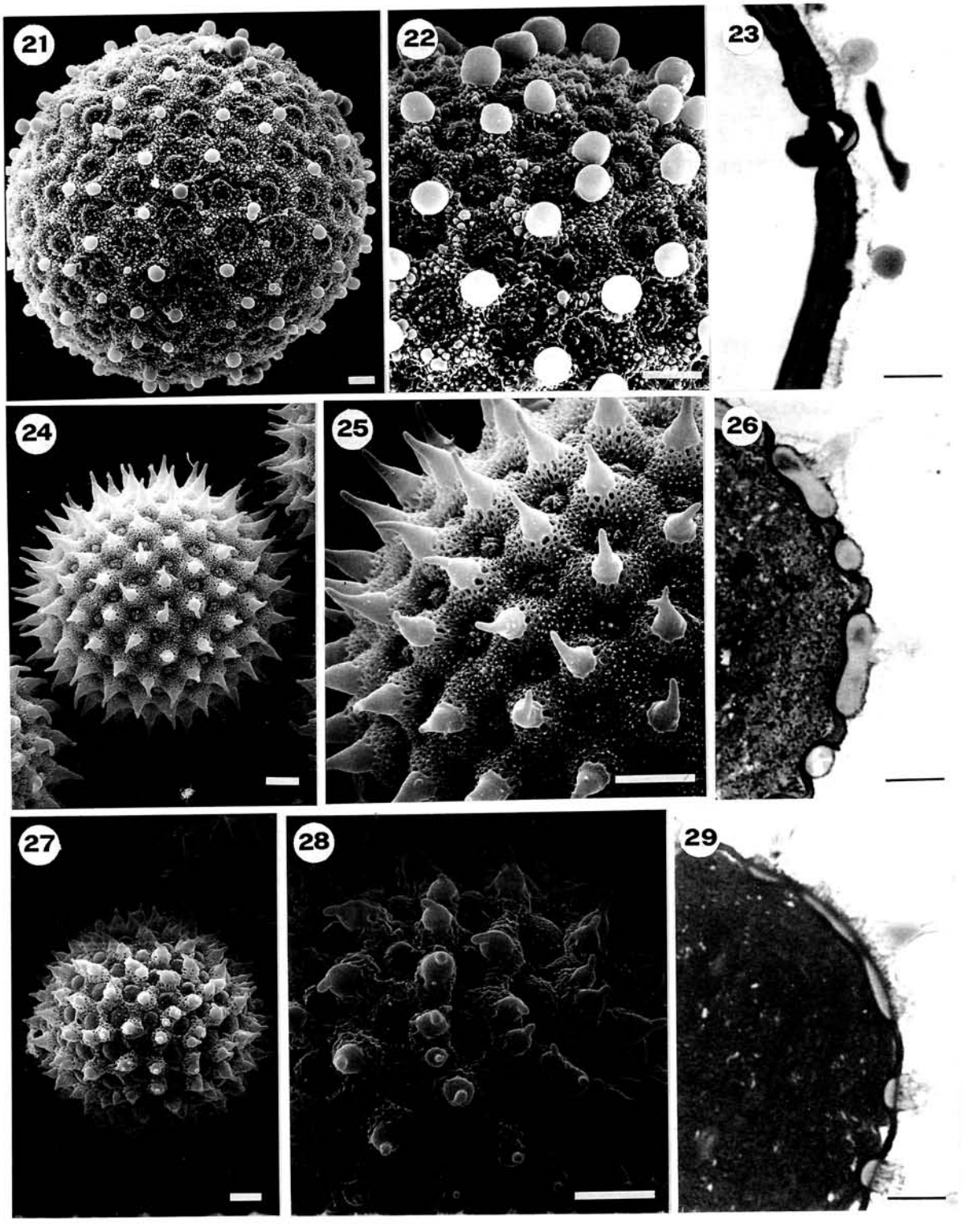
Ipomoea gracilis R. Brown 海牽牛 Figs. 27-29

Grains pantoporate, spherical, 59-79 μm wide. Pore diameter 4.7-6.9 μm, operculum less granulate. Nexine 2-3 μm thick, sexine (excluding spines) 2.9-4.4 μm thick. Tectum with spines in rows, the spines 7.9-10.9 μm long, broad and bulbous at base, gradually tapering towards the apex with a blunt tip and a distinct constriction at the neck region (Fig.2b). The spines in parallel rows, the pores also in parallel rows. The bacula under the rows of pores much smaller than those under the rows of spines. Fine reticulum present all over the surface of the grain. Lumina very small. The extraporal area obscure.

Ipomoea triloba L. 紅花野牽牛 Figs. 30-32

Grains pantoporate, spherical, 57-82 μm wide. Pore diameter 2.8-4 μm, operculum finely granulate. Each pore surrounded by an extraporal spinulose ring-shaped area. Nexine 1.1-2.1 μm thick, sexine (excluding spines) 0.5-0.9 μm thick. Tectum with spines and granules, the spines 5-7 μm long, broad and bulbous at base, gradually tapering towards the apex with a blunt tip and a distinct constriction at the neck region (Fig.2b). The spines and the ridges of the bacula around each extraporal region forming an irregular, linked area and the ridges of the linked spines punctuate. The bacula different in size, those towards the pore much smaller than those forming the ridges of the linked spine area. Fine reticulum present all over the surface of the grain. Lumina very small.

Group 2: The extraporal region and hexagonal area are absent; fine reticula are also present all over the surface of the grain.



Figs. 21-29. Pollen morphology. 21-23. *I. alba*. 24-26. *I. stolonifera*. 27-29. *I. gracilis*. Bar=10μm. (23,26,29 under LM; others under SEM)

Ipomoea obscura (L.) Ker-Gawl. 野牽牛 Figs. 33-35

Grains pantoporate, spherical, 57-69 μm wide. Pore diameter 6 μm, operculum finely granulate. Nexine 2.1-2.4 μm thick, sexine (excluding spines) 0.7-1.1 μm thick. Tectum with spines, the spines 5-7.4 μm long, broad at base, gradually tapering towards the apex with a more or less acute tip (Fig.2c). The downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina very small.

Ipomoea pes-caprae (L.) Sweet, subsp. **brasiliensis** (L.) Ooststt. 馬鞍藤 Figs. 36-38

Grains pantoporate, spherical, 63-91 μm wide. Pore diameter 4.6-6.3 μm, operculum finely granulate. Nexine 2.2-3 μm thick, sexine (excluding spines) 0.8-1.5 μm thick. Tectum with spines, the spines 9.6-12 μm long, broad and bulbous at base, gradually tapering towards the apex with a more acute tip and a faint, constricted neck (Fig.2e). The downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina very small.

Ipomoea cairica (L.) Sweet 番仔藤 Figs. 39-41

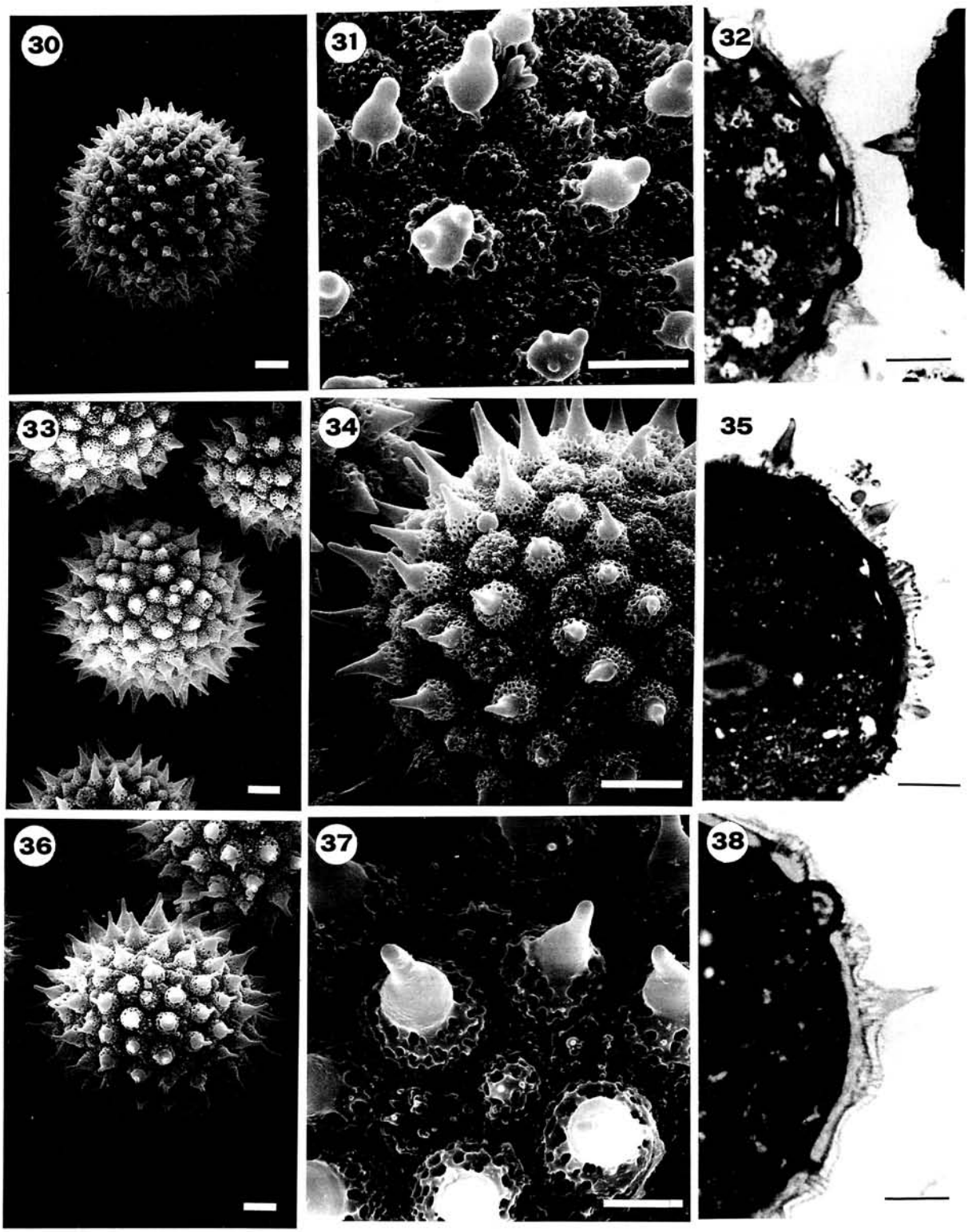
Grains pantoporate, spherical, 59-79 μm wide. Pore diameter 3.5-4.8 μm, operculum finely granulate. Nexine 1.6 μm thick; sexine (excluding spines) 1-1.2 μm thick. Tectum with spines, the spines 6-10 μm long, broad and bulbous at base, gradually tapering towards the apex with a less acute tip and a faint, constricted neck (Fig.2e). The downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina very small.

Ipomoea crassicaulis (Benth.) B. L. Robinson 樹牽牛 Figs. 42-44

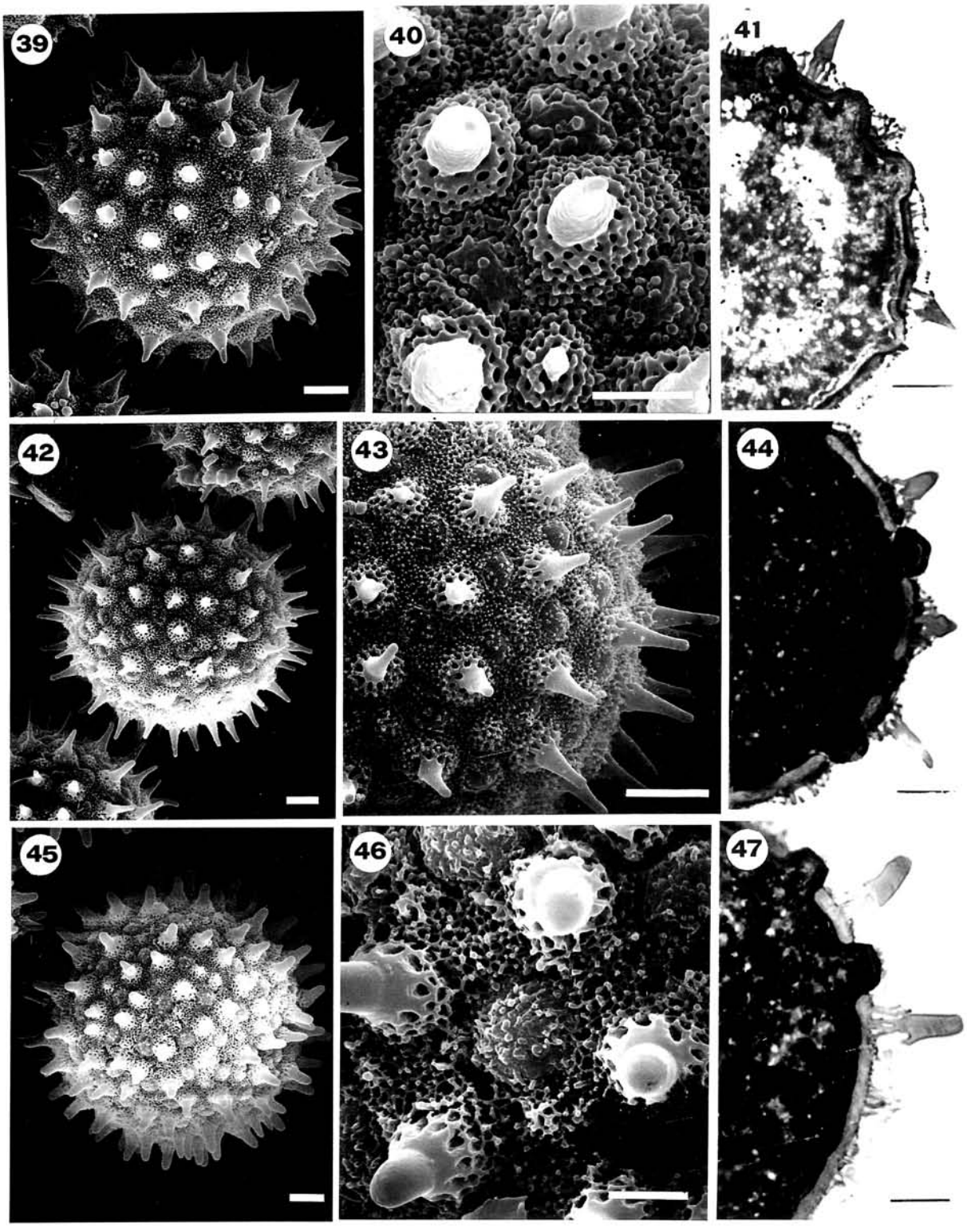
Grains pantoporate, spherical, 64-77 μm wide. Pore diameter 4.5-5.1 μm, operculum finely granulate. Nexine 2 μm thick, sexine (excluding spines) 1-1.2 μm thick. Tectum with spines, the spines 7.4-12.4 μm long, broad at base, gradually tapering towards the apex with a more or less acute tip (Fig.2c). The downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina very small.

Ipomoea tuba (Schlecht.) G. Don 圓萼天茄兒 Figs. 45-47

Grains pantoporate, spherical, 80-114 μm wide. Pore diameter 5.9-7.6 μm, operculum finely granulate. Nexine 2.1-2.8 μm thick, sexine (excluding spines) 1.7-3 μm thick. Tectum with spines, the spines 6.7-12 μm long, broad at base, cylinder-shaped, the apex with a flattened tip (Fig.2f). The downward basal projections of the spines and bacula seeming to form an undulating surface at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina small.



Figs. 30-38. Pollen morphology. 30-32. *I. triloba*. 33-35. *I. obscura*. 36-38. *I. pes-caprae* subsp *brasiliensis*. Bar=10μm, except Figs. 31,37 in which Bar=5μm. (32,35,38 under LM; others under SEM)



Figs. 39-47. Pollen morphology. 39-41. *I. cairica*. 42-44. *I. crassicaulis*. 45-47. *I. tuba*. Bar=10μm, except Figs. 40,46 in which Bar=5μm. (41,44,47 under LM; others under SEM)

Ipomoea sinensis (Desr.) Choisy 白花牽牛 Figs. 48-50

Grains pantoporate, spherical, 54-74 μm wide. Pores 7-12, pore diameter 5.9-9.2 μm, operculum fine, granulate. Nexine 1.5-2.5 μm thick, sexine (excluding spines) 0.1-0.8 μm thick. Tectum with spines, the spines 5-7 μm long, broad at base, gradually tapering towards the apex with a more or less acute tip (Fig.2c). The downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina very small.

Ipomoea sinensis (Desr.) Choisy cv. **Aurea-reticulata** 金網中牽牛 Figs. 51-53

Grains pantoporate, spherical, 54-77 μm wide. Pores 11-17, pore diameter 6.7-10 μm, operculum finely granulate. Nexine 1.5-2 μm thick, sexine (excluding spines) 0.1-0.9 μm thick. Tectum with spines, the spines 5.5-7.4 μm long, broad at base, gradually tapering towards the apex with a more or less acute tip (Fig.2c). The downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina very small. Apertures greater in number than those of *I. sinensis*.

Ipomoea pes-tigridis L. 九爪藤 Figs. 54-58

Grains pantoporate, spherical, 50-77 μm wide. Pore diameter 5.5-7 μm, operculum finely granulate. Nexine 1-1.5 μm thick, sexine (excluding spines) 0.1-0.2 μm thick. Tectum with spines, the spines 4-7 μm long, broad at base, cylinder-shaped, the apex with a flattened tip (Fig.2f) and often ramified (Figs.56,58). The downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine. The bacula under the spines much larger than the other parts of the grain's surface. Lumina very small.

Key to species of genus *Ipomoea* (based on pollen features)

1a. Extraporal region and hexagonal area present
 2a. The ridges of the linked spines present all over the surface
  3a. Exine with gemmate processes (Fig.2d) ..... *I. alba*
  3b. Exine with echinate processes
   4a. The spines having a more or less acute tip (Fig.2c) ..... *I. aquatica*
   4b. The spines having a blunt tip
    5a. The spines broad and bulbous at base with a faint, constricted neck (Fig.2b)
     6a. Pore diameter as wide or wider than extraporal area
      7a. Pore diameter as wide as extraporal area (1:1) ..... *I. nil*
      7b. Pore diameter wider than extraporal area (4:1)
       8a. The bacula distant ..... *I. hederacea*
       8b. The bacula dense ..... *I. batatas*
     6b. Pore diameter shorter than width of extraporal area ..... *I. quamoclit*
    5b. Base of spines broad, but not bulbous and without constricted neck (Fig.2a)
     ..... *I. acuminata*
 2b. The ridges of the linked spines punctuate without distinct hexagonal area

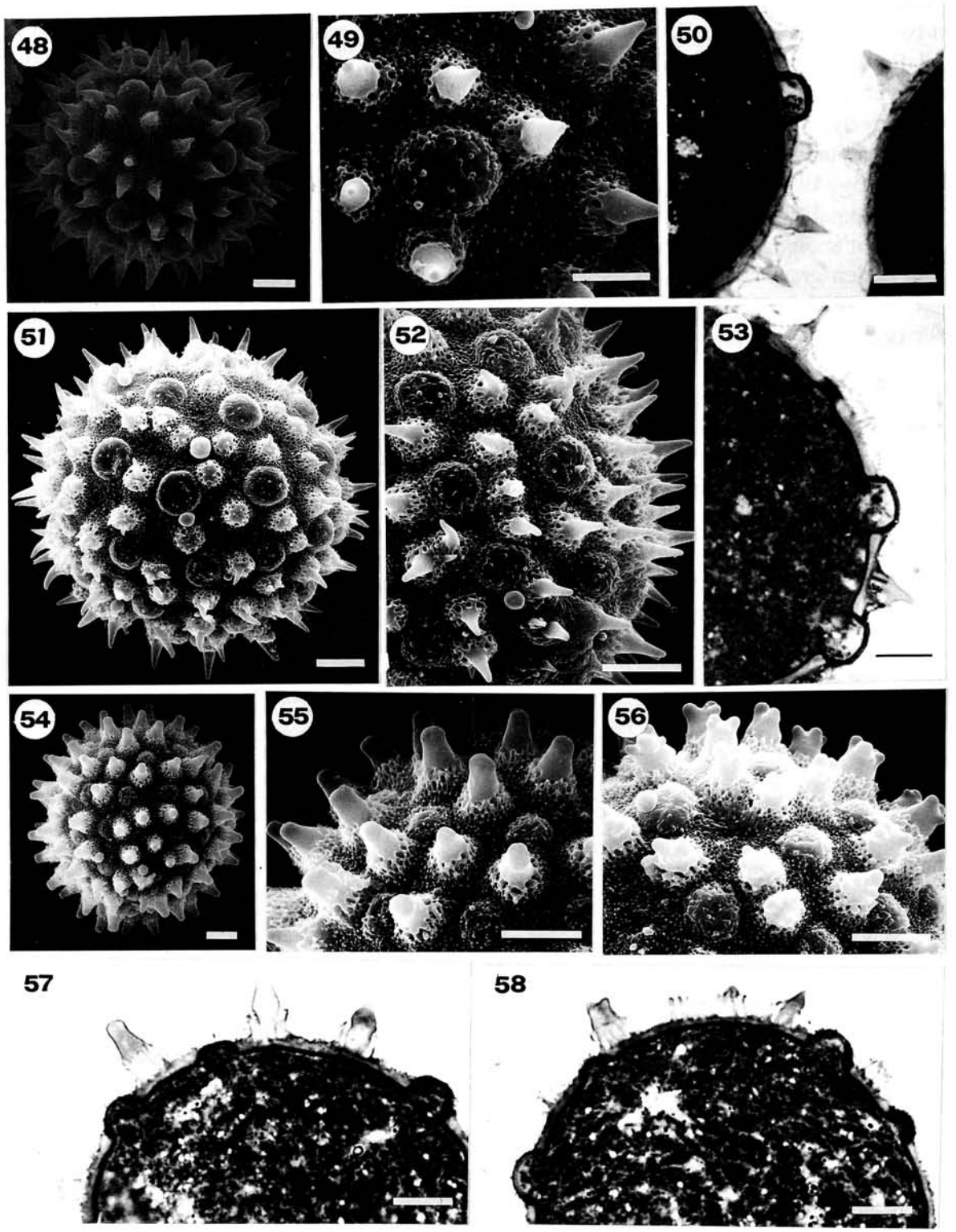
9a. The spines having a more or less acute tip (Fig.2c); the spines and the ridges of the bacula forming a tetragonal area ..... *I. stolonifera*
9b. The spines having a blunt tip with a faint, constricted neck (Fig.2b)
10a. The spines in parallel rows, the pores also in parallel rows ..... *I. gracilis*
10b. The spines and the bacula forming an irregular, linked area and the ridges of the linked spines punctuate ..... *I. triloba*
1b. Extraporal region and hexagonal area absent
11a. The spines having a more or less acute tip
12a. The spines broad and bulbous at base with a faint, constricted neck (Fig.2e)
13a. The spines and pores compact ..... *I. pes-caprae subsp. brasiliensis*
13b. The spines and pores distant ..... *I. cairica*
12b. The spines broad at base, but not bulbous, and without constricted neck (Fig.2c)
14a. The pore diameter more than 6 μm wide
15a. The pores dense 11-17 each grain ..... *I. sinensis cv. aurea-reticulate*
15b. The pores distant 7-12 each grain ..... *I. sinensis*
14b. The pore diameter less than 6 μm
16a. The spines 5-7 μm long ..... *I. obscura*
16b. The spines 7-12 μm long ..... *I. classicaulis*
11b. The spine having a flattened tip
17a. Pollen 80-114 μm wide; the downward basal projections of the spines and bacula forming an undulating surface at the base of the spine ..... *I. tuba*
17b. Pollen 50-77 μm wide; the downward basal projections of the spines and bacula forming a compact convex tuft at the base of the spine ..... *I. pes-tigridis*

DISCUSSION

We examined the pollen of 18 species of *Ipomoea* in Taiwan and found that : 1. the bacula are simple and unbranched; and 2. downward basal projections emerge from the spine base and seem to be connected with the nexine. These projections have been described by Erdtman (1952) as "basal rootlets". The bacula of the basal rootlets and the ridges of the hexagonal area are much longer than neighboring parts, forming a prominent reticula. The tectum of *Ipomoea* is fused incompletely forming a micro-reticula. In this genus, the nexine is thicker than the sexine (called crassinexinous) and the intine is very thin, but extends over the apertures to become operculum.

According to the results of this report, the pollen of *Ipomoea* can be divided into two groups. The Group 1 pollen include *I. acuminata* and 9 other species, possess spines, extraporal regions and tetragonal to hexagonal areas. The pores are surrounded by an extraporal region, and the spines and the ridges of the bacula form a tetragonal to hexagonal area around each extraporal region. Fine reticula are present all over the surface of the grain. The Group 2 pollen include *I. obscura* and 7 other species. The extraporal regions and tetragonal to hexagonal areas are absent. The ridges of linked spines are not present on the surface of the grain.

In pollen morphological study of Convolvulaceae, Sengupta (1972) subdivided the pantoporate type into four groups on the basis of the various characters of the exine pattern.



Figs. 48-58. Pollen morphology. 48-50. *I. sinensis*. 51-53. *I. sinensis* cv. *Aurea-reticulata*. 54-58. *I. pes-tigridis*. Bar=10μm, except Fig. 49 in which Bar=5μm. (50,53,57,58 under LM; others under SEM)

Group I has prominent hexagonal ridges and extraporal regions. Group II is similar to group I, but sometimes pentagonal ridges are present and ridges of the pentagon or hexagon appear to be punctuate. Group III is void of extraporal regions and hexagonal areas. Group IV is psilate. In Sengupta's study *Ipomoea* pollen were confined to Group I. In this study, however, *Ipomoea* pollen in Taiwan were found which corresponded to Groups I, II and III, respectively.

Sengupta previously constructed a key based on his observations of the pollen morphology of the genus *Ipomoea* (as seen via optical section and SEM). The key used mainly spinal characteristics as distinguishing features (Sengupta, 1966, 1972). However, that is not enough to identify species with precision. In this study, the use of thick sections of each pollen grain has allowed us to examine the exine stratification of *Ipomoea* pollen via LM and SEM (providing better results than mere viewing of optical sections). Therefore, it has been possible to construct a table based on both spinal characteristics and exine stratification.

At present, the pollen morphology of *Ipomoea* reveals that the *Ipomoea*-type pollen is unique to this genus (Erdtman, 1952). Although there are some differences in the spinal characteristics and exine stratification of various *Ipomoea* pollen, these differences serve only as diagnostic characteristics for identification purposes.

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旋花科牽牛屬的花粉形態

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摘　　要

本文研究以光學顯微鏡檢及掃描式電子顯微鏡檢觀察臺灣的 18 種牽牛屬植物的花粉形態，其特徵爲球形、多孔、具刺紋及顆粒狀突起。但依據細微的外壁特徵，此屬可分爲二群：第一群包括銳葉牽牛等 10 種，具有刺紋和圓柱體組成的六角形網脊圍繞在孔外圍區域，有明顯的網紋。第二群包括野牽牛等 8 種，不具孔外圍區域和六角形網脊，沒有網紋的分布。另外利用外壁及刺紋的特徵製作臺灣的牽牛屬花粉檢索表。

關鍵詞：牽牛屬、旋花科、花粉形態、掃描式電子顯微鏡檢。

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