

Pollen Flora of Yuenyang Lake Nature Preserve, Taiwan (IV)

Yu-Fa Wang⁽¹⁾ and Su-Hwa Chen^(1,2)

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ABSTRACT: Yuenyang Lake is an acidic lake situated within a nature preserve in northern Taiwan. The pollen of nineteen taxa, belonging to five families, was collected from this nature preserve and investigated with light and scanning electron microscopy. The results of this investigation are supplementary work to the previous publications in this journal (Chen and Wang, 1999, 2001; Wang and Chen, 2001). A total of 4 pollen classes were identified on the basis of the aperture on the pollen wall: 3-colpate, 6-colpate, 3-colporate, and 4-7-colporate pollen. These results could be useful in the reconstruction of vegetation history around the Yuenyang Lake.

KEY WORDS: Pollen Flora, Yuenyang Lake Nature Preserve, Taiwan.

INTRODUCTION

Pollen analysis has facilitated a reconstruction of the paleoecology of the terrestrial vegetation around Yuenyang Lake, Taiwan (Chen and Wu, 1999). A partial description of pollen flora in the forest surrounding this lake has been published previously (Chen and Wang, 1999, 2001; Wang and Chen, 2001). In this article, pollen morphology of 19 species of Rubiaceae, Rutaceae, Saliaceae, Schisandraceae, and Saxifragaceae is described. Fine structures observed under scanning electron microscopy (SEM) are presented as a supplement to light microscopic (LM) morphology.

MATERIALS AND METHODS

The fresh pollen grains of 19 species of plants belonging to 5 families of angiosperms (Tab. 1) were collected from the Yuenyang Lake Nature Preserve. The treatment of all specimens for LM- and SEM-observation was the same as in a previous study (Chen and Wang, 1999). Voucher specimens are deposited in the Palynological Laboratory, Department of Botany, National Taiwan University.

RESULTS

The pollen morphology of 19 species is described alphabetically by family. The habitat of each taxon is given after the description of the pollen morphology so that it can be used for future pollen analysis.

Rubiaceae

Pollen morphology of 7 genera and 8 species of Rubiaceae is investigated. The germination aperture varies in this family, from 3-4-colpate, 6-colpate, 3-colporate and 4-6-colporate. The exine ornamentation of Rubiaceae in this study is reticulate or spinulate/perforate.

1. Department of Botany, National Taiwan University, Taipei 106, Taiwan.

2. Corresponding author. E-mail: suchen@ccms.ntu.edu.tw

Damnacanthus indicus Gaertn. (Plate 2)

Pollen grains 3-4-colporate, isopolar, suboblate to subprolate (P/E= 0.87-1.2) in equatorial view, 24-36 × 24-35 μm; circular or slightly circular-lobate in polar view, 24-36 μm in diameter.

Colpi crassimarginate, up to 1.8 μm wide, colpus membranes scabrate. Ora lalongate or transversally parallel.

Exine 2.5-3 μm thick. Columellae distinct. Sexine reticulate; muri simpli-columellate, 0.3-0.7 μm wide, sometimes with minute granules on the top of muri; lumina rounded angular, decreasing in size towards the colpi and in apocolpia, up to 2 μm in dimension. Nexine as thick as sexine.

Evergreen small shrubs; growing in broad-leaved forests from 1,500 to 2,500 m throughout the island, and undergrounds in mesophytic forest community on the slopes around Yuenyang Lake.

It is difficult to distinguish the pollen characteristics between *Damnacanthus indicus* and *D. angustifolius*

Galium trifidum L. (Plate 3)

Pollen grains 6-colpate (rarely 7-colpate), isopolar, prolate-spheroidal to prolate in equatorial view, 17-25 × 14-21 μm (P/E= 1.06-1.36), 6-(7)-lobate-circular in polar view, 16-25 μm in diameter.

Colpi obscurely crassimarginate, as long as P axes, narrow, margins fractured.

Exine 1.5-2 μm thick. Sexine spinulate/perforate, spinules less than 0.2 μm wide, perforations irregularly distributed, less than 0.4 μm wide. Sexine thicker than nexine. Herbs confined to wet places; mixed in *Schoeoplectus mucronatus* subsp. *robustus* consociates in the marsh around Yuenyang Lake.

Lasianthus japonicus Miq. (Plate 4)

Pollen grains 3-4-colpate (rarely 5-colpate), isopolar, oblate (P/E= 0.5-0.72) in equatorial view, 31-44 × 43-68 μm; circular, semiangular, subangular or quadrangular with convex sides and obtuse angles in polar view, 43-68 μm in diameter.

Colpi very short, elliptical, colpus margins tattered, colpus membranes granulate, margo smooth.

Exine 2.5-3 μm thick. Columellae distinct. Sexine reticulate; muri simpli-columellate, with columellae at the corners and along the sides; lumina up to 1.6 μm in dimension. Nexine as thick as sexine.

Evergreen shrubs; growing in broad-leaved forests from low to high altitudes of the island, and undergrounds in mesophytic forest community on the slopes around Yuenyang Lake.

Mitchella undulata Sieb. & Zucc. (Plate 5)

Pollen grains 3-colporate (rarely 4-colporate), isopolar, oblate-spheroidal to subprolate (P/E= 0.96-1.3) in equatorial view; 25-47 × 23-40 μm, circular in polar view, 24-47 μm in diameter.

Colpi sunken, end obtuse, colpus membranes densely verrucate, verrucae less than 0.2 μm in dimension. Ora lalongate, crassimarginate.

Exine 2.5-3 μm thick. Columellae distinct. Sexine reticulate; muri simpli-columellate, 0.2-0.4 μm wide, sometimes with minute granules on the top of muri; lumina rounded

angular, up to 0.8 μm in dimension. Nexine as thick as than sexine.

Perennial scandent herbs; growing in the northern part of Taiwan, and on forest floors around Yuenyang Lake.

Neanotis hirsura (L.) W. H. Lewis (Plate 6)

Pollen grains 6-colporate, isopolar, suboblate to oblate-spheroidal in equatorial view, 23-35 \times 27-36 μm (P/E= 0.86-0.96), elliptical to circular in polar view, 24-39 \times 26-42 μm in diameter.

Colpi slit-like, short. Ora indistinctly transversally parallel.

Exine 3-5 μm thick. Sexine reticulate. Muri undulate, simpli-collumellate, 0.6-1.2 μm wide, spinulate on the muri, spinules blunt, less than 0.4 μm wide. Lumina very irregular, decreasing in size towards the colpi. Nexine thinner than sexine.

Herbs; growing at middle altitudes in the north of the island, and on forest floors around Yuenyang Lake.

Ophiorrhiza japonica Blume (Plate 7)

Pollen grains 3-colporate (rarely 4-colporate), isopolar, suboblate to prolate-spheroidal (P/E= 0.8-1.12) in equatorial view, 22-47 \times 25-44 μm ; semiangular or subangular with obtuse angles in polar view, 30-47 μm wide.

Colpi long, crassimarginate, deeply sunken, end obtuse, protruded in the ora areas. Colpus membranes verrucate. Ora circular or lolongate, crassimarginate. Apertures club type.

Exine 3-4 μm thick towards the colpi, 1-2 μm at equator. Columellae distinct. Sexine reticulate; muri simpli-columellate, straight in apocolpia and undulate in mesocolpia, 0.5 μm wide in mesocolpia; lumina circular to elliptical and isodiametric in apocolpia and near the colpi, up to 1 μm in dimension in apocolpia, irregularly shaped in mesocolpia. Nexine slightly thinner than sexine.

Herbs; growing in forests or on roadsides at low and middle altitudes, and on forest floors around Yuenyang Lake.

Rubia lanceolata Hayata (Plate 8)

Pollen grains 6-colpate, isopolar, prolate-spheroidal to subprolate in equatorial view, 13-21 \times 12-18 μm (P/E= 1.07-1.25), 6-lobate-circular in polar view, 14-22 μm in diameter.

Colpi crassimarginate, as long as P axes, narrow, sunken, up to 1.3 μm wide, margins fractured.

Exine 1.5-2 μm thick. Sexine spinulate/perforate, spinules less than 0.2 μm wide, perforations more or less regularly distributed, less than 0.5 μm wide.

Annual or perennial herbs; growing in sparse woodlands, forest margins or on roadsides from 1,500 to 3,000 m throughout the island, and on forest floors around Yuenyang Lake.

It is difficult to distinguish the pollen characteristics between *Galium trifidum* and *Rubia lanceolata* under LM. But under SEM, the later differs from the former by having perforations more regularly distributed.

Rutaceae

There are 2 species in 2 genera of Rutaceae in this study which posses 3-colporate and 4-5-colporate pollen. The exine ornamentation in this two species is striato-reticulate or reticulate.

***Skimmia reevesiana* Fortune (Plate 9)**

Pollen grains 4,5-colporate (rarely 6-colporate), isopolar, prolate-spheroidal to prolate (P/E= 1.13-1.45) in equatorial view, 24-39 × 19-30 μm, rectangular or pentagonal in polar view, 19-31 μm in diameter.

Colpi long, crassimarginate, narrow, ends acute, exine thickened towards the ora, colpus membranes verrucate, verrucae less than 0.4 μm in dimension. Ora transversally parallel.

Exine 2-3 μm thick. Columellae distinct. Sexine striato-reticulate, muri simpli-columellate, 0.15-0.45 μm wide, muri sometimes parallel to the colpi, branched, interlaced, curved in mesocolpia; lumina irregularly polygonal to elongated, 0.4-1.1 μm in dimension, decreasing in size towards the colpus margins and in apocolpia. Nexine as thick as sexine.

Evergreen shrubs; growing in forests at middle altitudes, and dominant in mesophytic forest community on the slopes around Yuenyang Lake.

***Tetradium ruticarpum* (A. Juss.) T. Hartley (Plate 10)**

Pollen grains 3-colporate, isopolar, oblate-spheroidal to prolate-spheroidal (P/E=0.96-1.09) in equatorial view, 16.5-32 × 16-29.5 μm, inter-hexagonal in polar view, 16.5-29.5 μm in diameter.

Colpi long, crassimarginate, ends acuminate, exine thickened towards the ora, colpus membranes scabrate. Ora transversally parallel or lalongate. Aperture fastigium type.

Exine 2.5-3.5 μm thick. Sexine reticulate, muri simpli-columellate; lumina polygonal, 0.5-1.5 μm in dimension in mesocolpia, decreasing in size towards the colpus margins, densely distributed with verrucae in the lumina, verrucae 0.25-0.45 μm in dimension. Nexine as thick as sexine.

Deciduous trees; growing in broad-leaved forests around 1,200 m throughout the island, and understory in mesophytic forest community on the slopes around Yuenyang Lake.

Salicaceae***Salix fulvopubescens* Hayata (Plate 11)**

Pollen grains 3-colporate, isopolar, prolate-spheroidal to prolate in equatorial view, 15-28 × 9-19 μm (P/E= 1.07-1.95); circular or slightly circular-lobate in polar view, 8-22 μm in diameter.

Colpi relatively long, intruding, end obtuse, 0.7-1 μm wide, colpus membranes granulate. Ora lalongate.

Exine 1-1.5 μm thick. Columellae distinct. Sexine reticulate, muri keeled, 0.3-0.5 μm wide; lumina irregularly angular, 0.4-1.3 μm in dimension at the center of mesocolpia, decreasing in size towards the colpus margins, sparsely covered with granules in the lumina.

Deciduous shrubs or small trees; growing in open places or forest margins from 2,000-3,000 m on high mountains, and undergrounds in mesophytic forest community on the slopes around Yuenyang Lake.

Schisandraceae***Schisandra arisanensis* Hayata (Plate 12)**

Pollen grains 6-colpate (rarely 5-colpate), heteropolar, distally-syncolpate, oblate to suboblate in equatorial view, 12-25 × 17-31 μm (P/E= 0.74-0.86), 6-lobate-circular in polar view, 16-31 μm in diameter.

Colpi narrow, end obtuse, delimited by solid and distinct sexious ridges, 0.3-2.2 μm wide, colpus membranes with narrow, linear median sexine thickenings, median thickenings usually solid and continuous. Three long colpi fused at the distal pole, formed a triradiate cracking, the others shorter and remained free and alternated with the longer, the apices of all 6-colpi equidistant from the proximal pole, delimited the boundary of only one apocolpium, apocolpium blank inaperaturate, the longer colpi usually twice the length of the shorter ones.

Exine 1.5-2 μm thick. Columellae distinct. Sexine reticulate. Sexine thicker than nexine. Muri simpli-columellate, frequently winding or less commonly consisting of straight segments, less than 0.4 μm wide. Lumina frequently irregularly shaped or less frequently polygonal, 1.2-3 μm in dimension, relatively small lumina frequently found in the vicinity of the colpus margins, larger at apocolpium than those at the distal ones.

Woody vines; growing in secondary forests, thickets, forest margins and the first layer of the primary broad-leaved forests from 1,200-2,500 m in mountains, and in mesophytic forests on slopes around Yuenyang Lake.

Saxifragaceae

There are 5 genera and 7 species of Saxifragaceae in this study which possess 3-colporate. The exine ornamentation of Saxifragaceae are reticulate, striato-reticulate or perforated.

Key to species

- 1a. Sexine perforated *Hydrangea paniculata*
- 1b. Sexine striato-reticulate or reticulate 2
 - 2a. Sexine striato-reticulate *Astilbe longicarpa*
 - 2b. Sexine reticulate 3
 - 3a. Colpi fusiform, colpus membranes spinulate *Schizophragma integrifolium* var. *fauriei*
 - 3b. Colpi linear to narrowly lanceolate, colpus membranes smooth, scabrate or finely reticulate 4
 - 4a. Lumina elongated and irregularly curved in equatorial view *Hydrangea integrifolia*
Pileostegia viburnoides
 - 4b. Lumina rounded angular in equatorial view 5
 - 5a. Colpus constricted in the equator *Deutzia taiwanensis*
 - 5b. Colpus not constricted in the equator *Hydrangea anomala*

Astilbe longicarpa (Hayata) Hayata (Plate 13)

Pollen grains 3-colporate, isopolar, suboblate to subprolate in equatorial view (P/E= 0.78-1.28), 11-20 \times 10-17 μm , circular or semiangular in polar view, 11-19 μm in diameter.

Colpi long, lanceolate to broadly lanceolate, sunken, colpus membranes scabrate to finely granulate. Sexine extended over the ora forming fringed equatorial bridge. Ora lalongate or transversally parallel.

Exine 1.5-2 μm thick. Columellae distinct. Sexine striato-reticulate, muri simpli-columellate, 0.25-0.4 μm wide, lumina rounded angular, 0.15-0.55 μm in dimension, decreasing in size towards the colpus margins. Nexine as thick as sexine.

Perennial herbs; growing from low to middle altitudes throughout the island, and on forest floors around Yuenyang Lake.

Deutzia taiwanensis (Maxim.) Schneider (Plate 14)

Pollen grains 3-colporate, isopolar, oblate-spheroidal to subprolate-spheroidal in equatorial view (P/E= 0.93-1.11), 13-20 \times 12-20 μm , circular or semiangular in polar view, 13-20 μm in diameter.

Colpi long, slightly constricted in the equator, colpus membranes smooth to scabrate. Ora circular.

Exine 1.5-2 μm thick. Columellae distinct. Sexine reticulate, muri simpli-columellate, lumina rounded angular, $0.3-0.8 \times 0.3-1.9 \mu\text{m}$, decreasing in size towards the colpus margins. Nexine as thick as sexine.

Deciduous shrubs; growing in forests from low to high altitudes throughout the island, and undergrounds in mesophytic forest community on the slopes around Yuenyang Lake.

Hydrangea anomala Don (Plate 15)

Pollen grains 3-colporate, isopolar, oblate-spheroidal to subprolate in equatorial view ($P/E=0.98-1.15$), $13-25 \times 12-23 \mu\text{m}$, circular or circular-lobate in polar view, 11-24 μm in diameter.

Colpi long, colpus membranes scabrate. Ora circular.

Exine 1-1.5 μm thick. Columellae distinct. Sexine reticulate, muri simpli-columellate, 0.2-0.3 μm wide, lumina rounded angular, $0.4-0.8 \times 0.45-1.5 \mu\text{m}$, decreasing in size towards the colpus margins, irregularly covered with fine granules in the lumina. Nexine as thick as sexine.

Climbing shrubs; in forests at high altitudes in the northern and central part of the island; in mesophytic forest community on the slopes around Yuenyang Lake.

Hydrangea integrifolia Hayata ex Matsum. & Hayata (Plate 16)

Pollen grains 3-colporate, isopolar, prolate spheroidal to subprolate ($P/E=1.08-1.3$) in equatorial view, $10-16 \times 9-15 \mu\text{m}$, circular or semiangular in polar view, 10-15 μm in diameter.

Colpi long, ends acute, colpus membranes scabrate to finely granulate. Ora circular.

Exine 1-1.5 μm thick. Columellae distinct. Sexine reticulate, muri simpli-columellate, 0.25-0.4 μm wide, lumina elongated, irregularly curved in equatorial view, less than 1.5 μm in dimension, decreasing in size towards the colpus margins. Nexine as thick as sexine.

Epiphytic shrubs; growing from 1,500-3,200 m in coniferous and broad-leaved mixed forests in mountain areas throughout the island, and in mesophytic forest community on the slopes around Yuenyang Lake.

Hydrangea paniculata Sieb. (Plate 17)

Pollen grains 3-colporate, isopolar, spheroidal to prolate ($P/E=1-1.45$) in equatorial view, $13-20 \times 10-17 \mu\text{m}$, circular, circular-lobate or semiangular in polar view, 12-17 μm in diameter.

Colpi long, constricted in the equator, ends acuminate or obtuse, colpus membranes finely granulate. Ora circular.

Exine 1.5-2 μm thick. Columellae distinct. Sexine perforated, perforations less than 0.4 μm in dimension. Nexine as thick as sexine.

Shrubs to small trees; growing in coniferous and broad-leaved mixed forests on Mts. Taiping, and dominant in thickets in the marsh and undergrounds in mesophytic forest community on the slopes around the Yuenyang Lake.

Pileostegia viburnoides Hook. f. & Thoms. (Plate 18)

Pollen grains 3-colporate, isopolar, prolate-spheroidal to subprolate in equatorial view ($P/E=1.13-1.15$), $10-25 \times 8-22 \mu\text{m}$, circular in polar view, 10-25 μm in diameter.

Colpi long, constricted in the equator, with margo. Ora circular.

Exine 1-1.5 μm thick. Columellae distinct. Sexine reticulate, muri simpli-columellate, 0.3-0.4 μm wide, lumina rounded angular in polar view, elongated and irregularly curved in equatorial view, 0.5-0.8 \times 0.8-1 μm , decreasing in size towards the colpus margins. Nexine as thick as sexine.

Evergreen shrubs, growing at medium altitudes in the central mountains, and undergrounds in mesophytic forest community on the slopes around Yuenyang Lake

Schizophragma integrifolium Oliv. var. *fauriei* (Hayata) Hayata (Plate 19)

Pollen grains 3-colporate, isopolar, oblate-spheroidal in equatorial view (P/E= 0.92-0.97), 14-26 \times 15-29 μm , circular in polar view, 14-26 μm in diameter.

Colpi long, sunken, fusiform with margo. Colpus membranes spinulate. Sexine extended over the ora forming longitudinally rectangular equatorial bridge. Ora circular.

Exine 1-1.5 μm thick. Columellae distinct. Sexine reticulate, muri simpli-columellate, 0.3-0.5 μm wide, lumina rounded angular in polar view, elongated to irregularly curved in equatorial view, 0.5-0.7 \times 0.5-1.3 μm , decreasing in size towards the colpus margins. Nexine as thick as sexine.

Deciduous climbing shrubs; climbing on rocks and trees in forests, and in mesophytic forest community on the slopes around Yuenyang Lake.

DISCUSSION

The pollen species described in this article belong to 4 pollen classes: 3-colpate, 6-colpate, 3-colporate, and 4-7-colporate. Among them, *Lasianthus japonica* is the only species having 3-colpate pollen. However, some pollen of this species is 4-colpate or 5-colpate, similar to the cases observed in other plants (Adams *et al.*, 1987; Huang, 1972; Frederic *et al.*, 2000).

There are 3 species having 6-colpate pollen: *Galium trifidum*, *Rubia lanceolata* and *Schisandra arisanensis*. The former two species belong to Rubiaceae and the later belongs to Schisandraceae. Pollen grains of *Schisandra* have a unique pollen type, with three longer colpi converging at the distal pole, and three short colpi, alternating to the longer ones, with the apices not fused at either pole (Plate 12A; Huang, 1972; Praglowski, 1976; Sun, 2000). Some pollen grains only have five colpi – one short and four long – with the longer ones fused pairwise with the shorter one to form a synrugoidate structure (Plate 12J; Jalan and Kapil, 1964). As indicated by Huang (1972), the majority of *Rubia* and *Galium* pollen are 6-colpate. However, 4-, 5-, 7-, or 8-colpate pollen grains might exist. The same results were obtained in the present study.

The pollen of *Damnacanthus indicus*, *Mitchella undulata*, *Ophiorrhiza japonicus*, *Tetradium ruticarpum*, *Salix fulvopubescens*, and all of Saxifragaceae are 3-colporate. Among them, *Tetradium ruticarpum* (Rutaceae) is the only species with inter-hexagonal pollen grains. *Damnacanthus indicus*, *Mitchella undulata*, and *Ophiorrhiza japonica* (all Rubiaceae) can be easily distinguished from other species by its larger pollen size (more than 23 μm in diameter). Both the *Damnacanthus* and *Mitchella* pollen have small suprategillar granules on the muri, as reported by Johansson (1987) and Robbrecht *et al.* (1991).

The typical *Salix* pollen is 3-colporate (Sohma, 1993; Yang, 1988). However, other types, such as 3-colpate (Chen, 1988) or 3-colporoidate (Wang, 1985; Horowitz & Baum, 1967) have been reported. In general, the ora of *Salix* pollen are circular or lolongate, sometimes

transversally parallel (Huang, 1972) or indistinct (Wang, 1985; Chen, 1988; Horowitz & Baum, 1967). Wang (1985) thought that 3-colpate pollen is a primitive type, while 3-colpate and 3-colporoidate pollen are more advanced. Accordingly, the *Salix fulvopubescens* in this study is of the advanced type.

The morphology of Saxifragaceae pollen has been studied by a number of researchers (Erdtman, 1952; Hideux & Ferguson, 1976; Huang, 1972; Pan, 1995; Verbeek-Reuvers, 1977; Wakabayashi, 1970). The majority of Saxifragaceae pollen has reticulate sexine sculpture (Huang, 1972). In the present study, all of five genera of Saxifragaceae belong to the *Deutzia* type, according to Wakabayashi's (1970) grouping, because of reticulate to striato-reticulate wall ornamentation. Only a few species, such as *Hydrangea paniculata*, are of *Kirengeshoma* type, due to foveoloid ornamentation.

There are three species of plants having 4-7-colporate pollen: *Damnacanthus angustifolius*, *Neanotis hirsura*, and *Skimmia reevesiana*. The pollen of *Skimmia reevesiana* differs from the other two in having striato-reticulate sculpture. Within the genus *Skimmia*, there are certain variations in exine sculpture, varying from reticulate, to striato-reticulate, to striate. This is similar to what has been observed by other authors (Hartley, 2001; Huang, 1972; Satô, 1971).

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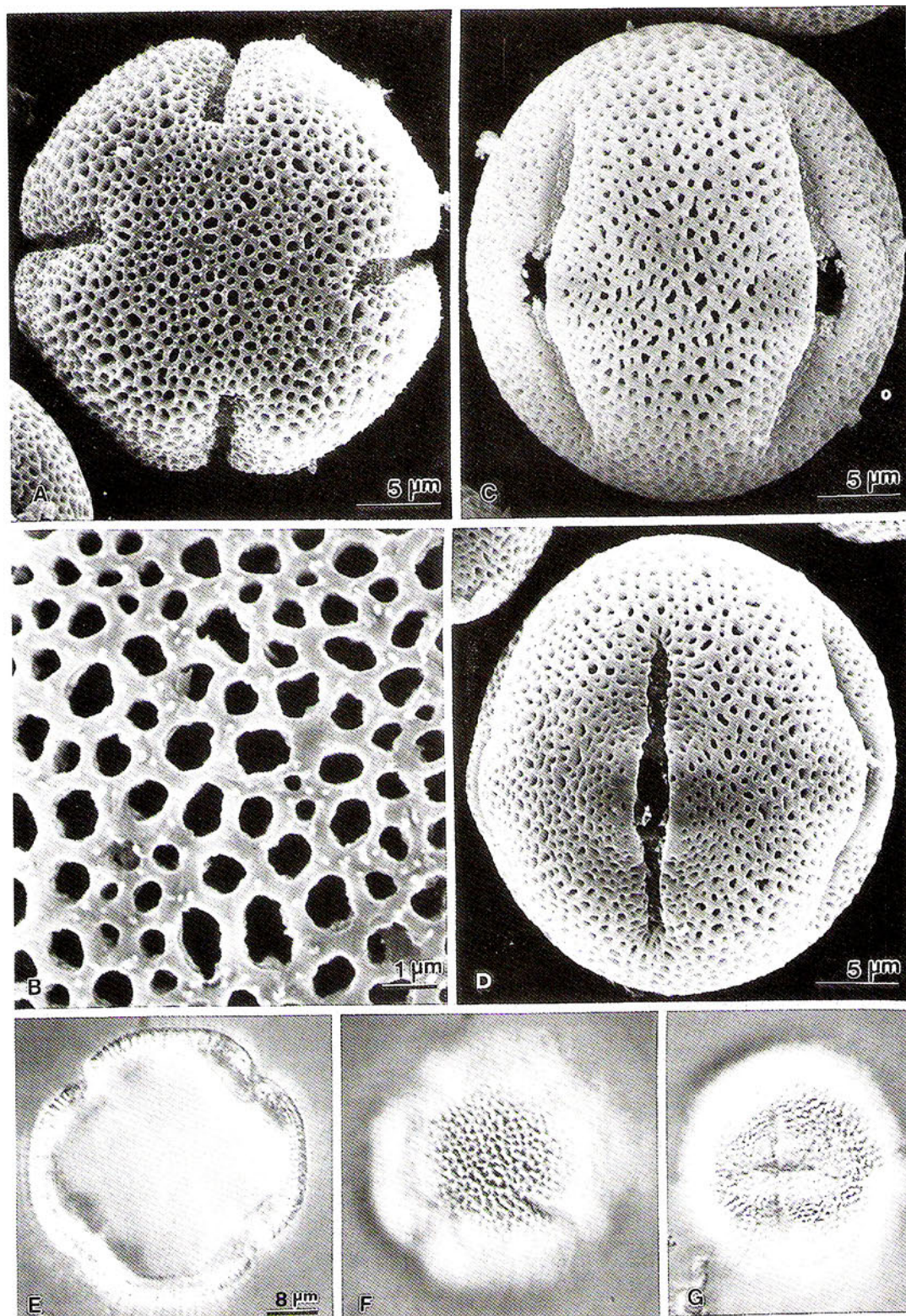


Plate 1. *Damnacanthus angustifolius* Hayata. A-D, SEM; E-G, LM. A, E & F, 4-colporate grains in polar view showing reticulate sexine. C, D & G, grains in equatorial view showing longate os and medium size of colpi. B, detail of sexine in apocolpium showing rounded angular lumina and minute granules irregularly spaced on the top of muri.

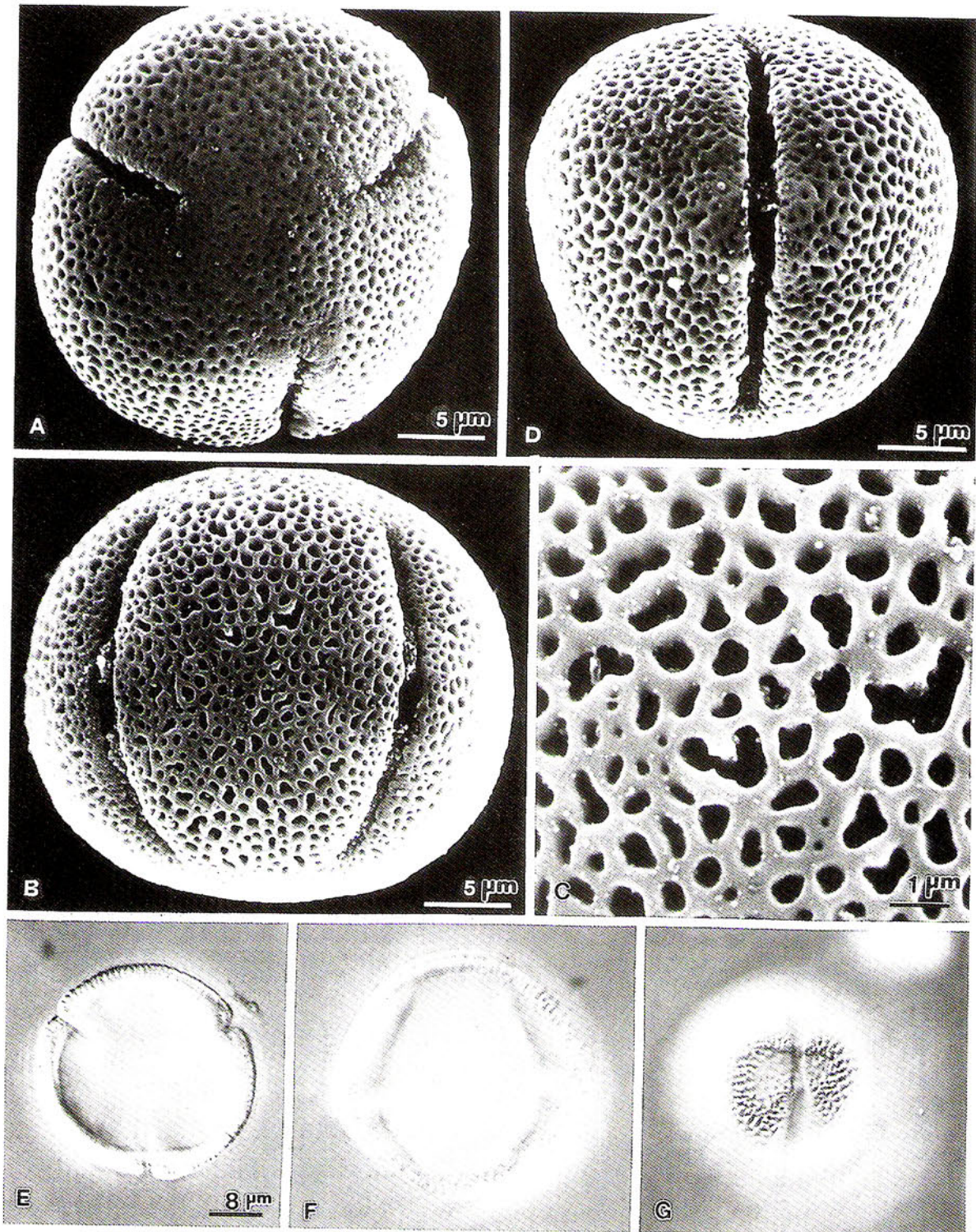


Plate 2. *Damnacanthus indicus* Gaertn. A-D, SEM; E-G, LM. A & E, 3-colporate grains in polar view showing reticulate sexine. B, D, F & G, grains in equatorial view showing reticulate sexine and longitudinal os. C, detail of sexine in mesocolpium showing rounded angular lumina and minute granules irregularly spaced on the top of muri.

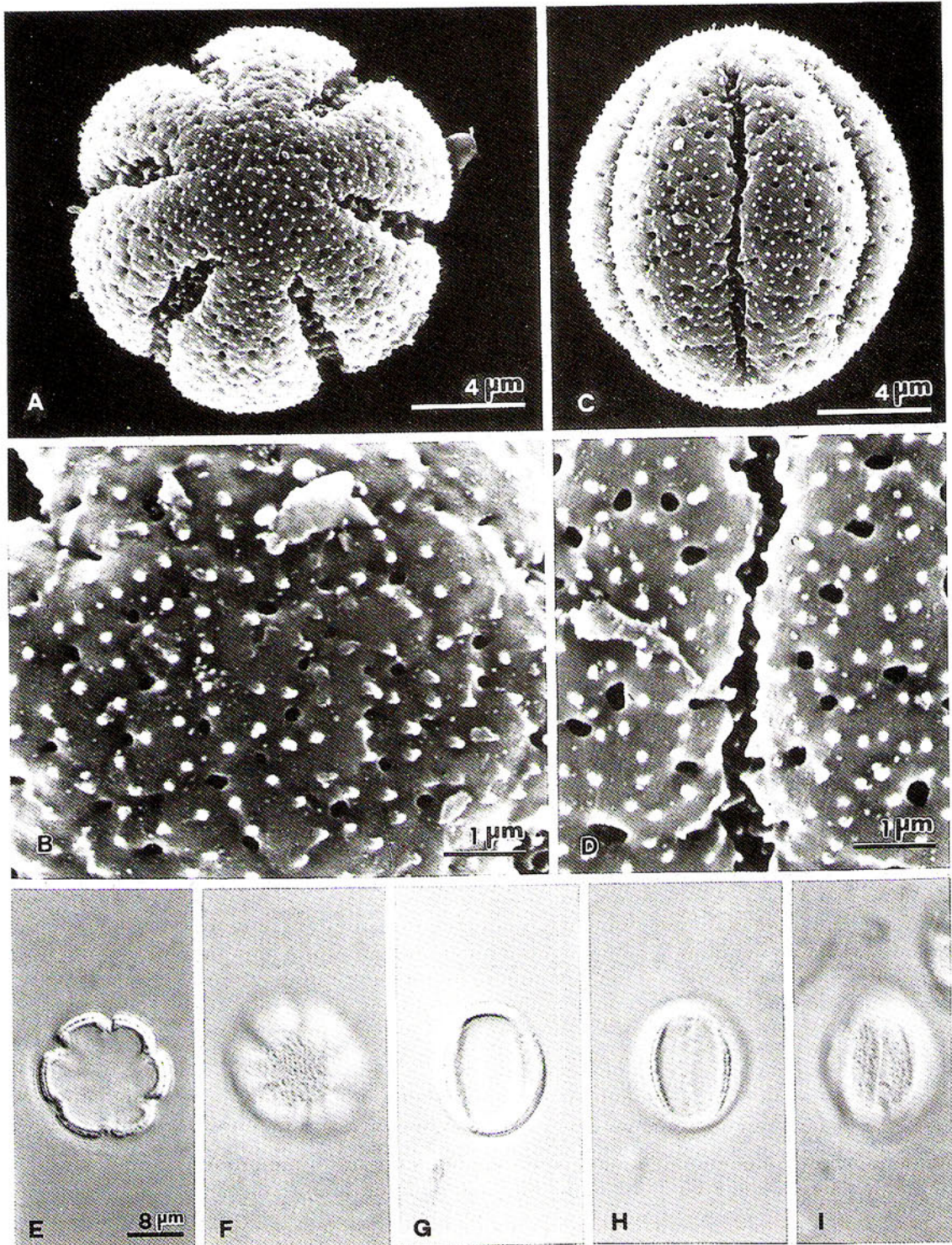


Plate 3. *Galium trifidum* L. A-D, SEM; E-I, LM. A, E & F, 6-colpate grains in polar view showing spinulate/perforate sexine. C & G-I, grains in equatorial view. B, detail of sexine in apocolpia showing spinules and perforations irregularly distributed. D, detail of sexine in mesocolpium showing long colpus and fractured colpus margins.

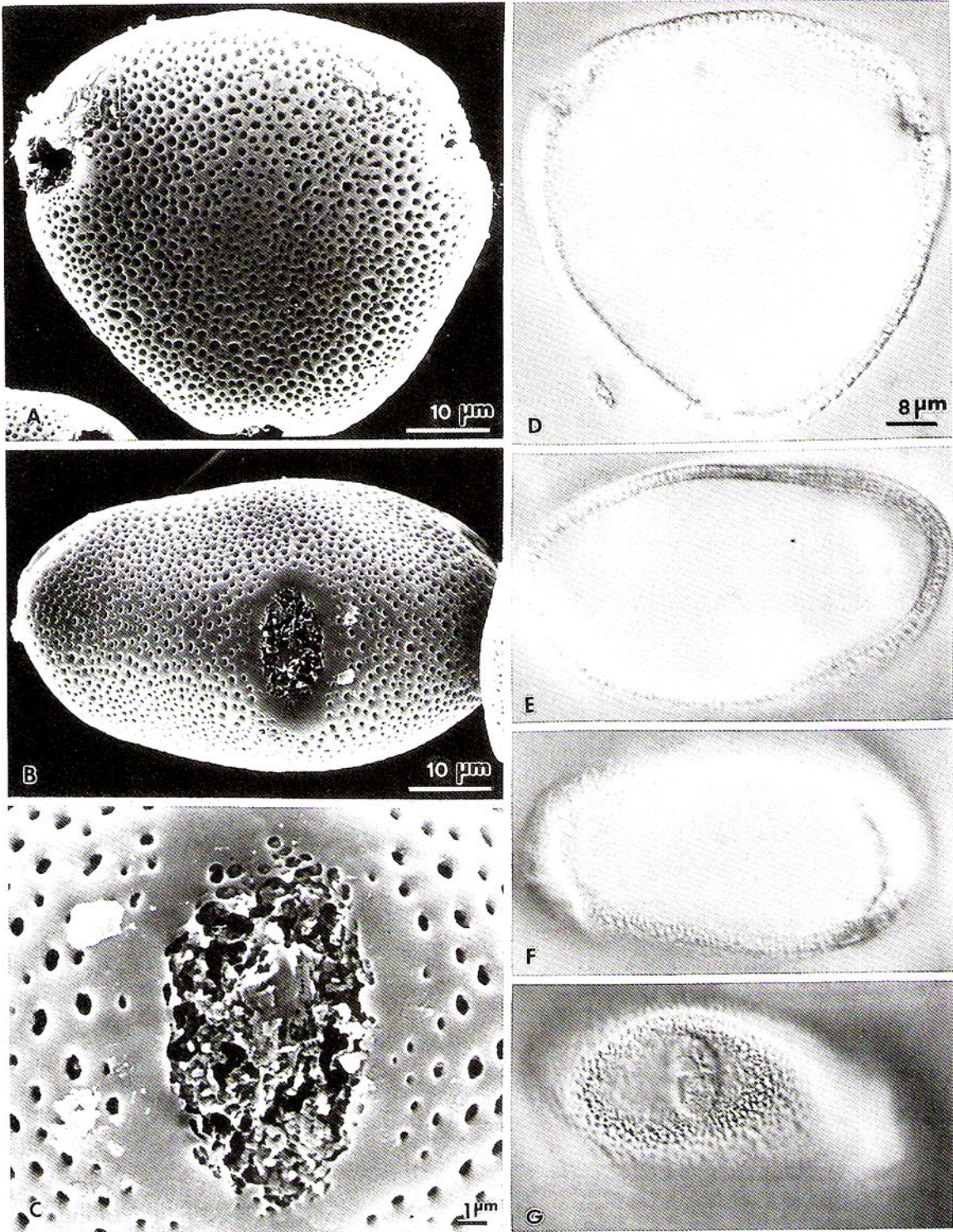


Plate 4. *Lasianthus japonicus* Miq. A-C, SEM; D-G, LM. A & D, 3-colpate grains in polar view showing reticulate sexine. B & E-G, grains in equatorial view showing very short, elliptical colpi and granulate colpus membranes. C, detail of short elliptical colpus showing tattered colpus margin, granulate colpus membrane and smooth margo.

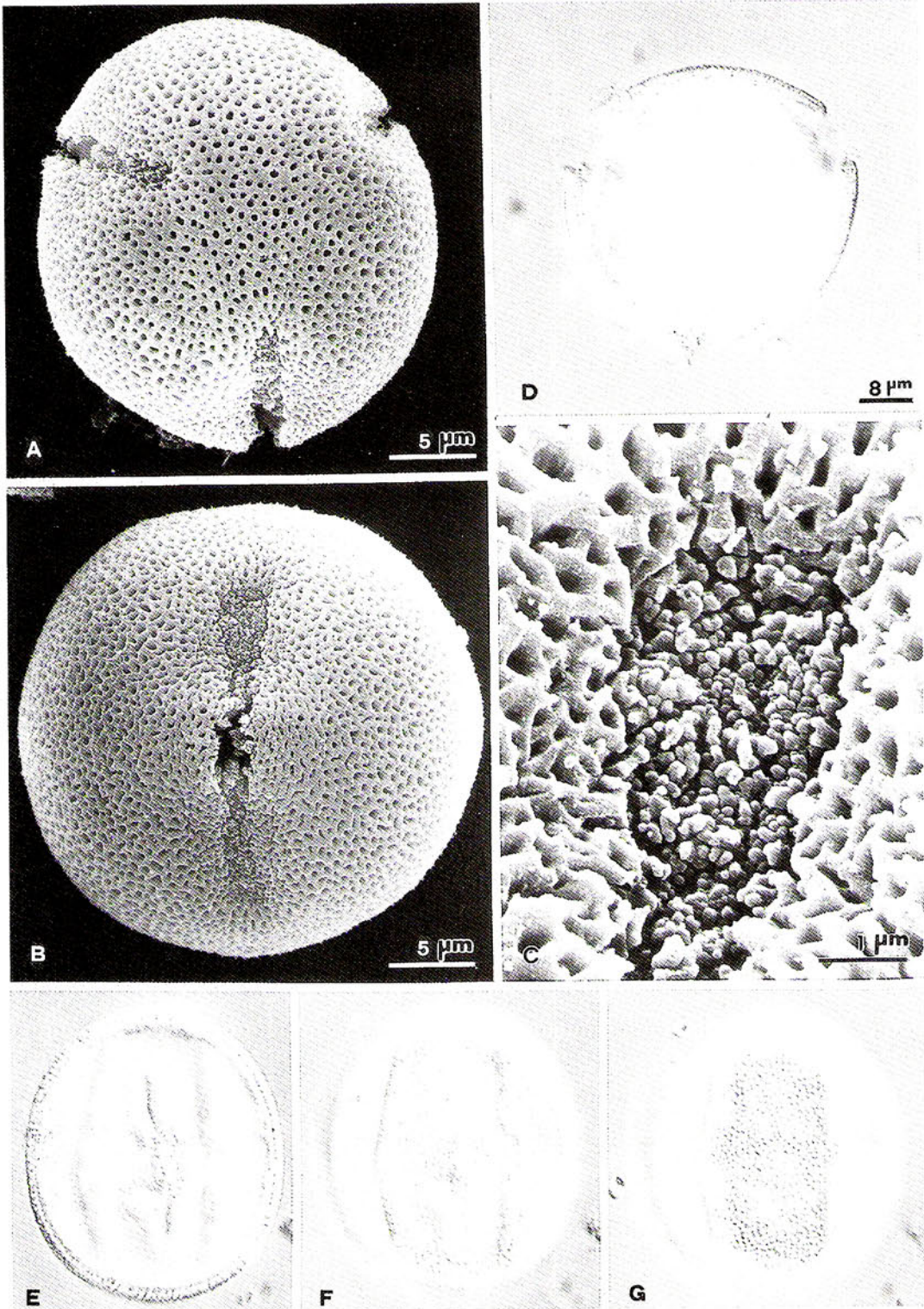


Plate 5. *Mitchella undulata* Sieb. & Zucc. A-C, SEM; D-G, LM. A & D, 3-colporate grains in polar view showing reticulate sexine. B & E-G, grains in equatorial view showing sunken colpi with obtuse ends and densely verrucate colpus membranes. C, detail of sunken colpus showing colpus membrane densely spaced with verrucae.

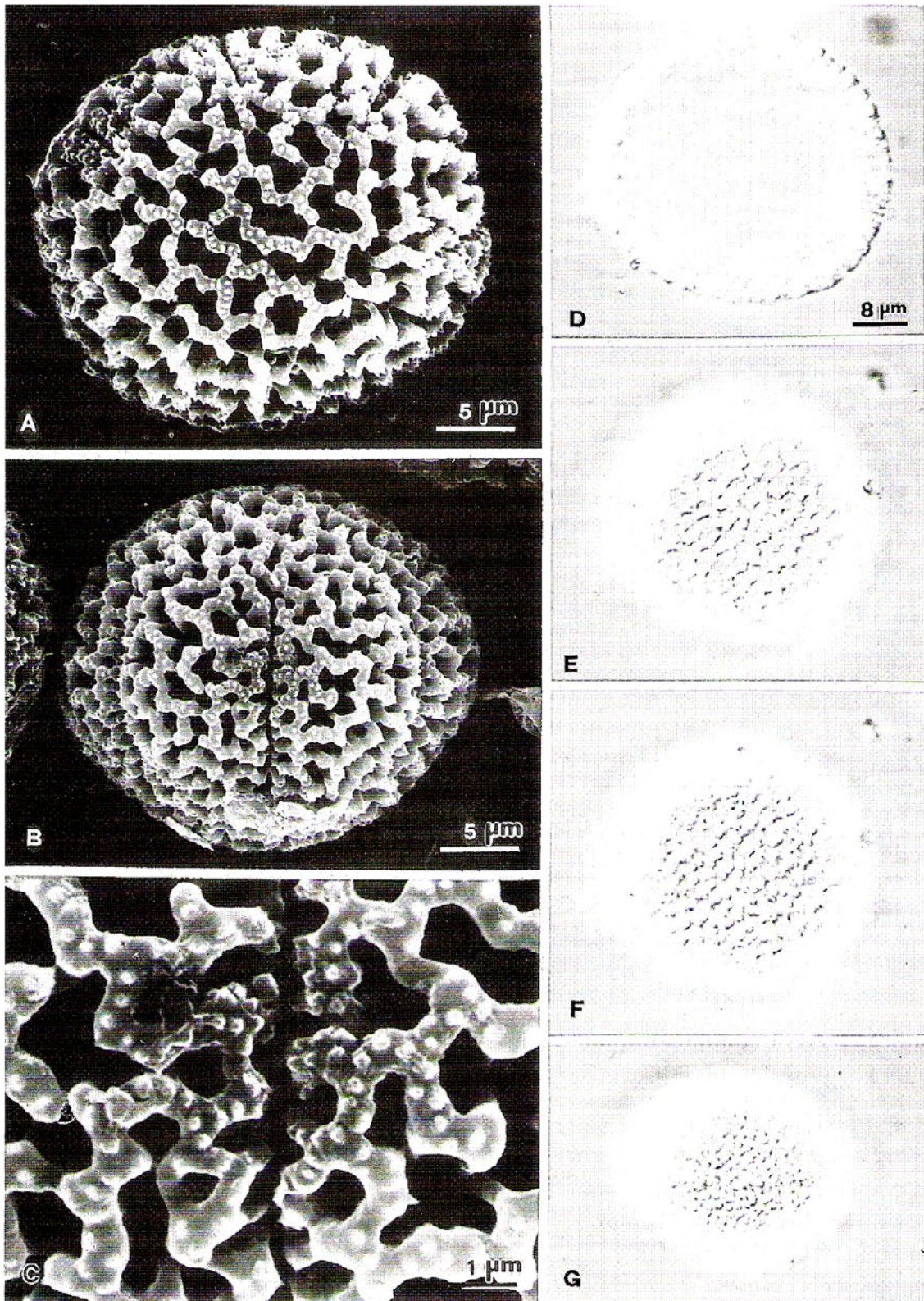


Plate 6. *Neanotis hirsuta* (L. f.) W. H. Lewis. A-C, SEM; D-G, LM. A & D-F, 6-colporate grains showing reticulate sexine. B & G, grains in equatorial view showing slit-like, short colpi and transversally parallel ora. C, detail of slit-like colpus and reticulate sexine with very irregularly angular lumina and blunt spinules distributed on the muri.

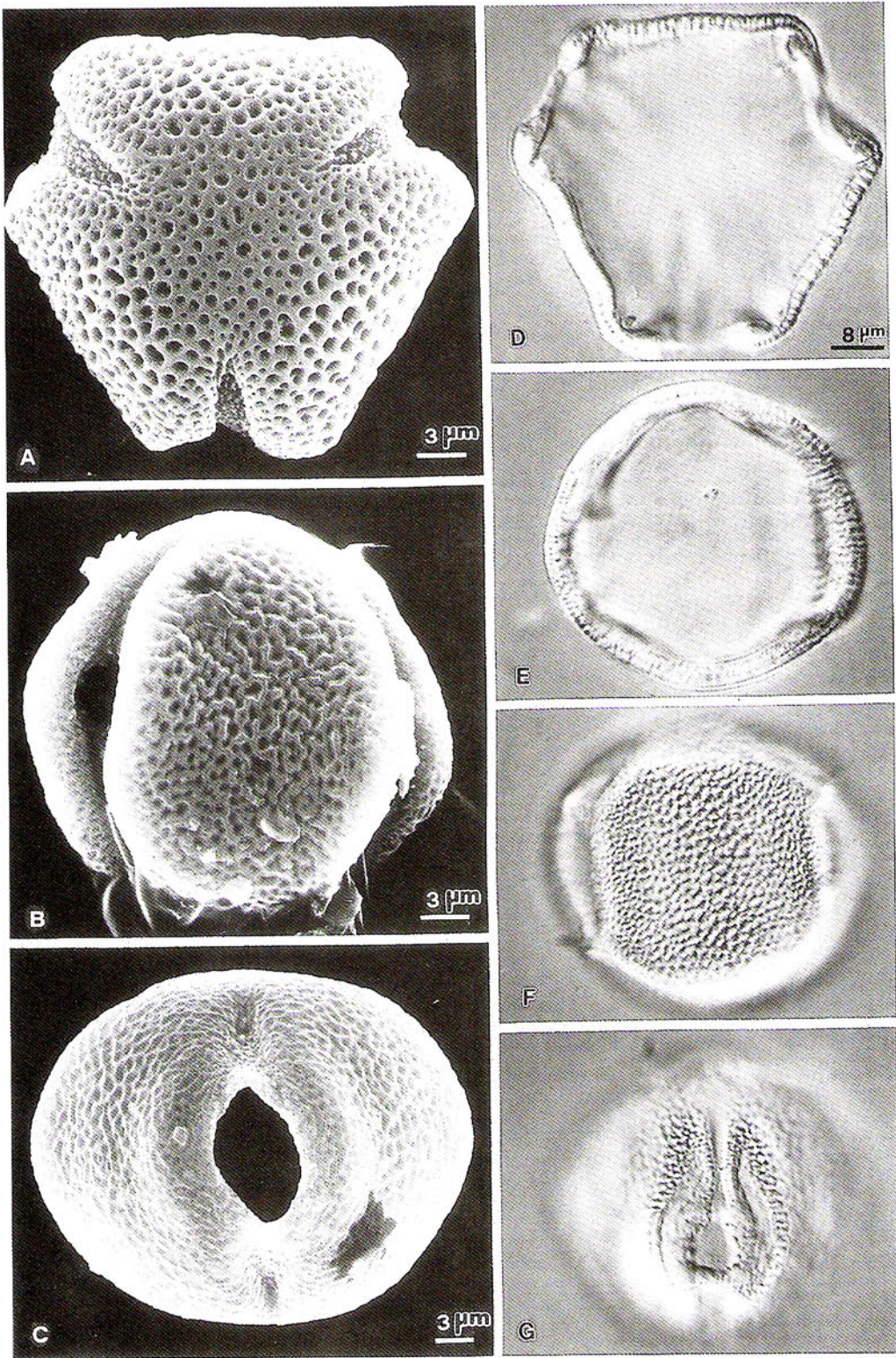


Plate 7. *Ophiorrhiza japonica* Blume. A-C, SEM; D-G, LM. A & D, 3-colporate grains in polar view showing reticulate sexine. B, C & E-G, grains in equatorial view showing circular ora and crassimarginate, deeply sunken colpi which protruded in the ora areas.

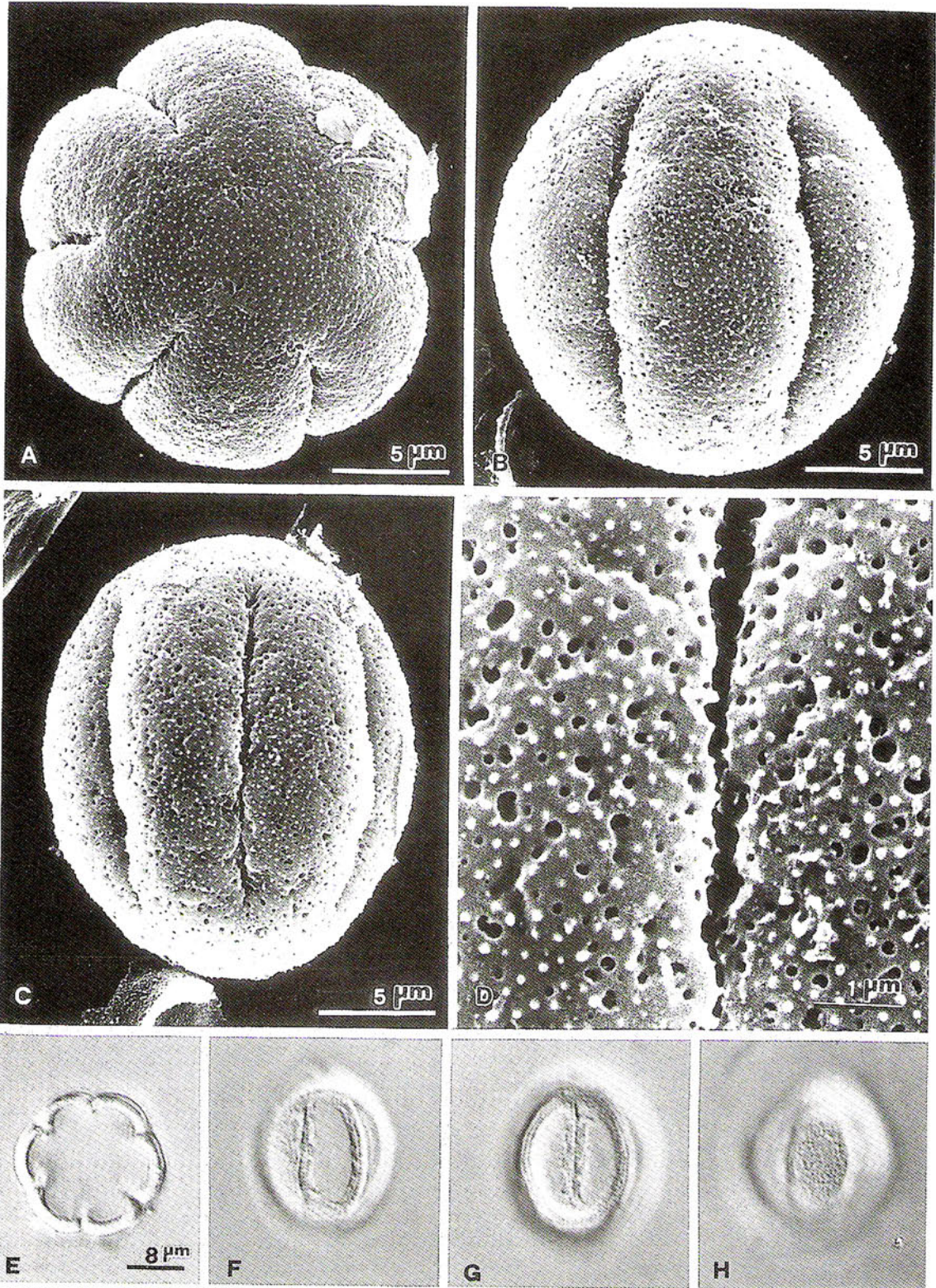


Plate 8. *Rubia lanceolata* Hayata. A-D, SEM; E-H, LM. A & E, 6-colpate grains in polar view showing spinulate/perforate sexine. B, C & F-H, grains in equatorial view showing crassimarginate, sunken colpi and fractured colpus margins. D, detail of sexine showing long colpus and fractured colpus margins.

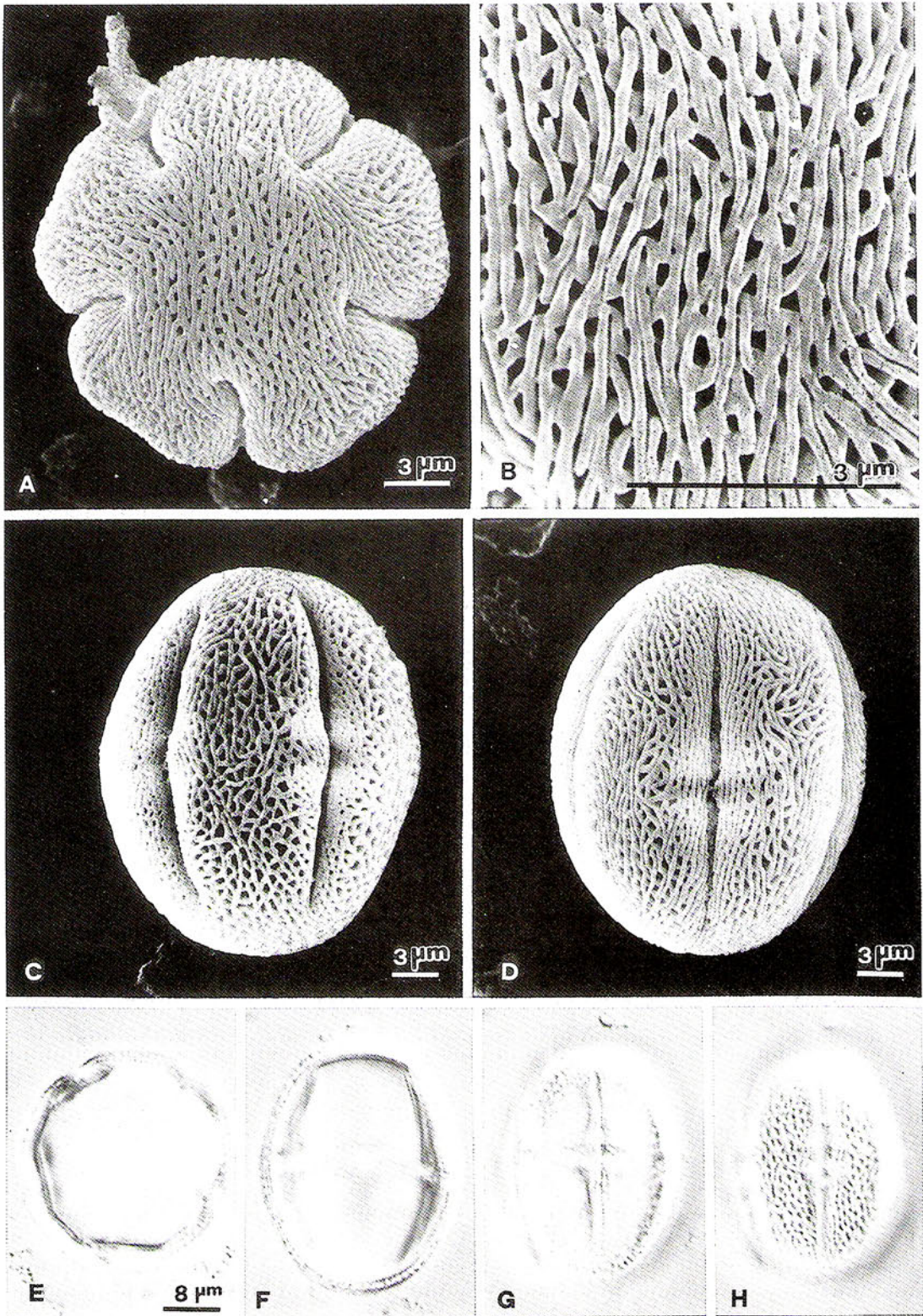


Plate 9. *Skimmia reevesiana* Fortune. A-D, SEM; E-H, LM. A & E, 5-colporate grains in polar view showing striato-reticulate sexine. C, D & F-H, grains in equatorial view showing transversally parallel os and long, crassimarginate and narrow colpi. B, detail of sexine in apocolpium showing muri parallel, branched or interlaced.

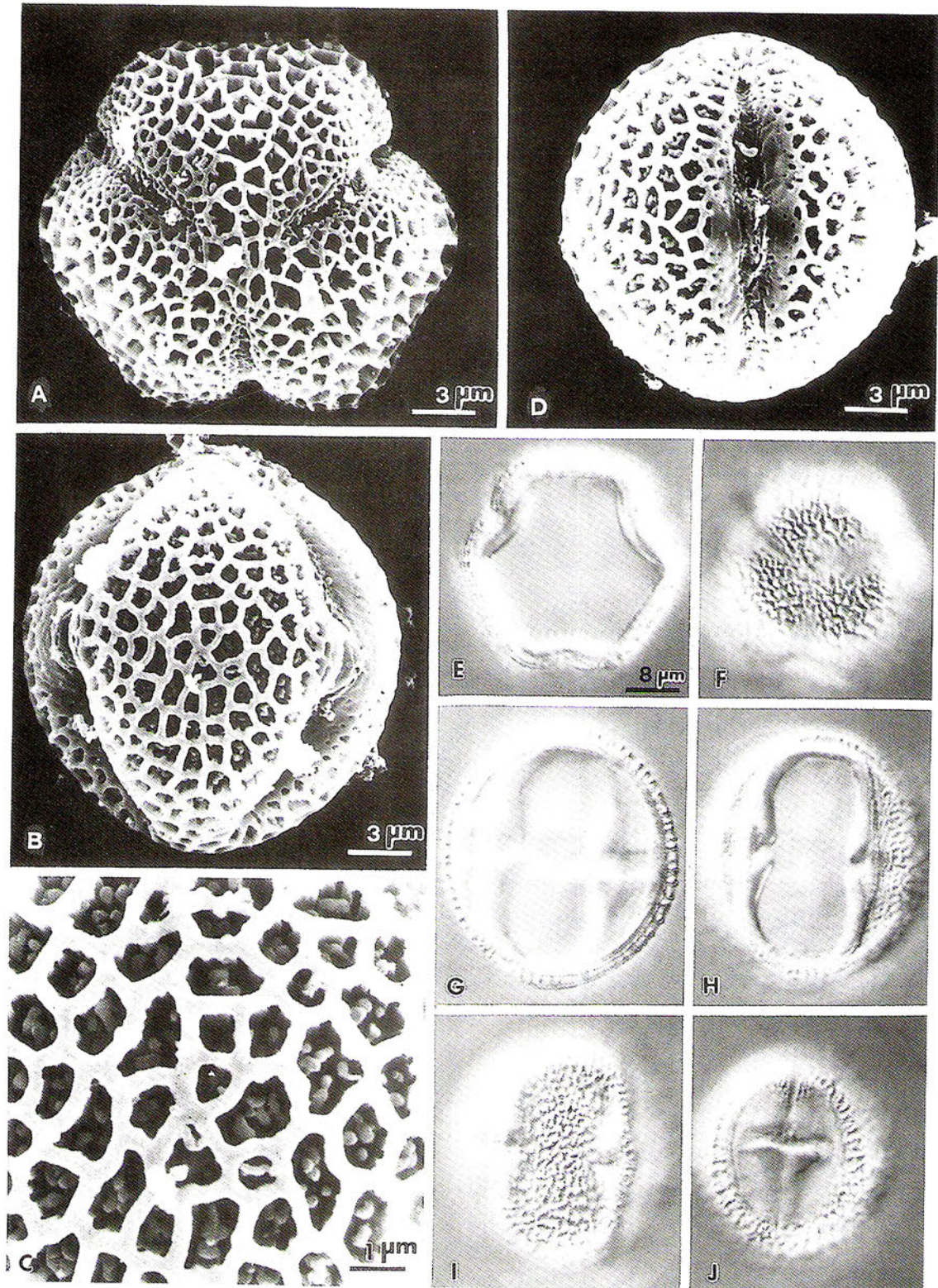


Plate 10. *Tetradium ruticarpum* (A. Juss.) T. Hartley. A-D, SEM; E-J, LM. A, E & F, 3-colporate grains in polar view showing reticulate sexine. B, D & G-J, grains in equatorial view showing long, crassimarginate colpi and transversally parallel ora. C, detail of sexine in mesocolpium showing polygonal lumina and verrucae densely distributed in the lumina.

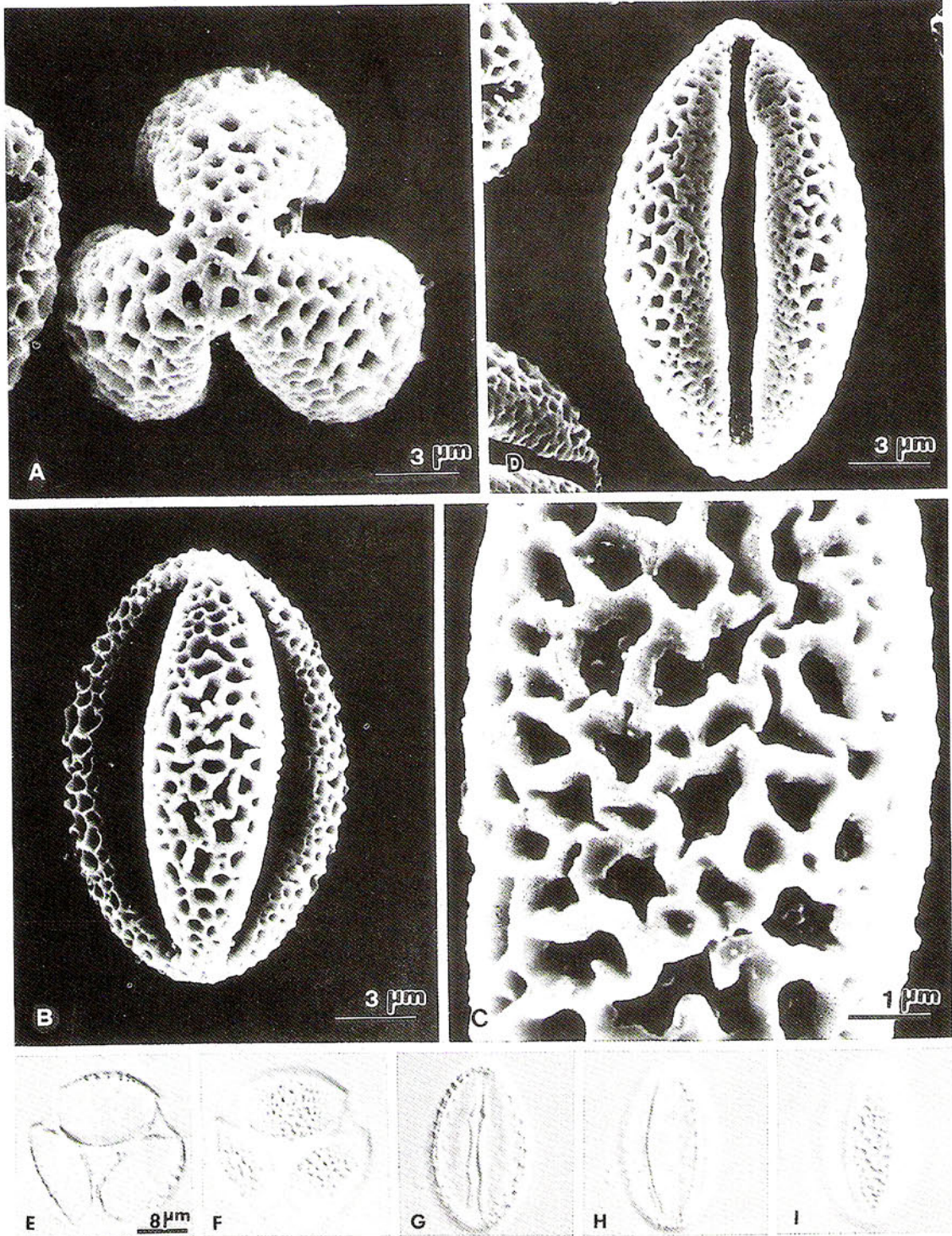


Plate 11. *Salix fulvopubescens* Hayata. A-D, SEM; E-I, LM. A, E & F, 3-colporate grains in polar view showing reticulate sexine. B, D & G-I, grains in equatorial view showing relatively long, intruding colpi, lumina decreasing in size towards the colpus margins. C, detail of sexine in mesocolpium showing keeled muri, irregularly angular lumina and granules sparsely covered in the lumina.

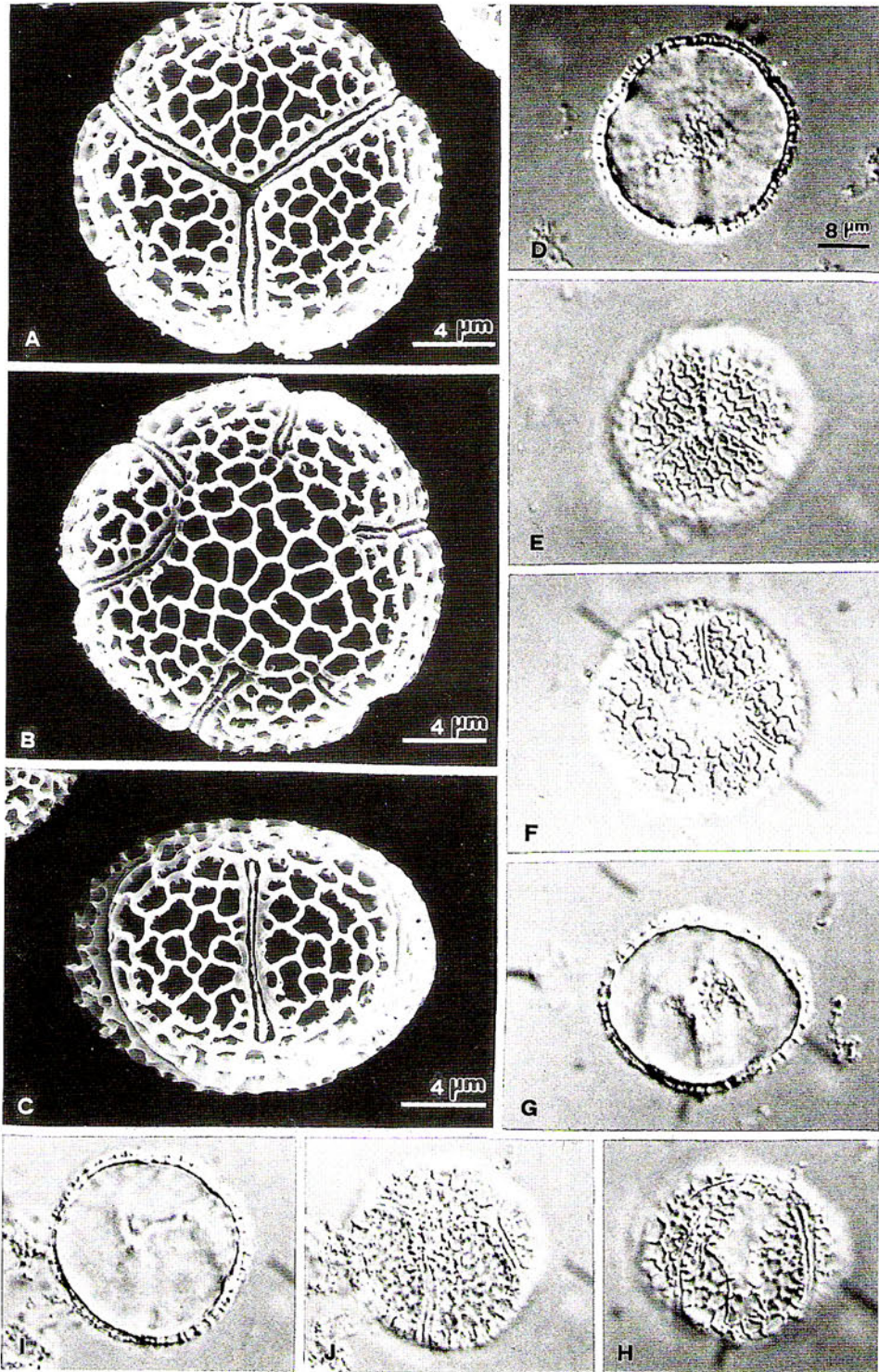


Plate 12. *Schisandra arisanensis* Hayata. A-C, SEM; D-J, LM. A, D & E, 6-colpate grains in distal view showing three long colpi fused, formed a triradiate cracking, the other 3 shorter and remained free and alternated with the longer. B & F, grains in proximal view showing the ends of all six colpi equidistant. C, G & H, grains in equatorial view showing linear colpus membrane and colpi which delimited by solid distinct sexious ridges. I & J, 5-synrugoidate grains in polar view showing one short and four long colpi, the longer fused pairwise with the shorter.

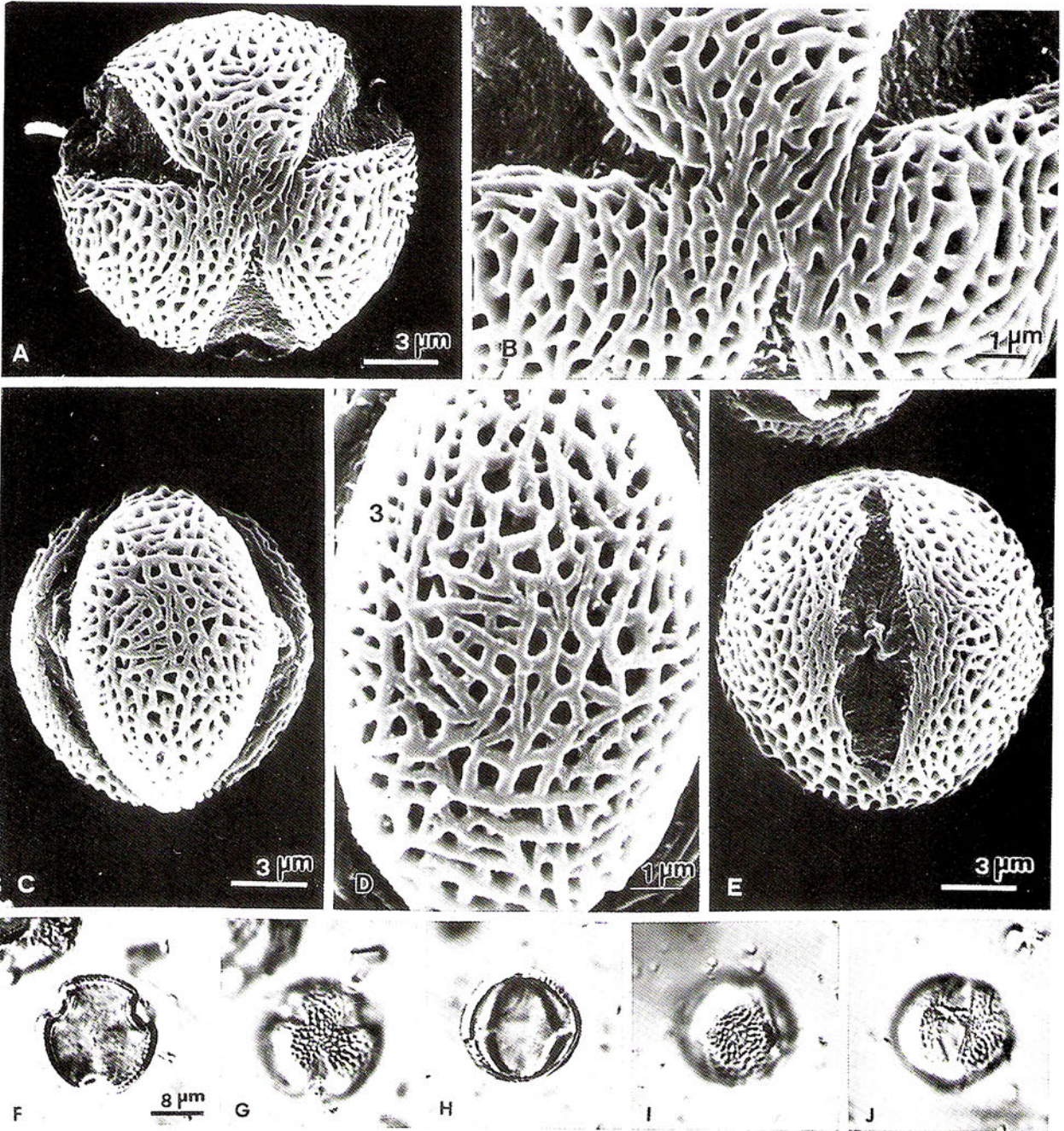


Plate 13. *Astilbe longicarpa* (Hayata) Hayata. A-E, SEM; F-J, LM. A, F & G, 3-colporate grains showing striato-reticulate sexine. C, E & H-J, grains in equatorial view showing long colpi, scabrate to finely granulate colpus membranes and transversally parallel ora. B & D, detail of sexine in apocolpium and mesocolpium showing muri and rounded angular lumina.

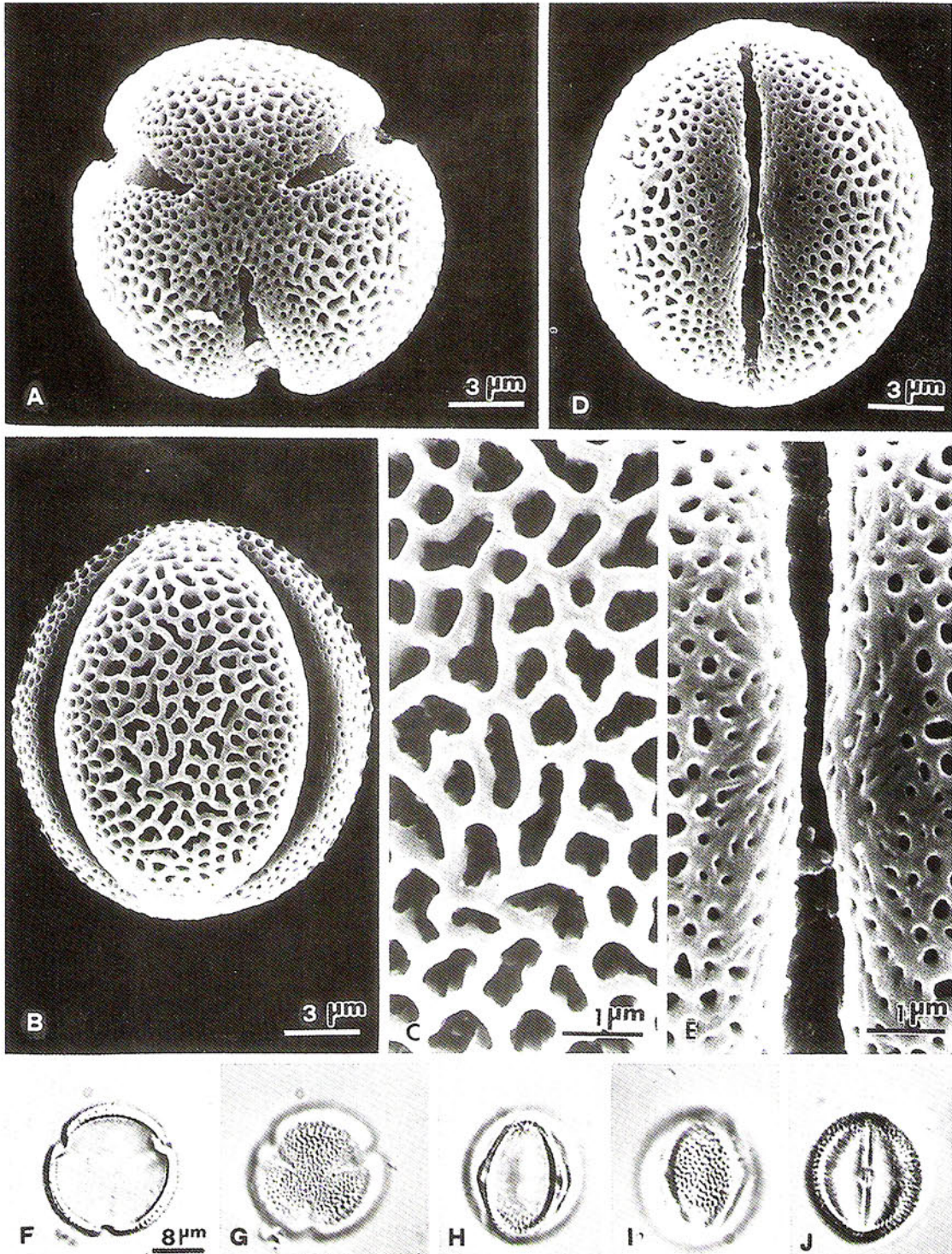


Plate 14. *Deutzia taiwanensis* (Maxim.) Schneider. A-E, SEM; F-J, LM. A, F & G, 3-colporate grains in polar view showing reticulate sexine. B, D & H-J, grains in equatorial view showing circular ora and long colpi constricted in the equator. C, detail of sexine in mesocolpium showing muri and rounded angular lumina. E, detail of colpus constricted in the equator and lumina decreasing in size towards the colpus margins.

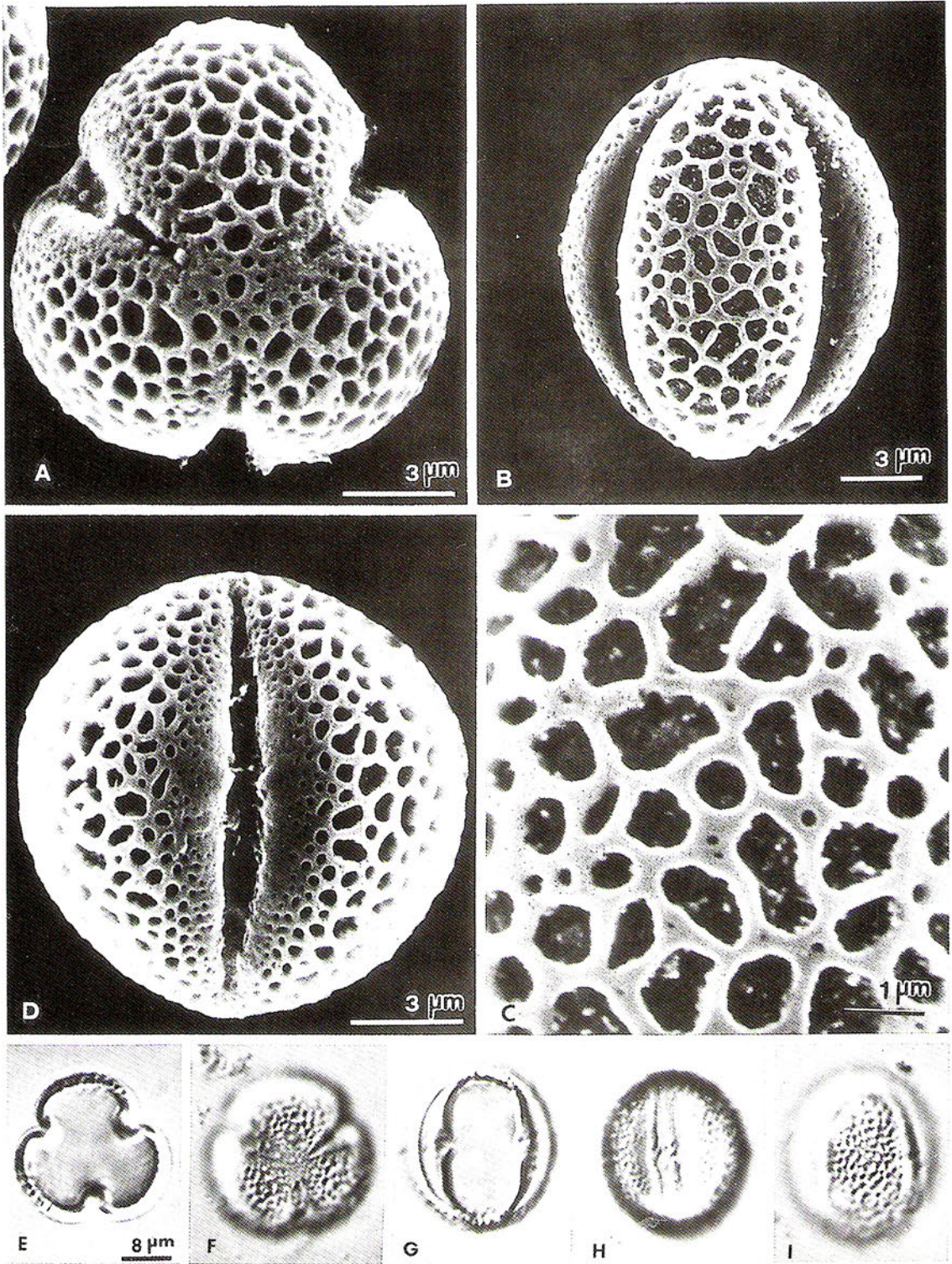


Plate 15. *Hydrangea anomala* D. Don. A-D, SEM; E-I, LM. A, E & F, 3-colporate grains in polar view showing reticulate sexine. B, D & G-I, grains in equatorial view showing long colpi and circular ora. C, detail of sexine in mesocolpium showing muri, rounded angular lumina and finely granules irregularly spaced in the lumina.

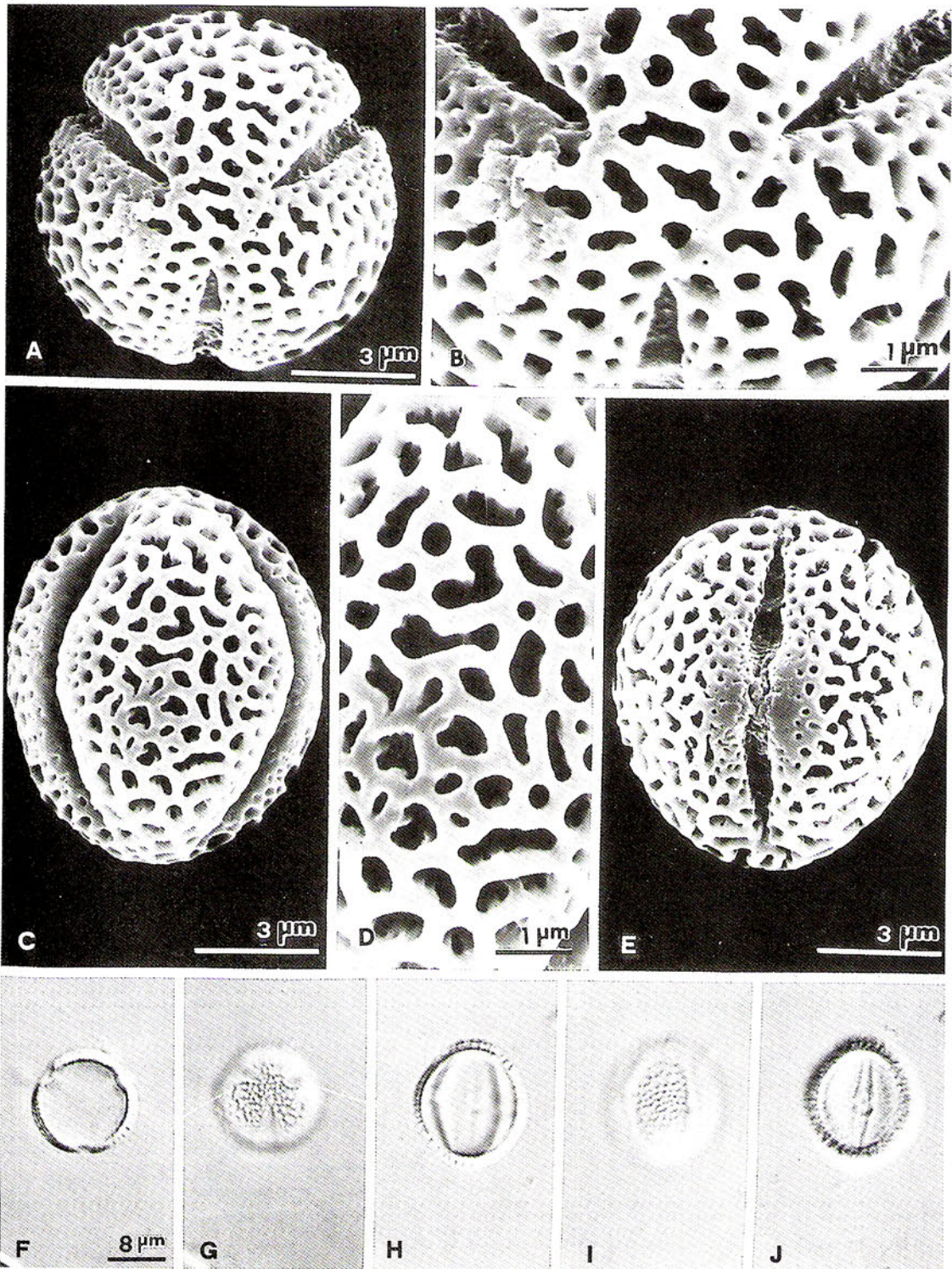


Plate 16. *Hydrangea integrifolia* Hayata ex Matsum. & Hayata. A-E, SEM; F-J, LM. A, F & G, 3-colporate grains in polar view showing reticulate sexine. C, E & H-J, grains in equatorial view showing circular ora and long colpi constricted in the equator. B & D, detail of sexine in apocolpium and mesocolpium showing muri and rounded angular lumina.

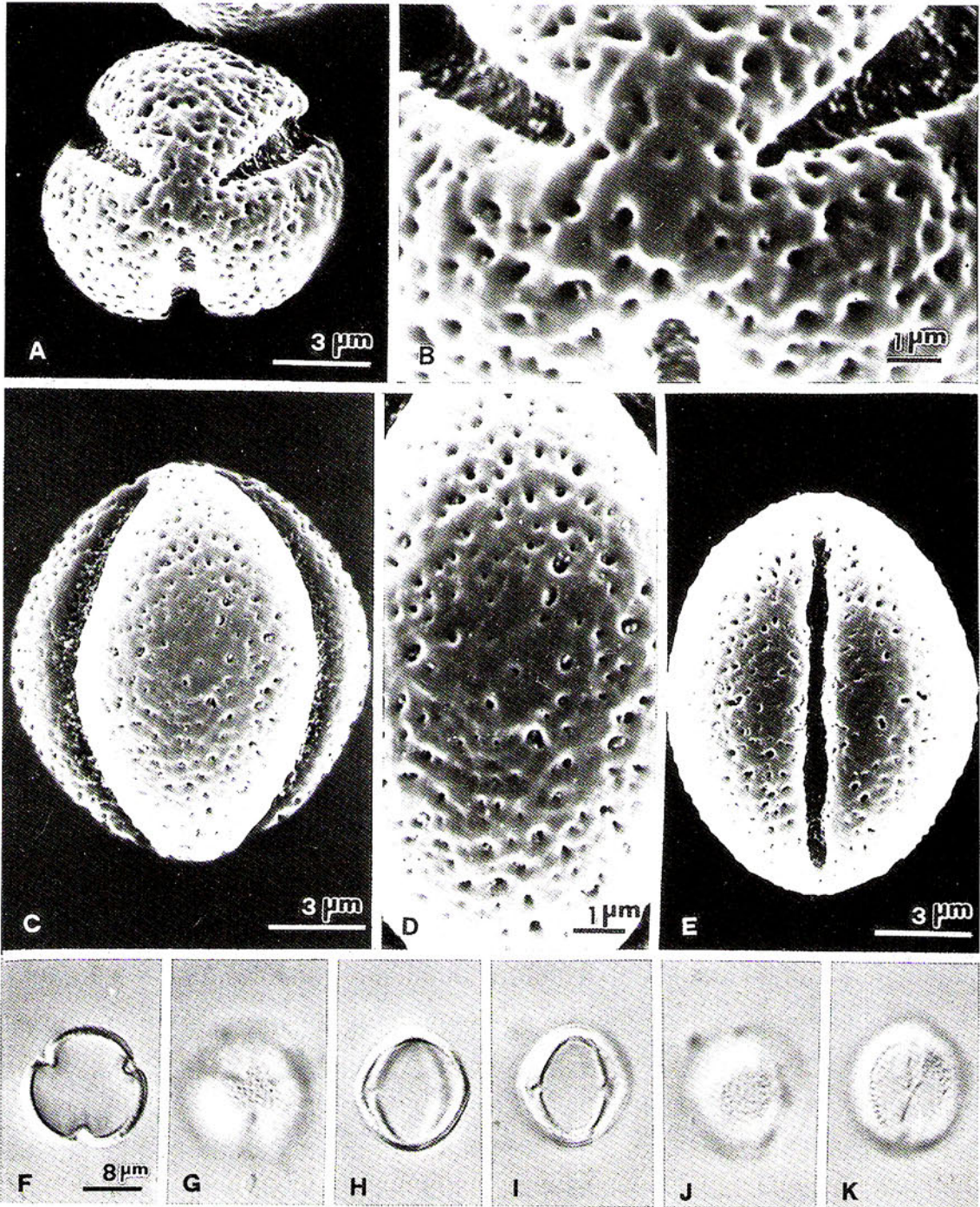


Plate 17. *Hydrangea paniculata* Sieb. A-E, SEM; F-K, LM. A, F & G, 3-colporate grains in polar view showing perforate sexine. C, E & H-K, grains in equatorial view showing long colpi and circular ora. B & D, detail of sexine in apocolpium and mesocolpium showing perforations irregularly spaced.

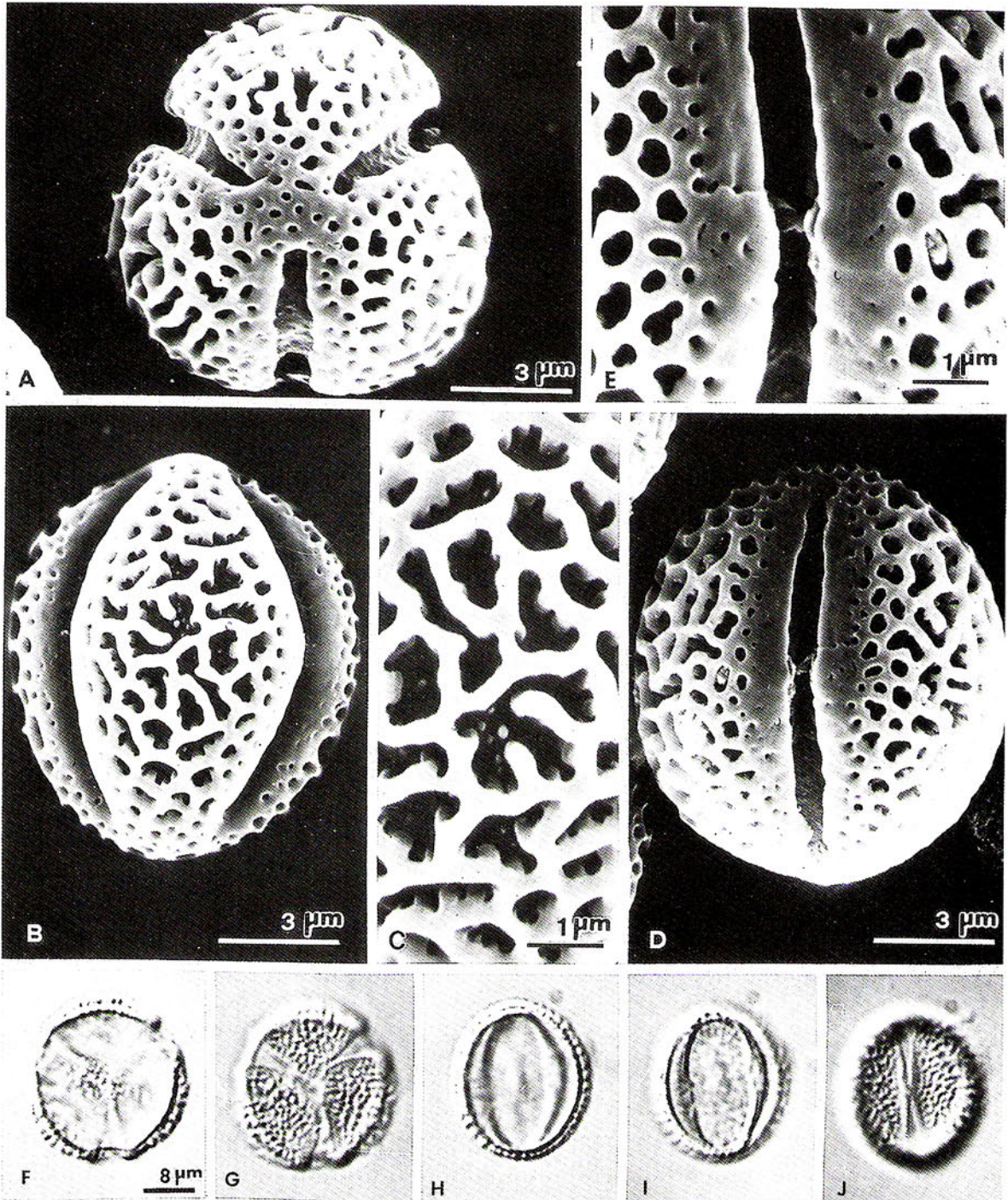


Plate 18. *Pileostegia viburnoides* Hook. f. & Thoms. A-E, SEM; F-J, LM. A, F & G, 3-colporate grains in polar view showing reticulate sexine. B, D & H-J, grains in equatorial view showing long colpi constricted in the equator. C, detail of sexine in mesocolpium showing muri and elongated to irregularly curved lumina. E, detail of colpi showing margo and lumina decreasing in size towards the colpus margins.

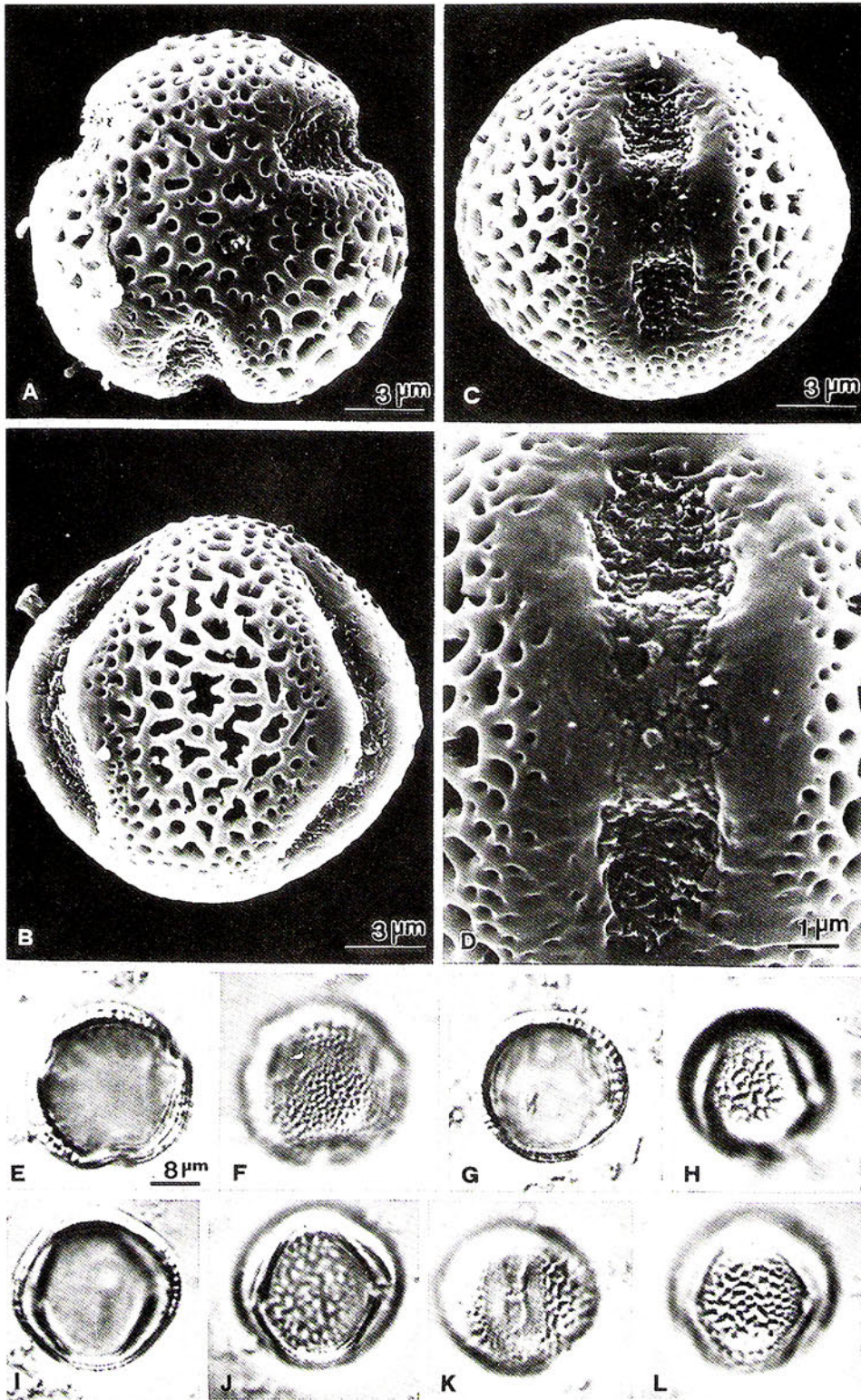


Plate 19. *Schizophragma integrifolium* Oliv. var. *fauriei* (Hayata) Hayata. A-D, SEM; E-L, LM. A, D & F, 3-colporate grains in polar view showing reticulate sexine. B, C & G-L, grains in equatorial view showing long colpi, spinulate colpus membranes and circular ora. D, detail of fusiform colpus, spinulate colpus membrane, margo and longitudinally rectangular equatorial bridge.

台灣鴛鴦湖自然保留區花粉誌 (IV)

王裕發⁽¹⁾、陳淑華^(1,2)

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摘 要

鴛鴦湖為酸性湖泊，位於台灣北部的自然保留區內。本研究採集該區隸屬五科十九種植物的新鮮花粉，經處理後，以光學顯微鏡和掃瞄式電子顯微鏡觀察這些花粉的形態。依花粉萌芽口的不同，分為四群：三溝、六溝、三溝孔和四至七溝孔的花粉。本研究為連續研究 (Chen and Wang, 1999, 2001; Wang and Chen, 2001) 之第四篇，這些結果可作為研究鴛鴦湖湖積物內之花粉，並進而作為重建鴛鴦湖周邊植群史的基本資料。

關鍵詞：花粉誌、鴛鴦湖自然保留區、台灣。

1. 國立台灣大學植物學系，台北市 106 羅斯福路 4 段 1 號，台灣。

2. 通信作者。E-mail: suchen@ccms.ntu.edu.tw