

เรณูวิทยาของพืชชายเลนในประเทศไทย



นายนรวิชัย ชุ่มฉิม

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

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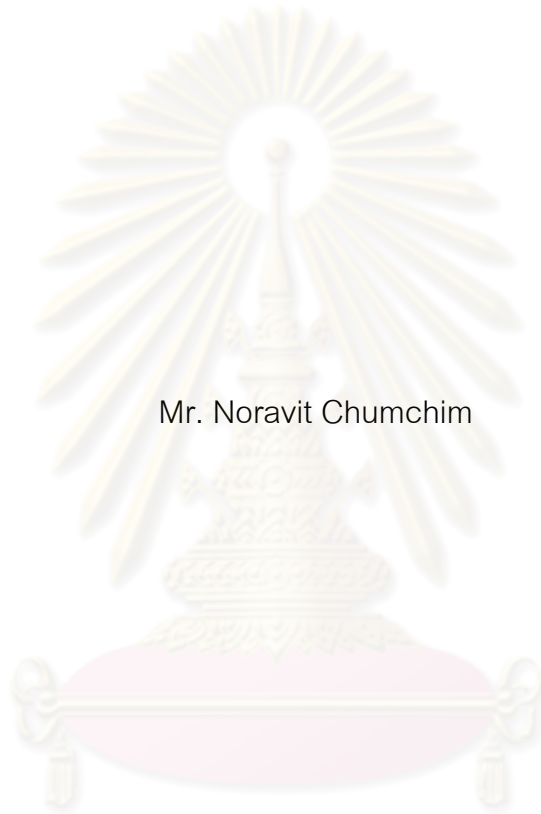
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PALYNOLOGY OF MANGROVE FLORA IN THAILAND



Mr. Noravit Chumchim

ศูนย์วิทยาศาสตร์  
จุฬาลงกรณ์มหาวิทยาลัย

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Accepted by the Faculty of Science, Chulalongkorn University in Partial  
Fulfillment of the Requirements for the Master's Degree

*S. Hannongbua*  
..... Dean of the Faculty of Science  
(Professor Supot Hannongbua, Dr.rer.nat.)

THESIS COMMITTEE

*Thaweesakdi Boonkerd*  
..... Chairman  
(Professor Thaweesakdi Boonkerd, Ph.D.)

*Chumpol Khunwasi*  
..... Thesis Advisor  
(Assistant Professor Chumpol Khunwasi, Ph.D.)

*Manit Kidyoo*  
..... Examiner  
(Assistant Professor Manit Kidyoo, Ph.D.)

*Kitichate Sridith*  
..... External Examiner  
(Associate Professor Kitichate Sridith, Ph.D.)

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ศึกษาเรณูและสปอร์พืชชายเลนในประเทศไทย 60 สกุล 80 ชนิด 37 วงศ์ ที่ผ่านกระบวนการเคมีอะซิโตไลซิส โดยศึกษาสัณฐานวิทยาของเรณูและสปอร์ด้วยกล้องจุลทรรศน์แบบใช้แสงและกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราด สามารถแบ่งรูปแบบเรณู และสปอร์ ออกได้ 53 รูปแบบ และ 22 รูปแบบย่อย ตามลักษณะช่องเปิด ขนาด รูปร่าง และลวดลายบนผิวเรณูและสปอร์

แม้ว่าความสัมพันธ์ระหว่างลักษณะของเทคท์มกับปัจจัยทางกายภาพในป่าชายเลน นั้นยังไม่ชัดเจน แต่ผลจากการศึกษานี้ ชี้ให้เห็นว่าเรณูของพืชชายเลนมีลักษณะของเทคท์มที่ค่อนข้างปิด นอกจากนี้รูปวิธานจำแนกรูปแบบเรณู และสปอร์ คำบรรยายรูปแบบเรณู และสปอร์แบบต่าง ๆ รวมทั้งสไลด์ถาวรของเรณู และสปอร์ที่ได้จากการศึกษาในครั้งนี้สามารถใช้เป็นเครื่องมือ ในการระบุชนิดพืช ชายเลนในการวิเคราะห์เรณูจากตะกอนดินป่าชายเลนของประเทศไทย

## ศูนย์วิทยทรัพยากร จุฬาลงกรณ์มหาวิทยาลัย

ภาควิชา.....พฤกษศาสตร์.....  
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The acetolyzed pollens and spores of 60 genera and 80 species belonging to 37 families of mangrove species in Thailand have been examined by light microscope and scanning electron microscope. The pollens and spores can be divided into 53 pollen and spore types and 22 subtypes based on characteristic of apertures, size, shapes and ornamentations etc.

The correlation between tectal characteristic and abiotic factors in mangrove habitats is still obscure. But the result from this study suggests that pollen grains of mangrove species seem to have closed tectum. Moreover, the constructed key to pollen and spore types, the pollen and spore type descriptions, and permanent slides of pollen and spores can be used as a tool to identify plant species for pollen analysis of mangrove sediment in Thailand.

ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

Department : ..... Botany ..... Student's Signature Noravit Chumchim  
Field of Study : ..... Botany ..... Advisor's Signature Chumpol Khunwasi  
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## CHAPTER I

### INTRODUCTION

Palynology is the study of pollen, spore and other biological materials studied by means of palynological method, including other applications (Hyde and Williams, 1944).

Pollen morphology gives an advantage for plant classification. It demonstrates the relationship in rank of families, tribes, genera and species (Erdtman, 1952). Pollen morphological study is not only provides a great wealth of plant taxonomy but also be able to apply in other branches of science, for example, aeropalynology, medical palynology, melissopalynology, and geopalynology (Erdtman, 1952, 1969).

In Thailand, mangrove forest can be found along coasts, estuaries and around islands which are in the tidal zone of southeastern, central, east coast of peninsula and west coast of peninsula (Aksornkoae *et al.*, 1992).

Because of unique ecology and floristic composition of mangrove vegetation, it is a suitable ecosystem to use palynology in tracing the history and evolution (Blasco, 1984). The reconstruction of vegetation types by means of pollen analysis can be carried out by experienced palynologists, and have enough data of pollen morphology or acetolyzed pollen slides of present day plant species. The works concerned the palynological study in mangrove sediments generally do not report pollen morphological data or propose the key. Moreover, a few palynological data of modern mangrove species which has been reported do not include all mangrove plant species in Thailand.

In Thailand, there are only some palynological studies in sediment in which pollen grains of mangrove plant species can be found (Somboon, 1998, 1990; Rugmai, 2006; Punwong, 2007). For pollen morphological study of modern mangrove plant species in Thailand, there are a few mangrove plant species in some plant families (Apocynaceae, Euphorbiaceae, Melastomataceae and Rhizophoraceae) have been done (Boonsermsuk, 1987; Chantaranothai, 1997; Kasetsinsombat, 1999; Sittha, 2007). There is not specific study of pollen and spore morphology of modern mangrove species in Thailand.

This is the first study of the mangrove pollen flora of Thailand. The results from this study had provided useful information for palynology concerned with mangrove plant species, and can be basic knowledge for applications in other branches of science.

#### Aims of this thesis

1. To investigate mangrove pollen flora in Thailand: to describe pollen and spore morphology, and to construct the key to pollen and spore types with their descriptions
2. To prepare the pollen and spore slides of mangrove flora in Thailand and kept in herbaria as references



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

## CHAPTER II

### LITERATURE REVIEWS

#### 2.1 Mangrove plant definition

The word “mangrove” means both individual plant (trees or shrubs) and tropical intertidal forest. Using the term “mangrove” solely may make some confusion in context. So the combination words, such as “mangrove plant” or “mangrove forest”, should be referred. Some author use the word “mangal” to refer mangrove vegetation (Tomlinson, 1986; Hogarth, 1999, 2007; Kathiresan and Bingham, 2001).

Tomlinson (1986) categorized mangrove plants into 3 groups (Table 1) – major elements of mangal (strict or true mangroves), minor elements of mangal, and mangrove associates. First, major elements of mangal include 34 species in 9 genera and 5 families. They possess all or most the following features:

- 1) distribute exclusively in mangrove habitat,
- 2) play a major role in the structure of the community and are able to form pure stands,
- 3) adapt some morphology to mangrove environment, such as aerial roots, pneumatophore, or vivipary,
- 4) have physiological adaptations for salt exclusion and/or secretion,
- 5) taxonomically isolated from terrestrial relatives at least at the generic level, and often at the subfamily or family level.

Second, minor elements of mangrove include 20 species in 11 genera and 11 families. They are less conspicuous elements of the mangrove vegetation and unable to form pure stands. Moreover, they may occupy peripheral mangrove habitat.

Last, mangrove associates do not inhabit strict to mangrove habitat. They generally occur in transitional vegetation between mangrove and terrestrial communities, and often occur in non-mangrove habitat. Many epiphytes: ferns, orchids, and other plants can be found in the mangrove high canopy because they cannot tolerate salt. Besides, terrestrial herbs (including grass and grass-like plants), climbers,



ferns, palms, pandan and cycad are also included in the group of mangrove associates (Giesen *et al.*, 2006).

**Table 1** List of major and minor elements of mangal (Tomlinson, 1986)

Family	Genus	Number of species
<b>Major elements of mangal</b>		
Avicenniaceae	<i>Avicennia</i>	8
Combretaceae	<i>Laguncularia</i>	1
	<i>Lumnitzera</i>	2
Palmae	<i>Nypa</i>	1
Rhizophoraceae	<i>Bruguiera</i>	6
	<i>Ceriops</i>	2
	<i>Kandelia</i>	1
	<i>Rhizophora</i>	8
Sonneratiaceae	<i>Sonneratia</i>	5
<b>Minor elements of mangal</b>		
Bombaceae	<i>Camptostemon</i>	2
Euphorbiaceae	<i>Excoecaria</i>	2
Lythraceae	<i>Pemphis</i>	1
Meliaceae	<i>Xylocarpus</i>	2
Myrsinaceae	<i>Aegiceras</i>	2
Myrtaceae	<i>Osbornia</i>	1
Pellicieraceae	<i>Pelliciera</i>	1
Plumbagianaceae	<i>Aegialitis</i>	2
Pteridaceae	<i>Acrostichum</i>	3
Rubiaceae	<i>Scyphiphora</i>	1
Sterculiaceae	<i>Heritiera</i>	3

Tomlinson (1986) discussed that the criterion 1 is the most significant and practical. According to criterion 1-5, the term “strict or true mangroves” of Tomlinson (1986) has different meaning from one of the other authors. The other ones refer the word “strict or true mangroves, restricted mangroves, exclusive mangroves, or core

mangroves (some authors also use the word “species” as a combination)” to the plants which are mainly found in the intertidal mangrove habitat, and/or rarely elsewhere (Santisuk, 1983; Thanikaimoni, 1987; Hogarth, 1999, 2007; Silva and Santos, 2009). So the word “true mangroves” should comprise both Tomlinson (1986)’s major and minor elements of mangal. The meaning of the word “mangrove associates” is concordant between every author. However, some author also use the word “non-exclusive mangrove species, peripheral mangrove species, or non obligatory mangrove species” as the word “mangrove associates” (Thanikaimoni, 1987; Hogarth, 1999, 2007; Silva and Santos, 2009).

In this report, the term “true mangrove species” is applied to the plants which are mainly found in the intertidal mangrove habitat, and/or rarely elsewhere. The term “mangrove associates” is the plants which generally occur in the transitional vegetation between mangrove and terrestrial communities, and often occur in non-mangrove habitat as well.

## 2.2 The study of mangrove flora in Thailand

A total of 268 plant species have been recorded in Southeast Asian mangrove vegetation, including 129 trees and shrubs, 50 terrestrial herbs (including 27 grasses and grass-like plants), 28 climbers, 28 epiphytes, 24 ferns, seven palms, one pandan and one cycad. Of these 268 species, 52 are true mangrove species. Furthermore, 186 out of 268 species, as well as 33 true mangrove species occur in Thailand (Giesen *et al.*, 2006).

In Thailand, Santisuk (1983) reported that there are 53 genera and 74 species belonging to 35 families of trees and shrubs in the mangrove formation of Thailand.

Moreover, 18 species of epiphytic and lithophytic orchids were found in mangrove forests of Songkhla, Satun, Phuket, Phangnga, Krabi, and Chantaburi. None of them are true mangrove species (Sahavacharin, Boonkerd, and Patanaponpaiboon, 1979).

By reconciling the meaning of the term “true mangrove species”, checklist of Santisuk (1983) and Giesen *et al.* (2006), 17 genera and 32 species belonging to 12 families of true mangrove species in Thailand were recognized as presented in Table 2.

**Table 2** List of true mangrove species of Thailand

Scientific name	Family	Life form
<i>Acanthus ebracteatus</i> Vahl	ACANTHACEAE	Shrub
<i>Acanthus ilicifolius</i> L.	ACANTHACEAE	Shrub
<i>Acanthus volubilis</i> Wall.	ACANTHACEAE	Climber
<i>Acrostichum speciosum</i> Willd.	PTERIDACEAE	Herb
<i>Aegialitis rotundifolia</i> Roxb.	PLUMBAGINACEAE	Small tree
<i>Aegiceras corniculatum</i> (L.) Blanco	PRIMULACEAE	Shrub
<i>Avicennia alba</i> Blume	ACANTHACEAE	Tree
<i>Avicennia marina</i> (Forssk.) Vierh.	ACANTHACEAE	Tree
<i>Avicennia officinalis</i> L.	ACANTHACEAE	Tree
<i>Bruguiera cylindrica</i> (L.) Blume	RHIZOPHORACEAE	Tree
<i>Bruguiera gymnorhiza</i> (L.) Savigny	RHIZOPHORACEAE	Tree
<i>Bruguiera hainesii</i> C.G. Rogers.	RHIZOPHORACEAE	Tree
<i>Bruguiera parviflora</i> (Roxb.) Wight & Arn. ex Griff.	RHIZOPHORACEAE	Tree
<i>Bruguiera sexangula</i> (Lour.) Poir.	RHIZOPHORACEAE	Tree
<i>Ceriops decandra</i> (Griff.) W. Theob.	RHIZOPHORACEAE	Small tree
<i>Ceriops tagal</i> (Perr.) C.B. Rob.	RHIZOPHORACEAE	Tree
<i>Excoecaria agallocha</i> L.	EUPHORBIACEAE	Tree
<i>Heritiera formes</i> Buch.-Ham.	MALVACEAE	Tree
<i>Kandelia candel</i> (L.) Druce	RHIZOPHORACEAE	Tree
<i>Lumnitzera littorea</i> (Jack) Voigt	COMBRETACEAE	Small tree
<i>Lumnitzera racemosa</i> Willd.	COMBRETACEAE	Small tree
<i>Nypa fruticans</i> Wurmb	ARECACEAE	Tree
<i>Phoenix paludosa</i> Roxb.	ARECACEAE	Tree
<i>Rhizophora apiculata</i> Blume.	RHIZOPHORACEAE	Tree
<i>Rhizophora mucronata</i> Lam.	RHIZOPHORACEAE	Tree
<i>Scyphiphora hydrophyllacea</i> C.F. Gaertn.	RUBIACEAE	Small tree
<i>Sonneratia alba</i> Sm.	LYTHRACEAE	Tree
<i>Sonneratia caseolaris</i> (L.) Engl.	LYTHRACEAE	Tree
<i>Sonneratia griffithii</i> Kurz	LYTHRACEAE	Tree
<i>Sonneratia ovata</i> Backer	LYTHRACEAE	Tree
<i>Xylocarpus granatum</i> J. Koenig	MELIACEAE	Tree
<i>Xylocarpus moluccensis</i> (Lam.) M. Roem.	MELIACEAE	Tree

### 2.3 Previous palynological works on modern mangrove plants

There are few works which directly related to the palynological works on the modern mangrove plants. The following reports are the most relevant works to this research.

Wright (1977, cited in Tomlinson, 1986: 142-144) studied North Queensland mangrove pollen flora. He studied pollen of many common genera of the Old World mangroves, and he also constructed the key to major pollen groups.

Bertrand (1983) described pollen morphology of four common New World mangroves in Jamaica: *Rhizophora mangle* L. (Rhizophoraceae), *Avicennia germinans* (L.) L. (Avicenniaceae), *Conocarpus erectus* L. and *Laguncularia racemosa* (L.) Gaertn. f. (Combretaceae). Pollen grains were studied both light and scanning electron microscopy. Pollen grains of these species are common in peat cores taken from such deposits. After these four species were studied in pollen morphology, the identification of pollen grains in the sediment is easier. However, pollen fossil materials of *Rhizophora mangle* and *Laguncularia racemosa* were hard to distinguished. Pollen of *Conocarpus erectus* and *Rhizophora mangle* can be easily found in high quantity in pollen diagrams because these plant species produce many pollen grains and probably are anemophilous plants.

Thanikaimoni (1987) studied pollen and spore morphology of mangrove plants around the world. This work used only light microscopy to study the pollen and spore morphology, so some characters might be misinterpreted. However, this work is one of the useful references for many mangrove palynologists because a number of mangrove species (both core or true mangroves and peripheral mangroves) were studied in pollen and spore morphology, and many pollen and spore photographs as well as a key to the mangrove pollen and spore were presented in this publication.

The pollen grains of 40 species of Chinese mangrove plants and of 3 species of Loranthaceae in mangrove were palynologically studied using light and scanning electron microscope (Liu and Tang, 1989). It was found that the pollen grains of Rhizophoraceae, Sonneratiaceae and some other species such as *Aegiceras corniculatum*, *Avicenna marina*, *Acanthus ebracteatus*, *Acrostichum aureum* etc. demonstrate a function which could be used to identify stratum.

Das and Ghose (1990) described pollen morphology of the mangrove flora of the Sundarbans, West Bengal. Pollen of 30 species from 20 genera and 15 families were palynologically studied by light and scanning electron microscope. A key to the pollen grains was presented.

Silva and Santos (2009) studied pollen morphology of the shrub and arboreal flora of mangroves of Northeastern Brazil. Pollen morphology of fourteen species belonging to seven families was light and scanning electron microscopic studied. The pollens of all species were described and illustrated in that first atlas of the pollen flora of the Brazilian mangroves.



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## CHAPTER III

### MATERIALS AND METHODS

#### 3.1 Materials for field work and sample collection

- 1) Paper envelopes
- 2) A plant press, size 30X46 cm
- 3) A pair of hand pruners
- 4) Plastic bags
- 5) Hand-lens
- 6) Collector's number cards

#### 3.2 Materials for slide preparation and pollen and spore morphological study

- 1) 10% Potassium hydroxide
- 2) Glacial acetic acid
- 3) Acetic acid anhydride
- 4) Concentrated sulfuric acid
- 5) 70%, 90%, and absolute ethyl alcohol
- 6) Distilled water
- 7) Benzene
- 8) Silicone oil AK 2,000
- 9) Paraffin wax
- 10) Immersion oil
- 11) Label stickers
- 12) Vials 1 dram
- 13) Sieving crucible
- 14) Beakers 50 ml and 100 ml
- 15) Glass rods
- 16) Hot plate
- 17) Warm plate
- 18) Centrifuge and centrifuge tubes

- 19) Vortex mixer
- 20) Microscope slides and cover glasses
- 21) Stage micrometer
- 22) Light microscope (LM) OLYMPUS model CH30 and NIKON model ECLIPSE E200 equipped with digital camera unit Nikon DS-Fi1
- 23) Scanning electron microscope (SEM) JEOL model JSM 5410 LV

### 3.3 Field work and sample collection

The pollens and spores of 60 genera and 80 species belonging to 37 families of mangrove species in Thailand has been examined (Table 3). Mature floral buds and spores were obtained from voucher specimens deposited at BCU (Professor Kasin Suvatabhandhu Herbarium, Department of Botany, Chulalongkorn University, BKF (The Forest Herbarium), PSU (Prince of Songkla University Herbarium), as well as specimens collected from field collection.

Field collection for herbarium specimens, as well as pollen and spore materials were made throughout the coasts of Thailand during 2009 to 2010. Mature flower buds of each species were kept and dried in paper envelopes. Vouchers plant specimens were kept at BCU and PSU.

### 3.4 Pollen and spore preparation for LM and SEM microscopy, and pollen and spore morphological study

First, pollens and spores were acetolyzed using the method adapted from the acetolysis method (Erdtman, 1960) as follow:

- 1) Boiled in 10% potassium hydroxide until reach boiling point
- 2) Washed pollen and spore residues with distilled water 3 times
- 3) Used glacial acetic acid to remove water
- 4) Removed organic matter with acetolysis mixture (9 vols. of chemically pure acetic anhydride and 1 vol. concentrated sulfuric acid) by boiling in water bath at 70°C for 30-60 seconds
- 5) Washed with glacial acetic acid
- 6) Washed with distilled water 3 times.



7) Dehydrated in an ethanol series (70%, 90% and absolute)

**Note:** At the end of each step, pollens and spores were centrifuged at 3,600 rpm.

For light microscopy, acetolyzed pollens and spores were suspended in benzene. Silicone oil was then added as a mounting medium (Anderson, 1980), then slides sealed with paraffin wax. Permanent slides of all species were deposited at BCU.

Measurements and morphological observations were taken under LM (OLYMPUS model CH3). All species were taken photographs using LM (NIKON model ECLIPSE E200). All measurements were based on at least 10 pollen grains.

For scanning electron microscopy, acetolyzed pollens and spores were suspended in absolute ethyl alcohol. Pollen and spore samples were dehydrated by critical-point-drying method (CPD) then mounted on stubs and coated with gold-palladium. Pollen and spore were studied and photographs were taken by scanning electron microscope (JEOL JSM 5410 LV)

Pollen and spore morphology was generally observed both polar view and equatorial view (figure 1). Moreover, pollen and spore wall stratification was observed as well (except intine and endospore which are not acetolysis resistant structures) (figure 2).

Pollen and spore morphology was divided into pollen and spore types. Eventually, key to pollen and spore type and each type description were then constructed.

The terminology used in this study is a combination of those used by Erdtman (1952), Punt *et al.* (2007) and Hesse *et al.* (2009). The plant classification adopts Angiosperm Phylogeny Group classification system (APG III, 2009).

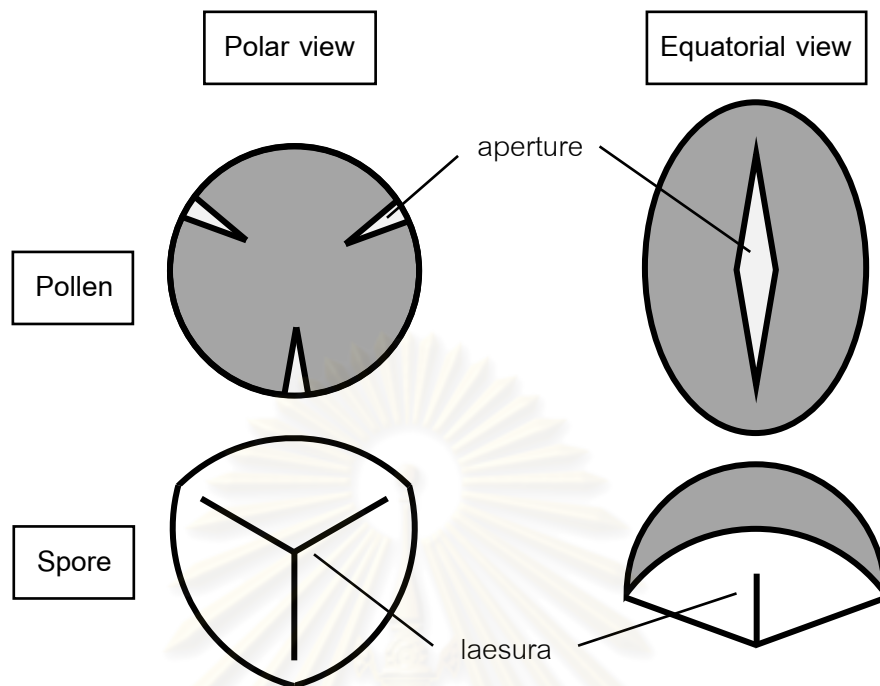


Figure 1 Pollen and spore on polar view and equatorial view (pictures redrawn from Punt *et al.* (2007))

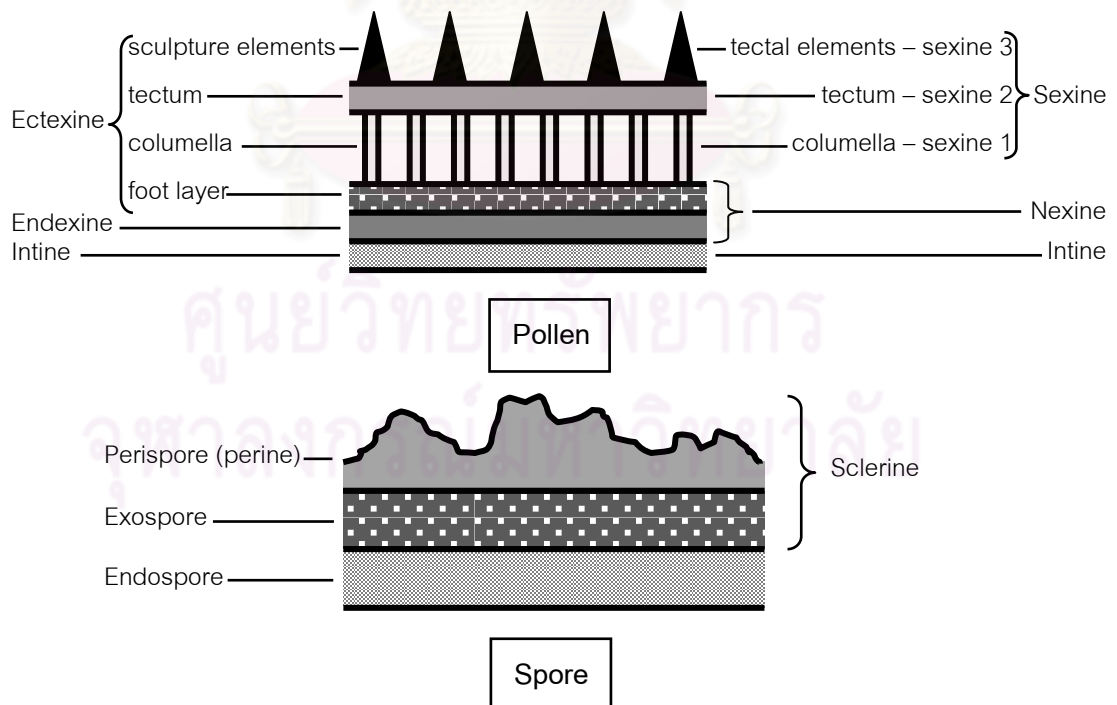


Figure 2 Diagram of pollen and spore wall stratification (pictures redrawn from Punt *et al.* (2007))

Table 3 List of the investigated specimens

Species	Families	Collection	Herbarium
<i>Acanthus ebracteatus</i> Vahl*	ACANTHACEAE	Muang, Songkhla/ N. Chumchim 0032/ 15 Apr. 2010	BCU**, PSU**
<i>Acanthus ilicifolius</i> L.*	ACANTHACEAE	Tung Wah, Satun/ N. Chumchim 0049/ 25 Apr. 2010	BCU**
<i>Acanthus volubilis</i> Wall.*	ACANTHACEAE	Muang, Ranong/ Pipat s.n./ 6 Feb. 1982	BKF
<i>Acrostichum aureum</i> L.	PTERIDACEAE	Tarutao Island, Satun/ Gordon Congdon 263/ 10-11 Jan. 1980	PSU
<i>Acrostichum speciosum</i> Willd.*	PTERIDACEAE	Wang Krachae, Trat/ N. Chumchim 0012/ 21 Nov. 2009	BCU**
<i>Aegialitis rotundifolia</i> Roxb.*	PLUMBAGINACEAE	Tarutao Island, Satun/ Congdon C937/ 3 Jul. 1981	PSU
<i>Aegiceras corniculatum</i> (L.) Blanco*	PRIMULACEAE	Wang Krachae, Trat/ N. Chumchim 0021/ 22 Nov. 2009	BCU**
<i>Aglaia cucullata</i> (Roxb.) Pellegr.	MELIACEAE	La-oon, Ranong/ Pipat & Thawatchai 3479/ 2 Nov. 1981	BKF
<i>Allophylus cobbe</i> (L.) Raeusch.	SAPINDACEAE	Satingpra, Songkhla/ P. Sirirugsa 831/ 26 May 1984	PSU
<i>Antidesma ghaesembilla</i> Gaertn.	PHYLLANTHACEAE	Pak Payoon, Phatthalung/ N. Chumchim 0044/ 17 Apr. 2010	BCU**
<i>Ardisia elliptica</i> Thunb.	PRIMULACEAE	Tepa, Songkhla/ J.F. Maxwell 85- 740/ 20 Jul. 1985	PSU
<i>Atalantia monophylla</i> DC.	RUTACEAE	Haad Yai, Songkhla/ J.F. Maxwell 84-531/ 17 Dec. 1984	PSU
<i>Avicennia alba</i> Blume*	ACANTHACEAE	Muang, Songkhla/ N. Chumchim 0030/ 11 Apr. 2010	BCU**
<i>Avicennia marina</i> (Forssk.) Vierh.*	ACANTHACEAE	Lam-Laung, Phetchaburi/ O. Thaithong164/ 28 Jun. 1985	BCU
<i>Avicennia officinalis</i> L.*	ACANTHACEAE	Tung Wah, Satun/ N. Chumchim 0053/ 25 Apr. 2010	BCU**
<i>Barringtonia asiatica</i> (L.) Kurz	LECYTHIDACEAE	Koh Hooyong, Similan Island National Park, Phangnga/ Th. Wongprasert s.n./ 8 Apr. 1999	BKF
<i>Barringtonia racemosa</i> (L.) Spreng.	LECYTHIDACEAE	Koh Mak, Trat/ Phengkhai <i>et al.</i> 14547/ 6 Mar. 2003	BKF
<i>Bruguiera cylindrica</i> (L.) Blume*	RHIZOPHORACEAE	Muang, Songkhla/ N. Chumchim 0029/ 11 Apr. 2010	BCU**
<i>Bruguiera gymnorhiza</i> (L.) Savigny*	RHIZOPHORACEAE	Muang, Songkhla/ N. Chumchim 0028/ 11 Apr. 2010	BCU**, PSU**

(Table 3 continued)

Species	Families	Collection	Herbarium
<i>Bruguiera parviflora</i> (Roxb.) Wight & Arn. ex Griff.*	RHIZOPHORACEAE	Khao Phra Taao, Phuket/ T. Santisuk s.n./ 21 Feb. 1978	BKF
<i>Bruguiera sexangula</i> (Lour.) Poir.*	RHIZOPHORACEAE	Wang Krachae, Trat/ N. Chumchim 0019/ 22 Nov. 2009	BCU**
<i>Caesalpinia crista</i> L.	FABACEAE	On the way to Je-bi-lung, Satun/ Herb. Trip 54/ 10 Oct. 1990	BCU
<i>Calophyllum inophyllum</i> L.	CALOPHYLLACEAE	Tarutao Island, Satun/ Congdon C147/ 10 Nov. 1979	PSU
<i>Calycopteris floribunda</i> (Roxb.) Lam. ex Poir.	COMBRETACEAE	Tarutao Island, Sataun/ Hamilton & Congdon 318/ 20 Feb. 1979	PSU
<i>Cerbera manghas</i> L.	APOCYNACEAE	Baang Bird, Chumphon/ Herb. Trip 819 (4/2)/ 4 Mar. 1994	BCU
<i>Cerbera odollam</i> Gaertn.	APOCYNACEAE	Muang, Songkhla/ N. Chumchim 0033/ 15 Apr. 2010	BCU**, PSU**
<i>Ceriops decandra</i> (Griff.) W. Theob.*	RHIZOPHORACEAE	Wang Krachae, Trat/ N. Chumchim 0006/ 21 Nov. 2009	BCU**
<i>Ceriops tagal</i> (Perr.) C.B. Rob.*	RHIZOPHORACEAE	Tung Wah, Satun/ N. Chumchim 0051/ 25 Apr. 2010	BCU**
<i>Clerodendrum inerme</i> (L.) Gaertn.	LAMIACEAE	Bang Poo, Samut Prakan/ N. Chumchim 0059/ 30 May 2010	BCU**
<i>Crinum asiaticum</i> L.	AMARYLLIDACEAE	Pak Payoon, Phatthalung/ N. Chumchim 0046/ 17 Apr. 2010	BCU**
<i>Cynometra ramiflora</i> L.	FABACEAE	Nakhon Si Thammarat/ U. Damsri 87/ 3 Feb. 1992	BCU
<i>Dalbergia candenatensis</i> (Dennst.) Prain	FABACEAE	Satingpra, Songkhla/ P. Sirirugsa 815/ 26 May 1984	PSU
<i>Derris trifoliata</i> Lour.	FABACEAE	Tung Wah, Satun/ N. Chumchim 0050/ 25 Apr. 2010	BCU**
<i>Diospyros areolata</i> King & Gamble	EBENACEAE	Kapur, Ranong/ T. Santisuk 844/ 25 Doc. 1976	BKF
<i>Dolichandrone spathacea</i> (L. f.) Seem.	BIGNONIACEAE	Kung Krabaen Bay, Chanthaburi/ N. Chumchim 0064/ 20 Jun 2010	BCU**
<i>Drynaria quercifolia</i> (L.) J. Sm.	POLYPODIACEAE	Wang Krachae, Trat/ N. Chumchim 0020/ 22 Nov. 2009	BCU**
<i>Excoecaria agallocha</i> L.*	EUPHORBIACEAE	Muang, Songkhla/ P. Sirirugsa 4029/ 9 Jun. 1982	PSU
<i>Ficus microcarpa</i> L. f.	MORACEAE	Adang Island, Satun/ J.F. Maxwell 87-344/ 15 Apr. 1987	PSU

(Table 3 continued)

Species	Families	Collection	Herbarium
<i>Flagellaria indica</i> L.	FLAGELLARIACEAE	Tumbol Khao Sa Ba, Unknown Province / K.K. <i>et al.</i> 12/ 2 Aug. 2008	PSU
<i>Glochidion littorale</i> Blume	PHYLLANTHACEAE	Pak Payoon, Phatthalung/ N. Chumchim 0042/ 17 Apr. 2010	BCU**, PSU**
<i>Heritiera littoralis</i> Aiton	MALVACEAE	Mangrove Forest Research Unit, Ranong/ P. Trisarasri 290/ 29 Apr. 1997	BCU
<i>Hibiscus tiliaceus</i> L.	MALVACEAE	Wang Krachae, Trat/ N. Chumchim 0003/ 21 Nov. 2009	BCU**
<i>Horsfieldia irya</i> (Gaertn.) Warb.	MYRISTICACEAE	Tarutao Island, Satun/ Congdon C181/ 19 Nov. 1979	PSU
<i>Intsia bijuga</i> (Colebr.) Kuntze	FABACEAE	Tak Bai, Narathiwat/ C. Niyomdham 779/ 14 Feb. 1984	BKF
<i>Kandelia candel</i> (L.) Druce*	RHIZOPHORACEAE	Wang Krachae, Trat/ N. Chumchim 0005/ 21 Nov. 2009	BCU**
<i>Lecanopteris sinuosa</i> (Wall. ex Hook.) Copel.	POLYPODIACEAE	Wang Krachae, Trat/ N. Chumchim 0013/ 22 Nov. 2009	BCU**
<i>Lumnitzera littorea</i> (Jack) Voigt*	COMBRETACEAE	Wang Krachae, Trat/ N. Chumchim 0015/ 21 Nov. 2009	BCU**
<i>Lumnitzera racemosa</i> Willd.*	COMBRETACEAE	Wang Krachae, Trat/ N. Chumchim 0004/ 22 Nov. 2009	BCU**
<i>Melaleuca cajuputi</i> Powell	MYRTACEAE	Pak Payoon, Phatthalung/ N. Chumchim 0037/ 17 Apr. 2010	BCU**, PSU**
<i>Melanthera biflora</i> (L.) Wild	ASTERACEAE	Bang Poo, Samut Prakan/ N. Chumchim 0058/ 30 May 2010	BCU**
<i>Melastoma saigonense</i> (Kuntze) Merr.	MELASTOMACEAE	Lam Sing, Chanthaburi/ Plant taxo 2535 19/ 29 Aug. 1992	BCU**
<i>Nypa fruticans</i> Wurm* จุฬาลงกรณ์มหาวิทยาลัย	ARECACEAE	Krasae Sin, Songkhla/ N. Chumchim 0036/ 15 Apr. 2010	BCU**
<i>Pandanus odoratissimus</i> L. f.	PANDANACEAE	Tarutao Island, Satun/ G. Congdon s.n./ July 1980	PSU
<i>Peltophorum pterocarpum</i> (DC.) Backer ex K. Heyne	FABACEAE	Singhanakhon, Songkhla/ N. Chumchim 0055/ 26 Apr. 2010	BCU**
<i>Pemphis acidula</i> J.R. & G. Forst.	LYTHRACEAE	Koh Kram, Chon Buri/ Herb. Trip 811 (8/7)/ 8 Jan. 1994	BCU
<i>Phoenix paludosa</i> Roxb.*	ARECACEAE	Ratchaburi/ A. S. Barfod, W. Ueachirakan, T. Burholt, and S. Barrow 45207/ 7 Feb. 1994	BKF

(Table 3 continued)

Species	Families	Collection	Herbarium
<i>Planchonella obovata</i> (R.Br.) Pierre	SAPOTACEAE	Haad Yai, Songkhla/ J.F. Maxwell 85-925/ 28 Sep. 1985	PSU
<i>Pluchea indica</i> (L.) Less.	ASTERACEAE	Krasae Sin, Songkhla/ N. Chumchim 0034/ 15 Apr. 2010	BCU**, PSU**
<i>Pongamia pinnata</i> (L.) Merr.	FABACEAE	Koh Rinde, La-Ngu, Satun/ Phengkhai 13908/ 8 Apr. 2003	BKF
<i>Pyrosia adnascens</i> (Sw.) Ching	POLYPODIACEAE	Wang Krachae, Trat/ N. Chumchim 0017/ 22 Nov. 2009	BCU**
<i>Pyrosia piloselloides</i> (L.) M.G. Price	POLYPODIACEAE	Wang Krachae, Trat/ N. Chumchim 0016/ 22 Nov. 2009	BCU**
<i>Rhizophora apiculata</i> Blume*	RHIZOPHORACEAE	Wang Krachae, Trat/ N. Chumchim 0007/ 21 Nov. 2009	BCU**
<i>Rhizophora mucronata</i> Lam.*	RHIZOPHORACEAE	Wang Krachae, Trat/ N. Chumchim 0018/ 22 Nov. 2009	BCU**
<i>Scaevola taccada</i> (Gaertn.) Roxb.	GOODENIACEAE	Pak-bara, Satun/ Anupong A-19/ 2 May 1985	PSU
<i>Scolopia macrophylla</i> (W. & A.) Clos	SALICACEAE	Muang, Pattani/ J.F. Maxwell 87-12/ 6 Jan. 1986	PSU
<i>Scyphiphora hydrophyllacea</i> C.F. Gaertn.*	RUBIACEAE	Wang Krachae, Trat/ N. Chumchim 0008/ 22 Nov. 2009	BCU**
<i>Sesuvium portulacastrum</i> (L.) L.	AIZOACEAE	Bang Poo, Samut Prakan/ N. Chumchim 0022/ 31 Mar. 2010	BCU**
<i>Shirakiopsis indica</i> (Willd.) Esser	EUPHORBIACEAE	Pak Payoon, Phatthalung/ N. Chumchim 0039/ 10 Apr. 2010	BCU**, PSU**
<i>Sonneratia alba</i> Sm.*	LYTHRACEAE	Kung Krabaen Bay, Chanthaburi/ N. Chumchim 0060/ 20 Jun. 2010	BCU**
<i>Sonneratia caseolaris</i> (L.) Engl.*	LYTHRACEAE	Bang Poo, Samut Prakan/ N. Chumchim 0026/ 31 Mar. 2010	BCU**
<i>Sonneratia griffithii</i> Kurz*	LYTHRACEAE	Ta Kua Pa, Phangnga/ Unknown collector 317/ 18 Oct. 1982	BKF
<i>Sonneratia ovata</i> Backer*	LYTHRACEAE	Wang Krachae, Trat/ N. Chumchim 0014/ 22 Nov. 2009	BCU**
<i>Stenochlaena palustris</i> (Burm. f.) Bedd.	BLECHNACEAE	Tepa, Songkhla/ J.F. Maxwell 87- 528/ 20 Jun. 1987	PSU
<i>Suaeda maritima</i> (L.) Dumort.	AMARANTHACEAE	Kung Krabaen Bay, Chanthaburi/ N. Chumchim 0062/ 20 Jun. 2010	BCU**
<i>Terminalia catappa</i> L.	COMBRETACEAE	Kuan Niang, Songkhla/ N. Chumchim 0048/ 17 Apr. 2010	BCU**, PSU**

(Table 3 continued)

Species	Families	Collection	Herbarium
<i>Thespesia populnea</i> (L.) Sol. ex Corrêa	MALVACEAE	Kung Krabaen Bay, Chanthaburi/ N. Chumchim 0065/ 20 Jun. 2010	BCU**
<i>Thespesia populneoides</i> (Roxb.) Kostel.	MALVACEAE	Bang Poo, Samut Prakan/ N. Chumchim 0024/ 31 Mar. 2010	BCU**
<i>Xylocarpus granatum</i> J. Koenig*	MELIACEAE	Si-chang, Chon Buri/ T. Seelanan <i>et</i> <i>al.</i> 521/ 26 Feb. 2005	BCU
<i>Xylocarpus moluccensis</i> (Lam.) M. Roem.*	MELIACEAE	Tung Wah, Satun/ N. Chumchim 0052/ 25 Apr. 2010	BCU**
<i>Xylocarpus rumphii</i> (Kostel.) Mabb.	MELIACEAE	Koh Kram, Chon Buri/ Herb. Trip 810 (8/60)/ 8 Jan. 1994	BCU

\* True mangrove species

\*\*Specimens which were collected by author



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## CHAPTER IV

### RESULTS

There is a considerable variation of pollen and spore morphology of mangrove flora in Thailand (Table 4). The keys constructed in this study are dichotomous. All characters used in these keys can be observed under LM. However, the characters from scanning electron microscope investigation were used as an option and used in the keys to subtypes of each pollen and spore type in case of hardly discriminant using LM.

#### 4.1 Keys to pollen and spore types

##### 4.1.1 Key for spore

- 1a Trilete spore.....*Acrostichum speciosum* type
- 1b Monolete spore.....2
- 2a Surface with small globules or mass of particles.....*Lecanopteris sinuosa* type
- 2b Grain echinate, gemmate, verrucate, or short baculate.....3
- 3a Grain echinate, echinae slender with point end (base width about 1  $\mu\text{m}$ ); interspinal area granulate to finely verrucate.....*Drynaria quercifolia* type
- 3b Grain echinate (echinae base width generally more than 5  $\mu\text{m}$ ), gemmate, or verrucate.....4
- 4a Grain densely gemmate and verrucate, gemmae and verrucae different in size; or echinate, spine shape conical with point end, some grains spines form like large gemmae, interspinal area gemmate.....*Pyrosia adnascens* type
- 4b Grain fairly verrucate or short baculate, present only on distal surface.....*Stenochlaena palustris* type

##### 4.1.2 Key for pollen

- 1a Simple aperturate pollen grain.....2
- 1b Compound aperturate pollen grain.....17
- 2a Grain porate.....3

2b	Grain colpate.....	8
3a	Grain 1-porate.....	4
3b	Grain 2-3-porate or polypantoporate.....	5
4a	Ornamentation perforate; annulus present.....	<i>Flagellaria indica</i> type
4b	Ornamentation granulate (LM); annulus absent.....	<i>Pandanus odoratissimus</i> type
5a	Grain 2-porate.....	<i>Ficus microcarpa</i> type
5b	Grain 3-zonoporate or polypantoporate.....	6
6a	Grain polypantoporate.....	<i>Suaeda maritima</i> type
6b	Grain 3-zonoporate.....	7
7a	Ornamentation microreticulate (LM).....	<i>Allophylus cobbe</i> type
7b	Ornamentation gemmate (LM).....	<i>Sonneratia griffithii</i> type
8a	Grain 1-colpate.....	9
8b	Grain 2-3-colpate.....	11
9a	Ring-like aperturate grain.....	<i>Nypa fruticans</i> type
9b	Aperture others.....	10
10a	Equatorial outline triangular with flat-top on longer equatorial view, and slightly quadrangular on shorter equatorial view.....	<i>Horsfieldia irya</i> type
10b	Equatorial outline circular-elliptic to elliptic.....	<i>Phoenix paludosa</i> type
11a	Grain 2-colpate.....	<i>Crinum asiaticum</i> type
11b	Grain 3-colpate.....	12
12a	Apertures fused at polar ends, 3-parasyncolpate.....	<i>Barringtonia racemosa</i> type
12b	Aperture not fused, 3-zonocolpate.....	13
13a	Ornamentation long gemmate and clavate (LM).....	<i>Aegialitis rotundifolia</i> type
13b	Ornamentation others.....	14
14a	Ornamentation granulate (LM).....	<i>Clerodendrum inerme</i> type
14b	Ornamentation others.....	15
15a	Ornamentation perforate (LM).....	<i>Sesuvium portulacastrum</i> type
15b	Ornamentation others.....	16
16a	Colpi relatively narrow or slit-like (0.40-2.40 $\mu\text{m}$ ).....	<i>Acanthus volubilis</i> type
16b	Colpi relatively wide (6.00-9.40 $\mu\text{m}$ ).....	<i>Dolichandrone spathacea</i> type
17a	Heterocolpate.....	18

17b	Not heterocolpate.....	21
18a	Colpori ectoaperture very short, half length of polar axis; fossulate-perforate on subsidiary colpi (SEM).....	<i>Calycopteris floribunda</i> type
18b	Colpori ectoaperture slightly shorter than polar axis; granules present on subsidiary colpi (SEM).....	19
19a	Ornamentation perforate (LM).....	<i>Lumnitzera littorea</i> type
19b	Ornamentation psilate (LM).....	20
20a	Endoapertures with acute equatorial ends, sometimes equatorial ends diffused; ornamentation psilate with very small round depressions, or with sparsely minute puncta (SEM).....	<i>Melastoma saigonense</i> type
20b	Endoapertures with obtuse equatorial ends; ornamentation rugulate with scattered minute puncta (SEM).....	<i>Terminalia catappa</i> type
21a	Grain colporate.....	<i>Scyphiphora hydrophyllacea</i> type
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22a	Grain polypantocolporate.....	<i>Thespesia populnea</i> type
22b	Grain 3-5-colporate.....	23
23a	Grain 4-5-colporate.....	24
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24a	Ornamentation microreticulate to finely reticulate (LM).....	<i>Glochidion littorale</i> type
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28a	Ectoapertures fused at polar ends, 3-parasyncolporate.....	<i>Melaleuca cajuputi</i> type
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- 32a Ectoaperture colpi, shape irregular or polygonal-oblong; endoaperture pori, shape irregular or polygonal, not protruding.....*Intsia bijuga* type
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- 33a Ornamentation on apocolpia different from ornamentation on mesocolpia (LM)...34
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- 34a Equatorial outline circular or subcircular; ornamentation perforate; granulate or granulate-perforate on mesocolpia (LM).....*Cerbera manghas* type
- 34b Equatorial outline oblong-elliptic with round polar ends; ornamentation psilate on mesocolpia; microreticulate on apocolpia (LM).....*Aglaia cucullata* type
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- 39a Ectoaperture polar ends obtuse.....*Ardisia elliptica* type
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- 40a Endoaperture lalongate elliptic or lalongate oblong, equatorial ends obtuse, generally wide open.....*Derris trifoliata* type
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- 42a Grain planaperturate; equatorial outline circular-elliptic...*Excoecaria agallocha* type
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- 44b Endoaperture circular or subcircular.....45
- 45a Equatorial outline elliptic to circular-elliptic; endoaperture protruding beyond ectoaperture.....*Pemphis acidula* type
- 45b Equatorial outline circular or subcircular; endoaperture not protruding beyond ectoaperture.....*Xylocarpus rumphii* type
- 46a Columellae distinct, clearly seen on both surface view and optical section, polygonal or rarely circular when see on surface view.....*Scaevola taccada* type
- 46b Columellae indistinct.....47
- 47a Ornamentation granulate (LM).....*Heritiera littoralis* type
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- 48a Endoaperture protruding beyond ectoaperture; equatorial outline circular or subcircular.....*Cynometra ramiflora* type
- 48b Endoaperture not protruding beyond ectoaperture, or rarely protruding; equatorial outline elliptic if endoaperture protruding.....49
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- 50b Grain very small to small, P=9.50-21.20  $\mu\text{m}$ .....*Cerriops decandra* type

## 4.2 Descriptions of pollen types

### 4.2.1 *Acanthus volubilis* type

Pollen class:	3-colpate
Dispersal unit:	Monad
Polarity:	Isopolar or subisopolar
P/E ratio:	(1.31)-1.62-(2.14)
Shape class:	Subprolate to perprolate
Size class:	Small to medium sized P=(25.50)-36.58-(44.60) $\mu\text{m}$ , E=(17.00)-23.01-(30.40) $\mu\text{m}$
Polar area index:	(0.20)-0.34-(0.51)
Polar outline:	Triangular to circular-triangular
Equatorial outline:	Elliptic to elliptic-oblong with straight or slightly concave sides, some grains more tapering toward one pole
Apertures:	Colpi, slightly shorter than polar axis, (21.50)-28.92-(37.40) X (0.40)-1.16-(2.40) $\mu\text{m}$ , narrow or slit-like, margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; costa colpi present, some grains costae indistinct.
Exine:	Semitectate; exine thickness (1.20)-2.15-(2.80) $\mu\text{m}$ ; sexine thicker than nexine; columellae simplicolumellate, distinct, clearly seen on both surface view and optical section, columellae circular when seen on surface view.
Ornamentation:	Microreticulate to reticulate (LM). Microreticulate, reticulate or perforate (SEM).
Included taxa:	<i>Acanthus ebracteatus</i> Vahl – เหงือกปลาหมอดอกขาว; เหงือกปลาหมอ (กลาง); แก้มหมอ (ACANTHACEAE) (Plate 1 A-J)

*Acanthus ilicifolius* L. – เหงือกปลาหมอดอกม่วง; แก้มหมอ, แก้มหมอเล (กระปี่); นางเกร็ง, จะเกร็ง, อีเกร็ง (กลาง); เหงือกปลาหมอ, เหงือกปลาหมอน้ำเงิน (ทั่วไป) (ACANTHACEAE) (Plate 2 A-J)



*Acanthus volubilis* Wall. – เหงือกปลาหมอเครือ (ACANTHACEAE)  
(Plate 3 A-J)

**Key to subtypes:**

- 1a Ornamentation reticulate, lumina irregular in size and shape, polygonal and oblong, heterobrochate; simplicolumellate (LM); muri smooth, narrower at the top and sudden broader below; margo present, psilate at the innermost, rounded by reticulate with discontinuous muri (SEM); colpus membrane psilate.....*Acanthus ilicifolius* subtype
- 1b Ornamentation perforate or microreticulate.....2
- 2a Ornamentation perforate or microreticulate; tectum or muri surface uneven granulate, lumina irregular in size and shape (SEM); opercula present, perforate to microreticulate with smooth surface, some grains opercula indistinct.....*Acanthus ebracteatus* subtype
- 2b Ornamentation microreticulate (LM); muri smooth, ridges at the top, lumina regular, more or less in circular outline, narrower to the base (SEM); colpus membrane granulate.....*Acanthus volubilis* subtype

**4.2.2 *Acrostichum speciosum* type**

Spore class:	Trilete
Dispersal unit:	Monad
Polarity:	Heteropolar
P/E ratio:	(0.58)-0.73-(0.85)
Shape class:	Oblate to suboblate
Size class:	Medium sized to large
	P=(28.20)-39.56-(48.00) $\mu\text{m}$ , E=(48.40)-53.80-(60.20) $\mu\text{m}$
Arm length/radius:	(0.48)-0.61-(0.77)
Shape:	Tetrahedral to tetrahedral-globose
Laesura:	Trilete, indistinct; arm size (0.80)-1.50-(2.80) X (12.50)-16.96-(22.00) $\mu\text{m}$ .



Sclerine:	Sclerine thickness (1.40)-2.04-(2.50) $\mu\text{m}$ ; perine thicker or thinner than exospore.
Ornamentation:	Granulate (LM). Finely granulate with rodlets attached to the surface both proximal and distal surface, or densely granulate on both proximal and distal surface, granules different in size (SEM).
Included taxa:	<i>Acrostichum aureum</i> L. – ประทอง, ประไข่, ประใหญ่; ประทะเล (กลาง, ใต้); ปี่โย (มลายู-สตูล) (PTERIDACEAE) (Plate 4 A-J)
	<i>Acrostichum speciosum</i> Willd. – ประหนู (ชุมพร, ตราด); ประ (กลาง, สมุทรสาคร) (PTERIDACEAE) (Plate 5 A-J)

#### Key to subtypes:

- 1a Ornamentation densely granulate on both proximal and distal surface, granules different in size.....*Acrostichum aureum* subtype
- 1b Ornamentation finely granulate with rodlets attached to the surface both proximal and distal surface.....*Acrostichum speciosum* subtype

#### 4.2.3 *Aegialitis rotundifolia* type

Pollen class:	3-colpate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.62)-0.74-(0.95)
Shape class:	Oblate to oblate spheroidal
Size class:	Medium sized to large P=(40.00)-46.11-(49.80) $\mu\text{m}$ , E=(52.00)-63.26-(74.20) $\mu\text{m}$
Polar area index:	(0.10)-0.17-(0.22)
Polar outline:	Triangular with convex sides to circular-triangular
Equatorial outline:	Elliptic to circular-elliptic
Apertures:	Colpi, slightly shorter than polar axis, (32.00)-39.48-(53.40) X (4.30)-7.13-(11.50) $\mu\text{m}$ , wide, margin distinct, widen at equator

- and tapering toward poles, polar ends acute or obtuse; colpus membrane granulate to gemmate.
- Exine: Tectate imperforate; exine thickness (7.40)-8.48-(10.00)  $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, clearly seen on optical section.
- Ornamentation: Long gemmate or clavate (LM) with fossulate-granulate terminal sculpturing, granules and finely gemmae present on tectum surface.
- Included taxa: *Aegialitis rotundifolia* Roxb. – ใบพาย (กลาง, เหนือ); แสม (กลาง, ใต้)  
(PLUMBAGINACEAE) (Plate 6 A-J)

#### 4.2.4 *Aglaiia cucullata* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (1.23)-1.52-(1.70)
- Shape class: Subprolate to prolate
- Size class: Small  
P=(17.00)-18.27-(19.80)  $\mu\text{m}$ , E=(10.80)-12.09-(15.00)  $\mu\text{m}$
- Polar area index: (0.66)-0.76-(0.84)
- Polar outline: Triangular with straight to convex sides
- Equatorial outline: Oblong-elliptic with round polar ends
- Apertures: Ectoapertures – colpi, very short, about one third of polar axis, (5.20)-6.27-(7.50) X (0.30)-0.45-(0.60)  $\mu\text{m}$ , very narrow or slit-like, margin distinct, polar ends acute; colpus membrane granulate.  
Endoapertures – pori, lalongate elliptic, (2.00)-2.41-(2.80) X (3.00)-3.77-(5.00), margin distinct; costa endopori present.
- Exine: Tectate perforate; exine thickness (0.80)-1.14-(1.40)  $\mu\text{m}$ ; sexine thicker than nexine; columella invisible under LM.
- Ornamentation: Psilate on mesocolpia; microreticulate on apocolpia (LM). Psilate with sparsely perforate on mesocolpia, puncta circular, smaller

than 0.5  $\mu\text{m}$ ; bimicroreticulate on apocolpia, lumina irregular in size and shape; heterobrochate (SEM).

Included taxa: *Aglaia cucullata* (Roxb.) Pellegr. – แดงน้ำ (ใต้, เหนือ); ตาเสือ (กลาง, นครศรีธรรมราช); แสมแดง (ชุมพร, ใต้) (MELIACEAE) (Plate 7 A-J)

#### 4.2.5 *Allophylus cobbe* type

Pollen class: 3-porate  
 Dispersal unit: Monad  
 Polarity: Isopolar or some subisopolar  
 P/E ratio: (0.61)-0.70-(0.78)  
 Shape class: Oblate to suboblate  
 Size class: Small to medium sized  
 $P=(16.00)-18.42-(20.00) \mu\text{m}$ ,  $E=(24.70)-26.26-(29.20) \mu\text{m}$   
 Polar area index: -  
 Polar outline: Triangular with slightly convex to slightly concave sides; angulaperturate  
 Equatorial outline: Rhomboidal elliptic to elliptic  
 Apertures: Pori, lalongate elliptic, lalongate elliptic or subcircular, (3.50)-4.53-(5.30) X (2.80)-4.01-(5.60)  $\mu\text{m}$ .  
 Exine: Tectate perforate; exine thickness (1.00)-1.30-(2.00)  $\mu\text{m}$ ; sexine thicker than nexine; columellae obscure.  
 Ornamentation: Microreticulate (LM). Rugulate-microreticulate, lumina irregular in size and shape, usually polygonal, decreasing in size toward apertures (SEM).  
 Included taxa: *Allophylus cobbe* (L.) Raeusch. – ต่อไส้ (กลาง, เหนือ); จำตอง (ลำพูน); ตานขโมย (กาญจนบุรี, เหนือ); ตาลอีลิ้น (สระบุรี); เพี้ยฟาน (เชียงใหม่, เหนือ) (SAPINDACEAE) (Plate 8 A-J)

#### 4.2.6 *Antidesma ghaesembilla* type

Pollen class: 3-colporate  
 Dispersal unit: Monad

Polarity:	Isopolar
P/E ratio:	(1.54)-1.69-(1.92)
Shape class:	Prolate
Size class:	Small
	P=(17.00)-18.66-(21.60) $\mu\text{m}$ , E=(10.20)-11.07-(12.40) $\mu\text{m}$
Polar area index:	(0.16)-0.23-(0.33)
Polar outline:	Triangular to slightly trilobate
Equatorial outline:	Oblong-elliptic
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (14.00)-15.92-(17.80) X (0.40)-0.70-(1.20) $\mu\text{m}$ , margin distinct, narrow, slightly widen at equator and gradually tapering toward poles, polar ends acute; colpus membrane granulate; costa ectocolpi present. Endoapertures – colpi, lalongate elliptic to lalongate oblong with acute equatorial ends, (1.00)-1.65-(2.20) X (4.50)-6.03-(7.00) $\mu\text{m}$ , margin distinct; costa endocolpi present.
Exine:	Semitectate; exine thickness (1.00)-1.38-(1.80) $\mu\text{m}$ ; sexine as thick as or thinner than nexine; columellae present, clearly seen on optical section, indistinct on surface view.
Ornamentation:	Microreticulate (LM). Striate-microreticulate, lumina oblong-elliptic to oblong (SEM).
Included taxa:	<i>Antidesma ghaesembilla</i> Gaertn. – เม่าไข่ปลา (ชลบุรี); ญแจ (มลาญ-นราธิวาส); ขะเม่าผา (ตะวันออกเฉียงเหนือ); มะเม่า (ตราด, สตูล); มะเม่าข้าวเบา (ชุมพร); มังเม่า (จันทบุรี); เม่าทุ่ง (ชุมพร, สงขลา) (PHYLLANTHACEAE) (Plate 9 A-J)

#### 4.2.7 *Ardisia elliptica* type

Pollen class:	3-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.92)-1.02-(1.14)
Shape class:	Oblate spheroidal to subprolate

Size class:	Small P=(11.50)-12.48-(13.20) $\mu\text{m}$ , E=(10.80)-12.26-(13.40) $\mu\text{m}$
Polar area index:	(0.30)-0.34-(0.41)
Polar outline:	Circular to triangular-circular
Equatorial outline:	Circular to circular-elliptic
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (8.80)-9.61-(10.80) X (1.80)-2.04-(2.40) $\mu\text{m}$ , margin indistinct, widen at equator and tapering toward poles, polar ends obtuse; colpus membrane with angular granules; costa ectocolpi present. Endoapertures – colpi, lalongate oblong with diffused equatorial ends, (1.00)-1.69-(2.00) X (4.20)-4.66-(5.20) $\mu\text{m}$ , margin indistinct.
Exine:	Semitectate; exine thickness (1.00)-1.16-(1.40) $\mu\text{m}$ ; sexine as thick as or thinner than nexine; columella invisible under LM.
Ornamentation:	Microreticulate (LM). Microreticulate, lumina polygonal, irregular in size and shape; heterobrochate; muri distinctly ridged, broader below (SEM).
Included taxa:	<i>Ardisia elliptica</i> Thunb. – รัมใหญ่, ทูลังกาสา (ชุมพร); ลังพิสา (ตราด); ป้อนา (มลายู-นราธิวาส) (PRIMULACEAE) (Plate 10 A-J)

#### 4.2.8 *Atalantia monophylla* type

Pollen class:	4(-5)-colporate
Dispersal unit:	Monad
Polarity:	Isopolar or heteropolar
P/E ratio:	(1.08)-1.14-(1.23)
Shape class:	Prolate spheroidal to subprolate
Size class:	Small P=(20.20)-22.43-(24.20) $\mu\text{m}$ , E=(17.40)-19.64-(21.20) $\mu\text{m}$
Polar area index:	(0.30)-0.34-(0.38)
Polar outline:	Circular to circular-tetragonal, or circular-pentagonal
Equatorial outline:	Elliptic to circular-elliptic

Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (13.40)-15.80-(19.00) X (1.20)-1.68-(2.20) $\mu\text{m}$ , margin distinct, slightly widen at equator and tapering toward poles, polar ends acute or obtuse; colpus membrane granulate; costa ectocolpi present. Endoapertures – colpi, lalongate elliptic, sometimes equatorial ends diffused, (2.00)-2.39-(2.80) X (4.00)-5.30-(6.20) $\mu\text{m}$ , margin distinct, some grains endoapertures slightly situated above or below equatorial plane; costa endocolpi present, somewhat indistinct.
Exine:	Tectate perforate; exine thickness (1.00)-1.51-(1.80) $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, clearly seen on surface view than on optical section, distinct when seen on apocolpium surface.
Ornamentation:	Psilate (LM). Fossulate with scattered minute puncta, puncta smaller than 0.5 $\mu\text{m}$ (SEM).
Included taxa:	<i>Atalantia monophylla</i> DC. – มะนาวผี (เชียงใหม่, ราชบุรี); กรูดเปรย (เขมร, จันทบุรี); กรูดผี (สุราษฎร์ธานี); กะนาวพลี (ใต้); จี้ดัว (เชียงใหม่, เหนือ); จ้าลิ้ว (เหนือ); นางกาน (ขอนแก่น); มะลิ้ว (เชียงใหม่) (RUTACEAE) (Plate 11 A-J)

#### 4.2.9 *Avicennia alba* type

Pollen class:	3-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.85)-1.00-(1.27)
Shape class:	Suboblate to subprolate
Size class:	Small to medium sized P=(21.20)-25.01-(36.00) $\mu\text{m}$ , E=(18.00)-25.20-(36.20) $\mu\text{m}$
Polar area index:	(0.09)-0.24-(0.44)
Polar outline:	Circular-triangular to circular
Equatorial outline:	Circular to circular-elliptic

- Apertures: Ectoapertures – colpi, slightly shorter than polar axis, (11.50)-19.99-(30.50) X (3.00)-8.88-(12.80)  $\mu\text{m}$ , wide, margin distinct, widely opened at equator and tapering toward poles, polar ends acute; colpus membrane granulate. Endoapertures – pori, circular or subcircular, or rarely lalongate elliptic, (2.50)-8.37-(12.60) X (3.40)-8.24-(11.20)  $\mu\text{m}$ , margin distinct.
- Exine: Tectate perforate; exine thickness (1.80)-2.26-(2.80)  $\mu\text{m}$ ; sexine as thick as, thinner, or thicker than nexine; columellae simplicolumellate, distinct, clearly seen optical section than on surface view.
- Ornamentation: Microreticulate or somewhat finely reticulate, lumina more or less regularly in size and shape, lumina circular and some polygonal, narrower to the base; muri smooth (LM, SEM).
- Included taxa: *Avicennia alba* Blume – แสมขาว (กลาง); พีพีเล (ตรัง); แสม (กลาง, ใต้); แหม (ใต้, ภูเก็ต); แหมเล (ใต้) (ACANTHACEAE) (Plate 12 A-J)
- Avicennia marina* (Forssk.) Vierh. – แสมทะเล (กลาง, ปัตตานี); พีปีดำ (ภูเก็ต) (ACANTHACEAE) (Plate 13 A-J)
- Avicennia officinalis* L. – แสมดำ, อ่าปีอ่าปี (มลายู-ปัตตานี) (ACANTHACEAE) (Plate 14 A-J)

Remarks:

It is difficult to divide this type into subtype because of the gradience of variation in ornamentation, pollen grain size and shape. However, it is noticeable that many pollen grains of *A. alba* have lumina increasing in size toward poles becoming reticulate. Some pollen grains of *A. marina* have an ornamentation in finely reticulate. Moreover, many pollen grains of *A. officinalis* have psilate ornamentation or very small puncta on apocolpia.



#### 4.2.10 *Barringtonia racemosa* type

Pollen class:	3-parasyncolpate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(1.07)-1.33-(1.64)
Shape class:	Prolate spheroidal to prolate
Size class:	Small to medium sized P=(31.80)-42.14-(52.60) $\mu\text{m}$ , E=(24.40)-31.77-(36.60) $\mu\text{m}$
Polar area index:	-
Polar outline:	Trilobate
Equatorial outline:	Elliptic
Apertures:	Colpi – slightly shorter than polar axis, (29.80)-36.68-(49.00) X (2.50)-4.06-(7.40) $\mu\text{m}$ , margin distinct, slightly widen at equator and tapering toward poles and anastomosing forming synaperturate with very small apocolpial field approximately 1 $\mu\text{m}$ in diameter; margo present, distinct, psilate, appearing like narrow, wave band, one side of margo of two adjacent ectoapertures expanding above apocolpium forming a cushion-like tectum; colpus membrane granulate; costa colpi present or indistinct.
Exine:	Tectate to tectate perforate; exine thickness (1.20)-1.72-(2.60) $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct or indistinct, clearly seen on mesocolpium surface view; irregular in size and shape, circular or polygonal in outline.
Ornamentation:	Psilate, perforate (LM). Perforate (SEM).
Included taxa:	<i>Barringtonia asiatica</i> (L.) Kurz – จิกทะเล; จิกเล, โคนเล (ใต้); อามุง (มลายู-นราธิวาส) (LECYTHIDACEAE) (Plate 15 A-J)  <i>Barringtonia racemosa</i> (L.) Spreng. – จิกสวน, จิกบ้าน (กทม.); ปู่ตะ (มลายู-นราธิวาส) (LECYTHIDACEAE) (Plate 16 A-J)

**Key to subtypes:**

- 1a Columellae indistinct; ornamentation perforate, pores increase in size toward aperture becoming foveolate.....*Barringtonia asiatica* subtype
- 1b Columellae distinct; ornamentation perforate, pores distribute regularly and no difference in size.....*Barringtonia racemosa* subtype

**Remarks:**

Acetolyzed pollen grains of *Barringtonia asiatica* subtype seem to be more shrunken than those of *Barringtonia racemosa* subtype although they were prepared with the same procedure. Sexine at apocolpial field of these two subtype pollen grains was easily detached from pollen wall.

**4.2.11 *Caesalpinia crista* type**

Pollen class:	3-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.69)-0.79-(0.88)
Shape class:	Oblate to oblate spheroidal
Size class:	Medium sized to large P=(28.40)-35.69-(38.40) $\mu\text{m}$ , E=(41.00)-45.14-(50.00) $\mu\text{m}$
Polar area index:	(0.13)-0.17-(0.20)
Polar outline:	Triangular; planaperturate
Equatorial outline:	Elliptic
Apertures:	Ectoapertures – colpi, as long as polar axis, (28.40)-35.69-(38.40) X (15.00)-15.94-(17.80) $\mu\text{m}$ , opened as wide as a misocolpium, margin distinct, widen at equator and tapering toward poles, polar ends acute or obtuse; colpus membrane perforate to microreticulate; margo distinct, psilate. Endoapertures – pori, lolongate elliptic with obtuse polar ends, much smaller than the width of ectoaperture, (6.40)-8.08-(9.80) X (2.00)-4.88-(7.60) $\mu\text{m}$ , margin distinct; costa endopori present.

- Exine: Semitectate; exine thickness (3.20)-3.58-(4.00)  $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, clearly seen on both surface view and optical section, columellae circular when seen on surface view; simplicolumellate.
- Ornamentation: Reticulate (LM), lumina irregular in size and shape, circular to oblong and polygonal; heterobrochate; muri psilate (SEM).
- Included taxa: *Caesalpinia crista* L. – เทพี (ชุมพร, ตราด); หมอระแอ (มลายู-นราธิวาส) (FABACEAE) (Plate 17 A-J)

#### 4.2.12 *Calophyllum inophyllum* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.85)-0.98-(1.08)
- Shape class: Suboblate to prolate spheroidal
- Size class: Small to medium sized  
 $P=(24.50)-26.68-(29.80) \mu\text{m}$ ,  $E=(25.20)-27.38-(29.80) \mu\text{m}$
- Polar area index: (0.20)-0.25-(0.34)
- Polar outline: Triangular to circular-triangular
- Equatorial outline: Circular to circular-elliptic
- Apertures: Ectoapertures – colpi, slightly shorter than polar axis, (18.40)-21.82-(25.00) X (2.00)-2.36-(4.00)  $\mu\text{m}$ , narrow, margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate; costa ectocolpi present, somewhat indistinct. Endoapertures – colpi, lalongate elliptic with acute equatorial ends, or lalongate oblong with obtuse or diffused equatorial ends, or endocingulum present, (2.40)-4.56-(6.80) X (9.80)-12.30-(15.50)  $\mu\text{m}$ , margin distinct.
- Exine: Semitectate; exine thickness (2.00)-2.48-(3.00)  $\mu\text{m}$ ; sexine thicker than nexine; columella invisible under LM.

- Ornamentation: Microreticulate (LM), lumina circular, polygonal, and oblong, irregular in size and shape, lumina border angulated; heterobrochate; muri smooth, narrower at the top and gradually broader below (SEM).
- Included taxa: *Calophyllum inophyllum* L. – กระจ่าง, กระจ่าง, กากกระจ่าง, กากกระจ่าง (กลาง); กระจ่าง (กระจ่าง); เนาวกาน (น่าน); สารภีทะเล (ประจวบคีรีขันธ์); สารภีแนน (เชียงใหม่, เหนือ) CALOPHYLLACEAE (Plate 18 A-J)

#### 4.2.13 *Calycopteris floribunda* type

- Pollen class: 3-colporate with 3-pseudocolpate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.90)-0.95-(1.02)
- Shape class: Oblate spheroidal to prolate spheroidal
- Size class: Small  
P=(16.50)-17.83-(19.80)  $\mu\text{m}$ , E=(17.20)-18.85-(21.20)  $\mu\text{m}$
- Polar area index: (0.50)-0.68-(0.80)
- Polar outline: Hexangular, triangular-hexangular, or circular-hexangular; planaperturate
- Equatorial outline: Elliptic to circular-elliptic
- Apertures: Ectoapertures – colpi, very short, half length of polar axis, (7.80)-9.08-(10.40) X (0.70)-1.07-(1.60)  $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate. Endoapertures – pori, lalongate elliptic or sometimes circular, (2.00)-2.81-(3.60) X (3.40)-3.97-(5.20)  $\mu\text{m}$ , margin distinct; costa endopori present or absent. Pseudoapertures – colpi, alternate with true apertures, as long as or slightly longer than ectoapertures.
- Exine: Tectate perforate; exine thickness (1.60)-1.90-(2.20)  $\mu\text{m}$ , exine relatively thin at pseudoaperture; sexine thinner than nexine; columella invisible under LM.

- Ornamentation: Psilate (LM). Perforate, puncta irregular in size and shape, puncta circular, elliptic or oblong, puncta smaller than 5  $\mu\text{m}$  (SEM); pseudoaperture surface psilate (LM), fossulate-perforate (SEM).
- Included taxa: *Calycopteris floribunda* (Roxb.) Lam. ex Poir. – ตังตัง, ตังตังตัวผู้ (เหนือ); กฐุด (สุราษฎร์ธานี); ข้าวตอกแดง (กลาง); งวงช่อม (ขอนแก่น, เลย); งวงส้ม (ตะวันออกเฉียงเหนือ, ปราจีนบุรี); งวงส้มขาว, เมี่ยงชะนวนไฟ, ส้มขยาขาว (พิษณุโลก, สุโขทัย); ดวงส้ม (อุบลราชธานี); ดอกโรด (เลย); ตะกฐุด (นครศรีธรรมราช); ตาโน๊ะ (มลายู-ยะลา); เกววัลย์นวล (ราชบุรี); ประโยค (ตราด); มันเครือ (กลาง, นครราชสีมา); มันแดง (กระบี่, ใต้); หน่วยสูด (ชุมพร, นครศรีธรรมราช) (COMBRETACEAE) (Plate 19 A-K)

#### 4.2.14 *Cerbera manghas* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.89)-0.94-(1.09)
- Shape class: Oblate spheroidal to prolate spheroidal
- Size class: Medium sized to large  
P=(42.80)-66.01-(75.20)  $\mu\text{m}$ , E=(45.70)-70.54-(82.80)  $\mu\text{m}$
- Polar area index: (0.28)-0.40-(0.55)
- Polar outline: Triangular to circular-triangular; angulaperturate
- Equatorial outline: Circular or subcircular
- Apertures: Ectoapertures – colpi, shorter than polar axis, (32.60)-52.60-(63.00) X (3.20)-9.57-(21.00)  $\mu\text{m}$ , margin distinct, oblong or widen at equator and sudden tapering toward poles, polar ends obtuse; margo present, psilate; colpus membrane granulate. Endoapertures – pori, lolongate elliptic or subcircular, (9.00)-17.47-(25.00) X (4.00)-13.47-(25.20), margin distinct.

- Exine: Tectate perforate; exine thickness (1.60)-2.18-(3.00)  $\mu\text{m}$ ; sexine as thick as or thicker than nexine; columella invisible under LM.
- Ornamentation: Perforate; granulate or granulate-perforate on mesocolpia (LM). Perforate, puncta circular or subcircular, puncta smaller than 0.5  $\mu\text{m}$ , fossulate-perforate or verrucate-perforate on mesocolpia (SEM).
- Included taxa: *Cerbera manghas* L. – ตีนเป็ดทราย (ปัตตานี); ตีนเป็ดเล็ก (กลาง, สุราษฎร์ธานี); เทียนหนู, เนียนหนู (สตูล); ปังปัง (พังงา); ปากเป็ด (ตราด); มะตากอ (มลายู-นราธิวาส); รักษา (จันทบุรี, เหนือ) (APOCYNACEAE) (Plate 20 A-K)
- Cerbera odollam* Gaertn. – ตีนเป็ดทะเล, ตีนเป็ดน้ำ, ตีนเป็ด (กลาง), ตุ่ม (กาญจนบุรี); มะตะกอ (มลายู-นราธิวาส); ลั้งลา (กระบี่, ระนอง) (APOCYNACEAE) (Plate 21 A-K)

#### 4.2.15 *Ceriops decandra* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.72)-1.05-(1.55)
- Shape class: Suboblate to prolate
- Size class: Very small to small  
P=(9.50)-14.69-(21.20)  $\mu\text{m}$ , E=(7.80)-14.14-(18.80)  $\mu\text{m}$
- Polar area index: (0.12)-0.28-(0.57)
- Polar outline: Triangular with slightly concave sides to triangular-circular
- Equatorial outline: Elliptic to circular-elliptic, or oblong-elliptic
- Apertures: Ectoapertures – colpi, slightly shorter than polar axis, (6.40)-12.69-(21.00) X (0.40)-1.15-(5.00)  $\mu\text{m}$ , wide or narrow, somewhat slit-like, margin distinct, slightly widen at equator and tapering toward poles, polar ends acute or obtuse; colpus membrane psilate or granulate; costa ectocolpi present. Endoapertures –



colpi, lalongate elliptic to lalongate oblong, or endocingulum present, equatorial ends obtuse, acute, or diffused, polar sides parallel or constrict at the middle part, (1.20)-2.37-(7.80) X (4.20)-6.49-(10.20)  $\mu\text{m}$ , margin distinct; costa endocolpi or costa endocinguli present.

Exine: Tectate imperforate, tectate perforate, somewhat semitectate; exine thickness (0.60)-1.26-(2.40)  $\mu\text{m}$ ; sexine as thick as or thinner than nexine; columella invisible under LM.

Ornamentation: Psilate (LM). Microreticulate, sparsely to densely perforate, puncta smaller than 0.5  $\mu\text{m}$ , or psilate with very small round depressions less than 0.5  $\mu\text{m}$  (SEM).

Included taxa: *Aegiceras corniculatum* (L.) Blanco – เล็บมีอนาง (กลาง, นครราชสีมา); ลำพู (กลาง, ตรัง); เล็บนาง (สตูล); แสมแดง (ชุมพร, ใต้); แสมทะเล (กลาง, ปัตตานี) (PRIMULACEAE) (Plate 22 A-J)

*Bruguiera cylindrica* (L.) Blume – ถั่วขาว (กระบี่, ระนอง); ถั่วแดง (กทม., ลำปาง); บรู๊ส, โปรย (มลายู-ใต้); ประสักขาว (จันทบุรี); ปรี๊ย (มลายู-สตูล); โปรย (ใต้, มลายู-ใต้); รุ๊ย (เพชรบุรี) (RHIZOPHORACEAE) (Plate 23 A-J)

*Bruguiera gymnorrhiza* (L.) Savigny – พังกาหัวสุมดอกแดง, พังกาหัวสุม, ประสัก, ประสักแดง, โกงกางหัวสุม (กลาง); พลัก (RHIZOPHORACEAE) (Plate 24 A-J)

*Bruguiera parviflora* (Roxb.) Wight & Arn. ex Griff. – ถั่วดำ (กระบี่, กลาง); ถั่วทะเล (ระนอง); รังกะแท้ (จันทบุรี, นราธิวาส); ลังกระได, หนังกะได (มลายู-ใต้) (RHIZOPHORACEAE) (Plate 25 A-J)

*Bruguiera sexangula* (Lour.) Poir. – พังกาหัวสุมดอกขาว, ประสักขาว, ประสักหนู; ชลัก (ชุมพร); บากาห์ (มลายู-นราธิวาส); ประสักแดง



(จันทบุรี, ตราด); พังกาหัวสุม (กระบี่, ตรัง) (RHIZOPHORACEAE)  
(Plate 26 A-J)

*Ceriops decandra* (Griff.) W. Theob. – โปรงขาว (สมุทรสาคร);  
โปรง, โปรงหนู, ปะโลง, โหลง (กลาง); กระบู้โลง, โปลง, โปรง  
(เพชรบุรี); แสมมานาะ (สตูล); แหม (ใต้, ภูเก็ต)  
(RHIZOPHORACEAE) (Plate 27 A-J)

*Ceriops tagal* (Perr.) C.B. Rob. – โปรงแดง (สมุทรสาคร); ปรง (กลาง,  
สมุทรสาคร); แสม (กลาง, ใต้) (RHIZOPHORACEAE) (Plate 28 A-J)

*Kandelia candel* (L.) Druce – รังกะเท้ (จันทบุรี, นราธิวาส); ลุย  
(จันทบุรี) (RHIZOPHORACEAE) (Plate 29 A-J)

*Rhizophora apiculata* Blume – โกงกางใบเล็ก (กลาง); โกงกาง  
(นครราชสีมา, สระบุรี); พังกาทราย (กระบี่); พังกาใบเล็ก (พังงา)  
(RHIZOPHORACEAE) (Plate 30 A-J)

*Rhizophora mucronata* Lam. – โกงกางใบใหญ่ (กลาง); กงกอน  
(ชลบุรี, เพชรบุรี); กงกานอก (เพชรบุรี); กงกง (นครปฐม); กางกง,  
พังกาใบใหญ่ (ใต้) (RHIZOPHORACEAE) (Plate 31 A-J)

#### Key to subtypes:

- 1a Ectoaperture relatively wide ((3.00)-3.92-(5.00)  $\mu\text{m}$  in width); endoaperture  
sometimes protruding beyond ectoaperture.....*Aegiceras corniculatum* subtype
- 1b Ectoaperture relatively narrow ((0.40)-0.84-(1.80)  $\mu\text{m}$  in width); endoaperture not  
protruding beyond ectoaperture.....2
- 2a Endocingulum present; grains subprolate to prolate; size class very small to  
small, P=(10.20)-11.50-(12.40)  $\mu\text{m}$ , E=(7.80)-8.35-(9.20)  $\mu\text{m}$ ; PAI=(0.33)-0.43-  
(0.57); equatorial outline elliptic to oblong-elliptic; ornamentation psilate with very  
small round depressions smaller than 0.5  $\mu\text{m}$  (SEM)..*Bruguiera parviflora* subtype

- 2b Endocingulum present or absent; if endocingulum present, Grains prolate spheroidal to subprolate; size class small,  $P=(17.20)-18.69-(21.00)$   $\mu\text{m}$ ,  $E=(15.88)-16.65-(18.20)$   $\mu\text{m}$ ;  $PAI=(0.19)-0.26-(0.38)$ ; equatorial outline elliptic to circular-elliptic; ornamentation microreticulate or perforate (SEM).....*Ceriops decandra* subtype  
(Including: *B. cylindrica*; *B. gymnorrhiza*; *B. sexangula*; *C. decandra*; *C. tagal*; *K. candel*; *R. apiculata*; *R. mucronata*)

**Remarks:**

Pollen grains in this type look similar when seen under LM. However, they can be subdivided into two as demonstrated in the key to subtypes. In *Ceriops decandra* subtype, pollen grains of *R. apiculata* and *R. mucronata* generally have endocingula, but sometimes endoapertures are elliptic oblong with diffused equatorial ends. In case of endocingulum are not presented, there is a gradient of variation in pollen morphology in this subtype. It is hard to distinguish these pollen grains, but it can be noticed that there are some differences in some grains of each species as follows:

- 1) Under SEM investigation, ornamentation of *R. apiculata* is densely perforate to microreticulate; *C. decandra*, *C. tagal*, *K. candel*, and *R. mucronata* are densely or sparsely perforate; *B. cylindrica*, *B. gymnorrhiza*, and *B. sexangula* are psilate with very small round depressions.
- 2) Polar outline of *B. gymnorrhiza*, *B. sexangula*, and *R. apiculata* is generally triangular with slightly concave to slightly convex sides while of *B. cylindrica*, *C. tagal*, *K. candel*, and *R. mucronata* is generally triangular with convex sides, and of *C. decandra* is generally triangular-circular.
- 3) Equatorial outline of *C. decandra* and *C. tagal* are generally subcircular, of *K. candel*, *R. apiculata* and, *R. mucronata* are generally circular-elliptic ( $P>E$ ), and of *B. cylindrica*, *B. gymnorrhiza*, and *B. sexangula* are generally circular-elliptic ( $P<E$ ).
- 4) Size of *B. cylindrical* and *C. tagal* is relatively smaller.

#### 4.2.16 *Clerodendrum inerme* type

Pollen class:	3-colpate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.98)-1.04-(1.11)
Shape class:	Oblate spheroidal to prolate spheroidal
Size class:	Medium sized P=(29.40)-35.71-(41.50) $\mu\text{m}$ , E=(30.00)-34.42-(40.00) $\mu\text{m}$
Polar area index:	(0.32)-0.43-(0.56)
Polar outline:	Circular-triangular
Equatorial outline:	Circular to circular-elliptic
Apertures:	Colpi, (17.50)-21.13-(27.00) X (2.00)-2.54-(3.50) $\mu\text{m}$ , margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; colpus membrane microechinate to echinate.
Exine:	Tectate perforate; exine thickness (1.40)-1.78-(2.00) $\mu\text{m}$ ; sexine as thick as or thicker than nexine; columellae distinct, clearly seen on both surface view and optical section.
Ornamentation:	Granulate (LM). Microechinate to finely echinate, echinae conical with point end; area between echinae perforate, puncta circular, smaller than 0.5 $\mu\text{m}$ , tectum surface psilate (SEM).
Included taxa:	<i>Clerodendrum inerme</i> (L.) Gaertn. – ส้มบาง, ส้มมะลิ้ง, ส้มลิ้ง (กลาง, ตะวันออก); เขี้ยววง (กลาง, สุราษฎร์ธานี); ทากี (ใต้); ส้มเนรา (ระยอง); สักขรีย่าน (ชุมพร); ส้มป็นงา (สตูล) (LAMIACEAE) (Plate 32 A-J)

#### 4.2.17 *Crinum asiaticum* type

Pollen class:	2-colpate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.88)-0.99-(1.15)
Shape class:	Suboblate to subprolate

Size class:	Medium sized to large P=(32.40)-40.35-(51.80) $\mu\text{m}$ , E=(35.80)-40.69-(46.70) $\mu\text{m}$
Polar area index:	(0.22)-0.29-(0.33)
Polar outline:	Circular to circular-elliptic
Equatorial outline:	Circular to circular-elliptic
Apertures:	Colpi, (6.00)-10.22-(21.80) X (27.80)-39.44-(45.20) $\mu\text{m}$ , margin distinct, widen at equator and gradually tapering toward poles, ends obtuse; colpus membrane granulate.
Exine:	Tectate imperforate; exine thickness (1.80)-2.19-(2.80) $\mu\text{m}$ ; sexine thicker than nexine; columella invisible under LM.
Ornamentation:	Granulate (LM). Microechinate to small echinate, area between echinae microbaculate (SEM).
Included taxa:	<i>Crinum asiaticum</i> L. – พลับพลึง (กลาง); ลิ้ว (เหนือ) (AMARYLIDACEAE) (Plate 33 A-J)

#### 4.2.18 *Cynometra ramiflora* type

Pollen class:	3-(syn)colporate
Dispersal unit:	Monad
Polarity:	Isopolar or heteropolar
P/E ratio:	(0.94)-0.99-(1.06)
Shape class:	Oblate spheroidal to prolate spheroidal
Size class:	Small to medium sized P=(23.60)-24.51-(27.40) $\mu\text{m}$ , E=(22.60)-24.85-(28.80) $\mu\text{m}$
Polar area index:	(0.12)-0.16-(0.21)
Polar outline:	Circular to circular-triangular
Equatorial outline:	Circular to subcircular
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (19.00)-21.62-(26.00) X (2.60)-3.66-(4.80) $\mu\text{m}$ , margin distinct, widen at equator and sudden tapering toward poles, polar ends acute or obtuse, somewhat fused at poles; costa ectocolpi present; colpus membrane granulate. Endoapertures – pori, large, circular

or subcircular, (4.00)-5.03-(7.20) X (4.00)-5.33-(7.20), margin distinct, slightly protruding, protruding beyond ectoaperture when open, some grains endoapertures situated near apocolpium.

- Exine: Tectate perforate; exine thickness (1.20)-1.70-(2.00)  $\mu\text{m}$ ; sexine as thick as nexine; columella invisible under LM.
- Ornamentation: Psilate (LM). Densely perforate, puncta smaller than 0.5  $\mu\text{m}$  (SEM).
- Included taxa: *Cynometra ramiflora* L. – มะ (กลาง, บัดตานี); มังคะ, พังคะ (กลาง, ใต้); พังก้า (ตรัง, นราธิวาส); มะคาก (ใต้); แมงคะ (ตราด) (FABACEAE) (Plate 34 A-J)

#### 4.2.19 *Dalbergia candenatensis* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.91)-1.03-(1.16)
- Shape class: Oblate spheroidal to subprolate
- Size class: Small  
P=(16.60)-19.71-(23.20)  $\mu\text{m}$ , E=(17.60)-19.19-(22.40)  $\mu\text{m}$
- Polar area index: (0.26)-0.41-(0.50)
- Polar outline: Circular to circular-triangular
- Equatorial outline: Elliptic to circular-elliptic
- Apertures: Ectoapertures – colpi, two thirds of polar axis, (11.00)-12.24-(14.00) X (1.80)-2.80-(5.40)  $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate; costa ectocolpi usually present, sometimes indistinct. Endoapertures – colpi, very large, lalongate oblong-elliptic, equatorial ends obtuse, (2.20)-3.73-(5.70) X (7.00)-8.13-(10.00), margin distinct, distinctly protruding beyond ectoaperture even

- endoaperture still colsed; costa endopori present, some grains costae indistinct.
- Exine: Tectate perforate; exine thickness (1.00)-1.37-(1.80)  $\mu\text{m}$ ; sexine thinner than nexine; columella invisible under LM.
- Ornamentation: Psilate (LM). Sparsely perforate, puncta smaller than 0.5  $\mu\text{m}$  (SEM).
- Included taxa: *Dalbergia candenatensis* (Dennst.) Prain – สักงี (กลาง, นราธิวาส); เถามันเปรียง (นราธิวาส, สุราษฎร์ธานี); เถาวัลย์เปรียง (กลาง, สุราษฎร์ธานี); ย่านมันเปรียง (นราธิวาส) (FABACEAE) (Plate 35 A-J)

#### 4.2.20 *Derris trifoliata* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.71)-0.89-(1.13)
- Shape class: Oblate to prolate spheroidal
- Size class: Small to medium sized  
P=(15.80)-19.85-(24.20)  $\mu\text{m}$ , E=(19.00)-22.49-(29.00)  $\mu\text{m}$
- Polar area index: (0.24)-0.39-(0.60)
- Polar outline: Triangular with convex sides to circular-triangular; angulaperturate
- Equatorial outline: Circular to circular-elliptic
- Apertures: Ectoapertures – colpi, (11.00)-15.37-(20.00) X (1.60)-2.94-(4.00)  $\mu\text{m}$ , wide, margin distinct, slightly widen at equator and tapering toward poles, polar ends acute or obtuse; colpus membrane granulate; costa ectocolpi present. Endoapertures – colpi, lalongate elliptic or lalongate oblong, equatorial ends obtuse, (2.80)-5.00-(8.20) X (6.40)-8.05-(10.50), margin distinct.
- Exine: Tectate perforate; exine thickness (0.80)-1.47-(2.00)  $\mu\text{m}$ ; sexine as thick as, thinner or thicker than nexine; columella invisible under LM.



Ornamentation: Microreticulate (LM). Perforate (SEM).  
 Included taxa: *Derris trifoliata* Lour. – ถอบแถบน้ำ, แควบทะเล, ผักแถบ (กลาง);  
 ถอบแถบทะเล (เพชรบุรี); ถั่วน้ำ (นราธิวาส); ทับแถบ (สมุทรสงคราม)  
 (FABACEAE) (Plate 36 A-J)

*Pongamia pinnata* (L.) Merr. – หยีน้า; กายี, ราโยด (ใต้); ปากี (มลายู-  
 สงขลา) (FABACEAE) (Plate 37 A-J)

#### Key to subtypes:

- 1a Ectoaperture polar ends obtuse; endoapertures lalongate elliptic or lalongate oblong; ornamentation perforate with globule-like granules inside puncta, puncta irregular in size and shape, circular, polygonal and oblong (SEM).....*Derris trifoliata* subtype
- 1b Ectoaperture polar ends acute; endoapertures lalongate elliptic; ornamentation perforate, puncta irregular in size and shape, circular, polygonal and oblong, puncta smaller than 0.5  $\mu\text{m}$  (SEM).....*Pongamia pinnata* subtype

#### 4.2.21 *Diospyros areolata* type

Pollen class: 3-colporate  
 Dispersal unit: Monad  
 Polarity: Isopolar or heteropolar  
 P/E ratio: (0.94)-1.04-(1.15)  
 Shape class: Oblate spheroidal to subprolate  
 Size class: Medium sized  
 $P=(33.20)\text{-}36.81\text{-}(39.20) \mu\text{m}$ ,  $E=(32.40)\text{-}35.30\text{-}(38.20) \mu\text{m}$   
 Polar area index: (0.15)-0.20-(0.26)  
 Polar outline: Triangular to circular-triangular  
 Equatorial outline: Circular to circular-elliptic  
 Apertures: Ectoapertures – colpi, as long as polar axis or slightly shorter, (29.40)-32.15-(35.00) X (2.20)-2.60-(3.40)  $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute or



- obtuse; colpus membrane granulate; costa ectocolpi present.  
Endoapertures – colpi, lalongate elliptic, (3.80)-4.83-(7.00) X (11.20)-13.14-(15.40)  $\mu\text{m}$ , margin distinct, some grains endoapertures slightly situated above or below equatorial plane; costa endocolpi present.
- Exine: Tectate imperforate; exine thickness (1.40)-1.76-(2.00)  $\mu\text{m}$ ; sexine as thick as or thicker than nexine; columella invisible under LM.
- Ornamentation: Psilate (LM). Microstriato-rugulate (SEM).
- Included taxa: *Diospyros areolata* King & Gamble – มะพลับ, พลับ (กลาง) (EBENACEAE) (Plate 38 A-J)

#### 4.2.22 *Dolichandrone spathacea* type

- Pollen class: 3-colpate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.93)-1.02-(1.16)
- Shape class: Oblate spheroidal to subprolate
- Size class: Medium sized  
P=(32.20)-39.15-(47.50)  $\mu\text{m}$ , E=(30.80)-38.43-(46.40)  $\mu\text{m}$
- Polar area index: (0.16)-0.22-(0.27)
- Polar outline: Circular-triangular
- Equatorial outline: Circular to circular-elliptic
- Apertures: Colpi, slightly shorter than polar axis, (24.20)-31.80-(40.50) X (6.00)-7.68-(9.40)  $\mu\text{m}$ , wide, margin distinct, widen at equator and gradually tapering toward poles, polar ends acute; colpus membrane psilate; costa colpi present.
- Exine: Semitectate; exine thickness (1.20)-1.75-(2.20)  $\mu\text{m}$ ; sexine as thick as nexine; columellae distinct, clearly seen on both surface view and optical section; simplicolumellate.

- Ornamentation: Reticulate, lumina irregular in size and shape, lumina circular and polygonal; heterobrochate (LM); muri psilate (SEM).
- Included taxa: *Dolichandrone spathacea* (L. f.) Seem. – แกทะเล (ตราด); แก่น้ำ (กลาง) (BIGNONIACEAE) (Plate 39 A-J)

#### 4.2.23 *Drynaria quercifolia* type

- Spore class: Monolete
- Dispersal unit: Monad
- Polarity: Heteropolar
- P/E ratio: (0.50)-0.62-(0.68)
- Shape class: Oblate
- Size class: Medium sized to large  
P=(27.00)-31.25-(33.80)  $\mu\text{m}$ , E=(44.40)-50.74-(55.20)  $\mu\text{m}$
- Arm length/radius: -
- Shape: Ellipsoidal or boat-shape
- Laesura: Monolete, distinct, protruding, (0.80)-1.42-(2.20) X (11.00)-17.59-(25.00)  $\mu\text{m}$ .
- Sclerine: Sclerine thickness (0.80)-1.16-(1.50)  $\mu\text{m}$ ; perine thinner than exospore.
- Ornamentation: Echinata, echinae slender conical with point end, (0.50)-0.68-(1.00) X (2.20)-3.24-(3.70)  $\mu\text{m}$  (LM); area between echinae granulate to finely verrucate (SEM).
- Included taxa: *Drynaria quercifolia* (L.) J. Sm. – กระแตไต่ไม้ (กลาง); กระปรอกว่าว (ชลบุรี, ปราจีนบุรี); กูดขาออก, เข้าวะนะ, พุดองและ (กะเหรี่ยง, แม่ฮ่องสอน); เฒ่านก้าโละ (มลายู-ปัตตานี); ไบหูช้าง, สะไบนาง (กาญจนบุรี); สะโมง (นราธิวาส, ส่วย-สุรินทร์); หัวว่าว (ใต้, ประจวบคีรีขันธ์) (POLYPODIACEAE) (Plate 40 A-H)

#### 4.2.24 *Excoecaria agallocha* type

- Pollen class: 3-colporate
- Dispersal unit: Monad

Polarity:	Isopolar
P/E ratio:	(0.80)-0.89-(1.02)
Shape class:	Suboblate to prolate spheroidal
Size class:	Small to medium sized P=(24.20)-27.45-(30.00) $\mu\text{m}$ , E=(23.80)-31.14-(38.80) $\mu\text{m}$
Polar area index:	(0.18)-0.21-(0.26)
Polar outline:	Triangular with straight sides to circular-triangular; planaperturate
Equatorial outline:	Circular-elliptic
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (21.40)-23.86-(28.50) X (0.60)-2.06-(3.20) $\mu\text{m}$ , very narrow or slit-like, margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; costa ectocolpi present; margo present, psilate; colpus membrane granulate. Endoapertures – pori, lalongate oblong or lalongate elliptic, equatorial ends diffused, some grains endoaperture indistinct, (3.20)-4.57-(6.20) X (5.40)-7.83-(11.40) $\mu\text{m}$ .
Exine:	Semitectate; exine thickness (2.20)-0.65-(3.00) $\mu\text{m}$ ; sexine as thick as nexine; columellae distinct, clearly seen on both surface view and optical section, columellae circular when seen on surface view.
Ornamentation:	Microreticulate (LM). Microreticulate to finely reticulate, lumina circular or elliptic, different in size; muri with minute granules, especially around lumina, narrower at the top and sudden broader below (SEM).
Included taxa:	<i>Excoecaria gallocha</i> L. – ตาคุ่ม, ตาคุ่มทะเล (กลาง); บูดอ (มลาชู-ปัตตานี) (EUPHORBIACEAE) (Plate 41 A-J)

#### 4.2.25 *Ficus microcarpa* type

Pollen class:	2-porate
Dispersal unit:	Monad
Polarity:	Subisopolar

P/E ratio:	(0.70)-0.78-(0.88)
Shape class:	Oblate to oblate spheroidal
Size class:	Very small to small P=(7.00)-8.09-(9.00) $\mu\text{m}$ , E=(9.30)-10.46-(12.50) $\mu\text{m}$
Polar area index:	-
Polar outline:	Elliptic
Equatorial outline:	Elliptic with one slightly convex side and one distinctly convex side
Apertures:	Pori subcircular to lologate elliptic, (1.20)-1.41-(1.80) X (0.70)-1.05-(1.20) $\mu\text{m}$ .
Exine:	Exine thickness (0.70)-0.85-(1.00) $\mu\text{m}$ ; exine stratification obscure.
Ornamentation:	Psilate (LM). Psilate with uneven surface (SEM).
Included taxa:	<i>Ficus microcarpa</i> L. f. – ไทรช้อยใบทู่ (นครศรีธรรมราช); ไทรช้อย (สุราษฎร์ธานี); ไทรหิน (ชุมพร); ไอรี (เพชรบูรณ์) (MORACEAE) (Plate 42 A-G)

#### 4.2.26 *Flagellaria indica* type

Pollen class:	1-porate
Dispersal unit:	Monad
Polarity:	Heteropolar
P/E ratio:	(0.81)-0.90-(0.99)
Shape class:	Suboblate to oblate spheroidal
Size class:	Small P=(15.00)-16.49-(18.50) $\mu\text{m}$ , E=(16.40)-18.44-(21.80) $\mu\text{m}$
Polar area index:	-
Polar outline:	Circular or subcircular
Equatorial outline:	Circular to circular-elliptic
Apertures:	Pori, circular to subcircular, (2.20)-2.73-(3.20) X (2.20)-2.54-(3.00) $\mu\text{m}$ , pore membrane granulate; annulus present.

Exine:	Tectate perforate; exine thickness (1.20)-1.59-(1.80) $\mu\text{m}$ ; sexine thicker than nexine; columella invisible under LM.
Ornamentation:	Perforate (LM). Uneven with irregular sexine elements in various polygonal shape and irregular perforate (SEM).
Included taxa:	<i>Flagellaria indica</i> L. – หวายลิง (ใต้, นราธิวาส); หวายเข้บจาก, หวายดี (ใต้) (FLAGELLARIACEAE) (Plate 43 A-G)

#### 4.2.27 *Glochidion littorale* type

Pollen class:	4-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.88)-0.94-(1.01)
Shape class:	Suboblate to prolate spheroidal
Size class:	Small to medium sized P=(19.50)-22.02-(24.40) $\mu\text{m}$ , E=(20.40)-12.45-(25.60) $\mu\text{m}$
Polar area index:	(0.33)-0.38-(0.45)
Polar outline:	Circular to circular-tetragonal
Equatorial outline:	Circular to subcircular
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (12.60)-14.56-(17.20) X (0.60)-1.79-(2.80) $\mu\text{m}$ , margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; margo present, psilate; colpus membrane granulate. Endoapertures – pori, circular or subcircular, (1.80)-2.41-(3.00) X (2.00)-2.54-(3.00) $\mu\text{m}$ , margin distinct; costa endopori present.
Exine:	Semitectate; exine thickness (2.20)-2.58-(2.80) $\mu\text{m}$ ; sexine thicker than nexine; columellae simplicolumellate, distinct, clearly seen on both surface view and optical section.
Ornamentation:	Microreticulate to finely reticulate, lumina circular, elliptic, or somewhat polygonal, irregular in size and shape; heterobrochate; muri psilate (SEM).

Included taxa: *Glochidion littorale* Blume – มันปู (ตัง, สงขลา); นกนอทะเล (นราธิวาส) (PHYLLANTHACEAE) (Plate 44 A-J)

#### 4.2.28 *Heritiera littoralis* type

Pollen class: 3-colporate  
 Dispersal unit: Monad  
 Polarity: Isopolar or heteropolar  
 P/E ratio: (0.92)-0.96-(1.01)  
 Shape class: Oblate spheroidal to prolate spheroidal  
 Size class: Small  
 $P=(15.20)-17.46-(19.00) \mu\text{m}$ ,  $E=(15.50)-18.28-(20.60) \mu\text{m}$   
 Polar area index: (0.20)-0.28-(0.34)  
 Polar outline: Circular to circular-triangular  
 Equatorial outline: Circular to subcircular  
 Apertures: Ectoapertures – colpi, as long as polar axis or slightly shorter, (11.80)-13.66-(14.80) X (0.60)-0.92-(1.40)  $\mu\text{m}$ , margin distinct, slightly widen at equator and tapering toward poles, polar ends acute or obtuse; colpus membrane granulate; costa ectocolpi present. Endoapertures – colpi, lalongate elliptic, (1.40)-1.73-(2.00) X (2.80)-3.84-(5.00)  $\mu\text{m}$ , margin distinct, some grains endoapertures slightly situated above or below equatorial plane.  
 Exine: Tectate perforate; exine thickness (0.60)-0.94-(1.20)  $\mu\text{m}$ ; sexine as thick as or thinner than nexine; columellae obscure.  
 Ornamentation: Granulate (LM). Granulate-rugulate(SEM).  
 Included taxa: *Heritiera littoralis* Aiton (W. & A.) Clos – หงอนไก่ทะเล (กลาง, สุราษฎร์ธานี); ไข่ควาย (กระบี่, ชุมพร); ดุหนุ (ตัง); หงอนไก่ (กลาง, อุบลราชธานี) (MALVACEAE) (Plate 45 A-J)

#### 4.2.29 *Horsfieldia irya* type

Pollen class: 1-colpate  
 Dispersal unit: Monad

Polarity:	Heteropolar
P/E ratio:	(0.75)-0.83-(0.92)
Shape class:	Oblate to oblate spheroidal
Size class:	Small P=(12.80)-14.03-(15.20) $\mu\text{m}$ , E=(14.80)-16.90-(19.00) $\mu\text{m}$
Polar area index:	-
Polar outline:	Oblong-elliptic
Equatorial outline:	Triangular with flat-top on longer equatorial side, and slightly quadrangular on shorter equatorial side
Apertures:	Colpi, (11.40)-12.85-(14.80) X (1.20)-1.68-(2.20) $\mu\text{m}$ , margin distinct, outline oblong, ends obtuse.
Exine:	Semitectate; exine thickness (0.80)-1.10-(1.40) $\mu\text{m}$ ; sexine thicker than nexine; infratectum columellate, columellae clearly seen on optical section.
Ornamentation:	Microreticulate, lumina polygonal, irregular in size and shape; heterobrochate (LM); muri psilate (SEM).
Included taxa:	<i>Horsfieldia irya</i> (Gaertn.) Warb. – กรวย, กรวยน้ำ, กรวยสวน (กทม.); กะเพราะพระ, เพราะพระ (ชุมพร); จุมพรี (นครศรีธรรมราช); ดือระแฮ (มลายู-ปัตตานี); ตุมพระ (นครศรีธรรมราช, สตูล); ยางู (สตูล); ระหัน (ปัตตานี); หัน (ใต้, ปัตตานี) (MYRISTICACEAE) (Plate 46 A-J)

#### 4.2.30 *Intsia bijuga* type

Pollen class:	3-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.90)-1.04-(1.19)
Shape class:	Oblate spheroidal to subprolate
Size class:	Medium sized to large P=(48.80)-56.70-(72.40) $\mu\text{m}$ , E=(45.50)-54.75-(62.20) $\mu\text{m}$
Polar area index:	(0.48)-0.55-(0.63)
Polar outline:	Circular to circular-triangular



Equatorial outline:	Elliptic to circular-elliptic
Apertures:	Ectoapertures – colpi, short, (18.00)-25.72-(33.20) X (4.20)-7.68-(11.00) $\mu\text{m}$ , margin distinct, shape irregular or polygonal-oblong, polar ends obtuse or acute; colpus membrane granulate. Endoapertures – pori, shape irregular or polygonal, (8.80)-10.26-(11.50) X (6.00)-8.70-(12.00) $\mu\text{m}$ , margin (in)distinct.
Exine:	Semitectate; exine thickness (8.00)-9.29-(10.40) $\mu\text{m}$ ; sexine thicker than nexine; columellae simplicolumellate, distinct, large, clearly seen on both surface view and optical section; on surface view columellae irregular in size and shape, circular, polygonal, or oblong.
Ornamentation:	Reticulate (LM). Reticulate, lumina polygonal, irregular in size and shape, heterobrochate; muri psilate; lumina with free-standing columellae, sharp or blunt end (SEM).
Included taxa:	<i>Intsia bijuga</i> (Colebr.) Kuntze – หลุมพอททะเล (สุราษฎร์ธานี); ژیوبالاไอ้ (มลายู-นราธิวาส); ประคู้ทะเล (กลาง) (FABACEAE) (Plate 47 A-J)

#### 4.2.31 *Lecanopteris sinuosa* type

Spore class:	Monolete
Dispersal unit:	Monad
Polarity:	Heteropolar
P/E ratio:	(0.60)-0.66-(0.79)
Shape class:	Oblate to suboblate
Size class:	Small to medium sized
	P=(24.20)-29.35-(34.80) $\mu\text{m}$ , E=(37.80)-44.57-(48.80) $\mu\text{m}$
Arm length/radius:	-
Shape:	Ellipsoidal or boat-shape
Laesura:	Monolete, distinct, protruding, (0.80)-1.08-(1.60) X (15.50)-18.19-(21.00) $\mu\text{m}$ .

Sclerine:	Sclerine thickness (0.80)-1.12-(1.40) $\mu\text{m}$ ; perine thinner than exospore.
Ornamentation:	Granulate or psilate (LM). Psilate with small globules or mass of particles on surface (SEM).
Included taxa:	<i>Lecanopteris sinuosa</i> (Wall. ex Hook.) Copel. – ตาลมังกกร (กทม., ตะวันตกเฉียงใต้) (POLYPODIACEAE) (Plate 48 A-H)

#### 4.2.32 *Lumnitzera littorea* type

Pollen class:	3-colporate with 3-pseudocolpate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.60)-0.94-(1.11)
Shape class:	Oblate to prolate spheroidal
Size class:	Small to medium sized P=(15.20)-24.00-(31.60) $\mu\text{m}$ , E=(15.20)-25.62-(32.50) $\mu\text{m}$
Polar area index:	(0.14)-0.25-(0.36)
Polar outline:	Triangular-hexangular or hexangular, concave on the middle part of each side
Equatorial outline:	Elliptic to circular-elliptic
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (15.00)-20.71-(27.00) X (2.40)-3.53-(4.60) $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate. Endoapertures – colpi, lalongate elliptic or rarely lalongate oblong and circular, (2.40)-5.40-(7.80) X (4.60)-7.25-(11.50) $\mu\text{m}$ , margin distinct. Pseudoapertures – colpi, alternate with true apertures.
Exine:	Tectate perforate; exine thickness (1.80)-2.14-(2.80) $\mu\text{m}$ ; sexine as thick as or thinner than nexine; columella invisible under LM.
Ornamentation:	Perforate (LM and SEM); pseudoaperture surface psilate (LM), flattened granulate or densely granulate (SEM).

Included taxa: *Lumnitzera littorea* (Jack) Voigt – ฝาดแดง (กลาง, ใต้); ตำเสาทะเล (กระบี่, พังงา) (COMBRETACEAE) (Plate 49 A-K)

*Lumnitzera racemosa* Willd. – ฝาดขาว (กลาง); กะลุง (ชุมพร); ขวาด (เชียงใหม่, สุโขทัย); ฝาด (กลาง, พังงา); ลำแพน (กลาง, สตูล); ลำแพน หิน (จันทบุรี, ตรัง) (COMBRETACEAE) (Plate 50 A-K)

#### Remarks:

Noticeably, under SEM, the detail of ornamentation between these two species is quite different. Perforations of *L. littorea* seem to be smaller than 0.5  $\mu\text{m}$  while those of *L. racemosa* are generally bigger than 0.5  $\mu\text{m}$  and irregular in size and shape - circular, oblong or polygonal. Moreover, pollen grains of *L. littorea* have densely granulation on pseudocolpi, and have triangular-hexangular or hexangular polar outline. Pollen grains of *L. racemosa* have pseudocolpi with psilate or flattened granulate, and have hexangular or rarely triangular-hexangular polar outline.

#### 4.2.33 *Melaleuca cajuputi* type

Pollen class: 3-parasyncolporate  
 Dispersal unit: Monad  
 Polarity: Isopolar  
 P/E ratio: (0.39)-0.54-(0.73)  
 Shape class: Peroblate to oblate  
 Size class: Very small to small  
 Polar area index:  $P=(7.20)-8.35-(10.20) \mu\text{m}$ ,  $E=(13.00)-15.92-(19.00) \mu\text{m}$   
 Polar area index: (0.29)-0.40-(0.50)  
 Polar outline: Triangular with straight to concave sides; angulaperturate  
 Equatorial outline: Elliptic to elliptic-oblong  
 Apertures: Ectoapertures – colpi, slightly shorter than polar axis, (5.00)-6.28-(7.00) X (0.20)-0.40-(0.60)  $\mu\text{m}$ , narrow or slit-like, margin distinct, slightly widen at equator and tapering toward poles and anastomosing forming synaperturate with triangular apocolpial

field; colpus membrane granulate. Endoapertures – colpi, lalongate oblong with obtuse equatorial ends, (0.60)-0.77-(1.00) X (3.00)-3.73-(4.60), margin distinct; costa endocolpii present, somewhat indistinct.

Exine: Tectate imperforate; exine thickness (0.60)-0.84-(1.20)  $\mu\text{m}$ ; sexine thinner than nexine.

Ornamentation: Psilate (LM). Fossulate-granulate (SEM).

Included taxa: *Melaleuca cajuputi* Powell – เสม็ด (กลาง); เม็ด, เหม็ด (ใต้)  
(MYRTACEAE) (Plate 51 A-J)

#### 4.2.34 *Melastoma saigonense* type

Pollen class: 3-colporate with 3-pseudocolpate

Dispersal unit: Monad

Polarity: Isopolar

P/E ratio: (0.89)-1.06-(1.20)

Shape class: Oblate spheroidal to subprolate

Size class: Small

P=(16.00)-19.68-(24.80)  $\mu\text{m}$ , E=(21.50)-18.50-(15.70)  $\mu\text{m}$

Polar area index: (0.11)-0.14-(0.23)

Polar outline: Circular to circular-hexangular; planaperturate

Equatorial outline: Circular to circular-elliptic

Apertures: Ectoapertures – colpi, slightly shorter than polar axis, (13.50)-15.68-(20.00) X (2.20)-2.63-(4.20)  $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute; colpus membrane finely granulate. Endoapertures – colpi, lalongate oblong-elliptic with acute equatorial ends, sometimes equatorial ends diffused, (2.00)-3.99-(6.20) X (5.80)-8.57-(11.00)  $\mu\text{m}$ , margin distinct. Pseudoapertures – broad colpi with obtuse polar ends, alternate with true apertures, as long as ectoaperture.

- Exine: Tectate to slightly tectate perforate; exine thickness (0.80)-1.00-(1.20)  $\mu\text{m}$ ; sexine as thick as nexine; columella invisible under LM.
- Ornamentation: Psilate (LM). Psilate with very small round depressions less than 0.5  $\mu\text{m}$ , or with sparsely minute puncta (SEM); pseudoaperture surface psilate (LM), finely granulate (SEM).
- Included taxa: *Melastoma saigonense* (Kuntze) Merr. – โคลงเคลงขวน (ตะวันออก); โคลงเคลงขวน (ปราจีนบุรี); ม่ายะ (ทอง-ตราด); เอ็นฮ่า (ปราจีนบุรี, อุบลราชธานี) (MELASTOMATACEAE) (Plate 52 A-K)

#### 4.2.35 *Nypa fruticans* type

- Pollen class: 1-zona-aperturate
- Dispersal unit: Monad
- Polarity: Isoopolar
- P/E ratio: (1.00)-1.06-(1.14)
- Shape class: Oblate spheroidal to subprolate
- Size class: Medium sized  
P=(32.20)-39.71-(48.00)  $\mu\text{m}$ , E=(31.00)-37.29-(42.50)  $\mu\text{m}$
- Polar area index: -
- Polar outline: Circular to subcircular
- Equatorial outline: Circular to subcircular
- Apertures: Colpi, (1.20)-1.45-(1.80)  $\mu\text{m}$  in width, ring-like, margin distinct; sulcus membrane psilate.
- Exine: Semiectate; exine thickness (1.50)-2.02-(2.40)  $\mu\text{m}$ ; sexine (excluded spines) thinner than nexine; columellae distinct, clearly seen on both surface view and optical section.
- Ornamentation: Echinate, echinae conical with point end, (1.80)-2.63-(3.40) X (2.80)-3.93-(5.40)  $\mu\text{m}$ , area between echinae perforate, finely foveolate, microreticulate, or reticulate, puncta or lumina irregular in size and shape, occasionally circular or elliptic, (LM). Echinate, area between echinae microreticulate to finely reticulate (SEM).

Included taxa: *Nypa fruticans* Wurm. – จาก (กลาง); อัดตะ (มลายู-ใต้)  
(ARECACEAE) (Plate 53 A-F)

#### 4.2.36 *Pandanus odoratissimus* type

Pollen class: 1-porate  
 Dispersal unit: Monad  
 Polarity: Heteropolar  
 P/E ratio: (1.15)-1.27-(1.39)  
 Shape class: Subprolate to prolate  
 Size class: Small  
 $P=(16.80)-17.86-(20.20) \mu\text{m}$ ,  $E=(13.00)-14.15-(15.20) \mu\text{m}$   
 Polar area index: -  
 Polar outline: Circular or subcircular  
 Equatorial outline: Elliptic  
 Apertures: Pori, subcircular to elliptic, (2.10)-2.84-(3.60) X (1.20)-1.89-(3.20)  $\mu\text{m}$ , situated at or near one of the longer axis, not always clearly visible.  
 Exine: Tectate imperforate; exine thickness (0.80)-1.07-(1.50)  $\mu\text{m}$ ; sexine as thick as or thicker than nexine; columella invisible under LM.  
 Ornamentation: Granulate (LM). Microechinate to echinate, echinae conical with point end, area between echinae densely granulate (SEM).  
 Included taxa: *Pandanus odoratissimus* L. f. – ลำเจียก, เตยทะเล (กลาง); ปะหนัน, ปาเนะ (มลายู-นราธิวาส) (PANDANACEAE) (Plate 54 A-H)

#### 4.2.37 *Peltophorum pterocarpum* type

Pollen class: 3-colporate  
 Dispersal unit: Monad  
 Polarity: Isopolar  
 P/E ratio: (0.90)-0.95-(1.00)  
 Shape class: Oblate spheroidal to prolate spheroidal

Size class:	Medium sized P=(30.80)-39.34-(42.40) $\mu\text{m}$ , E=(32.20)-41.59-(45.50) $\mu\text{m}$
Polar area index:	(0.41)-0.49-(0.53)
Polar outline:	Circular to circular-triangular
Equatorial outline:	Elliptic to circular-elliptic
Apertures:	Ectoapertures – colpi, slightly longer than half of polar axis, (19.40)-23.87-(27.40) X (5.00)-5.86-(7.80) $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends obtuse or acute; colpus membrane granulate. Endoapertures – pori, lalongate elliptic or subcircular, (4.50)-6.20-(8.80) X (5.20)-7.23-(9.40) $\mu\text{m}$ , margin distinct, protruding beyond ectoaperture; costa endopori present.
Exine:	Semitectate; exine thickness (3.50)-4.35-(5.20) $\mu\text{m}$ ; sexine thicker than nexine, sexine usually detached from nexine; columellae simplicolumellate, distinct, clearly seen on both surface view and optical section; on surface view columellae irregular in size and shape, circular or polygonal.
Ornamentation:	Reticulate (LM). Reticulate, lumina polygonal, irregular in size and shape, heterobrochate; muri psilate; lumina with small granules (SEM).
Included taxa:	<i>Peltophorum pterocarpum</i> (DC.) Backer ex K. Heyne – นนทรี (กลาง); กระถินแดง (ตราด); กระถินป่า (ตราด, สุโขทัย); สารเงิน (เชียงใหม่, เหนือ) (FABACEAE) (Plate 55 A-M)

#### 4.2.38 *Pemphis acidula* type

Pollen class:	(3-)4-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(1.08)-1.16-(1.39)
Shape class:	Prolate spheroidal to prolate
Size class:	Small to medium sized



	P=(27.00)-29.59-(35.50) $\mu\text{m}$ , E=(23.00)-25.44-(28.20) $\mu\text{m}$
Polar area index:	(0.31)-0.41-(0.50)
Polar outline:	Circular to circular-tetrangular or some grains triangular; planaperturate
Equatorial outline:	Elliptic to circular-elliptic
Apertures:	Ectoapertures – colpi, half length of polar axis, (13.00)-15.69-(18.00) X (2.00)-2.56-(3.20) $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute or obtuse; colpus membrane granulate. Endoapertures – pori, circular or subcircular, (3.20)-5.41-(7.20) X (3.60)-5.58-(7.80), margin distinct, protruding beyond ectoaperture when open.
Exine:	Tectate imperforate; exine thickness (1.20)-1.83-(2.00) $\mu\text{m}$ ; sexine thicker than nexine; colemae distinct, clearly seen on both surface view and optical section, distinct when seen on apocolpium surface.
Ornamentation:	Psilate (LM and SEM).
Included taxa:	<i>Pemphis acidula</i> J.R. & G. Forst. – เทียนเด (สุราษฎร์ธานี) (LYTHRACEAE) (Plate 56 A-L)

#### 4.2.39 *Phoenix paludosa* type

Pollen class:	1-colpate
Dispersal unit:	Monad
Polarity:	Heteropolar
P/E ratio:	(0.81)-0.88-(1.03)
Shape class:	Suboblate to prolate spheroidal
Size class:	Small
	P=(12.60)-13.97-(16.00) $\mu\text{m}$ , E=(14.60)-15.82-(17.80) $\mu\text{m}$
Polar area index:	-
Polar outline:	Elliptic
Equatorial outline:	Circular-elliptic to elliptic on longer equatorial view, and circular-elliptic on shorter equatorial view

- Apertures: Colpi, as long as or slightly shorter than longest equatorial axis (13.50)-14.03-(15.00) X (2.50)-3.04-(3.80)  $\mu\text{m}$ , margin distinct, irregular, outline oblong, ends obtuse; colpus membrane granulate; margo present, psilate.
- Exine: Semitectate; exine thickness (1.00)-1.36-(1.60)  $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, more clearly seen on optical section than on surface view.
- Ornamentation: Perforate or microreticulate (LM). Microreticulate or finely reticulate, lumina circular or polygonal and different in size; heterobrochate; muri psilate (SEM).
- Included taxa: *Phoenix paludosa* Roxb. – ฝรั่งทะเล (กลาง) (ARECACEAE) (Plate 57 A-J)

#### 4.2.40 *Planchonella obovata* type

- Pollen class: 3(-4)-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (1.47)-1.53-(1.74)
- Shape class: Prolate
- Size class: Small to medium sized  
P=(21.80)-24.35-(28.50)  $\mu\text{m}$ , E=(14.60)-15.86-(17.00)  $\mu\text{m}$
- Polar area index: (0.45)-0.52-(0.58)
- Polar outline: Circular to triangular-circular, or tetrangular-circular
- Equatorial outline: Oblong-elliptic with round polar ends
- Apertures: Ectoapertures – colpi, (15.20)-17.46-(22.00) X (0.60)-0.90-(1.20)  $\mu\text{m}$ , narrow, margin distinct, slightly protruding over endoapertures, polar ends obtuse; colpus membrane granulate. Endoapertures – colpi, lalongate elliptic, (1.40)-2.23-(3.50) X (3.20)-4.25-(5.20), margin distinct; costa endocolpi present.

- Exine: Tectate to slightly tectate perforate; exine thickness (0.80)-1.23-(1.40)  $\mu\text{m}$ ; sexine thinner than nexine; columella invisible under LM.
- Ornamentation: Psilate (LM). Slightly rugulate with sparsely minute puncta on mesocolpia, puncta circular, smaller than 0.5  $\mu\text{m}$ ; psilate on apocolpia (SEM).
- Included taxa: *Planchonella obovata* (R. Br.) Pierre – งาไซ (จีน, สุราษฎร์ธานี); โกงกางบก (ชลบุรี, ระนอง); จันทิตสอ (กลาง); ทีไร (ปัตตานี); พังกาบก (ใต้); โพอาศัย (เชียงใหม่, ระนอง); มะดินทราย (สงขลา); สันขวาน (ลำปาง); ฝรั่ง (สมุทรปราการ) (SAPOTACEAE) (Plate 58 A-J)

#### 4.2.41 *Pluchea indica* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.70)-0.87-(1.01)
- Shape class: Oblate to prolate spheroidal
- Size class: Small  
P=(14.80)-17.60-(20.80)  $\mu\text{m}$ , E=(15.00)-20.43-(25.00)  $\mu\text{m}$
- Polar area index: (0.29)-0.44-(0.54)
- Polar outline: Circular, circular-triangular or triangular with slightly convex sides
- Equatorial outline: Circular to circular-elliptic
- Apertures: Ectoapertures – colpi, (8.80)-12.51-(19.20) X (0.80)-1.70-(3.00)  $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate. Endoapertures – colpi, lalongate oblong or elliptic with obtuse equatorial ends, or lalongate rhomboidic with acute equatorial ends and rarely diffused, (2.50)-3.23-(4.50) X (4.20)-6.23-(9.60)  $\mu\text{m}$ , margin distinct.

Exine: Tectate perforate; exine thickness (1.20)-1.58-(2.00)  $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, clearly seen on both surface view and optical section.

Ornamentation: Echinate, echinae conical with point end, (2.20)-3.03-(4.00) X (2.20)-3.33-(4.80)  $\mu\text{m}$  (LM), puncta present on echinus bases; area between echinae granulate and perforate, puncta irregular in size and shape, puncta bigger at echinae base, circular, polygonal or oblong, puncta smaller than 0.5  $\mu\text{m}$  (SEM).

Included taxa: *Melanthera biflora* (L.) Wild – ผักกระดาดทะเล (กทม.) (ASTERACEAE) (Plate 59 A-J)

*Pluchea indica* (L.) Less. – ขลุ่ (กลาง); ขลุ (ใต้); หนวดจ้ว, หนวดจ้ว, หนวดจ้ว (อุครธานี); หนวดจ้ว (กทม., อุครธานี) (ASTERACEAE) (Plate 60 A-J)

#### Key to subtypes:

- 1a Endoapertures lalongate rhomboidic, equatorial ends acute or rarely diffuse.....*Melanthera biflora* subtype
- 1b Endoapertures lalongate oblong or lalongate elliptic, equatorial ends obtuse.....*Pluchea indica* subtype

#### 4.2.42 *Pyrosia adnascens* type

Spore class: Monolete

Dispersal unit: Monad

Polarity: Heteropolar

P/E ratio: (0.52)-0.61-(0.75)

Shape class: Oblate to suboblate

Size class: Small to medium sized

P=(22.40)-29.39-(37.50)  $\mu\text{m}$ , E=(40.20)-47.98-(62.80)  $\mu\text{m}$

Arm length/radius: -

Shape: Ellipsoidal or boat-shape

- Laesura: Monolete, indistinct, (0.60)-0.93-(1.50) X (12.80)-19.86-(29.20)  $\mu\text{m}$ .
- Sclerine: Sclerine thickness (1.80)-2.23-(3.20)  $\mu\text{m}$ ; perine thicker than exospore.
- Ornamentation: Gemmate and verrucate, gemmae and verrucae different in size; or echinate, spine shape conical with point end, some echinae slightly recurved, (5.80)-8.67-(15.50) X (5.80)-8.34-(13.20)  $\mu\text{m}$ , some grains echinae form like large gemmae, gemmae present on area between echinae, gemmae different in size (LM and SEM).
- Included taxa: *Pyrrrosia adnascens* (Sw.) Ching – ผักปึกไก่ (เขียงราย); เฟินงูเขียว (กทม.) (POLYPODIACEAE) (Plate 61 A-H)
- Pyrrrosia piloselloides* (L.) M.G. Price – กีบม้าม (เขียงใหม่, เหนือ); เกตุคนาคราช (กลาง, เลข); มันเหี้ย (ชลบุรี) (POLYPODIACEAE) (Plate 62 A-H)

#### Key to subtypes:

- 1a Ornamentation gemmate and verrucate.....*Pyrrrosia adnascens* subtype
- 1b Ornamentation echinate, some grains echinae form like large gemmae, gemmae present on area between echinae.....*Pyrrrosia piloselloides* subtype

#### 4.2.43 *Scaevola taccada* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (0.97)-1.07-(1.16)
- Shape class: Oblate spheroidal to subprolate
- Size class: Medium sized to large
- P=(35.50)-45.90-(50.00)  $\mu\text{m}$ , E=(36.50)-42.74-(45.50)  $\mu\text{m}$
- Polar area index: (0.23)-0.28-(0.31)

Polar outline:	Circular or subcircular
Equatorial outline:	Circular to circular-elliptic
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (26.80)-37.78-(42.00) X (4.60)-5.91-(8.20) $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute or obtuse; costa ectocolpi present; colpus membrane finely granulate. Endoapertures – colpi, lalongate elliptic or lalongate oblong, some grains equatorial ends diffused, (4.00)-7.42-(9.50) X (17.50)-20.69-(25.40) $\mu\text{m}$ , margin distinct; costae endocolpi present, somewhat indistinct.
Exine:	Tectate perforate; exine thickness (2.80)-3.00-(3.20) $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, clearly seen on both surface view and optical section, columellae polygonal or rarely circular when seen on surface view.
Ornamentation:	Psilate (LM). Perforate and granulate, puncta circular, smaller than 0.5 $\mu\text{m}$ (SEM).
Included taxa:	<i>Scaevola taccada</i> (Gaertn.) Roxb. – รักษะเด (ชุมพร); โหระ (กลาง, สงขลา); บงบั้ง (มลายู-ภูเก็ต) บงบง (ใต้) (GOODENIACEAE) (Plate 63 A-J)

#### 4.2.44 *Scolopia macrophylla* type

Pollen class:	3-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.90)-1.12-(1.43)
Shape class:	Oblate spheroidal to prolate
Size class:	Small
	P=(14.20)-15.56-(17.20) $\mu\text{m}$ , E=(12.00)-13.95-(16.40) $\mu\text{m}$
Polar area index:	(0.24)-0.30-(0.33)
Polar outline:	Circular-triangular
Equatorial outline:	Elliptic to circular-elliptic

Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (10.80)-11.68-(13.50) X (0.80)-1.40-(2.80) $\mu\text{m}$ , margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; colpus membrane densely granulate; costa ectocolpi present. Endoapertures – colpi, lalongate elliptic, some grains equatorial ends diffused, sometimes endoaperture indistinct, (1.20)-1.72-(2.00) X (2.50)-3.39-(4.20) $\mu\text{m}$ , margin (in)distinct.
Exine:	Semitectate; exine thickness (0.80)-1.11-(1.50) $\mu\text{m}$ ; sexine as thick as or thinner than nexine; columellae obscure.
Ornamentation:	Microreticulate (LM), lumina irregular in size and shape, circular, polygonal and oblong; muri angulated or smooth, narrower at the top and gradually broader below (SEM).
Included taxa:	<i>Scolopia macrophylla</i> (W. & A.) Clos – ตะขบน้ำ, ตะขบทะเล (นราธิวาส); ขี้ลาโก้ (มลายู-นราธิวาส) (SALICACEAE) (Plate 64 A-J)

#### 4.2.45 *Scyphiphora hydrophyllacea* type

Pollen class:	3-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.77)-0.89-(0.98)
Shape class:	Suboblate to oblate spheroidal
Size class:	Small to medium sized P=(18.80)-21.70-(24.00) $\mu\text{m}$ , E=(20.50)-24.44-(28.20) $\mu\text{m}$
Polar area index:	(0.14)-0.23-(0.29)
Polar outline:	Triangular-circular; angulaperturate
Equatorial outline:	Elliptic to circular-elliptic
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (14.50)-18.74-(22.60) X (2.50)-3.36-(3.80) $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate; costa ectocolpi present. Mesoaperture – pori, lalongate elliptic or subcircular, (2.50)-5.75-(8.00) X (2.40)-



3.97-(5.60)  $\mu\text{m}$ , margin distinct, protruding; costa mesopori present. Endoapertures – pori, lalongate elliptic with diffused equatorial ends, (5.20)-8.23-(10.50) X (7.80)-12.35-(15.00)  $\mu\text{m}$ , margin distinct; costa endopori present, some grains costae indistinct.

Exine: Semitectate; exine thickness (1.50)-1.68-(2.20)  $\mu\text{m}$ , generally increase toward aperture; sexine thicker than nexine; columellae distinct, clearly seen on optical section than on surface view.

Ornamentation: Microreticulate (LM). Microreticulate, lumina polygonal or circular, irregular in size and shape, heterobrochate; muri psilate (SEM).

Included taxa: *Scyphiphora hydrophyllacea* C.F. Gaertn. – จิ้งจ่า (กทม.); จิ้งจ่า (ตรัง); ชี้อ่ำ (มลายู-ภูเก็ต, สตูล); รังแก (ชุมพร) (RUBIACEAE) (Plate 65 A-J)

#### 4.2.46 *Sesuvium portulacastrum* type

Pollen class: 3-colpate

Dispersal unit: Monad

Polarity: Isopolar

P/E ratio: (0.76)-0.89-(0.97)

Shape class: Suboblate to oblate spheroidal

Size class: Small

P=(16.00)-18.09-(20.40)  $\mu\text{m}$ , E=(18.00)-20.45-(22.80)  $\mu\text{m}$

Polar area index: (0.18)-0.25-(0.31)

Polar outline: Circular to trilobate

Equatorial outline: Elliptic to circular-elliptic

Apertures: Colpi, slightly shorter than polar axis, (16.60)-14.70-(12.20) X (3.00)-4.83-(6.40)  $\mu\text{m}$ , wide, margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate.

- Exine: Tectate perforate; exine thickness (0.60)-1.05-(1.50)  $\mu\text{m}$ ; sexine as thick as or thicker than nexine; columellate distinct, clearly seen on both surface view and optical section.
- Ornamentation: Perforate (LM). Granulate-perforate, pore irregular in size and shape, pore circular or polygonal, pore smaller than 0.5  $\mu\text{m}$  (SEM).
- Included taxa: *Sesuvium portulacastrum* (L.) L. – ผักเบี้ยทะเล (เพชรบุรี); แพงพวยทะเล (ชุมพร) (AIZOACEAE) (Plate 66 A-J)

#### 4.2.47 *Shirakiopsis indica* type

- Pollen class: 3-colporate
- Dispersal unit: Monad
- Polarity: Isopolar
- P/E ratio: (1.12)-1.20-(1.27)
- Shape class: Prolate spheroidal to subprolate
- Size class: Small to medium sized  
P=(23.60)-27.69-(30.20)  $\mu\text{m}$ , E=(20.00)-23.16-(26.60)  $\mu\text{m}$
- Polar area index: (0.14)-0.21-(0.28)
- Polar outline: Triangular-circular
- Equatorial outline: Elliptic
- Apertures: Ectoapertures – colpi, slightly shorter than polar axis, (20.50)-22.44-(24.20) X (1.40)-1.83-(2.50)  $\mu\text{m}$ , margin distinct, widen at equator and tapering toward poles, polar ends acute; margo present, distinct, psilate; colpus membrane densely granulate; costa ectocolpi present. Endoapertures – pori, sometimes indistinct, lalongate elliptic, equatorial ends diffused, (2.00)-3.41-(5.00) X (3.50)-4.81-(5.80)  $\mu\text{m}$ , margin distinct or indistinct; costa endopori present, some grains costae indistinct.
- Exine: Semitectate; exine thickness (1.80)-1.86-(2.00)  $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, clearly seen on both surface

view and optical section, columellae circular when seen on surface view.

Ornamentation: Microreticulate, lumina circular or elliptic, different in size (LM); muri smooth, narrower (SEM).

Included taxa: *Shirakiopsis indica* (Willd.) Esser – สมอทะเล, กระทุศ (กลาง); กือเราะ, กือรัก, กือระ, กือระ, กือลา (มลายู-ใต้) (EUPHORBIACEAE) (Plate 67 A-J)

#### 4.2.48 *Sonneratia griffithii* type

Pollen class: 3-porate

Dispersal unit: Monad

Polarity: Isopolar

P/E ratio: (1.16)-1.44-(1.79)

Shape class: Subprolate to prolate

Size class: Small to medium sized

$P=(27.50)-34.21-(39.00) \mu\text{m}$ ,  $E=(18.00)-23.94-(29.20) \mu\text{m}$

Polar area index: -

Polar outline: Triangular with protruding pore on each side, and with convexity on the middle part of each side, then appearing as 6-lobate, hexangular, circular-hexangular, or circular with protruding pore on each side.

Equatorial outline: Elliptic-oblong to elliptic, rhomboidal-elliptic, or barrel-shape.

Apertures: Pori – circular or subcircular, (3.20)-4.36-(7.50) X (3.50)-4.56-(6.40)  $\mu\text{m}$ ; opercula present, gemmate, gemma different in size and shape; annulus present, distinct.

Exine: Tectate; exine thickness (1.80)-2.43-(3.80)  $\mu\text{m}$ , relatively thicker at apocolpium; sexine thicker than nexine; columellae distinct, clearly seen on both surface view and optical section, more distinct on apocolpium surface view, columellae circular or polygonal when seen on surface view; irregular in size.

Ornamentation: Granulate to gemmate; apoporia psilate, columellae present under tectum on apoporia when seen on polar view (LM). Granulate to gemmate, granules or gemmae irregular in size and shape; apoporia psilate with sparsely perforate or foveolate (SEM).

Included taxa: *Sonneratia alba* Sm. – ลำแพน (กลาง, สดุด); รำป่าด (มลายู-สดุด); ปาด (พังงา, ภูเก็ต); บูแม (มลายู-นราธิวาส) (LYTHRACEAE) (Plate 68 A-J)

*Sonneratia caseolaris* (L.) Engl. – ลำพู (กลาง, ฝรั่ง) (LYTHRACEAE) (Plate 69 A-J)

*Sonneratia griffithii* Kurz. – ลำแพนหิน (จันทบุรี, ตราด); ลำแพนทะเล (กลาง); ลำแพน (กลาง, สดุด) (LYTHRACEAE) (Plate 70 A-J)

*Sonneratia ovata* Backer. – ลำแพน (กลาง, สดุด); ลำพูพิน (กลาง) (LYTHRACEAE) (Plate 71 A-J)

#### Key to subtypes:

- 1a Ridges on mesopodium present.....2
- 1b Ridges on mesopodium absent.....3
- 2a Polar outline triangular with protruding pore on each side, triangular with convexity on the middle part of each side, or 6-lobate; gemmate-fossulate on ridge at mesopodium .....*Sonneratia alba* subtype
- 2b Polar outline triangular with protruding pore on each side, triangular with convexity on the middle part of each side, or hexangular; fossulate on ridge at mesopodium .....*Sonneratia griffithii* subtype
- 3a Polar outline circular-hexangular or circular with protruding pore on each side, or triangular with convex sides; equatorial outline elliptic or rhomboidic-elliptic, very tapering toward apopodium.....*Sonneratia caseolaris* subtype

- 3b Polar outline hexangular or triangular with protruding pore on each side; equatorial outline elliptic-oblong, or barrel-shape.....*Sonneratia ovata* subtype

#### 4.2.49 *Stenochlaena palustris* type

Spore class:	Monolete
Dispersal unit:	Monad
Polarity:	Heteropolar
P/E ratio:	(0.50)-0.62-(0.70)
Shape class:	Peroblate to oblate
Size class:	Small to medium sized
	P=(20.00)-24.74-(29.40) $\mu\text{m}$ , E=(35.20)-39.91-(49.20) $\mu\text{m}$
Arm length/radius:	-
Shape:	Ellipsoidal or boat-shape
Laesura:	Monolete, (1.80)-2.20-(3.00) X (18.00)-25.42-(32.00) $\mu\text{m}$ .
Sclerine:	Sclerine thickness (1.40)-1.78-(2.20) $\mu\text{m}$ ; perine thicker than exospore.
Ornamentation:	Verrucate or short baculate present only on distal surface, proximal surface and interbaculate area psilate (LM and SEM).
Included taxa:	<i>Stenochlaena palustris</i> (Burm. f.) Bedd. – ประสน, ผักขอดแดง (กลาง); นีติง (มลายู-นราธิวาส); ปากูมะติง (มลายู-ยะลา); ผักกูดแดง (กทม., ลำปาง); ผักกูดมอญ (กทม.); ลำเท็ง (ยะลา); ลำมะเท็ง (นครราชสีมา, ประจวบคีรีขันธ์) (BLECHNACEAE) (Plate 72 A-H)

#### 4.2.50 *Suaeda maritima* type

Pollen class:	Polyantoporate
Dispersal unit:	Monad
Polarity:	Apolar
P/E ratio:	(1.00)-1.03-(1.06)
Shape class:	Oblate spheroidal to prolate spheroidal
Size class:	Small
	Diameter (14.80)-17.06-(18.80) X (14.20)-16.64-(18.50) $\mu\text{m}$

Polar area index:	-
Outline:	Circular or subcircular
Apertures:	Pori circular or subcircular, (1.20)-1.65-(2.00) X (1.00)-1.62-(2.00) $\mu\text{m}$ ; operculum microechinate.
Exine:	Tectate perforate; exine thickness (1.50)-1.78-(2.00) $\mu\text{m}$ ; sexine thicker than nexine; columellae distinct, clearly seen on optical section than on surface view.
Ornamentation:	Granulate (LM). Perforate and microechinate, pore smaller than 0.5 $\mu\text{m}$ (SEM).
Included taxa:	<i>Suaeda maritima</i> (L.) Dumort. – ชะคราม (กลาง, หนองคาย); ชักคราม (กลาง); ตำคราม (สมุทรสาคร) (AMARANTHACEAE) (Plate 73 A-F)

#### 4.2.51 *Terminalia catappa* type

Pollen class:	3-colporate with 3-pseudocolpate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(1.01)-1.15-(1.37)
Shape class:	Prolate spheroidal to prolate
Size class:	Small P=(14.00)-15.46-(17.20) $\mu\text{m}$ , E=(12.20)-13.45-(15.20) $\mu\text{m}$
Polar area index:	(0.18)-0.26-(0.34)
Polar outline:	Hexangular with constriction on each side or 6-lobate
Equatorial outline:	Elliptic to circular-elliptic
Apertures:	Ectoapertures – colpi, slightly shorter than polar axis, (9.40)-11.54-(13.00) X (1.00)-1.42-(2.00) $\mu\text{m}$ , very narrow, margin distinct, slightly widen at equator and tapering toward poles, polar ends acute; colpus membrane granulate. Endoapertures – colpi, lalongate elliptic to oblong-elliptic, (1.80)-2.16-(3.00) X (3.00)-3.57-(4.20) $\mu\text{m}$ , margin distinct. Pseudoapertures – colpi, alternate with true apertures, as long as ectoaperture.

- Exine: Tectate imperforate; exine thickness (0.80)-1.08-(1.20)  $\mu\text{m}$ ; sexine as thick as nexine; columella invisible under LM.
- Ornamentation: Psilate (LM). Rugulate with scattered minute puncta, puncta smaller than 0.5  $\mu\text{m}$  (SEM); pseudoaperture surface psilate (LM), granulate (SEM).
- Included taxa: *Terminalia catappa* L. – หูกวาง (กทม., เหนือ); โคน (นราธิวาส); ตัดมือ, ตัดมือ (ตรัง); ตาปั้ง (พินนุโลก, สตูล); ตาแป๊ะ (มลายู-นราธิวาส); หลุมปั้ง (ใต้, สุราษฎร์ธานี) (COMBRETACEAE) (Plate 74 A-K)

#### 4.2.52 *Thespesia populnea* type

- Pollen class: Polyantocolporate
- Dispersal unit: Monad
- Polarity: Apolar
- P/E ratio: 1.00-(1.05)-1.15
- Shape class: Oblate spheroidal to subprolate
- Size class: Large to very large  
Diameter (57.20)-81.24-(111.25) X (54.00)-78.00-(103.75)  $\mu\text{m}$
- Polar area index: -
- Outline: Circular or subcircular
- Apertures: Ectoapertures – colpi, very short, slightly longer than endoapertures, (4.80)-10.58-(19.20) X (0.80)-2.04-(3.50)  $\mu\text{m}$ , margin distinct, ends acute or obtuse; colpus membrane psilate or granulate. Endoapertures – pori, circular or subcircular, (4.00)-6.59-(9.20) X (4.00)-6.25-(8.80)  $\mu\text{m}$ , margin distinct; costa endopori present.
- Exine: Tectate perforate; exine thickness (2.00)-3.90-(6.40)  $\mu\text{m}$ ; sexine (exclude spines) thicker than nexine; columellae distinct, clearly seen on both surface view and optical section; on surface view columellae irregular in size and shape, smaller and usually circular under interspinal area, bigger and polygonal under spinal base.



Ornamentation: Echinatae, echinae conical with point end, (2.80)-5.22-(9.00) X (5.50)-11.52-(19.00)  $\mu\text{m}$ ; cushion present at echinus bases, (6.50)-11.31-(18.20) X (1.40)-2.36-(4.00)  $\mu\text{m}$ ; area between echinae perforate to microreticulate (LM), tectum surface with granules (SEM).

Included taxa: *Hibiscus tiliaceus* L. – ปอทะเล (กลาง); ขมิ้นนางมัทรี (เลย); บา (กลาง, ใต้); ปอนา (ใต้); ปอฝ้าย (กลาง, เหนือ); ผีหยิก (เลย); โปทะเล (กทม., เพชรบุรี) (MALVACEAE) (Plate 75 A-H)

*Thespesia populnea* (L.) Sol. ex Corrêa – โปทะเล (ก้านยาว) (กทม., เพชรบุรี); บากู (ปัตตานี, มลายู-นราธิวาส); ปอกะหมัดไพร (ราชบุรี); ปอ มัดไซ (เพชรบุรี) (MALVACEAE) (Plate 76 A-H)

*Thespesia populneoides* (Roxb.) Kostel. – โปทะเล (ก้านยาว) (กทม., เพชรบุรี) (MALVACEAE) (Plate 77 A-H)

#### Key to subtypes:

- 1a Area between echinae sparsely perforate (LM), puncta circular, smaller than 0.5  $\mu\text{m}$ , densely at cushion, tectum surface almost psilate with sparsely distributed granules (SEM); grains large to very large, diameter=(92.50)-102.00-(111.25) X (91.25)-99.00-(103.75)  $\mu\text{m}$ .....*Hibiscus tiliaceus* subtype
- 1b Area between echinae densely perforate to microreticulate (LM), puncta or lumina irregular in size and shape, circular, polygonal or oblong, tectum surface with sparsely or densely granules (SEM); grains large, diameter=(57.20)-70.86-(99.20) X (54.00)-67.50-(97.80)  $\mu\text{m}$ .....*Thespesia populnea* subtype  
(Including: *Thespesia populnea*; *Thespesia populneoides*)

#### Remarks:

This type can be subdivided in to two subtypes by sizes and the detail of perforations. Moreover, Aperture number is not exactly counted, but it is noticeable that *Hibiscus tiliaceus* subtype seem to have more aperture number rather than *Thespesia*

*populnea* subtype. Within *Thespesia populnea* subtype, *T. populnea* grains have densely perforations on interspinal area while *T. populneoides* grains have sparsely perforations on interspinal area.

#### 4.2.53 *Xylocarpus rumphii* type

Pollen class:	(3-)4(-5)-colporate
Dispersal unit:	Monad
Polarity:	Isopolar
P/E ratio:	(0.81)-0.99-(1.14)
Shape class:	Suboblate to subprolate
Size class:	Small to medium sized
	P=(22.50)-29.89-(36.00) $\mu\text{m}$ , E=(25.50)-30.28-(37.50) $\mu\text{m}$
Polar area index:	(0.39)-0.53-(0.63)
Polar outline:	Circular to circular-tetragonal or triangular with convex sides
Equatorial outline:	Circular to subcircular
Apertures:	Ectoapertures – colpi, shorter than half length of polar axis, (6.80)-10.57-(16.20) X (0.60)-1.02-(1.60) $\mu\text{m}$ , margin distinct, oblong or slightly widen at equator and tapering toward poles, polar ends acute or obtuse; colpus membrane psilate; margo present, slightly protruding around ectoaperture, indistinct. Endoapertures – pori, circular or subcircular, (1.80)-3.00-(4.60) X (2.00)-3.21-(5.00) $\mu\text{m}$ , margin distinct; costa endopori present, distinct.
Exine:	Tectate perforate; exine thickness (0.80)-1.29-(2.00) $\mu\text{m}$ ; sexine as thick as or thicker than nexine; columella invisible under LM.
Ornamentation:	Psilate or perforate (LM). Perforate, puncta circular and elliptic, irregular in size and shape, almost smaller than 0.5 $\mu\text{m}$ (SEM).
Included taxa:	<i>Xylocarpus granatum</i> J. Koenig. – ตะบูนขาว, ตะบูน, กระบูนขาว (กลาง, ใต้) (MELIACEAE) (Plate 78 A-J)

*Xylocarpus moluccensis* (Lam.) M. Roem. – ตะบูนดำ (กลาง);  
ตะบัน (กลาง, ใต้) (MELIACEAE) (Plate 79 A-J)

*Xylocarpus rumphii* (Kostel.) Mabb. – ตะบัน (กลาง, ใต้)  
(MELIACEAE) (Plate 80 A-L)

**Remarks:**

There is a variation in aperture number of these three species. Some grains of *X. granatum* are 3-aperturate grains while 5-aperture found in *X. moluccensis*. Some grains of *X. rumphii* are 3- and 5-aperturate grains. Besides, endopori of *X. granatum* are approximately 1.5 as big as endopori of *X. moluccensis*. and *X. rumphii*.



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จุฬาลงกรณ์มหาวิทยาลัย

**Table 4** Pollen and spore morphological data of mangrove flora in Thailand (Pol.=Polarity: I=Isopolar, S=Subisopolar, H=Heteropolar, A=Apolar; PAI=Polar Area Index; Shape class: pobi=peroblate, obl=oblate, sobl=suboblate, obls=oblate spheroidal, pros=prolate spheroidal, spro=subprolate, pro=prolate, ppro=perprolate; PXE=Polar grain size showing mean for polar axis (P) and equatorial diameter (E); Size class: SS=very small, S=small, M=medium sized, X=large, XL=very large; Ectoaperture=size of ectoaperture presented in polar width $\times$ equatorial width; Endoaperture=size of endoaperture presented in polar width $\times$ equatorial width; Exine=exine thickness; Ornamentation: psi=psilate, gra=granulate, gem=gemmate, ver=verrucate, mbac=microbaculate, bac=baculate, cla=clavate, mech=microechinate, ech=echinate, mrug=microrugulate, rug=rugulate, mstr=microstriate, str=striate, glb=globule, rod=redlet, msp=mass of particles, fos=fossulate, per=perforate, fov=foveolate, mret=microreticulate, ret=reticulate, bmret=bimicroreticulate, srd=very small round depressions smaller than 0.5  $\mu\text{m}$ ; <sup>1</sup>=ratio of laesura arm length and spore radius; <sup>2</sup>=size of laesura arm presented in length $\times$ width; <sup>3</sup>=sclerine thickness; <sup>4</sup>=sulcus size presented in length $\times$ width)

Species	Pollen class	Pol.	PAI	P/E ratio	PXE	Shape class	Size class	Ectoaperture ( $\mu\text{m}$ )	Endoaperture ( $\mu\text{m}$ )	Exine ( $\mu\text{m}$ )	Ornamentation	
											LM	SEM
<i>Acanthus ebracteatus</i>	3-colpate	I-S	0.26	1.44-1.81	30.63X18.83	pro	S-M	-	24.43X1.20	1.2-2.0	mret	gra-per-mret
<i>Acanthus ilicifolius</i>	3-colpate	I-S	0.38	1.31-2.14	38.08X20.77	spro-ppro	S-M	-	31.30X0.86	2.0-2.8	ret	ret
<i>Acanthus volubilis</i>	3-colpate	I	0.38	1.34-1.48	41.03X29.42	pro	M	-	31.03X1.43	2.0-2.8	mret	mret
<i>Acrostichum aureum</i>	trilete	H	0.60 <sup>1</sup>	0.58-0.75	34.71X52.34	obl-sobl	M-L	-	16.61X1.56 <sup>2</sup>	2.0-2.5 <sup>3</sup>	gra	gra
<i>Acrostichum speciosum</i>	trilete	H	0.61 <sup>1</sup>	0.72-0.85	44.40X55.25	obl-sobl	M-L	-	17.30X1.43 <sup>2</sup>	1.4-2.3 <sup>3</sup>	gra	gra-rod
<i>Aegialitis rotundifolia</i>	3-colpate	I	0.17	0.62-0.95	46.11X63.26	obl-obls	M-L	-	39.48X7.13	7.4-10.0	gem-cla	gem-cla
<i>Aegiceras corniculatum</i>	3-colporate	I	0.33	1.06-1.37	18.92X15.91	pros-pro	S	18.71X3.92	2.66X8.23	0.6-1.0	psi	per
<i>Aglaia cucullata</i>	3-colporate	I	0.76	1.23-1.70	18.27X12.09	spro-pro	S	6.27X0.45	2.41X3.77	0.8-1.4	psi, mret	per, bmret
<i>Allophylus cobbe</i>	3-porate	I-S	-	0.61-0.78	18.42X26.26	obl-sobl	S-M	-	4.53X4.01	1.0-2.0	mret	rug-mret
<i>Antidesma ghaesembilla</i>	3-colporate	I	0.23	1.54-1.92	18.66X11.07	pro	S	15.92X0.70	1.65X6.03	1.0-1.8	mret	str-mret
<i>Ardisia elliptica</i>	3-colporate	I	0.34	0.92-1.14	12.48X12.26	obls-spro	S	9.61X2.04	1.69X4.66	1.0-1.4	mret	mret
<i>Atalantia monophylla</i>	4(-5)-colporate	I-H	0.34	1.08-1.23	22.43X19.64	pros-spro	S	15.80X1.68	2.39-5.30	1.0-1.8	psi	fos-per
<i>Avicennia alba</i>	3-colporate	I	0.25	1.00-1.14	23.78X22.63	obls-spro	S-M	19.32X9.50	7.95X8.19	1.8-2.2	mret-ret	mret-ret
<i>Avicennia marina</i>	3-colporate	I	0.32	0.85-1.27	23.34X23.41	sobl-spro	S-M	16.68X6.42	6.49X6.88	1.8-2.8	mret-ret	mret-ret
<i>Avicennia officinalis</i>	3-colporate	I	0.15	0.88-0.99	27.92X29.56	sobl-obls	S-M	23.97X10.72	10.68X9.66	2.0-2.6	mret	mret
<i>Barringtonia asiatica</i>	3-parasyncolpate	I	-	1.23-1.64	46.82X33.94	spro-pro	M-L	-	43.31X4.40	1.2-2.0	psi-per-fov	per-fov
<i>Barringtonia racemosa</i>	3-parasyncolpate	I	-	1.07-1.38	37.45X29.60	pros-pro	S-M	-	34.05X3.71	1.6-2.6	psi-per	per

Table 4 (continued)

Species	Pollen class	Pol.	PAI	P/E ratio	PXE	Shape class	Size class	Ectoaperture ( $\mu\text{m}$ )	Endoaperture ( $\mu\text{m}$ )	Exine ( $\mu\text{m}$ )	Ornamentation	
											LM	SEM
<i>Bruguiera cylindrical</i>	3-colporate	I	0.29	0.88-1.20	10.93X10.75	sobl-spro	SS-S	8.94X0.64	2.04X5.45	0.8-1.2	psi	psi-srd
<i>Bruguiera gymnorhiza</i>	3-colporate	I	0.23	0.75-0.97	13.41X15.40	obl-obls	S	10.97X1.56	2.41X6.42	1.2-1.8	psi	psi-srd
<i>Bruguiera parviflora</i>	3-colporate	I	0.43	1.23-1.55	11.50X8.35	spro-pro	SS-S	7.62X0.58	2.79 in width	0.7-1.2	psi	psi-srd
<i>Bruguiera sexangula</i>	3-colporate	I	0.18	0.72-1.00	11.60X13.36	sobl-pros	S	9.97X0.60	1.91X6.17	1.0-1.5	psi	psi-srd
<i>Caesalpinia crista</i>	3-colporate	I	0.17	0.69-0.88	35.69X45.14	obl-obls	M-L	35.69X15.94	8.08X4.88	3.2-4.0	ret	ret
<i>Calophyllum inophyllum</i>	3-colporate	I	0.25	0.85-1.08	26.68X27.38	sobl-pros	S-M	21.82X2.36	4.56X12.30	2.0-3.0	mret	mret
<i>Calycopterus floribunda</i>	3-colporate + 3-pseudocolpate	I	0.68	0.90-1.02	17.83X18.85	obls-pros	S	9.08X1.07	2.81X3.97	1.6-2.2	psi	per
<i>Cerbera manghas</i>	3-colporate	I	0.45	0.89-1.00	68.22X73.75	obls-pros	L	53.63X13.87	19.46X15.48	2.0-2.8	per, gra	per, fos-per
<i>Cerbera odollam</i>	3-colporate	I	0.35	0.92-1.09	63.80X67.33	obls-pros	M-L	51.56X5.26	15.47X11.45	1.6-3.0	per, gra-per	per, ver-per
<i>Ceriops decandra</i>	3-colporate	I	0.38	0.89-1.07	15.80X16.17	obls-pros	S	12.20X1.04	3.34X6.06	1.2-1.8	psi	per
<i>Ceriops tagal</i>	3-colporate	I	0.29	0.82-0.98	10.75X11.61	sobl-obls	S	8.60X0.50	1.73X5.24	0.8-1.0	psi	per
<i>Clerodendrum inerme</i>	3-colpate	I	0.43	0.98-1.11	35.71X34.42	obls-pros	M	-	21.13X2.54	1.4-2.0	gra	mech-ech-per
<i>Crinum asiaticum</i>	2-colpate	I	0.29	0.88-1.15	40.35X40.69	sobl-spro	M-L	-	39.44X10.22 <sup>4</sup>	1.8-2.8	gra	mech-ech-mbac
<i>Cynometra ramiflora</i>	3-(syn)colporate	I-H	0.16	0.94-1.06	24.51X24.85	obls-pros	S-M	21.62X3.66	5.03X5.33	1.2-2.0	psi	per
<i>Dalbergia candenatensis</i>	3-colporate	I	0.41	0.91-1.16	19.71X19.19	obls-spro	S	12.24X2.80	3.73X8.13	1.0-1.8	psi	per
<i>Derris trifoliata</i>	3-colporate	I	0.50	0.76-1.00	18.35X21.93	sobl-pros	S-M	12.45X3.61	3.87X7.23	0.8-1.5	mret	per
<i>Diospyros areolata</i>	3-colporate	I-H	0.20	0.94-1.15	36.81X35.30	obls-spro	M	32.15X2.60	4.83X13.14	1.4-2.0	psi	mstr-rug
<i>Dolichandrone spathacea</i>	3-colpate	I	0.22	0.93-1.16	39.15X38.43	obls-spro	M	-	31.80X7.68	1.2-2.2	ret	ret
<i>Drynaria quercifolia</i>	monolete	H	-	0.50-0.68	31.25X50.74	obl	M-L	-	17.59X1.42 <sup>2</sup>	0.8-1.5 <sup>3</sup>	ech	ech-gra-ver
<i>Excoecaria agallocha</i>	3-colporate	I	0.21	0.80-1.02	27.45X31.14	sobl-pros	S-M	23.86X2.06	4.57X7.83	2.2-3.0	mret	mret
<i>Ficus microcarpa</i>	2-porate	S	-	0.70-0.88	8.09X10.46	obl-obls	SS-S	-	1.41X1.05	0.7-1.0	psi	psi
<i>Flagellaria indica</i>	1-porate	H	-	0.81-0.99	16.49X18.44	sobl-obls	S	-	2.73X2.54	1.2-1.8	per	gra-per
<i>Glochidion littorale</i>	4-colporate	I	0.38	0.88-1.01	22.02X12.45	sobl-pros	S-M	14.56X1.79	2.41X2.54	2.2-2.8	mret-ret	mret-ret

Table 4 (continued)

Species	Pollen class	Pol.	PAI	P/E ratio	PXE	Shape class	Size class	Ectoaperture ( $\mu\text{m}$ )	Endoaperture ( $\mu\text{m}$ )	Exine ( $\mu\text{m}$ )	Ornamentation	
											LM	SEM
<i>Heritiera littoralis</i>	3-colporate	I-H	0.28	0.92-1.01	17.46X18.28	obls-pros	S	13.66X0.92	1.73X3.84	0.6-1.2	gra	gra-rug
<i>Hibiscus tiliaceus</i>	polyantocolporate	A	-	1.00-1.09	102.00X99.00	obls-pros	L-XL	7.91X2.41	7.48X7.27	4.2-6.4	echi-per	echi-gra-per
<i>Horsfieldia irya</i>	1-colpate	H	-	0.75-0.92	14.03X16.90	obl-obls	S	-	12.85X1.68 <sup>4</sup>	0.8-1.4	mret	mret
<i>Intsia bijuga</i>	3-colporate	I	0.55	0.90-1.19	56.70X54.75	obls-spro	M-L	25.72X7.68	10.26X8.70	8.0-10.4	ret	ret
<i>Kandelia candel</i>	3-colporate	I	0.18	0.77-1.13	16.58X15.20	sobl-pros	S	14.42X0.90	2.13X7.83	1.2-1.8	psi	per
<i>Lecanopteris sinuosa</i>	monolete	H	-	0.60-0.79	29.35X44.57	obl-sobl	S-M	-	18.19X1.08 <sup>2</sup>	0.8-1.4 <sup>3</sup>	psi-gra	msp-glb
<i>Lumnitzera littorea</i>	3-colporate + 3-pseudocolpate	I	0.23	0.60-1.02	25.87X28.27	obl-pros	S-M	22.27X3.02	5.98X8.60	1.8-2.8	per	per
<i>Lumnitzera racemosa</i>	3-colporate + 3-pseudocolpate	I	0.28	0.84-1.11	22.14X20.00	sobl-pros	S-M	19.14X4.04	4.81X5.89	1.2-1.8	per	per
<i>Melaleuca cajuputi</i>	3-parasyncolporate	I	0.40	0.39-0.73	8.35X15.92	pobl-obl	SS-S	6.28X0.40	0.77X3.73	0.6-1.2	psi	fos-gra
<i>Melanthera biflora</i>	3-colporate	I	0.48	0.70-0.90	19.15X22.95	obl-obls	S-M	14.30X1.08	3.15X7.26	1.4-2.0	ech	ech-gra-per
<i>Melastoma saigonense</i>	3-colporate + 3-pseudocolpate	I	0.14	0.89-1.20	19.68X18.50	obls-spro	S	15.68X2.63	3.99X8.57	0.8-1.2	psi	psi-srd-per
<i>Nypa fruticans</i>	1-colpate	I	-	1.00-1.14	39.71X37.29	obls-spro	M	-	1.45 in width	1.5-2.4	ech-per-fov- mret-ret	ech-mret-ret
<i>Pandanus odoratissimus</i>	1-porate	H	-	1.15-1.39	17.86X14.15	spro-pro	S	-	2.84X1.89	0.8-1.5	gra	mech-echi-gra
<i>Peltophorum pterocarpum</i>	3-colporate	I	0.49	0.90-1.00	39.34X41.59	obls-pros	M	23.87X5.86	6.20X7.23	3.5-5.2	ret	ret
<i>Pemphis acidula</i>	(3-)4-colporate	I	0.41	1.08-1.39	29.59X25.44	pros-pro	S-M	15.69X2.56	5.41X5.58	1.2-2.0	psi	psi
<i>Phoenix paludosa</i>	1-colpate	H	-	0.81-1.03	13.97X15.82	sobl-pros	S	-	14.03X3.04 <sup>4</sup>	1.0-1.6	per-mret	mret-ret
<i>Planchonella obovata</i>	3(-4)-colporate	I	0.52	1.47-1.74	24.35X15.86	pro	S-M	17.46X0.90	2.23X4.25	0.8-1.4	psi	rug-per
<i>Pluchea indica</i>	3-colporate	I	0.40	0.76-1.01	16.06X17.91	sobl-pros	S	10.72X2.32	3.30X5.19	1.2-2.0	ech	ech-gra-per
<i>Pongamia pinnata</i>	3-colporate	I	0.29	0.71-1.13	21.35X23.05	obl-pros	S-M	18.28X2.26	6.12X8.87	1.4-2.0	mret	per
<i>Pyrrosia adnascens</i>	monolete	H	-	0.52-0.75	26.08X43.93	obl-sobl	S-M	-	19.90-0.90 <sup>2</sup>	1.8-2.2 <sup>3</sup>	gem-ver	gem-ver



Table 4 (continued)

Species	Pollen class	Pol.	PAI	P/E ratio	PXE	Shape class	Size class	Ectoaperture (µm)	Endoaperture (µm)	Exine (µm)	Ornamentation	
											LM	SEM
<i>Pyrrosia piloselloides</i>	monolete	H	-	0.59-0.72	32.70X52.02	obl	S-M	-	19.81X0.95 <sup>2</sup>	2.0-3.2 <sup>3</sup>	gem-ech	gem-ech
<i>Rhizophora apiculata</i>	3-colporate	I	0.27	1.03-1.24	19.35X16.89	pros-spro	S	19.06X0.84	2.76 in width	1.0-1.4	psi	per-mret
<i>Rhizophora mucronata</i>	3-colporate	I	0.25	1.04-1.25	18.02X16.40	pros-spro	S	16.38X1.00	1.89 in width	1.6-2.4	psi	per
<i>Scaevola taccada</i>	3-colporate	I	0.28	0.97-1.16	45.90X42.74	obls-spro	M-L	37.78X5.91	7.42X20.69	2.8-3.2	psi	gra-per
<i>Scolopia macrophylla</i>	3-colporate	I	0.30	0.90-1.43	15.56X13.95	obls-pro	S	11.68X1.40	1.72X3.39	0.8-1.5	mret	mret
<i>Scyphiphora hydrophyllacea</i>	3-colporate	I	0.23	0.77-0.98	21.70X24.44	sobl-obls	S-M	18.74X3.36	8.23X12.35	1.5-2.2	mret	mret
<i>Sesuvium portulacastrum</i>	3-colpate	I	0.25	0.76-0.97	18.09X20.45	sobl-obls	S	-	14.70X4.83	0.6-1.5	per	gra-per
<i>Shirakiopsis indica</i>	3-colporate	I	0.21	1.12-1.27	27.69X23.16	pros-spro	S-M	22.44X1.83	3.41X4.81	1.8-2.0	mret	mret
<i>Sonneratia alba</i>	3-porate	I	-	1.30-1.77	37.25X24.66	spro-pro	S-M	-	4.50X4.26	3.0-3.8	gem, psi	gem, gem-fos-per
<i>Sonneratia caseolaris</i>	3-porate	I	-	1.16-1.42	32.72X25.45	spro-pro	S-M	-	5.21X5.08	1.8-2.6	gem, psi	gem, psi
<i>Sonneratia griffithii</i>	3-porate	I	-	1.26-1.60	35.01X25.22	spro-pro	S-M	-	4.23X4.56	1.8-2.6	gem, psi	gem, fos-per, per
<i>Sonneratia ovate</i>	3-porate	I	-	1.41-1.79	31.85X20.42	pro	S-M	-	3.48X4.34	1.8-2.4	gem, psi	gem, fov
<i>Stenochlaena palustris</i>	monolete	H	-	0.50-0.70	24.74X39.91	pobl-obl	S-M	-	25.42X2.20 <sup>2</sup>	1.4-2.2 <sup>3</sup>	ver-bac	ver-bac
<i>Suaeda maritime</i>	polyantoporate	A	-	1.00-1.06	17.06X16.64	obls-pros	S	-	1.65X1.62	1.5-2.0	gra	mech-per
<i>Terminalia catappa</i>	3-colporate + 3-pseudocolpate	I	0.26	1.01-1.37	15.46X13.45	pros-pro	S	11.54X1.42	2.16X3.57	0.8-1.2	psi	rug-per
<i>Thespesia populnea</i>	polyantocolporate	A	-	1.01-1.09	79.68X76.60	pros	L	14.89X2.38	7.22X6.43	2.0-4.5	ech-per-mret	ech-gra-per
<i>Thespesia populneoides</i>	polyantocolporate	A	-	1.00-1.15	62.04X58.39	obls-spro	L	8.93X1.34	5.08X5.04	3.0-4.0	ech-per-mret	ech-gra-per
<i>Xylocarpus granatum</i>	(3-)4-colporate	I	0.50	0.88-1.08	32.88X32.94	sobl-pros	M	12.31X1.15	4.02X4.32	0.8-1.2	psi-per	per
<i>Xylocarpus moluccensis</i>	4(-5)-colporate	I	0.54	0.93-1.14	30.20X29.82	obls-spro	M	9.35X1.00	2.25X2.42	1.0-1.4	psi, per	per
<i>Xylocarpus rumphii</i>	(3-)4(-5)-colporate	I	0.55	0.81-1.04	26.58X28.09	sobl-pros	S-M	10.04X0.92	2.74X2.89	1.2-2.0	psi, per	per



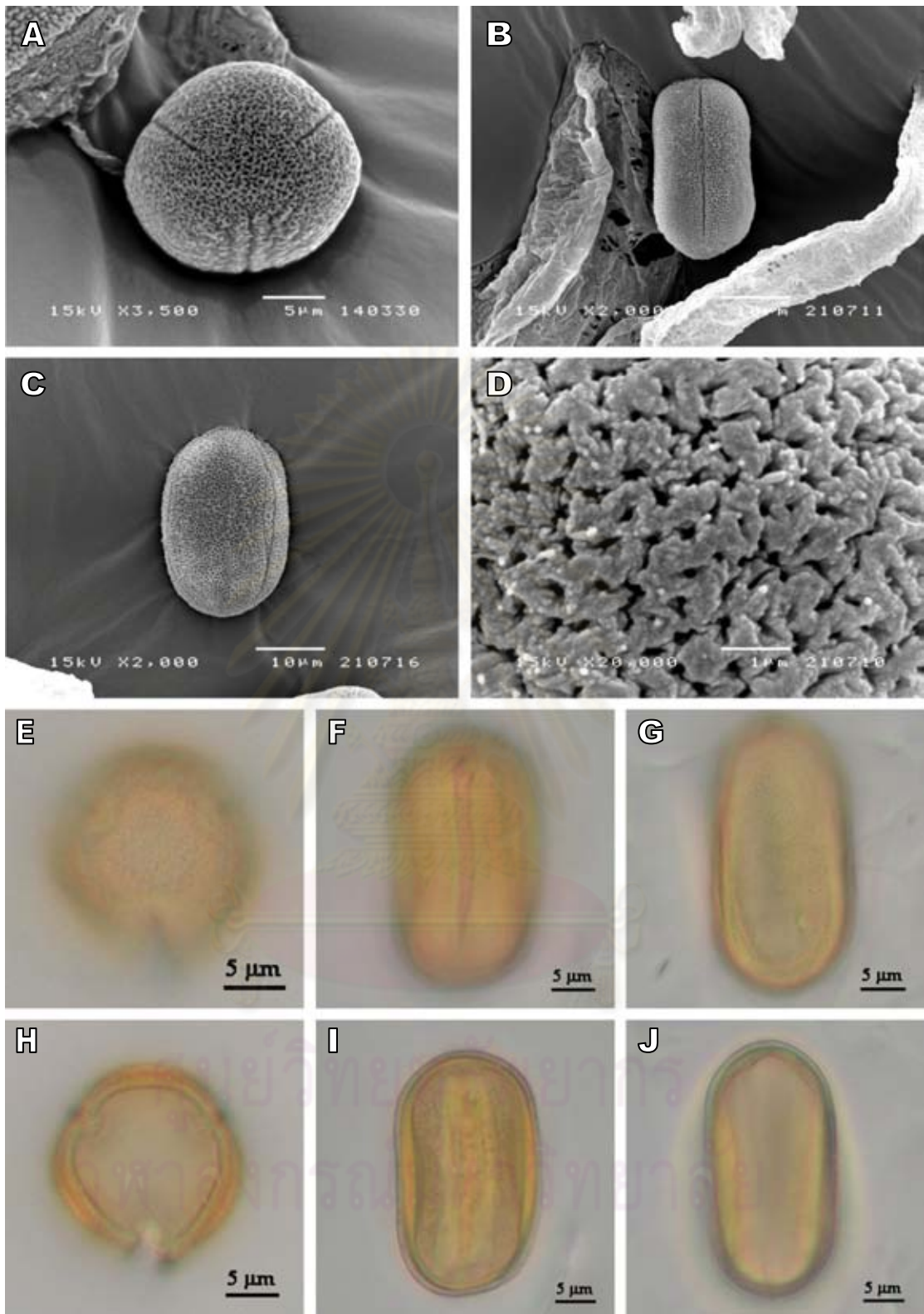


Plate 1 *Acanthus ebracteatus* Vahl: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

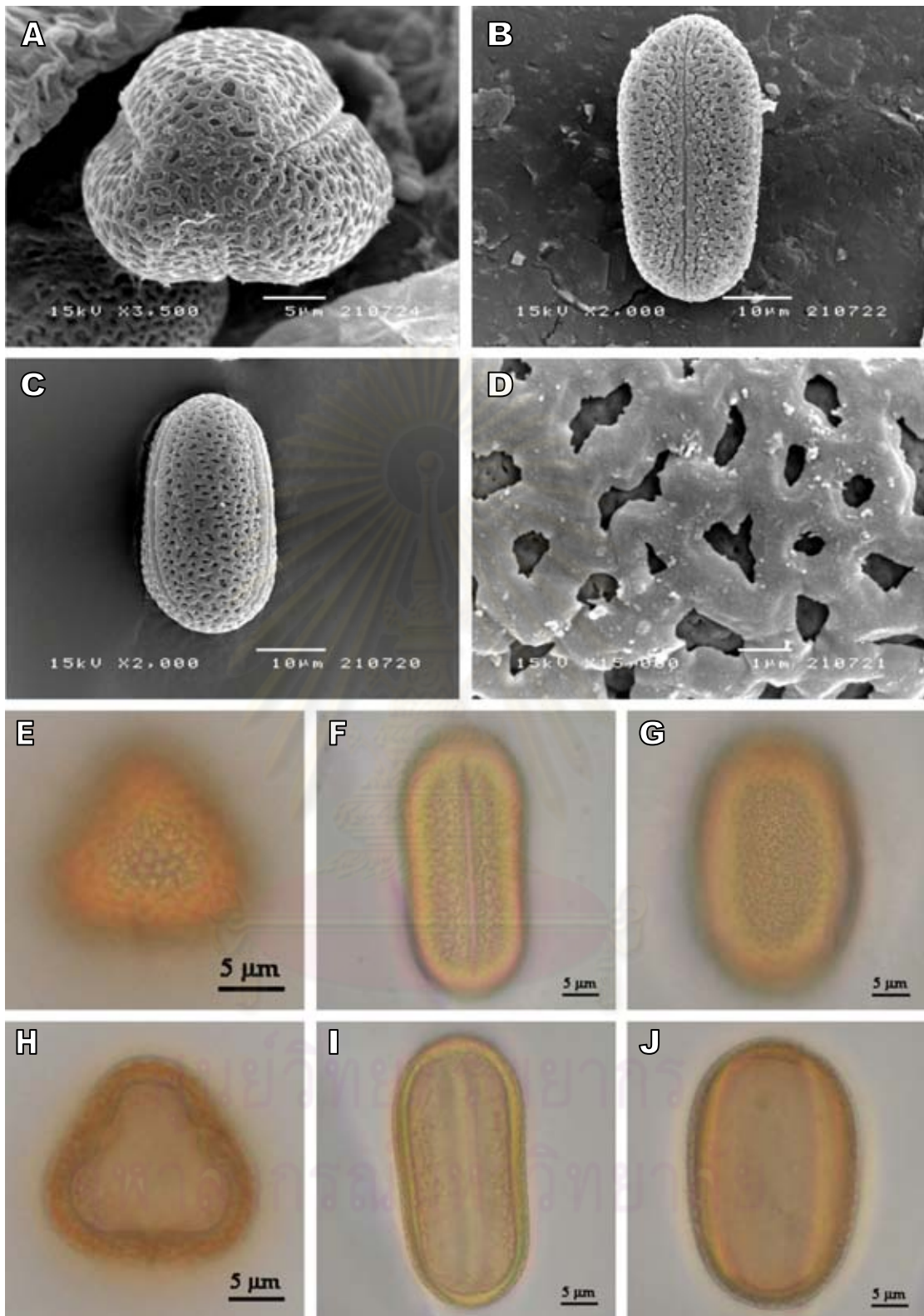


Plate 2 *Acanthus ilicifolius* L.: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

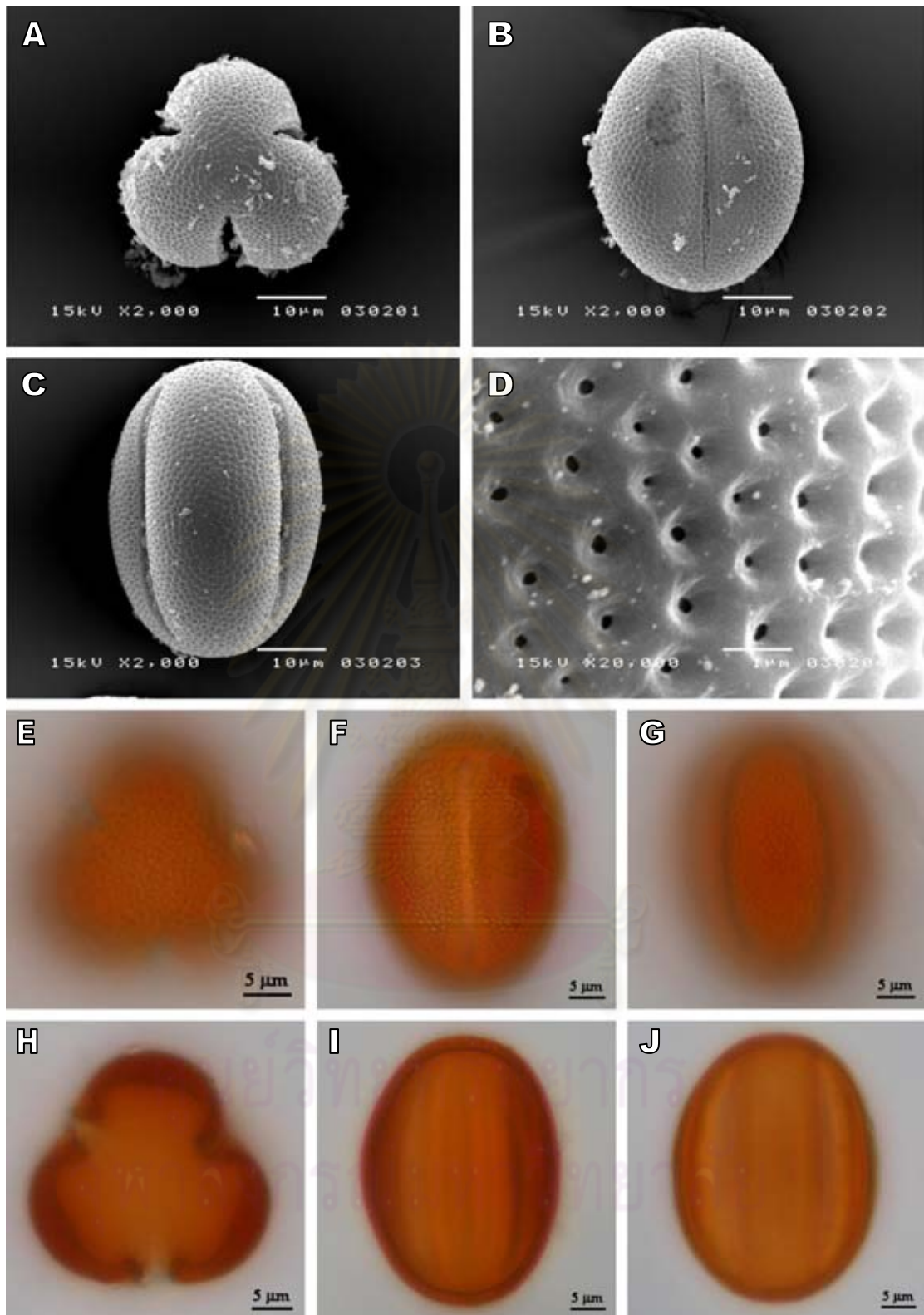


Plate 3 *Acanthus volubilis* Wall.: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).



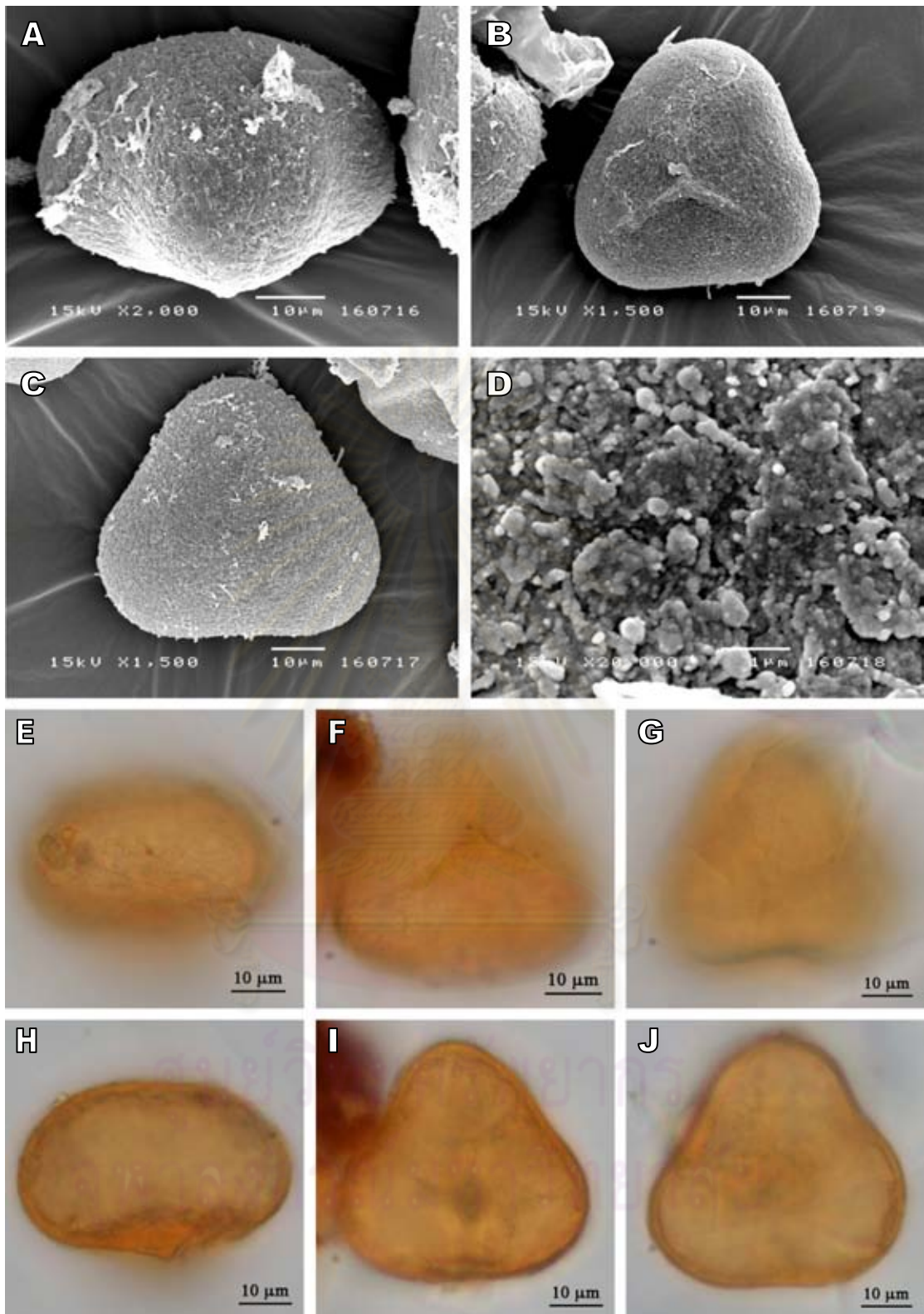


Plate 4 *Acrostichum aureum* L.: (A) Equatorial view, (B) Polar view, proximal side, laesura (C) Polar view, distal side, (D) Distal side, surface, (E) Equatorial view, surface, (F) Polar view, laesura, (G) Polar view, distal side, surface, (H) Equatorial view, optical section, (I) Proximal side, optical section, (J) Distal side, optical section (A-D: SEM; E-J: LM).

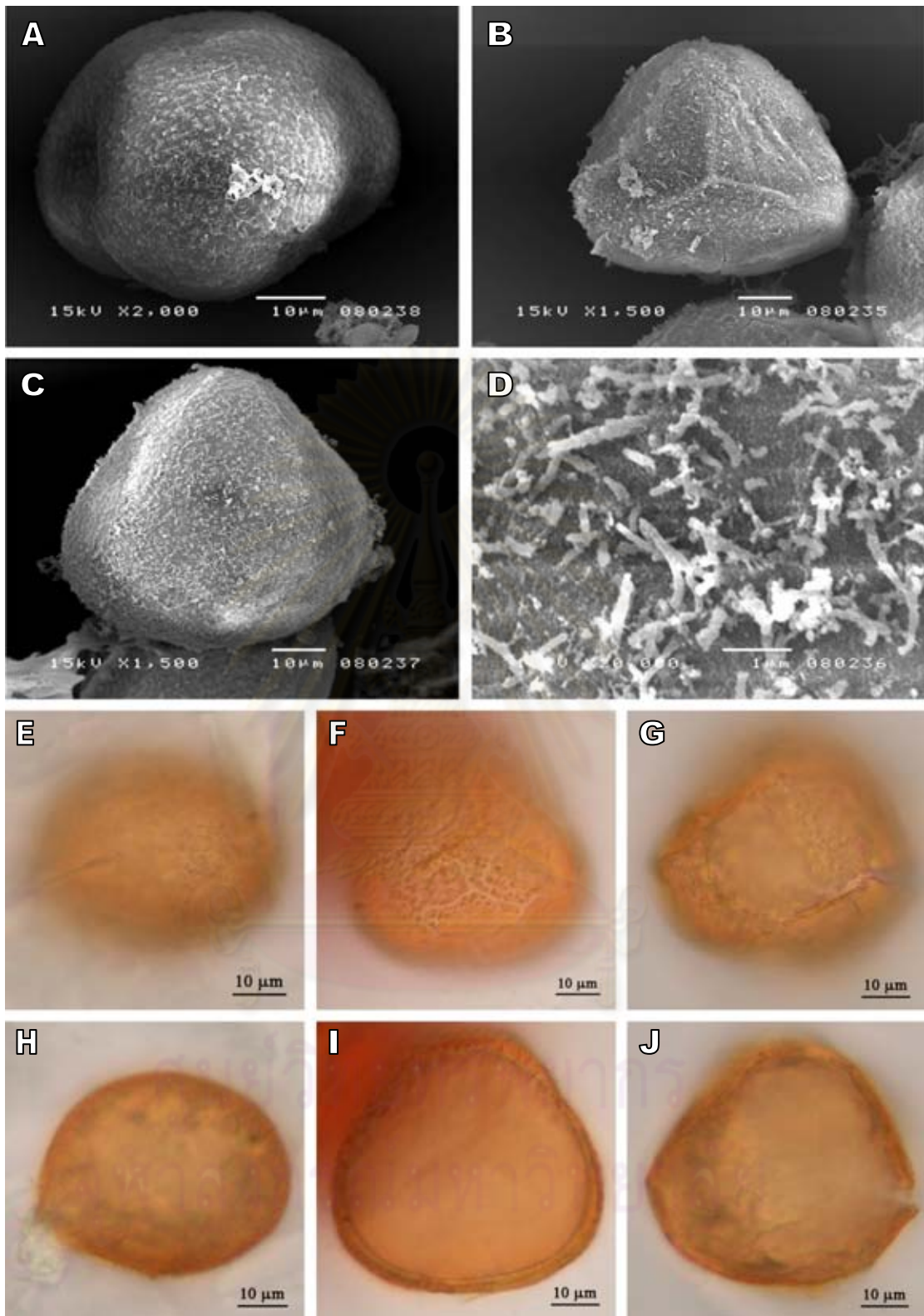


Plate 5 *Acrostichum speciosum* Willd.: (A) Equatorial view, (B) Polar view, proximal side, laesura (C) Polar view, distal side, (D) Distal side, surface, (E) Equatorial view, surface, (F) Polar view, laesura, (G) Polar view, distal side, surface, (H) Equatorial view, optical section, (I) Proximal side, optical section, (J) Distal side, optical section (A-D: SEM; E-J: LM).



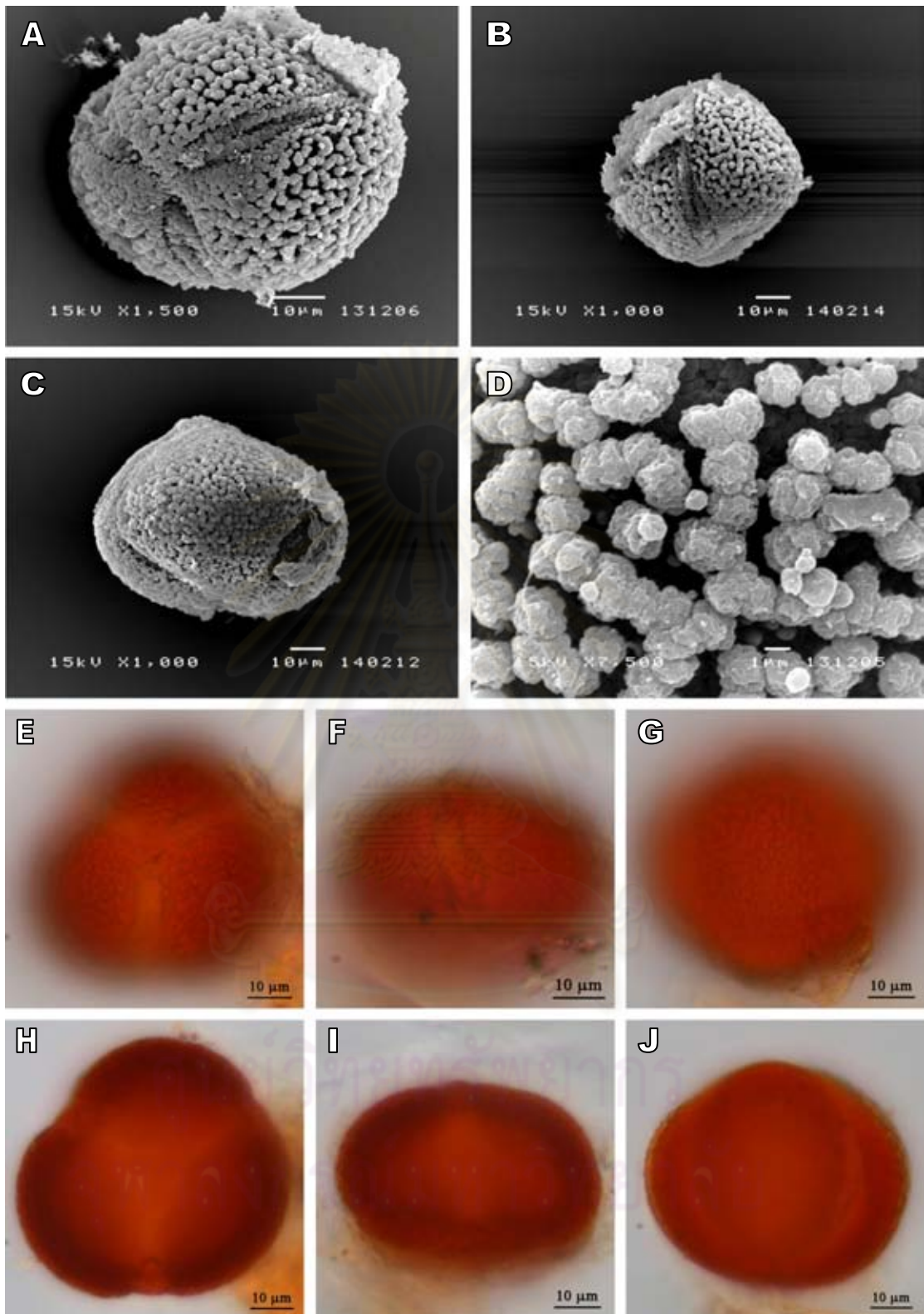


Plate 6 *Aegialitis rotundifolia* Roxb.: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

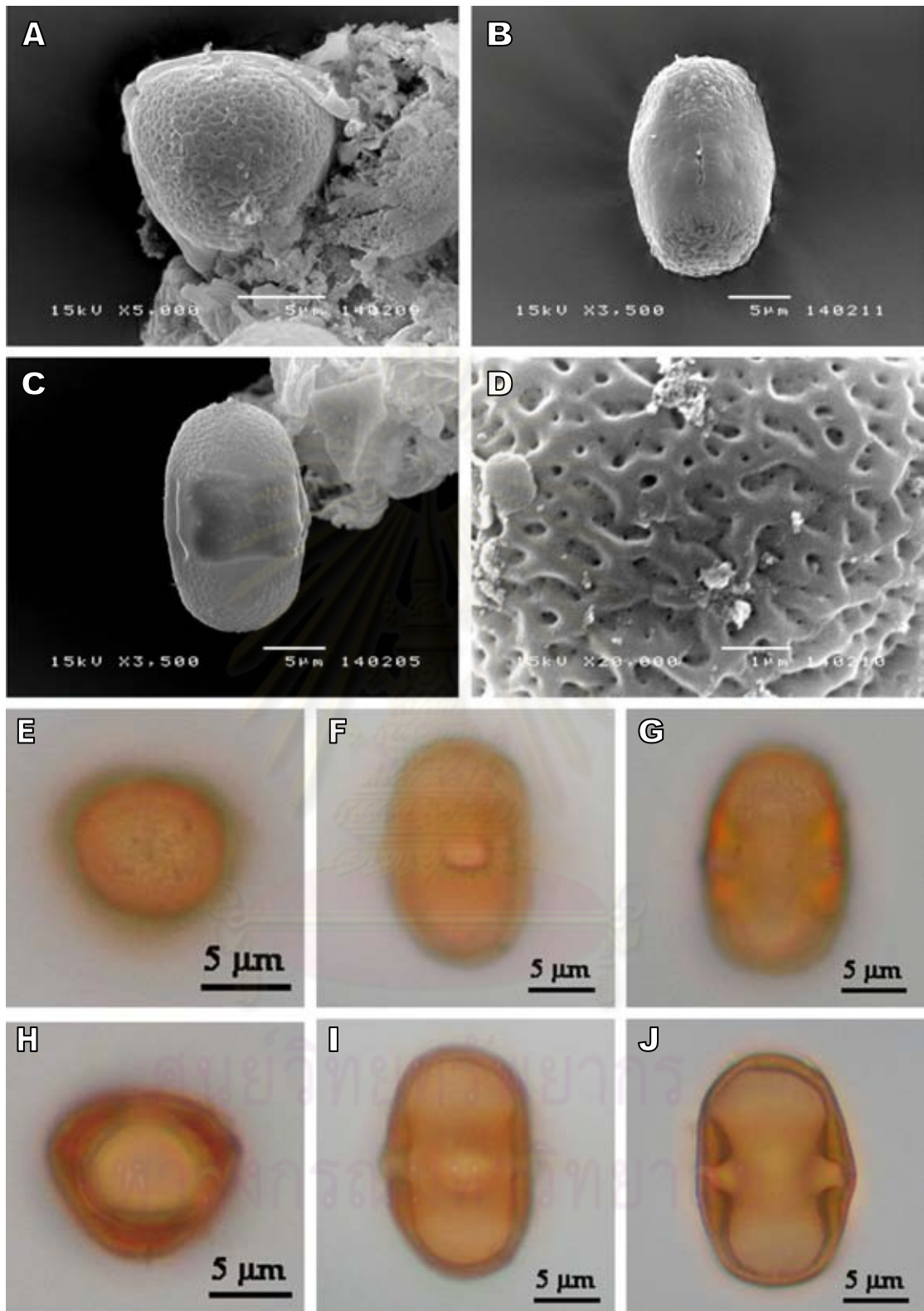


Plate 7 *Aglaia cucullata* (Roxb.) Pellegr.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Polar view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa endopori (A-D: SEM; E-J: LM).



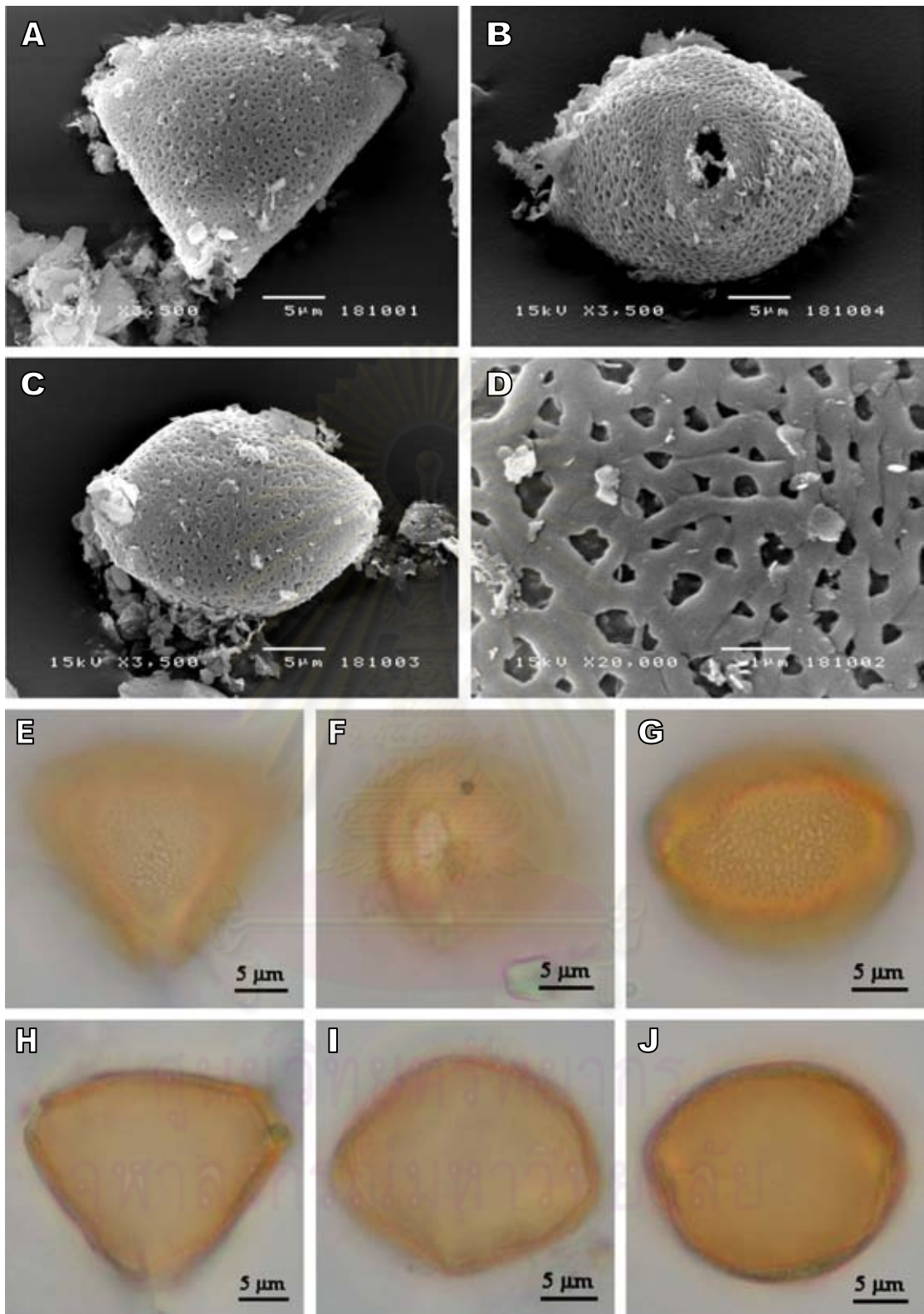


Plate 8 *Allophylus cobbe* (L.) Raeusch.: (A) Polar view, (B) Equatorial view, porus, (C) Equatorial view, mesoporus, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, porus, (G) Equatorial view, mesoporus surface, (H) Polar view, optical section, (I) Optical section under porus, (J) Optical section under mesoporus (A-D: SEM; E-J: LM).

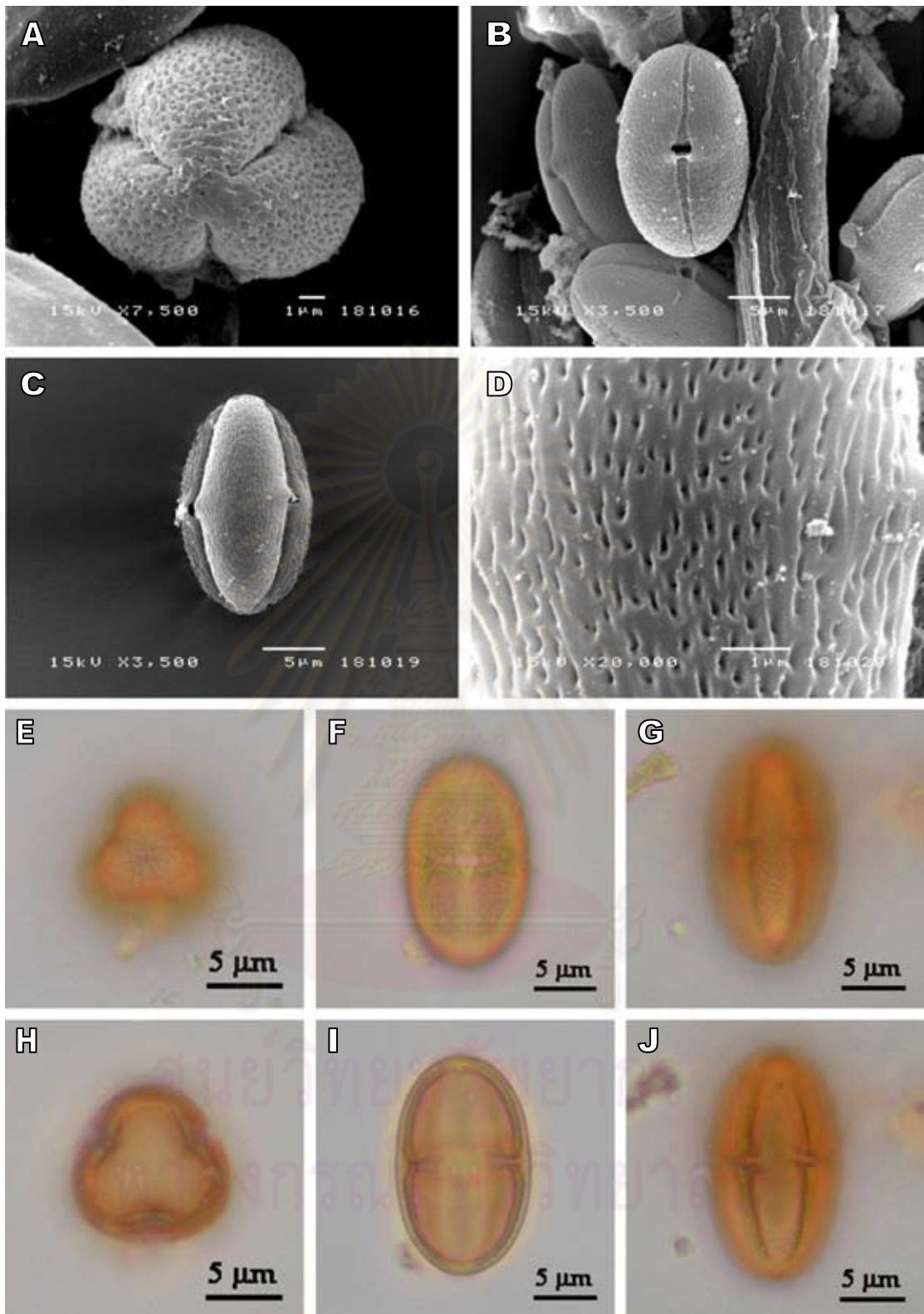


Plate 9 *Antidesma ghaesembilla* Gaertn.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

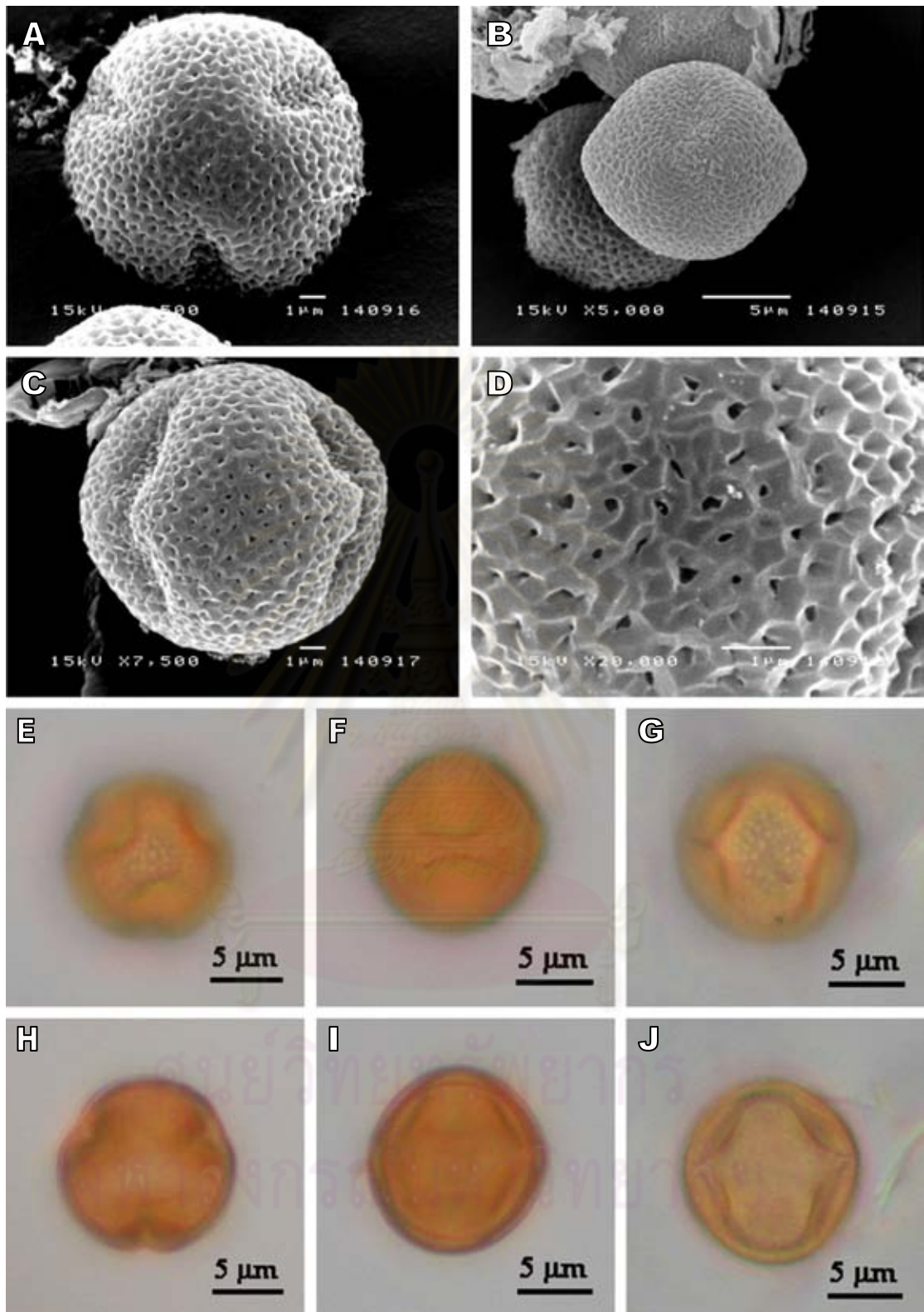


Plate 10 *Ardisia elliptica* Thunb.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).



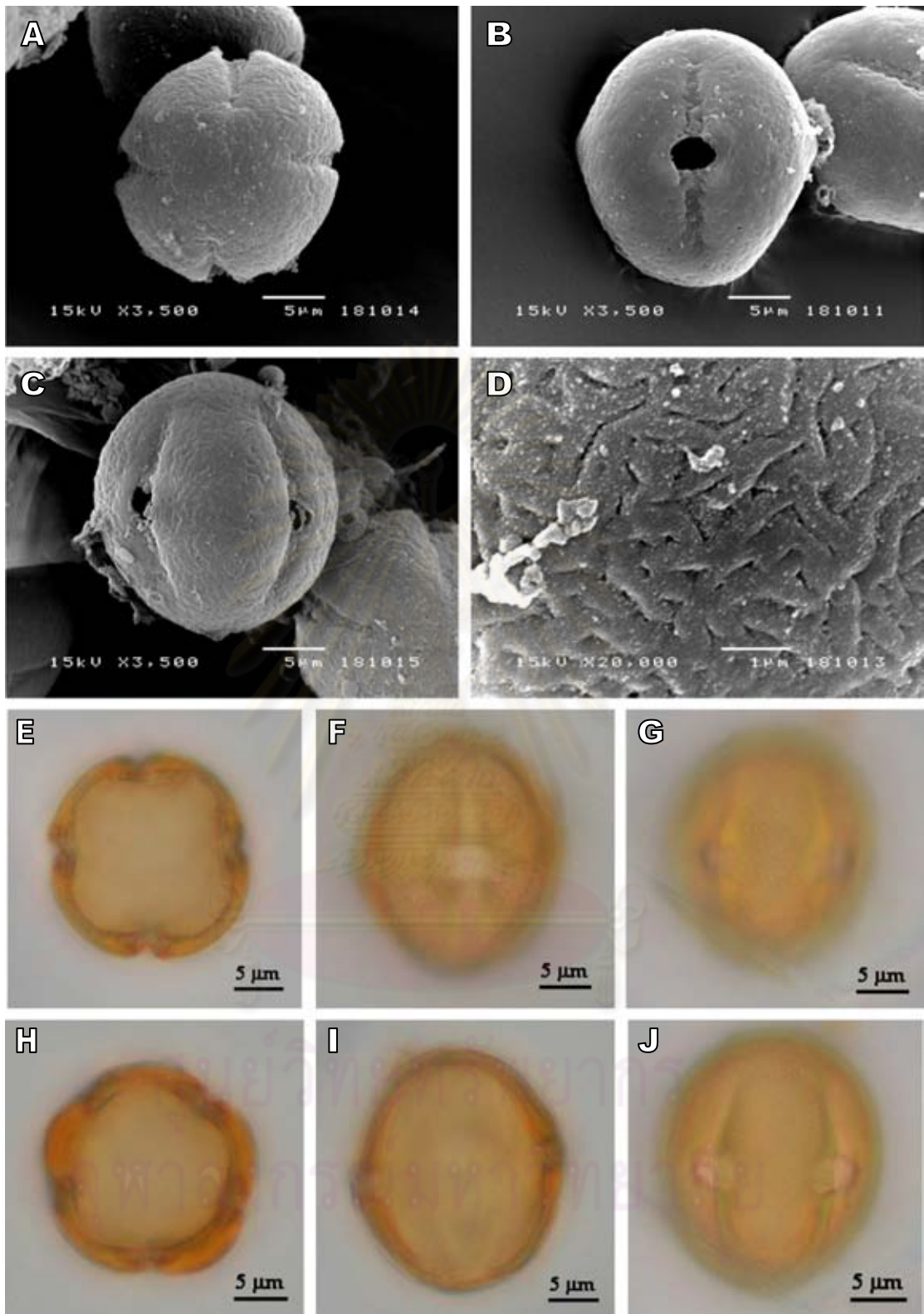


Plate 11 *Atalantia monophylla* DC.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view of 4-aperturate grain, optical section, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view of 5-aperturate grain, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).

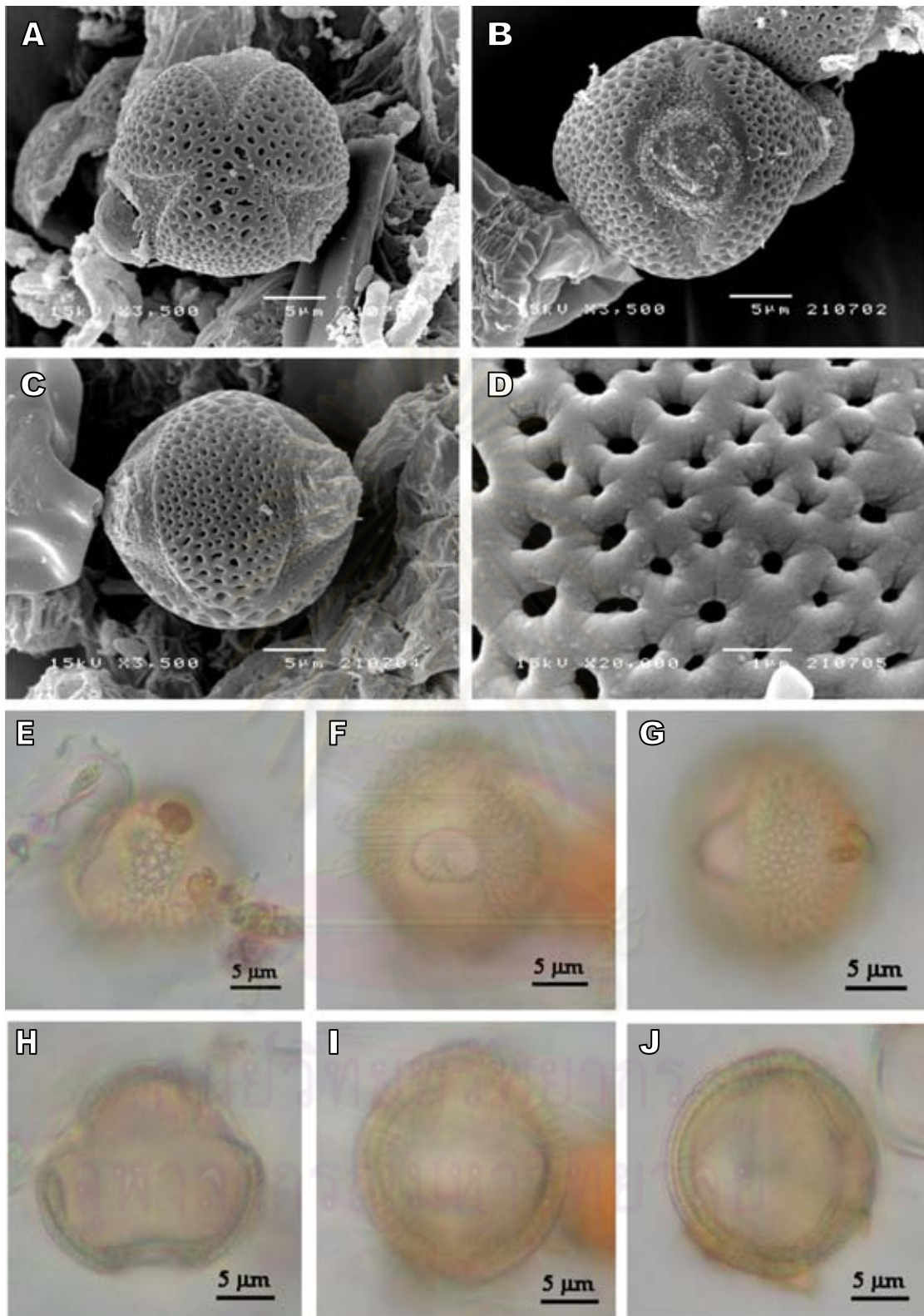


Plate 12 *Avicennia alba* Blume: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

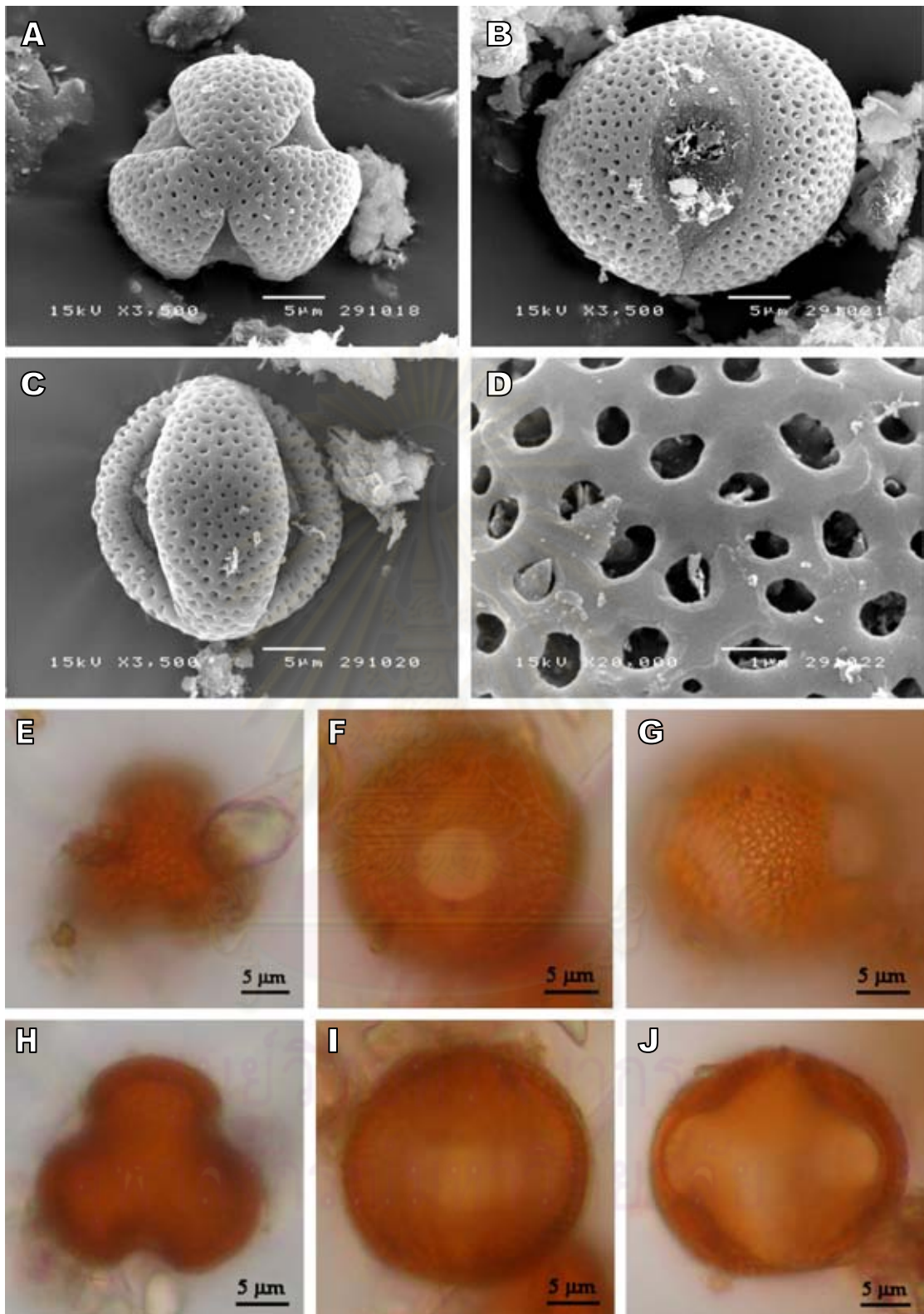


Plate 13 *Avicennia marina* (Forssk.) Vierh. : (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).



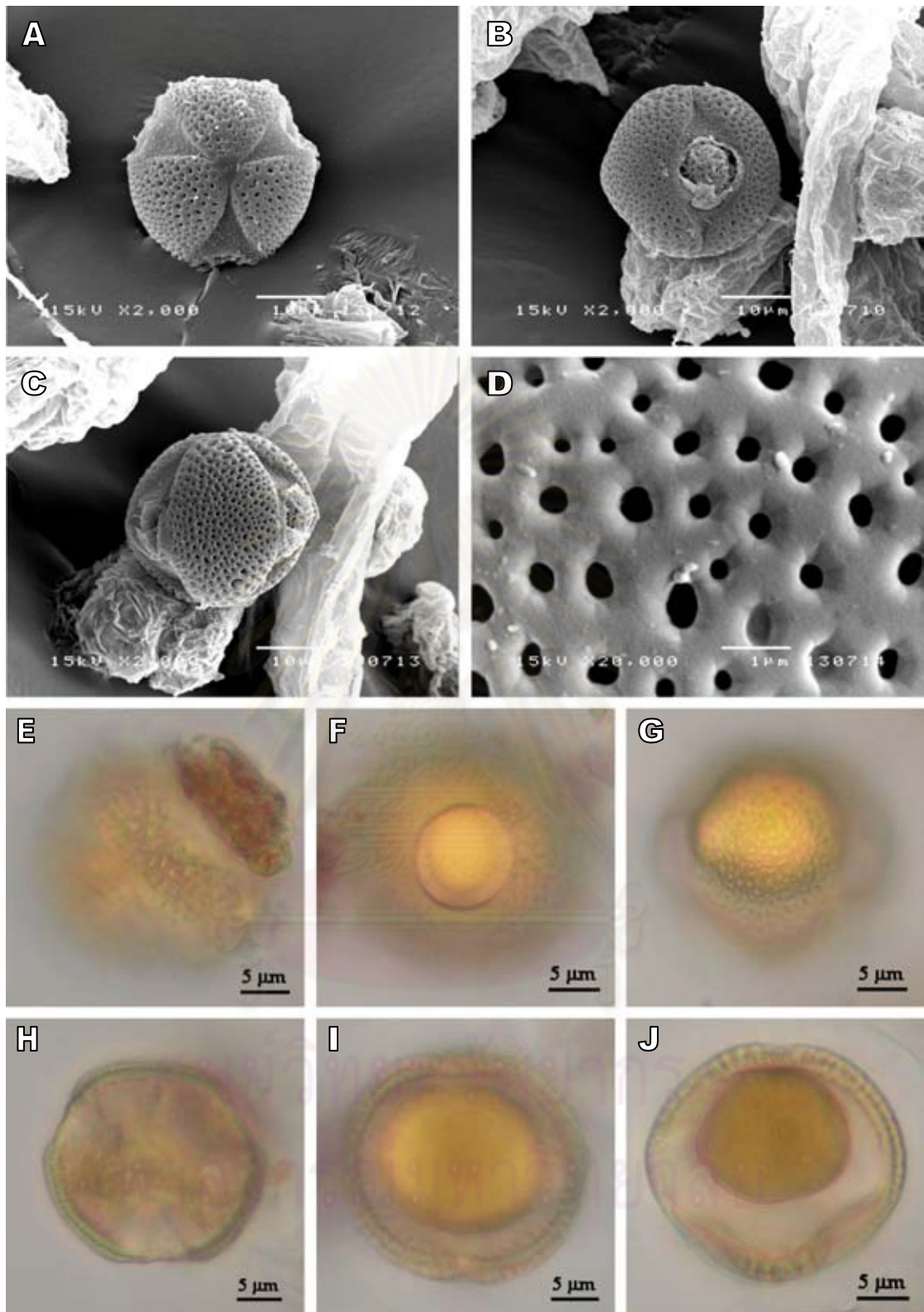


Plate 14 *Avicennia officinalis* L.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).



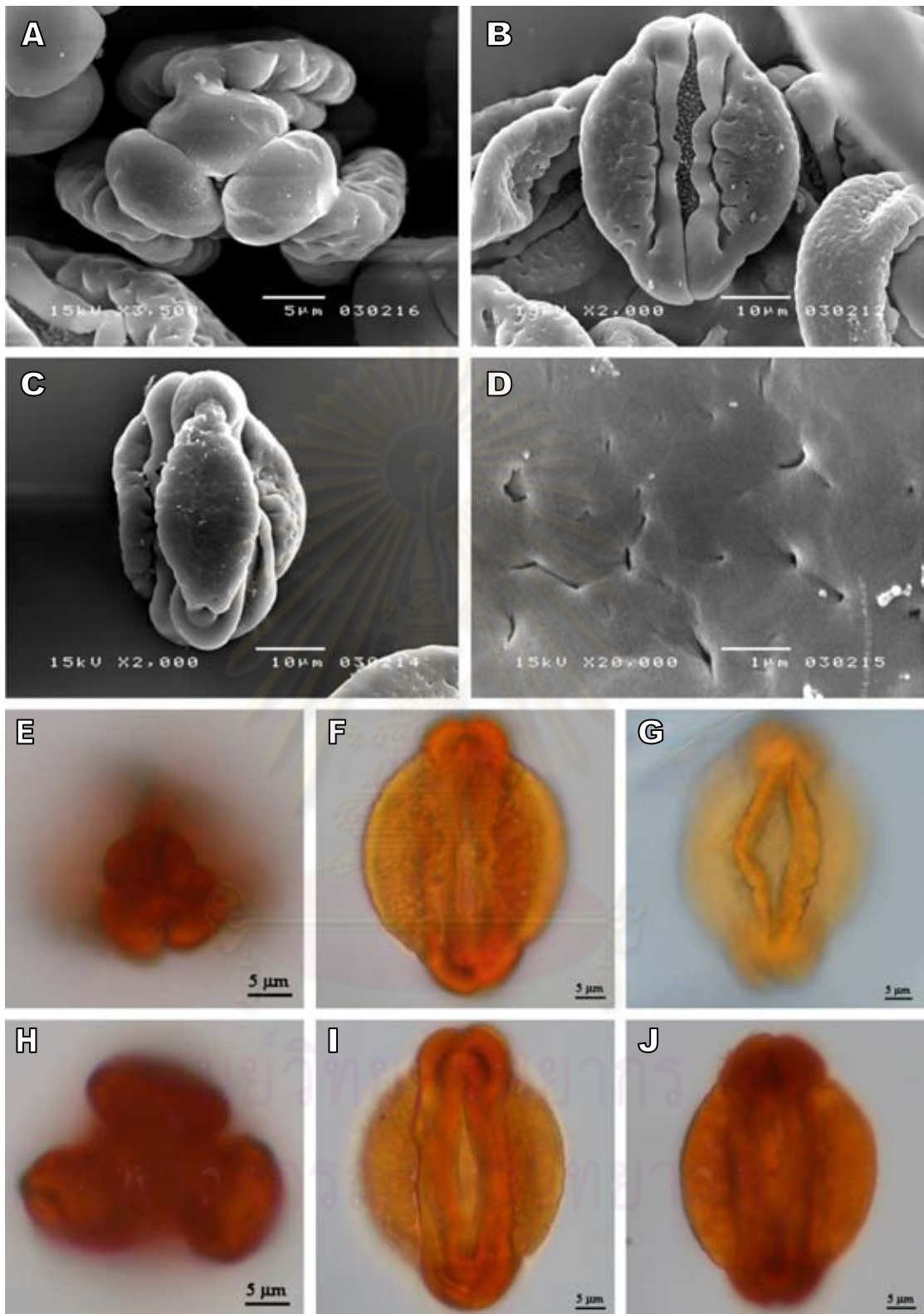


Plate 15 *Barringtonia asiatica* (L.) Kurz: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

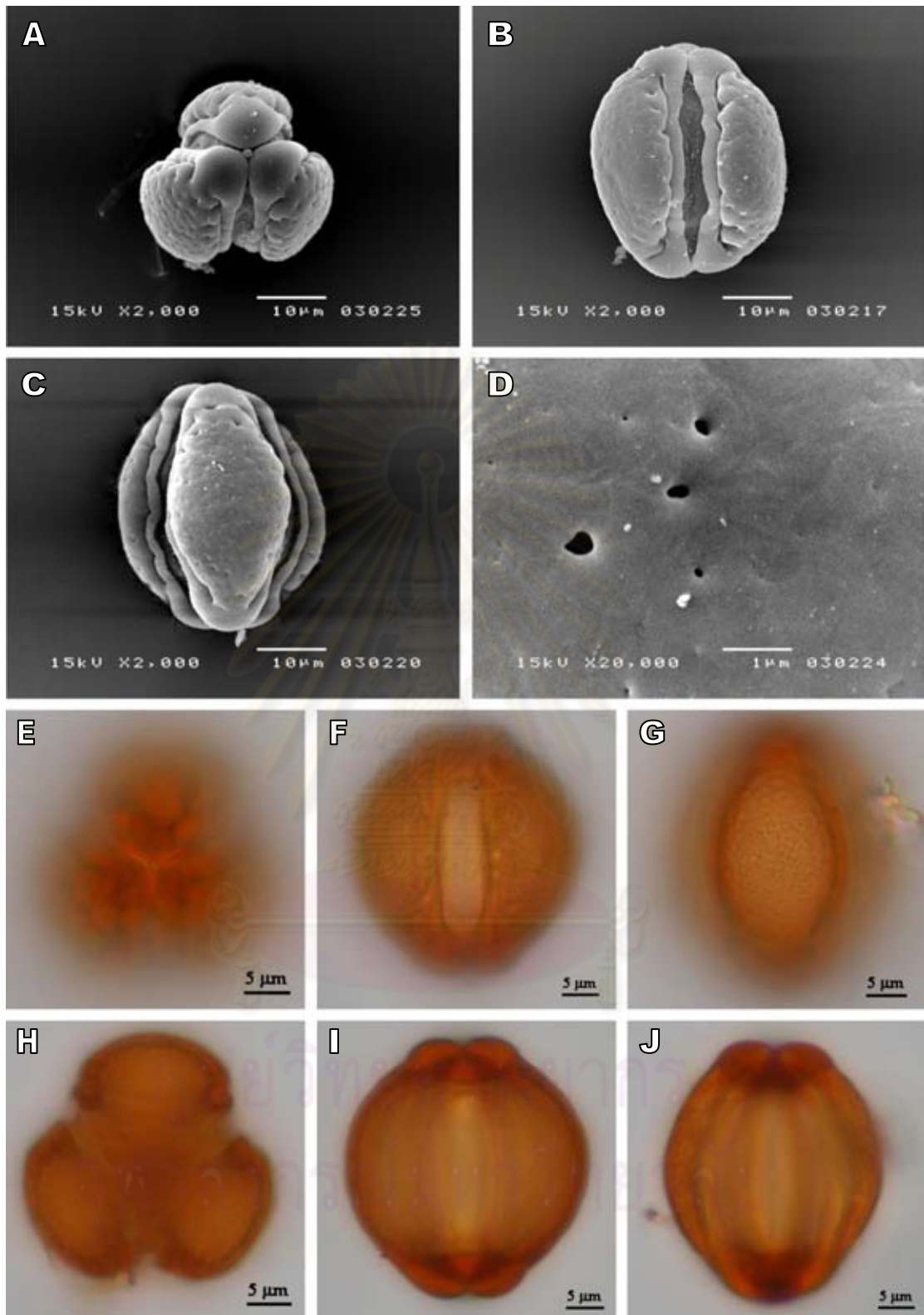


Plate 16 *Barringtonia racemosa* (L.) Spreng.: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

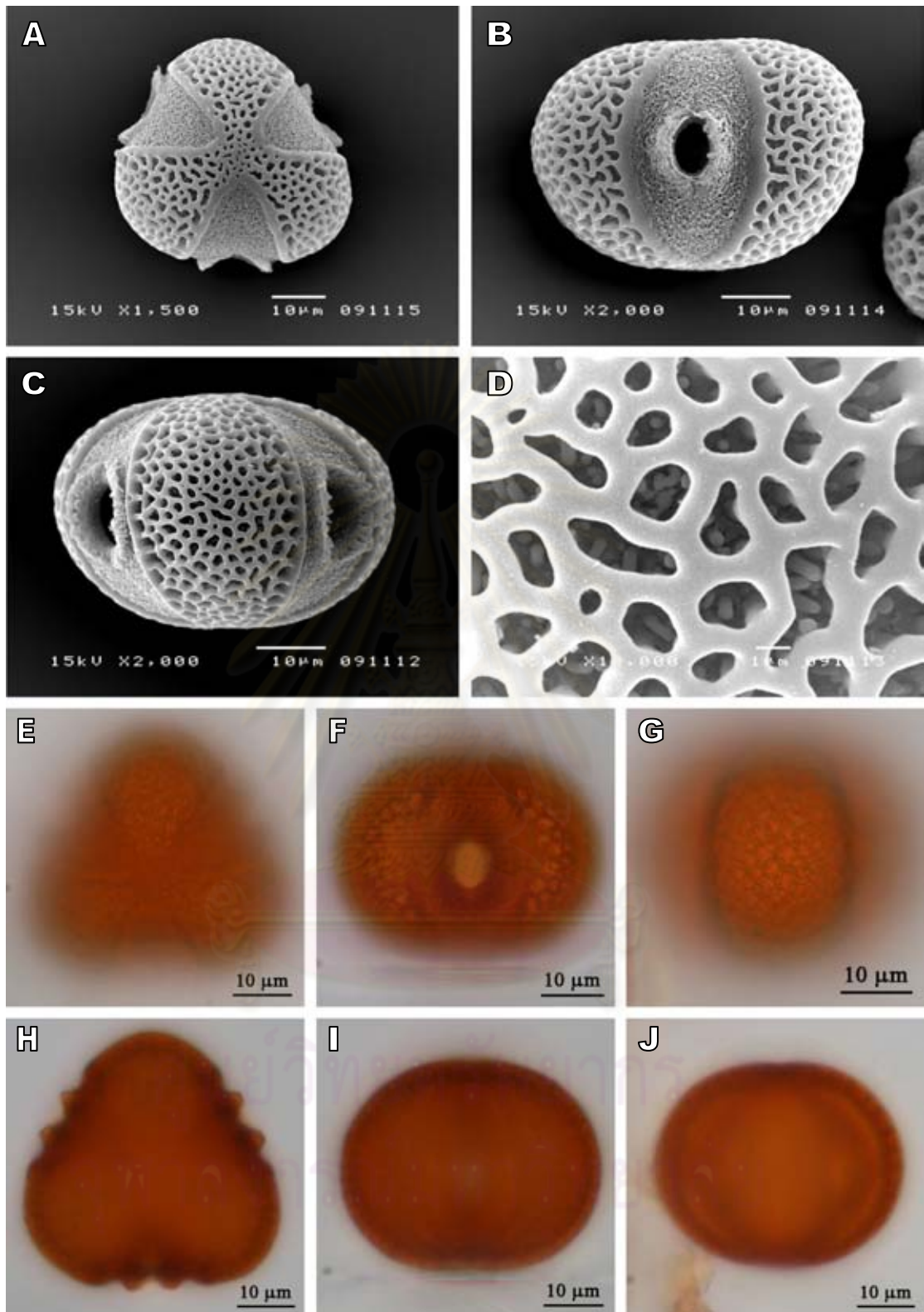


Plate 17 *Caesalpinia crista* L.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).



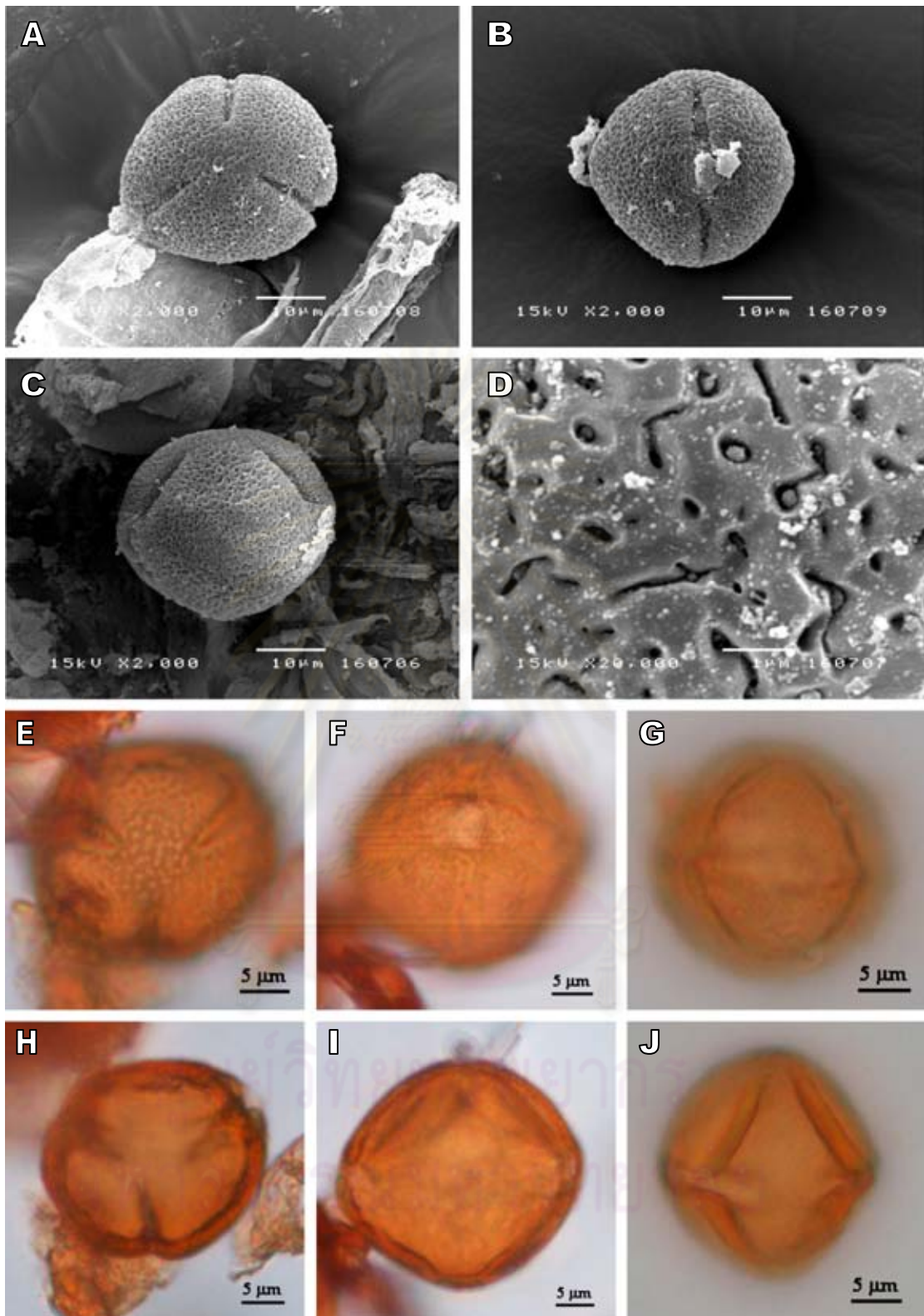


Plate 18 *Calophyllum inophyllum* L.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture lalongate elliptic with acute ends, (G) Equatorial view, endocingulum under mesocolpium, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).

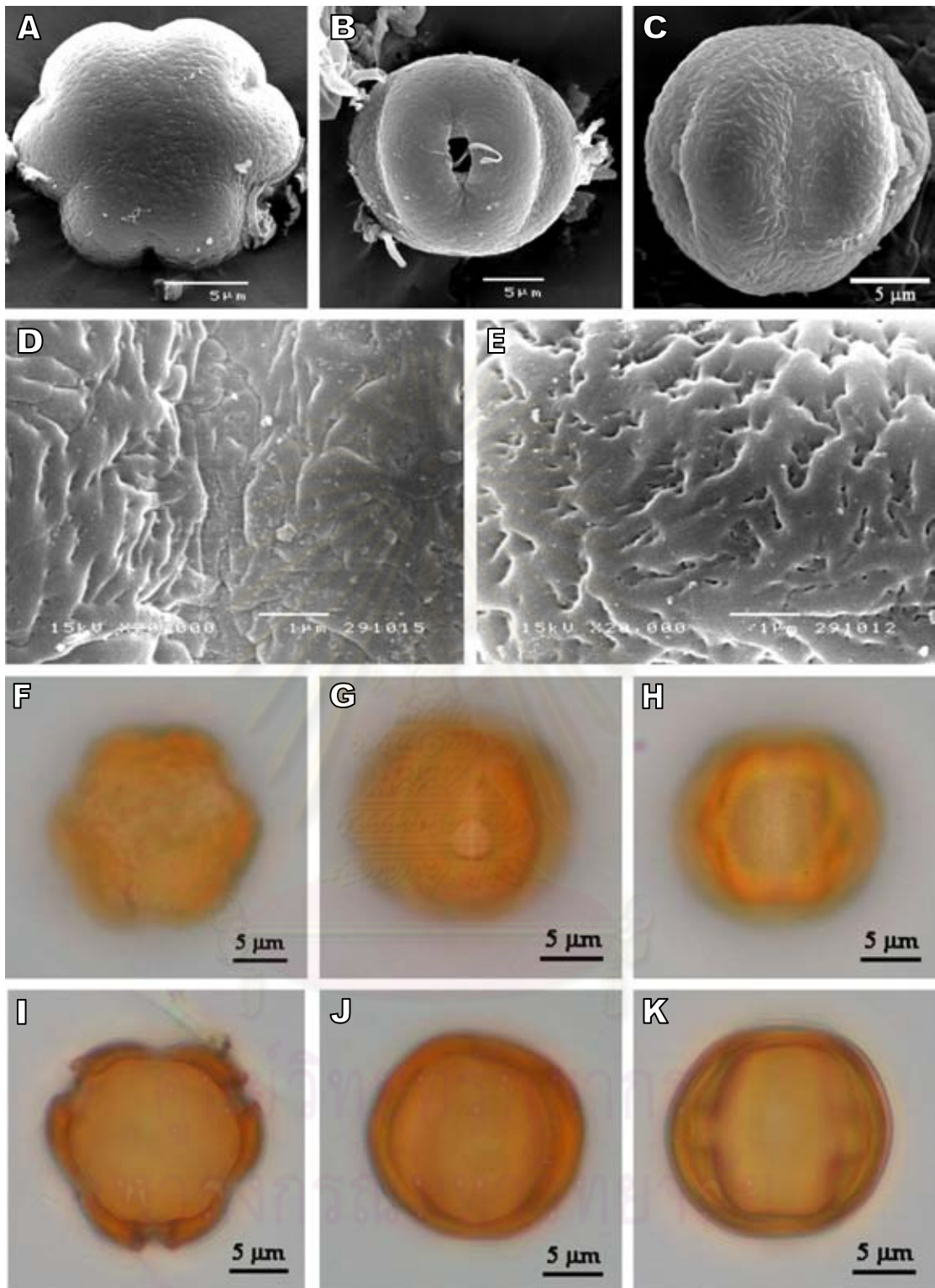


Plate 19 *Calycopteris floribunda* (Roxb.) Lam. ex Poir.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, pseudocolpus, (D) Equatorial view, pseudocolpus surface, (E) Surface between true and pseudoaperture, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, pseudocolpus surface, (I) Polar view, optical section, (J) Optical section under colporus, (K) Optical section under pseudocolpus (A-E: SEM; F-K: LM).



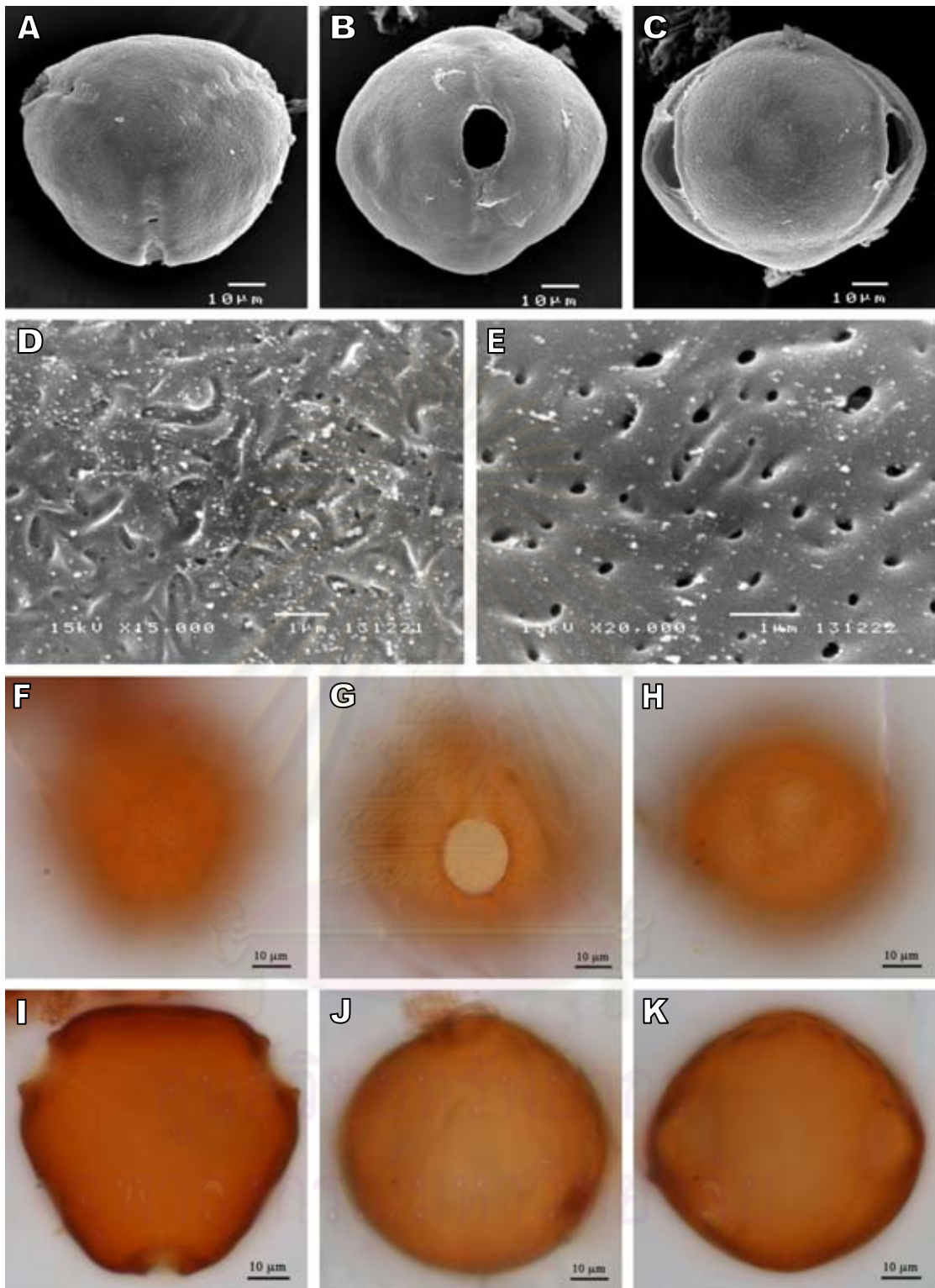


Plate 20 *Cerbera manghas* L.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, mesocolpium surface, (E) Polar view, surface, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, mesocolpium surface, (I) Polar view, optical section, (J) Optical section under colporus, (K) Optical section under mesocolpium (A-E: SEM; F-K: LM).

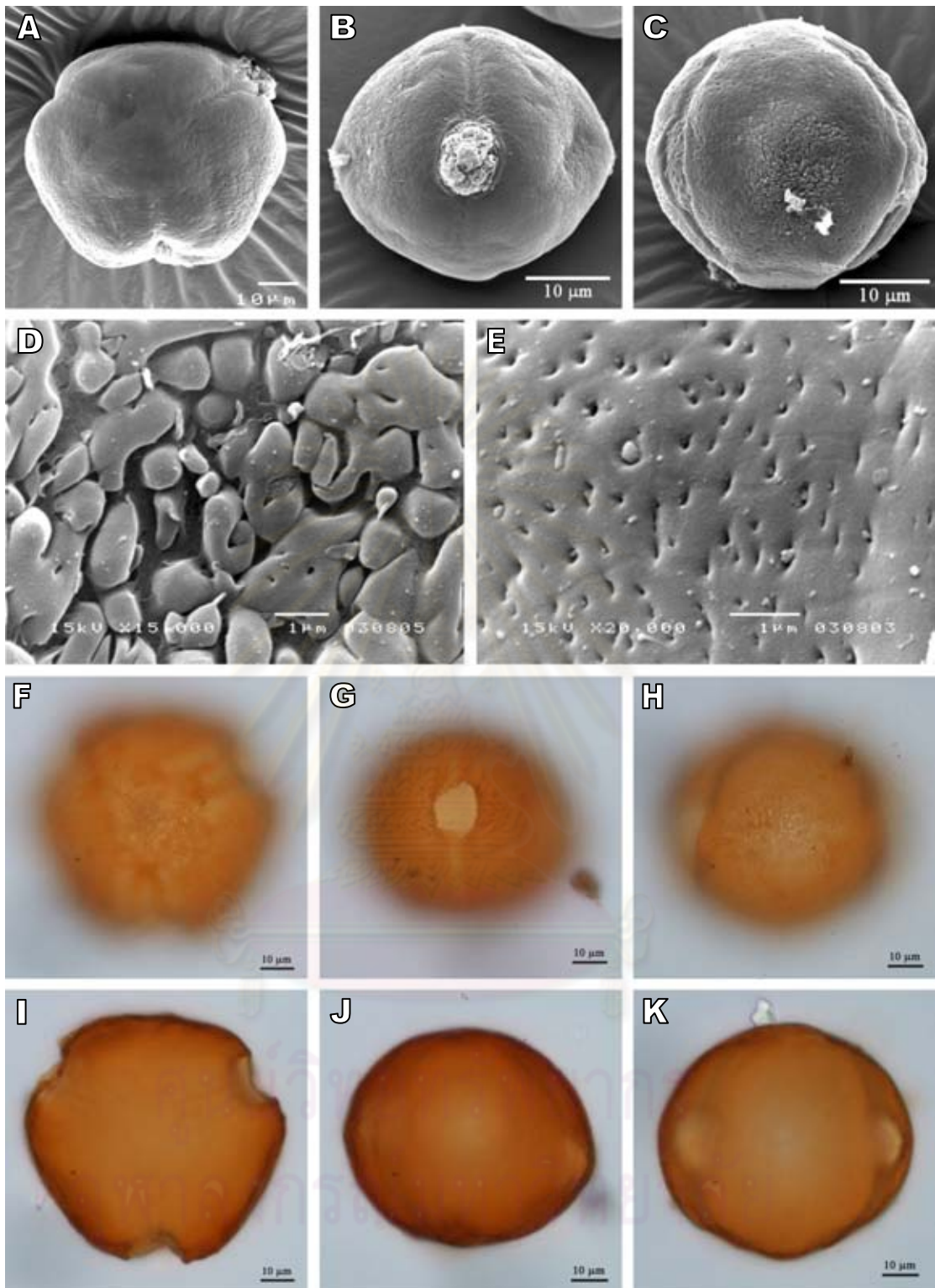


Plate 21 *Cerbera odollam* Gaertn.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, mesocolpium surface, (E) Polar view, surface, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, mesocolpium surface, (I) Polar view, optical section, (J) Optical section under colporus, (K) Optical section under mesocolpium (A-E: SEM; F-K: LM).



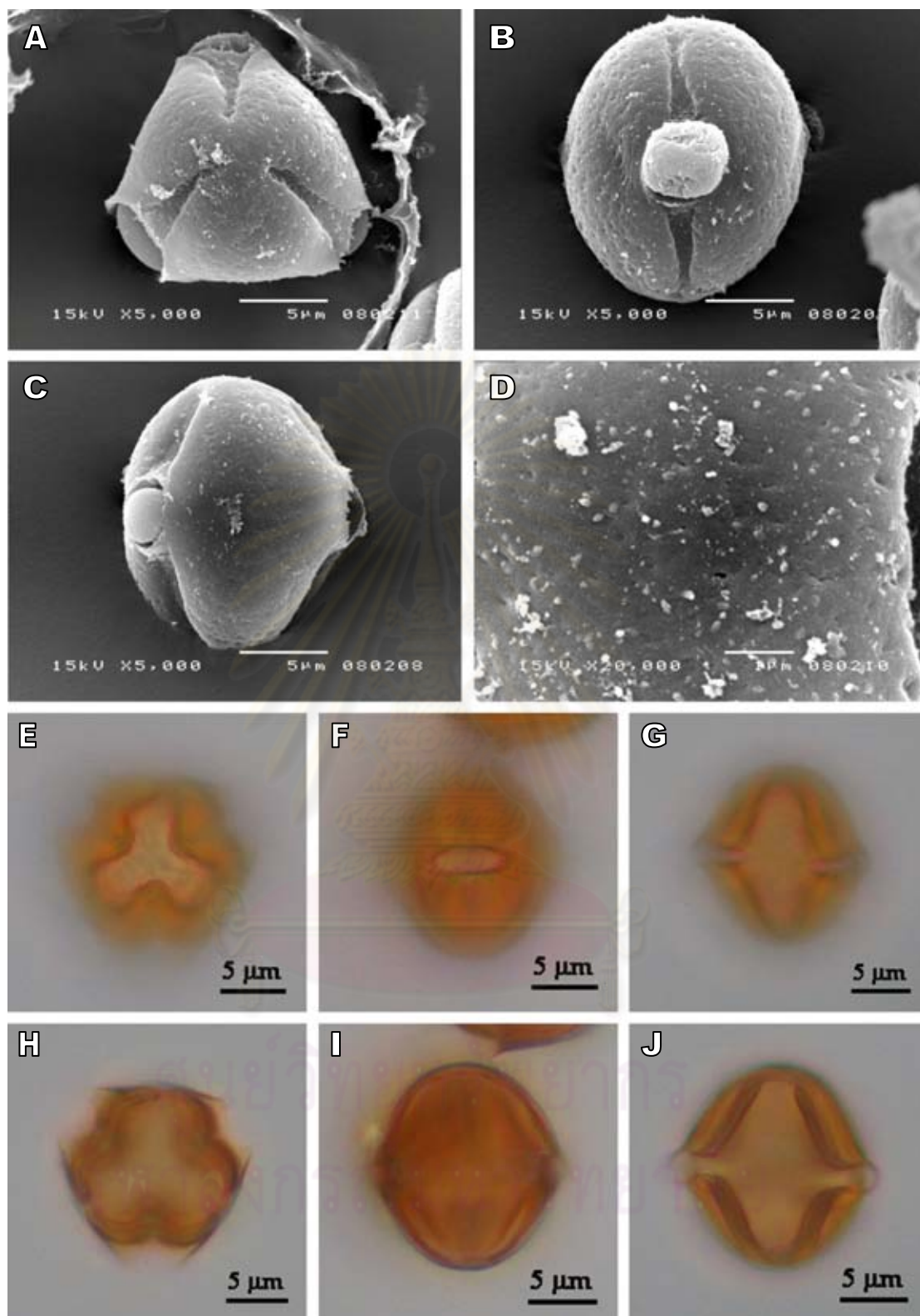


Plate 22 *Aegiceras corniculatum* (L.) Blanco: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

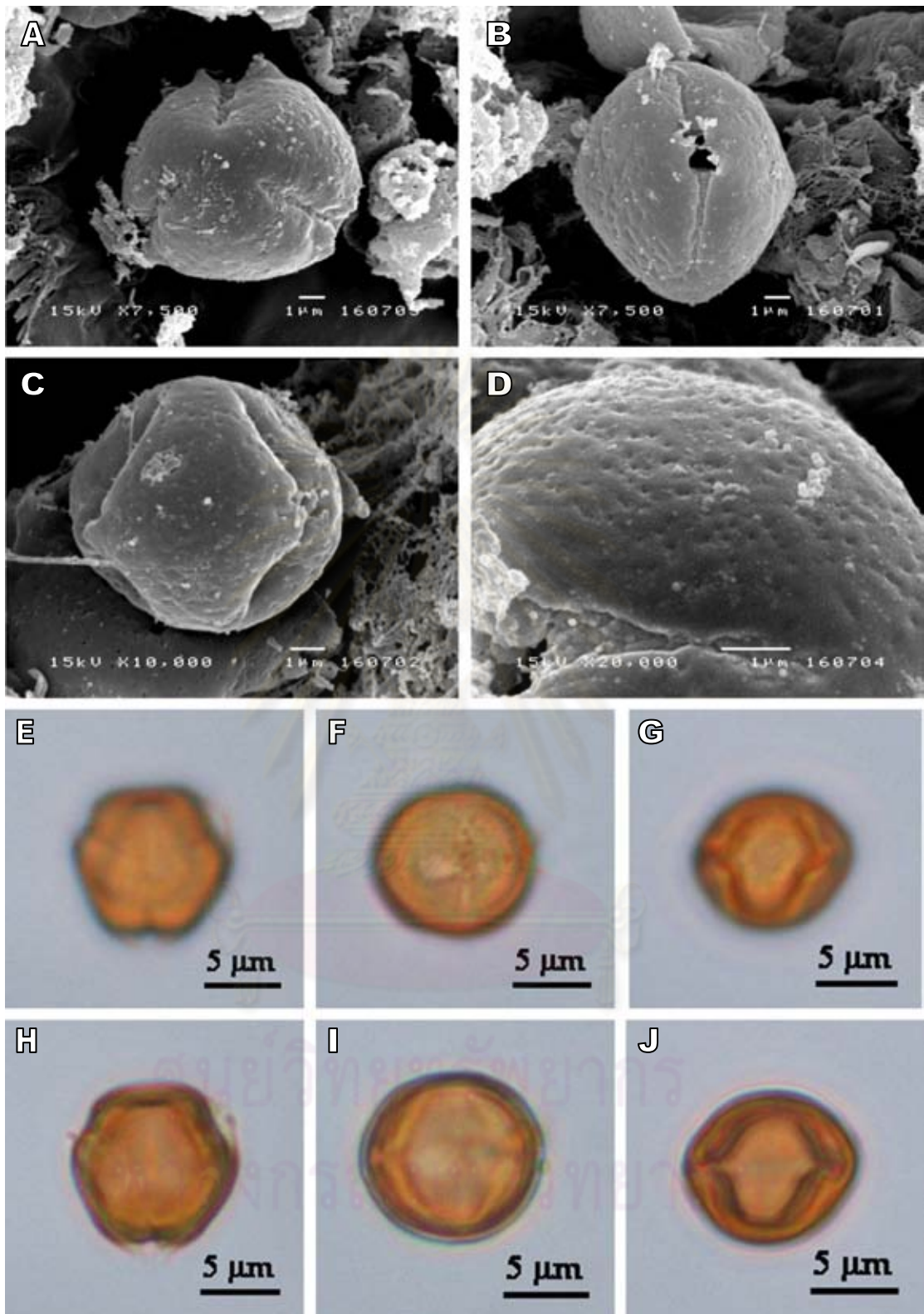


Plate 23 *Bruguiera cylindrica* (L.) Blume: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

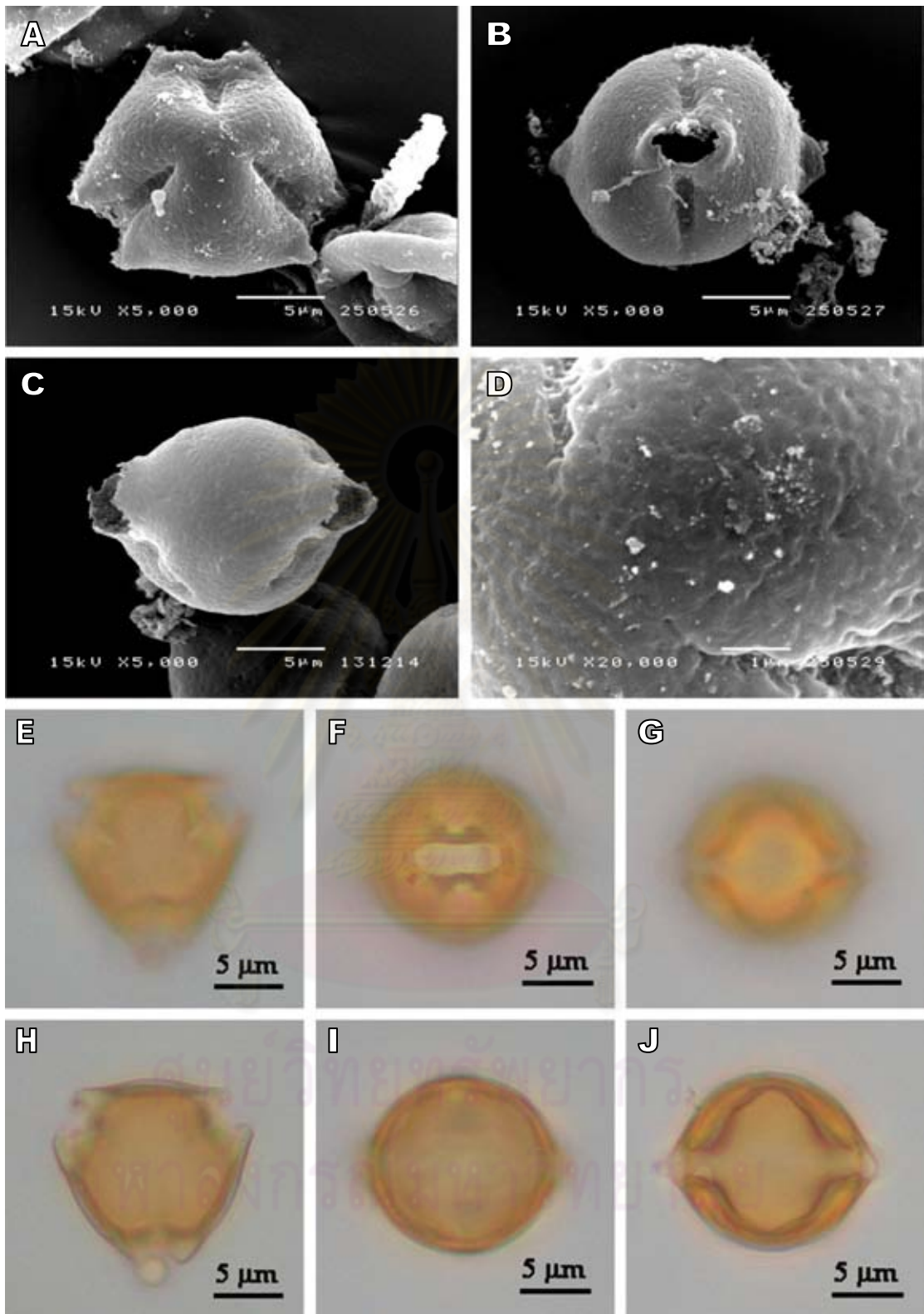


Plate 24 *Bruguiera gymnorhiza* (L.) Savigny: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Oblique polar view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).



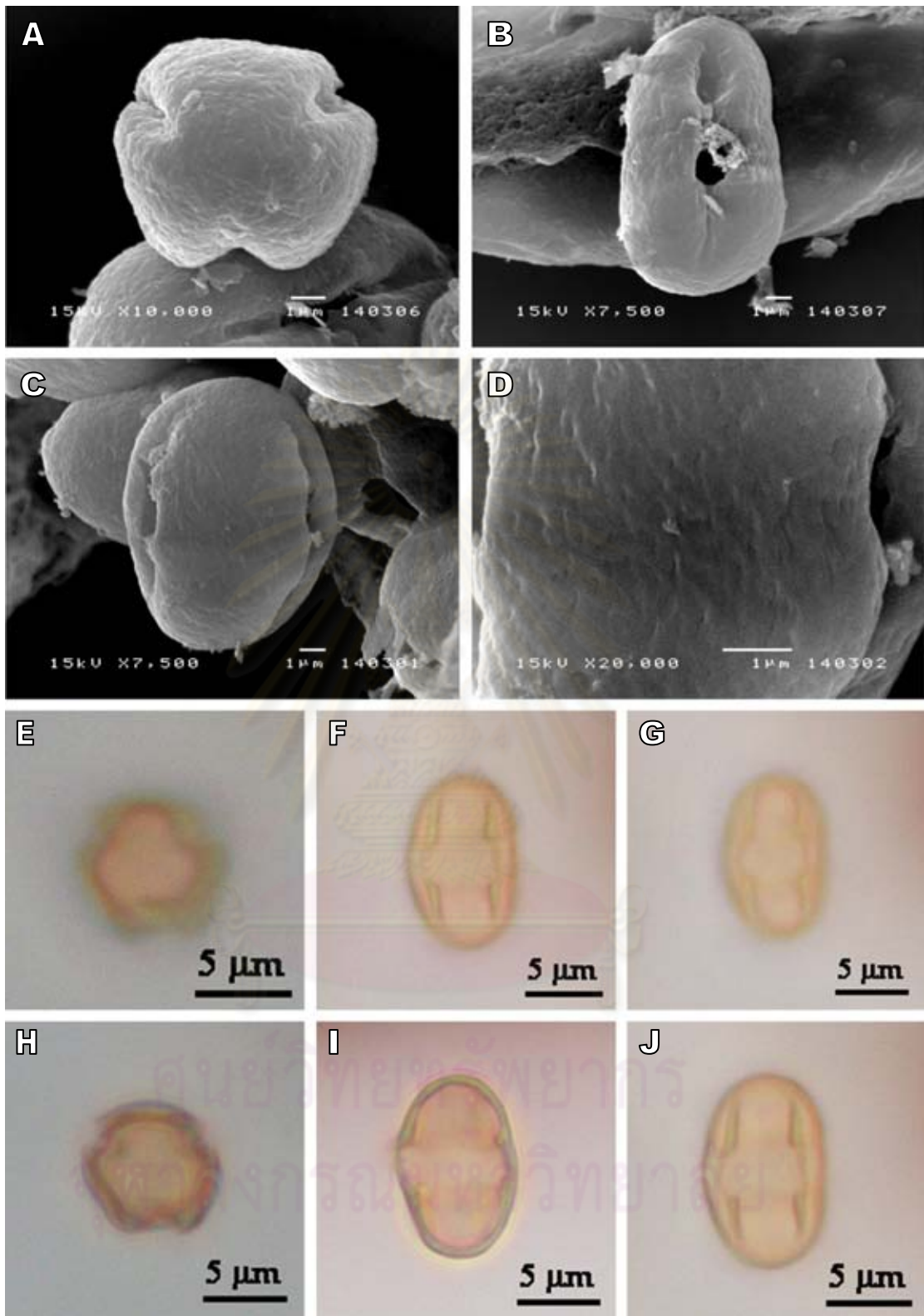


Plate 25 *Bruguiera parviflora* (Roxb.) Wight & Arn. ex Griff.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endocingulum, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

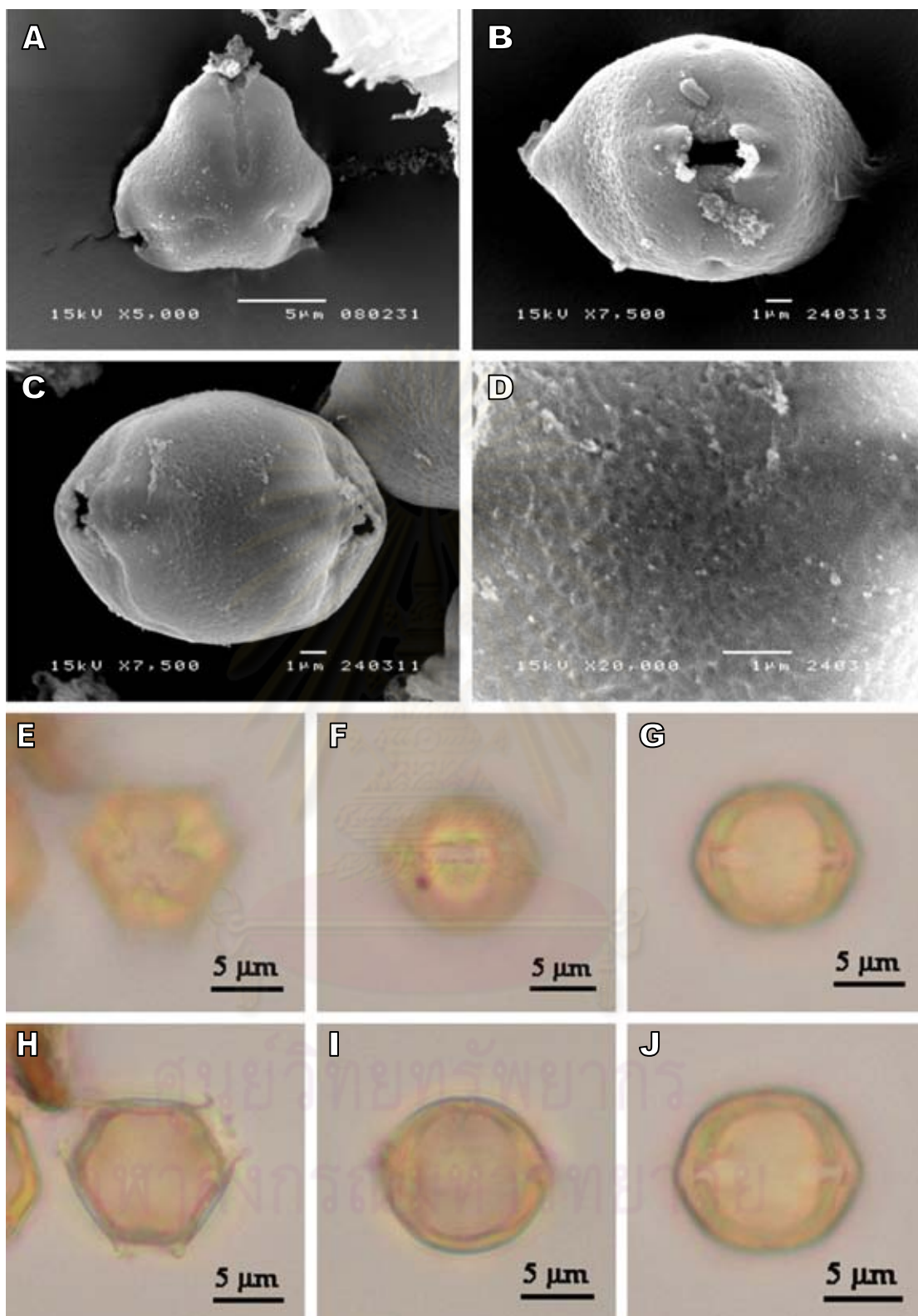


Plate 26 *Bruguiera sexangula* (Lour.): (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

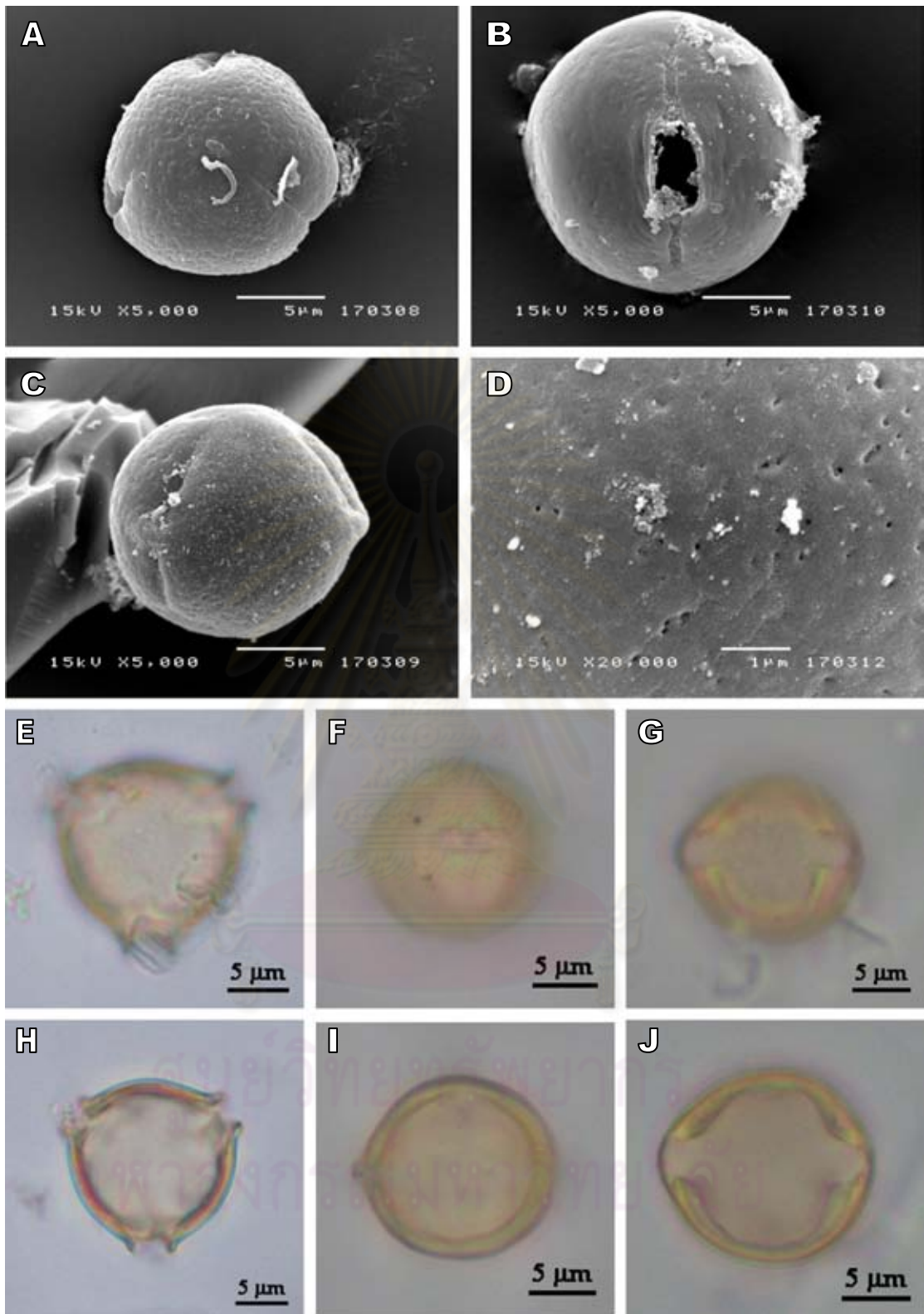


Plate 27 *Ceriops decandra* (Griff.) W. Theob.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).



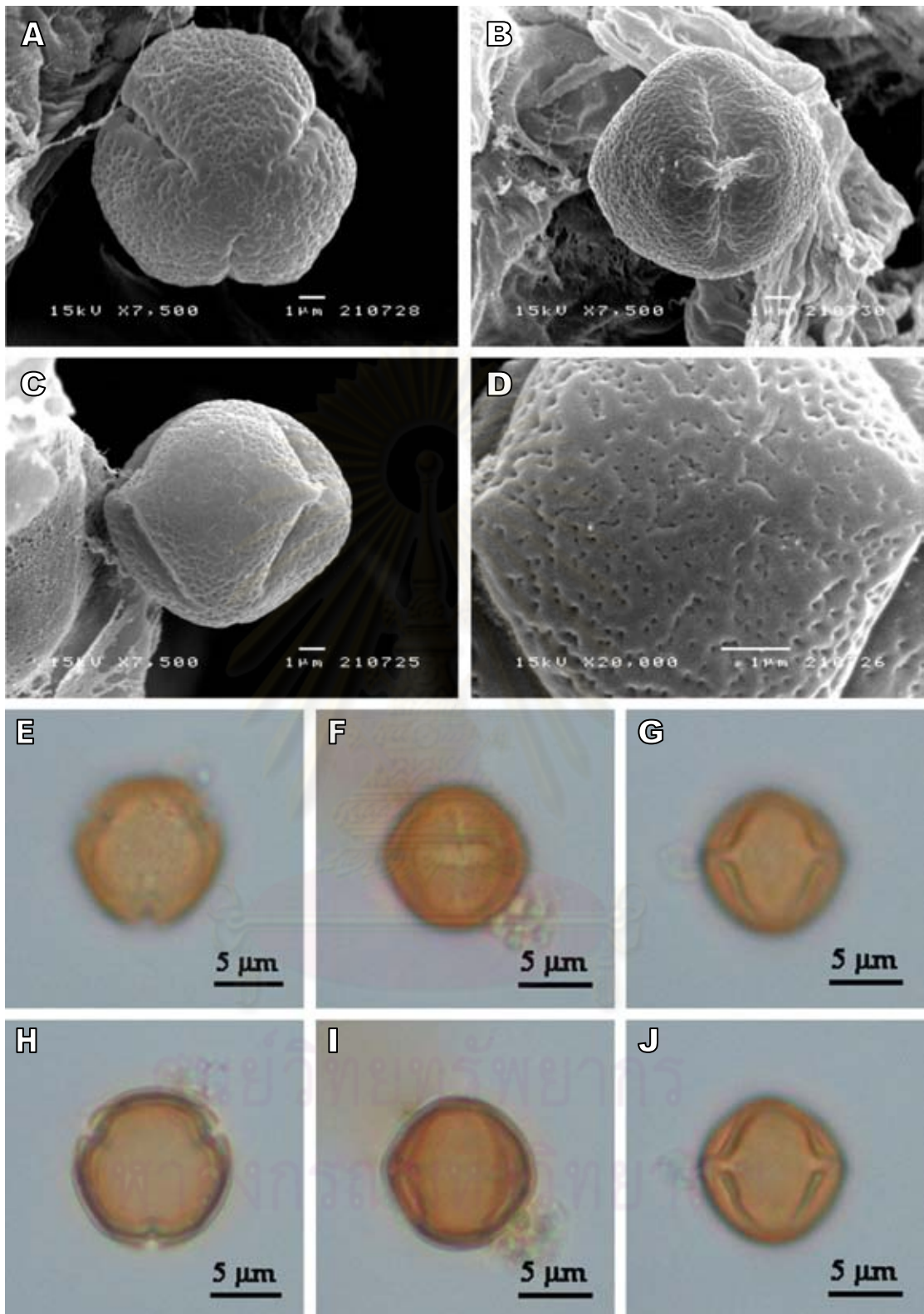


Plate 28 *Ceriops tagal* (Perr.) C.B. Rob.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).



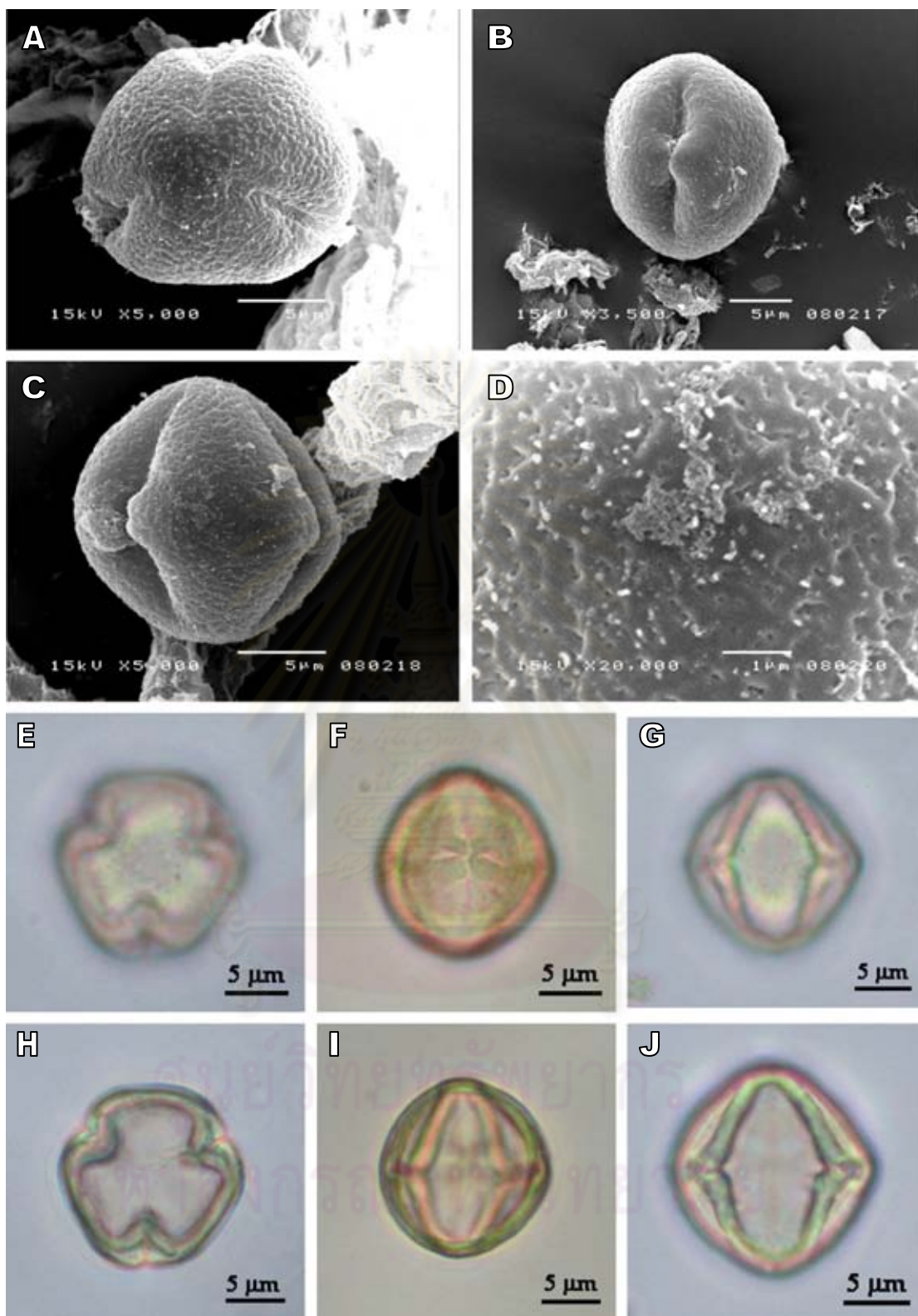


Plate 29 *Kandelia candel* (L.) Druce: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

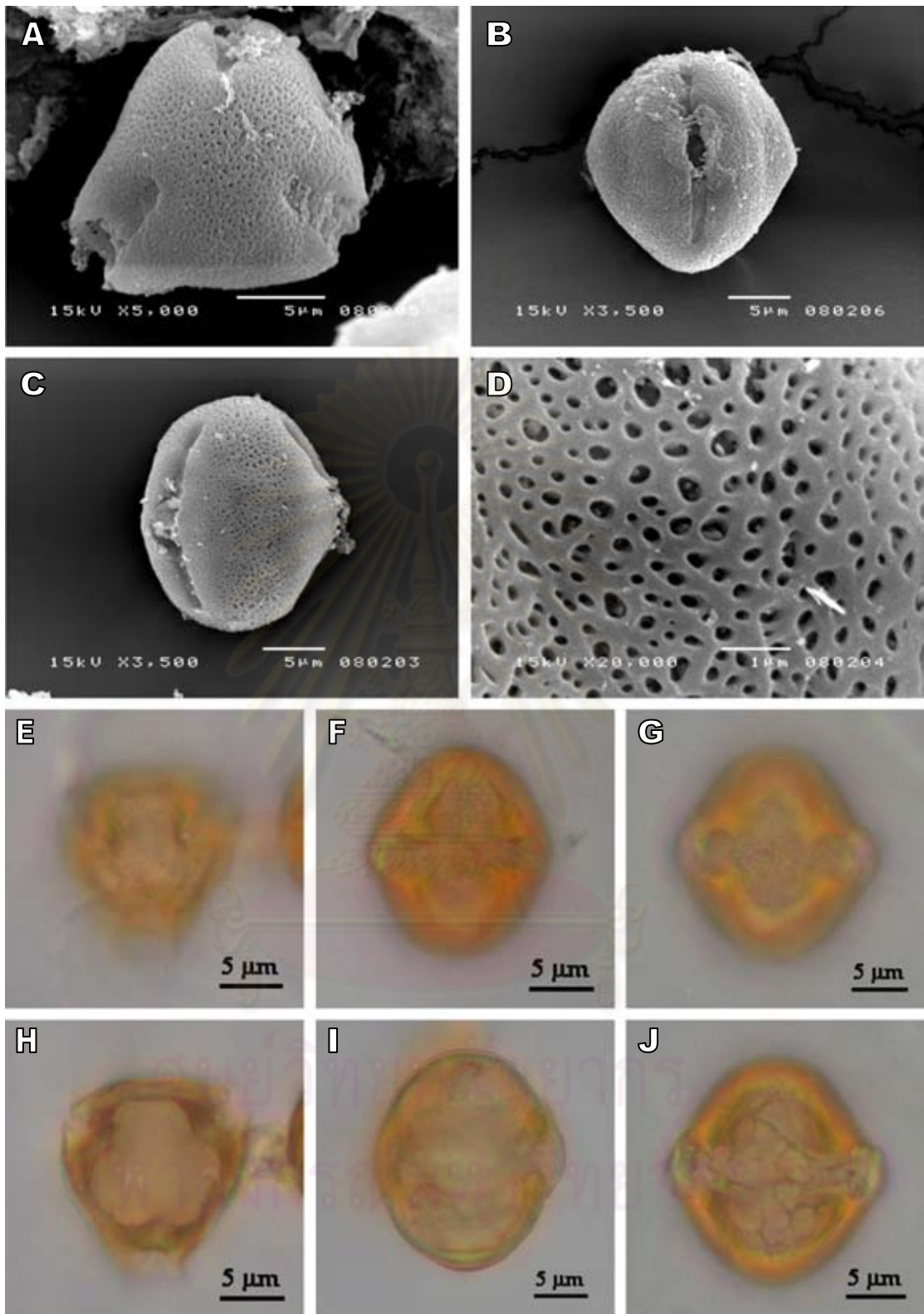


Plate 30 *Rhizophora apiculata* Blume: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endocingulum, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

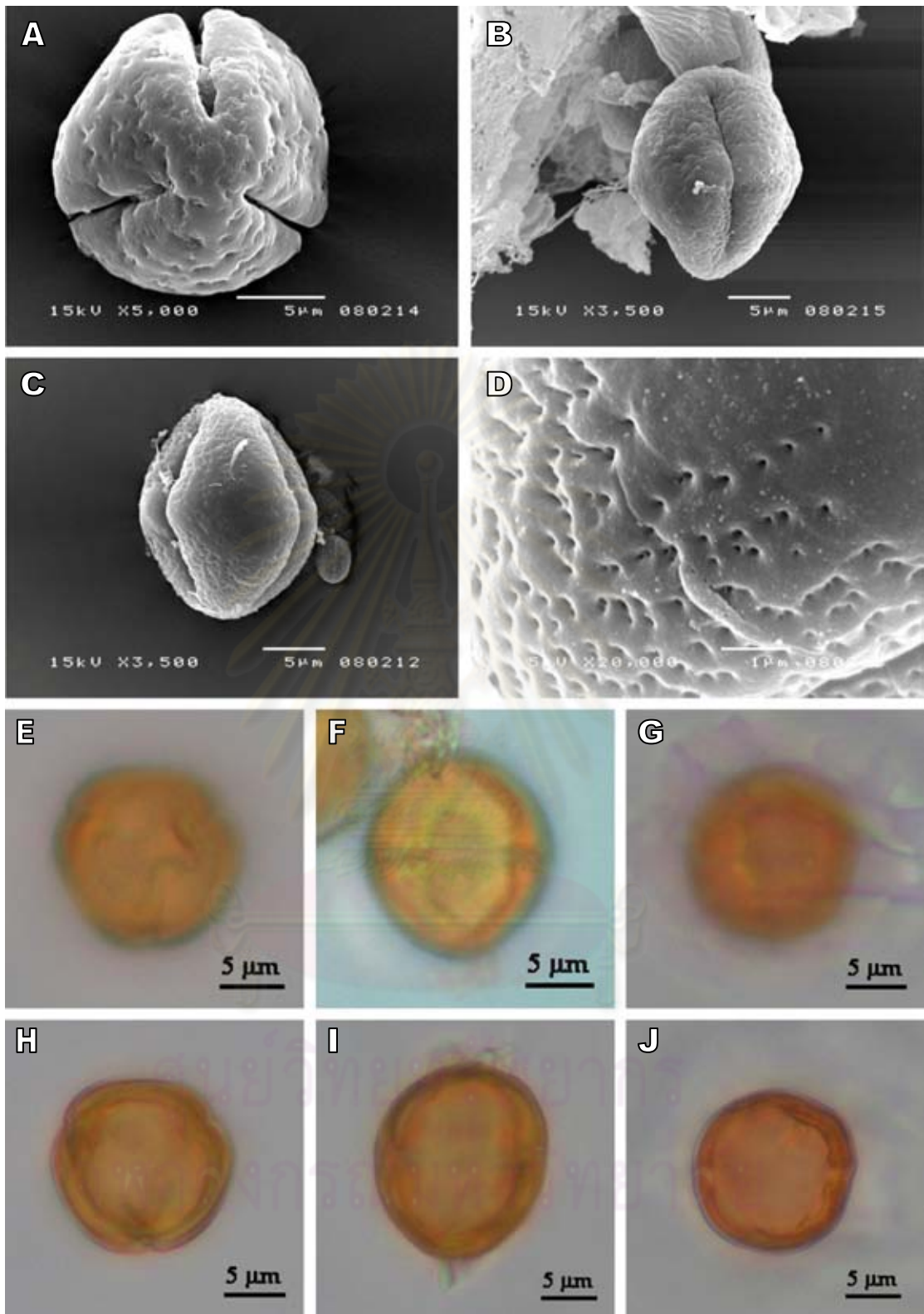


Plate 31 *Rhizophora mucronata* Lam.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endocingulum, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).



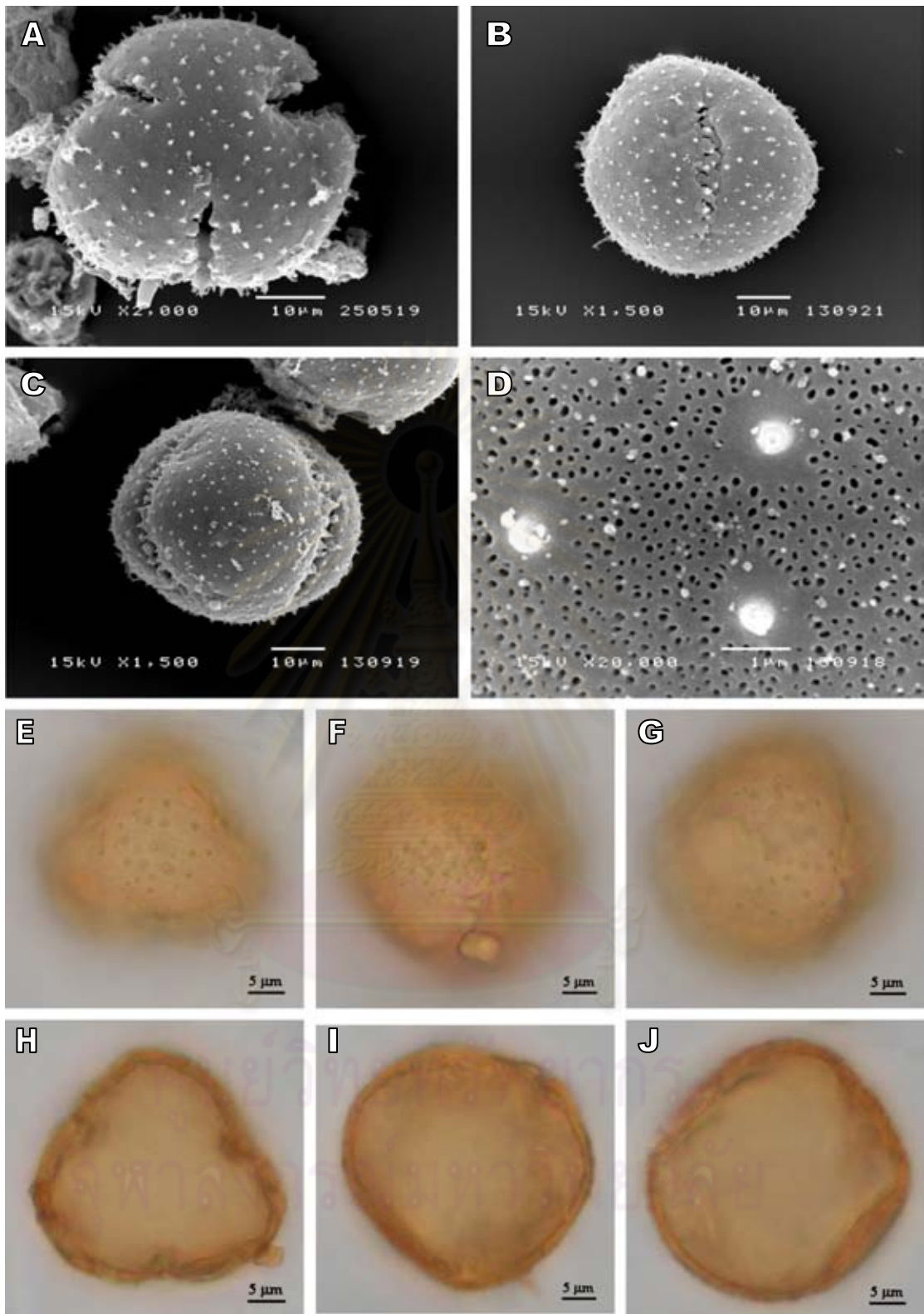


Plate 32 *Clerodendrum inerme* (L.) Gaertn.: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

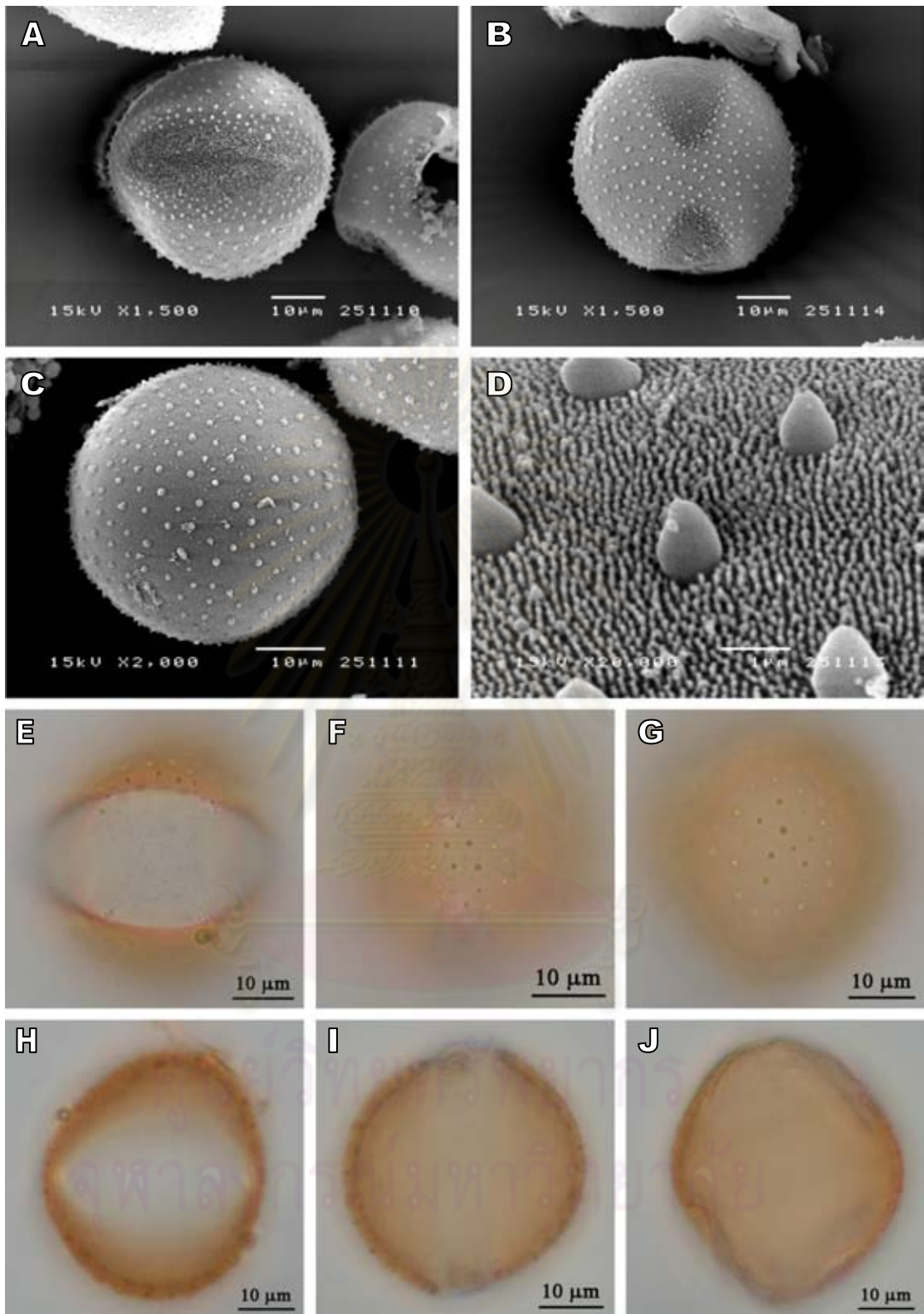


Plate 33 *Crinum asiaticum* L.: (A) Polar view, (B) Shorter equatorial view, (C) Longer equatorial view, (D) Equatorial view, surface, (E) Polar view, colpus, (F) Shorter equatorial view, surface, (G) Longer equatorial view, surface, (H) Polar view, optical section, (I) Shorter equatorial view, optical section, (J) Longer equatorial view, optical section (A-D: SEM; E-J: LM).



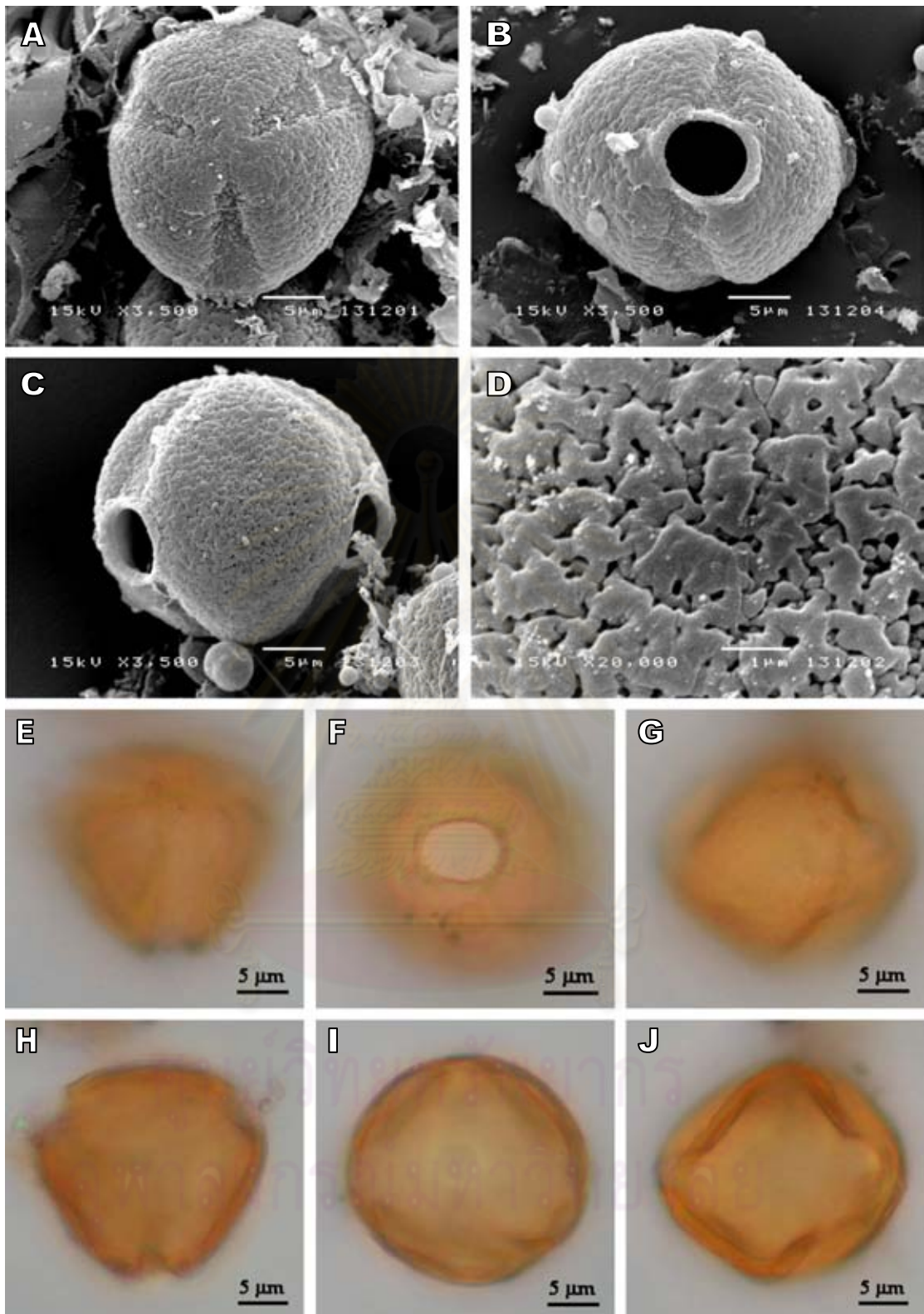


Plate 34 *Cynometra ramiflora* L.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).

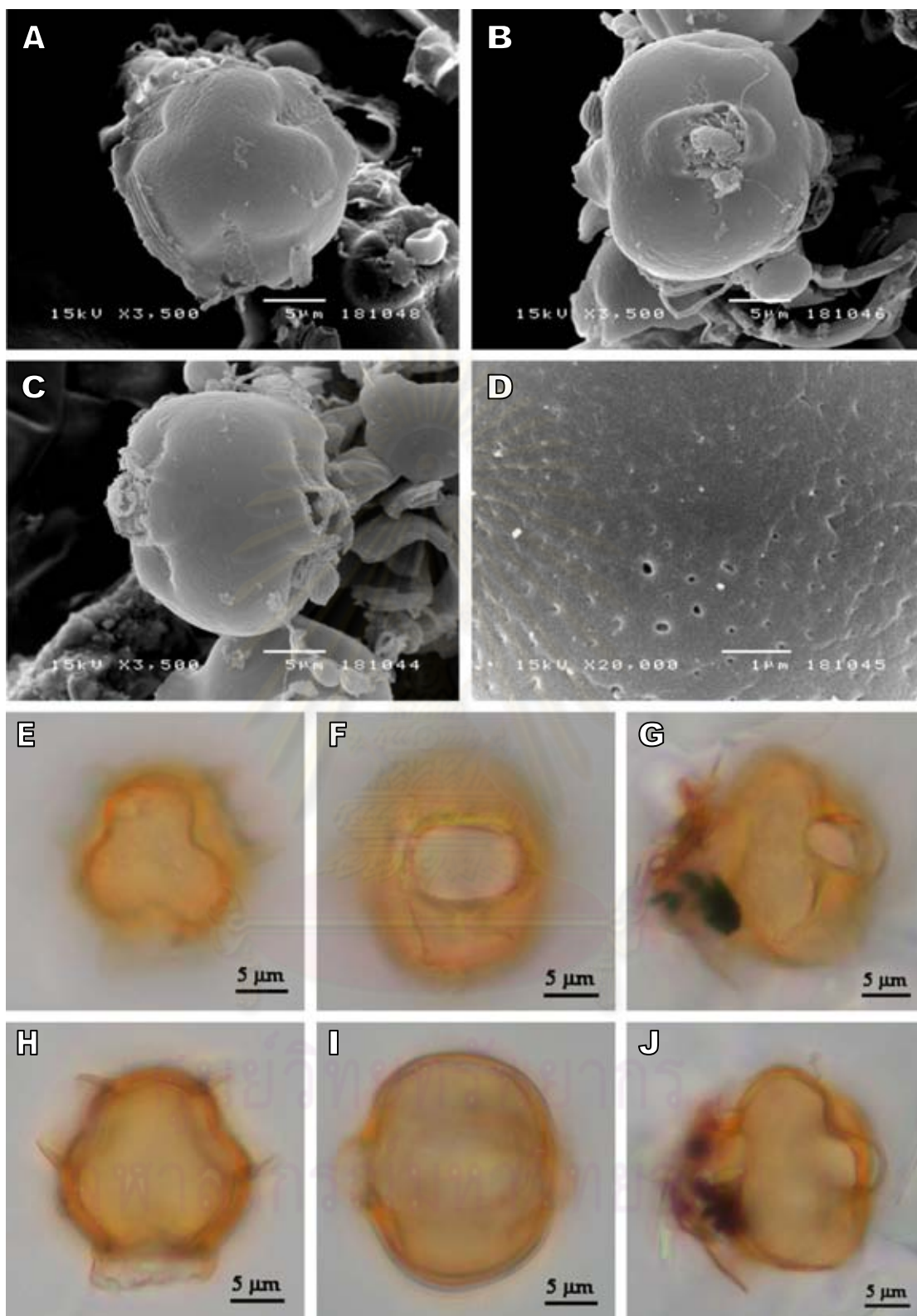


Plate 35 *Dalbergia candenatensis* (Dennst.) Prain: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).

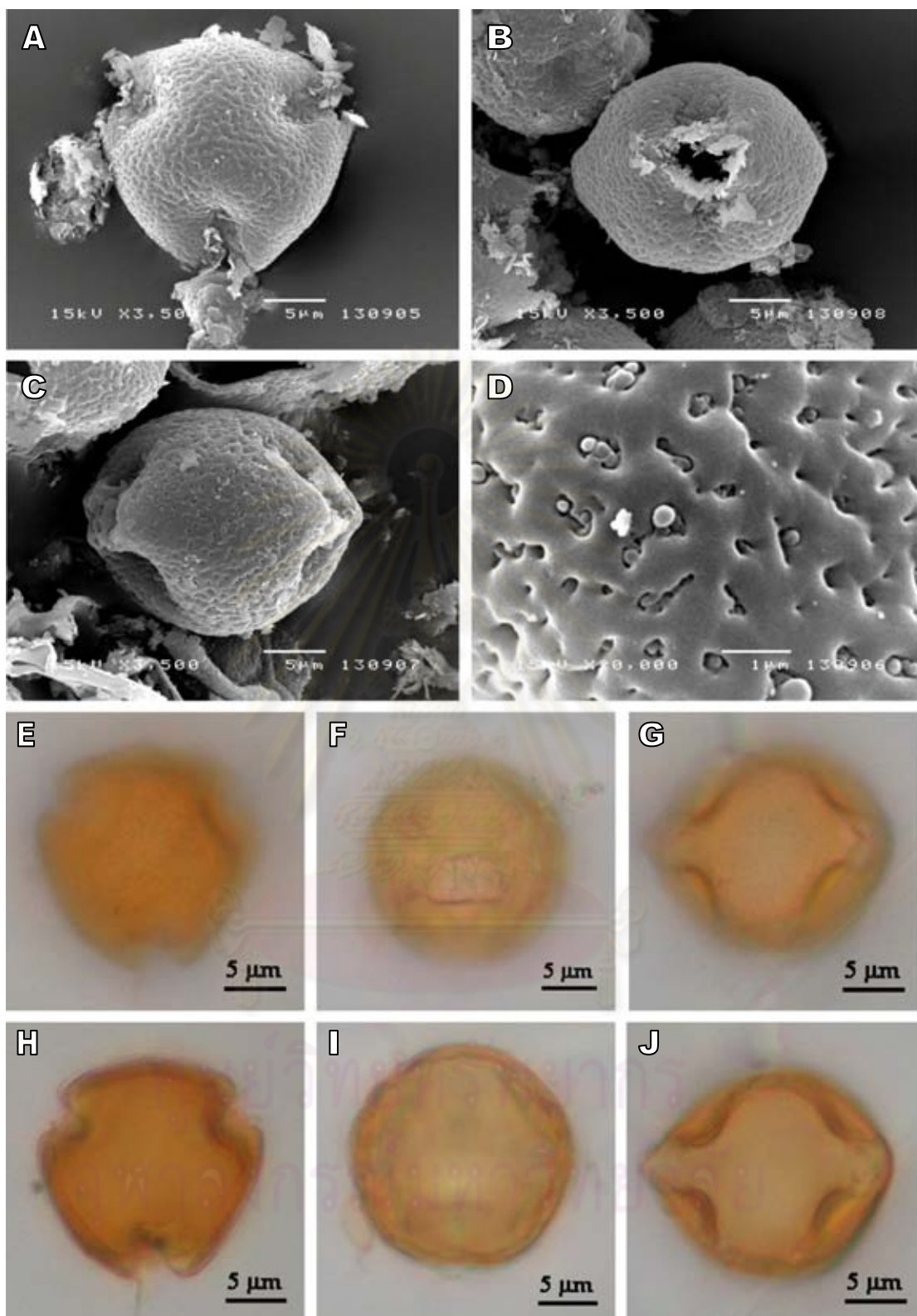


Plate 36 *Derris trifoliata* Lour.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).



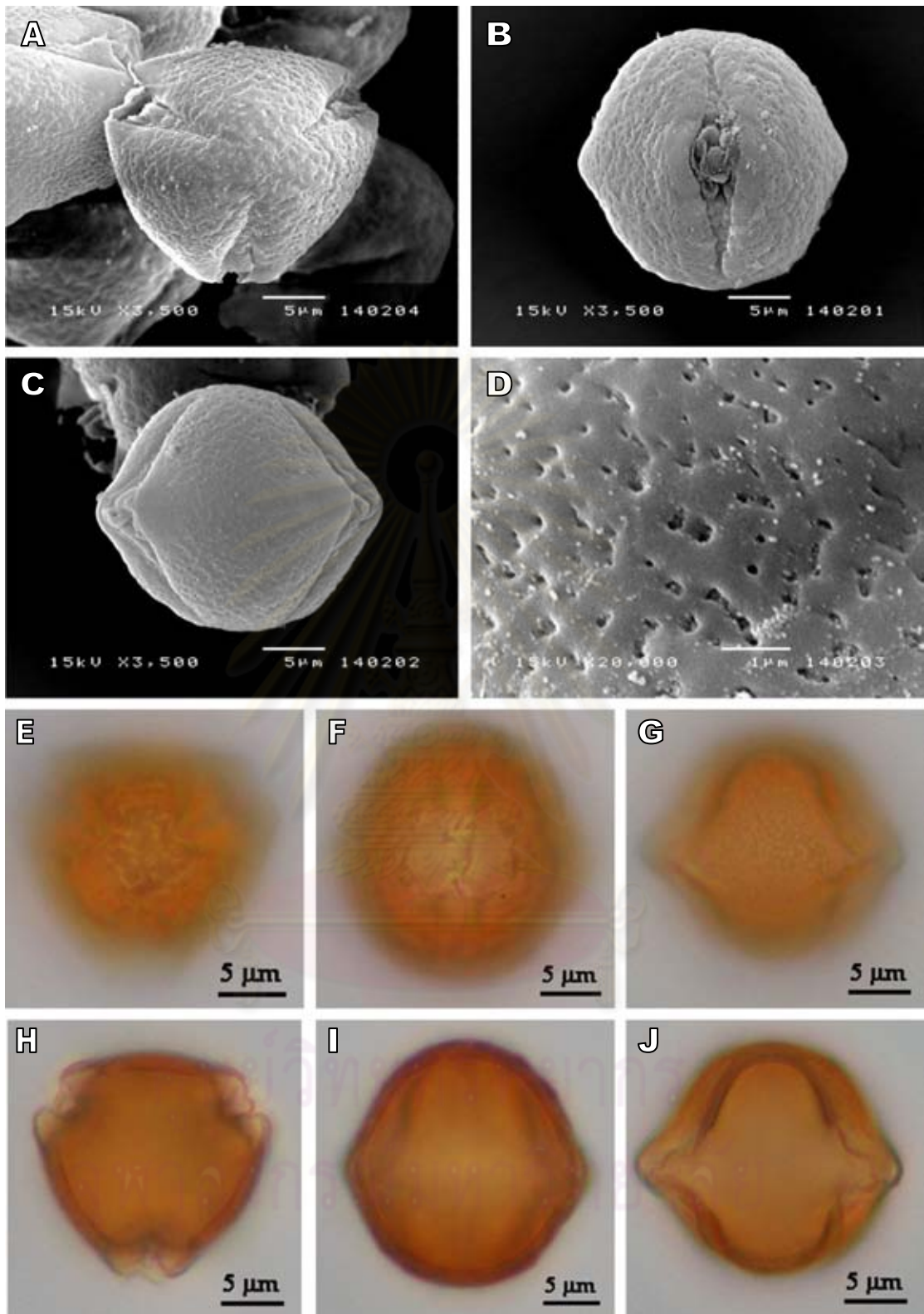


Plate 37 *Pongamia pinnata* (L.) Merr.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).

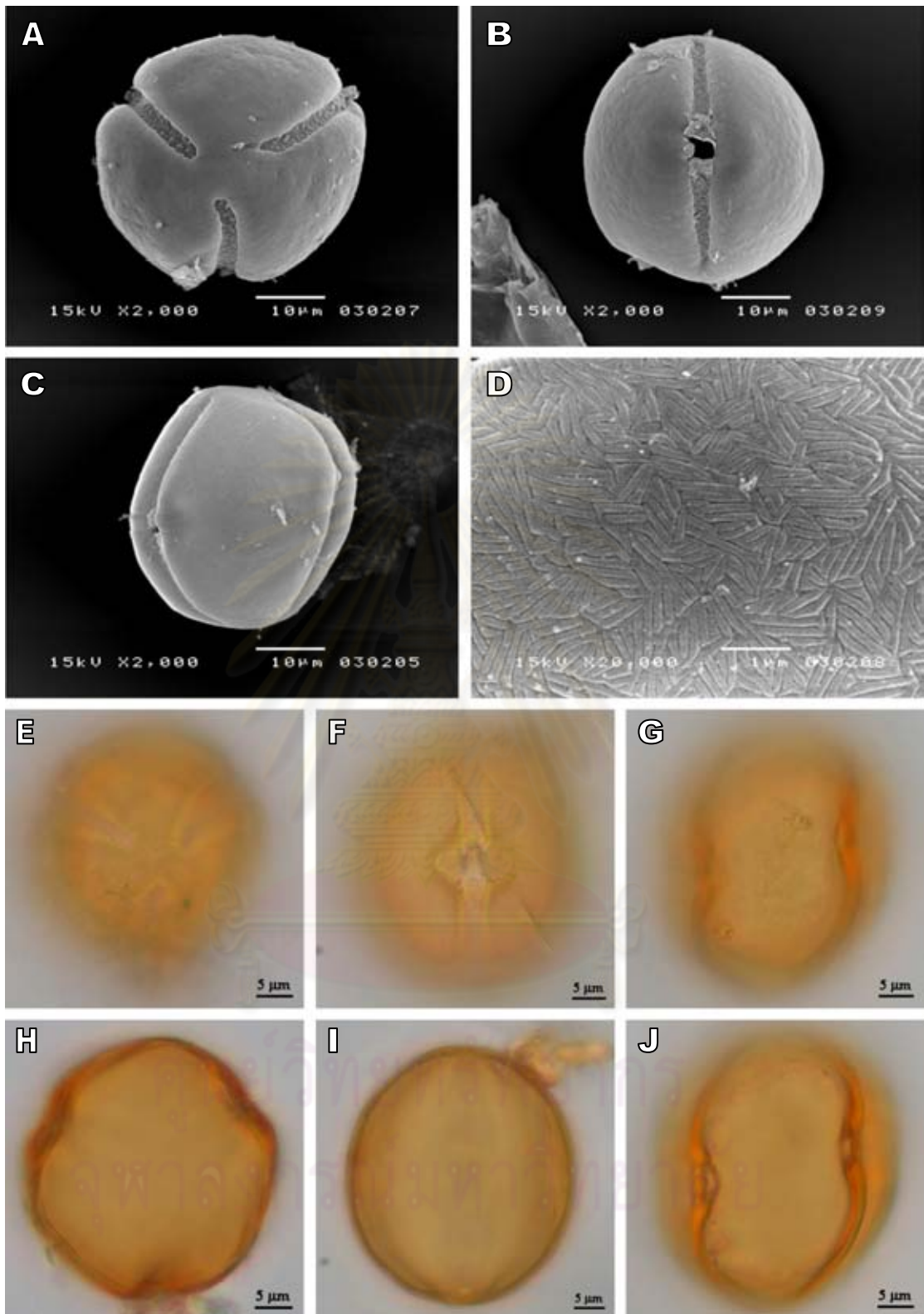


Plate 38 *Diospyros areolata* King & Gamble: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).



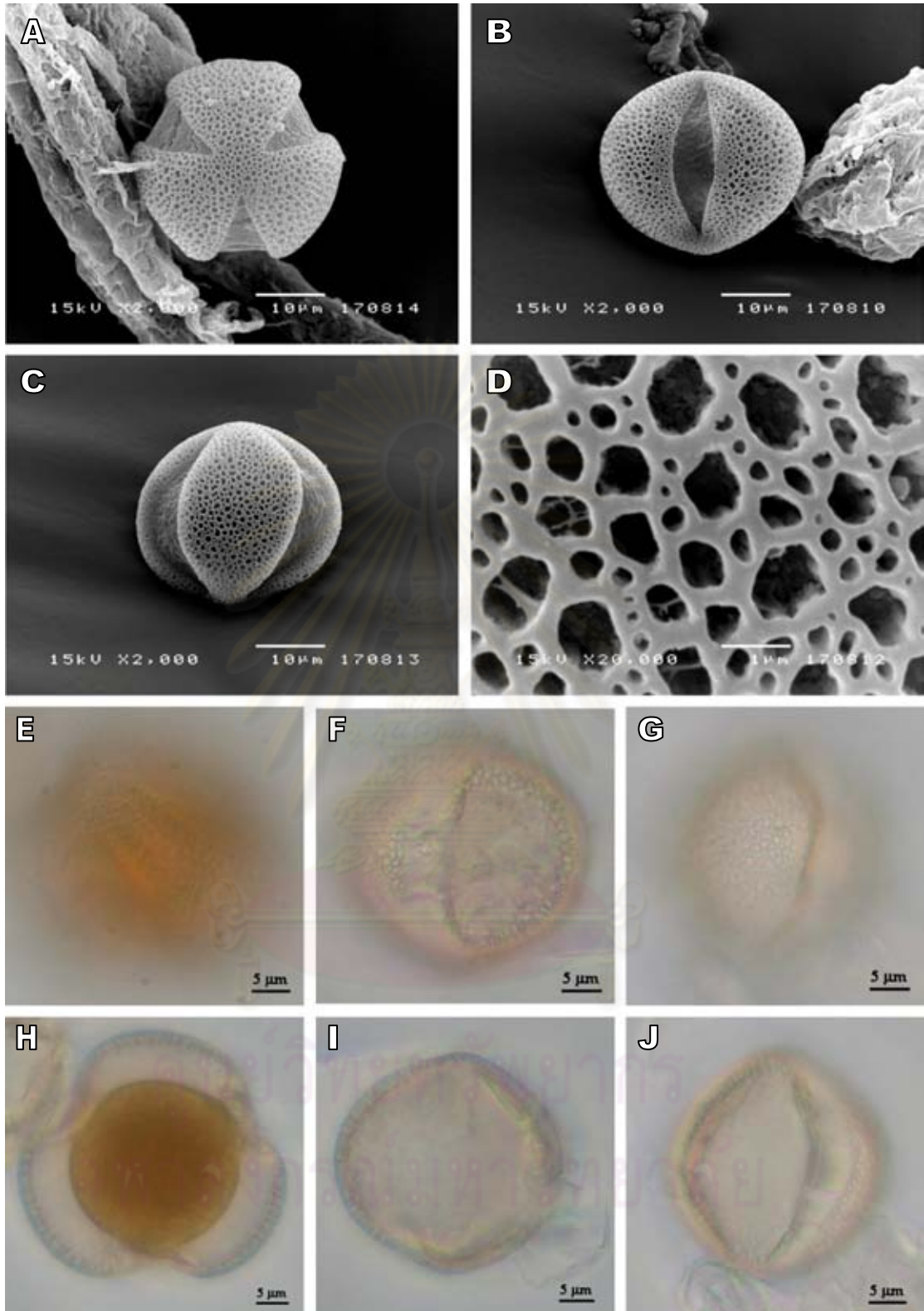


Plate 39 *Dolichandrone spathacea* (L. f.) Seem.: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium at costa colpi (A-D: SEM; E-J: LM).

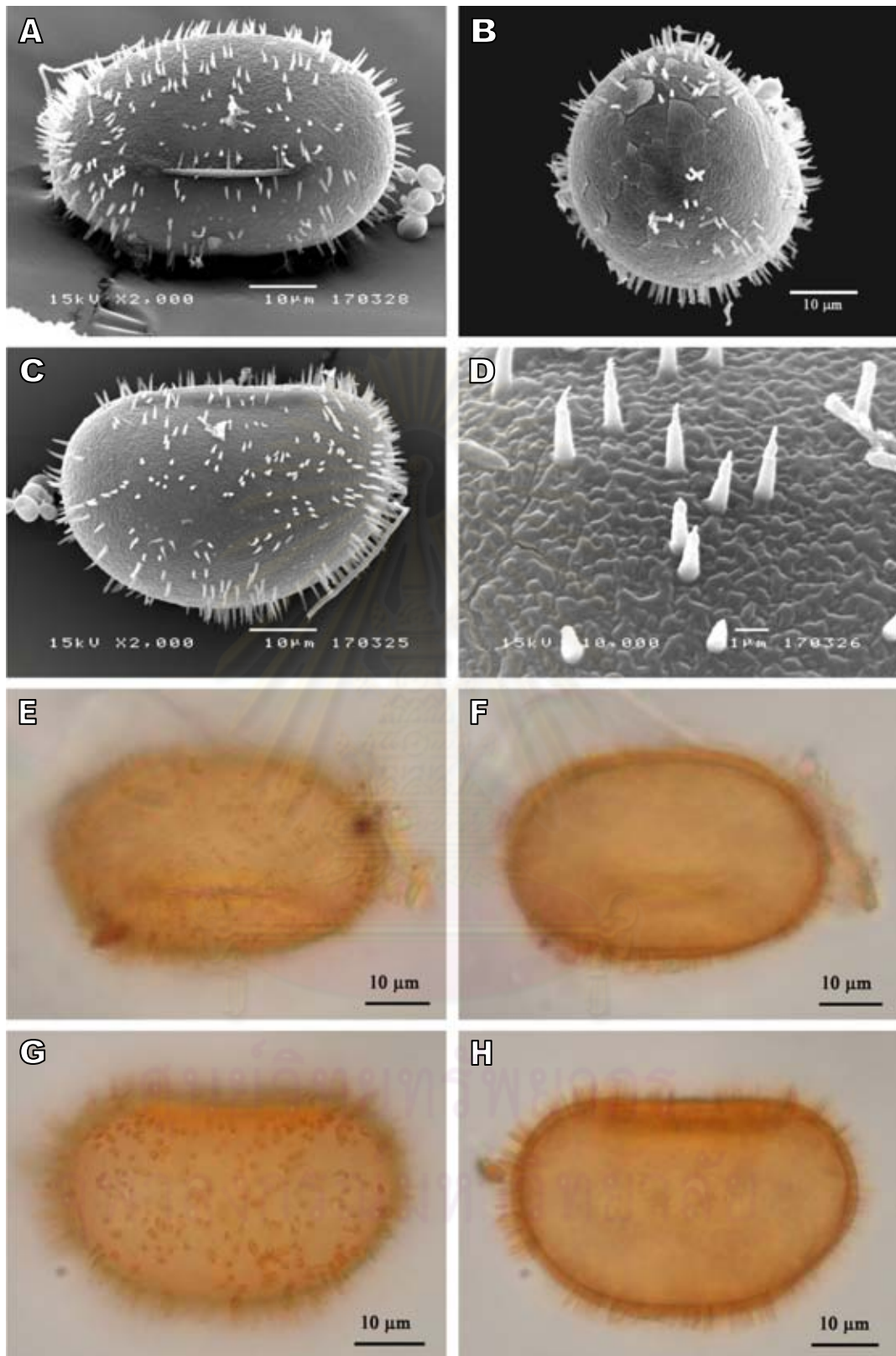


Plate 40 *Drynaria quercifolia* (L.) J. Sm.: (A) Polar view, laesura, (B) Shorter equatorial view, (C) Longer equatorial view, (D) Equatorial view, surface, (E) Polar view, laesura, (F) Polar view, optical section, (G) Longer equatorial view, surface, (H) Longer equatorial view, optical section (A-D: SEM; E-H: LM).

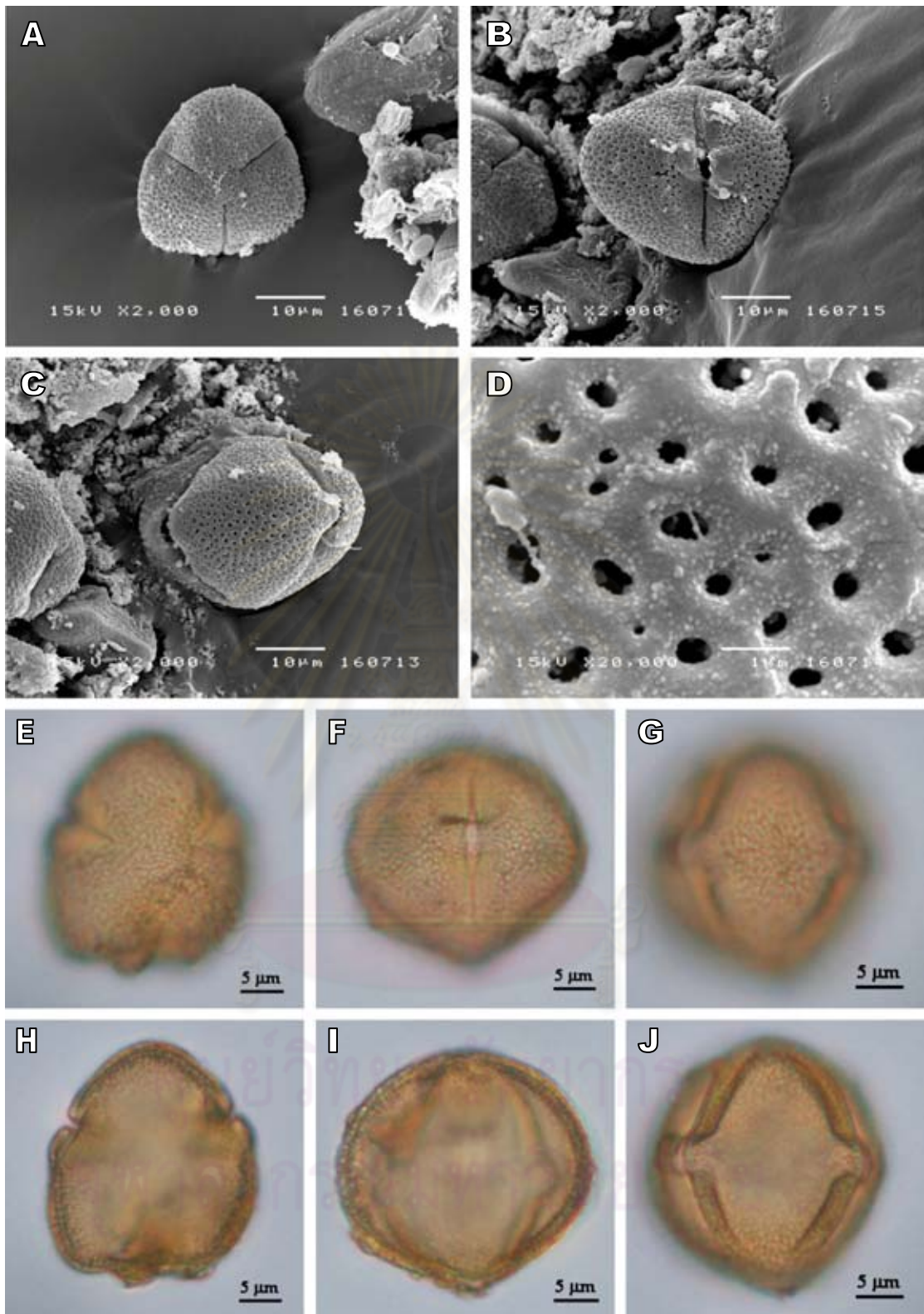


Plate 41 *Excoecaria agallocha* L.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).



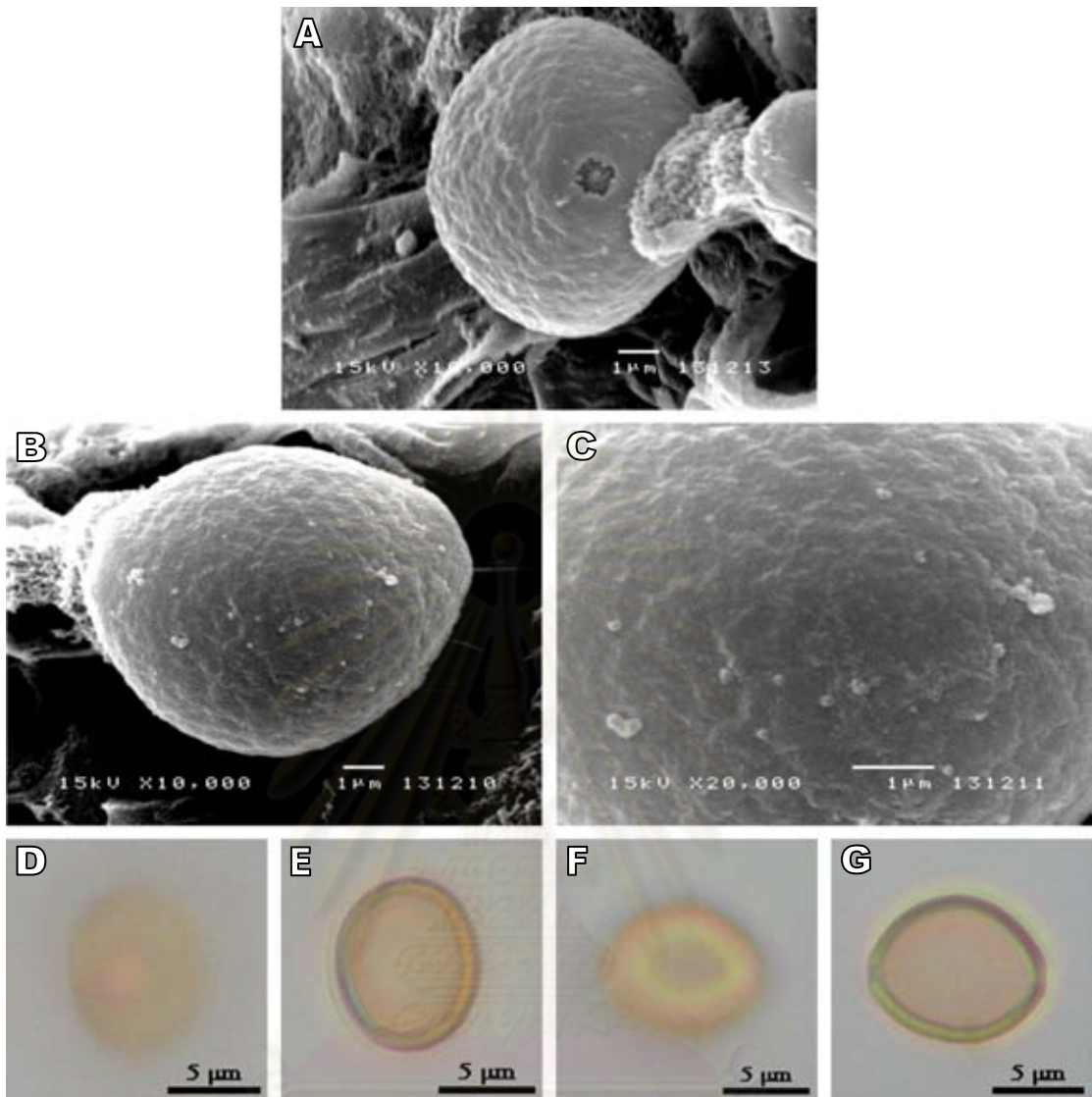


Plate 42 *Ficus microcarpa* L. f.: (A) Shorter equatorial view, porus, (B) Longer equatorial view, mesopodium, (C) Equatorial view, surface, (D) Shorter equatorial view, porus, (E) Shorter equatorial view, optical section, (F) Longer equatorial view, mesopodium surface, (G) Longer equatorial view, optical section (A-C: SEM; D-G: LM).

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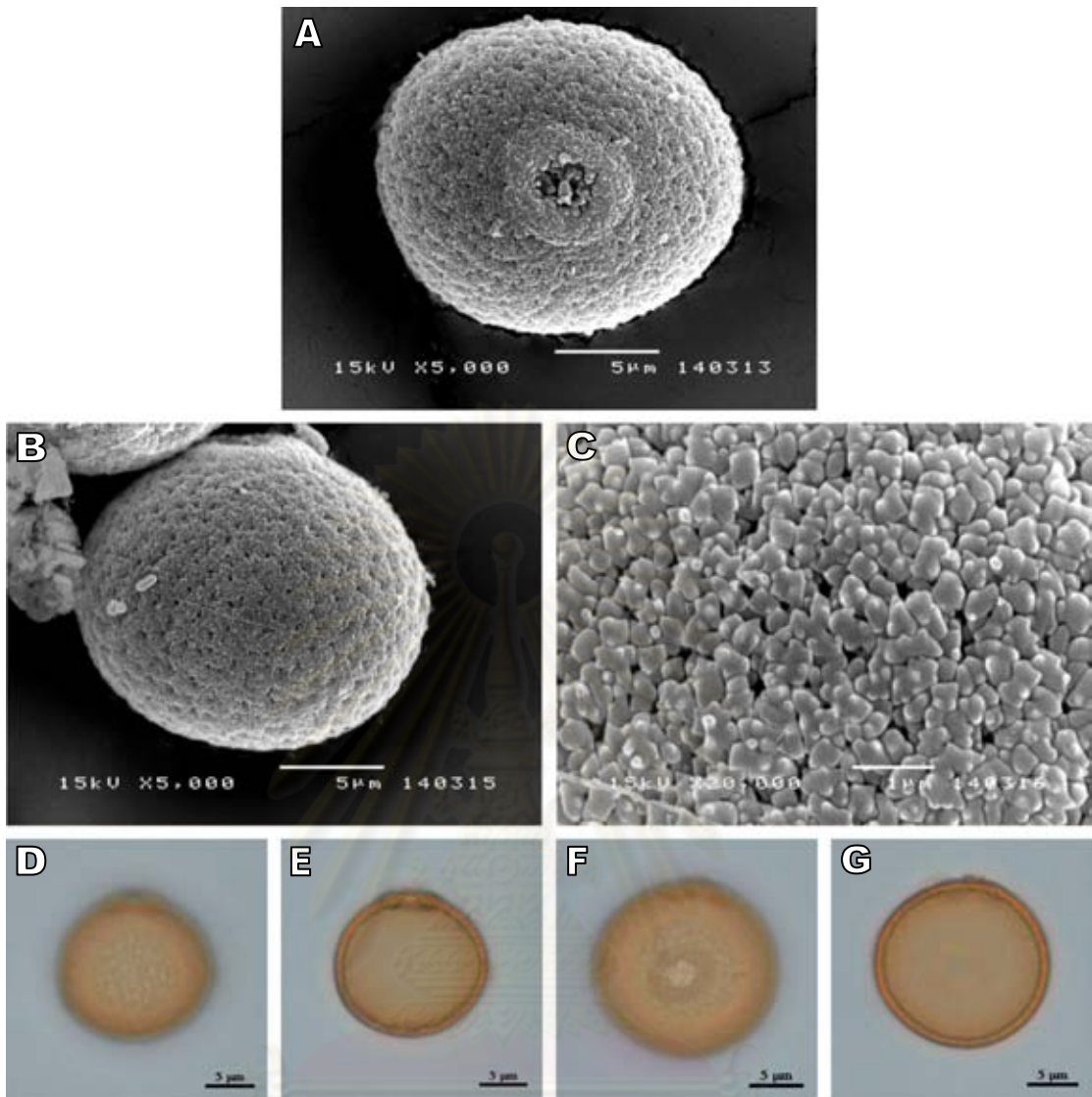


Plate 43 *Flagellaria indica* L.: (A) Polar view, porus, (B) Equatorial view, (C) Surface, (D) Equatorial view, surface, (E) Equatorial view, optical section, (F) Polar view, porus, (G) Polar view, optical section (A-C: SEM; D-G: LM).

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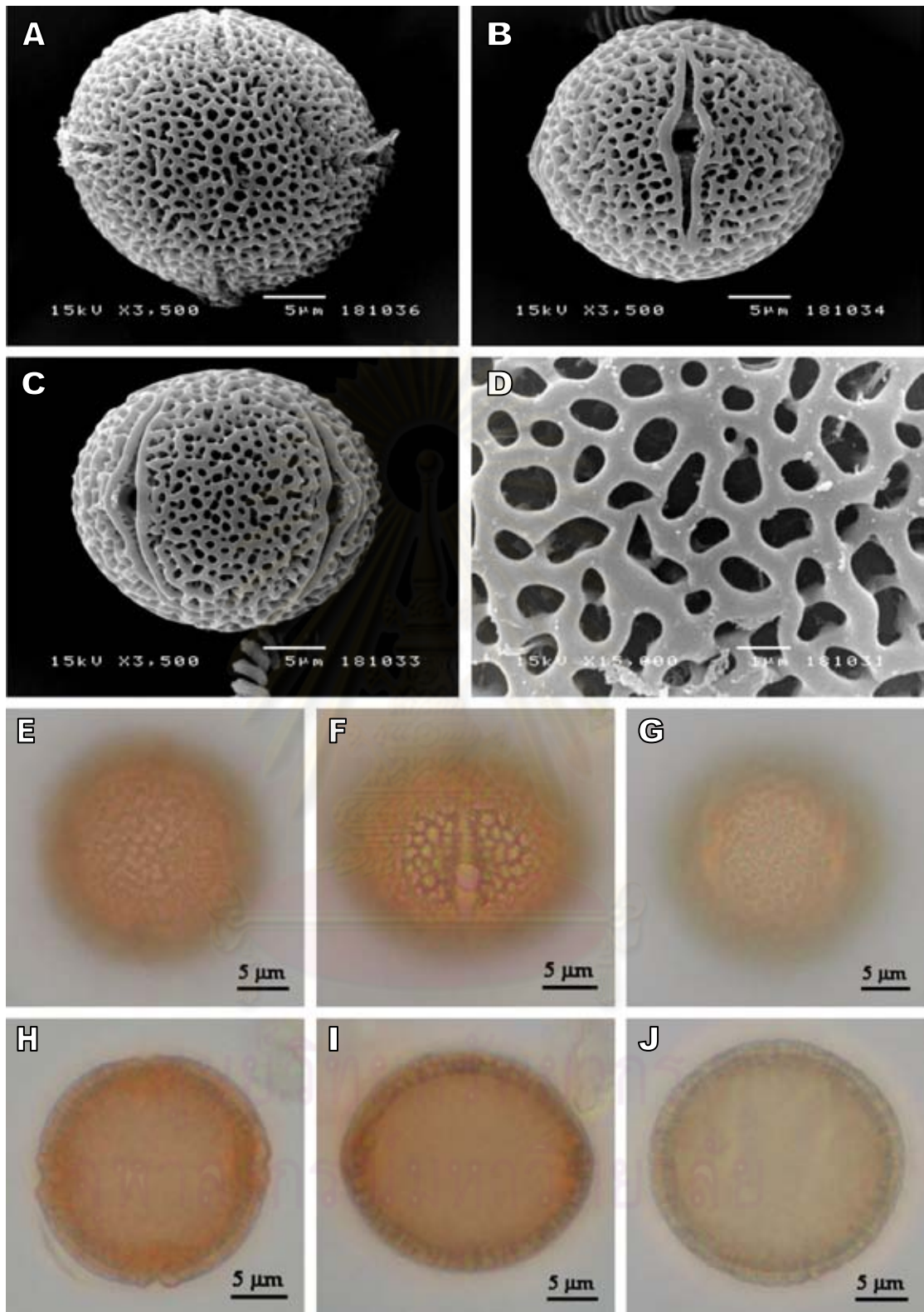


Plate 44 *Glochidion littorale* Blume: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

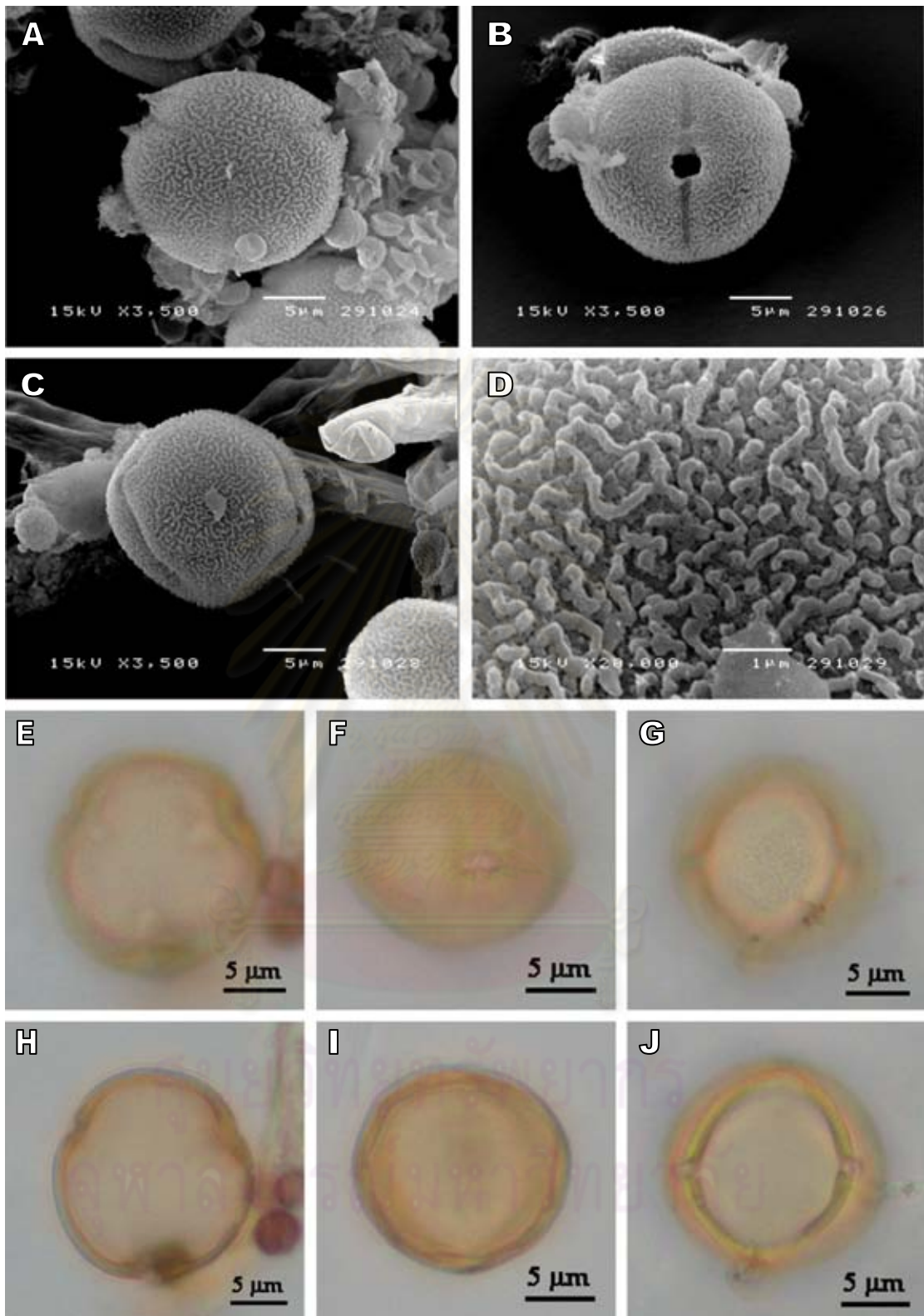


Plate 45 *Heritiera littoralis* Aiton: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).

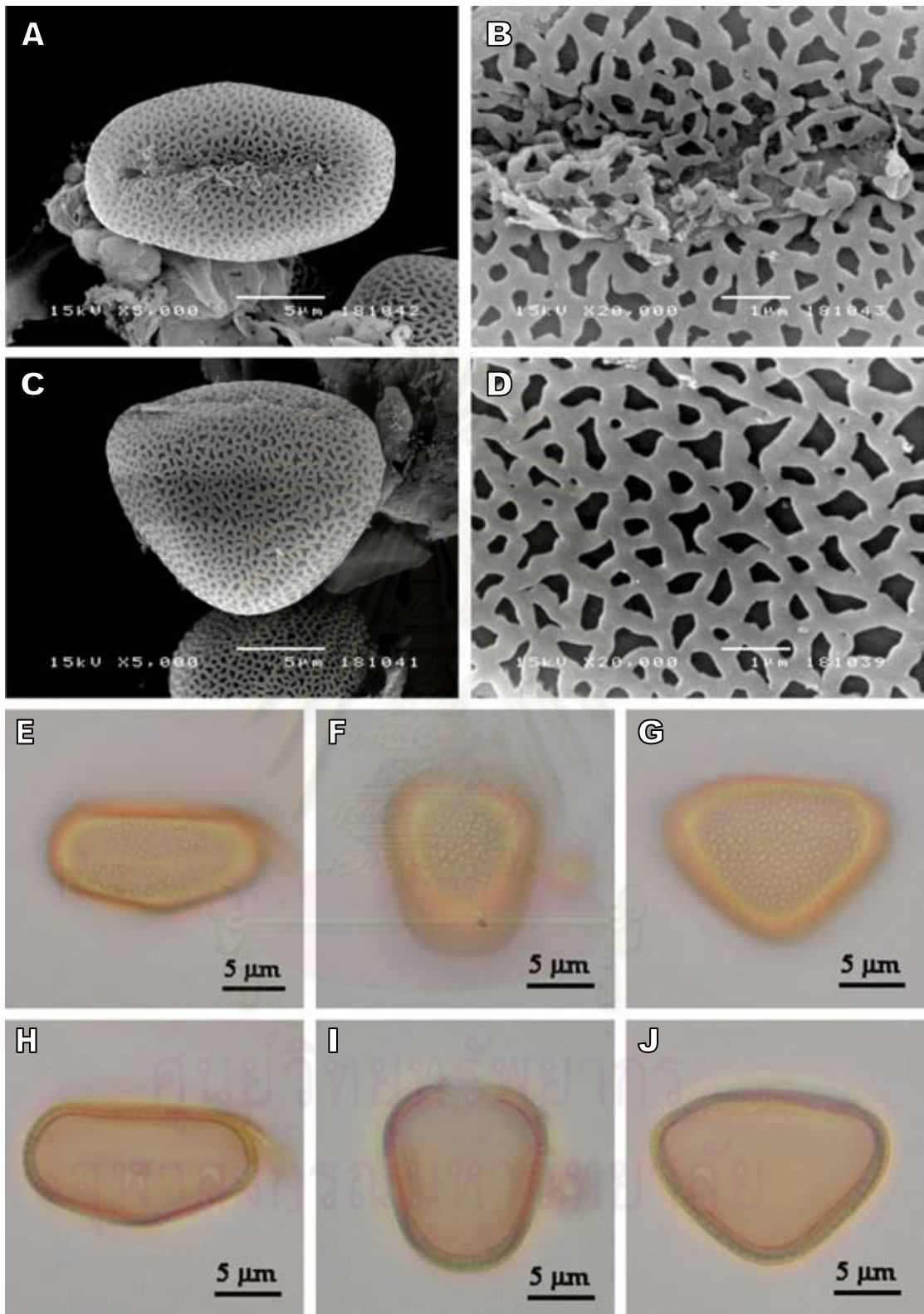


Plate 46 *Horsfieldia irya* (Gaertn.) Warb.: (A) Polar view, (B) Colpus, (C) Longer equatorial view, (D) Equatorial view, surface, (E) Polar view, colpus, (F) Shorter equatorial view, surface, (G) Longer equatorial view, surface, (H) Polar view, optical section, (I) Shorter equatorial view, optical section, (J) Longer equatorial view, optical section (A-D: SEM; E-J: LM).



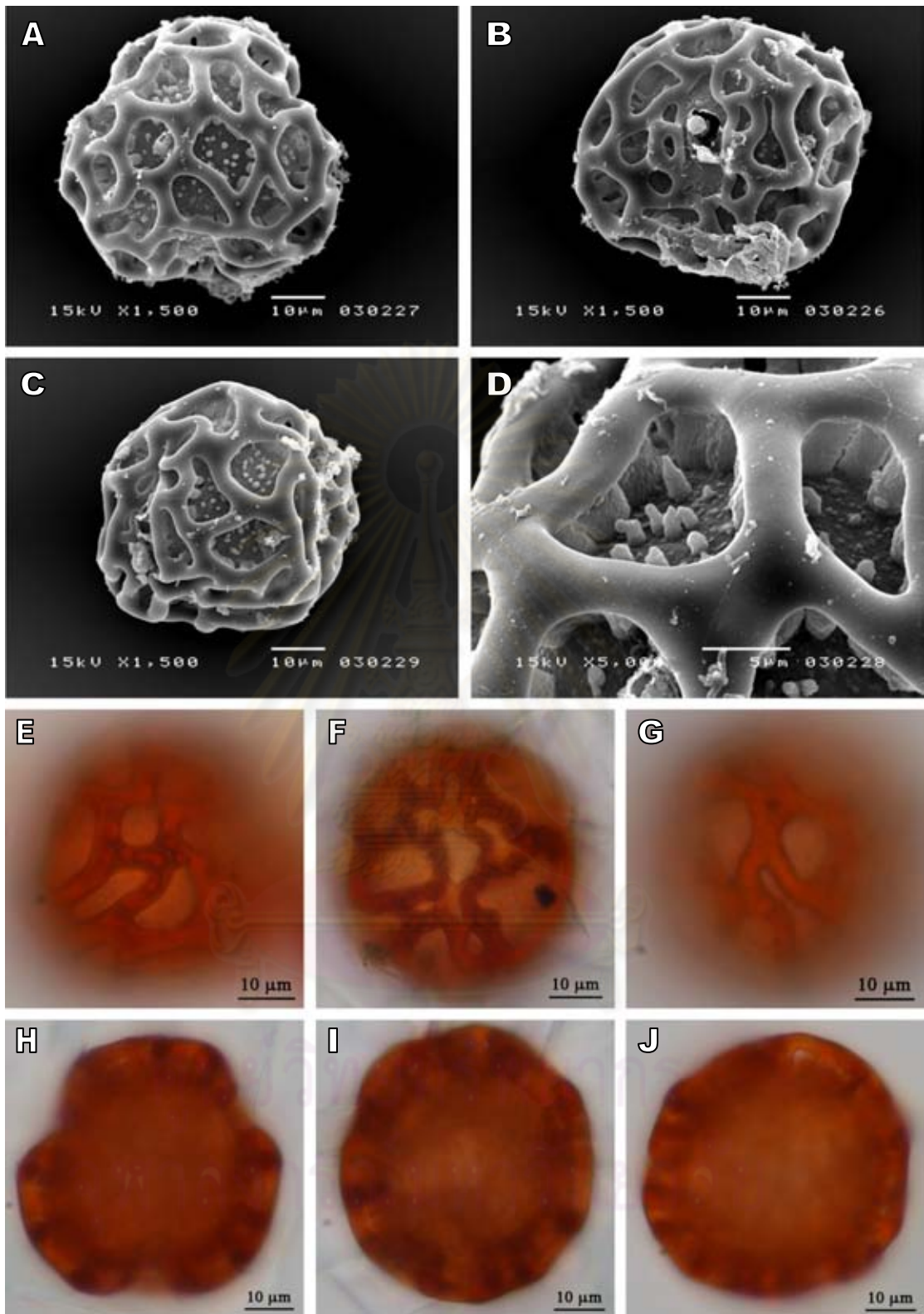


Plate 47 *Intsia bijuga* (Colebr.) Kuntze: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

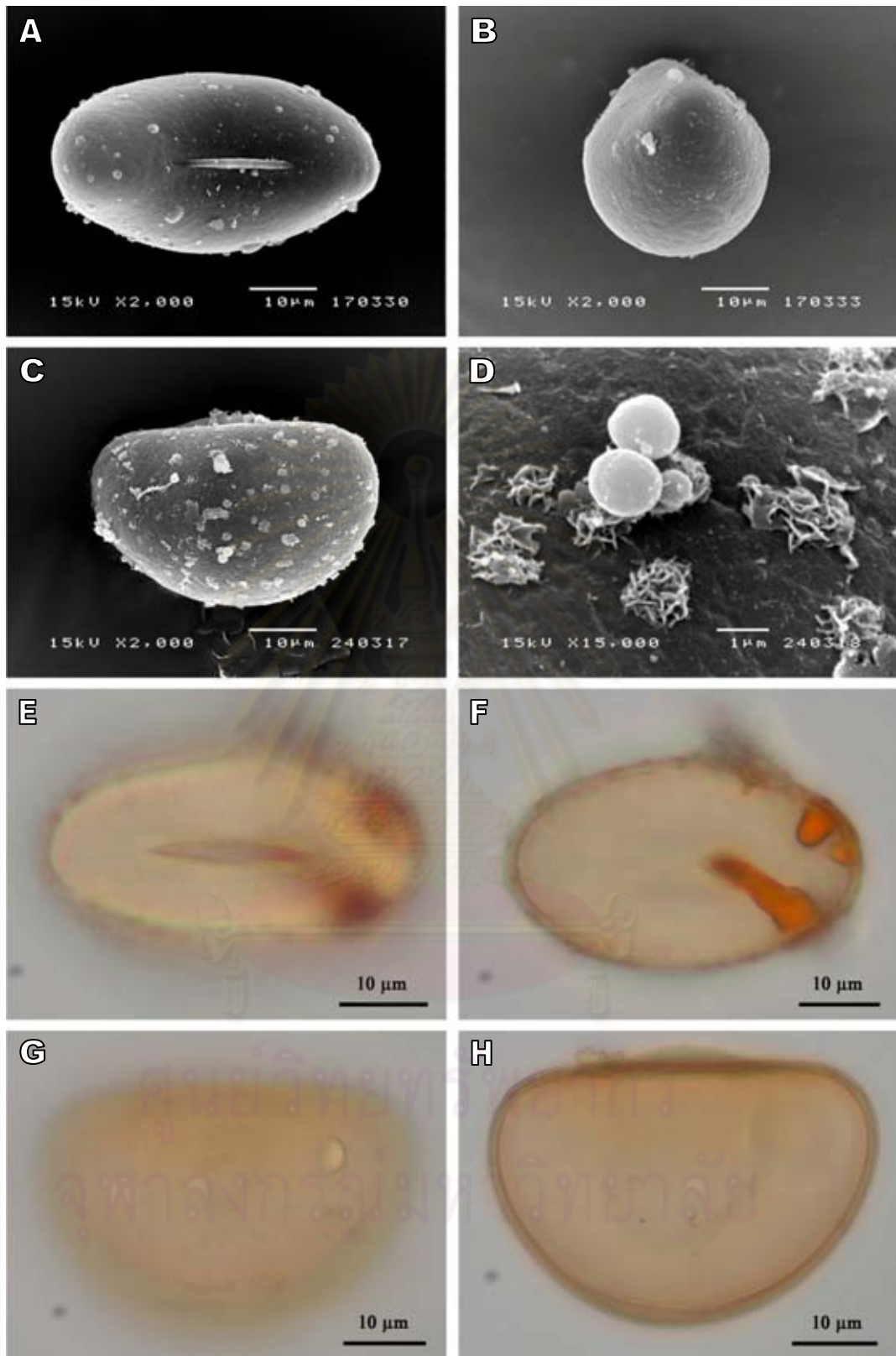


Plate 48 *Lecanopteris sinuosa* ( Wall. ex Hook. ) Copel.: (A) Polar view, laesura, (B) Shorter equatorial view, (C) Longer equatorial view, (D) Equatorial view, surface, (E) Polar view, laesura, (F) Polar view, optical section, (G) Longer equatorial view, surface, (H) Longer equatorial view, optical section (A-D: SEM; E-H: LM).



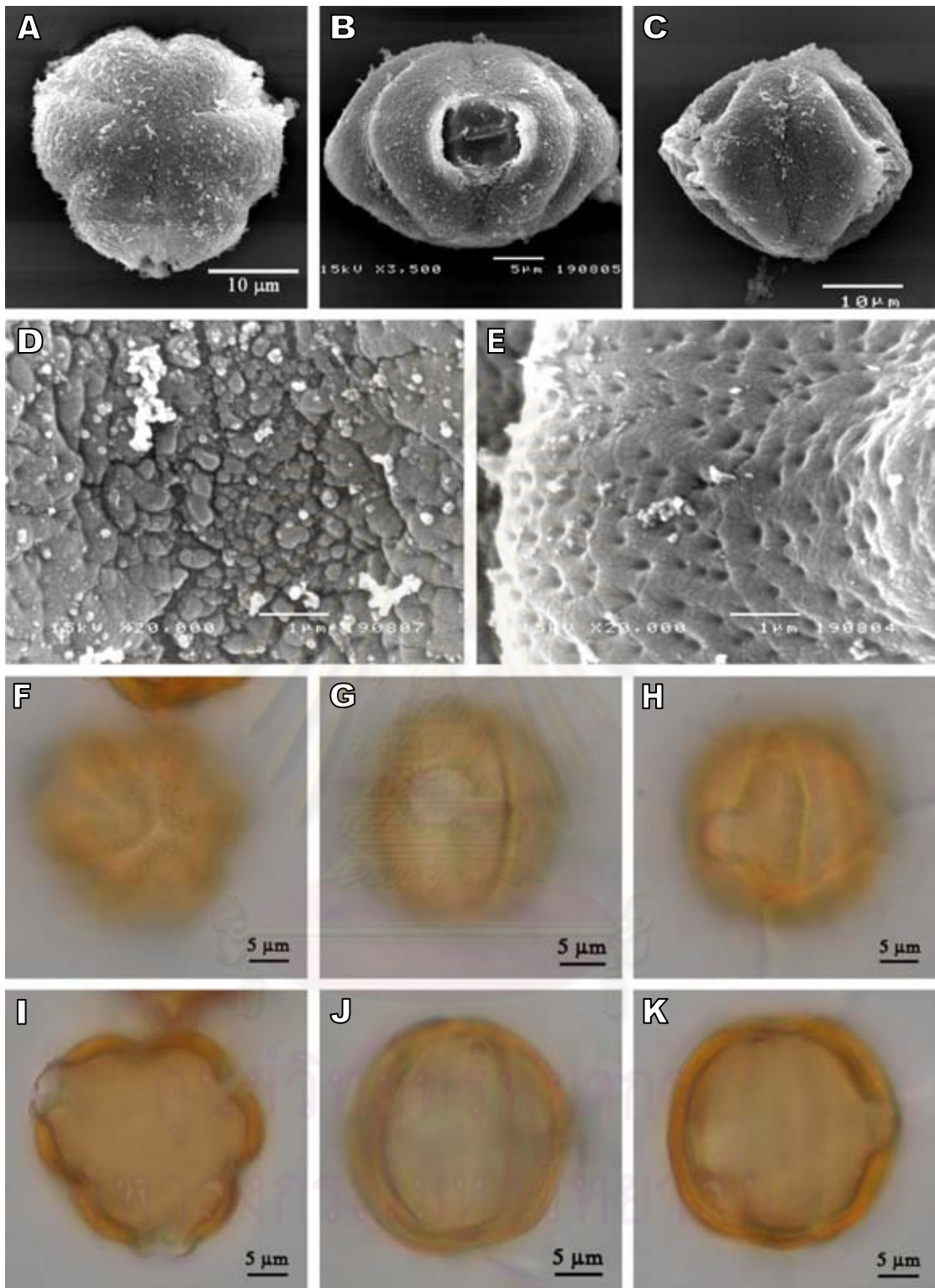


Plate 49 *Lumnitzera littorea* (Jack) Voigt: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, pseudocolpus, (D) Equatorial view, pseudocolpus surface, (E) Surface between true and pseudoaperture, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, pseudocolpus surface, (I) Polar view, optical section, (J) Optical section under colporus, (K) Optical section under pseudocolpus (A-E: SEM; F-K: LM).

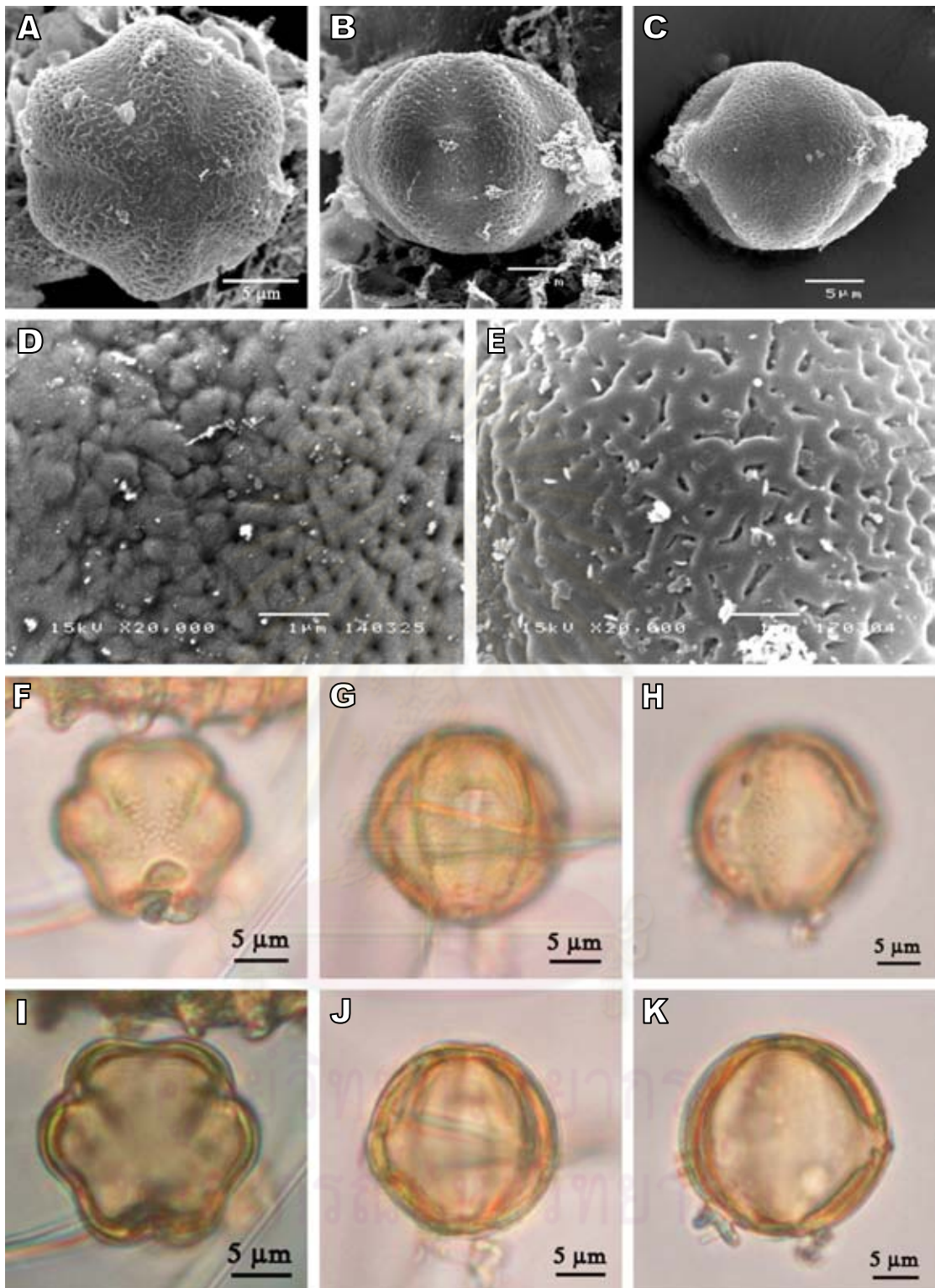


Plate 50 *Lumnitzera racemosa* Willd.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, pseudocolpus, (D) Equatorial view, pseudocolpus surface, (E) Surface between true and pseudoaperture, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, pseudocolpus surface, (I) Polar view, optical section, (J) Optical section under colporus, (K) Optical section under pseudocolpus (A-E: SEM; F-K: LM).

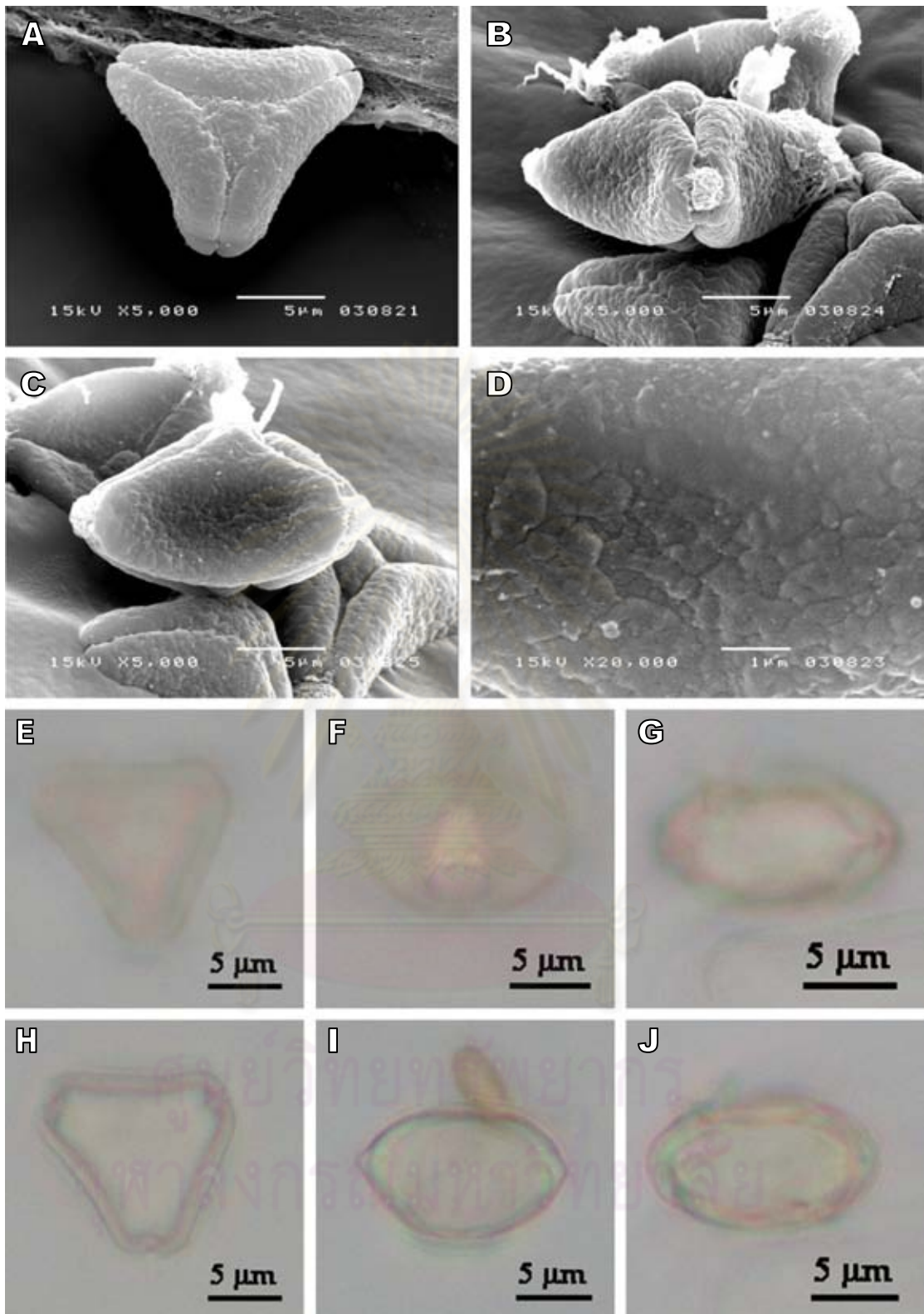


Plate 51 *Melaleuca cajuputi* Powell: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).



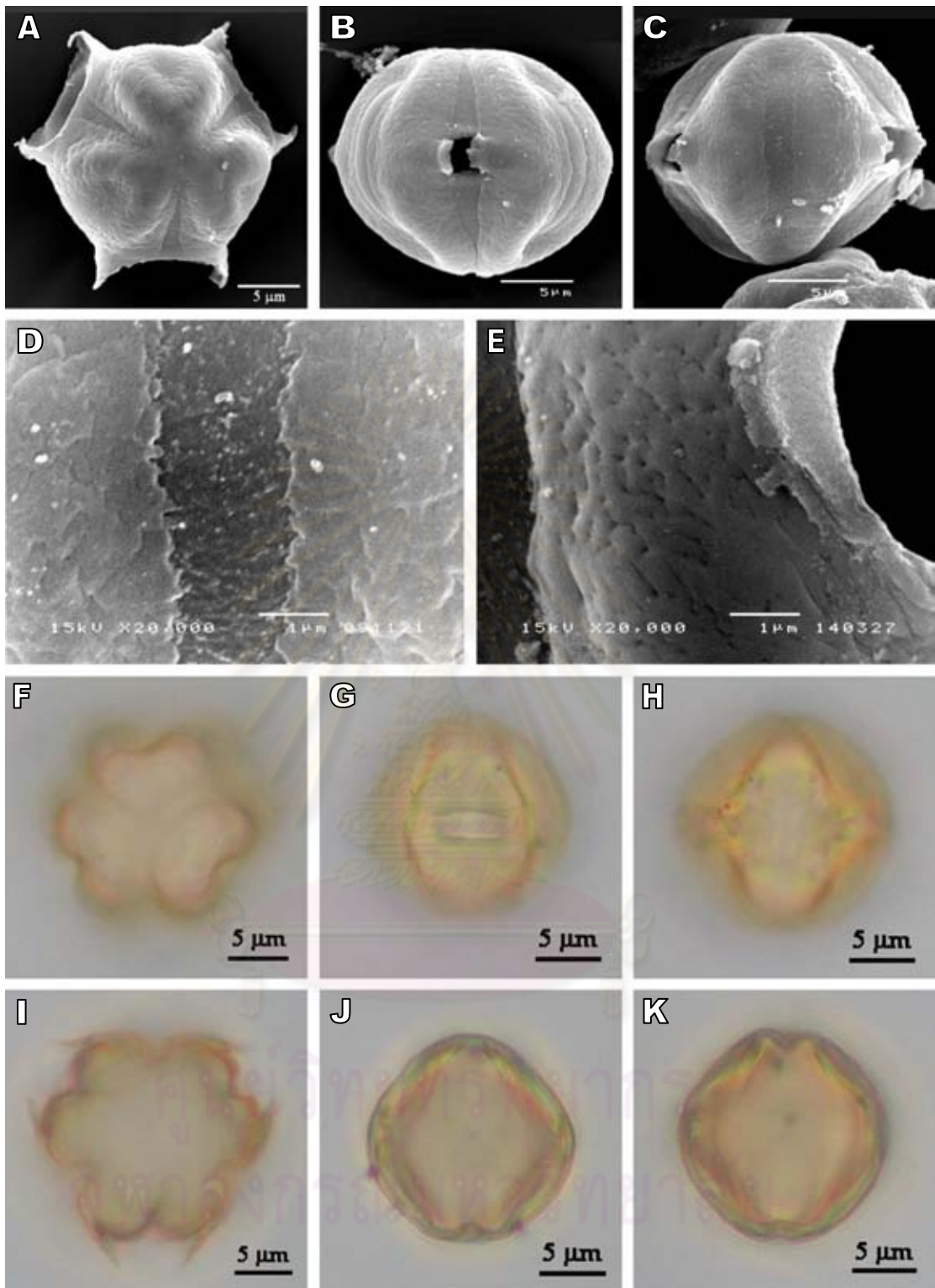


Plate 52 *Melastoma saigonense* (Kuntze) Merr.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, pseudocolpus, (D) Equatorial view, pseudocolpus surface, (E) Surface between true and pseudoaperture, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, pseudocolpus surface, (I) Polar view, optical section, (J) Optical section under colporus, (K) Optical section under pseudocolpus (A-E: SEM; F-K: LM).

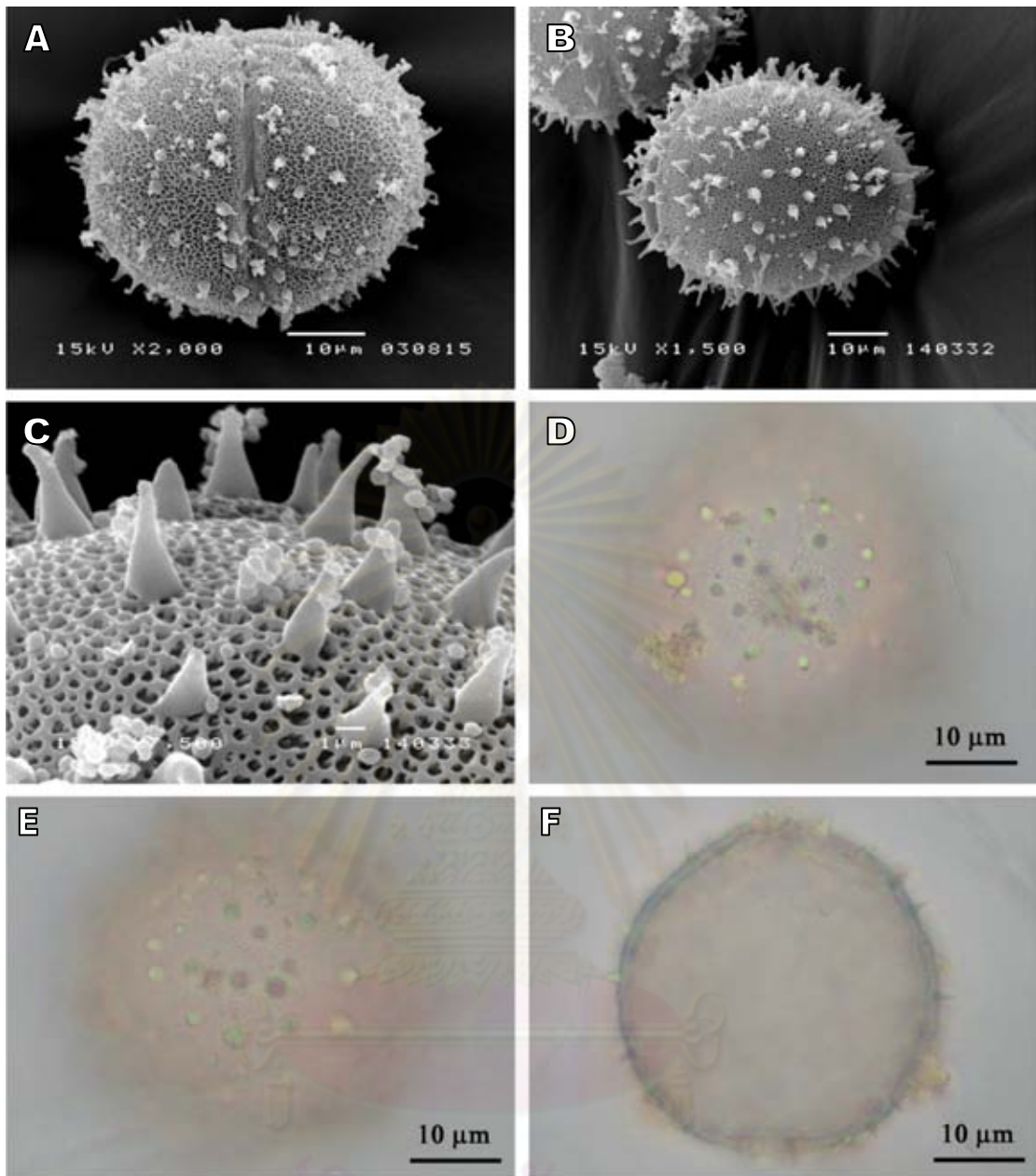
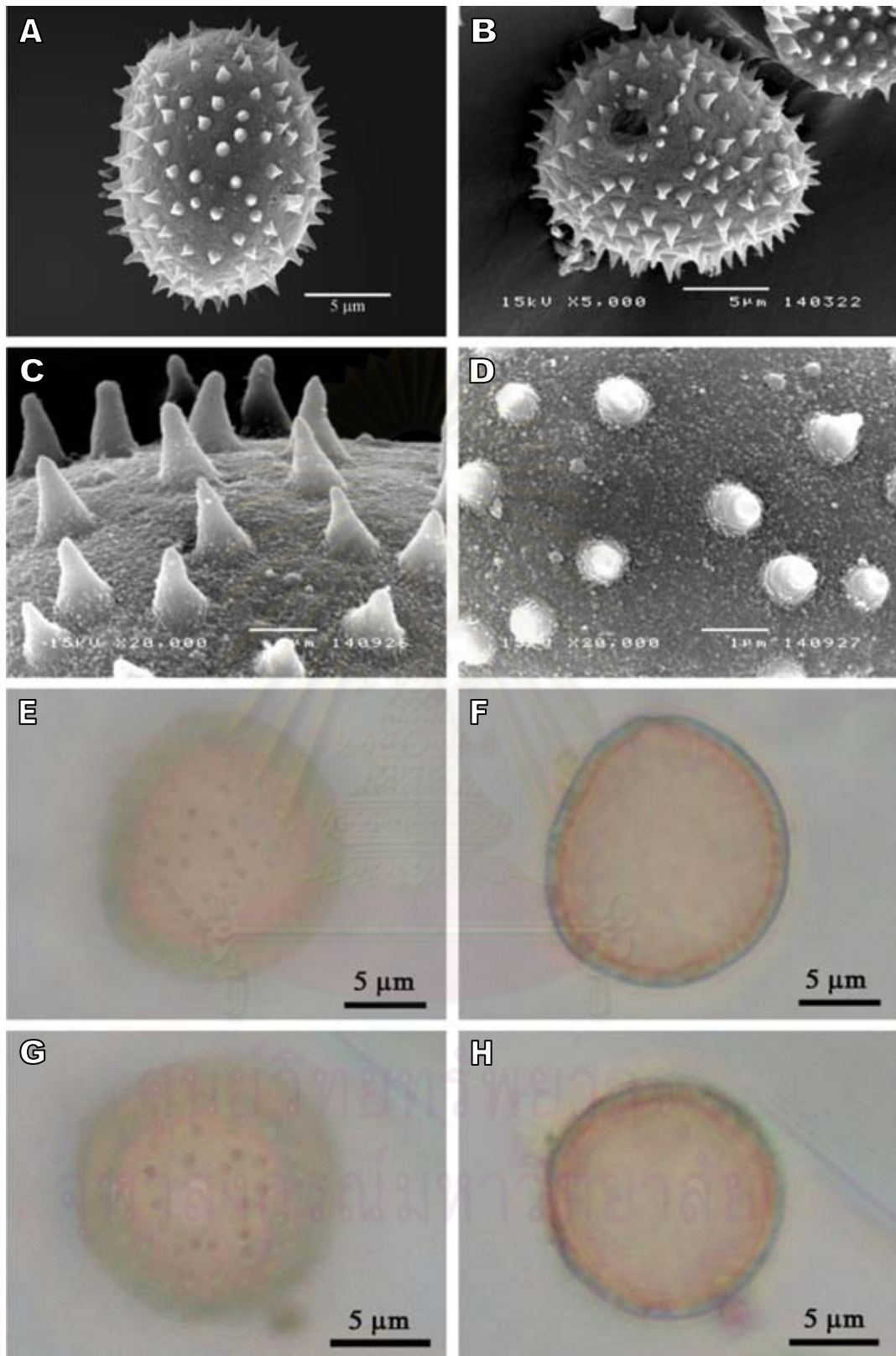


Plate 53 *Nypa fruticans* Wurm: (A) Colpus, (B) Equatorial view, (C) Equatorial view, surface, (D) Colpus, (E) Equatorial view, surface, (F) Optical section under colpus (A-C: SEM; D-F: LM).

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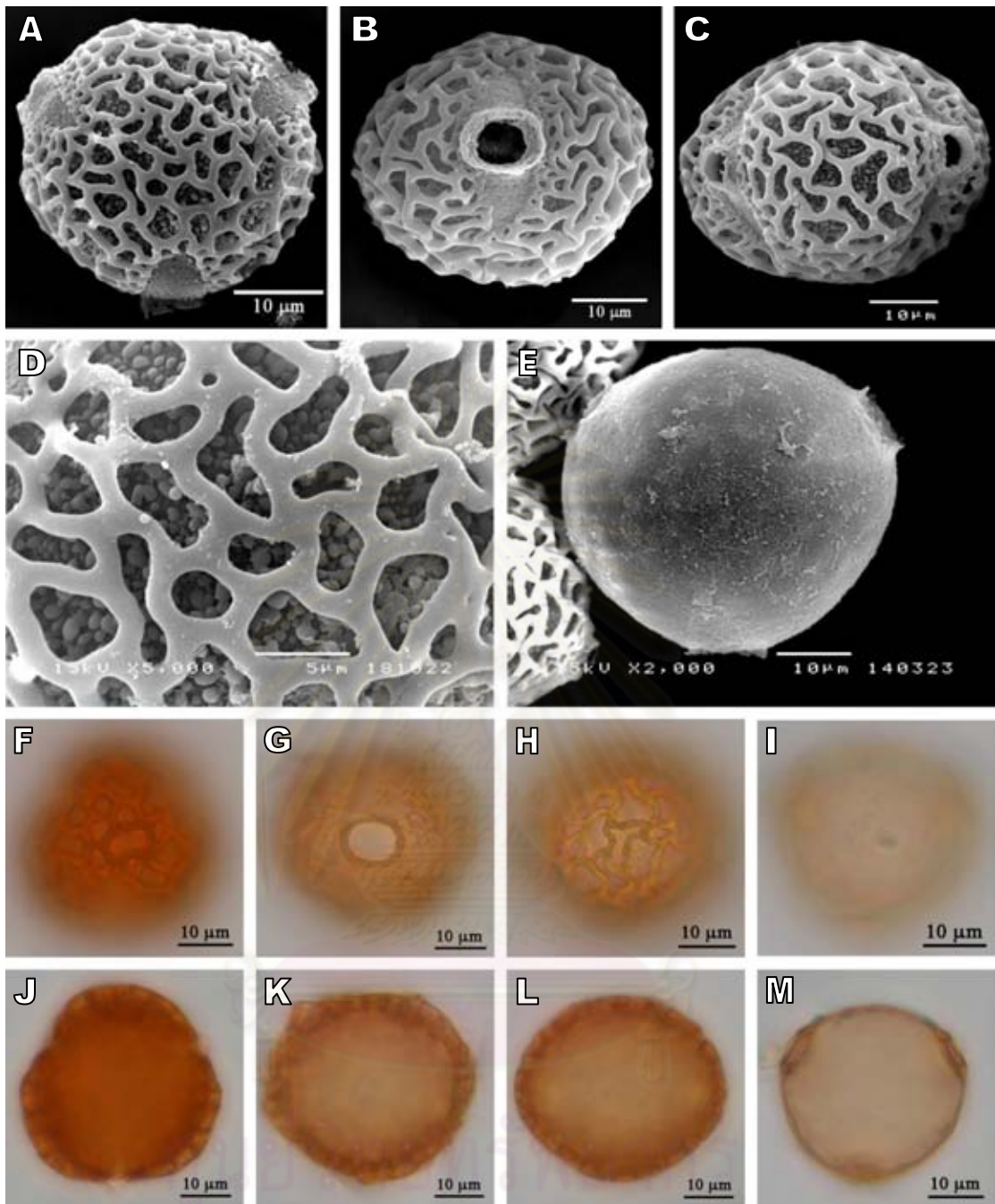


Plate 55 *Peltophorum pterocarpum* (DC.) Backer ex K. Heyne: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial, ornamentation, (E) Polar view of sexineless grain, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, mesocolpium surface, (I) Polar view of sexineless grain, surface, (J) Polar view, optical section, (K) Optical section under colporus, (L) Optical section under mesocolpium, (M) Polar view of sexineless grain, optical section at costa endoppori (A-E: SEM; F-M: LM).

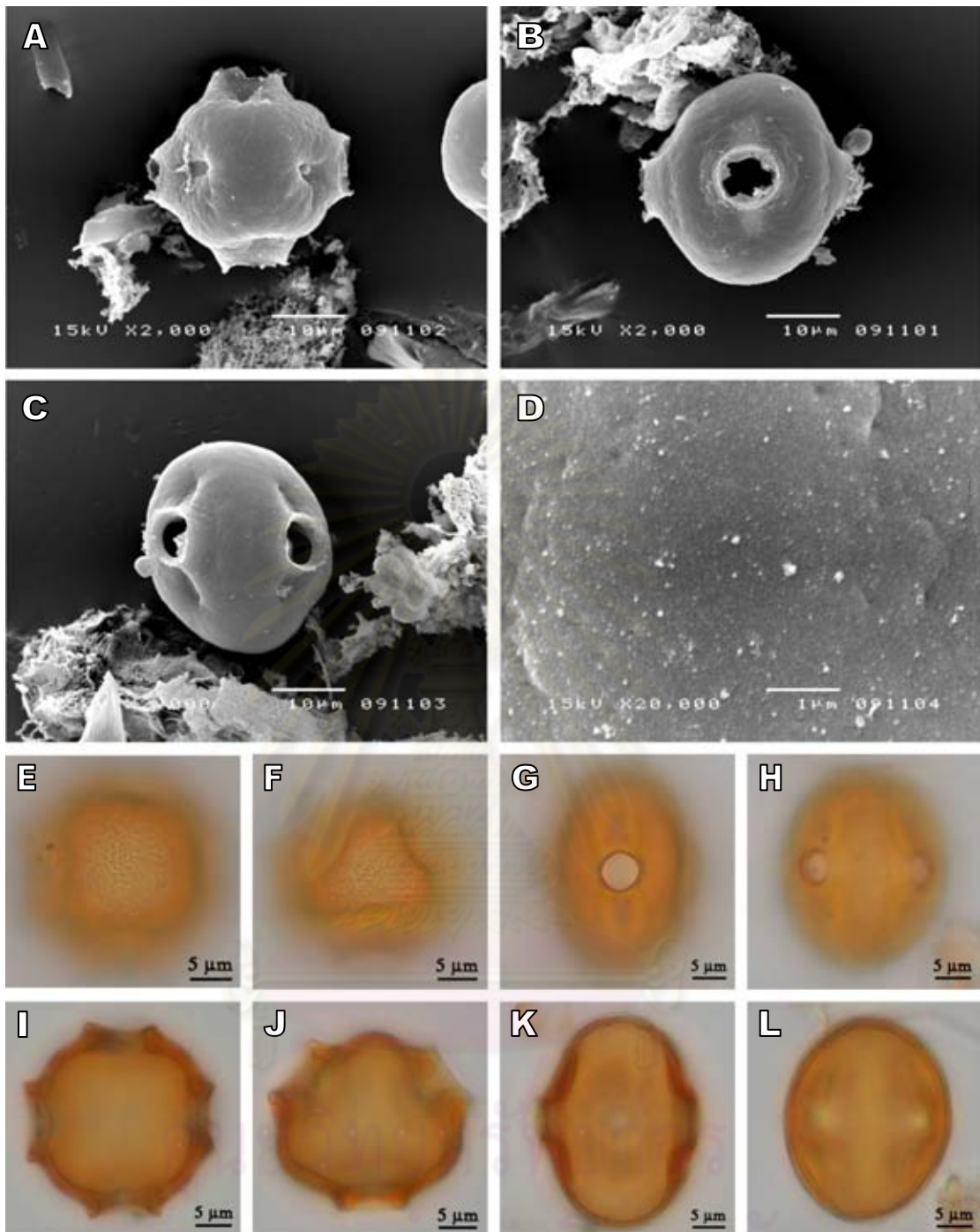


Plate 56 *Pemphis acidula* J.R. & G. Forst.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view of 4-aperturate grain, surface, (F) Polar view of 3-aperturate grain, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, mesocolpium surface, (I) Polar view of 4-aperturate grain, optical section, (J) Polar view of 3-aperturate grain, optical section, (K) Optical section under colporus, (L) Optical section under mesocolpium (A-D: SEM; E-L: LM).



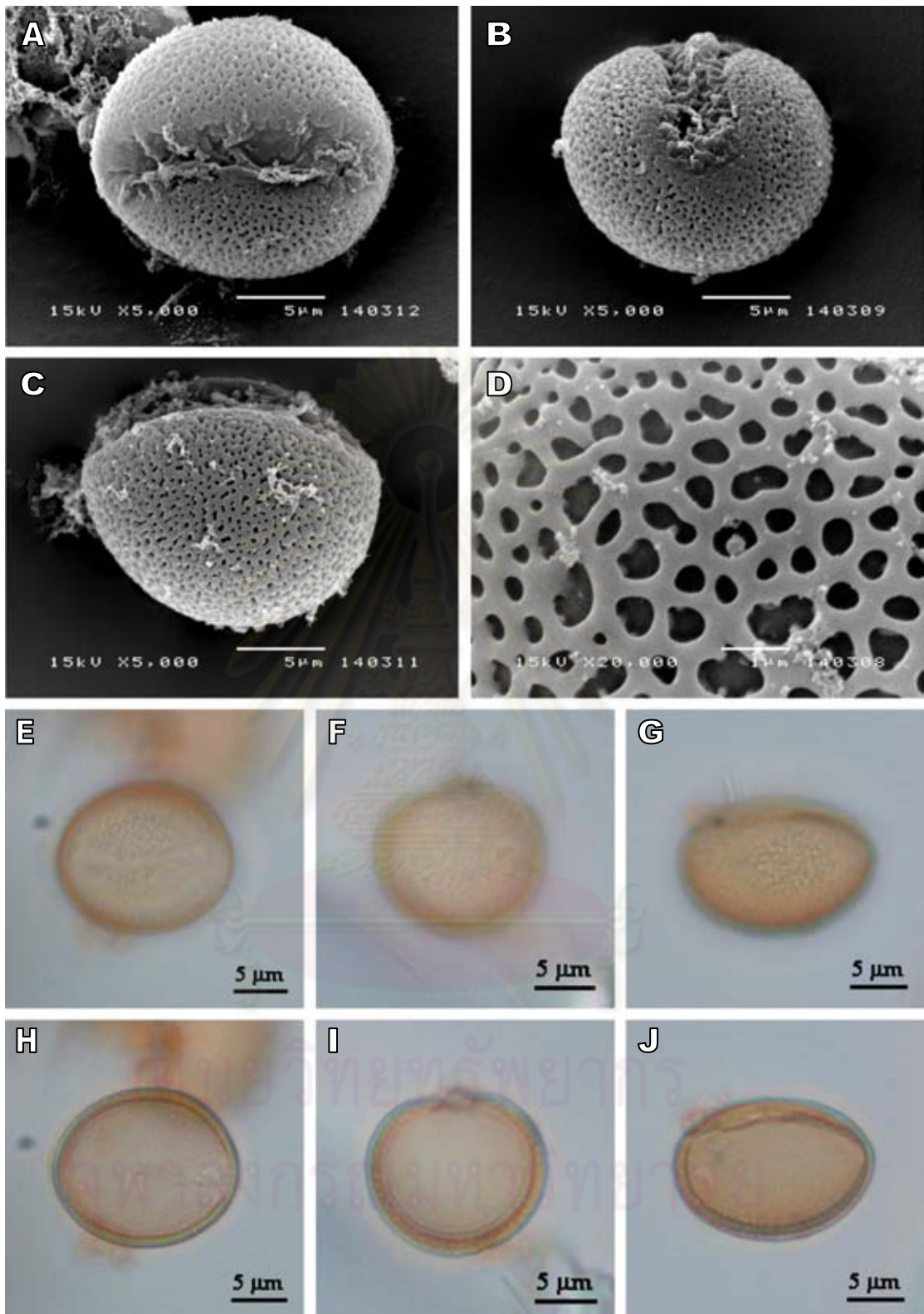


Plate 57 *Phoenix paludosa* Roxb.: (A) Polar view, (B) Shorter equatorial view, (C) Longer equatorial view, (D) Equatorial view, surface, (E) Polar view, colpus, (F) Shorter equatorial view, surface, (G) Longer equatorial view, surface, (H) Polar view, optical section, (I) Shorter equatorial view, optical section, (J) Longer equatorial view, optical section (A-D: SEM; E-J: LM).



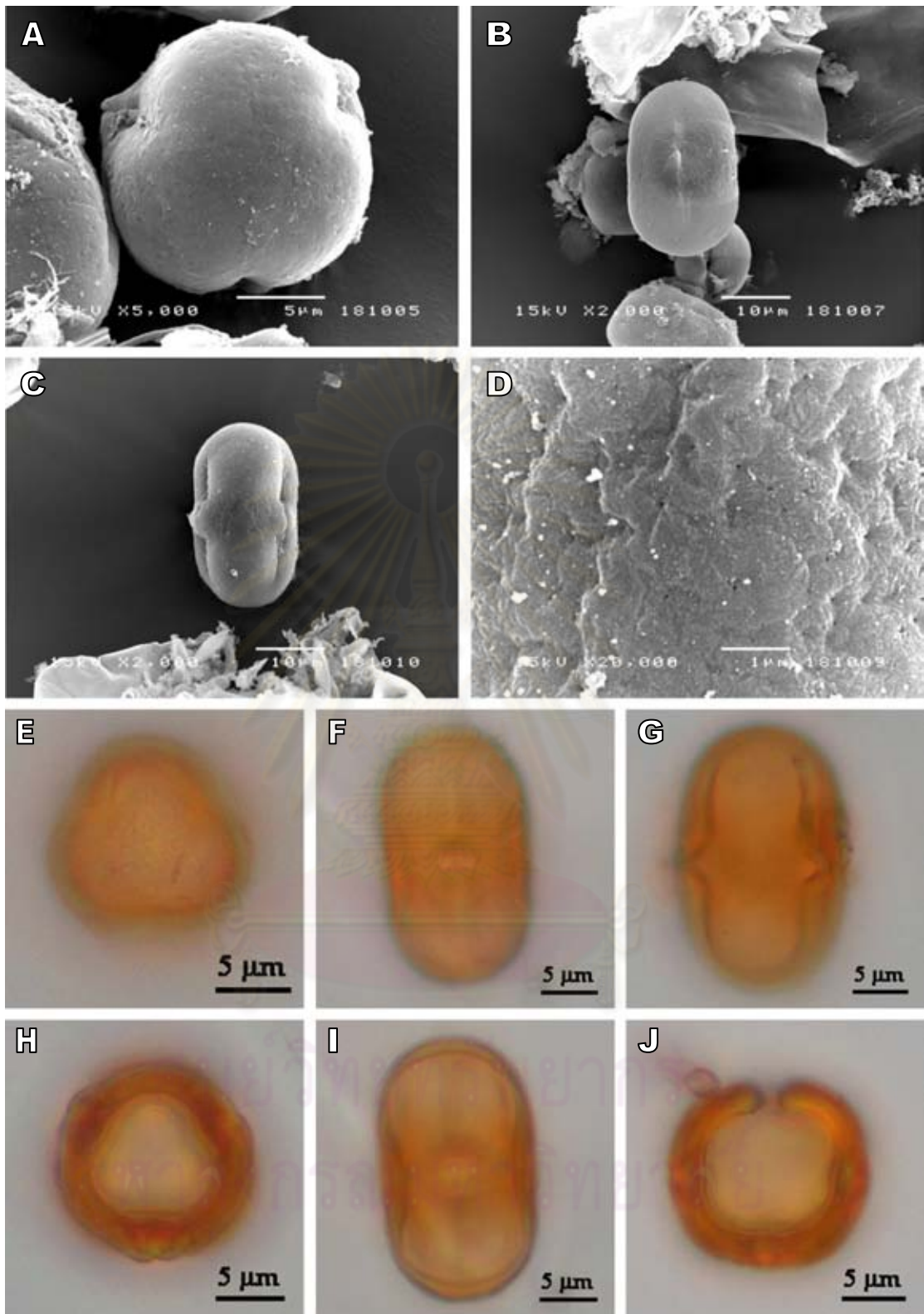


Plate 58 *Planchonella obovata* (R.Br.) Pierre: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view of 3-aperturate grain, optical section, (I) Optical section under colporus, (J) Polar view of 4-aperturate grain, optical section (A-D: SEM; E-J: LM).

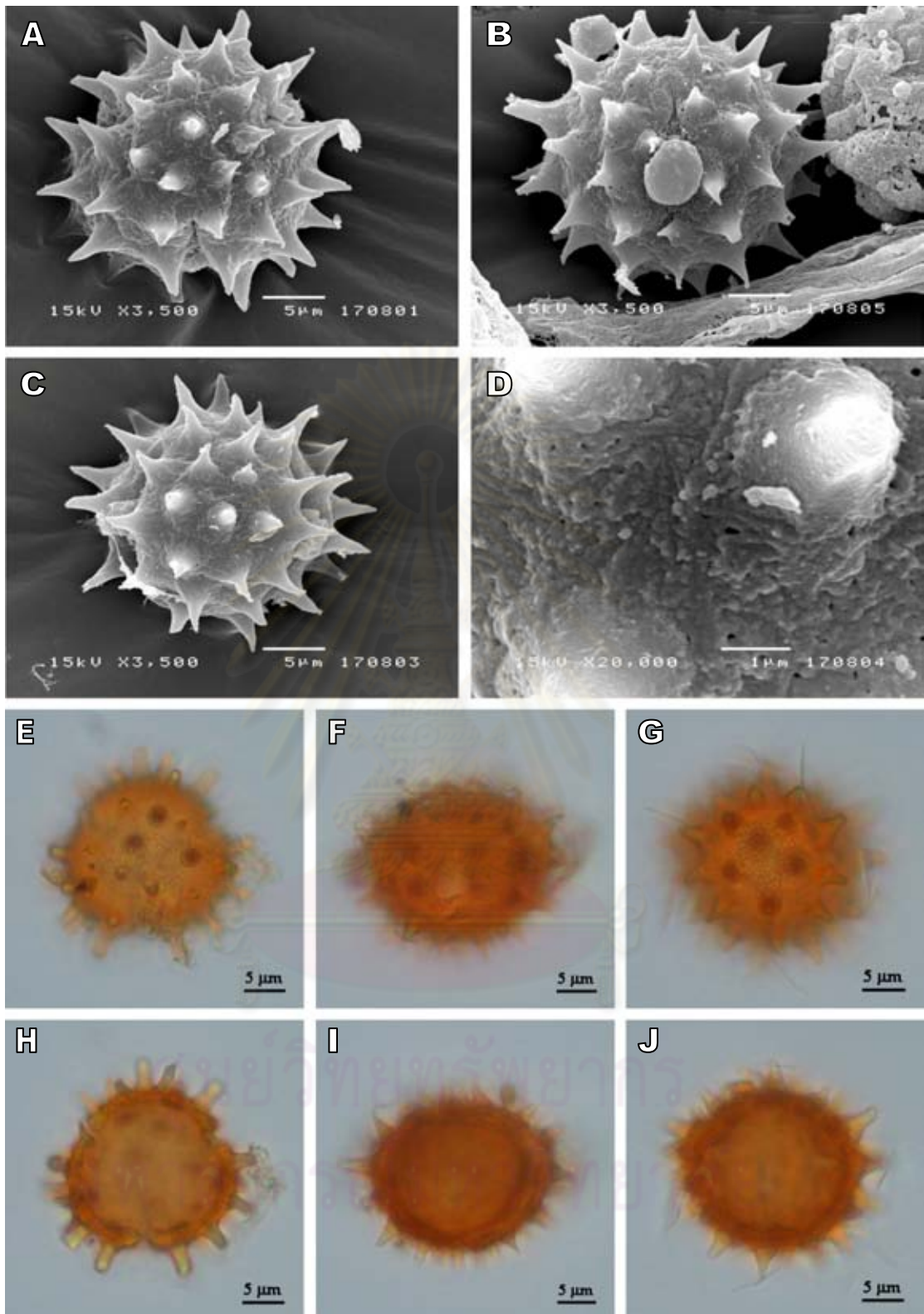


Plate 59 *Melanthera biflora* (L.) Wild: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

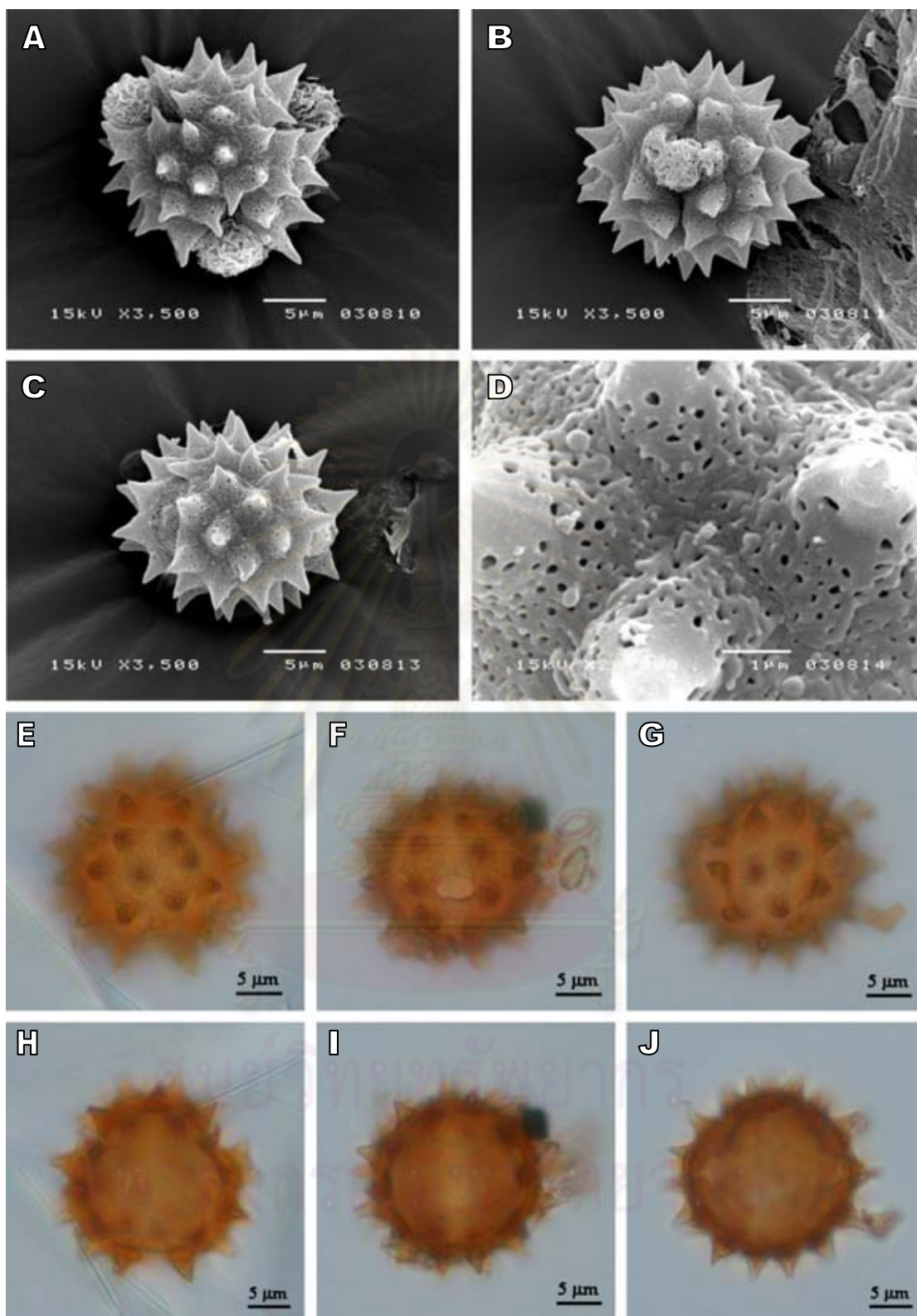


Plate 60 *Pluchea indica* (L.) Less.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).



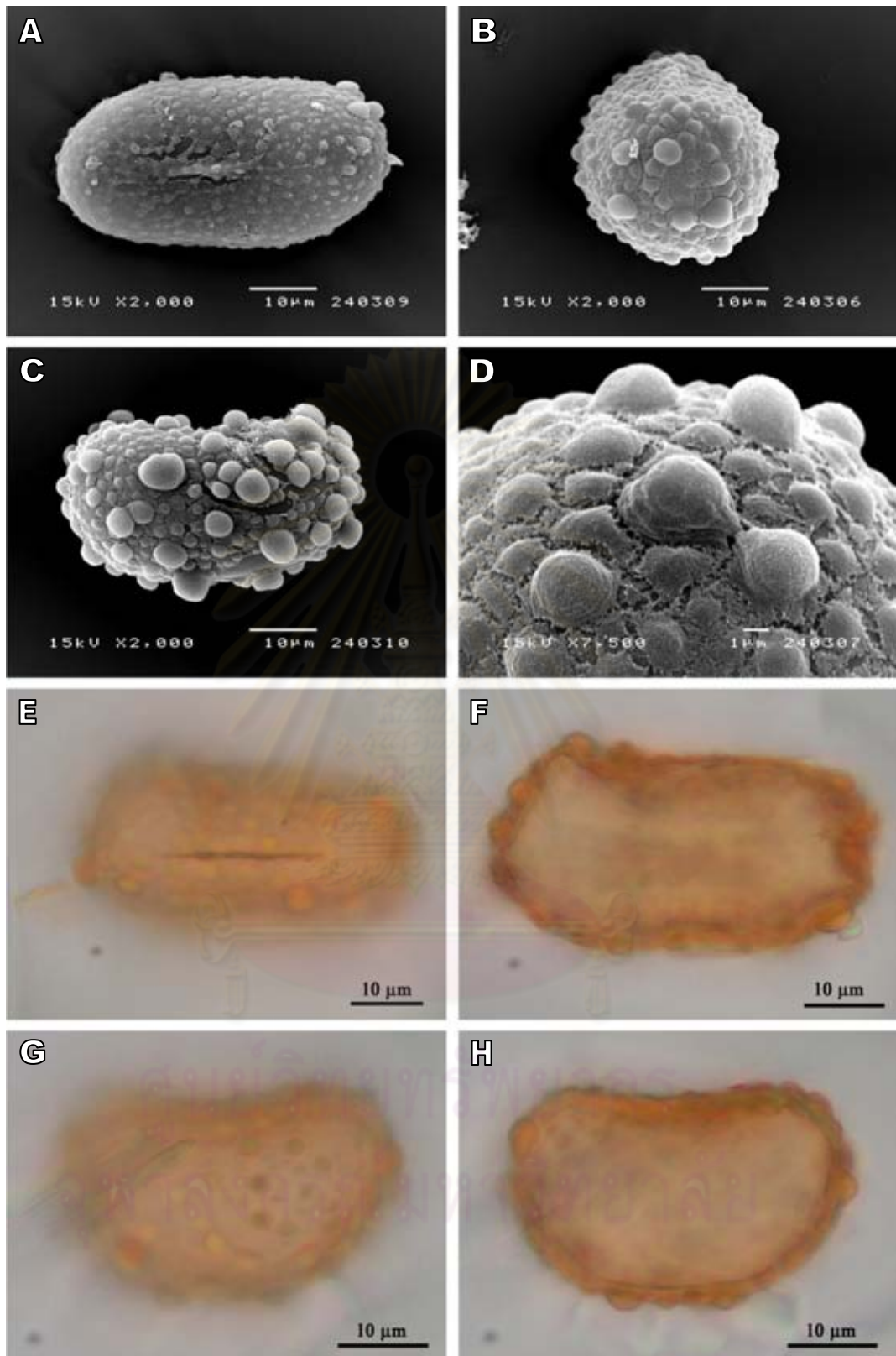


Plate 61 *Pyrrrosia adnascens* (Sw.) Ching: (A) Polar view, laesura, (B) Shorter equatorial view, (C) Longer equatorial view, (D) Equatorial view, surface, (E) Polar view, laesura, (F) Polar view, optical section, (G) Longer equatorial view, surface, (H) Longer equatorial view, optical section (A-D: SEM; E-H: LM).



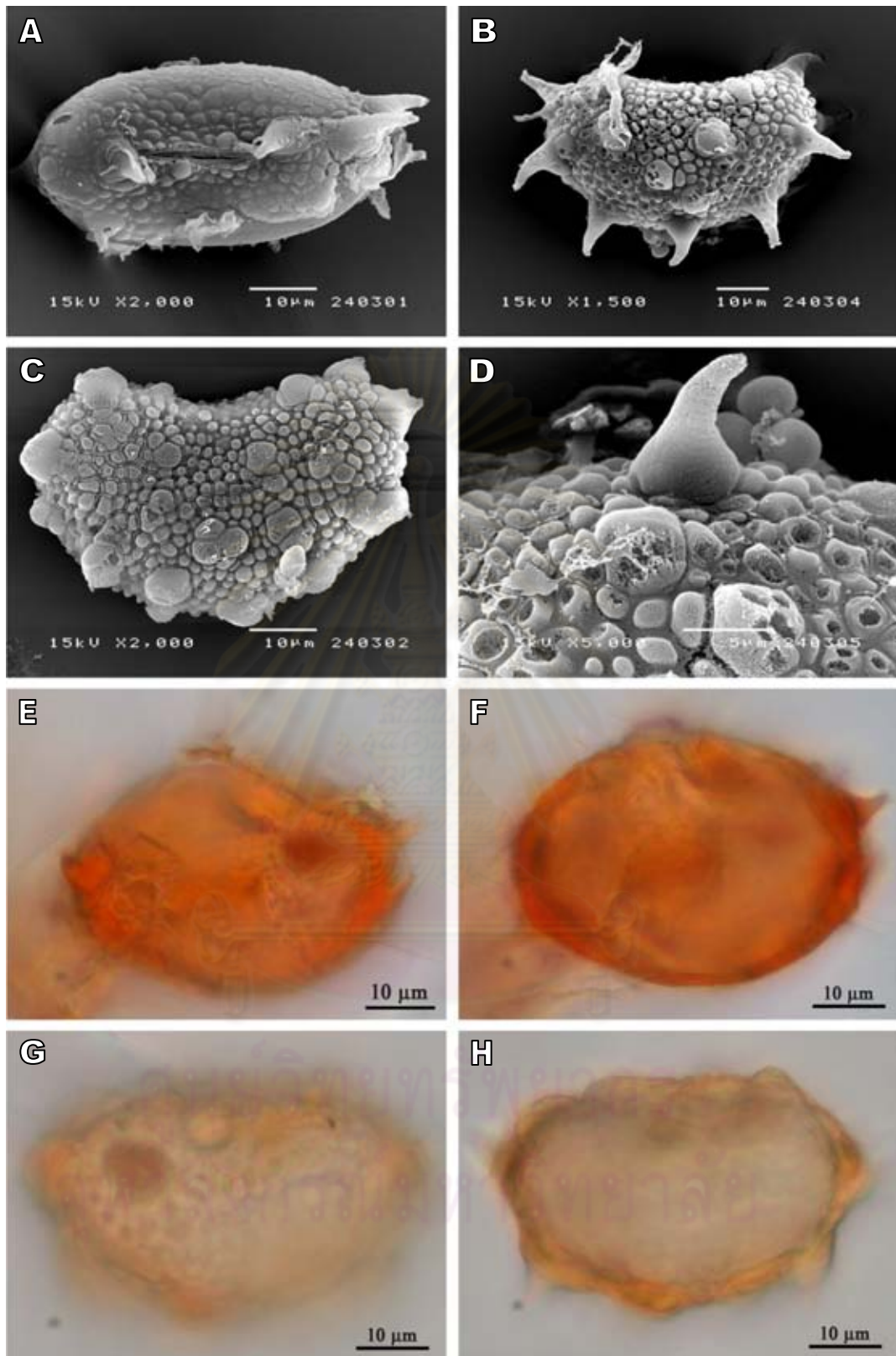


Plate 62 *Pyrrrosia piloselloides* (L.) M.G. Price: (A) Polar view, laesura, (B) Longer equatorial view, echinate (C) Longer equatorial view, gemmate, (D) Equatorial view, surface, (E) Polar view, laesura, (F) Polar view, optical section, (G) Longer equatorial view, surface, (H) Longer equatorial view, optical section (A-D: SEM; E-H: LM).

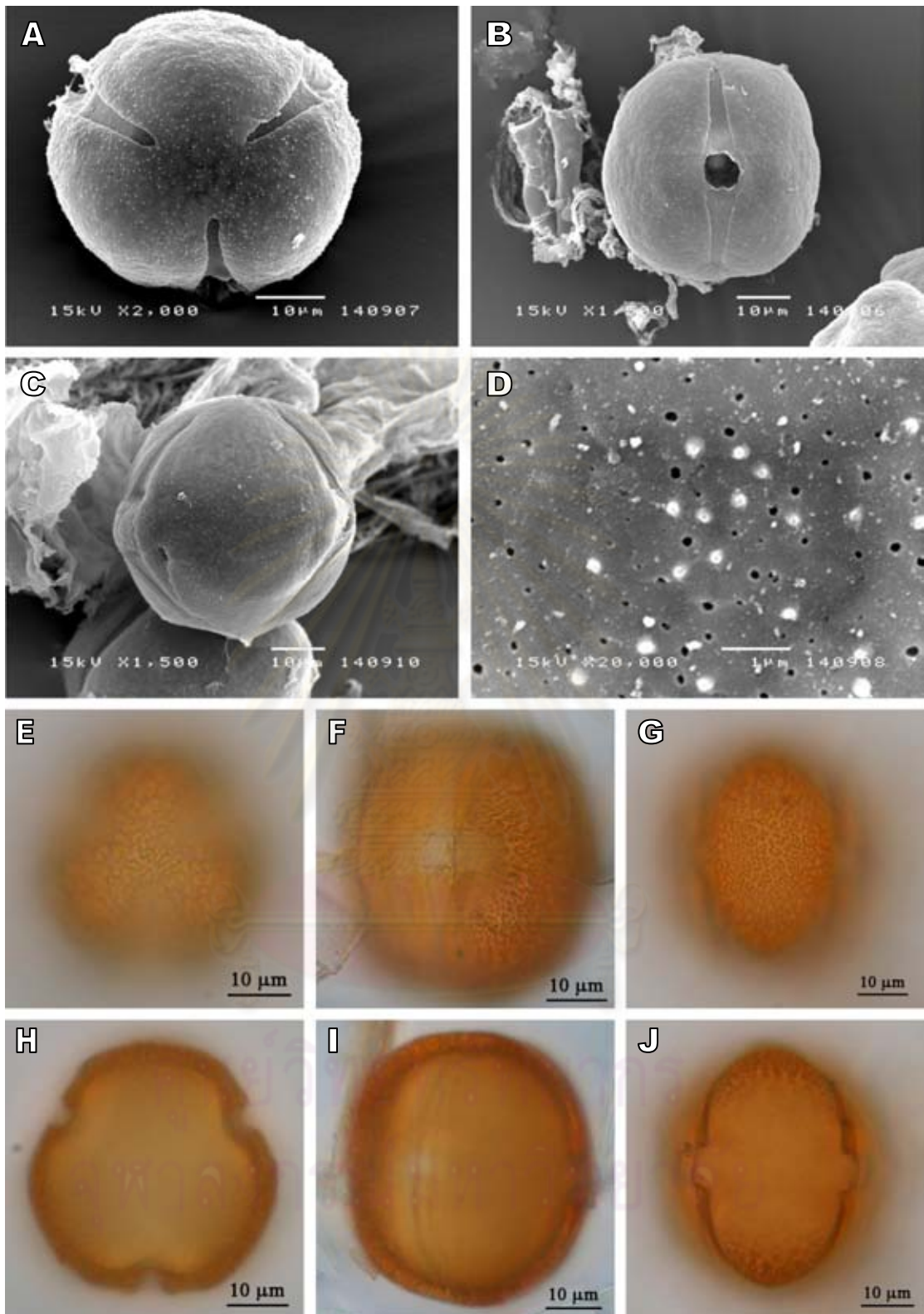


Plate 63 *Scaevola taccada* (Gaertn.) Roxb.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

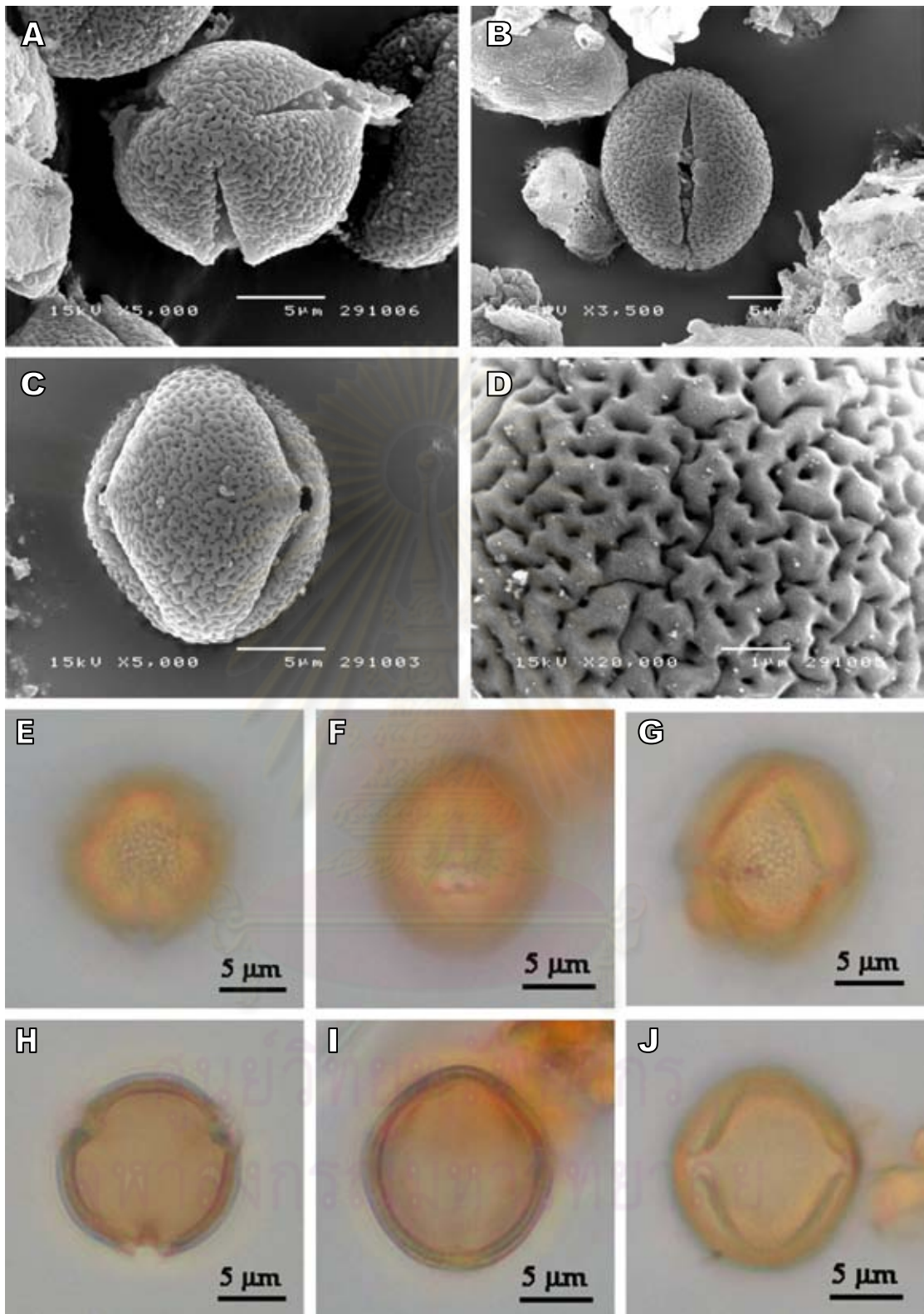


Plate 64 *Scolopia macrophylla* (W. & A.) CLOS: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).



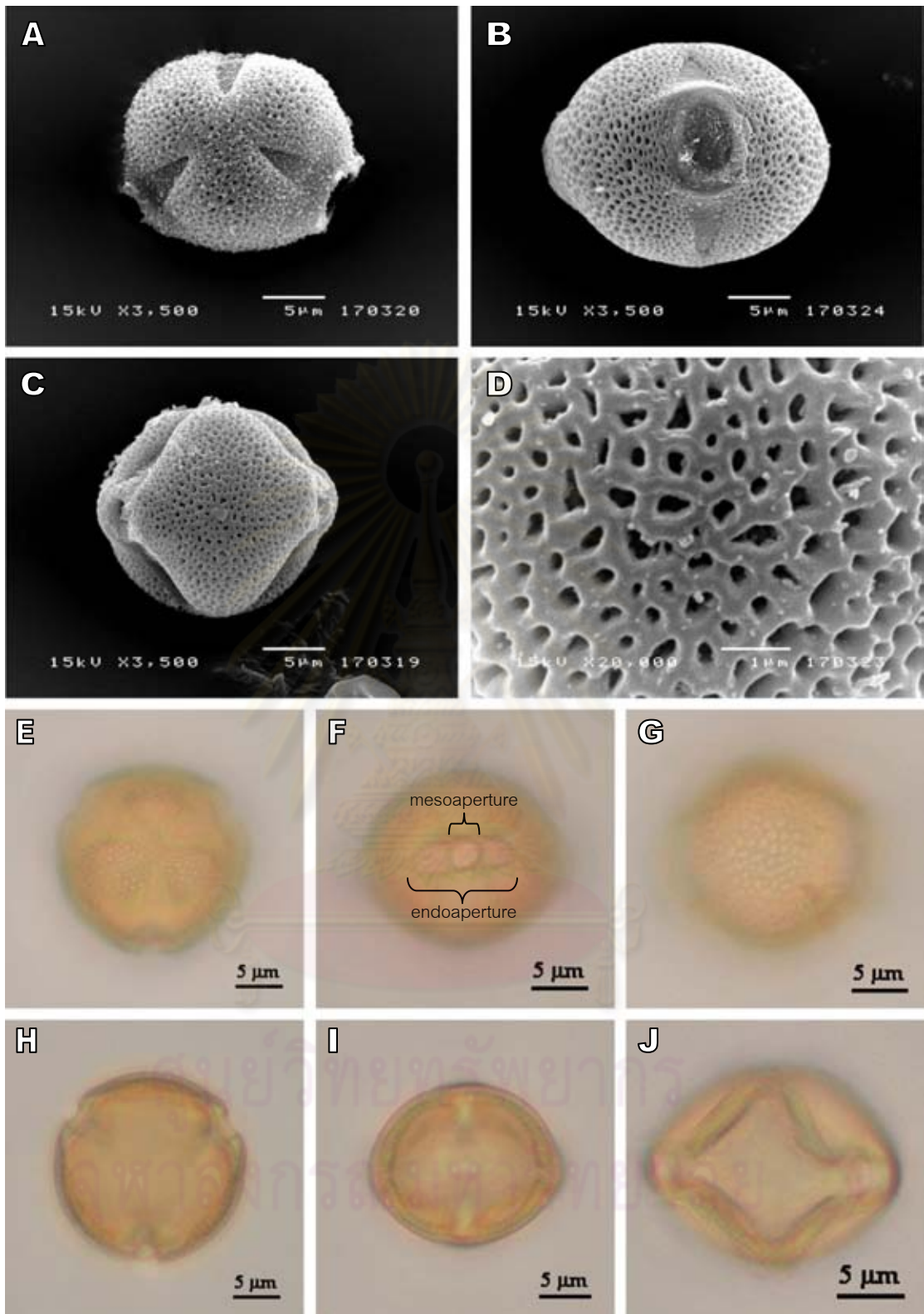


Plate 65 *Scyphiphora hydrophyllacea* C.F. Gaertn.: (A) Polar view, (B) Equatorial view, colpororus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, mesoaperture and endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpororus, (J) Optical section under mesocolpium at costa ectocolpi (A-D: SEM; E-J: LM).



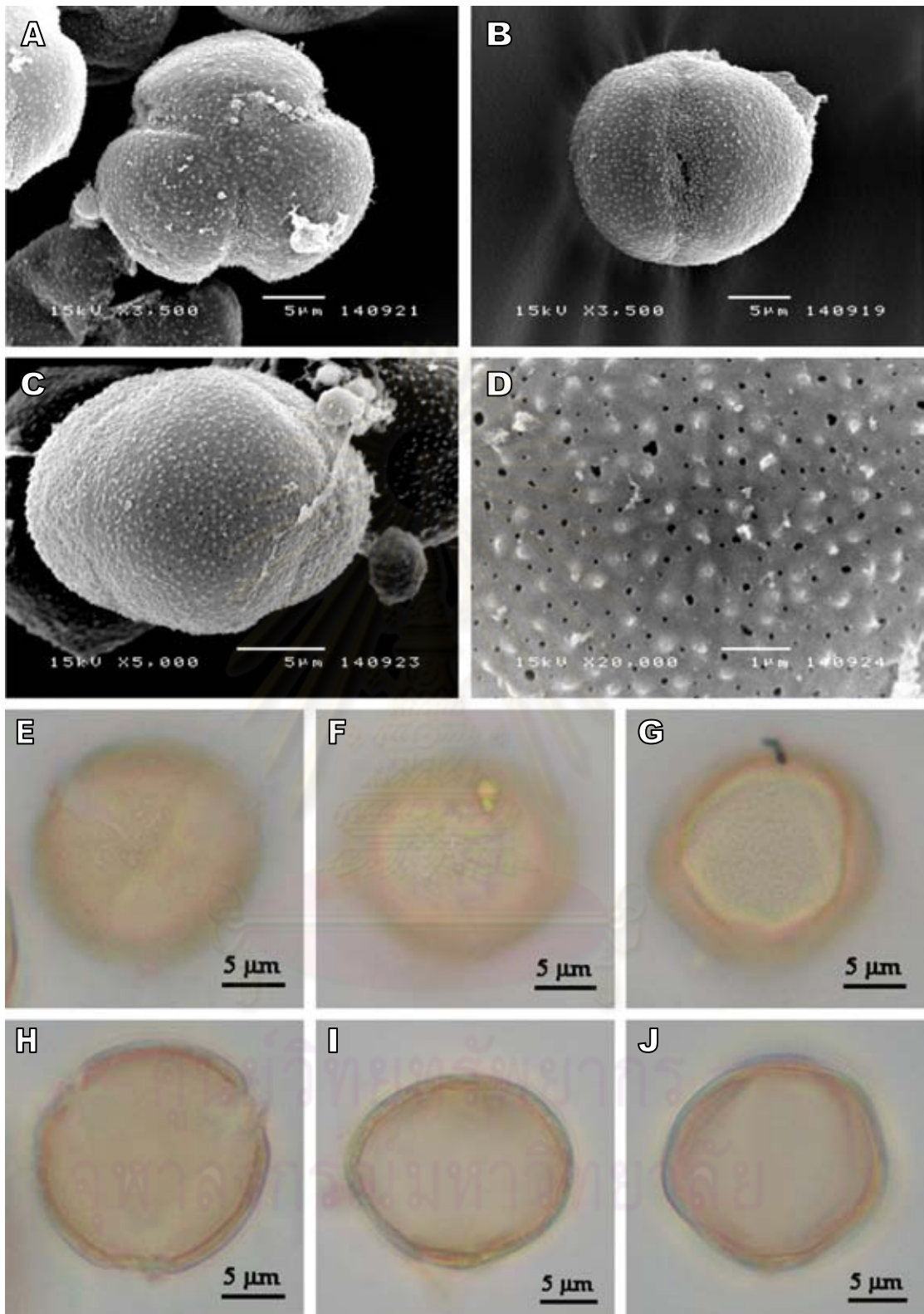


Plate 66 *Sesuvium portulacastrum* (L.) L.: (A) Polar view, (B) Equatorial view, colpus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, colpus, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colpus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

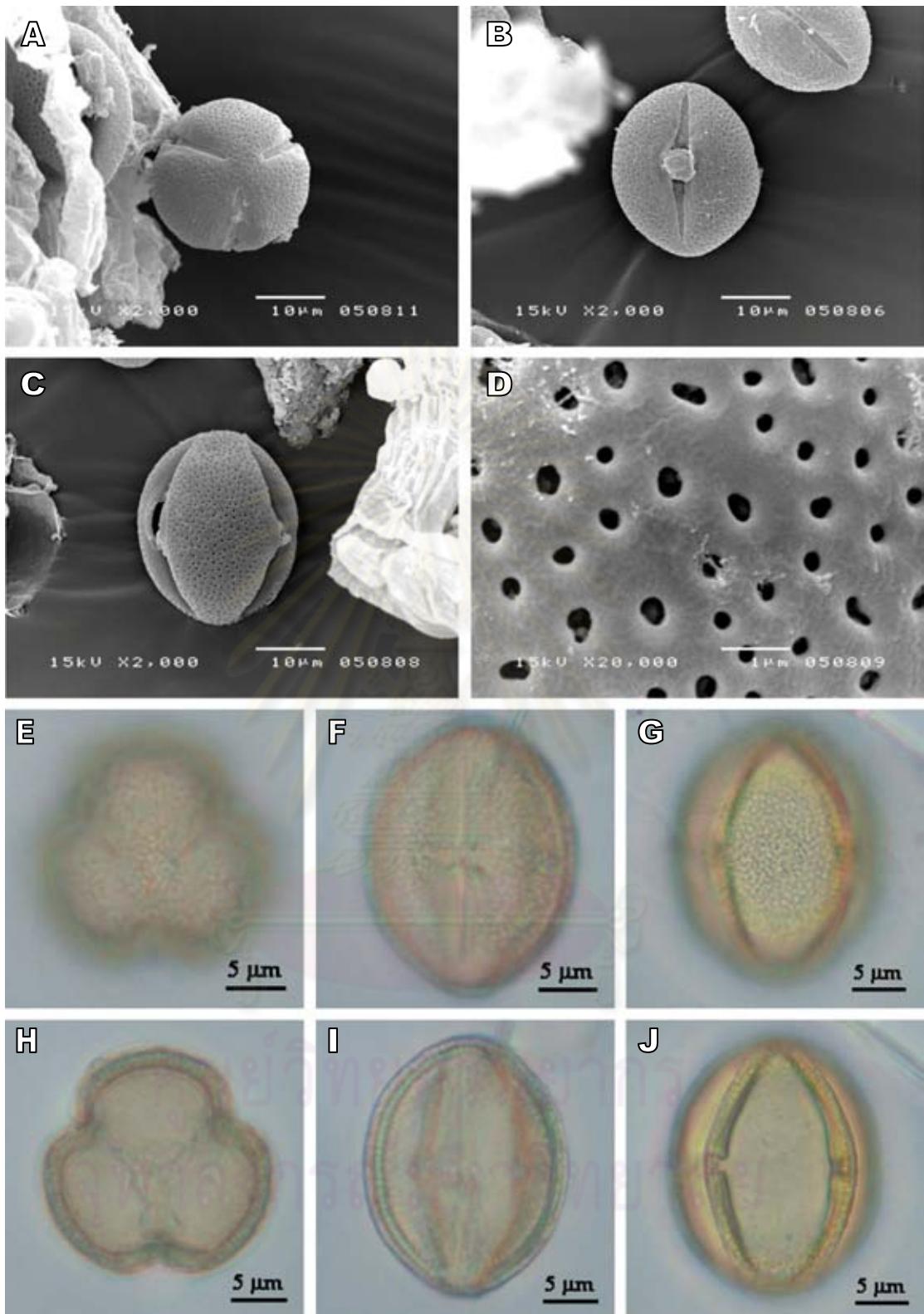


Plate 67 *Shirakiopsis indica* (Willd.) Esser: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium at costa ectocolpi and costa endopori (A-D: SEM; E-J: LM).

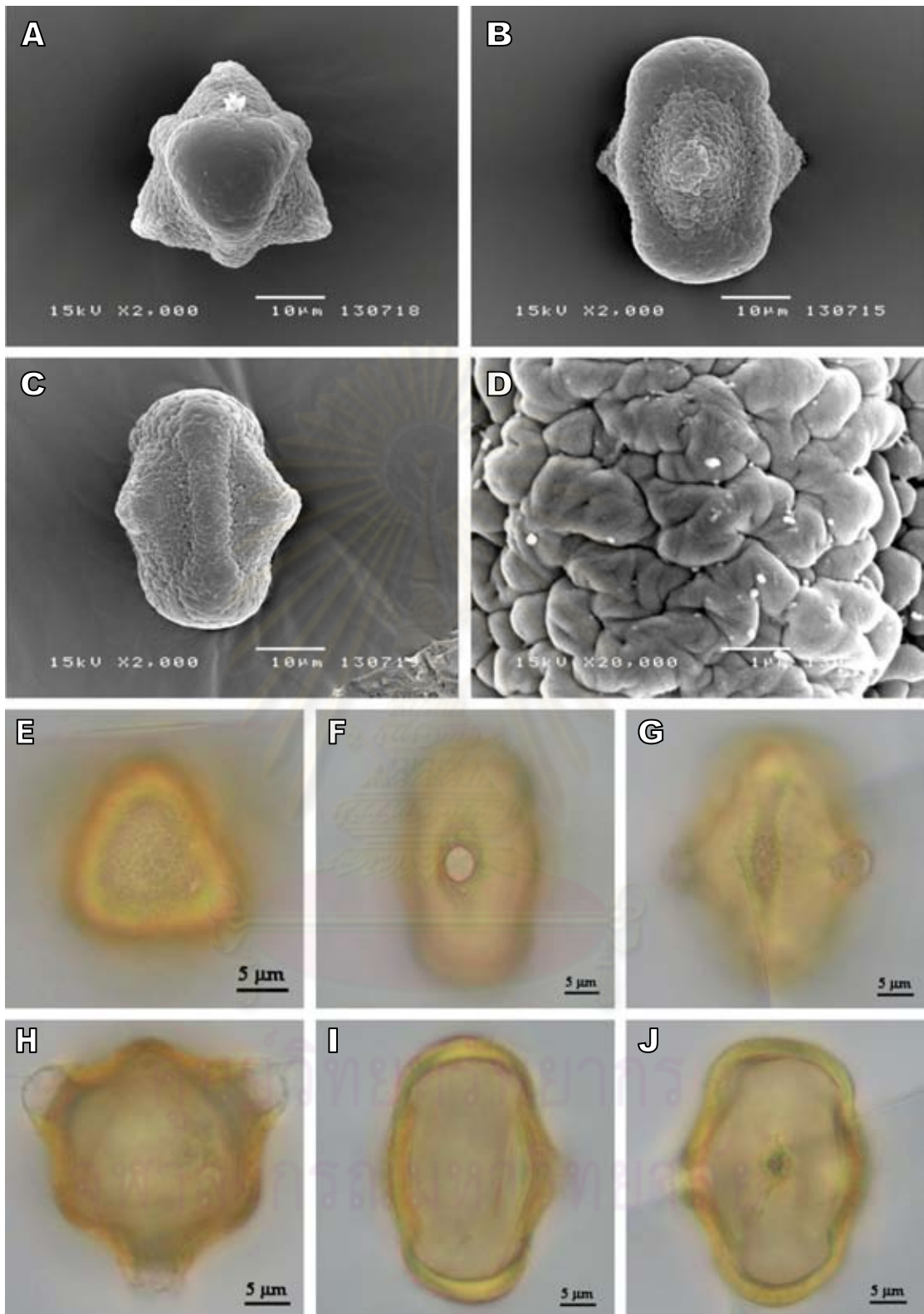


Plate 68 *Sonneratia alba* Sm.: (A) Polar view, (B) Equatorial view, porus, (C) Equatorial view, mesopodium, (D) Equatorial view, surface on ridge on mesopodium, (E) Polar view, surface, (F) Equatorial view, porus, (G) Equatorial view, mesopodium surface, (H) Polar view, optical section, (I) Optical section under porus, (J) Optical section under mesopodium (A-D: SEM; E-J: LM).



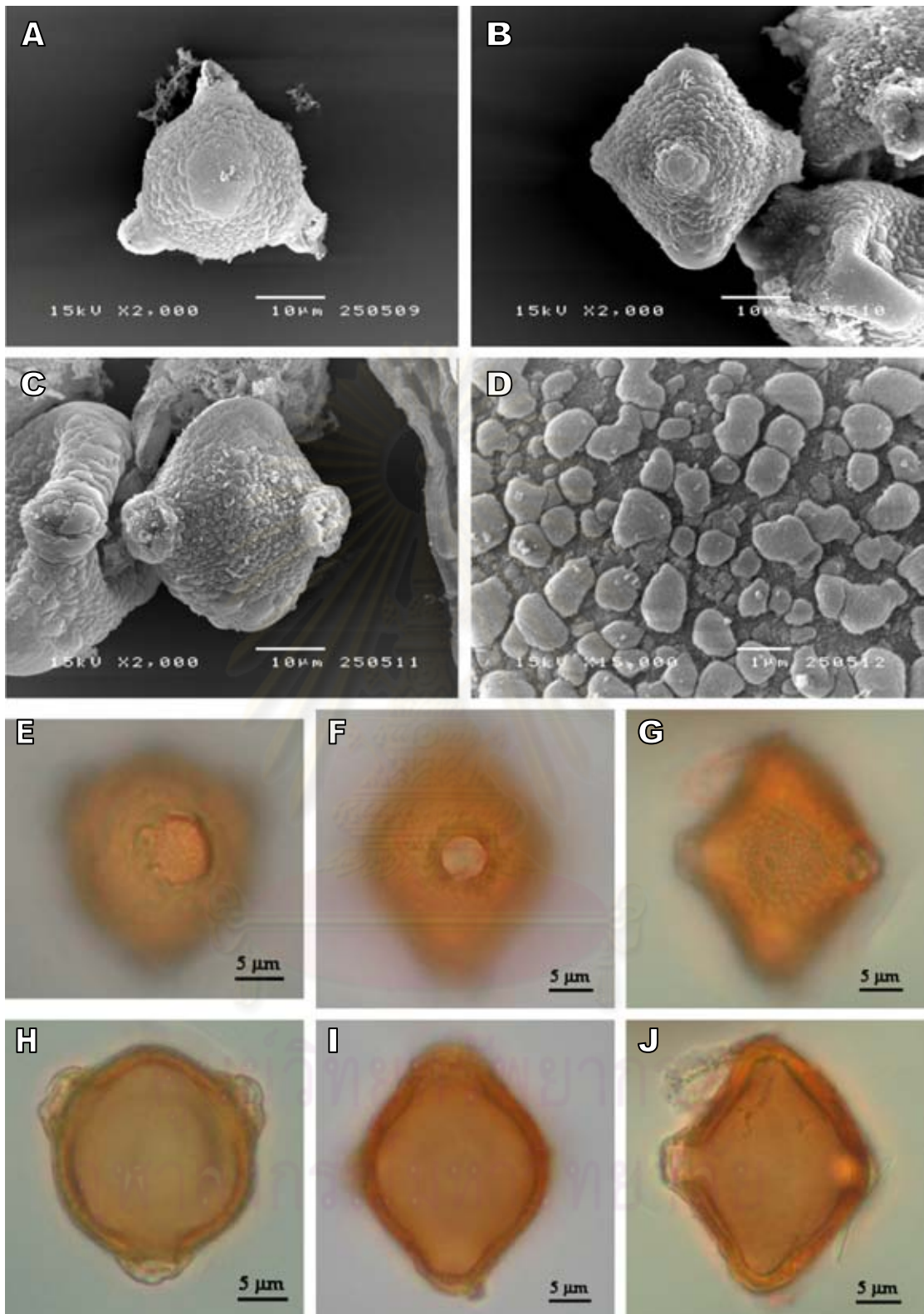


Plate 69 *Sonneratia caseolaris* (L.) Engl.: (A) Polar view, (B) Equatorial view, porus, (C) Equatorial view, mesopodium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, porus, (G) Equatorial view, mesopodium surface, (H) Polar view, optical section, (I) Optical section under porus, (J) Optical section under mesopodium (A-D: SEM; E-J: LM).



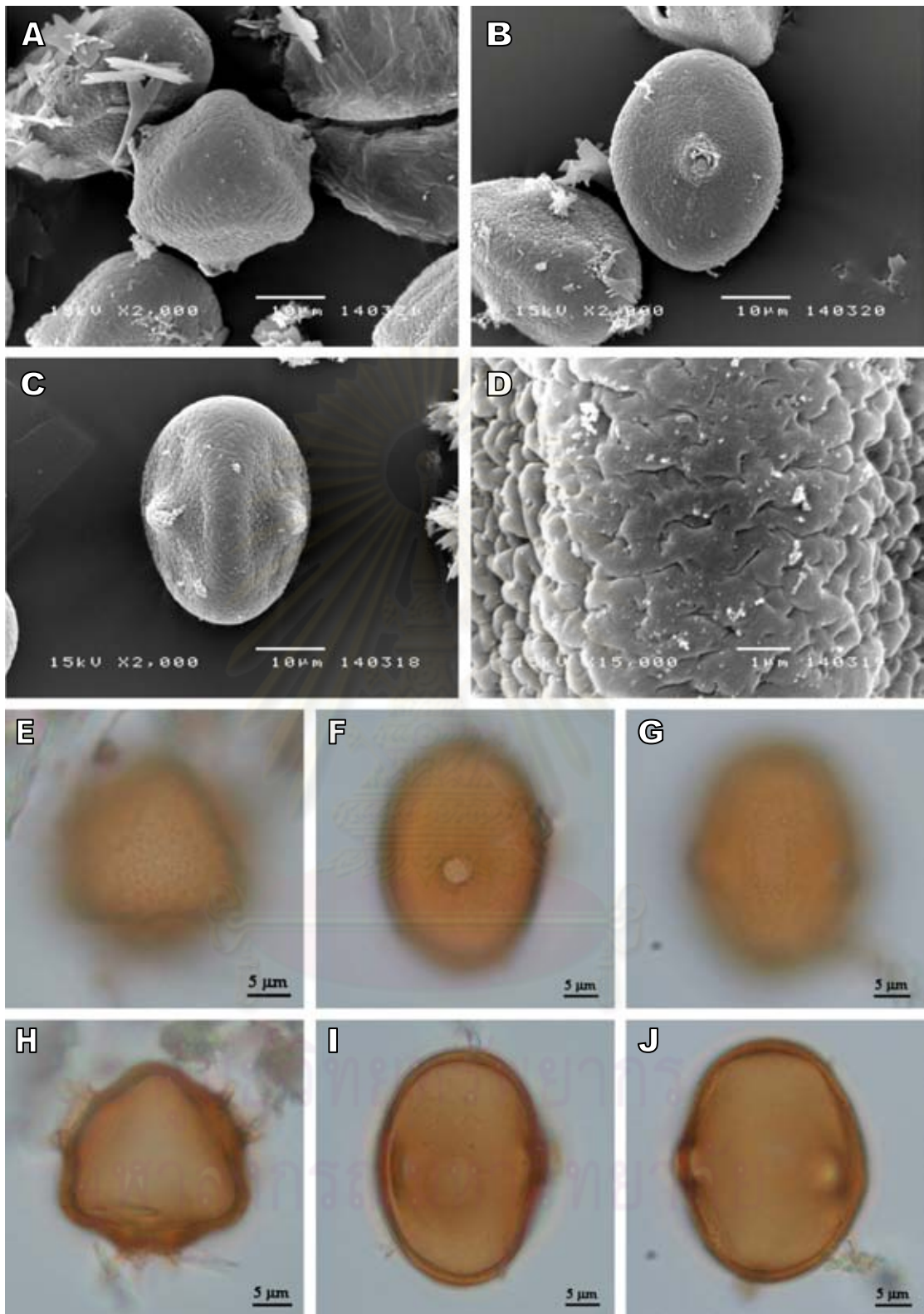


Plate 70 *Sonneratia griffithii* Kurz: (A) Polar view, (B) Equatorial view, porus, (C) Equatorial view, mesopodium, (D) Equatorial view, surface on ridge on mesopodium, (E) Polar view, surface, (F) Equatorial view, porus, (G) Equatorial view, mesopodium surface, (H) Polar view, optical section, (I) Optical section under porus, (J) Optical section under mesopodium (A-D: SEM; E-J: LM).

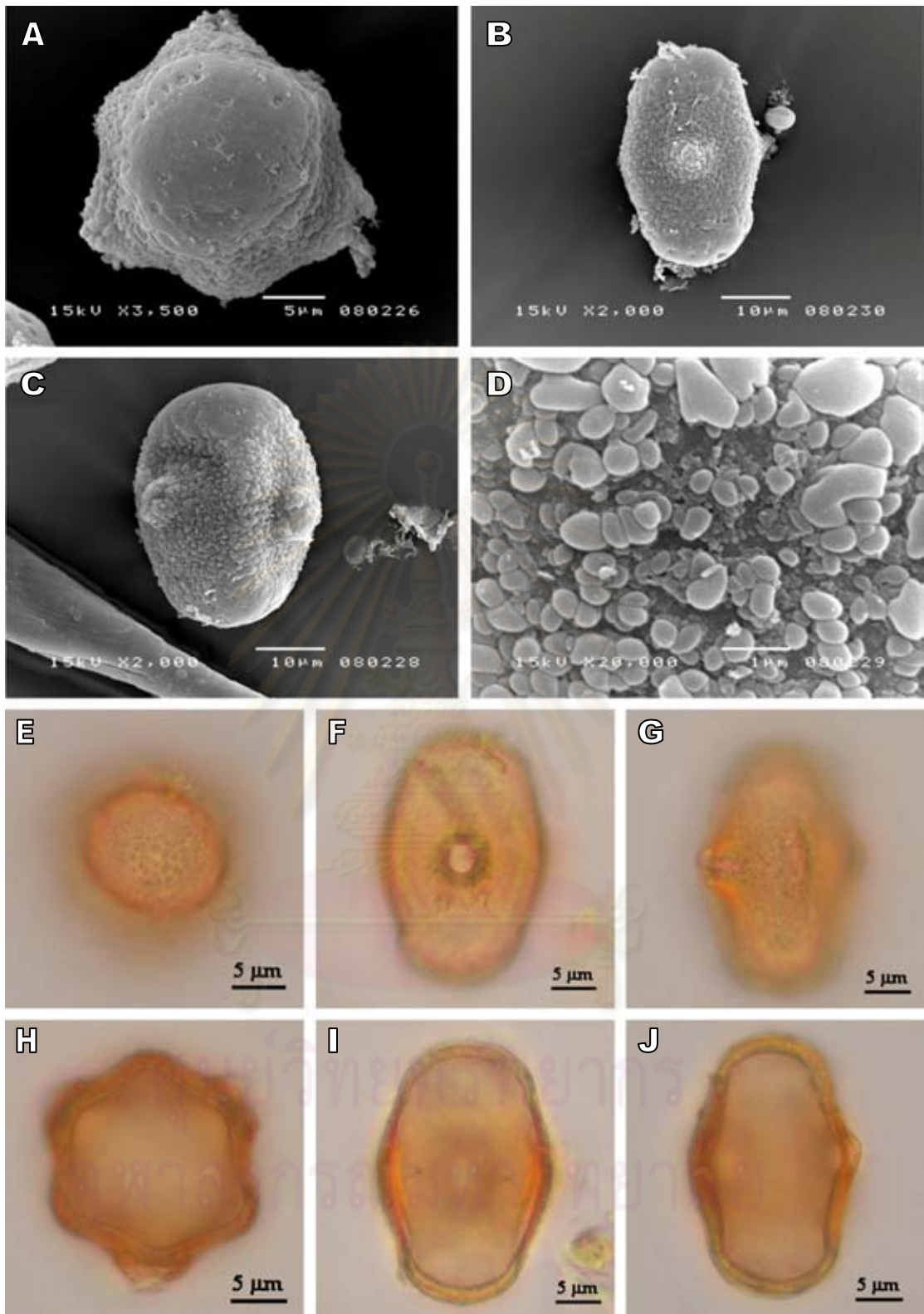


Plate 71 *Sonneratia ovata* Backer: (A) Polar view, (B) Equatorial view, porus, (C) Equatorial view, mesopodium, (D) Equatorial view, surface, (E) Polar view, surface, (F) Equatorial view, porus, (G) Equatorial view, mesopodium surface, (H) Polar view, optical section, (I) Optical section under porus, (J) Optical section under mesopodium (A-D: SEM; E-J: LM).

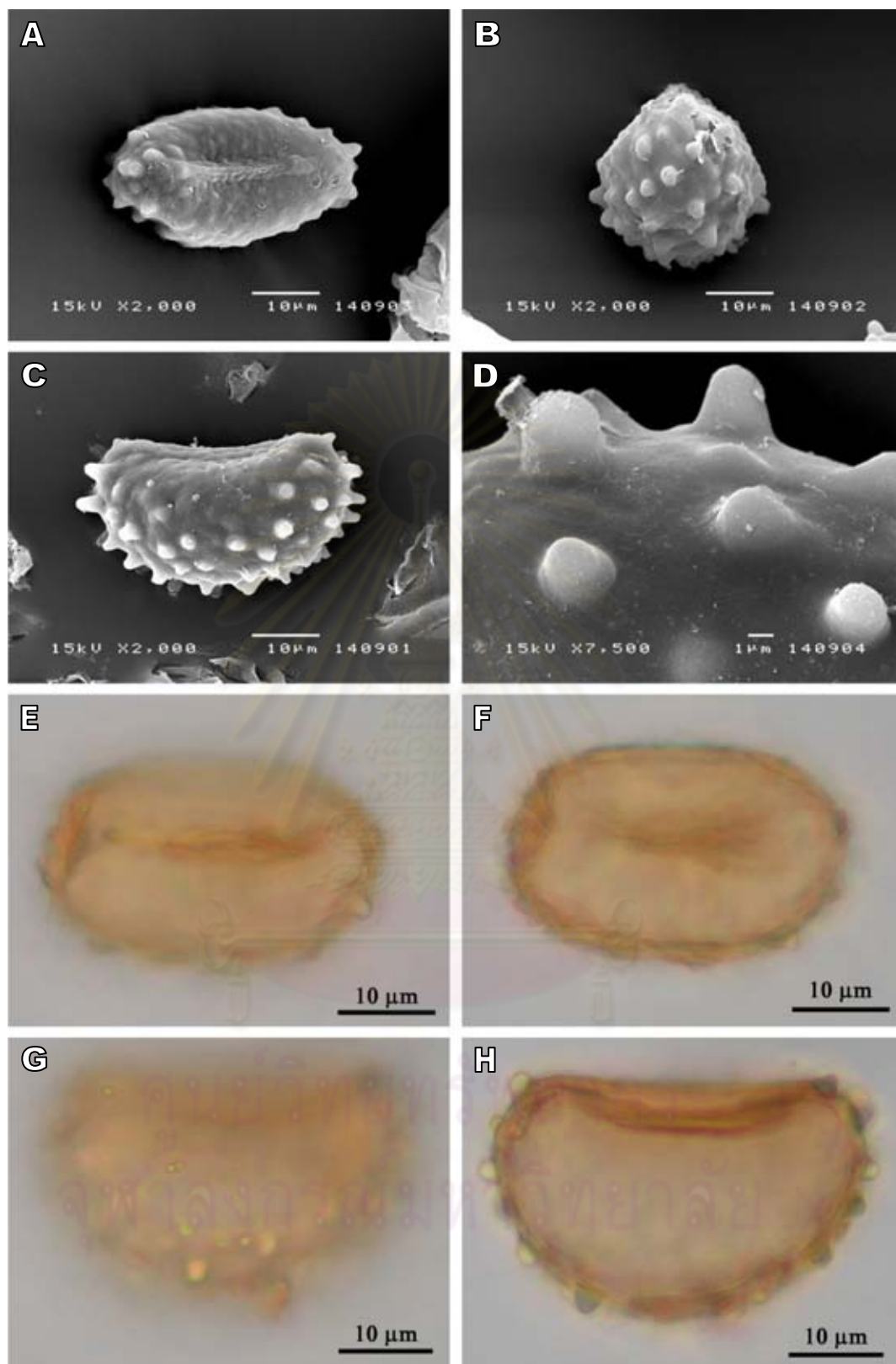


Plate 72 *Stenochlaena palustris* (Burm. f.) Bedd. : (A) Polar view, laesura, (B) Shorter equatorial view, (C) Longer equatorial view, (D) Equatorial view, surface, (E) Polar view, laesura, (F) Polar view, optical section, (G) Longer equatorial view, surface, (H) Longer equatorial view, optical section (A-D: SEM; E-H: LM).



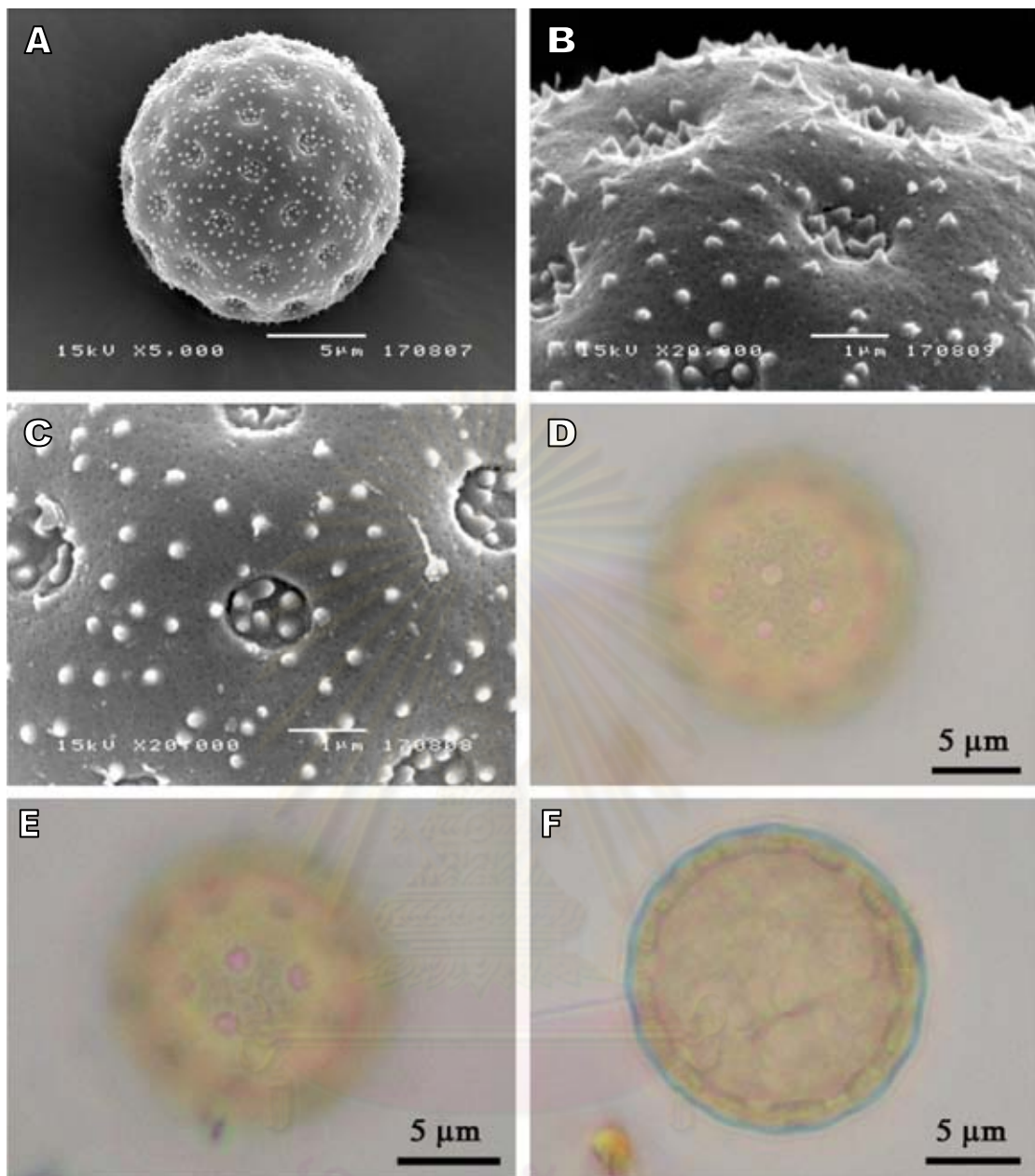


Plate 73 *Suaeda maritima* (L.) Dumort.: (A) Whole grain, polyantopori, (B) Surface, microechinate-perforate, (C) Operculum, microechinate, (D) Pori, (E) Surface, granulate, (F) Optical section, columella distinct (A-C: SEM; D-F: LM).



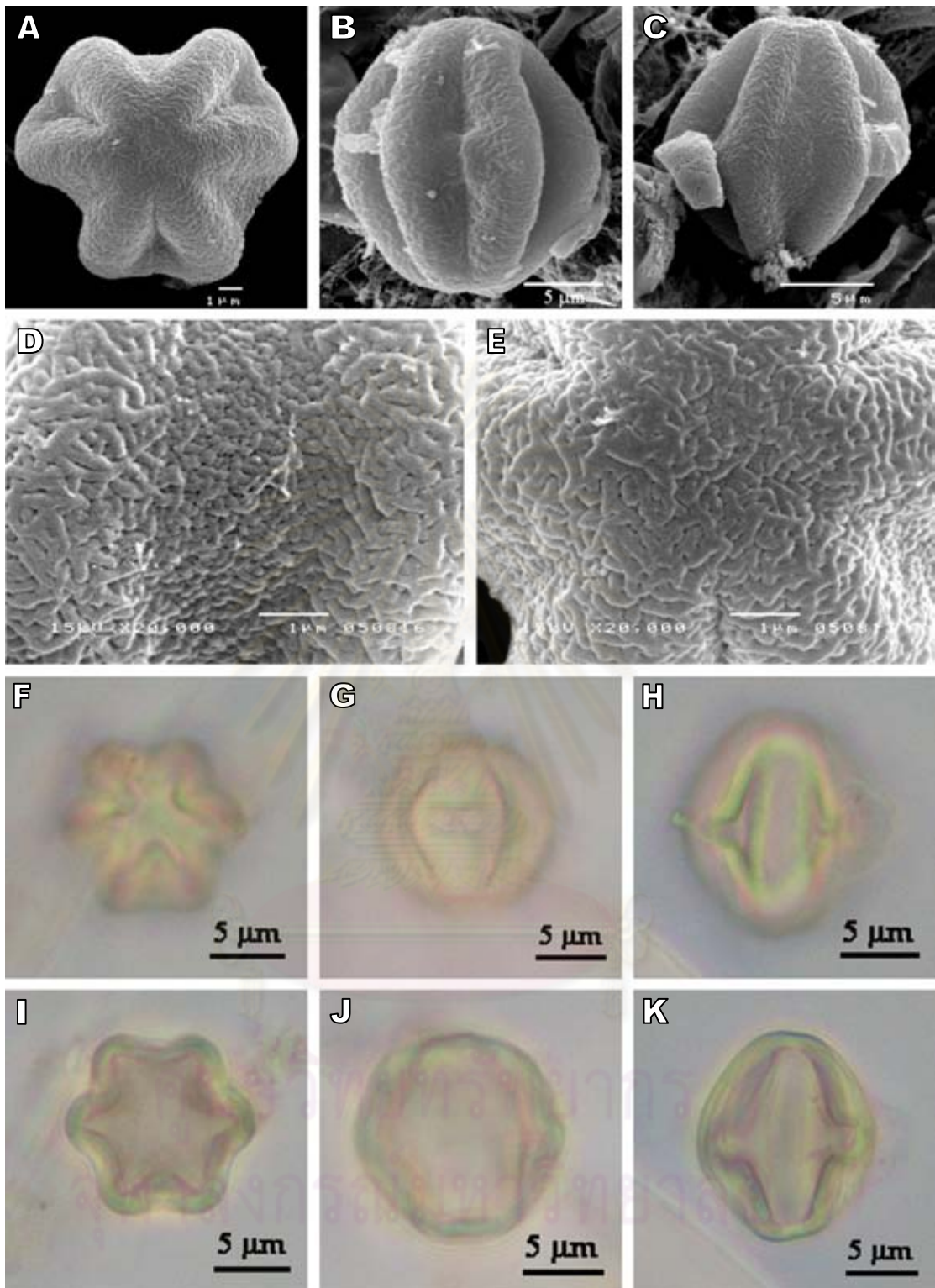


Plate 74 *Terminalia catappa* L.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, pseudocolpus, (D) Equatorial view, pseudocolpus surface, (E) Polar view, surface, (F) Polar view, surface, (G) Equatorial view, endoaperture, (H) Equatorial view, pseudocolpus surface, (I) Polar view, optical section, (J) Optical section under colporus, (K) Optical section under pseudocolpus (A-E: SEM; F-K: LM).

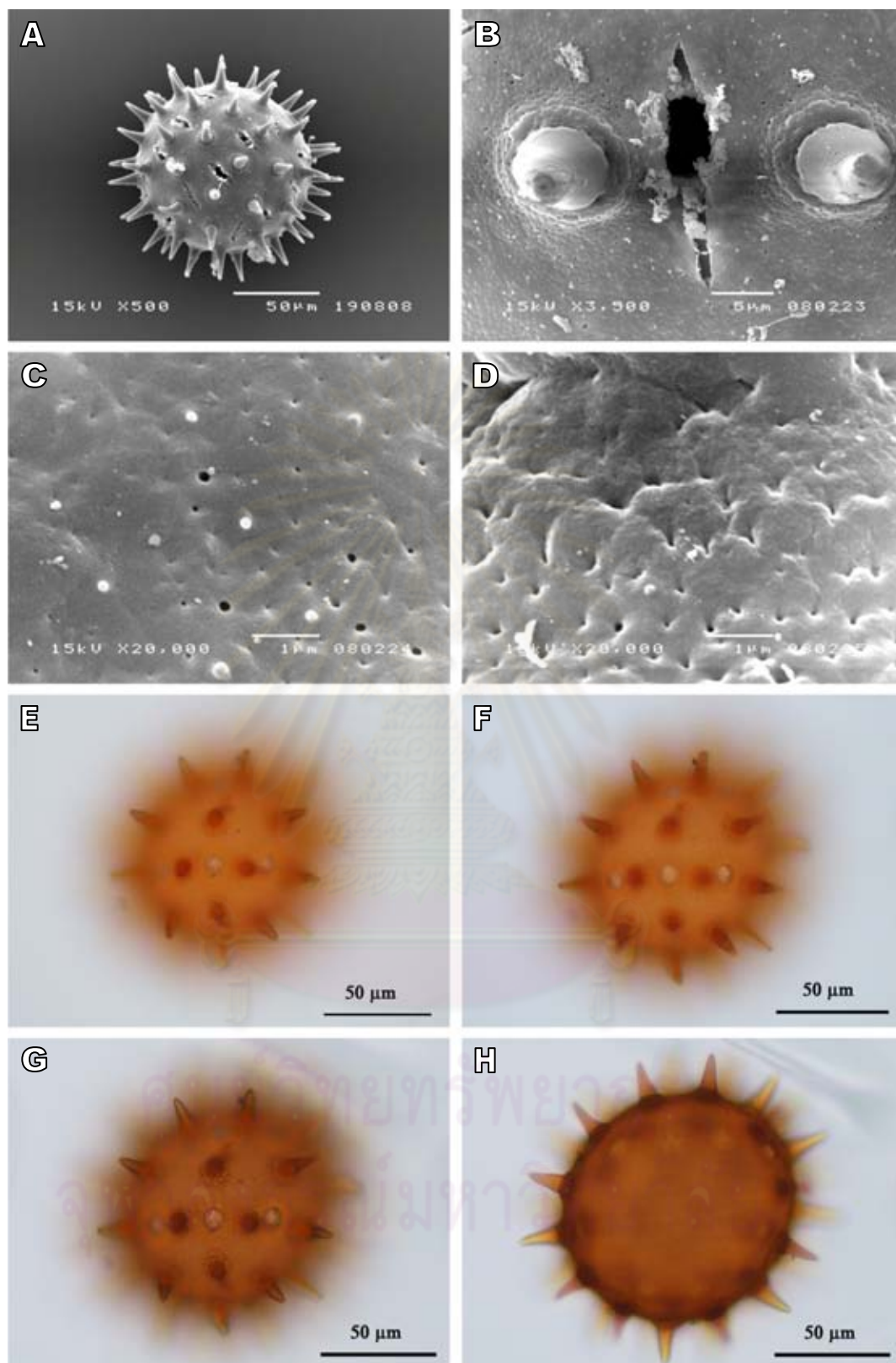


Plate 75 *Hibiscus tiliaceus* L.: (A) Whole grain, echinate, (B) Colporus, (C) Perforation and granulation on interspinal area, (D) Perforation on cushion, (E) Ecotocolpus, (F) Endoporus, (G) columellae under tectum at interspinal area and cushion, (H) Optical section (A-D: SEM; E-H: LM).

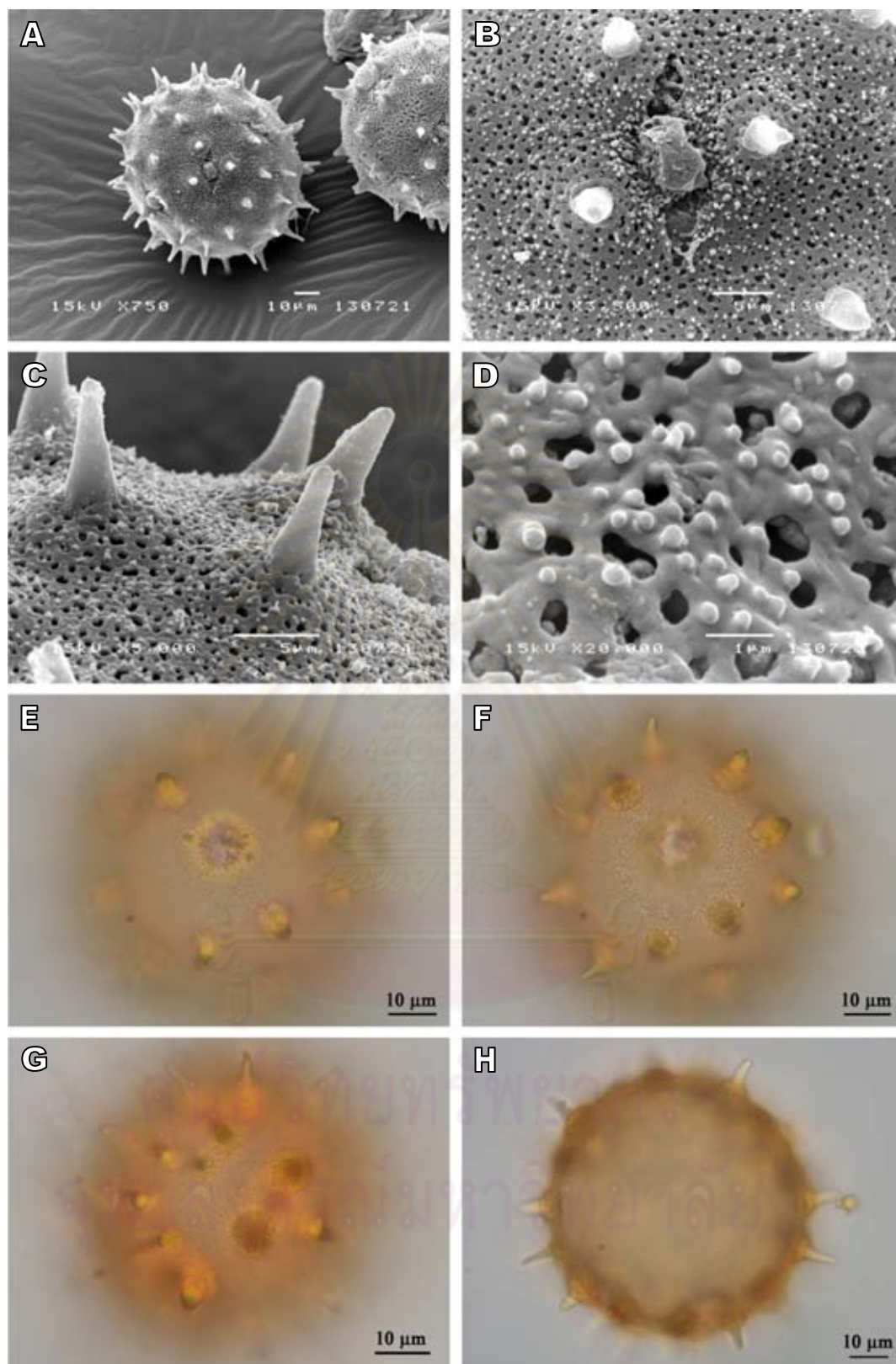


Plate 76 *Thespesia populnea* (L.) Sol. ex Corrêa: (A) Whole grain, (B) Colporus, (C) Ornamentation echinate, (D) Surface on interspinal area, (E) Ecotocolpus, (F) Endoporus, (G) columellae under tectum at interspinal area and cushion, (H) Optical section (A-D: SEM; E-H: LM).



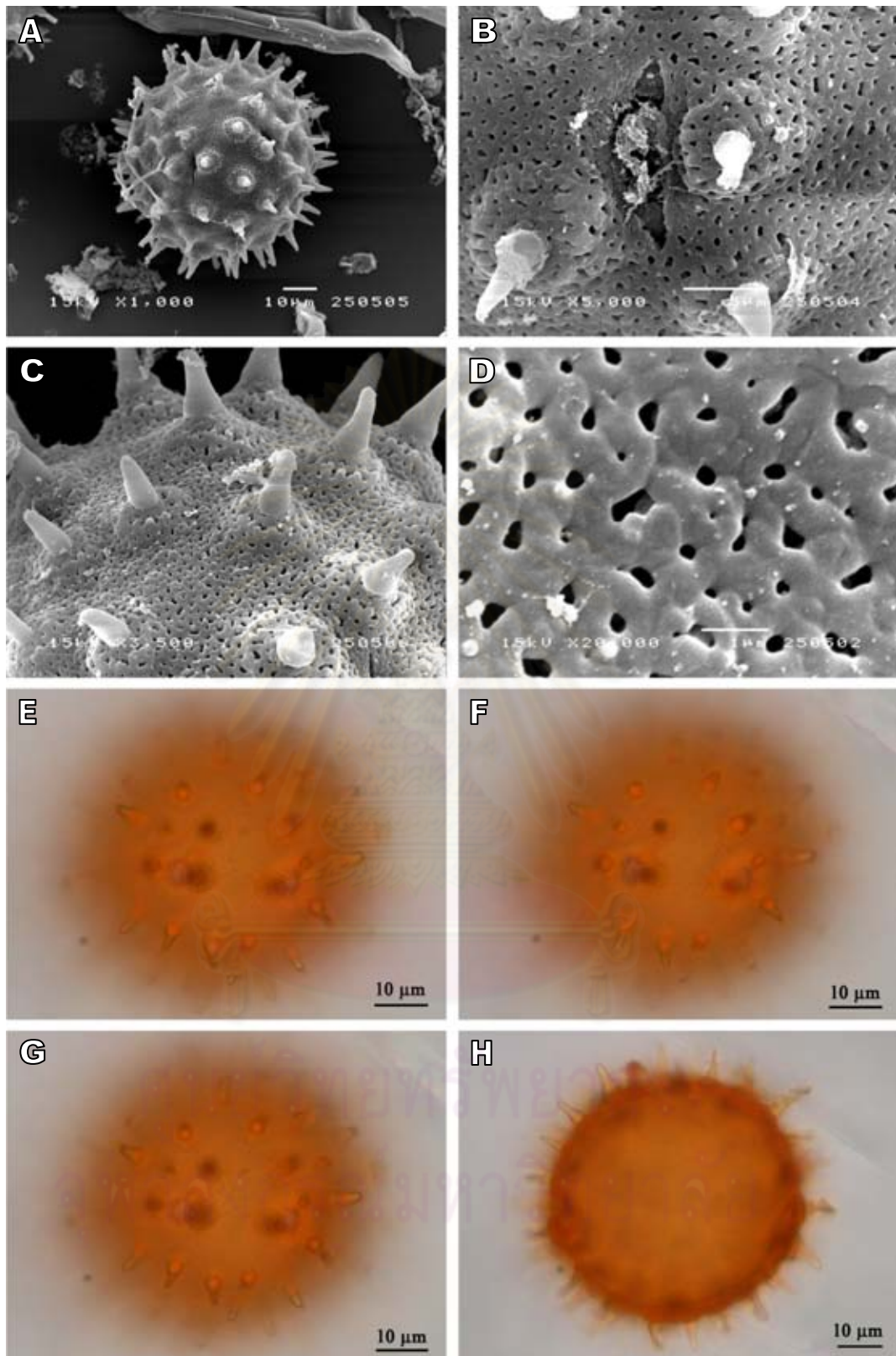


Plate 77 *Thespesia populneoides* (Roxb.) Kostel.: (A) Whole grain, (B) Colporus, (C) Ornamentation echinate, (D) Surface on interspinal area, (E) Ecotocolpus, (F) Endoporus, (G) columellae under tectum at interspinal area and cushion, (H) Optical section (A-D: SEM; E-H: LM).



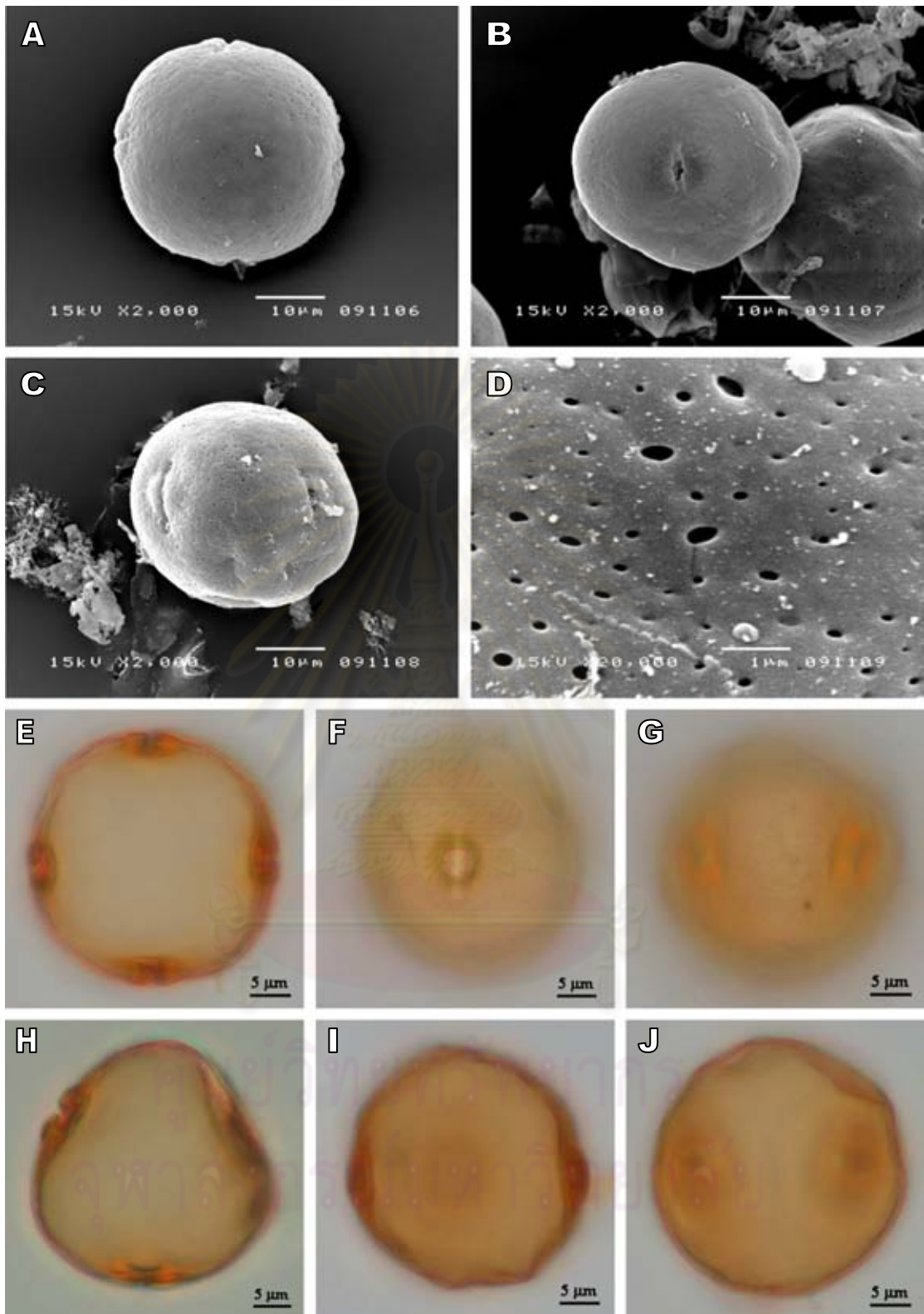


Plate 78 *Xylocarpus granatum* J. Koenig: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view of 4-aperturate grain, optical section, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view of 3-aperturate grain, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

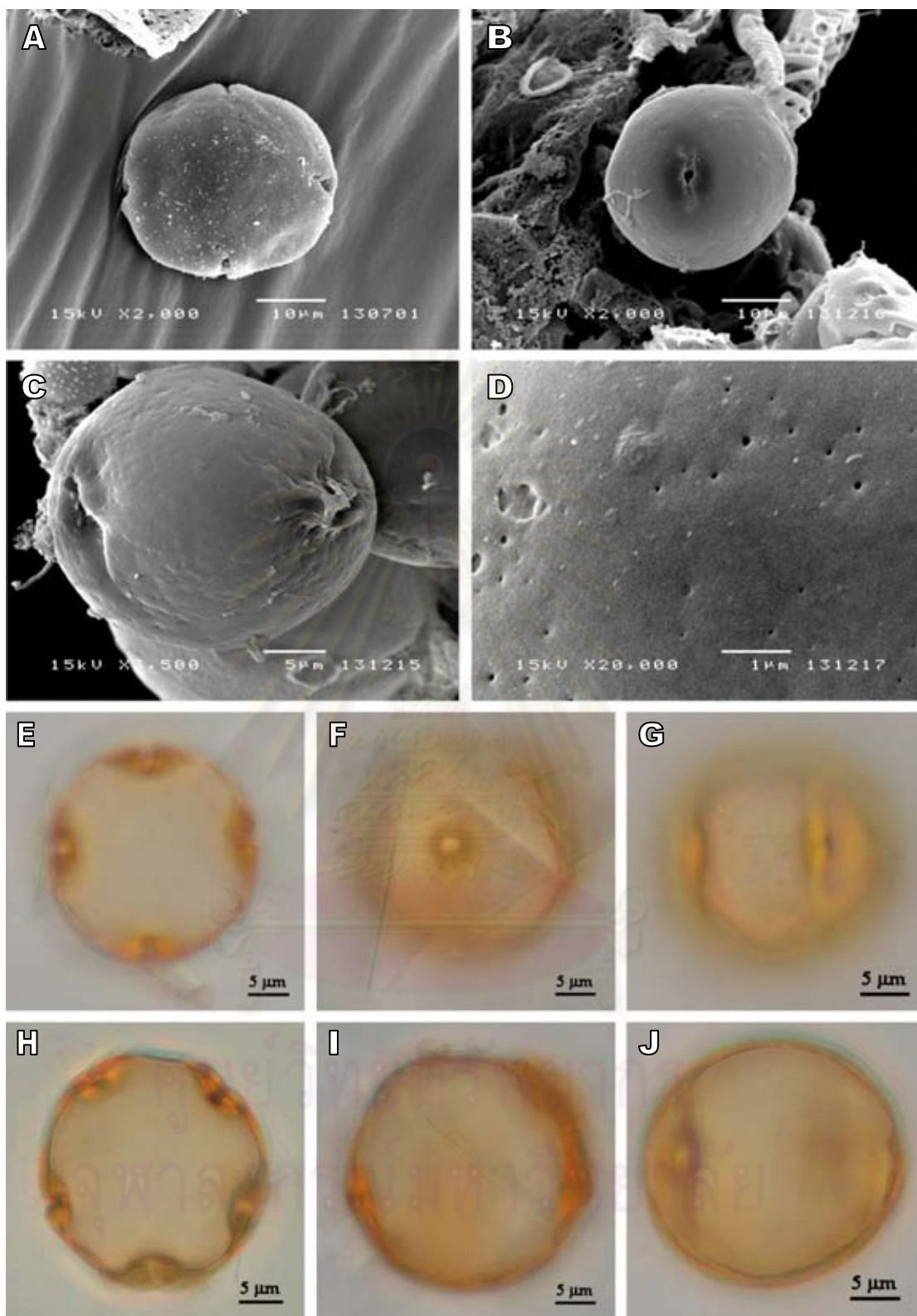


Plate 79 *Xylocarpus moluccensis* (Lam.) M. Roem.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view of 4-aperturate grain, optical section, (F) Equatorial view, endoaperture, (G) Equatorial view, mesocolpium surface, (H) Polar view of 5-aperturate grain, optical section, (I) Optical section under colporus, (J) Optical section under mesocolpium (A-D: SEM; E-J: LM).

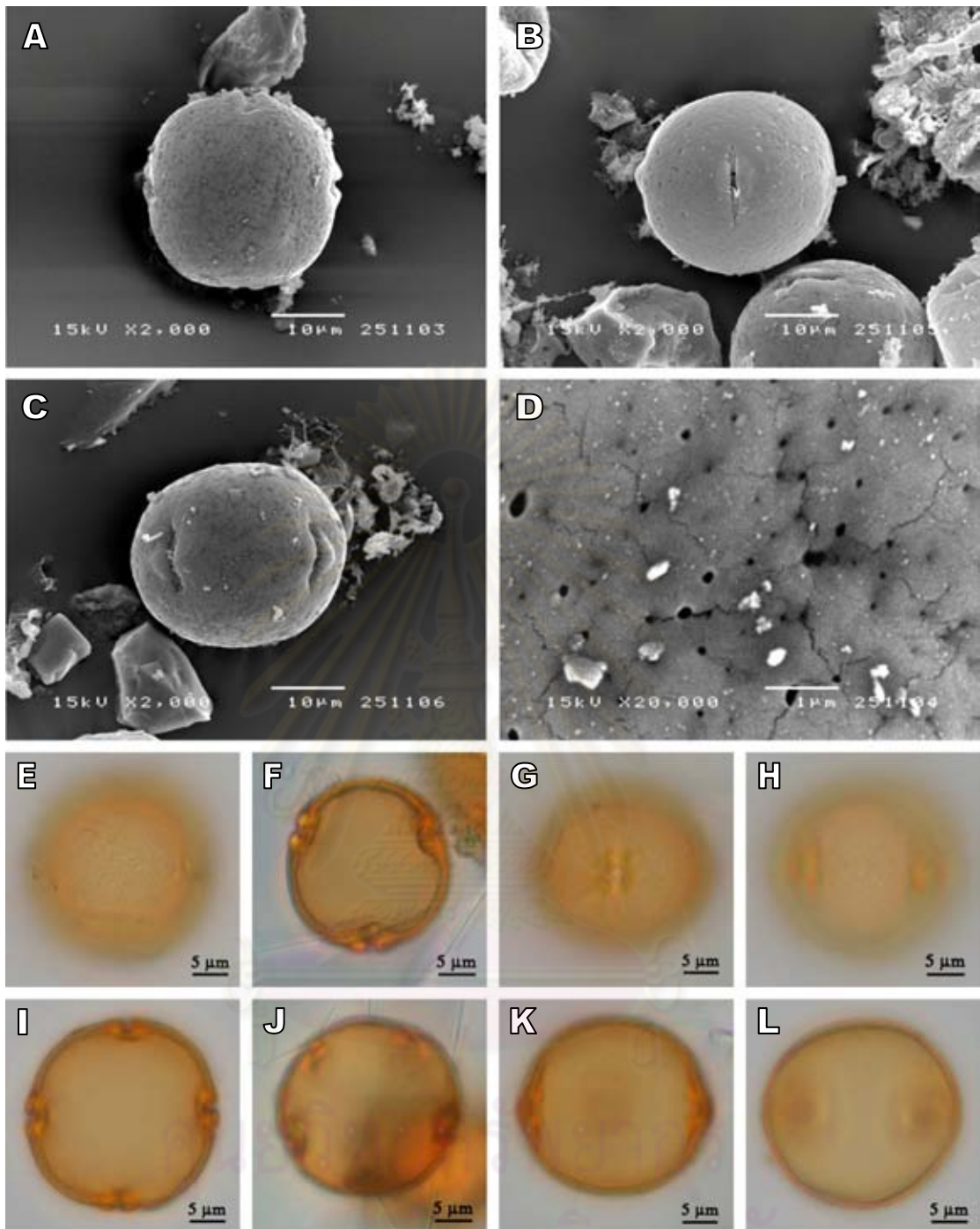


Plate 80 *Xylocarpus rumphii* (Kostel.) Mabb.: (A) Polar view, (B) Equatorial view, colporus, (C) Equatorial view, mesocolpium, (D) Equatorial view, surface, (E) Polar view of 4-aperturate grain, surface, (F) Polar view of 3-aperturate grain, optical section, (G) Equatorial view, endoaperture, (H) Equatorial view, mesocolpium surface, (I) Polar view of 4-aperturate grain, optical section, (J) Polar view of 5-aperturate grain, optical section, (K) Optical section under colporus, (L) Optical section under mesocolpium (A-D: SEM; E-L: LM).



## CHAPTER V

### DISCUSSION AND CONCLUSION

#### 5.1 General pollen and spore morphology

There is a considerable variation in pollen and spore morphology of mangrove flora in Thailand. It can be divided into 53 pollen and spore types and 22 subtypes based, mainly, on characteristic of apertures, size, shapes and ornamentations etc.

##### 5.1.1 Polarity

While all mangrove ferns have heteropolar spores, most flowering plants have isopolar pollen grains. Apolar pollen grains are found in the *Thespesia populnea* type which has polypantocolporate grains, and the *Suaeda maritima* type which has polypantoporate grains. Heteropolarity is found in monocolpate pollen grains of *Horsfieldia irya* type and *Phoenix paludosa* type, as well as monoporate pollen grains of *Flagellaria indica* type and *Pandanus odoratissimus* type. However, in *Atalantia monophylla* type, *Cynometra ramiflora* type, *Diospyros areolata* type, and *Heritiera littoralis* type, with generally isopolar and colporate grains, some grains of which have endoapertures that did not situate on equator but shift more or less toward poles. Thus, they are categorized in heteropolar pollen grains. Subisopolar pollen grains are found in *Ficus microcarpa* type. Pollen grains of *Acanthus volubilis* type and *Allophylus cobbe* type are generally isopolar but some grains are subisopolar.

##### 5.1.2 Polar area index

The polar area index of pollen grains can vary from very small (0.14 as in *Melastoma saigonense* (Kuntze) Merr.) to large (0.76 as in *Aglaia cucullata* (Roxb.) Pellegr.). Besides, apocolpial field of *Barringtonia racemosa* type pollen grains are very small and are approximately 1  $\mu\text{m}$  in diameter.



### 5.1.3 Shape and outline

Fern spores are generally in peroblate (as in *Stenochlaena palustris* (Burm. f.) Bedd.) to suboblate shape class (as in *Acrostichum aureum* L., *Acrostichum speciosum* Willd., *Lecanopteris sinuosa* (Wall. ex Hook.) Copel. , and *Pyrrosia adnascens* (Sw.) Ching). Shape of monolete spores is ellipsoidal or boat-shape while shape of trilete spores is tetrahedral to tetrahedral-globose.

For flowering plants, shape class is varying from peroblate (as in *Melaleuca cajuputi* Powell) to perprolate (as in *Acanthus ilicifolius* L.).

The polar outlines of pollen grains generally vary from triangular (to hexangular) with concave to convex sides to circular, or 6-lobate, or somewhat elliptic (as in *Ficus microcarpa* L. f.) to oblong-elliptic (as in *Horsfieldia irya* (Gaertn.) Warb.).

The equatorial outlines of pollen grains can vary from oblong-elliptic ( $P > E$ ) to circular to elliptic ( $P < E$ ). For monoporate pollen grains, there are two planes of equatorial axis length (longer and shorter equatorial axis). In *Horsfieldia irya* (Gaertn.) Warb., equatorial outline is triangular with flat-top on longer equatorial view, and slightly quadrangular on shorter equatorial view. In *Phoenix paludosa* Roxb., equatorial outline is circular-elliptic to elliptic on longer equatorial view, and circular-elliptic on shorter equatorial view.

### 5.1.4 Size

The range of size (average size of each species) of pollen grains and spores of mangrove plant species in Thailand is very wide. It is from very small (8.09  $\mu\text{m}$  as in *Ficus microcarpa* L. f.) to very large (102.00  $\mu\text{m}$  as in *Hibiscus tiliaceus* L.). Most pollen grains and spores are small to medium sized.

### 5.1.5 Aperture

For fern spore, laesurae are categorized into two laesura types, monolete (one laesura) and trilete (three laesurae or triradiate laesura).

For flowering plants, apertures are categorized into three main apertural types and their derivatives.

First, porate aperture type, aperture number of this aperture type is one (as in *Flagellaria indica* type and *Pandanus odoratissimus* type), two (as in *Ficus microcarpa* type), three (as in *Allophylus cobbe* type and *Sonneratia griffithii* type), and polyaperturate (as in *Suaeda maritima* type).

Second, colpate aperture type, aperture number of this type is one (as in *Horsfieldia irya* type, *Phoenix paludosa* type, or ring-like aperture in *Nypa fruticans* type), two (as in *Crinum asiaticum* type), and three (as in *Clerodendrum inerme* type, *Dolichandrone spathacea* type, and *Sesuvium portulacastrum* type).

Third, colporate aperture type, the majority of pollen grains are in this aperture type. Aperture number of this type is three to five or somewhat polyaperturate (as in *Thespesia populnea* type).

Fourth, heterocolpate aperture type, pollen grains comprise three colpi alternated with three colpi (as in *Calycopteris floribunda* type, *Lumnitzera littorea* type, *Melastoma saigonense* type, and *Terminalia catappa* type).

Last, 3-colporate, pollen grains comprise ectoapertures, mesoapertures, and endoapertures (as in *Scyphiphora hydrophyllacea* type).

#### 5.1.6 Exine or sclerine

For fern spores, perispore is easily detached from grains. Sometimes, spore have smooth surface instead of ornamented wall. The sclerine thickness is 0.8  $\mu\text{m}$  (as in *Drynaria quercifolia* (L.) J. Sm. and *Lecanopteris sinuosa* (Wall. ex Hook.) Copel.) to 3.2  $\mu\text{m}$  (as in *Pyrrosia piloselloides* (L.) M.G. Price).

For flowering plants, pollen grains are tectate imperforate, tectate perforate and semitectate. Under light microscopy, infratectal layer has columellae and clearly seen on both surface view and optical section. But in many species columellae seen to be indistinct, so scanning or transmission electron microscopy may help to ascertain the detail or exine stratification. The exine thickness is 0.6  $\mu\text{m}$  (as in *Aegiceras corniculatum* (L.) Blanco, *Heritiera littoralis* Aiton (W. & A.) Clos, *Melaleuca cajuputi* Powell, and *Sesuvium portulacastrum* (L.) L.) to 10.4  $\mu\text{m}$  (as in *Intsia bijuga* (Colebr.) Kuntze). The sexine is usually thicker than the nexine, somewhat the sexine is as thicker as or thinner

than nexine. In some case (as in *Sonneratia griffithii* type), exine at apocolpia is thicker than exine at other parts of grains.

#### 5.1.7 Ornamentation

There are so many kinds of ornamentation of mangrove plant pollen grains and spores, but they can be grouped into three forms. The first one is the present of lumina or puncta on tectum. This form includes perforate, foveolate, microreticulate, reticulate, and fossulate pattern. The second form is various kinds of projections, i.e. echinate, microechinate, baculate, microbaculate, clavate, granulate, verrucate, gemmate, rugulate, microrugulate, striate, as well as the present of rodlets, globules and mass of particles on surface. The last form is no sculpturing which is called psilate. The combination of each pattern can occur in many cases, e.g., *Pluchea indica* type has echinate ornamentation, and has perforations present on area between echinae.

#### 5.1.8 Comparing with the previous researches

This study found that pollen grains of *Cerbera manghas* L. and *Cerbera odollam* Gaertn. (Apocynaceae) have lolongate elliptic or subcircular endoapertures, But Sittha (2007) reported that pollen grains of these two species have lalongate elliptic to elliptic-circular endoapertures. Moreover, this study reported that the ornamentation on mesocolpia is different from other area, which was not reported in Sittha's study.

The pollen grains of *Glochidion littorale* Blume (Phyllantaceae) and *Melastoma saigonense* (Kuntze) Merr. (Melastomataceae) in this study are a little bit different from those in previous study (Chantaranothai, 1997; Kasetinsombat, 1999) in size and shape.

For pollens of plants in Rhizophoraceae, there are some differences between this study and Boonsermsuk's study (1987). Boonsermsuk reported that pollen grains of *Bruguiera* spp. have perforate or rugulate-perforate ornamentation while pollen grains of those in this study have psilate ornamentation with very small round depressions. Besides, Boonsermsuk did not report the present of endocingula in pollen grains of *Bruguiera parviflora* (Roxb.) Wight & Arn. ex Griff., *Rhizophora apiculata* Blume, and *Rhizophora mucronata* Lam., which are found in this study.

## 5.2 Combination of pollens and spores in mangrove sediment

In mangrove sediment, many pollen and spore types can be found, such as *Acanthus volubilis* type, *Acrostichum speciosum* type, *Aegialitis rotundifolia* type, *Avicennia alba* type, *Ceriops decandra* type, *Excoecaria agallocha* type, *Lumnitzera littorea* type, *Nypa fruticans* type, *Phoenix paludosa* type, *Scyphiphora hydrophyllacea* type, *Sonneratia griffithii* type, and *Xylocarpus rumphii* type. The combination of these pollen and spore types can indicate that sediment is from mangrove habitat.

## 5.3 Ecological influence to tectum

Excluding fern spores of seven fern species, it is noticeable that pollen grains from 29 species of true mangrove species of flowering plants included in this study, there are pollen grains from 5 species are tectate imperforate, 13 species are tectate perforate with very small and minute puncta, and 11 species is semitectate which are microreticulate to reticulate with rather small size lumina.

Besides, these kinds of characters are also found in pollen grains of mangrove associates. There are only 6 (*Caesalpinia crista* L., *Dolichandrone spathacea* (L. f.) Seem., *Glochidion littorale* Blume, *Horsfieldia irya* (Gaertn.) Warb., *Intsia bijuga* (Colebr.) Kuntze, and *Peltophorum pterocarpum* (DC.) Backer ex K. Heyne) species of flowering plants of mangrove associates from 44 species of flowering plants of mangrove associates, which have pollen grains with widely opened microreticulate or reticulate ornamentation.

There are some researches reporting correlation between tectum and abiotic factors or environment. High temperature can affect wall architecture on microsporogenesis (Porch and Jahn, 2001; Koti *et al.*, 2005). Hebda & Lott (1973, cited in Rowley, 1976: 43) reported that a variation of exine ornamentation related to environment. Higher temperature could cause the development of larger lumina relative to narrower muri (microreticulate) while lower ones cause smaller lumina relative to wider muri (foveolate). This effect is also similar to pollen grains of Eurasian species of the genus *Buxus* (Buxaceae). Pollen grains of this genus which have verrucate or pilate ornamentation as well as wide-mesh reticulate pattern are restricted to subtropics or



tropics with higher temperature while pollen grains which have finer reticulation are found in north or northwest regions with lower temperature (Brückner, 1993).

From the reports as mentioned above, they demonstrate that there is a correlation between temperature and tectal characteristic of pollen grains. However, the effect of climate condition to mangrove vegetation is not yet understood. Mangal occur in areas where the average annual temperature is at or above 18°C (Chapman, 1976; 1977, cited in Giesen *et al.*, 2006: 14). Many true mangrove species have morphological and physiological adaptation to inundation, high salinity and unstable soil, i.e., pneumatophores, salt glands, and stilt roots *etc.* (Hovenden and Allaway, 1994; Paliyavuth, Clough, and Patanaponpaiboon, 2004; Evans, Okawa, and Searcy, 2005).

There is no certain research reporting about the direct effect of salinity to tectal characteristic. However, Ambwani and Kumar (1993) found that plants in genus *Licuala* (Arecaceae) which distribute in saline water condition have pollen grains with coarser reticulate pattern than those in fresh water condition. Their result is not concordant with the result from this study.

#### 5.4 Conclusion

Because of variation of taxa in different ranks included in this study, there is a considerable variation of pollen and spore morphology of mangrove flora in Thailand. It can be divided into 53 pollen and spore types and 22 subtypes based mainly on characteristic of apertures, size, shapes and ornamentations *etc.*

The correlation between tectal characteristic and abiotic factors in mangrove habitats is still obscure. But the result from this study suggests that pollen grains of mangrove species seem to have closed tectum.

This research is the first time to study mangrove pollen flora of Thailand. The result of this study gives rise to an idea about pollen and spore types of mangrove flora in Thailand. Moreover, the constructed key to pollen and spore types, the pollen and spore type descriptions, and permanent slides of pollen grains and spores can be used as a tool to identify mangrove plant species in Thailand to which unknown pollen grains and spores belong.

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## BIOGRAPHY

Mr. Noravit Chumchim was born on August 31<sup>st</sup>, 1985 in Phatthalung Province. He earned his Bachelor Degree of Science in Biology from the Department of Biology, Faculty of Science, Prince of Songkla University, Songkhla in 2008. Then, he continued his study in Master of Science in Botany from the Department of Botany, Faculty of Science, Chulalongkorn University from 2008-2010.



ศูนย์วิทยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย