

Spore Characteristics of Thai *Pyrrrosia* Mirbel (Polypodiaceae)

สัณฐานวิทยาสปอร์เฟินสกุล *Pyrrrosia* Mirbel (Polypodiaceae) ในประเทศไทย

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Abstract

The spore morphology of 18 taxa of *Pyrrrosia* Mirbel in Thailand was studied by light and scanning electron microscopy. The results show that the spore is monolete, bilaterally symmetrical and anisopolar. The laesura is straight for about 1/3 of the spore length. The spore shapes are ellipsoidal or oblong in polar view and concavo-convex in the equatorial profile. The sizes are medium or large. Six patterns of spore ornamentation viz. psilate, parallel folds to longitudinal axis, verrucate with globules, verrucate with large verrucae, tuberculate with gross verrucae and verrucate with coarse echinae groups, are useful with taxonomic significance.

บทคัดย่อ

ศึกษาลักษณะสัณฐานวิทยาของสปอร์เฟินสกุล *Pyrrrosia* Mirbel ในประเทศไทย จำนวน 18 แทกซา ด้วยกล้องจุลทรรศน์แบบใช้แสง และกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราด พบว่า สปอร์เป็นเม็ดเดี่ยว มีสมมาตรด้านข้าง มีขั้วแบบไม่สมมาตร มีช่องเปิดแบบรอยเชื่อมเดี่ยว ยาวประมาณ 1/3 ของความยาวสปอร์ สปอร์มีรูปร่างแบบ ellipsoidal หรือ oblong ตามแนวแกนขั้ว และรูปร่างแบบ concavo-convex ตามแนวเส้นศูนย์สูตร สปอร์มีขนาดกลางหรือขนาดใหญ่ ลวดลายบนผนังชั้นนอกจำแนกได้เป็น 6 กลุ่ม คือ psilate, parallel folds to longitudinal axis, verrucate with globules, verrucate with large verrucae, tuberculate with gross verrucae และ verrucate with coarse echinae

Keywords: spore, Thai *Pyrrrosia*

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Introduction

Pyrrrosia is a large genus of common epiphytic ferns, which comprises about 100 species. The genus is widely distributed in tropical and subtropical Africa, Asia and Australia, while only two species are found in South America (Holtum, 1968; Hovenkamp, 1986), and 18 species have been recorded in Thailand (Tagawa and Iwatsuki, 1989). The presence of stellate hairs all over the fronds is a character of crucial importance much used to separate *Pyrrrosia* from other Polypodioid ferns (Holtum, 1968).

The spore of the *Pyrrrosia* has been studied by many workers using light microscopy (LM) (Nayar, 1962; Erdtman and Sorsa, 1971; Bir and Satija, 1980) and by scanning electron microscopy (SEM) (van Uffelen, 1985; Tryon and Lugardon, 1991). The spore of *Pyrrrosia* is unique among the leptosporangiate ferns, as compared with those of other genera in the Polypodiaceae (Hennipman, 1990). Tryon and Lugardon (1991) proposed five spore types in *Pyrrrosia* mainly based on perispore ornamentation: *P. perinceps* type, *P. subfurfuracea* type, *P. christii* type, *P. rupestris* type and *P. nummularifolia* type. The aims of the present study are to classify, describe and illustrate the spore morphology of Thai *Pyrrrosia* by LM and SEM.

Material and Methods

Spores of 18 taxa of genus *Pyrrrosia* in Thailand were collected in the field by the first author and examined by LM and SEM. For LM and SEM, spores were prepared according to the standard method of acetolysis (Erdtman, 1960). For LM study, spores were mounted in silicone oil, and permanently sealed with paraffin. For SEM study, drops of spore-ethanol suspension were placed on specimen stubs with

double sided cellophane tape and dried, then sputter-coated with a gold-palladium mixture, and observed with a LEO 1450 VP SEM. Measurements of spore were made on polar axis (P), equatorial axis (E), exine (EX) and laesura length (LL) using a LM at least ten spores per sample. Descriptive terminology is according to Tryon and Lugardon (1991). The spore morphological data of the specimens examined are compiled in Table 1 and voucher specimens are listed separately.

Results

General spore morphology

The spore of Thai *Pyrrrosia* is remarkably uniform. It is monolete, bilaterally symmetrical and anisopolar. The laesura is straight, and about 1/3 of the spore length. The polar view is ellipsoidal or oblong. The equatorial profile is concavo-convex. The size is medium or large (P= 20–62.5 μm ; E= 40–92 μm). The exine is 1–5 μm in thickness. A comparison of variations in ornamentation of the perispore shows that six spore types could be distinguished.

Group 1: Occurs in *P. floccigera* and *P. stigmosa* (Figures 1–2)

The spores are oblong in polar view and plane to concavo-convex, P= 25.0–32.5 μm , E= 47.5–77.5 μm . The laesura is 15.0–35.0 μm in length. The exine is 1.25 μm in thickness. The ornamentation of the perispore is psilate.

Group 2: Occurs in *P. angustata* (Figure 3)

The spores are oblong in polar view and plane to concavo-convex, P= 25.0–35.0 μm , E= 47.5–62.5 μm . The laesura is 15.0–22.5 μm in length. The exine is 1.25–2.5 μm in thickness. The ornamentation of the perispore is folds parallel to the longitudinal axis.

Group 3: Occurs in *P. mollis*, *P. penangiiana*, *P. tonkinensis* and *P. sp.2* (Figures 4–10)

The spores are ellipsoidal to oblong in polar view and plane to concavo-convex, P= 25.0–62.0 μm , E= 50.0–62.5 μm . The laesura is 15.0–35.0 μm in length. The exine is 1–2.5 μm in thickness. The ornamentation of the perispore is verrucate with globules.

Group 4: Occurs in *P. adnascens*, *P. eberhardtii*, *P. heteractis*, *P. heteractis var. minor*, *P. lanceolata*, *P. longifolia* and *P. sp.3* (Figures 11–18)

The spores are ellipsoidal to oblong in polar view and plane to concavo-convex, P= 20.0–42.5 μm , E= 40.0–62.5 μm . The laesura is 15.0–35.0 μm in length. The exine is 1.25–3.0 μm in thickness. The ornamentation of the perispore is verrucate with large verrucae.

Group 5: Occurs in *P. varia*, *P. nuda* and *P. sp.1* (Figures 19–22)

The spores are ellipsoidal in polar view and plane to concavo-convex, P= 25.0–40.0 μm , E= 45–62.5 μm . The laesura is 15.0–35.0 μm in length. The exine is 2.5–5.0 μm in thickness. The ornamentation of the perispore is tuberculate with gross verrucae.

Group 6: Occurs in *P. piloselloides* (Figures 23–24)

The spores are ellipsoidal in polar view and plane to concavo-convex, P= 25.0–37.5 μm , E= 42.5–52.5 μm . The laesura is 12.5–25.0 μm in length. The exine is 2.25 μm in thickness. The ornamentation of the perispore is verrucate with coarse echinae.

Discussion and Conclusions

Table 1 shows that the spore morphology of Thai *Pyrosia* is generally homogenous. The size of

the spore (length of equatorial axis) varies in an individual species, according to Erdtman and Sorsa (1971). The spore of all species are large size, 51–87 μm , except for *P. adnascens*, *P. lanceolata* and *P. piloselloides* are medium size, 43.2–47.5 μm .

The shapes in polar view are mostly ellipsoidal except in *P. angustata*, *P. floccigera*, *P. lanceolata*, *P. longifolia* and *P. stigmosa*, which are oblong. In all taxa examined, the spores are plane to concavo-convex in equatorial view, as observed by LM.

The ornamentation of the spores is verrucate in LM, except in *P. floccigera* and *P. stigmosa*, which are psilate. The details shown in SEM are variable, e.g. verrucate with large verrucae, verrucate with globules, tuberculate with gross verrucae, verrucate with coarse echinae, folds parallel to the longitudinal axis. The ornamentation of the perispore can be divided into six groups. Group 1 is distinguished from all other five groups by psilate ornamentation. Group 3 is similar to group 4, but the former have smaller verrucate ornamentation and sometimes the lateral fusion of globules or small verrucae are found in group 3 and only verrucae are found in group 4. *P. varia*, *P. nuda* and *P. sp.1* in group 5 are similar in morphology but they differ in stipe length (Tagawa and Iwatsuki, 1989). Further study is needed to decide their status. The spore morphology can be used to separate the genus from other leptosporangiate ferns but cannot be used to identify to the species level.

In addition, the ornamentation of the perispore is useful for the identification of *P. angustata* in group 2 and *P. piloselloides* in group 6. The former has folds parallel to the longitudinal axis and the latter has verrucate with coarse echinae. Both characters agree well to the work of Hennipman (1990) and

Tryon and Lugardon (1991) because they suggest that the genus *Pyrrosia* has striking perispore ornamentation.

Specimens Examined

All specimens examined are deposited at KKU. *Pyrrosia adnascens* (Sw.) Ching, Kanokorn 35/1999. – *P. angustata* (Sw.) Ching, Kanokorn 67/1999. – *P. eberhardtii* (H. Christ) Ching, Kanokorn 41/1999. – *P. floccigera* (Blume) Ching, Kanokorn 39/1999. – *P. flocculosa* (D. Don) Ching, Kanokorn 31/1999. – *P. heteractis* (Mett. ex Kuhn) Ching, Kanokorn 67/2000. – *P. heteractis* var. *minor* (C. Chr) Ching, Kanokorn 80/2000. – *P. lanceolata* (L.) Farwell, Kanokorn 51/2000. – *P. longifolia* (Burm. f.) C.V. Morton, Kanokorn 36/1999. – *P. mollis* (Kunze) Ching, Kanokorn 70/2000. – *P. nuda* (Giesenh.) Ching, Kanokorn 54/2000. – *P. nummularifolia* (Sw.) Ching, Kanokorn 59/2000. – *P. penangiana* (Hook.) Holtt., Kanokorn 64/2000. – *P. piloselloides* (L.) M.G. Price, Kanokorn 10/1999. – *P. stigmosa* (Sw.) Ching, Kanokorn 40/1999. – *P. tonkinensis* (Giesenh.) Ching, Kanokorn 52/2000. – *P. varia* (Kaulf.) Farwell, Kanokorn 37/1999. – *P. sp.1*, Kanokorn 54/2000. – *P. sp.2*, Kanokorn 69/2000. – *P. sp. 3*, Kanokorn 68/2000.

Acknowledgements

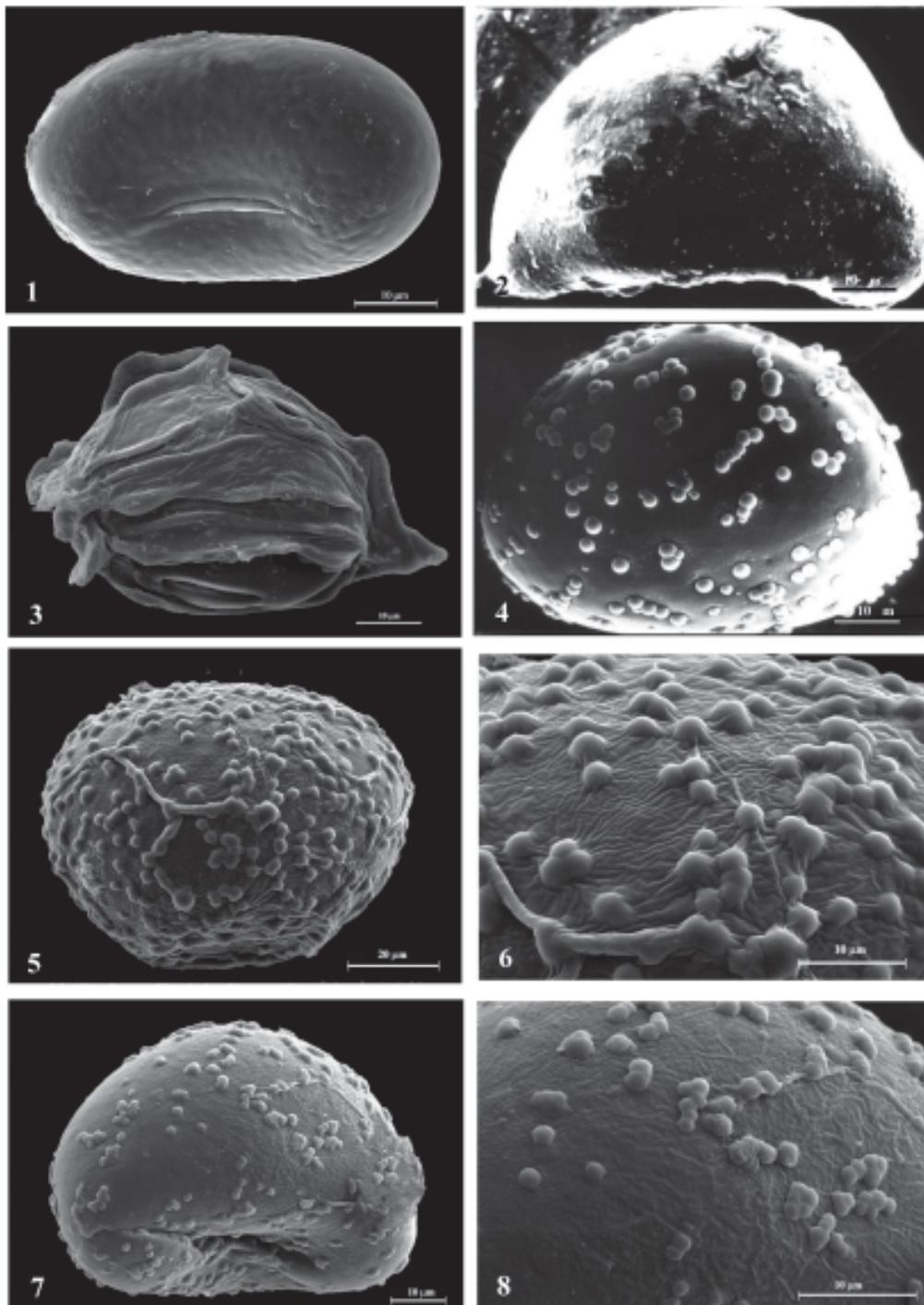
This work was supported by the TRF/BIOTEC Special Program for Biodiversity Research and Training grant (BRT 543001). The authors are grateful to Mr Watthana Suadprakhon, Faculty of Science, Khon Kaen University for technical assistance with SEM.

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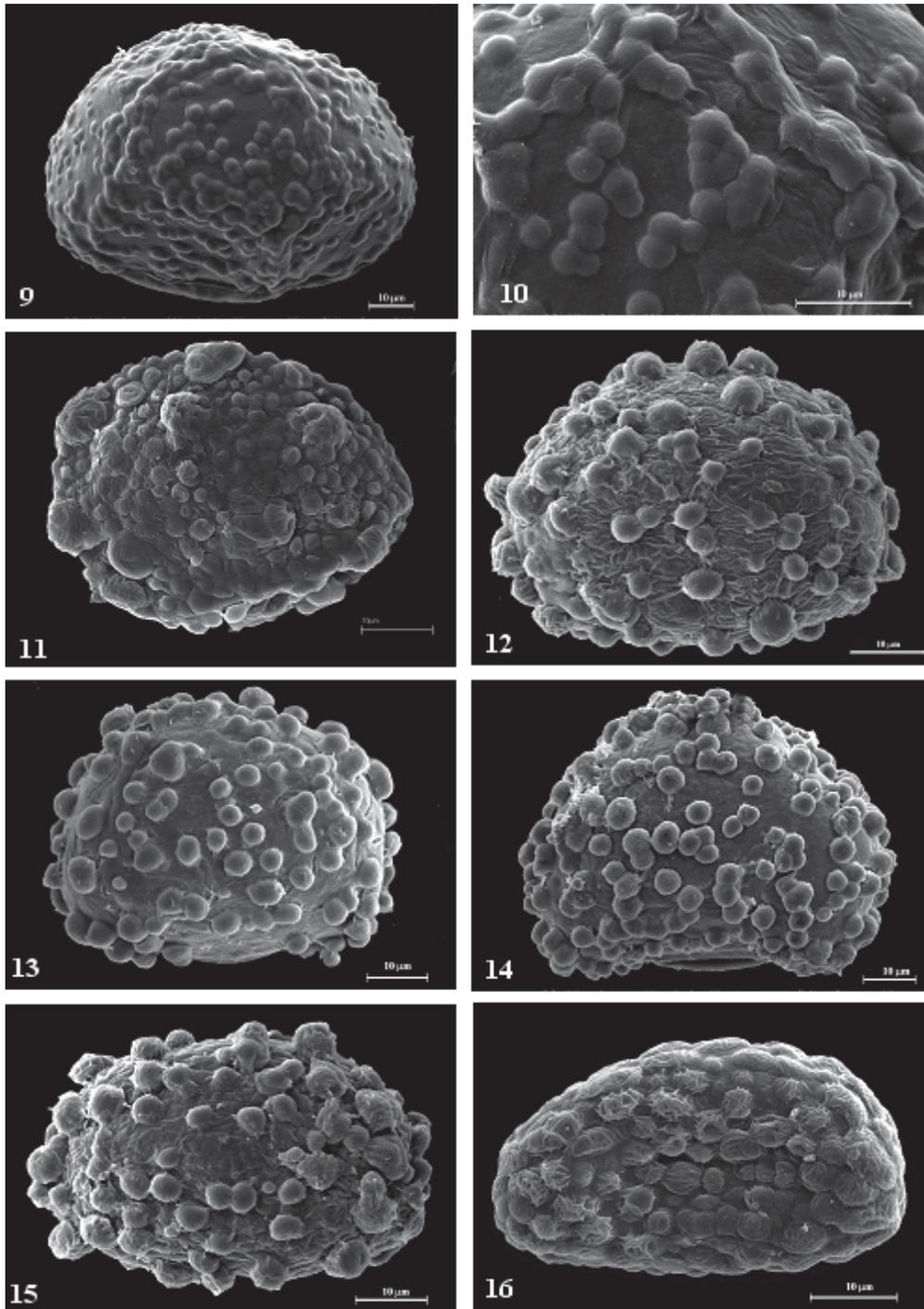
Table 1. Spore morphological data of Thai *Pyrrosia*.

Taxon	Polar axis (μm)	Equatorial axis (μm)	Laesura length (μm)	Exine (μm)	Shape (polar view)	Ornamentation
<i>P. adnascens</i>	25.0-35.0	40.0-55.0	20.0-27.5	2.5	oblong	verrucate with large verrucae
<i>P. angustata</i>	25.0-35.0	47.5-62.5	15.0-22.5	1.25-2.5	oblong	folds parallel to longitudinal axis
<i>P. eberhardtii</i>	25.0-45.0	65.0-70.0	25.0-35.0	2.5-5.0	ellipsoidal	verrucate with large verrucae
<i>P. floccigera</i>	25.0-32.5	60.0-77.5	25.0-35.0	1.25	oblong	psilate
<i>P. heteractis</i>	25.0-37.5	52.5-62.5	25.0	2.5-3.0	ellipsoidal	verrucate with large verrucae
<i>P. heteractis</i> var. <i>minor</i>	35.0-42.5	50.0-62.5	22.5-30.0	2.5	ellipsoidal	verrucate with large verrucae
<i>P. lanceolata</i>	20.0-25.0	40.0-50.0	15.0-25.0	1.25-2.5	oblong	verrucate with large verrucae
<i>P. longifolia</i>	22.5-25.0	47.5-62.5	17.5-25.0	2.5	oblong	verrucate with large verrucae
<i>P. mollis</i>	50.0-62.5	75.0-92.0	25.0-37.5	2.5	ellipsoidal	verrucate with globules
<i>P. nuda</i>	30.0-40.0	45.0-62.5	15.0-35.0	2.5-5.0	ellipsoidal	tuberculate with gross verrucae
<i>P. penangiana</i>	45.0-50.0	60.0-72.5	25.0-37.5	2.5	ellipsoidal	verrucate with globules
<i>P. pilose/loides</i>	25.0-37.5	42.5-52.5	12.5-25.0	2.5	ellipsoidal	verrucate with coarse echinae
<i>P. stigmosa</i>	25.0-32.5	47.5-52.5	15.0-25.0	1.25	oblong	psilate
<i>P. tonkinensis</i>	40.0-50.0	59.0-69.0	30.0-42.0	1-2	ellipsoidal	verrucate with globules
<i>P. varia</i>	32.5-37.5	55.0-62.5	25.0	2.5	ellipsoidal	tuberculate with gross verrucae
<i>P. sp. 1</i>	25.0-40.0	50.0-57.5	20.0-35.0	2.5	ellipsoidal	tuberculate with gross verrucae
<i>P. sp. 2</i>	50.0-60.0	72.5-87.5	25.0-37.5	1.25-2.5	ellipsoidal	verrucate with globules
<i>P. sp. 3</i>	37.5-50.0	55.0-75.0	25.0-37.5	2.5	ellipsoidal	verrucate with large verrucae



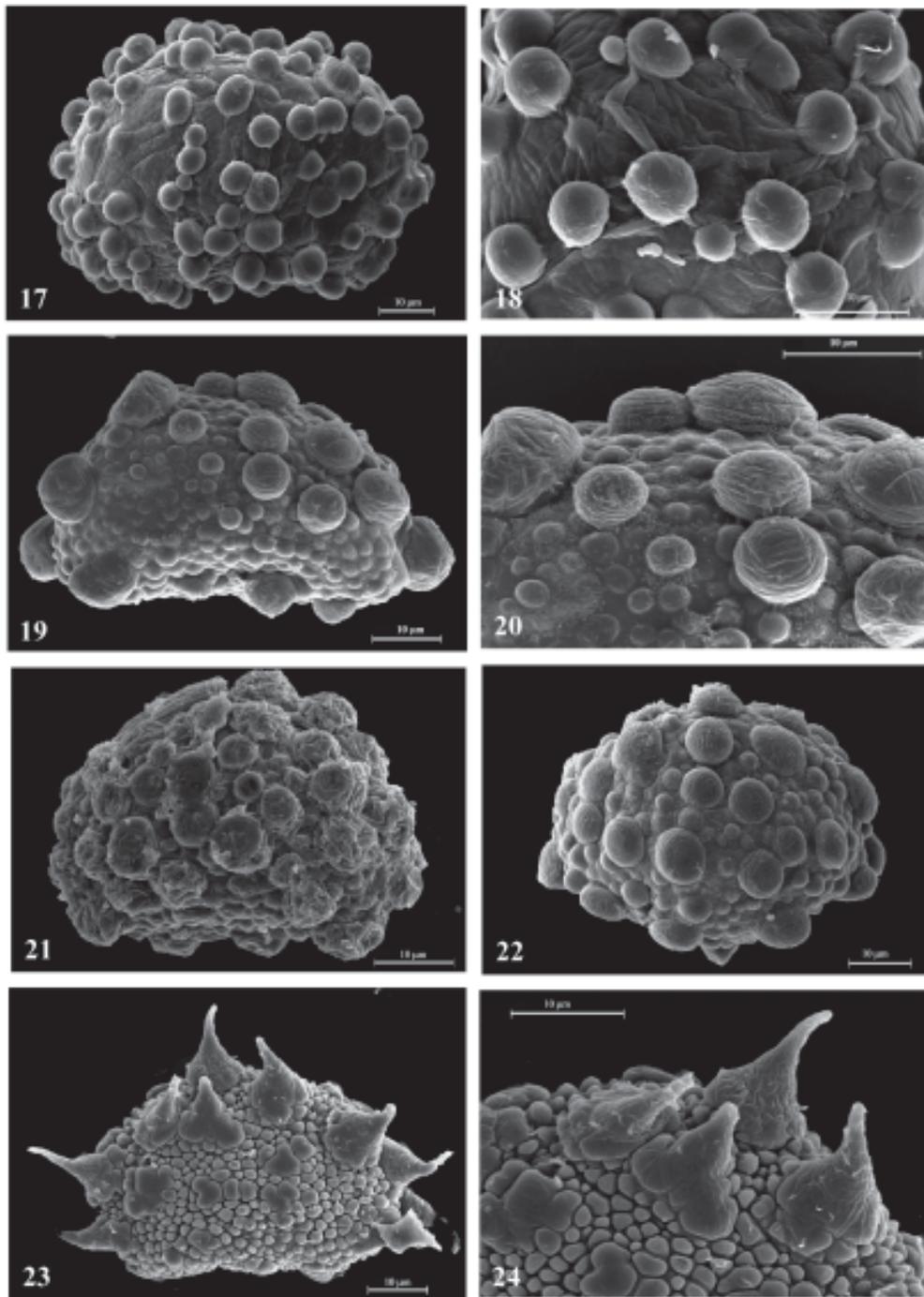
Figures 1–8. Scanning electron micrographs of spore of Thai *Pyrrisia*.

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| (1) <i>P. stigmata</i> , showing a polar view; | (2) <i>P. floccigera</i> , showing an equatorial view; |
| (3) <i>P. angustata</i> , showing an equatorial view; | (4) <i>P. tonkinensis</i> , showing an equatorial view; |
| (5) <i>P. mollis</i> , showing an equatorial view; | (6) <i>P. mollis</i> , detail of the surface; |
| (7) <i>P. penangiana</i> , showing an equatorial view; | (8) <i>P. penangiana</i> , detail of the surface. |



Figures 9–16. Scanning electron micrographs of spore of Thai *Pyrrrosia*.

- (9) *P. sp. 2*, showing an equatorial view;
- (10) *P. sp. 2*, detail of the surface;
- (11) *P. adnascens*, showing a distal view;
- (12) *P. eberhardtii*, showing a distal view;
- (13) *P. heteractis*, showing an equatorial view;
- (14) *P. heteractis* var. *minor*, showing an equatorial view;
- (15) *P. lanceolata*, showing a distal view;
- (16) *P. longifolia*, showing an equatorial view.



Figures 17–24. Scanning electron micrographs of spore of Thai *Pyrrisia*.

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| (17) <i>P. sp. 3</i> , showing a distal view; | (18) <i>P. sp. 3</i> , detail of the surface; |
| (19) <i>P. nuda</i> , showing an equatorial view; | (20) <i>P. nuda</i> , detail of the surface; |
| (21) <i>P. varia</i> , showing an equatorial view; | (22) <i>P. sp. 1</i> , showing a distal view; |
| (23) <i>P. piloselloides</i> , showing an equatorial view; | (24) <i>P. piloselloides</i> , showing a distal view. |