

Pollen morphology of the tribe Inuleae (Compositae) in Thailand

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ABSTRACT. Pollen of 17 species belonging to four genera of the tribe Inuleae (Compositae) in Thailand was studied by means of LM and SEM. The pollen grains are monad, radially symmetrical, isopolar, subspheroidal and echinate. Features regarded as distinctive include size, spine rows and spine length. Two pollen groups based on a number of spine rows between apertures are established: Group I has one genus, *Anisopappus*, and Group II has 3 genera, *Blumea*, *Duhaldea* and *Pentanema*, with 5 and 3–4 spine rows, respectively.

INTRODUCTION

The delimitation of the tribe Inuleae has been somewhat controversial. Benthams (1873) recognized 9 subtribes whereas for Merxmüller et al. (1977) it was 3, Inulinae (including Plucheinae), Athrixiinae and Gnaphaliinae. The pollen morphology was used by Merxmüller et al. (1977) as one of the major key characters of two of their three subtribes; the last two subtribes. Anderberg (1989) suggested that the tribe should be divided into 3 tribes; Gnaphalieae (including Athrixiinae), Inuleae s.str. and Plucheae based on characters of the capitula, anthers, styles, cypselas and pollen. Both subtribes Inulinae and Plucheinae have pollen with only one baculate sexine layer but Gnaphaliinae has two-layered sexine pollen. We accept Anderberg's work of Inuleae s.str. The Inuleae is a rather small tribe in Compositae, comprising 38 genera and 480 species occurring world-wide (Anderberg, 1991). Four genera and 29 species are enumerated in Thailand (Pornpongrueng & Chantaranothai, in prep.).

Breitwieser & Sampson (1997) investigated pollen of 45 taxa of Gnaphalieae in New Zealand, the size, spine density, spine length, spine shape and nature of perforation are taxonomically useful in classification of New Zealand Gnaphalieae. However, there have been without any detailed description and comprehensive discussion between the taxa from the tribe Inuleae s.str. The present paper gives a survey of the pollen morphology of the tribe Inuleae in Thailand.

MATERIALS AND METHODS

Pollen grains of 17 species of tribe Inuleae in Thailand were examined by light microscopy (LM) and scanning electron microscopy (SEM). Pollen obtained from the material collected in the wild by the first author. For both LM and SEM, pollen was acetolyzed

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and alkalide maceration according to Erdtman (1960) and Faegri & Iversen (1975), respectively and also directly collected from dried specimens for SEM. For LM studies, pollen grains were mounted in silicone oil, and sealed with paraffin. At least 10 pollen of each taxon were measured: polar axis (P), equatorial axis (E), exine (EX), colpus length (CL), pore diameter (PD), spine length (SL) and number of spine rows between apertures (SR). For SEM studies, pollen grains in 95% ethanol were dried by critical point drying (CPD) and affixed to aluminum stubs with double sided cellophane tape. Specimens were sputter-coated with a gold-palladium mixture, and observed with a JEOL (JSM-35CF) SEM at the Electron Microscopy Laboratory, Kasetsart University. The pollen morphological data of the specimens examined are compiled in Table I. A general pollen description is given under each genus. The terminology for descriptions follows Punt et al. (1994).

RESULTS

The pollen of the Thail Inuleae is remarkably uniform: monad, radially symmetrical, isopolar, tricolporate, small or medium-sized ($P = 15\text{--}30\text{ }\mu\text{m}$, $E = 12.5\text{--}27.5\text{ }\mu\text{m}$) and prolate-spheroidal to suboblate in shape ($P/E = 0.75\text{--}2.00$). Pores diameter varies from $2\text{--}7.5\text{ }\mu\text{m}$ and usually circular to elliptical or slightly rectangular (figs. 14 & 17). The colpus ranges from $10\text{--}25\text{ }\mu\text{m}$ and taper gradually towards the poles. The exine sculpture is echinate with perforations at spine base. The spine length ranges between $1\text{--}5\text{ }\mu\text{m}$. the spines in all taxa investigated are conical and the tip are acute. Generally, the spine bases have a rounded outline. The interspinal area may be large in *Blumea laciniata* (fig. 8) or very small in *B. lacera* (fig. 7) but *B. clarkei* has no interspinal area (fig. 4). Number of spine rows between apertures in all species are 4 except 3 and 5 in *B. laciniata* and *Anisopappus chinensis*, respectively.

Anisopappus (Fig. 1.)

The pollen grains are mostly oblate-spheroidal, $P = 21\text{--}25\text{ }\mu\text{m}$; $E = 21\text{--}27.5\text{ }\mu\text{m}$; $P/E = 0.95$. The colpi $14\text{--}17.5\text{ }\mu\text{m}$, pores $2\text{--}5\text{ }\mu\text{m}$ in diameter. The exine is $2\text{--}2.5\text{ }\mu\text{m}$ in thickness. The spine length is $1\text{--}1.3\text{ }\mu\text{m}$ with 5 spine rows between apertures.

Blumea (Figs. 2–13)

The pollen grains are mostly prolate-spheroidal, subprolate or oblate-spheroidal, $P = 15\text{--}30\text{ }\mu\text{m}$; $E = 12.5\text{--}27.5\text{ }\mu\text{m}$; $P/E = 0.95\text{--}1.25$. The colpi $10\text{--}25\text{ }\mu\text{m}$, pores $2.5\text{--}7.5\text{ }\mu\text{m}$ in diameter. The exine is $1.3\text{--}2.5\text{ }\mu\text{m}$ in thickness. The spine length is $1.3\text{--}5\text{ }\mu\text{m}$ with 3–4 spine rows between apertures. The longest spines are found in *Blumea fistula* ($4\text{--}5\text{ }\mu\text{m}$) and *B. laciniata* ($3.8\text{--}5\text{ }\mu\text{m}$). Some spines in *B. virens* can be up to $5\text{ }\mu\text{m}$.

Duhaldea (Figs. 14–16)

The pollen grains are mostly prolate-spheroidal, subprolate or suboblate, $P = 17.5\text{--}30\text{ }\mu\text{m}$; $E = 20\text{--}27.5\text{ }\mu\text{m}$; $P/E = 0.85\text{--}1.15$. The colpi $12.5\text{--}22.5\text{ }\mu\text{m}$, pores $3.8\text{--}7.5\text{ }\mu\text{m}$ in diameter. The exine is $1.3\text{--}2.5\text{ }\mu\text{m}$ in thickness. The spine length is $2.5\text{--}3.8\text{ }\mu\text{m}$ with 4 spine rows between apertures.

Pentanema (Fig. 17)

The pollen grains are mostly prolate-spheroidal, $P = 15\text{--}20\text{ }\mu\text{m}$; $E = 13.8\text{--}20\text{ }\mu\text{m}$; $P/E = 1.04$. The colpi $10\text{--}15\text{ }\mu\text{m}$, pores $2\text{--}5\text{ }\mu\text{m}$ in diameter. The exine is $1.3\text{--}2.5\text{ }\mu\text{m}$ in thickness. The spine length is $2.5\text{ }\mu\text{m}$ with 4 spine rows between apertures.

DISCUSSION AND CONCLUSIONS

Our results show that the pollen morphology of the thai Inuleae is generally homogenous. The pollen of tribe Inuleae in Thailand can be characterized as having monad, 3-colporate, isopolar, radially symmetrical. The exine are echinate with perforations at the spine base. However, the pollen of these four genera in Thai Inuleae can be divided into two groups on the basis of the number of the spine rows between apertures.

Group I. (Fig. 1)

Pollen grains 3-zonocolporate, oblate-spheroidal, $P = 21\text{--}25\text{ }\mu\text{m}$, $E = 21\text{--}27.5\text{ }\mu\text{m}$. Colpi $14\text{--}17.5\text{ }\mu\text{m}$ long. Ora $2\text{--}5\text{ }\mu\text{m}$. Spine rows is 5 with spine length $1\text{--}3\text{ }\mu\text{m}$ long.

Taxa included: *Anisopappus*.

Group II. (Figs. 2–17)

Pollen grains 3-zonocolporate, prolate-spheroidal, subprolate, oblate-spheroidal or suboblate, $P = 15\text{--}30\text{ }\mu\text{m}$, $E = 12.5\text{--}27.5\text{ }\mu\text{m}$. Colpi $10\text{--}25\text{ }\mu\text{m}$ long. Ora $2.5\text{--}7.5\text{ }\mu\text{m}$. Spine rows generally 4 except 3 in some grains of *Blumea lacinata* (fig. 8), with spine length $1.3\text{--}5\text{ }\mu\text{m}$ long.

Taxa included: *Blumea*, *Duhaldea* and *Pentanema*.

Pollen morphology of Group I (*Anisopappus*) is different from the other by having 5 spine rows between the apertures. The character is agreed well to the work of Anderberg (1991) that the genus is paraphyletic and basal in the tribe. It is also notable that many species of *Anisopappus* are strikingly similar in habit, floral characters etc. to members of basal group of the closely related tribe Ganaphalieae. But ganaphalieae differs mainly in having pollen grains with a double esxine.

Blumea, *Duhaldea* and *Pentanema* in Group II are hardly distinguishable on the basis of the pollen morphology although there are some slight differences. The pollen of *B. lacinata* has usually 3 spine rows and somewhat 4 rows.

Table 1 Pollen morphological data of Thai Inuleae. Measurements represent mean, low and high values, P = Polar axis; E = Equatorial axis; P/E = shape of pollen grain expressed as ratio; 0.75–0.88 = suboblate; 0.88–1.00 = oblate-spheroidal; 1.00–1.14 = prolate-spheroidal; 1.14–1.33 = subprolate; EX = Exine; CL = Colpus length; PD = Pore diameter; SL = Spine length; SR = Number of Spine rows between apertures. All units in μm .

Taxon	P	E	P/E	EX	CL	PD	SL	SR
<i>Anisopappus chinensis</i>	22.8 (21.0–25.0)	23.9 (21.0–27.5)	0.95	2.2 (2.0–2.5)	16.0 (14.0–17.5)	3.3 (2.0–5.0)	1.0 (1.0–1.3)	5
<i>Blumea aromatica</i>	22.4 (20.0–27.5)	20.8 (18.8–25.0)	1.08	2.0 (1.3–2.5)	16.3 (12.5–20.0)	5.1 (3.8–6.3)	2.2 (1.3–2.5)	4
<i>B. balsamifera</i>	25.0 (22.5–27.5)	20.3 (17.5–25.0)	1.23	2.4 (1.3–2.5)	18.0 (15.0–22.5)	5.3 (5.0–7.5)	2.8 (2.5–3.8)	4
<i>B. clarkei</i>	18.0 (15.0–20.0)	19.0 (15.0–22.5)	0.95	2.4 (1.3–2.5)	12.5 (10.0–15.0)	5.6 (5.0–7.5)	1.9 (1.3–2.5)	4
<i>B. fistulosa</i>	21.0 (17.5–23.0)	20.7 (17.5–23.0)	1.02	2.3 (2.0–2.5)	16.2 (14.0–17.5)	4.0 (2.5–5.0)	4.8 (4.0–5.0)	4
<i>B. hieraciifolia</i>	26.3 (22.5–30.0)	24.8 (22.5–27.5)	1.06	2.4 (1.3–2.5)	19.5 (15.0–25.0)	5.8 (5.0–7.5)	3.3 (2.5–3.8)	4
<i>B. lacera</i>	21.5 (20.0–25.0)	21.3 (20.0–22.5)	1.01	2.0 (1.3–2.5)	15.3 (12.5–17.5)	5.3 (5.0–6.3)	2.3 (1.3–2.5)	4
<i>B. laciniata</i>	20.8 (20.0–22.5)	18.6 (15.0–22.5)	1.12	2.0 (1.3–2.5)	13.0 (10.0–15.0)	6.6 (5.0–7.5)	4.5 (3.8–5.0)	3
<i>B. lanceolaria</i>	22.6 (21.3–25.0)	22.5 (20.0–25.0)	1.0	2.2 (1.3–2.5)	16.9 (13.8–20.0)	5.3 (5.0–6.3)	2.8 (2.5–3.8)	4
<i>B. membranacea</i>	22.0 (15.0–25.0)	19.0 (12.5–22.5)	1.16	2.1 (1.3–2.5)	14.5 (12.5–17.5)	4.2 (3.0–5.0)	2.6 (2.5–3.0)	4
<i>B. mollis</i>	21.2 (17.5–22.5)	20.2 (18.8–22.5)	1.05	2.0 (1.3–2.5)	14.8 (12.5–17.5)	5.3 (5.0–6.3)	2.4 (1.3–2.5)	4
<i>B. napifolia</i>	22.5 (17.5–27.5)	18.0 (15.0–20.0)	1.25	2.3 (1.3–2.5)	15.0 (12.5–20.0)	6.1 (5.0–7.5)	2.5	4
<i>B. virens</i>	22.0 (17.5–25.0)	21.8 (17.5–25.0)	1.01	1.9 (1.3–2.5)	14.8 (10.0–17.5)	4.5 (2.5–5.0)	3.9 (2.5–5.0)	4
<i>Duhaldea cappa</i>	27.3 (25.0–30.0)	23.8 (22.5–27.5)	1.15	2.0 (1.3–2.5)	19.3 (17.5–22.5)	5.8 (5.0–7.5)	2.6 (2.5–3.8)	4
<i>D. eupatorioides</i>	20.0 (17.5–25.0)	23.5 (22.5–27.5)	0.85	1.3	13.8 (12.5–15.0)	7.0 (5.0–7.5)	2.9 (2.5–3.8)	4
<i>D. nervosa</i>	23.3 (21.3–25.0)	22.9 (20.0–25.0)	1.02	2.5	17.0 (12.5–20.0)	5.5 (3.8–7.5)	3.4 (2.5–3.8)	4
<i>Pentanema indicum</i>	17.6 (15.0–20.0)	17.0 (13.8–20.0)	1.04	1.8 (1.3–2.5)	11.8 (10.0–15.0)	4.3 (2.5–5.0)	2.5	4

SPECIMENS INVESTIGATED

All specimens investigated are deposited at Khon Kaen University herbarium.

- Anisopappus chinensis* Hook. & Arn., *P. Pornpongrungrueng* 100.
Blumea aromatica DC., *P. Pornpongrungrueng* 159.
B. balsamifera (L.) DC., *P. Pornpongrungrueng* 97.
B. clarkei Hook.f., *P. Pornpongrungrueng* 140.
B. fistulosa (Roxb.) Kurz, *P. Pornpongrungrueng* 221.
B. hieraciifolia (D.Don) DC., *P. Pornpongrungrueng* 293.
B. lacera (Burm.f.) DC., *P. Pornpongrungrueng* 298.
B. laciniata (Roxb.) DC., *P. Pornpongrungrueng* 308.
B. lanceolata (Roxb.) Druce, *P. Pornpongrungrueng* 292.
B. membranacea DC., *P. Pornpongrungrueng* 235.
B. mollis (D.Don) Mer., *P. Pornpongrungrueng* 305.
B. napifolia DC., *P. Pornpongrungrueng* 98.
B. virens DC., *P. Pornpongrungrueng* 77.
Duhaldea cappa (Ham. Ex D.Don) A.Anderb., *P. Pornpongrungrueng* 248.
D. eupatorioides (DC.) A.Anderb., *P. Pornpongrungrueng* 76.
D. nervosa (Wall. Ex DC.) A.Anderb., *P. Pornpongrungrueng* 63.
Pentanema indicum (L.) Ling, *P. Pornpongrungrueng* 53.

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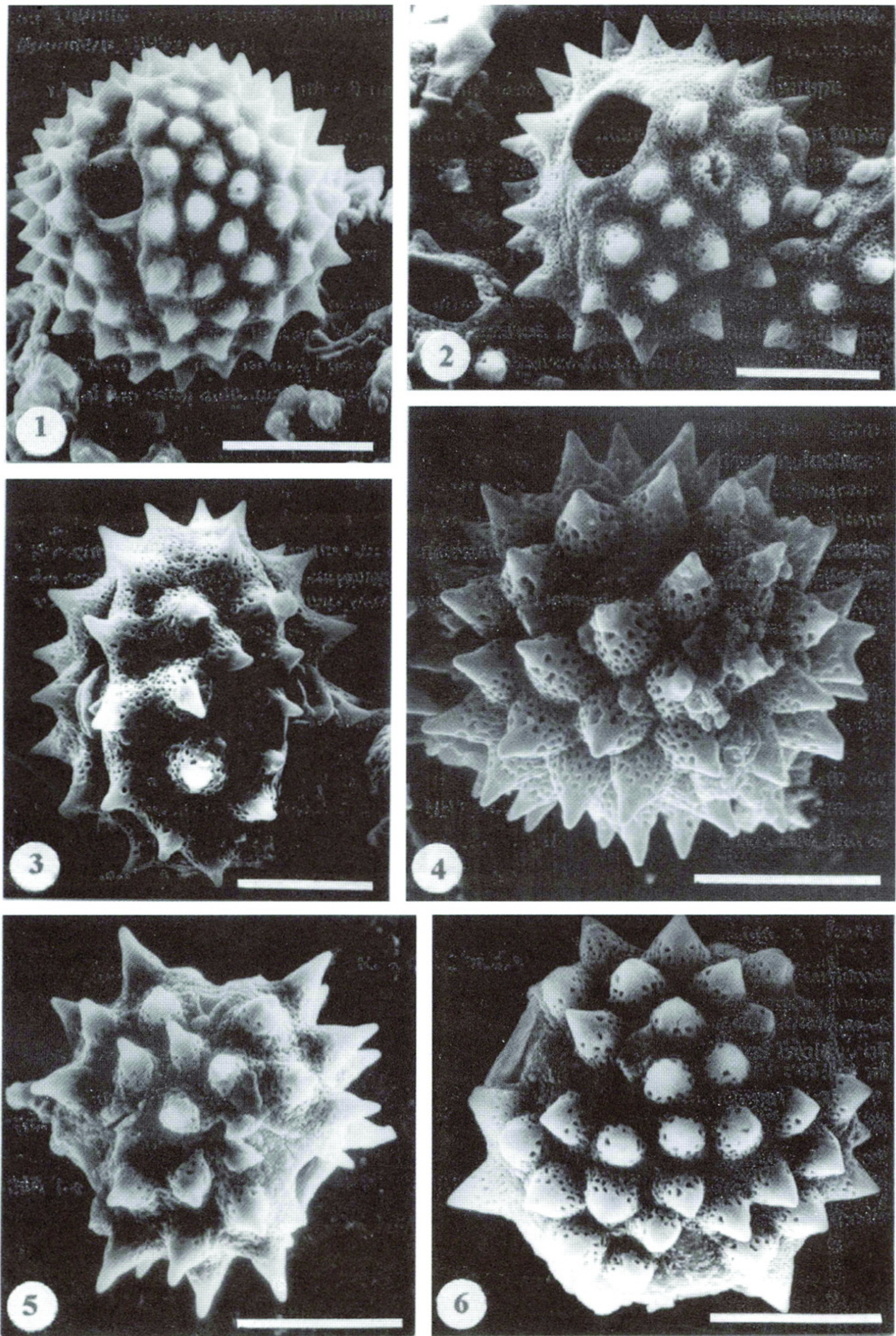


Figure 1-6. Scanning electron micrograph of pollen grain of tribe Inuleae; Scale bars - 10 μm. (1) *Anisopappus chinensis* (2) *Blumea aromatica* (3) *B. balsamifera* (4) *B. clarkei* (5) *B. fistulosa* (6) *B. hieraciifolia*.

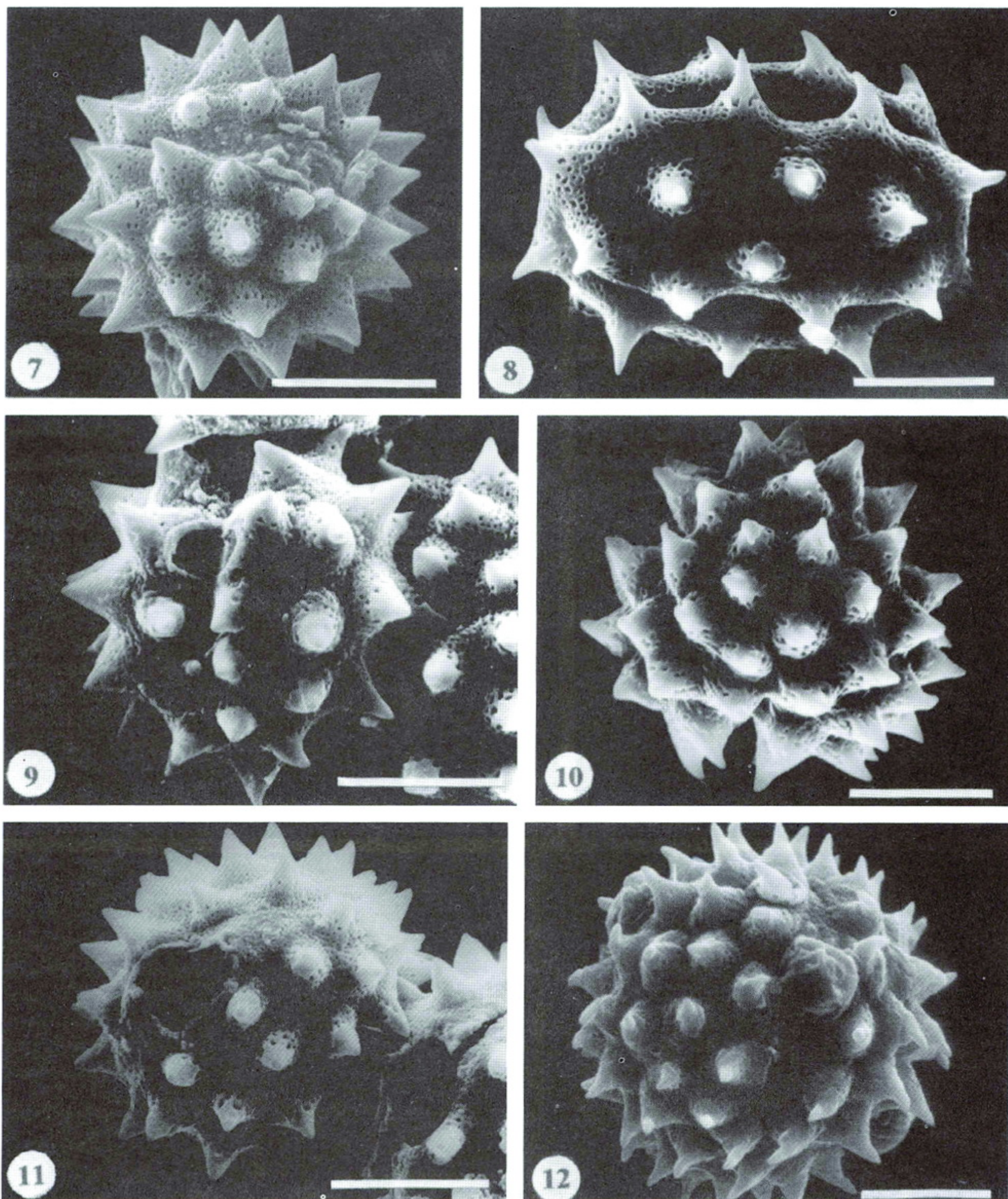


Figure 7-12. Scanning electron micrograph of pollen grain of tribe Inuleae; Scale bars - 10 μ m. (7) *Blumea lacera* (8) *B. laciniata* (9) *B. lanceolaria* (10) *B. membranacea* (11) *B. mollis* (12) *B. napifolia*.

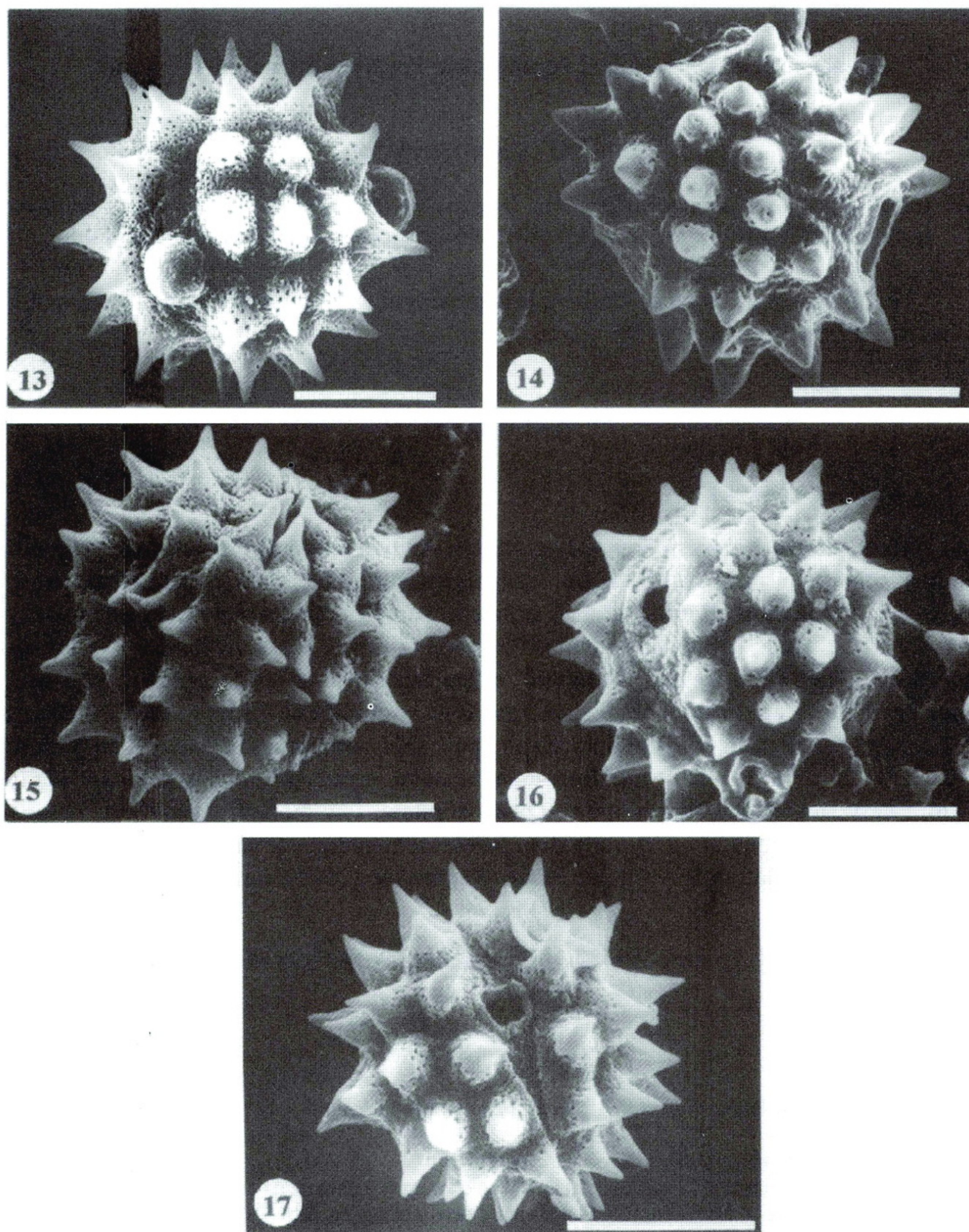


Figure 13-17. Scanning electron micrograph of pollen grain of tribe Inuleae; Scale bars - 10 μ m. (13) *Blumea virens* (14) *Duhaldea cappa* (15) *D. eupatorioides* (16) *D. nervosa* (17) *Pentanema indicum*.