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Pollen Flora of Pakistan - XIII. *Campanulaceae*

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Abstract: The pollen morphology of 10 species belonging to the 3 genera of the family *Campanulaceae* were investigated with a light microscope and scanning microscope. It is eurypalynous in nature. Pollen grains are mostly oblate-spheroidal, rarely prolate-spheroidal or spheroidal, often suboblate. Tectum striate-rugulate, often subsperate with spinules. On the basis of apertural types 2 distinct pollen types are recognized viz. *Campanula latifolia* - type, *Codonopsis clematidea* - type.

Key Words: Pollen morphology, Campanu, Pakistan.

Pakistan'ın Polen Florası - XIII. *Campanulaceae*

Özet: Pakistan'da yetişen *Campanulaceae* familyasına dahil 3 cinse ait 10 türün polen morfolojisi ışık ve taramalı elektron mikroskobu kullanılarak incelenmiştir. Familya polen morfolojisi açısından çeşitlilik göstermektedir (öripalinoz). Polenler çoğunlukla oblat-sferoidal, nadiren prolat-sferoidal ya da sferoidal, sıklıkla sub-oblattır. Tektum striat-rugulat, sıklıkla spinüllü sub-psilattır. Apertür tiplerine bağlı olarak iki belirgin polen tipi belirlenmiştir. Bunlar *Campanula latifolia* - tip ve *Codonopsis clematidea* - tipdir.

Anahtar Sözcükler: Polen morfolojisi, Campanulaceae, Pakistan.

Introduction

Campanulaceae is a large cosmopolitan family with about 87 genera and 1950 species, distributed mainly in the northern hemisphere (1, 2). It is represented in Pakistan by 3 genera and c. 26 native species (3).

Cronquist (4) divided the family *Campanulaceae* into three subfamilies i.e., *Campanuloidae*, *Cyhoioideae*, *Lobelioideae*. The comparative pollen morphology of the family *Campanulaceae* has been studied by Chapman (5). Dunbar & Wellentinus (6) utilized the palynological data of the family *Campanulaceae* in numerical taxonomy. Sahay (7) examined the pollen morphology of some members of the family *Campanulaceae* from Eastern India. Dunbar (8) studied the pollen morphology of *Campanulaceae* and related families with special reference to ultrastructure. Avetisian (9) described the palynology of the order *Campanulales*. Oybak and Pinar (10) examined the pollen morphology of some species of the family *Campanulaceae* from Turkey. The pollen morphology of the family *Campanulaceae* has also been studied by Tarvashi (11), Avetisian (12, 13), Geslor &

Medas (14), Erdtman (15), Fernandes (16), Badre et al. (17), Belem (18), Inceoglu (19-21) and Moore & Webb (22). There are no previous reports available dealing with the pollen morphology of the family *Campanulaceae* from Pakistan. The present investigation is based on the pollen morphology of 10 species distributed in 3 genera.

Materials and Methods

Pollen samples were obtained from Karachi University Herbarium (KUH) or were collected from the field. The list of voucher specimens is deposited in KUH. The pollen grains were prepared for light (LM) and scanning microscopy (SEM) by the standard methods described by Erdtman (15). For light microscopy, the pollen grains were mounted in unstained glycerine jelly and observations were made with a Nikon Type 2 microscope, under (E40, 0.65) and oil immersion (E100, 1.25), using a 10x eye piece. For SEM studies, pollen grains were suspended in a drop of water and directly transferred with a fine pipette to a metallic stub using double-sided adhesive tape and coated with gold in a sputtering

Table 1. General pollen characters of species found in pollen type *Campanula latifolia*.

Name of taxa	Shape	Aperture No.	Polar length (P) in μm	Equatorial diameter (E) in μm	Pore diameter in μm
<i>Asyneuma thomsonii</i> (Hook. f.) Bornm.	Pr-sph	4	28.12(34.08 \pm 0.66) 37.6	25.12(33.84 \pm 0.66) 37.76	5.38(6.48 \pm 0.21) 7.18
<i>Campanula leucoclada</i> Boiss	Sph	3	25.13(27.1 \pm 0.78) 35.91	25.12(27.18 \pm 1.13) 35.9	4.38(5.67 \pm 0.21) 7.18
<i>C. aristata</i> Wall.	Pr-sph	6-7	25.4(28.8 \pm 0.36) 30.6	26.9(30.70 \pm 0.51) 32.31	3.22(3.77 \pm 0.13) 5.38
<i>C. latifolia</i> L.	Ob-sph	3	29.7(32.56 \pm 0.39) 34.91	29.97(32.63 \pm 0.11) 35.99	5.9(6.54 \pm 0.11) 6.99
<i>C. tenuissima</i> Dunn	Ob-sph	3	19.98(20.1 \pm 0.25) 21.64	20.31(23.8 \pm 0.22) 23.31	2.99(3.57 \pm 0.15) 4.99
<i>C. argyrotricha</i> Wall.	Ob-sph	3	25.3(27.36 \pm 0.37) 29.11	25.3(28.51 \pm 0.17) 28.71	3.59(6.08 \pm 0.29) 7.18
<i>C. cashmeriana</i> Royle	Ob-sph	3	21.8(28.61 \pm 0.62) 33.02	25.11(28.91 \pm 0.47) 32.31	-
<i>C. pallida</i> Wall.	Ob-sph	3	28.72(34.41 \pm 0.72) 39.4	25.11(33.6 \pm 0.66) 39.4	5.38(5.71 \pm 0.17) 6.82

Table 2. General pollen characters of species found in pollen type *Codonopsis clematidea*.

Name of taxa	Shape	Aperture No.	Polar length (P) in μm	Equatorial Diameter (E) in μm	Colpus length in μm
<i>Codonopsis clematidea</i> (Schrenk) C.B. Clarke	Sub-ob	8-10	43.08(46.31 \pm 1.45) 46.61	50.26(54.11 \pm 1.20) 57.41	32.31(37.01 \pm 0.18) 43.03
<i>C. obtusa</i> (Chipp) Nannf.	Sub-ob	6-7	43.08(49.31 \pm 5.45) 65.44	48.07(48.19 \pm 1.20) 54.5	35.31(46.01 \pm 0.32) 34.49

chamber (Ion sputter JFC-1100). Coating was restricted to 150Å. The S.E.M examination was carried out under a Jeol microscope JSM-T200. The measurements were based on 15-20 readings from each specimen. Pollen diameter, polar axis (P) and equatorial diameter (E), colpi

length, apocolpium, mesocolpium and exine thickness were measured (Tables 1 & 2).

The terminology used is in accordance with Erdtman (15); Kremp (23); Faegri & Iversen (24) and Walker & Doyle (25).

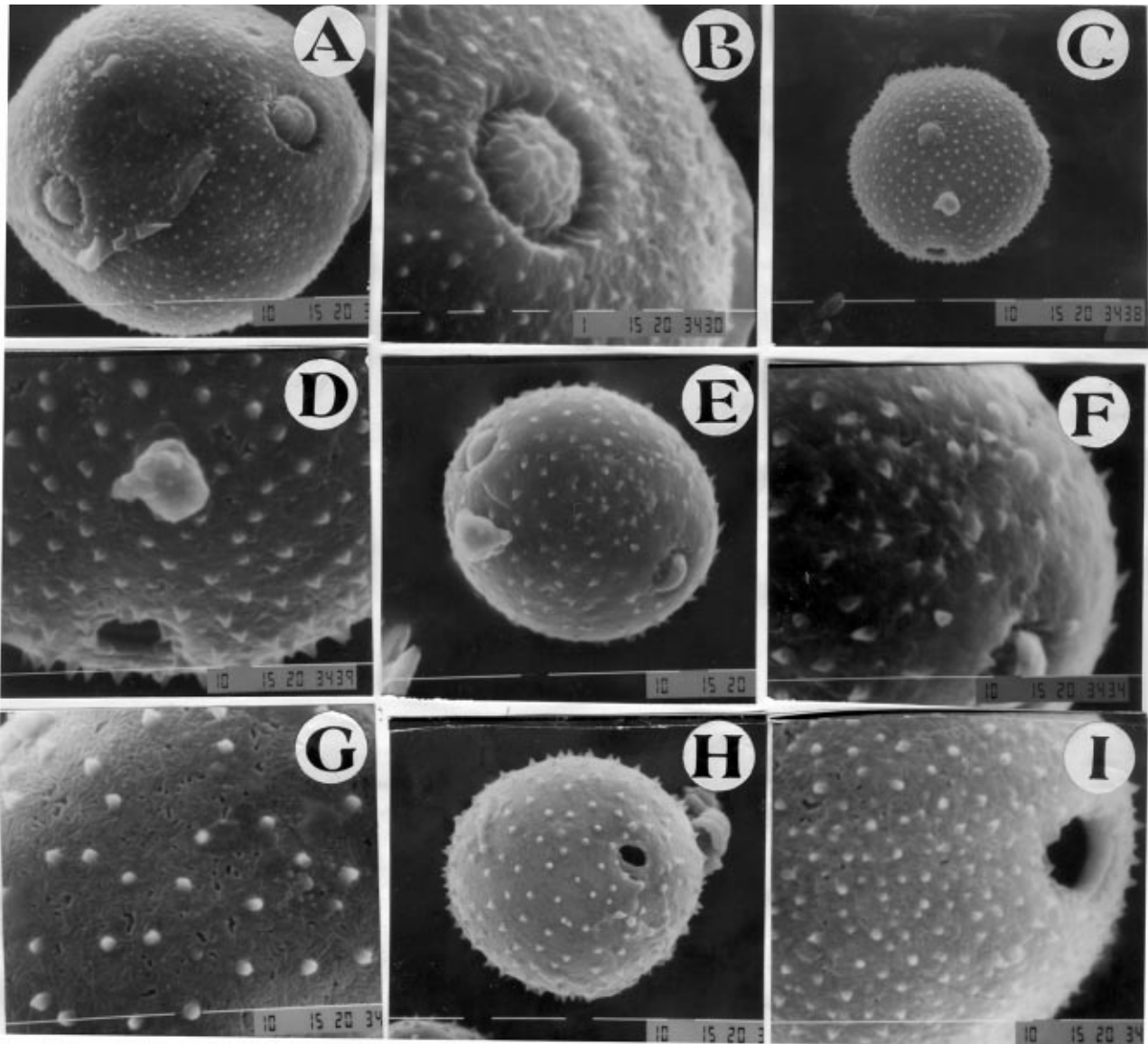


Figure 1. Scanning Electron micrographs of pollen grains. *Asyneuma thomsonii*: A, Equatorial view; B, Exine pattern. *Campanula argyrotricha*: C, polar view. D, Exine pattern. *C. Cashmeriana*: E, Equatorial view; F, Exine pattern. *C. latifolia* G, Exine pattern; H, Equatorial view. *C. tenuissima*: I, Exine pattern. Scale bar = A, C-I = 10 μ m; B = 1 μ m.

Observations

General pollen characters of the family *Campanulaceae*

Pollen grains are generally radially symmetrical, isopolar, rarely apolar, mostly oblate-spheroidal, rarely prolate-spheroidal or suboblate, often spheroidal, colpate-porate. Sexine thicker or thinner than the nexine, often as thick as the nexine. Tectum rugulate-reticulate or rugulate-striate, rarely subsilate with spinules. On the

basis of apertural types 2 distinct pollen types are recognized viz. *Campanula latifolia* - type, *codonopsis clematidea* - type,

Pollen type I: *Campanula latifolia* - type (Fig. 1 A-I; Fig. 2 A-D; Fig. 3 A-D).

Pollen class: Triporate rarely 4-7-porate

P/E ratio: Subtransverse to semi-erect, rarely semitransverse.

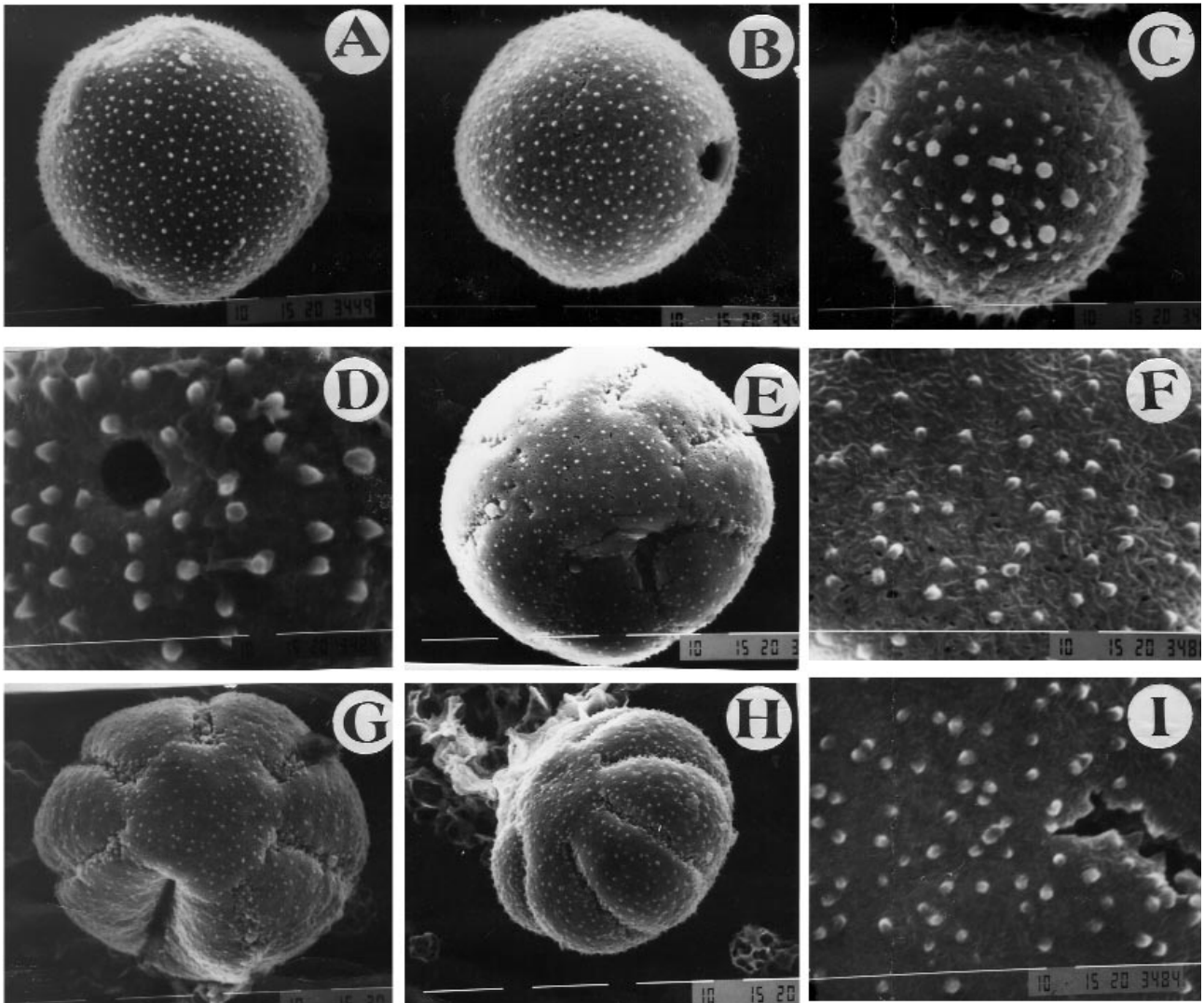


Figure 2. Scanning Electron micrographs of pollen grains. *Campanula tenuissima*: A, polar view; B, Equatorial view. *C. aristata*: C, polar view; D, exine pattern. *Codonopsis clematidea*: E, Polar view; F, Exine pattern. *Codonopsis obtusa*: G, Polar view; H, Equatorial view, I, Exine surface. Scale bar = A-I = 10 μ m.

Shape: Prolate-spheroidal to oblate-spheroidal, rarely spheroidal.

Apertures: Ectoaperture-pori small circular, often with operculum.

Exine: Sexine thicker than the nexine, rarely thinner than the nexine, often as thick as the nexine.

Ornamentation: Tectum finely reticulate-rugulate, often finely punctate with spinules, 0.71-1.88 μ m in size.

Measurements: Polar length (P) 19.98

(29.94 \pm 0.13) 39.9 μ m, Equatorial diameter (E) 20.6 (29.75 \pm 1.41) 39.41 μ m, pori 2.29 (5.35 \pm 1.94) 7.81 μ m in diameter. Mesopodium 10.7 (18.54 \pm 0.22) 21.5 μ m. Apopodium 7.12 (18.54 \pm 0.36) 29.11 μ m. Exine 0.33 (1.57 \pm 0.19) 2.81 μ m thick.

Species included:

Asyneuma thomsonii (Hook. f.) Bornm., *Campanula argyrotricha* Wall., *C. aristata* Wall., *C. leuoclada* Boiss., *C. latifolia* L., *C. pallida* Wall., *C. tenuissima* Dunn,

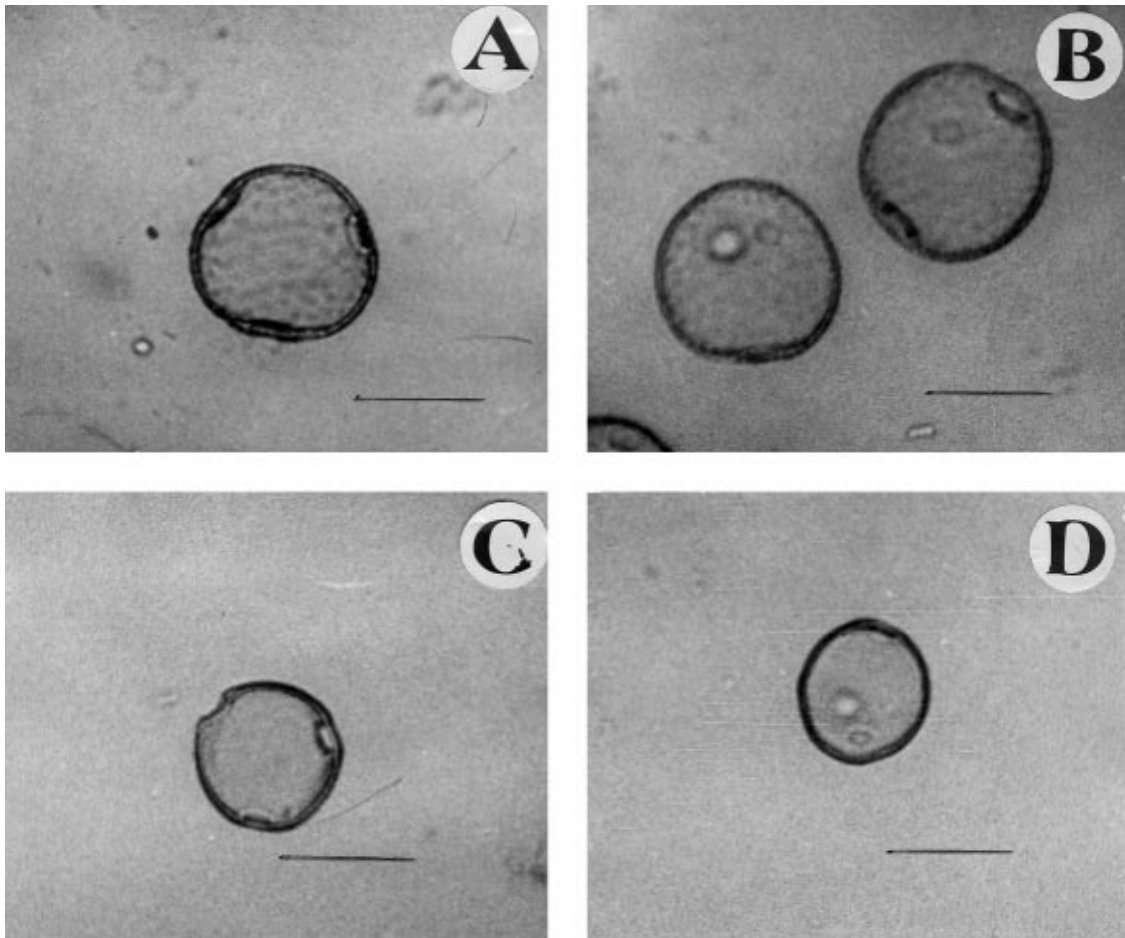


Figure 3. Light micrographs of pollen grains.
Campanula artistata: A, polar view; B, Equatorial view. *C. leucoclada*: C, polar view; D, Equatorial view.
 Scale bar = A-D = 20

Key to the species

1. + Pollen grains prolate-spheroidal - - - - - 2
 - Pollen grains oblate-spheroidal or spheroidal- 3
2. + Tectum finely striate with spinules - *Asyneuma thomsonii*
3. + Pollen grains spheroidal -*Campanula leucoclada*
 - Pollen grains oblate-spheroidal - - - - - 4
4. + Polar length 19.9 -21.61 μm - - *C. tenuissima*
 - Polar length 21.9-39.41 μm - - - - - 5
5. + Tectum subspsilate with spinules *C. cashmeriana*
 - Tectum not as above- - - - - 6
6. + Apoporium 12.5-14.3 μm - - - *C. argyrotricha*
 - Apoporium 7.18-10.81 μm - - - - - *C. pallida*

Pollen type II: *Codonopsis* - type (Fig. 2E-I).

Pollen class: 6-10-colpate, zonoaperturate.

P/E ratio: Semitransverse.

Shape: Suboblate.

Apertures: Ectoaperture-colpi medium, narrow with acute ends. Endoaperture: absent.

Exine: Sexine thicker than the nexine rarely thinner than the nexine.

Ornamentation: Tectum finely reticulate-rugulate with spinules.

Measurements: Polar length (P) 43.08 (54.11 \pm 0.13) 65.4 μm , Equatorial diameter (E) 43.09 (50.05 \pm 1.41) 57.27 μm , colpus 32.2 (37.64 \pm 1.94) 43.06 μm long. Mesocolpium 14.36 (17.87.6 \pm 0.22)

21.6 µm. Apocolpium 7.18 (9.87±0.36) 12.6 µm. Exine 0.72 (1.97±0.19) 3.28 µm thick. P/E ratio: 0.75-1.10 (Table 2).

Species included

Codonopsis clematidea (Schrenk) C.B. Clarke, *C. obtusa* (Chipp) Nannf.

Key to the species

- 1. + Tectum finely reticulate-rugulate with spinules
----- *Codonopsis clematidea*
- Tectum striate-rugulate with spinules
----- *C. obtusa*

Discussion

Campanulaceae is a eurypalynous family in which the pollen morphology is significantly useful at generic and specific level. Erdtman (15) also reported a similar type of pollen in this family.

In our study the most striking variation was found in apertural types. The pollen grains are radially symmetrical, isopolar, rarely apolar, oblate-spheroidal to suboblate or prolate-spheroidal, porate or colpate, sexine thicker or thinner than the nexine, often as thick as the nexine. Tectum rugulate-reticulate or rugulate-striate often finely punctate with spinules.

On the basis of apertural types 2 pollen types are recognized viz *Campanula latifolia* - type and *Codonopsis*

clematidea - type.

Pollen type I is easily distinguished by its three pores (rarely 4-7). Tectum finely striate - rugulate, rarely finely punctate (*Asyneuma thomsonii* (Hook. f.) Bornm., *Campanula argyrotricha* Wall.) with spinules. The pollen grains are generally subtransverse to semi-erect rarely semitransverse. This pollen type includes all the studied species of the genus *Campanula* L., *Campanula argyrotricha* Wall., *C. aristata* Wall., *C. cashmeriana* Royle, *C. leuoclada* Boiss., *C. latifolia* L., *C. pallida* Wall., *C. tenuissima* Dunn, and a single species (*Asyneuma thomsonii* (Hook. f.) Bornm) of the genus *Asyneuma* Griseb. et Schrenk. A similar type of pollen grain in the same genus has also been reported by Inceoglu (19). However, species of *Campanula* L., genus show considerable variation in their shape, size, apopodium and exine ornamentation which are significant enough for characterizing the species (see key to the species).

Pollen type II is easily recognized by its 6-10-colpate pollen grains. Tectum is finely reticulate to striate-rugulate with spinules. Shape is usually suboblate, 2 species of genus (*Codonopsis* Wall.) are included in this pollen type. Although the species are alike palynologically, they show little variation in their tectum type. In *Codonopsis clematidea* (Schrenk) C.B. Clarke, the tectum is finely reticulate-rugulate with spinules, whereas *C. obtusa* (Chipp) Nannf. has a striate-rugulate tectum with spinules. Erdtman (15) also described a similar type of pollen in this genus.

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