

Spore morphology of some south Indian species of *Asterella* P. Beauv. (Marchantiophyta)Naveen Sahu¹, Afroz Alam^{2*}, Krishna Kumar Rawat³, Praveen Kumar Verma⁴¹Naveen Sahu, Department of Botany, University of Lucknow-226 007 (U.P.) India.^{2*}Department of Bioscience and Biotechnology, Banasthali Vidyapith-304022 (Rajasthan) India*afrozalamsafvi@gmail.com³K K Rawat, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow – 226 001, India; e-mail:drkkrawat@rediffmail.com⁴Praveen Kumar Verma, Rain Forest Research Institute, Deovan Sotai Ali, Post Box # 136 Jorhat – 785 001 (Assam), India;e-mail: pkverma_bryo@yahoo.co.in

Abstract: The study provides morphological data of spores of three south Indian species of *Asterella* Beauv. viz., *A. wallichiana* (Lehm. et Lindenb.) Grolle, *A. mussuriemis* (Kashyap) Kashyap, *Asterella khasyana* (Griff.) Pande, K.P. Srivast. & Sultan Khan, in relation to the taxonomy of the genus.

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1. Introduction

Spore, the first cell of the gametophytic generation in the liverworts, not only helps in reproduction but also helps in extending the range of taxa by acting as vector for gene flow both within and between populations (Longton, 1976). The spores of bryophytes are very important tool for their study and research and bear stable and important morphological features that help in the clear elucidation of taxa. The thickenings deposited on the spore coat have a very important taxonomic specificity in the different taxa of the liverworts. This is one of the important character and stable markers in the systematics of liverworts (Muller, 1954; Srivastava & Udar, 1975). In the recent past considerable work has been done in India on spore morphology (Bharadwaj, 1971; Udar, Srivastava & Mehrotra, 1974; Udar, 1964, 1976; Gupta, 1980, Gupta & Udar, 1986).

Chandra (1967) in his unpublished work, studied spores of various taxa of family Aytoniaceae including a total of 22 taxa of *Asterella* Beauv. from India in relation to spore morphology as well as plant morphology and recognized only seven genuine species of *Asterella* viz. *A. wallichiana*, *A. parvipora*, *A. khasiana*, *A. blumeana*, *A. mussuriensis*, *A. leptophylla* and *A. sanguinea* while rest were either treated as synonyms or as doubtful.

Recently Long (2006) in his revision of genus *Asterella* in Eurasia, also studied 16 species with complete morpho-taxonomy and spore details and confirmed synonymy of various species. Alam and Srivastava (2009; 2012) also produced evidences that palynotaxonomy is one the important parameter to find out any taxa at specific level.

Present work deals with spore and elater morphology of 3 south Indian species of genus *Asterella* P. Beauv. (*A. mussuriensis*, *A. khasyana* and *A. wallichiana*).

2. Materials and Methods**Plant material:**

For the study, mature sporophytes were obtained from fresh as well as dried herbarium specimens deposited in the Hepatic herbarium, Department of Botany, University of Lucknow, Lucknow (LWU).

Plant specimens were soaked in luke-warm water for 3-4 hours for complete stretching. Few plants with un-dehisced and mature sporophyte were selected. At least 5 capsule of each species were examined for the detailed morpho-taxonomic study of the spores and elaters. Since the spores are dark in colour, few spores were acetolyzed following Erdtman (1960) and were treated with the concentrated Sulphuric acid or Nitric acid. Both acetolysed and non- acetolysed spores were mounted in 70% aqueous glycerin and at least 20 spores as well as elaters were examined from each sample for the range of variations in sculpturing and reticulations. A minimum of 10 counts were made for size measurement from each sample. All the line-drawings are made by one of us (NS). Nikon Labophot 184868 with micro photographic attachment Camera (Nikon FX - 35) was used for the spore and elater microphotographs.

3. Observations and Results

Asterella wallichiana (Lem. et Lindenb.) Pande et al. ex Grolle, *Ergebn. Forsch. -Unterne.*

Nepal Himalaya 1: 262 (1966). (Plate: 1, Figs.: 1-10; Plate 2, Figs.: 1-4)

Basionym: *Fimbriaria wallichiana* Lehm & Lindenb. *Novarum et Minus Cognitarum Stripium Pugillus Quartus* 4 (1832). Type: India orientalis, Burma (Myanmar), Wallich s.n. (S, herb Lehmann, Lectotype, designated by Long, 2006).

Synonyms:

Asterella sanguina (Lehm. & Lindenb.) Kachroo, *Journ. Hattori Bot. Lab.* 19: 4 (1958).

Asterella nepalensis (Taylor) Pande et al. ex Kachroo, *Journ. Hattori Bot. Lab.* 19: 3 (1958).

Asterella angusta (Steph.) Mahab. & Bhate, *J. Univ. Bombay* 13(5): 5 (1945).

Asterella maculata (Steph.) Pande et al. ex Parihar, *University of Allahabad Studies, Botany section*, 1961-62: 27 (1962)

Asterella gollanii (Steph.) Pande et al. ex Parihar, *University of Allahabad Studies, Botany section*, 1961-62: 27 (1962)

Asterella indica (Steph.) Pande et al. ex Parihar, *University of Allahabad Studies, Botany section*, 1961-62: 27 (1962)

Asterella mescarana (Steph.) Pande et al. ex Parihar, *University of Allahabad Studies, Botany section*, 1961-62: 27 (1962) 'mescarana'.

Asterella gangetica (Kashyap) Parihar, *University of Allahabad Studies, Botany section*, 1961-62: 27 (1962)

Asterella mysorensis (R.S. Chopra) Pande et al. ex Kachroo & Bapna, *J. Indian bot. Soc.* 56: 75 (1977).

(For detailed synonymy and type details, refer Long, 2006)

Spores dark brown, rounded-triangular, anisopolar, trilete, 50-120 × 40-100 μm in size; distal surface convex, lamellate, lamellae irregular, distinct to faint, of variable length and width, wavy, sometimes fusing to form broad reticulated pattern, minor reticulations absent; equatorial rim absent; ventral surface with prominent trilete mark, rays equal to variable length, lateral facets smooth or with few short, wavy, lamellae.

Elaters are yellowish-brown, usually monospirate, rarely bispirate or trispirate in some portions, 75 – 180 × 12 - 32 μm in size, rarely branched.

Spores of *A. wallichiana* shows a wide range of variation in sporoderm architecture. The upper surface shows irregular lamellae (Plate 1, figs. 2,3) to broad reticulated pattern (Plate 2, figs. 3,4) as well as the lower surface usually shows only triradiate lamellae (Plate 2, fig. 4), while in some spores some irregular lamellae are also visible on lateral facets (Plate 1, figs. 3,4).

Asterella mussuriensis (Kashyap) Verd. *Annales Bryologici* 8: 156 (1935). (Plate: 3, Figs.: 1-4)

Basionym: *Fimbriaria mussuriensis* Kashyap, J. Bombay Nat. Hist. Soc. 24: 345 (1916). Type: [India, Uttaranchal] Mussoorie, June 1913, Kashyap 74, ex Panjab University (JE, ? isotype) (Long, 2006)

Spores yellow-brown, triangular, anisopolar, 101 - 126 μm in length and 88 - 121 μm in width. Reticulations thinner, in peripheral reticulations broad partitions wall present and covered by the partitioned wall of the neighbouring reticulations. Reticulations of middle portion form regular outline. Small projections present due to irregular margins. Some reticulations have secondary lamellae which are in different shape i.e., Y, H, T etc. Sickle shaped lamellae are also present. Some reticulations do not have secondary reticulations. Sickle shaped sculpturing are small and loosely scattered and are present below the outer sculpturing. Secondary lamellae are in various shape. Spore wing with partition wall.

Proximal surface with distinct tetrad mark. Spore margin spinulate.

Elaters brown-light brown in colour. Mono to bispirate, 90-205 μm long and 6-12 μm wide.

Asterella khasyana (Griff.) Pande, K.P. Srivast. & Sultan Khan, *J. Hattori Bot. Lab.* 11:7 (1954) 'khasiana'; Long, *Bryophyt. Biblioth.* 63: 169 (2006). (Plate: 4, Figs.: 1-5)

Basionym: *Octokepos khasyanum* Griff., *Notulae ad Plantas Asiaticus* (2): 343 (1849). Type: [India, Assam] Moflang, Khasyah, Griffith 100 (BM, lectotype, designated by Long, 2006).

Synonyms:

Asterella blumeana Auct. Plur. Non (Nees) Kachroo; *Jour. Hattori Bot. Lab.* 12: 36-38 (1954).

Asterella papulosa (Steph.) Pande et al. ex Kachroo, *Jour. Hattori Bot. Lab.* 19: 4 (1958).

Asterella butleri (Steph.) Pande et al. ex Parihar, *University of Allahabad Studies, Botany section*, 1961-62: 27 (1962)

Spores yellowish-brown. anisopolar, spherical-triangular, 96 - 123 × 91 - 116 μm in size, Distal face convex, with 4-6 large, spherical, shallowly-pitted, primary areolae, secondary areolae small, deeply-pitted; equatorial rim prominent; proximal face with distinct trilete mark, facets three, equal or unequal, with numerous secondary areolae, variable in size. Tetrad mark trilete, letes extending from pole to more or less margin, rarely H - shaped mark present. Lamellae present in middle portion are relatively smaller, like small sickle - shaped lamellae.

Wing surface shows sickle-shaped margin. Sometimes polyangular minute reticulations are present.

Proximal surface have tetrad mark, tetrad mark trilete type, three letes are equal in length sometimes unequal in length with one is larger than the other two letes.

Elaters bispiral, dark brown in color, 205 - 287 µm long and 8 - 12 µm wide.

4. Conclusion

Spore, the first cell of haplophase, provides very sound and stable characters for the investigations of species. These characters are mostly not affected by adversaries of environmental conditions. Most of the taxa can be typified on the basis of spore morphology, however, some time the spore morphology remain inadequate and then the other gametophytic characters play an important role in species identification.

Spores of Marchantiales are very unique and large with rigid sculpturing that provides very stable taxonomic characters in the differentiation of several taxa. In family Aytoniaceae all the members have specific spore characteristics which are useful in study of the status of various taxa and their relationship with others. Similarly, within the genus also they are very useful at species level identification.

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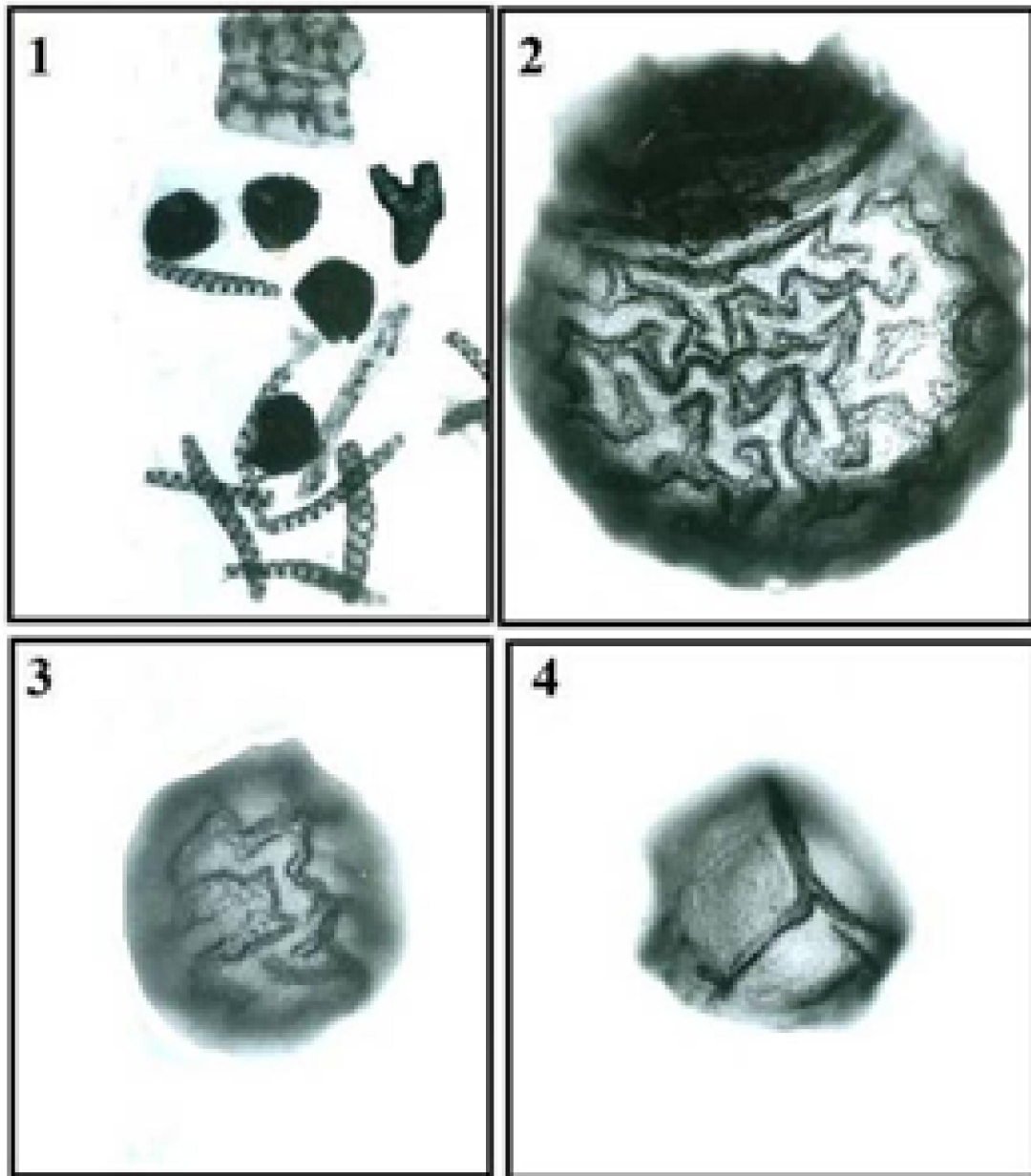


Plate 1. *Asterella wallichiana*. 1. Spores and Elaters, 2, 3. Dorsal surface of spore, 4. Ventral surface showing triradiate mark and smooth lateral facets.

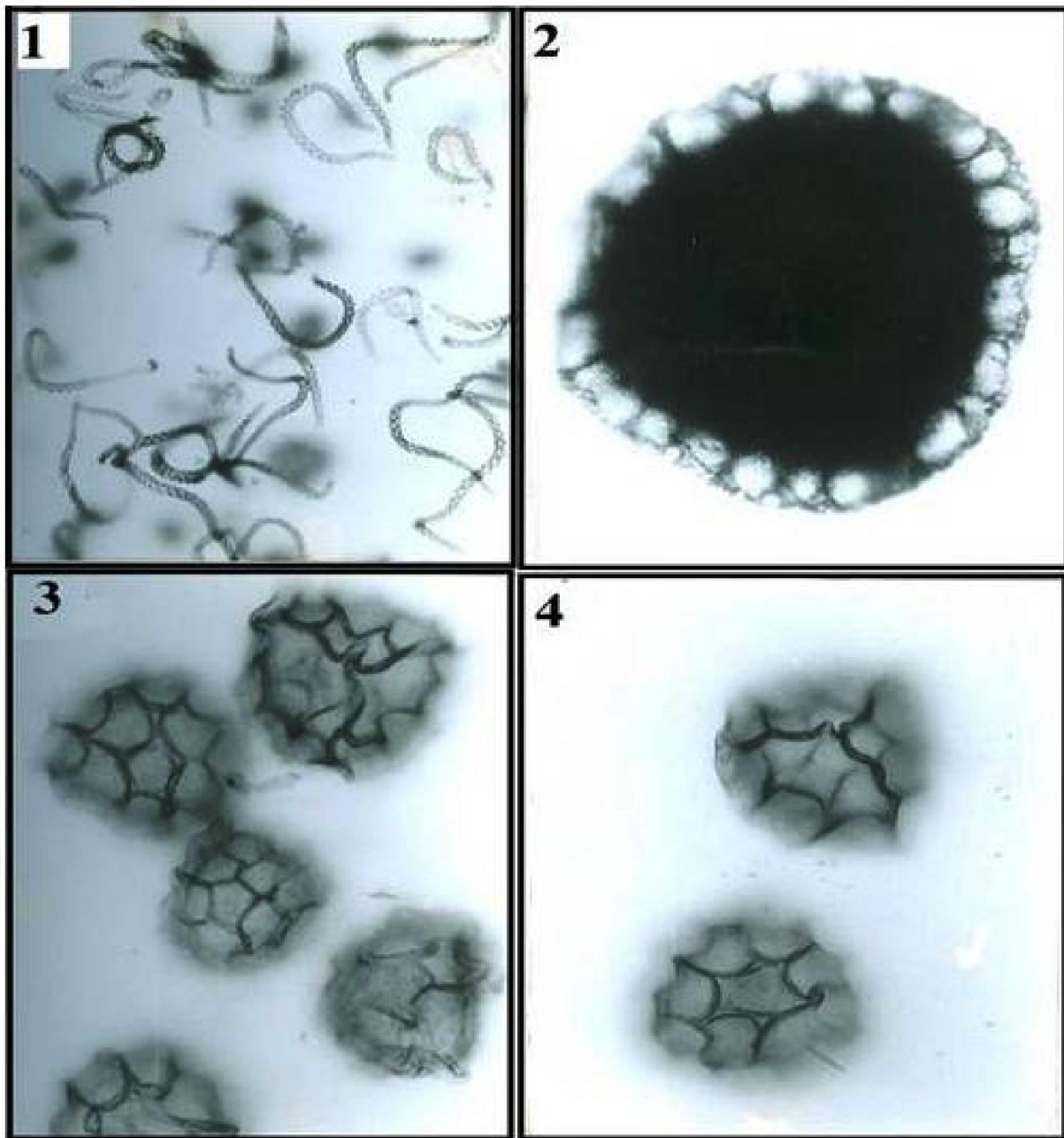
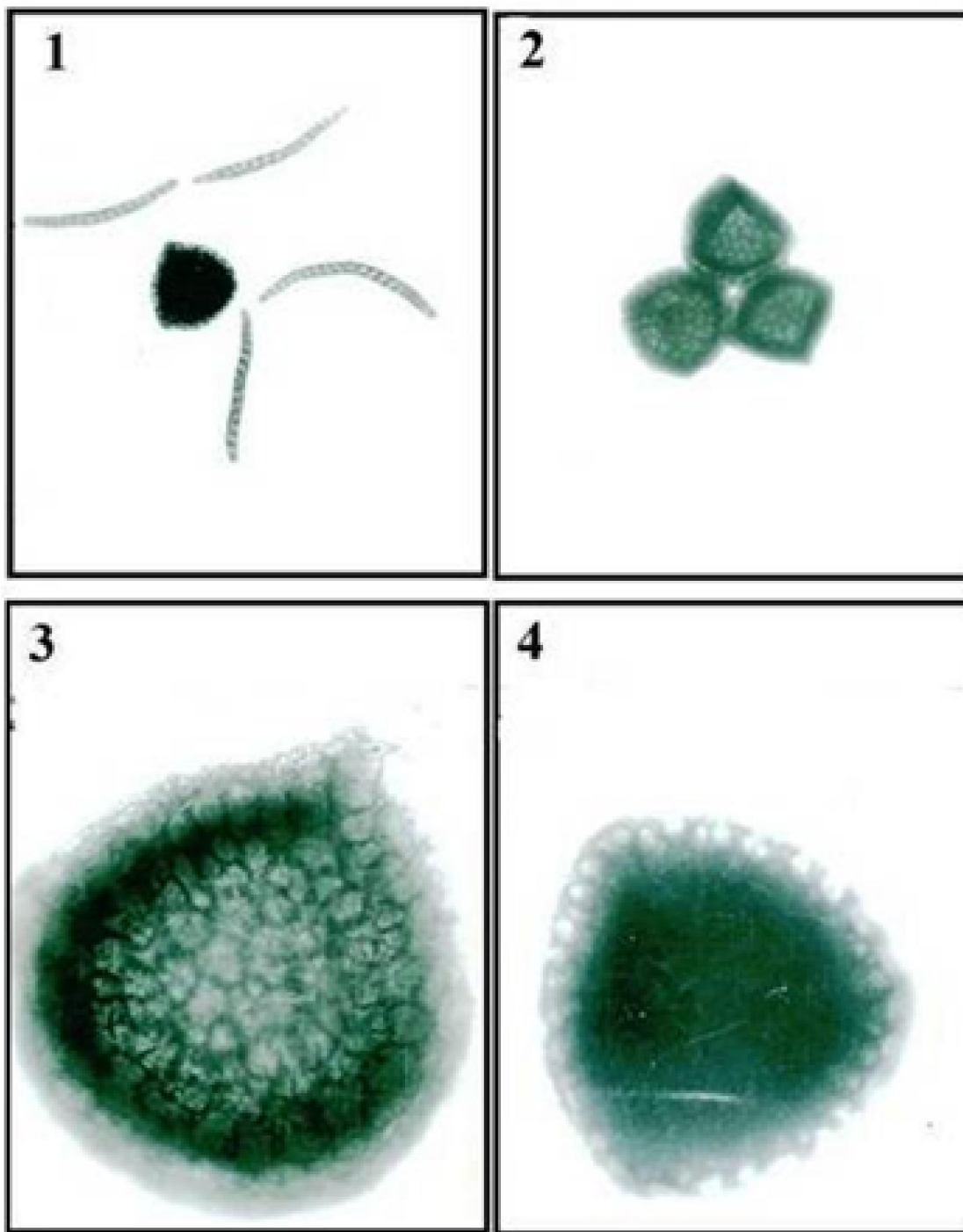


Plate 2. *Asterella wallichiana*. 1. Spore and elaters, 2. Spore, enlarged showing equatorial wing, 3,4. Dorsal and ventral surfaces with lamellae forming broad and irregular reticulations.



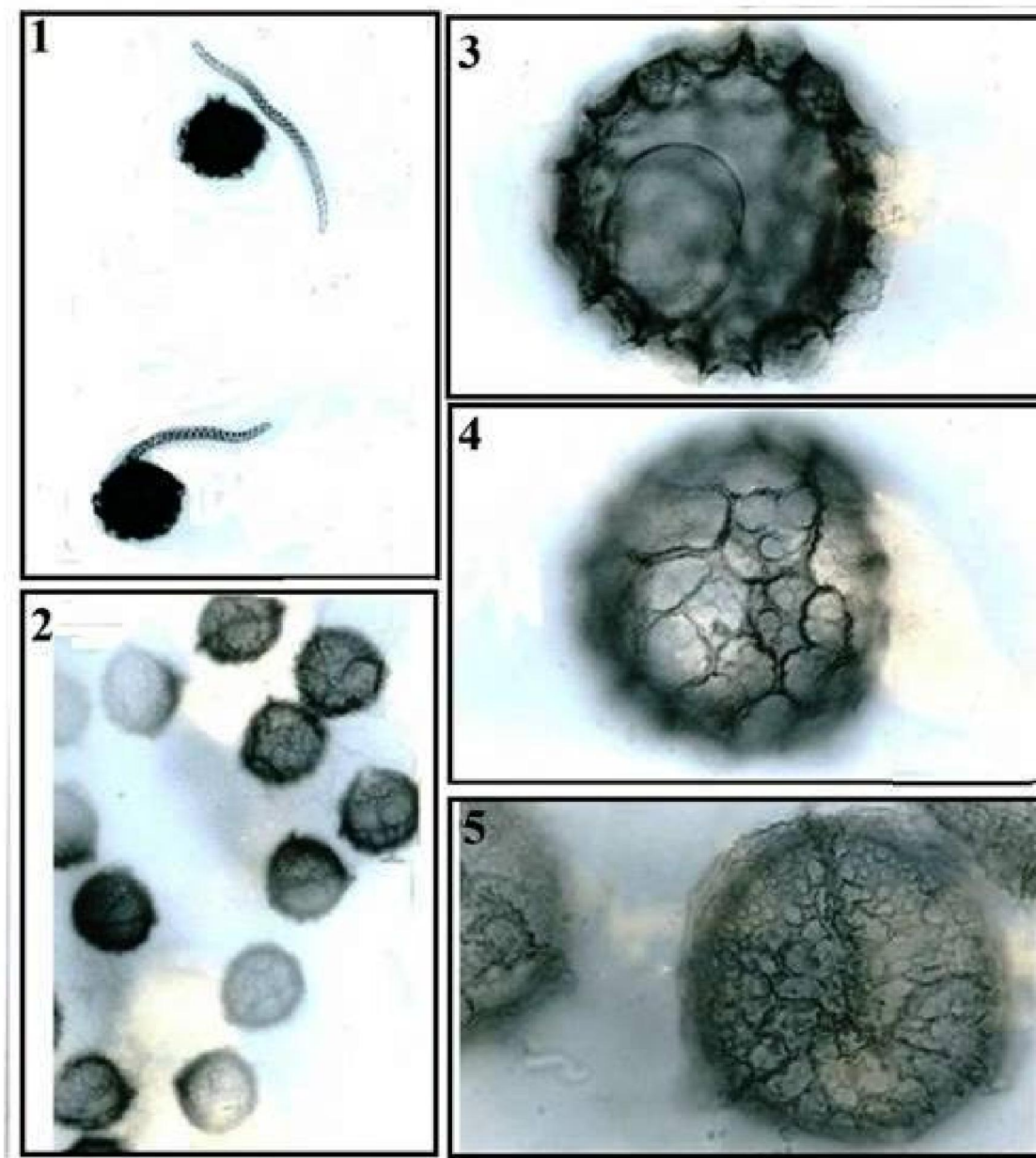


Plate 4. *Asterella khasyana*, 1, 2. Spore and elaters, 3,4. Dorsal surface of spores, showing large reticulation, 4. Ventral surface showing triradiate mark and small irregular reticulations on lateral facets.