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MORPHOLOGICAL AND ANATOMICAL PROPERTIES OF HIMALAYAN HERB *STELLARIA WEBBIANA*

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Abstract

Stellaria webbiana is a Himalayan endemic herb, distributed in Central and Western Himalaya. The present study is based on the morphological properties, anatomical properties and seed microstructure of the species. Number of valves in mature fruit, anatomical properties, stomata type, trichomes, seed microstructure and Western most limit of the species in the Himalaya is described first in the present study.

Key words: Anatomy, Morphology, Seed microstructure, *Stellaria*, Stomata

Introduction

The genus *Stellaria* L. is represented by 120 species in the world and distributed worldwide with high frequency in the north temperate regions of the globe (Ghazanfar & Nasir, 1974; Mabberly, 2008; Morton, 2005). This genus occurs in different habitats from plains to alpine regions and plants are often found in shady locations or on rocky slopes. In India this genus is represented by 18 species mainly distributed in temperate to alpine Himalaya (Majundar, 1993; Chandrasekar & Srivastava, 2007; Pusalkar & Srivastava, 2015). The *Stellaria* genus is characterized by swollen nodes, exstipulate leaves, dichasial cyme – solitary terminal inflorescence, free sepals, petals bipartite varying from mid to base, fruit a dehiscent capsule, opening by valves twice as many as styles.

Stellaria webbiana (Benth. ex G. Don) Edgew. & Hook. f. is a Himalayan endemic herb distributed from Central Nepal to Afganistan. This is a little known and improperly described species. It was initially described as *Leucostemma webbianum* Benth. ex G. Don. Later, Edgeworth placed this species under *Stellaria* genus, on the basis of deeply bipartite petals of species (Edgeworth & Hooker, 1874) and indicated its distribution in Kumaon and Sirmor in the Western Himalaya. However, recent information indicates relatively wider distribution of this species from Nepal to Kashmir and westwards to Kurram Valley at Afganistan–Pakistan border (Majumdar, 1993, Press *et al.*, 2000).

Material & Methods

Plant specimens were collected from different localities of Uttarakhand state, India and critically observed under Labo dissection microscope (DM 1020) and Olympus compound microscope (OIC 66657). Species was identified with the help of protologue and description of species (Don, 1831; Edgeworth & Hooker, 1874; Majundar, 1993), specimen housed in Forest research Institute (DD) Dehradun and image of herbarium sheets from Kew Botanical Garden (K), London and National Museum of Natural History (P) Paris. Terminology used in description follows Lawrence (1951) and Simpson (2010). Illustrations were drawn after observing flowering and fruiting specimens. Trichomes are classified after following Payne (1978) and stomata are classified as per Prabhakar (2004). For anatomical study thin sections were cut by hand and photographs were taken under Olympus BX5ITF compound microscope with image

analyser system. Seeds were first observed under light microscope to ensure normal size and development. For scanning electron microscopy (SEM), fully dehydrated selected seeds were mounted directly on aluminium stubs using double-sided adhesive tape and were sputter coated with a thin layer (*ca.* 25 nm) of gold. The SEM micrographs were taken in Jeol (JSM-6610LV). The seed micromorphology was described after following Mahdavi *et al.*, (2012) and Sadeghian *et al.* (2014).

Specimens Examined:

INDIA. Uttarakhand: Garhwal, Tehri Garhwal, near Zabberkhet, April 1882, *J. F. Duthie* 1389 DD!; Mussoorie, 1935, *R.R. Stewart*, 14934 DD!; Dehradun, Sahashtradhara, 5 May 1963, *S.K. Malhotra* 27627 BSD!; Kumaon, 1830, *N. Wallich* *s. n.* K001111460 K (Image!); K001111461 K (Image.); K000723660 K (Image.); 1839 *T. Thomson* *s. n.* P05436765 P (Image!); Ranikhet, April 1882, *J. F. Duthie* 5382 DD!; Bageshwar, 5 may 1962, *U.C. Bhattacharya*, 21409 BSD!; Nainital, 21 March 1961, *M.A. Rau*, 14406 BSD!; Okhalkanda, near Hospital, 24 April 2013, *D.S. Rawat*, acc. No. 735 G.B. Pant University Herbarium!; Almora, near Golju Temple, 12 May 2014, *Satish Chandra* acc. No. 736 G.B. Pant University Herbarium!.

AFGHANISTAN: Kurrum valley 1879, *J. E. T. Aitchison* *s. n.* P05436767 P (Image!); 793 DD!.

NEPAL: 1830, *N. Wallich* 1753343 MO (Image!).

Results

Morphological properties

Description

Stellaria webbiana (Benth. ex G. Don) Edgew. & Hook. f. in *Fl. Brit. India* 1: 230. 1874; Majumdar in *Fl. India* 2: 591. 1993. *Leucostemma webbianum* Benth. ex G. Don in *Gen. Hist.* 1: 449. 1831.

Herb, perennial. Stem 10–30 cm long, erect–prostrate, tetragonal, sparsely hairy, pubescence strigose type, both glandular and eglandular hairs present. Leaves sessile, linear, 7–15×1–1.5 mm long, hairy, 1 nerved, apex acute. Flower axillary, suberect. Pedicel capillary 1–4 cm long, hairy. Sepal 4, ovate–lanceolate, 4–7×1.5–2 mm, apex acuminate, margins narrowly scarious, veins 3.

Petal 4, white, bipartite up to base or middle, 6–11 mm, apex rounded, veins 3, twice to one and half to total length of sepals. Stamen 8, diplostemonous, filament 3–4 mm long, antisepalous larger, with prominent gland at base, antipetalous smaller, basal gland lacking, anther yellow. Ovary ovoid, 1–2 × 1 mm, styles 2, 1.5–2 mm long. Capsule ovoid, 5–6×3 mm, enclosed by persistent sepals, as long as sepals, dehiscent up to base into 4 valves, valve lanceolate. Seed 15–20 per fruit, brown, 0.8–1 mm, compressed, papillae along margin (Fig. 1).

Seed microstructure

Seed of species were comma shaped with pappilate surface. Seed microstructure showed irregular polygonal testa, colliculate-columellate sculpturing, margin of testa cells were obscure and outer periclinal wall of seed were convex with scaly elevation (Fig. 2 E,F).

Anatomical properties

Root

The root of species was perennial. The outermost layer of root was made by 3– many layered dark coloured peridermal cells. Cortex is constituted of two types of cells– the outer 4–6 layered small parenchymatous cells and inner 3–4 layered large irregular and polygonal parenchymatous cells. Boundary between these two layers was not clear. Crystal druses were absent. The phloem contained 4–7 layered irregular or rectangular cells. Boundary between cortex and phloem was not clear. Phloem and xylem delimited by cambium band. Cambium consists of small irregular cells. The xylem was composed of tracheary elements. The xylem vessels are surrounded by pervasive parenchyma. The rays were not distinguishable. The primary xylem occupied root centre (Fig.2 B).

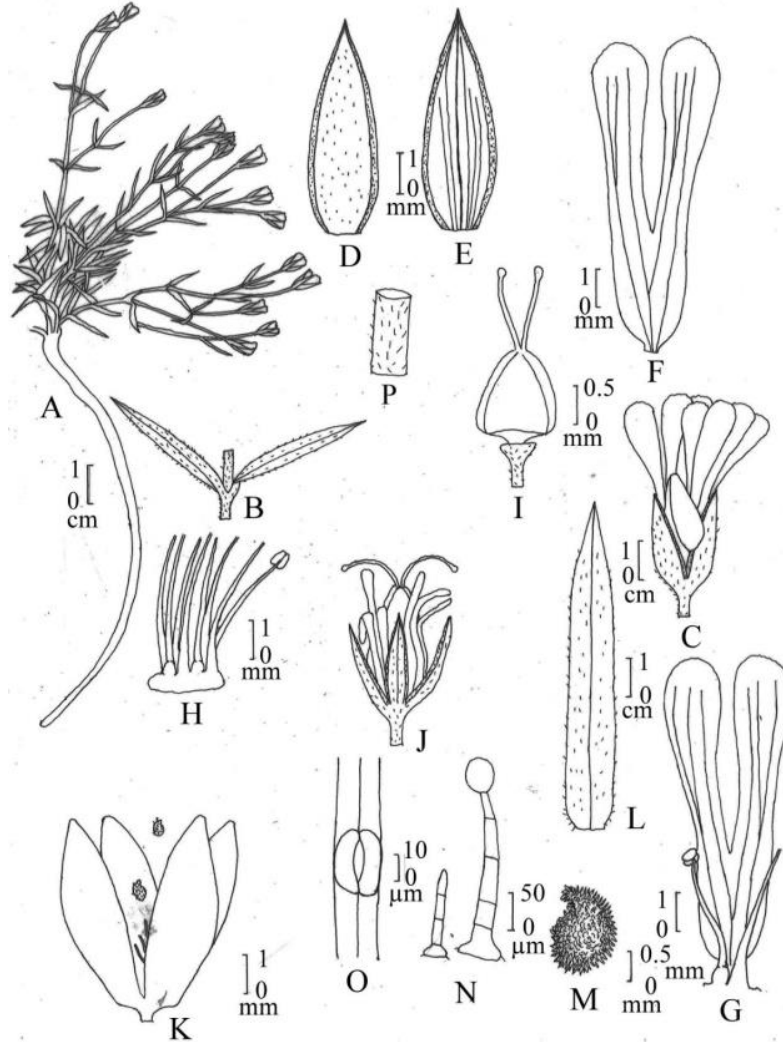


Figure 1. Morphology of *Stellaria webbiana*. A. Habitat, B. Leaf base, C. Flower, D. Sepal abaxial surface, E. Sepal adaxial surface, F. petal, G. Petal and stamen, H. Stamen, I. Ovary, J. Flower, K. Fruit, L. Leaf, M. Seed, N. Trichomes, O. Stomata, P. Vestiture Stem

The transverse section of stem was taken from the middle part. The epidermis was composed of one layers thick almost square or rectangular cells. Epidermal cells were compactly arranged and bear stomata and trichomes. The cortex was 3–7 layered and consists of ovoid or polyhedral parenchymataous cells. The cortex was delimited by 2–3 layered cells, cortical cells disintegrated when plant attain maturity. The boundary among cortex, endodermis and pericycle was not clear. Crystal druses were absent in both cortex and pericycle. The phloem was made up of 3–4 layered square or rectangular cells. The cambium was not distinguishable. The xylem

was composed of large orbicular tracheae. The tracheas were 5–11 μm in length. The pith consists of large orbicular or polyhedral parenchymatous cells in young shoots and disintegrates subsequently forming a hollow tube (Fig. 2 C).

Leaf

In transverse section, upper and lower epidermis comprise of uniseriate, orbicular cells enclosed with thin layer of cuticle. Both upper and lower epidermis consists of Desmocyctic type of stomata, being more abundant on the abaxial surface. The mesophyll cells and palisade parenchyma cells were not distinguishable. Air spaces were well developed, and continuous with environment by stomata. The mid-rib was well developed and phloem was surrounded by xylem in the vascular tissue (Fig. 2 D).

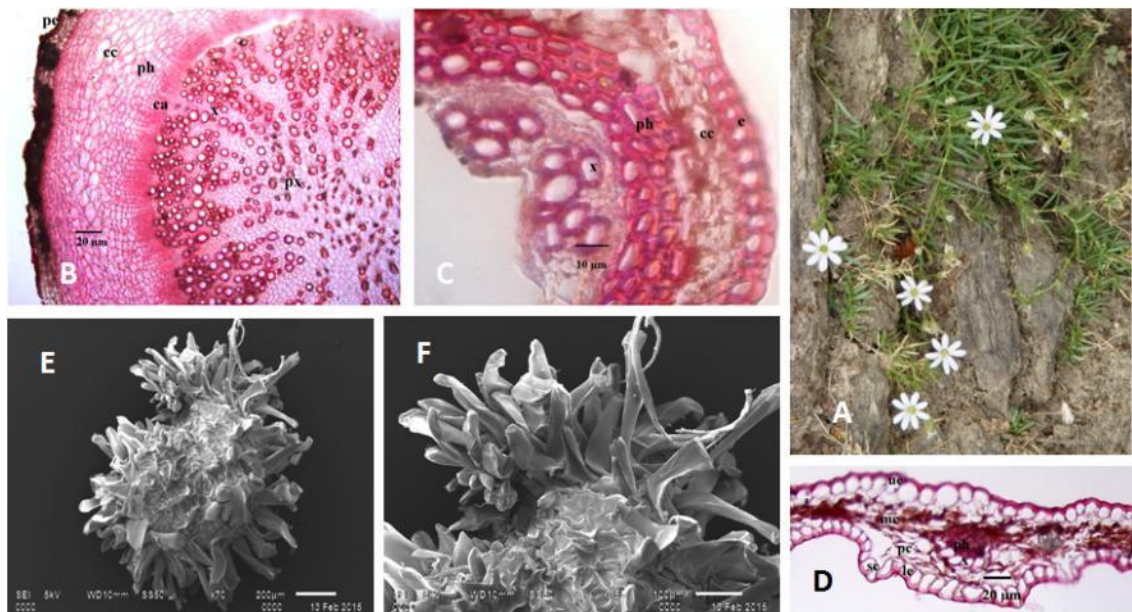


Figure. 2. A. Habitat of *Stellaria webbiana* (Benth. ex G. Don) Edgew. & Hook. f.; B. The cross-sections of the Root; C. The cross-sections of the Stem; D. The cross-sections of the Leaf; E. SEM micrograph of seed surface; F. SEM micrograph Testa of seed. (e. Epidermis; cc. Cortical cells; ph. Phloem; x. Xylem; px. Protoxylem; Pe Periderm; ue. Upper epidermis; mc. Mesophyll cell; sc. Stomata cell; pc. Palisade cell; le. Lower epidermis)

Stomata

Desmocyctic types of stomata are present on both side of leaf surface. 35–45 stomata/mm² on abaxial side, 20–30 stomata/mm² on adaxial side were recorded. The length of stomata varies from 20–33µm. Guard cells 7– 12µm wide and surrounded by elongated subsidiary cells (Fig. 1 O).

Trichomes

Stem hairy in strigose vestiture. Both glandular and eglandular hairs are present. Leaf hairy at both surface and margin. Pedicel hairy in same fashion as of stem. Sepals hairy at adaxial surface, all other floral parts glabrous. Glandular hairs are 3–7 cells long, varying from 75–250 µm. Eglandular hairs are 3– 5 cells long, varying from 75–150 µm. Both types of hairs present in all plant parts, glandular hairs are more frequent than eglandular hairs (Fig. 1 N).

Discussion

The morphological features of *S. webbiana* were consistent with the description given in the protologue of species (Edgeworth & Hooker, 1874) and flora of India (Majumdar, 1993), except number of valve present in the fruit. In the protologue Edgeworth & Hooker (1874) mentioned opening of fruit by 6 valve, same repeated by Majumdar (1993). This species having two styles and in *Stellaria* genus fruit open by twice number of valves as of styles. Hence, in this species fruit must open by 4 valves. In present study it is reported that fruit open by 4 valves, which open up to the base of fruit. Due to presence of 4 sepals, 4 petals and 2 styles this species placed in Section *Leucostemma* (Benth.) Fenzl of *Stellaria* genus (Schischkin, 1936).

Furthermore, anatomical characteristics, trichome type, stomata type and seed micromorphology of species described here first. Trichome of species were eglandular and glandular uniseriate, which consistent with Metcalfe & Chalk (1950). Stomata were present on both surface of leaf and are desmocyctic type. Metcalfe & Chalk (1950) also mentioned rare present of Caryophyllaceous type of stomata in the genus *Stellaria*.

Comma shaped seeds with irregular polygonal testa and colliculate-columellate sculpturing also present in *Mcneillia graminifolia*, *Minuartia rupestris* and *M. verna* (Minuto *et al.*, 2006; Sadeghian *et al.*, 2014). In *Stellaria* genus *S. media*, *S. holostea*, *S. pallida* also show

colliculate-columellate sculpturing of testa (Mahdavi *et al.*, 2012; Minuto *et al.*, 2006; Sadeghian *et al.*, 2014)

In anatomical characters, species shows absence of crystal druses and sclereids in the cortex and other paranchymatous cells of stem and root and this is peculiar characteristic feature of subfamily Alsinoideae (Schweingruber, 2007). Aerial parts of species are transitory and show annual type of ring characteristic, while perennial root show secondary growth. The root cross-section showed that the root was externally covered by layer of brown cork cells and rays were altogether absent. These results were consistent with the anatomical description of Caryophyllaceae given by Metcalfe & Chalk (1950) and Carlquist (2010). In the root pervasive parenchyma present, this surrounded xylem vessels and reported distinguishing to subfamily Alsinoideae (Schweingruber, 2007). The cells of pervasive parenchyma store food and thus, act as storage organ (Carlquist, 2010). This species shown simple vessel perforation of xylem vessels, high vessel density and narrow vessel diameter (<50 µm), which are some peculiar characteristics of family Caryophyllaceae (Schweingruber *et al.*, 2011). These characters were also shown by *A.cililata* L. and *Minuartia rubra* (Scop.) McNeill and many other species of subfamily Alsinoideae (Schweingruber *et al.*, 2011, Schweingruber *et al.*, 2013).

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