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SILICA DEPOSITION PATTERN IN SAND PAPER VINE *PETREA VOLUBILIS* L.

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ABSTRACT

Petrea volubilis L. is an ornamental flowering liana, belonging to family Verbenaceae. This ornamental flowering liana absorbs the silica in the form of monosilicic acid from the soil through their roots and deposited in the cells of leaves. Silica is one of the most beneficial elements for plants growing under biotic and abiotic stresses. Present study demonstrates the silica deposition pattern in the leaves of *P. volubilis* and reported a number of phytolith types.

Keywords : Hair, Hair base, Petrea, Phytolith, Silica

Introduction

Silica is a tetravalent metalloid and second most abundant element in the earth's crust after oxygen (Ma and Yamaji 2006). Silica is essential element for the most life forms on earth (Epstein 1999, 2009). The skeletal structures of various sponges, diatoms, radiolarians are made up of silica (Brümmer 2003). Plants also absorb silica in the form of soluble monosilicic acid [$(Si(OH)_4$] from the ground water which is deposited in the form of amorphous silicon dioxide in and between the cells and tissues of plants called phytoliths (Chauhan et al. 2011).

Silicon in plants reduces the extent of stress due to water deficiency. This is possible by the formation of a glass like plate of silica beneath the cuticle leading to reduced cuticular transpiration (Ma et al. 2001, Ma 2004).

Silicon plays key role in plant physiology to provide mechanical strength and stiffness to entire plant and provide a defense mechanism against herbivores, predators, bacterial, viral and fungal diseases as well as enhance the plant growth and yield (Tripathi et al. 2014). It also checks the excess of evaporation, improves rate of photosynthesis, reproduction and reduce grain chaffness (Shakoor et al. 2014, Kumar et al. 2013). It is recognized as a beneficial element for plants growing under biotic (bacterial stress, fungal stress, pests and pathogens) and abiotic stresses (i.e. salt stress, metal toxicity, drought stress, radiation damage, nutrient imbalance, high temperature, salinity and freezing) (Mitani and Ma 2005, Ma 2004). It also minimizes or inhibits the toxicity of many heavy metals such as Aluminium, Cadmium, Chromium, Iron, Manganese, Zinc in plants (Kumar et al. 2013, Singh et al. 2011, Tripathi et al. 2012, 2012a, Ma 2004). Phytoliths are also useful as a source of information for future research in different disciplines like archaeology, ethnobotany, historical ecology, palaeobotany, palaeoecology, palaeoclimatology, and palaeoenvironment (Tripathi et al. 2012b, Morris et al. 2009).

Petrea volubilis is an ornamental flowering liana, native to Mexico and Central America, belonging to family Verbenaceae. The plant

is very attractive because of a climber with drooping long racemes of delicate violet-purple star-like flowers. Plants have rough, coriaceous leaves having very high rate of silica deposition in its leaf tissues, hence commonly known as sandpaper vine. The objective of the present study is to find out the occurrence and morphology of various types of phytoliths of *P. volubilis* formed by the deposition of silica in the cells of leaves which make this plant as a most acceptable plant growing in different climatic conditions.

Material and Methods

Sample collection

Fresh leaves of *P. volubilis* were collected from Roxburgh Botanical Garden, Department of Botany, University of Allahabad, Allahabad in the month of March last, 2015. Fresh leaves were thoroughly hand washed several times with distilled water mixed with dilute HCL so as to wipe out dust particle completely then cut it in small pieces and dried it in oven at 60 °C for 48 hours.

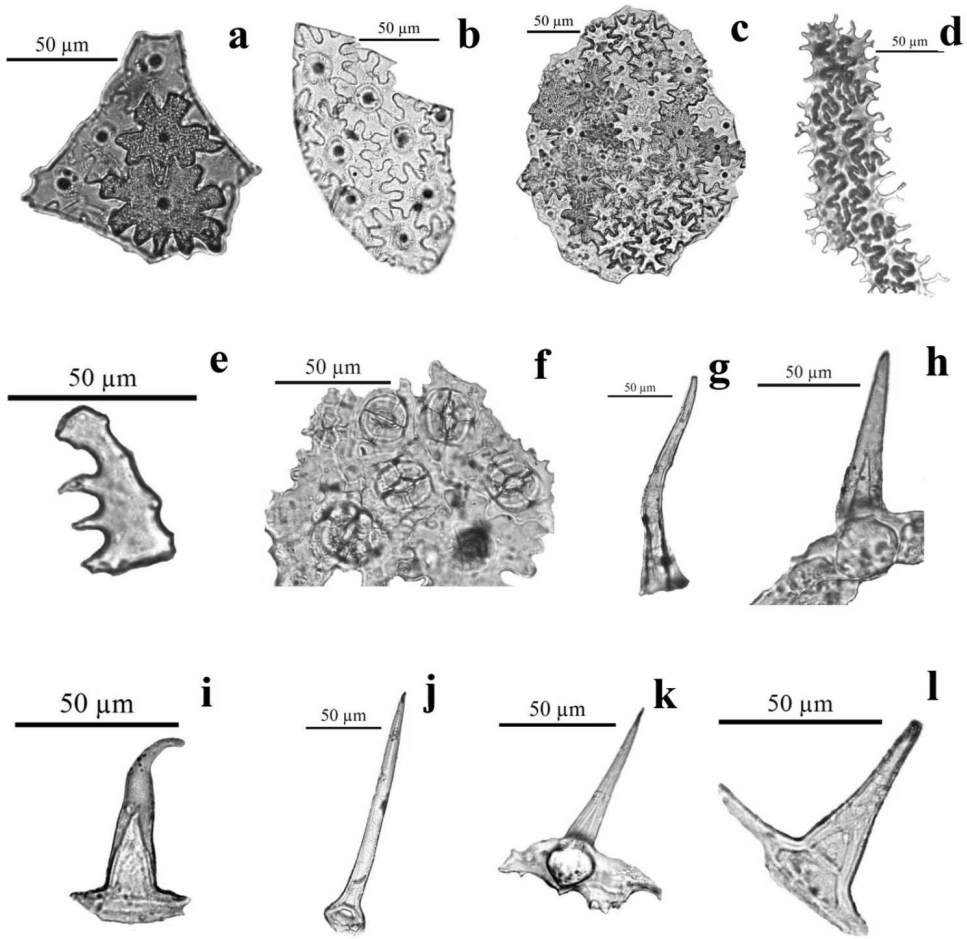

Fig. 1: Flat sheet Jigsaw phytoliths from the upper epidermis of the leaf showing imprints of the epidermal cells (a, b), cast of jigsaw phytoliths from the upper epidermis of the leaf (c, d), cast of single Jigsaw phytolith (e), flat sheet phytolith from the lower epidermis of the leaf showing imprints of stomata and epidermal cells (f), various types of silicified trichomes (g-l).

Silicified cells extraction

Silicified cells (Phytolith) extraction from the leaf of *P. volubilis* was performed by using dry ash technique (Twiss et al., 1969). Oven dried leaves material were placed in ceramic crucible and ashed for at least 4-6 hours at 400-500 °C, in Muffle furnace until the ash appeared whitish. The ash was mounted in Canada balsam for microscopic slides.

Observations

The leaves of *P. volubilis* accumulate about 15.13% silica in the form of various types of phytoliths. Silica is deposited over the upper and lower epidermal cells, just below the cuticle and formed amorphous sheets of flat phytoliths having imprints of epidermal cells, papillae and stomata (fig. 1a, b, f). In *P. volubilis*, upper epidermal cells become filled with silica and form solid caste

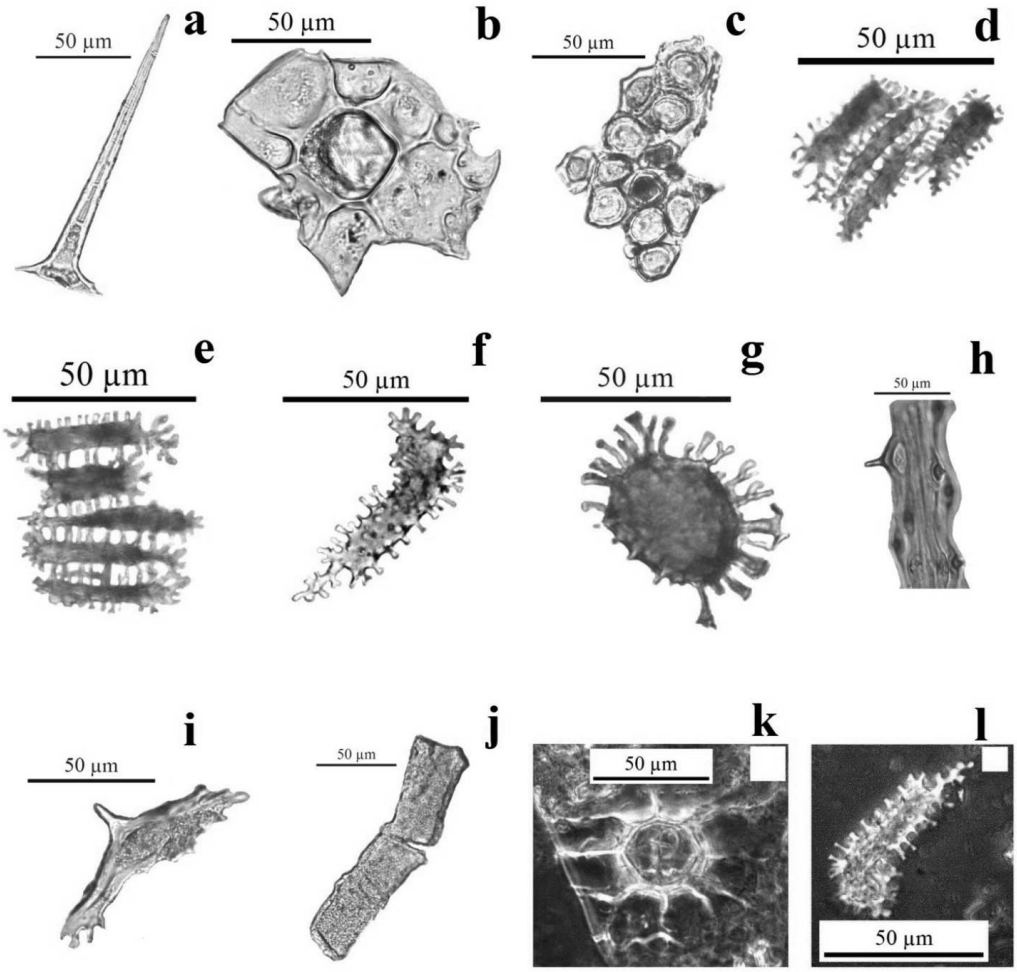

Fig. 2: Silicified trichome (a), silicified hair bases (b, k), silicified spongy parenchyma of the mesophyll cells (c), group of silicified sclereids showing knobbed projections (d, e), spiny phytoliths (f, l), single silicified sclereid showing projections (g), silicified cells of vein areas showing papillae (h, i), silicified cast of cells of vein area (j). k, l are Phase Contrast photographs.

of cells called Jigsaw phytoliths (fig. 1d, e). These Jigsaw phytoliths are scattered here and there in the upper surface of the leaves. Trichomes and trichome bases are also become silicified (fig. 1g-l, fig. 2a, b, k). The cell walls of spongy parenchyma are filled with silica (fig. 2c). Sclereids with knobbed spines are silicified and these sclereids are present in groups to provide mechanical strength to the lamina of the leaves (fig. 2d-f, l). Silicified cells are also present in the vein areas of leaves showing tracheids and papillae (fig.2h-j).

Discussion and conclusion

Accumulation of huge amount of silica in *P. volubilis,* provide mechanical strength to the leaves. The presence of flat sheet phytoliths provides an additional protection mechanism against the growth of pathogens and check transpiration. Silicified sheets of phytoliths carry out optical functions and redirect sunlight to protect the leaves against excess of heat. The spores of pathogens do not able to penetrate their haustoria or hyphae inside the leaf tissue because of flat sheet phytoliths. Silicified trichomes and jigsaw phytoliths inhibits the activity of grazers.

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