



Research Article

Petiole anatomy of Indian species of the genera *Smilax* L. and *Heterosmilax* Kunth. (Smilacaceae).

S. Baruah^{1*}, D. Baro² and S. K. Borthakur³¹Department of Botany, Bodoland University, Kokrajhar – 7833 70, Assam, India.^{2,3}Department of Botany, Gauhati University, Guwahati– 7810 14, Assam, India.

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Abstract: Petiole anatomy of 12 species, 11 species of *Smilax* L. and one species of *Heterosmilax* Kunth., of the family Smilacaceae have been studied. Anatomical features of the petiole provide supporting evidences for the infra-specific circumscription of the occurring in India.

Keywords: Petiole anatomy, taxonomy, *Smilax*, *Heterosmilax*, India

Introduction

Smilax L. (1753: 1028) is the type genus of family Smilacaceae, with ca. 350 species [1] mainly distributed in tropical and temperate areas throughout the world, but mostly confined to Asia and America [2]. The genus *Heterosmilax* is a small south eastern Asiatic genus that is closely allied to the genus *Smilax* [3]. *Heterosmilax* is comprised of about 11 species recorded from southern China, Myanmar, Thailand, Indo-China, and western Malaysia, with one species extending to the Ryukyu Archipelago, and Assam and Khasia in India [4]. In India the family represented by 33 species of *Smilax* L. and another four species viz., *S. collina*, *S. decipiens*, *S. obliqua* and *S. singaporensis* as doubtful species and two species viz., *S. wallchi*, *S. villandia* as imperfectly known species [5]. Out of 33 species reported by Hooker only 24 are from the present political boundary of India which includes five species from South India and 17 from northeast India [6]. However, like other monocots of NE India the Smilacaceae is yet to be properly documented and studied. Recently, from north eastern part of India several important studies have been performed on genus *Smilax* and *Heterosmilax* [7-9].

The identity of the genus *Smilax* is often difficult due to close morphological similarity of the species and dioecious nature of the plants. Most often it is unlikely that both male and female plants occur in the same locality and this very often leads to difficulty in ascertaining the proper identity of the members of the genus. Reproductive characters often are also not reliable for species delimitation [10]. Therefore, alternative attributes are required to resolve identity of the species with certainty.

In recent years, anatomical characters including the petiole characters have been widely used in solving taxonomic problems in vascular plants [11-15]. The

structure of petiole shows differences between genera and species. In the present study, anatomical characters of the petiole of 12 species belonging to the family Smilacaceae were examined and compared.

Materials and Methods

Plant materials were collected from different localities of Northeastern India (Table 1). The collected plant materials were fixed in F.A.A. and then preserved in 70% alcohol. Permanent transverse hand sections of middle part of petiole were made and stained with Safranin and Fast Green [16] dehydrated with an ethanol gradient (70% in three steps to 100%) and finally incubated in xylol (99.5%). The stained dehydrated sections were then mounted on slides using DPX and studied under bionocular research and compound Nikon microscope.

Results and Discussion

Cross sections of petioles are shown in Plate No. I, Figs. a-i. There are three kinds of tissue in each cross section (Figs. a-i). The exterior parenchymatous cortical tissue at the periphery of petiole is bounded by a single layer of epidermis. The centre of the petiole is occupied primarily by parenchymatous ground tissue. Vascular bundles are the third tissue.

Smilax perfoliata [Fig. a]

The petiole in t.s. is shallowly grooved with two short acuminate lateral outgrowths and acuminate in abaxial surface. Epidermis comprises of single layer of isodiametric cells. The 20-25 randomly distributed vascular bundles of variable size are confined to the central part of the petiole and are of different in size.

*Corresponding Author:

Dr. Sanjib Baruah,

Asst. Professor & HOD,

Dept. of Botany, Bodoland University, India.

E-mail: sanjibbaruah9@gmail.com

Smilax ovalifolia [Fig. b]

In t. s. the adaxial side of the petiole is deeply grooved with two wide obtuse lateral projections, whereas the abaxial face is acute. Epidermis consists of single layer isodiametric cells. The hypodermis is irregular in thickness and comprises of isodiametric parenchymatous cells with dark cell content. The 45-50 conjoint, collateral vascular bundles of variable size are randomly distributed and surrounded by 3-4 layers of sclerenchyma.

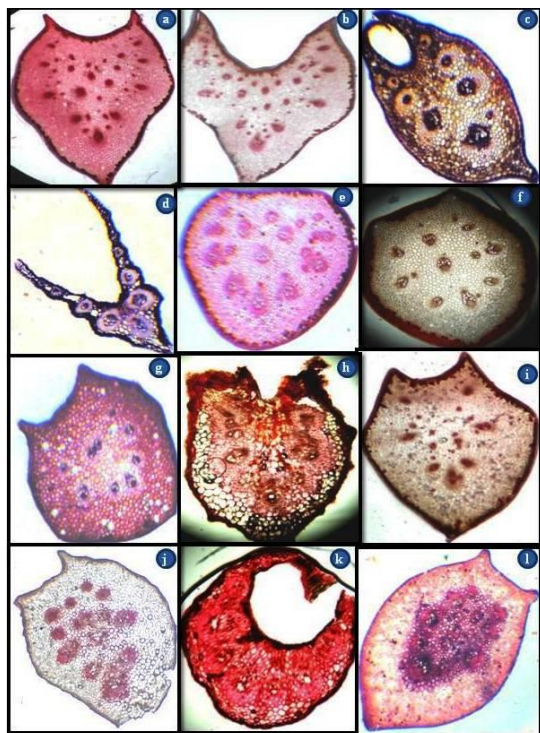


Plate No. I; Figures (a-i); (a) *S. perfoliata* × 20, (b) *S. ovalifolia* × 20, (c) *S. glabra* × 20, (d) *S. china* × 20, (e) *S. orthoptera* × 20, (f) *S. ocreata* × 20, (g) *S. lanceifolia* × 20, (h) *S. aspericaulis* × 20, (i) *S. arisanensis* × 20, (j) *S. zeylanica* × 20, (k) *Smilax* sp. × 20, (l) *Heterosmilax japonica* × 20.

Smilax glabra [Fig. c]

In t. s. the adaxial side of the petiole is deeply grooved with two lateral projections touching each other by their margins and the abaxial side is nearly acuminate. The epidermis comprises of single layer of oval cells with thick cuticle. Hypodermis is of two layers of chlorenchymatous cells. Of eight scattered vascular bundles three are big and five are small. Each vascular bundle is surrounded by 2-3 layers of sclerenchyma.

Smilax china [Fig. d]

In t. s. the adaxial side of the petiole exhibit a deep groove with two very long tapering lateral outgrowths and narrowly acute abaxial side. Epidermis is single layered with well developed cuticle. The seven or eight vascular bundles are arranged linearly in descending order by their size and encircled by 3-4 layers of sclerenchymatous cells.

Smilax orthoptera [Fig. e]

In t. s. petiole is flat on adaxial side without lateral projections and almost round on abaxial side. Epidermis is of single layer with thin cuticle. The hypodermis is of two-layers of chlorenchymatous cells. The 12-13 vascular bundles of variable size are arranged in two circles around a central zone.

Smilax ocreata [Fig. f]

In cross section the adaxial side of the petiole is horizontally flat and nearly round on adaxial side. The single epidermal layer has thin exterior cuticle layer. Hypodermis varies in thickness with dark cell content. The 20-22 conjoint, collateral vascular bundles of variable size are randomly distributed and are surrounded by 3-4 layers of sclerenchyma.

Smilax lanceifolia [Fig. g]

The outline of the petiole in t.s is horse-shoe shaped with a shallow groove on adaxial side and abruptly acute on abaxial side. Epidermal cells are circular and cutic layer is thick. Hypodermal layer is absent. The numbers of vascular bundles are 8-10 and are of different size.

Smilax aspericaulis [Fig. h]

The outline of the petiole in t.s is slightly wavy forming angles at points with adaxial side forming a v-shaped groove and acuminate on abaxial side. The epidermal cells are cutinized, irregular in sized and several layerd on the adaxial side but numbers of layers on lateral and abaxial sides are less. The 6-7 vascular bundles of variable size are encircled by 3-4 layers of sclerenchyma. Tanniferous cells are distributed in ground tissue and in vascular bundles.

Smilax arisanensis [Fig. i]

The outline of the petiole in t. s. is circular with shalowly u-shaped groove on the adaxial side and acuminate on the abaxial side. The epidermal layer is single cell thick and cuticle is thin. Hypodermis is single layered and number of vascular bundle of variable size is 18-20.

Smilax zeylanica [Fig. j]

The adaxial side of the petiole in t. s. is slightly inclined with two unequal lateral projections and acuminate on abaxial side. Epidermis consists of single layer of thick-walled oval cells with thick cuticle. Hypodermis is distinct and consists of either single or double layers. Numbers of vascular bundles are 14-16 and their size is variable.

***Smilax* sp.** [Fig. k]

As exhibited in t. s. the adaxial side of the petiole is deeply grooved with two lateral projections overlapping each other and the abaxial face is round. Epidermis consists of single layer of thick-walled round cells with cuticle. The 5-7 variable size vascular bundles are arranged in a liner pattern and each of them are surrounded by 3-4 layers of sclerenchyma.

Heterosmilax japonica [Fig. 1]

Adaxial face of the petiole as exhibited in t. s. shallowly grooved with two short lateral projections and acuminate on abaxial side. The epidermis is consisting of single layer followed by 10-12 layers of parenchymatous cortex. The numbers of vascular bundles are 10-12 and their sizes are different.

Scrutiny of the literature revealed that no work has so far been done on anatomy of petiole of species of *Smilax* and *Heterosmilax*. Data obtained from the present study shows that anatomy of the petiole can be used for proper identification of these species. The significant attributes of the petioles for taxonomic use include outlines of the petioles (Plate No I, Figs. a - l; Table 2). The deeply grooved petiole on adaxial face has been recorded in *Smilax glabra*, *S. ovalifolia*, *S. arisanensis*, *Smilax* sp. and shallow grooved petiole is found only in *S. orthoptera* (Fig. e) and *S. ocreata* (Fig. f) and *H. japonica* (Fig. l). Likewise, acuminate outline of petiole on abaxial face has been recorded in *Smilax china*, *S. glabra*,

S. ovalifolia, *S. aspericaulis*, *S. arisanensis*, *Smilax* sp. and *Heterosmilax japonica*. In case of *Smilax ocreata* and *S. orthoptera* abaxial face have been recorded as round.

The pattern of arrangement of vascular bundles also varies from linear to circular or even scattered among the species studied. The scattered vascular bundle has been recorded in *Smilax ovalifolia* and *S. perfoliata*. The linear arrangement of the vascular bundle has been recorded in *S. china*, *S. glabra* and *Smilax* sp. The numbers of vascular bundles vary from species to species (Table 2). The vascular tissue is capped by sclerenchyma layer in all the species. Sclerenchymatous layer are continuous in *S. aspericaulis*, *Smilax* sp. and *Heterosmilax japonica*. The ground tissue is parenchymatous in all the species studied but it is massive covering the central part except in *Smilax china*, *S. aspericaulis* and *Smilax* sp. The tanniferous cells are recorded in the cortex and in the ground tissue in *S. aspericaulis* and *Smilax* sp. respectively.

Table 1. Localities of studied Smilacaceae taxa.

Taxa	Locality	GPS Coordinates	Specimen acc. No.
<i>Smilax perfoliata</i> Lour.	Borkusia chak, Nalbari, Assam	N26°22'514"/ E91°26'.785"/ EL 118m	555 (GUBH, Assam, India)
<i>Smilax ovalifolia</i> Roxb.	Khetri, Kamrup, Assam	N26°08'657"/ E092°10'522"/ EL 56.5m	480 (GUBH, Assam, India)
<i>Smilax glabra</i> Roxb.	Hailakandi, Assam	N 24°54'378"/ E92°45'367"/ EL 100m	531 (GUBH, Assam, India)
<i>Smilax china</i> L.	Kodh-hati, Ri-Bhoi, Meghalaya	N25°48'846"/ E92°04'894"/ EL 1004 m	535 (GUBH, Assam, India)
<i>Smilax lanceifolia</i> Roxb.	Tinsukia, Assam	N 27° 26'.008"/ E 95°44'393"/EL 37m	535 (GUBH, Assam, India)
<i>Smilax aspericaulis</i> Wall. ex A. DC.	Ri Bhoi, Meghalaya	N25°51'878"/ E091°53'096"/ EL 551m	587 (GUBH, Assam, India)
<i>Smilax orthoptera</i> A. DC.	Karbi Anglong, Assam	N26°22'.164"/ E91°26'.733"/ EL 119 m	651 (GUBH, Assam, India)
<i>Smilax ocreata</i> A. DC.	North Cacher Hills, Assam	N26°08'757"/ E092°10'753"/ EL 59.5m	487(GUBH, Assam, India)
<i>Smilax arisanensis</i> Hayata	East Siang, Arunachal Pradesh	N 27°36' 31.23"/ E 94° 44/ 43.7"/ EL521m	226(GUBH, Assam, India)
<i>Smilax zeylanica</i> L.	East Siang, Arunachal Pradesh	N 27°35' 31.23"/ E 94° 43/ 33.63"/ EL400m	622 (GUBH, Assam, India)
<i>Smilax</i> sp.	Tinsukia, Assam	N 27° 25/ 54.5"/ E 095° 21/ 54.9/EL300m	532 (GUBH, Assam, India)
<i>Heterosmilax japonica</i> Kunth	Karbi Anglong, Assam	N26°03'051"/E093°43'51"/ EL143m	538 (GUBH, Assam, India)

*Gauhati University Botanical Herbarium (GUBH)

Table 2. Comparative petiole anatomical features of the studied species

Taxa	Shape of the petiole Adaxial	Nature of cuticle Abaxial	Hypodermis	Sclerenchyma layers in vascular bundle	No. vascular bundle layer	Larger size	Small size	Arrangement of vascular bundles
<i>S. perfoliata</i>	shallowly grooved	acuminate	Thick	single layer	3-4 layers	15	10	scatteredly arranged
<i>S. china</i>	deeply groove, fork shaped	acuminate	Thick	not distinguish	3-4 layers	3	5	linear
<i>S. glabra</i>	deeply grooved	acuminate	Thin	double layer	2-3 layers	3	8	linear pattern
<i>S. ovalifolia</i>	deeply grooved	acuminate	Thin	single layer	3-4 layers	22	20	scatteredly arranged
<i>S. orthoptera</i>	flat	round	Thick	double layer	2-3 layers	8	4	circular pattern
<i>S. ocreata</i>	flat	round	Thick	single layer	3-4 layers	11	10	scatteredly arranged
<i>S. lanceifolia</i>	horse-shoe shaped	slightly acute	Thin	single layer	1-2 layers	8	2	circular pattern
<i>S. aspericaulis</i>	slightly wavy	acuminate	Thick	single layer	5-6 layered	6-7	-	circular arranged
<i>S. arisanensis</i>	shallowly u-shaped groove	acuminate	thin	Absent	3-4 layers	10	8	scatteredly arranged
<i>S. zeylanica</i>	slightly inclined	acuminate	Thin	double layer	2-3 layers	12	2	scatteredly arranged
<i>Smilax</i> sp.	deeply grooved O-shaped	round	Thick	Absent	3-4 layers	3	2	linear line
<i>H. japonica</i>	Flat	acuminate	Thick	1 layer	5-6 layers	4	8	circular line


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