

Morphological and Anatomical Variations Seen in *Sida* L., Kanyakumari District, Tamilnadu

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Abstract

Macro and micro morphological studies of root and stem of five *Sida* species, *S. acuta*, *S. cordata*, *S. cordifolia*, *S. rhombifolia* and *S. schimperiana* were carried out and compared, in order to determine the taxonomic relationship between them. Druses, hydropoten cells and trichomes occurred in all the species. Stomata are anisocytic. The foliar trichomes of *Sida* however possessed a remarkable diversity. Epidermal peeling of leaf shows biaxial trichomes. The foliar trichomes of *Sida* however possess a remarkable diversity such as peltate, stellate forked stalked and capitate trichomes. Much variation is noticed in anatomical characters of stem and root also. The present study provides the basic information and the interrelationship between the different plant species of *Sida* which are currently found in Kanyakumari district. The knowledge of taxonomy is a great tool for identification of the different plant species.

Key Words: Micromorphology, Macromorphology, Anatomical, Calcium Oxalate crystals, Trichomes, Stomata

Introduction

The genus *Sida* L., belongs to the family Malvaceae. The family Malvaceae is one of the largest flowering plants and is commonly known as 'Mallow family'. It has 82 genera and 1500 species distributed widely in tropical and subtropical regions of the world^[1]. In India, the family is represented by 22 genera and 93 species. The members are mostly annual or perennial herbs, but in the tropics they are shrubs or rarely soft woody trees. The stem is fibrous and the herbaceous portions are more or less covered with stellate hairs. The plant parts are often mucilaginous. The leaves are stipulated, alternate, simple, entire and often with stellate trichomes. In the recent revision,^[2] Malvaceae was divided into five tribes- Abutilaeae, Decaschistaeae, Hibisceaeae, Malvaceae and Ureneae. The family Malvaceae of Southern Peninsular India was revised by^[3].

The name *Sida* L., was validated by Linnaeus in "Species Plantarum". 20 species of *Sida* occur in India^[3, 4, 5]. 13 species are found in Tamil Nadu, along with two sub species^[6]. The significance of mericarp morphology of the species of *Sida* has studied by^[7, 8] .^[9, 10, 11]. Due to its various ecological, medicinal and economical value, the genus *Sida* is of great interest to botanists, horticulturists and farmers.

Plants represent one of the important elements of biodiversity. Practically Kanyakumari District remains to be explored from the taxonomic point of view considering changes that took place in last few decades owing to heavy agriculture, tsunami, urbanization, industrialization and other such factors. The present study is designed to have a thorough study on the description, macro-morphology, floral characters, microscopic study and preparing an artificial key of *Sida* species.

Materials and Methods

Species of *Sida* were collected from various locations of Kanyakumari District during flowering period. The specimens were identified with the authentic taxonomic literature^[13]. From freshly collected specimens, macro-morphological and floral variation studies were done with the help of simple dissection microscope. Microscopic studies were performed based on hand sections of the roots stems and epidermal peel and were observed under compound microscope. Photographs were taken with a Motic microscope camera. Materials for foliar epidermal anatomy were prepared following the technique of^[14].

Results

The systematic position of the genus *Sida* L., is Class: Dicotyledonae,

Sub class : Polypetalae, Series : Thalamiflorae, Order : Malvales and Family : Malvaceae.

This genus is easily distinguished from other genera of Malvaceae by the absence of epicalyx, calyx morphology and uniovulate mericarps.

From different parts of the study area, 5 species have been identified authentically^[13]. The general characters of *Sida* is as follows: perennial or annual herb or undershrub, erect or prostrate, glabrous or pubescent. Most of the parts are covered with stellate, glandular or simple hairs. Leaves simple, petiolate, leaf blade cordate, elliptic, linear, rhomboid, ovate, serrate. Stipules thread like to lanceolate, foliar nectaries absent. Flowers small, axillary or subterminal, solitary or clustered to racemes, panicles or umbels. Bracteoles absent, pedicel slender, epicalyx absent. Calyx companulate or cup shaped with 5 fused sepals. Corolla mostly yellow, creamy white, orange or sometimes dark yellow. Petals 5, free, connate at base. Staminal column included, filament tube pubescent or glabrous with numerous anthers at apex. Capitate stigma ovary 5 to 10 loculed each with one ovule, pendulous. Styles branches as many as carpels. Stigma capitate, fruit schizocarpic. Mericarp differentiated into a lower one seeded indehiscent cell and an upper empty dehiscent part that is often endowed with a pair of awns. Seeds solitary and one per mericarp, smooth glabrous or minute hairs around hilum. Most of them are seen in sunny areas but few are seen in shady places.

Macro and micro morphological study:

The morphological and floral variations seen in the five different species of *Sida* under study are depicted in Table 1&2.

1. *Sida acuta* Burm. f.,

Annual, erect herbs or undershrubs, 0.5 - 2 m high; stems pubescent with simple minute stellate hairs. Leaves 1 - 9 x 0.5 - 2.5 cm, lanceolate to linear, elliptic-lanceolate, acute at apex, mostly serrate, 3-nerved at base, hairs simple; petioles 2 - 6 mm long
Flowers axillary, solitary or 2 - 8 in clusters of 3 - 12 mm long. Calyx 5 - 6 mm across, campanulate, Corolla light yellow, 8 - 10 mm across; petals as long as or slightly exceeding calyx lobes. Mericarps 6 - 10, apically 2 awned of equal length; 1-seeded; Seeds dark brown.

Flowering and Fruiting : July to March

Distribution: Along roadsides, in wastelands, both shady and open places.

2. *Sida cordata* (Burm. f.) Borss.,

Prostrate herbs up to 1 m high, stems slender; branched throughout or mostly towards base, rarely rooting at nodes in trailing condition; stems, petioles and pedicels pubescent with simple and minute stellate hairs. Leaves 0.5 - 8 x 0.3 - 5.5 cm, ovate to cordate, acute to acuminate at apex, crenate-dentate or serrate, 5 - 7-nerved at base, appressed simple hairy mixed with some stellate-hairs on both surfaces; petioles 1.5 - 30 mm long;

Flowers axillary, solitary, 8-10 mm diameter, Calyx 5 x 6 mm across, campanulate, 5-fid, simple and some stellate-hairy outside, glabrous inside except along margin. Corolla orange- yellow, 10 mm across; petals 6 x 5 mm, obovate, ciliate at base. Schizocarps 4 x 3 mm, globose, enclosed in persistent calyx; mericarps 5, awnless. Seeds brownish black.

Flowering and Fruiting Throughout the year, mainly during Sept. - Nov.

Distribution: In waste lands, humid and shady places up to 1500 m.

3. *Sida cordifolia* L.,

Erect undershrubs, up to 1 m high; stems branched with minute stellate hairs mixed with simple hairs. Leaves 6 x 5 cm, ovate to oblong or sub-orbicular, shallowly cordate at base, crenate-serrate, 5 - 7-nerved at base, densely velutinous with minute stellate hairs on both surfaces; petioles 4 - 5 mm long, densely stellate-hairs mixed with some simple hairs

Flowers axillary, solitary; pedicels 2 - 10 mm long, accrescent up to 2 cm, jointed towards apex. Calyx 5 - 9 mm across, campanulate, somewhat accrescent; lobes triangular acute to acuminate, densely tomentose with stellate and simple hairs. Corolla dark yellow, ca 15 mm across; petals obliquely obovate, Mericarps 8 - 10, apex of mericarp with a pair of awns with unequal length, Seeds dark brown or black.

Flowering and Fruiting: Throughout the year.

Distribution: In dry waste places.

4. *Sida rhombifolia* L.,

Erect branched herbs or undershrubs up to 1 m high. Stem cinereous with stellate hairs. Leaves obovate to cuneate, often more or less rhomboid, ovoid, or lanceolate, apically serrate to crenate, entire towards base, Leaf blades ca 6x 3cm, Flowers axillary, solitary, sometimes in apparent racemes; flowers ca 1.5 cm diameter. Calyx 5 x 6 mm, campanulate, pubescent. Corolla pale-yellow or creamy-white, ca 10 x 7 mm, mericarps 8-10, apex with a pair of short divergent awns of unequal length. Seeds brown or black

Flowering and Fruiting: August to January.

Distribution: Common along roadsides, wastelands, moist places and hills slopes.

5. *Sida schimperiana* Hochst. ex A. Rich.,

Perennial undershrubs or herbs, up to 90 cm high; stems woody, erect or procumbent; Stems, appressed stellate-hairy. Leaves 0.5 - 15 x 3 - 5 mm, wedge- shaped, oblong, cuneate at base, retuse at apex with a small toothlet in the hollow middle, entire.

Flowers axillary, solitary, sometimes crowded towards the end of branchlets; pedicels ca 1 mm long. Calyx lobes 3 - 5 x 1 - 2 mm, ovate, sacute, Corolla yellow; petals ca 5 x 2 mm, glabrous; mericarps 5, prominently reticulate, 2 minute awns; Seeds brownish.

Flowering and Fruiting: November to March.

Distribution: In dry places of Karnataka, Andhra Pradesh, Tamil Nadu and Kerala

Artificial key to the species of *Sida* L.,

- 1a. Plants prostrate, awnless *S. cordata*
- 1b. Plants erect, awned..... 2
- 2a. Leaves retuse, margins wedge shaped..... *S. schimperiana*
- 2b. Leaves cordate, acute, ovate, obovate 3
- 3a. Mericarps 6-10, flowers light yellow, leaf tip acute *S. acuta*
- 3b. Mericarps 8-10, flowers dark yellow, orange yellow 4
- 4a. Awns 2, equal length *S. cordifolia*
- 4b. Awns 2, unequal length *S. rhombifolia*

Table 1. Morphological variation seen in *Sida* species

Binomial	Habit	Stem	Leaf Shape	Number of Lateral veins	Petiole Length (in mm)
<i>S. acuta</i>	Erect, Herb or Undershrub	Pubescent with simple stellate hairs	Lanceolate to linear	3	2 to 6

<i>S. cordata</i>	Prostrate herb	Pubescent with simple stellate hairs	Ovate cordate to	5 to 7	1.5 to 30
<i>S. cordifolia</i>	Erect undershrub	Pubescent with stellate hairs	Ovate to sub orbicular	5 to 7	4 to 5
<i>S. rhombifolia</i>	Erect herb or Undershrub	Cinereous with stellate hairs	Obovate to cuneate	10 to 13	0.5 to 1
<i>S. schimperiana</i>	Erect, repeatedly forked branched perennial herb	<u>Appressed with stellate hairs</u>	Retuse, Wedge shaped	3	1.2

Table 2. Floral variation seen in *Sida* species

Binomial	Corolla Color	Mericarp number	Awn/Awnless	Seed Color
<i>S. acuta</i>	Light yellow	6 to 10	2 awned, equal length	Dark brown
<i>S. cordata</i>	Orange yellow	5	Awnless	Brownish Black
<i>S. cordifolia</i>	Dark yellow	8 to 10	2 awned, equal length	Dark Brown to black
<i>S. rhombifolia</i>	Yellow	8 to 10	2 unequal divergent awns	Brown
<i>S. schimperiana</i>	Yellow	5	2 ,minute awns	Brownish black

Microscopic studies:

a) Root

Transverse section of root is circular in outline in all the 5 species (**Fig1.1to1.5**). Bark is thin with cork consisting of 4 to 7 rows of thin walled tangentially elongated cells. Cortex is narrow, comprising of 3 to 4 layers in *S. acuta* and *S. cordata*, 5 to 6 in *S. cordifolia* and *S. rhombifolia* and multi-layered in *S. schimperiana*. Calcium oxalate crystals and starch grains are frequent in cortical cells. Tannin deposition is characteristic of *S. cordifolia* noticed in its cortex, xylem vessels and medullary rays. Bast fibre is seen in tangential bands of 3 to 6 rows alternating with thin walled phloem elements. Secondary xylem shows remarkable variations among the 5 species. In *S. acuta* the vessels are larger in size and more in number. In *S. cordata* and *S. rhombifolia* the vessels are smaller in size, lesser in number with more number of tracheids. In *S. cordifolia* and *S. schimperiana* the vessels are scanty, however with more tracheids. Xylem parenchyma cells that surround the vessel contain starch grains in all 5 species. Medullary rays are uniseriate or biseriate with deposition of calcium oxalate crystals and starch. Presence of prominent pith is noticed in *S. schimperiana* and *S. cordifolia*.

b) Stem

Cross section of stem (**Fig2.1to2.5**) shows circular outline with trichomes in all 5 species. Epidermis is radially elongated, thin walled. Cortex is chlorenchymatous with 4 to 6 layers. Deposition of calcium oxalate and tannin are more in *S. cordifolia* in comparison to the other 4 species. Conical shaped bast fibre is prominent in *S. rhombifolia*. Vessels are lesser in number in stem when compared to the root of the same species. Among the 5 species, *Sida acuta* showed larger vessels. In *S. schimperiana*, xylem is represented with only tracheids, fibres and parenchyma and very few vessels with narrow lumen. Large pith is noticed in *S. schimperiana*, *S. cordata* and *S. cordifolia*.



Fig. 1.1 *Sida acuta*

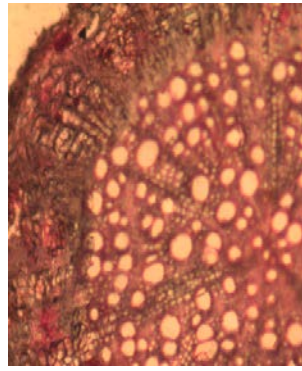


Fig. 1.2 *Sida cordata*

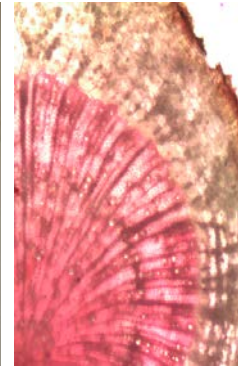


Fig. 1.3 *Sida cordifolia*

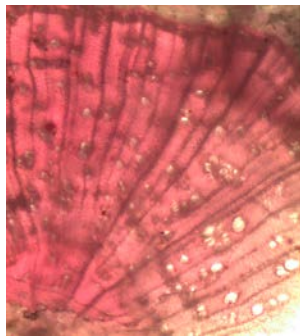


Fig. 1.4 *Sida rhombifolia*

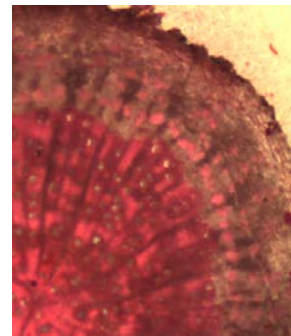


Fig. 1.5 *Sida schimperiana*

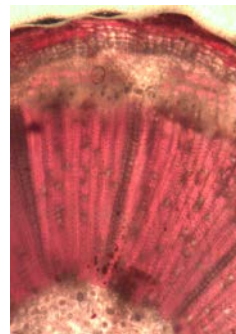


Fig. 1 – Root Morphology and Anatomy



Fig. 2.1 *Sida acuta*

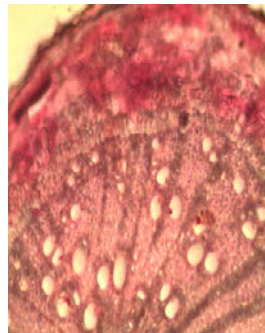


Fig. 2.2 *Sida cordata*



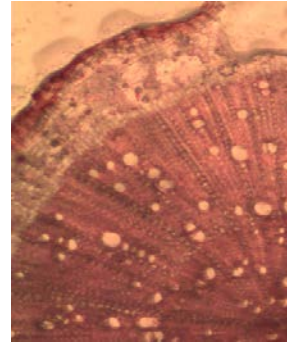
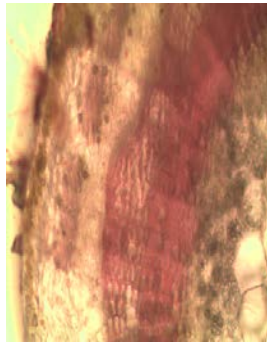


Fig. 2.3 *Sida cordifolia*

Fig. 2.4 *Sida rhombifolia*

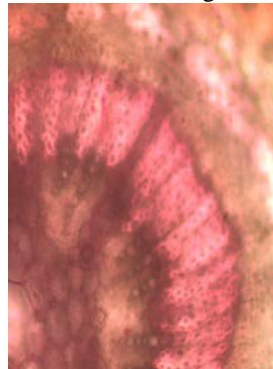


Fig. 2.5 *Sida schimperiana*

Fig. 2 – Stem Morphology and Anatomy

c) Leaf

Epidermal peeling of leaf shows biaxial trichomes. The foliar trichomes of *Sida* however possess a remarkable diversity such as peltate, stellate forked stalked and capitate trichomes (Fig.4.1to4.4). Stomata are anisocytic (Fig.3.1to3.5).

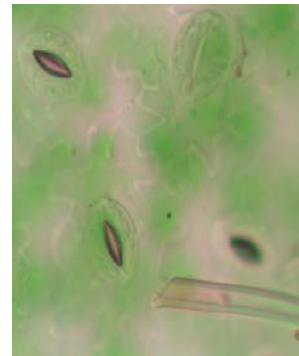
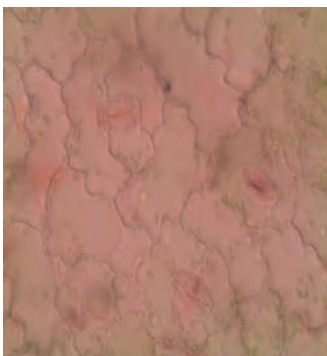


Fig. 3.1 *Sida acuta*

Fig. 3.2 *Sida cordata*

Fig. 3.3 *Sida cordifolia*

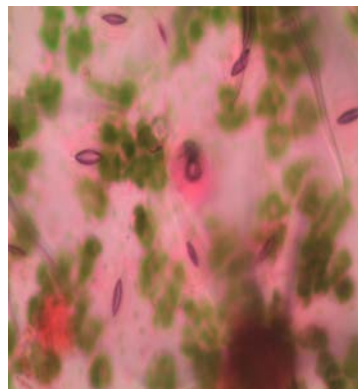
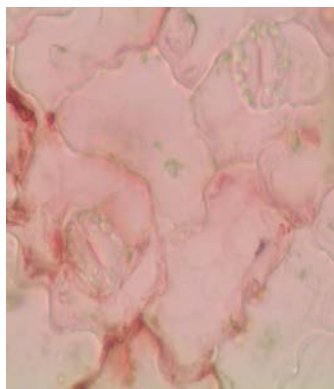


Fig.3.4 *Sida rhombifolia*

Fig. 3.5 *Sida schimperiana*

Fig. 3 – Stomata

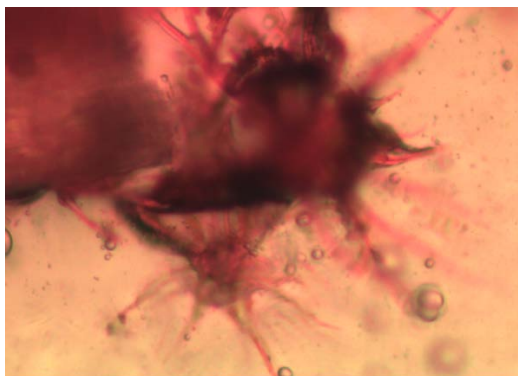


Fig. 4.1 *Sida acuta*

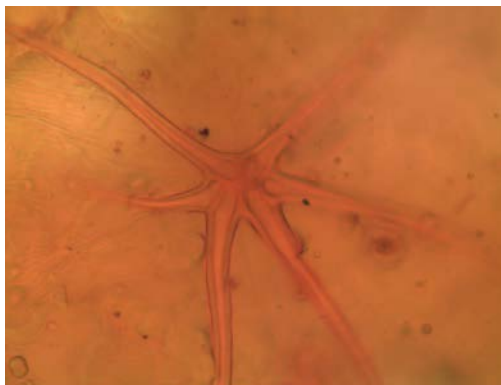


Fig. 4.4 *Sida rhombifolia*

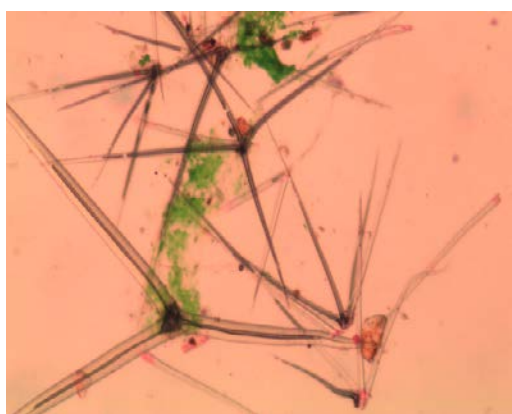


Fig. 4.2 *Sida cordata*

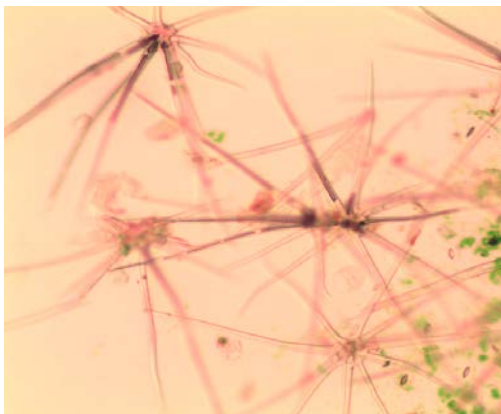


Fig 4.3 *Sida cordifolia*

Fig. 4. – Epidermal Hair

DISCUSSION

As a part of taxonomic studies on *Sida*, field explorations are conducted in different parts of the district under study. *Sida acuta* and *Sida cordata* are distributed throughout the district and grow on waste lands and along roadsides. *Sida rhombifolia* occurred more or less throughout the district and undergrowth of disturbed forests. *Sida cordifolia* is found to be common mostly in shady and waterfed areas of the district. *Sida schimperiana* is rare and collected only in the dry hilly slopes of the district.

Sida acuta differs from other species by having leaves with acute tip. *Sida cordata* showed a peculiar habit of being prostrate while other species are erect. *Sida schimperiana* shows woody habit with repeatedly forked stem. In *Sida cordata*, the leaves are cordate (heart) shaped and in *Sida schimperiana*, the leaves are wedge shaped.

Micromorphological features and the floral variations of the species of *Sida* were examined, in order to determine the taxonomic relationship between them. Druses, hydropoten cells and trichomes occurred in all the species. Stomata are anisocytic. The foliar trichomes of *Sida* however possessed a remarkable diversity.

Features of hairs are broadly regarded as useful for establishing the systematic relations within the Malvaceae^[1,16]. *Sida* species shared some common characters like presence of trichomes and stomata. The foliar trichomes may be peltate, stellate or capitate. Two armed trichomes are seen in *S. acuta*. Hydropoten cells, cited by^[15] as structures that facilitate the transport of water and ions into the plants. These cells are more prominent and abundant in leaves of *S. cordifolia* which were collected from muddy roadsides. Leaves of *S. cordata* and *S. rhombifolia* show more undulations in the epidermal cells.^[16] observed that cell wall undulation is a reflection of adequate habitat moisture and that undulating walls provide leaves with great tensile strength. The result of the present study is also similar to the results observed by^[14,15] in their work. They suggested that the degree of undulation of epidermal cell walls plays a vital role in distinguishing sun and shade morpho types. The undulation pattern is frequently more pronounced in shade than in leaves exposed to sun.

The mericarp structure shows great diversity in different species in *Sida*. It is one of the key characters in identifying the species. This concurs with the suggestions made earlier by^[7,8]. In the present study, it is observed that *Sida cordata* is the only species which lacks awns. This feature is used as a taxonomic delimitation of the species from other species.

Some of the morphological, anatomical and floral variations investigated show that some of the species are closely related to each other. Characters like, presence of awns, number of mericarps, leaf tip, leaf shape also help to group the related species together. This present investigation coincides with the observations of^[7,8].

S. acuta is a vigorous competitor in degraded pastures, plantation crops, vegetables, road sides and waste lands. An important positive role of *S. acuta* is its ability to accumulate heavy metals and therefore may serve a phytoremediation role in contaminated sites.

S. cordifolia commonly known as 'Bala' attracts the attention of Ayurvedha, Sidha, Homeopathy and modern allopathic physicians for its immense medicinal properties. The whole plant is being used for treating diseases such as bleeding piles, leucorrhoea, facial paralysis and rheumatism. *S. rhombifolia* is widely used in Ayurvedha as well as in Indian folklore and traditional medicine. The root of this plant is widely accepted as the source plant of the renowned Ayurvedic drug. *Sida cordata* is often used along with 'Bala'. The juice of the plant is applied to boils and pimples. The juice of the root is used to treat indigestion. It is also used in the treatment of gonorrhoea and other venereal diseases. The juice of the leaves is used to treat cuts and wounds.

CONCLUSION

The present study provides the basic information and the interrelationship between the different plant species of *Sida* which are currently found in Kanyakumari district. The knowledge of taxonomy is a great tool for identification of the different plant species. Taxonomic knowledge is crucial to meet the challenges of biodiversity conservation in the 21st century. It is of fundamental importance for understanding biodiversity and ecosystem functioning, as it provides us with the data to explore and describe biodiversity through scientific analysis. Since most of the species of *Sida* are used in Ayurvedha, Sidha and Homeopathy, the unscientific and skill-less uprooting of the whole plant results in the deterioration of this genus in the near future. Hence it becomes the role of the local and regional authorities to take proper steps to conserve this precious phyto-diversity for better future use.

REFERENCES

1. N. Shaheen, "Foliar epidermal anatomy and its systematic implication within the genus *Sida* L. (Malvaceae)" in *African Journal of Biotechnology*, 2009, pp. 5328 -5336.
2. T. K Paul and M. P. Naya, "*Malvaceae*" In: M. P. Nayar, K. Thothathri & M. Sanjappa (eds.), Fascicles of Flora of India, Fascicle 19. Botanical Survey of India, Calcutta. 1988, pp 64-233.
3. V. V Sivarajan and A. K. Pradeep, "*Malvaceae of Southern Peninsular India: A Taxonomic Monograph*", Daya Publishing House, New Delhi. 1996, pp. 224-312.
4. M. Sivadadan and N. Anil Kumar, "*Sida ravii*, a new species of Malvaceae from India" in *Willdenowia*, Vol.25, 1996) pp. 651-665.
5. E. S. Santhosh Kumar, A. E. S Khan, and S. Binu, *Sida unicornis* Maris (Malvaceae), a new record for India in *Rheedea*, Vol.11, 2001 pp.53-56.
6. P. Daniel and P. Umamaheswari, "*The Flora of the Gulf of Mannar, Southern India*", Botanical Survey of India, 2001.
7. V. V.Sivarajan, A.K. Pradeep and E.J. George, "Meriacarp morphology of Indian species of *Sida* L.(Malvaceae) in relation to taxonomy" in *J Taiwan Mus*, Vol.45,1992, pp 65- 73.
8. Kumar Avinash Bharati, "Identification of Indian *Sida* L. through mericarp", in *Journal of Pharmacognosy*, Vol 8, issue 5, 2016, pp.67-74
9. Gajanan, M. Tambde, Ramchandra D.Gore, and Milind M. Sardesai, "A Synopsis of the genus *Sida* L. (Malvaceae) from Maharashtra, India", in *Taiwania*, Vol.61, Issue.3,2016,pp. 243-252 .
10. Debasmita Dutta Pramanick, G.G Maiti, Amber Srivastava, "Micro-morphological Study of 'BALA' Plant(*Sida cordifolia* L., Malvaceae) wth special reference to its propagation technique", in *Journal of Medicinal Plants Studies*, Vol.3, Issue.4, 2015, pp.127-131.
11. V.Sharma, Mehta,S.C.and Sinoriya,P, "Pharmacognostical Study of the Whole Plant of *Sida rhombifolia* L." *J Pharmacogn & Phytochem.*, Vol.2, Issue.3, 2013,pp. 1-4.
12. P.K.K. Nair, "Plant taxonomy", *Curr Sci*, Vol.86, Issue.5, 2004, pp.665- 667.
13. J.S. Gamble, *Flora of Presidency of Madras*, Vol. 1, Reprint edition, Calcutta, 1957, pp. 1389.
14. R. Cotton, "Cytotaxonomy of the genus *Vulpia*", *Ph.D. Thesis*, University of Manchester, USA, In: Hippocastanaceae through Theaceae. Deyua, H. (Eds). Beijing: Science Press,1974.
15. M.E. Basseyy, A. C. Effiom and E. Mbong, "Anatomical Investigation of Leaves of *Sida* L. in Uyo, Nigeria and the Taxonomic Implications", in *Asian Research Journal of Biotechnological Sciences*, Vol.1, Iss. 1, 2016, pp. 1-8.
16. John A Raven, "Speedy small stomata", in *J. of Experimental Biology*, Vol.65, Iss.6,2014, pp.1415 -1424.
17. M. Navas, M. Dan, and P.G. Latha "Comparative root anatomy of the species under *Sida rhombifolia* complex (Malvaceae)", in *J. Pharmacogn.*, Vol.5, Iss.6, 2013, pp. 269-274.
18. V. Sharma, S.C. Mehta and Sinoriya. P, "Pharmacognostical Study of the Whole Plant of *Sida rhombifolia* L." in *J Pharmacogn. & Phytochem.*, Vol.2, Iss.3,2013, pp.1-4.
19. Pramod V. Pattar and M. Jayaraj, "Pharmacognostic and phytochemical investigation of *Sida cordifolia* L. - a threatened medicinal herb", in *International Journal of Pharmacy and Pharmaceutical Sciences*, Vol 4, issue 1,2012, pp.82-88.

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