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Leaf Architecture in the Seedling of Wrightia arborea (Dennst.) D.J. Mabberley

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ABSTRACT

Wrightia arborea (Densst.) Mabb. belonging to the family Apocynaceae, is a small deciduous tree, distributed throughout the warmer parts of India. Different organs (root, bark and leaf) have been used in traditional medicine for many years. The present study was undertaken to investigate the Leaf architecture including venation pattern in the seedlings of *Wrightia arborea* (Densst.) Mabb. of the Apocynaceae. The Leaves are simple, opposite, estipulate; petiole 3-7 mm, stout, tomentose; lamina 6-15 x 3-6.5 cm, elliptic, elliptic-ovate, ovate or obovate; base acute; apex acuminate; margin entire, tomentose on both sides, chartaceous; lateral nerves 9-13 pairs, tomentose, prominent, pinnate; intercostae reticulate. The major venation pattern conforms to pinnate camptodromous type with festooned brochidodromous secondaries. The qualitative and quantitative features are studied. The leaf size, areole size, number of vein endings entering the areoles and number of vein terminations entering the areoles were studied. The highest degree of vein order is observed up to 5°. Isolated tracheids, isolated vein endings, isolated free vein endings and tracheoidal elements are noticed. Loops may be formed by vein-lets only or by vein-lets and tracheids. The terminal tracheids of vein endings show an increase in cell diameter are of various shapes and occur single or in groups of 2 - 3 or more per vein-let terminus. The primary and secondary veins are surrounded by a multiseriate bundle sheath and vein-lets and vein endings have uniseriate sheath.

Keywords : Leaf architecture, seedling, Tracheid, *Wrightia arborea.*

I. INTRODUCTION

Leaf characters are considered as important morphological features for taxonomic studies (Swaminathan et al., 2012). These include leaf architectural characters, venation patterns (Pulan and Buot, 2014), and petiole anatomical characters (Ruzi et al., 2009; Solereder, 1908). Although leaves are generally plastic, mostly to environmental conditions, and are sometimes neglected in taxonomy, the leaf architecture and venation patterns have long been considered useful for the taxonomy of different dicotyledonous families. The taxonomic importance of the architecture in the anatomy of the genus *Wrightia arborea* was described as very useful in the species identification.

Leaf architecture has been studied in some members of the Composite (Banerjee and Deshpande 1973; Banerjee 1978a,b; Ravindranath and Inamdar 1982).

Wrightia arborea (Densst.) Mabb. genus is ecologically and medicinally important plant. *Wrightia arborea* is a deciduous tree with a rounded crown; it can grow up to 20 meters tall. The bole can be up to 35cm in diameter; it is un buttressed.

The tree is sometimes harvested from the wild for local medicinal use and as a source of wood and dyes. It is sometimes grown as an ornamental in Africa. As very scanty work done with anatomical features of the plant and very little knowledge about its leaf architecture, the present study was undertaken to investigate the Leaf architecture including venation pattern in *Wrightia arborea* (Densst.) Mabb. of the Apocynaceae.

II. METHODS AND MATERIAL

Clearing

Fresh leaves were collected from the seedlings to study the leaf architecture. They were cleared by the method of Mohan Ram and Nayyar (1978) and stained with Safranin, the stained materials were mounted in 50% glycerin.

Leaf architectural characters

Leaf shape, venation, margin, base, apex, area, areolation, blade class, organization, presence of trichomes, and other epidermal (appendages/ indumentum) were examined following the standard and tested procedures (Dilcher, 1974; Hickey, 1973).

Photo microscopy

Photomicrographs were taken with a Carl-Zeiss photomicroscope using Agfa film. The photomicrographs of areole size, the number of vein lets entering in areole and the number of vein endings entering in areole were taken in five different fields of different leaves. Terminologies to describe leaf and cotyledonary architecture were adopted from Hickey (1973) and Hickey and Wolfe (1975).

III. RESULTS

1. Leaf Architecture

The organization of the first and subsequent leaf is simple consisting of a single lamina. Generally the lamina and leaf base are symmetrical. The apex is short, obtuse, acute to attenuate, acute to obtuse or roundish and margin may be concave. The leaf base is obtuse, acute, connate or rounded. Generally the leaf margin is entire and smooth without noticeable projections. The texture of leaf is chartaceous. Leaves are petiolate. Petiole is terrate. (Table:-1)

Table 1 : Morphological features of leaves.

Plant	Lamina					Petiolate or sessile	Second pair of leaf phyllotaxy
	Texture	Symmatrical/ Asymmetrical	Shape	Apex	Base		
Wrightia arborea	Herbacious	Symmatrical	Ovate	Acute	Obtuse	Petiolate	Opposite

2. Venation

2.1 Type of Venation

The venation is pinnate with a single primary vein (midvein). It is camptodromous as secondary veins do not terminate at margin. Hicky (1979) further classified the camptodromous venation into four types on the basis of the characters of secondary veins. In the leaves of the seedlings of Apocynaceae family subtype of venation is cladodromous as secondaries are ramified towards the margin or brochidodromous where the secondaries joined together in arches as in *Wrightia arborea* (Table 2)

Table : 2 Type of Venation	
Plant	*Wrightia arborea*
Type of venation	Pinnate
Subtype of venation	Camptodromous / Brochidodromous
Primary vein size	Massive
Course of primary vein	Sinuous unbranched
Secondary vein angle of divergence	Acute narrow
Marginal ultimate venation	Incomplete
Course of secondary vein	Curve

2.2 Primary vein

The thickest vein is primary vein (Fig. 1). This serves as an origin for the higher order venation. Its thickness gradually decreases towards the apex. The size of primary vein is determined midway between the leaf apex and base as the ratio of vein width (Vw) to leaf width (Lw) (Hicky, 1979).

$$Size\ (Primary\ Vein) = \frac{Vw}{Lw} \times 100\ \%$$

Thus in dicotyledonous plants the size of primary vein can be :

(i) Massive :> 4.00 %
(ii) Stout : 2.00– 4.00 %
(iii) Moderate : 1.25 – 2.00 %
(iv) Weak :< 1.25 %

In the leaves of the seedlings the size of primary vein is "stout" or "massive" (Table:-2). The course of primary vein is straight (branched or unbranched) or sinuous (Table:- 2).

2.3 Secondary veins

The secondary veins (2°) arise on either side of the primary vein in alternate or opposite fashion. The angle of secondary veins measured between the branch and the continuation of the source vein above the point of branching is acute moderate or acute narrow (Table:-2). The course of secondary veins is curved bending in shallow or more or less straight arch. The intersecondary veins are mostly thinner than secondaries. The secondary veins are branched in *Wrightia arborea* (Fig. 1). The branches may unite (Fig. 1).

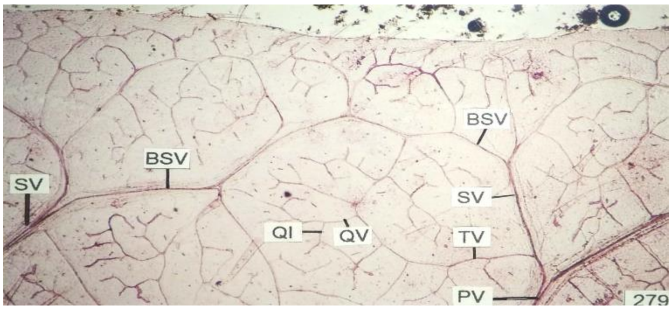

Fig. 1(279): Surface view of the portion of cleared leaves of Wrightia arborea
(X60, BSV – branch of secondary vein; PV – primary vein; QV – quaternary vein; SV – secondary vein; TV – tertiary vein)

2.4 Tertiary veins

The finer branches of the secondary veins are tertiary veins (Fig. 2). They are ramified, branching into higher order with or without rejoining the secondary veins. They are wavy or straight.

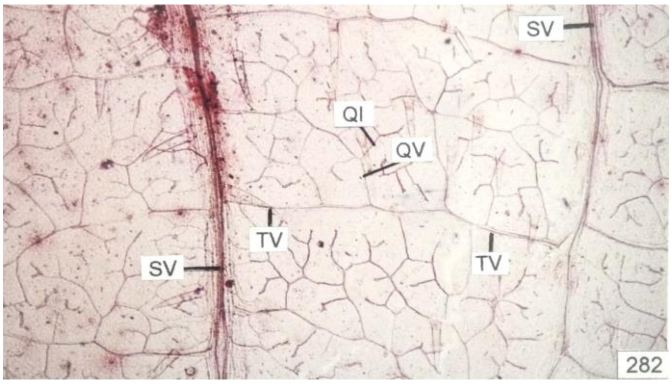

Fig. 2(282): Surface view of the portion of cleared leaves of Wrightia arborea
(X60, IT- isolated tracheid; IV- inter secondary vein; PV – primary vein; QI – quaternary vein; QV- quaternary vein; SV- secondary vein; TV – tertiary vein)

2.5 Quaternary and quinary veins

The finest veins originating from tertiary are quaternary and those from quaternary are quinary veins. Hickey (1979) classified them in to two types;

(a) Thick : Wider than expected.
(b) Thin : narrow than expected.

The quaternary and quinary veins are distinct (Fig.2). They are classified as "thick" and "wide" and their course is relatively randomly oriented (Fig. 2).The quinary veins are "thick" and their course is random similar to quaternaries.

2.6 The marginal ultimate venation

The marginal ultimate venation is incomplete with some freely ending vein-lets directly adjacent to the margin. The venation features are presented in Table:-2.

2.7 Vein-lets

The freely ending ultimate veins of the leaf is vein-lets. They are simple or branched. The simple vein-let may be linear or curved. (Figs. 3, 4, 5)

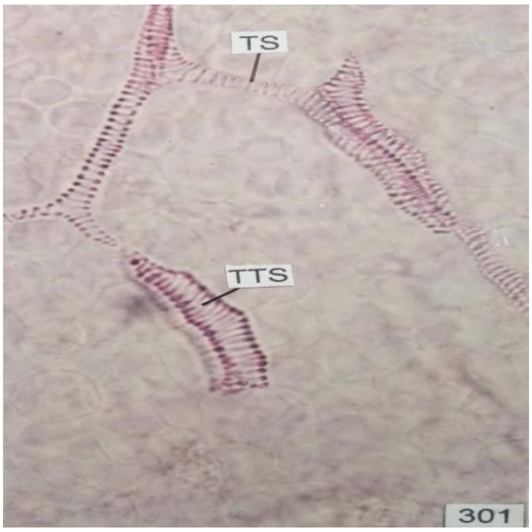

Fig. 3(301): Surface view of the portion of cleared leaves of Wrightia arborea, (X120, TS- trisegmental vein ending ; TTS – terminal tracheids)

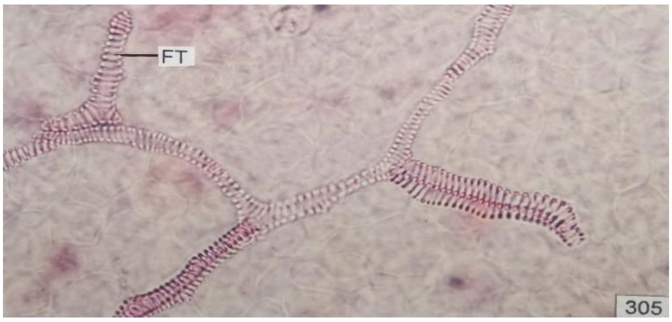

Fig. 4(305): Surface view of the portion of cleared leaves of Wrightia arborea
(X120, FT – foot shape terminal tracheid)

Fig. 5 (307): Surface view of the portion of cleared leaves of Wrightia arborea
(X120, TS – tri-segmented vein ending)

The nature of the branched veinlet is interesting.. Veinlet may terminate into two free branches (Fig. 7). The branching may be equal (Fig. 7) or unequal. Out of the two branches (A,B) only one (branch B) again forms two branches. The vein endings may be unisegmented (Fig. 6), bisegmented or trisegmented (Figs. 3).

In latter all the segments are uniseriate (Fig. 5) or sometimes the middle segment is biseriate (Fig. 3).
The trachieds that terminate at the ultimate tips show an increase in cell diameter. They may he present singly (Fig. 7), or in group of two (Fig. 3) and three or more. In such cases their arrangement may be juxtaposed, superposed, or juxtaposed - superposed. Sometimes juxtaposed trachieds are arranged near the end at right angle to multiseriate veinlet. They are of various shapes viz., roundish, pterygoid (Fig. 6), vermiform, triangular, oval, foot shape (Fig. 4), cylindrical and barrel -shape.

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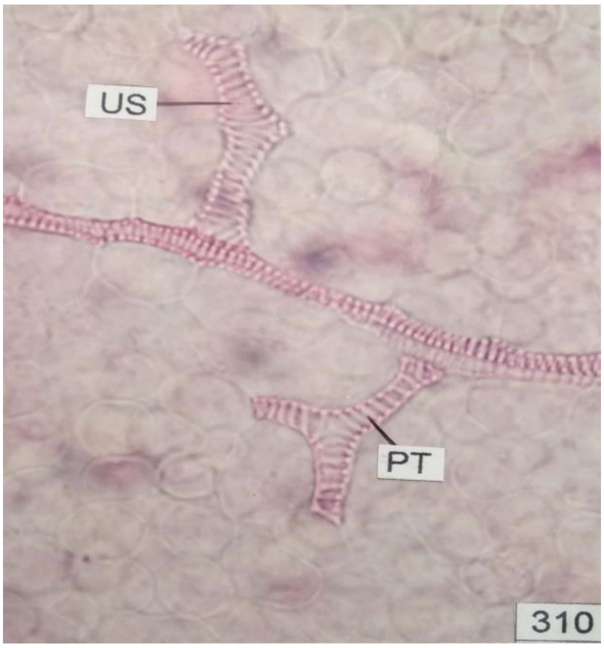
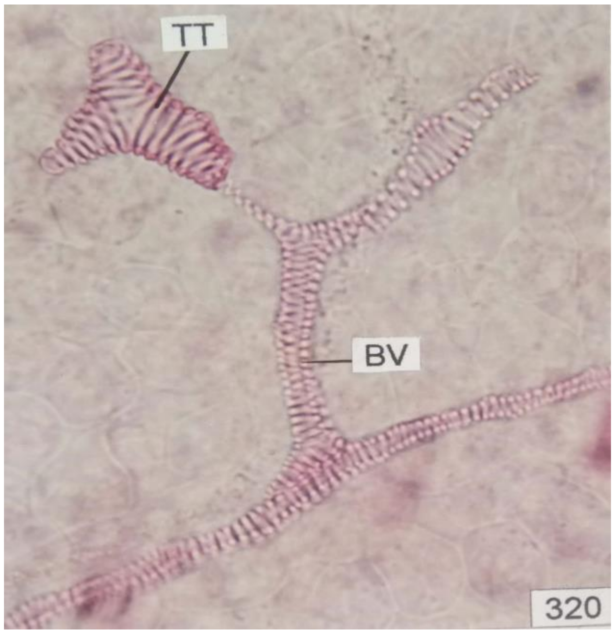


Fig. 6 (310): Surface view of the portion of cleared leaves of Wrightia arborea
(X120, PT – perigoid terminal tracheid; US – unisegmented vein ending)



Figs. 7 (320): Surface view of the portion of cleared leaves of Wrightia arborea.
(X570,BV – branched veinlet; TT –terminal tracheid).

2.8 Isolated Trachieds

An isolated trachieds are observed in *Wrightia arborea*. They are not frequent.

2.9 Loop

Loop formation is observed in *Wrightia arborea* (Fig. 8).The loops may be formed by veinlets, tracheids or veinlets and tracheids. It may be tetra angular (Figs. 3), lenticular , pentagular in shape, occurring singly (Figs. 8, 9,10) or in group of two.

2.10 Areoles

The areoles are the smallest areas of the leaf tissue surrounded by veins which form a contiguous field over most of the area or the leaf. They are angular in nut line, more or less variable in size and formed by all types of veins. Their arrangement is random showing no preferred orientation (Figs. 1, 2).

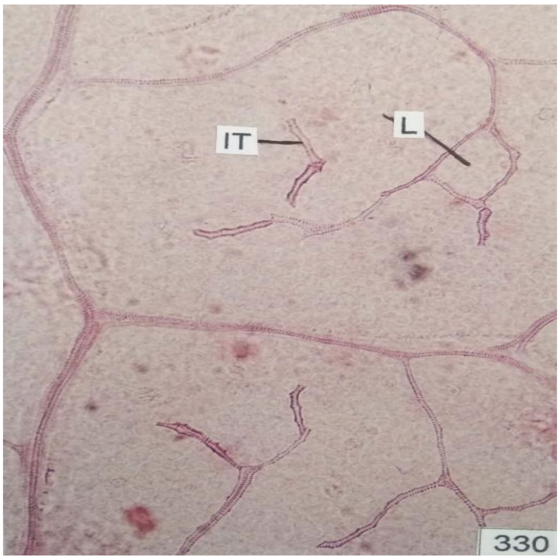


Fig. 8 (330): Surface view of the portion of cleared leaves of Wrightia arborea. (X120,
IT – isolated tracheid; L – loop)

2.11 Vein sheath

In this species it is found that the primary vein is covered by a multiseriate bundle sheath, running parallel to the vein. Secondary also has multiseriate sheath (Fig 2). The veinlets and vein endings have a uniseriate bundle sheath.

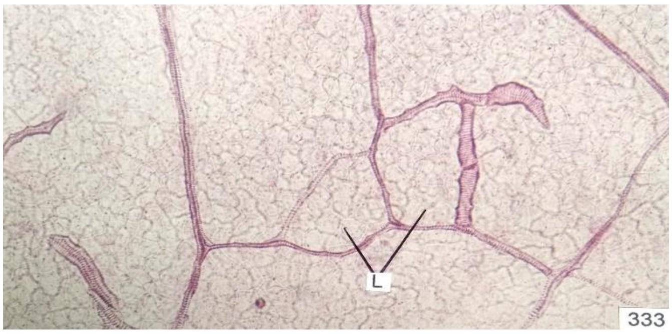


Fig. 9 (333): Surface view of the portion of cleared leaves of Wrightia arborea. (X570,L- loop).

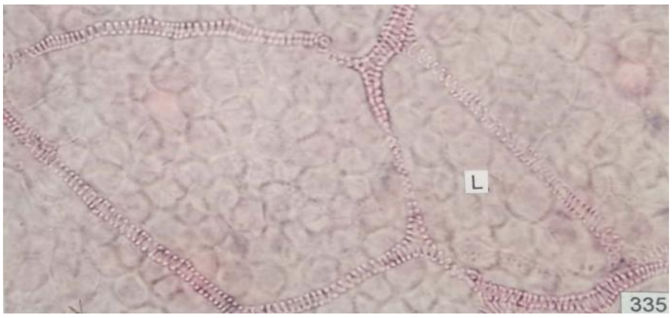


Fig. 10 (335): Surface view of the portion of cleared leaves of Wrightia arborea. (X570,L- loop).

IV. DISCUSSION

1. Leaf Architecture

The most comprehensive surveys of the venation of foliage leaves was carried out by Von Ettinghausen (1854a, 1854b, 1957, 1858a, 1858b, 1861, 1865, 1872). This classical study, although devoid of morphological and phylogenetic conclusion, nevertheless represents the first attempt to devise a classical descriptive classification of venation systems based on the course of main veins in the lamina. From the standpoint of venation type the classical studies of Von Ettinghausen (1861) remained the most extensive to date and had greatly influenced the later classifications (de Bary, 1884; Kerner and Oliver, 1894). Melville (1969) traced the evolution of the angiosperm leaf from Permian *Glossopteris* by comparing the venation pattern of living plants from the countries which formed

Gondwana land with their fossil records. Hicky (1973)developed a classification on leaf architecture in dicotyledonous leaves. Melville (1976) gave terminology of leaf architecture of angiosperms. Foster (1950) in his study on venetation of *Quiina acutangula,* explained the need for intensive exploration of leaf venation. Perhaps, his opinion might have prompted many workers to undertake such studies and in the last several years, considerable work has been done on leaf venation in angiospermous plants. The leaf architecture in the family Apocynaceae had not been studied except the work of Chandra *et al.* (1972).

The study of leaf architecture of the seedlings of *Wrightia arborea* of Apocynaceae reveals that they resemble in following features in venation pattern :

1. Venation is pinnate, camptodromous.
2. Primary vein is "stout" or "massive" and it's course is straight or sinuous.
3. The course of secondary veins is curved bending in shallow / more or less straight arch.
4. Inter secondary veins are observed.
5. Teritary veins straight and percurrent joining with other tertiary veins of opposite secondaries.
6. Quaternary and Quinary veins are "thick".
7. The marginal ultimate venation is "incomplete" or "looped".
8. The arrangement of moles is random.

The present study also shows different types of vein-lets, the branching may be once or twice, equal or unequal. The vein endings may be unisegmented, bisegmented or trisegmented with uni or biseriate segments.

Pray (1954) found that the terminal tracheids of vein endings show an increase in cell diameter. Such terminal tracheids are common in the leaves of the seedlings of investigated species. They are also reported in the leaves of Papilionaceae (Rao, 1981; Patel, 1999) and Caesalpiniaceae (Shah, 2001).

The tracheids are variously shaped, occurring singly or in groups of 2 — 3 or more per vein-let terminus. According to Strains (1933) vein endings are of taxonomic significance but Dckison (1969) believes them to be of limited importance. On the other hand Hall and Melville (1951, 1954) and Varghese (1969) painted out that they can be used at taxonomic levels, in the conjunction with other characters. From the present study it can be suggested that they are of less taxonomic value since more than one type are observed in almost all the investigated taxa.

It seems Kasapligil (1951) was the first to report the occurrence of isolated veins (cf. Herbst, 1972). He is followed by Foster (1966, 1968), Foster and Arnott (1960), Lersten (1965), Herbst (1972) and Inamdar and Murthy (1978) in recording their presence in several dicotyledonous plants.. According to Hara (1962) such isolated veins may be formed when certain extension cells fail to differentiate into vascular tissue. In the present work, isolated veins and isolated tracheids are observed.

The primary and secondary veins are surrounded by a multiseriate bundle sheath and vein-lets and vein endings have uniseriate bundle sheath. Wylie (1952) studied the bundle sheath of several dicotyledonous plants and found that bundle sheath cells are closely joined and intercellular spaces are not farmed. Rao (1981) observed intercellular spaces arising schizogenously in the contiguous wall of the sheath cells in *Trifolium dubium.* Such schizogenous intercellular spaces are not observed in the leaves of *Wrightia arborea* of Apocynaceae.

V. CONCLUSION

Based on result obtained in Wrightia arborea, there are very unique pattern found in Leaf architecture, where primary vein is thick and straight. They are pinnate, camptodromous venation. The secondary veins (2°) arise on either side of the primary vein in alternate fashion. The secondary veins are branched in *Wrightia arborea*, The branches may unite The inter-secondary veins are thinner than secondaries. Tertiary vein-lets are united with each other and produce loop in-between. In the present work, isolated veins and isolated tracheids are also observed.

VI. REFERENCES

[1] . Chandra, V., Mitra, R., Kapoor, S. L. and Kapoor, L. D., 1972.Epidermal and venation studies in Apocynaceae : IV Bull. Bot. Surv. India. 14 : 76 - 82.

[2] . de Bary, A., 1884. Comparative anatomy of the vegetative organs of the phanerogams and ferns. Clarendon Press, Oxford.

[3] . Dickision, W. C., 1969. Comparative morphological studies in Dilleniaceae - IV. Anatomy of node and vascularization of leaf. J. Arnold. Mb. 50 : 384 - 400.

[4] . Dickison, W. C., 1975. The base of angiosperm phylogeny. Vegetative anatomy. Ann. Missouri. Bot. Gard. 62 :590 - 620.

[5] . Foster, A. S. 1949.. Practical Plant anatomy. Van Mostrand, New York.

[6] . Foster, A. S. and Arnott, H. J., 1960. Morphology and dichotomous vasculature of the leaf of Kingdonia uniflora. Am. J. Bot. 75 : 684 - 698.

[7] . Foster, A. S., 1950. Morphology and venation of the leaf of Quiinaacutangula. Am. J. Bot. 37 : 159 -171.

[8] . Foster, A. S., 1966. Morphology of anastomoses in the dichotomous venation of Circaeaster. Am. J. Bot. 53, 588 - 599.

[9] . Foster, A. S., 1968. Further morphological studies on anastomoses in the dichotomous venation of Circaeaster. J. Arnold Arbor. 49 , 52 - 72.

[10] . Gupta, M., 1978. Cotyledon architecture in Trifolieae. Acta. Bot. India. 6 : 171 - 176.

[11] . Hara, N., 1962. Structure and seasonal activity of the vegetative shoot apex of Daphne pseudornezerettm. Bot. Gaz. 124: 30 - 42.

[12] . Hickey, L. J., 1973. Classification of the architecture of dicotyledonous leaves. Am. J. Bot. 60 : 17 - 33.

[13] . Hickey, L. J., 1979. A revised classification of the architecture of dicotyledonous leaves. In : C. R. Metcalfe and L.

[14] . Inamdar, J. A. and Murthy, G. S. R., 1978. Leaf architecture in some Solanaceae. Flora 167 : 265 - 272.

[15] . Kasapligil, B., 1951. Morphological and ontogenetic studies of Umbellularia californica Nutt. and Laurus nobilis L. Univ. Calif. Publ. Bot. 25 : 115 - 240.

[16] . Kerner, A. J. and Oliver, F., 1895. The natural history of plants. New York.

[17] . Lersten, N. R., 1965. Histogenesis of leaf venation in Trifoliumworinskioldii (Leguminosae). Am. J. Bat. 52 : 767-

[18] . Lersten, N. R., 1981. Testa topography in Leguminosae, Subfamily Popilionoideae. Proc. Iowa. Acad. Sci. 88 : 180 - 191.

[19] . Melville, R., 1969. Leaf, venation patterns and the origin of angiosperms. Nature 224 : 221 - 225.

[20] . Melville, R., 1976. The terminology of leaf architecture. Taxon. 25, 549 - 561.

[21] . Patel, B. R., 1999. Anatomical studies of the seeds and seedlings of some taxa of Papilionaceae. Ph. D. Thesis South Gujarat University. Surat, India.

[22] . PROTA, 2015. PROTA4U web database., ed. by Grubben GJH, Denton OA]. Wageningen, Netherlands: Plant Resources of Tropical Africa. http://www.prota4u.info

[23] . Rao, M. G., 1981. Anatomical studies in Papilionoideae, Tribe Trifolieae. Ph. D. Thesis, S. P. University, Vallabh Vidyanagar, Gujarat, India.

[24] . Shah, Ketaki., 2001. Anatomical studies on the seedlings of some taxa of Caesalpinae. Ph. D. Thesis, S. G. University, Surat, India.

[25] . Strains, R. W., 1933. A study of vein endings in leaves. Am. Mid. Natur. 14 : 367 - 373.

[26] . Sutarno H, Rudjiman H, 1999. Catharanthus roseus (L.) G. Don. Record from Proseabase. Proseabase ed. by Padua, L. S. de \Bunyapraphatsara, N. \Lemmens, R. H. M. J.]. Bogor, Indonesia: PROSEA (Plant Resources of South-East Asia) Foundation.

[27] . http://www.proseanet.org