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Leaf Architecture in some *Convolvulaceae*

By

J. A. INAMDAR and K. N. SHENOY *)

With 1 plate

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Abstract

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Leaf architecture is studied in 7 genera and 10 species of the *Convolvulaceae*. Leaves are simple, univeined. The venation pattern is pinnate, festooned brochidodromous. Major veins are jacketed by parenchymatous bundle sheath. Areoles are variable in size and shape and formed by all catagories of major and minor veins. Highest vein order is seen up to 5° or 6°. Vein endings whether simple or branched may or may not terminate in terminal tracheids. The nature of vein ending may be uniseriate or multiseriate. Terminal tracheids at the vein endings are variable in size, shape and orientation. Isolated free vein endings, isolated tracheids are observed. Transfusion tracheids and secretory idioblasts have also been noticed in some cases. Extension cells between the veins and tracheids are observed in several cases.

INAMDAR J. A. & SHENOY K. N. 1981. Blattbau bei einigen *Convolvulaceae*. — Phyton (Austria) 21 (1): 115–125, 1 Tafel. — Englisch mit deutscher Zusammenfassung.

Es wird der Blattbau von 10 Arten aus 7 Convolvulaceen-Arten untersucht. Der Blattbau ist einfach, die Nervatur pinnat und girlandenartig brachidodrom (im Sinne HICKEY's 1973). Die Hauptnerven sind mit Bündelscheiden versehen. Die Areolen variieren in Form und Größe, sie werden sowohl von Haupt- wie von Nerven höherer Ordnung gebildet, es kommen Nebennerven bis zur 5.–6. Ordnung vor. Die Endigungen sind einfach oder verzweigt, endständige Tracheiden sind vorhanden oder können fehlen, die Enden sind ein-

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*) J. A. INAMDAR and K. N. SHENOY, Department of Biosciences, Sardar Patel University Vallabh Vidyanagar 388 120, Gujarat, India.

oder mehrreihig, die endständigen Tracheiden variieren in Größe, Form und Orientierung. Isolierte freie Nervenendigungen und isolierte Tracheiden wurden beobachtet. In einigen Fällen finden sich Transfusionstracheiden und sekretorische Idioblasten, desgleichen „Extensionszellen“, d. s. Zellen zwischen den Nerven und Tracheiden.

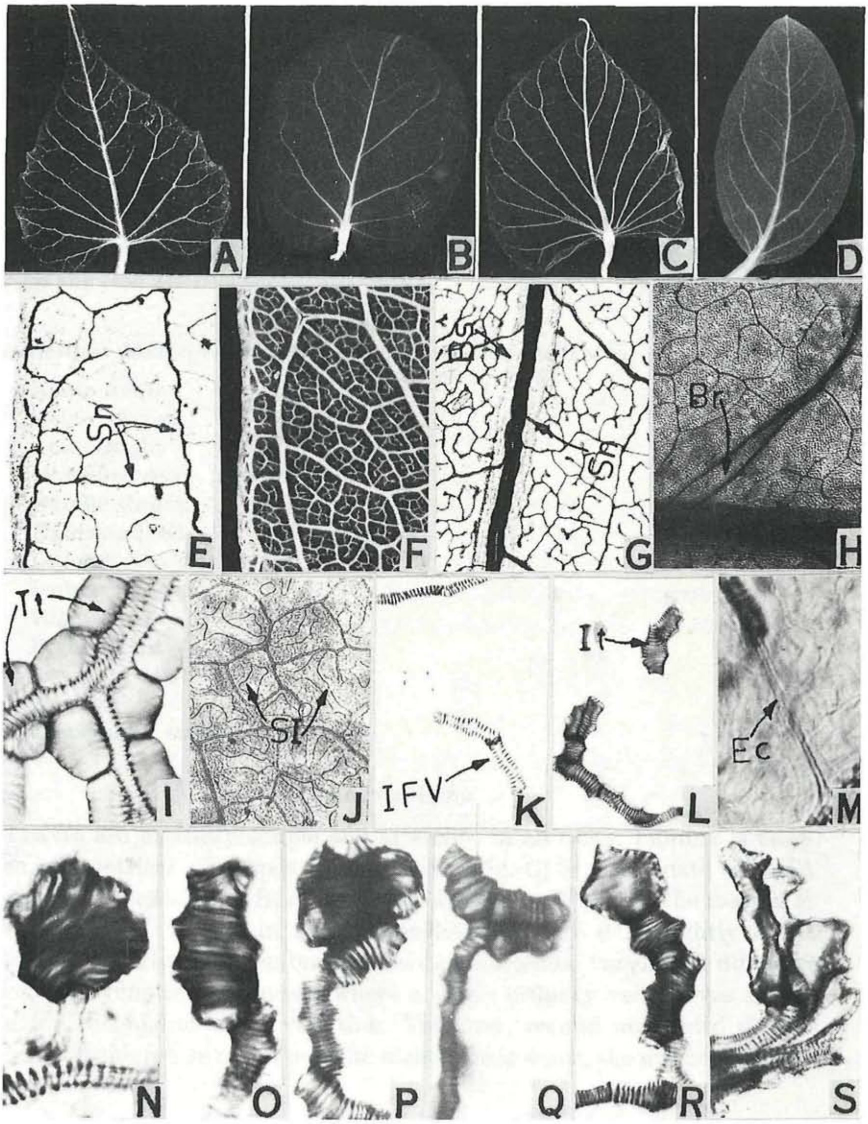
(Ed. transl., abbrev. and compl.)

Introduction

Leaves are highly polymorphic organs and provide sets of diverse features. The veins and veinlets which form the vasculature, called the 'venation', is an important feature of mature leaves. LEVIN (1929) and STRAIN (1933) discussed the taxonomic significance of veinislet areas and vein endings. FOSTER (1950a, b) studied the venation pattern in *Quiina acutangula*, *Touroulia guianensis* and *Foresia tricarpapires*. GUPTA (1961) studied the absolute veinlet termination numbers and absolute veinislet numbers in leaves of some Solanaceous plants. HICKEY (1973), HICKEY & WOLFE (1975) and MELVILLE (1976) classified the architecture of dicotyledonous and angiospermous leaves respectively. DILCHER (1974) reviewed it in the approaches to the identification of angiosperm leaf remains. PATEL & SHAH (1974) in their foliar studies of brinjal and chilli described the venation of lamina particularly vein endings. COLEMAN & GREYSON (1976) studied the leaf ontogeny in tomato and narrated the development of major and minor venation patterns. Leaf architecture and venation pattern studied in different families of dicotyledons are: *Berberidaceae* (SINGH *et al.* 1978), *Betulaceae* (FRANK 1979), *Bignoniaceae* (JAIN 1978), *Compositae* (BANERJEE & DESHPANDE 1973), *Euphorbiaceae* (SEHGAL & PALIWAL 1974), *Labiatae* (TYAGI & KUMAR 1978), *Rosaceae* (MERRILL 1978), *Scrophulariaceae* (VERGHESE 1969) and *Solanaceae* (INAMDAR & MURTHY 1978). The present work is undertaken to give a comprehensive account of the venation pattern and leaf architecture in 7 genera and 10 species of the *Convolvulaceae* as no report exists on the subject.

Material and Methods

Material of 7 genera and 10 species: *Calonyction speciosum* CHOISY, *Convolvulus arvensis* L., *Convolvulus microphyllus* (ROTH) SIEB., *Erycibe paniculata* ROXB., *Evolvulus alsinoides* (L.) L., *Evolvulus nummularius* (L.) L,. *Hewittia sublobata* (L. f.) O. K., *Jacquemontia paniculata* (BURM. f.) HALL. f., *Jacquemontia pentantha* (JACQ.) G. DON and *Porana paniculata* ROXB. were collected from Gujarat and Kerala states. The mature leaves were cleared in (i) 10% aqueous sodium hydroxide solution followed by sodium hypochlorite solution (PAYNE, 1969) and (ii) solution of trichloroacetic acid and phenol crystals mixed in 2 : 1 (by weight) at 60° C (MOHAN RAM & NAYYAR 1978). Cleared leaves were stained in fast green or Kores



Explanation to plate figures (A—S) showing cleared leaves, venation pattern, vein endings and other features of:

A. *Hewittia sublobata* (× 2); B. *Evolvulus nummularius* (× 4); C. *Calonyction speciosum* (× 2); D. *Evolvulus alsinoides* (× 4); E. *Jacquemontia pentantha* (× 36); F. *Erycibe paniculata* (× 4); G. *Convolvulus arvensis* (× 30); H. *Evolvulus nummularius* (× 10); I. *Convolvulus microphyllus* (× 220); J. *Evolvulus nummularius* (× 85); K. *Jacquemontia pentantha* (× 250); L. *Calonyction speciosum* (× 155); M. *Calonyction speciosum* (× 800); N. *Calonyction speciosum* × 680); O. *Calonyction speciosum* × 600); P. *Hewittia sublobata* (× 900); Q. *Calonyction speciosum* (× 300); R. *Hewittia sublobata* (× 540); S. *Erycibe paniculata* (× 175).

stamp pad purple ink (manufactured by Kores India Ltd. Bombay, 400 018). Staining in Kores pad ink (modified from MOHAN RAM & NAYYAR 1978) retains the stain for a considerable period. Photographs were taken with ZEISS photomicroscope-I, using yellow filter and ORWO NP 15 film. Leaf size was measured using graph paper. Areole size and number of vein endings were taken from five different fields of different leaves. Terminologies as defined by HICKEY (1973) and HICKEY & WOLFE (1975) are adopted to describe the leaf architecture.

Abbreviations used in the manuscript, plate figures and Table:

AA	Acute Acute
AO	Acute Obtuse
AR	Acute Right
Br	Branched secondary vein
Bs	Bundle sheath
Ec	Extension cell
IFV	Isolated free vein ending
It	Isolated tracheid
RA	Right Acute
RR	Right Right
SI	Secretory idioblasts
Sn	Sinuous
Tt	Transfusion tracheids

Observations

Leaves are basically simple and alternate in all cases. Lamina is more or less symmetrical. The apex is acuminate (Fig. C) or mucronate (Fig. D) or rounded/truncate (Fig. B) or obtuse or attenuate (Fig. A). The margin is entire in all cases except in *Hewittia sublobata*, where it is slightly lobed (Fig. A). The texture is membranaceous or coriaceous, varying in different species. The venation is pinnate where a single primary vein serves as the origin for the higher order venation. The first, second and third degree veins are considered as major and the higher order veins, the minor venation patterns.

Major venation pattern:

The primary vein is the thickest vein of the leaf and its thickness decreases gradually towards the apex and it gives off other degree veins on either side. In all cases, a single strand enters the base of the lamina from the petiole and forms the primary vein which after travelling a short distance branches laterally. Major veins are generally jacketed by parenchymatous sheath called 'Bundle sheath' (Fig. G). The thickness of the sheath may vary. Primary vein may be straight or sinuous (Fig. G). Sometimes, even 2° and 3° veins are sinuous (Fig. E, G). The primary vein is

Table 1

Qualitative Leaf Features of *Convolvulaceae*

(Abbreviations see Chapter Material and Methods)

Name of the taxa	Shape	Apex	Base	Margin	Texture	Primary vein size	Predominant tertiary vein angle	Marginal ultimate venation
Calonyction speciosum	ovate ovate	acuminate	cordate	entire	membranaceous	stout	RR, AA AR	incomplete
Convolvulus arvensis	ovate narrow ovate	acuminate	hastate	entire	membranaceous	stout	AA, RA RR	incomplete
Convolvulus microphyllus	elliptic narrow elliptic	obtuse	obtuse normal	entire	membranaceous	stout	AA, RR	incomplete
Erycibe paniculata	oblong narrow oblong	acuminate	acute	entire	coriaceous	stout	RR, RA AR	looped complete
Evolvulus alsinoides	elliptic elliptic	mucronate	obtuse normal	entire	membranaceous	massive	RR, AR	incomplete
Evolvulus nummularius	elliptic orbiculate	rounded/truncate	lobate	entire	membranaceous	massive	RR, AR	incomplete
Hewittia sublobata	ovate wide ovate	attenuate	lobate	serrate convex concave	membranaceous	stout	AR, RR AO	incomplete
Jacquemontia paniculata	ovate ovate	acuminate	cordate	entire	membranaceous	massive	AR, RR	incomplete
Jacquemontia pentantha	ovate narrow ovate	acuminate	cordate	entire	membranaceous	stout	AA, RR RR	incomplete
Porana paniculata	elliptic suborbiculate	rounded	cordate	entire	membranaceous	moderate	RR, AR	incomplete

mostly stout occasionally massive or moderate. The second degree veins are strongly brochidodromous. The secondaries have a set of secondary loops outside the main brochidodromous and thus forms 'festooned brochidodromous' type (Fig. A—D). The number of second degree veins on either side of the primary vein vary from 5 to 10. Intersecondary veins are observed in all cases. Rarely in *Evolvulus nummularius*, one of the secondary veins is peculiarly bifurcated at the point of origin from the primary. Eventually both the branches fuse to form common strand of secondary vein (Fig. H).

Minor venation pattern:

The highest order veins is identified up to 5 degree in most cases, but in some up to 6 degrees. The qualitative leaf features and numerical data on the venation pattern are charted in Table 1 and 2. Marginal ultimate venation is incomplete in all the species studied, except in *Erycibe paniculata* where it is looped and complete (Fig. F). The areoles are 'imperfect' and the shape may be triangular, orbicular, polygonal or rectangular. The size of the areole is not constant, varies in different species and even in the same species. The plasticity of venation characters is shown by the variations in areole size, number of veinlets per areole and organisation of terminal vein endings in different species.

Vein endings:

The ultimate veins of the leaf are either simple or branched. Simple vein endings may be linear or curved. The branched ones may divide dichotomously once or twice and branches may be symmetrical or asymmetrical. The veinlets are mostly uniseriate, biseriate or multiseriate. They may be long and thin or thick and short. Usually a large number of vein endings are present in a big areole (Fig. F, G). But in most of the cases where areoles are devoid of vein endings, a loop like structure is seen which is formed due to the union of veins or tracheids (Fig. E). Loop formation thus decreases the distance between the veins and help in transporting system.

Tracheids:

Tracheids are seen terminally at the vein endings. They vary in size, shape and orientation. The tracheids may be uniseriate or biseriate. Uniseriate tracheids are dilated and isodiametric (Fig. N) or elongated (Fig. O). They occur singly or in groups (Fig. R). Uniseriate tracheids may be juxtaposed or superimposed (Fig. R). Biseriate tracheids may be either isodiametric or elongated. A group of uniseriate tracheids wherein a group of juxtaposed dilated tracheids lie at right angles to an elongated tracheids is seen in *Hewittia sublobata* (Fig. P). A group of biseriate tracheids is seen in *Erycibe paniculata* (Fig. S). A group of both biseriate and uniseriate tracheids lying opposite to each other is noticed in *Calonyction speciosum* (Fig. Q).

Table 2

Numerical Data on the Venation Patterns of *Convolvulaceae* (average values)

Name of the taxa	Leaf area mm²	Number of 2° veins along one side of midrib	Angle between 1° & 2° vein	Veinlets entering areole per mm²	Vein ending termination per mm²	Size of the areole mm²	Absolute areole numbers (×1000)	Absolute vein termination number (×1000)	Highest vein order
Calonyction speciosum	772	5	30°—40°	28	65	1.0	0.77	50.18	6
Convolvulus arvensis	130	9	35°—40°	18	80	0.5	0.26	10.4	5
Convolvulus microphyllus	47	8	40°—45°	24	63	0.33	0.14	2.96	5
Erycibe paniculata	1406	5	32°—40°	8	28	1.0	1.4	39.37	5
Evolvulus alsinoides	23	5	42°—54°	21	54	0.33	0.69	1.24	5
Evolvulus nummularius	138	5	42°—48°	32	52	0.5	0.28	7.17	6
Hewittia sublobata	142	10	58°—66°	46	96	0.5	0.28	13.63	6
Jacquemontia paniculata	432	9	35°—40°	22	62	0.5	0.86	10.78	5
Jacquemontia pentantha	112	6	55°—75°	28	42	1.0	0.11	4.70	5
Porana paniculata	242	6	50°—62°	16	20	0.5	0.48	4.84	5

Isolated tracheids:

These are tracheids either uniseriate or biseriate, lying free in the areole (Fig. L). Sometimes tracheids are connected with the free vein ending by extension cells which are parenchymatous in nature. Such tracheids may be regarded as isolated, as they are not connected with the vein ending by tracheary elements.

Isolated vein endings:

These are vein endings either uniseriate or multiseriate with terminal tracheids lying free and disjunct in the areole.

Isolated free vein endings:

These are freely existing isolated vein endings in the areole without the terminal tracheids (Fig. K).

Extension cells:

These are parenchymatous cells which adjoin two veins or isolated tracheids with a vein (Fig. M). Extension parenchymatous cells have failed to differentiate into either sieve or tracheary elements and may be uniseriate or biseriate.

Transfusion tracheids:

These are relatively short, squarish box shaped cells with spiral or reticulate or pitted walls which occur along the borders of veins and vein endings (Fig. I). They are abundant at the apex and margin, gradually declining towards the remaining parts of the lamina. They have been observed in *Evolvulus alsinoides*, *E. nummularius*, *Convolvulus microphyllus*, and *Calonyction speciosum*.

Secretory idioblasts:

These are specific more or less variously elongated or branched cells, clearly distinguished from the other cells of the mesophyll tissue by their size and structure. These secretory idioblasts lie disjunct (Fig. J), and are seen in the mesophyll between veinlets. Their frequency is however, more towards the base and apex of the lamina.

Discussion

Leaf venation in angiosperm varies both in pattern (Hickey 1973) and regularity (Hickey & Doyle 1972). According to Pray (1954), the veins of first, second and third order form major venation pattern and those of subsequent orders constitute minor venation patterns. The venation pattern studied in 10 species of the *Convolvulaceae* conforms to festooned brochidodromous type of HICKEY & WOLFE (1975). According to HICKEY & WOLFE (1975), leaves of *Polemoniales* are basically simple, margin entire, venation pinnate, secondary veins are strongly brochidodromous and tending to form an intramarginal vein. The present observations are in accordance with those of HICKEY & WOLFE (1975) except the formation of intramarginal veins. The plasticity of venation varies in different species and sometimes in the same species by variations in areole size and shape; number of vein endings and other qualitative features. NICELY (1965) reported significant variations within the same leaf as regards the size and shape of areoles and number of vein endings in each veinislet. SEHGAL & PALIWAL (1974) on the basis of their study of venation pattern of 150 species of *Euphorbia*, have concluded that the size of the areole cannot be of much significant value particularly when there are large number of species in a genus, as the areole size overlaps considerably in several species. Since diversity of opinions exist regarding the size of the areole and number of vein endings, the statistical data will not be of any use. The number of vein endings are in no way connected to the size of the areole, as the nearby areoles even though more or less equal in size vary in their number of vein endings. Loop formation is a common feature in the areoles where there are few vein endings or none. Marginal ultimate venation is generally incomplete. HICKEY (1973) classified the vein endings into simple and branched. Branched ones divide once, twice or thrice dichotomously. In *Erycibe paniculata*, the veinlets are thick and multiseriate. In *Porana paniculata, Jacquemontia paniculata* and *J. pentantha*, they are long and uniseriate. Mostly tracheids at the vein endings increase the cell diameter and are extraordinarily variable in size, shape and orientation. Both uniseriate and biseriate tracheids are observed in different species. In the same areole both uniseriate and biseriate tracheids are observed at the veinendings. KASAPLIGIL (1951), FOSTER & ARNOTT (1960), HERBST (1972) have reported the occurrence of isolated veins in dicotyledonous leaves. SEHGAL & PALIWAL (1974) described the tracheidal elements lying free in the areole as 'free vein ending'. But there is no clear cut distinction between isolated veins, isolated free vein endings and isolated tracheids. FOSTER (1956) used the terms tracheary idioblasts (for dilated enlarged terminal tracheids at the vein endings) and tracheoidal idioblasts (for isolated tracheids that lie free and disjunct in the areole), though these structures donot show much difference. The term enlarged terminal tracheary idioblasts is used for such modified cellular entities occuring at the termination and in intimate continuation with the underlying normal or conventional tracheary elements. The term tracheoidal idioblasts is applied to those elements that are found isolated from and independent of the veins and vein endings (*see* TUCKER 1964). GOVINDARAJALU (1972) observed in 15 species of *Alangium*, the occurrence of tracheoidal idioblasts in varying proportion and combination. SEHGAL & PALIWAL (1974) designated uni, bi and tri veined leaves on the basis of number of strands entering the base of the petiole and serves as the origin for the higher order venation. Hara (1962) reported some elongated cells termed as extension cells between one vein and vein endings of another vein. Such cells have been observed in all the species studied. The primary veins are covered by a parenchymatous bundle sheath and in few cases even second and third degree veins. Foster (1972) described the occurrence of transfusion tracheids in the two species of *Ephedra*. Earlier, Scheit (1883) also reported such cells in *Ephedra altissima*, but called them 'tracheid border'. Occurrence of transfusion tracheids in the same species was also recorded by Thompson (1912). During the course of present observations, transfusion tracheids have been seen in *Calonyction speciosum*, *Convolvulus microphyllus*, *Evolvulus alsinoides* and *E. nummularius*. The occurrence of transfusion tracheids perhaps attributed to adaptive features. However, their presence in specific leaves alone indicates the localised need to compensate and assist the water distributing system. Secretory idioblasts have also been reported as isolated cells between palisade and spongy parenchyma in the *Convolvulaceae* by Metcalfe & Chalk (1950).

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