LEAF ARCHITECTURAL STUDY ON SOME MEMBERS OF CONVOLVULACEAE IN MANDALAY AND PYIN OO LWIN AREA*

Soe Myint Aye[1], Hnin Wai Lwin[2]

Abstract

Leaf architectural characteristics of the Family Convolvulaceae in Mandalay and Pyin oo lwin area were collected and studied during the year 2016 – 2017 . According to the identification 21 species of 7 genera were recorded in study area. The resulting species were one species of *Evolvulus*, *Jacquemontia*, *Operculina* and *Porana*, two species of *Argyreia*, five species of *Merremia* and ten species of *Ipomoea*. The leaves samples were decolorized by Method of Mishra *et al.* (2010) in Department of Botany, University of Mandalay. The qualitative features and the venation pattern of cleared leaves samples were characterized. It was found that the leaves were variously observed in shape, base, apex and margin. The margins were entire or 3-lobed. The primary veins were stout or massive and predominant tertiary vein angles were Right Right (RR), Acute Obtuse (AO), Obtuse Acute (OA), Right Obtuse (RO), Acute Right (AR), Right Acute (RA), or Acute Acute (AA). The marginal ultimate venations were looped, incomplete, or fimbriate. The primary vein categories are pinnate, actinodromous basal and actinodromous suprabasal. The secondary vein categories were brochidodromous, weak brochidodromous, cladodromous, weak cladodromous and actinodromous. Stoma types were anisocytic, anomocytic and paracytic. According to the quantitative characteristics, leaf areas were found to be variously between 40 mm^2 and 460 mm^2. The smallest leaf area was observed in *Evolvulus nummularis* (L.) L. and the largest one was in *Argyreia laxiflora* (Prain) Prain. The number of secondary veins along one side was variously observed between 4 and 13. The angle between primary and secondary vein, number of areoles per mm^2, veinlets entering areoles per mm^2, and highest vein order were different among the species. According to the different qualitative and quantitative characteristics, the leaf arichitecture provides valuable data for practical identification on members of Convolvulaceae.

Key words: Leaf architectural characters, Convolvulaceae, Myanmar

[1] Professor, Dr, Department of Botany, University of Mandalay
[2] M.Sc.-student, Botany, University of Mandalay

***Best Paper Award Winning Paper in Botany (2017)**

Introduction

Convolvulaceae, known as the morning glory family, is widely distributed in tropical, subtropical and temperate regions. The Convolvulaceae are mostly twining herbs or shrubs, sometime with milky sap, comprising about 85 genera and 2,800 species in the World (Qi-ming & De-lin, 2009). In Myanmar (Burma), Hundley & Chit Ko Ko (1987) recorded 13 genera and about 90 species.

Since the time of Linnaeus the identification and reconstruction of relationships between plants have been based largely on features of the reproductive organs. Although flower and fruit characters have proved very useful in both botany and paleobotany, there are situations in which these organs are not available for study. In spite of the success of Linnaeus's sexual system and its descendants, there is a great need to be able to identify and classify dispersed leaves (Ash *et al.* 1999).

Melville (1976) stated that leaf architecture was first used and described by Hickey(1973) to represent the position and form of elements constituting the outward expression of leaf structure including venation pattern, marginal configuration, leaf shape and gland position. Leaf architecture plays an important role in ecology, plant systematics, paleobotany and conservation. Venation patterns, in particular, for identifying and classifying plants.

The arrangement of the veins in the lamina is termed venation. The veins are differentiated into number of size classes depending upon their relative size at their point of origin and behavior in relation to other veins and to the margin of the leaf. The venation is pinnate where the primary vein or midrib serves as the origin for the higher order venation. The primary (1°), secondary (2°) and tertiary (3°) veins constitute the major and those of subsequent categories (4°, 5° etc.) including the ultimate veinlets, the minor venation (Melville 1976).

The principal characteristics of the leaf venation pattern of a species are, in general, genetically fixed. This priovide the basis for using the leaf venation as taxonomic tool. Mechanical demands, transport constraints and possibly other aspects, such as ontogenetic factors, are interlinked and form a complex pattern of factors contributing to the functional background of the evolution of leaf venation patterns (Roth-Nebelsick *et al.* 2001).

The leaves of extant terrestrial plants show highly diverse and elaborate patterns of leaf venation. One fundamental feature of many leaf venation patterns, especially in the case of angiosperm leaves, is the presence of anastomoses. Anastomosing veins distinguish a network topologically from a simple dendritic (tree-like) pattern with represents the primitive venation architecture. In palaeobotany, macrofossils showing leaf venation patterns are extensively utilized in identifying fossil taxa (Roth-Nebelsick *et al.* 2001). The high interspecific variability of leaf venation patterns indicates strong selective pressures acting on the architectural arrangement of the conducting bundles of a leaf. High variability is also demonstrated by the venation density which shows strong differences on the intra specific and individual level (Uhl & Mosbrugger 1999 as cited in Roth-Nebelsick *et al.* 2001).

Recent studies on leaf architecture of dicotyledons have much interest and led to several investigations in this field (Saibaba & Rao 1990). The study on leaf venation patterns puts forth several characteristics of leaf architecture that are diagnostics and help in the identification of species (Saibaba & Rao 1990).

Leaf architecture in some Convolvulaceae of India was studied by Inamdar & Shenoy (1980). A review of the literature revealed that no work has been done in this direction in the family Convolvulaceae of Myanmar, and therefore, the present study was undertaken to give a comprehensive account of the leaf architecture in Convolvulaceae and to evaluate its taxonomic significance. The present study was undertaken to examine the leaf architecture of the Convolvulaceae in order to provide additional information for generic circumscription and to shed new light on intrafamilial and interfamilial relationships of the family. The specific objectives of this investigation are to study leaf architecture of the Convolvulaceae, and to provide the data that will be applicable in practical identification when no reproductive organs can be found on plants.

Materials and Methods

The specimens of Convolvulaceae were collected from different localities of Mandalay area. Identification of specimen was carried out by using literatures Dassanayake (1980) and Qi-ming & De-lin (2009). Myanmar names were referred to Hundley & Chit Ko Ko (1987) and Kress *et al*. (2003).

The leaf samples of the resulting species, a total of 21 species under 7 genera of the Convolvulaceae, were prepared to study the leaf architectural characteristics. The mature fresh leaves were cleared following the method of Mishra *et al.* (2010). Leaves were immersed in 80% ethanol for 48-72 hrs to remove chlorophyll pigments. The leaf samples were then washed and treated again with 10% NaOH for 24-36 hrs. When the leaf sample becomes cleared, it was stained in 10% safranin for 30 minutes. The pattern of veins was prominent on the cleared leaf because of the absorbing of safranin. The sample was mounted with glycerin and preserved between the wax paper.

The leaf samples showing the prominent venation pattern were putting on light box and taken the photographs. Leaf area was measured by using graph paper method. The leaf base and leaf margin were observed under microscope and taken the photomicrographs. The stoma type was studied and taken a photo. The areole size and number of vein endings were taken from different leaves. The areole and veinlet frequencies per mm² were measured by the help of square ocular micrometer after comparing to 1 mm of stage micrometer. Terminologies of Hickey (1973) and Hickey & Wolfe (1975) have been followed to describe the leaf architecture in this investigation.

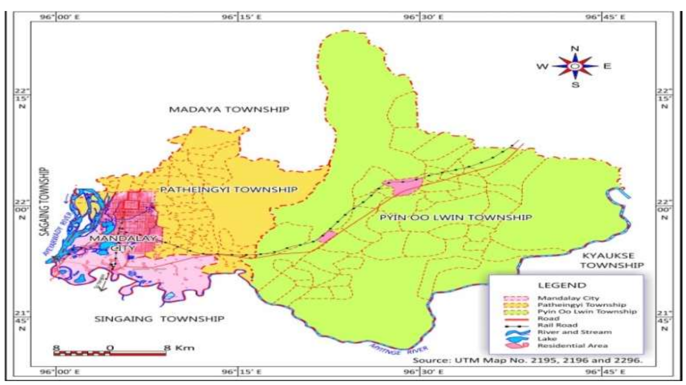

Figure 1. Location map of the specimens collected area

Results

The leaf architectural study on some members of Convolvulaceae in Mandalay area were collected, identified and studied their leaf characteristics. All together 21 species belonging to seven genera were included (Table 1). The leaf characteristics of the species were described systematically. Comparable Quantitative and Qualitative data on venation pattern of collected species was stated in Table 2 and Table 3. The cleared leaves of collected specimens represented the architectural characteristics were stated in Figure 2 and Figure 3.

Table 1 List of the Collected Species from Mandalay Area

Family	Species	Myanmar name
Convolvulaceae	1. *Argyreia hirsutissima* (Clarke) Raiz.	unknown
	2. *Argyreia laxiflora* (Prain) Prain	unknown
	3. *Evolvulus nummularis* (L.) L.	Kyauk kwe
	4. *Ipomoea aquatica* Forssk.	Ye kazun
	5. *Ipomoea biflora* (L.) Pers.	Le kazun yaine
	6. *Ipomoea cairica* (L.) Sweet	Tauk tet let wa
	7. *Ipomoea carnea* Jacq.	La thar pan
	8. *Ipomoea hederifolia* L.	Myat lay ni
	9. *Ipomoea indica* (Burm.f.) Merr.	Unknown
	10. *Ipomoea marginata* (Desr.) Verd.	Taw ka zun
	11. *Ipomoea obscura* (L.) Ker. Gawl	unknown
	12. *Ipomoea tricolor* Cav.	unknown
	13. *Ipomoea triloba* L.	Kazun yaing
	14. *Jacquemontia pentantha* (Jacq.) G. Don	unknown
	15. *Merremia aegyptia* (L.) Urban	unknown
	16. *Merremia emarginata* (Burm. f.) Hall. f.	Anya myin kwa
	17. *Merremia hederacea* (Burm. f.) Hall.f.	New shoke
	18. *Merremia umbellata* (L.) Hall. f.	Kazun war
	19. *Merremia vitifolia* (Burm. f.) Hall. f.	Sa pyit nwe
	20. *Operculina turpethum* (L.) S. Manso.	Kya hin bin
	21. *Porana volubilis* Burm. f.	Sein tha zin

Table 2. Qualitative Leaf Features of Collected Species of Convolvulaceae

Name of the taxa	Shape	Apex	Base	Margin	Texture	Primary vein category	Predominate tertiary vein angle	Marginal ultimate venation
Argyreia hirsutissima (Clarke) Raiz.	ovate	acuminate	cordate	entire	coriaceous	pinnate	RR, AO	looped
Argyreia laxiflora (Prain) Prain.	ovate	obtuse	cordate	entire	coriaceous	pinnate	OA, RO	looped
Evolvulus nummularis (L.)L.	elliptic	rounded	lobate	entire	membranaceous	pinnate	RR, AR	incomplete
Ipomoea aquatic Forssk.	ovate	acute	cordate	entire	membranaceous	pinnate	AO, RR	looped
Ipomoea biflora (L.) Pers.	broadly ovate	acuminate	cordate	entire	membranaceous	actinodromous	AA, AO	looped
Ipomoea cairica (L.) Sweet	elliptic - lanceolate	acute	acute	palmately loed entire	membranaceous	actinodromous	RR, AR	looped
Ipomoea carnea Jacq.	ovate	acuminate	cordate	entire	coriaceous	pinnate	AO, RA	looped
Ipomoea hederifolia L.	ovate	acuminate	deeply cordate	entire	membranaceous	actinodromous	AA, RO	fimbriate
Ipomoea indica (Burm.f.) Merr.	broadly ovate	acuminate	cordate	3-lobed entire	membranaceous	actinodromous	AR, RR	fimbriate
Ipomoea marginata (Desr.) Verd.	cordate	acuminate	cordate	entire	membranaceous	actinodromous	RO, OA	looped
Ipomoea obscura (L.) Ker. Gawl	cordate	acuminate	deeply cordate	entire	membranaceous	actinodromous	OA, RO	looped

Table 2 (Continued)

Name of the taxa	Shape	Apex	Base	Margin	Texture	Primary vein size	Predominate tertiary vein angle	Marginal ultimate venation
Ipomoea tricolor Cav.	ovate	acuminate	deeply cordate	entire	membranaceous	pinnate	RR, AO	fimbriate
Ipomoea triloba L.	ovate	mucronate	deeply cordate	entire	membranaceous	actinodromous	RR, AR	looped
Jacquemontia pentantha (Jacq) G. Don	ovate	mucronate	cordate	entire	membranaceous	pinnate	RA, RR	incomplete
Merremia aegyptia (L.) Urban	elliptic	acuminate	acute	palmately lobed entire	membranaceous	actinodromous	AA, AO	looped
Merremia emarginata (Burm.f.) Hall. f.	ovate to reniform	emarginate	cordate	entire	coriaceous	actinodromous	RO, AO	incomplete
Merremia hederacea (Burm. f.) Hall. f.	ovate	acuminate	Broadly cordate	entire	membranaceous	pinnate	AO, AR	incomplete
Merremia umbellata (L.) Hall. f.	ovate	rounded	cordate	entire	membranaceous	pinnate	RR, RO	looped
Merremia vitifolia (Burm. f.) Hall. f.	ovate	acuminate	cordate	palmately lobed entire	membranaceous	actinodromous	RO, RR	fimbriate
Operculina turpethum (L.) S.Manso.	ovate	mucronate	cordate	entire	membranaceous	pinnate	RO, OA	incomplete
Porana volubilis Burm. f.	ovate	acuminate	cordate	entire	membranaceous	actinodromous	OA, RA	looped

RR - Right Right, AO - Acute Obtuse, OA - Obtuse Acute, RO - Right Obtuse, AR - Acute Right, AA - Acute Acute, RA - Right Acute

Table 3. Quantitative Data on the Venation Patterns of Collected Species of Convolvulaceae (average values)

Name of the taxa	Leaf area in mm^2	Number of 2° vein along one side of midrib	Angle between 1° & 2° vein	Number of areoles per mm^2	Veinlets entering areole per mm^2	Highest vein order
Argyreia hirsutissima (Clarke) Raiz.	400	13-14	42˚-50˚	12	5	4
Argyreia laxiflora (Prain) Prain.	460	10-11	50˚-70˚	9	3	5
Evolvulus nummularis (L.) L.	40	5-6	30˚-40˚	18	6	5
Ipomoea aquatica Forssk.	270	8-9	40˚-60˚	6	2	4
Ipomoea biflora (L.) Pers.	130	7-8	45˚-50˚	15	7	5
Ipomoea cairica (L.) Sweet	150	10-11	40˚-55˚	10	5	4
Ipomoea carnea Jacq.	280	8-9	35˚-65˚	7	3	4
Ipomoea hederifolia L.	210	8-9	35˚-60˚	13	6	5
Ipomoea indica (Burm.f.) Merr.	360	5-6	40˚-60˚	8	4	5
Ipomoea marginata (Desr.) Verd.	230	6-7	50˚-70˚	18	9	5
Ipomoea obscura (L.) Ker. Gawl	240	7-8	45˚-75˚	16	7	5

Table 4.3 (Continued)

91

Name of the taxa	Leaf area in mm^2	Number of 2° vein along one side of midrib	Angle between 1° & 2° vein	Number of areoles per mm^2	Veinlets entering areole per mm^2	Highest vein order
Ipomoea tricolor Cav.	120	8-9	40˚-55˚	10	4	4
Ipomoea triloba L.	190	7-8	40˚-45˚	17	10	5
Jacquemontia pentantha (Jacq) G. Don	110	6-7	55˚-75˚	12	5	5
Merremia aegyptia (L.) Urban	290	11-12	32˚-50˚	14	6	4
Merremia emarginata (Burm. f.) Hall. f.	160	5-6	35˚-55˚	9	2	5
Merremia hederacea (Burm. f.) Hall. f.	130	8-9	45˚-75˚	8	2	4
Merremia umbellata (L.) Hall. f.	240	7-8	55˚-70˚	15	8	4
Merremia vitifolia (Burm. f.) Hall. f.	360	5-6	38˚-60˚	8	3	5
Operculina turpethum (L.) S. Menso.	330	9-10	40˚-65˚	13	5	4
Porana volubilis Burm. f.	370	4-5	42˚-55˚	20	13	5

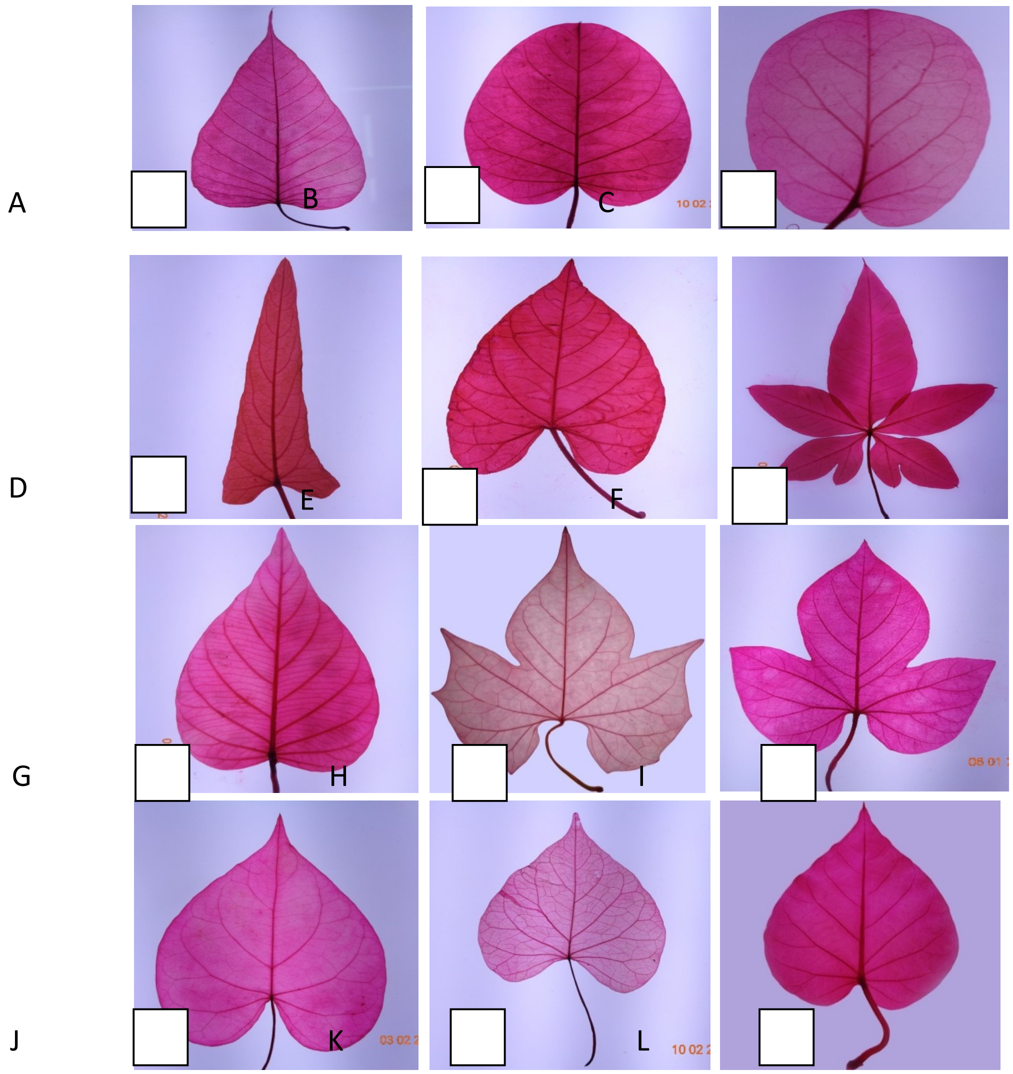

Figure 2. Cleared Leaves of **A**. *Argyreia hirsutissima* (Clarke) Raiz; **B**. *Argyreia laxiflora* (Prain) Prain.; **C**. *Evolvulus nummularis* (L.) L. ; **D**. *Ipomoea aquatica* Forssk.; **E**. *Ipomoea biflora* (L.) Pers. **F**. *Ipomoea cairica* (L.) Sweet ; **G**. *Ipomoea carnea* Jacq.; **H**. *Ipomoea hederifolia* L.; **I.** *Ipomoea indica* (Burm.f.) Merr.; **J.** *Ipomoea marginata* (Desr.) Verd. **K.** *Ipomoea obscura* (L.) Ker. Gawl **L.** *Ipomoea tricolor* Cav..

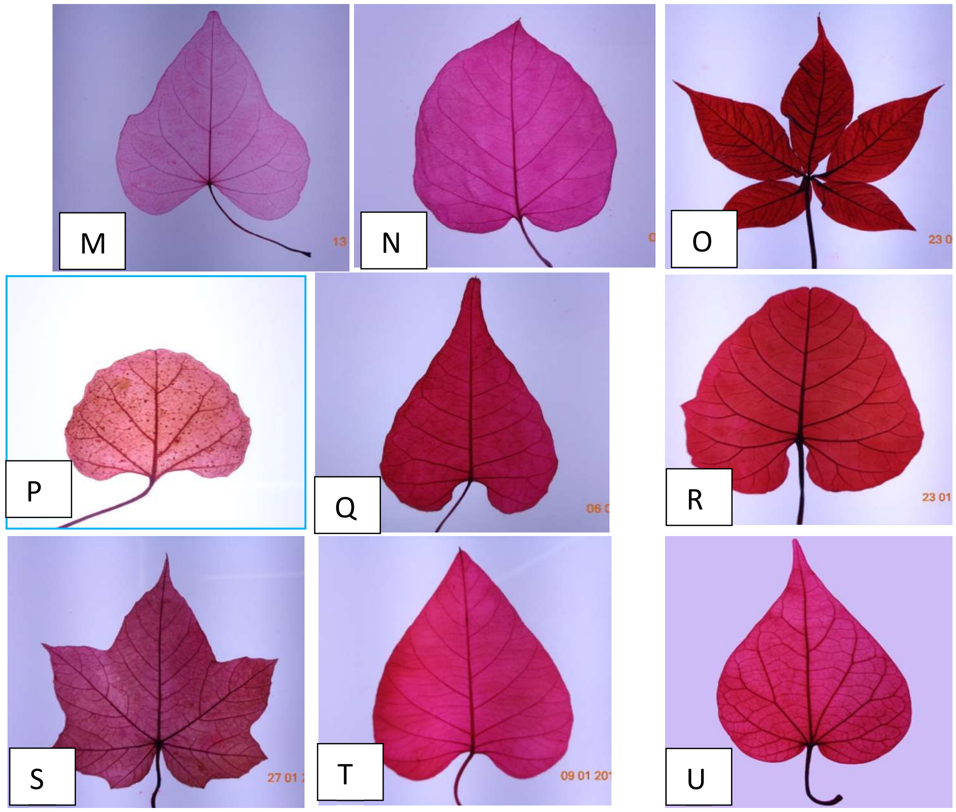

Figure 3. Cleared Leaves of **M.** *Ipomoea triloba* L.; **N.** *Jacquemontia pentantha* (Jacq) G. Don **O.** *Merremia aegyptia* (L.) Urban**.; P**. *Merremia emarginata*(Burm. f.) Hall. f. ;**Q.** *Merremia hederacea* (Burm. f.) Hall. f.; **R.** *Merremia umbellata* (L.) Hall. f. ;**S.** *Merremia vitifolia* (Burm. f.) Hall. f.; **T.** *Operculina turpethum* (L.) S. Menso.;**U.** *Porana volubilis* Burm. f.

Discussion and Conclusion

The present research work deals with the leaf architectural characteristics of Convolvulaceae found in Mandalay and Pyin oo lwin area. Altogether 21 species of 7 genera were identified based on the vegetative and reproductive characters of plant samples comparing with recent literatures and keys of Dassanayake (1980) and Qi-ming & De-lin (2009).

By the study on leaf architectural characteristics of cleared leaves, it was found that the leaves of collected species showed different characters of shape, apex, base, margin, texture. The venation patterns are also variable between the species. The leaves shapes are ovate in *Argyreia hirsutissima* (Clarke) Raiz., *Argyreia laxiflora* (Prain) Prain, *Ipomoea aquatica* Forssk, *Ipomoea carnea* Jacq., *Ipomoea hederifolia* L., *Ipomoea tricolor* Cav., *Ipomoea triloba* L., *Jacquemontia pentantha* (Jacq) G. Don, *Merremia hederacea* (Burm.f.) Hall. f., *M. umbellata* (L.) Hall. f., *Merremia vitifolia*, *Operculina turpethum* (L.) S. Manso and *Porana volubilis* Burm.f. The leaves are elliptic in *Evolvulus nummularis* (L.) L., and *Merremia aegyptia* (L.) Urban. The leaves of *Ipomoea biflora* (L.) Pers. and *Ipomoea indica* (Burm.f.) Merr. were broadly ovate. The leaves are elliptic-lanceolate in *Ipomoea cairica* (L.) Sweet. The leaves were cordate in *Ipomoea marginata* (Desr.) Verd. and *Ipomoea obscura* (L.) Ker. Gaw. The leaves were ovate to reniform in *Merremia emarginata* (Burm. f.) Hall. f.

The apex of the leaves were also different. It was acuminate in *Argyreia hirsutissima* (Clarke) Raiz., *Ipomoea biflora* (L.) Pers., *Ipomoea carnea* Jacq., *Ipomoea hederifolia* L., *Ipomoea indica* (Burm.f.) Merr., *Ipomoea marginata* (Desr.) Verd., *Ipomoea obscura* (L.) Ker. Gawl, *Ipomoea tricolor* Cav., *Merremia aegyptia* (L.) Urban., *Merremia hederacea* (Burm. f.) Hall. f., *Merremia vitifolia* (Burm. f.) Hall. f. and *Porana volubilis* Burm. f., obtuse in *Argyreia laxiflora* (Prain) Prain, rounded in *Evolvulus nummularis* (L.) L. and *Merremia umbellata* (L.) Hall. f., acute in *Ipomoea aquatica* Forssk. and *Ipomoea cairica* (L.) Sweet., mucronate in *Ipomoea triloba* L., *Jacquemontia pentantha* (Jacq.) G. Don and *Operculina turpethum* (L.) S. Manso., emarginate in *Merremia emarginata* (Burm. f.) Hall. f.

The base of the leaves was cordate in *Argyreia hirsutissima* (Clarke) Raiz., *Argyreia laxiflora* (Prain) Prain, *Ipomoea aquatica* Forssk., *Ipomoea biflora* (L.) Pers., *Ipomoea carnea* Jacq., *Ipomoea indica* (Burm.f.) Merr., *Ipomoea marginata* (Desr.) Verd., *Jacquemontia pentantha* (Jacq.) G. Don, *Merremia emarginata* (Burm. f.) Hall. f., *Merremia umbellata* (L.) Hall. f., *Merremia vitifolia* (Burm. f.) Hall. f., *Operculina turpethum* (L.) S. Manso., and *Porana volubilis* Burm. f., lobate in *Evolvulus nummularis* (L.) L., acute in *Ipomoea cairica* (L.) Sweet., and *Merremia aegyptia* (L.) Urban., deeply cordate in *Ipomoea hederifolia* L., *Ipomoea obscura* (L.) Ker. Gawl, *Ipomoea tricolor* Cav., and *Ipomoea triloba* L., broadly cordate in *Merremia hederacea* (Burm. f.) Hall.f.

The leaf margin was entire in *Argyreia hirsutissima* (Clarke) Raiz., *Argyreia laxiflora* (Prain) Prain, *Evolvulus nummularis* (L.) L., *Ipomoea* *aquatica* Forssk., *Ipomoea biflora* (L.) Pers., *Ipomoea carnea* Jacq., *Ipomoea hederifolia* L., *Ipomoea marginata* (Desr.) Verd., *Ipomoea obscura* (L.) Ker. Gawl, *Ipomoea tricolor* Cav., *Ipomoea triloba* L., *Jacquemontia pentantha* (Jacq.) G. Don, *Merremia emarginata* (Burm. f.) Hall. f., *Merremia hederacea* (Burm. f.) Hall. f., *Merremia umbellata* (L.) Hall. f., *Operculina turpethum* (L.) S. Manso. and *Porana volubilis* Burm. f., 3-lobed in *Ipomoea indica* (Burm.f.) Merr., palmately lobed entire in *Ipomoea cairica* (L.) Sweet., *Merremia aegyptia* (L.) Urban., and *Merremia vitifolia* (Burm.f.) Hall. f.

The texture of leaves was membranaceous in most of the study species. The coriaceous texture was observed only in *Argyreia hirsutissima* (Clarke) Raiz., *Argyreia laxiflora* (Prain) Prain, *Ipomoea carnea* Jacq. and *Merremia emerginata* (Burm.f) Hall. f. The primary vein size was stout in most of the species. The massive size was found in *Evolvulus nummularis* (L.) L., *Ipomoea biflora* (L.) Pers., *Ipomoea cairica* (L.) Sweet., *Ipomoea hederifolia* L., *Ipomoea marginata* (Desr.) Verd., *Ipomoea obscura* (L.) Ker.-Gawl, *Ipomoea triloba* L. and *Porana volubilis* Burm. f.

The maximum leaf area of *Argyreia laxiflora* (Prain) Prain. is 460 mm^2. The minimum leaf area of *Evolvulus nummularis* (L.) L. in 40 mm^2. The maximum number of areoles was *Porana volubilis* Burm. f. in 20 per mm^2. The minimum number of areole was *Ipomoea aquatica* Forssk. in 6 per mm^2. The highest vein order of 5 in most of the species. The highest vein order of 4 in *Argyreia hirsutissima* (Clarke) Raiz., *Ipomoea aquatica* Forssk., *Ipomoea cairica* (L.) Sweet., *Ipomoea carnea* Jacq., *Ipomoea tricolor* Cav., *Merremia aegyptia* (L.) Urban., *Merremia hederacea* (Burm. f.) Hall. f., and *Operculina turpethum* (L.) S. Manso.

Stoma type was anisocytic in *Argyreia hirsutissima* (Clarke) Raiz., *Ipomoea biflora* (L.) Pers., and *Ipomoea tricolor* Cav., paracytic in *Argyreia laxiflora* (Prain) Prain., *Ipomoea cairica* (L.) Sweet., *Ipomoea carnea* Jacq., *Ipomoea hederifolia* L., *Ipomoea marginata* (Desr.) Verd., *Merremia aegyptia* (L.) Urban., *Merremia hederacea* (Burm. f.) Hall.f., and *Merremia vitifolia* (Burm. f.) Hall. f.. It was anomocytic in *Evolvulus nummularis* (L.) L., *Ipomoea aquatica* Forssk., *Ipomoea indica* (Burm.f.) Merr., *Ipomoea obscura* (L.) Ker. Gawl, *Ipomoea triloba* L., *Jacquemontia pentantha* (Jacq.) G. Don, *Merremia emarginata* (Burm. f.) Hall. f., *Merremia umbellata* (L.) Hall. f., *Operculina turpethum* (L.) S. Manso. and *Porana volubilis* Burm. f.

The first comprehensive account of venation patterns in leaves was recorded by Ettinghausen (1861 as cited in Bhat 1995). Later Kerner & Oliver (1897) and Moutan (1970) classified the venation pattern of angiosperm leaves. They made an attempt to study the venation pattern and leaf architecture in some dicotyledons.

The present study of the leaf architecture in the family Convolvulaceae, with special reference to its taxonomic significance, is based exclusively upon the classification. The major venation pattern in all the species conformed to the typical pinnate actinodromous type. Therefore it is showing that this structure is constant criterion for taxonomic purposes in studying Convolvulaceae. Hickey (1973) stated that aeroles were well developed and usually exhibited free vein endings which were with or without terminal tracheids. Among the study species *Ipomoea hederifolia* L., *Ipomoea marginata* (Desr.) Verd., *Ipomoea obscura* (L.) Ker. Gawl., *Ipomoea tricolor* Cav., *Ipomoea triloba* L., *Jacquemontia pentantha* (Jacq.) G. Don. and *Merremia emarginata* (Burm.f.) Hall. f. possessing the terminal tracheids.

Ash *et al.* (1999) stated that the most systematically valuable features of leaves are in the venation, and quantification of vein networks. The initial sorting of a collection is usually done on the basic of toothed versus entire margins, primary and secondary vein patterns, and the presence and type of lobes. These characters are usually stable within morphotypes. According to the present study on Convolvulaceae also these characters are valuable characteristics.

Inamdar & Shenoy (1980) stated that the leaves of Convolvulaceae possess the highest vein order up to 5° or 6°. The number of second degree veins on either side of the primary vein vary from 5 to 10. In the present study the highest vein order was up to 5° and the number of second degree vein were found to be up to 14. Inamdar & Shenoy (1980) observed that eventually both the branches of secondary vein fuse to form common strand it was peculiarly bifurcated at the point of origin from the primary in *Evolvulus nummularis*. According to the present study these characteristics was also found in *Ipomoea hederifolia* L., *Ipomoea indica* (Burm.f.) Merr., *Ipomoea obscura* (L.) Ker. Gawl.

During the present study, simple or branched vein endings were observed. The marginal ultimate venation was incomplete and this remained more or less consistent within the species of one genus. The major leaf architectural characters, therefore, can be used for taxonomic consideration.

Bhat (1995) stated that because of the minor characters, such as aeroles and vein endings differ even within the species, they cannot be used as taxonomic criteria among the genus *Hibiscus*. Zhang *et al*. (2015) stated that characters from leaf venation were once considered difficult to use for taxonomic purposes, owing to problems with their description. The more detailed investigations of minor characters of venation of a wide range of species will be helpful for a better understanding of leaf architecture. In the present study, the leaf architectural characters are found as valuable characters for members of Convolvulaceae. Todzia & Keating (1991) stated that although leaf architecture of extant angiosperms has been shown to be useful to identify fossil remains and elucidate to intra- and interfamilial relationships, leaf architecture has been studied in only a relatively minute fraction of angiosperms. Therefore, it is needed to extend to research works on various members and groups of flowering plants.

It is sincerely concluded that the architectural characteristics of present study among the species under Convolvulaceae are the valuable evidence for taxonomic identification and systematic study on that family in the future.

References

Ash, A., B. Ellis, L. J. Hickey, K. Johnson, P. Wilf & S. Wing. (1999). Manual of leaf architecture. Department of Paleobiology, Smithsonian Institution, Washington DC.

Bhat, R. B. (1995). Taxonomic implications of leaf architecture in the genus *Hibiscus*. S., Afr. J. Bot. 61(4): 209-214.

Dassanayake, M. D. (1980). A revised handbook to the flora of Ceylon. Vol. I. New Delhi.

Hickey, L. J. 1973. Classification of the architecture of dicotyledonouis leaves. American Journal of Botany. Vol. 60. No.1:17-33.

Hickey, L. J. & J. A. Wolfe. (1975). The bases of angiosperm phylogeny vegetative morphology. Ann. Mo. Bot. Gdn. 62: 538-589.

Hundley, H. G. & Chit Ko Ko. (1987). List of trees, shrubs, herbs and principal climbers, etc. Fourth Revised Edition. Swe Daw Oo Press, Rangoon, Burma.

Inamdar, J. A. & K. N. Shenoy. (1980). Leaf architecture in some Convolvulaceae. Phyton (Austria) Vol. 21. 115-125.

Kerner, A. J. & F. Oliver. (1897). The natural history of plants. Blakie and Son; London.

Kress, J. W., A. D. Robert, F. Ellen & Yin Yin Kyi. 2003. A checklist of the trees, shrubs, herbs and climbers of Myanmar. Department of Systematic Biology-Botany. National Museum of Natural History, Washington DC. USA.

Melville, R. (1976). The terminology of leaf architecture. *Taxon* 25:549-561.

Mishra, M. K., D. Padmajyothi, N. S. Prakash, A. S. Ram, C. S. Srinivasan & M. S. Sreenivasan. 2010. Leaf architecture in Indian coffee (*Coffea araica* L.) cultivars and their adaptive sinificance. World Journal of Fungal and Plant biology 1 (2): 37-41.

Moutan, J. A. (1970). Architecture de la narvation foliar. *Compte rendu* 92: 165-176.

Qi-ming, H. U. & W. U. De-lin, 2009. Flora of Hong Kong Vol-3. Hong Kong Herbarium South China Botanical Garden, Chinese Academy of Sciences.

Roth-Nebelsick, A., D. Uhl, V. Mosburgger & H. Kerp. (2001). Evolution and function of leaf venation architecture. Annals of Botany 87: 553- 556.

Saibaba, A. M. & S. Raja Shanmukha Rao. (1990). Leaf venation studies in Indian *Sida* (Malvaceae). Plant Anatomy and Taxonomy Laboratory, Department of Botany, Sardar Patel College, India.

Todzia, C. A. & R. C. Keating. (1991). Leaf architecture of the Chloranthaceae. Ann. Missouri Bot. Gard. 78: 476-496.

Uhl, D. & V. Mosbrugger. (1999). Leaf venation density as a climate and/ or environmental proxy – a critical review and new data. Palaeocli-matology Palaeogeography Palaeoecology 149: 17-30.

Zhang, Z., N. Xia & R. J. Gornall. (2015). Leaf venation patterns in the genus *Saxifraga* (Saxifragaceae). Phytotaxa 221 (2): 123-136.