FOLIAR VENATION PATTERNS IN *POLYGONUM* SPECIES

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ABSTRACT

Venation patterns of 12 species of *Polygonum* L. have been studied to determine their value in the systematics of this genus. The major venation pattern is pinnate, camptodromous type; the primary or 1° vein gives rise to secondaries in the opposite or sub-opposite manner. The angle of divergence of secondary veins is narrow to wide acute in the various species. The veins of the next order, i.e. tertiaries or quaternaries are quite thin. They are randomly oriented and form a dense reticulum. Distinct bundle sheath has been observed in *P. amplexicaule*, *P. aviculare*, *P. emodi*, *P. plebejum*, *P. recumbens* and *P. serrulatum*, composed of rectangular elements. The development of areoles is perfect, though their shape and size is highly variable. In *P. serrulatum*, 1.8 vein-endings have been counted per areole whereas in *P. delicatum* this figure is only 1.0 per areole. The highest ramification of vein-tips has been observed in *P. serrulatum* (3.4 per areole) and lowest in *P. delicatum* (1.2 per areole). Thus alongwith the distinct epidermis, venation patterns, especially the minor venation, areole size, number of vein-endings, and vein-tips, free vein-endings as well as presence of bundle sheath are the features which may be extremely helpful in the identification of *Polygonum* species and should find a mention in any treatment dealing with the systematics of the genus.

INTRODUCTION

Polygonum has been a problematic genus to the taxonomists since long. Diverse criteria have been employed in the past to resolve this difficulty. These include the study of type of inflorescence, cytology, embryology, etc. However, emerged from these attempts so much so that some of the biosystematists still consider it as an everfresh 'riddle'.

Recently, foliar venation has been tested to provide great value for taxonomic study especially when used with other charcateristics, since by itself its usefulness is rather limited. Furthermore, it has been shown that minute anatomical characters of leaves, such as accumulation of tracheids and presence or absence of tracheidal nodules, taken singly, also appear to furnish significant contribution for taxonomic consideration. The present work on *Polygonum* was undertaken to find whether or not characters of leaf morphology and anatomy could provide some data towards the solution of such problems in this genus.

The comparative analysis of foliar venation which is the main theme of the present study, has attracted the attention of several morphologists and anatomists over a long period. For instance, as early as 1895, KERNER AND OLIVER offered a broad classification of venation patterns. Subtle variations in the leaf venation have long been useful to palaeobotanists, and the early work of VAN ETTINGSHAUSEN (1861) is still very valuable from such a point of view.

In matters of phylogeny also, the major venation patterns have provided significant information. For example, FOSTER (1959, 1966) has suggested that the open dichotomous venation of the ranalean genera, *Kingdonia* and *Circaster*, may be primitive within the angiosperm, and this idea seems worthy of consideration. On the other hand, SUBRAMANYAM AND BANERJI (1967) encountered a similar situation in several species of

Utricularia, a member of the comparatively advanced family, Lantibulariaceae and suggested that the dichotomous venation might be an adaptive feature. SOLBRIG (1960) has also recorded this feature in the *Raoulia*, a member of the Asteraceae, and considers it to be a derived rather than primitive character. Recently, MELVILLE (1969) has traced the evolution of angiospermous leaf by comparing the venation patterns of living plants from the continents which once formed the Gondwanaland with their fossil records (*cf.* also ALVIN & CHALONER, 1970).

In addition, several authors have shown that careful description of venation, together with studies of other details of leaf anatomy, can supplement the various taxonomic features (CARLQUIST, 1959 ; DEDE, 1962 ; VARGHESE, 1969). The work of PRAY (1955a, b) also suggests that distinctive patterns of minor vein ontogeny as well as mature venation can bear comparative analysis.

MATERIALS AND METHODS

We have selected the leaves of following species for the present investigation : (Locality of collection Tungnath, Garhwal) : 1. *Polygonum amplexicaule* D. Don, 2. *P. aviculari* Linn., 3. *P. capitatum* Buch-Ham ex D. Don, 4. *P. plebejum* R. Br., 5. *P. vaccinifolium* Wall. ex Meissn., 6. *P. glabrum* Willd., 7. *P. emodi* Wall. ex Meissn., 8. *P. viviparium* Linn., 9. *P. delicatum* Meissn., 10. *P. serrulatum* Lagasc., 11. *P. recumbens* Royle ex Bad., 12. *P. nepalense* Meissn.

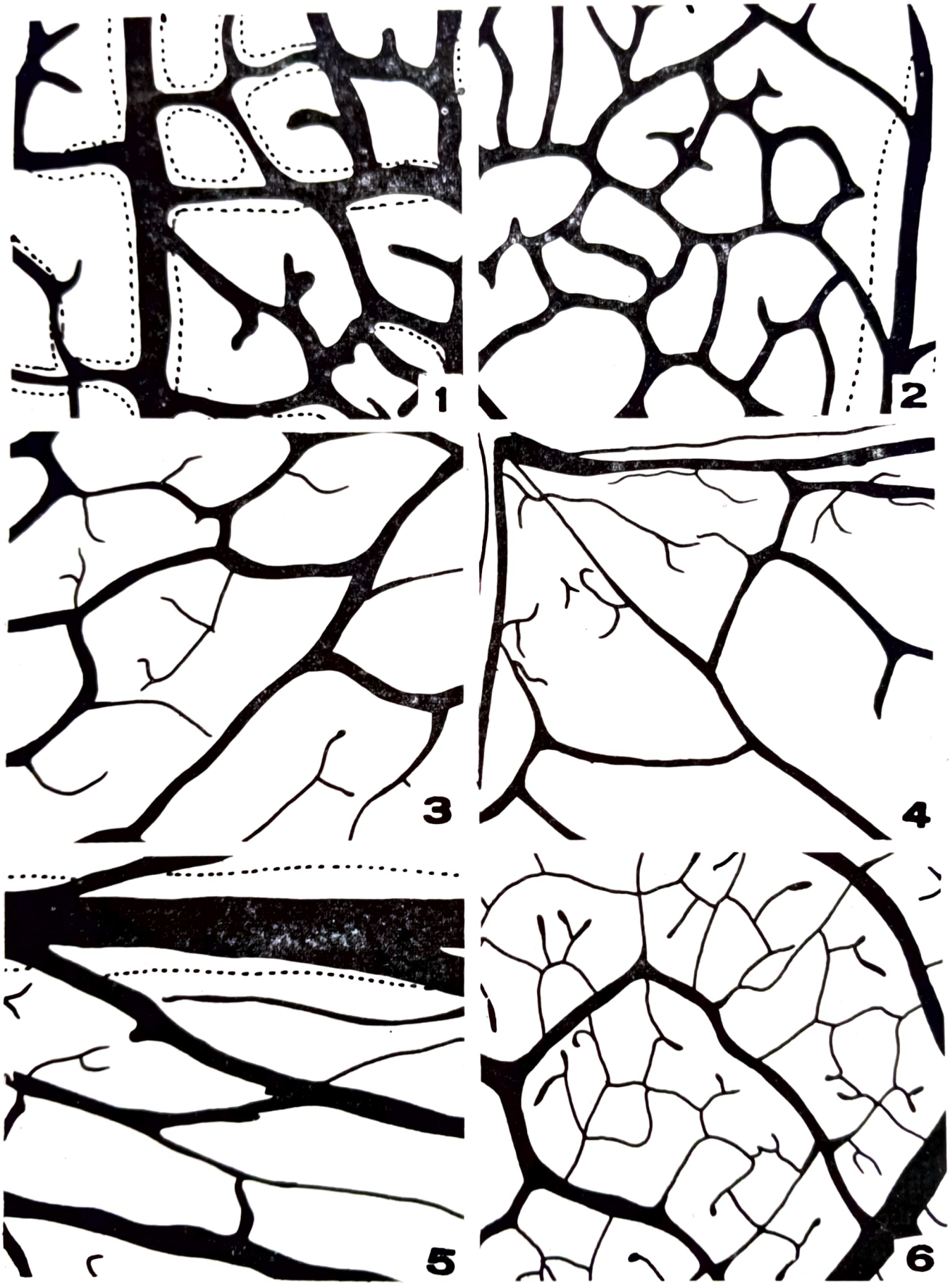
Fresh leaf material was employed for the present investigation. The clearing method adopted was that proposed by PALIWAL AND KAKKAR (1969). In brief, it consisted of softening the dried leaves by keeping them in warm water overnight, whereas the pickled leaves were transferred directly from FAA into the clearing series. These were at first kept in 5 per cent aqueous solution of sodium hydroxide for 2-6 days at 60°C to soften the tissues and remove the pigments. Later they were thoroughly washed with water to remove the alkali. Further the material was shifted to the mixture of hydrogen peroxide and saturated aqueous solution of chloral hydrate (1 : 1) till it became completely transparent. The leaves were then passed through a descending series of chloral hydrate (75, 50 and 25%) by dipping them for about ten minutes in each grade and finally washed in water.

Dehydration has been carried out by passing through an alcohol series (25, 50, 70, 90% and absolute) and staining with 1 per cent safranin dissolved in a mixture of xylene and absolute alcohol (1 : 1). The time given was five minutes in each grade and mounting were done in canada balsam. For large leaves/leaflets parts from the middle region besides the midrib have been marked out after mounting so as to make detailed study of vascularization from the particular region.

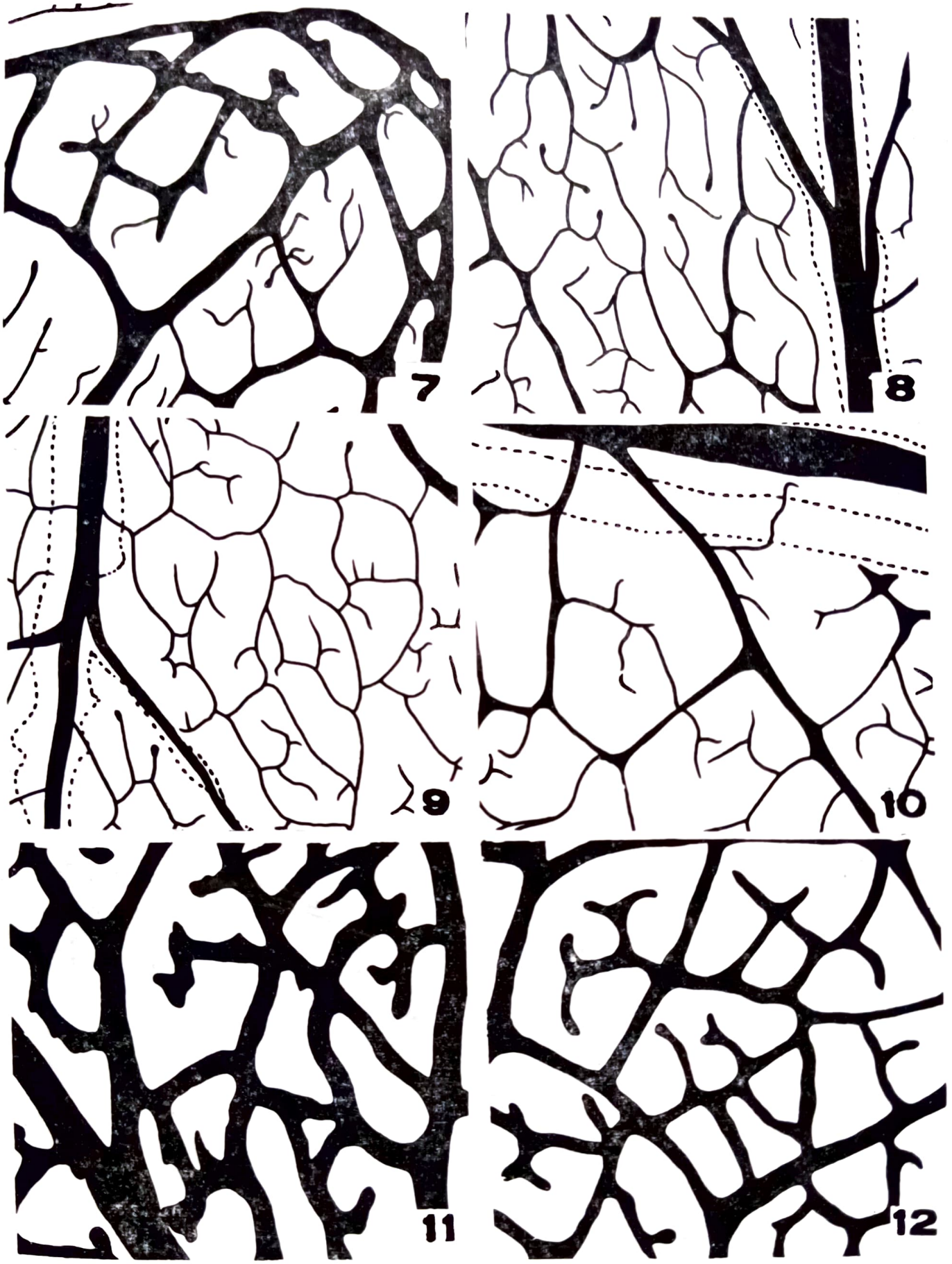
In the case of such taxa for which complete leaves could not be procured due care was taken to clear those pieces which were attached to midrib. In an attempt to provide as accurate picture of type of venation as possible, specific observations have been taken from the same marked region for which illustrations have been drawn. We are fully aware that such a comparison is subject to criticism by developmental morphologists, but under the circumstances this appeared to us to be the best course to follow for the type of investigation and analyses we have undertaken.

OBSERVATIONS

Species of *Polygonum* bear leaves of variable configuration : alternate, opposite or whorled, and may be persistent, deciduous or caducous and sessile or sub-sessile, or



Figs. 1—6. iFolar venation patterns in *Polygonum* species : (1) *P. amplexicaule;* (2) *P. aviculare;* (3) *P. capitatum;* (4) *P. delicatum;* (§) *P. emodi;* (6) *P. glabrum.* A11×70.



Figs. 7—12. Foliar venation patterns in *Polygonum* species: (7) *P. nepalense*; (8) *P. plebejum*; (9) *P. recumbens*; (10) *P. serrulatum*; (11) *P. vaccinifolium*; (12) *P. viviparium*. All×70.

even petiolate. The margins range from entire to serrate, distantly serrulate, serrulate towards the tip, dentate or even crenate. The apices may be acute, obtuse, mucronate, apiculate or acuminate.

The major venation pattern is often pinnate, camptodromous type. The primary or 1° veins give rise to secondaries in an opposite or sub-opposite manner. The angle of divergence of secondary veins is narrow acute to wide acute in the various species. The veins of the next order, i.e. tertiaries and quaternaries are quite thin. The bundle sheath has been observed in *P. amplexicaule* (Fig. 1), *P. aviculare* (Fig. 2), *P. emodi* (Fig. 5), *P. plebejum* (Fig. 8), *P. recumbens* (Fig. 9) and *P. serrulatum* (Fig. 10) being composed of rectangular elements. The development of areole is perfect though their shape and average size is highly variable as given in the following table.

Table 1—Areole size, vein-endings and vein-tips per areole

Taxa studied	Areole size (mm^2)	Vein-endings (per areole)	Vein-tips (per areole)
Polygonum aviculare	428.3	1.1	2.9
P. capitatum	957.4	1.4	2.2
P. amplexicaule	381.0	1.3	2.3
P. delicatum	545.1	1.0	1.2
P. emodi	446.7	1.3	2.4
P. glabrum	388.4	1.3	2.5
P. nepalense	780.5	1.0	1.3
P. plebejum	219.1	1.3	1.7
P. recumbens	268.8	1.7	2.1
P. serrulatum	577.8	1.8	3.4
P. vaccinifolium	384.7	1.7	2.3
P. viviparium	443.9	1.2	2.2

DISCUSSION

A survey of literature on leaf anatomy reveals that the data obtained from it have been employed amply for the elucidation of taxonomic and phylogenetic relationships. The commonly used characters are venation patterns, structure of epidermis (stomata, trichomes, cuticle), laticifers, and general anatomy of the leaf, petiole, and node.

Two trends become apparent from the analysis : either the anatomical features of the leaf have been employed singly or in conjunction with the characters drawn from disciplines other than morphology and anatomy. Examples for the former are found in the contributions of Morley (1953) on the revision of the genus *Mouriri*, Hagerup (1953) on the several monocotyledonous families. The usefulness of the anatomy in Gramineae is suggested by the work of Prat (1932) and Stebbins (1956). The studies of Brady *et al.* (1964) and Simola (1968) on several leguminous taxa indicate the taxonomic value of floral and foliar vasculature in this group. Recently Paliwal and Kakkar (1970) have even supported the erection of a separate family, Garryaceae, on this basis.

On the other hand, ERDTMAN AND METCALFE (1963), FORMAN (1966), and PALIWAL (1966) couple the leaf features with the information obtained from pollen morphology, cytology, and embryology in drawing phylogenetic conclusions. Various aspects thus emerged from these studies on the morphology and anatomy of leaves of 12 species of *Polygonum* have been assessed, particularly in relation to the diversity of habit and habitat and earlier conclusions with regard to the classification of this interesting taxon. A perusal of literature reveals that some of the more important lacunae which still exist in our knowledge of the mature venation pattern among angiosperms are :

(1) To what extent do climatic factors influence the various features associated with the veins ?

(2) Which of the venation features are more important from the systematic viewpoint and to what degree ?

(3) What is the plasticity of venation characters within various species of a genus or different genera of a family ?

LEVIN (1929) has postulated that vein-islet numbers in a unit area is more or less constant for a species. GUPTA (1961) has proposed that the absolute number of vein-islet and vein-endings are constant for a species in a mature leaf. On the contrary, studies of NICELY KENNITH (1965), SEHGAL AND PALIWAL (1974) and SINGH *et al.* (1974) have shown their variation in shape, size, and absolute number of vein-islet and vein-endings in a unit area in mature leaves. All these authors opine that venation pattern can be of a major value, along with other characters of the leaf. Our observations of *Polygonum* lend support to their findings.

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