Venation pattern in some Indian species of *Grewia* Linn.

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Venation pattern in 14 Indian species of *Grewia* Lin. is described and its taxonomic significance is discussed. A key to the species has been provided.

Key-words – Angiosperm, Leaf venation pattern, *Grewia*, Tiliaceae.

INTRODUCTION

THE genus *Grewia* Linn. in India is distributed both in peninsular as well as extra-peninsular regions. It has a long geologic history in India, beginning from Palaeocene and is found both in the form of woods as well as leaf-impressions. Since venation studies have been found to be of relevance not only in systematics but also in the indentification of fossil leaves (Foster, 1936, 1952; Hall & Melville, 1951, 1954; Wolfe, 1959; Krusmann, 1960; Stace, 1965; Mouton 1966, 1967; Lucic, 1970; Madler & Straus, 1971; Ferguson 1971; Walther, 1972; Hickey, 1973, 1979; Dilcher, 1974). An attempt has been made to study the venation details of the leaves of 14 Indian species of *Grewia* Linn. and assess its taxonomic significance. Such studies in the genus *Grewia* are so far restricted only to *G. optiva* (Badola *et al.*, 1983).

MATERIAL AND METHOD

The mature leaves of most of the species were collected from plants growing in forests of Maharashtra. A few were also collected from Karnataka, Andhra Pradesh and Dehra Dun. Their identity was ascertained with the reference collection of *Grewia* species from the Herbarium, Western Circle, Botanical Survey of India, Pune. The vouchered specimens are deposited in R.J. College, Ghatkopar, Bombay. The leaves were cleared by treating with sodium hypochlorite. They were stained in Safranin and mounted in glycerine jelly.

The terminology used in describing the venation pattern is after Hickey (1979). The terms massive, stout and moderate used for the size of primary vein are based upon the formula suggested by Dilcher (1974).

OBSERVATION

General leaf architectural features of *Grewia*

Leaves petiolate, lamina symmetrical or asymmetrical; base symmetrical or asymmetrical; shape oblong, ovate-oblong, oblong-lanceolate, oblong-elliptic, lanceolate, roundish ovate or narrow obovate; apex mostly acute, acuminate in some, rarely obtuse; base mostly cordate, rounded in few, rarely cuneate; margin serrate/crenate with irregular spacing, minutely serrate-dentate or bidentate; texture scabrous or glabrous, in a few species tomentose beneath or villose on mid-rib; glands absent.

Venation actinodromous; position of first point of primary vein radiation either basal or suprabasal; development perfect, reticulate, marginal or imperfect-reticulate. Primary veins (1^{o}) three or five, massive or stout, central primary vein unbranched, straight or curved, the lateral primary veins (1^{o}) nearly straight, branched or unbranched. Angle of divergence of secondary veins (2^{o}) acute, narrow or narrow to moderate, upper secondary veins more obtuse than lower, thick, curved uniformly. Loop forming branches either absent or enclosed by (3^{o}) or (4^{o}) - secondary arches. Intersecondary and intramarginal veins absent. Angle of origin of tertiary veins (3^{o}), AA, RR, RA, AR and RO; pattern percurrent, veins arising from lateral - primary veins (1^{o}) also percurrent; course mostly simple, sometimes forked, convex and sinuous; mostly at right-angles to the midrib, oblique and/or angle - decreasing apically; arrangement predominantly alternate, opposite in some. Higher venation order distinct, 3^{o}, 5^{o}, 6^{o} or 7^{o}; the marginal ultimate venation either fimbrial or

incomplete. Veinlets absent, when present simple, curved, unbranched or branched once or twice. Areoles well-developed or imperfect, random or oriented, triangular, quadrangular, pentagonal, polygonal or irregular. Tooth apex non-glandular, apical termination mostly simple, rarely setaceous. The tooth supplied directly by -centrally traversing secondary or tertiary veins; accessory veins absent.

Diagnostic features of the species

1. *Grewia umbellata* Roxb. (Pl. 3, figs 41-44)– Leaf oblong- elliptic. Tertiary veins (3°), angle of origin OR, RR. Quarternary veins (4°), thin, relatively randomly oriented. Quinternary veins (5°), thin, random. Highest vein order 5°.
2. *G. abutilifolia* Vent. ex Juss. (Pl. 1, figs 5-8) – Leaf roundish ovate-cordate. Secondaries from the central primary vein (1°) narrow while those from lateral primary veins (1°) moderate. Highest vein order 3°.
3. *G. asiatica* Linn. (Pl. 3, figs 49-52) – Leaf ovate or sub- orbicular. Primary veins (1°), five. Angle of divergence of secondary veins (2°) acute, narrow, variation in angle of divergence nearly uniform. Tertiary veins (3°) mostly simple, sometimes forked, mostly convex, few straight and sinuous. Highest vein order 3°.
4. *G. columnaris* sm. (Pl. 3, figs 45-48) – Leaf oblong. Course of primary veins (1°) straight. Quarternary veins (4°). Quinternary veins (5°) thin, orthogonal. Highest vein order 6°.
5. *G. flavescense* Juss. (Pl. 1, figs 1-4) – Leaf oblong-lanceolate. Variation in angle of divergence of secondary veins (2°) nearly uniform. Loop forming branches join superadjacent secondaries at right angles. Quarternary veins (4°) and quinternary veins (5°) thin, orthogonal. Highest vein order 5°.
6. *G. heterotricha* Mast. (Pl. 2, figs 25-28) – Leaf ovate-oblong. Course of the central primary vein (1°) straight, that of the lateral primary veins (1°) curved. Tertiary veins (3°) alternate and opposite in equal proportions. Quarternary veins (4°) and quinternary veins (5°) thin, orthogonal. Highest vein order 6°.
7. *G. orientalis* Linn. (Pl. 1, figs 9-12) – Leaf ovate-lanceolate. Course of primary veins slightly curved. Course of tertiary veins (3°) mostly simple, very few forked, mostly convex and few sinuous. Quarternary veins (4°) and quinternary veins (5°) thin, orthogonal. Highest vein order 6°.
8. *G. rotundifolia* Juss. (Pl. 3, figs 53-56) – Leaf narrow-obovate; apex obtuse. Primary veins (1°) five, central three massive, the lateral two stout, centrals curved, laterals straight to slightly curved. Arrangement of tertiary veins (3°) alternate and opposite in nearly equal proportions. Quarternary veins (4°) and quinternary veins (5°) thin, orthogonal. Highest vein order 6°.
9. *G. serrulata* DC. (Pl. 3, figs 37-40) – Leaf narrow-obovate; apex attenuate; base cuneate. Secondary veins (2°) curved uniformly. Loop forming - branches enclosed by 3° or 4° secondary arches. Quarternary veins (4°) thin, relatively randomly oriented. Quinternary veins (4°) thin, random. Highest vein order 7°.
10. *G. villosa* Willd. (Pl. 1, figs 17-20) – Leaf roundish ovate to cordate, apex acute to sub-acute; margin rounded, crenate- serrate, serrators with tuft of hairs; texture rugose above and villose beneath. Primary veins (1°) three, laterals branches at the base; secondary veins (2°), angle of divergence acute, narrow to moderate. Highest vein order (3°). Apical termination of tooth setaceous.
11. *G.laevigata* Vahl. (Pl. 1, figs 13-16) – Leaf lanceolate, apex acuminate. Angle of divergence of secondary veins (2°) acute, narrow; loop forming branches enclosed by 3° or 4° secondary arches. Quarternary veins (4°) and quinternary veins (5°) thin, orthogonal. Highest vein order 6°. Marginal ultimate - venation looped.
12. *G. polygama* Roxb. (Pl. 2, figs 21-24) – Leaf oblong-lanceolate; margin serrate, serrators regularly spaced in lower half, irregularly in upper; texture glabrous above and velvety beneath. Quarternary veins (4°) thin, relatively randomly oriented. Quinternary veins (5°) thin, orthogonal. Highest vein order 6°. Marginal ultimate venation incomplete.
13. *G. tiliaefolia* Vahl. (Pl. 2, figs 29-32) – Leaf roundish ovate-cordate, apex acuminate; texture membranous and scabrous. Primary veins (1°) three, lateral primary veins curved and branched; secondary veins (2°), angle of divergence acute, narrow to moderate. Tertiary veins (3°) predominantly opposite towards the basal part and alternate towards the upper. Quarternary veins (4°) thin, orthogonal. Quinternary veins (5°) thin, random. Highest vein order 6°. Marginal ultimate venation looped. Areoles imperfect, random.
14. *G. microcos* Linn. (Pl. 2, figs 33-36) – Leaf elliptic-oblong, apex acuminate. Secondary veins (2°), loop forming branches joining super-adjacent secondary at right/obtuse angle, enclosed by 3° or 4° secondary arches. Quarternary veins (4°) and quinternary veins (5°) thin, orthogonal. Highest vein order 6°. Veinlets rarely simple, linear.

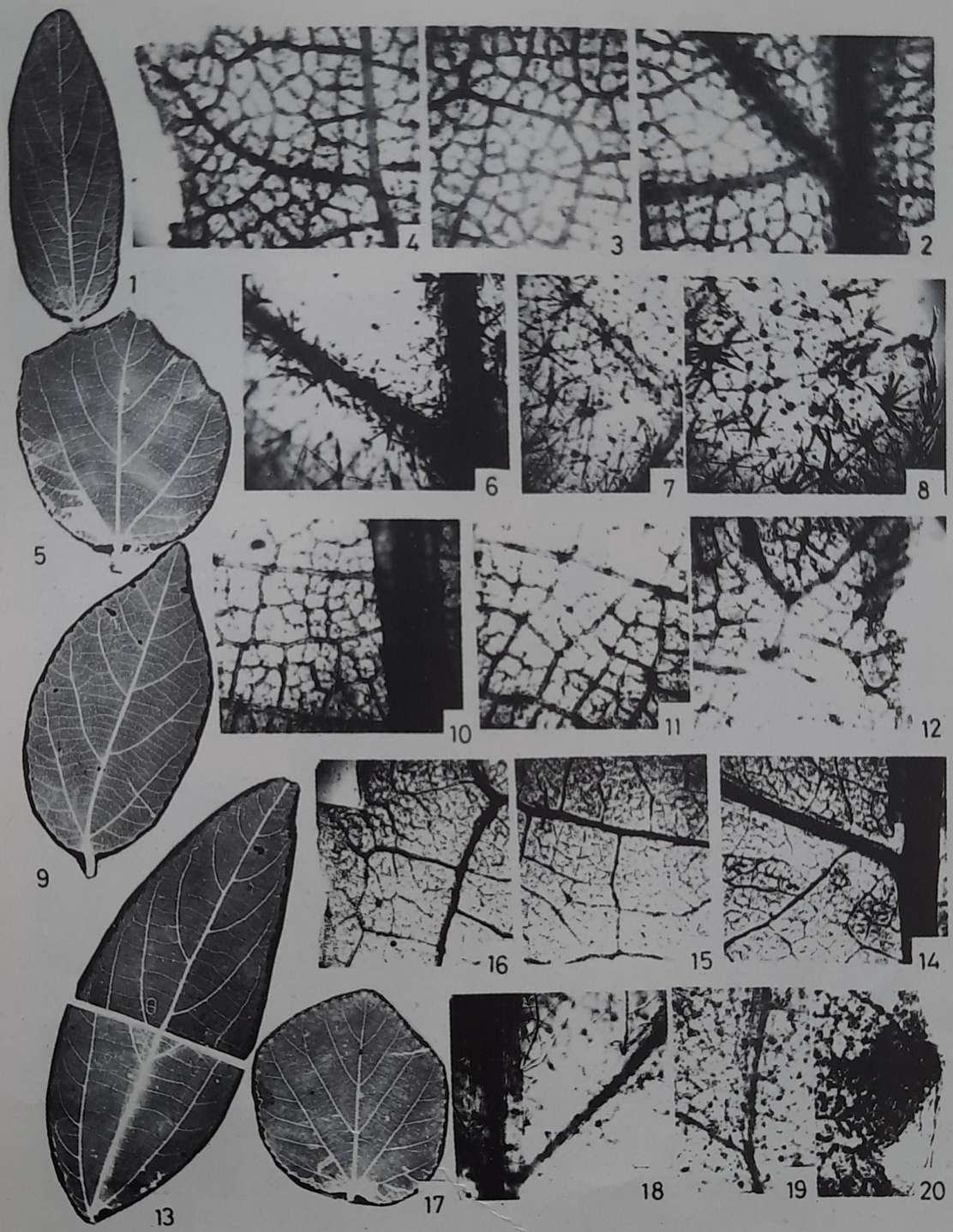

Plate 1

Figures 1-20. Cleared portion of leaves.

1-4. *G. flavescens*. 5-8. *G. abutilifolia*. 9-12. *G. orientalis*. 13-16. *G. laevigata*. 17-20. *G. villosa*. (Figures 1 and 13, x 1.2; 5, x 1; 9, x 1.7; 17, x 1.3; 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16, 18, 19, 20, x 89).

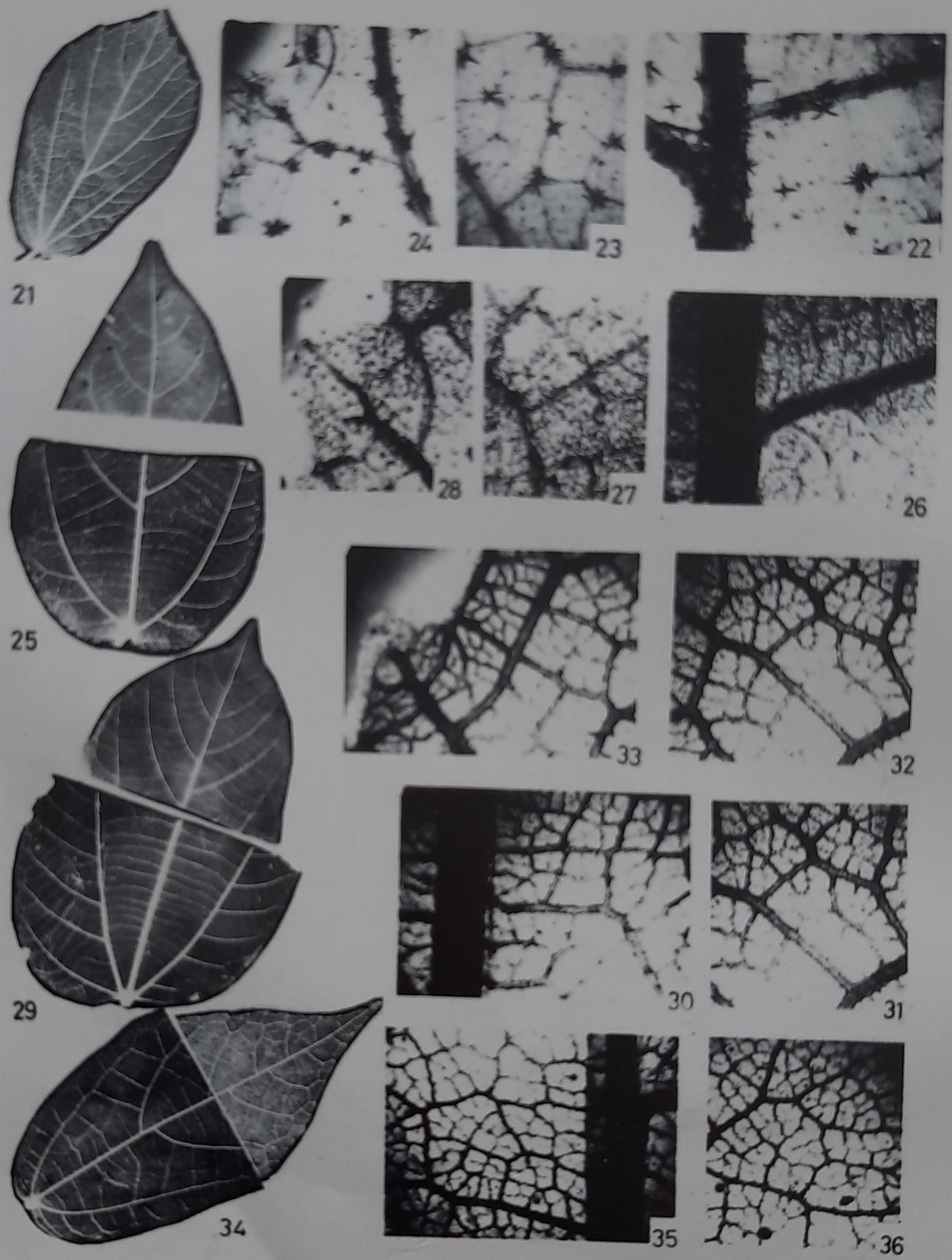

Plate 2

Figures 21-36, Cleared portion of leaves.

21-24. *G. polygama*. 25-28. *G. heterotricha*. 29-32. *G. tiliaefolia*. 33-36. *G. microcos*.
(Figures 21 x 1; 25, x 1.3; 29, x 1.1; 33, x 1.2; 22, 23, 24, 26, 27, 28, 30, 31, 32, 34, 35, 36, x 89).

DISCUSSION

The elevation of *Grewia microcos* to the generic level, *Microcos paniculata* though finds support on wood anatomical evidence (Chattway, 1936) is not tenable on the basis of venation studies. The venation details presented by *M. paniculata* do not differ in any significant way from those of other species of *Grewia*. Burret (1936) elevated *G. flavescens* to *Vinticena flavescens* on the basis of fruit structure. However, Narayanswami and Rao (1950) pointed that the species could be treated under a separate section of the genus. *G. flavescens* shares major features of the genus but could be readily distinguished on the basis of supra basal position of first point of primary vein radiation, a feature not shared by any other studied species, thus supporting Narayanswami and Rao's (1950) contention.

The following is the key proposed to differentiate 14 species of *Grewia* on the basis of venation pattern:

KEY to the species

A.	Primary veins three:	
B.	Position of the first point of primary veins radiation-suprabasal	*G. flavescens*
BB.	Position of the first point of primary veins radiation-basal.	
C.	Central Primary veins curved.	
D.	Development of lateral primary veins-perfect	*G. abutilifolia*
DD.	Development of lateral primary veins-imperfect	*G. orientalis*
CC.	Central primary veins straight	
E.	Development of lateral primary veins-perfect.	
F.	Secondary vein-loop forming branches present	*G. laevigata*
FF.	Secondary vein-loop forming branches absent.	
G.	Highest vein order - 3°	*G. villosa*
GG.	Highest vein order - 6°.	
H.	Secondary vein-angle of divergence acute, narrow.	*G. polygama*
HH.	Secondary vein-angle of divergence acute, moderate.	*G. heterotricha*
HHH.	Secondary vein-angle of divergence acute, narrow to moderate	*G. tiliaefolia*
EE.	Development of lateral primary veins imperfect.	
I.	Secondary vein-loop forming branches present.	
J.	Highest vein order - 6°	*G. microcos*
JJ.	Highest vein order - 7°	*G. serrulata*
II.	Secondary vein-loop forming branches absent.	
K.	Highest vein order - 5°	*G. umbellata*
KK.	Highest vein order 6°	*G. columnaris*
AA.	Primary veins five:	
L.	Highest vein order - 3°	*G. asiatica*
LL.	Highest vein order - 6°	*G. rotundifolia*

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REFERENCES

Badola, H.K., Bisht, P.S., Paliwal, G.S. 1983. Studies on the sequential development of the leaves of some Himalayan trees - I. *J. Indian bot. Soc.* **62**(3): 259-267.

Chattway, M.M. 1936. Anatomical evidence that *Grewia* and *Microcos* are distinct genera. *Trop. Woods* 46: 9-11.

Dilcher, D.L. 1974. Approaches to the identification of leaf remains. *Bot. Rev.* **40**: 1-85.

Ferguson, D.K. 1971. The Miocene flora of Kreuzau, Western Germany. 1. The leaf remains. *Verh. Kon. Ned. Akad.Wet. Afd. Natuurk* **60**(1): 1-297.

Foster, A.S, 1936. Leaf differentiation in angiosperms; *Bot. Rev.* **2**: 349-372.

Foster, A.S, 1952. Foliar venation in angiosperms from an ontogenic stand point. *Amer. Jour. Bot.* **39**: 752-766.

Hall, J.P. & Melville, C. 1951. Veinlet termination number. A new character for the determination of leaves *J. Pharm. Pharmac.* **3**: 934-941.

Hall, J.P. & Melville, C. 1954. Veinlet termination number, some further observations *J. Pharm. Pharmac.* **6** 129-133.

Hickey, L.J. 1973. Classification of architecture of dicotyledonous leaves. *Amer. Jour. Bot.* **60**: 1: 17-33.

Hickey, L.J. 1979. A revised classification of architecture of dicotyledonous leaves in Anatomy of Dicotyledons. In: C.R. Metcalfe and Chalk, 1979, Vol. 1: 25-39.

Krusmann, G. 1960. *Handbuch der Laubac Holze. I & II* Berlin.

Lucic, P.C. 1970. *Detailed leaf venation studies of selected species of Acer.* M.A. thesis. University of California, Berkelely.

Mädler, K. & Straus A. 1971. Em system der blattformen mit spezieller anwendung fur die bestimung Neogener blattreste (Miozan and Pliozan). *Bot. J.* **90**: 562-574.

Mouton, J.A. 1966. Sur la systematique foliare en paeobotanique. *Hull, - de la ser. bot. Fr.* **113**: 492-502.

Mouton, J.A. 1967. Architecture de la nervation Foliare. *92 Congress national des societetes savantes*, Strasbourg at Colmar, III: 165-176.

Narayanswami, V. & Rao, R.S. 1950. Indo-Burmese species of *Grewia*. *J. Indian bot. Soc.* **29**(4): 177-190.

Stace, C.A. 1965. Cuticular studies as an aid to plant taxonomy. *Hull. Brit. Mus. Bot.* **4**(1): 1-78.

Walther, H. 1972. Studien Uber tertiare Acer Milteleuropas *Abh. Staatl. Mus. Mineral. Geol. Dresden*, **19**: 1-309.

Wolfe, J.A. 1959. *Tertiary Juglandaceae of Western - North America.* Master's thesis in Paleontology in graduate division of the University of California, Berkeley.