Proc. Indian Acad. Sci. (Plant Sci.), Vol. 95, No. 2, September 1985, pp. 87–94.

The veinsheath syndrome in Cunoniaceae I *Pancheria* Brongn. & Gris.

T ANANDA RAO and WILLIAM C DICKISON*

The Karnataka Association for the Advancement of Science, Mathematics Building Annexe, Central College, Bangalore 560001, India

* Department of Biology, The University of North Carolina, Chapel Hill, North Carolina 27514, USA

MS received 1 January 1985

Abstract. Veinlet sheathing of twenty-six species of *Pancheria* is described and illustrated. Within the genus foliar vein sheathing varies from almost completely lacking to abundant, and individual sheath cells show much variation in cell wall composition and structure. The topographical distribution of sheath cells along the vein system, when coupled with the structure of individual sheathing elements, can be utilized to distinguish three anatomical groups of species. Although the evolutionary sequence and ecological significance of the diverse sheath types are at present unresolved, features of vein sheathing appear to be of systematic significance and may provide an additional basis for a better understanding of infraspecific relationships within this genus.

Keywords. Veinsheath syndrome; *Pancheria*; Cunoniaceae

1. Introduction

There exists considerable anatomical variation with regard to the type and distribution of sheath cells associated with the ultimate leaf venation in the Cunoniaceae (Dickison 1975), suggesting a progressively increasing differentiation of the bundle sheath cells at the vein termini. An investigation of foliar anatomy was undertaken with a view to record the total range of structural variation, topographical distribution, and potential systematic usefulness of veinsheath elements within the family.

Our initial contribution deals with the endemic New Caledonian genus *Pancheria* Brongn. & Gris. *Pancheria* is composed of *ca.* 26 species (Guillaumin 1948) that occur in a variety of habitats. They range in growth form between small to medium-sized shrubs or small trees, with a few species assuming the rosette tree form. Leaves are quite diverse in morphology, size, texture, and hairyness.

2. Materials and methods

A total of twenty-six species were examined. Leaf sectors were initially partially cleared by soaking them in 5 % sodium hydroxide overnight at 60 °C. Subsequently, they were thoroughly washed in distilled water and flooded with a mixture of trichloroacetic acid and phenol (2:1) for 30 minutes at 60° (Mohan Ram and Nayyar 1978) until they became perfectly transparent (Rao and Naidu 1981). The sectors were dehydrated in an alcohol series and mounted in Canada Balsam without staining. A few pieces were mounted in Lactophenol for camera lucida sketches. The following species of *Pancheria* were studied.

P. alaternoides Brongn. & Gris, Baumann-Bodenheim 6312 (Z); *P. beauverdiana* Pampan., Vieillard 2657 (P); *P. billardieri* (D. Don) Pampan., Collector unclear 1790 (P); *P. brunshesii* Pampan., Balansa 1070 (P); *P. calophylla* Guill., Balansa 3508 (P); *P. communis* Bak. f., Dickison 181 (NCU); *P. confusa* Guill., Dickison 177 (NCU); *P. elegans* Brongn. & Gris, Dickison 158 (NCU); *P. engleriana* Schltr., Dickison 161 (NCU); *P. ferruginea* Brongn. & Gris, Dickison 165 (NCU); *P. gatopensis* Vieill. ex Guill., Dickison 271 (NCU). *P. heterophylla* Vieill. ex Guill., Vieillard 2252 (P); *P. hirsuta* Vieill. ex Pampan., Dickison 143 (NCU); *P. humboldtiana* Guill., Baumann-Bodenheim 15515 (A); *P. insignis* Schltr., McKee 1106 (A); *P. multijuga* Guill., Baumann-Bodenheim 15357 (Z); *P. obovota* Brongn. & Gris, Baumann-Bodenheim 15012 (Z); *P. phylliraeoides* Brongn. & Gris, ex Guill., Guillaumin & Baumann-Bodenheim 13163 (Z); *P. pinnata* Pampan., McKee 4390 (A); *P. pirifolia* Brongn. & Gris, Guillaumin & Baumann-Bodenheim 13201 (A), 13163 (Z); *P. reticulata* Guill., Guillaumin & Baumann-Bodenheim 11219 (Z); *P. rivularis* Schltr., Hurlimann 1772 (A); *P. robusta* Guill., Dickison 171 (NCU); *P. sebertii* Guill., Guillaumin & Baumann-Bodenheim 10590 (Z), 14444 (A); *P. ternata* Brongn & Gris, Baumann-Bodenheim 13867 (A). *P. vieillardii* Brongn. & Gris, Balansa 3292 (P).

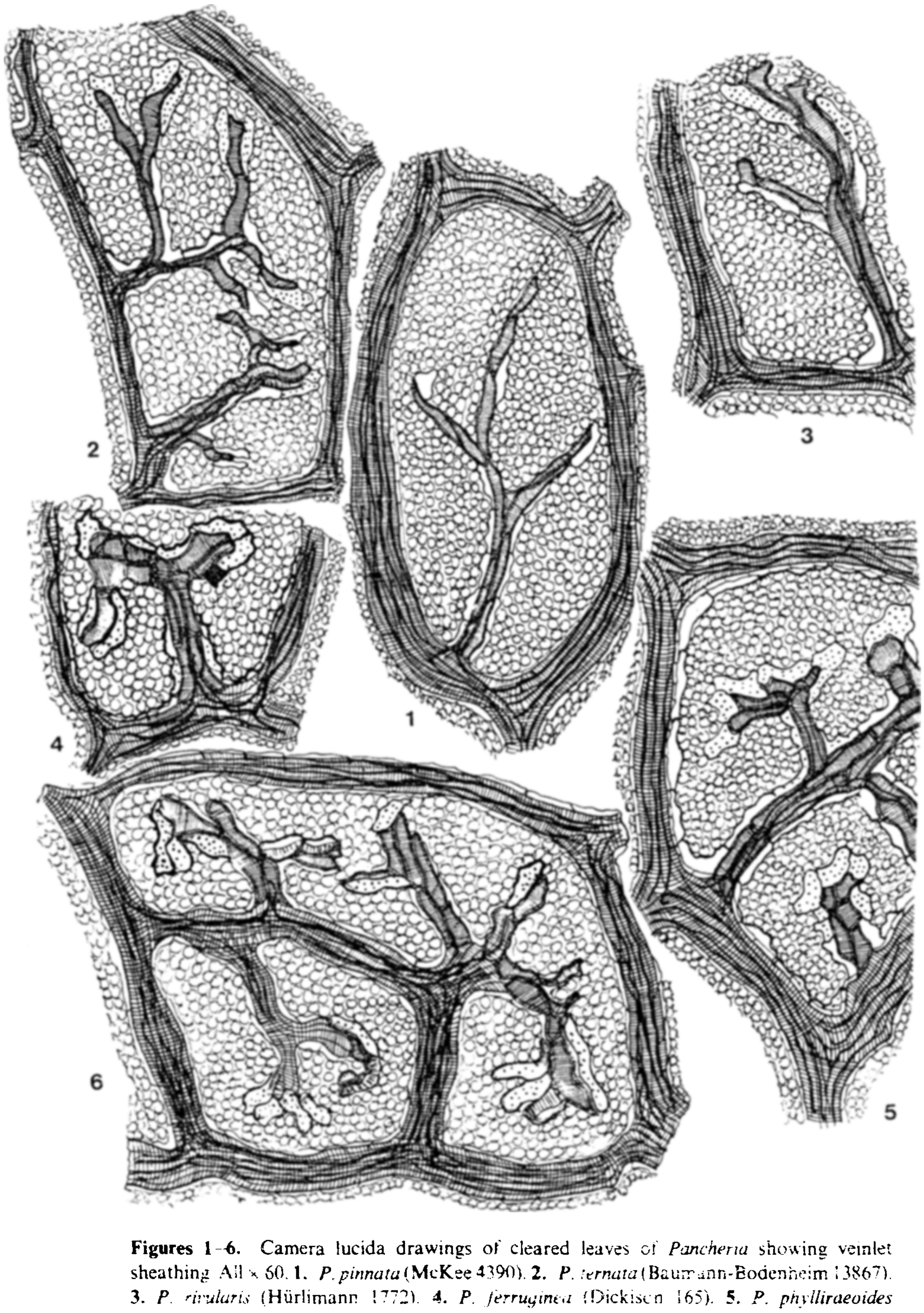
3. Observations

Species of *Pancheria* show three distinct categories of bundle sheathing.

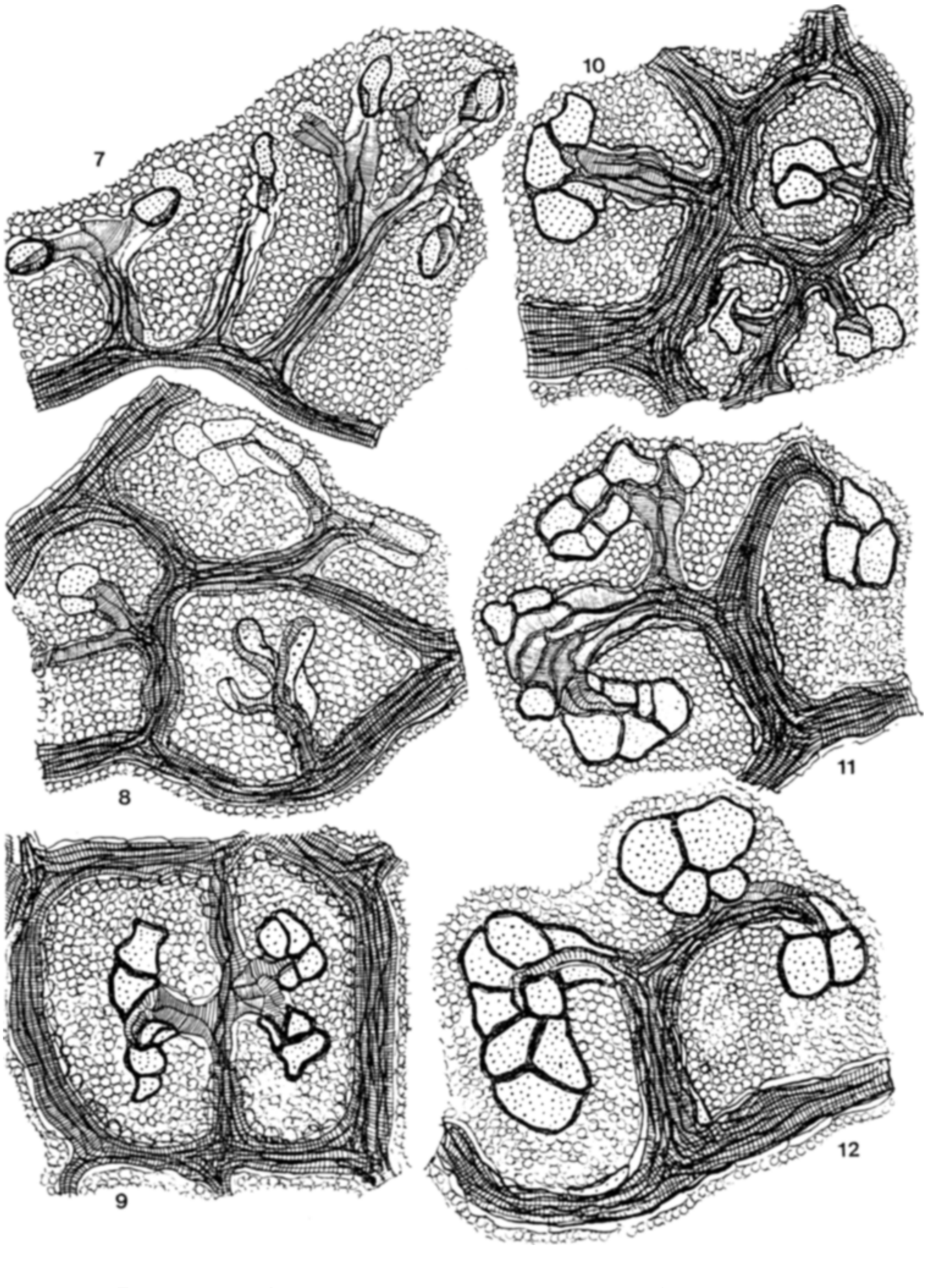
Veinlets provided with sheathing of parenchymatous cells combined with thin to thick-walled, pitted cells at the vein termini (figures 1–6, 13). The bundle sheathing is continuous or occasionally interrupted by imperfectly oblong to cylindrical cells with non- or slightly lignified secondary walls. Vein endings consist of uniseriate or biseriate linear tracheids. In some cases the terminal elements are accompanied by dilated, pitted cells that resemble the elements of the sheath. These features are observed in *P. beauverdiana*, *P. billardieri*, *P. ferruginea*, *P. phylliraeoides*, *P. pinnata*, *P. reticulata*, *P. sebertii*, and *P. ternata*.

Veinlets devoid of sheathing or associated with only a few sheath cells, but possessing a cluster of enlarged, sclerotic, pitted or helicoid cells at the vein endings (figures 7–12, 21–24). Sheathing is either absent or inconspicuous around the vein reticulam. Where present the sheath is composed of uniformly thick-walled parenchymatous cells, and a few sclerotic elements resembling sclereids. Sheathing elements are birefringent and their wall reaction is positive to phloroglucinol-HCL test. Veinlets are terminated by clusters of sclerotic cells of varied sizes and shapes, that range from globose or ovoid to cylindrical. This syndrome characterizes *P. brunshesii*, *P. calophylla*, *P. confusa*, *P. gatopensis*, *P. heterophylla*, *P. hirsuta*, *P. insignis*, *P. obovata*, *P. robusta*, and *P. vieillardii*.

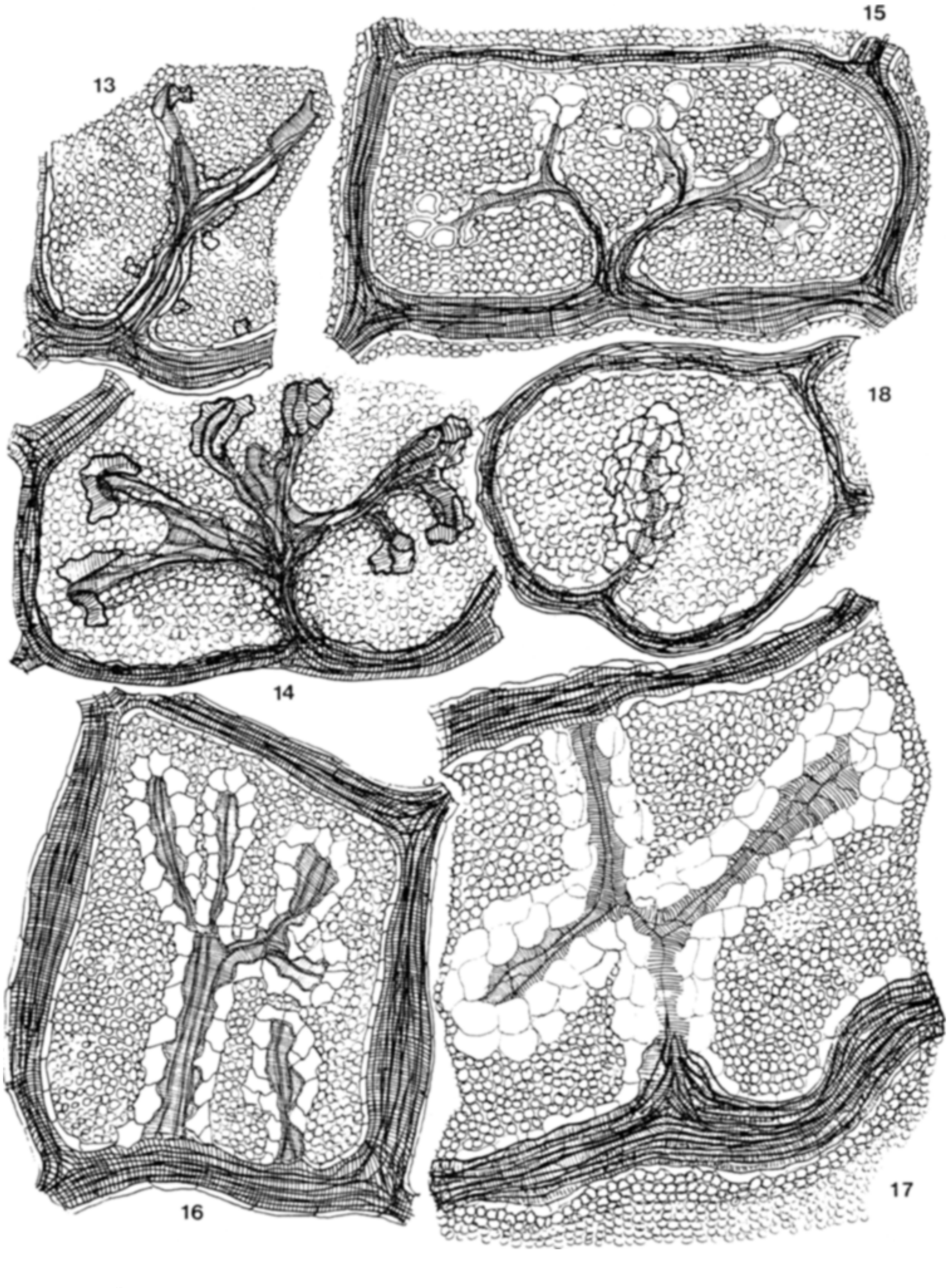
Vein reticula are without prominent sheath cells whereas the bulbous or club-shaped ultimate veinlets are surrounded by a conspicuous sheath consisting of one to a few layers or cells (figures 14–20). The third category, as observed in *P. alaternoides*, *P. communis*, *P. engleriana*, *P. humboldtiana*, *P. multijuga*, *P. pirifolia*, is distinguished by the presence of single, double, or multiple sheath layers of dilated cells around the ultimate veinlets. The sheath cells vary in size and shape although they are characteristically thin-walled, non-pitted and non-lignified. The veinlets are typically bulbous or club-shaped in appearance. They are surrounded by oblong sheath cells



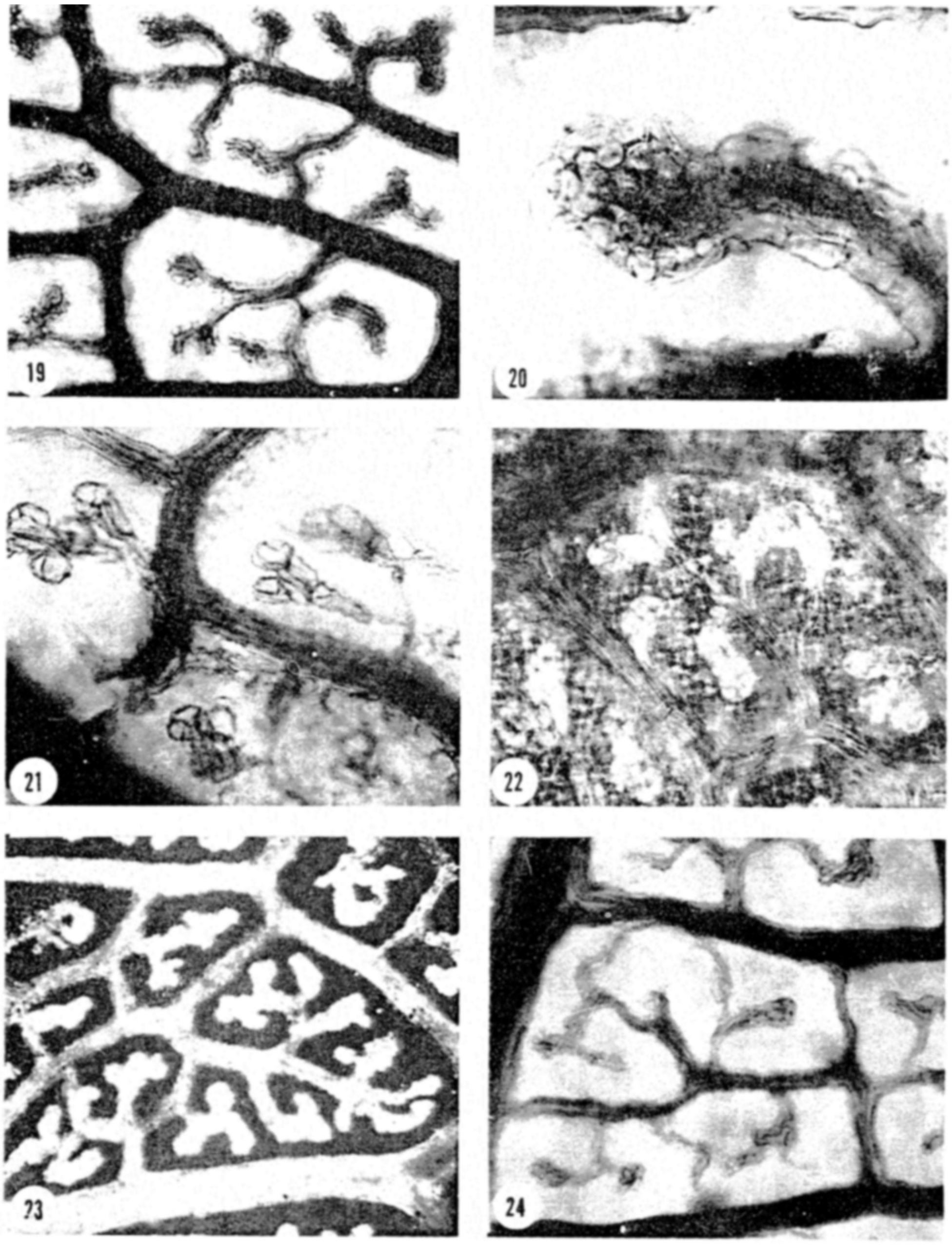
Figures 1–6. Camera lucida drawings of cleared leaves of *Pancheria* showing veinlet sheathing All × 60. **1.** *P. pinnata* (McKee 4390). **2.** *P. ternata* (Baumann-Bodenheim 13867). **3.** *P. rivularis* (Hürlimann 1772). **4.** *P. ferruginea* (Dickison 165). **5.** *P. phylliraeoides* (Guillaumin & Baumann-Bodenheim 13163). **6.** *P. reticulata* (Guillaumin & Baumann-Bodenheim 11219).



Figures 7–12. Camera lucida drawings of cleared leaves of *Pancheria* showing veinlet sheathing. All × 55. **7.** *P. confusa* (Dickison 177). **8.** *P. obovata* (Baumann-Bodenheim 15012). **9.** *P. insignis* (McKee 1106). **10.** *P. gatopensis* (Dickison 271). **11.** *P. hirsuta* (Dickison 143). **12.** *P. robusta* (Dickison 171).



Figures 13–18. Camera lucida drawings of cleared leaves of *Pancheria* showing veinlet sheathing. All × 55. **13.** *P. sebertii* (Guillaumin & Baumann-Bodenheim 10590). **14.** *P. pirifolia* (Guillaumin & Baumann-Bodenheim 13201). **15.** *P. alaternoides* (Baumann-Bodenheim 6312). **16.** *P. communis* (Dickison 181). **17.** *P. engleriana* (Dickison 161). **18.** *P. humboldtiana* (Baumann-Bodenheim 15515).



Figures 19–24. Cleared leaves of *Pancheria* showing veinlet sheathing. **19.** *P. communis* (Dickison 181), photographed under optical light, × 100. **20.** *P. communis* (Dickison 181), detail of vein ending, × 200. **21.** *P. robusta* (Dickison 171), photographed under optical light, × 100. **22.** *P. robusta* (Dickison 171), photographed under polarized light, × 100. **23.** *P. confusa* (Dickison 177), photographed under polarized light, × 100. **24.** *P. obovata* (Baumann-Bodenheim 15012), photographed under optical light, × 100.

having a splayed appearance in *P. pirifolia*, (figure 14). A multilayered parenchymatous sheath encases the veinlets of *P. humboldtiana*, (figure 18). The sheath cells associated with the higher order reticula are thin-walled hyaline cells of uniform size and shape, sometimes not clearly distinguished from adjacent mesophyll cells.

4. Discussion

It is evident from the comparative study of twenty-six species of *Pancheria* that the genus is characterized by either the presence, or less frequently the absence, of sheath cells and the occurrence of specialized terminal elements accompanying the ultimate venation of the leaves. Within the genus sheathing varies from essentially lacking to abundent, and individual sheath cells show much variation in cell wall composition and structure in addition to reaction to phloroglucinol and polarized light. The occurrence of multiple layered sheaths composed of thin-walled cells around the veinlets of a few species is particularly striking. Veinlets range between simple, twice or more rarely thrice branched and are composed of single or multiple rows of tracheary elements. Veinlet terminal cells are thin or thick-walled and pitted, and varied in shape. The thicker walled elements have the appearance of terminal sclereids (Metcalfe and Chalk 1956; Dickison 1975; Rao and Das 1979). It is unclear whether these terminal idioblasts are derived from procambium or from bundle sheath precursors. None of the species examined possess diffuse foliar sclereids except *P. heterophylla* and *P. sebertii* where sometimes idioblastic subspheroidal sclereids are present near the veinlets.

The topographical distribution of sheath cells along the vein system, when coupled with the structure of individual sheathing elements, can be utilized to distinguish three anatomical groups of species. Each group represents a syndrome of characters with respect to vein sheath orientation and the composition of vein termini that differ markedly from that of the other two groups. Although the evolutionary sequence and ecological significance of the diverse sheath types are at present unresolved, features of vein sheathing appear to be of systematic significance and may provide an additional basis for a better understanding of infraspecific relationships within this genus. Clearly, however, further detailed studies of the species utilizing other parts of plant are required.

Carlquist (1975, 1977, 1980) and Rury and Dickison (1984) have drawn attention to the structural and physiological relationships that exist between the wood and leaf. In some plants the foliage appears to buffer the xylem tissues from prevailing environmental conditions and, therefore, enable more primitive xylem structures to be retained in taxa growing in rather xeric habitats. Despite the fact that some species of *Pancheria* grow in exposed, dry conditions, the wood anatomy of the genus is uniformly primitive and characterized by vessel elements with sclariform perforations (Dickison 1980). This could be explained by the occurrence in these species of very scleromorphic or pubescent foliage that reduces the water demands made by the leaves upon the xylem of the shoot.

Acknowledgements

The second author thanks the many individuals who assisted him in various ways while collecting plants used in the present study. These collections were made possible by the

United States National Science Foundation grant DEB-8025976. Thanks are also extended to the Curator of the Herbarium, Botanischer Garten und Institut fur Systematische Botanik der Universitat Zurich and Dr N Halle, Laboratoire de Phanerogamie, Paris.

References

Carlquist S 1975 *Ecological strategies of xylem evolution.* (Berkeley, Los Angeles, London: Univ. California Press)

Carlquist S 1977 Ecological factors in wood evolution: a floristic approach; *Am. J. Bot.* **64** 887–896

Carlquist S 1980 Anatomy and systematics of Balanopaceae; *Allertonia* **2** 191–246

Dickison W C 1975 Leaf anatomy of Cunoniaceae; *Bot. J. Linn. Soc.* **71** 275–294

Dickison W C 1980 Comparative wood anatomy and evolution of the Cunoniaceae; *Allertonia* **2** 281–321

Guillaumin A 1948 *Flore analytique et synoptique de la Nouvelle-Caledonie-Phanerogames*; (Paris: Office de la Recherche Scientifique Coloniale)

Metcalfe C R and Chalk L 1957 *Anatomy of the dicotyledons.* Vols. I & II (repr. ed.) (Oxford: Clarendon Press)

Mohan Ram H Y and Nayyar V 1978 Leaf clearing technique with a wide range of applications. *Proc. Indian Acad. Sci.* (*Pl. Sci.*) **B87** 125–127

Rao T A and Das S 1979 Leaf sclereids—occurrence and distribution in the angiosperms; *Bot. Notiser* **132** 319–324

Rao T A and Naidu T R B 1981 On the epidermal fibre-like sclereids in the two sibling genera of the Poaceae; *Curr. Sci.* **50** 958–959

Rury P M and Dickison W C 1984 Structural correlations among wood, leaves and plant habit. In *Contemporary problems in plant anatomy* (eds) R A White and W C Dickison (New York and London: Academic Press) pp. 495–540