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Foliar sclereids and vein sheaths in the New Caledonian species of *Scaevola* L. (Goodeniaceae)

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Abstract

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The leaf sclereids and veinlet sheaths of 9 species of *Scaevola* are described and illustrated. Individual sheath cells and sclereids showed some variation in lignification and shape. The structure of the leaf sclereids and veinlet sheaths is characteristic for the species. A key based on vegetative characters is given.

Introduction

A revision of the New Caledonian species of *Scaevola* was undertaken with a view to solve the problems that arose when Guillaumin's key (1948) was used. In the course of this study the leaf-anatomy was examined, in order to test if this might furnish new taxonomic characters. Rao & Mody (1961) described the occurrence of laminar sclereids in some species of *Scaevola*. A number of studies (e.g., Tucker 1964, De Roon 1967) have shown that sclereids have significant taxonomic value. Rao & Dickison (1985) demonstrated the taxonomic significance of the structure of the vein sheaths.

Examination of bleached leaf fragments showed considerable diversity of sclereids and vein sheaths. The various sclereid and vein sheath types differ from each other in size, shape, and wall diameter.

Material and methods

The specimens used in this investigation were solely obtained from herbaria. Leaf fragments were boiled and then bleached by using the clearing technique according to Sattler et al. (1988). Although the leaves were often partly sclerotized, the bleached parts became transparent with this method.

The following species and specimens of *Scaevola* were investigated:
S. balansae Guillaumin: Däniker 2772 (Z), Guillaumin & Baumann 14874 (Z), MacKee 12418 (Z).
S. beckii Zahlbruckner: Däniker 151 (Z), Guillaumin 19 (Z), 11375 (Z).
S. coccinea Däniker: MacKee 34072 (Z), Veillon 5845 (Z).
S. cylindrica Schlechter & Krause: Bernardi 9966 (Z), Franc 1651 (Z), MacKee 41758 (Z).

S. erosa Guillaumin: Bernardi 12536 (Z), 12680 (Z), MacKee 4279 (Z), 18836 (Z), 30832 (Z), Schmid 2597 (Z).
S. montana Labill.: MacKee 19262 (Z), 29202 (Z), 43680 (Z).
S. taccada (Gaertn.) Roxb.: Däniker 1192 (Z), Lauri 177 (Z), MacKee 43686 (Z).
S. racemigera Däniker: Baumann 15514 (Z).
S. spec. nova: Baumann 15426 (P), MacPherson 3092 (P), 5111 (P).

Observations

I. Sclereids

Both terminal and diffuse sclereids were found in the species examined. In some there is a wide range in the density of the sclereids. Species of *Scaevola* show two distinct categories of sclereids, namely (i) even in shape, with short processes or totally devoid of processes (=monomorphic sensu Rao & Bhupal 1972) and (ii) uneven in shape, often with forked and gnarled processes (=cacomorphic sensu Rao 1980).
(i) In *S. coccinea* the sclereids are spherical or comma-shaped. They are thick-walled, striated, pitted and possess small, irregular lumina. Similar thick-walled sclereids, but with a tendency towards rectangular shape, are found in *S. beckii.* The sclereids of *S. racemigera* are spherical, or subspherical to rectangular, and closely spaced (figures 7, 8). They are either totally devoid of processes or have short, compact processes. The cell is thin-walled, in contrast to those of *S. coccinea* and *S. beckii* (figures 3, 5, 6). The length of the sclereids of *S. beckii* and *S. racemigera* is from 80 to 200 µm, while in those of *S. coccinea* it is from 60 to 150 µm. *S. taccada* has smaller, angular sclereids (40–80 µm). They are thin-walled, striated and pitted.
(ii) All sclereids of the second group have thin, striated and pitted cell-walls; their size ranges from 80 to 200 µm. This type of sclereid is encountered in *S. balansae, S. cylindrica, S. erosa, S. montana, S. taccada* and *S. spec. nova* (figures 1, 9–17). In *S. erosa* they are densely arranged (figure 9). The sclereids of this species also have a tendency towards the presence of longer processes.

II. Vein sheaths

The veinlets are simple or branched, straight or curved. They may be club-shaped, without or with a single layer of sheath cells. The types of vein sheaths can be distinguished as follows:
(i) vein sheath absent
Bundle sheath cells absent. This is found in *S. taccada* (figure 2).
(ii) shape of the bundle sheath cells differing from that of the adjacent mesophyll cells
Vein sheath cells have a characteristic, papilla-like shape. The sheathing is very prominent. Veins of higher order also possess this kind of sheathing. This is seen in *S. beckii* and *S. erosa* (figures 4, 10).
(iii) shape of the bundle sheath cells is mostly like that of the adjacent mesophyll cells,
This characterizes *S. balansae, S. coccinea, S. cylindrica, S. racemigera, S. montana, S. spec. nova* (figures 6, 8, 12, 14, 16, 17).

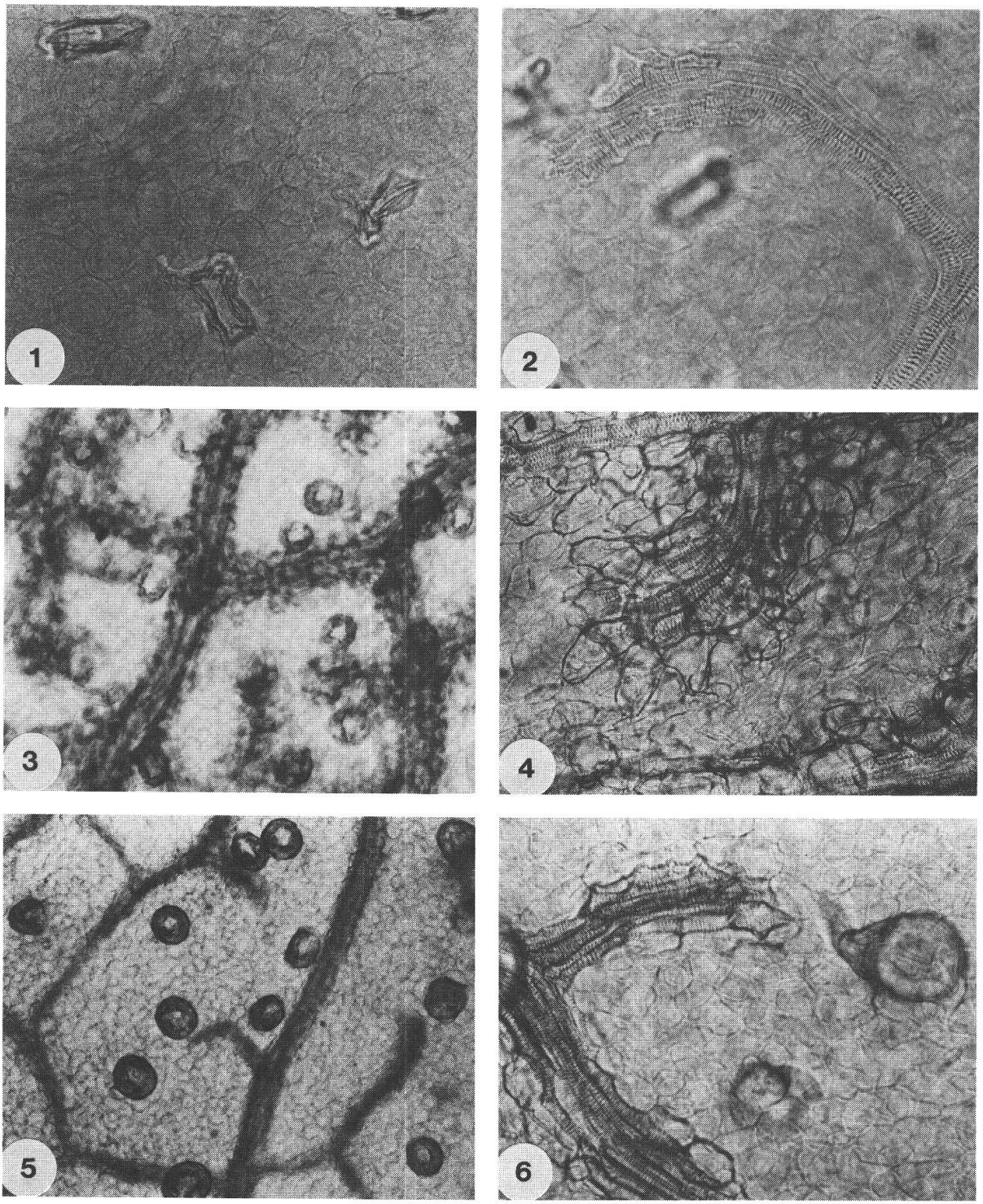


Fig. 1–6. 1. *S. taccada* 63×; 2. 180× – (MacKee 43686). 3. *S. beckii* 63×; 4. 180× – (Däniker 151). 5. *S. coccinea* 63×; 6. 180× – (Veillon 5845).

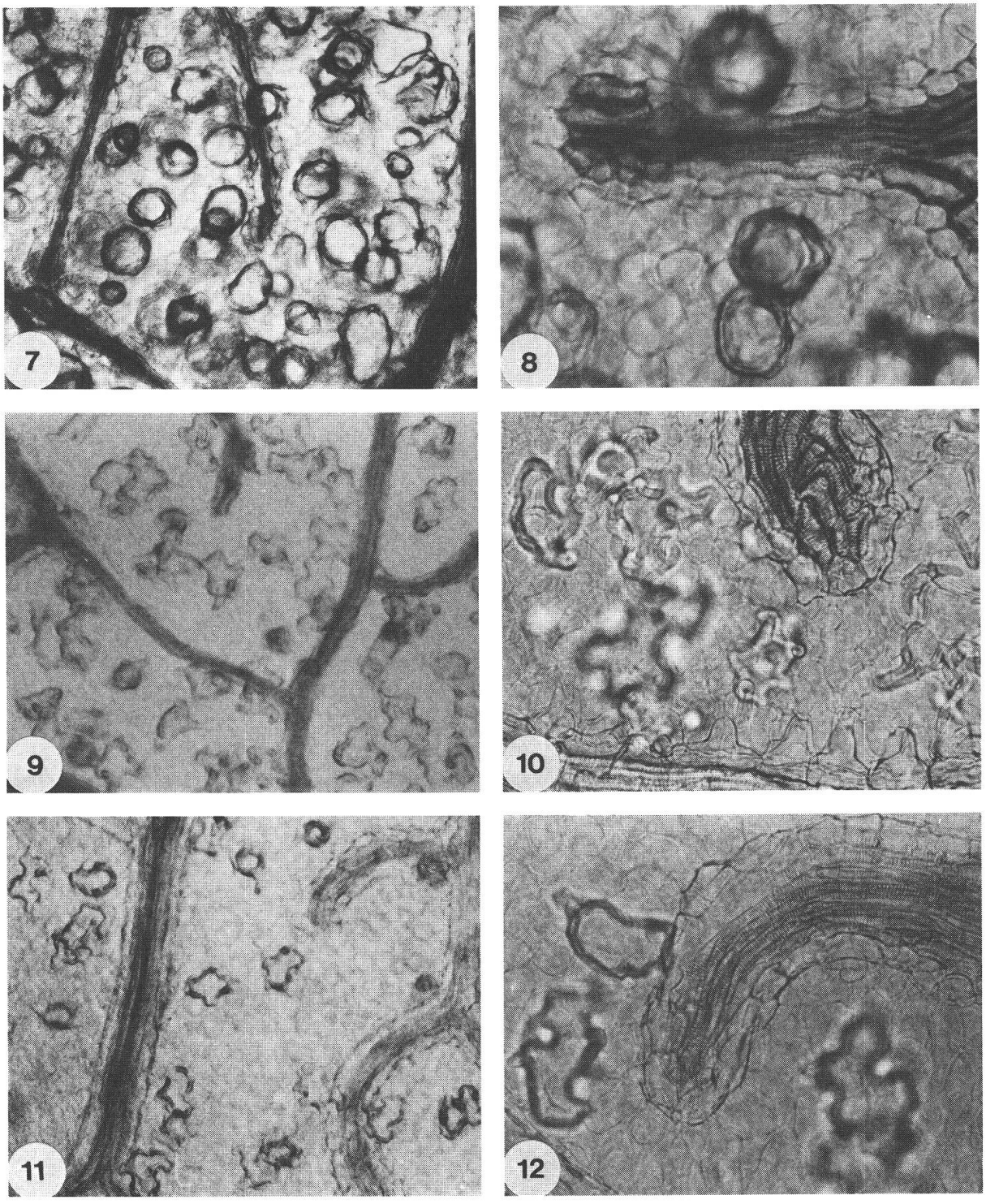
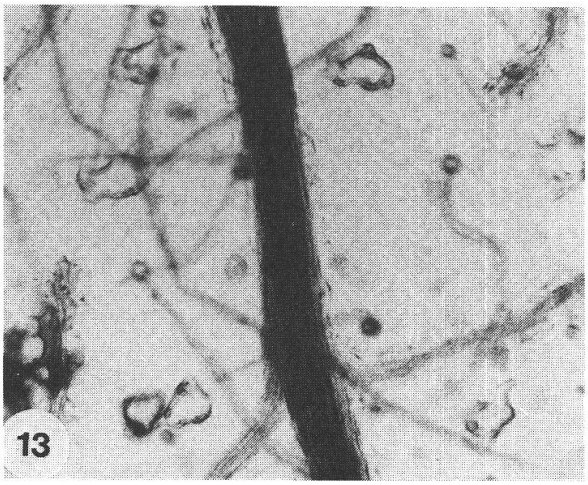
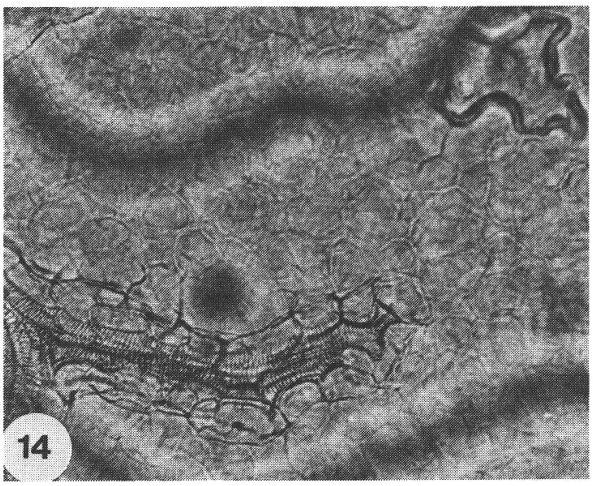
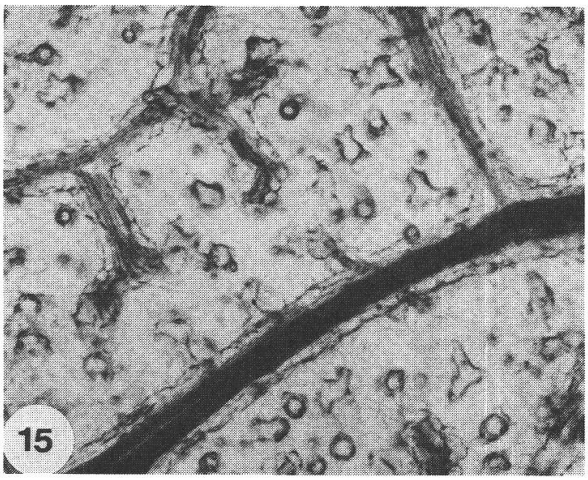
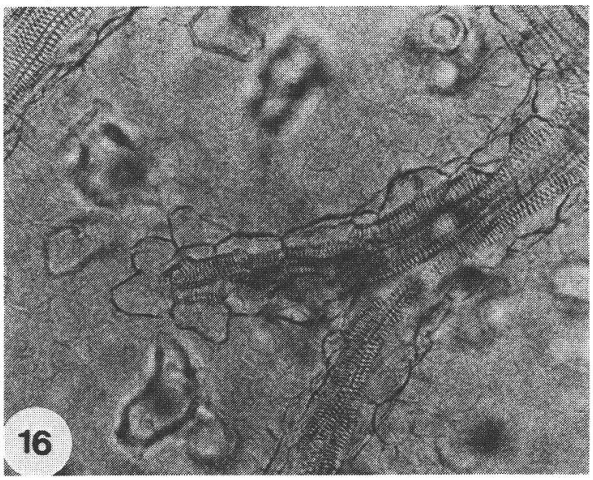


Fig. 7–12. 7. *S. racemigera* 63×; 8. 180× – (Baumann 15514). 9. *S. erosa* 63×; 10. 180× (MacKee 30832). 11. *S. spec. nova* 63×; 12. 180× – (MacPherson 3092).









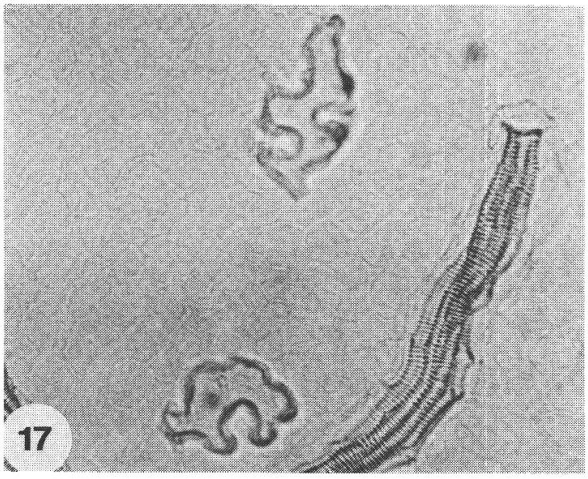


Fig. 13–17. 13. *S. balansae* 63×; 14. 180× – (MacKee 12418). 15. *S. montana* 63×; 16. 180× – (MacKee 29202). 17. *S. cylindrica* 180× – (MacKee 41758).

Key

Key to the New Caledonian species of Scaevola, based on anatomical characters.

1 A. veinlets devoid of sheathing; sclereids angular, not exceeding 100 µm *S. taccada*
1 B. veinlets with prominent sheathing
  2 A. wall of sclereids as thick as lumen (fig. 5)
    3 A. outer surface of sheath cells with papilla-like protrusion, sclereids 80–200 µm (fig. 4) . . . . . *S. beckii*
    3 B. outer surface of sheath cells more or less smooth, sclereids not exceeding 150 µm (fig. 6) . . . . . *S. coccinea*
  2 B. wall of sclereids much thinner than diameter of lumen (fig. 11)
    4 A. sclereids more or less spherical (fig. 7) . . . . . *S. racemigera*
    4 B. sclereids not spherical, with wavy outline (fig. 9, 11)
      5 A. diameter of lamina exceeding 300 µm
        6 A. sclereids in both palisade and mesophyll tissue
          7 A. outer surface of sheath cells with papilla-like protrusion (fig. 10) . . . . . *S. erosa*
          7 B. outer surface of sheath cells more or less smooth (fig. 12) . . . . . *S. spec. nova*
        6 B. sclereids between palisade and mesophyll tissue . . . . . *S. balansae*
      5 B. diameter of lamina not exceeding 300 µm
        8 A. density of sclereids per 1/2 mm^2: 0–10, number of elongate bundle sheath cells near vein endings: 0–2 . . . . . *S. cylindrica*
        8 B. density of sclereids per 1/2 mm^2: 8–16, number of elongated bundle sheath cells near vein endings: (0)–1–5 . . . . . *S. montana**

Discussion

The present study shows that characters of sclereids and vein sheaths are often important for distinguishing species. Rao (1980) stressed that examination in many taxa showed the sclereids to be an important diagnostic tool for future revisionary studies.

The function of sclereids is not yet fully understood, and in spite of widely divergent explanations, as, e.g., a mechanical function, or constituting a dump for noxious substances. However, their usefulness in taxonomy has been shown many times. In the species examined, two types of sclereids (sensu Rao & Bhupal 1973, Rao 1980) can be distinguished: monomorphic and cacomorphic. In *S. beckii, S. coccinea, S. racemigera* and *S. taccada* sclereids of the first type occur, whereas the remaining species possess sclereids of the second type. Although phylogenetic conclusions based on the distribution of sclereids do not seem to be feasible as yet (Thorne 1983), it appears that in some cases, sclereid features may provide supporting evidence for taxonomic grouping (Rao & Nayak 1985, Foster 1946).

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* These species pair gives some difficulties in the differentiation, the characteristics used cannot separate them clearly.

It would be highly speculative to draw conclusion on the phylogeny of the plants exclusively on the basis of the morphology of sclereids. It is, however, remarkable that the three species that possess spherical sclereids: *S. beckii, S. coccinea* and *S. racemigera,* are also separated macromorphologically from the others, which are held together by a homogeneous flower structure.

The work of Rao & Dickinson (1985a, b) suggests that features of the vein sheaths are of systematic significance. In these studies, generic descriptions and groupings of species on the basis of evidence from the structure of the bundle sheath cells were possible.

Bundle sheath cells are widely distributed in angiosperms, but their ecological significance is not yet known. Veinlets of the species examined are either without sheaths or the bundle sheath cells vary in shape. Three groups could be distinguished. Groupings of the species on the basis of either vein sheaths or of sclereid characters do not run parallel.

The type of bundle sheath cells, in association with the type of sclereid, characterizes almost every species and can be used for constructing a key based on vegetative characters. Only in the case of *S. montana* and *S. cylindrica* a distinction based on characters of sclereids and vein sheaths is insecure. Interestingly, these two species are difficult to separate by macromorphological characters as well, and they also show a great range of variation, perhaps partly due to hybridization. Anatomical characters thus do not reduce the difficulties encountered in separating the two species.

The ecological significance of the various sheath and sclereid types is at present unknown, but sclereids and vein sheaths clearly constitute important characters of the species examined. Their range of variability, also as influenced by ecological factors, merits close examination in large series of specimens. Further experimental work in this field is required for evaluating the importance of sclereids and vein sheaths as a taxonomic tool.

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