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FLOWERS AND FRUITS IN FLACOURTIACEAE. V. THE SEED ANATOMY AND POLLEN MORPHOLOGY OF BERBERIDOPSIS AND STREPTOTHAMNUS

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SUMMARY

Seed anatomy and pollen morphology support the transference of the Australian *Streptothamnus beckleri* to the Chilean genus *Berberidopsis*.

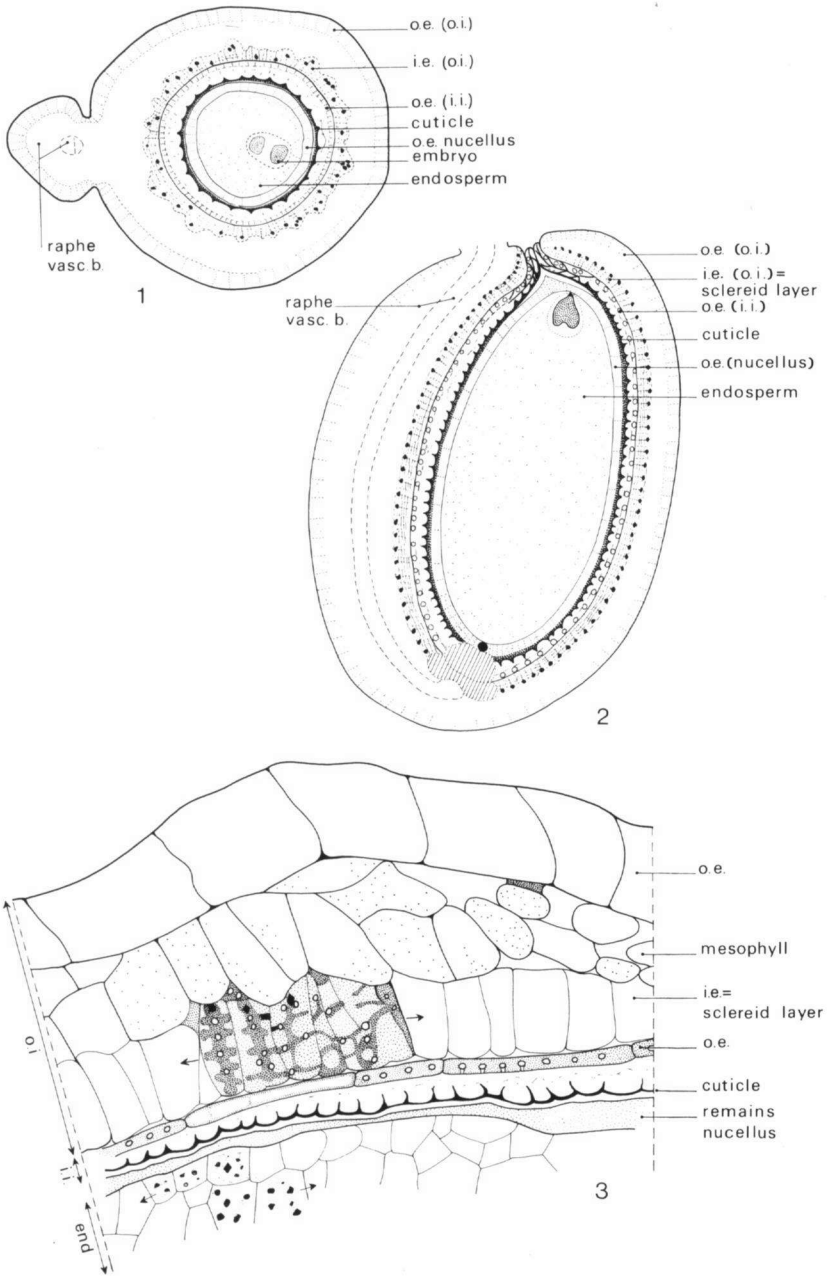
INTRODUCTION

The fruits and seeds of *Berberidopsis corallina* Hook. f. were first described in my paper of 1979. The seed structure proved to be very characteristic, but at the same time unusual in the Flacourtiaceae. In a search for seeds with a similar structure in that family, seeds of *Streptothamnus beckleri* F.v.M. (*Floyd 1381*) were obtained in alcohol. They were almost identical to those of *Berberidopsis corallina*. During routine identification work an herbarium specimen (*Schodde 3245*) was encountered by Van Balgooy and Veldkamp, which seemed to belong to the Chilean genus *Berberidopsis*, but which turned out to be the Australian *Streptothamnus beckleri*.

The above coincidence has led to the present closer comparison of the genera *Berberidopsis* and *Streptothamnus*. The latter genus has another Australian species named *S. moorei* F.v.M. All three species are scandent shrubs.

SEED ANATOMY – Table 1; Figs. 1–3

The knowledge on seed anatomy in the Flacourtiaceae has been summarized and extended by Corner (1976). I have also contributed some papers on the subject (1973, 1974, 1977, 1979). The seeds of most Flacourtiaceae, so far known, are exotegmic, that is the outer epidermis of the inner integument develops into lignified fibres during seed maturation. The whole outer integument differentiates into a sarcotesta. Only in *Hydnocarpus, Kiggelaria* and *Erythrospermum* I have found that also derivatives of the inner epidermis of the outer integument contributed to the formation of the hard layers of the seed. Therefore these seeds are endotestal as well as



Figs. 1–3. *Berberidopsis beckleri* (F.v.M.) Veldk. (*Floyd 1381*). 1. CS of seed, × 35; 2. LS of seed, × 35; 3. LS of testa, × 225. Abbreviations: o.i. and i.i. = outer and inner integument; o.e. and i.e. = outer and inner epidermis.

Table 1. Characters of the fruit and seed.

Berberidopsis corallina	*Berberidopsis beckleri*	*Streptothamnus moorei*
Marticorena et al. 1140 (Chile, 1-xii-1976)	*Floyd 1381* (N.S.W., 11-xi-1979)	*Tomlins s.n.* (*NSW 59025*, 30-x-1908)
Matthei y Quezada 61 (Chile, 13-xii-1983)	*McGillivray & Coveny 423* (*NSW 112273*, 23-vii-1968)	
	Johnson & Briggs (*NSW 130081*, 2-xi-1968)	
Berry ± 14 × 9 mm	Berry ± 11 × 9 mm	Berry 13 × 8 mm
Style and stigma persisting	Style and stigma persisting	Style and stigma persisting
Persistent extrastaminal disc	Persistent extrastaminal disc	No extrastaminal disc
No persistent calyx	No persistent calyx	Persistent calyx
Placentae 3	Placentae 5	Placentae 4
Seeds angular-ovoid ± 3 × 2 mm	Seeds angular-ovoid ± 2 × 1.5 mm	Seeds angular-ovoid ± 3 × 2 mm
Protuberant 'sausage-shaped' raphe	Protuberant 'sausage-shaped' raphe	Median-lateral chalazal aril
o.e. (o.i.) large cuboid cells, cytoplasm red + saffranine	o.e. (o.i.) large cuboid cells, cytoplasm red + saffranine	o.e. (o.i.) large cuboid cells, cytoplasm red + saffranine
i.e. (o.i.) palisade layer of strongly lignified pitted cells, each with one crystal	i.e. (o.i.) palisade layer of strongly lignified pitted cells, each with one crystal	i.e. (o.i.) palisade layer of strongly lignified pitted cells, each with one crystal
o.e. (i.i.) finally absorbed In *Matthei y Quezada 61* persisting at places as longitudinal, weakly lignified, pitted cells	i.e. (i.i.) longitudinally stretched, weakly lignified, pitted cells (in *Floyd 1381*, not in the others), partly disrupting and compressed later	o.e. (i.i.) compressed
i.e. (i.i.) inside and radial walls weakly lignified, outside walls absorbed	i.e. (i.i.) inside and radial walls weakly lignified, outside walls absorbed	compressed, partly toothed
thick cuticle between testa and nucellus (endosperm)	thick cuticle between testa and nucellus (endosperm)	thick cuticle between testa and nucellus (endosperm)
small embryo	small embryo	small embryo

Abbreviations: o.i. and i.i. = outer and inner integument; o.e. and i.e. = outer and inner epidermis.

exotegmic. These distinctions are of great taxonomic importance. My results indicate that the seeds of *Berberidopsis* and *Streptothamnus* are endotestal, the inner epidermis of the outer integument forming a hard layer of very similar construction. As such their seeds do not fit in the Flacourtiaceous scheme. However, as indicated in table 1, I have now found elongated, lignified and pitted cells which develop into a fibrous exotegmen in one (alcohol) specimen of *Streptothamnus beckleri*, but not in two other (dried) specimens (fig. 3). Moreover, newly received fresh seeds of *Berberidopsis corallina* showed remains of a very similar exotegmen at the chalaza and near the micropyle. This may reflect a certain variation in final seed development. So maybe these seeds are endotestal and exotegmic after all, which would fit better with Flacourtiaceae in so far as *Hydnocarpus, Kiggelaria* and *Erythrospermum* are concerned. However, the cellular construction of the endotestal layers of *Berberidopsis* and *Streptothamnus* differs considerably from that of the three genera mentioned. The characteristic palisade of lignified, strongly pitted cells, each with a crystal, is not known in the Flacourtiaceae. However, our knowledge of that family is limited. The seed anatomy described recalls that of Dilleniaceae. Likewise the small embryo contrasts with the large embryo of Flacourtiaceae. Also *Hydnocarpus, Kiggelaria* and *Erythrospermum* have large embryos. A sausage-shaped raphe is not known in Flacourtiaceae. The arilloid of *Streptothamnus moorei* occurs also in *Lindackeria dentata*.

POLLEN MORPHOLOGY – Table 2; Photos 1–6

1. **Berberidopsis corallina** Hook. f. – *Marticorena et al. 1089* (L), Chile.

The pollen of this species was described by Keating (1973, 1975). The tricolpate aperture type together with the almost imperforate tectum place the pollen at a primitive level among the tricolporate and microperforate, mostly reticulate, pollen of the Flacourtiaceae. In my preparations the rupture of the colpi on acetolysis took place irregularly. Furthermore colpi of pollen that were swollen and then critical-point dried did not show a rupture in the middle. The scanning of the inside of sectioned pollen did not reveal any preformed endoaperture. These results also give an indication for the colpate aperture type. Keating reported that the pollen is somewhat rough-surfaced with microperforations of 0.03 μm occurring infrequently. However, I found a minutely pitted, foveolate tectum.

2. **Berberidopsis beckleri** (F.v.M.) Veldkamp – *Schodde 3245* (L) and *Coveny et al. 6017* (K), both from New South Wales.

This species was not seen by Keating. There is no difference between the two specimens studied. The pollen has three long colpi very similar to those of *Berberidopsis corallina*, viz. heavily covered with coarse particles (Keating). On acetolysis rupture of the colpi occurred preferably in the middle. Critical-point dried pollen showed the intine protruding over the whole length of the colpi. The covering of the colpus membrane with particles is frequently heavier in the middle, giving the impression of

operculum formation. Below these thicker areas the rupture of the colpi took place on acetolysis. After sectioning of pollen, the scanning of the inside of colpi did not reveal marked preformed endoapertures. Therefore the aperture type may be tricolpate. The tectum is imperforate and striate. Exine projections or bridges are formed over the middle of the colpi extending from the mesocolpic areas. This was also observed in *Berberidopsis corallina*, but only sporadically.

3. **Streptothamnus moorei** F.v.M. – *Tomlins s.n.* (L), New South Wales, Astoneville, 30.x.1908.

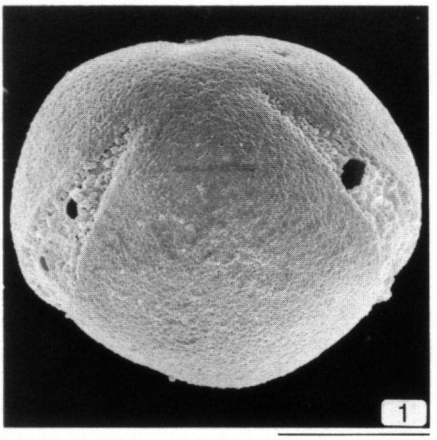
The pollen is smaller than in the other two species (see table 2). On acetolysis the colpi membranes ruptured on different places, but preferably in the middle. Then they showed large rectangular gaps similar to those pictured by Keating for *Erythrospermum*, *Streptothamnus moorei*, and most other Flacourtiaceae. The scanning of the inside of the colpi, after sectioning of the pollen, did not present evidence of clear endoapertures. Therefore also this species may have colpate pollen. The tectum is rugulate becoming reticulate toward the poles. On the mesocolpia the rugulate sculpture may be dense (imperforate), or somewhat wider (microperforate). Keating did not describe this pattern. His material showed a simple microperforate tectum as frequently occurs in Flacourtiaceae. Possibly another species is involved here. In my samples the exine shows a tendency to form bridges over the middle of the colpi. The colpus membranes are covered with particles like in the other two species.

The results may be summarized as in table 2:

Table 2. Characters of the pollen.

Berberidopsis corallina	*Berberidopsis beckleri*	*Streptothamnus moorei*
tricolpate	probably tricolpate	probably tricolpate
tectum imperforate, foveolate	tectum imperforate, striate	tectum perforate, rugulate to reticulate
25–30 μm	20–25 μm	smaller than 15 μm

All three species have a tectum sculpture unlike other Flacourtiaceae which were studied by S.E.M. in this respect. Probably the same is valid for the aperture type. All three have small ektexinous particles on the colpus membrane, and show bridge formation over the colpi. This is reported also for other Flacourtiaceae.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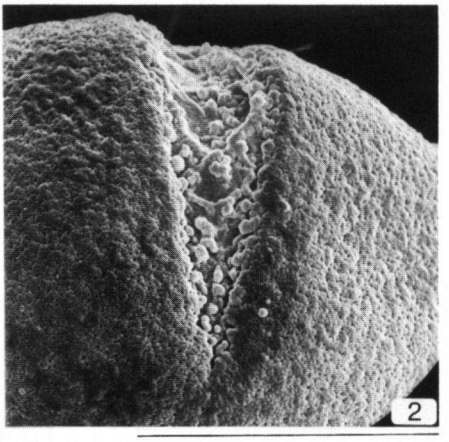
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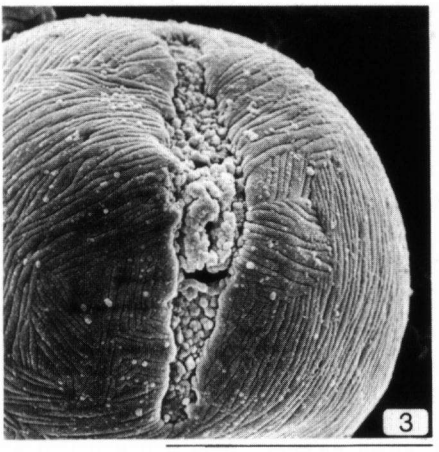
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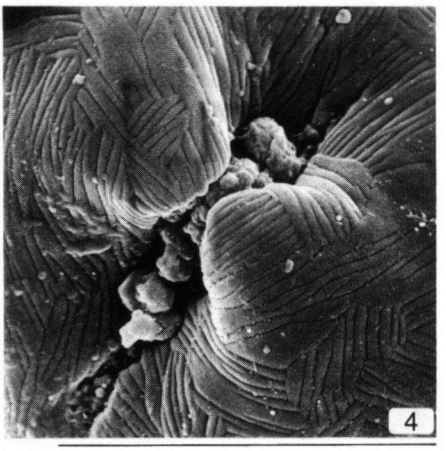
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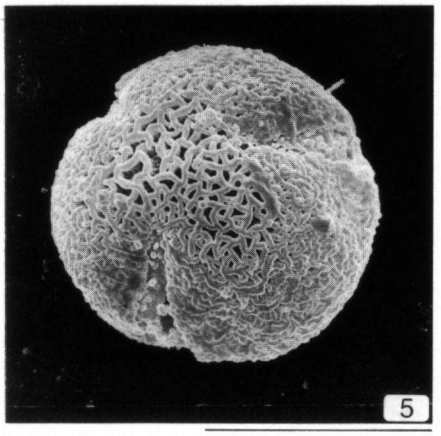
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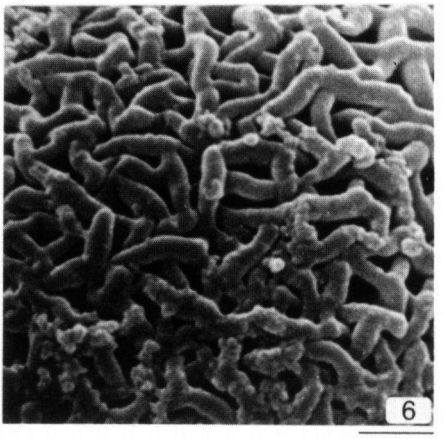
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CONCLUSION

Some arguments plead in favour of placing all three – scandent – species in one single genus, namely the berry structure, the seed anatomy, the small embryo, and probably the colpate pollen aperture type, the more so because these characters (the berry structure excepted) are unusual in the Flacourtiaceae. However, my results on the seed anatomy of *Streptothamnus moorei* were derived from one herbarium specimen only, and so further well fixated samples must be investigated. Except for the difference in leaf form, which would not seem very important, and the flower arrangement, all arguments against placing the three species in one genus are presented by the deviating characters of *Streptothamnus moorei*, viz. the persistent calyx, the tepal arrangement, the absence of a disc, the numerous stamens, and the perforate tectum. At the same time this means that the characters shared by *Berberidopsis corallina* and *Streptothamnus beckleri* suffice to unite these species in one genus, viz. the spiral transitional tepals, the disc, the number of stamens, the peculiar 'sausage-shaped' raphe, and the non-microperforate tectum. The difference in the inflorescence presents the only opposing argument. Therefore I consider the realignment as proposed by Veldkamp (1984, this issue) fully justified. According to that *Streptothamnus beckleri* becomes *Berberidopsis beckleri* (F.v.M.) Veldkamp. By this the genus *Berberidopsis* has one species in Chile and at least one other species in Australia. A decision on the position of *Streptothamnus moorei* must wait on the investigation of more and better collections of this species.

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REFERENCES

CORNER, E. J. H. 1976. The seeds of Dicotyledons.

HEEL, W. A. VAN. 1973. Flowers and fruits in Flacourtiaceae. I. Scaphocalyx spathacea Ridl. Blumea 21: 259–279.

—— 1974. Ibidem II. The seeds of Pangium edule Reinw. Blumea 22: 15–19.

—— 1977. Ibidem III. Some Oncobeae. Blumea 23: 349–369.

—— 1979. Ibidem IV. Hydnocarpus spp., Kiggelaria africana L., Casearia spp., Berberidopsis corallina Hook. f. Blumea 25: 513–529.

KEATING, R. C. 1973. Pollen morphology and relationships of the Flacourtiaceae. Ann. Missouri Bot. Gard. 60: 273–305.

—— 1975. Trends of specialization in pollen of Flacourtiaceae with comparative observations of Cochlospermaceae and Bixaceae. Grana 15: 29–49.

VELDKAMP, J. F. 1984. Berberidopsis (Flacourtiaceae) in Australia. Blumea 30: 21–29 (this issue).

Photos 1 & 2: *Berberidopsis corallina* Hook. f. — 3 & 4: *Berberidopsis beckleri* (F.v.M.) Veldk. — 5 & 6: *Streptothamnus moorei* F.v.M. The scale at photos 1–5: 10 μm, that at photo 6: 1 μm.