

**Palynology of South Pacific Cyrtandra (Gesneriaceae) with
notes on some Hawaiian taxa.**

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Palynology of South Pacific *Cyrtandra* (Gesneriaceae) with notes on some Hawaiian taxa

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Pollen of 34 accessions (23 species, one putative hybrid) of South Pacific and Hawaiian *Cyrtandra* was investigated by SEM. Most pollen grains are isopolar, 3-colpate, spheroidal in equatorial view, and circular in polar view. Only *C. kamoooloensis* (Hawaii) exhibits suboblate pollen grains. Average equatorial diameters range from 9 to 16 μm . In general, colpi are long and tapering. Colpus membranes show granular elements which decrease in size from the equatorial to the polar regions. Most taxa exhibit a microreticulate mesocolpial exine pattern, in some cases with a tendency to reticulate or fossulate pattern. Lumina size varies within the mesocolpial region of single grains, average lumina diameter is either similar throughout grains or decreases towards the colpal borders or the apocolpial region. *C. kamoooloensis* exhibits the smallest lumina reported for Hawaiian *Cyrtandra* so far. In some species, distinct free-standing columellae are present. Except for a fine granular ornamentation of shallow grooves on the muri of the Samoan *C. richii* supracteal elements are lacking.

Pollen of South Pacific *Cyrtandra* does not provide characters directly suitable for generic subdivisions. There is no obvious correlation between morphologically defined species groups and exine types, but some evidence for parallel evolution of these types. Nearly related taxa (e.g., the *C. cymosa* group of Gillett 1973) show considerable palynological differences. Variation within some currently accepted species is more prominent than between taxa clearly belonging to different evolutionary lines. This could reflect deficiencies in species delimitation.

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The genus *Cyrtandra* is by far the largest genus of the Gesneriaceae, comprising more than 600 species (Smith 1991). Its distribution corresponds to the Malesian type sensu van Balgooy (1971: p. 65, Fig. 25) with the bulk of taxa occurring in Malesia and the Pacific. Not only the huge number of species and the large distribution area cause difficulties in creating infrageneric classifications for the genus as a whole; the major reason is the lack of sufficient biological data for most of the species (Gillett 1973, Wagner et al. 1990, Smith 1991).

Pollen morphology has often provided characters useful for reliable taxonomic subdivisions. Palynology of Malesian and Hawaiian *Cyrtandra* investigated by Luegmayr (1993 a, b) revealed a eurypalynous situation in the Malesian species and a high degree of uniformity in the pollen of Hawaiian taxa. For some Malesian species initial correlations of obtained data with existing subgeneric divisions could be drawn. A general assessment of the taxonomic value of the palynological findings, however, was not possible due to the poor state of the infrageneric classification and the lack of information for taxa especially from the South Pacific (Luegmayr 1993 b).

The aim of the present work is to fill a gap by providing pollen data for *Cyrtandra* from the South Pacific. The 21 taxa of South Pacific origin investigated here exhibit differences in morphological characters used for generic subdivisions (e.g., unequally or equally sized opposite leaves, various calyx and corolla forms). They are related to four (I, II, IV,

V) of the six informal groups established by Gillett (1967) for Fijian *Cyrtandra*, represent more than 1/5 of the South Pacific species recognized by Gillett (1973), and originate from 7 of the 10 geographical regions distinguished by Gillett (1973). Thus it can be assumed that they provide a representative picture of pollen morphology of *Cyrtandra* from the area.

The results of studies on two additional taxa from Hawaii are also included in this paper.

MATERIAL AND METHODS

Pollen samples were obtained either from ethanol (70%) or FAA (35% formaldehyde:glacial acetic acid:50% ethanol; 2:1:17) preserved flowers, or from herbarium sheets. Origins of the investigated material are included in Table I; voucher specimens are deposited in the herbaria listed in Table I.

Because of the marked protandry in *Cyrtandra* flower buds shortly before anthesis proved best for pollen examination. For SEM preparation the preserved samples were dehydrated in an ethanol series subsequently followed by DMP (2,2-Dimethoxypropane) and transferred to acetone. After critical point drying pollen grains were placed on aluminium stubs and sputter coated with gold. Anthers of dried herbarium specimens were first soaked in a 10% aqueous mixture of dioctyl sodium sulfosuccinate and 95% acetone for 24–32 hours (Peterson et al. 1978) and then treated like fixed samples. Alternatively, pollen samples from some herbarium specimens were directly spread on aluminium stubs and sputter coated. The pollen grains were investigated with a SEM JEOL T-300 at 10 kV. Pollen diameter, number and size of lumina μm^2 were measured on SEM

micrographs from representative pollen grains. The description of pollen morphology follows Punt et al. (1994).

RESULTS

General pollen morphology is very similar in all 34 investigated *Cyrtandra* accessions comprising 23 different taxa (21 of South Pacific origin, two from Hawaii) and one putative hybrid from Samoa. Pollen grains are isopolar, 3-colpate, spheroidal in equatorial view, and circular in polar view. Only one species (the Hawaiian *C. kamoooloensis*) was found to have suboblate pollen grains. The average equatorial diameter ranges from 9 µm to 16 µm. The colpi in most taxa are long and tapering (Fig. 2 B), sometimes exhibiting rounded ends (e.g., in the Marquesan *C. feaniana*, Fig. 1 A). The colpus membrane shows granular elements which decrease in size from the equatorial to the polar region (Figs. 1 A, 1 B, D & 2 B).

A fossulate exine pattern was found in *C. compressa* and

one of the two investigated *C. biflora* accession: the lumina are irregularly shaped (Fig. 2 C) and, therefore, only their length, not their diameter can be measured.

Most of the investigated species show a microreticulate exine, in some cases with a tendency to reticulate (*C. feaniana*) or fossulate pattern (the two accessions of *C. nr. cymosa* from Vanikoro Island, the second accession of *C. biflora* from the Society Islands). Lumina size varies considerably within the mesocolpial region of individual pollen grains (Figs. 1 B, 2 C, D). The average diameter of the lumina is either stable throughout the whole pollen grain (Fig. 2 E) or decreases towards the colpial border or the apocolpial region (Fig. 1 A; species in Table I marked with *). One accession of the Samoan *C. richii* (Bristol 2109) shows shallow grooves radiating from the lumina as fine ornamentation on the muri (Figs. 1 D, 1 E). Other supratectal elements are lacking. In *C. compressa* (Samoa), one accession of *C. pogonantha* (MK-940818-2/2, Samoa), and *C. feaniana* distinct columellae within the lumina are visible (Fig. 1 B, C).

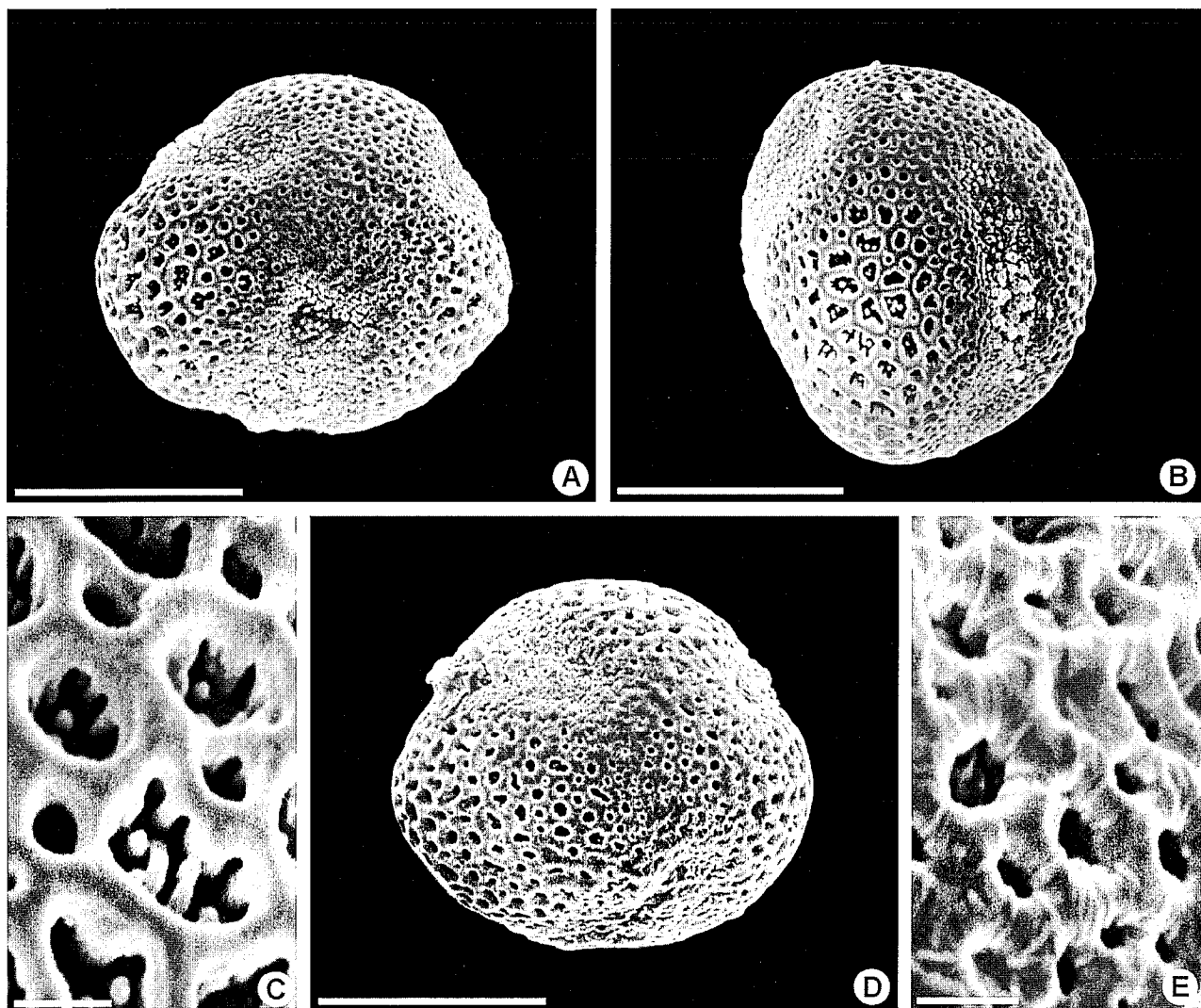


Fig. 1. A–C. *Cyrtandra feaniana* pollen grains. SEM. (A) Polar view; (B) Equatorial view; (C) Mesocolpial detail, free standing elements within the lumina. D, E. *C. richii* pollen. SEM. (D) Polar view; (E) Mesocolpial detail, shallow grooves on the muri. Scale bars: A, B, D = 10 µm; C, E = 1 µm.

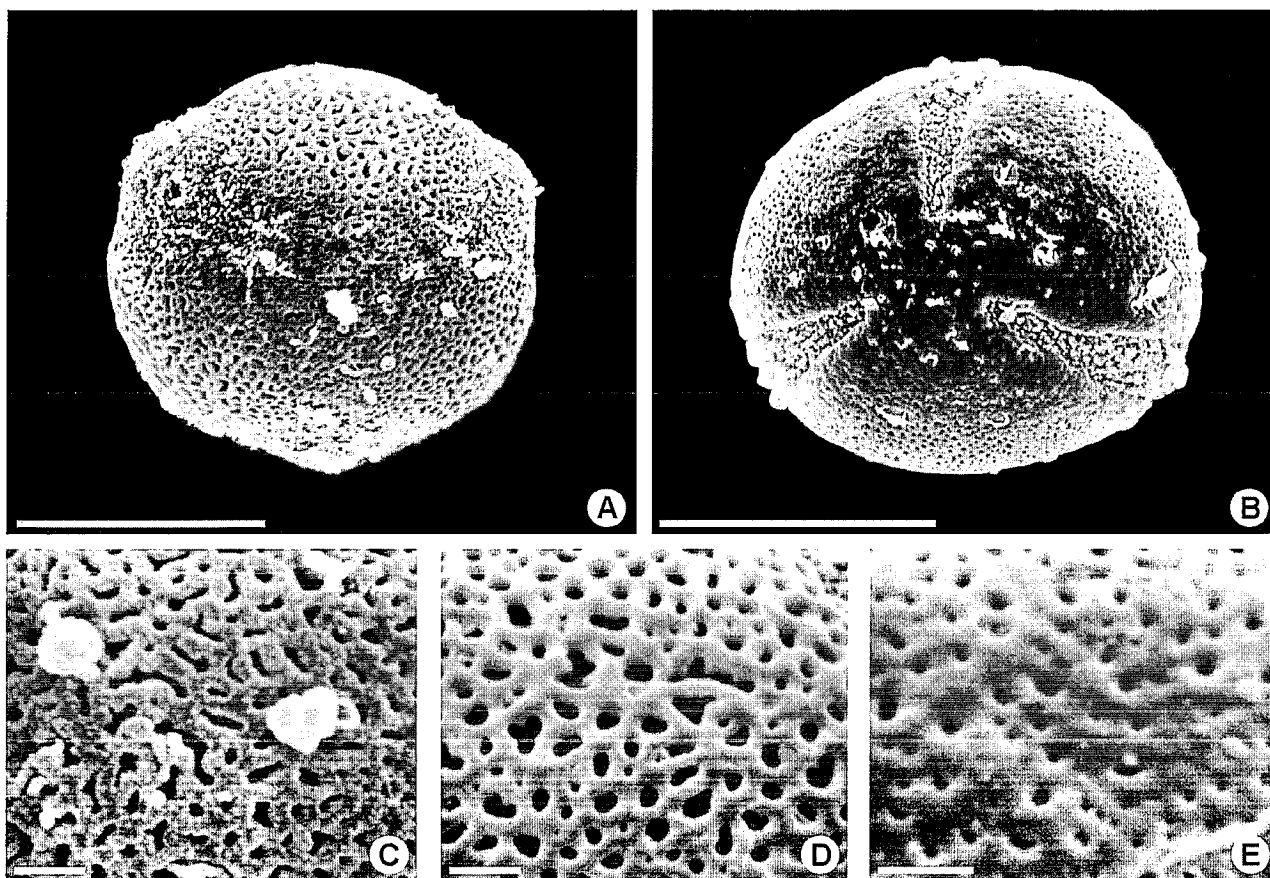


Fig. 2. A, B. SEM of *Cyrtandra* pollen grains. (A) *Cyrtandra compressa*, polar view; (B) *C. kamoooloensis*, polar view. C-E. SEM; Mesocolpial details, different exine patterns. (C) *C. compressa*, fossulate; (D) *C. cf. milnei*, microreticulate; (E) *C. kamoooloensis*, microreticulate. Scale bars: A, B = 10 µm; C-E = 1 µm.

DISCUSSION AND CONCLUSIONS

For discussing the taxonomic significance of the observed palynological variation, it must be related to existing sub-generic groupings, to the geographical distribution, and also to the specific level.

Exine pattern, geographical distribution, and subgeneric divisions

The microreticulate exine type is the most common one in South Pacific *Cyrtandra*. It occurs in all four investigated informal groups of Gillett (1967) and is also predominantly found in the investigated Hawaiian taxa (Luegmayer 1993 b). Thus the occurrence of this exine type does not corroborate the subdivisions of Gillett (1967). It could, however, represent a common basic character state for pollen of *Cyrtandra* of the South Pacific region and Hawaii, a group for which monophyly is indicated by molecular studies (Samuel et al. 1997).

If at all, differences in lumina sizes are useful as distinguishing characters at the species level. *C. kamoooloensis* exhibits the smallest lumina reported for any Hawaiian *Cyrtandra* so far (cf. data of Luegmayer 1993 b).

The fossulate type is found in two geographically separated taxa, which do not seem to be closely related on the basis of other morphological characters. Therefore it can be assumed that this type has evolved in these taxa in a parallel fashion.

Pollen morphology of related taxa

One of the morphologically and ecologically most clearly distinguished entities of South Pacific *Cyrtandra* is the *C. cymosa* group of Gillett (1973): it comprises nine species of ± coastal distribution ranging from the Caroline Islands to the Cook Islands, some of which possibly even are conspecific (Gillett 1973). Seven accessions covering four taxa of this group are included in the current study (*C. cymosa*, *C. futunae*, *C. samoensis*, and *C. rarotongensis*). Surprisingly, they exhibit most of the palynological variation documented for the genus in this area (Table I): microreticulate and microreticulate/fossulate exine pattern occur, mesocolpial lumina diameters remain constant or decrease towards the colpial border and the apocolpium, lumina numbers per 25 µm² vary between 40 and 140, and largest lumina sizes range between 0.3 µm and 0.9 µm. Thus pollen characters do not reflect the close relationship of these taxa.

Table I. Pollen morphology of *Cyrtandra*.

Taxa are arranged geographically following the grouping in Gillett (1973). Sculpt.: supratectal elements present (+), absent (-); free-standing columellae: present (+), absent (-); number of lumina per 25 µm² of the mesocolpium and average diameter or length (°) of the largest lumina of the mesocolpium; short description of the exine pattern: retic. = reticulate exine; m-retic. = microreticulate exine; foss. = fossulate exine; * = mesocolpial lumina diameter decreases towards the colpal border and the apocolpium. Abbreviations of herbaria follow Holmgren et al. 1990.

Taxon	Origin, collector, voucher number (herbarium of deposition)	Sculpt.	Free-standing columellae	Lumina No./ size (µm)	Exine pattern
<i>C. heteronema</i> G. W. Gillett	South Pacific Bougainville Islands, Corner N.G.F. 13751 (K)	-	-	90/0.6	m-retic.
<i>C. fulvo-villosa</i> Rechinger	Solomon Islands, Mauriasi & coll. BSIP 14431 (K)	-	-	140/0.3	m-retic.
<i>C. aff. cymosa</i> J. R. & G. Forst.	Solomon Islands, Mauriasi & coll. BSIP 16669 (K)	-	-	130/0.3	m-retic.
<i>C. nr. cymosa</i> J. R. & G. Forst.	Vanikoro Island, Whitmore BSIP 1744 (K)	-	-	110/0.8	m-retic./foss.
<i>C. nr. C. cymosa</i> J. R. & G. Forst. (= <i>C. kajewskii</i> Guillaum.)	Vanikoro Island, Whitmore BSIP 1575 (K)	-	-	40/0.3	m-retic./foss.
<i>C. neo-hebridensis</i> G. W. Gillett	Vanuatu, Bourdy 78 (K)	-	-	120/0.5	*m-retic.
<i>C. cf. milnei</i> A. Gray	Fiji, Vodonaivalu & al. sub MK-940807-1/1 (SUVA, WU)	-	-	105/0.4	m-retic.
<i>C. futunae</i> Kraenzl.	Futuna, Mackee 19748 (K)	-	-	130/0.5	m-retic.
<i>C. compressa</i> C. B. Clarke	Western Samoa, Kiehn & al. MK-940823-2/1 (WU)	-	+	25/0.8°	foss.
<i>C. falcifolia</i> C. B. Clarke	Western Samoa, Kiehn & al. MK-940823-3/1 (WU)	-	-	70/0.6	*m-retic.
	Western Samoa, Christophersen 630 (K)	-	-	80/0.5	m-retic.
<i>C. pogonantha</i> A. Gray	Western Samoa, Kiehn & al. MK-940814-2/1 (WU)	-	-	120/0.5	m-retic.
	Western Samoa, Kiehn & al. MK-940818-2/2 (WU)	-	+	70/0.6	m-retic.
	Western Samoa, Kiehn & al. MK-940819-3/1 (WU)	-	-	120/0.5	m-retic.
<i>C. ? pogonantha</i> A. Gray × <i>C. richii</i> A. Gray	Western Samoa, Kiehn & al. MK-940818-2/4 (WU)	-	-	50/0.5	*m-retic.
<i>C. richii</i> A. Gray	Western Samoa, Bristol 2109 (K)	+	-	40/0.6	m-retic.
	Western Samoa, Kiehn & al. MK-940824-1/1 (WU)	-	-	30/1.1	m-retic./retic.
<i>C. cf. richii</i> A. Gray	Western Samoa, Kiehn & al. MK-940818-2/1 (WU)	-	-	120/0.4	m-retic.
	Western Samoa, Kiehn & al. MK-940819-3/2 (WU)	-	-	40/0.4	*m-retic.
	Western Samoa, Kiehn & al. MK-940824-2/1 (WU)	-	-	60/0.6	*m-retic.
<i>C. samoensis</i> A. Gray	Western Samoa, Kiehn & al. MK-940819-1/1 (WU)	-	-	80/0.9	*m-retic.
	Western Samoa, Kiehn & al. MK-940819-2/1 (WU)	-	-	130/0.5	*m-retic.
<i>C. sp. I</i>	American Samoa, Whistler W 2731 (K)	-	-	70/0.6	m-retic.
<i>C. sp. II</i>	American Samoa, Whistler W 3087 (K)	-	-	60/0.6	*m-retic.
<i>C. rarotongensis</i> Cheesem.	Cook Islands, Wilder 29 (K)	-	-	100/0.5	m-retic.
<i>C. biflora</i> J. R. & G. Forst.	Society Islands, Grant 4466 (K)	-	-	40/1.2	retic./foss.
<i>C. biflora</i> J. R. & G. Forst. (as <i>C. parksii</i> Setch.)	Society Islands, Grant 4158 (K)	-	-	10/1.0°	foss.
<i>C. longiflora</i> J. W. Moore	Society Islands, Florence 5157 (K)	-	-	20/0.8	*m-retic.
<i>C. feaniana</i> F. Brown	Marquesas Islands, Perlmann 10.184 (PTBG)	-	+	15/1.0	*m-retic./retic.
	Marquesas Islands, Perlmann 10.261 (PTBG)	-	+	14/1.2	*m-retic./retic.
<i>C. sp. III</i>	Marquesas Islands, Perlmann 10.232 (PTBG)	-	-	80/0.8	*m-retic.
<i>C. sp. IV</i>	Marquesas Islands, Perlmann 10.233 (PTBG)	-	-	90/0.8	*m-retic.
	Hawaii				
<i>C. cyaneoides</i> Rock	Kauai, Flynn 3046 (PTBG)	-	-	50/0.8	*m-retic.
<i>C. kamoooloensis</i> St. John	Kauai, Flynn 3314 (PTBG)	-	-	190/0.07	m-retic.

Palynological findings also do not corroborate relationships in *Cyrtandra* suggested on the basis of morphology by Wagner et al. (1990): e.g., pollen of *C. feaniana* clearly differs from pollen of taxa belonging to Sect. *Macrosepala* in Hawaii (Luegmayer 1993 b; *C. kamoaloensis*, this study). *C. pogonantha*, *C. cf. milnei*, and Sect. *Verticillatae* in Hawaii (Luegmayer 1993 b; *C. cyaneoides*, this study) are heterogeneous regarding their pollen.

These results indicate that observed variation in pollen characters of South Pacific *Cyrtandra* is not helpful to characterise the mentioned groups of closely related taxa.

Pollen morphology of accepted species

In several cases, pollen of different accessions of one species or species group is heterogeneous (Table I): in the taxa keying out in the *C. cymosa* relationship two different exine patterns occur. They are congruent with the geographical distribution of the investigated collections: the microreticulate exine type is found in the two collections from the Solomon Islands, the type intermediate between microreticulate and fossulate occurs in both collections from Vanikoro Island. Pollen of the latter also differs in number and size of the lumina. It is noteworthy that the same collector has made the two Vanikoro Island collections, and gave different names to them.

A similar situation exists in *C. biflora*. Two different exine types occur in the two investigated accessions. The same person collected both. One of the collections was originally determined as *C. parksii*, a taxon put into synonymy with *C. biflora* by Gillett (1973).

Variation in pollen of the Samoan taxa *C. pogonantha*, *C. richii*, and *C. falcifolia* (Table I) might correspond to other morphological differences observed in these taxa during field work and preliminary herbarium studies (Kiehn: unpubl.).

Pollen of *C. feaniana* clearly differs from pollen of other taxa from the Marquesas (Table I). Only investigations of more species from this island group can reveal the taxonomic value of these findings.

General conclusions

Pollen of South Pacific *Cyrtandra* is relatively uniform. This situation is similar to the picture obtained for Hawaiian taxa and differs remarkably from the eurypalynous state of SE Asian *Cyrtandra* (Luegmayer 1993 a, b). As molecular data (Samuel et al. 1997, Smith et al. 1999) indicate monophyly for the Pacific taxa of *Cyrtandra*, this uniformity (and especially the microreticulate exine) could represent a basic character state for Pacific *Cyrtandra*.

The obtained data provide evidence for the assumption that the observed variation in pollen characters of South Pacific *Cyrtandra* has (at least partly) evolved in a parallel fashion. Thus these differences do not contribute much to a

clearer picture of infrageneric divisions. In some cases they seem to provide diagnostic characters for distinguishing species in groups exhibiting morphological similarity. For a better understanding of such implications of these results, however, more taxa must be investigated palynologically and further biological data for the corresponding taxa are needed.

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REFERENCES

- Balgooy, M. M. J. van 1971. Plant geography of the Pacific. – *Blumea* Suppl. Vol. 6: 1–222.
- Gillett, G. W. 1967. The genus *Cyrtandra* in Fiji. – *Contributions from the United States National Herbarium* 37: 107–159.
- Gillett, G. W. 1973. The genus *Cyrtandra* in the South Pacific. – *University of California Publications in Botany* 66: 1–59.
- Holmgren, P. K., Holmgren, N. H. & Barnett, L. C. 1990. Index Herbariorum. Part 1: The Herbaria of the World, ed. 8. – New York Botanical Garden, Bronx NY.
- Luegmayer, E. 1993 a. Pollen characters of Old World Gesneriaceae (Cyrtandroideae). With special reference to SE Asian taxa. – *Grana* 32: 221–232.
- Luegmayer, E. 1993 b. Pollen of Hawaiian *Cyrtandra* (Gesneriaceae) including notes on Southeast Asian taxa. – *Blumea* 38: 25–38.
- Peterson, R. L., Hersey, R. E. & Brisson, J. D. 1978. Embedding softened herbarium material in Spurr's resin for histological studies. – *Stain Technology* 53: 1–9.
- Punt, W., Blackmore, S., Nilsson, S. & Le Thomas, A. 1994. Glossary of pollen and spore terminology. – LPP Contrib. Ser.No.1, LPP Foundation, Utrecht.
- Samuel, R., Pinsker, W. & Kiehn, M. 1997. Phylogeny of some species of *Cyrtandra* (Gesneriaceae) inferred from the atp/rbcL cpDNA intergene region. – *Botanica Acta* 110: 503–510.
- Smith, A. C. 1991. *Flora Vitiensis Nova*. A new flora of Fiji (Spermatophytes only), Vol. 5. – NTBG, Lawai (Hawaii).
- Smith, J. F., Cronk, Q. C. B., Kiehn, M. & Wagner, W. L. 1999. Adaptive radiation and phylogeny of Pacific *Cyrtandra* (Gesneriaceae) based on molecular and morphological data. – In: 14th Int. Bot. Congr. St. Louis 1999, Abstracts (ed. Org. Comm.: P.M. Jorgensen), p. 33. No. 4.2.5 – Mo.Bot.Gard., St. Louis MO.
- Wagner, W. L., Herbst, D. R. & Sohmer, S. H. 1990. *Manual of the flowering plants of Hawai'i*. – Bishop Mus. Spec. Publ. 83. Univ. Hawaii Press & Bishop Museum Press, Honolulu HI.