

A NEW SPECIES OF ZYGOGYNUM (WINTERACEAE)

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SUMMARY

A new species, *Zygogynum vinkii*, is described within the woody Ranalean family Winteraceae. It differs from other species of the endemic New Caledonian genus in having 302–371 stamens per flower. Unspecialized cells of the lower leaf surface are covered with cuticular papillae of a type hitherto unreported in *Zygogynum*. The three species with non-tetrad pollen, *Z. pomiferum*, *Z. mackeei* and *Z. vinkii* are compared.

INTRODUCTION

When the occurrence of pollen grains, not united in permanent tetrads, was described for the first time within the primitive Ranalean family Winteraceae, the plant possessing this type was identified as *Zygogynum pomiferum* (Sampson, 1974, 1975). Subsequently, Vink (1977), in his taxonomic monograph of *Zygogynum*, recorded monad pollen not only in *Z. pomiferum* ssp. *pomiferum* (previously *Z. pomiferum*) but also in *Z. pomiferum* ssp. *balansae* (previously *Z. balansae*) and *Z. mackeei*. Pragłowski (1979) described pollen of all species and subspecies recognized by Vink (1977). The publication of Vink's monograph prompted the writer to undertake a more detailed examination of floral and vegetative features of the plants from which non-tetrad pollen had first been described. Results indicated that the plants were not in fact *Z. pomiferum* but a new species *Z. vinkii* which is described herein.

MATERIALS AND METHODS

Immature and submature flower buds and submature fruits of *Zygogynum vinkii* were preserved in formalin-acetic-alcohol and herbarium material (*WELTU 12123*) collected on December 13, 1967 by F.B. Sampson, from Katrikoin forest near the Boghen river at approximately 400 m altitude, 15 km due north of Moindou, New Caledonia. Dr. G. McPherson, Noumea, New Caledonia, kindly made several recent visits to this locality and collected young buds (November, 1979) but has been unable to obtain open flowers. For comparative purposes preserved floral material of *Z. pomiferum* ssp. *pomiferum* was examined (*McPherson 2827*, July 1980, Mt Do,

850 m altitude; *McPherson & Dawson*, June 1980, Mt Mandjéla, 600 m altitude) as well as herbarium specimens from Mt Do, *McPherson 4208 (WELTU 13914)*; Mt Mandjéla, *McPherson 4198 (WELTU 13913)* and Mé Ori, 600 m altitude, near Katrikoin, *McPherson 4182 (WELTU 13912)*. In addition, recent examination of a fruiting specimen (*WELTU 12125*) from the original collection from Katrikoin revealed it was *Z. pomiferum* ssp. *pomiferum* and not *Z. vinkii*.

To facilitate comparison with Bongers' (1973) study of epidermal leaf characters in the family, the same methods were used, i.e.: (a) Cuticular preparations were obtained by boiling leaf portions from herbarium specimens in water, then macerating them in a mixture of hydrogen peroxide and glacial acetic acid. (b) Dried leaves for scanning electron microscope examination were extracted with ether before coating.

Clearings were made from dried leaves which were boiled in water, then in 95% ethyl alcohol and placed in 5% sodium hydroxide at 50° C for 24 hours or more. Microtome sections, stained with safranin and fast green, were obtained from dried leaves which were boiled in water, fixed in formalin-acetic-alcohol, dehydrated in a tertiary butyl alcohol series, and embedded in paraplast wax. Material for scanning electron microscope examination was sputter coated with a thin layer of platinum and viewed under a Philips 505 SEM.

OBSERVATIONS AND DISCUSSION

General description

Zygogynum vinkii Sampson, *nov. spec.* – Fig. 1, 3, 5, 8, 13, 16–19.

Arbor ad c. 7 m alta. *Folia* supra atroviridia infra albida. Petioli 1.5–2.5 cm longi. Laminae foliorum obovatae vel oblanceolatae, 12–22 × 4–8 cm, subcoriaceae, apice obtusa, basi anguste cuneata, costa subtus triangulari. *Inflorescentiae* 1-florae. Calyx irregulariter lobatus. Petala 11–12. Stamina 302–371. Pollinis grana solitaria. Pistillum stigmatibus 21–39 rel. magnis, breviter stipitatis. *Fructus* immaturus globosus usque ad 4 cm diametrum. – Typus: *WELTU 12123 (WELTU)*, in Katrikoin silva, c. 400 m, Nova Caledonia, F.B. Sampson, 13 December 1967.

A small tree to c. 7 m high. Fresh leaves mid to dark green on upper surface and whitish on the lower surface except for the prominent midrib and the leaf margin which are light green. The white colour disappears when leaves are dried with heat. *Petioles* 1.5–2.5 cm long, rounded to subtriangular below. *Blade* obovate to oblanceolate, 12–22 × 4–8 cm, subcoriaceous, apex obtuse, base narrowly cuneate, decurrent along upper lateral part of petiole; midrib prominent, triangular below. Lateral veins at centre of blade form an angle of 55°–75° to the midrib; veins conspicuous on either side in dried material. Distinct alveolar material covers stomatal apparatus of mature leaves; these alveolar plugs not or only slightly sunken. Unspecialized cells of lower epidermis covered with many papillae. *Inflorescences* always 1-flowered.

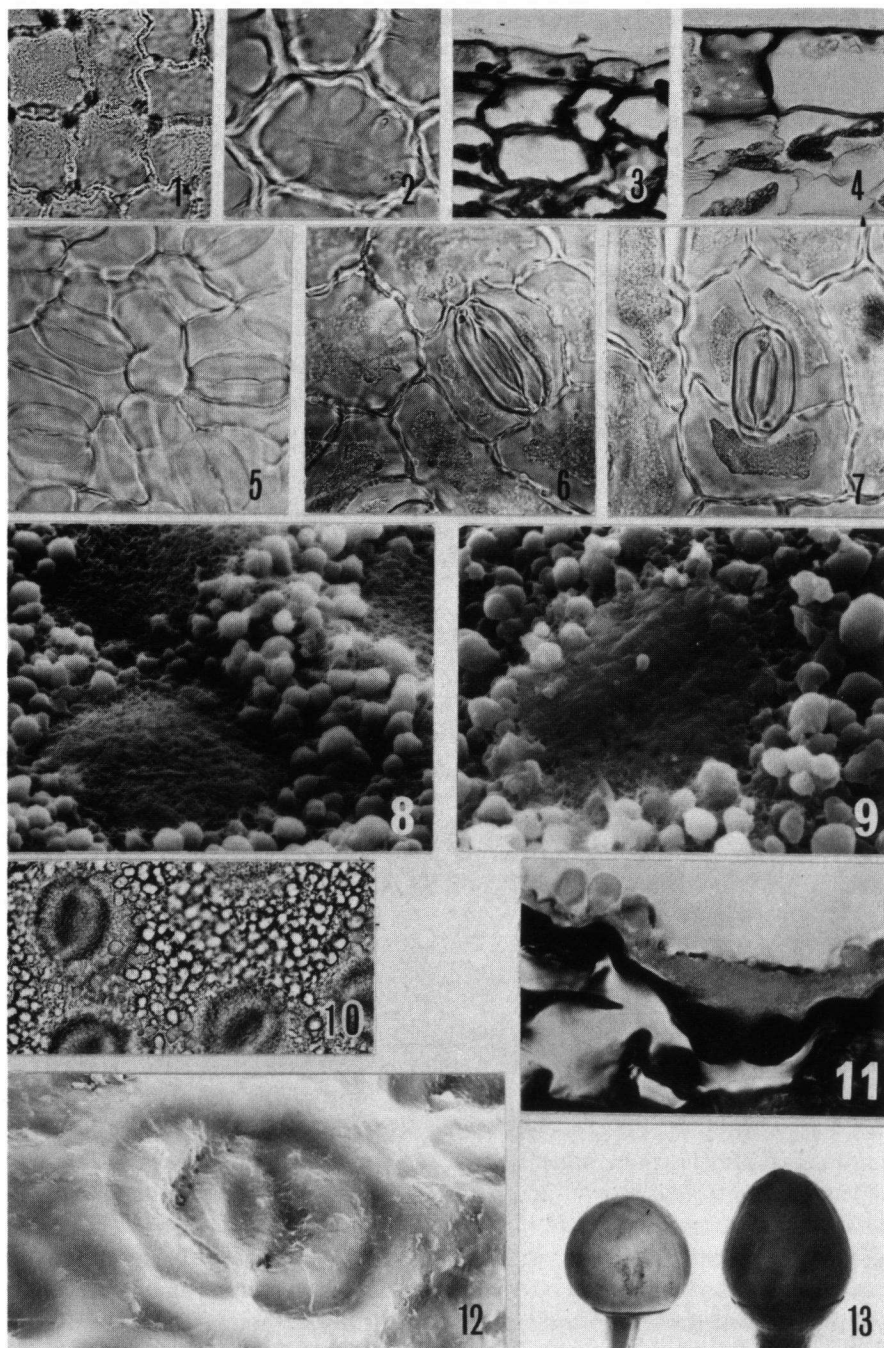
Pedicels round to oval, sometimes with 1 or 2 slight ridges, 20–25 × 5–9 mm when bearing submature fruits. *Calyx* (at submature fruit stage) cup-shaped, 10–16 mm diameter (including torus width), with irregularly lobed margin, reflexed in dried, but not in living condition. *Torus* 7–9 mm high, between calyx and submature fruit. *Petals* 11–12, the 4 outer visible externally in submature buds, free to their bases, with cream-yellow abaxial surfaces. No open flowers seen. Brachysclereids in clusters, often large ones, throughout petals, occasionally solitary. *Stamens* 302–371, in c. 12 irregular layers between petals and pistil; pollen grains solitary. *Pistil* with 21–39 stigmatic crests, relatively large, shortly stipitate, elliptical, with greatest diameter (along slit in centre of each crest) parallel to pedicel-flower axis, except crests at top and occasionally near base of pistil; ovules 17–29 per locule. *Compound fruits* globose, up to 4 cm diameter (submature) mid-green coloured with remains of stigmatic crests dark brown; largest fruits with tough woody wall c. 9 mm thick, densely packed with brachysclereids. No mature fruits were observed. *Seeds* (submature) up to 5 × 2 mm.

Distribution. At present only known from type locality, Katrikoin forest, near the Boghen river, c. 400 m altitude, 15 km due north of Moindou, New Caledonia.

Notes. The species is named in honour of Dr. W. Vink, who has contributed so much to our knowledge of the Winteraceae. It differs from other species in the large number of stamens per flower (302–371) which considerably exceed numbers previously recorded (Vink, 1977) for *Zygygynum* (20–250). It resembles 2 (*Z. pomiferum*, *Z. mackeei*) of the 6 other species in possessing solitary pollen grains. Mature leaves have a papillate lower surface, different from *Zygygynum* species studied by Bongers (1973). All specimens had single-flowered inflorescences. If this is invariably so, when more material is found, it will be an additional distinctive feature, shared with only one taxon, *Z. mackeei* ssp. *paniense*, recently described by Carlquist (1981). Although several other species (*Z. bicolor*, *Z. acsmithii*, *Z. vieillardii*, and *Z. baillonii*) have some inflorescences single-flowered, none have them always so (Vink, 1977).

Leaf anatomy

In surface view the cells of the upper epidermis are more or less isodiametric with somewhat undulating anticlinal flanges (fig. 1) and a finely striated cuticular surface. They differ markedly from those of *Z. pomiferum* (fig. 2) which are larger and have thin areas of the outer periclinal wall visible as loops (Vink, 1977). The upper epidermal cells (fig. 3) resemble other species, except *Z. pomiferum*, in possessing outer periclinal walls which are not appreciably thickened (0.5–1.5 µm), but are covered by a comparatively thick cuticle (3–9 µm). This contrasts with *Z. pomiferum*, with its thick outer periclinal walls, with several thinner parts per cell, and thin cuticle (fig. 4). As is true for all species except *Z. baillonii*, palisade parenchyma is not clearly differentiated within the mesophyll. Oil cells occur throughout the mesophyll. Brachysclereids, occurring singly, are sparsely, but evenly distributed and do not touch the adaxial or abaxial epidermis. Crystals, including druses, which are rare to



frequent in *Zygotynum* leaves (Vink, 1977), were not observed. Veins and veinlets are sheathed by thick walled sclerenchyma. Stomata, as in all Winteraceae, confined to the abaxial epidermis (Bongers, 1973), are randomly oriented, abundant, and of the paracytic type (fig. 5). Guard cell pairs are usually more rounded, less oval, than in *Z. pomiferum* ssp. *pomiferum* (fig. 6). Occasional stomata were found of the anisocytic type in this latter species (fig. 7), the first record of this type in the Winteraceae. Only one member of the family, *Takhtajania perrieri* (syn. *Bubbia perrieri*), has a third stomatal type, anomocytic (Bongers, 1973). Unspecialized lower epidermal cells of *Zygotynum vinkii* (fig. 5) are smaller than *Z. pomiferum* (figs. 6, 7) and have uniformly thin walls, 0.5–1.5 μm , whereas those of the latter species are thick, with thinner regions visible as faint loops (fig. 6), as in the upper epidermis. Small cuticular papillae cover the unspecialized cells of the lower epidermis (figs. 8–11). The cuticle reaches 10 μm in thickness, measured to the tip of papillae, down to 3 μm in thickness, between papillae. Such papillae have not been reported previously in *Zygotynum*. They contrast with the large papillae, one per cell, which Bongers (1973) reported in a few taxa of *Drimys*. However, Bongers (1973) has illustrated (photos 36, 39) examples of what are termed 'heterogeneous alveolar material' covering unspecialized lower epidermal cells of *Drimys* and *Bubbia*, which bear some resemblance to the papillae of *Z. vinkii*. [Although Bongers (1973) reportedly examined 6 species of *Zygotynum*, re-examination of the herbarium specimens he studied has revealed that only 2 species, *Z. baillonii* and *Z. pomiferum*, were present (Vink, 1977).] The stomatal apparatus, including the subsidiary cells, is covered by alveolar material of a different type, which forms an open meshwork (fig. 8), typical of many Winteraceae (Bongers, 1973). The thickness of the cuticle, including alveolar material, of the subsidiary and guard cells ranges from 5 μm to 12 μm . Rarely, these alveolar plugs have a tectum-like covering (fig. 9), which resembles that illustrated for *Z. pomiferum* ssp. *pomiferum* (Bongers, 1973, photo 41). The lower epidermis of *Z. pomiferum* with its comparatively smooth surface (fig. 12), is a marked contrast to that of *Z. vinkii*.

Floral and fruit characters

At all stages in their development, flower buds of *Z. vinkii* have an ovoid shape, with their largest diameter as an extension of the pedicel axis, in contrast to some species, e.g. *Z. pomiferum*, with more rounded buds (fig. 13). The ovoid shape is a reflection of the comparatively large part of the receptacle to which stamens are attached (compare figs. 14–17). Stamens are considerably narrower than those of *Z. pomiferum* (figs. 14, 16). The stigmatic crests of *Z. vinkii* (fig. 16) occupy a larger surface area of the gynoecium than in *Z. pomiferum* (fig. 14). Ovules are arranged in two rows in each locule and as the rows are closer together at each end, they form an oval shape (fig. 17). Submature compound fruits (figs. 18, 19) have an extremely tough sclerenchymatous wall enclosing the seeds, and a saw is required to bisect the fruit! Some brachysclereids, occurring singly or in small clusters, are present in this region in submature buds, but many more are formed from parenchyma cells during fruit development. It is not known how the seeds are dispersed.

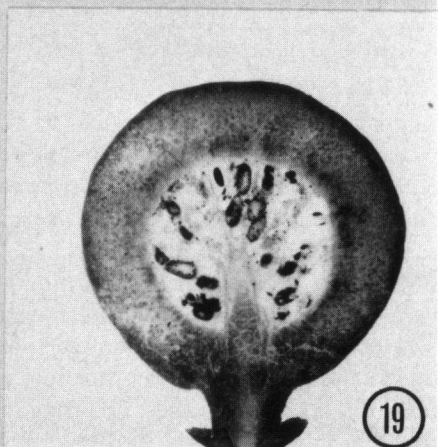
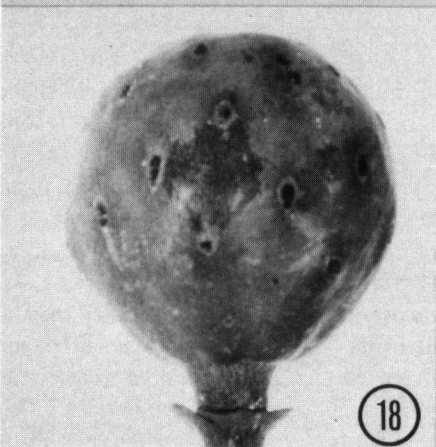
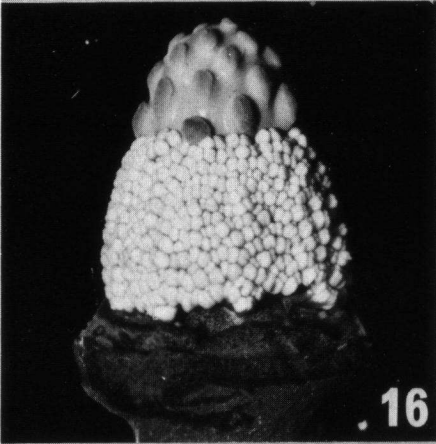
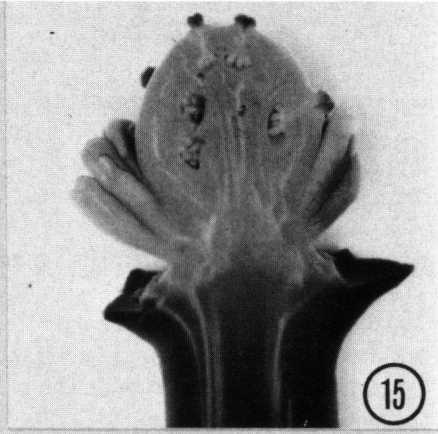
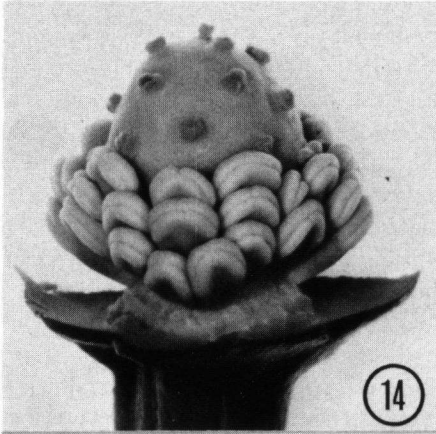


Table 1. Summary of characters of *Zyogynum* species with solitary pollen grains.

	<i>vinkii</i>	<i>pomiferum</i>	<i>mackeei</i>
<i>Leaf characters</i>			
Lower surface with unspecialized cells white	+	—	partly white
Epidermis with strongly thickened outer periclinal walls	—	+	—
Alveolar material over stomata only	—	+	—
Papillate alveolar material covering unspecialized cells of lower epidermis	+	—	—
Brachysclereids present	+	±	—
Druses present	—	+	rarely
<i>Floral characters</i>			
Flowers/inflorescence	1	(2-)3-5	3-5 (1 in ssp. <i>paniense</i>)
Petal number	11-12	(3-)4-15	12-13
Petals free	+	+ (-)	—
Number of stamens	302-371	20-103	96-136
Number of stigmatic crests (= number of fused carpels)	21-39	8-23	14-19 (9-11 in ssp. <i>paniense</i>)
Brachysclereids present in outer part of gynoecium	+	-*	+*
* personal communication W. Vink (1981).			

CONCLUSION

Table 1 summarizes some differences in vegetative and floral characters in the 3 species of *Zyogynum* with solitary pollen grains and is based on the present study and information from Vink (1977) and Carlquist (1981). The monad (solitary) type of pollen in *Zyogynum* clearly seems to have evolved secondarily from the tetrad form (Sampson, 1981). However, the 3 species which share this pollen type do not form a coherent group, when all species are compared. It is therefore possible that solitary pollen grains have evolved more than once in the genus. Both Vink (1977) and Carlquist (1981) have stressed that most species of *Zyogynum* are geographically considerably variable. Thus, if *Z. vinkii* is found in other localities, the description given here may well need amendment. It was sympatric with *Z. pomiferum* ssp. *pomiferum* in Katrikoin forest and therefore other regions where the latter species occurs should be examined for its presence.

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LEGENDS FOR FIGURES

Fig. 1–13. — 1. *Zygogynum vinkii*, surface view, upper epidermis of cleared leaf, x 320. — 2. *Z. pomiferum* ssp. *pomiferum* (WELTU 12125), as for fig. 1, x 320. — 3. *Z. vinkii*, TS portion of leaf, showing upper epidermis and some mesophyll cells, x 320. — 4. *Z. pomiferum* ssp. *pomiferum* (WELTU 13912), as for fig. 3, x 320. — 5. *Z. vinkii*, surface view, lower epidermis of cleared leaf, x 320. — 6. *Z. pomiferum* ssp. *pomiferum* (WELTU 12125), surface view, lower epidermis of cleared leaf, showing a typical stomatal apparatus, x 320. — 7. *Ibid.*, showing an anisocytic stomatal type, x 320. — 8. *Z. vinkii*, surface view, portion of lower leaf epidermis, SEM, x 700. — 9. *Ibid.*, showing alveolar plug with a tectum-like covering, SEM, x 750. — 10. *Ibid.*, cuticular peel of lower epidermis, with outlines of stomatal apparatus and papillae on unspecialized cells, x 320. — 11. *Ibid.*, TS portion of leaf showing lower epidermis, including stoma, x 320. — 12. *Z. pomiferum* ssp. *pomiferum* (WELTU 13914), surface view, portion of lower leaf epidermis, with stoma, SEM, x 460. — 13. Submature flower buds of *Z. pomiferum* ssp. *pomiferum* (McPherson 2827), at left and *Z. vinkii* (right), x 1.

Fig. 14–19. — 14. Submature flower buds, *Zygogynum pomiferum* ssp. *pomiferum* (McPherson 2827), with petals removed, x 4. — 15. *Ibid.*, inner surface of median vertical bisection of same bud as fig. 14, x 4. — 16. Submature flower bud, *Z. vinkii*, with calyx and petals removed, x 4. — 17. *Ibid.*, inner surface of median vertical bisection of same bud as fig. 16, x 4. — 18. *Ibid.*, submature compound fruit, x 1. — 19. *Ibid.*, same fruit as fig. 18 in median vertical bisection, x 1.