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THE WINTERACEAE OF THE OLD WORLD
II. ZYGOGYNUM — MORPHOLOGY AND TAXONOMY

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SUMMARY

In *Zygogynum* six species are recognized, of which two are newly described. *Z. spatulatum* is reduced to synonymy, *Z. balansae* is ranked as a subspecies of *Z. pomiferum*. Leaf anatomy provided suitable specific characters on which an alternative key could be constructed. Notes are given on the morphology of the inflorescence, flower, and fruit; the calyx is calyptrate in very early stages, the petals are mostly connate in bud. Corrections of identifications cited in literature on anatomy etc. are given on p. 239.

INTRODUCTION

In 1867 Baillon described a new genus, *Zygogynum*, for a new species related to *Drimys* (*sensu lato*) but differing mainly by its connate carpels. Already in 1873 he could add two more species, although one (*Z. stipitatum*) with some hesitation as the carpels were less strongly united.

In 1900 Van Tieghem made a thorough revision of *Zygogynum*. He removed *Z. stipitatum*, which was transferred to his new genus *Exospermum*, and added four new species. He divided the genus into two sections, based on the number of flowers in the inflorescence.

In 1943 A.C. Smith reviewed the existing knowledge. As he had no access to European herbaria because of war conditions, he could not make contributions on the specific level, but rightly rejected Van Tieghem's division into sections.

In the present paper the number of species recognized is the same (six) as already in existence since 1900. However, *Z. spatulatum* is reduced to synonymy, and *Z. balansae* is given the status of subspecies; the ranks are filled by two new species.

On the specific level the results of the present study are certainly not final. The delimitation of species is very difficult as the characters are all variable. The available material represents a fairly good sample from Central and South New Caledonia, but the populations in the Northern half of the island are strongly underrepresented. Further collections from this area could blurr the differences presented in this paper, necessitating future reconsideration.

ACKNOWLEDGEMENTS

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NOTES ON MORPHOLOGY AND ANATOMY

(for literature see p. 249)

1. Twig. The vegetative twigs elongate monopodially and flush-like. When the new leaves are still very young, the twig is already terminated by a bud. The outer cataphylls do not enclose the terminal bud tightly, but spread somewhat at their apices. Upon renewed elongation of the twig, the cataphylls drop off and leave a ring of well-spaced scars smaller than those of the leaves. The cataphylls continue the 2/5 spiral of the leaves and are similar to those at the base of the inflorescence.

As the inflorescence is terminal, elongation of the twig after flowering is sympodial from a vegetative bud in the axil of a higher or the highest cataphyll (bract) below the flowers. Sometimes two axillary buds develop; in that case one of these can be vegetative, the other mixed, that is, producing a short twig terminated by an inflorescence of which some higher bracts are replaced by leaves (e.g. fig. 2e).

A relation between the appearance of new leaves and that of flowers could not be established. Although in most cases flowering material does not show young leaves, in several specimens these were found together.

2. Indumentum. Hairs or distinct papillae were not found in this genus.

3. Leaf. The leaves are aromatic, more or less coriaceous, generally have a rounded to retuse apex and an acute to narrowly cuneate base often decurrent on the upper half of the petiole; the midrib is always flat to rounded above and can be rounded to triangular below; the nerves are rather straight, prominulous to inconspicuous; the veins are reticulate, the stronger ones ascending near the midrib, reticulate near the margin and there connecting the nerves by a wide reticulation or by distinct arcs.

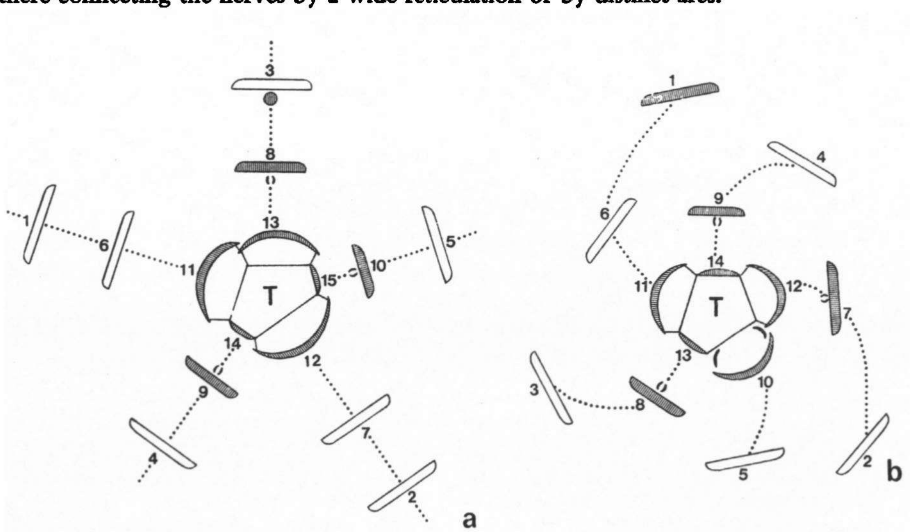

Fig. 1. Two diagrams of inflorescences of *Zygogynum pomiferum* ssp. *pomiferum* (*MacKee 23755*). — Numbering started at arbitrarily chosen leaves. — Straight symbols: leaves. — Curved symbols; bracts. — Ibidem, solid black: bracteoles.— Hatched: scars. — T: terminal flowerbud (a) or old flower (b). — Flowerbuds indicated by the outline of the insertions of their pedicels. — Distinct vegetative buds indicated.

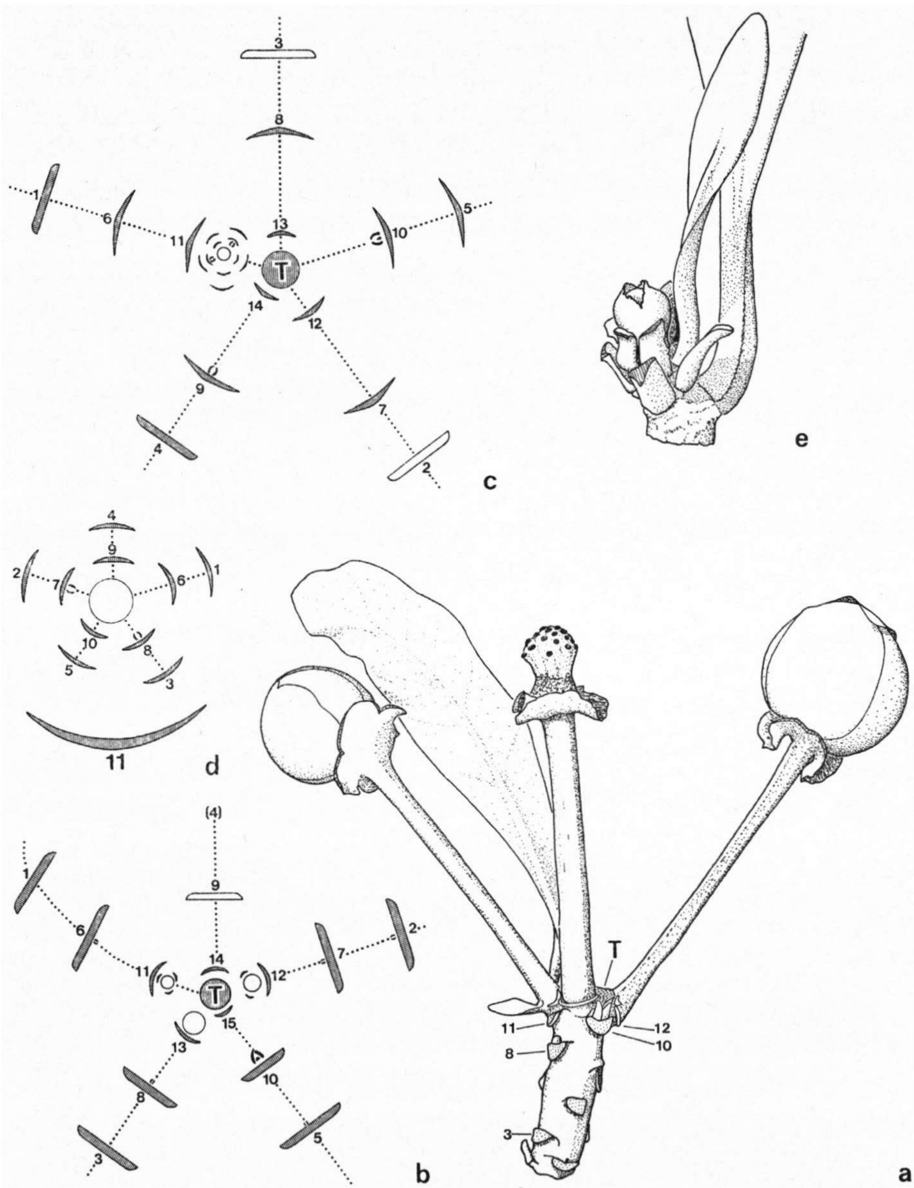

Fig. 2. Inflorescences. — a, b. *Zygogynum pomiferum* ssp. *pomiferum* (*MacKee 12805*); a. habit, X 1½; b. diagram of the same (flowers indicated by circles, see further legend to fig. 1), position 4 completely empty. — c, d. *Z. baillonii* (*MacKee 7777*), 'branched' inflorescence, with secondary inflorescence in axil of bract 11 enlarged. — e. *Z. baillonii* (*Hürlimann 1650*), 'mixed' inflorescence X 2½, one bract replaced by young leaf; calyx already ruptured.

The lower leaf surface shows white-coloured stomata; between the stomata the epidermis is not white-coloured to entirely grey or white. The margin and the midrib are never white.

The white colour is caused by a combination of alveolar material and wax. When the plants are dried with much heat, or are treated with alcohol prior to drying, the white colour can faint or disappear. In many cases the absence of a distinct white or grey colour thus becomes inconclusive. Therefore, the presence or absence of alveolar material was studied by means of hand-sections of boiled but otherwise untreated leaves from herbarium specimens. This study revealed anatomical characters useful for the distinction of species, as was already reported by Van Tieghem (1900). For a more detailed study of epidermal characters see Bongers (1973).

The untreated sections did not permit the observation of reticulate thickenings of the mesophyll cell walls reported by Van Tieghem for *Z. baillonii* and *Z. vieillardii*, and by Bailey & Nast (1944b) for *Z. acsmithii* (sub *Z. vieillardii*), *Z. baillonii*, and *Z. bicolor*; however, these thickenings were observed in bleached sections of *Pancher s.n.* and in phloroglucine-stained sections of *MacKee 17587* (both *Z. baillonii*). Van Tieghem reported the absence of these thickenings for *Z. pomiferum*.

The midrib and leaf margin were not studied systematically and therefore these are not described here.

The nerves and major veins always have a (thick to thin) sclerenchymatous sheeth; these sheeths never touch the epidermides. As far as could be ascertained, the observation by Bailey & Nast that such sheeths of terminal veinlets are only absent in *Z. pomiferum*, is confirmed.

Leaf in transverse section:

Zygogynum

(*all species*)

Adaxial *cuticle* 3—21 μm; abaxial cuticle 1.5—23 μm, alveolar material over stomata only, or also covering (part of) unspecialized cells, always forming stomatal plugs; outer periclinal epidermal cell walls rarely appreciably thickened and than with thin areas in (faint) loops (as seen in surface view) of anticlinal walls. *Stomata* not deeply sunken. *Palissade* parenchyma rarely distinctly differentiated. Mesophyll often (partly) with (strongly) birefringent cell walls which probably implies lignification; cell walls often with reticulate thickenings. *Oil cells* throughout mesophyll. *Brachysclereids* (sometimes tending to asterosclereids) solitary and in small clusters, rarely absent, rarely touching adaxial epidermis. Rhomboid (to irregular) *crystals* and druses (3—) 4.5—18 (—27) μm in diam. rare to frequent in mesophyll, one per cell. Unidentified small globular to ellipsoid crystals *c.* 1—8 μm in length rare throughout lamina.

KEY TO THE SPECIES

1a. Outer periclinal walls of epidermis cells strongly thickened . . . 1. **Z. pomiferum**
b. Outer periclinal walls of epidermis cells not appreciably thickened 2
2a. Palissade parenchyma distinctly differentiated, lignified (cells longer than wide) 6. **Z. baillonii**

b. Palissade parenchyma not distinctly differentiated (cells squarish, or shorter than wide, or irregular) 3
3a. Brachysclereids partly touching adaxial epidermis . . . . 3. **Z. bicolor**
b. Brachysclereids, if present, not touching adaxial epidermis 4
4a. Alveolar material over stomata only . . . . 4. **Z. acsmithii**
b. Alveolar material over stomata and over (part of) unspecialized cells 5
5a. Brachysclereids absent; cuticle 3—9 μm. . . . . 2. **Z. mackeei**
b. Brachysclereids present; cuticle 10—23 μm . . . . 5. **Z. vieillardii**

(1a) **Z. pomiferum** ssp. **pomiferum**

(Balansa 2328; MacKee 12805, 23755, 28456; Veillon 1034; Vieillard 2266)

Adaxial *cuticle* 3—7 μm, underlying cell wall 2—12 μm with thin areas in (faint) loops (as seen in surface view) of anticlinal walls; abaxial cuticle 1.5—6 μm, underlying cell wall 3—15 μm with thin areas in (faint) loops (as seen in surface view) of anticlinal walls, alveolar material only over stomata. *Palissade* parenchyma not differentiated; cell walls of mesophyll (faintly) birefringent in (part of) abaxial half of lamina. *Brachysclereids* absent (though present in midrib), in *Veillon 1034* rare, not touching adaxial epidermis. *Druses* 3.5—15 μm in diam. rather common to frequent in mesophyll.

(1b) **Z. pomiferum** ssp. **balansae**

(Balansa 2804; Baumann-Bodenheim 14074, 14078; Hürlimann 1520; MacKee 5093)

Adaxial *cuticle* 3—4.5 μm, underlying cell wall 2—9 μm with thin areas in (faint) loops (as seen in surface view) of anticlinal walls; abaxial cuticle 3—4.5 μm, underlying cell wall 7—12 μm with thin areas in (faint) loops (as seen in surface view) of anticlinal walls, alveolar material only over stomata. *Palissade* parenchyma not differentiated; cell walls of mesophyll (very) faintly birefringent throughout lamina or mostly or exclusively in abaxial half of lamina. *Brachysclereids* rare to rather common, solitary and in small clusters, not touching adaxial epidermis. *Druses* 7.5—18(—27) μm in diam. (very) frequent in mesophyll.

(2) **Z. mackeei**

(Compton 1776; MacKee 13804, 13805)

Adaxial *cuticle* 4.5—9 μm; abaxial cuticle 3—7.5 μm, alveolar material over stomata and part of unspecialized cells, over the latter up to 0.8 of thickness of cuticle. *Palissade* parenchyma not very distinctly differentiated (cells low to squarish), in one, sometimes in two layers; cell walls of mesophyll birefringent throughout lamina. *Brachysclereids* absent. Globular to rhomboid *crystals* or druses 3—15 μm in diam. extremely rare, smaller ones sometimes several per cell, larger ones one per cell.

(3) **Z. bicolor**

(Bernardi 9916; Foster 78; Guillaumin & Baumann-Bodenheim 8726, 8813; Lécard s.n.; MacKee 6548, 8186, 17587; Thorne 28387)

Adaxial *cuticle* 6—12 μm; abaxial cuticle 4.5—10.5 μm, alveolar material over all cells, over unspecialized cells 0.8—0.9 of thickness of cuticle. *Palissade* parenchyma not distinctly differentiated; cell walls of mesophyll birefringent in abaxial half of lamina. *Brachysclereids* frequent, solitary and in small clusters, several touching adaxial epidermis. Rhomboid (to globular) *crystals* or druses 4.5—18 μm in diam. (rare to) frequent in mesophyll.

(4) Z. acsmithii

(Franc 1740; MacKee 15409)

Adaxial *cuticle* 7.5—10.5 μm; abaxial cuticle 3—6 μm, alveolar material only over guard cells and subsidiary cells. *Palissade* parenchyma not distinctly differentiated; cell walls of mesophyll not birefringent or slightly so in abaxial half of lamina. *Brachysclereids* rather rare to very rare, solitary and sometimes in small clusters, not touching adaxial epidermis. Rhomboid *crystals* and druses 9—18 μm in diam. common in mesophyll.

(5) Z. vieillardii

(Godefroy s.n.=Herb. d'Alleizette 55; MacKee 15862, 26369; Vieillard 187)

Adaxial *cuticle* 10—21 μm; abaxial cuticle 10—23 μm, alveolar material over all cells, over unspecialized cells 0.1—0.4 of thickness of cuticle. *Palissade* parenchyma not distinctly differentiated; cell walls of mesophyll rarely to frequently birefringent in abaxial half of lamina. *Brachysclereids* common to frequent, solitary and in small clusters, not touching adaxial epidermis. Irregularly rhomboid *crystals* or druses 6—27 μm in diam. frequent in mesophyll; sometimes also aggregations of small crystals 1.5—4.5 μm in diam.

(6) Z. baillonii

(Hürlimann 1607; Lucien & Hürlimann 3304; MacKee 7777; Pancher s.n.; Schmid 4325; Thorne 28642, 28676)

Adaxial *cuticle* 7.5—15 μm; abaxial cuticle 6—15 μm, alveolar material over all cells, over unspecialized cells 0.1—0.2 of thickness of cuticle. *Palissade* parenchyma distinctly differentiated, in one layer, strongly birefringent; cell walls of mesophyll birefringent throughout lamina. *Brachysclereids* frequent, solitary and in small clusters, not touching adaxial epidermis. Rhomboid *crystals* or druses 7.5—16.5(—27) μm in diam. frequent in mesophyll.

4. Inflorescence. The inflorescence is terminal, strongly condensed, and consists of bracts (cataphylls similar to those of the vegetative bud) close together on the apex of the branchlet, a terminal flower, and non-pedunculate solitary flowers in the axils of the higher bracts. Often these lateral flowers are absent; if they are present then often one or two drop off at an early stage. When lateral flowers are present, the insertions are so crowded that they influence each others outline (fig. 1). Often one or two bracts with empty axils are present between the terminal flower and the lateral ones.

Usually the inflorescence bud produces cataphylls and flowers only, but sometimes (fig. 2e) a few of the middle or higher bracts are replaced by leaves (mixed terminal buds).

Often the lateral flowers have two minute bract(eole)s at their base, and the terminal flower occasionally has a minute bracteole on its pedicel, suggesting that the pedicels can be regarded as reduced branching systems.

The number of bracts varies, but is usually less than 10. In young stages these bracts do not enclose the terminal bud tightly, but the outer bracts almost immediately spread out at their apices and by the time the calyx of the very young flowerbud starts to open, all bracts have spread out and the flowerbud is exposed. This is unlike the situation in *Drimys*, where the bracts protect the flowerbud for a considerable time; in *Zygogynum* and in all other genera of the *Winteraceae* this protection is performed by the petals.

Normally the sympodial elongation of the twig after flowering is by means of a leafy twig with a terminal inflorescence bud. In some cases, and in a few herbarium specimens always, the new branchlet is very short and lacks foliage leaves (fig. 2c, d). Such a condition is comparable to the inflorescences of *Pseudowintera* (which are, however, axillary instead of terminal) producing flowers in several seasons. In such *Zygogynum* specimens the foliage leaves present are from up to six earlier inter-flowering periods. As older scars become indistinct in outline, it is not possible to establish whether this type of inflorescence occurs alternating with the normal elongation of the twig, or represents the termination of elongation of certain branches of the plant.

In the few cases suitable for observation, the flowering was centrifugal (e.g. fig. 2a). This general outline of the inflorescence of *Zygogynum* is illustrated by the following selected cases.

The twig (partly) shown in diagram fig. 1a had acropetally: 3 widely spaced rather narrow scars (cataphylls of vegetative bud), 4 mature leaves, 4 scars of cataphylls, 12 leaves (of which 7 shown in the diagram) decreasing in size and maturity, 3 scars of

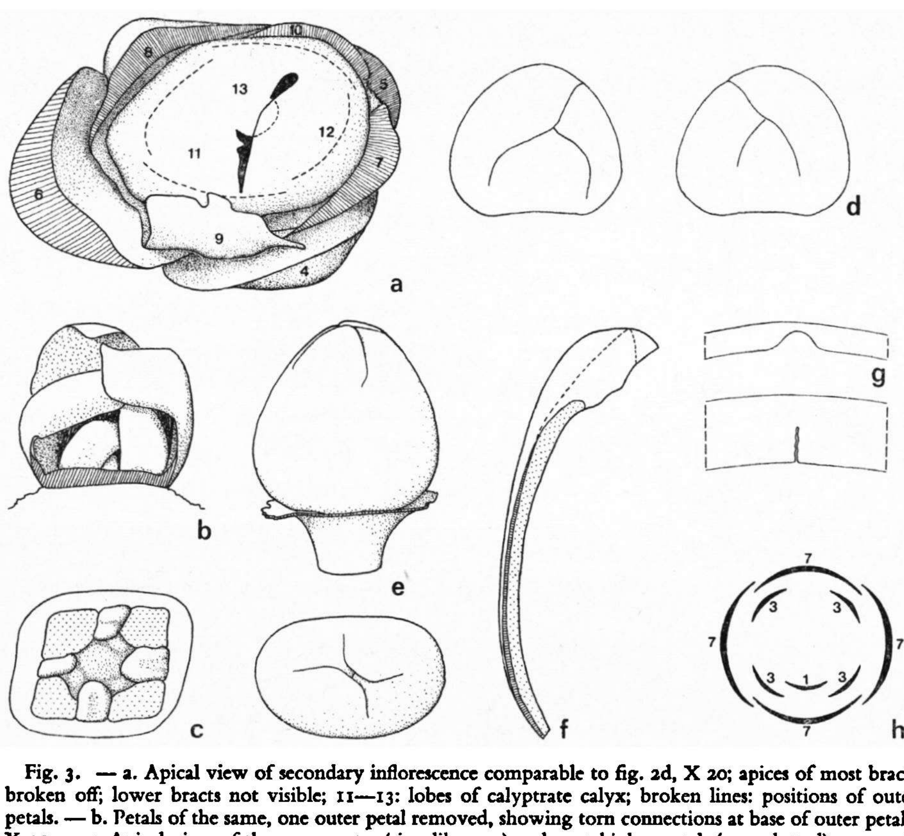

Fig. 3. — a. Apical view of secondary inflorescence comparable to fig. 2d, X 20; apices of most bracts broken off; lower bracts not visible; 11—13: lobes of calyptrate calyx; broken lines: positions of outer petals. — b. Petals of the same, one outer petal removed, showing torn connections at base of outer petals, X 25. — c. Apical view of the same, outer (ring-like scar) and next-higher petals (scars dotted) removed, showing primordia of two more whorls, X 25. — d. Opposite sides of a young corolla, X 10. — e. Flower-bud, lateral and apical view, X 2½ (in this case the outer pair of petal apices not overlapping). — f. Lateral view of petal from inner pair of outer whorl, from bud; hatched: torn tissue; dotted: valvate part with epidermis intact; apex with impressions made by other petals; X 5. — g. Schematic drawing of cross-sections through connate part of outer petals in very young and in later stages resp. — h. Diagram of corolla with number of traces at insertion of petals. — a—g: *Zygogynum baillonii*; h: *Z. pomiferum* ssp. *pomiferum*. — (a—c: *Hürlimann 1607*; d & g: *Hürlimann 1650*; e: *MacKee 19587*; f: *Thorne 28666*; h: *Blanchon 1034*).

probably early dropped young leaves, and finally 5 scars of bracts; the 3 lower bracts had solitary flowers in their axils, crowded around the terminal flower. Of these four flower-buds the measurements of the pedicels were 7, 6½, 6½, and 12 mm, of the closed corollas 4, 5½, 5, and 7 mm, all in acropetal sequence. Fig. 1b gives the diagram of another twig from the same specimen; here the orthostiches show a torsion, again the highest leaves have dropped, the terminal flower is post-anthesis (petals and stamens dropped). In acropetal sequence the 4 pedicels were 13, 13, 20, and 15 mm, the closed corollas of the 3 flowerbuds were 8, 12, and 14 mm high. In this inflorescence the lowest flowerbud has two minute bracteoles at the insertion of the pedicel. More bracteoles are present in the inflorescence

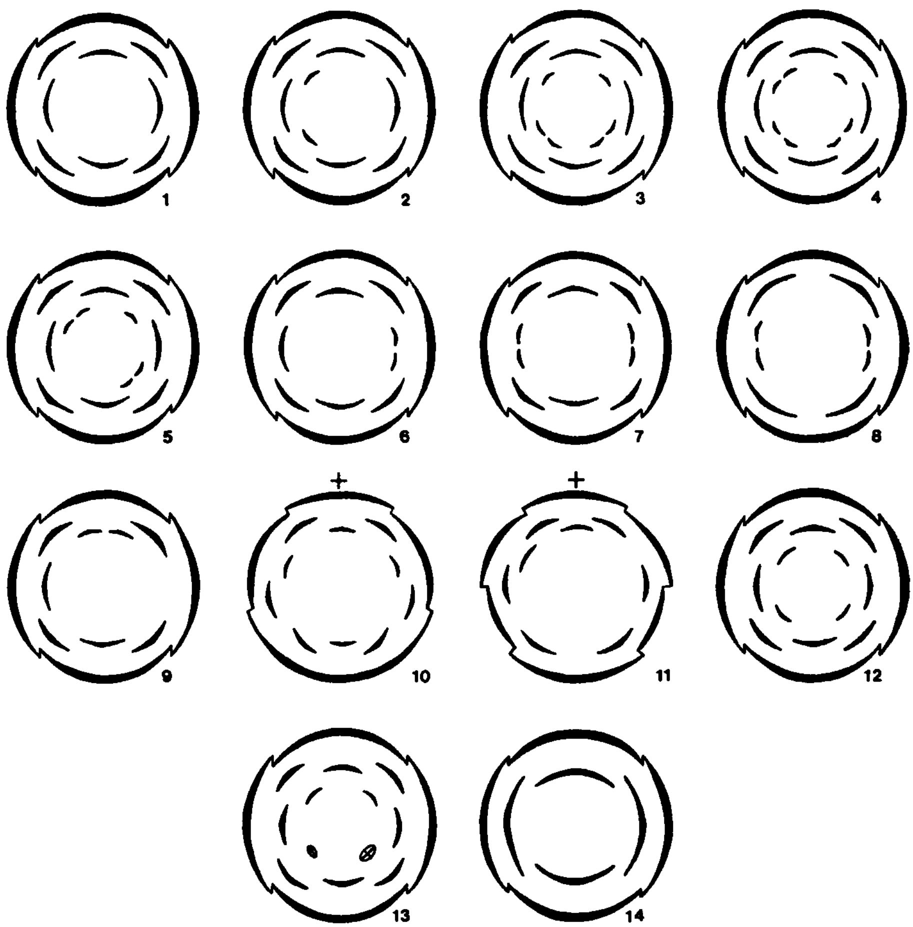

Fig. 4. Petal arrangements. Deviations from the 'normal' arrangement (1) most common in the highest petals present. Adaxial side of flower (+) only indicated if known with certainty for lateral flowers. — 10. Considerable difference in size of ab- and adaxial sides. — 11. Completely deviating arrangement. — 13. Two inner petals replaced by very large stamens. — 14. Inner petals not alternating with outer ones; only once seen. — 1 & 2: *Zygogynum baillonii* (*Hürlimann 1607*); 3—5: ibidem (*Hürlimann 1571*); 6—11: *Z. bicolor* (*MacKee 8186*); 12 & 13: *Z. spec.* (*MacKee 21725*); 14: *Z.* aff. *mackeei* (*Veillon 1976*).

depicted in figs 2 a & b (for convenience drawn in a different way): the lower and smallest flowerbud has an additional abaxial bracteole on the lower part of its pedicel, the highest lateral flower is post-anthesis and lacks bracteoles; the terminal flower has dropped already. From these three diagrams can be concluded that a) flowering is centrifugal, and b) the number of bracteoles — if present — decreases acropetally.

Figs 2c & d give the diagram of a twig of *Z. baillonii*, a species with usually many bracts but only one (the terminal) flower per inflorescence; if more flowers are present, the lateral ones have at most two bracteoles. In this case the terminal flower of the inflorescence is represented by a withered scar; in the axil of the 5th bract downwards a new inflorescence has developed, apparently in another flowering phase (season?). The two lower bracts of this secondary inflorescence take the same positions as the bracteoles mentioned earlier, indicating that the bracteoles represent remnants of a more complicated branching system. This type of 'branched' inflorescences is rather rare in the genus, but relatively more common in *Z. baillonii*.

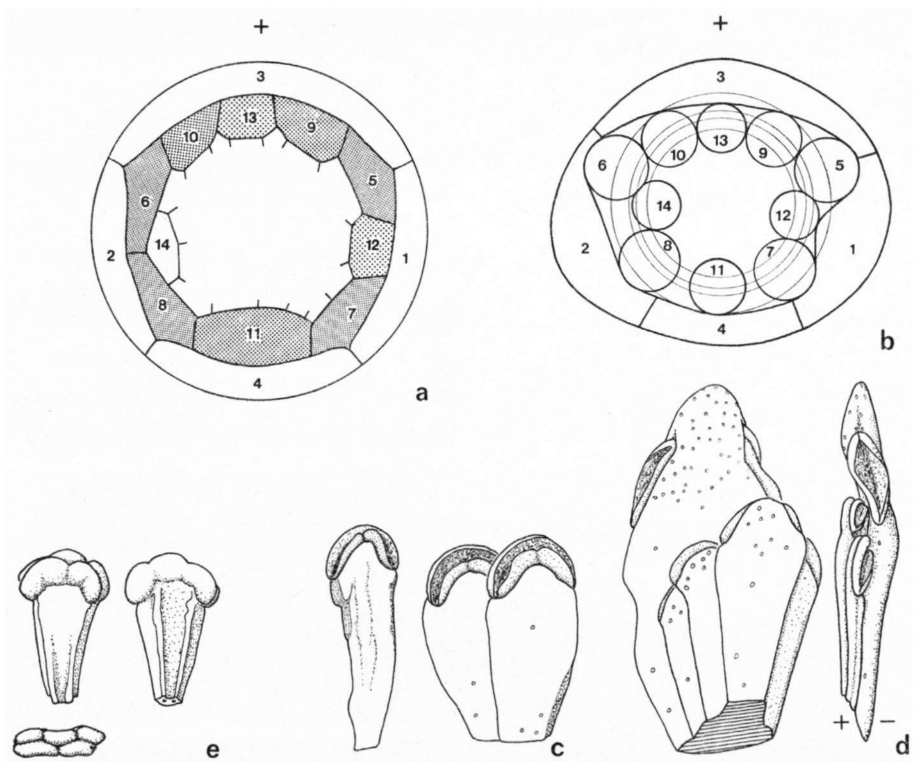

Fig. 5. — Petal arrangement in bud axillary to bract 12 of fig. 1b, semi-schematic; petals numbered according to apical overlap (see also fig. 6b), positions of adjoining stamens indicated; b. interpretation (see text). — c. Abaxial view of 1 higher and 2 lower stamens with slits of thecae confluent, X 7½. — d. Adaxial and lateral view of subpetaloid stamen with lateral thecae and of adjoining normal stamens showing increase in size towards centre of flower, X 7½. — e. Abnormal stamen; left: abaxial and apical view; right: adaxial view showing 2 traces at insertion, X 7½. — a—d: *Zygogynum pomiferum* ssp. *pomiferum*; e. ssp. *balansae*. — (a & b: *MacKee 23755*; c & d: *MacKee 12805*; e: *Baumann-Bodenheim 14171*).

5. Flower. Young stages of flowers were very scarce in the material at my disposal. In *Z. baillonii* a few very young buds up to 2 mm in diameter were found.

The **calyx** of the buds was calyptrate with three apical lobules which continued the spiral of the bracts (fig. 3a). In buds 3 mm in diameter the calyx was already ruptured and the original lobes were unrecognizable (fig. 2e).

In later stages the calyx of *Zygogynum* can be irregularly lobed to almost entire, but the discoloured margins always testify of the earlier rupturing. In these stages the number of lobes does not necessarily indicate the number of sepals. From the number of minute, smooth parts of the margin of ruptured calices I gained the impression that 2- and 3-

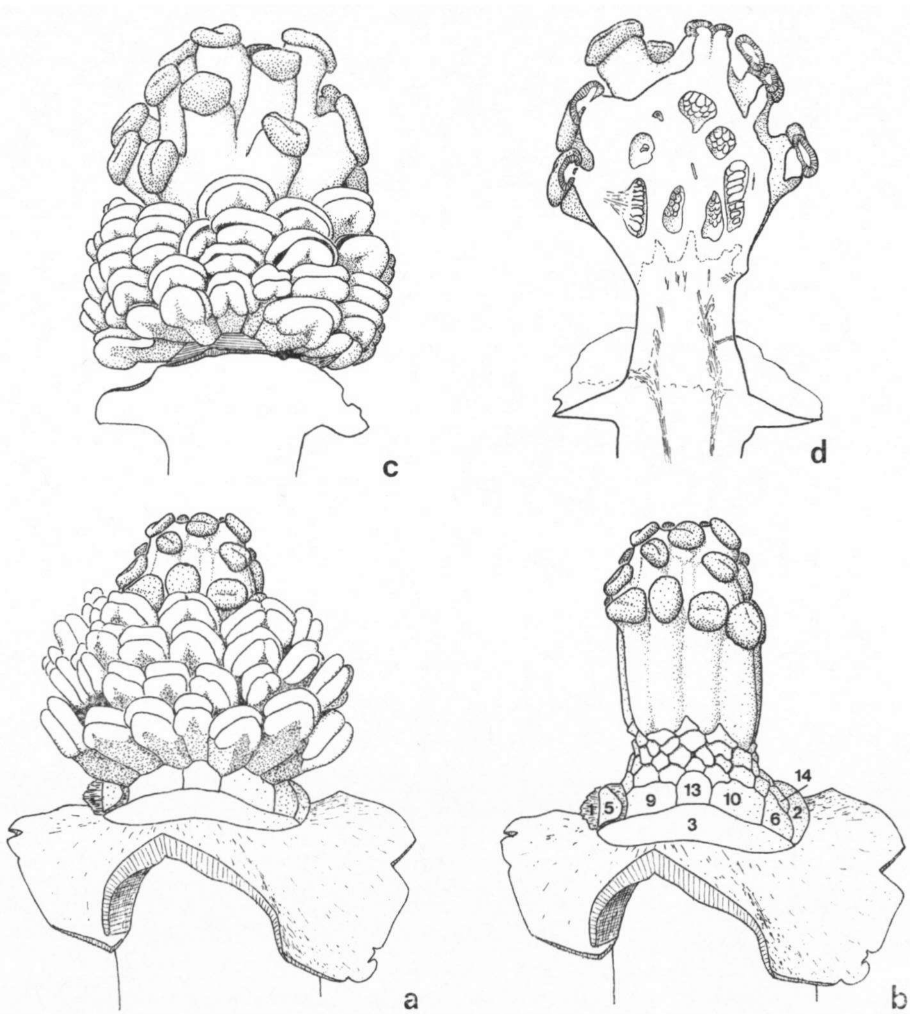

Fig. 6. *Zygogynum pomiferum* ssp. *pomiferum*. From flowerbuds after removal of petals. — a & b: same bud (*MacKee 23755*), in b. stamens removed, petal scars numbered as in fig. 5a. — c & d: same bud (*Blanchon 1034*), stigmas abnormally large and long-stipitate; in d. stamens removed, longisection with view to opposite side. — (all X 5).

sepalled calices are equally common. The formation of 'lobes' by rupturing is probably more dependent on mechanical causes than on the number of tiny lobes of the young calyptra which represent the sepals.

The calyx is persistent in fruit and is then often shorter than in the flowerbuds on the same specimen, suggesting an erosion of the margin upon ageing.

In *Z. baillonii* the **petals** were found to be initiated centripetally. In all species the outer 'whorl' of petals usually consists of four decussate petals; two apices form an opposite pair, valvate or overlapping, and covering the other two apices (fig. 3d, e). When in the young buds of *Z. baillonii* (fig. 3b) the four outer petals are 1 mm long, they are connate over their basal 0.15—0.25 mm. The connecting part is thinner than the petals and in later stages (already when the bud is 3 mm in diam.) this area becomes compressed between the thickening petals (fig. 3g). In all relevant species the outer petals of larger buds are, as seen in cross-sections, connate in the abaxial third; a double epidermis with its cuticle

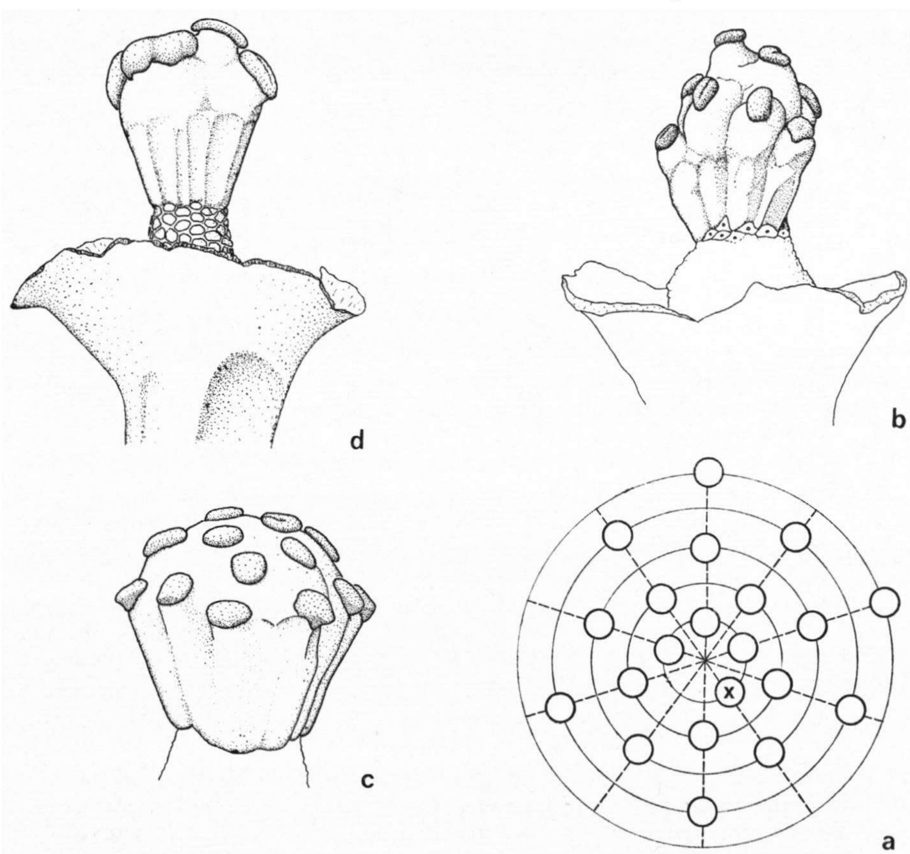

Fig. 7. — a. Arrangement of carpels in a 20-carpelled pistil of *Zygogynum pomiferum* ssp. *pomiferum* (*MacKee 12805*); the carpels are probably not in true whorls, the diagram intends only to give the relative positions; carpel **x** has a nearly central (apical) position. — b. Pistil in bud of *Z. pomiferum* ssp. *balansae* (*Baumann-Bodenheim 14171*). — c. Pistil from open flower of *Z. bicolor* (*MacKee 8186*). — d. Old flower of *Z. vieillardii* (*Godefroy s.n., herb. d'Alleizette 55*). — (all X 5).

penetrates the ring of petals for two thirds from the adaxial side, providing a predetermined line of rupture. In herbarium material the epidermis is often compressed and hardly recognizable, but the cuticle is always visible. Upon anthesis the petals rupture apart, showing on their lateral margins ruptured tissue abaxially and an intact cuticle adaxially (fig. 3f).

As far as I could ascertain, the connate petals have not been noted by earlier authors.

The apices of the petals are always free. In larger buds the length of the lateral connection varies from (almost) nil (in *Z. pomiferum*) to nine tenths of the petal length; in *Z. baillonii* this length is rather variable: 1/5 to 4/5.

If more petals are present, these additional ones are always free, smaller than the outer ones, and decreasing in size centripetally. The second and further 'whorls' of petals alternate with the outer one and with each other, but many aberrancies occur in the same way as described for the 'stamen arrangement' in *Drimys* (Vink, 1970).

In young buds of *Z. baillonii* the petals are arranged in whorls, the latter being defined as consisting of members which are initiated at the same time. In fig. 3c the third whorl consists of four primordia of about the same stage of development. The 12 petals of the bud shown in fig. 3d were already all present, but the differences in size are still indicative of an arrangement in whorls:

whorl 1: outer pair 2.7 mm, inner pair 2.2—2.5 mm
whorl 2: 1.2—1.5 mm
whorl 3: 0.7—0.8 mm

However, young stages of flowers with a deviating arrangement were not available.

The 'normal' arrangement is shown in fig. 4:1. Deviations are quite common in the innermost 'whorl' available (fig. 4) where petals can be lacking or where two petals can be present in a position expected to be filled by one. Probably this phenomenon is related to the acropetal decrease in size, in size of the insertions, and in number of traces at the insertion (fig. 3h; could be observed in a very few cases only) of the petals. Deviations from the more or less decussate arrangement of the four outer petals are rather rare and they mostly occur in solitary and in terminal flowers (fig. 4: 10 & 11).

The aberrant arrangement of the petal insertions of the bud, depicted in figs 1b and 6a & b, is shown semi-schematically in fig. 5a. Petals which by comparison with the 'normal' regular arrangement belong to the same 'whorl' are shaded in the same way. The numbering is in accordance with the apical overlap of the petals in bud. As is shown in fig. 5b this arrangement can be explained as the result of initiation of petals in a sequence according to available space at the largest distance (indicated by thin lines) from the centre of a floral apex with a non-circular basal outline. The situation is slightly more complicated; the differences between the lateral halves of the flower are not considered in this diagram, but as these differences are consistent (5—6, 7—8, 9—10) they indicate only a slightly larger half of the floral apex at the right.

As in almost all cases the number and arrangement of the sepals cannot be established, the correlation between the arrangements of sepals and petals remains unknown. In lateral flowers the position of the two outer petals in relation to the bract proved to be inconsistent: in most verifiable cases these petals were located perpendicular to the bract, which is at variance with the hypothetical diagram in Vink (1970) 280, but flowers with these petals parallel to the bract were also found (fig. 4: 10 & 11).

In one flower (fig. 4: 14) the second whorl of petals did not alternate with the outer one.

Usually the distance between the insertions of the two outer petals is adaxially slightly smaller than abaxially, but this difference occurs also in terminal flowers (fig. 3d).

The inner surface of the innermost petals shows permanent impressions made by the stamens and the stigmas. The apices of these petals can also be irregular because of mutual compression in the bud.

The colour of the petals in open flowers varies widely within the species, even at the same locality; see e.g. *Z. baillonii* and *Z. mackeei.*

The number of **stamens** varies widely within the genus: 20—250, and it varies also within species and within individual plants. The stamens are probably arranged according to the principle of available space as described for *Drimys* (Vink, 1970); due to the lack of ontogenetic information this cannot be proved, but is inferred from the arrangements of already completely differentiated stamens.

The material available did not permit observations on the sequence of initiation or of dehiscence of the stamens.

Stamens inserted next to each other can differ considerably in diameter of their filaments, probably because of differences between maximum and minimum space available to the primordium. However, in general the size of the stamens — and especially their length — increases acropetally along the torus (see fig. 5c, d). Just above the petals a large to very large stamen can fill a gap in the arrangement of the petals.

The filaments are obovoid, obpyriform, or clavate (in sicco to rod-shaped), slightly flattened, obtuse-angled with the angles fitting between the neighbouring filaments, and one-veined.

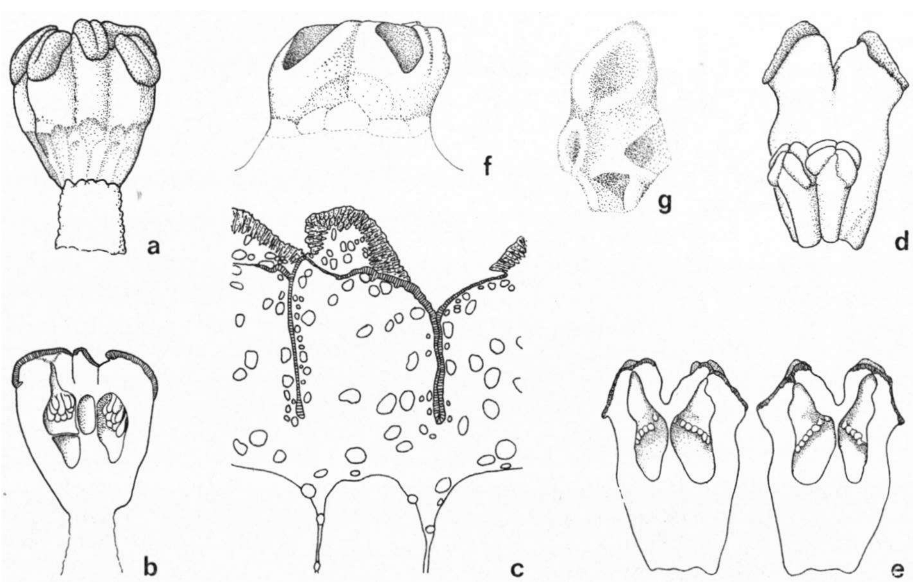

Fig. 8. Pistils from buds, *Zygogynum baillonii.* — a & b. Lateral view and longisection, X 5; c. detail showing compression of stipes revealed by course of epidermis (hatched), X 30 (*Hürlimann 1607*). — d. Pistil and two stamens with thecae not confluent; e. longisection showing ii-shaped arrangement of young ovules, X 10 (*Pancher s.n.*). — f & g. Very young pistil, lateral and apical view resp., X 75 (*Hürlimann 1650*).

The thecae are situated horizontally to laterally on the apex of the filament, usually at a sharp angle to the latter. At the apices the thecae can be separated by a narrow groove, but mostly they touch each other (fig. 8d) or they are externally connate. Often the ad- and/or abaxial side of these connate thecae do not show a groove. In about one third of the specimens seen, the slits of both thecae are confluent upon dehiscence, suggesting the presence of monothecal stamens, but as far as ascertained an internal separation is always present. This continuous slit can occur in a few to all stamens of a flower (fig. 6). No correlation with any other character could be traced.

The stamens are always shorter than the pistil, leaving the stigmata exposed (fig. 6).

Like in *Drimys*, aberrant structures intermediate between petals and stamens have their thecae marginal and distinctly below their apex (fig. 5d).

The **torus** of the flower is relatively large. Usually it is conical when young and becomes a cylinder during the development of the fruit, giving the latter a 'stipitate' appearance. The scars of the petals and stamens remain distinct for a long time after flowering (fig. 11c).

The **pistil** of *Zygogynum* differs from that of all other genera of the *Winteraceae* by being 2—∞-locular as it is composed of as many connate carpels.

In general outline the pistil is globose to obovoid or obconical. The lower part often shows impressions made by the stamens. The stigmatical crests are sessile or shortly stipitate and located on the upper 1/4 to 2/3 of the pistil. Often grooves in the upper part of the pistil demarcate the locules, but these grooves have no internal continuation. In *Z. baillonii* sometimes a sterile apical bulge is present; in longitudinal section this bulge does not show a structure deviating from the wall of the pistil.

Only once a very young pistil was observed (fig. 8f, g; from herbarium material). This pistil was 1/3 mm high and wide. Apical-laterally it had four relatively wide openings at slightly unequal distances which may indicate a deviation from a true whorl. The long axes of the openings were in the radii of the laterally flattened pistil. The primordial locules were more or less V-shaped in cross-section. The outer surface of the pistil showed no signs of postgenital fusion; on the contrary, in one case the narrow ridge between two openings served as margin for either opening.

From the arrangement of the stigmas and (in cross-sections) of the locules, Van Tieghem (1900) concluded that the carpels are arranged in whorls of four along the floral axis; in *Z. baillonii* the four carpels are said to alternate with the inner petals. Though in some cases these observations fit in with mine, in the majority of the flowers the carpel arrangement is not according to a fixed pattern (fig. 9d). On the contrary, I believe that the carpels are arranged in the same way as the stamens; however, sufficient suitable material of very early stages was again not available. An example of an arrangement is given in fig. 7a.

The stigmas are brown to black in sicco, circular to elliptic or ovate in outline, usually impressed along the median indicating where the original opening is closed by stigmatic tissue. In very young flowerbuds the stigmatic tissue is not yet developed and each carpel has a slit-like opening on the surface of the pistil. This slit is the external opening of a flattened canal which remains visible in later stages (fig. 11b); its internal opening into the locule is also slit-like and is surrounded by the placenta (fig. 10). If the stigma is raised from the general surface of the pistil by a short stipe, this stipe always contains only this flattened canal, the locule with the placenta never extend into it (fig. 6d). The stipe thus could be called a style but because of the general morphology of the family I will refer to it as 'stipe' or call the stigmas 'stipitate'.

Often the lower stigmas are not orientated in a radius of the pistil but at an angle or even perpendicular to it (fig. 6b). In those cases the flattened canal is twisted, so its opening into the locule is still in line with the radii of the pistil. The location of the twist in the canal varies within the same pistil from just below the stigmatical crest to well within the pistil wall (fig. 10d).

Z. baillonii generally has shortly stipitate stigmas. In one specimen the stigmas seemed to be sessile, but in longitudinal sections it appeared that the stipes were pressed together as testified by a double cuticle separating them (fig. 8a—c).

In FAA-fixed flowerbuds of *MacKee 26369* (*Z. vieillardii*) the stigmas were covered with a coagulated, pinkish white exudate; some of the exudate was also present between the pistil and some of the upper stamens (that is, below the level of the stigmas) and probably had flowed down from the stigmas. This observation could explain why in herbarium material often the stigmas are in bud sticking firmly to the adjoining petal and upon dissecting of the bud even get torn from the pistil.

The locules are separated by very thin to relatively rather thick walls that do not show any relic of an original separation between the carpels. The walls have no projections into the cavity of the locule comparable to the 'dorsal ridge' in *Drimys* (Vink, 1970, p. 262).

When many locules are present, these are arranged at different heights around and on top of the floral axis which continues from the torus. In the apical locules the opening towards the stigma is situated central-apically, in the lower locules this opening is found in the apical or central part of the abaxial wall (fig. 6d, 9b, c).

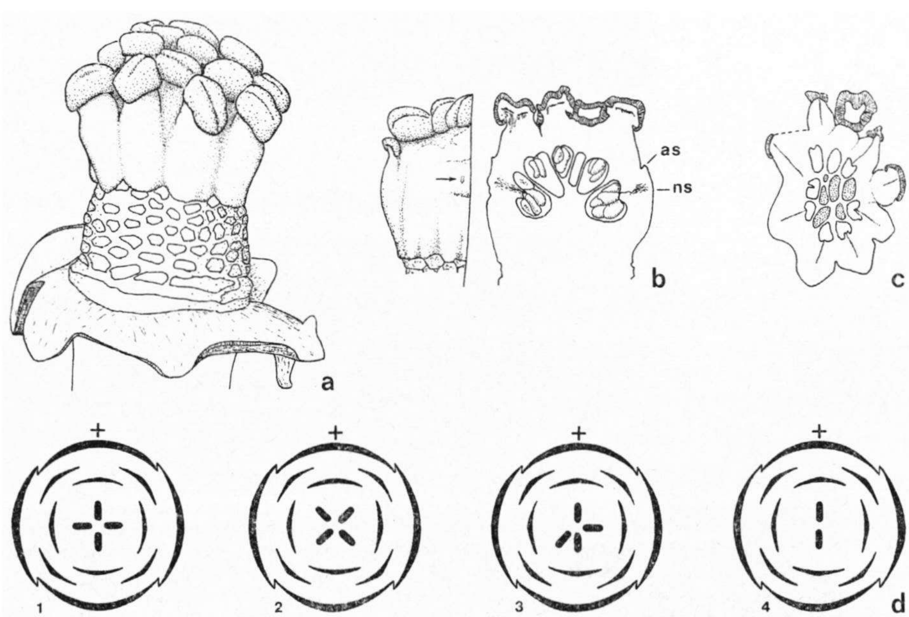

Fig. 9. — a—c. *Zygogynum mackeei* (*MacKee 13805*). a. Old flower, X 5; b. longisection of pistil from another old flower, with its lateral view; *arrow*: minute stigma; *as*: abortive stigma; *ns*: no remnant of stigma visible; X 5; c. cross-section, bottom of dotted locules less than 1 mm below section, of the other locules lower, X 5. — d. Orientation of stigmas in relation to petals in *Z. baillonii* (1: *Thorne 28666*; 2: *Thorne 28676*; 3 & 4: *Pancher s.n.*).

The **ovules** are bitegmic, anatropous, inserted in one row around and at a short distance from the opening towards the stigma, their micropyle turned away from this opening (fig. 10). This situation is similar to that in *Drimys* and *Pseudowintera*.

The placenta is a very low ridge connecting the closely lined insertions of the ovules. When the ovules develop, the space available to them is too small and they press each other out of the row, giving the impression of two or locally even three rows or of an irregular arrangement. Careful removal of the ovules shows, however, that the insertions are still in one row (fig. 10e, f). When the placenta is also deformed, the arrangement becomes complicated. Another difficulty in assessing the arrangement of the ovules or of young seeds can be the minute outgrowths of the placenta developing below the insertions

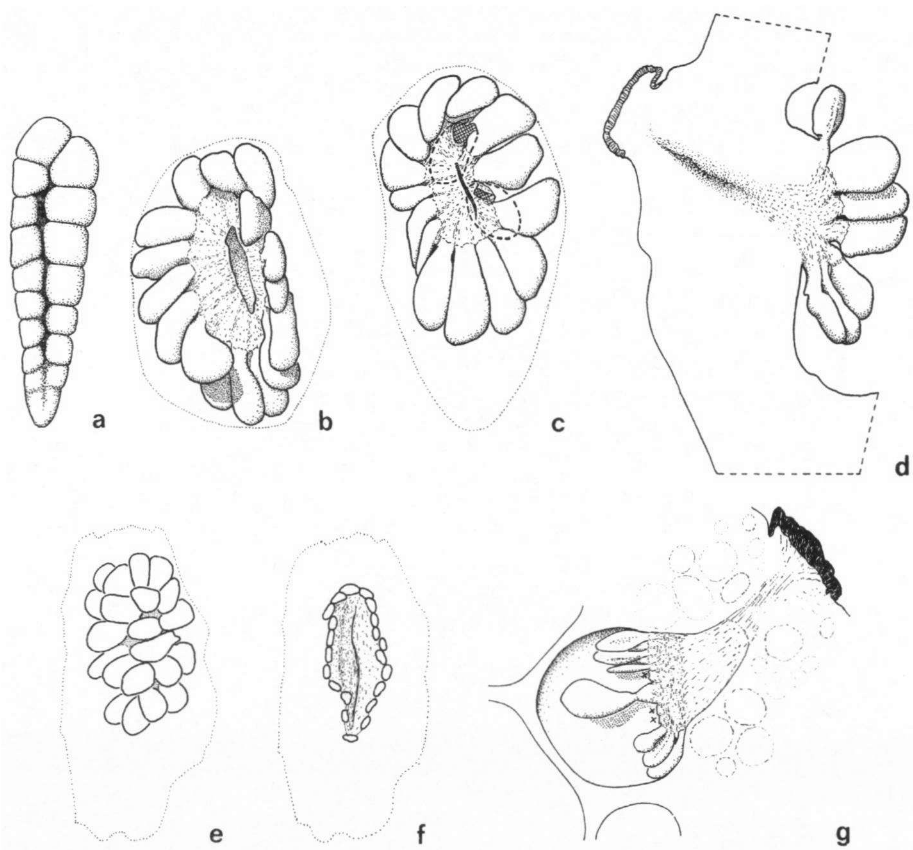

Fig. 10. Arrangement of ovules. — a. Very young placenta with still incomplete ovule primordia, from a lower carpel (*Zygogynum acsmithii*, *Franc 1740*, X 80). — b & c. Ovules in two lower locules from the same pistil, around slit-like opening of canal towards stigma; in c. two ovules (broken lines) were pressed out of line by enlarging neighbouring ones, their scars (cross-hatched) shown (*Z. pomiferum* ssp. *pomiferum*, *Bernardi 9661*, X 30). — d. Longisection through wall of same locule as in b; canal to stigma twisted (end near stigma not in this plane) (X 30). — e & f. Ovules seemingly irregularly arranged but their insertions in one line (*Z. bicolor*, *Guillaumin & Baumann-Bodenheim 8706*, X 25). — g. Locule in young fruit, with canal to stigma; central ovule with a stipe, three large ovules removed (x); clusters of brachysclereids in fruit wall indicated (*Z. acsmithii*, *MacKee 15409*).

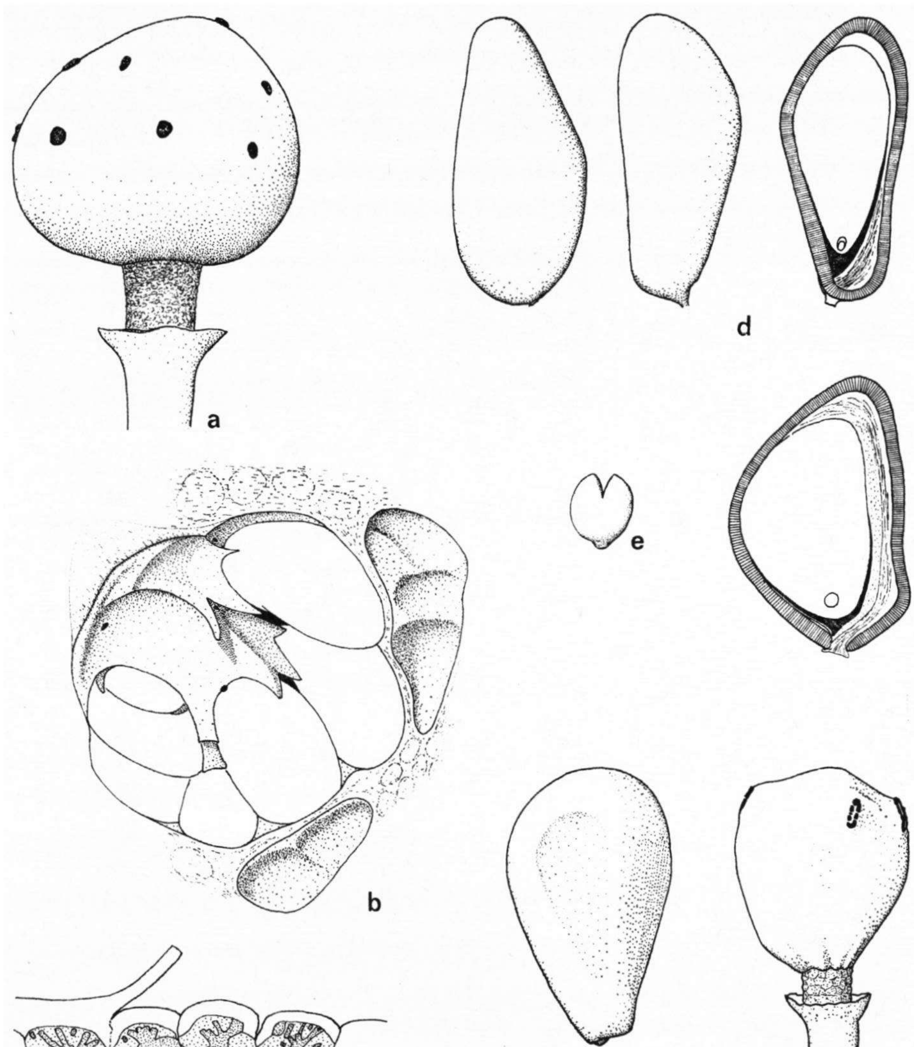

Fig. 11. — a. Fruit of *Zygogynum bicolor*, X 1½ (*MacKee 8186*). — b. Locule of fruit; remnant of canal to stigma at upper left; some seeds (white) removed, showing pulpa (dotted) protruding between seeds; some insertions of seeds (black dots) in original location near canal, others on pulpa projections; at right and bottom parts of two other locules; clusters of brachysclereids in fruit wall indicated; X 5 (*Z. bicolor*, *Thorne 28387*). — c. Fruit (X 1½) and seed (X 7½) of *Z. baillonii* (*MacKee 4858*). — d—f. *Z. pomiferum* ssp. *pomiferum* (*MacKee 21301*); d. seeds, habits and longisections (hatched: epidermis; black: operculum), X 7½; e. embryo, X 35; f. distal part of epidermis cells of seed (see text), outer layer of cuticle partly torn away.

of those ovules that are pressed to the outside of the group (fig. 10g). In herbarium material the shrunken ovules mostly stick strongly together and form a clump with indetectable arrangement.

Often young ovules of the same placenta are of unequal size; in the lower locules the ovules on the apical part of the placenta are larger, in apical locules with the placenta centrally at their ceiling the ovules in the central part of the placenta are larger. Probably this reflects the sequence of initiation as the differences are already visible before all ovule primordia are distinct (fig. 10a).

In all species O-shaped placentas were observed. In addition U-shaped placentas were found in *Z. acsmithii*, Ů-shaped in *Z. baillonii*, and II-shaped in *Z. bicolor*.

Aberrancies are quite common. Often two or three stigmatical crests are coalescent, without or with the pertinent canals being joined. Lower carpels of a many-carpelled pistil can have minute stigmas or lack these altogether (fig. 9b), or these carpels are abortive and apically separated from the pistil.

The vascularization of the pistil will be subject of a separate study.

6. Fruit. The fruits are (sub)globose to obovoid; they can reach a diameter of 4 cm (in *Z. pomiferum*). Usually the remnants of the stigmatical crests are distinct dark brown to black dots on the surface of the fruit. If the stigmas were stipitate on the pistil, the stipes have disappeared in fruit.

The fruits of *Z. mackeei* are not known; of *Z. acsmithii* and *Z. vieillardii* only immature fruits were available.

In *Z. baillonii* and *Z. bicolor* the entire fruit wall, between the epidermis and the locules, is filled with closely packed globose clusters of brachysclereids up to 1 mm in diameter. These clusters are also present throughout the wall of the immature fruits of *Z. acsmithii* and *Z. vieillardii*, but here the clusters are smaller and less closely set in a thin outer layer. In all these species the dried fruits are hard and (almost) not flattened by the pressing of the specimens.

In *Z. pomiferum* the fruit wall contains thin-walled brachysclereids which are solitary or in well-spaced small irregular clusters. In herbarium specimens of this species the fruits are usually somewhat compressed.

A few to many of the locules of a fruit can be compressed, or contain only abortive seeds. In most locules well-developed seeds are present but in these nearly always some abortive seeds are found as well.

The locules contain a pulpa arising from the inner lining of the locule as well as from the placenta. This pulpa fills the spaces between the seeds but does not separate the seeds completely. Often the placenta itself becomes partly 'pulpous' and forms irregular plate-like projections into the locule, thereby moving also part of the insertions of the seeds away from the original arrangement of ovules (fig. 11b). Probably this is to be correlated with the outgrowths of the placenta under the insertions of some ovules (p. 234), but this could not be studied.

7. Seed. The seeds are obovoid to ovoid, with flattened lateral faces if the seeds were pressed together in their locule. In cross-section they are circular to triangular. A distinct funiculus is absent. Unlike in *Drimys*, their axis is straight, but otherwise the general morphology is similar.

The epidermis consists of rather high cells. As in *Drimys* these cells are filled with a brown to black material, probably also tannins, which makes the epidermis hard and brittle. However, towards the distal end of the cells there is an internal constriction through which the protoplast(?) protrudes and ramifies into the distal part of the cell which is filled with a clear substance (fig. 11f). The outer wall of these cells consists of two transparent layers of which only the inner one is birefringent. When handling boiled seeds from herbarium specimens a layer, consisting of the outer cell walls and of the distal parts of the cells containing the ramifications, is easily rubbed off, changing the surface of the seed from dull to shining black. In immature seeds the ramifications in the distal parts of the cells were not found.

The operculum does not protrude through the microphyle.

The embryo is small (*c.* 0.3 mm), almost globose, cleft at the apex into two lobes, and slightly pointed at the base (fig. 11e).

POLLINATION

No observations on pollination have come to my knowledge. However, the architecture of the flowers of *Zygogynum* is suggestive of beetle-pollination.

The petals (in bud protecting the stamens and pistil) are thick, hard and stiff, and contain many brachysclereids; in anthesis they spread, giving free access to the stamens.

The anthers are sitting on top of a mass of closely fitting, thickened (?always) apices of filaments, which surrounds the apex of the hard (brachysclereids) pistil with its stigmas close to its surface. Stamens and pistil thus form together a subglobose strong surface with anthers and stigmas only slightly protruding, which must be ideal for pollen-eating beetles.

INSECT DAMAGE

Flowerbuds of *Zygogynum* were never found to contain larvae; in *Drimys* these were very often present.

ZYGOGYNUM

Zygogynum Baill., Adansonia 7 (1867) 298, *descr. gen.-spec.*; ibidem, 372; Hist. Pl. 1 (1868) 160, 190; v. Tieghem, J. de Bot. 14 (1900) 279, 340; Hutchinson, Kew Bull. (1921) 191; Lemée, Dict. 6 (1935) 1018; A. C. Smith, J. Arn. Arb. 24 (1943) 161; Guillaumin, Bull. Soc. Bot. Fr. 89 (1943) 3; Fl. Anal. Syn. N. Caled. (1948) 120; Hutchinson, Gen. Fl. Pl. 1 (1964) 62. — Type species: *Z. vieillardii* Baill.

Zygogynum sect. *Monanthum* v. Tieghem, o.c. 341; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 109. — Syntype species: *Z. vieillardii* Baill., *Z. baillonii* v. Tieghem, *Z. bicolor* v. Tieghem.

Zygogynum sect. *Pleianthum* v. Tieghem, o.c. 341; Pilger l.c. — Syntype species: *Z. pomiferum* Baill., *Z. balansae* v. Tieghem, *Z. spatulatum* v. Tieghem.

Shrubs or trees; entirely glabrous. Terminal buds with cataphylls in the same spiral as the leaves. Elongation of vegetative shoots monopodial, of flowering shoots sympodial. On *lower leaf surface* stomata white, occluded by alveolar material and wax; unspecialized cells with or without white to grey alveolar material. *Inflorescences* terminal, composed of a terminal flower and often also of solitary flowers in the axils of the cataphylls. *Flowers* bisexual, (sessile to) pedicellate. *Calyx* enclosing bud in very young stages only, soon rupturing; persistent. *Petals* (3 or) 4—19; (3 or) 4 (or 5) outer ones free, or connate but separating upon anthesis; inner ones smaller, free. *Stamens* 20—251; filaments obovoid or clavate and slightly flattened, to rod-shaped, *in vivo* sometimes swollen at apex; thecae

Table 1. Review of the external characters of the species of Zygogynum

	pomiferum	*mackeei*	*bicolor*	*acsmithii*	*vieillardii*	*baillonii*
flowers/inflorescence	(2—) 3—5	3—5	1—3	1—3	1—3	1—3
petal number	(3—) 4—15	12—13	11—14	10—13	(4—) 9—12	11—19
petals free	+ (—)	—	—	—	—	—
number of stamens	20—103	96—136	142—251	135—173	60—113	36—65
number of stigmas	8—23	14—19	10—24	10—15	5—10	2—8
pedicel length in mm	10—34	15—28	10—35	(5—) 11—14	6—13	0—7
pedicel diam. in mm	2—4	2—4	2—7	(3—) 4—6	3—5½	2—4
pollen in tetrads	—	—	+	+?	+	+
on lower leaf surface						
unspecialized cells:						
white	—	—	+	—	—	(+)
partly white	—	+	—	—	—	—
grey	—	—	—	—	(+)	+
not white or grey	+	—	—	+	+	—
midrib below:						
rounded	—	—	(—)	—	+	+
triangular	+	+	+	+	—	(—)

(—): occurring rarely and not in all flowers or leaves of a specimen

(+): represented by a few specimens only apical, horizontal to vertical, slits of thecae often continuous over apex of stamen. Pollen grains in tetrahydral tetrads or solitary. *Pistil* 2—33-carpellate and -loculate; stigmas sessile or shortly stipitate; placentas O- to II-shaped, with one row of ovules. *Fruits* (sub)globose to obovoid, 2—33-loculed, with many seeds; pulpa developed from both placenta and wall of locule, separating seeds incompletely, sometimes several seeds inserted on pulpa; seeds with straight axis, black, dull.

Chromosome number: n=86 (*Z. baillonii*, Ehrendorfer c.s. 1968; by typographical error cited in Takhtajan, 1973, 52 as: 2n=72).

Distribution: Endemic in New Caledonia with six species.

Habitat: Forests or shrubberies on different soils; altitudinal range 150—1200 m.

Taxonomy: Van Tieghem (1900) divided *Zygogynum* into two sections based on the number of flowers in the inflorescence. His section *Pleianthum* comprised *Z. pomiferum*, *Z. balansae*, and *Z. spatulatum*, which in the present treatment are united into a single species (with two subspecies). In this new circumscription *Z. pomiferum* does indeed take a position rather separate from the species included by Van Tieghem in his section *Monanthum*: *Z. vieillardii*, *Z. baillonii*, and *Z. bicolor* (to which can be added: *Z. acsmithii*). The main differences are: flowers not solitary, petals free, pollen grains solitary. But the new species *Z. mackeei* takes an intermediate position: flowers not solitary, petals connate, pollen grains solitary. Moreover, the species of section *Monanthum* all show a variation of solitary flowers to 3-flowered inflorescences. Therefore, the sections cannot be upheld (apart from the question of the usefulness in a genus of six species), as was already stated by A. C. Smith (1943).

The specific delimitation proved to be rather difficult. Numbers of flower parts vary considerably even within the same specimen; the leaves are rather similar but variable in size within the species; the white colour on the lower leaf surface is often damaged or has disappeared in herbarium specimens; only a few specimens have open flowers as the petals and stamens easily drop *in vivo*; because of the low number of flowers in the terminal inflorescences, each specimen has only one or a few flowerbuds. Moreover, the total number of collections is low in regard of the variability encountered.

Table 1 gives a review of the external characters to illustrate the variability and overlapping ranges of many characters, as well as to give an additional aid in identification. When using this table, it should be borne in mind, that of *Z. mackeei*, *Z. acsmithii*, and *Z. vieillardii* only very limited material was available.

Notes: I have refrained from extracting the literature on anatomy etc., but instead list the relevant references below.

Anatomy: Bailey (1944; correction of identification: *Z.* '*vieillardi*'=*Z. acsmithii*); Bailey & Nast (1944a, 1944b; correction of identification: *Z.* '*vieillardii*'=*Z. acsmithii*); Baranova (1972); Bongers (1973; correction of identifications: Group I=*Z. baillonii*, Group II=*Z. pomiferum*); Dehay & Ghestem (1969); Gupta (1934); McLaughlin (1933); van Tieghem (1900).

Morphology: Bailey & Nast (1943a, correction of identification: *Z.* '*vieillardi*'= *Z. acsmithii*; 1943b, 1945); Leinfellner (1966; correction of identification: *Z.* '*vieillardii*'= *Z. acsmithii*); van Tieghem (1900).

Palynology: Bailey & Nast (1943a; correction of identification: *Z.* '*vieillardi*'= *Z. acsmithii*); Hotchkiss (1955; correction of identification: *Z.* '*vieillardii*'=*Z. acsmithii*); Sampson (1974; correction of identification: *Z. balansae*=*Z. pomiferum* ssp. *pomiferum*); Swamy (1952).

Cytology: Ehrendorfer c.s. (1968).

Embryology: Bhandari & Venkataraman (1971); Corner (1976); Swamy (1952)

KEY TO THE SPECIES

Note. The description should be consulted after keying out to a species as many characters show overlapping ranges which undoubtedly will be widened when additional material becomes available. The white colour on the lower leaf surface can have disappeared during the processing of the specimens.

1a. In bud petals (almost) free; on lower leaf surface only stomata white. Pollen grains solitary . . . . **1. Z. pomiferum**

b. In bud outer petals for (1/5—)1/2—4/5 connate; on lower leaf surface either only stomata white or also (part of) unspecialized cells white to grey. Pollen grains solitary or in tetrads 2

2a. Stigmas 10 or more. Midrib *c.* triangular below, at least in basal part. Pollen grains solitary or in tetrads. — Pedicels 5—35 mm; stamens 96—251 4

b. Stigmas 10 or less. Midrib *c.* rounded below. Pollen grains in tetrads . . . . . 3[1])

3a. Pedicels 0—7 mm long; stigmas 2—8, usually shortly stipitate; stamens 36—65. **6. Z. baillonii**

b. Pedicels 6—13 mm long; stigmas 5—10, subsessile; stamens 60—113. **5. Z. vieillardii**

4a. On lower leaf surface only stomata white; pedicels (5—)11—14 mm long. **4. Z. acsmithii**

b. On lower leaf surface stomata and (part of) unspecialized cells white or grey; pedicels 10—35 mm long 5

5a. Calyx rather thin, distinctly lobed, often some lobes reflexed; on lower leaf surface islets consisting of white stomata and white unspecialized cells separated by narrow strands of cells not white-coloured; stigmas very large, together almost covering apex of pistil . . . . **2. Z. mackeei**

b. Calyx thick, usually shallowly lobed, lobes not reflexed; on lower leaf surface stomata and all unspecialized cells white; stigmas rather large, scattered on apex of pistil. **3. Z. bicolor**

1. Zygogynum pomiferum Baill.

For synonomy, see under the subspecies.

Shrub or treelet 2—8 m high. Branchlets rather stout; dry epidermis minutely bullate, the cells usually conspicuous at X 30, convex. *Petioles* 0.5—2.5 cm, rounded to subtriangular below. *Blade* obovate to oblanceolate or spathulate, 8—25 × 2—7.5 cm, subcoriaceous; apex obtuse to rounded to minutely retuse, base narrowly cuneate, decurrent along upper part of petiole; midrib (strongly) prominent and triangular below; nerves at the middle of the blade at an angle of (35°—)50°—70° to the midrib, prominulous to inconspicuous on either side, as are the veins. On lower surface only stomata white. *Inflorescences* (2—)3—5-flowered. *Pedicels* 2- or 3-angled or with 2 narrow wings, 10—34 × 2—4 mm. *Calyx* 2—5 mm wide, thin or rather thick, ruptured margin distinctly lobed, lobes reflexed or not. *Torus* 2—4 mm high. *Petals* 3—5 or 9—15, free, rarely outer ones up to 1/5 connate in bud; 15—23 × 7—13 mm (no open flowers seen in ssp. *balansae*), inner ones smaller. Brachysclereids solitary in abaxial part of outer petals or in clusters and solitary throughout petals. *Stamens* 20—103, slits of thecae often confluent; pollen grains solitary. *Pistil* obovoid to globose, 4—6 mm high; stigmas 8—23, sessile to up to 1 mm stipitate, relatively small to medium sized; *c.* 11—29 ovules per locule. *Fruits* globose, up to 40 mm

1) compare also 7. Z. spec.

in diameter; walls with well-spaced, thin-walled, solitary or irregularly clustered brachysclereids. *Seeds* up to 5 × 3 × 2.5 mm.

Distribution: Throughout New Caledonia in two geographically separated subspecies. — **Fig. 12.**

Notes: Baillon based his *Zygogynum pomiferum* on two specimens: *Balansa 2328* and *2804*. Van Tieghem took the latter as the type of his *Z. balansae* and left the former with *Z. pomiferum*, thus making a lectotypification.

Only the type of *Z. spatulatum* is in flower; those of *Z. pomiferum* and *Z. balansae* are in fruit and their number of petals has been assessed with some degree of certainty from the remnants of petal scars below the fruits (in *Z. balansae* the only fruit is cut into many pieces).

The rank of subspecies is used here as the relevant taxa are indistinguishable vegetatively and show a geographical segregation; their leaf anatomy is similar and differs from that of the other species in the genus by the much thickened outer periclinal cell walls of the epidermis.

The subspecies differ in:

a) number of petals.
b) number of stamens; in view of the wide variability of this character in the genus, a wider overlap can be expected when more material becomes available.
c) the stigmas. In ssp. *pomiferum* they are sessile; however, in *Blanchon 1034* they are even more distinctly stipitate than in ssp. *balansae*. In ssp. *balansae* they are more or less distinctly stipitate, but in *Foster 218* they are sessile. This character thus appears to be not strictly correlated with the number of petals.
d) *In sicco* the flower(bud)s of ssp. *pomiferum* are blackish and have a thin calyx with (partly) reflexed lobes; in ssp. *balansae* they are usually light brown and have a thicker, more or less patelliform calyx. This difference is probably caused by a difference in amount of brachysclereids.

KEY TO THE SUBSPECIES

— Petals 9—15 . . . . ssp. **pomiferum**
— Petals (3 or) 4 (or 5) . . . . ssp. **balansae**

a. ssp. **pomiferum** — **Fig. 1a, 6.**

Z. pomiferum Baill., Adansonia 10 (1873) 334; v. Tieghem, J. de Bot. 14 (1900) 340; Pilger in E. & P., Nat Pfl., Nachtr. 3 (1908) 109; A. C. Smith, J. Arn. Arb. 24 (1943) 163; Guill., Bull. Soc. Bot. Fr. 89 (1943) 3. — Lectotype (by v. Tieghem): *Balansa 2328* (P; dupl. A *n.v.*, K, P).

Z. spatulatum v. Tieghem, o.c. 341; Pilger l.c. ('*spathulatum*'); A. C. Smith, l.c. ('*spathulatum*'); Guill., l.c. and Mém. Mus. Nat. Hist. Nat. IIB, 8—2 (1959) 122 ('*spathulatum*') .— *Drimys austro-caledonicus* Vieillard *in sched., p.p.*, cited by v. Tieghem, l.c., and Smith, l.c. — Type: *Vieillard 2266* (P, holo; GH *n.v.*, K).

Pedicels often with 2 narrow wings. *Calyx* 3—5 mm wide, thin, usually ruptured into 3 lobes, lobes (partly) reflexed. *Petals* 9—15, free, rarely outer petals up to 4 mm connate; outer petals 15—23 × 7—13 mm, inner ones smaller. Brachysclereids solitary, in abaxial part of outer petals only. *Stamens* 20—60. *Stigmas* 15—23, sessile, rarely stipitate. *Ovules c.* 11—29 per locule.

Petals white to yellow, with (always?) red markings on adaxial side. *Fruits* greenish yellow.

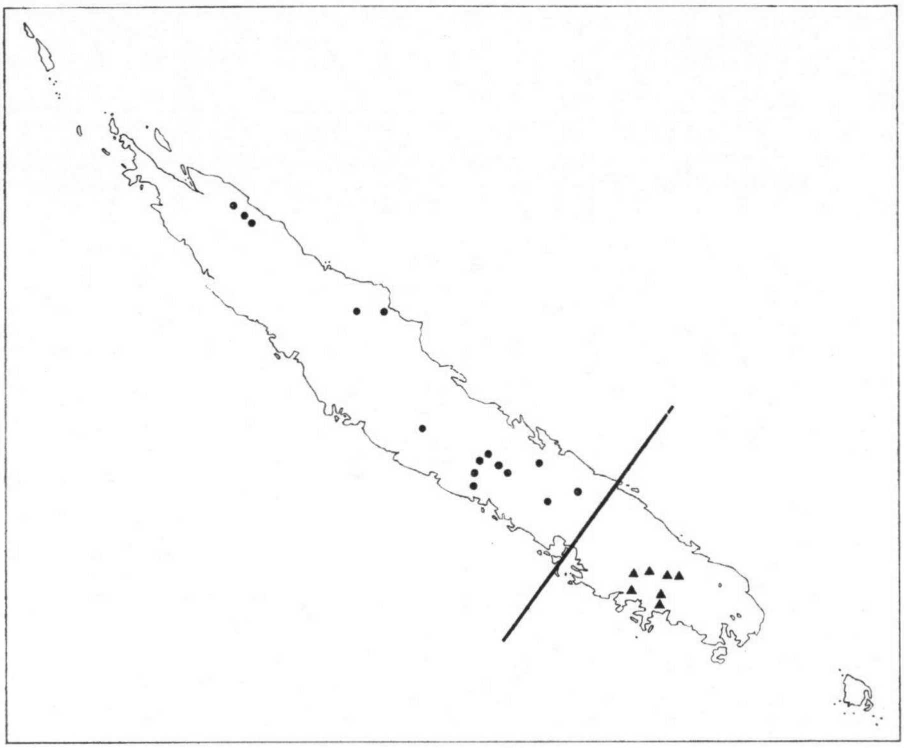

Fig. 12. *Zygogynum pomiferum*. Distribution from specimens studied. — dots: ssp. *pomiferum*; triangles: ssp. *balansae*.

D i s t r i b u t i o n: North and Central New Caledonia (17 collections seen). — **Fig. 12.**

E c o l o g y: Rainforests at 450—1000 m altitude. Five times reported from schists, twice from serpentine (Mt Do). Fl. March—July; fr. July—Dec. (—Febr.).

b. ssp. **balansae** (v. Tieghem) Vink, *nov. stat.* — **Fig. 7b.**

Z. balansae v. Tieghem, J. de Bot. 14 (1900) 341; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 109; A. C. Smith, J. Arn. Arb. 24 (1943) 163; Guill., Bull. Soc. Bot. Fr. 89 (1943) 3; Mém. Mus. Nat. Hist. Nat. IIB, 8—2 (1959) 122. — T y p e: *Balansa 2804* (P).

Pedicels 2- or 3-angled or with 2 narrow sharp ridges. *Calyx* 2—3 mm wide, rather thick, usually ruptured into 2 (terminal flowers) or 3 (lateral flowers) lobes, lobes usually not reflexed. *Petals* (3 or) 4 (or 5), free; no open flowers seen. Brachysclereids in clusters and solitary, throughout petals, less dense and more often solitary towards adaxial side. *Stamens* 50—103. *Stigmas* 8—21, (sub)stipitate, rarely sessile. *Ovules c.* 14—16 per locule. *Petals* white to yellow.

D i s t r i b u t i o n: South New Caledonia (18 collections seen). — **Fig. 12.**

E c o l o g y: Rainforests (gallery forests) at 150—700 m altitude. Four times reported from serpentine, once from gabbros. Fl. April—Oct.; fr. April.

2. Zygogynum mackeei Vink, *nov. spec.* — **Fig. 8a.**

Z. balansae auct. non v. Tieghem: Bak.*f.*, J. Linn. Soc. Bot. 45 (1921) 268.

Petioli 1—2.5 cm longi. Laminae foliorum obovato-oblongae vel oblanceolatae, 10.5—22 × 3.5—7 cm, (sub)coriaceae, apice rotundatae, basi anguste cuneatae, costa crassa subtus triangulari. Stomata strato albo obtecta, pluria una cum cellulis epidermidis strato griseo obtectis quasi ad insulas cellulis epidermalibus haud strato albo-griseo obtectis separatas disposita. *Inflorescentiae* 3—5-florae. Pedicelli 15—28 × 2—4 mm. Calyx tenuis, irregulariter lobatus et reflexus. Petala 12 vel 13, 4 exteriora pro parte majore in alabastro connata, sub anthesi separata, 12—20 × 6—11 mm. Stamina 96—136. Pistillum obovoideum, 4—5 mm longum, stigmatibus 14—19 rel. magnis, breviter stipitatis. *Fructus* ignotis.
T y p u s: *Compton 1776* (BM), in monte Panié dicto, Nova Caledonia.

Tree(let). Branchlets stout; dry epidermis wrinkled in minute, sharp, longitudinal ridges, the cells not conspicuous at X 30. *Petioles* 1—2.5 cm, triangular (rounded near base) below. *Blade* obovate-oblong to oblanceolate, 10.5—22 × 3.5—7 cm, (sub)coriaceous; apex rounded, base narrowly cuneate, decurrent along upper part of petiole; midrib strongly prominent and triangular below; nerves at the middle of the blade at an angle of 60°—80° to the midrib, prominulous on either side, as are the veins. On lower surface islets consisting of white stomata and white to grey unspecialized cells separated by narrow strands of cells not white- or grey-coloured. *Inflorescences* 3—5-flowered. *Pedicels* elliptic in cross-section or 2—4-angled, 15—28 × 2—4 mm. *Calyx* 2.5—3.5 mm wide, thin, ruptured margin distinctly lobed, lobes (partly) reflexed. *Torus* 2—3.5 mm high. *Petals* 12 or 13, the 4 outer ones more than halfway connate in bud; 12—20 × 6—11 mm, inner ones smaller. Brachysclereids bot solitary and in small clusters, in outer petals dense but less so at adaxial side, in the other petals not dense and mainly in middle layers. *Stamens* 96—136, slits of thecae often confluent; pollen grains solitary. *Pistil* obovoid, 4—5 mm high; stigmas 14—19, some stigmas of lower locules can be minute and on lateral faces of pistil; normal stigmas shortly stipitate, relatively very large, together covering apex of pistil almost completely. *Fruits* unknown.

Petals: 4 outer ones green outside, yellow inside, inner ones yellow (*type*); dark red (*MacKee 13804*); bright yellow with red marks on inside (*MacKee 13805*).

D i s t r i b u t i o n: NE. New Caledonia.

Compton 1776 (type), Mt Panié, 500 m alt.; fl. Aug. — *MacKee 13804* (P), *13805* (L, P), Oua Pandieme, vallée du creek Tao, 300—400 m alt.; fl. Nov.
Probably belong here: *MacKee 26424* (L), Touho, Tonine, 900 m alt.; y. fl. March. — *Veillon 1976* (NOU), Inédète, 650 m alt.; fr. June.

E c o l o g y: Forests on schists or gneiss at 300—500 m altitude. Fl. Oct., Nov.

N o t e s: This species is named in honour of Dr. H. S. MacKee who contributed so much to the knowledge of the New Caledonian flora by his extensive collecting activities. Of the material used in this study, one third was collected by Dr. MacKee.

The closest relative of this new species is *Z. bicolor*, from which it differs a.o. by the discontinuous white cover on the lower leaf surface, the thin and reflexed calyx, the very large stigmas, and the solitary pollen grains.

Two specimens from the Touho area, *MacKee 26424* and *Veillon 1976*, are leaf-anatomically identical to *Z. mackeei*, but they differ in a number of external characters: leaf blades smaller (7.5—11 × 2.3—4.0 cm); lower leaf surface *probably* entirely white or grey; inflorescences 1-flowered; pedicels 11—16×3.5—5 mm; calyx thick and not lobed nor reflexed; petals 8, 9, and 11; stamens 139; stigmas 11, 14, and *30*. Most of these characters would fit *Z. bicolor*, but leaf anatomy, the size of the stigmas, and the solitary pollen grains point to *Z. mackeei*. It is not impossible that these specimens represent a subspecies of *Z. mackeei*, but the material available is too scanty (five collections in all) to draw a conclusion of this kind.

The high number of stigmas in *MacKee 26424* (14 and 30) is shared with *Veillon 1556* (24 and 33), classified by me as *aff. Z. bicolor*. The latter has, however, larger and thicker leaves, a thick granulate alveolar layer covering the entire abaxial epidermis, and (compared with *Veillon 1976*, 11 stigmas) much larger fruits.

The differences in petal colour between the consecutive collections of MacKee are remarkable and comparable to a similar situation in *Z. baillonii*.

3. Zygogynum bicolor v. Tieghem — Fig. 7c, 11a.

Z. bicolor v. Tieghem, J. de Bot. 14 (1900) 341; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 109; A. C. Smith, J. Arn. Arb. 24 (1943) 163; Guill., Bull. Soc. Bot. Fr. 89 (1943) 3. — Type: *Lécard s.n., Mus. Col. catal. no. 41* (P, holo; P, Z).

Shrub or treelet 3—10 m high. Branchlets rather to very stout; dry epidermis minutely wrinkled, the cells not conspicuous at X 30. *Petioles* 1—3 cm, rounded (often triangular in apical half) below. *Blade* obovate to oblanceolate, (3.5—)8—24×(1.3—)3—8.5 cm, sub- to strongly coriaceous; apex rounded, sometimes minutely retuse, base narrowly cuneate, decurrent along upper part of petiole; midrib strongly prominent and (rounded to) triangular below; nerves at the middle of the blade at an angle of 60°—80° to the midrib, inconspicuous to prominulous on either side, as are the veins. On lower surface stomata and (most of) the unspecialized cells equally and intensively white. *Inflorescences* 1—3-flowered. *Pedicels* terete or 2—5-angled, 10—35×2—7 mm. *Calyx* 2—6 mm wide, thick, ruptured margin usually not distinctly lobed, not reflexed. *Torus* 5—8 mm high. *Petals* 11—14, the 4 (rarely 3 or 5) outer ones more than halfway connate in bud; *c.* 20—23× 8—13 mm, inner ones smaller. Brachysclereids both solitary and in clusters throughout all petals. *Stamens* 142—251, slits of thecae often confluent; pollen grains in tetrads. *Pistil* obovoid to globose, 5—8 mm high; stigmas 10—24, (sub)sessile, relatively rather large; 20—35 ovules per locule. *Fruits* (sub)globose, up to 26 mm in diameter; walls densely packed with globose clusters of brachysclereids. *Seeds* up to 5×3×2 mm.

Petals white or cream; *stamens* pink.

Distribution: Central New Caledonia (10 collections seen).

Ecology: Forests and forest edges at 600—1000 m altitude; three times reported from serpentine. Fl. Aug.—Jan.; fr. throughout the year.

Notes: The specimens from Mé Amméri have generally thinner branchlets, thinner and narrower leaves, and thinner and longer pedicels than the specimens from 'Forêt de Bourail', Plateau de Dogny, and Mé Ornana.

Veillon 1556 (haute vallée de Boghen) is an aberrant specimen by the almost complete lack of brachysclereids in its leaves, by its thick and densely granulate alveolar material which gives the lower leaf surface a grey colour, and by its high number of stigmas (24 and 33) on its large (3.5 cm) fruits. If this specimen proves to represent a deviating population, the specific description has to be emended.

4. Zygogynum acsmithii Vink, *nov. spec.*

Z. vieillardii auct. non Baill.: A. C. Smith, J. Arn. Arb. 24 (1943) 162, *pro spec. Franc 1740*, f. 6 f, j; Bailey & Nast, J. Arn. Arb. 24 (1943) 346, f. 6, 10; ditto, 25 (1944) 348, f.1; Hotchkiss, Proc. Linn. Soc. NSW 80 (1955) 51; Leinfellner, Österr. Bot. Ztschr. 113 (1966) 258, f. 7.

Petioli 1.3—2.3 cm longi. Laminae foliorum (obovatae vel) ellipticae vel (obovata-)oblongae, 5.5—21 × 2—6 cm, coriaceae, apice obtusae vel rotundatae vel retusae, basi anguste cuneatae, costa crassa subtus triangulari. Stomata strato albo obtecta, cellulae epidermales ceterae haud albo-obtectae. *Inflorescentiae* 1—3-florae. Pedicelli (5—)11—14 × (3—)4—6 mm. Calyx crassus, irregulariter lobatus. Petala 10—13, 4 vel 5 exteriora pro parte majore in alabastro connata, sub anthesi separata. Stamina 135—173. Pistillum stigmatibus 10—15 rel. magnis, breviter stipitatis. *Fructus* immaturus (sub)globosus, usque 19 mm longus.

Typus: *Franc 1740* (P, holo; A, B, BM, K, UC *n.v.*, Z), Prony, Nova Caledonia.

Tree(let). Branchlets rather slender to stout; dry epidermis almost smooth to bullate or longitudinally wrinkled, at X 30 the cells inconspicuous and flat to conspicuous and convex. *Petioles* 1.3—2.3 cm, triangular below. *Blade* (obovate or) elliptic to (obovate-) oblong, 5.5—21 × 2—6 cm, coriaceous; apex obtuse to rounded or retuse, base acute to narrowly cuneate, decurrent along upper part of petiole; midrib prominent and triangular below; nerves at the middle of the blade at an angle of 70°—85° to the midrib, prominulous on either side; veins prominulous to inconspicuous on either side. On lower surface only stomata white. *Inflorescences* 1—3-flowered. *Pedicels* terete to 5-angled, (5—)11—14 × (3—)4—6 mm. *Calyx* 3—5 mm wide, thick, ruptured margin distinctly lobed, lobes not reflexed. *Torus* 4—6 mm high. *Petals* 10—13, the 4 or 5 outer ones halfway or more connate in bud. No open flowers seen. *Stamens* 135—173, no mature thecae seen; pollen probably in tetrads. *Pistil* with 10—15 shortly stipitate, relatively large stigmas; *c.* 15—26 ovules per locule. Immature *fruits* (sub)globose, up to 19 × 20 mm; walls densely packed with globose clusters of brachysclereids, these smaller and less dense in outer 0.5—0.7 mm of the wall. Only immature *seeds* seen.

Distribution: South New Caledonia.

Franc 1740 (type), Prony. — *MacKee 15409* (L, P), Route de Yaté, entre le pont de la Rivière des Lacs et le barrage, 200 m alt.; y. fr. Aug.

Ecology: Forests at low altitude, on serpentine.

Notes: As the material contains only flowerbuds and immature fruits, it was after some hesitation that I decided to describe a new species on it. Far more material is needed to unravel the relations with the other species, especially with *Z. vieillardii* from which it differs as follows:

	acsmithii	*vieillardii*
stamens	135—173	60—113
stigmas	10—15	5—10
midrib below	triangular	rounded
alveolar material on unspecialized cells of abaxial epidermis	absent	present
cuticle of abaxial epidermis	3—6 μm	10—21 μm
brachysclereids in leaf lamina	few	many

These differences are based on a few specimens for each species only. Although they may seem to be slight, they concern characters used for the delimitation of the other species of this genus.

This new species is named in honour of Dr. A. C. Smith, who contributed so much to the taxonomy of the *Winteraceae*.

5. Zygogynum vieillardii Baill. — Fig. 7d.

Z. vieillardii Baill., Adansonia 7 (1867) 298, pl. 4 ('*vieillardi*'); ibidem, 372; Hist. Pl. 1 (1868) 160, f. 208—210; v. Tieghem, J. de Bot. 14 (1900) 340, 346, 347; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 109; Guill., Ann. Mus. Col. Marseille II, 9 (1911) 95, *p.p.*; Bull. Soc. Bot. Fr. 89 (1943) 3, *p.p.*; A. C. Smith, J. Arn. Arb. 24 (1943) 162 ('*vieillardi*') *p.p.*, excl. f. 6 f, j. — Type: *Vieillard 187* (Herb. Mus. colon. gallic.) (P, holo and iso).

Treelet 4—8 m high. Branchlets rather slender to rather stout; dry epidermis longitudinally to bullately wrinkled, the cells mostly inconspicuous at X 30, flat. *Petioles* 1—3 cm, (triangular-) rounded below. *Blade* elliptic or obovate to (obovate-)oblong, 5.5—18 × 1.7—6 cm, coriaceous; apex rounded to retuse, base acute to (narrowly) cuneate, often decurrent along upper part of petiole; midrib (strongly) prominent and (triangular-)rounded below; nerves at the middle of the blade at an angle of 60°—80° to the midrib, prominulous above, prominulous to inconspicuous below; veins prominulous to inconspicuous on either side. On lower surface stomata white, unspecialized cells probably never white but with greyish appearance because of the granular surface of the thick cuticle. *Inflorescences* 1—3-flowered. *Pedicels* terete or 2—5-angular, 6—13 × 3—5.5 mm. *Calyx* (1.5—) 2—3 mm wide, thick, ruptured margin shallowly lobed, not reflexed. *Torus* 2—3 mm high. *Petals* (?4—)9—12, the 4 outer ones more than halfway connate in bud; *c.* 19—20 × 10—11 mm, inner ones smaller. Brachysclereids both solitary and in small clusters throughout all petals. *Stamens* 60—113, slits of thecae not confluent; pollen grains in tetrads. *Pistil* obovoid, *c.* 4 mm high; stigmas 5—10, subsessile, relatively small. Immature *fruits* (depressedly) globose, up to 16 × 17 mm; walls densely packed with globose clusters of brachysclereids.

Flowers yellow. Young *fruits* yellowish green.

Distribution: Throughout New Caledonia (5 collections seen).

Ecology: Shrubberies at 500—600 m altitude; twice reported from serpentine. Fl. March, Oct.; y. fr. Sept., Oct.

Notes: The circumscription of this species met with some difficulties.

The information provided by Baillon (1867) consists of a general description in French (pp. 297—298), a formal description in Latin (pp. 298—299), plate 4, and a summary (p. 372). The combination of this information comes down to: Flowers solitary; pedicel 5—15 mm; calyx not or shallowly lobed; petals 3, 4, or 5, with 3 or 4 in the outer whorl, free; stamens 36; stigmas 8 or 10, 1—2 mm stipitate, roundish.

On the holotype no (remnants of the) flowers are left, as already noted by Van Tieghem (p. 346). The isotype in the Paris Herbarium has only one detached old flower and one detached outer petal; these clearly belong to *Z. baillonii* (more than one whorl of petals, outer petals connate, 5 stigmas, short pedicel), which might have induced Guillaumin (1911) to reduce *Z. baillonii* to *Z. vieillardii*.

The herbarium of Baillon in Paris contains a sheet (isotype) with some detached leaves and a small twig with young leaves, one flowerbud and one old flower. The description is: Inflorescence 2-flowered; pedicel 6—9 mm; calyx shallowly lobed; petals 12, the 4 outer ones more than halfway connate; stamens about 60—70; stigmas 5 or 6, minutely stipitate, elliptic to obovate. However, the reconstruction of a dissected corolla in the envelope on the sheet reveals: probably 4 connate outer petals and an incomplete second whorl of petals (two petals present, maybe a third one missing), the positions of the other petals of the second whorl as well as those of the third whorl distinctly taken by stamens.

A variation in the number of petals as encountered here was never found in any other specimen of *Zygogynum*. I cannot explain what has happened in this case, but the only sound action is to accept the combination of characters found in the bud and the old flower which were still attached to the specimen in the herbarium of Baillon. The description as given by Baillon does not fit any known specimen, including the type material, it certainly contains errors (e.g. ovules inserted in the internal angle of the locules), and was already doubted by Van Tieghem (p. 346).

Z. vieillardii is closely related to and difficult to distinguish from *Z. acsmithii* and *Z. baillonii* (see notes under these species).

6. Zygogynum baillonii v. Tieghem — Fig. 2e; 8a, d; 11c.

Z. baillonii v. Tieghem, J. de Bot. 14 (1900) 340—345 ('*bailloni*'); Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 109; A. C. Smith, J. Arn. Arb. 24 (1943) 162. — Type: *Pancher s.n.* (P, holo); isotypes are unnumbered or numbered *P. 17* (sometimes erroneously copied on labels as *Vieillard 17*), *Mus. Néocal. 283*, and *4708*[1], in various combinations (BM, K, P).

Z. vieillardii auct. non Baill.: Guillaumin, Mém. Mus. Nat. Hist. Nat. IIB, 8—2 (1959) 122; Thorne, Am. Nat. 97 (1963) 292, f. 3; Guillaumin c.s., Univ. Iowa Stud. Nat. Hist. 20—7 (1965) 29, f. 31.

Shrub or treelet 2—8 m high, trunk up to 15 cm in diam. Branchlets rather slender to stout; dry epidermis minutely bullate, the cells conspicuous at X 30, convex. *Petioles* 0.7—1.5(—2) cm, rounded below. *Blade* elliptic to (obovate-)oblong, rarely elliptic-lanceolate or linear, 3.5—17 × 1.5—5(—6.5) cm, coriaceous; apex (narrowly) rounded, base acute to narrowly cuneate, often decurrent along upper part of petiole; midrib prominent and mostly rounded below; nerves at the middle of the blade at an angle of 60°—75° to the midrib, prominulous to inconspicuous on either side, as are the veins. On lower surface stomata white, unspecialized cells (very light) grey (rarely almost white). *Inflorescences* 1—3-flowered. *Pedicels* terete (or 2—5-angular), 0—7 × 2—4 mm. *Calyx* 1—3.5 mm wide, thick, ruptured margin not to distinctly lobed, lobes not reflexed. *Torus* 2—3.5 mm high. *Petals* 11—19, the 4 outer ones halfway or more (rarely for 1/5) connate in bud; *c.* 12—21 × 3—7.5 mm, inner ones smaller. Brachysclereids both solitary and in clusters throughout all petals. *Stamens* 36—65, slits of thecae often confluent; pollen grains in tetrads. *Pistil* obovoid to obconical, 4—6.5 mm high; stigmas 2—8, (sessile to) up to 1(—1.5) mm stipitate, relatively large; *c.* 8—19 ovules per locule. *Fruits* obovoid, up to *c.* 16 × 14 mm; walls densely packed with globose clusters of brachysclereids. *Seeds* up to 5 × 3 × 3 mm.

Flowers (very) fragrant. *Petals* white, (light) yellow, yellow with red markings, salmon, pink, red, orange, or brownish yellow! *Pistil* light yellow. *Fruits* dark red to black.

Distribution: South (and Central?) New Caledonia (43 collections seen).

Ecology: Forests, forest edges, and shrubberies at 350—1200 m altitude; eleven times reported from serpentine, four times from peridotite. Fl. April—Dec.; fr. May—July.

Notes: Van Tieghem (1900, p. 343, 344) described the flowers of *Z. baillonii* to contain 8 petals, *c.* 52 stamens, and a pistil with 4 stigmas. In two flowers of the holotype I found 12 petals, 54 stamens, 4 stigmas, and 12 petals, 40 stamens, 2 stigmas, respectively. I found never less than 11 petals in this species, a difference with the original description I cannot explain.

In *Z. baillonii* the bracts of the inflorescence are usually slightly but distinctly longer persistent (caducous) than in the other species (fugaceous). They are ligulate, *c.* 4—5 × 2—2.5 mm, and (sub)acute.

In many specimens the white colour of the lower leaf surface is well-preserved. At X 30 the stomata are purely white, whereas the unspecialized cells are greyish white or grey, the separate cells mostly being recognizable. When the status of preservation is not optimal, the unspecialized cells often still show a minutely granular surface. This adds to the difficulty of distinguishing *Z. baillonii* from *Z. vieillardii*, as all characters (except for the leaf anatomy) show overlapping ranges; future collection will certainly extend these overlaps.

	baillonii	*vieillardii*	*acsmithii*
stamens	36—65	60—113	135—173
stigmas	2—8	5—10	10—15
pedicel length in mm	0—7	6—13	(5—)11—14

In *Z. acsmithii* the lower side of the midrib is triangular, in the two other species it is rounded. *Z. baillonii* and *Z. vieillardii* are difficult to key out, but in most cases the identification will nevertheless not be difficult: *Z. baillonii* has usually shortly stipitate stigmas, shorter pedicels, and smaller leaves more white on their lower surface.

In spite of these difficulties in delimitation, and in view of the differences in leaf anatomy (thickness of cuticle, differentiation of palissade parenchyma) I find these two taxa sufficiently different to maintain them as separate species.

One specimen is inserted in this species as doubtful: *Godefroy s.n.*, (*Herb. d'Alleizette NC 326*) (P): leaves very wide (up to 6.5 cm), palissade parenchyma only partly differentiated, alveolar material on lower leaf surface heterogeneous (in the sense of Bongers) and taking up a larger part of the thickness of the cuticle. Maybe this is an intermediate to *Z. vieillardii*.

Local populations are not very distinct from each other. Five specimens from Mt Koghis have pedicels 3—6 mm long, whereas twelve specimens from Mtgne des Sources have pedicels 0—4 mm long. Otherwise there are no constant differences.

From the material available it appears that, if the present species occurs in the same localities as *Z. pomiferum* ssp. *balansae*, there are differences in the altitudinal range (number of collections between brackets):

	baillonii	ssp. *balansae*
Mt Koghis	600—1060 m (5)	400—600 m (4)
Mt Mou	700—1200 m (3)	700 m (1)

The wide variation in petal colour, even in the same locality and the same time of the year, was noted by Buchholz on his labels.

7. Zygogynum spec.

MacKee 21725, Kouaoua, Aréha, maquis sur pente rocheuse serpentineuse, alt. 500 m, j. fl. mars; arbuste grêle 2 m; feuilles vert foncé sur les deux faces.

Inflorescences 2—4-flowered; pedicel of *just opening bud* 12 mm; calyx shallowly but distinctly lobed; petals 14—16, outer ones more than halfway connate; stamens 51—60; stigmas 3 or 4. *Leaf anatomy*: adaxial cuticle 12—18 μm; abaxial cuticle 10—15 μm, underlying cell walls very thin; alveolar material over unspecialized cells absent; palissade parenchyma not differentiated; mesophyll almost without birefringent cell walls; brachysclereids frequent, solitary and (mostly) in small clusters, rarely touching adaxial epidermis; irregularly rhomboid crystals and druses 12—20 μm in diam. frequent in mesophyll.

I cannot place this specimen and more collections are necessary to evaluate its status; at present the description of a new species seems not warranted.

REFERENCES

BAILEY, I. W. 1944. The comparative morphology of the Winteraceae. III. Wood. J. Arn. Arb. 25: 97—103.
BAILEY, I. W., & C. G. NAST. The comparative morphology of the Winteraceae.
— 1943(a). I. Pollen and stamens. J. Arn. Arb. 24: 340—346.
— 1943(b). II. Carpels. o.c.: 472—481.
— 1944(a). IV. Anatomy of the node and vascularization of the leaf. J. Arn. Arb. 25: 215—221.
— 1944(b). V. Foliar epidermis and sclerenchyma. o.c.: 342—348.
— 1945. VII. Summary and conclusions. J. Arn. Arb. 26: 37—47.
BARANOVA, M. 1972. Systematic anatomy of the leaf epidermis in the Magnoliaceae and some related families. Taxon 21: 447—469.
BHANDARI, N. N., & R. VENKATARAMAN. 1971. Embryology of the Magnoliales and comments on their relationships. J. Arn. Arb. 52 (1971) 1—39, 285—304.
BONGERS, J. M. 1973. Epidermal leaf characters of the Winteraceae. Blumea 21: 381—411.
CORNER, E. J. H. 1976. The seeds of Dicotelydons 1: 282.
DEHAY, C., & A. GHESTEM. 1969. Caractères de l'appareil libéro-ligneux foliaire chez quelques Wintéracées. Bull. Soc. Bot. Fr. 116: 168, f. 7.
EHRENDORFER, F., c.s. 1968. Chromosome numbers and evolution in primitive Angiosperms. Taxon 17: 337—353.
GUPTA, K. M. 1934. On the wood anatomy and theoretical significance of homoxylous Angiosperms. J. Ind. Bot. Soc. 13: 71—101.
HOTCHKISS, A. T. 1955. Chromosome numbers and pollen tetrad size in the Winteraceae. Proc. Linn. Soc. N.S.W. 80: 51.
LEINFELLNER, W. 1966. Wie sind die Winteraceen-Karpelle tatsächlich gebaut? III. Die Karpelle von Bubbia, Belliolum, Pseudowintera, Exospermum und Zygogynum. Öst. Bot. Ztschr. 113: 245—264.
MCLAUGHLIN, R. P. 1933. Systematic anatomy of the woods of the Magnoliales. Trop. Woods 34: 22, 30.
SAMPSON, F. B. 1974. A new pollen type in the Winteraceae. Grana 14: 11—15.
SMITH, A. C. 1943. Taxonomic notes on the Old World species of Winteraceae. J. Arn. Arb. 24: 119—164.
SWAMY, B. G. L. 1952. Some aspects in the embryology of Zygogynum baillonii v. Tiegh. Proc. Nat. Inst. Sc. India 18: 399—406.
TAKHTAJAN, A. 1973. Evolution und Ausbreitung der Blütenpflanzen.
TIEGHEM, M. P. VAN. 1900. Sur les Dicotylédones du groupe des Homoxylées. J. de Bot. 14: 340—348.
VINK, W. 1970. The Winteraceae of the Old Worl. I. Pseudowintera and Drimys — Morphology and taxonomy. Blumea 18: 225—354.

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