THE WINTERACEAE OF THE OLD WORLD

I. PSEUDOWINTERA AND DRIMYS — MORPHOLOGY AND TAXONOMY

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SUMMARY

The primitive woody Angiosperm family *Winteraceae* is centred in the southwest Pacific, has an outpost in Madagascar (1 species), and a section of *Drimys* (4 species) in the New World. *Pseudowintera* is restricted to New Zealand, the Old World section *Tasmannia* of *Drimys* extends from the Philippines to Tasmania.

Since A. C. Smith's review of the family in 1943 about ten times as much material has become available and it appears that the taxonomy of the section *Tasmannia* is far more complicated than it seemed to be in 1943. This induced me to make a field study in New Guinea and to pay special attention to its morphology in the hope of finding additional criteria. On this basis the Australian species of *Drimys* could be better defined but the characters of the New Guinean taxa (Smith: 29 species) proved to be highly unstable.

It was found that in the section *Tasmannia* the stomata are occluded by waxy plugs. The structure of the inflorescence is described and compared with that in section *Drimys*. In the flower two zones are distinguished. In the lower zone the floral appendages are arranged in (sub)opposite pairs, in the higher zone they are arranged according to the space available at the greatest possible distance from a focus of the floral apex which I termed 'activity centre'; this centre often does not coincide with the 'topographical apex'. The tilt of the floral apex appears to influence the arrangements as well. Shifting of determination factors in relation to the available locations on the floral apex is assumed to play an important role.

As for the specific delimitation, the New Guinean material appeared to be the crux. The very heterogeneous material did not show correlated discontinuities in characters, which made it impossible to reach a division into species. The variability of the resulting very complex species *Drimys piperita* is described with the aid of a non-taxonomic subdivision, the units of wich are called 'entities'. Field studies revealed that local populations are often very stable, but the morphological discontinuities between such local populations are obscured by material from other localities. It is supposed that vegetative propagation as observed in the field, combined with incidental cross-breeding, may be of importance in establishing such a situation.

In Australia besides *D. piperita* four other species can be distinguished.

The sections of *Drimys* are maintained, although Ehrendorfer *c.s.* and Smith proposed raising them to generic rank.

In *Pseudowintera* the arrangement within the inflorescence is spiral, not decussate as described earlier, and a terminal flower is present. Minute hairs on bracts and young leaves, the mode of opening of the calyx cupule, and details of the lower leaf surface are used as a new set of specific characters. The fact that about twenty per cent of the specimens show varying combinations of specific characters is thought to be caused by hybridisation.

CONTENTS

Introduction and acknowledgements 226
The genus Pseudowintera
  Introduction 227
  Morphology
    1. Twig 227
    2. Lower leaf surface 227
    3. Inflorescence 228
    4. Flower 228

5. Fruit 231
6. Seed 231
7. Conclusions 233
Sporogenesis and embryology 233
Specific delimitation. 233
Specific descriptions. 235
Taxonomy. 235

The genus Drimys

Morphology

1. Introduction 244
2. Twig 244
3. Leaf. 246
4. Occlusion of the stomata 246
5. Inflorescence 248
6. Flower 259
7. Fruit 263
8. Seed 264
Ontogeny of the flower. 266
1. Sect. Tasmannia: D. piperita 266
2. Sect. Tasmannia: D. purpurascens, D. stipitata, D. insipida. 274
3. Sect. Tasmannia: D. lanceolata. 274
4. Sect. Drimys. 277
Diagram of the flower 277
Comparison of arrangements of floral appendages 278
Reproduction. 281
Specific delimitation in Sect. Tasmannia. 283
1. New Guinea 283
1a. Mt Wilhelm 284
1b. Mt Wilhelmina complex. 287
1c. Mt Ambua c.s. 289
1d. Entity 'heteromera' c.s. 295
1e. Use of characters 299
1f. Conclusion 301
2. Philippines to Moluccas, and Flores. 301
3. Australia 301
Phytochemistry. 301
Taxonomy. 302
Fossils 351
Excluded from the Winteraceae 351
Literature 352
Index 353

INTRODUCTION AND ACKNOWLEDGEMENTS

Since A. C. Smith published his 'Taxonomic notes on the Old World species of Winteraceae' (J. Arn. Arb. 24, 1943, 119—164) no further taxonomic work has been done on this family. Such work is the more important as Smith had no access to the material in the European herbaria because of the war; moreover, in the last two decades the collections have increased enormously, enlarging our possibilities for research. To illustrate this point: for the 1943 review were available 25 New Guinean collections, whereas for the present work I had 480 collections from that area at may disposal.

In this paper the genus *Pseudowintera* and the section *Tasmannia* of the genus *Drimys* are treated. I have refrained from including the American section *Drimys* as this has been fully revised by A. C. Smith (l.c., pp. 1—33).

A discussion of the characters of the family will be given in a future paper when the remaining genera have been treated.

This study could not have been made without the generosity of the directors of the following herbaria, who kindly put their collections at my disposal: Adelaide, Arnold Arboretum, Berlin, Bishop Museum, British Museum of Natural History, Bogor, Canberra, Christchurch, Copenhagen, Florence, Kew, Lae, Leiden, Manilla, Melbourne, Paris, Rancho Santa Ana, Singapore, Stockholm, Sydney, Utrecht, Washington, Wellington, and Zürich.

The Netherlands Foundation for the Advancement of Tropical Research WOTRO financed an exploration of the Doma Peaks area in New Guinea, where I was able to make extensive collections.

I am much indebted to the Director of the Department of Scientific and Industrial Research at Christchurch for information concerning the New Zealand localities, and to Dr. W. van Heel and Dr. C. Kalkman for criticism. To Mrs. C. den Hartog, I am most grateful for the considerable improvements of the English text.

THE GENUS PSEUDOWINTERA

INTRODUCTION

For a review of the taxonomic and nomenclatural history of the genus *Pseudowintera* I refer to the excellent introductions by J. E. Dandy, J. Bot. 71 (1933) 119—121 and A. C. Smith, J. Arn. Arb. 24 (1943) 154—155. For the complications arising from the typification of *Drimys*, see p. 237, 303.

MORPHOLOGY

1. Twig. The twigs (long shoots) of *Pseudowintera* bear normal leaves only, cataphylls are not formed. The terminal bud consists of young leaves and is usually very small; it often disintegrates, an axillary bud taking over as leader.

The short shoot, forming an axillary inflorescence, may sometimes produce apically a vegetative long shoot. The bracts are then often slightly larger and longer persistent than in the normal inflorescence. The result is a normal lateral shoot bearing, however, in its basal part cataphylls (enlarged bracts) with flowers, fruits, or scars of these in their axils. Although this is a rare phenomenon, it appears regularly in some specimens (fig. 4 d).

Nast (1944) and Sampson (1963) report the development of vegetative shoots in the axils of bracts, replacing the secondary inflorescences (see below).

For a description of the structure of the vegetative shoot apex, see Gifford (1950) 603, 605.

2. Lower leaf surface. The cuticle of the lower leaf surface consists of two layers. The inner one, next to the outer wall of the epidermis cells, is homogeneous and has often distinct plasmodesma-like structures (described by Sampson as 'invaginations, apparently of the wall into the cuticle'). Overlying this layer is a non-homogeneous, white-coloured layer which is alveolar according to Bailey & Nast (1944b). In *P. colorata* this alveolar layer carries fine tubercles. Although not actually observed, the presence of waxes in or on the alveolar layer is deduced from the disappearance of the white colour when applying gentle heat. The white colour can be restored by boiling and drying the leaf. It is assumed that the wax melts when heat is applied, replacing the air or the crystalline structure of the wax in the interstices of the alveolar layer. After cooling the white colour does not return as this is caused by reflection on the interstices filled with air or crystalline wax. Boiling will remove the wax and subsequent drying admits the air into the interstices, thus restoring the white colour.

Over the subsidiary cells and the guard cells the homogeneous layer thins out, while the alveolar layer at the same places increases in thickness. The front cavity of the stomata is completely occluded by alveolar material. Whether the occlusion is provided with

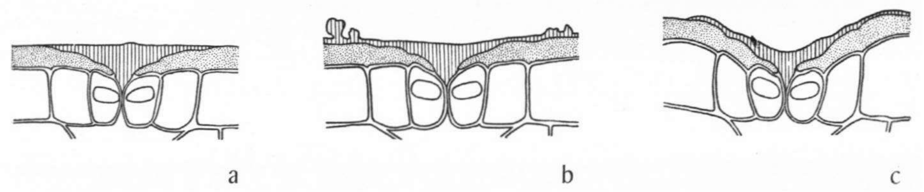

Fig. 1. Schematic cross-sections through lower leaf surfaces of *Pseudowintera;* dotted: homogeneous cuticular layer; hatched: alveolar material. a. *P. axillaris.* b. *P. colorata.* c. *P. traversii.*

narrow canals or with interstices larger than those in the alveolar layer over the epidermis cells, could not be established.

The three species of *Pseudowintera* show different combinations of the situations described above and of the position of the stomata in relation to the surface of the epidermis, as follows:

P. axillaris: alveolar layer absent over epidermis cells; surface of the occlusion not sunken below the general surface of the epidermis (fig. 1a).

P. colorata: alveolar layer present over epidermis cells and provided with minute tubercles; surface of the occlusion not sunken below the general surface of the epidermis (fig. 1b).

P. traversii: alveolar layer present over part of the epidermis cells, forming white blotches or a discontinuous layer, not provided with tubercles; surface of the occlusion distinctly sunken below the general surface of the epidermis (fig. 1c).

3. **Inflorescence.** The inflorescence consists of a minute or very short shoot in the axil of a normal leaf or its scar. The bracts are very small and caducous; they are arranged not in pairs, as stated by Sampson (1963), but in a $\frac{2}{5}$ spiral, usually with the 4th bract adaxially in the median plane; their size increases acropetally. In the first flowering season flowerbuds develop in the terminal position and (usually) in the axils of the upper bracts. The size of the flowerbuds increases acropetally (fig. 3a, b). Although the number of flowerparts varies only slightly between flowers of the same inflorescence, the highest number is usually attained by the terminal flower. My impression is that flowering is centrifugal, although this is based on a few observations only (fig. 4c).

As far as could be ascertained from herbarium material, the sequence of initiation of the bracts and their axillary buds is acropetal.

In the following flowering season the buds in the axils of the lower bracts develop into secondary inflorescences which repeat the organisation of the primary one just described (fig. 3c—e).

The presence of flowering activity in a third season by the development of tertiary inflorescences in the axils of bracts of the secondary ones, reported by Nast (1944), could not be confirmed with the material available.

Sometimes reduced secondary inflorescences were found in the axils of the upper bracts of the primary inflorescence in the first flowering season. Then the terminal flowers of the secondary inflorescences did not differ from the—normaly solitary — lateral flowers of the primary inflorescence.

4. **Flower.** For this study only herbarium material was available. This prevented a comparative study of the ontogeny of the flower. Nevertheless, much information was acquired from very young flowerbuds.

The *calyx* consists of 2 or 3 sepals united into a cupule. In very young flowerbuds the free apices overlap and the petals are thus completely enclosed by the calyx (figs. 4b, 6b).

The sepals of the terminal flower usually continue the spiral of the bracts (fig. 3b, c, e). If three sepals are present the uppermost one generally deviates from this spiral, filling the space between the lower ones. The positions of the sepals are established by the position of their apices in the early stages of development of the flower. The spiral arrangement is further corroborated by a few rare cases in which the outer and the inner one of three sepals overlapped at their margins instead of being connate (fig. 3c—e). In one such case a half sepaloid, half petaloid flower part formed the transition between calyx and corolla (fig. 6d).

The material available was not sufficient to establish the relation between the bracts at the base of axillary flowers (reduced secondary inflorescences) and the sepals of these flowers.

Sampson (1963) reported: "A very few young buds of *P. colorata* and *P. traversii* were examined and it was found that each flower has two sepals, opposite each other, but one is initiated a short time after the other, closer to the apical meristem and lags a little behind in its growth. The lower part of the sepals soon becomes a continuous cylinder which is slightly higher and less notched at one point of junction than the other. By the time the petals have initiated, the sepals have overlapped at their tips to form a cap..." This may indicate that the sepal primordia behave more like those of section *Drimys* than those of *Drimys piperita*, described in this paper. The difference in time and place of initiation corroborates with the idea of the spiral arrangement, if the possible occurrence of three sepals is also taken in account.

Long before anthesis the calyx cupule opens at its apex (fig. 4a). The still closed corolla protrudes through this opening and protects the stamens and carpels until anthesis. Upon opening either the margin of the calyx cupule is ruptured (*P. axillaris*, fig. 6c) or the growth of this margin (almost) keeps up with the increase in diameter of the opening, thus producing an (nearly) entire calyx (*P. colorata*, fig. 4f, g; *P. traversii*).

The ruptured calyx margin of *P. axillaris* has often been defined as 'irregularly lobed' in earlier descriptions. However, the discoloured edges distinctly indicate the ruptured parts of the margin.

Contrary to the observations by A. C. Smith, the calyx was always found to be 'glandular', that is, containing oil cells.

The *petals* display various arrangements. It should first of all be noted that the relative positions of the overlapping petal apices in the bud often do not coincide with the relative sizes of these petals and their positions on the torus (fig. 3e). I found the lateral overlap of the petals to be a more useful indicator.

Most common are arrangements that approximate a $\frac{2}{5}$ spiral or those which are more or less decussate. Whorls of three petals also occur rather often.

My impression is that the $\frac{2}{5}$ spiral is the basic petal arrangement, a continuation of the spiral of the bracts through the sepals and the petals having been observed occasionally. Superimposed on this basic pattern is the influence of the irregular form of the floral apex which in its turn is determined by the position of the sepals (fig. 8b, c).

The *stamens* have apically broadened filaments on the obtuse apex of which the thecae are inserted. They greatly resemble those of *Bubbia*.

The apparently large number of irregular stamen arrangements can be reduced to a basic pattern of alternating whorls (probably of the successive type), the outer whorl being

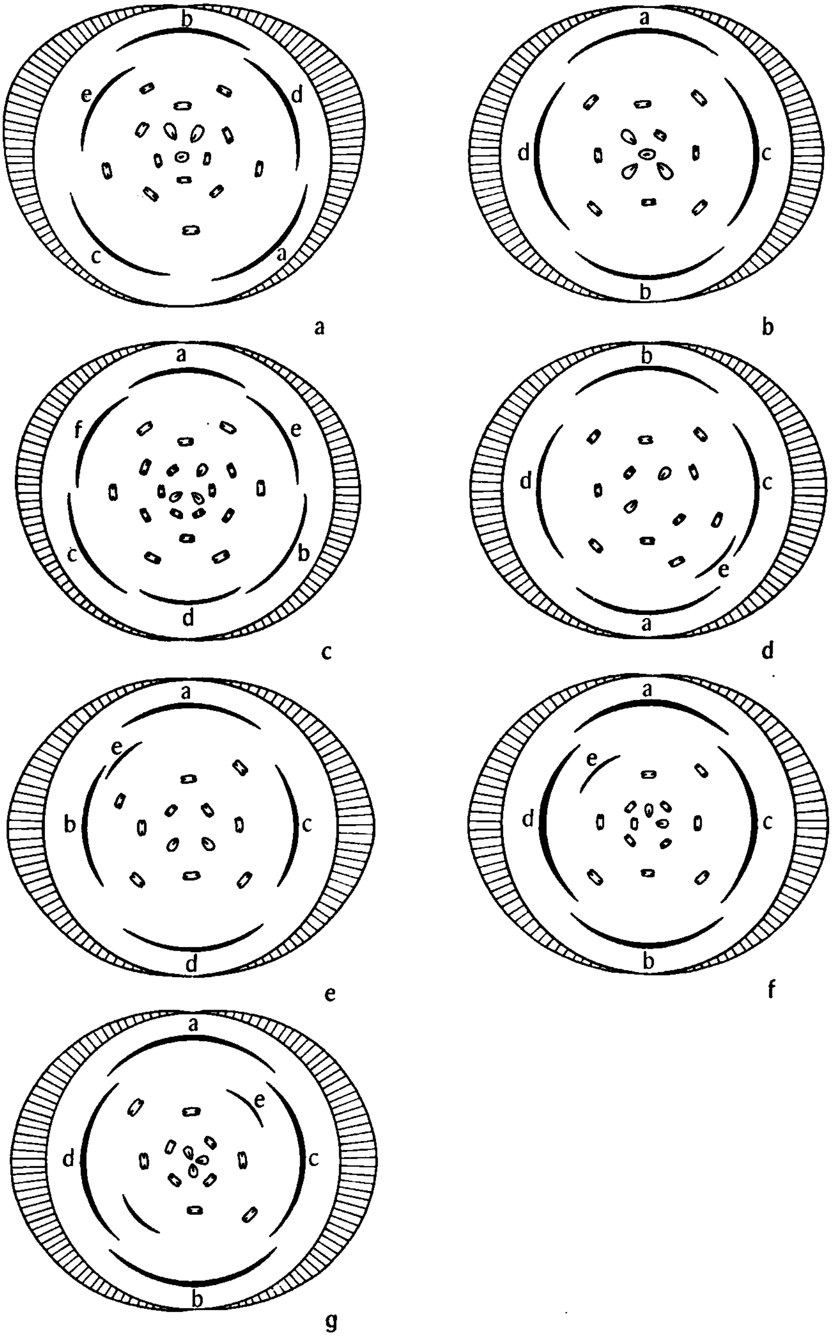

Fig. 2. Flower diagrams of *Pseudowintera axillaris*; for explanation see text (a & g. *coll. unknown*, Titirangi Ra., 1872; b, d—f. *Poole DSIR 63925*; c. *Melville 6724*).

alternate with the petals, whereas the carpels continue the stamen arrangement distally.

In such a pattern deviations from the $\frac{2}{5}$ spiral in the petal arrangement to two whorls of 2 or 3 may have an influence on the number of stamens in the outer whorl, fig. 2a—c.

However, in a high proportion of the flowers dissected, 4 petals are (nearly) decussate and the 5th petal is inserted above the overlap of two neighbouring ones. In that case the stamens of the outer whorl can still alternate with all five petals; the consequent irregular distribution of the stamens is then corrected by displacements of stamens more centripetally, fig. 2d. The stamens alternating with the 5th petal can also be reduced in number, the higher whorls becoming 4-merous, fig. 2e. In the strictly 4-merous arrangements the 5th or even the 6th petal is included in the outer whorl of stamens, fig. 2f, g.

The carpels continue the arrangement of the stamens. They can appear anywhere in the highest whorl of stamens or start a new whorl themselves. During their development the carpels quickly become larger than the stamens which often results in a partial displacement of the latter.

Judging from differences in size of the stamens — especially in 5-merous flowers — the whorls are of the successive type. This recalls the situation found in *Drimys* but a similar evaluation of the sequence of initiation could not be made because of a lack of adequate material. Sampson (1963) described the stamens as 'arranged in two or three turns of a low tapering spiral' without further details.

According to Sampson the initiation of the stamens is centripetal.

In very young buds the floral apex was sometimes strongly tilted during the early stages of stamen development (fig. 6b) as was also found in *Drimys*.

Carpels. In very young buds the apical cleft in the carpel primordium was found to be surrounded by a continuous margin, usually somewhat lower on the ventral side (fig. 6g). The cleft remains in a position almost perpendicular to the main axis of the flower and is at a later stage closed by the coherent stigmatic ridges. The two placentas are parallel to the cleft and usually inserted slightly lower on the ventral than on the dorsal side of the locule (fig. 6f). Each placenta bears 2—6 ovules. The arrangement and gross structure of the ovules do not deviate principally from those in *Drimys*.

5. **Fruit.*** Already in the carpels the dorsal side is more strongly developed than the ventral one. In fruit this difference is accentuated, resulting in an obovoid fruit with the narrow end adaxial from the line between the stigmatic crest and the base of the fruit (fig. 4j).

The fruits are red to black. Apparently this is a specific character, but this could not be compared with the other specific characters as the labelling of the herbarium material is inadequate.

The seeds are embedded in a pulpa arising from both the endocarp and the placentas. If the seeds are strongly appressed laterally, the pulpa encloses the group of seeds rather than each seed separately. The pulpa contains many oil cells.

Usually only one or two carpels develop into fruits, the remaining ones (if present) becoming abortive.

The structures, described by Bhandari (1963) and interpreted as probably constituting an obturator, need further attention. They could just as well represent the early stages of the pulpa or combine these possibilities.

6. **Seed.*** The seeds are more or less obovoid and about triangular in cross-section.

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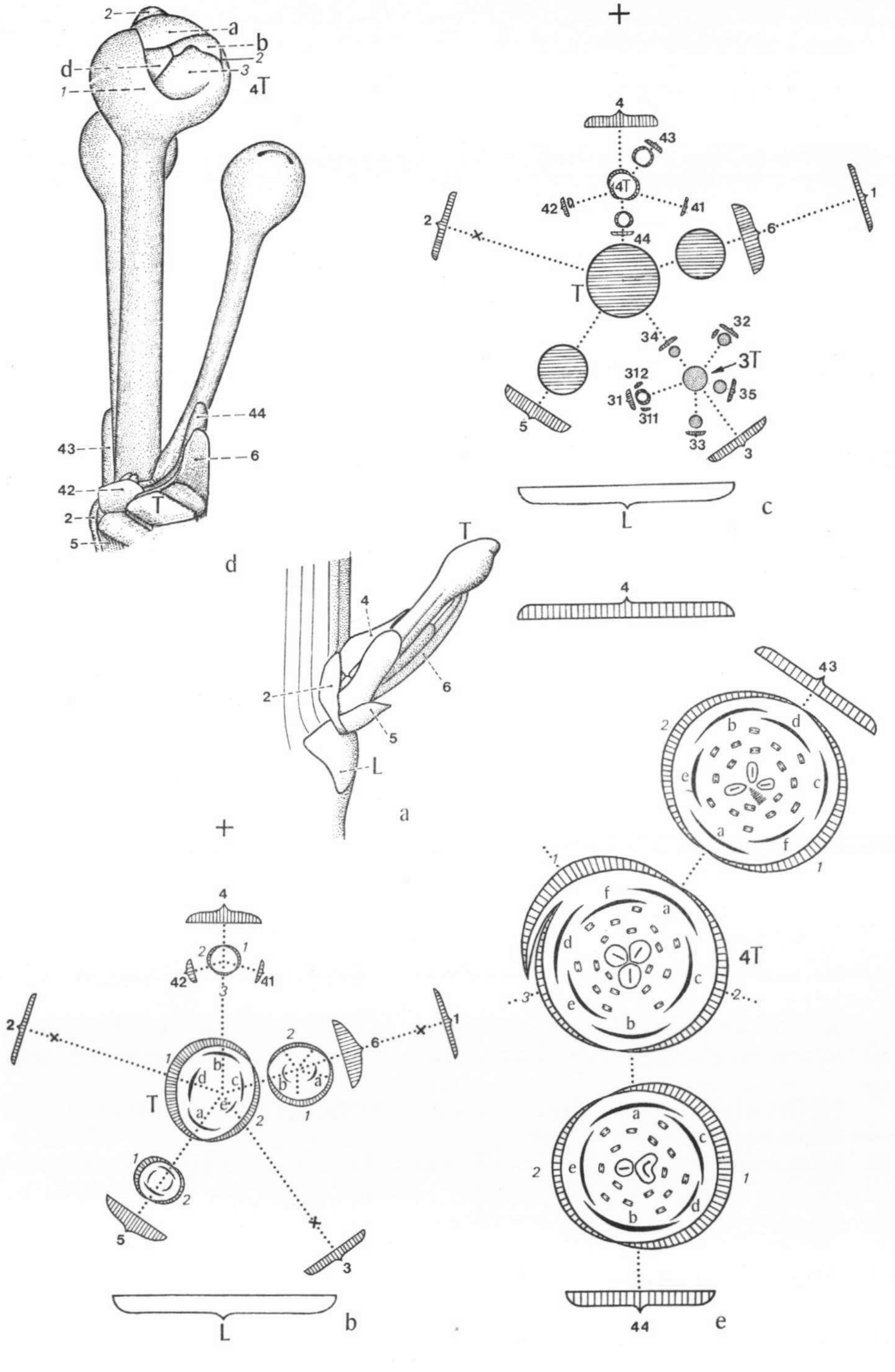
*) Not adequately observed in *P. traversii*.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Their main axis is straight, not reniformly curved as in *Drimys*. The outer micropyle is distinctly visible next to the hilum and often the hardened terminal part of the inner integument (operculum) protrudes through it. The general structure of the seed is similar to that of the black *Drimys* seeds (see also Bhandari, 1963).

7. Conclusions. In comparison with *Drimys* I regard *Pseudowintera* as more primitive because of the following characters:

1. twigs without cataphylls;
2. inflorescences with the same arrangement of bracts as the leaves ($\frac{2}{5}$ spiral);
3. inflorescences producing new inflorescences from lateral buds in the next season;
4. flowers bisexual;
5. seed not reniformly curved.

Other characters can be explained either as primitive or as advanced; that is, if one does not adhere to presupposed lines of evolutionary thought:

1. occlusion of the stomata;
2. form of the stamens;
3. construction of the carpels;
4. presence and form of pulpa;
5. short period of enclosure of the flower bud by the calyx;
6. the occurrence of hairs.

SPOROGENESIS AND EMBRYOLOGY

For this subject I refer to Sampson (1963) and Bhandari (1963) who studied *P. axillaris* and *P. colorata* respectively. As no voucher specimens are cited, the identification could not be checked with the present specific delimitation.

Bhandari mentions some differences between these species: glandular *versus* periplasmodial tapetum, cytokinesis by furrowing *versus* by cleavage, presence *versus* absence of ephemeral cell plate during Meiosis I of the microspore mother cells. Observations like these are probabably indications of specific differences but for a taxonomic evaluation the constancy of these differences has to be considered as well; for this purpose the number of observations is far too low and, moreover, not supported by herbarium material.

SPECIFIC DELIMITATION

The bulk of the available herbarium material could easily be separated into the three species on the characters given in the key. About twenty per cent of the specimens, however, showed combinations of the characters of *P. axillaris* and *P. colorata.*

When making a scatter diagram, as was also done successfully for *Drimys* specimens (p. 292), by plotting maximum leaf length against maximum pedicel length for each specimen and symbolising the key characters, it appeared that these combinations of characters could be explained by the assumption of frequent hybridisation (fig. 5).

Fig. 3. *Pseudowintera axillaris.* a & b. Young inflorescence in first flowering season; c—e. inflorescence in second flowering season; d & e give the same detail; note the overlapping sepals *1* and *3* in flower 4T, the open space instead of a carpel in flower 43, and the coalescence of two carpels in flower 44. — T. terminal flower; *x*. minute bud; bracts (heavy type) and sepals (italics) numbered acropetally; sequence of petals according to overlap at their apices; in c pedicel scars of first flowering season horizontally hatched, those of some broken buds of second flowering season dotted. (a & b. *McMahon s.n.*; c—e. *Melville 6724*; a & d. × 10).

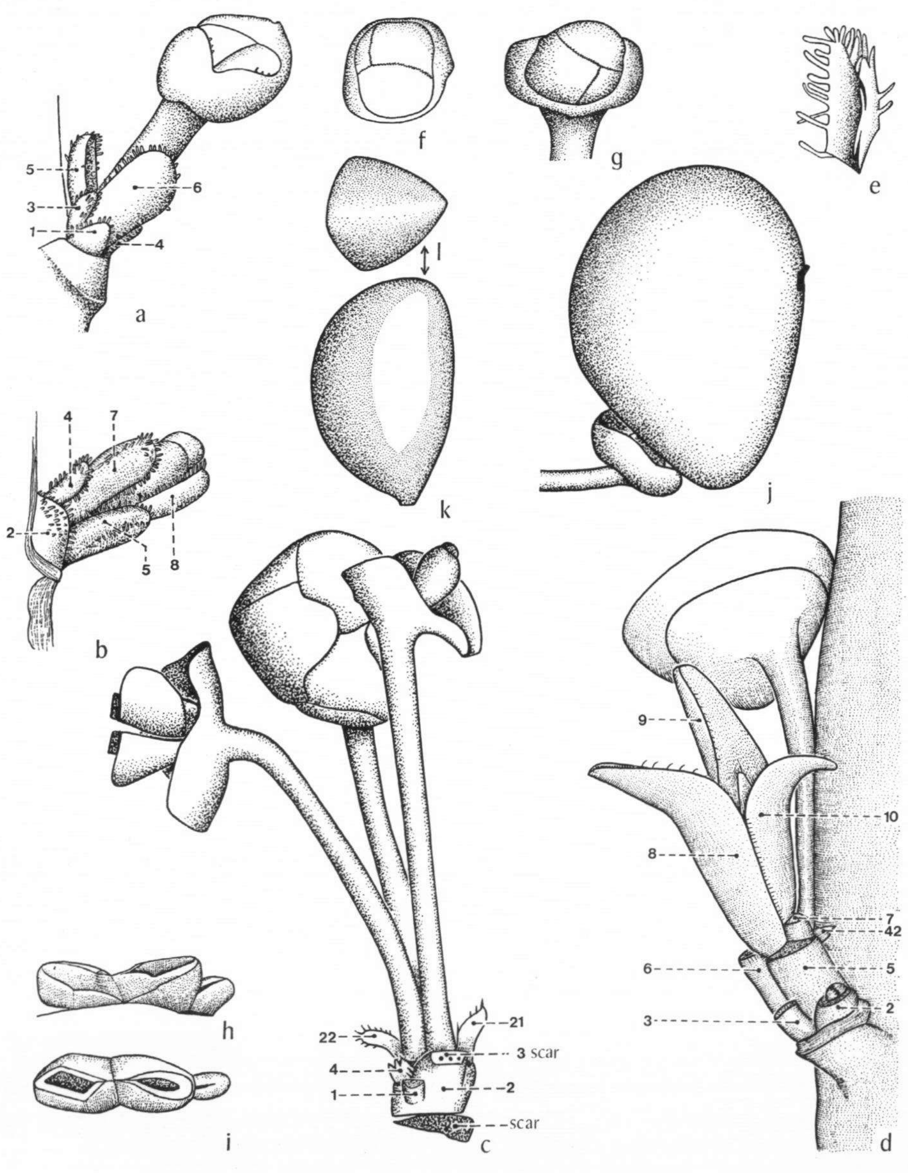


Fig. 4. *Pseudowintera colorata*. a. & b. Young inflorescences in first flowering season, terminal flower with calyx just opening and still closed resp., × 10; c. mature inflorescence in first flowering season, terminal flower (left) and that in axil of bract 3 passed flowering, flower in axil of bract 2 still closed, × 10; d. inflorescence with vegetative terminal bud, flower bud in axil of bract 4 (not shown), only scars of bracts shown, × 10; e. bract, × 20; f & g. flowerbud, apical and lateral view resp., calyx not ruptured, × 10; h & i. two carpel primordia and one stamen primordium (right), lateral and apical view resp., apical furrow of carpels not yet closed; j. fruit, × 5; k & l. seed, lateral and apical view resp., × 10. (a, b, h, i. *DM 25460*; c, d, e. *Petrie s.n.* = *NSW 68546*; f & g. *J. H. Davis s.n.*; j, k, l. *Walker 4768*).

For the separation of *P. axillaris* and *P. colorata* the maximum leaf length is not of very much use. This is probably partly due to the fact that it is impossible to group the unnumbered sheets into collections from the same treelet *c.q.* shrub. A comparison with work on well-documented *Drimys* material showed that such a situation results in unsatisfactory data on the maximum leaf length, especially in large-leaved taxa. But, although better collecting methods may result in a better separation, I expect that the overlap will remain considerable.

It is emphasized that the scatter diagram is not the result of a population study but is derived from herbarium material which partly originates from the area where only one species *(P. colorata)* is present. Fieldwork may refine the results and then probably other characters can be used as well. In the present study a subdivision according to the degree of hairiness was omitted, the method used here being regarded as rather crude and the available material was insufficient both in quality and quantity to use narrower gradations. Other characters that should be included are fruit colour, colour of the leaves, and ecology.

The apparently stronger influence of hybridisation on *P. axillaris* than on *P. colorata* could be artificial, due to the unequal distribution of the material over these species (*P. axillaris* 26, *P. colorata* 48, intermediates 19 specimens) and to the origin of part of the *colorata* material from outside the area shared by both species. Omission of the latter specimens, however, leaves too little material for comparison.

The hybridisation could have been promoted by the extension of the *Pseudowintera* populations through selective grazing by goats, *Pseudowintera* species being unpalatable. Hybridisation between the two species is reported by Allen, Fl. N. Z. 1 (1961), but denied by Sampson (1963). Kirk, For. Fl. N. Z. (1889), mentioned abortive flowers in *P. colorata* which may have some bearing in this respect.

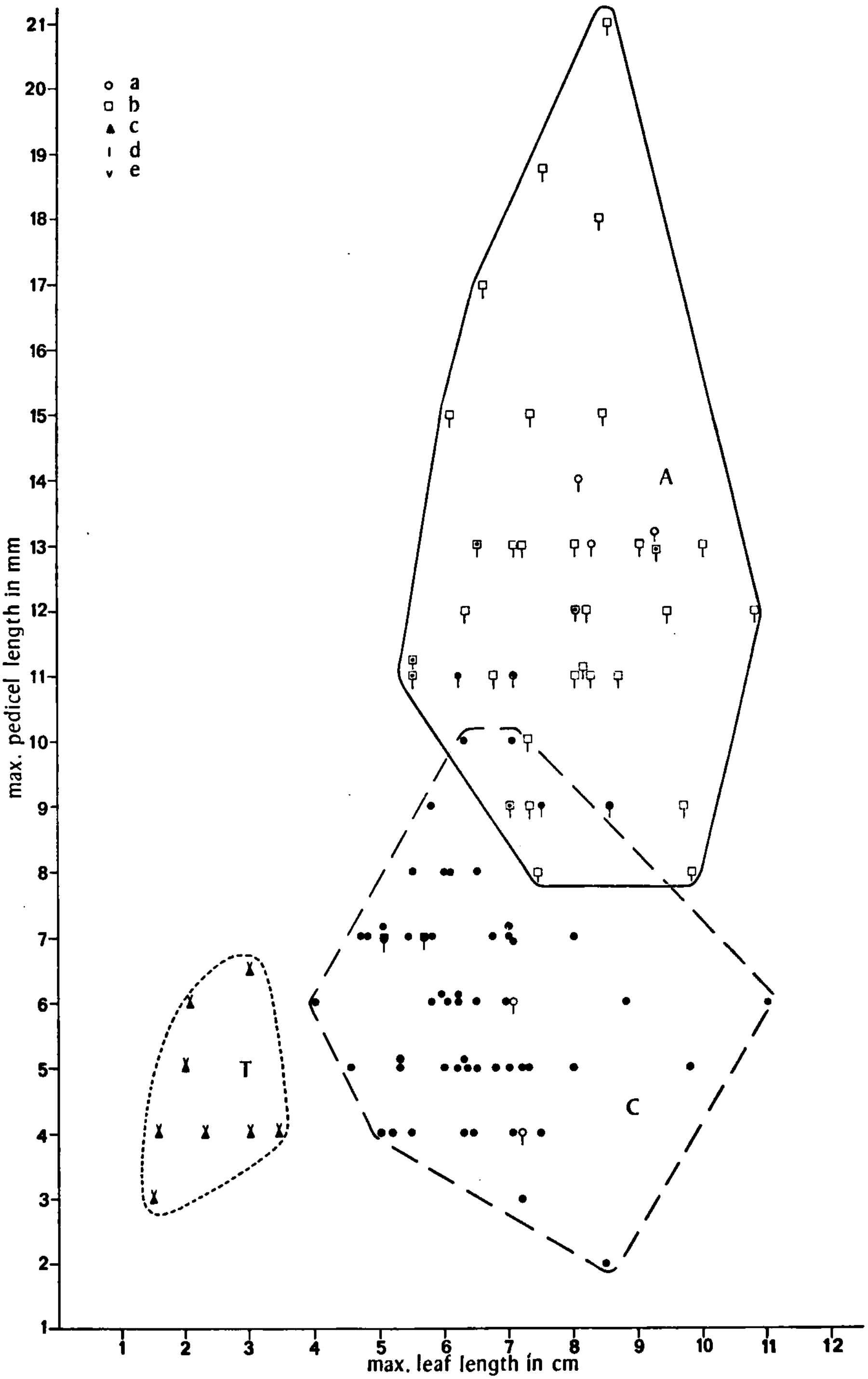
SPECIFIC DESCRIPTIONS

The specific descriptions have been made from specimens regarded as representing the pure species; supposed hybrids have not been used for this purpose. The descriptions are based on actual observations; as the specific characters accepted here deviate from those generally used, I have refrained from incorporating measurements given by other authors.

Most of the herbarium material has not been numbered by the collectors. An enumeration of specimens thus becomes less useful. Therefore I have replaced these lists by maps showing the distribution of the specimens examined.

PSEUDOWINTERA

Dandy, J. Bot. 71 (1933) 121; A. C. Smith, J. Arn. Arb. 24 (1943) 153; Allen, Fl. N. Z. 1 (1961) 134. — *Drimys* J. R. & G. Forst., Char. Gen. ed. quart. (1776) 83, t. 42; ed. fol. (1776) 42, t. 42, *pro parte;* Hook. *f.*, Fl. N. Z. 1 (1853) 12; Handb. N. Z. Fl. (1864) 10; Cheeseman, Man. N. Z. Fl. (1906) 29; ed. 2 (1925) 445; Oliver, Trans. N. Z. Inst. 56 (1926) 3. — *Wintera* Murray in L., Syst. Veg. ed. 14 (1784) 507, *pro parte, quoad circumscriptionem in nota, nom. illeg.*; Forst. *f.*, Fl. Ins. Austr. Prodr. (1786) 42. — *Wintera* (Forst. *f. ex*) v. Tiegh., J. de Bot. 14 (1900) 277, 290; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 108; Hutchinson, Kew Bull. (1921) 190. — *Drimys* sect. *Drimys* DC., Syst. 1 (1817) 442. — *Drimys* sect. *Eudrimys ('Eudrymis')* DC., Prodr. 1 (1824) 78, *non* v. Tiegh., l.c. 288; Baillon, Hist. Pl. 1 (1868) 158. — *Drimys* Div. *1* Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 43, repr. Contr. Bot. 1 (1861) 132. — *Wintera* sect. *Pleurowintera* v. Tiegh., l.c. 291; Pilger, l.c.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TYPIFICATION. All taxa not cited *pro parte: Drimys axillaris* J. R. & G. Forst.

Shrubs or treelets; entirely glabrous or with minute hairs on bracts and young leaves. Terminal bud without cataphylls. *Inflorescences* as minute or very short shoots in the axils of leaves or their scars, producing flowers for several flowering seasons; bracts in $\frac{2}{5}$ spiral. *Flowers* bisexual. *Calyx* enclosing bud in very young stages only, later with entire or irregularly ruptured margin; persistent. *Petals* free, 4—9. *Filaments* clavate, flattened. *Carpels* free, 1—3 (—5), stigma apical. *Fruits* with pulpa (unknown for *P. traversii*); seeds with straight axis, black, dull.

CYTOLOGY. $n = 43$, for all three species (Hair & Beuzenberg, N.Z.J. Bot. 4, 1966, 257).

PALEONTOLOGY. Pollen known from Waitakian (Middle Oligocene) till the Recent, *fide* Couper, N. Z. Geol. Surv., Paleont. Bull. 32 (1960) 46.

DISTRIBUTION. Three species in New Zealand.

REMARKS. When introducing the name *Wintera*, Murray did not create a new genus consisting of the species *W. aromatica* and *W. granadensis*, leaving *Drimys axillaris* as the type of *Drimys*, as was stated by Oliver. According to his foot-note, Murray definitely intended to rename *Drimys* as *Wintera*, thus creating a superfluous name. The renaming of the genus also affected *D. axillaris*, although this species was not listed by Murray. The actual new combination was made by Forster *f.*

Van Tieghem founded a new genus with *D. axillaris* as type. For this genus he took up the name *Wintera*, supposing Forster *f.* had intended to take *D. axillaris* from *Drimys* and to place it in a new monotypic genus *Wintera*. However, Forster apparently abandoned the name *Drimys* in favour of Murray's *Wintera*, so Van Tieghem has to be considered the first one to divide the then known species into two genera. As the name *Wintera* was already occupied Dandy proposed the new name *Pseudowintera*.

In current usage *Drimys axillaris* is considered to be the type of *Pseudowintera*, but De Candolle, Syst. 1 (1817) 442, lectotypified *Drimys* with this species. To avoid confusion resulting from the necessary name changes, the conservation of *Drimys* with the type *Drimys winteri* has been proposed (Taxon 18, 1969, 592); see further under *Drimys*.

KEY TO THE SPECIES

1a. At anthesis calyx with ruptured margin. Plant glabrous. White cutin layer on lower leaf surface present over stomata only . . . . **1. P. axillaris**

b. At anthesis calyx entire or subentire. Young leaves (also in terminal bud) and/or bracts with minute hairs. White cutin layer on lower leaf surface continuous or discontinuous 2

2a. White cutin layer on lower leaf surface continuous, the stomata with their occlusions not distinctly sunken below this level. Petioles patent. Carpels 1—3 (—5). Maximum length of leaf blades 4—11 cm . . . . **2. P. colorata**

b. White cutin layer on lower leaf surface discontinuous, the stomata with their occlusions distinctly sunken below this level. Petioles appressed to twigs. Carpels solitary. Maximum length of leaf blades 0.5—3.5 cm . . . . **3. P. traversii**

Fig. 5. Maximum leaf length plotted against maximum pedicel length (101 herbarium specimens). A: *Pseudowintera axillaris*; C: *P. colorata*; T: *P. traversii*. a—c: White cutin layer on lower leaf surface: a. continuous, b. on stomata only, c. subcontinuous; d. calyx margin ruptured (*versus* entire or subentire); e. distinct cluster of minute hairs on lower side of apex of young leaves present (*versus* absent); black symbols: with many minute hairs on bracts and on margins of very young leaves; symbols with a dot: *ibidem*, but with few hairs only; open symbols: glabrous. Intermediates between a and b have a continuous white cutin layer which is very thin between the stomata.

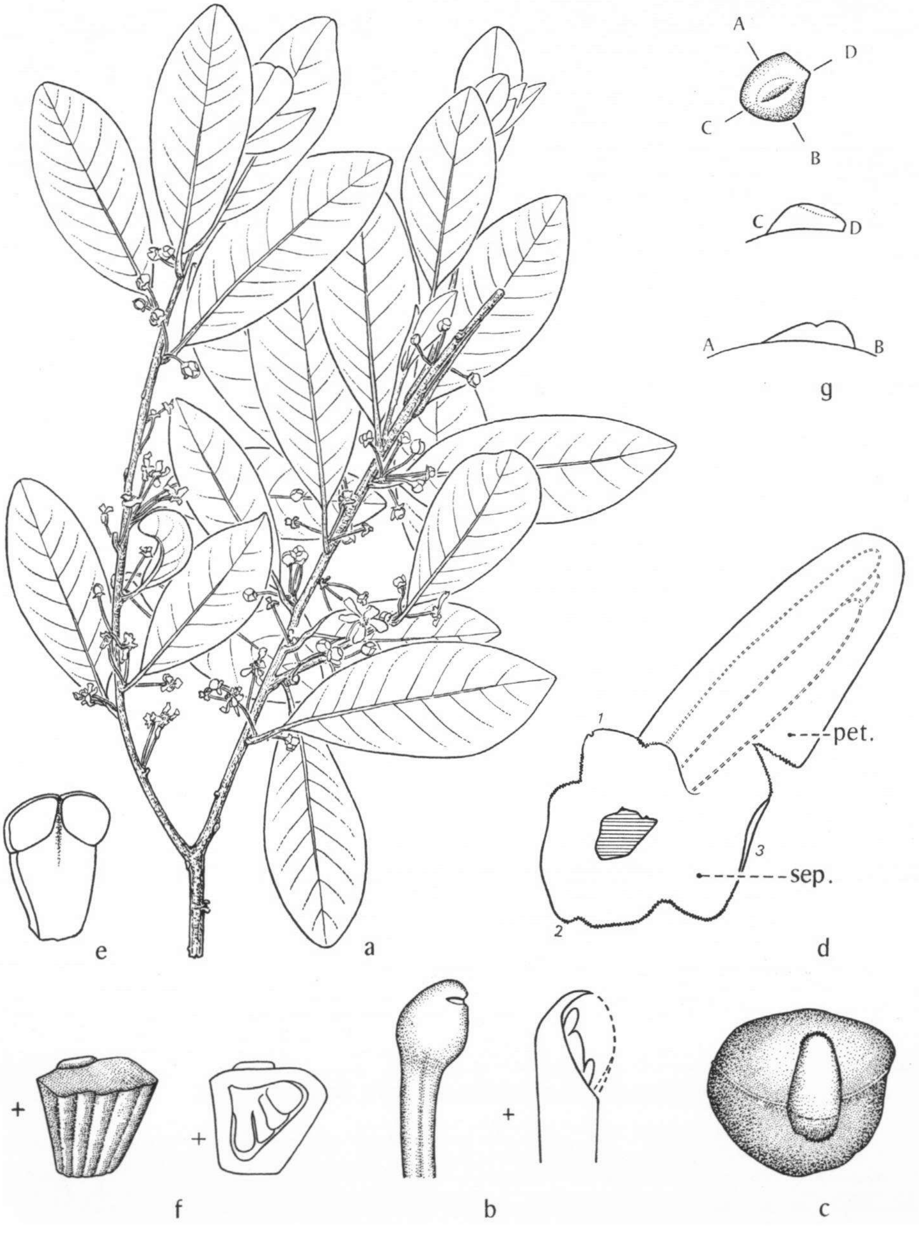

Fig. 6. *Pseudowintera axillaris*. a. Habit, × ½; b. very young flowerbud showing closed calyx cupule and, in longitudinal section, the strongly tilted floral apex, × 10; c. apical view of a just opening calyx cupule, rupturing on two sides, × 12; d. mature calyx seen from below, the third member partly sepaloid, partly petaloid, × 10; e. stamen; f. carpel in lateral view and longitudinal section; g. carpel primordium: apical view and two sections, the ventral side towards D. (a. *Kirk DM 1225*; b. *McMahon sn.*; c & g. *Melville 6724*; d. *Powel NSW 68542*; e & f. *Poole DSIR 63925*).

1. **Pseudowintera axillaris** (J. R. & G. Forst.) Dandy, J. Bot. 71 (1933) 121; A. C. Smith, J. Arn. Arb. 24 (1943) 155, *excl.* var. *colorata*; Connor, Pois. Pl. N. Z. (1951) 9; Allen, Fl. N. Z. 1 (1961) 134; Salmon, N. Z. Fl. & Pl. in colour, ed. 2 (1967) 89, f. 262; Field Guide Alp. Pl. N. Z. (1968) 55, f. 69. — *Drimys axillaris* J. R. & G. Forst., Char. Gen. ed. quart. (1776) 84, t. 42; ed. fol. (1776) 42, t. 42; Forst. *f.*, Nova Acta Reg. Sc. Ups. 3 (1780) 182; L. *f.*, Suppl. (1781) 270; Lamk, Encycl. 2 (1786) 331; Gmelin, Linné Syst. Veg. 1 (1796) 852; DC., Syst. 1 (1817) 443; Prodr. 1 (1824) 78; Poiret in Lamk, Tabl. Encycl. 3 (1823) 37, t. 494 f. 2; A. Rich. in Dumont D'Urville, Voy. Astrol. Bot. 1 (1832) 290; Hook. *f.*, Ic. Pl. 6 (1834) t. 576; Cunn., Ann. Nat. Hist. 4 (1840) 257; Raoul, Choix Pl. N. Z. (1846) 47; Hook. *f.*, Fl. N. Z. 1 (1853) 12; Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 43, repr. Contr. Bot. 1 (1861) 132; Hook. *f.*, Handb. N. Z. Fl. (1864) 10; Baillon, Hist. Pl. 1 (1868) 158, *excl.* f., 203, 204, *excl. syn.*; Featon, Art Alb. (N. Z. Fl.) (1889) 12, pl. 5 f. 3; Kirk, For. Fl. N. Z. (1889) 1, pl. 1, *excl. var.*; Stud. Fl. N. Z. (1899) 22, *excl. var.*; Cheeseman, Man. N. Z. Fl. (1906) 29; ed. 2 (1925) 456; Laing & Blackwell, Pl. N. Z., ed. 5 (not dated) 180. — *Wintera axillaris* (J. R. & G. Forst.) Forst. *f.*, Flor. Ins. Austr. Prodr. (1786) 42; Willd., Linné Sp. Pl. 2 (1800) 1240; Persoon, Syn. Pl. (1807) 84; v. Tiegh., J. de Bot. 14 (1900) 290; Cockayne in Engl. & Drude, Veg. der Erde 14, ed. 2 (1928) 125; Cockayne & Turner, Trees of N. Z., ed. 2 (1938) 130, f. 112. — *Pseudowintera axillaris* var. *typica* A. C. Smith, J. Arn. Arb. 24 (1943) 157, f. 5 f—j. — **Figs 3, 6.**

TYPIFICATION. Lectotype: *Forster s.n.* (BM).

Shrub or treelet 3—5 (—10) m high. *Leaves* glabrous in all stages; blade obovate, 2—11 × 1—4.5 cm, base cuneate to obtuse, apex narrowly rounded, subcoriaceous; petiole patent, 3—11 (—15) mm; nerves *c.* 6—14, in the middle of the blade at an angle of 45°—75° to the midrib, prominulous on either side; on lower leaf surface the white cutin layer restricted to the stomata, the occluded stomata not sunken below the general surface. *Inflorescences* with 1—6 (—11) flowers simultaneously; bracts glabrous; pedicels 3—21 mm, glabrous. *Calyx* at anthesis with ruptured margin, glabrous. *Petals* 4—7, 4—7.5 × 1.5—3.7 mm. *Stamens* 8—18. *Carpels* (1 or) 2 or 3; ovules 4—7. *Fruits* bright red to red *(ex litt.)*, obliquely obovoid, 5—7 mm long, 1—7 seeded, with pulpa. *Seeds* obovoid, more or less triangular in cross-section, 3—3.5 × 1.7—2.5 × 1.5—2 mm.

DISTRIBUTION. North Island; on South Island near Cook Strait (fig. 7).

ECOLOGY. Forests and shrubberies; 180—850 m altitude.

REMARKS. The Forsters accompanied Cook on his second voyage, 1772—1775, with the ships 'Resolution' and 'Adventure'. In New Zealand both Dusky Sound ('Dusky Bay') and Queen Charlotte Sound were visited.

In BM is a sheet with *P. colorata*, collected by the Forsters at Dusky Bay. This or a similar sheet will have induced authors like Hooker *f.* to state that there is no difference between the species of the Forsters and that of Raoul.

Both in BM and in GOET a sheet with a mixture of *P. axillaris* (Q. Charlotte Sound) and *P. colorata* (Dusky Bay) is present.

To save the communis opinio it is necessary to select a Queen Charlotte Sound specimen of the northern species as the lectotype of *Drimys axillaris*, leaving the widespread species (Dusky Bay specimens) under Raoul's *Drimys colorata*. Therefore I selected part of the above mentioned mixture in BM as the lectotype of *Drimys axillaris*.

In BM is a sheet marked 'Nova Zelandia: Dusky Bay. 1773. W. Anderson'. Anderson


a
b
c
d
e

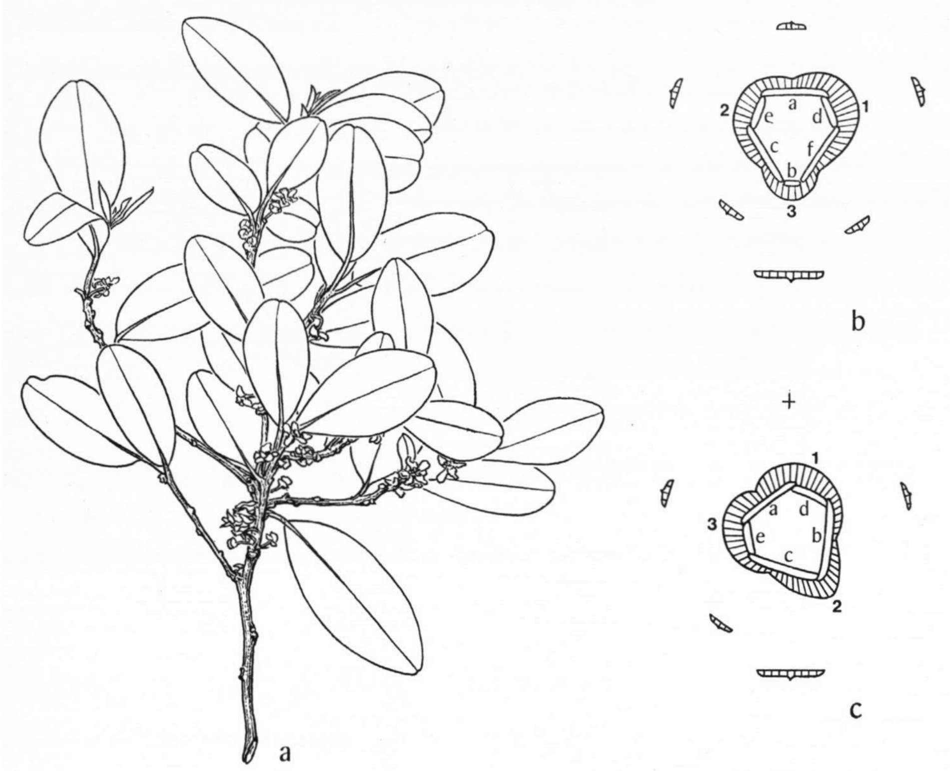

Fig. 8. *Pseudowintera colorata.* a. Habit, × ½; b & c. two secondary inflorescences from the same primary one, showing deviations from the spiral arrangement by the third sepal, causing deviations from this spiral by the petals (indicated with letters). (a. *Buchanan s.n.*; b & c. *DM 25460*).

collected during Cook's third voyage, whereas the annotation on this sheet indicates Cook's second voyage. Probably the material on this sheet was obtained from the Forster collections and incorporated in the Anderson herbarium, resulting in a sheet with a twig of *P. axillaris* and one of *P. colorata*, labelled 'Dusky Bay'. As this is the only record of *P. axillaris* on South Island outside the area near Cook Strait, it is, in view of the above, regarded as unreliable.

2. P. colorata (Raoul) Dandy, J. Bot. 71 (1933) 121; Allen, Fl. N. Z. 1 (1961) 135; Salmon, N. Z. Fl. & Pl. in colour, ed. 2 (1967) 85, f. 247 & 248, and 185, f. 584; Field Guide Alp. Pl. N. Z. (1968) 52, f. 64 & 65, and 54, f. 67 & 68. — *Drimys colorata* Raoul, Ann. Sc. Nat. III, Bot. 2 (1844) 121; Choix Pl. N. Z. (1846) 24, 47, t. 23; Parment., Bull. Sc. Fr. & Belg. 27 (1896) 227, 303; Cheeseman, Man. N. Z. Fl. (1906) 30; ed. 2 (1925) 456; Laing & Blackwell, Pl. N. Z. ed. 5 (not dated) 180. — *Drimys axillaris* var. *colorata* (Raoul)

Fig. 7. Distribution of specimens studied of *Pseudowintera axillaris* (symbols) and of *P. traversii* (broken line). — a. *P. axillaris*; b. *ibidem*, but with continuous white cutin layer; c. *ibidem*, but with a few hairs; d. *P. axillaris* × *colorata*; e. probably erroneously labelled (*Anderson s.n.*).


a
b
c
d
e
f

Kirk, For. Fl. N. Z. (1889) 2, pl. 2; Stud. Fl. N. Z. (1899) 22. — *Wintera colorata* (Raoul) v. Tiegh., J. de Bot. 14(1900) 290, 277; Cockayne, N. Z. State For. Serv., Bull. 4^2 (1928) 43; in Engl. & Drude, Veg. der Erde 14, ed. 2 (1928) 125; Cockayne & Turner, Trees of N. Z., ed. 2 (1938) 131, f. 113. —*Wintera monogyna* v. Tiegh., l.c. 291. — *Pseudowintera axillaris* var. *colorata* (Raoul) A. C. Smith, J. Arn. Arb. 24 (1943) 158, f. 5 k & l. — **Figs 4, 8.**

TYPIFICATION. Lectotype of *Drimys colorata: Raoul s.n.* (L); holotype of *Wintera monogyna: Hombron s.n.* (P).

Shrub or treelet 2—8 m high. In terminal bud and in newly unfolded *leaves* scattered hairs on margins of blades, often also on margins of petioles, rarely on one or both sides of basal part of midrib, very rarely on lower surface of basal part of blades but than longer persistent; blade elliptic to obovate to oblong, 0.7—11 × 0.5—4.5 cm, base acute to broadly rounded, apex broadly to narrowly rounded, subcoriaceous; petiole patent, 1—10 mm; nerves *c.* 5—13, in the middle of the blade at an angle of 45°—75° to the midrib, prominulous to inconspicuous on either side; on lower leaf surface the white cutin layer continuous, absent on margins and midrib, the occluded stomata not sunken below the general surface. *Inflorescences* with 1—4 (—7) flowers simultaneously; bracts on outside with minute hairs, often near apex and on margins only; pedicels 2—10 mm, glabrous, very rarely papillate. *Calyx* at anthesis entire or with slightly ruptured margin, margin often with some minute hairs. *Petals* 4—9, 3—5 × 1—3 mm. *Stamens* 8—17. *Carpels* 1—3; ovules 7—11. *Fruits* dark red to black *(ex litt.)*, obliquely obovoid, 5—11 mm long, 1—6 seeded, with pulpa. *Seeds* obovoid, more or less triangular in cross-section, 3—3.5 × 1.7—2.2 × 1.3—1.7 mm.

DISTRIBUTION. North Island, South Island, Stewart Island (*fide* Kirk a. o.), fig. 9.
ECOLOGY. Forests and shrubberies; altitude 120—1050 m, on Stewart Island 0—300 m (Wells & Mark, N. Z. J. Bot. 4, 1966, 275, 276). Unpalatable to goats although possibly browsed as seedlings (Atkinson, Proc. N. Z. Ecol. Soc. 11, 1964, 41).

3. **P. traversii** (Buchanan) Dandy, J. Bot. 71 (1933) 122; A. C. Smith, J. Arn. Arb. 24 (1943) 159; Allen, Fl. N. Z. 1 (1961) 135; Salmon, Field Guide Alp. Pl. N. Z. (1968) 53, f. 66. — *Hymenanthera traversii* Buchanan, Trans. N. Z. Inst. 15 (1883) 339, pl. 28 f. 1—1b. — *Drimys traversii* (Buchanan) Kirk, Trans. N. Z. Inst. 30 (1898) 379; Cheeseman, Man. N. Z. Fl. (1906) 30; ed. 2 (1925) 456; Ill. N. Z. Fl. 1 (1914) pl. 8. — *Wintera traversii* (Buchanan) Cockayne, N. Z. State For. Serv., Bull. 4^2(1928) 43; in Engl. & Drude, Veg. der Erde 14, ed. 2 (1928) 456, 262. — **Fig. 10.**

TYPIFICATION. Type: *H. H. Travers s.n.* (WELT, iso), Dec. 1882, mountains behind Collingwood, Nelson.

Densely branched straggling or semi-prostrate shrub 0.2—2 m high. In terminal bud young *leaves* with scattered hairs on margins and with a (rarely lacking) cluster of hairs at apex; in newly unfolded leaves often some scattered hairs on margins of basal part of

Fig. 9. Distribution of specimens studied of *Pseudowintera colorata*. — a. *P. colorata*; b. *ibidem*, but white cutin layer on stomata only; c. *ibidem*, but with a few hairs only; d. *ibidem*, but calyx ruptured; e. *ibidem*, but with short hairs on leaf surface, petiole, twig, and/or pedicel; f. occurrence *ex litt.*

blade and of petiole, initially on lower side of apex with a small cluster of hairs; blade obovate, rarely oblong, 0.5—3.5 × 0.3—1.5 cm, base acute, sometimes obtuse to rounded, apex broadly rounded, often slightly emarginate, rarely obtuse or acute, coriaceous; petiole appressed to twig, 1—5 mm; nerves *c.* 4—6, in the middle of the blade at an angle of 30°—45° to the midrib, usually inconspicuous on either side; on lower leaf surface the white cutin layer discontinuous, absent on margins and midrib, the occluded stomata distinctly sunken below the general surface. *Inflorescences* with 1 (or 2) flower(s) simultaneously; bracts on outside with minute hairs, often near apex and on margins only; pedicels 3—6.5 mm, glabrous. *Calyx* at anthesis entire, often with a few minute hairs on the margin. *Petals* 4—6, *c.* 2—3 × 1—2 mm. *Stamens* 5—8. *Carpel* solitary; ovules 5—9. *Fruits* 1—6 seeded.

DISTRIBUTION. South Island, Nelson District, fig. 7.

ECOLOGY. Forests, forest borders, and shrubberies; 500—1200 m altitude.

REMARKS. Only two open flowers and one submature fruit were available to me. The fruit was obliquely obovoid, 4 mm long, 1-seeded; seed 3 × 2 × 1.5 mm, broadly obovoid, laterally flattened *(Hay s.n., DSIR 93127)*.

I did not see the holotype, but the isotype in WELT is a fragment of the holotype (*cf.* Kirk l.c.).

REJECTED TAXA

1. **Wintera terminalis** v. Tiegh., J. de Bot. 14 (1900) 291. — Type: *Sinclair s.n., s.l.* (P).
This specimen has the ruptured calyx and the glabrous bracts found in *P. axillaris*, but the white cutin layer on the lower leaf surface as in *P. colorata*. I consider it to be of hybrid origin. It is exceptional for *Pseudowintera* in having several terminal inflorescences in addition to the normal axillary ones.

2. **Wintera sect. Euwintera** v. Tiegh., J. de Bot. 14 (1900) 291; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 108. — Type: *Wintera terminalis* v. Tiegh.

THE GENUS DRIMYS

MORPHOLOGY

1. **Introduction.** The work on the morphology and the ontogeny of the flower presented here, was carried out in search of characters that might contribute to the solution of the taxonomic problems encountered in the Malesian material. In this respect the results were negative. As in the course of this work many details that deviate from those already published by other authors for other species became known, I give a full record of my findings. Many points need further — especially histogenetical — research; however, such further work would have deviated too far from the present subject, a taxonomic review.

2. **Twig.** The twig bears foliage leaves in a clockwise or counterclockwise $\frac{2}{5}$ spiral and is terminated by a bud; the scales of the bud continue the spiral of the foliage leaves. This terminal bud is either vegetative, producing flush-like a new shoot, the leaves of which

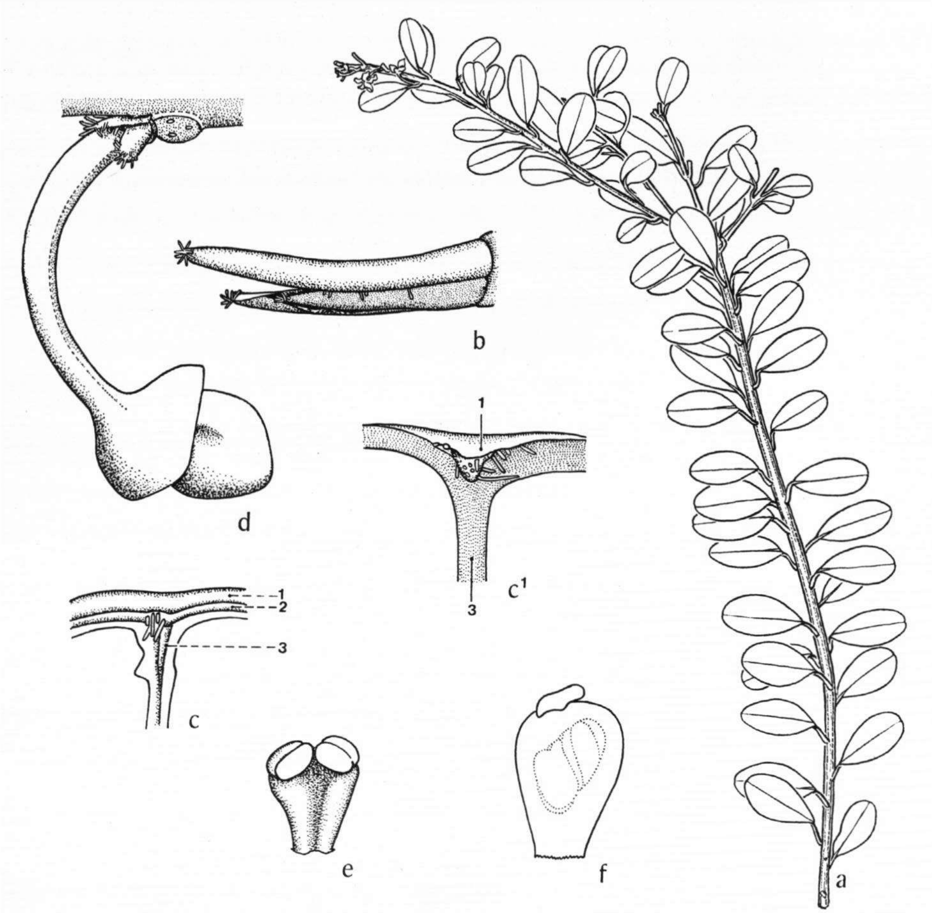

Fig. 10. *Pseudowintera traversii.* a. Habit, × ½; b. terminal bud, × 15; c & c^1. lower side of leaf apex (1. thickened margin, 2. intramarginal nerve, 3. midrib); d. flowerbud, × 10; e. stamen; f. carpel. (a. *Townson DM 1222*; b & c. *Hay DSIR 93128*; d. *Hay DSIR 93126*; e & f. *Kirk s.n.*).

continue the spiral of the bud scales, or it is mixed and produces both a new shoot as well as flowers in the axils of the bud scales. From mixed buds the flush can appear together with the flowers or the growth of the flush is retarded until after anthesis, even until the ripening of the fruits.

The bud scales are caducous, leaving rings of densely packed, wide and short scars. Usually a few of the upper scars are slightly wider spaced.

In the majority of cases the foliage leaves, inserted between two rings of scars or between the terminal bud and a ring of scars, are more or less evenly spaced: 'leaves scattered' in the descriptions. Sometimes, however, only 2—4 leaves are present on such a 'periodical shoot increment' ('p.s.i.') and crowded just below its apex: 'pseudoverticillate' in the descriptions. In *Drimys insipida* (fig. 31 e) the p.s.i. is often very short and leafless, but all transitions to the normal situation with scattered leaves occur.

A lateral shoot usually first produces one or more vegetative terminal buds after which only mixed buds are formed until the shoot apex terminates its activity. In *Drimys insipida*, however, many specimens showed an alternation of vegetative and mixed terminal buds as could be determined by the absence or presence of pedicel scars in the axils of the scars of the bud scales (see p. 313).

The mean of the leaf lengths per p.s.i. increases distally along the twig. In comparison with the leading shoot the lateral shoots pertaining to it have lower values for these means. The increase of the leaf length ceases with the termination of the activity of the shoot apex. Then a lateral shoot takes over as leader. If the main twig is overtopped by a lateral shoot but continues to grow, the means on the main twig are substantially reduced above the insertion of this overtopping lateral shoot and are sometimes even lower than those on the new leader.

There seems to be a correlation between this mean and the diameter of the p.s.i. concerned, provided such increments of the same age and relative position are compared. There are also indications of a correlation between the diameter of the p.s.i. and the number of scales in its terminal bud. Exact data are not available in sufficient quantity.

The twigs are terete or have ridges or narrow wings descending from the lateral sides of the insertions of the petioles. Ridges descending from the middle of the insertions of the petioles are rare. When dried, the wings (e.g. in *Drimys piperita, 8. giluwe*) collapse and look like fine ridges; on the other hand, branchlets terete *in vivo* may become angular on drying. All intergrades between terete and winged were found, thus rendering it impossible to use the outline of the cross-section of the branchlets as a key character in such a heterogeneous species as *D. piperita*.

In herbarium specimens a fine cover of white needle-shaped crystals which melt on applying heat is often found on the twigs. These crystals were also found on specimens collected by myself and which *in vivo* showed no trace of such a cover at all. I conclude that the crystals are formed during the processing of the specimens by a recrystallisation of substances originating from the epidermis of the twig.

For the anatomy, vascularisation, and organogenesis I refer to Bailey (1944), Bailey & Nast (1944a, 1945), Benzing (1967), and Gifford (1950, 1951a, b).

3. **Leaf.** Usually the leaf is petiolate, is widest in its distal half, and has a cuneate leaf base and an acute to acuminate apex. Rather exceptional are sessille leaves, a cordate to auriculate leaf base, and a rounded apex. General outline and xeromorphy vary widely, even in rather homogeneous species. The angle made by the nerves and the midrib varies from 5° to 90°. It is impossible to distinguish between phenotypic and genotypic variation of these characters in herbarium material (see *sub D. piperita*).

The cuticle of the epidermis varies from thin to very thick and often intrudes between the epidermis cells (fig. 11c). On the lower side of the leaf the cuticle is smooth to tuberculate, rarely densely papillate; in the latter case the epidermis cells often protrude into the papillae (fig. 11b). An alveolar layer (see p. 227) is usually absent. Waxy coverings of the cuticle can, *in vivo*, give the lower leaf side a glaucous or pruinose appearance.

4. **Occlusion of the stomata.** Bailey and Nast (1944b) found the orifice of the stomata occluded by alveolar material which commonly extends outward over the subsidiary cells; this is white in surface view and is probably cutinaceous. They supposed this to be characteristic for the whole family.

When studying New Guinean *Drimys* material, however, I found no occlusions. At most, the outer ledges of the guard cells are well developed, sealing off the front cavity

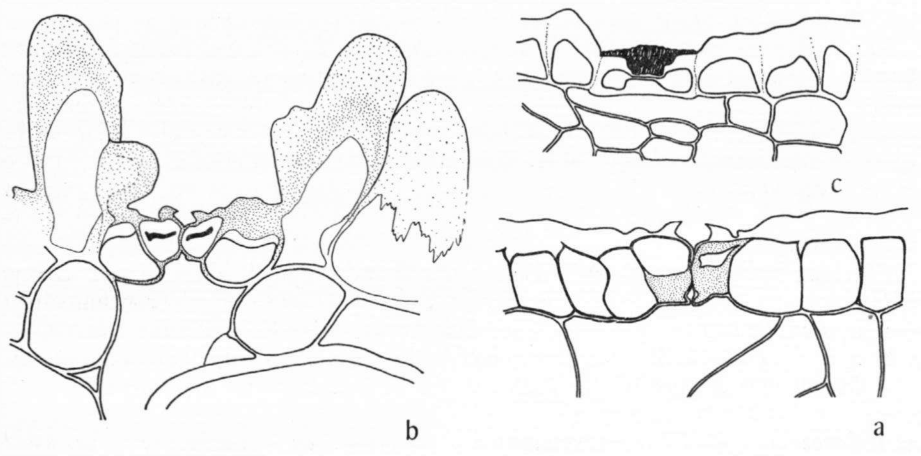

Fig. 11. Stomata of *Drimys piperita*, × 410. — a. entity *1. reducta (Vink 16275)*, dotted: dark blue after staining with saffranin—fast green; b. entity *7. papillata (Kalkman 4504)*, dotted: staining with Sudan IV; c. entity *39. xerophila (Schodde 1278)*, soaked in HF-solution, waxy occlusion black.

except for a longitudinal slit. The sections concerned were prepared from both boiled herbarium material (e.g. *Brass 9104* of *D. piperita, 36. rubiginosa; Hoogland & Pullen 5674, ibidem, 9. montis-wilhelmi*) and FAA-fixed material (*Vink 16275* of *D. piperita, 1. reducta,* fig. 11a). In surface view no white stomatal occlusions were shown by this material nor by the relevant dry herbarium specimens.

Dried leaves of the Australian *D. piperita, 39. xerophila (Schodde 1278)* showed very distinct white occlusions in surface view, but sections made of boiled herbarium material did not reveal any occlusion at all; even the extended outer ledges were not present. Sections made of dry material and of dried leaves soaked in a HF-solution, however, showed distinct stomatal plugs (fig. 11c) of a lamellate, tubular, or rod-shaped structure. As the conclusion must be that these plugs are dissolved in boiling water and in FAA, the surface view of dried leaves was studied under the application of heat (just extinguished match head; concentrated light bundle). Before the application of the heat the stomatal plugs and the surrounding area were white in colour with a finely reticulate surface structure. After applying heat the white colour and the reticulation had vanished and the underlying epidermis cells as well as the front cavity were visible. The white colour did not return upon cooling, not even after several weeks. From these data I conclude the existence an outer waxy covering and waxy stomatal plugs; these are white because of the reflection of light in their interstices. The wax melts when heat is applied and forms upon cooling a homogeneous layer with a smooth surface; as the interstices have disappeared, the layer is clear instead of white. Boiling with water or treatment with FAA removes all of the wax.

The same observations apply to *D. lanceolata*, but in very xerophilous leaves with a thick cuticle, the cavity in the cuticle outside the outer ledges is very narrow so that in sections usually a part of the cavity wall is present as well, giving the impression that the cavities are occluded with cuticular material.

Checking material belonging to sect. *Drimys* I found the same organisation as described by Bailey & Nast (1944b). However, the application of heat also resulted in a permanent disappearance of the white colour. From this observation the presence of waxy material in or on top of the cutinaceous layers must be assumed.

The precente of waxy covers is the more probable as several collectors (incluiding myself, e.g. in *D. piperita, 10. giluwe*) have reported a glaucous or pruinose lower leaf surface which in the herbarium specimens usually is invisible (melted or dissolved when processing the specimens). In such herbarium material wax crystals appear on the edges of drying-up droplets of ether. With ether such crystals can often also be formed from leaves which neither in the field nor in the herbarium showed any visible trace of waxy coverings. This suggests that the waxes are more widespread than visual observation can establish.

Checking widely through sect. *Tasmannia* and only limitedly through sect. *Drimys* (which was apparently fairly well checked by Bailey & Nast) I reach the conclusion that

a. in sect. *Drimys* the stomata are occluded by cutinaceous and waxy material;
b. in sect. *Tasmannia* the stomata are occluded by waxy plugs only. If no occlusions are found their absence might be due to the processing of the specimens.

5. **Inflorescence.** The flowers are inserted — either solitary, 'clustered', or on branched structures — in the axils of the scales of the mixed terminal bud, occasionally also in the axil of the first leaf above these scales.

The whole complex consisting of the bud scales, the part of the twig on which these are inserted, the flowers, and if present the axes between the bud scale and the flowers, is called an inflorescence. This inflorescence is terminated by a vegetative apex*; accordingly Nast (1944) termed it intercalary.

The partial inflorescences, termed inflorescence by Gifford (1950) and Tucker (1959), will be called florescences.

All bud scales of a mixed terminal bud will be called bracts as potentially they subtend florescences. All leafy organs between the bract and the flower are indicated as bracteoles, following Tucker (1959).

Within the flower (or florescence) two planes will be referred to: the sagittal plane bisecting the bract(eole) subtending the flower (florescence) and the frontal plane, perpendicular to the sagittal one (Tucker & Gifford 1966a). The ab- and adaxial sides of the flower are hence separated by the frontal plane, the lateral sides by the sagittal plane.

The terms dorsal and ventral will be used to indicate the (in relation to the flower axis) abaxial and adaxial sides of the floral appendages respectively.

a. Section Drimys. The material available was limited: apart from herbarium material, I had at my disposal only a few terminal buds of an unidentified specimen from the Botanic Gardens at Kew, preserved in FAA. However, from a combination of my restricted observations with those made by Tucker (1959) a general picture could be derived.

Within an inflorescence there are several acropetal tendencies: the bracts decrease in length and width, the number of flowers and bracteoles per florescence decreases (apart for some minor irregularities), and — in comparable positions within the florescences — the initiation of flower primordia and of floral appendages is in an acropetal sequence. According to Tucker flowering of the florescences also takes place acropetally.

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*) In one aberrant case an inflorescence was found to be provided with a terminal flower instead of with the usual vegetative apex *(Hotchkiss 112, D. insipida).*

Usually the 1—3 lower bracts either have empty axils (Tucker: sterile bracts) or subtend reduced or retarded florescences.

MIXED TERMINAL BUD, sect. DRIMYS (Drimys spec.)

	bract number, counting acropetally											
	1	2	3	4	5	6	7	8	9	10	11	12
bract:												
length in mm	16½	12	11	8½	8	7½	6	5½	5	5	4½	4
width in mm	6	6	6	5	4½	4½	3½	3½	3	2½	2½	2
width base in mm	4	4	4	4	4	3½	3	3	3	2½	2½	2
number of:												
lateral flower primordia	—	—	8	7	6	5	5	4	3	—	—	—
bracteoles	5	5	8	7	6	5	5	4	3	4	3	—

(FAA-fixed material from Kew Botanic Gardens)

If a *florescence* has a solitary flower only, the pedicel is inserted in the axil of the bract, and bracteoles are absent.

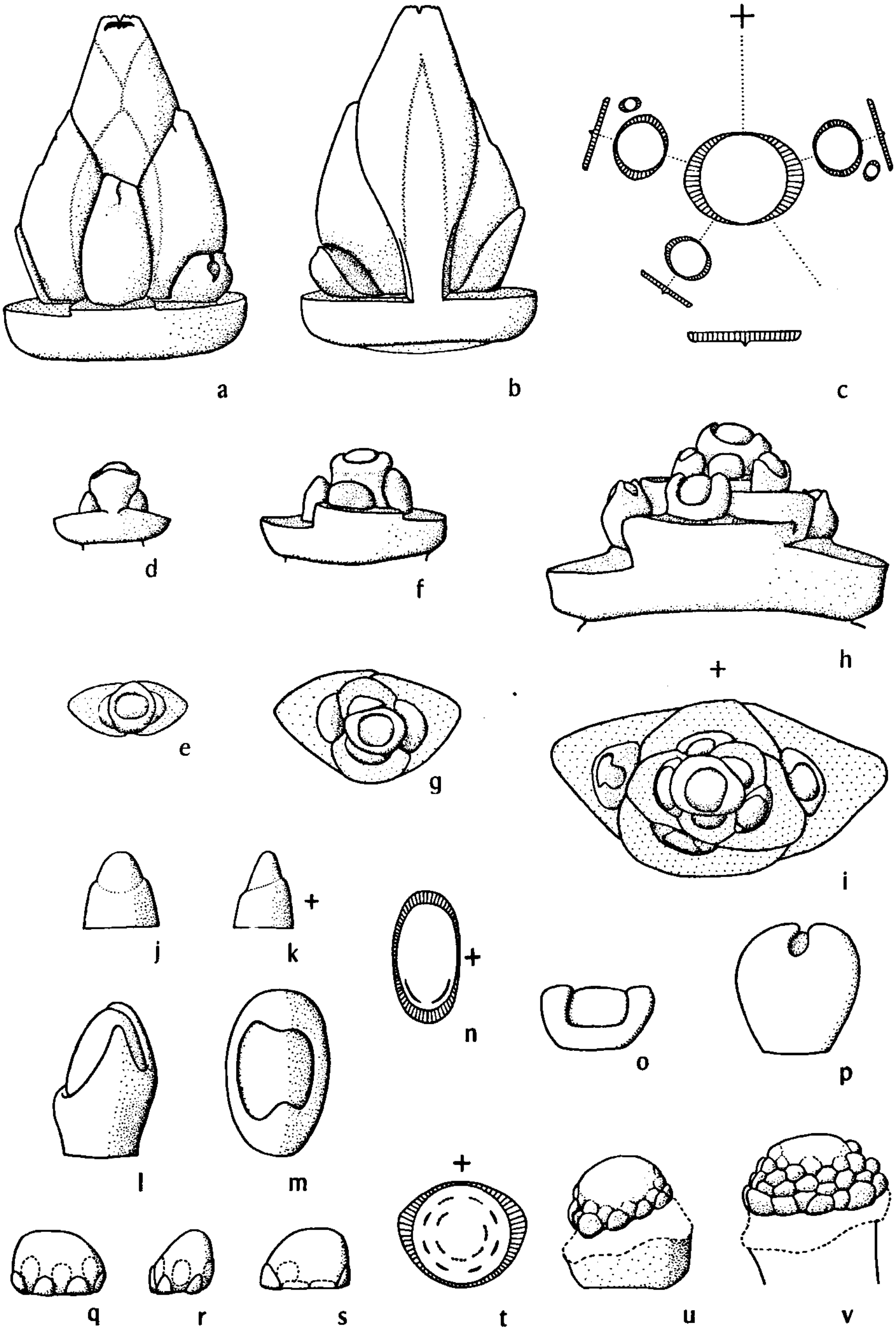
Otherwise a florescence has a terminal flower (in one case a vegetative young shoot) and lateral flowers which are arranged either decussately, or in a ⅖ spiral, or in a manner intermediate between these patterns. I suppose that the arrangement is ontogenetically according to a ⅖ spiral but that in florescences with two or four lateral flowers the decussate position is more or less approximated through later growth (fig. 12d—i). This makes the assumption of a shift from a spiral to a decussate arrangement and *vice versa* (Tucker, 1959, p. 297) unnecessary. The diagrams given by Tucker (her figures 2 and 3) can quite easily be interpreted as (compressed) ⅖ spiral arrangements. The distinctness of the arrangements is complicated by the failure of several internodes to elongate, so that the nodes become crowded.

Several times lateral flowers of second order were found, in one case (some florescences in *W. H. Camp E-4370, Drimys granadensis*, fig. 12a—c) without subtending bracteoles. These lateral flowers of second order were inserted at an angle of *c.* 45°—60° to the bracteole first order, thus giving evidence of a ⅖ spiral arrangement rather than of a decussate one. Such evidence is also given by the insertions of the lowest pair of bracteoles: these are further apart on the abaxial side of the young florescence than on the adaxial side where they often touch.

Irregularities (torsion) in the ⅖ spiral arrangement can be related with the compressed form of the young florescence in the sagittal plane. Reductions of the florescence in the sagittal plane are quite common.

Within a florescence the initiation of bracteoles and lateral flowers is acropetal. Sepals as well as petals are first initiated in the terminal flower, then in acropetal order in the lateral flowers (fig. 12 d—i). According to Tucker flowering follows the same pattern as the initiation of sepals and petals; the few observations I could make on herbarium material agree with hers.

Not enough suitable material was available to establish — as was done for sect. *Tasmannia* — whether there is a relationship between on one hand pedicel length and the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number of flower parts, on the other the position of the flower within the florescence. If such a relationship exists it is probably not very pronounced as was indicated by the few cases that could be checked.

b. Section Tasmannia. Herbarium material was abundant. Further some FAA-fixed material from New Guinea *(D. piperita)* was available.

Within a terminal bud (fig. 31) the bracts increase *(D. lanceolata)* or decrease (the other species) in size acropetally. In the latter case the outer bract initially encloses the terminal bud, but after opening the higher inserted bracts may elongate and outsize the outer bract before dropping.

As in *D. lanceolata, D. purpurascens, D. stipitata,* and *D. insipida* the florescence consists of a solitary flower, my attention was focused on *D. piperita.* In that species the florescence consists of either a solitary flower or a 'cluster' of flowers (fig. 15f). Peduncle and bracteoles are always absent.

Within an *inflorescence* acropetal tendencies are also present, but they are far less strict than in sect. *Drimys.* Both the number of flowers per florescence and the number and size of flower parts (of flowers in comparable positions within the florescences) generally decresae acropetally. The initiation of flowers and of flower parts as well as the anthesis (with the same provision concerning the position of the flowers) generally progress apically. However, these trends are usually reversed in at least the 1—4 lower florescences. Sometimes even a complete lack of flowerbuds or the replacement of flowers by vegetative buds was observed in the axils of the lower bracts. If flowerbuds are present here, they are often abortive.

Vegetative buds have been found in the axils of the highest bracts. Conversely, flowers or aborted flowerbuds are sometimes present in the axil of the first leaf above the inflorescence. Thus the usual distinction between cataphylls (with vegetative buds in their axils or with empty axils) and bracts (with flowers in their axils) is quite meaningless here. Therefore in this paper both categories are called bracts.

From the above description it follows that the best developed florescence will in general be found in the lower part of the inflorescence. A strict relation between this maximal development and the position of the florescence within the inflorescence, however, could not be traced. In several cases the most prolific florescences were even found near the distal end of the inflorescence. It should be pointed out here that for different characters, e.g. number of flowers per florescence, length of pedicel, number of floral appendages, beginning of flowering (always of flowers in comparable positions within the florescences),

Fig. 12. *Drimys* sect. *Drimys.* — *Drimys granadensis.* Young florescence with flowerbuds second order; bracts removed, the impressions of their margins still visible on the flowerbuds. a. abaxial. b. adaxial, × 25, c. diagram. — *Drimys* spec. d—i. young florescences, bracts removed, in abaxial and apical view, × 25, in d—g sepals initiated in terminal flowerbud only, in h & i sepals initiated in all flowerbuds except the two highest lateral ones; j & k. abaxial and lateral view of flower primordium just before the sepals arise, × 100; l—n. young flowerbud in lateral and apical view, × 100, and diagram resp., showing unequal development of calyx, in diagram two petal primordia shown on the low lateral side of the flowerbud; o & p. two flowerbuds from the same florescence showing decreasing size of the opening of the calyx, × 45; q—t. tilted floral apex after removal of calyx in abaxial, lateral, and adaxial view, × 47, and diagram resp.; u & v. two floral apices after removal of calyx showing absence of differences in size between the petal (lower) and stamen (higher) primordia, × 47. — (a—c. *W. H. Camp 4370,* herbarium material; d—v. FAA-fixed material from Kew Botanic Gardens).

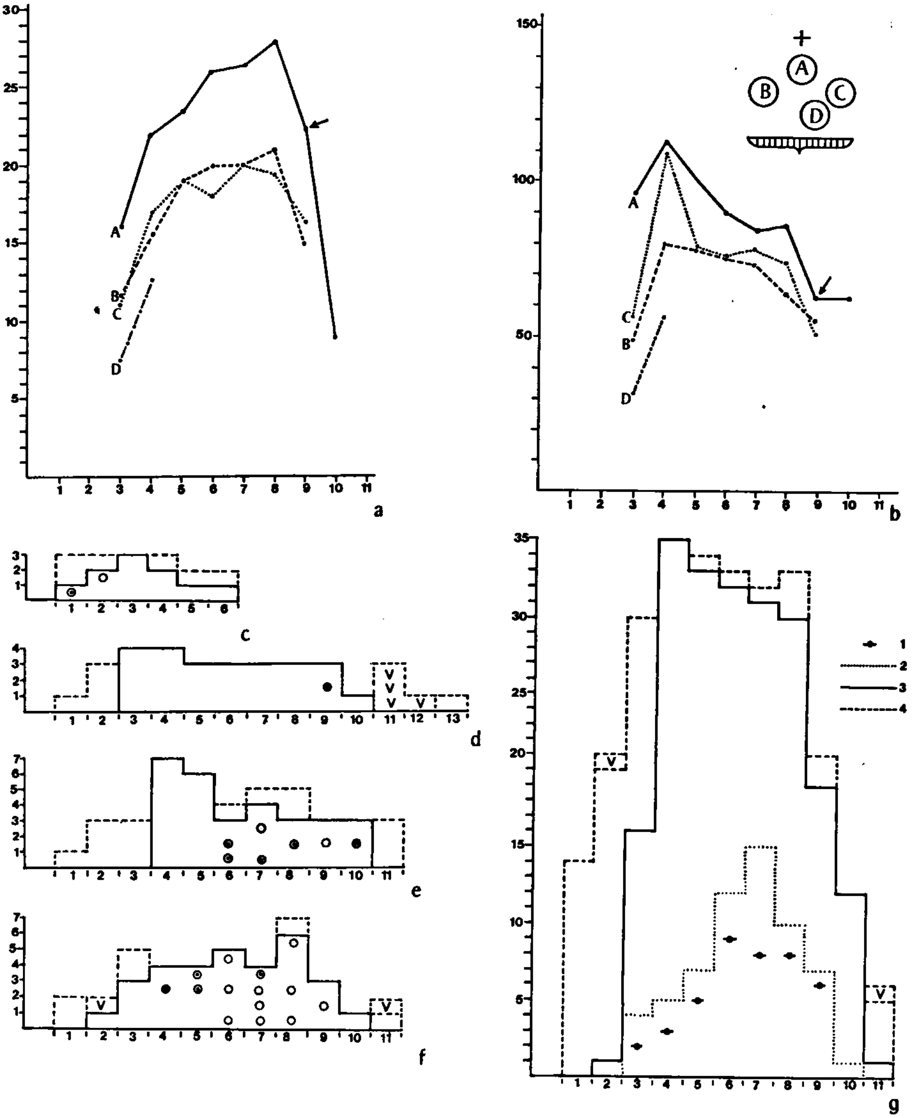


Fig. 13. Inflorescences of *Drimys piperita*. — a. Pedicel lengths in mm (ordinates) plotted against bract number, counting acropetally; those from the same positions within the florescence (see inset in b) connected; arrow indicates just opening flowerbud, the other buds are still closed. — b. Number of flower parts above the lateral petals of the same flowerbuds as in a; the longest pedicel, the highest number of flower parts, and the beginning of flowering are found in different florescences; within the florescences the plotted values decrease centrifugally. — c—f. Number of structures in the axils of the bracts of four inflorescences; solid line: (sub)mature flower(bud)s; broken line: abortive flowerbuds or vegetative buds (v); circles: open flowers; circles with dots: just opening flowers. — g. Number of structures in the axils of the bracts totalled for 8 inflorescences of the same plant to illustrate general trends of their distribution; 1. open flowers; 2. *ibidem* plus just opening flowers; 3. as 2 but including closed flowerbuds as well; 4. all axillary structures, including abortive flowerbuds and vegetative buds (v). Twin flowers, one in each of the florescences 7, 9 and 10, have been counted as one structure. — (a, b, d—g. entity *22. coriacea, Vink 17566*, ♂; c. entity *25. heteromera, Vink 17316*, ♂).

the maxima are often situated in different parts of the same inflorescence (fig. 13). This shows that the correlation between these maxima is not very strong. The following table illustrates a number of these diviations; the data are from a FAA-fixed mixed terminal bud of *Vink 16927, D. piperita 22. coriacea*, ♀.

bracts numbered acropetally	in central flowerbud already initiated			length central flowerbud in mm	bract length in mm	number of flowerbuds in axil of bract
	sepals	petals	number of carpels			
1		vegetative bud			20.0	1
2		vegetative bud			18.0	1
3	—	—	—	0.17	16.0	2
4	—	—	—	0.13	15.0	3
5	—	—	—	0.17	13.7	3
6	+	+	8	1.33	12.8	3
7	+	+	10	1.40	11.1	3
8	+	+	9	1.53	10.0	3
9	+	+	8	1.67	8.6	3
10	—	—	—	0.17	4.5	3

When comparing inflorescences of the same plant it was found that the absolute and relative positions of such maxima are not fixed. In the following table three inflorescences of *Vink 17566, D. piperita 22. coriacea*, ♂, are compared for the positions of the maxima of pedicel length, of the number of petals + stamens + carpels (both of the central flowers of the florescences), of the number of flowerbuds initiated (including abortive ones), and of the number of flowers developed (excluding abortive ones):

	bract number, counting acropetally									
	1	2	3	4	5	6	7	8	9	10
max. pedicel length				C	C	C	B	A		
max. number petals + stamens + carpels				ABC						
max. number flowerbuds initiated			A	AB				C		
max. number flowerbuds developed			A	AB				C		

(inflorescences indicated by A, B, and C)

Thus the general acropetal tendencies mentioned in the beginning of this paragraph can only be deduced from the study of a great number of inflorescences; deviations are part of the picture.

As can already be inferred from the above, correlations between pedicel length, the number of floral appendages, and the beginning of flowering of flowers in comparable positions in different florescences of the same inflorescence could not be traced.

In view of the above conclusions for sect. *Tasmannia*, it is possible that, if more observations could be made, the tendencies recorded for the inflorescence of sect. *Drimys* prove to be less strictly acropetal.

The *florescences* lack peduncles and bracteoles. The flowers are arranged in 1—3 rows parallel to the base of the bract. The adaxial flower in the sagittal plane of the florescence is called the *central* flower. Solitary flowers take the position of the central flower.

Disregarding a small number of irregularities, the initiation of flower primordia starts with the central flower and is followed by two adjacent flowers, one on each side in the adaxial row (fig. 15c). The next pair of primordia can be situated either laterally in the same row or in the second row in positions alternating with the three primordia in the

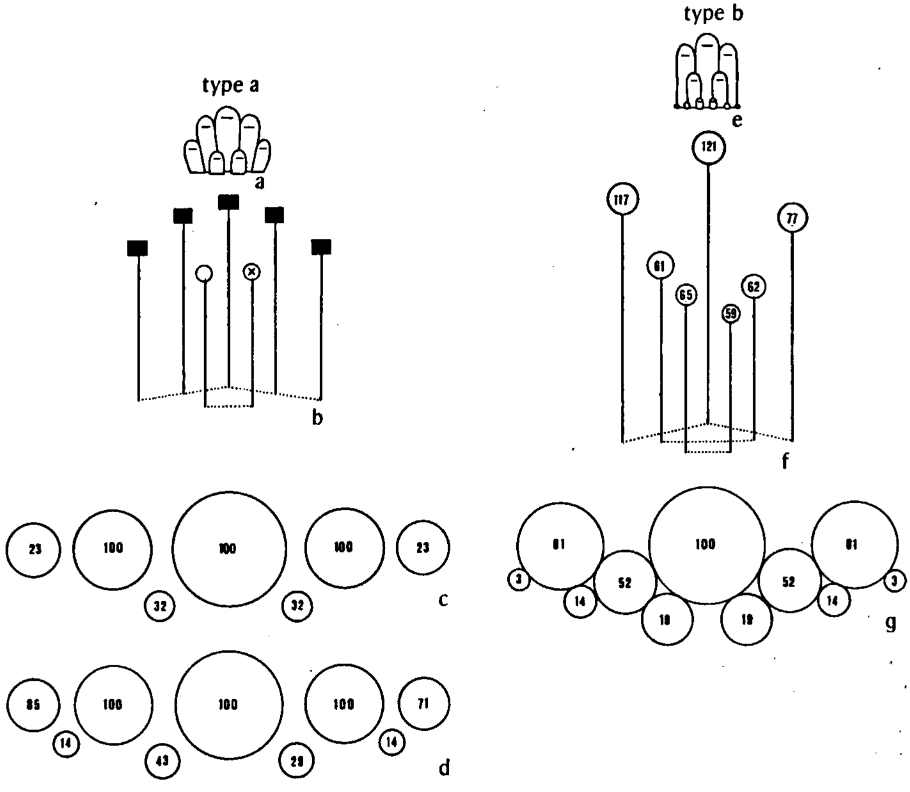


Fig. 14. *Drimys piperita*. Two types of florescences (see text). — a—d. Type *a*; e—g. type *b*; — a & e. young florescences from closed terminal buds (schematically); — b. mature florescence with relative pedicel length; black fruits; open circle: flower; circle with cross: flowerbud; — c, d & g. frequencies of presence of flowerbuds (see text); diameter of circles gives relative size of buds; — c: 33 florescences from two terminal buds; d. 7 florescences from one terminal bud; g. 21 florescences from one terminal bud. — f. submature florescence with all buds still closed, showing relative pedicel length and number of flower parts above lateral petals. — (a, b & c. entity *25. heteromera, Vink 17312*, ♀; d. entity *21. robusta, Kostermans 2311*, ♂; e & g. entity *21. robusta, Kostermans 2388*, ♂; f. entity *22. coriacea, Vink 17566*, ♂).

first row. The adaxial row contains at most 5 primordia. If a third, abaxial row is formed, its primordia will be the last to become initiated and they alternate with those of the second row.

This sequence is rather strictly followed by the further floral development: the initiation of floral appendages and, in (sub)mature stages, the length of the pedicel, the number of floral appendages, and the beginning of flowering.

The flowers are inserted on a low cushion of light coloured tissue. Although differences in the height of insertion on this cushion are minute, the pattern of initiation of the floral primordia is distinctly reflected (fig. 22 h & i).

Rarely the central flower was found to be peduncled (fig. 24 h).

Comparing the above observations in sect. *Tasmannia* with those in sect. *Drimys*, the florescences of sect. *Tasmannia* are thought to represent reduced branching systems of which the axes have merged into the cushion and the bracteoles are lost.

For an interpretation of the reduced florencences we have to turn to those with as many flowers as possible. These are found in *D. piperita*, entities *19. beccariana*, *21. robusta*, *22. coriacea*, and *25. heteromera*. The relevant material, however, is very scarce. As suitable ontogenetic and (sub)mature stages were found together in only one specimen, I was compelled to compare ontogenetic and (sub)mature stages from different specimens, even from different entities (figs 14 & 15).

On this basis two types of florescences can be distinguished:

a. in early stages of development the adaxial row consists of 5 flowerbuds; the buds in the second row are smaller than those of the adaxial row and the buds in the abaxial row are still smaller. In (sub)mature stages this pattern is also reflected by the length of the pedicels, the number of floral appendages per flower, and the beginning of flowering.

b. in early stages of development the adaxial row consists of 3 flowerbuds; the distribution of the bud sizes is further as in type a. However, in (sub)mature stages the outer lateral flowers of the florescence are the largest next to the central flower, whereas in type a this relative size is attained by the flowers adjacent to the central flower; this deviating pattern is also reflected by the characters mentioned for type a.

When we suppose that the flowers taking the most peripheral positions in a branching system disappear first when the number of flowers decreases, then a comparison of all florescences of an inflorescence is useful. For both types the frequencies of presence of flowers were calculated for each flower position within the florescence. To a well developed flowerbud the value 1 and to an apparently abortive flowerbud the value ½ was attributed. For each postion from all florescences of an inflorescence these values were totalled. The means of these totals for comparable positions on either side of the sagittal plane are presented as percentages of the total for the central flower in fig. 14. The results are in accordance with the above observations on the size distribution of the flowerbuds, with only one exception.

The types a and b are apparently not the expression of principally different arrangements of the flowers as they can be explained as variants of the same basic arrangement. Moreover, in *Vink 17533*, *22. coriacea*, both types were found in the same inflorescence.

Two solutions can be envisaged for the basic arrangement of the florescence (fig. 15a & b):

α. a primary cyme, the lateral branches of which produce cymes of second and third order. This means that the main axis of the florescence is branched only once which is unlikely in comparison with the situations in sect. *Drimys*, *Pseudowintera*, and *Bubbia*. In sect. *Drimys* the acropetal production of flowers laterally attached to the main axis is even the most important way of increasing the number of flowers in a florescence.

β. a main axis with a terminal flower and up to 4 lateral flowers or lateral branches arranged in a $\frac{2}{5}$ spiral *with reduction on the adaxial side*. This situation is far more probable if compared with that in sect. *Drimys* and in *Pseudowintera*, and even with that in *Bubbia*.

However, from each of these basic arrangements both the types a and b can be derived by putting emphasis on the branching of second (and third) order either towards the lateral sides of the florescence (type a) or towards the abaxial side of the sagittal plane of the florescence (type b). The presence of both types in the same entity and even within the

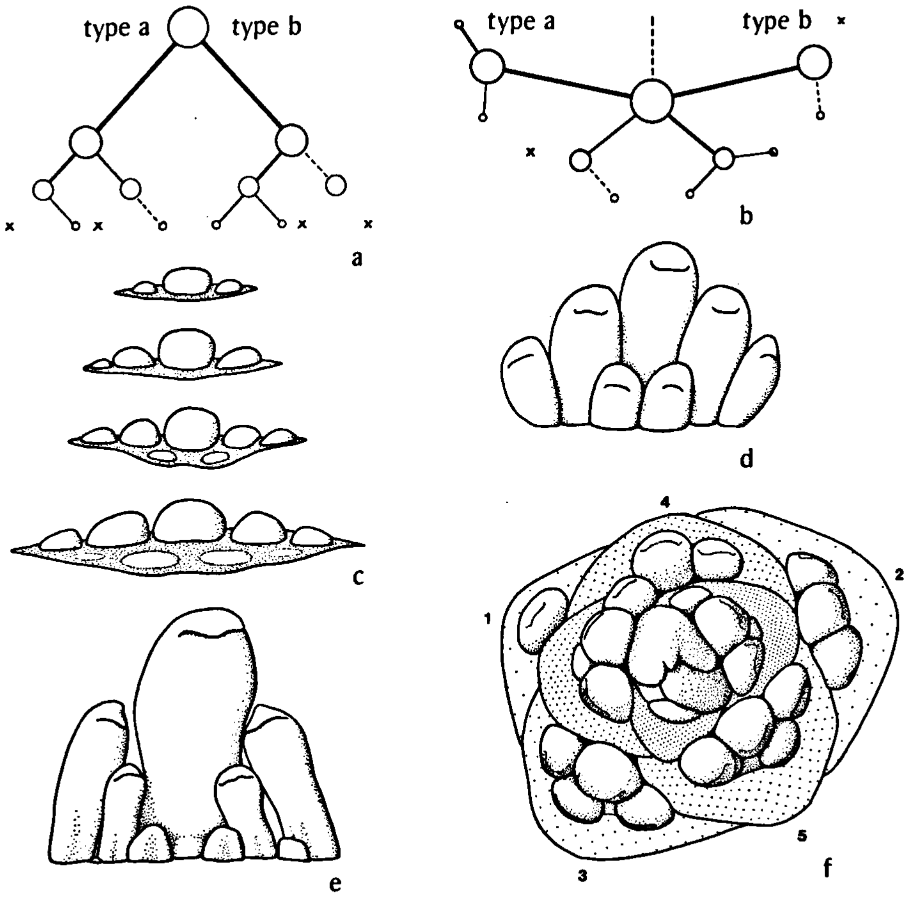


Fig. 15. *Drimys piperita*. a & b. Two solutions for the basic arrangement of the flowers in the florescence (see text); c. very young florescences from the same terminal bud, showing centrifugal sequence of flower primordia, × 75; d. example of florescence type *a*, × 25; e. example of florescence type *b*, × 25; f. apical view of mixed terminal bud after removal of bracts; vegetative part in the centre; bract scars dotted, the lower ones numbered acropetally; $^2/_5$ spiral slightly distorted; × 20. (c. entity *21. robusta, Kostermans 2311*; d. *entity 25. heteromera, Vink 17312*; e. entity *21. robusta, Kostermans 2388*; f. entity *25. heteromera, Vink 16930*).

same inflorescence strengthens the probability of such derivations on one hand and makes those types useless as characters for classification on the other.

One difficulty has yet to be discussed. In sect. *Drimys* and in *Pseudowintera* the sepals always take the orientations that would have been taken by the next pair of bracteoles (if these would have developed). This means that in a (semi)decussate arrangement the orientation of the sepals turns *(c.)* 90° with each extension of the axis below the flower that includes a pair of bracteoles. This can be checked, independent of the basic arrangement applied, when comparing single-flowered and three-flowered florescences. Indeed, in sect. *Drimys* such a change in the orientation of the sepals takes place. In the solitary flower (where the bracteoles are absent) the sepals are orientated perpendicular to the bract. In the three-flowered florescences the sepals of all three flowers are perpendicular to the bracteoles and parallel to the bract. In *D. piperita* this is not the case: the sepals of the central flower are always parallel to the bract, both in single-flowered and in three-flowered florescences. Although bracteoles are absent here, the lateral flowers could be expected to have a similar influence on the orientation of the sepals of the terminal (central) flower.

I think the lack of change in the orientation may be due to the fact that in *D. piperita* the flowers are initiated in a centrifugal order, whereas in sect. *Drimys* the initiation is acropetal. I did not check histogenetically whether this implicates the determination of the orientation of the calyx in the central flower of *D. piperita* before additional flowers are formed.

It is stressed that the basic arrangements discussed above do implicate a mainly centrifugal sequence of flower initiation that does not differ principally from the acropetal sequence found in sect. *Drimys*, except for the early initiation of the central flower which may be due to the complete reduction of the main axis.

The number of flowers per florescence is apparently primarily determined by the space available in the axils of the bracts. Rich florescences are only found on stout branchlets with big terminal buds and wide bracts. The thinner lateral branches bear less rich florescences than the stouter leading branches of the same plant. In *D. piperita* inflorescences with solitary flowers are — with a few exceptions — found in entities with slender to very slender branches. A second factor determining the number of flowers per florescence is the position of the florescence within the inflorescence as already discussed.

Several times the two flowers on the abaxial side of the central flower were found to be coherent or even to form a twin flower with twice as many floral appendages as could be expected in that position. In other cases only one flower developed normally and the other was indicated by an aborted primordium, by an empty space, or no trace of it was left at all and the remaining flower was situated in the sagittal plane of the florescence.

An interesting abnormality was found in *Vink 16929, D. piperita, 22. coriacea* (fig. 16). In an inflorescence the two lower bracts each subtended a solitary vegetative bud. Bracts 3 and 4 each subtended a central vegetative bud flanked by two abortive flowerbuds. Bracts 5—12 subtended normally developed (4 or) 5-flowered florescences, although in bract 5 the lateral flowers were lagging behind and were apparently on the verge of aborting; on the latero-adaxial side of the insertion of the central flower a bracteole was present, that is, in the same position as the first leaf of a central vegetative bud.

The first leaf above the bracts subtended three vegetative buds and five indefinite primordia, arranged in the same way as flowerbuds in a florescence. In the axils of the second

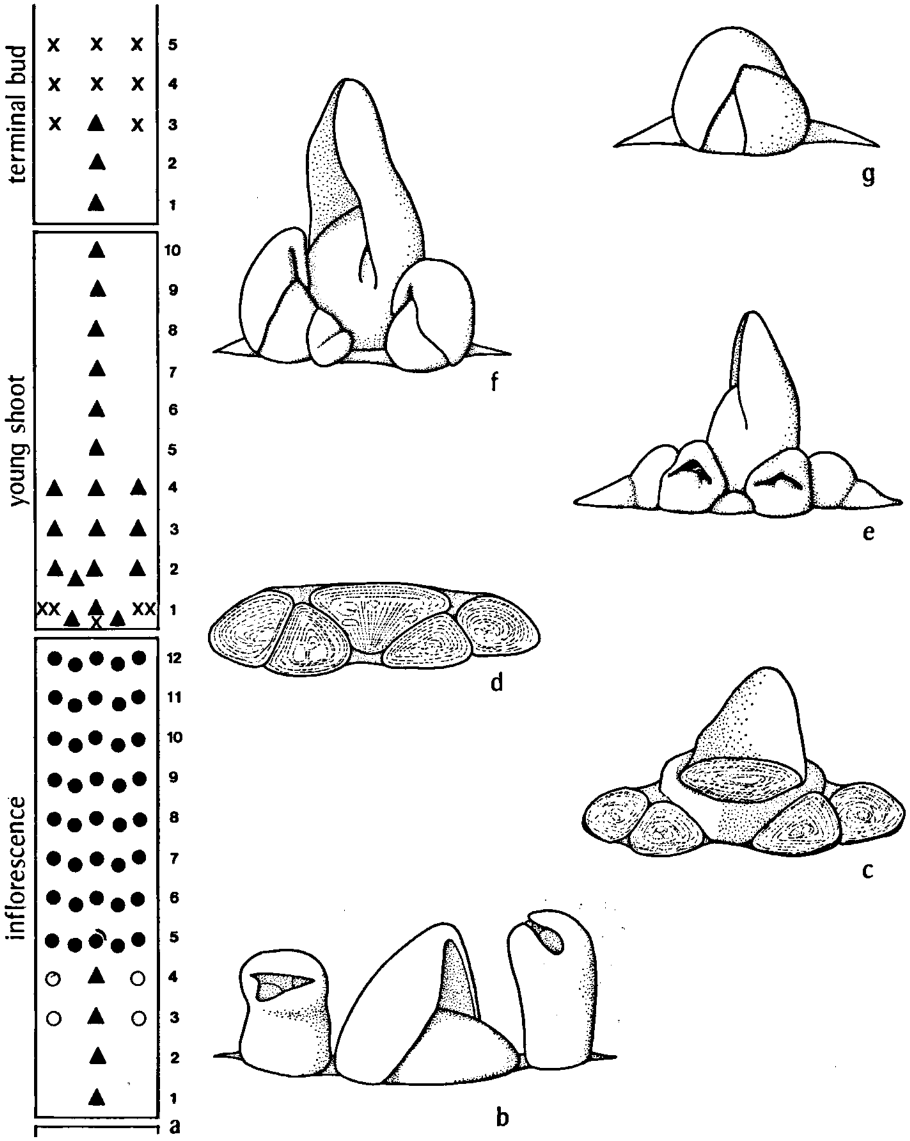


Fig. 16. *Drimys piperita*, entity *22. coriacea*. Abnormal inflorescence. a. Arrangements of axillary structures; bracts and leaves numbered acropetally; dots: flowerbuds; open circles: abortive flowerbuds; triangles: vegetative buds; crosses: indefinite primordia. b. florescence in axil of bract 4, × 25; c. pedicel scars and one bracteole in axil of bract 5, × 12½; d. pedicel scars in axil of bract 6, × 12½; e—g. structures in the axils of leaves 1, 3, and 5, the latter a normal vegetative bud, × 25. *(Vink 16929)*.

to fourth leaf the number of vegetative buds decreased, until in the axil of the fifth leaf one vegetative bud was present as is normal. In the young terminal bud the same sequence was being repeated.

This case demonstrates clearly that several separate factors controlling the construction of the inflorescence can become disconnected:

a. the formation of bracts;
b. the transition from vegetative to floral apex;
c. the formation of the branching system of the florescence.

Many of the buds called vegetative above differed from true vegetative buds in having an elongated first leaf not enclosing the other ones. This may be taken as an indication of the formation of bracteoles (as the bracteole in the axil of bract 5).

In sect. *Drimys* Tucker (1959) described the transition of the florescence apex into a floral apex as taking place after the initiation of the lateral appendages (bracteoles and flowers). Comparing this with the failure of central buds in the above case to produce a flower although lateral flowerbuds were present, this failure could indicate a similar acro-(centri-)petal sequence in the initiation of flowers in a florescence in *D. piperita*. This supports the explanation of the observed centrifugal sequence of initation as a special case of the acropetal sequence as in sect. *Drimys* (see p. 257).

6. Flower. In this chapter the flowers of sect. *Tasmannia* will be discussed and where necessary differences with sect. *Drimys* will be indicated.

Sex. The flowers of sect. *Drimys* are bisexual, those of sect. *Tasmannia* are unisexual (dioecious). In many cases both male and female flowers (or fruits) are present in the same collection number. Backed up by experience in the field, I have taken these as collections from more than one plant. A few specimens of *D. piperita* have bisexual flowers, usually accompanied by male or female flowers or both. In *Schodde 1932* (entity *1. reducta*), ♂ and ⚥ flowers as well as a fruit were found on the same twig. In this case the carpels are not fully developed: 0—6 ovules per carpel against 11—24 in normal ♀ flowers. In other cases bisexual flowers have very short stamens, often with indehiscent anthers, or structures intermediate between stamens and carpels; see also the discussions on e.g. the entities *8. crassipes*, *22. coriacea*, and *35. oligandra*.

The *pedicel* is usually dorsiventrally flattened and often more or less winged along the margins. If the flowers are not solitary, the form of the cross-section of the pedicel is determined by its position within the florescence and can be triangular, rectangular, or trapeziform. Bracteoles are absent.

The *calyx* is calyptrate. Its small opening is in *D. lanceolata* and in sect. *Drimys* apical and in the sagittal plane; it is closed by two lateral, overlapping, finely laciniate, twisted lips. In the other species of sect. *Tasmannia* this opening is situated on the abaxial subapical side of the calyptra; it is closed by two overlapping median lips of which the adaxial is the outer one. Both lips are entire or slightly lobed and not twisted. As will be discussed later the calyptra is composed of two (rarely three) sepals; the lips represent the apices of the sepals.

Just before anthesis the calyptra is ruptured, in sect. *Drimys* (always?) on the abaxial and adaxial sides, in sect. *Tasmannia* on the lateral sides. In *D. lanceolata* the ruptures thus bisect the two sepals composing the calyptra, in all other cases the ruptures occur more or less along the line connecting the sepals. In large flowers additional ruptures occur, most often on the abaxial side. These are apparently caused by the expansion of the petals and stamens which in large flowers is also directed towards the lower abaxial part of the calyptra (fig. 17a). When dissecting submature buds of such flowers it is necessary to make an extra incision in the abaxial half of the calyptra before this half can be folded downwards. As the additional rupture thus is a mechanical necessity for the opening of the calyptra it does not provide evidence on the presence of more than two sepals.

Nast (1944) observed that the number of vascular bundles (traces) of the calyptra is not constant. It is not quite clear whether she counted the bundles above or below the insertion of the calyx, but I assume she means the number of bundles at the level of insertion of the calyx. Within the calyx the bundles are usually unbranched.

As the basic number of bundles for each part of the calyptra is thought to be three, two-lipped calices with more than 6 bundles need additional interpretation. Nast gives two solutions: (1) the number of traces has been increased because of the difference in size of the sepals, and (2) the sepal with a higher number of bundles is a composite of two sepals.

From many observations I conclude that there is a distinct relation between the number of bundles and the width of sepal halves. The width of the halves is related to the number of floral appendages in the flower and therefore also to the position of the flower within the florescence. In terminal buds of the same plants the deviations from the two-sepalled condition are scarce and not related to the position of the flower within the florescence. Therefore I accept the first interpretation of Nast as being the correct one.

The calyptra is dropped soon after it is ruptured.

The *petals* are free, obovate or oblanceolate, entire, rounded at apex, and provided with 1—3 traces at their point of insertion. In bud the apices and/or margins are often folded between the anthers which causes irregularities in the outline of the mature petals. The number of petals varies from 4 to 25 in sect. *Drimys* (Smith 1943a) and from (0—) 2 to 15 in sect. *Tasmannia*. The petals of two-petalled flowers usually overlap at their apex in bud, but no relation exists between the position of the outer petal within the flower and the position of the flower within the florescence.

The arrangement of the petals will be discussed in the chapter on the ontogeny.

The *stamens* have a subcylindrical, slightly dorsiventrally flattened filament. The connective is narrow and does not overtop the anthers except in one specimen of *D. lanceolata* and in a specimen of *D. brasiliensis* mentioned by Smith (1943a). The anther locules converge slightly distally; they are laterally or dorso-laterally dehiscent with longitudinal slits. Within a flower the sequence of dehiscence is basipetal.

In sect. *Drimys* there are, according to Smith (1943a), 15—65 stamens per flower; in sect. *Tasmannia* I found 7—109 stamens per flower. Their arrangement will be discussed in the chapter on the ontogeny.

The stamens have one trace at their point of insertion.

In sect. *Tasmannia* the filaments of the higher-inserted stamens are usually longer than those of the lower-inserted ones, although this trend is reversed at the very base of the torus.

In sect. *Tasmannia* the stamens are absent in ♀ flowers. Sometimes, e.g. in the type of *D. arfakensis (D. piperita, 19. beccariana)*, they are present as sterile appendages much smaller than normal stamens.

The *pollen* was studied by Fiser & Walker (1967). Their general description of the pollen of sect. *Tasmannia* reads: 'The pollen grains are united in tetrahedrally arranged groups of four, each grain contacting its neighbours along three lines. The maximum diameter of tetrads varies between 15 μ and 34 μ. The free, or distal, pole of each grain is occupied by a more or less isodiametric pore. This pore, which is closed by a membrane supporting granula, verrucae or bacula, is distinctly delimited; the diameter varies between 7.5 μ and 12.5 μ.

A reticulum surrounds the pore and extends to the line of contact between the grains. The mesh is composed of bacula supporting a tectum which, in places, is so discontinuous as to be reduced to a thin band (1.0—2.5 μ wide).'

The *carpels* (fig. 17) are free, globular to obovoid, laterally flattened, and sessile to stipitate. A longitudinal slit extends over the apex and the ventral side but often does not reach the base of the carpel c.q. the apex of the stipe. The margins of the slit are bordered and interlocked by papillate stigmatic tissue ('stigmatic crest' in further discussions).

The ovules are anatropous, bitegmic, and crassinucellate. They are inserted on two placentas, one on either side of and as long as the slit in the carpel wall. Often the ovules form two rows on each placenta, but in early stages they are distinctly arranged in one row per placenta, the two rows in later stages being caused by the close packing of the growing ovules.

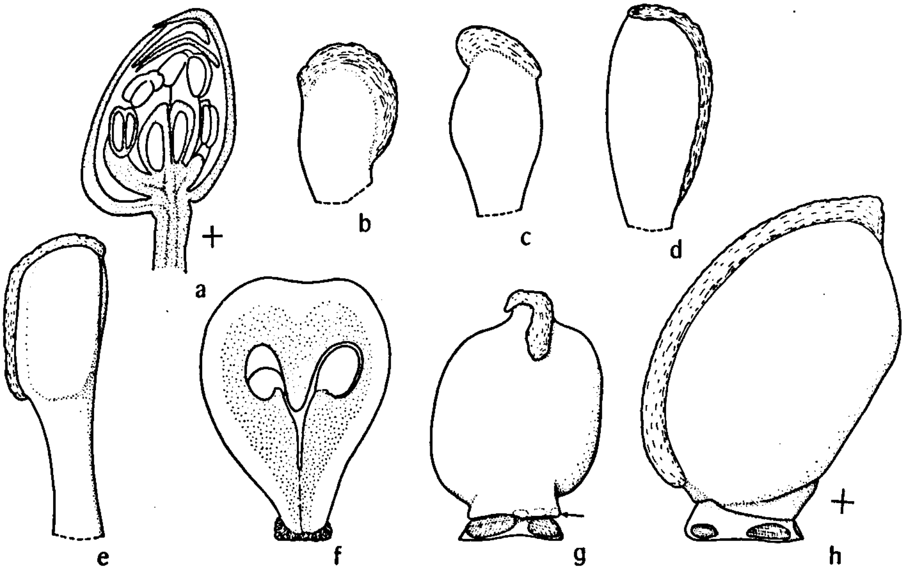


Fig. 17. a. Longitudinal section of submature flowerbud showing abaxial bulge of calyx, × 10 (*Drimys piperita*, entity *10. giluwe*). — b—d. carpels of *D. piperita*: b. sterile, entity *10. giluwe*, × 20; c. fertile, entity *16. myrtoides*, × 10; d. fertile, entity *22. coriacea*, × 10. — e & f. fertile carpel of *D. stipitata*: e. lateral view, × 10; f. cross-section, × 25, part not dotted is green. — g & h. fertile carpels of *D. lanceolata*, torus with petal scars, × 25: g. from bud still enclosed by bracts, dorsal view, arrow indicates 'disc'; h. from submature bud, lateral view showing the torus to be higher on the ventral side of the carpel. (a & b. *Schodde 1999*, ♂; c. *Darbyshire 331*, ♀; d. *Hoogland & Pullen 6029*, ♀; e & f. *Hoogland 8603*, ♀; g. *Gifford s.n.*, ♀; h. *Schodde 3999*, ♀).

The carpels of sect. *Drimys* differ from the above description (1) by never being distinctly and abruptly stipitate, and (2) by the length and the position of the stigmatic crest and the underlying slit: these are very short, located on the ventral side of the apex or slightly below the apex, and often raised from the carpel body by a short flattened tube. The placentas are longer than the slit, especially on the lower side of it, and — according to Leinfellner (1966) — sometimes connected with each other apically and basally.

In both sections the carpels usually have three vascular bundles: one on the dorsal side of the carpel and one on each side of the slit. The ventral bundles may fuse at the base of the carpel. Usually they form apical and lateral anastomoses with the dorsal bundle.The ovules are inserted between the dorsal and ventral bundles and are supplied partly by one of these bundles, partly by the anastomosed branches (Bailey & Nast 1943b).

D. lanceolata differs by the presence of a double dorsal bundle (Tucker & Gifford 1964).

In ♂ flowers of sect. *Tasmannia* the carpels are sterile (ovules not developed) and smaller than in ♀ flowers.

In sect. *Drimys* the number of carpels is 2—24 per flower with 6—26 ovules per carpel (Smith 1943a). In sect. *Tasmannia* ♀ flowers have 1—15 carpels and 2—46 ovules per carpel; ♂ flowers have 1—11 (—17, once) carpels.

In sect. *Tasmannia* the higher-inserted carpels are usually larger than the lower-inserted ones (compare the size distribution in the filaments), even in rather young stages as shown in fig. 22 g; in the carpels illustrated the stigmatic crest has not yet developed. In flowers with many carpels the number of ovules per carpel usually decreases acropetally.

In cross-section the carpel wall is usually slightly thickened at the dorsal side and tapering towards the margins of the slit. However, the parts between the placentas and the slit can be thickened considerably and on the dorsal side a longitudinal ridge may project into the cavity (*dorsal ridge* in descriptions, e.g. *D. stipitata*) (fig. 17f).

Tucker & Gifford (1966b) described a 'disc' for *D. lanceolata*. This is a papillate structure at the base of the carpel (fig. 17g) which has never been reported for other species. See further the discussion *sub D. lanceolata.*

A discussion on the conduplicate or peltate nature of the carpel will be given in a future paper after the remainder of the genera of this family have been revised.

The form of the *torus* is important in establishing the arrangement of the floral appendages and therefore needs some attention.

The base of the torus is nearly always tilted towards the abaxial side. The longitudinal axis of the torus is usually more or less in line with that of the pedicel. The tapering torus thus has a short slope on the adaxial side and a long slope on the abaxial side.

In solitary flowers the outline of the base of the torus is usually elliptic to trapeziform with the greatest width on the abaxial side. Deviations are induced by the position of the flower within the florescence and — also in solitary flowers — by the torsion of the main axis of the inflorescence which leaves an asymmetrical space between this axis and the bract. The differences in the widths of the adaxial and abaxial sides of the base of the torus are reflected by the numbers of stamens inserted there, especially in large flowers.

If a flower contains many stamens the outer abaxial ones are inserted nearly perpendicular to the pedicel, whereas the upper abaxial and the adaxial ones are more or less parallel to it. Together with an irregular dome-shaped form of the torus and an irregular number of carpels at its apex, these factors make it impossible to divide the torus of male flowers into well-defined ad- and abaxial halves on which the number of stamens can be determined. However, I got the impression that in such flowers the number of stamens is largest on the abaxial side. This, together with the angle of insertion juist mentioned, causes the bulge of the flower on its abaxial base which again — as described above — necessitates the irregular rupture of the calyx.

In sect. *Drimys* the ultimate apex of the torus bears no appendages and is non-vascularised (Nast 1944); in sect. *Tasmannia* the apex is completely covered by the insertions of the carpels.

7. **Fruit** (fig. 18). The form of the fruits is similar to that of the carpels except for a relative increase of the diameter.

If a gynoecium consists of more than one carpel, one or a few become abortive or reach maturity with a considerable smaller size than the other ones.

The fruit wall is fleshy and juicy; I noticed in the field that when maturing its colour turns from green to purplish red to almost black. In *D. insipida* specimens with white ripe fruits are recorded (see p. 311). In *D. purpurascens* the fruits are pruinose.

The placentas have the same relative position as in the carpel, but usually they are further apart at the middle, together forming a spindle-shaped figure.

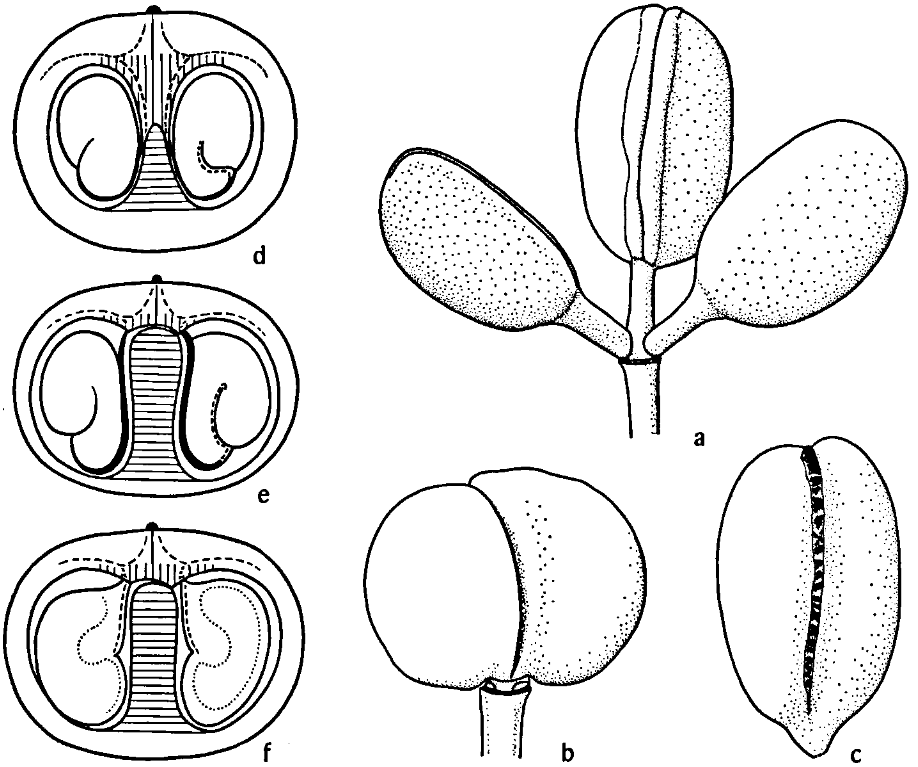


Fig. 18. Fruits. a. *Drimys purpurascens*, × 3; b. *D. lanceolata*, ventral side, × 6; c. *D. piperita*, entity *22B. coriacea*, detached, ventral side, × 3; d—f. schematic cross-sections of *D. stipitata* (d), *D. purpurascens* (e), and *D. insipida* (f); horizontally hatched: dorsal ridge; vertically hatched: placentas. (a. *Schodde 3212*; b. *Burbidge & Gray 6414*; c. *Womersley & Thorne NGF 12840*).

Except for the differences in stipe length (long in *D. purpurascens* and in *D. stipitata*, short or zero in the other species of sect. *Tasmannia*) and for inward extensions of the fruit wall, the fruits are very uniform. In the descriptions only their maximum size is recorded because of the wide variability of their dimensions even within the same gynoecium.

The fleshy and juicy inward extensions of the fruit wall may be — somewhat arbitrarily — divided into three categories:

(1) the *dorsal ridge*, already mentioned in the description of the carpel. It forms a longitudinal plate with an irregular margin and is less well developed or absent at both ends of the carpel *c.q.* fruit. Its height varies considerably and it can even be connected with the placentas *(D. insipida)*;

(2) the *transverse septa*, projecting from the inside of the fruit wall, perpendicular to the dorsal ridge; they are thinner than the latter. The septa separate the seeds from each other and can be perfect (dividing the fruit cavity into separate 'locules') or imperfect (forming incomplete separations), both conditions occurring often within the same fruit. The dorsal ridge and, if present, the enlarged placentas may participate in the formation of the septa;

(3) the *enlarged placentas* vary from slightly thickened areas of insertion of the ovules or seeds to a longitudinal plate projecting into the cavity of the fruit. In cross-section a line separating both placentas is still visible in the tissue of this plate. It is possible that these plates are projections of the fruit wall underlying the placentas rather than placental enlargements but this was not checked histogenetically.

These three types of extensions of the fruit wall — here collectively called *pulpa* — differ from each other in their structure and are still in need of detailed description. The structure of the enlarged placentas is very similar to that of the fruit wall proper; the tissue of the septa seems to differ most from the latter.

The (enlarged) placentas may become connected with the dorsal ridge and form a false longitudinal septum, imperfect towards both ends of the fruit. Transverse septa were never found in the absence of a false longitudinal septum except for a slight development of such septa in *D. piperita*, 38. *membranea.*

According to Smith (1943a) pulpa is present throughout sect. *Drimys.* However, in sect. *Tasmannia* it was found to be either present or absent.

8. Seed (sect. *Tasmannia*) (fig. 19). The number of seeds per fruit is lower than the number of ovules per carpel as several ovules become abortive.

The seeds are laterally flattened and slightly to strongly curved. Their irregular form corresponds with their appression. Usually the seeds are sessile but in *D. purpurascens* and in *D. stipitata* a distinct funiculus is developed. In *D. piperita* a minute elongation of the base of the seed was found in a few specimens, but in longitudinal section this elongation proved to belong to the body of the seed; the epidermis of the funiculus can be distinguished from that of the seed by the smaller size of its cells. The hilum — or the insertion of the funiculus — is found next to the (usually closed) exostomium.

The *outer integument* forms three layers in the seed:

(1) the epidermis, generally consisting of high, narrow cells, filled with a dark reddish brown to black substance (in *Pseudowintera* this consists of tannin and phenolic compounds according to Bhandari, 1963); the epidermis is hard and brittle, its outer surface is brownish black to black, dull (*D. stipitata* only) or shining;

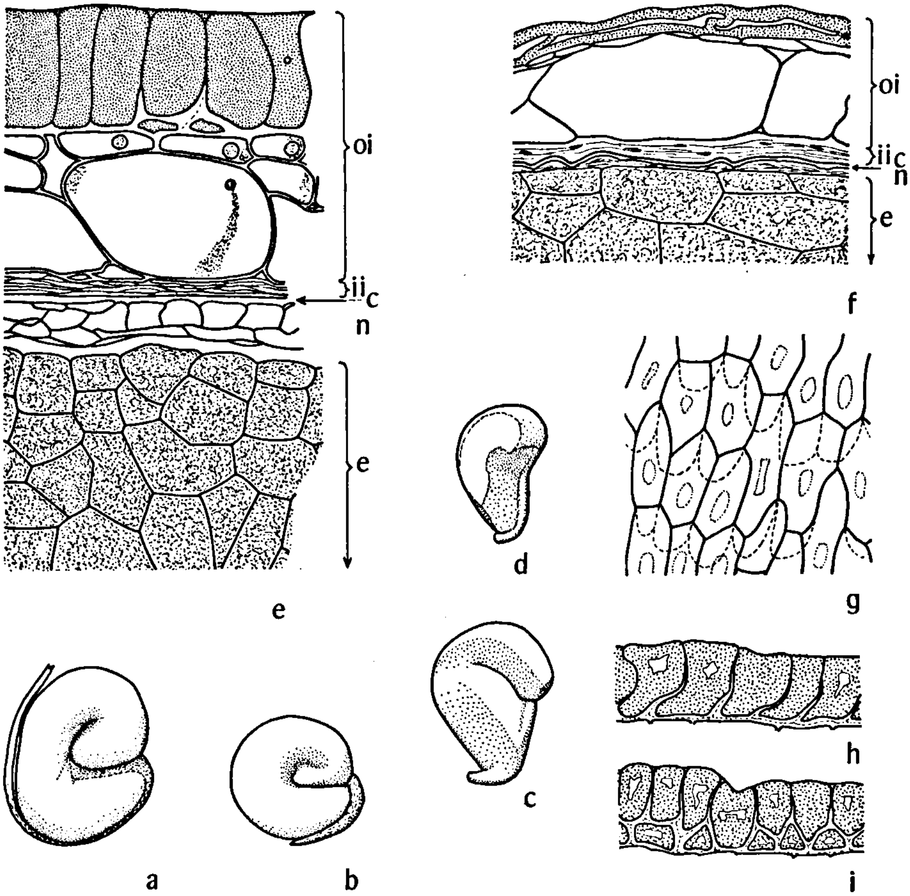


Fig. 19. Seeds. a. *Drimys purpurascens*, × 6. b. *D. stipitata*, × 6. c. *D. piperita*, entity *9. montis-wilhelmi*, × 6. d. *D. piperita*, entity *21. robusta*, × 6. e. cross-section of testa of black type of seed with high epidermis cells (*D. piperita*, entity *22. coriacea*); space between nucellus and endosperm probably artificial. f. *ibidem* yellowish brown type of seed with crushed epidermis cells (*D. piperita*, entity *32. cordata*). g—i. epidermis, of transitional type of seed with boot-shaped cells (*D. piperita*, entity *? 24. chartacea*): g. surface view; h. section parallel to axis of seed; i. section perpendicular to axis of seed. — oi. outer integument; ii. inner integument; c. cuticle; n. nucellus remnant; e. endosperm. — (a. *Reik 031*; b. *Davis NSW 68491*; c. *Brass 30061*; d. *Sleumer & Vink BW 14132*; e. *Vink 17245*; f. *Sayers & Millar NGF 19876*; g—i. *Hoogland 9223*).

(2) a layer 1—3 cells thick; the cells are thin-walled and flattened to completely crushed;
(3) a layer 1 cell thick; the cells are thin-walled, large, and often contain fatty substances.

The *inner integument* is completely crushed. Around the endostomium its outer and inner cell layers form a hard and brittle cap (operculum) of which the cells are filled with a brown to dark reddish brown substance.

The supposed remnant of the *nucellus* has a rather thick, clear cuticle (staining with

Sudan IV) on the side of the layers of the inner integument; its cells are either small, very thin-walled, and about cubicular, without any visible contents, or form a crushed layer.

The *endosperm* consists of thin-walled cells larger than those of the nucellus remnant.

The *embryo* is very small, ovoid to obovoid; its apex is slightly to distinctly bilobed, but it is not differentiated further.

In a number of entities of *D. piperita* the epidermis is not black but brown to light orange-brown, and leathery instead of brittle. Here the cells of the epidermis are very low to completely crushed (in herbarium material) and the brown to dark brown substance is deposited in the thickened walls only. Intermediates between this type of epidermis and the normal one are also found; there the cells are square, or low to high boot-shaped in sections parallel to the axis of the seed; the amount of dark brown to black substance varies accordingly.

Within *D. piperita* there is a certain correlation between the curvature of the axis of the seed and the type of epidermis, the most strongly curved seeds having flattened epidermis cells. However, this correlation is not strict. Moreover, the very strongly curved seeds of *D. purpurascens* and *D. stipitata* have the normal type of black epidermis.

ONTOGENY OF THE FLOWER

For the study of the ontogeny of the flower FAA-fixed material of *D. piperita*, *D. lanceolata*, and an unidentified species of sect. *Drimys* was available. From herbarium material also valuable information could be obtained. The material was studied with a binocular dissecting microscope at × 32 magnification; a few buds were sectioned for supporting evidence.

This investigation was primarily aimed at sect. *Tasmannia;* additional observations were made on sect. *Drimys* and compared with those of Tucker (1959). For histogenitical descriptions I refer to Tucker (1959, 1965) and Tucker & Gifford (1966 a, b).

Because of the differences existing even in flowers of the same florescence, a series of exact measurements cannot be given; those in the description below serve only to give a general idea.

1. Section Tasmannia: D. piperita.

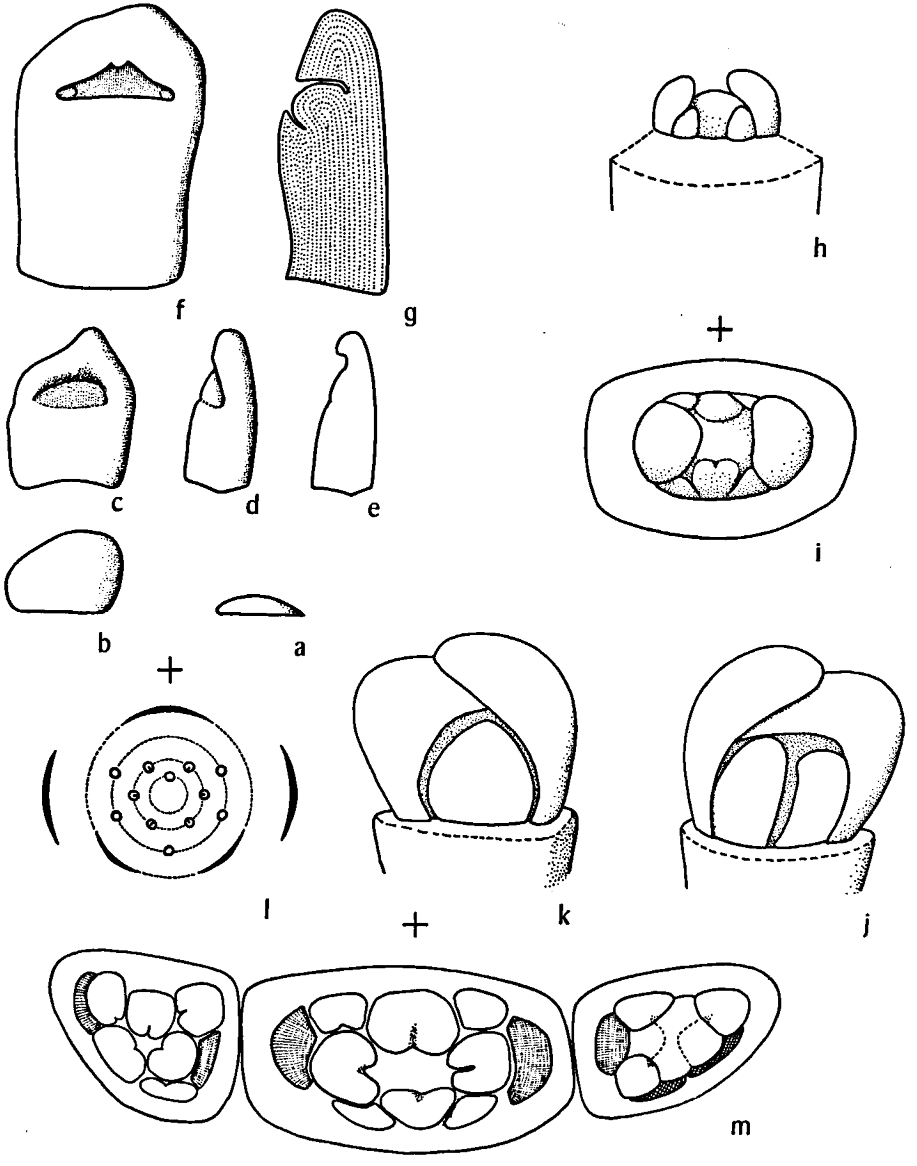
The *flower primordium* is dorsiventrally flattened and slanting adaxially.

Sepals (fig. 20 a—g). When the flower primordium is 0.2—0.3 mm high the adaxial sepal is initiated as a semi-circular ridge along the adaxial side of the apex. Slightly later

Fig. 20. Flower development in *Drimys piperita*. — a—g. Flower primordia c.q. flowerbuds from the axils of bracts 3 to 6 of the same inflorescence, × 50: a & b. primordia in abaxial view; c—e. bud just before the abaxial sepal arises, abaxial and lateral view and longitudinal section resp.; f & g. calyx nearly closed, lateral petal primordia becoming distinct, abaxial view and longitudinal section resp.—h. young bud, calyx removed, abaxial view, two primordia on the base of the floral apex adjacent to the petals, × 75. — i. *ibidem*, apical view, two primordia arising in the sagittal plane, the abaxial one with first stage of carpel furrow, × 75. —j—l. young bud, calyx removed, showing two additional petals on abaxial side (j), one on adaxial side (k), × 75; the diagram (l) is an approximation and shows the increase of number of appendages above the adaxial petal; the higher inserted younger carpel primordia develop faster than the lower ones and already have an apical furrow. — m. apical view of three-flowered florescence after removal of calices (× 75, schematic), showing influence of position of the bud within the florescence on form of torus and consequently on arrangement of floral appendages; of petals only scars drawn; cross-hatched: abortive carpel (left) and abortive petal (right). — (a—g. entity *2. subalpina*, *Van Balgooy 225*, ♂; h & i. entity *25. heteromera*, *Vink 16930*, ♀; j—l. entity *32. cordata*, *Van Balgooy 220*, ♀; m. entity *22. coriacea*, *Vink 17159*, ♀).

the lower part of the ring is closed by the initiation of the abaxial sepal. Together the sepal primordia enclose the floral apex which is now located on the abaxial side of the flower primordium as an almost circular area.

The ring formed by the sepal primordia enlarges as a cylinder, but growth is faster in the sagittal plane. In this way the adaxial sepal forms a cap over the floral apex and the abaxial one forms a lip which becomes located between the floral apex and the tip of



the cap. The opening of the calyx cupule is then closed by the overlapping cap and lip; although its diameter increases during further development, it becomes smaller in comparison to the calyx cupule itself.

Petals. Two petals are initiated in lateral positions at the base of the floral apex when the free apices of the calyx start to overlap. The flowerbud is then 0.4—0.7 mm long, pedicel included.

In the meantime the floral apex has enlarged but its base retains the original tilted position which often remains visible in the mature flower as the tilt of the base of the torus. Because of this tilt the floral apex has its top (topographical apex, see below) located on its adaxial side and its adaxial slope is shorter than the abaxial one.

In *Vink 17316* (entity *25. heteromera*) all buds dissected and some individual buds from other specimens showed a tilt of the base of the floral apex towards the adaxial side although the sepals did not show any aberrancies (the earliest stages showing the initiation of the sepals were not present). This, however, is distinctly an exceptional case (fig. 21f).

The lateral petals divide the base line of the floral apex in an adaxial and an abaxial side. Especially in the entities with a fairly large number of stamens or carpels there is a distinct difference between the widths of these sides directly after the initiation of the lateral petals. The outline of the base of the floral apex thus is more or less trapeziform. In the entities with only a few stamens or carpels this difference in width is less pronounced and the base of the floral apex is more elliptic.

In flowerbuds occupying the lateral positions within a florescence the base of the floral apex is often more or less triangular and tilted towards the abaxial-lateral side, corresponding with the space between the central flower, the main axis, and the bract. Irregularities in the arrangement of the floral appendages are distinctly related to this distorted form (fig. 20 m).

Stamens. When the flowerbud is about 0.5—0.8 mm long a new series of floral appendages is started with the initiation of primordia on the latero-abaxial sides of the base of the floral apex, next to the petals, followed by two primordia in similar positions on the adaxial side. This sequence is reversed if the tilt of the base of the floral apex is adaxial. Whether they will give rise to stamens, carpels, or additional petals does not affect their location and their sequence of initiation. For convenience they will be indicated as stamen primordia in the following discussions.

Stamen arrangement. In entities with only a few stamens the following four stamen primordia will be located above and alternating with the already existing ones, that is, in the sagittal and frontal planes. In such entities the tilt of the floral apex is small and correspondingly the difference in time of initiation of the abaxial and the adaxial primordia is very small or not traceable. Here the first eight stamen primordia can be considered as being arranged in two alternating whorls. The whorls are of the successive type but approach the simultaneous type. Additional stamen primordia are again arranged in whorls above and alternating with the already existing ones.

I will use this simple arrangement as a basis for the description of the more complicated ones. Two more definitions are needed for such a description:

(1) the *topographical apex* of the floral apex: the highest point of the surface of the floral apex, that is, the point furthest from the insertion of the flowerbud;
(2) the *activity centre* of the floral apex: the point or area on the surface of the floral apex forming the centre of the initiating primordia.

In the simple cases the topographical apex and the activity centre more or less coincide. Often, however, the activity centre is located abaxially and slightly basipetally from the topographical apex. This is not very surprising as the activity centre is in a similar position at the time of the initiation of the sepals. Extreme cases were found in ♀ flowers only (fig. 21h—j), where the adaxial carpel primordium of the second 'whorl' may occupy the whole area between the topographical apex and the pair of adaxial primordia of the first 'whorl'; at the same time this adaxial primordium had increased considerably in size in comparison with the abaxial primordium, suggesting a correlation between this increase and the high insertion on the floral apex. Such a correlation was also found when

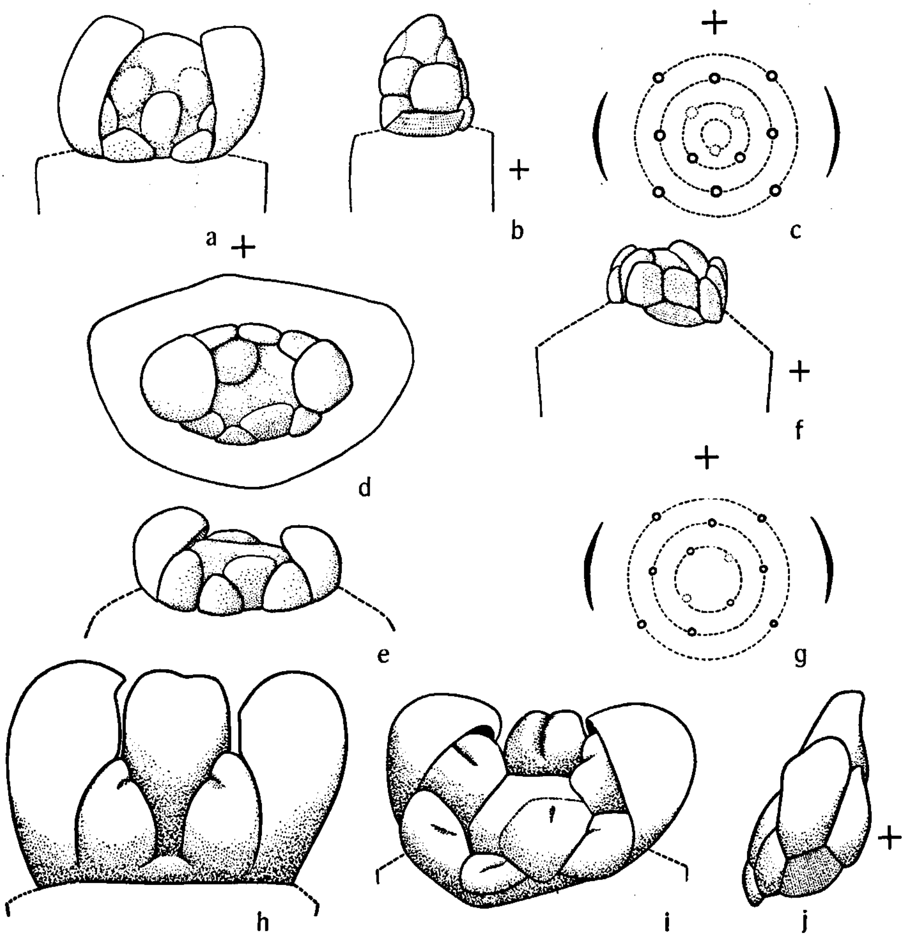


Fig. 21. Flower development in *Drimys piperita*. — a—c. Young bud, calyx removed, × 75; activity centre coinciding with slightly adaxial topographical apex of the not tilted floral apex, causing earlier intiation of primordia on the abaxial side; a. adaxial view; b. lateral view (petals removed); c. approximate diagram. — d—g. *ibidem*, × 75; adaxial tilt of floral apex and difference in width of adaxial and abaxial sides of base of floral apex; d. apical view; e. abaxial view; f. lateral view (petals removed); g. approximate diagram. — h—j. *ibidem*, × 85; activity centre abaxially below topographical apex which is occupied by the adaxial sagittal carpel primordium; tilt of floral apex abaxial;furrow in carpel primordia not continuous with surface of floral apex; h. adaxial; i. abaxial; j. lateral (petals removed). — (a—c. entity *9. montis-wilhelmi*, *Vink 17392*, ♂; d—g. entity *25. heteromera*, *Vink 17157*, ♀; h—j. entity *22. coriacea*, *Vink 16927*, ♀).

comparing primordia of different 'whorls': the higher inserted ones very soon become larger than the older, lower inserted ones. These differences between carpels in ♀ flowers become distinct at an earlier stage than those between stamens in ♂ flowers. Whether an overall difference in the rate of growth between primordia on the adaxial and those on the abaxial side is involved als well could not be ascertained as it is difficult to establish which primordia are of the same age without making use of their size. Moreover the comparison of sizes of primordia is already difficult in itself as the adaxial primordia tend to be flattened longitudinally and the abaxial ones apically.

In several female flowers the activity centre was located so far down on the abaxial side of the floral apex that it occupied a central — rarely even a slightly abaxial — position on the tilted floral apex.

In entities with a large number of stamens the space between the first pair of stamen primordia on either side of the base of the floral apex is large enough for one or more primordia that are initiated later (fig. 21d—g). The number of primordia filling this space varies in accordance with the space available, both when comparing the abaxial or adaxial sides of different flowers or the adaxial and the abaxial side within one flower. In case the available space is too small for even one primordium, as in the above simple cases, there can still be a difference between the space on either side of the floral apex. Then the primordia become located at different heights above the base line of the floral apex; the smaller the available space between the already existing primordia the higher their location.

Although I compared many flowerbuds, I could not ascertain whether the differences in the space available between the first primordia are due to (1) initial differences in the size of the circumference of the floral apices, (2) different rates of growth of the floral apices between the initiations of stamen primordia, (3) differences in space used up by the stamen primordia, or (4) combinations of these possibilities. My impression is that the first possibility is the most likely one. It will be very difficult to obtain definite proof because of the impossibility of predicting the number of stamens, even when considering the position of the flowerbud within the (in) florescence. In (sub)mature flowers a relation between the circumference of the torus and the number of stamens inserted on its base is easily observed when comparing flowers of the same florescence.

From the above as well as from the arrangements of the stamens observed in all stages of development in several hundreds of flowers, I am forced to conclude that the stamens are not arranged in fixed patterns like whorls or spirals. The arrangements are according to the space available at the greatest possible distance from the activity centre, either at the base of the floral apex or above already existing primordia. In simple cases this arrangement approaches a whorl.

In order to check this interpretation some constructions were made. Before doing so the following assumptions had to be made:

(1) the growth of the floral apex during the initiation of the stamens allows the use of a cylinder as a model; this is in accordance with the more or less cylindrical form of the basal part of the torus in (sub)mature flowers with many stamens;
(2) all stamen primordia take an equal part of the surface of the floral apex;
(3) there exists a minimum distance between the stamen primordia; in the constructions the primordia have been drawn as circles the radius of which is half the minimum distance.

In such constructions it is the form of the base which determines the results. From observations the following data are obtained:

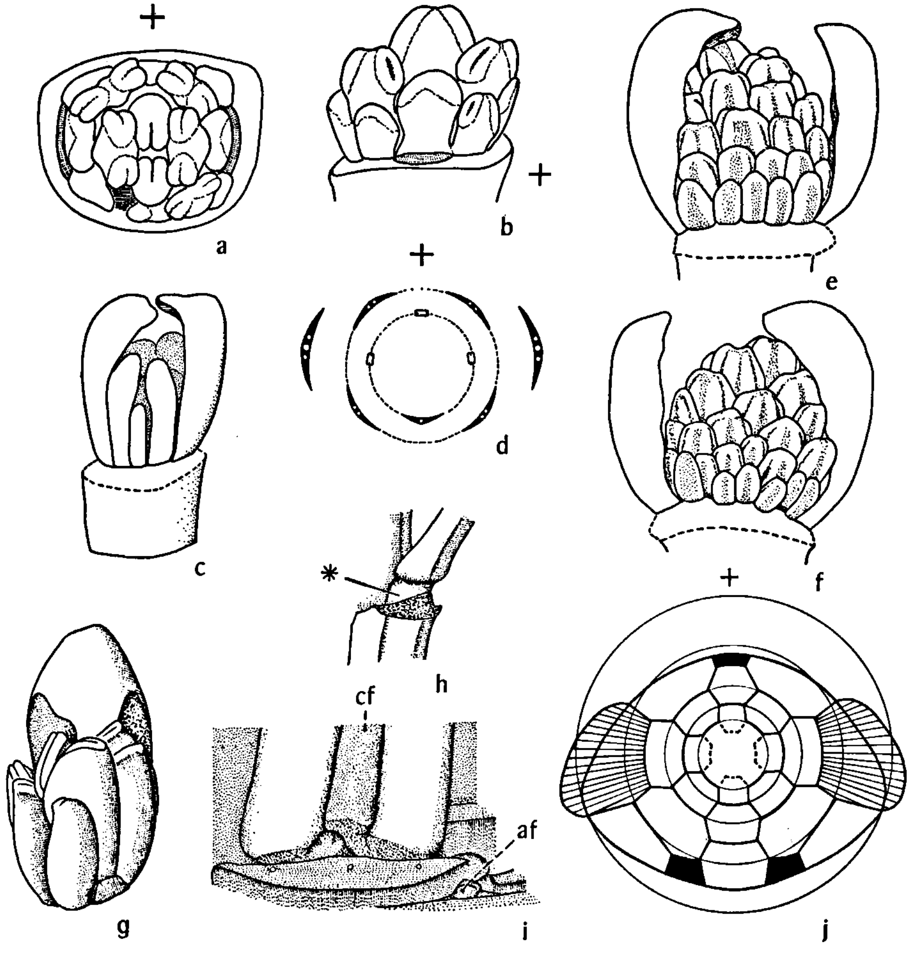


Fig. 22. a & b. Young male bud, calyx and petals removed, × 50; showing early difference in size between adaxial and abaxial stamens and between higher and lower inserted ones; a. apical; b. lateral; horizontally hatched: abortive stamen primordium. — c. young bud, calyx removed, × 25, showing decreasing size of petals towards the sagittal plane. — d. diagram of lower part of a flower showing number of traces at insertion of petals. — e & f. abaxial and adaxial sides of bud after removal of calyx, × 50, showing arrangements of stamens. — g. young carpels, stigmatic tissue not yet developed, showing differences in size. — h. unusual occurrence of 'cushion' (*) at the insertion of a solitary flower. — i. 'cushion' of three-flowered florescence; central flower (cf) inserted distinctly higher; abortive flowerbud (af) at lower right. — j. diagram of young flower in which the initiation of appendages is not yet finished, showing differences of the height of the floral apex and of the width of its base between the adaxial and abaxial sides; black: open spaces; hatched: petal insertions. — (a—d, g—j. *Drimys piperita*; e & f. *D. purpurascens*. — a & b. entity *10. giluwe, Vink 17110*; c. entity *32. cordata, Vink 16038*; d. *ibidem, Van Balgooy 668*; e & f. *Story 7435*; g & i. entity *22. coriacea, Vink 17615*; h. *ibidem, Vink 17556*; j. entity *25. heteromera, Vink 17316*, ♂).

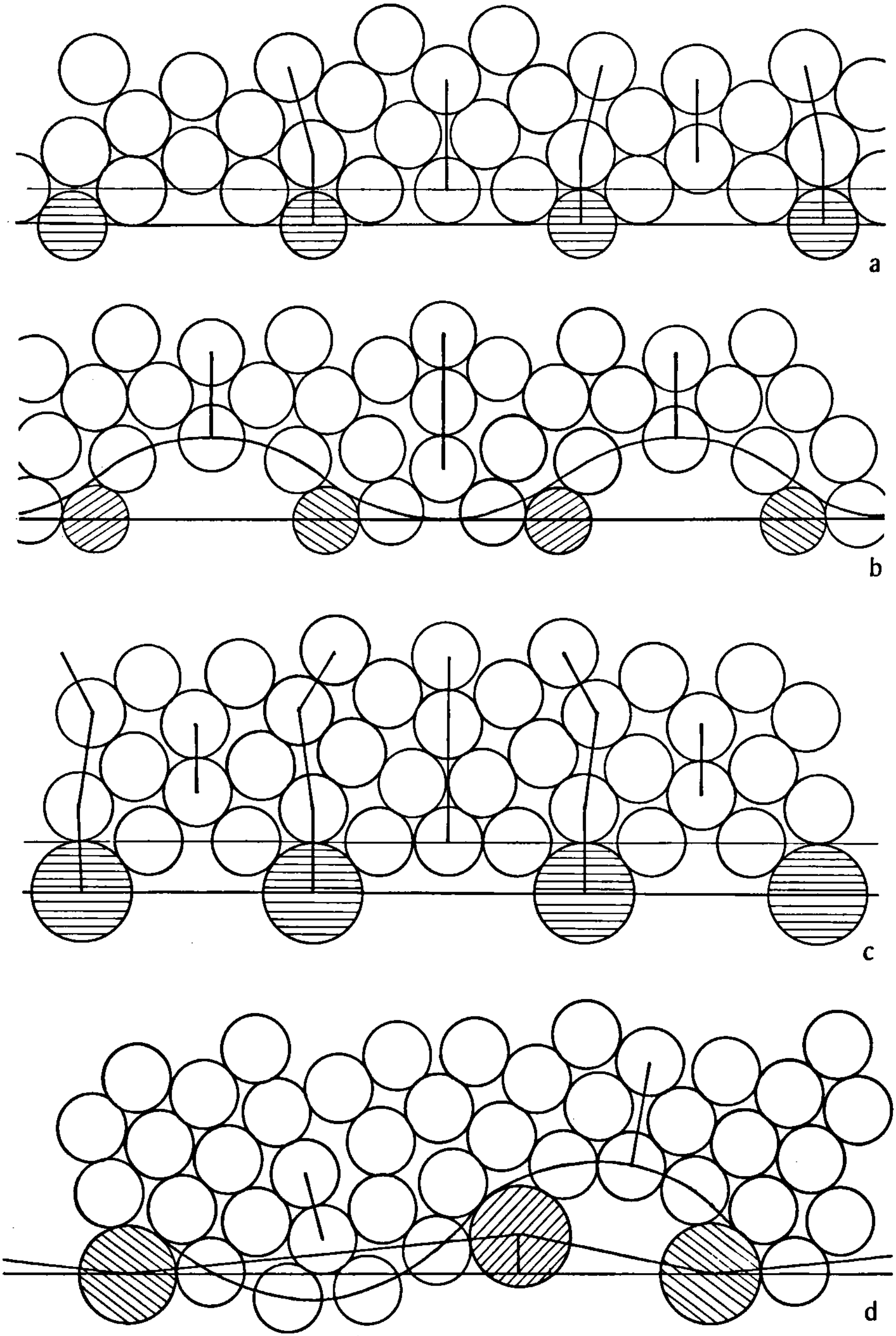


Fig. 23. Constructions of stamen arrangements according to the space available at the greatest distance from the activity centre; for explanation see text.

(4) the width of the base of the torus, between the insertions of the stamens, is abaxially often larger than adaxially;
(5) the first four primordia are located on the base line, adjacent to the petals;
(6) the petal insertions vary from as large as to very much lager than the stamen insertions;
(7) the adaxial side of the base line often curves upwards, the abaxial one downwards.

In the constructions the insertions of the petals, the base line of the floral apex, and the first four primordia were drawn in accordance with the above. The following primordia were placed as low in the drawing as possible. Four of the constructions obtained in this way are presented in fig. 23. The arrangements shown in the constructions agree very well with the actual stamen arrangements, supporting the intrepretation outlined above. This interpretation is valid for all material of *Drimys* I have seen, including sect. *Drimys*. All attempts to fit the observed arrangements into the classical schemes of whorls or spirals failed. Hiepko (1966) constructed a diagram with a spiral arrangement based on measurements of the angles of divergence, but the zygomorphic to asymmetrical form of the torus was not taken in account.

Carpel arrangement in ♂ flowers. In young male flowerbuds the carpels are arranged in the same way as the stamens. In flowers with a low number of almost whorled stamens the carpels distinctly continue the stamens arrangement. The transition from stamens to carpels has no fixed location, neither within the 'whorls' nor between two 'whorls'. In later stages the carpels use up more space on the torus and the resulting differential growth of the torus often distorts the arrangements of the upper stamens. In flowers with a large number of stamens (up to 109!) it is impossible to ascertain the arrangement of the upper stamens and the transition to the formation of carpels, but I found no indication that the situation was different here.

In some ♂ flowers of *Vink 17566*, entity *22. coriacea*, the large number of carpels was arranged in two more or less alternating rows along the sagittal plane and with the morphological ventral sides towards this plane instead of towards the centre of the flower. The abaxial side of this 'comb' of carpels was distinctly nearer the base of the torus than the adaxial side. This probably means that the activity centre, on the verge of terminating its activity, migrated along the sagittal plane, leaving carpels in its wake.

Additional petals. In entities with as a rule more than two petals (4—11) most of the petals are inserted on the base of the torus. However, they are arranged in the same way as the petals and lower stamens in 2-petalled flowers. This conclusion was reached from the following observations made on material from Borneo *(Ding Hou 249, 254)* and material of entity *32. cordata* (due to the condition of the material no observations could be made on other entities concerned):
(1) in submature buds the aestivation of the petals shows 2 outer lateral petals, followed by the abaxial- and adaxial-lateral ones, the petals in the sagittal plane occupying more inward positions;
(2) the first primordia initiated after the sepals are those situated laterally;
(3) in later stages of development the size of the young petals decreases from the lateral to the sagittal ones (fig. 22c);
(4) if the petals have different numbers of traces at their insertions (1—3) then the lateral petals have the largest, the petals in the sagittal plane the smallest number (fig. 22d);
(5) if the petal in the sagittal plane is absent its place is taken by a stamen (fig. 22d);
(6) in entity *25. heteromera*, which often has a variable number of petals within a single (in)florescence, the petal(s) additional to the lateral ones replace (a) stamen(s).

Usually the number of additional petals is not constant, not even within a single florescence. In many entities, however, these petals are always present just as in another set of entities they are always absent (2-petalled flowers) or very rare. In a few entities, like *25. heteromera*, the additional petals may be present or absent; in one case *(Vink 17157)* I found in that entity 2- and 6-petalled flowers in the same florescence.

Absence of petals. As said above petals can replace stamens; in some aberrant cases the situation was reversed and the lateral petals were replaced by stamens; these were distinctly more robust — especially their anthers — than the neighbouring stamens.

Irregular growth of the floral apex. In some cases the floral apex increased in size after the initiation of the first 'stamen' primordia. In some buds of *32. coriacea* there was space for only one primordium between the lateral petals, but at a later stage more primordia were initiated above this solitary one, showing that more space had become available (fig. 20j—l).

In other buds of the same entity some sectors of the torus showed an increase in the number of floral appendages in comparison with the remaining sectors. The sectors were defined — on the lower part of the torus — by the positions of the lateral, sagittal, and adaxial- and abaxial-lateral appendages on the base of the torus. Admittedly such a situation can also be explained as resulting from an initially irregular form of the floral apex.

Carpels. In male flowers the early primordia of stamens and carpels look identical, but the carpel primordia soon become larger than those of the stamens and, moreover, develop a ventral-apical median furrow. In nearly all cases the furrow ended open towards the floral apex, the margin of the furrow being compressed hippocrepiform (fig. 20 i & m). Dorsal growth of the primordium brings the furrow into a vertical position on the ventral side, the furrow still being open towards the floral apex when the carpel is *c.* ¾ mm high. Sometimes the furrow and the floral apex are already separated at a very early stage by a stipe a few cells high. When the carpel primordium becomes larger the furrow widens towards the inside of the carpel, and the opening of the furrow — which has been very narrow all the time — closes by appression of its margins. In later stages the margins develop stigmatic crests and the carpel is lifted by the development or the elongation of the short stipe.

A lip on the ventral side of the furrow was not observed in very early stages, except in *Vink 16927*, ♀, entity *22. coriacea* (fig. 21h—j), where the bottom of the initial furrow did not reach the floral apex and the margin enclosed the furrow on all sides as soon as it became outlined. As the early stages of the carpel can only be studied accurately in properly fixed material, the observations were restricted to the entities *9. montis-wilhelmi*, *10. giluwe*, *22. coriacea*, and *25. heteromera*. Thus the fact that only a single specimen was found in which the ventral lip (Tucker: adaxial lip) is present does not allow any conclusion on the distribution of this character in *D. piperita.*

2. Section Tasmannia: D. purpurascens, D. stipitata, D. insipida. Only very limited observations could be made on herbarium material. As far as could be verified no important differences with *D. piperita* are present.

3. Section Tasmannia: D. lanceolata. Tucker & Gifford (1966a) have published an excellent description of the ontogeny of the flower of this species, so I will restrict myself to some additional notes.

The tilt of the floral apex (already existent in the flower primordium) is present in this species as well. It is described by Tucker and Gifford as a curvature in the axis of the flower (see also their figs 6, 12, 14, 16, 18).

The number of sepals is considered to be two. Closer observation, however, shows that in the larger flowerbuds usually a minute lobe is present in the hinges between the two sepal apices, curved inwardly. When checking the early stages of development it was revealed that two (rarely three) distinctly defined lateral sepal primordia are present, connected by ridges. The abaxial ridge is wider and inserted lower than the adaxial one. In later stages the ridges often form more or less separate lobes which in all stages are far smaller than the lateral sepals. I think it is a matter of opinion whether these lobules are interpreted as (remnants of) a second, inner pair of sepals or as the result of unequal growth of the ridges connecting the lateral sepals. As the margin of the lateral sepals can be slightly bilobed in later stages, and in other species the sepal apices can be lobed as well, I prefer to maintain the concept of one pair of fused sepals, with the connecting ridges showing some minute lobing.

The abaxial petals (on the lower side of the floral apex) are the first to be initiated, followed by the adaxial ones. Differences in size of petal primordia on one side of the flowerbud were in accordance with a lateral tilt of the floral apex. Although the observations are too limited to draw firm conclusions, they are in complete agreement with the descriptions given for *D. piperita*, the 'helical succession of appendages' mentioned by Tucker & Gifford being at least questionable.

Tucker & Gifford indicate the carpel as terminal because 'it utilizes the entire apex, leaving no residuum. During carpel enlargement the base of the cleft, the supposed refugium for the apical remnant, bears no resemblance to the floral apex. The possibility that the apex persists, overtopped and low on one side of the enlarging carpel, is unsupported by any visual evidence.... Carpel initiation in *D. lanceolata*, being terminal, involves processes in early stages unlike those which produce lateral carpels.'

Purely descriptively the carpel is terminal as is quite evident from the descriptions given by the authors. However, in case their opinion — as cited above — expresses a situation principally different from 'lateral' I would like to bring forward some contradicting evidence:

(1) The carpel is orientated with its stigmatic crest towards the abaxial side of the flower. If a second carpel is present, this is opposite to and abaxial from the first carpel. Both behave, as far as orientation is concerned, as lateral appendages.
(2) The entire floral apex is used up by the solitary carpel. But this is also the case in flowers of *D. piperita* with many carpels. This is unlike the situation in sect. *Drimys*, but *D. lanceolata* should first of all be compared with the other species in sect. *Tasmannia.*
(3) In (sub)mature flowers the torus below the carpel is higher on the abaxial side than on the adaxial one (fig. 17h).

Although the terminology introduced on p.268 is based purely on the external morphology of the floral apex and has no roots at all in histogeny, I suggest that the solitary carpel of *D. lanceolata* is terminal in reference to the topographical apex, but adaxial in reference to the activity centre; the latter terminates its activity and is lost in the abaxial side of the torus (not of the carpel). Such a process could be compared with the early development of the flower in *D. piperita*, where the adaxial sepal is initiated on the topographical apex of the flower primordium and the activity centre (floral apex) is located on the abaxial side.

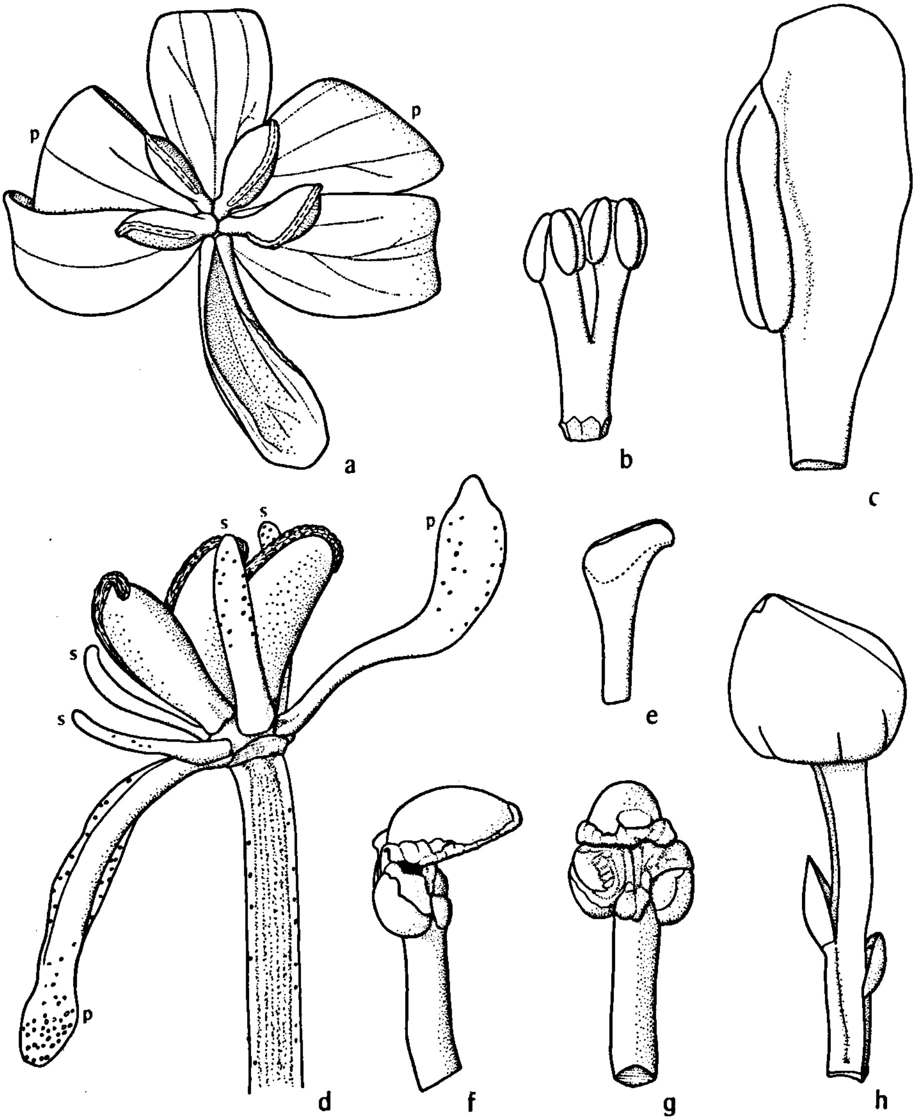


Fig. 24. Abnormal structures in *Drimys piperita*. — a. Female flower with lateral petals (p), three additional petals, and an appendage intermediate between petal and carpel, × 5. b. double stamen with two traces at the point of insertion, × 12½. c. petaloid stamen, × 12½. d. female flower with two petals (p) and four staminodes (s), × 7½. e. sterile carpel from male flower with long stipe, the slit not closed, and without stigmatic tissue, × 12½. f & g. structure intermediate between stamen (basal part) and carpel (apical part) in lateral and ventral view resp., × 12½. h. peduncled central flower of a 5-flowered florescence, × 5. (a. entity *25. heteromera, Vink 17157*; b & e. entity *32. cordata, van Balgooy 221*; c. entity *32. cordata, van Balgooy 668*; d. entity *25. heteromera, Millar NGF 14644*; f & g. entity *8. crassipes, van Balgooy 180*; h. entity *22. coriacea, Vink 17553*).

4. **Section Drimys.** Tucker (1959) has published comprehensively on this subject. Again I will confine myself to some additional remarks.

The flower primordium and the base of the floral apex are usually tilted both abaxially and laterally, due to the position within the dorsiventrally compressed florescence, whereas the outline of the base of the floral apex is strongly influenced by the bracteoles and the neighbouring flowerbuds. Thus, on judging the arrangement of the floral appendages, the form of the floral apex or torus needs careful consideration.

The limited number of FAA-fixed terminal buds that was at my disposal was supplemented by both terminal buds and flowerbuds of relatively large size from herbarium material. From this material I concluded that both petals and stamens are arranged according to the same principle as the 'stamens' in *D. piperita.*

An additional argument for this is the rapid succession of the initiations. In *D. piperita* there is a distinct interval in time (as expressed by the size of the appendage primordia) between the initiations of the sepals and the lateral petals and between the lateral petals and the 'stamens', whereas within each category the succession of initiation is very rapid. In the material of sect. *Drimys* such an interval is only present between the initiations of the sepals on one hand and the petals plus the stamens on the other. In early stages the primordia of the petals cannot be distinguished from those of the stamens (fig. 12q—v), just as is the case with the 'additional' petals in *D. piperita.*

The situation in sect. *Drimys* may prove to be more complicated through the inclusion of more than one type of petal arrangement (compare the different arrangements of lateral and additional petals in sect. *Tasmannia*). A terminal flower in unidentified material from the Botanische Garten in Münster, with a strongly leafy calyx, had two outer lateral petals alternating with the sepals, two petals alternating with the outer ones, and 11 petals in the 'stamen arrangement'. As early stages of development were not available it is difficult to ascertain whether such an arrangement is accidental or not.

Within a florescence the terminal flower is the first to initiate sepals, followed by the lateral flowers in acropetal succession (fig. 12d—i). The young sepals are always slightly adaxial from the true lateral position, the connecting ridges being shorter and inserted higher on the adaxial side, corresponding with the tilt of the floral apex (fig. 12l—n).

When comparing very young flowerbuds from the same florescence it appears that the ridges connecting the sepals are shorter in the older and larger buds (fig. 12 o & p). It could not be established whether this implicates a narrowing of this separation of the sepals in a single calyx in the course of its growth.

DIAGRAM OF THE FLOWER

From the chapters on the morphology and ontogeny it is evident that in endeavouring to construct a diagram of the flower one is faced with quite a number of difficulties. Summarizing these are:

a. the tilt of the base of the torus;
b. the dorsi-ventral flattening of the flower;
c. the activity centre often not coinciding with the topographical apex;
d. the widths of the adaxial and abaxial sides of the base of the torus often being different;
e. the position of the flower within the florescence which may cause additional lateral tilt and an asymmetrical outline of the base of the torus;
f. the arrangement of the additional petals, the stamens, and the carpels according to the space available at the greatest distance from the activity centre.

In constructing the diagram of *Drimys winteri*, Hiepko (1966) did not take these complications in account so that in my opinion his diagram is far too much idealized.

Because of these complications it is virtually impossible to construct a diagram of general validity. Only certain less complicated cases can be represented reasonably exact, for instance the flowers with a small number of stamens and with a regularly outlined, not tilted base of the torus. In those cases whorls can be recognized. In all other cases the arrangements defy a classification in one of the traditional categories, whorls or spirals.

Figure 22 j is an approximation of the situation in a male flowerbud (*Vink 17316, D. piperita, 25. heteromera*) in wich the initiation of floral appendages was not yet completed. This figure gives the arrangement in relation to the activity centre and shows both the tilt and the abaxial-adaxial difference in width of the base of the floral apex. I did not succeed in making such constructions for more complicated flowers.

COMPARISON OF ARRANGEMENTS OF FLORAL APPENDAGES

It is useful to pay attention to the inflorescence described on p. 257 before we compare the arrangements of the floral appendages in *Drimys* and in *Pseudowintera*. This inflorescence demonstrates that several factors controlling its construction can become disconnected, that is, factors determining certain aspects of the inflorescence are not as well co-ordinated in time and space as is necessary for its normal development.

When considering the differences in the location of the maximum development of certain characters, e.g. maximum pedicel length, maximum number of floral appendages, and the beginning of flowering in the 'normal' inflorescences of sect. *Tasmannia*, it is evident that the co-ordination between these factors is weak. Within the florescences, however, this co-ordinantion is very strong.

Comparing the irregularities in co-ordination with the regularities it becomes clear that we may assume the presence of a large number of separate factors, each determining a certain aspect of the total construction of the inflorescence. These factors show a certain mutual co-ordination which can be weak or disturbed.

In comparing the arrangements of the floral appendages we wil use the form, consistency, etc. to determine the name of an appendage (e.g. sepal, petal). To compare the locations of the appendages we need a reference; for this I have chosen the level between the arrangement in (sub)opposite pairs and that according to the principle of available space at the greatest distance from the activity centre, outlined on p. 270 onward. In 2-petalled *D. piperita* flowers this level separates the petals and the stamens or carpels, in *D. lanceolata* it separates the calyx and the petals. The part of the flower below this level of reference is called *A*, that above it *B*.

I am not sure whether the *A*-arrangement cannot be explained in the same way, in accordance with the 'available space', as the *B*-ones. If so, the distinction is still useful as in that case an additional explanation is needed for the change in the ratio of numbers of primordia and the size of the floral apex.

As described for *Drimys*, petals can occur just above, just below, or on either side of the level of reference. In *Drimys piperita* only two petals are present in *A*, but in *Bubbia* four petals are inserted in this zone.

The co-ordination between the availability of certain locations on the floral apex and of the petal-determining factor shows different degrees of stability. In normally 2-

petalled entities of *D. piperita*, 3-petalled flowers occur rarely to rather often. There the petal-determining factor is normally confined to the availability of locations in the *A*-zone, but occasionally is prolonged in activity and induces a petal in the next available *B*-location.

In entity *25. heteromera* this prolongation occurs more often and to a larger extent. The result is the occurrence within the same florescence of 2—6-petalled flowers; two of the petals are inserted in the *A*-zone, the others in the lower locations in the *B*-zone. In a number of entities this prolongation is stabilized and the number of petals is at least four, but never constant. This inconstancy is probably related with the irregular availability of locations in the *B*-zone; thus it is impossible to establish a constancy in the duration of the prolonged activity of the petal-determining factor from the number of petals present.

When the beginning of the activity of the petal-determining factor shows a complete and stabilized shift into the *B*-zone, the arrangements of *D. lanceolata* and sect. *Drimys* arise.

Rarely the petal-determining factor terminates its activity too early, resulting in the replacement of one (or even all) petal(s) of the *A*-zone by stamens.

It is difficult to decide whether a wide or a narrow petal zone should be regarded as primitive. As the more primitive (by other characters) genera have a higher number of petals and the most reduced forms of *D. piperita* are 2-petalled, it is likely that a wide zone is more primitive. The term 'prolongation' in the above description does not indicate a phylogenetic line of thought, but is merely used to interpret the more complicated cases on the basis of the simpler (probably reduced) ones.

When the locations of the sepals are related to their orientation with regard to the bract(eoles) subtending the flower and to their distance from the level of reference, we also find a shifting of the sepal-determining factor if different taxa are compared. A prolongation of the sepal-determining factor (3-sepalled calyces) was rarely found.

With these comparisons in mind we can make a basic diagram; the addition of the co-ordination between the locations and the appendage-determining factors will result in the diagrams of the separate taxa (fig. 25). These diagrams have been greatly simplified; the difference between the *A*- and *B*-zones is schematic. In diagrams 2 and 3 the determinations in the locations of the *B*-zone have not been indicated as these are highly variable; in diagram 4 only the lower ones have been indicated to show the complete shift of the petal-determining factor into the *B*-zone. From these diagrams an acropetal shifting upwards of the sepal-determining factor can be inferred as already stated, but this raises the unanswered question of the influence of 'bypassed locations' on the orientation of the sepals.

Normally the change in determination is sharp, although the higher placed petals decrease in size and sometimes show a decrease in the number of traces at their insertions. When there is a short overlap of the activities of successive determination factors, 'terata' are formed (fig. 24). These have characters of two kinds of appendages: sepaloid-petaloid, petaloid-staminoid, and staminoid-carpelloid in male flowers, sepaloid-petaloid and petaloid-carpelloid in female flowers.

Summarizing: it is assumed that (unknown) determination factors have a more or less stable co-ordination with each other and with the availability of locations on the floral apex. Changes in this co-ordination result in different diagrams, in changes in the number of certain kinds of floral appendages, and occasionally in terata.

These assumptions fit in with the theory of serial genetic action in flower formation

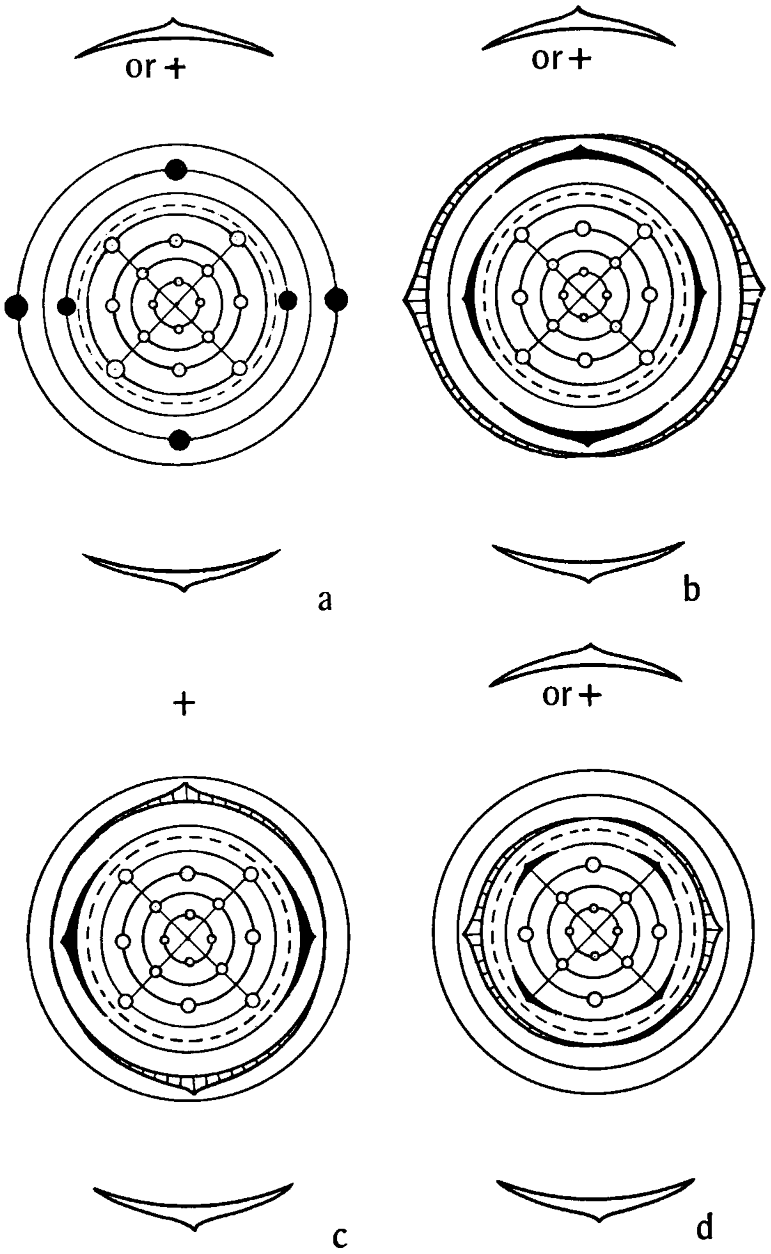


Fig. 25. Comparison of flower diagrams. — a. Basic diagram; broken line gives level of reference, the filled circles are in the *A*-zone, the open circles in the *B*-zone. — b. simplified diagram of *Pseudowintera* and *Bubbia*. — c. *ibidem* of *Drimys* sect. *Tasmannia* except *D. lanceolata*. — d. *ibidem* of *Drimys lanceolata* and of *Drimys* sect. *Drimys*. — hatched: sepals; black: petals; open circles: additional petals, stamens, and/or carpels.

outlined by Wardlaw (1965), and with that on the determination processes given by Zimmermann (1965). It should be understood, however, that the term 'determination factors' used in this paper often comprises a complete set of '*Elementarprozesse*' as defined by Zimmermann. The above description of the abnormal inflorescence is an illustration of the '*Dissoziation der Elementarprozesse*'.

REPRODUCTION*

As can be inferred from the herbarium material and as I have observed in the field, the production of fruits and seeds is in *Drimys piperita* good to very rich. Mature seeds that were dissected usually appeared to be healthy and contained an embryo, though very small. Nevertheless, something seems to be wrong with the generative reproduction.

In 1962 (Arfak Mts), 1963 (Kubor Ra.), 1965 (Mt Wilhelm), and 1966 (Mt Ambua etc.) seeds of various entities of *Drimys piperita* were sent from New Guinea to Holland and sown out in Leiden, Boskoop, and Wageningen. Both entire fruits and cleaned seeds were used. Although seeds of quite a number of species from other families (sent in the same batches) germinated, not a single *Drimys* seed did. Parts of the 1966 batch were treated with heat, cold, and acid without result.

In 1965 Mr. van Balgooy on my request searched for young seedlings on Mt Wilhelm but did not find any. When visiting the Doma Peaks area (Mt Ambua c.s.) I traced only 13 seedlings, 11 of these close together at 3120 m altitude om Mt Ne, the remaining two at 3180 m altitude on the same ridge; mature plants of *Drimys*, however, were quite common and wide-spread.

Apparently the reproduction is not by seed, at least in some areas. This observation triggered the search for indications of vegetative reproduction.

In the Doma Peaks area I observed reproduction by 'runners' in entity *24. chartacea*, and by the toppling over of slender treelets followed by rooting and sprouting at the nodes in entity *22. coriacea* (see also p. 290, 291).

A shrubbery on Mt Ambua, consisting of *Prunus pullei* and entity *9. montis-wilhelmi*, had male *Drimys* plants on one side, female on the other side, and both male and female in the middle.

Mr. Van Balgooy reported a small male population of entity *25. heteromera* and a small female population of entity *2. subalpina (Van Balgooy 571)*.

On the Kubor Range plants of *1. reducta* usually occurred gregariously. On the labels of his *reducta* collections from Mt Giluwe Schodde mentioned 'soboliferous shrub' and he collected a specimen recalling the method of vegetative reproduction found in *chartacea* (*Schodde 1739* in CANB). The adventitious roots and ascending habit of specimens from the Kubor Range *(Vink 16071)* are suggestive of a similar habit.

From these observations I am inclined to conclude that, at least in some entities, the vegetative reproduction is more important than generative reproduction. This will have a stabilizing effect on the local populations and may contribute to the confused systematics, as discussed in the chapter on the specific delimitation. Further evidence from field botanists is desirable.

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*) Exclusively based on *Drimys piperita*.

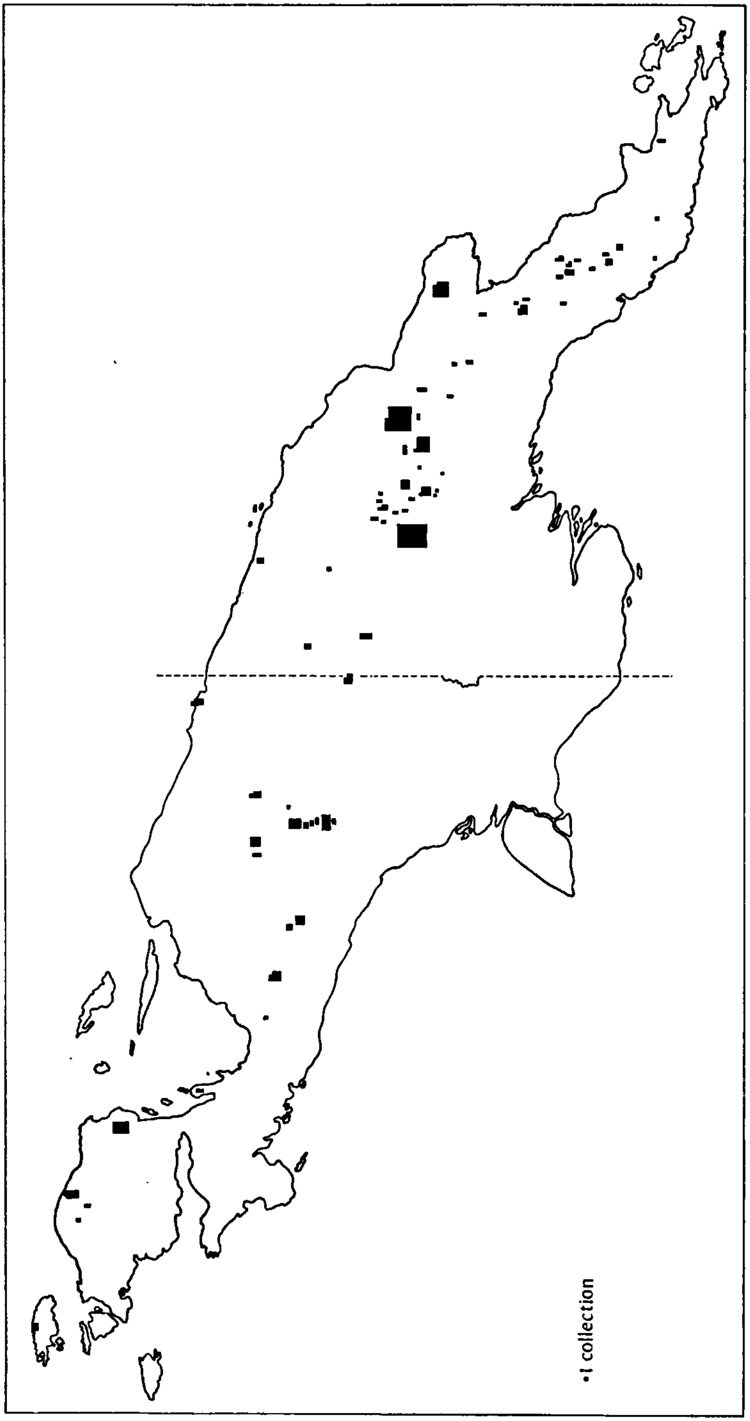


Fig. 26. Distribution of all *Drimys* collections from New Guinea studied.

SPECIFIC DELIMITATION IN SECTION TASMANNIA

A. C. Smith (1943b) recognized 1 species in the Philippines, Borneo, and Celebes, 6 species in Australia, and *c.* 29 species in New Guinea.

Of these the Australian *D. lanceolata* is easily separated from the other species by its lateral sepals and by the confinement of the petals to the *B*-zone (see p. 278). All the other species have their sepals in the sagittal plane and their *A*-zone is normally provided with two petals.

Further the Australian *D. purpurascens* and *D. stipitata* can be easily distinguished by their funiculus and their distinctly and abruptly stipitate fruits provided with septate pulpa. The likewise Australian *D. insipida* can be picked out from the remainder of the species by its transversely and longitudinally septate pulpa. As the development of the transversely septate pulpa is often imperfect in *D. insipida* and as there are tendencies within the remainder of the section to form such septa, this distinction is rather weak compared with the delimitions of the other species mentioned. Nevertheless I consider this delimitation to be justified as the result is a rather homogeneous species with a variability of its own.

The part of sect. *Tasmannia* that remains after recognizing the four species just mentioned shows a range from minutely-leaved epiphytes to large-leaved treelets and to scramblers with pseudoverticillate, cordate, sessile leaves, the widest range of morphological differentiation within the whole genus! Nevertheless it proved to be impossible to make a sound subdivision of this bulk of material into species as will be explained below.

1. New Guinea.

As is already evident from the distribution of Smith's species, sect. *Tasmannia* has its widest morphological differentiation in New Guinea; therefore attention has to be focused on this island first.

Of Smith's 29 species 20 were known from one locality only, 7 from two localities (often very close together), and 2 from four localities. At present far more material is at our disposal and the areas of several of these species have been widened considerably, but the main feature in this overall picture remains the same, that is, the individual entities have generally proportionally small distributional areas.

With this pattern in mind it is worth while investigating the distribution over the island of the collections available for the present revision. In fig. 26 all these collections have been mapped. The unnumbered sheets of MacGregor from SE New Guinea have been grouped into 'collections' as far as the material and the labels permitted.

When studying this map and remembering the large number of taxonomic entities involved, it is clear that only two areas have been sampled sufficiently to give a reliable base for the study of the relationships between these small taxonomic units: (1) the block formed by the Eastern, Western, and Southern Highlands in eastern New Guinea, and (2) the Mt Wilhelmina complex (from Lake Habbema in the north to Mt Perameles in the south) in western New Guinea. The distance between these areas largely outmeasures the distributional areas of most of the entities, making interpolations extremely difficult.

From the above it must be concluded that in many cases it is impossible to make a study of the variability within an entity throughout its distributional area. This is regrettable because ample data are especially important if the delimitation of the individual entities is vague. Such a vagueness is highly probable as Smith (1943a) reported sharp delimitations to be absent in sect. *Drimys*. To check this point we will consider the behaviour of *Drimys* in some well-collected localities: (1) Mt Wilhelm; (2) the Mt Wilhelmina complex; (3) Mt Ambua *c.s.*

1a. Mt Wilhelm. (summit *c.* 4500 m a.s.l.; on the S side cultivated up to *c.* 2600 m a.s.l.; in the subalpine zone large deforestations).

From Mt Wilhelm 70 collections are available, making it the second best sampled mountain within the area of the genus.

Mr. Van Balgooy kindly provided me with a map on which his collecting localities are plotted exactly. After studying the labels of other collectors as well, it turned out that the 70 numbers originate from an area of less than 36 sq. km (14 sq. miles) on the E, S, and NW slopes.

Entity *2. subalpina* of the present revision is a shrub or treelet of (1.2—) 2—3 m height, occurring in the open subalpine vegetation between 3800 and 4175 m altitude, but also descending in open terrain to 3350 m altitude. It is mainly characterized by its narrow leaves with steep nerves. The veins are indistinguishable between the nerves. The 2-petalled flowers are solitary. Although brown *in sicco*, the twigs are yellowish green to yellow *in vivo*, often tinged with red. The leaves are not or weakly aromatic and have a weak to sharp peppery taste (*f.* Van Balgooy). This entity is represented by 27 collections from about 8 sq. km on the S and E slopes and by 1 collection from the NW slope.

No records from outside this small area exactly fitting this picture are available. The nearest is entity *6. subpittosporoides* from Mt Wilhelmina (see there) which differs only in its habitat (shrubberies) and its thicker leaves with less steep nervation. *Subalpina* is sharply delimited from other entities from Mt Wilhelm and no transitions towards these are known.

The material is very homogeneous. In fact, this homogeneous population is over-represented in the herbaria in comparison with populations from other localities; this could easily influence our opinion of its importance if the small size of the sampled area on Mt Wilhelm was not traced.

The entity *1. reducta*, known from the Wissel Lakes, the Mt Wilhelmina complex, Mt Giluwe, and the Kubor Range occurs also in open subalpine vegetation. It differs from *subalpina* by: smaller overall height (0.1—1, rarely up tot 3 m), smaller leaves (up to 3.5 × 1.2 cm against up tot 4.5 × 1.6 cm), the nerves usually at a wider angle with the midrib in the apical halves of the leaves, slightly smaller flowers, and generally fewer fertile carpels (usually 1 against 2—5).

The entities *subalpina* and *reducta* thus differ only in numbers of flowerparts and in dimensions and behave as a pair of replacing taxa. Their narrow relationship is furthermore demonstrated by the entity *subpittosporoides*, which, although occurring in a different habitat, connects them morphologically. An unexplained circumstance is the presence of the smallest form of *reducta* in its locality nearest to Mt Wilhelm, the Kubor Range.

The entity to be considered next is *9. montis-wilhelmi.* It was collected in subalpine shrubberies or on edges thereof at 3300—3800 m altitude. The principal characters are: shrub or treelet 1—6 m high, having rather small leaves with a distinct nervation on either side and this nervation impressed — *in sicco* — on the upper side of very young leaves; the 2-petalled flowers are solitary; the twigs are green *in vivo* and the leaves are not or hardly aromatic and their taste is not peppery (*f.* Van Balgooy).

Montis-wilhelmi is represented by 8 collections from *c.* 2.5 sq.km from Lake Pinde to Kombugomambuno. Seven of these compose a uniform group of which only *Brass 30061* is reported to have aromatic leaves. One collection *(Van Balgooy 270)* is slightly different; it was collected a few metres outside the forest edge in the grassland. Its leaves are approximately double the size of those of the other collections and *in vivo* its twigs were yellow; besides, the leaves were slightly aromatic. This plant can only be separated from small-leaved *25. heteromera* by the impressed nervation and venation on the upper side of its young leaves and by its solitary flowers.

Montis-wilhelmi is known from Mt Ambua and Mt Sugarloaf eastwards as far as Mt Amungwiwa (S of Wau), where it becomes transitional to entity *4. versteegii.* The latter again can only be distinguished from *reducta* by its habit (2—4.5 m high) and habitat (forests and forest borders)! If there are any connections of *montis-wilhelmi* with plants from the Mt Wilhelmina complex, these are not clear.

Intermediate between *montis-wilhelmi* and the next entity is *Van Balgooy 281*, although there are no clear differences with *Van Balgooy 270* just mentioned. This next entity is *8. crassipes*, a shrub 2—3.5 m high in subalpine shrubberies or edges thereof at 3535—3800 m altitude, known from 5 collections only. It is closely related to *montis-wilhelmi*, but differs from it by its candelabriform habit, its more robust twigs, thicker and larger leaves, and larger fruits. In the most coriaceous leaves the venation is partly obscured but in young leaves the nervation and venation are distinctly impressed *in sicco*. Its leaves are aromatic and have a sharp peppery taste, but this is also reported for *montis-wilhelmi* from the Kubor Range. The young parts of the twigs, the petioles, and the pedicels are red to reddish *in vivo*.

Two collections from the Kubor Range, doubtfully assigned to *montis-wilhelmi*, are actually intermediate between the latter entity and *crassipes*. On the other hand the plants from Mt Wilhelm are very difficult to separate from entity *6. subpittosporoides* from Mt Wilhelmina, making the network of relationships still more complicated (see above *sub subalpina*).

Shrublets or treelets from subalpine shrubberies attaining 0.5—5 m height, with larger, more elliptic, and acute to acuminate leaves are grouped together in entity *25. heteromera.* The 2-petalled flowers are non-solitary in at least one florescence of each inflorescence. Nervation and venation are of the same type as in *montis-wilhelmi*, but *in sicco* these are not impressed on the upper side of the young leaves. In the end this proves to be the only character delimiting *heteromera* from *montis-wilhelmi* (but see p. 290) as the smell and the taste of the leaves is variable and in *Van Balgooy 839* the flowers are solitary and the leaves are so small that the difference with *Van Balgooy 270* is of the same order as the difference between the latter specimen and the other plants of *montis-wilhelmi*.

There are 13 collections of *heteromera* at our disposal. These were all gathered in the neighbourhood of the lakes Aunde and Pinde. Two collections with solitary flowers and a generally slightly more pronounced nervation originate from 2740 and 2770 m altitude respectively; these could be grouped as *25. heteromera B*, but this distinction is untenable outside Mt Wilhelm (see p. 299).

Entity *22. coriacea* is represented on Mt Wilhelm by 1 collection from 2740 m altitude. It is a more robust plant than *heteromera*, but outside Mt Wilhelm these entities become inseparable.

The last entity to be recorded is *32. cordata*, a very distinct plant known by 11 collections from shrubberies and forests at 2530—3350 m altitude. *Cordata* is a shrub of 1.5—4 m high, characterized by its scrambling habit, its pseudoverticillate, sessile, cordate, coarsely nerved leaves, and its 5—9-petalled non-solitary flowers. It is known to occur from Mt Wilhelm as far westwards as the Wabag Subdistrict. Further to the west, between this subdistrict and the Mt Wilhelmina complex, no botanical collections have been made except in the Hindenburg Range and in the Star Mts, where it was not found. In the Mt Wilhelmina complex we find it replaced by entity *31. rosea*. This has smaller leaves with the less coarse nerves placed closer together and at a smaller angle to the midrib; in addition the leaf base is narrower and rounded instead of distinctly cordate. On the basis of these differences *rosea* and *cordata*, although being very similar, can be clearly delimited from each other. It should be remembered, however, that the known distributional areas of *cordata* (200 km long) and of *rosea* (275 km long) are separated by an area, 525 km long, from which no extensive botanical collections are available (on the Hindenburg Range the vegetation is very much disturbed and the subsoil consists of limestone, two factors which may have inhibited the occurrence of *cordata* here). As the identity of the only *rosea* plant from the Mt Wilhelmina complex (Mt Hellwig) is suspect, the gap between the distributional areas of *cordata* and *rosea* is widened to even as much as 700 km! This makes the distinction of these entities suspect at least with regard to its constancy. The suspicion is strengthened by the heterogeneity of the *rosea* plants at hand. Some of the characters are rather inconstant, e.g. leaves less strictly pseudoverticillate, shortly petioled, and with a very narrowly rounded base. In a variability pattern like this, cordate leaves would not be a strange extrapolation. But if there are any intermediates, these have to be sought in the botanically nearly unknown intervening area.

East of Mt Wilhelm no *cordata* is known, but 2 collections from Mt Otto (especially *Brass & Collins 31044*) resemble it very much. They differ from *cordata* by a cuneate leaf base, the presence of petioles, and a less strict arrangement of the leaves in pseudowhorls. These collections connect *rosea* with *heteromera* and *26. polymera*.

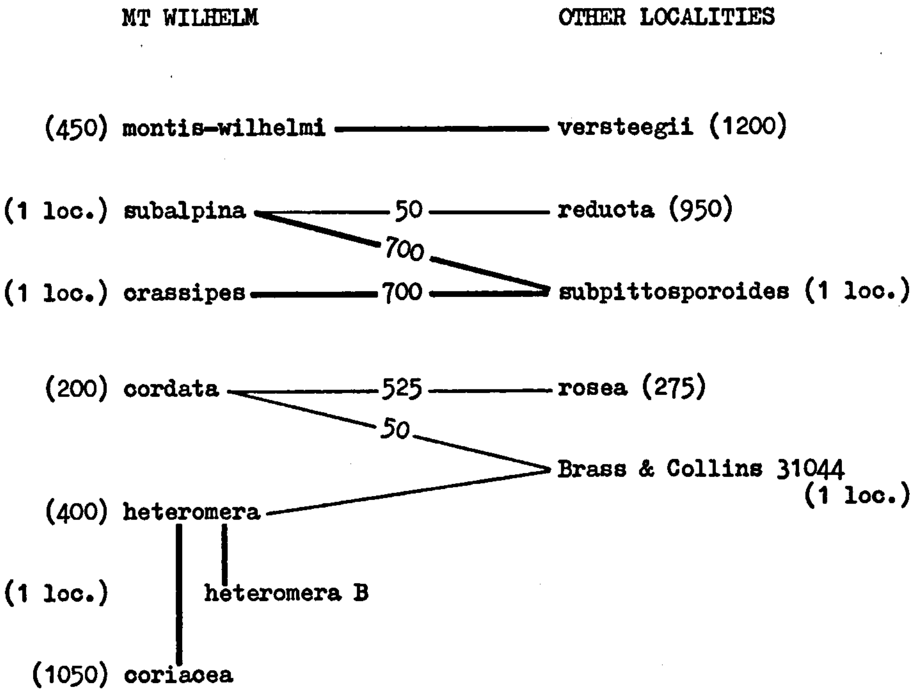
Conclusion. The local populations on Mt Wilhelm are often quite distinct morphologically and can be more or less satisfactorily delimited from each other, often with the aid of field characters. When the same and related entities from other mountains are taken into consideration as well, they appear to form part of an intricate network of relationships which obscures the differences found between the local populations. In some cases intermediates are found on Mt Wilhelm itself, but usually these form a minority of the collections. Lack of adequate information hampers the evaluation of characters, e.g. the cordate leaf base.

KEY TO ENTITIES OF DRIMYS PIPERITA FROM MT WILHELM

(intermediate specimens not included)

1a. Leaves sessile, cordate, subopposite or pseudoverticillate; petals 5—9; up to 5 flowers per bract . . **32. cordata**
b. Leaves petiolate, with cuneate (rarely rounded) base, scattered; petals generally 2; either up to 7 flowers per bract or all flowers solitary 2
2a. Flowers all solitary 3
b. Flowers up to 7 per bract 6
3a. In mature leaves veins inconspicuous between nerves . . . . **2. subalpina**
b. In mature leaves veins at least partly distinct between nerves 4
4a. *In sicco* nerves flat on upper side of young leaves . . . . **25. heteromera B**
b. *In sicco* nerves impressed on upper side of young leaves 5
5a. Leaves up to 5.5 × 3 cm, firmly coriaceous, *in vivo* taste peppery; twigs erect, little branched, *in vivo* petioles and pedicels red or reddish . . . . **8. crassipes**
b. Leaves up to 4 × 2 cm, coriaceous, *in vivo* taste not peppery; twigs not erect, repeatedly branched; *in vivo* petioles and pedicels light green to green . . . . **9. montis-wilhelmi**
6a. Leaves up to 14 × 4 cm . . . . **25. heteromera**
b. Leaves up to 20 × 8 cm . . . . **22. coriacea**

The relationships of the entities found on Mt Wilhelm can be summarized as follows:



Thick lines: inseparable entities; thin lines: narrowly related ones. Length (km) of known distributional areas between brackets. Numbers in connecting lines: distance (km) between known distributional areas.

1b M Wilhelmina complex. The area between bivouac Alkmaar on the Lorentz River in the south and the valleys of the Baliem River in the north are treated as one mountain complex of which Mt Wilhelmina forms the highest part (*c.* 4700 m a.s.l.). From Mt Wilhelmina southwards the following ridges and peaks are of importance here: Mt Hubrecht (3390 m), Mt Wichmann (3100 m), Mt Hellwig (2600 m), and Mt Perameles (*c.* 1000 m). They were botanised by von Römer (1909—1910) and Pulle (1912—1913). Brass & Meijer Drees collected (1938—1939) on the northern slopes of this complex: from the base of Mt Wilhelmina to Lake Habbema (3225 m) and the Bele River (*c.* 2200 m). The 38 Drimys collections available originate from an area of roughly 100 sq.km (*c.* 38 sq. miles). The density of *Drimys* collecting thus is far lower than that om Mt Wilhelm.

The differences between the entities are (in herbarium material) even smaller than on Mt Wilhelm; to add to the difficulties, the fieldnotes are quite insufficient for our purpose. Notwithstanding this situation it is quite useful to group the specimens into entities as otherwise the overall variability would become extremely large.

Reaching the 'forest limit' at 4050 m altitude is entity *6. subpittosporoides* (Brass 1941). Four collections have been made at 3800—3900 m altitude. The resemblance with *2. subalpina* is striking: shrubs of medium height with rather narrow leaves and 2-petalled solitary flowers, occupying the extreme high habitat. It differs from the latter by having strongly coriaceous leaves which are more variable in length and width and have a more conspicuous and less steep nervation. Although these differences are difficult to describe, they could be used for delimitation. However, this is a hazardous task when we realize what we have in hand: 4 *subpittosporoides* collections from an area of at most 10 sq. km and 27 *subalpina* collections from 8 sq. km, the localities being 700 km apart! Moreover, these differences are obscured in *Brass 9068* (arranged here under *reducta*) from Lake Habbema which is intermediate between *subpittosporoides, subalpina,* and *reducta.* As already stated when discussing the Mt Wilhelm entities, *subpittosporides* links the — on Mt Wilhelm quite different — *subalpina* and *crassipes.*

The entity *1. reducta* is represented by 2 collections from the vicinity of Lake Habbema (3000—3300 m altitude) and 1 from Mt Wichmann (3000 m altitude). It is smaller than *subpittosporoides* in overall height and in leaves and flowers.

Entity *4. versteegii* is known from the Mt Wilhelmina complex by 1 collection only (Mt Hubrecht, 3100 m). In this locality the differences with *reducta* in leaf size and leaf texture are more pronounced than in eastern New Guinea, from where the other collections of *versteegii* originate. The disjunction between Mt Hubrecht and its next station, Mt Dickson, is about 1000 km wide! In view of the small areas of the entities this may point to parallelism.

Entity *18. acutifolia* was twice collected on Mt Perameles (1100 m altitude) and twice on Mt Hellwig (altitude unknown).Its rather narrow leaves are sharply acuminate to cuspidate. Four collections from Lake Habbema (3225 m) to Bele River (2350 m) have wider leaves with acute to acuminate apices; these have been inserted into entity *27. reticulata* (two of them as 'doubtful' as their thicker leaves have a coarser nervation and their flavone/flavonol ratio is different). Both entities have rather small fruits and acuminate flowerbuds. Although at first sight the entities seem to be sufficiently distinguishable, an *acutifolia* collection from the Nassau Mts (2500 m) with wider leaves makes it impossible to delimit these entities from each other.

23. obovata occurs in nearly the same area as *reticulata.* It differs from the former by its more coriaceous and generally larger leaves with a less distinct nervation and by its not distinctly acuminate flowerbuds. As these entities occur in almost the same habitat, these differences are expected to be genotypic and of taxonomic significance. Delimitation of the entities as a whole, however, is again impossible: they are connected through the series *25. heteromera — 22. coriacea — 22 B. coriacea.*

This brings us back to Mt Hellwig where (between 1900—2600 m) *22. coriacea* is represented by plants more robust than those of *obovata* and with a prominent nervation and venation. But as it is included in the series connecting *reticulata* and *obovata,* delimitation is impossible.

Three entities with medium-sized leaves and non-solitary flowers are left. The first one is *36. rubiginosa,* a prostrate and ascending shrublet up to ½ m high with 2-petalled flowers, known from one collection at 3225 m altitude near Lake Habbema. Its direct relationships are not clear.

The other two entities have several characters in common: more or less pseudoverticillate leaves and flowers with 4 or more petals. Entity *33. verticillata* is represented by 5 collections, all from Mt Hellwig (1800—2600 m), *31. rosea* by 1 collection from the same locality (2500 m).

Verticillata has thinner, petiolate leaves with a cuneate to acute base and smaller flowers, whereas *rosea* has thicker, sessile to subsessile leaves with a rounded base and larger flowers. The only *rosea* collection from the Mt Wilhelmina complex is more or less intermediate but closest to *rosea* in its thick leaves and narrowly rounded leaf base. More material is needed for a further evaluation of the mutual relations. For the relations between *rosea* and *cordata* see p. 286.

In the series *acutifolia—reticulata—obovata—coriacea*, all entities with non-solitary flowers, the size and thickness of the leaves increase in the sequence given, the leaf apices at the same time becoming less acuminate. The delimitations of these entities from each other are weak and in a description would be reduced to leaf size ranges as the other characters escape precise definition; by ample fieldnotes the delimitations are expected to be improved.

Similar difficulties are present in the series with solitary flowers: *versteegii—reducta—subpittosporoides*. In this series all entities have smaller leaves than those of the first series, and the leaf apices are never acuminate.

The third series is formed by the entities *verticillata* and *rosea* with their non-solitary many-petalled flowers and pseudoverticillate leaves.

When considering the possibility of taking these three series as taxonomic units, their delimitation was attempted. This did not work out even when using the specimens from the Mt Wilhelmina complex only: *rubiginosa* is intermediate between the first and the second series. As the number of petals in the first series can vary from 2 to 5 within the same specimen, the delimitation between the third series on one hand, and the first and the second on the other, would be reduced to: leaves pseudoverticillate against scattered, and petals 4—9 against 2—5. But in this case material from other areas breaks down this distinction completely: entity *3. buxifolia* is the more-petalled equivalent of *reducta* and the leaves of *rosea* can be scattered as well.

Conclusion. A number of entities can be distinguished, often on rather weak characters; sometimes intermediates are present. The collecting density is to low to establish the morphological constancy of the populations or the importance of the intermediates. In most cases the differences found between the entities on the Mt Wilhelmina complex are obscured by material from other localities.

It is not possible to give a key with clearly defined differences for the entities in this area.

1c. Mt Ambua c.s. Thanks to a grant from the Netherlands Foundation for the Advancement of Tropical Research (WOTRO) I was able to study *Drimys* in the field during the 1966 expedition to Mt Ambua *c.s.*

The area comprises Mt Ambua (3567 m), Mt Ne (3340 m), and Mt Kerewa (3555 m), connected by the Ibiwara-plain (*c.* 2700 m), all east of Tari in the Southern Highlands District. For a description of the area and its vegetation, see Kalkman & Vink (1970).

Besides numerous observations, 77 *Drimys* collections were made in this area from about 65 sq. km (25 sq. miles); 3 *Drimys* collections were made in the Tari Basin near Tigibi at 1600 m altitude.

In the open grasslands on the summits of Mt Ambua and Mt Kerewa *Drimys* is absent. On other mountains this habitat is occupied by such entities as *1. reducta, 2. subalpina, 5. pittosporoides, 6. subpittosporoides*, and *13. fistulosa*. The absence could be explained by the small size of these grasslands combined with their repeated burning. Another factor might be the isolated position of these mountains in relation to the main range, but the presence of *reducta* on the equally isolated Mt Giluwe — only 80 km east of Mt Ambua — invalidates such an argumentation.

The shrubberies above the zone of mossy forest are apparently all fire-induced; they harbour entity *9. montis-wilhelmi*, of which 16 collections were made. Probably due to the more complete destruction of the forests at the higher altitudes, it was not found on Mt Kerewa. In this entity the relatively small and stiff leaves are never acuminate; *in vivo* they are not glaucous below and do not have a sharp peppery taste; *in sicco* the upper side of the midrib is almost flat and in young leaves the nervation is impressed on the upper side. The branchlets are terete *in vivo*, often minutely ribbed *in sicco*. The flowers are solitary.

Some specimens were found in dense shade in mossy forest, often without any pedicel scar on the plant. The leaves of these shaded plants are larger than those of plants exposed to direct light: largest leaves in collections from exposed plants 3.2—6.5 cm long, from shaded plants 6.1—7.5 cm long.

The collections made all fit nicely into the entity as already recognized from other localities.

Entity *10. giluwe* (15 collections) is a densely branched understory shrub in forests on the mountain slopes, including the mossy forests. Its main differences with *montis-wilhelmi* are: the *in vivo* glaucous lower side of the leaves, the *in sicco* impressed mibrid and — in young leaves — the not impressed nervation, and the narrow wings on the brachlets which are more distinct *in vivo* than *in sicco*.

Plants of *giluwe* were also found in the shrubberies, exposed to direct light. These had smaller and thicker leaves: largest leaves in collections from shaded plants 5.5—8 cm long, from exposed plants 2.8—5 cm long. It appears that the impression of the nervation on the upper side of young leaves *in sicco* is related to the thickness of the leaves. Thus in *Vink 17527* from a shaded site no such impression is visible whereas it is present in *Vink 17105* from a site exposed to direct light. This has a bearing on the delimitation of *montis-wilhelmi* from *25. heteromera* from Mt Wilhelm (see p. 285, 286): the differences in leaf size and in impression of nervation can be explained as phenotypic characters as well, leaving the number of flowers per bract as the sole, inconstant, distinguishing character.

The collection *Vink 17105* shows strong similarity with entity *11. lamii* from Mt Doorman. The latter has a more xeromorphic appearance and has a higher number of petals, but is apparently also glaucous on the lower side of the leaves.

Outside the present area *giluwe* is only known from Mt Giluwe (two collections) and the area of Laiagam (one collection). This inhibits a thorough comparison of the present collections with material from other localities.

Entity *22. coriacea* (23 collections) was found in forests throughout the Ibiwara-plain and on the slopes of the mountains up to about 3150 m altitude. It is a slender, laxly branched understory shrub, the taller plants often slanting. *Vink 16987* had toppled over, the apex of the plant was dead and on the main stem several new shoots, up to 3 m high, had been formed (see Gillison, 1970, photo 5), adventitious roots being present on the main stem on the side opposite to the insertions of the new shoots. This method of vegetative propagation was never observed in the entities *montis-wilhelmi*, *giluwe*, and *heteromera*, but several times in *coriacea*.

The main differences with *montis-wilhelmi* and *giluwe* are: the large, generally acuminate leaves on the more robust twigs and the florescences with up to 7 flowers. Young leaves are sometimes glaucous (*Vink 16915*) but mature ones are never so. *In sicco* the upper side of the midrib is flat to convex.

Entity *25*. ***heteromera*** has a far wider ecological range than any of the other entities in this area. 15 collections of it were made. It is found in the same habitats as *coriacea*, but on Mt Ambua it also occurs upslope through the mossy forest into the lower parts of the fire-induced shrubberies. Although it was collected in the pass between Mt Ne and Mt Kerewa it was not found on either of these mountains. Compared with the wide distribution on Mt Ambua this is inexplicable, the more so as the forests on the southern slope of Mt Ne are nearly undisturbed.

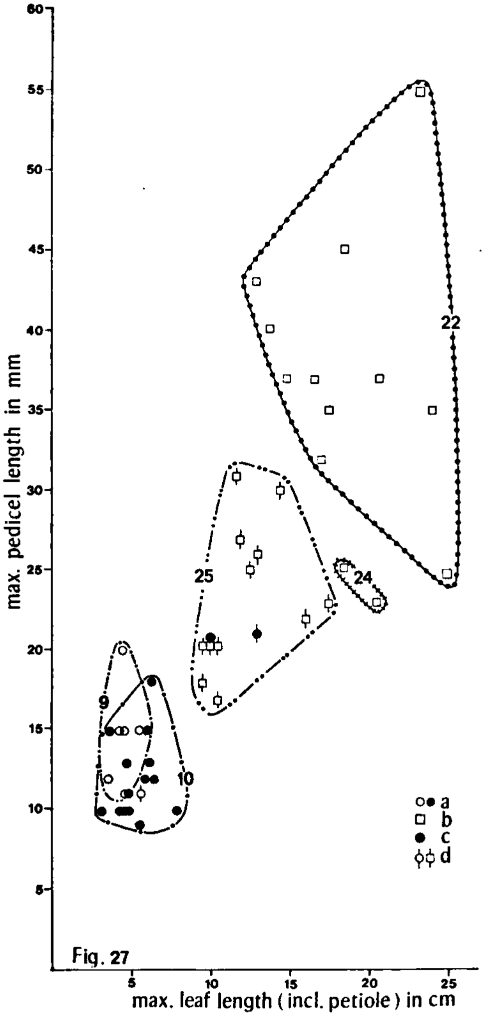
The shrubs or treelets are moderately large-leaved and rather densely branched. As in *coriacea* the leaves are often acuminate and the florescences contain up to 7 flowers, but the leaves are thinner and have *in vivo* a sharp peppery taste, the nerves are at a slightly wider angle to the midrib, and the twigs are not as robust. In *heteromera*, specimens with 2-petalled flowers form the common type but plants with 2—6-petalled flowers are not rare (e. g. *Vink 17157:* 2—6 petals; *17279:* 2—5 petals; *17312:* 2—4 petals). In the present area minor variations in the number of petals are not rare in the other entities, but a variation as wide as in *heteromera* was only found in *giluwe: Vink 17411* with 2—5 petals.

Specimens exposed to direct light (in shrubberies and forest margins) generally have smaller, thicker, less acuminate leaves than specimens growing in dense shade.

Three specimens collected in the remnants of *Castanopsis*-forest near Tigibi, in the Tari Basin, have thinner leaves and more slender twigs than the collections of *coriacea*. They are fully comparable with entity *24*. *chartacea*. In the field I was not aware of these slight differences, so I took it for granted that it was the same entity which occurred everywhere along the track between Tigibi and the Ibiwara-plain. It was only afterwards, when comparing the dried material, that these differences came to my attention. A similar difference in leaf-texture between the entities *coriacea* and *heteromera* was also unnoticeable in the field but quite distinct in the herbarium material. This is the reason why I cannot state whether the differences between *chartacea* and *coriacea* show a gradual transition with the altitude or are more or less sharply defined. There might be a difference in the taste of the bark: peppery in *chartacea* and not peppery in *coriacea;* but only one observation was made of each.

Vegetative propagation by subterraneous runners was observed on collecting *Vink 16816A* and *16853*.

Putative hybrids (5 collections). With the locally acquired knowledge of the behaviour of the characters it was possible to pick out a number of intermediates. These are classed here as putative hybrids. In some cases the intermediates can pass unnoticed as the differentiating characters do not lend themselves to recognition when in an intermediate state. Thus *montis-wilhelmi* and *coriacea* differ in a number of measurements, in the number of flowers per florescence [1 and (1—3)—(1—7) resp.], and in habit and habitat. As outside the normal habitat (e.g. exposed *versus* shaded) the habit and measurements already change, the only reliable difference is the number of flowers per florescence; however, this character does not allow intermediate states here. Extremes like *montis-wilhelmi* with non-solitary flowers and *coriacea* with exclusively solitary flowers were not found. If the measurements of leaves and flowers are intermideate, the collections have to be inserted into either of the entities according to the distinction solitary — non-solitary flowered.


max. pedicel length in mm
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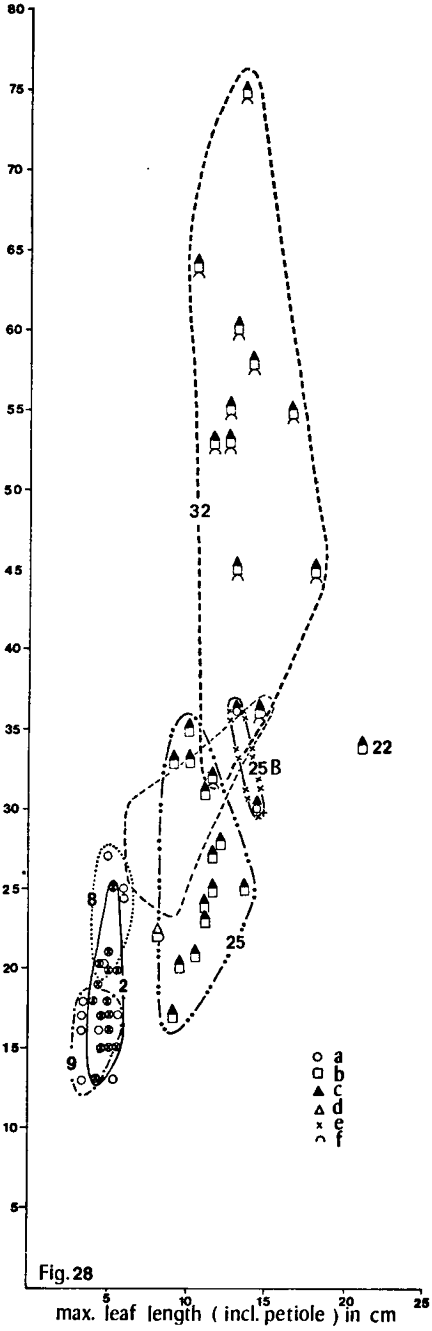
max. leaf length (incl. petiole) in cm

Fig. 27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a
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15
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25
max. leaf length (incl. petiole) in cm

Fig. 28

An additional character, the acuminate leaf apex, is apparently connected with leaf size and amount of shade and thus is of little value.

In several places collections of plants from different entities could be made within a few square metres:

(1) Mt Ambua, open shrubberies, 3375—3380 m alt.:
Vink 17411, ♀, xeromorphic form of *giluwe;*
Vink 17418, sterile, *montis-wilhelmi;*
Vink 17420, sterile, narrow-leaved form of *montis-wilhelmi;*
Vink 17419, ♀, xeromorphic form of *giluwe*, but *in vivo* branchlets subterete, leaves subglaucous and with weakly peppery taste, flowers solitary (putative hybrid *giluwe* × *heteromera*); *heteromera* was collected at 3340 and 3390 m altitude on the same ridge.
(2) Mt Ambua, mossy forest, 3340 m alt.:
Vink 17415, sterile, shade form of *montis-wilhelmi;*
Vink 17414, ♂, *giluwe;*
Vink 17413, sterile, *heteromera;*
Vink 17412, fruiting, leaves intermediate between *giluwe* and *heteromera*, *in vivo* subglaucous, with sharp peppery taste, branchlets terete but *in sicco* distinctly ribbed; flowers solitary (rarely 2 per florescence) (putative hybrid *giluwe* × *heteromera*).
(3) Mt Ambua, mossy forest, 3300 m alt.:
Vink 17315, ♀, fruiting, *giluwe;*
Vink 17310, fruiting, 2-petalled *heteromera;*
Vink 17312, ♀, 2—4-petalled *heteromera;*
Vink 17316, ♂, 2-petalled *heteromera*, but habit as in *coriacea*.
(4) Mt Ambua, montane forest, 3155 m alt.:
Vink 17450, ♂, *giluwe;*
Vink 17451, fruiting, *heteromera;*
Vink 17452, fruiting, leaves intermediate between *giluwe* and *heteromera*, *in vivo* subglaucous, taste not peppery; twigs slender, *in vivo* subterete, *in sicco* distinctly ribbed; florescences up to 3-flowered (putative hybrid *heteromera* × *giluwe*).
(5) South slope Mt Ne, tall mossy forest, 3155 m alt.:
Vink 17109, ♀, fruiting, *giluwe;*
Vink 17110, ♀, *giluwe;*
Vink 17111, sterile, *coriacea;*
Vink 17108, sterile, either shade form of *montis-wilhelmi* or hybrid *montis-wilhelmi* × *coriacea* (*montis-wilhelmi* was found 55 m upslope: *Vink 17113*).
(5A) 15 m below site 5:
Vink 17159, ♀, *coriacea* but with slightly peppery taste;
Vink 17160, sterile, main stem leaning, with vertical branches over nearly its entire length; either shade form of *montis-wilhelmi* or putative hybrid *montis-wilhelmi* × *coriacea*.

From this enumeration it is clear that plants of several entities do grow side by side, accompanied by intermediates of various degree.

On the north slope of Mt Ne the situation is slightly different. Here material belonging to the entities *montis-wilhelmi* and (probably) *coriacea* has the sharp taste, although *heteromera* is absent except at the foot of Mt Ne:

Fig. 27. Scatter diagram of *Drimys piperita*, entities *9. montis-wilhelmi*, *10. giluwe*, *22. coriacea*, *24. chartacea*, and *25. heteromera*, from Mt Ambua *c.s.* — a. all flowers solitary; b. not all flowers solitary; c. glaucous lower leaf surface (*in vivo*); d. taste of leaves sharp peppery (*in vivo*).

Fig. 28. Scatter diagram of *Drimys piperita*, entities *2. subalpina*, *8. crassipes*, *9. montis-wilhelmi*, *22. coriacea*, *25. heteromera*, and *32. coriacea*, from Mt Wilhelm; the thin broken line gives, in outline only, the *coriacea* specimens from other localities to illustrate the restricted value of this diagram. — a. all flowers solitary; b. not all flowers solitary; c. leaves acuminate; d. leaves mostly acuminate; e. veins inconspicuous (*in sicco*); f. leaves cordate, sessile.

Vink 16276, ♂, flowers solitary, leaves with peppery taste; either shade form of *montis-wilhelmi* or hybrid *montis-wilhelmi* × *heteromera*.

Vink 17278, ♀, with stout twigs and leaves thicker than in any other collection made in the entire area of Mt Ambua *c.s.* and with peppery taste; resembles entity *21. robusta* (taste not known) but has its nerves at a wider angle to the midrib and the nervation is sharply prominent whereas it is more flattened in *robusta*. It should probably be regarded as an excessively thick-leaved hybrid *coriacea* × *heteromera*.

A search for characters that could be measured and that are suitable to use in a scatter diagram left me with only the maximum lengths of the leaves and of the mature pedicels; these can be established if enough sheets of a certain collection are available and without destroying too much of the herbarium material. The maximum number of flowers per florescence can also be established in this way but shows less variability.

When using the field characters glaucescence and taste as additional characters, the scatter diagram shows a nice separation of *coriacea*, *chartacea*, *heteromera*, and the combination *montis-wilhelmi* — *giluwe* (fig. 27). In fig. 28 the specimens from Mt Wilhelm have been plotted in the same way; here the separation is also quite nice, except that *subalpina* overlaps *montis-wilhelmi* and *crassipes*. To demonstrate that the value of such scatter diagrams is local only, the specimens of *cordata* from outside Mt Wilhelm have been inserted as well; these blur the separation between *cordata* and *heteromera* completely.

When plotting the maximum leaf length against the maximum number of flowers per florescence, the scatter diagram for Mt Ambua *c.s.* shows a discontinuity between the small-leaved, solitary-flowered entities and the large-leaved, non solitary-flowered ones. Material from other sources (as *29. macrantha* and *25. heteromera B*) blurs this discontinuity as well (fig. 29).

In the table on p. 296 the observations made on material from Mt Ambua *c.s.* have been listed. It was also possible to give a key for the entities occurring in this area but the distinction between *chartacea* and *coriacea* is very weak.

From the 4 collections (13 specimens) of seedlings only *Vink 17163* (5 specimens) could with certainty be assigned to one of the entities *(giluwe)* as it had a glaucous lower leaf surface. The other collections could not be linked with either *montis-wilhelmi* or *coriacea*, both present at this site.

Conclusion. The entities *montis-wilhelmi*, *giluwe*, *coriacea*, *chartacea*, and *heteromera* can be nicely delimited from each other locally with the aid of field characters; with herbarium characters alone it is also possible but far more difficult. These entities behave locally as species and several putative hybrids could be detected. When the entities are considered on a regional basis (see e.g. p. 299) for which only herbarium characters can be used, they appear to be not or very badly separable, however.

The differences between the local entities are apparently largely genotypic, but phenotypic changes can blur the differences in herbarium characters considerably (e.g. leaf size, -texture, and impression of nervation in young leaves).

Several cases of vegetative propagation were found.

KEY TO ENTITIES OF DRIMYS PIPERITA FROM MT AMBUA c.s.

(putative hybrids not included)

1a. Flowers all solitary; largest leaves (including petiole) 3—8 cm long; leaves never acuminate . . 2
b. Flowers 1—3 to 1—7 per bract; largest leaves (including petiole) 10—26 cm long; leaves often acuminate 3

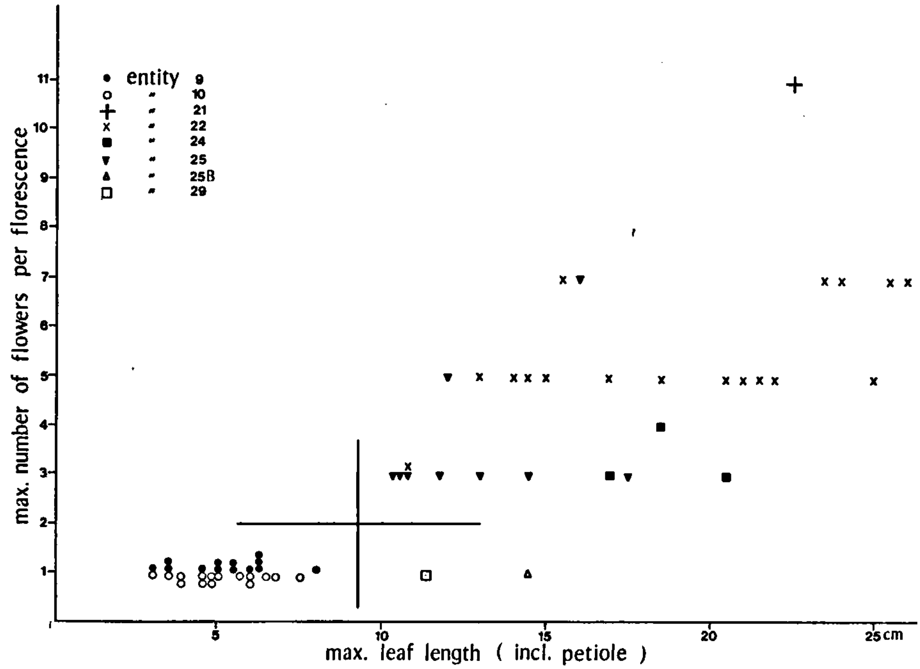

Fig. 29. Scatter diagram of *Drimys piperita*, entities *9. montis-wilhelmi*, *10. giluwe*, *22. coriacea*, *24. chartacea*, and *25. heteromera*, from Mt Ambua *c.s.* The discontinuity is lost when material from other localities is used as is shown by the maximum values of the entities *25B. heteromera* (from Mt Wilhelm) and *29. macrantha*. The maximum values of *21. robusta* show the most prolific florescences known.

2a. *In vivo* lower leaf surface glaucous (waxy) and branchlets distinctly ribbed to subwinged; *in sicco* midrib impressed above and leaves (sub)chartaceous; usually occurring in shaded places **10. giluwe**
b. *In vivo* lower leaf surface not glaucous (waxy) and branchlets terete; *in sicco* midrib *c.* flat to crested above and leaves (sub)coriaceous; usually occurring in places exposed to full light **9. montis-wilhelmi**
3a. Taste of leaves *in vivo* sharp peppery; *in sicco* midrib impressed above . . . . **25. heteromera**
b. Taste of leaves *in vivo* not sharp peppery; *in sicco* midrib *c.* flat to crested above 4
4a. Leaves chartaceous; twigs rather slender to rather stout . . . . **24. chartacea**
b. Leaves (sub)coriaceous; twigs stout to very stout . . . . **22. coriacea**

1d. Entity heteromera c.s. The entity *25. heteromera*, although rather homogeneous and rather nicely delimited in the area of Mt Ambua *c.s.*, is very heterogeneous and difficult to delimit from entity *26. polymera* when all available material is studied. The differences with *10. giluwe* are then less pronounced as well. In this paper these three entities are distinguished on leaf texture, distinctness of nervation, number of flowers per florescence, and number of petals, a combination of characters that is rather useful in some other cases. Quite a number of collections, however, can be placed into one of these entities with considerable hesitation only, widening the circumscriptions of especially *heteromera* and *polymera*.

These three entities occur in the relatively well-collected area between Mt Ambua and Edie Creek, which led me to try another approach by mixing the material of these

Material collected on Mt Ambua *c.s.*

	9. montis-wilhelmi
overall height (m)	1—3.5
leaves:	
peppery taste	—
glaucous lower side	—
apex: acuminate	—
acute	+
obtuse	+
rounded	(+)
base: cuneate	+
rectangular	+
obtuse	(+)
rounded	(+)
midrib impressed above	—
angle of nerves	(35°—)45°—70°(—80°)
extremes of all available leaves:	
blades (cm)	1—6.7 × 0.7—2.7
largest blades (cm)	2.7—6.7 × 1.2—2.7
smallest blades (cm)	1—2.5 × 0.7—1.2
maximum leaf length including petiole (cm)	3—7.5
leaves of:	
plants exposed to full light	1—5.5 × 0.7—2.5
plants in half shade	—
plants in full shade	1.5—6.7 × 0.7—2.2
watershoots	2—6.2 × 0.7—2.7
twigs:	
very slender	—
slender	(+)
rather slender	+
rather stout	(+)
stout	—
very stout	—
terete	+
minutely ribbed	+
ribbed to winged	—
flowers per florescence	1
length mature pedicels (mm)	5—20
altitudinal range (m)	3120—3555
habitat:	
shrubberies on mountains	+
mossy forest	(+)
forests on slopes of mountains	—
forests in plain (2700 m)	—
forest margins in plain	—
forest remnants in Tigibi	—

[a]) one specimen only.

10. giluwe	*22. coriacea*	*25. heteromera*	*24. chartacea*
0.7—3	1—7	1.5—7	1.5
—	—	+	—
+	—	—	—
—	+	+	+
+	+	+	+
+	—	+	—
+	—	(+)	—
+	+	+	+
—	+	(+)	—
—	(+)	(+)	—
—	(+)	(+)	—
+	—	+	—
(45°—)55°—80°(—90°)	(45°—)50°—70°(—80°)	60°—90°	55°—75°
0.7—7 × 0.4—2	5.5—23.5 × 2—11	2—18 × 0.5—6.5	3—19.5 × 1—7.5
2.5—7 × 1—2	10.5—23.5 × 3.5—11	9—18 × 4—6.5	16—19.5 × 6—7.5
0.7—1.5 × 0.4—0.7	5.5—10.5 × 2—3.5	2—7 × 0.5—3	3—11.5 × 1—3.5
2.8—8	10.5—26	10—19.5	17.5—20.5
0.7—4.5 × 0.4—1.7	6—18.5 × 2—7	2—12 × 1—4.5	—
—	6—12.5 × 2—7 a)	3.5—15 × 0.5—5.5	3—19.5 × 1—7.5
1—7 × 0.5—2	5.5—23.5 × 2—11	3—18 × 1.3—6.5	—
—	—	—	—
+	—	—	—
+	—	—	—
—	—	+	+
—	+	+	+
—	+	—	—
—	+	—	—
—	+	+	+
—	+	+	+
+	—	—	—
1	(1—3) — (1—7)	(1—3) — (1—7)	(1—4)
2—18	18—45	5—35	15—25
2720—3375	2690—3155	2700—3490	1600
(+)	(+)	+	—
+	(+)	+	—
+	+	+	—
(+)	+	+	—
—	(+)	+	—
—	—	—	+

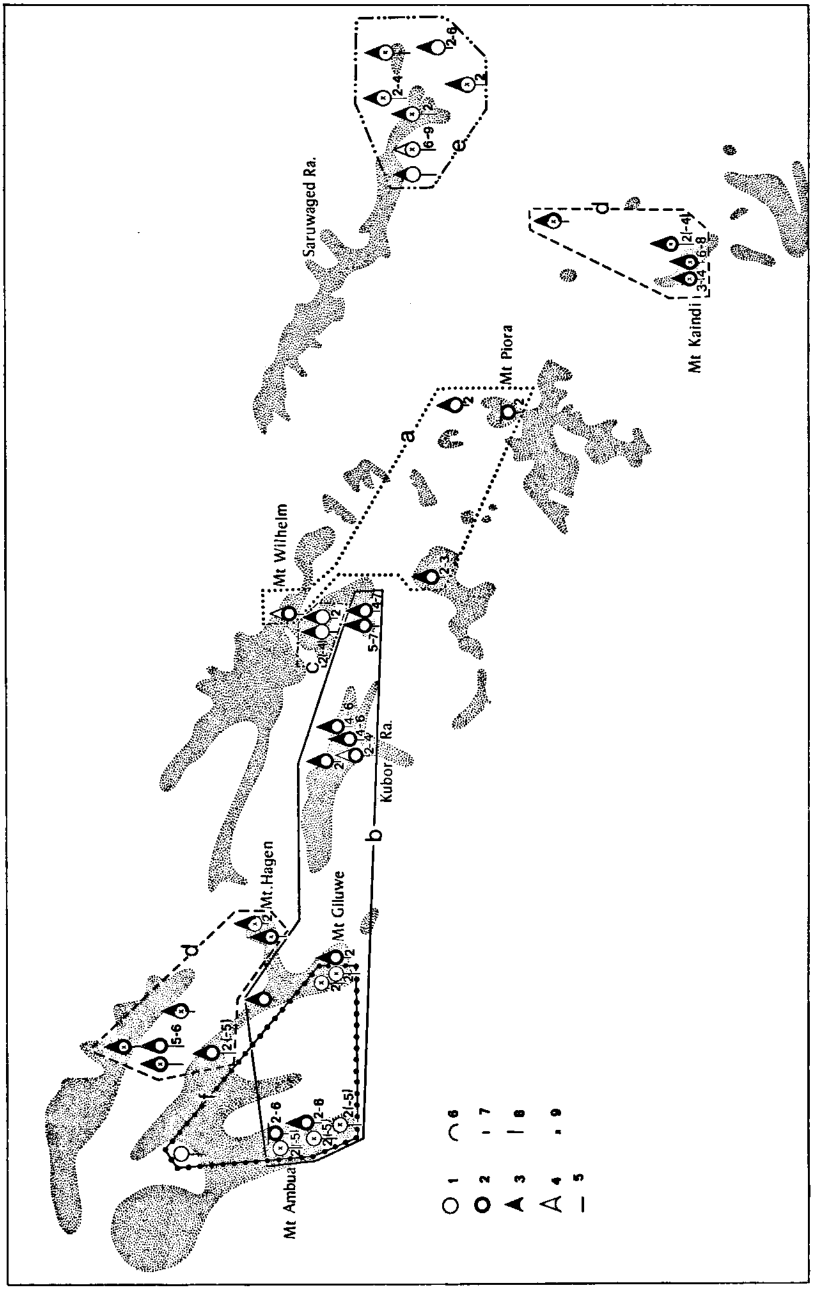

Fig. 30. Regional complexes of *Drimys piperita*, entities *10. giluwe*, *25. heteromera*, and *26. polymera* in part of the central range of eastern New Guinea. — a—f: complexes discussed in text. — 1. all flowers solitary; 2. not all flowers solitary; 3. leaves acuminate; 4. leaves mostly acuminate; 5. leaves acute; 6. leaves rounded to obtuse; 7. branchlets minutely ribbed; 8. branchlets ribbed to subwinged; 9. (remnants of) glaucescence on lower leaf surface *in sicco* or *in vivo*. — Number of petals indicated for each collection. — Dotted: area above 2400 m alt., partly after Brass, Bull. Am. Mus. Nat. Hist. 127 (1964) f. 1 opposite p. 152.

entities and plotting the combinations of characters on a map. The results of the above local studies (especially those on Mt Wilhelm and Mt Ambua *c.s.*) indicate a homogeneity in restricted areas and the mapping of characters might reveal the extent of this homogeneity within a wider area (fig. 30).

The following characters were selected for the purpose:
(1) leaf apex, (2) glaucescence of lower side of leaves, (3) nitidity of leaves, (4) circumference of branchlets, (5) number of flowers per florescence, (6) number of petals, and (7) flavone-flavonol ratio.

In this way the material can indeed be divided into regional complexes *provided deviations are allowed for each character* and the number of petals is neglected. That is, idealized pictures of these regional complexes can be drawn up, but in practice they are inseparable. These idealized combinations of characters are:

(a) leaves acuminate, not glaucous but more or less nitidous below, branchlets minutely ribbed to terete, florescences 1—7 flowered (petals [2] — [2—4])*;
(b) as (a) but leaves dull below (petals [2]—[4—7]);
(c) as (a) but flowers solitary (petals [2]—[2—4]);
(d) as (a) but leaves glaucous below and branchlets subwinged (petals [2]—[6—8]);
(e) as (d) but flowers solitary (petals [2]—[5—9]);
(f) as (e) but leaves not acuminate (petals [2]—[2—7]).

In the complexes (a), (b), and (f) the flavonols are dominant, the flavones in the complexes (c), (d), and (e).

When maximum pedicel length is plotted against maximum leaf length no separation is obtained.

Complex (a) is the extended *heteromera* from Mt Wilhelm; its Mt Piora collection is transitional to *22. coriacea.* Complex (b) is the extended *heteromera* from Mt Ambua *c.s.*; the collections from Mt Elandora have very narrow leaves and, together with some collections from the Kubor Range, they constitute a large part of the entity *polymera.* Complex (c) is the *heteromera B* from Mt Wilhelm. Complexes (d) and (e) originate from both *heteromera* and *polymera*; the former is transitional to *coriacea B.* Complex (f) is congruent with *giluwe.*

This method can be useful if a dense network of intensively collected localities covers this area; with the present material it does not bring us clearly defined units. The advantage of the increase in homogeneity of the flavone/flavonol ratio is offset by the increase in the number of morphologically badly definable units. The conclusion must be that a classification based on this method is equally unsatisfactory as the one I have followed in this paper.

In the enumeration of the material of *heteromera* and *polymera* the collections used here have been indicated with the letters of the complexes to which they were ascribed.

1e. Use of characters. Initially the New Guinean herbarium material was grouped into what are called 'entities' in this paper, each of these containing specimens that without doubt have to be placed in the same taxon.

The next step was to find discontinuities between these entities or groups of entities to reach a division of the material into species. This proved to be impossible.

The characters to be used for delimitation on the specific level should meet two requirements: (1) they have to be present in herbarium material as the labelling of this is usually

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* The numbers of petals found in single collections are enclosed by square brackets.

inadequate, and (2) they have to allow description from which they can be indubitably recognized.

Habit, taste of leaves and bark, colour of twigs, and glaucescence of leaves do not meet the first requirement. Varying degrees of coriaceousness, absolute and relative prominence of nervation and venation, minor differences in general thickness of branchlets, twigs, and terminal buds, and the slight differences in acumination escape precise description and thus do not meet the second requirement.

Apart from these, wide ranges of largely overlapping variations like the numbers of stamens, carpels, ovules, and seeds, and the dimensions of all parts of the specimens are useless for subdividing this mass of material. It should be understood that most of the above characters can be used to delimit a pair of sufficiently different entities from each other, but they do not delimit a given entity from all the rest of the material.

A few characters are left that need further consideration:

(1) the number of petals;
(2) the number of flowers per florescence;
(3) the form of the leaf base;
(4) the epidermis of the seed.

Number of petals. Generally speaking each entity is characterized by 2-petalled or by 4—11-petalled flowers. In this respect there are no differences between male and female specimens. Of the 36 entities recognized, 234 flowering collections were available (1636 flowers dissected). Of these

5 (2.1 %) had 0—2 or 1—2 petals,
193 (82.5 %) had 2 or 4—11 petals,
15 (6.4 %) had 2—3 petals and
21 (9.0 %) had 2—4 to 2—7 petals.

As only the latter 21 collections, spread over 10 entities, obscure the discontinuity in the numbers of petals, the latter could be acceptable as a delimiting character if the other characters show a certain correlation. This, however, is not the case: the pairs of entities *1. reducta—3. buxifolia* and *14. microphylla—15. vaccinioides* each differ only in their number of petals, whereas the 2-petalled *reducta* and *vaccinioides* differ from each other in quite a number of characters.

Number of flowers per florescence. A distinction could be made — and usually holds for the entities — between specimens with all florescences single-flowered and those with at least one 3-flowered florescence per inflorescence. The number of aberrant specimens is about 20 and includes as well specimens combining both these qualities as those with a number of flowers per florescence different from that of the entity to which they have been assigned.

Again, and for the same reason, this character is not acceptable: entity *29. macrantha* is closer related to the non-solitary-flowered entities *32. cordata* and *22. coriacea* than to any of the other solitary-flowered ones; a similar case is the relation of *20. buffelhoorn* with *19. beccariana* and *22. coriacea;* see also the relationships within the *25. heteromera—26. polymera* complex described on p. 299.

Form of the leaf base. Usually the leaf base is acute to cuneate with, in relatively wide leaves, a tendency to become narrowly rounded. The cordate leaf base of *32. cordata* is an exception and could be used for delimitation. As the discontinuity in the form of the leaf base is not congruent with the discontinuities of other characters, I have refrained from using it (see also p. 286 and the next paragraph).

Epidermis of the seed. The differences in the testa described on p. 266 do not show a sharp discontinuity. Although the orange-brown epidermis is characteristic of e. g. *32. cordata*, some entities such as *27. reticulata* do have both qualities without any other correlated differentiating character.

1f. Conclusion. Although the entities have been shown to behave locally as species and may grow side by side, the herbarium material of New Guinean *Drimys* cannot be divided into well-defined units. The 'entities' described in this paper are only useful as focal points in the more or less continuous variation; their circumscription in many cases certainly depends on differences in collecting density. The variability allowed for within the entities (except in a few cases like *25. heteromera*) is far smaller than that in species like *D. lanceolata*. As most of the characters used are ill-defined and do not or only partly correlate, the use of sets of characters is not possible. New material tends to be slightly different from the entities already recognized; this widens the circumscription of the latter, thus contributing to the vagueness in delimitation, or gives rise to even more entities which in the end becomes quite meaningless. Because of all this vagueness it is impossible to construct a key for all the entities already recognized, demonstrating the impossibility of making a subdivision on infraspecific level. Much more intensive fieldwork is needed to unravel the relationships of the locally morphologically rather stable populations.

Apparently a similar situation is prevalent in sect. *Drimys* in southern America as is evident from the revision by A. C. Smith (1943a; see his conclusion pp. 7—8). Dividing the material geographically on a basis of morphological trends, as Smith did, is out of question in the Old World.

The highly incomplete key on p. 317 is given to enable the reader to obtain an approximate idea of the floristic affinity of a collection.

2. Philippines to Moluccas, and Flores.

In this area the variability is less wide than in New Guinea. Nevertheless, here too are found specimens with 2 petals (Celebes), with all flowers solitary, and with a glaucous lower leaf surface. Although the majority of the specimens have more than 3 petals, their flowers not all solitary, and non-glaucous leaves, a correlation between these characters could not be established, so a breakdown of the mass of material into entities could not be achieved. An additional difficulty is the generally low collecting density.

3. Australia.

Here three entities are found. They could be treated as species if they were separable from the New Guinean material, but the wide variability of the latter engulves them completely. Within Australia it would be appropriate to treat these entities as subspecies of *D. piperita*. A key to these three entities is given on p. 345.

PHYTOCHEMISTRY

Kubitzky has made a study of some flavonoids of the *Winteraceae* (Kubitzky & Reznik, 1966; Kubitzky & Vink, 1967).

He found that the flavonols quercetin and kaempferol as well as the flavanonol dihydroquercetin are present throughout *Drimys* and *Pseudowintera*. The flavones luteolin and apigenin are almost absent in sect. *Drimys* but (often strongly) represented in sect. *Tasmannia* and in *Pseudowintera*. This, however, does not constitute a distinguishing character for the two sections of *Drimys* as several entities of *D. piperita* (sect. *Tasmannia*) show the same distribution of flavonoids as sect. *Drimys* (entities *19* and *23*) or contain flavonols only (entities *9*, *10*, *22* eastern collections, *26*; see Kubitzki & Vink, p. 8).

In general the ratio of flavones/flavonols was constant for the samples taken from the same entity. In some cases a further subdivision of the entities was possible on the basis of this ratio and of the geographical distribution, without any morphological support, however; the entities concerned are *1. reducta* and *22. coriacea* in which the flavones are more pronounced in the West Guinea collections than in those from East New Guinea. The morphologically heterogeneous entities *25. heteromera* and *26. polymera* were found to be heterogeneous in their flavone/flavonol ratio as well. For a further discussion of these entities I refer to p. 295.

Kubitzki stated that the presence of flavonols has to be regarded as more primitive in comparison with the presence of flavones; the change is suggested to be due to 'an irreversible loss of enzymes which are responsible for the final establishment of the flavonoids. Therefore, it is impossible that taxa containing flavonols can be derived from those with flavones.' However, when trying to find a pattern amongst the entities of *D. piperita* this conclusion is not much help as e.g. both states occur within the same entity (*22. coriacea* and appendices *22A* and *22B*). The explanation could be that this irreversible loss has taken place at different levels so that both situations now occur in morphologically less advanced entities with large leaves and many-flowered florescences, as well as in those with the more advanced condition of small leaves and solitary flowers.

DRIMYS

J. R. & G. Forst., Char. Gen. ed. quart. (1776) 83, t. 42; ed. fol. (1776) 42, t. 42; Forst. *f.*, Nova Acta Reg. Sc. Ups. 3 (1780) 181; Lamk, Encycl. 2 (1786) 330; Juss., Gen. Pl. (1789) 280, repr. by Usteri (1791) 311; DC., Syst. 1 (1817) 442; Prodr. 1 (1824) 78; St Hil., Fl. Bras. Merid. 1 (1825) 19 (*'Drymis'*); Endl., Enchir. Bot. (1841) 428; Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 42, repr. Contr. Bot. 1 (1861) 132; Benth. in Benth. & Hook. *f.*, Gen. Pl. (1862) 17; Eichl. in Mart., Fl. Bras. 13 (1864) 133; Baillon, Hist. Pl. 1 (1868) 156, 190; Prantl in E. & P., Nat. Pfl. III, 2 (1891) 19; v. Tiegh., J. de Bot. 14 (1900) 280; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 108; Hutchinson, Kew Bull. (1921) 190; A. C. Smith, J. Arn. Arb. 24 (1943) 10; Soukup, Biota (Lima) 6 (1966) 53. — *Wintera* Murr. in L., Syst. Veg. ed. 14 (1784) 507, *nom. ill.* (see p. 237); Gmelin, Linné Syst. Veg. 1 (1796) 852; Persoon, Syn. Pl. 2 (1806) 84; Lindley, Introd. Nat. Syst. Bot. (1830) 27.

For further synonymy see under the separate sections.

TYPIFICATION. *Drimys* (and *Wintera* as superfluous name): lectotype species *cons. prop.*: *Drimys winteri* J. R. & G. Forst.

Shrublets to trees, rarely epiphytes; entirely glabrous. Terminal bud with cataphylls in the same spiral as the leaves. *Inflorescences* composed of 1—many-flowered florescences in the axils of the cataphylls. *Flowers* uni- or bisexual. *Calyx* enclosing bud until anthesis, then rupturing and dropping. *Petals* free, (0—) 2—25. *Filaments* subulate. *Carpels* free, 1—24, stigma long or short, ventral. *Fruits* with or without pulpa; seeds straight to strongly curved, black, rarely orange-brown, shining to dull, rarely with funiculus.

Distribution. Nine species in Malesia (1), Australia (5), and South America (4).

Remarks. The first lectotypification of *Drimys* was made by De Candolle, Syst. 1 (1817) 442, by erecting the section *Drimys* with the single species *D. axillaris*. As this lectotypification makes it necessary to change the name *Drimys* from its present usage to replace *Pseudowintera*, leaving *Drimys* auct. with the name *Tasmannia*, the conservation of *Drimys* with the new lectotype *D. winteri* has been proposed (Taxon 18, 1969, 592).

Although the number of differentiating characters is rather high, the Old World and New World units are more closely related to each other than to any of the other genera of the *Winteraceae*. Therefore I agree with the ranking of these units as sections of *Drimys*, as done by A. C. Smith (1943), thus expressing the narrow bonds more clearly than in ranking them as separate genera as suggested lately again by Ehrendorfer *c.s.* in Taxon 17 (1968) 338 and A. C. Smith, Taxon 18 (1969) 289.

Sect. 1. **Drimys**

Drimys sect. *Wintera* DC.*), Syst. 1 (1817) 443; A. C. Smith, J. Arn. Arb. 24 (1943) 10. — *Drimys* div. *2, 3, 4* Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 43, 45, 47, repr. Contr. Bot. 1 (1861) 133, 135, 136. — *Drimys* sect. *Winterana* Baill., Hist. Pl. 1 (1868) 160. — *Drimys sensu* Lindley, Nat. Syst. Bot. ed. 2 (1836) 17; Meisner, Pl. Vasc. Gen. 1 (1837) 3, 2 (1837) 5; Endl., Gen. Pl. (1839) 839; Spach, Hist. Nat. Veg. (1839) 436; Gay, Hist. Chil. Bot. 1 (1845) 60; Lindley, Veg. Kingd. ed. 2 (1846) 419; A. C. Smith, Taxon 18 (1969) 289. — *Wintera sensu* Humb. & Bonpl., Pl. Equin. 1 (1808) 205. — for further references see A. C. Smith, J. Arn. Arb. 24 (1943) 10.

Stomata occluded by cutin and wax. Florescences with (or without when flowers solitary) peduncles and bracteoles. Flowers bisexual. Stigma short, ventrally subapical. Fruits pulpate. $n = 43$.

Distribution. Four species in southern America (see treatment by A. C. Smith, J. Arn. Arb. 24, 1943, 1—33).

Remarks. Contrary to the opinion expressed by A. C. Smith, J. Arn. Arb. 24 (1943) 123, I think the sections of Baillon have to be typified as follows:

section *Eudrimys* DC.:	*D. axillaris* J. R. & G. Forst.
section *Sarcodrimys* Baill.:	*D. crassifolia* Baill.
section *Tasmannia* (DC.) F. v. M.:	*D. lanceolata* (Poir.) Baill.; *D. dipetala* R. Br. *ex* DC.
section *Winterana* Baill.:	*D. winteri* J. R. & G. Forst.

Sect. 2. **Tasmannia**

(R. Br. *ex* DC.) F. v. M., Pl. Indig. Col. Vict. 1 (1860) 20; Baillon, Hist. Pl. 1 (1868) 160; A. C. Smith, J. Arn. Arb. 24 (1943) 122. — *Tasmannia* R. Br. *ex* DC., Syst. 1 (1817) 445; Prodr. 1 (1824) 78; Lindley, Nat. Syst. Bot. ed. 2 (1836) 17; Meisner, Pl. Vasc. Gen. 1 (1837) 3, 2 (1837) 5; Spach, Hist. Nat. Veg. (1839) 433; Endl., Gen. Pl. (1839) 838; Enchir. Bot. (1841) 428; Lindley, Bot. Reg. 31 (1845) t. 43; Veg. Kingd. ed.

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*) Not: sect. *Wintera* (Murr.) DC., as *Wintera* Murr. is a superfluous name (see p. 237).

2 (1846) 419; Hook. *f.*, Fl. Tasm. 1 (1855) 10; Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 109, repr. Contr. Bot. 1 (1861) 139; A. C. Smith, Taxon 18 (1969) 287. — *Drimys* sect. *Eudrimys* v. Tiegh., J. de Bot. 14 (1900) 288 *pro parte, non* DC., Prodr. 1 (1824) 78.

TYPIFICATION. *Tasmannia:* lectotype: *T. insipida* R. Br. *ex* DC. (A. C. Smith, 1969); syntype: *T. aromatica* R. Br. *ex* DC. (= *D. lanceolata*).

Stomata if occluded by wax only. Florescences without peduncles and bracteoles. Flowers unisexual (dioecious). Stigma long to rather short, apical-ventral. Fruits pulpate to apulpate. *n = 13.*

DISTRIBUTION. Five species in N. and E. Malesia and Australia.

KEY TO THE SPECIES

1a. Bracts of (sub)mature terminal bud increasing in size acropetally; in bud apices of sepals lateral; fruit sessile, depressed-globose, with a median groove, nearly always solitary; petals (1—) 4 (—9), the outer (1—) 4 inserted between the lateral and median positions (*Australia*) . **1. D. lanceolata**

b. Outer bract enclosing (sub)mature terminal bud; in bud apices of sepals median; fruits sessile to stipitate, globose or longer than wide, at least dorsally without a median groove, 1—18 per pedicel; petals (0—) 2—11, the outer (1 or) 2 inserted laterally 2

2a. Seeds with funiculus; carpels *c.q.* fruits distinctly and abruptly stipitate; transversely septate pulpa present 3

b. Seeds without funiculus; carpels *c.q.* fruits sessile or shortly, rarely abruptly, stipitate; transversely septate pulpa present or absent. 4

3a. Funiculus as long as, or longer than seed; in fruit false longitudinal septum mainly composed of dorsal ridge; fruits pruinose, up to 14 × 8 × 7 mm (stipe excluded); leaf blades 6.5—18 × 1.8—7.5 cm (*Australia*) **2. D. purpurascens**

b. Funiculus about half as long as seed; in fruit false longitudinal septum composed of placentas (half to two thirds) and of dorsal ridge (half to one third); fruits not pruinose, up to 11 × 7.5 × 6 mm (stipe excluded); leaf blades 2.5—12 × 0.5—2.5 cm (*Australia*) . . . . **3. D. stipitata**

4a. In fruit transversely septate pulpa present, dorsal ridge forming false longitudinal septum; leaf base always narrowly rounded (*Australia*) . . . . **4. D. insipida**

b. In fruit transversely septate pulpa absent, dorsal ridge absent or present, but not forming a false longitudinal septum; leaf base cuneate to cordate (*Malesia to Australia*) . . . . . . **5. D. piperita**

1. **D. lanceolata** (Poiret) Baillon, Hist. Pl. 1 (1868) 159, f. 205—207; Ewart, Fl. Vict. (1930) 517*; Vickery, Proc. Linn. Soc. NSW 62 (1937) 82, *excl. var.;* A. C. Smith, J. Arn. Arb. 24 (1943) 128; Curtis, Stud. Fl. Tasm. 1 (1956) 24, f. 8; Willis, Vict. Nat. 73 (1957) 189; Audas, Nat. Trees Austr. ed. 2 (not dated) 186; Galbraith, Wildflowers Vict. (not dated) 71, pl. 45. — *Winterania lanceolata* Poiret in Lamk, Encycl. 8 (1808) 799. — *Tasmannia aromatica* R. Br. *ex* DC., Syst. 1 (1817) 445; De Lessert, Ic. Sel. Pl. 1 (1820) 22, t. 84; DC., Prodr. 1 (1824) 78; Lindley, Bot. Reg. 31 (1845) t. 43; Hook. *f.*, Fl. Tasm. 1 (1855) 11; Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 110, repr. Contr. Bot. 1 (1861) 139; Meredith, Bush Friends Tasm., Last Ser. (1891) 63, pl. 11. — *Drimys aromatica* (R. Br. *ex* DC.) F. v. M., Pl. Indig. Col. Vict. 1 (1860) 20, *non* Descourt *ex* Baillon (1868); Bentham, Fl. Austr. 1 (1863) 49; F. v. M., Nat. Pl. Vict. (1879) 19, 187, f. 44 A, B*; Key Syst. Vict. Pl. 1 (1888) 121*, l.c., 2 (1885) f. 3 A, B*; C. Moore, Handb. Fl. NSW (1893) 13*; Rodway, Tasm. Fl. (1903) 5; De Wildeman, Ic. Sel. Horti Then. 5 (1906)

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* Descriptions including *D. piperita* Hook. *f.*, 39. '*xerophila*'.

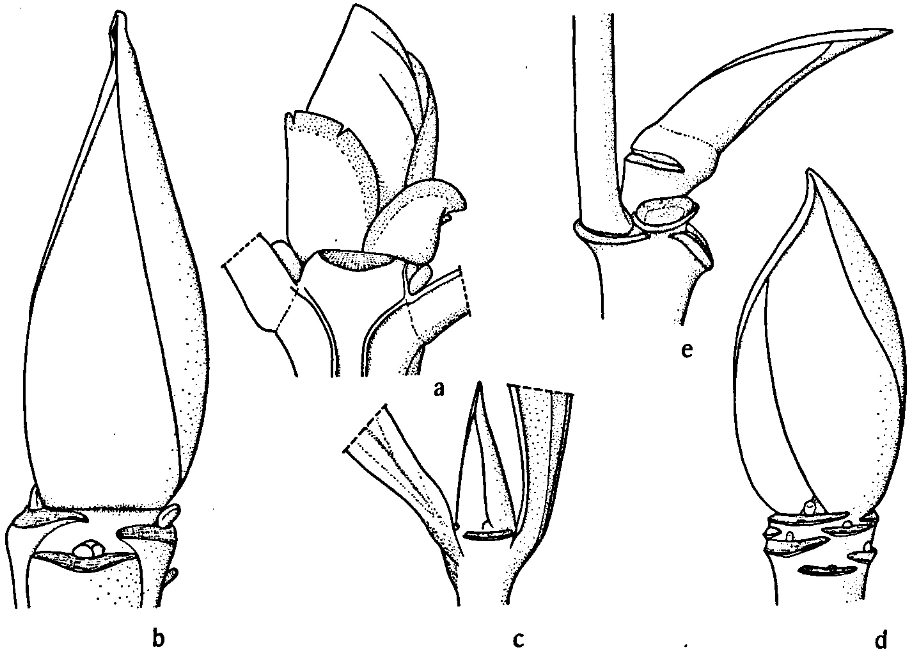

Fig. 31. Terminal buds. — a. *Drimys lanceolata*, × 5. — b. *D. purpurascens*, a vegetative bud and abortive flowerbuds in axils of bract scars, June, × 3. — c. *D. stipitata*, April, × 3. — d. *ibidem*, September, abortive flowerbuds in axils of bract scars, × 3. — e. *D. insipida*, March; shoot between old inflorescence (with one pedicel) and terminal bud very short and provided with the scar of one abortive leaf only; × 7½. — (a. *Story 6529*; b. *Story 7435*; c. *Vickery NSW 23859*; d. *Hotchkiss 107*; e. *Blakely NSW 68330*).

127, t. 191; Maiden & Betche, Census NSW Pl. (1916) 79. — *Drimys xerophila* Parment. [or *aromatica* (R. Br. *ex* DC.) F. v. M.?] var. β *aromatica* Parment., Bull. Sc. Fr. Belg. 27 (1896) 226, 231, 300. — *Tasmannia lanceolata* (Poir.) A. C. Smith, Taxon 18 (1969) 287. — **Fig. 34 a—c.**

TYPIFICATION. *Winterania lanceolata: Labillardière s.n.* in herb. Desfontaines *(non vidi)*, isotype (*ex* herb. Poiret) in P. *Tasmannia aromatica:* lectotype: *R. Brown s.n.* in herb. DC. (G, microfiches seen), Van Diemen's Island. *Drimys xerophila* var. β *aromatica: coll. unknown, s.n.* (P), Mt Bischoff, Tasmania.

Shrub or treelet 0.5—3 m high. *Leaves* scattered, blade (obovate-)elliptic to (obovate-) lanceolate, 1.0—11.5 × 0.4—4.0 cm, base cuneate, apex (sub)acute, sometimes mucronulate, chartaceous to coriaceous; petiole 2—15 mm; nerves in the middle of the blade at an angle of 10°—30° (—35°) to the midrib, prominulous to inconspicuous on either side; veins inconspicuous above, prominulous to inconspicuous below. *Flowers* 1 per bract; outer bracts of terminal bud dropping off when leaves mature; next spring bracts (just before opening of the terminal bud) 3—12 × 2—5 mm, increasing in size acropetally, margins withered. *Sepals* lateral, free apices minutely laciniate, at anthesis calyx cupule usually rupturing along lateral lines (often also along one median line). *Petals* basically 4, alternating with sepals. ♂ *flowers:* pedicel 5—23 mm; sepals 2.5—6 mm long; petals 1—9, 3.5—9 × 1—2.5 mm; stamens 9—28 (—43); carpels 1—3. ♀ *flowers:* pedicel 2—16 mm; sepals 2.5—4 mm long; petals 3—5, 2.5—5.5 × 0.7—2 mm; carpels 1 (or 2), dorsally furrowed, with 9—19 ovules. *Fruits* usually slightly wider than long and with a furrow along the median line, up to 7 × 8 × 6 mm, maroon, stigmatic crest nearly reaching base of fruit and sunken into the furrow; septate pulpa absent, a low dorsal ridge often present, placenta not considerably enlarged. *Seeds* black, 2—3.3 × 1.6—2.5 × 1—1.5 mm; without funiculus.

CYTOLOGY. $n = 13$: Raven & Kyhos, Evolution 19 (1965) 244.

DISTRIBUTION. Australia: New South Wales (from Blue Mts southwards) to Tasmania (fig. 33).

ECOLOGY. Moist places (in gullies and near creeks) in dry sclerophyll woodland, *Eucalyptus* forests, and temperate rain forests; in Tasmania sclerophyllous forms also in open terrain on high mountains; in Tasmania also forming thickets. Altitudinal range: from 650—1200 m in New South Wales to 0—1250 m in Tasmania. Flowers: Sept.—Jan.; fruits Dec.—June; young leaves collected in Jan. only. Flowering in Tasmania is probably slightly later than on the mainland.

ONTOGENY, VASCULARIZATION OF FLOWERS. Tucker & Gifford, Phytomorph. 14 (1964) 197—203; Am. J. Bot. 53 (1966) 433—442, 671—678; Tucker, Am. J. Bot. 52 (1965) 624.

DISCUSSION. *D. lanceolata* has a rather wide (apparently phenotypic) variability. Specimens from sheltered spots have large thin leaves with a distinct nervation and venation; specimens from exposed habitats in high altitudes (Tasmania) have thick small leaves with an inconspicuous nervation and venation. J. W. Vickery annotated the specimen *Vickery NSW 68453* from Cradle Mt, Tasmania, as follows: 'From field observations in Tasmania, I am satisfied that this small-leaved form with contracted branches is only a habitat form, and grades into the larger-leaved form found in more sheltered situations. Some bushes showed both large and small forms on the one plant.'

The present species differs from all other species in sect. *Tasmannia* by the lateral position of the sepals and the absence of the lateral petals. These characters are more easily observed in flowerbuds where the free sepal apices distinctly overlap laterally and, in older stages, are minutely laciniate. Once the calyx is ruptured the lateral position of the sepals is less obvious as the ruptures occur on the lateral sides of the calyx as in the other species. The free sepal apices are often ruptured as well, simulating a total of 3 or 4 free apices. The largest part of the calyx cupule may split by an additional rupture more or less along the median line, but this does not indicate that the cupule consists of three sepals.

Tucker & Gifford (1966, p. 677) reported the existence of a '*disc*', a papillate collar of tissue around the base of the carpel. Indeed, especially on the side opposite to the stigmatic crest, a lobe protrudes from the base of the carpel (cf. l.c., figs 13, 14; the *d* at right in fig. 13 probably does not indicate the 'disc', but the free part of the torus). Its function is not clear and field botanists are invited to check whether any secretion is formed by this 'disc'.

Being part of the carpel, this structure should be renamed to avoid confusion with structures of the receptacle (torus) in other families. A substituting term should only be proposed after the function of this structure has been established.

The fruit differs from that of other species by its almost globular to depressed-globular shape with a furrow along the median line (fig. 18b). In the absence of septate pulpa, in the often present dorsal ridge, and in the shape of the seeds, *D. lanceolata* corresponds with *D. piperita*. For a comparison with *D. piperita*, entity *39. xerophila*, see there.

REMARKS. In Parmentier's work the nomenclature is rather confused (see remark by A. C. Smith in J. Arn. Arb. 24, 1943, 33). As I gather that it was his intention to rank the varieties *alpina* and β *aromatica* under his new species *xerophila*, I have cited them in that way although the actual combination was not published. The published combinations with *Drimys aromatica* are apparently only citations of Von Mueller's labels.

The typification of the taxa described by Parmentier is also not clear. The citations of the material belonging to his concept of *Drimys aromatica* and *D. xerophila* are in accordance with the sheets preserved in the Paris herbarium. For his var. *alpina* Parmentier cites in footnote 1 material from the Melbourne herbarium with the annotation 'Mt Bischoff'; for both his var. β *aromatica* and his *Drimys muelleri* he refers to footnote 2 which reads 'D. aromatica F. v. M. — (M. Victoria, Tasmann; c. Flover)'. Obviously a mistake has been made. When comparing his publication with the material in the Paris herbarium it appears that the correct typification is as follows:
var. *alpina:* material from Baw Baw Ranges (in publication omitted);
var. β *aromatica:* material from Mt Bischoff (footnote 1);
Drimys muelleri: material from Mt Victoria (footnote 2).
The citations by Willis are in accordance with the above corrections.

AUSTRALIA. New South Wales. Blue Mts: *Atkinson MEL 5465*, ♂ (MEL); Blackheath, *Maiden NSW 68467*, fr (L); Nellies's Glen, W. of Blackheath, 900 m alt., *Constable NSW 43185*, ♂ (BM, K, L, U). Bago For. Res. nr Batlow: *de Beuzeville 8*, ♂ (A, NSW). Tumbarumba: *Cambage s.n.*, fr (A). Mt Currockbilly, 50 miles SSW. of Nowra, 1100 m alt.: *Rodway 203*, fr (K). Braidwood: 15 miles to the E., *Burbidge 13*, st (CANB); Sugarloaf Mt, *Bäuerlen NSW 68468*, ♂ (NSW), *Boorman s.n.*, ♀ (C, NSW, US); Clyde Mt, Budawang Ra., *W. Hartley 1753*, ♂ (CANB), *Pullen 783*, st (CANB), *Vickery NSW 3582*, fr (L, US), *Schodde 3455*, 670 m alt., fr (A, AD, CANB, L). Budawang, *Maiden s.n.*, ♂ (U). Captains Flat: *Adam 728*, ♂ (K, L), *C. W. E. Moore 2002*, ♂ (CANB, L). Brown Mt, nr Littleton, E. of Nimmitabel: *Betche NSW 68473*, fr (NSW), *Schodde 3450*, 1100 m alt., fr (A, AD, CANB, L), *Schodde 3398*, 1160 m alt., ♂ (CANB, L), *3399*, ♀ (CANB, L), *3400*, ♂ (CANB, L). Geehi R. crossing on Alpine Way, W. of Mt Kosciusko: *Vickery NSW 68420*, fr (NSW). — Australian Capital Territory. Parrott Rd turn off, Brindabella Ra.: *Burbidge & Gray 6409*, fr (CANB). Wark's Rd — Parrott Rd: *Burbidge 7405*, ♂ (CANB, L, NSW). Between Parrott Rd and Bendora: *Burbidge & Gray 6411*, fr (CANB, L), *6413*, fr (CANB, L), *6414*, fr (CANB). Franklin Rd, *c.* 1130 m alt.: *Darbyshire 521*, ♀ (CANB, K, L, NSW). Near Mt Franklin: *Story 6529*, st (CANB). — Victoria. Grampians, SE. slope of Mitchell Plateau: *McCann MEL 5426*, ♂ (MEL). Macedon: *Meebold 21821*, fr (L), *Purdie 177*, ♀ (MEL), *St John MEL 5431*, fr (MEL), *Sutton MEL 5433*, ♂ (MEL), *Walter MEL 5442*, fr (MEL). Beech Forest: *Murchison MEL 5443*, fr (MEL). Mt Buffalo: *Cowle MEL 5438*, ♂, fr (MEL), *Von Mueller s.n.*, fr (K), *Walter MEL 5440* (MEL). Buffalo R.: *Mitchell 246*, ♂ (MEL). Ovens R.: *McCann MEL 5452* (MEL). Mt Hotham: *Weindorfer MEL 5429*, ♂, fr (MEL), *Martin MEL 5449*, 1830 m alt., st (MEL). Brittannia Ck nr Yarra Junction: *St John MEL 5430*, ♂ (MEL). Mt Donna Buang, 1000 m alt.: *Van Steenis 17723*, st (L). Warburton: *St John s.n.*, ♂ (K). Cumberland Valley: *Mauritzon s.n.*, ♂ (S), *St John MEL 5432*, fr (MEL). Mt Baw Baw: *Melvin s.n.*, fr (A), *Tisdall MEL 5448*, fr (MEL). Mt Mueller nr Mt Baw Baw: *Melvin s.n.*, fr (A, MEL). Berwick: *coll. unknown MEL 5456* (MEL). Bunyip R.: *Von Mueller MEL 5454*, fr (MEL). Darnum, Little Moe R.: *Worth MEL 5444*, st (MEL). Tarra Valley Nat. Park nr Yarram: *Healy MEL 5435*, fr (MEL). Mt Latrobe: *coll. unknown MEL 5461*, st (MEL). Sealers Cove: *coll. unknown MEL 5450*, ♂ (MEL). Black Spur, Lindt Hermitage: *Andersson s.n.*, ♂ (S). Bonang—Croujingolong: *Morris MEL 5459*, st (MEL). Mt Ellery: *Purdie 308*, st (MEL). Orbost: *Rowe NSW 68463*, ♂ (NSW). Bemm R.: *Sayer MEL 5455*, fr (MEL). Dividing Ranges: *Walter NSW 68462*, ♀ (NSW). Nungutta Mts: *Von Mueller MEL 5466*, ♀ (MEL). Without locality: *Kuntze 20113*, 1000 m alt., fr (A). — Tasmania 'King Isl. and d'Entrecasteaux Channel': *Lechenault s.n.*, fr (G, P). Circular Head: *Gunn s.n.*, fr (S). Mt Bischoff: *Bell MEL 5479*, fr (MEL), *Kayser MEL 5480*, fr (MEL). Pieman R.: *Comber 21*, fr (K). Ocean Beech, Strahan: *Vickery NSW 68454*, st (NSW). Macquarie Harbor:

Cunningham s.n., ♂ (BM, K). Mt Sorrell: *coll. unknown MEL 5496*, st (MEL). Hampshire & Surrey Hills: *Milligan MEL 5483*, ♀ (MEL). Cradle Mt Nat. Park: between Crater Lake and Marion's Lookout, *Eichler 16841*, fr (AD); Cradle Mt, *Sutton s.n.*, fr (US), *Vickery NSW 68453*, st (NSW), *68455*, ♂ (NSW). Lake St Clair: *Gunn s.n.*, st (K), *Vickery NSW 68458*, fr (NSW). Derwent Bridge — Rd Lake St Clair: *Morris MEL 5501*, fr (MEL). S. end Great Lake nr Chalet, 1220 m alt.: *V. H. Millar MEL 5434*, fr (MEL). Deloraine: *Beccari s.n.*, fr (FI). Golden Valley towards Westbury Rd: *Rodway 125*, fr (A, CANB, K). Port Dalrymyle: *R. Brown s.n. or 4918*, ♂, fr (BM, MEL). Launceston: *Gunn s.n.*, ♂ (BM, K), *Hannaford MEL 5487*, ♀ (MEL), *Von Mueller MEL 5477*, ♀ (MEL). Nile R. and S. Esk R.: *coll. unknown MEL 5492*, ♂ (MEL). Mt Arthur: *Cleland NSW 68441*, ♂ (NSW), *Coates & Sullivan 109*, 1100 m alt., st (MEL). Mt Barrow: *Burbidge 2991*, fr (CANB, K), *3017*, ♂ (CANB), *Rupp NSW 68443*, fr (NSW). Old Man's Head, Interlaken, 915 m alt.: *M. Davis 1144*, st (MEL). Bond Bay, Port Davey, sealevel: *M. Davis 1274*, fr (MEL), *Rodway (leg. C. Davis) 2361*, fr (K). N. Breaksea Isl., Port Davey, 90 m alt.: *M. Davis 1335*, fr (A, MEL). Mt Field Nat. Park: Mt Mawson, *Burbidge 3295*, ♂ (CANB, K); Mt Field, *Giblin s.n.*, ♀ (K), *Rolin s.n.*, ♂ (CANB); Mt Field W., *Eichler 16732*, fr (AD, L); Mt Field E., *Vickery NSW 68452*, fr (NSW). New Norfolk: *Gunn s.n.*, ♂, ♀, fr (BM, K, L), *Rémy s.n.* (P). Hobart: *Gunn s.n.*, ♂, ♀, fr (BM, MEL), *Siemssen MEL 5490*, ♂ (MEL). Mt Wellington: ('Table Mt') *R. Brown s.n. or 4920*, fr (BM, K, MEL), *Cunningham s.n.*, fr (K), *Darbyshire 1078*, 1250 m alt., ♂ (CANB, NSW), *Gunn s.n.*, ♂, fr (A, BM, K, MEL, NSW), *Helms s.n.*, fr (MEL, NSW), *Lucas NSW 68444*, fr (L), *Martin NSW 68437*, 1160 m alt., ♂ (L, MEL), *68438*, 1250 m alt., ♂ (NSW), *Oldfield s.n.*, fr (US), *Rodway NSW 68439*, fr (NSW), *Sullivan & Coates 34*, 1250 m alt., ♂ (MEL), *Verreaux C-744* (P), *Vickery NSW 68450*, fr (L), *68451*, fr (NSW). Hartz Moors, 850 m alt.: *Martin NSW 68442*, ♂ (NSW). Hastings Caves: *Schodde 3405*, 150 m alt., fr (CANB), *3408*, 150 m alt., fr (AD, CANB, L), *T. & J. Whaite 2213*, fr (NSW). Fire Hut below Adamson's Peak, 915 m alt.: *T. & J. Whaite 2295*, fr (NSW). Port Arthur: *Bufton 56*, st (MEL). Lake Margaret: *Vickery NSW 68456*, fr (L). Mt Owen: *Emmett MEL 5495*, ♀ (MEL). Honeywood: *Blyth MEL 5475*, fr (MEL). Without locality: *Cunningham s.n.*, fr (BM, K, MEL, SING), *R. Brown s.n. or 2918*, fr (A, BM, G, K, MEL, P), *Gunn s.n.*, ♂, ♀, fr (A, L, P, S, SING), *Le Guillou (leg. Archer) 5* (P), *Lindley s.n.*, fr (K), *Milligan 22* (P). — Australia without locality: *Labillardière s.n.*, fr (A, K, P), *Lemaire s.n.*, fr (P), *Paterson s.n.*, ♀ (A).

2. **D. purpurascens** Vickery, Proc. Linn. Soc. NSW 62 (1937) 78, f. 1, pl. 5; Fraser & Vickery, l.c. 288; A. C. Smith, J. Arn. Arb. 24 (1943) 128. — *Tasmannia purpurascens* (Vickery) A. C. Smith, Taxon 18 (1969) 287. — **Fig. 34 h.**

TYPIFICATION. *D. purpurascens: Fraser & Vickery s.n. (NSW) 68476)*, Barrington Tops, May 1936 (NSW).

Shrub or treelet 1—3 m high. *Leaves* scattered; blade obovate to obovate-oblong, 6.5—18 × 1.8—7.5 cm, base attenuate, ultimate base often very narrowly rounded, apex acute to obtuse with a tendency to become acuminate, acumen narrowly rounded, rarely apex broadly rounded, chartaceous to subcoriaceous; petiole 0—5 mm; nerves in the middle of the blade at an angle of 30°—45° to the midrib, prominent to prominulous above, prominent to inconspicuous below; veins prominent to inconspicuous on either side. *Flowers* 1 per bract; outer bracts of terminal bud caducous before new leaves have matured; next spring the then outer bracts (just before opening of the terminal bud) 13—27 × 4—14 mm, enclosing the terminal bud; the bracts decreasing in length and especially in width acropetally. ♀ *flowers* unknown; pedicels in fruit 12—45 mm; carpels 2—18, with 11—27 ovules. ♂ *flowers:* pedicels 20—45 mm; *sepals* situated in the median plane, 5.5—8 mm long, sometimes one or both bilobed, free apices or lobes (sub)entire; at anthesis calyx cupule rupturing along lateral lines; *petals* 2 or 3 (—8), (outer ones) inserted laterally, 10—12 × 2—4.5 mm; *stamens* 60—98; *carpels* 1—4, stipitate, stipe 0.2—1 times as long as carpel. *Fruits* ellipsoid, stipitate, up to 14 × 8 × 7 mm, pruinose, stipe 2—5 mm, stigmatic crest (nearly) reaching apex of stipe; (often imperfect) transversely septate pulpa present, false longitudinal septum mainly composed of dorsal ridge. *Seeds* black, 2.5—3.5 × 2—3 × 1—1.5 mm; funiculus 1—2 times as long as seed.

CYTOLOGY. *n* = *13:* Hotchkiss, Proc. Linn. Soc. NSW 80 (1955) 47.

DISTRIBUTION. Australia: NE. New South Wales (fig. 33).

ECOLOGY. *Nothofagus* and *Eucalyptus* forests; 1220—1615 m altitude. Flowers: Nov.; fruits: Dec.—June; young leaves: data insufficient.

DISCUSSION. *D. stipitata* and *D. purpurascens* share two characters which distinguish them from the other species in sect. *Tasmannia:* the stipitate carpels and fruits, and the presence of a funiculus. The distributional areas of both species are small and adjacent. This raises the question whether *D. stipitata* and *D. purpurascens* should be considered as subspecies of a single species.

The differences in the dimensions of the vegetative and generative organs of *D. purpurascens* and *D. stipitata* do not oppose such a taxonomic arrangement. Comparable differences do not only occur within the extremely variable *D. piperita*, but also within the far less variable *D. lanceolata*. Even the differences in length-width ratio of the leaves would be acceptable.

However, I refrain from lowering their rank, as the characters distinguishing the present species also include structural differences of the fruits (fig. 18 d & e). In *D. stipitata* the dorsal ridge and the enlarged placentas meet somewhere near the middle of the fruit, together forming a (towards the base and the apex of the carpel usually imperfect) false longitudinal septum. In *D. purpurascens* a similar false septum is formed by the dorsal ridge only, the placentas being relatively little enlarged. The length of the funiculus (fig. 19 a & b) seems to be correlated with the behaviour of the placentas: short in *D. stipitata* with its considerably enlarged placentas, long in *D. purpurascens* with slightly enlarged placentas. The latter situation should also be compared with *D. insipida*, where the false septum is also formed by the dorsal ridge only, but where a funiculus is absent (fig. 18 f).

The material of *D. purpurascens* available to me contained only one specimen with (mouldy) male flowers and another specimen with two damaged flowers preserved in spirit; additional observations were made on very small buds still enclosed in the terminal bud. Female flowers were not available.

AUSTRALIA. New South Wales. Manning R.: *Reik 031*, fr (L, NSW). Barrington Tops: Moonan Brook, *Carter MEL 5587*, fr (MEL); upper Williams and Allyn R., *Rodway 1892*, st (K, L); Carey's Peak, 1615 m alt., *Salasoo 2467*, st (NSW); E. Barrington Tops, 1370 m alt., *Schodde 3212*, ♂, fr (AD, CANB, L); tributary of Gloucester R., *Todd NSW 68499*, 1220 m alt., st (NSW); *Ashby s.n.*, 1350 m alt., ♂ (US), *Boorman s.n.*, 1550 m alt., fr (C, NSW, US), *Fraser & Vickery NSW 68476*, fr (NSW), *68502 = MEL 5556*, fr (MEL, NSW), *Vickery & Fraser NSW 68504*, ♂ (NSW), *Harrison NSW 68505*, st (NSW), *Brough s.n.*, fr (CANB), *Hopson 57/24*, fr (NSW), *Hotchkiss 248*, 1370 m alt., fr (US), *249*, 1370 m alt., fr (RSA), *250*, *251*, 1370 m alt., fr (NSW), *Story 7435*, fr (CANB), *Veech NSW 68507*, st (NSW), *C. T. White 11472*, 1525 m alt., fr (A, K).

3. **D. stipitata** Vickery, Proc. Linn. Soc. NSW 62 (1937) 80, f. 2; A. C. Smith, J. Arn. Arb. 24 (1943) 130. — *Drimys aromatica* (R. Br. *ex* DC.) F. v. M. var. *pedunculata* Maiden, Agric. Gaz. NSW 5 (1894) 600; Maiden & Betche, Census NSW Pl. (1916) 79. — *Tasmannia stipitata* (Vickery) A. C. Smith, Taxon 18 (1969) 287. — **Fig. 34 k.**

TYPIFICATION. *Drimys stipitata:* holotype: *Maiden s.n.*, Guy Fawkes, Feb. 1895 (NSW). *Drimys aromatica* var. *pedunculata:* lectotype: *Maiden s.n.*, Beilsdown Ck, Dorrigo For. Res., Dec. 1893 (A).

As Maiden (l.c., 218) collected in the Dorrigo Res. in Dec. 1893, the above specimen belongs to the type material of var. *pedunculata*. The sheet in A does not have Maiden's new varietal name written on one of its labels, so it is probably not the holotype. As, however, no other sheet or collection from the type material was found, I have indicated the above sheet as the lectotype.

Shrub or treelet 1—6 m high. *Leaves* scattered; blade obovate to linear-lanceolate, 2.5—12 × 0.5—2.5 cm, base attenuate to cuneate, apex acute to narrowly rounded, rarely obtuse, (sub)coriaceous; petiole 1—3 mm; nerves in the middle of the blade at an angle of (15°—) 25°—35° to the midrib, prominulous to faint or minutely impressed above, prominulous below; veins prominulous to inconspicuous on either side. *Flowers* 1 per bract; outer bracts of terminal bud caducous before new leaves have matured; next spring the then outer bracts (just before opening of the terminal bud) 9—16 × 6—10 mm, enclosing the terminal bud; the bracts decreasing in length and especially in width acropetally; pedicels 6—42 mm. *Sepals* situated in the median plane, 2—8.5 mm long, free apices entire, at anthesis calyx cupule rupturing along lateral lines. *Petals* (1 or) 2 (—6), (outer ones) inserted laterally, 7—14 × 1.5—5 mm. *Stamens* 21—65. *Carpels* stipitate, stipe 0.5—2 times as long as carpel; ♂ *flowers:* carpels 1—5; ♀ *flowers:* carpels 4—10, with dorsal ridge, with 13—22 ovules. *Fruits* ellipsoid, abruptly stipitate, up to 11 × 7.5 × 6 mm, pale blue, stipe 2.5—5 mm, stigmatic crest nearly reaching apex of stipe; (often imperfect) transversely septate pulpa present, longitudinal false septum composed of placentas (half to two thirds) and of dorsal ridge (half to one third). *Seeds* black, 2.2—3 × 1.7—2.5 × 0.7—1 mm; funiculus one third to half as long as seed.

CYTOLOGY. *n = 13:* Hotchkiss, Proc. Linn. Soc. NSW 80 (1955) 47.

DISTRIBUTION. Australia: NE. New South Wales (fig. 33).

ECOLOGY. Scrubberies or their margins, roadsides; 600—1400 m altitude. Flowers: Sept.—Nov.; fruits: Nov.—Apr.; young leaves: data insufficient.

DISCUSSION. See under *D. purpurascens.*

AUSTRALIA. New South Wales. Gibraltar Ra. State For., Glenn Innes Dist.: *McCaffrey NSW 68481*, ♂ (NSW). Clarence R.: *Wilcox MEL 5553*, ♂, y fr (MEL). Backwater: *McKee 497*, st (NSW). Guy Fawkes: *Maiden NSW 68478*, fr (NSW). Jeogla: *Fraser & Vickery NSW 68495*, fr (NSW). Styx R. State For.: *Batterbee NSW 68490*, ♂ (L). Little Styx R., 1400 m alt.: *C. Davis NSW 68491*, fr (NSW). Top of the Big Hill, Jeogla-Kempsey Rd, 1200 m alt.: *C. Davis NSW 68492*, fr (NSW), *68494*, fr (NSW), *O'Neill NSW 68493*, fr (L). Point Lookout, SE. of Ebor: *Constable NSW 68498*, ♂ (NSW), *McKee 2302*, fr (NSW), *2303*, fr (NSW). Dorrigo State For.: head of the Bellinger R., *MEL 5552*, y fr (MEL); Beilsdown Ck, *Maiden s.n.*, y fr (A); *C. T. White 7572*, 600 m alt., ♂ (A, BM, NSW, S). Dorrigo Tablelands, nr Megan, 670 m alt.: *Hoogland 8603*, ♀ (CANB, K, L, NSW), *8604*, ♂ (CANB, K, L, NSW). Dorrigo, Rocky Ck Gully, 670 m alt.: *Hotchkiss 102*, ♂, st (A, RSA, US), *107*, st (RSA, US), *114*, st (US), *195*, fr (BO, PNH, RSA, US). Dorrigo, 1300 m alt.: *Aubréville & Heine 17* (P). Between Dorrigo and Deervale: *Vickery NSW 68483*, fr (NSW). Deervale: *Vickery NSW 23859*, fr (A, BM, BO, K, L, NSW, U, US). Callaghan Swamp, Walcha: *Campbell NSW 68497*, ♂ (NSW). Upper Hastings R.: *Maiden NSW 68496*, Nov. 1897, y fr (NSW). Hastings R.: *Beckler s.n.*, ♂ (K, MEL), *C. Moore s.n.*, ♂ (A, K).

4. **D. insipida** (R. Br. *ex* DC.) [v. Tiegh., J. de Bot. 14 (1900) 267, *nomen provisorium*; Pilger in E. & P., Nat. Pfl., Nachtr. 3 (1908) 108] Druce, Rep. 1916 Bot. Exch. Club Br. Isl., Suppl. 2 (1917) 620; Domin, Bibl. Bot. Heft 89 (1925) 669, repr. p. 115; C. T. White, Contr. Arn. Arb. (1933) 28; Vickery, Proc. Linn. Soc. NSW 62 (1937) 82; A. C. Smith, J. Arn. Arb. 24 (1943) 124; Anderson, Trees of NSW (1947) 212; Beadle, Evans & Carolin, Handb. Vasc. Pl. Sydney (1962) 129. — *Tasmannia insipida* R. Br. *ex* DC., Syst. 1 (1817) 445; Prodr. 1 (1824) 78; Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 110, repr. Contr. Bot 1 (1861) 139. — [*Tasmannia dipetala* R. Br. *ex* DC., Prodr. 1 (1824) 78, *nomen inval.*] — *Tasmannia monticola* Rich. in Dumont D'Urville, Voy. Astrol. Bot. 2

(1834) 50, 160, Atlas (1833) pl. 19. — *Drimys dipetala* [R. Br. *ex* DC.] F. v. M., Pl. Indig. Col. Vict. 1 (1860) 21, *nomen inval.*; Bentham, Fl. Austr. 1 (1863) 49; Baillon, Hist. Pl. 1 (1868) 160; C. Moore, Handb. Fl. NSW (1893) 13; Parment., Bull. Sc. Fr. Belg. 27 (1896) 227, 301; Bailey, Queensl. Fl. 1 (1899) 18; Pilger, l. c.; Bailey, Compr. Cat. Queensl. Pl. (1913) 21, f. 7. — **Fig. 34 i, j.**

TYPIFICATION. *Tasmannia insipida:* lectotype: *R. Brown s.n.* in herb. DC. (G, microfiches seen), Port Jackson. *Tasmannia monticola: Fraser s.n.* (P), Blue Mts.

Shrub or treelet 0.7—6 m high. *Leaves* scattered; blade (elliptic or) obovate to lanceolate to linear-lanceolate, 4—23.5 × 0.5—5.5 cm, base usually attenuate, ultimate base abruptly and narrowly rounded, apex acuminate, acumen up to 3 cm long, chartaceous, rarely subcoriaceous; petiole 1—4 mm; nerves in the middle of the blade at an angle of 25°—50° to the midrib, prominulous to faint on either side; veins prominulous to inconspicuous on either side. *Flowers* 1 per bract; outer bracts (just before opening of the terminal bud) 7—10 × 2.5—4 mm, enclosing the terminal bud; often some scars of reduced leaves just below the terminal bud. *Sepals* situated in the median plane, free apices entire, at anthesis calyx cupule rupturing along lateral lines. *Petals* 2 (—4), (outer ones) inserted laterally. ♂ *flowers:* pedicel 8—37 mm; sepals 3.5—8 mm long; petals 6.5—14.5 × 1.5—3.5 mm; stamens 17—65; carpels 1 (rarely none or 2). ♀ *flowers:* pedicel 8—29 mm; sepals 4.5—7 mm long; petals 6—10 × 1.5—4.5 mm; carpels 1, with 15—40 ovules. *Fruits* ellipsoid, up to 17 × 9 × 8 mm, stipe, if present, up to 1 mm long, stigmatic crest reaching down to 1—5 mm from base of fruit; (usually imperfect) transversely septate pulpa present, false longitudinal septum mainly composed of dorsal ridge. *Seeds* black, 3—4 × 1.5—2.5 × 1—1.5 mm; without funiculus.

CYTOLOGY. $n = 13$: Hotchkiss, Proc. Linn. Soc. NSW 80 (1955) 47.

DISTRIBUTION. Australia: SE. Queensland and New South Wales (fig. 32).

ECOLOGY. In rain forests, in *Nothofagus* forests or in scrub, often in gullies; 25—1100 m altitude. Flowers: mainly Aug.—Nov.; fruits: mainly Dec.—May. Young leaves appear together with the flowerbuds or slightly later (but often the leaves above an inflorescence are reduced to scales or absent; the new shoot then consists only of a very short new twig crowned by a terminal bud).

DISCUSSION. *D. insipida* differs from *D. piperita* in the presence of septate pulpa and of a dorsal ridge connected with the placenta, forming a false longitudinal septum (fig. 18f). Although the septa and the lower and upper parts of the dorsal ridge are usually imperfect, their presence is always clear.

The normal colour of the fruit when ripe is purplish black or black. Several collectors drew attention to a form with mature fruits of a white colour, reddish mottled when in the sun. As I could not find a correlated character, I refrain from distinguishing this taxonomically.

Once at wig has started to produce inflorescences, it will continue to do so in all following seasons, until the apex disintegrates and a lateral shoot takes over. The older twig will thus show at its base some rings of bract scars with vegetative buds or minute indefinite structures in their axils, acropetally followed by rings of bract scars with scars of pedicels in at least some of their axils. As far as could be ascertained this situation exists in all species of sect. *Tasmannia*, except in the present *D. insipida*.

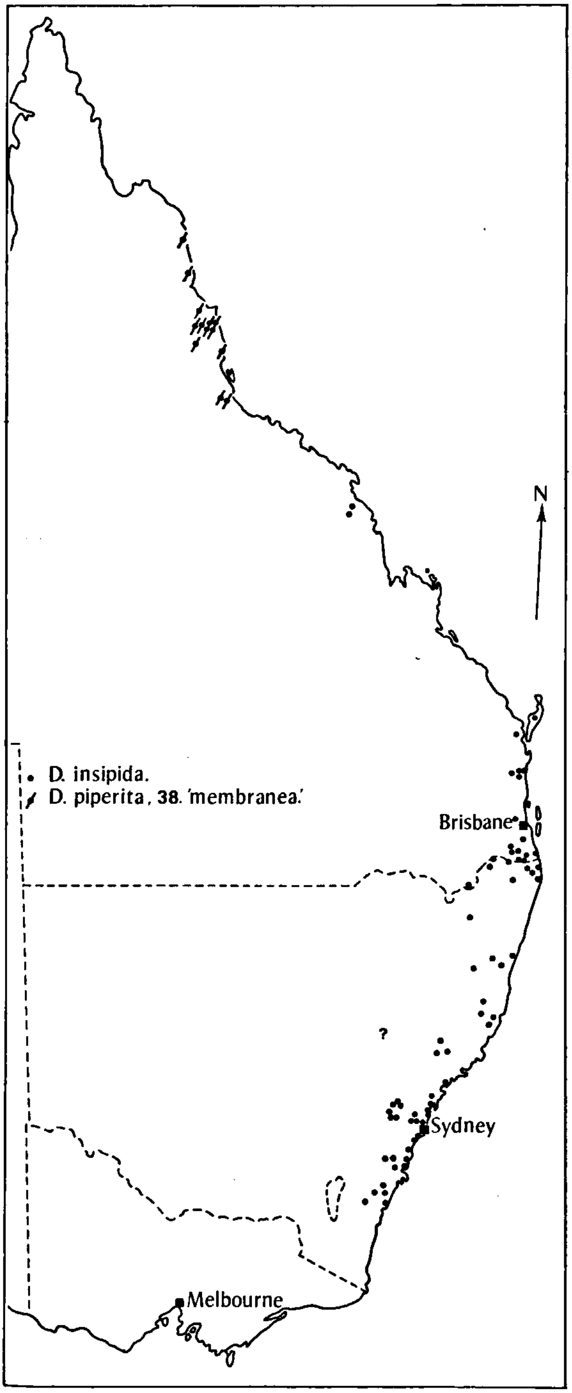

Fig. 32. Distribution of specimens studied.

Here in quite a number of cases rings of bract scars with and without scars of pedicels alternate, suggesting alternate production of mixed and vegetative terminal buds. This is often found together with a reduction of the leaves to bracts, or even to their complete absence in the new shoots arising from mixed terminal buds. Whether this alternate production takes place in the same or in successive seasons could not be concluded from the herbarium material; this needs the attention of field botanists.

It is stressed that this alternation is often found together with the normal situation within the same herbarium specimen.

NOMENCLATURE. In his Prodromus De Candolle cited under *Tasmannia insipida* the herbarium name *Tasmannia dipetala*, which thus is an invalid name. When transferring *T. insipida* to *Drimys*, Von Mueller incorrectly took up the epithet *dipetala* instead of *insipida*. In the genus *Drimys* Van Tieghem made the correct combination but in a footnote stated clearly he did so provisionally, which under the present rules means invalid publication. Pilger, often cited as the author of the correct combination, published only an extract of Van Tieghem's work ('van Tieghem zerlegt die Gattung *Drimys* Forst. in mehrere Gattungen:', followed by short descriptions of the genera and their sections and an enumeration of the species belonging to these). The provisional status of *D. insipida* is not mentioned; however, the publication of this combination is not due to taxonomic conclusions of Pilger (on the contrary: both *D. insipida* and *D. dipetala* are listed!), but to the shortness of the extract and has thus to be regarded as 'incidental mention' *(nomen invalidum)*. Druce was the first who deliberately and definitely made the correct combination.

AUSTRALIA. Queensland. Eungella Ra.: *Francis NSW 68344*, ♀ (NSW), *C. T. White 12955*, ♂ (A, CANB). Dalrymple Heights: *Clemens s.n.*, ♂, ♀ (A, K). Fraser Isl.: *Eaves MEL 5576*, st (MEL). Tinana Ck: *C. T. White 3476*, fr (A). Imbil: *Wilson s.n.*, st (A). Cooroy scrubs: *Longman s.n.*, y fr (K). Eumundi: *Bailey NSW 68343*, ♂, fr (NSW), *Simmonds s.n.*, fr (A). Noosa Bay: *Eaves MEL 5574*, st (MEL). Mt Glorious: *Clemens s.n.*, fr (K), *Eames & Hotchkiss NSW 68350*, fr (NSW), *68351*, fr (NSW), *Eames, Hotchkiss & Smith s.n.*, fr (US), *Lam 7625*, 600 m alt., ♂ (A, L), *Nicolson 1378*, ♂ (LAE, US), *Smith & Hotchkiss 5001*, 700 m alt., fr (L), *5002*, 700 m alt., fr (L). Tamborine Mt: *Scotezchini 152*, ♂ (MEL), *C. T. White 3568*, ♂ (A), *C. T. White NSW 68345*, fr (NSW). Mt Mistake: *Bailey s.n.*, ♂, fr (US), *Clemens 43597*, fr (A), *Smith & Webb 3654*, fr (CANB), *C. T. White s.n.*, ♂ (A). Cunningham's Gap: *Bailey MEL 5578*, ♂ (MEL), *C. T. White 6862*, fr (A, K). Mt Greville: *Everist 556*, fr (A), *Everist s.n.*, 450 m alt., y fr (CANB), *C. T. White 9949*, fr (A). Tallebudgera: *C. T. White 1866*, fr (A). Goffs Gully, New England: *MEL 5570*, fr (MEL). Mt Merino, 1100 m alt.: *Johnson NSW 68347*, st (NSW). Lamington Nat. Park: *Eames & Hotchkiss s.n.*, fr (US), *Smith & Webb 3625*, 900 m alt., ♂ (CANB), *Tryon & White s.n.*, fr (BO), *C. T. White s.n.*, fr (A, PNH); Roberts Plateau, *Shirley 31*, fr (NSW), *C. T. White 6062*, ♂, ♀ (A, S). Tugun: *Clemens 42719*, ♂ (A). E. of Bald Mt, 23 miles S. of Warwick: *L. S. Smith 11461*, fr (K). Mt Spurgeon: *C. T. White 10737*, y fr (A, BM). — New South Wales. Acacia Plateau: *Constable NSW 3611*, 1070 m alt., fr (NSW, US), *Dunn NSW 68361*, fr (NSW), *68362*, ♂ (NSW), *Jones 1414*, fr (CANB), *C. T. White 12506*, fr (A). Macpherson Ra.: *Perry 513*, fr (CANB), *T. M. Whaite 259*, ♀ (NSW), *C. T. White s.n.*, fr (A, K); Mt Lindesay, *Constable NSW 24133*, 1140 m alt., y fr (K, NSW), *Tryon & White s.n.* (P), *Hill MEL 5572*, st (MEL); Mt Wilson, *Fraser NSW 68329*, fr (NSW), Waterfall Ck, *Johnson NSW 14532*, 915 m alt., ♂ (NSW); Mt Glennie, *Constable NSW 22250*, 800 m alt., fr (K, NSW). Nightcap Ra.: *Eames & Hotchkiss s.n.*, fr (US). Whian Whian State For.: *Constable NSW 22673*, 600 m alt., fr (K, NSW), *Jones 1452*, st (CANB), *Webb & Tracy s.n.*, st (CANB). Pottsville Beach: *Jones 1969*, st (CANB). Cape Byron: *MEL 5571*, ♂ (MEL). Mt Lennans, Clarence R.: *MEL 5568*, fr (MEL). Clarence R.: *Wilcox MEL 5560*, y fr (MEL). Richmond R.: *Fawcett 14*, ♂ (MEL, NSW), *Henderson 25*, ♂ (B, MEL), *Henderson s.n.*, ♂ (NSW, P), *Hodgkinson MEL 5577*, fr (MEL). Gibraltar Ra.: *McReaddie NSW 68348*, fr (NSW). Styx R. State For.: *G. L. Davis (32)*, ♂ (AD, NSW). Dorrigo: *Aubréville & Heine 18*, 1300 m alt. (P), *Boorman NSW 68368*, fr (NSW). E. Dorrigo, Killungourdie Plains: *Swain 177/186 NSW 68360*, ♂ (NSW). Bellingen: *Hewitt NSW 1602*, fr (NSW), *Hotchkiss 112*, 23 m alt., ♂ (A, US). Coffs Hrbr: *Boorman s.n.*, fr (L, NSW). Mt Boss State For.: *Constable NSW 41190*, ♀ (NSW). Hastings R.: *Beckler s.n.*, fr (K, U), *Fraser s.n.*, ♂ (K), *C. Moore s.n.*, ♂ (BM). Off Doyte's Rd, 48 miles W. of Wauchope: *Garden*

NSW 68359, ♂ (NSW). Kendall: *Bailey 44*, ♂ (NSW). Black Ck nr Kendall: *T. M. Whaite 508*, fr (NSW). Cassilis (*annot.*: 'surely not the present Cassilis, NSW'): *Leichhardt NSW 68341*, ♂ (NSW). Barrington Tops: *Fraser NSW 68352*, ♂ (NSW), *N. H. White s.n.*, ♂ (CANB); Allyn R., *Rodway 1891*, ♂ (A, K), *Story 7329*, st (CANB, K, MEL, NSW). Massey Ck State For., upper Paterson R.: *McDonald NSW 68353*, fr (NSW). Upper Williams R.: *Earp NSW 68355*, ♂ (NSW), *Fraser & Vickery NSW 68354*, fr (NSW), *Hotchkiss 258* (PNH), *259*, fr (US), *C. T. White 11473*, fr (A), *R. J. Williams 11*, 425 m alt., ♂ (CANB). Olney State For., SW. of Newcastle, 345 m alt.: *Constable NSW 11150*, (K, L, U). Sugarloaf Mt: *Maiden s.n.*, fr (U). Blue Mts: *Atkinson 10*, fr (MEL), *55*, ♀ (MEL); Tomah, *Cunningham s.n.*, y fr (MEL); Mt Irvine, 900 m alt., *Constable NSW 11411*, fr (K, L, US); Blacksmith Ck nr Bilpin, 670 m alt., *Constable NSW 48301*, y fr (NSW); Wentworth Falls, *Blakely NSW 68330*, fr (K, NSW); Woodford, *Bowden NSW 68331*, fr (NSW); Springwood, *Betche NSW 68333*, fr (NSW), *Fletcher NSW 68334*, ♂ (NSW), *Hamilton NSW 68332*, ♂ (NSW); first branch of the Grose: *R. Brown 4919*, fr (BM). Ourimbah Ck: *MEL 5561*, fr (MEL), *Betche NSW 68316*, ♀ (NSW). Wamberal: *Cheel NSW 68317*, fr (NSW). Hawkesbury R.: Piles Ck, *Blakely & Shiress NSW 68319*, ♂ (NSW); Wondabyne, *Blakely & Brown NSW 68322*, st (NSW). Christies Gully, Mooney Mooney Ck nr Gosford: *Blakely, Darnell-Smith & Shiress NSW 68320*, ♂ (L). Matcham: *Dept. Agric. s.n.*, fr (NSW, S, Z). Kuring-Gai Chase, McCarr's Ck: *Wilson 566*, fr (NSW, US). Trunks Ck, Dural: *Johnson 786*, ♀ (NSW). Mona Vale ('Moonam Vale'): *Maiden s.n.*, fr (A). Paramatta: *R. Brown s.n. or 4919*, fr (K, MEL), *MEL 5569*, fr (MEL). Chatswood: *Fitzhardinge NSW 68325*, ♀ (NSW). Sydney: *Stepenson 393*, ♂ (K), *Weinthal 1528*, ♂ (B). Port Jackson: *Boorman s.n.*, ♂ (S, Z), *R. Brown s.n.*, fr (G), *Caley s.n.*, ♀, fr (A, MEL, NSW). Otford: *Maiden NSW 68328*, ♂ (NSW). Austinmer: *Day s.n.*, st (CANB). Illawarra: *MacArthur 23*, ♂ (BM, K). Fitzroy Falls, 490 m alt.: *Schodde 3180*, y fr (AD, CANB, K, L, NSW). Robertson: *Maiden s.n.*, ♂ (BO, NSW). Minnamurra Falls, Kiama Dist.: *Johnson NSW 22754*, fr (BM, K, NSW), *C. W. E. Moore 2500*, fr (CANB). Cambewarra Mt: *Common 49*, st (CANB, L), *Forsyth NSW 68337*, ♂ (NSW). Shoalhaven: *Banerton 607*, ♀ (MEL). The Vines, Endrick State For.: *Constable NSW 46725*, ♀ (A, BM, K, NSW). Head of Clyde R., 550 m alt.: *Constable NSW 57944*, ♂ (NSW). Table Mt, Milton: *Cambage 4024*, y fr (NSW). The Pointer, 5 miles NW. of Milton: *Hadley 2916*, fr (K). Milton: *Rodway 2916*, fr (A). Pebbly Beach between Kioloa and Durras Water: *Johnson & Constable NSW 68339*, st (NSW). Clyde Mt, E. of Braidwood: *Pullen 4010*, y fr (CANB).

Bucca Ck: *Boorman s.n.*, y fr (B, NSW). Five Isl. Dist.: *Cunningham s.n.*, ♂ (BM, L). Patonga Ck: *Blakely NSW 68321*, ♀ (NSW).

5. **D. piperita** Hook. *f.*, Icon. Pl. 9 (1852) t. 896; Mueller, Walpers Ann. Bot. Syst. 4 (1857) 43; Becc., Malesia 1 (1877) 185; Stapf, Trans. Linn. Soc. London Bot. 4 (1894) 128; Parment., Bull. Sc. Fr. & Belg. 27 (1896) 227, 302; F. v. M., Trans. Roy. Soc. Vict. 1 (1899) 1; Merrill, Philip. J. Sc. 1, Suppl. (1906) 53; Philip. J. Sc. 2 (1907) Bot. 272; Merrill & Merritt, Philip. J. Sc. 5 (1910) Bot. 349; Merrill, En. Born. (1921) 252; En. Philip. 2 (1923) 154; A. C. Smith, J. Arn. Arb. 24 (1943) 137. — *Tasmannia piperita* (Hook. *f.*) Miers, Ann. Mag. Nat. Hist. III, 2 (1858) 110, repr. Contr. Bot. 1 (1861) 140. — *Drimys reticulata* Hook. *f.*: F. v. M., Pl. Indig. Col. Vict. 1 (1860) 21, *sphalm.* for *D. piperita*, *non* Diels (1916).

For further synonymy see under the separate entities.

TYPIFICATION. *D. piperita:* holotype *Low s.n.* (K), Mt Kinabalu, Borneo.

Shrub, sometimes scrambling or epiphytic, or treelet, 0.1—13 m high. *Leaves* scattered to pseudoverticillate; blade elliptic or obovate to lanceolate, 0.5—25 × 0.15—11 cm, base cuneate to cordate or truncate, apex acute to rounded or acuminate, acumen up to 2.5 cm long, chartaceous to firmly coriaceous; petiole 0—30 mm; nerves in the middle of the blade at an angle of 7°—90° to the midrib, inconspicuous to prominent on either side, sometimes impressed above; veins inconspicuous to prominent on either side. *Flowers* 1 or 1—11 per bract; outer bract enclosing terminal bud, just before opening of terminal bud 1—32 × 0.5—12 mm; pedicel 3—70 mm. *Sepals* situated in the median plane, 1.7—12 mm long, free apices entire or slightly lobed; at anthesis calyx cupule rupturing along lateral lines (sometimes also along a median one). *Petals* (0—) 2—15, 2.5—23 × 0.5—11 mm, outer two inserted laterally. *Stamens* 7—109. *Carpels* in ♂ flowers (0 or) 1—10, in ♀ flowers 1—15 with 2—46 ovules. *Fruits* obovoid to ellipsoid, up to 15 × 8 × 7.5 mm, black when ripe, tapering into stipe 0—5 mm long, rarely abruptly stipitate, stigmatic crest usually nearly reaching apex of stipe; without transversely septate pulpa; dorsal ridge, if present, not connate with placentas, the latter rarely distinctly enlarged. *Seeds* black and nitidous to orange-brown and dull, 2—4.5 × 1—3.3 × 0.3—1.5 mm; without funiculus.

CYTOLOGY. *n = 13:* Ehrendorfer *c.s.*, Taxon 17 (1968) 338. Borgmann, Zeitschr. Bot. 52 (1964) 142, counted *2 n = 28* for the entities *25. heteromera* and *32. cordata;* this is probably erroneous for *2 n = 26* (see Ehrendorfer *c.s.*, l.c.).

DISTRIBUTION. Philippines, Borneo, Celebes, Flores, Moluccas, New Guinea, Australia.

ECOLOGY. Primary and secondary forests, scrubberies, and subalpine grasslands, 800—4175 m altitude, in Australia at 500—1850 m altitude. Flowers and fruits in the tropics throughout the year, sometimes with local seasonal variations; in Australia: flowers Nov.—Apr., fruits Jan.—May.

DISCUSSION. The difficulties in subdividing the material brought together in the present species are already outlined in the chapter on specific delimitation in sect. *Tasmannia.*

The material from the Philippines, Borneo, Flores, Celebes, and the Moluccas was not broken up into entities as its variability is less wide and less distinct, and the collecting density is rather low compared with that in New Guinea and Australia.

The character of glaucescence has been inserted into the descriptions only if confirmed by field observations. The herbarium specimens usually do not allow a decision concerning the presence or absence of glaucous leaf surfaces.

NOMENCLATURE. Some of the infraspecific groups recognized here can definitely be regarded as taxa in the sense of units resulting from classificatory work, e.g. *papillata, macrantha, cordata.* Some others can only locally be recognized as taxa in this sense (see description of Mt Ambua *c.s.*). Most of the other groups, however, are not the result of a classification but merely groupings of specimens as an aid for the discussion and description of the variability within the species; their circumscription is vague to arbitrary, e.g. the series *reducta* to *montis-wilhelmi* and *beccariana* to *hatamensis.* Some are even largely defined by their locality, e.g. *hatamensis.* Some of these groups definitely belong to one taxon, e.g. the series *beccariana—robusta—coriacea—obovata—chartacea,* but the extremes like *robusta* and *chartacea* could easily represent a set of taxa in the absence of the other groups.

All of these infraspecific groups, of which the taxa defined as above form a minority, have been indicated as 'entities' to emphasize that this is not a taxonomic subdivision but a non-taxonomic breakdown of the variability for the reasons given above.

The type originates from Mt Kinabalu and falls outside the few taxa recognized, requiring the application of the formal hierarchical sequence of infraspecific ranks to the non-taxonomically subdivided mass of specimens, which is impossible. For this reason the few taxa had to be drowned in the sea of entities.

Some specimens could not even be placed in the entities; this would require the raising of still more entities for relatively few specimens which would serve no good purpose. These specimens have been listed on p. 345.

New material from localities thusfar not represented often defies insertion into one of the entities, but this is only proof of the statement that most of the entities are not equivalent to taxa.

PHILIPPINES (material not listed by A. C. Smith). Luzon. Abra Prov.: *Ramos BS 7231*, fr (BO). Mountain Prov. Bontoc Subprov.: *Klemme FB 13404*, ♂ (L). Fugao Subprov., Kiangan: *Dawa PNH 13877*, fr (PNH). Bayninan, Banaue, Ifugao, 1200 m alt.: *Conklin & Buwaya PNH 79610*, ♀ (K, L, PNH). Benguet Subprov.: *Bacani FB 15898* (P), *Loher 21*, ♂, ♀, fr (K, US), *22*, ♂ (K), *Ramos BS 5724*, fr (BO, L); Mt Data, 2200 m alt.: *Steiner 2140*, ♀ (L); Mt Polis, 1900 m alt.: *Steiner 2194*, ♀ (L), *Steiner, van Royen & Sleumer 2185*, ♂ (L); Mt Pauai: *Clemens 9207*, ♀, fr (A), *R. C. McGregor BS 8462*, 2100 m alt., ♀ (MEL), *Mearns BS 4408*, 2100 m alt., fr (L), *Sulit PNH 7495*, 2450 m alt., ♂ (PNH); Mt Pulog: *Celestinó PNH 4354*, ♂ (BO, L, PNH), *Curran c.s. FB 18037*, ♂ (BO), *18043* (P), *R. C. McGregor BS 8897*, ♂, fr (MEL), *Steiner 1945*, 2200 m alt., ♂ (L), *2026*, 2300 m alt., ♀ (L), *2102*, 2400 m alt., ♂ (L). Bataan Prov.: *Whitford s.n.*, ♀ (PNH); Upper Lamao R., Mt Mariveles, 1150 m alt.: *R. S. Williams 754*, ♂ (A, K, US). Rizal Prov.: *Loher 12601*, ♀ (BM), *14030*, ♂ (BO); Balacbac: *Loher 12993*, ♂ (BO); Angilog: *Loher 5523*, ♀ (K). Laguna Prov.: *Sulit FB 31111*, ♂ (SING, Z). Camarines Sur Prov. Mt Isarog: *Convocar PNH 2880*, ♂ (PNH), *Edaño BS 76276*, fr (U, Z). — Mindoro. Mt Halcon: *Edaño PNH 3294*, 862 m alt., fr (PNH), *3571*, 862 m alt., fr (L, PNH, SING), *Merritt FB 4383*, ♀ (BO), *Rabor PNH 20488*, 1600 m alt., ♂ (PNH). — Palawan. Mt Mantaliñgahan, Brooke's Point: *Edaño PNH 88*, 1886 m alt., ♂ (L, PNH, SING), *57*, 1900 m alt., ♀ (A, PNH, SING). — Panay. Capiz Prov., Mt Madiaas: *Ramos & Edaño BS 30731*, ♂ (A, BM, GH, K, P, US). — Negros. Mt Malbug, 840 m alt.: *Edaño PNH 7380*, ♂ (PNH). Cuernos de Negros, 1904 m alt.: *Edaño PNH 7164*, fr (PNH), *7179*, ♂ (PNH), *7288*, ♂ (BO, L, PNH, SING, US). — Biliran. Mt Suiro: *Sulit PNH 21690*, 1130 m alt., ♀ (L, PNH), *21700*, ♂ (K, PNH). — Mindanao. Misamis Prov. Mt Malindang: *Mearns & Hutchinson FB 4754*, fr (SING). Bukidnon Prov. Mt Katanglad: *Sulit PNH 9983*, 1900 m alt., fr (A, PNH), *10058*, 2200 m alt., fr (A, L, PNH), *10126*, 2300 m alt., ♀ (A, L, PNH). Malaybalay: *Britton PNH 19663*, fr (L, PNH). Mt Candoon: *Ramos & Edaño BS 38901*, fr (L, P). Agusan Prov. Mt Hilong-hilong, Cabadbaran: *Mendoza & Convocar PNH 10805*, ♂ (PNH, SING). Davao Prov. Mt Batangan: *Warburg 14771*, fr (B). Mt McKinley: *Edaño PNH 978*, 2255 m alt., fr (PNH, SING), *989*, 2466 m alt., ♂, ♀, fr (A, L, PNH, SING). Mt Apo: *Edaño PNH 1411*, 2100 m alt., ♂, fr (A, BO, L, PNH), *1549*, 2130 m alt., ♀, fr (A, BO, L, PNH), *1555*, 2333 m alt., fr (A, PNH), *1465*, 2650 m alt., ♀, fr (BO, L, PNH, SING), *Pancho PNH 34624*, 2285 m alt., fr (PNH), *34621*, 2440 m alt., fr (PNH), *Hachisuka s.n.*, 2700 m alt., ♂ (BM).

BORNEO. Sarawak. Mt Berumput: *Brooke 8593*, 915 m alt., ♂ (L), *Sibat anak Luang S 15097*, 1460 m alt., fr (K, L). Mt Poi: *Hewitt 1*, ♂ (BO, K), *Mjöberg 193*, ♂ (A, BM). Mt Bungoh, 1070 m alt.: *Brunig S 9503*, fr (L, SING). Mt Bongo nr Tegora: *Haviland s.n. (2067)*, ♂, fr (BO, K, L). Hose Mts: Bt Temudu, 1800 m alt., *Banying ak Nyudong S 19030*, ♂, ♀ (K, L); Bt Kajang, 1800 m alt., *ibidem S 17205*, ♂ (A, K, L); Ulu Temalad, 1350 m alt., *ibidem S 17648*, ♀, fr (BM, K, L). Mt Temaboh, upper Baram: *Moulton 6687*, ♂ (K, SING), *6687b*, ♀, fr (SING). Mt Dulit: *Richards 1872*, 800—1000 m alt., fr (K), *1645*, 1230 m alt., ♂ (A, K, SING), *1896*, 1300 m alt., ♀, fr (K, SING), *2507*, 1300—1400 m alt., ♂, ♀, fr (A, BO, K, SING), *Asah ak Luang S 22738*, 1300 m alt., ♀ (K). Mt Mulu: *Chew Wee-Lek 350*, 1220 m alt. (K, L), *J. A. R. Anderson 4526*, 2010 m alt., ♂ (A, K, L, SING). Bario, Ulu Baram, Bukit Ra'an Nyabar, 1100 m alt.: *J. A. R. Anderson S 20140*, ♂, ♀ (K, L). Mt Murud: *Moulton 187*, ♀ (K, SING), *Mjöberg 101*, ♂, ♀ (BM, BO), *102*, ♂ (SING). Marigan Ra., 790 m alt.: *Brunig S 8734*, ♀, fr (K, L). — Brunei. Pagon Ridge: *P. S. Ashton BRUN 1043*, 1450 m alt., ♂ (L), *2303*, 1525 m alt., fr (L), *2305*, 1525 m alt., fr (L), *2347*, 1525 m alt., ♂ (L). — Sabah. Kumu Rengis, 2440 m alt.: *Sow KF 71633*, *71690*, ♂ (K, L). Maraipavai, 1525 m alt.: *Holttum s.n.*, ♂ (SING). Sapong Arginon: *Combes 4050*, ♀, fr (K, L). Nungkok Mt, 1650 m alt.: *Darnton 584*, ♂ (BM), *590*, fr (BM). Mt Kinabalu a.e., 1675—3800 m alt.: *J. A. R. Anderson S 27098*, ♂ (K), *Carr SF 26399*, ♂ (SING), *27652*, fr (PNH, SING), *Chew & Corner RSNB 4104*, fr (K, L), *Chew, Corner & Stainton RSNB 186*, ♀ (K, L, SING), *719*, ♂ (CANB, K, L, SING), *755*, fr (CANB, K, L, SING), *1037*, ♂ (CANB, K, L), *1056*, ♂ (K, L, SING), *1082*, ♂, ♀ (CANB, K, L, SING), *Clemens 10564*, ♂ (A, BO), *10687*, fr (A), *27111*, ♂, ♀, fr (BO, K, L), *31950*, ♂, ♀, fr (A, BO, L), *Collenette 552*, ♂ (K), *Fuchs 21052*, ♂ (L), *Fuchs & Collenette 21438*, fr (K, L), *Gibbs 4206*, st (K), *4426*, ♂, ♀ (BM), *Griswold 44*, ♂ (A), *48*, ♂ (A), *76*, ♀ (A), *Haviland 1175*, ♂ (K), *11* fr (K), *1177*, ♀, fr (K), *1178*, ♂, ♀ (K, SING), *Jacobs 5757*, ♂ (L), *Low s.n.*, ♂, ♀ (K), *Meijer SAN 20361*, ♂ (K, L), *20372*, fr (K, L), *22128* (K, L), *29175*, ♀ (K, L), *29259*, fr (K, L), *Sinclair c.s. 9020*, ♂ (L, SING), *Sleumer 4697*, ♀ (L), *Wood & Wyatt Smith SAN A 4473*, fr (L). Ranau: *Darnton 555*, ♀ (BM), *Lajangah SAN 33121*, fr (L), *Lampangi SAN 24091*, 1830 m alt., fr (PNH), *Prot. Badak 32309*, fr (K, L), *32397*, 1430 m alt., fr (L). Trus Madi: *Collenette 662*, 2620 m alt., ♂, fr (K), *Mikil SAN 31787*, 2440 m alt., fr (L), *32062*, 1525 m alt., fr (L), *32087*, fr (K, L), *41867*, 2440 m alt., ♂ (K, L). — Indonesian Borneo. Bukit Raja, 1250 m alt.: *Winkler 934*, ♀ (BO), *937* (BO). Amai Ambit: *Hallier 3413*, ♀, fr (A, BM, BO, L, PNH, SING). Batoe Lesoeng: *Amdjah 462*, fr (BO). Mt Kemoel: *Endert 3876*, 1300 m alt., ♀, fr (BO, L), *4265*, 1600 m alt., fr (BO), *3989*, 1850 m alt., ♂, ♀, fr (A, BO, L). Mt Palimassan nr Tabang, Belajan R., 700 m alt.: *Kostermans 12905*, *12908*, fr (L). Mt Beratus (Peak of Balikpapan), 1200 m alt.: *Meijer 897*, fr (BO, L), *898*, ♂ (BO), *Kostermans 7536*, ♂, ♀ (A, BO, L, SING), *7537*, ♂, ♀, fr (A, BO, L, PNH, SING). Boekit Batoe Tibang, 1400 m alt.: *Mjöberg 38*, ♂ (BO), *55*, ♀ (BO).

CELEBES. Between Lake Lindoe and Mt Ngilalaki: *Bloembergen 3997*, 2000 m alt., fr (L), *3970*, 2100 m alt., fr (A, BO, L). Mt Kamboeno, 2700—2800 m alt.: *Eyma 1349*, ♂ (L). Tomongkobae Mts: *Eyma 3959*, ♂ (L). Mt Loemoet: *Eyma 3584*, ♂ (L, U). Mt Lokai-Tamboenan: *Eyma 3772*, ♂ (L). Mt Sinadji: *Rachmat 903*, ♀ (L). Angin—Angin—Pintealon, 1500—2600 m alt.: *Eyma 469*, ♂, ♀, fr (BO, L, U). Mt Poka Pindjang: *Kjellberg 1478*, 2400—2600 m alt., ♀, fr (BO, S), *3966*, 2800 m alt., ♂, fr (BO, S). Poka Pindjang—Tinabang, 2800—3000 m alt.: *Eyma 631*, ♂, fr (A, K, L, PNH, SING, U). Rante Mario—Rante Kombola, 3000 m alt.: *Eyma 904*, fr (L). Mt Asoemtatoempoeng, 2500 m alt.: *Toxopeus 14*, ♀ (BO). Peak of Bonthain (Lompobatang): *Warburg 16896*, fr (B), *Monod de Froideville 238*, 2900 m alt., st (BO), *van Zijll de Jong 15*, 2700—2850 m alt., fr (A, BO, L), *21*, 2800 m alt., ♂, fr (BO), *Bünnemeyer 12323*, 2500 m alt., fr (L), *11885*, 2300 m alt., ♀ (L), *12049*, 2000 m alt., fr (L), *12295*, 1800 m alt., ♂ (L), *Sarasin 1242*, 2000 m alt., fr (K), *van Zijll de Jong bb 20226*, 1600 m alt., ♂ (BO), *20227*, fr (BO), *20554*, fr (A, BO, L, SING).

FLORES. Ruteng: *Verheijen 2001*, *2002*, 1500 m alt., fr (L), *1671*, *1672*, 1930 m alt., ♀, fr (L).

MOLUCCAS. Batjan. Mt Sibela: *Roepke 14*, 1600—2000 m alt., st (BO), *Warburg 18270*, 2199 m alt., fr (B), *de Haan bb 23238*, 2199 m alt., fr (BO, L). — Obi. Lawoei, Djiko Dolong, 800 m alt.: Nedi 599, ♂, ♀ (BO, L). — Buru. Mt Fogha, 2000 m alt.: *Stresemann 378*, ♀ (L). — Ceram. Mt Seahari, 1200 m alt.: *Eyma 2148*, ♂ (A, B, BO, K, L). Moenoea—Oeeimpoekoe: *Eyma 2220*, ♂ (BO, K, L). — Ambon. Mt Salahoetoe: *Buwalda 6201*, ♂ (BO, L), *Teysmann s.n.*, st (A, BO, L, U).

TENTATIVE KEY TO THE NEW GUINEAN ENTITIES

As the entities are no sharply dilimited units, the construction of a good key is impossible. Because of the large number of entities some sort of key is, however, necessary but it is advisable to compare new collections with those already identified during the present revision.

1.a. Flowers always solitary 2
b. Flowers in at least one axil per inflorescence in groups of three or more 27
2.a. Apex of leaves acuminate 3
b. Apex of leaves acute to rounded. 6
3.a. Shrublet 0.15—0.3 m high . . . . **? 12. 'nettoti'**
b. Shrub over 1 m high. 4
4.a. Occurring in West New Guinea. . . . . **35. 'oligandra'**
b. Occurring in East New Guinea 5
5.a. Petals (0—) 2 (—6) . . . . **25. 'heteromera'**
b. Petals 4—11 . . . . **29. 'macrantha'**
6.a. Lower side of leaves densely papillate . . . . **7. 'papillata'**
b. Lower side of leaves smooth to tuberculate. 7
7.a. Petals 4—11 8
b. Petals (0—) 2 (—5) 16
8.a. Leaf blades 5.5—10 × 2—4 cm. *Waigeo Island* . . . . **20. 'buffelhoorn'**
b. Leaf blades 0.5—5 × 0.2—2.3 cm. *New Guinea mainland*. 9
9.a. Leaves recurvate . . . . **13. 'fistulosa'**
b. Leaves flat or margins recurved 10
10.a. Petals 12—23 × 5—11 mm . . . . **17. 'elongata'**
b. Petals 2.5—11 × 0.6—5.5 mm 11
11.a. Petals 2—5.5 mm wide . . . . **16. 'myrtoides'**
b. Petals 0.6—2.5 mm wide 12
12.a. Leaf blades 0.5—1.0 × 0.2—0.5 cm . . . . **14. 'microphylla'**
b. Leaf blades 1.2—5 × 0.5—1.5 cm 13
13.a. Petals 4.5—8 mm long 14
b. Petals 2.5—4 mm long 15
14.a. Shrub *c.* 2 m high; leaves coriaceous. . . . . **11. 'lamii'**
b. Shrub 0.2—0.3 m high; leaves (stiffly) chartaceous . . . . **12. 'nettoti'**
15.a. Leaf blades 1.2—2.5 cm long, coriaceous; pedicels 8—14 mm. . . . . **3. 'buxifolia'**
b. Leaf blades 2.5—5 cm long, chartaceous to subcoriaceous; pedicels 15—21 mm **35. 'oligandra'**
16.a. Leaf blades 0.15—0.2 cm wide. . . . . **15. 'vacciniodes'**
b. Leaf blades 0.4—4.2 cm wide 17
17.a. Bases of leaves all abruptly narrowly rounded. . . . . **5. 'pittosporoides'**
b. Bases of leaves at least partly cuneate to obtuse. 18
18.a. Seeds orange-brown 19
b. Seeds black 20
19.a. Petals 5—8 mm long . . . . **12. 'nettoti'**
b. Petals 2.5—4 mm long . . . . **35. 'oligandra'**

20.a. *In sicco* midrib grooved above; *in vivo* lower side of mature leaves distinctly glaucous **10. 'giluwe'**
b. *In sicco* midrib flat to slightly crested above; *in vivo* lower side of mature leaves not glaucous 21
21.a. Petals 0.7—1.3 mm wide . . . . **35. 'oligandra'**
b. Petals 1.5—5 mm wide 22
22.a. Leaf blades 0.6—2.1 cm long . . . . **4. 'versteegii'**
b. Leaf blades 1.0—6.5 cm long 23
23.a. Occurring on Mt Wilhelm in open subalpine vegetation. . . . . **2. 'subalpina'**
b. Occurring outside Mt Wilhelm, or in shrubberies or forest(margins) 24
24.a. Shrub 0.1—1 (—3) m high; leaf blades 1.0—3.5 × 0.4—1.2 cm . . . . **1. 'reducta'**
b. Shrub 1—6 m high; leaf blades 1.0—6.5 × 0.5—4.2 cm. 25
25.a. Occurring in West New Guinea. . . . . **6. 'subpittosporoides'**
b. Occurring in East New Guinea 26
26.a. Twigs erect, little branched . . . . **8. 'crassipes'**
b. Twigs not erect, repeatedly branched. . . . . **9. 'montis-wilhelmi'**
27.a. Petals (0—) 2 (—6) 33
b. Petals (3 or) 4—9. 28
28.a. Leaves scattered 31
b. Leaves pseudoverticillate. 29
29.a. Leaves 3—7 mm petioled; leaf base cuneate to acute. . . . . **33. 'verticillata'**
b. Leaves (sub)sessile; leaf base rounded to auriculate. 30
30.a. Leaf base narrowly rounded to minutely auriculate. West New Guinea. . . . . . **31. 'rosea'**
b. Leaf base cordate to auriculate. East New Guinea . . . . **32. 'cordata'**
31.a. Leaves (sub)sessile; leaf base narrowly rounded to minutely auriculate . . . . . . **31. 'rosea'**
b. Leaves 2—12 mm petioled; leaf base cuneate to obtuse. 32
32.a. Leaf blades 1.5—4 × 1—2.5 cm; occurring on Mt Doorman, West New Guinea **34. 'pachyphylla'**
b. Leaf blades 3—10 × 1—3.5 cm; East and West New Guinea, not known from Mt Doorman **26. 'polymera'**
33.a. Leaf base abruptly and narrowly rounded to minutely auriculate . . . . . **30. 'densifolia'**
b. Leaf base cuneate to obtuse, some leaves of a specimen sometimes rounded 34
34.a. Branchlets stout to very stout; leaves firmly coriaceous, blades 8—20 × 2.5—6.5 cm; Arfak Mts **21. 'robusta'**
b. Branchlets slender to stout; leaves chartaceous to coriaceous, blades 1.5—23.5 × 0.5—11 cm; throughout New Guinea 35
35.a. Leaf blades 1.5—5 cm long, obtuse to rounded . . . . **36. 'rubiginosa'**
b. Leaf blades 3.5—23 cm long; acute to rounded or acuminate to cuspidate 36
36.a. Occurring in East New Guinea . . . . 37, c, e, g, h
b. Occurring in West New Guinea. . . . . 37 a—g
37.a. Leaf blades 3.5—9.0 × 0.9—2.6 cm, apex acute to cuspidate; midrib often impressed above; flower buds often acuminate . . . . **18. 'acutifolia'**
b. Leaf blades 3.5—14 × 1—3.5 cm, apex obtuse to acuminate; midrib flat to impressed above; flower buds rounded to acute . . . . **28. 'hatamensis'**
c. Leaf blades 4—10 × 1.5—3 cm, apex acute to acuminate; midrib flat to impressed above; flower buds rounded to acute; venation more densely reticulate than in (b) . . . **27. 'reticulata'**
d. Leaf blades 4—12 × 1—4 cm, apex rounded to acuminate; midrib flat to crested above; flower buds rounded . . . . **19. 'beccariana'**
e. Leaf blades 5.5—23.5 × 2—11 cm, apex acute to acuminate; midrib flat to crested above; flower buds rounded . . . . **22. 'coriacea'**
f. Leaf blades 7—16 × 1.5—6 cm, apex rounded to acuminate; midrib usually flat above; flower buds usually rounded . . . . **23. 'obovata'**
g. Leaf blades 8—19 × 2—6 cm, apex acuminate; midrib usually flat above; flower buds usually rounded **24. 'chartacea'**
h. Leaf blades 3.5—18 × 0.5—6.5 cm, apex (obtuse to) acuminate; midrib often impressed above; flower buds rounded; very variable. . . . . **25. 'heteromera'**

entity 1. 'reducta' — *Drimys reducta* Diels, Nova Guinea 14 (1924) 77; A. C. Smith, J. Arn. Arb. 24 (1943) 134. — *Drimys brassii* A. C. Smith, o.c. 23 (1942) 421; o.c. 24 (1943) 135 f. 35 o, p. — *Tasmannia brassii* (A. C. Smith) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. reducta: Pulle 976* (B). *D. brassii: Brass 9068* (A).

Shrub 0.1—1 (—3) m high. *Leaves* scattered; blade obovate, sometimes elliptic or obovate-oblong, 1.0—3.5 × 0.4—1.2 cm, base cuneate to obtuse, apex broadly rounded to obtuse, sometimes mucronulate, coriaceous; petiole 1—3 mm; nerves at 25°—60° to the midrib, inconspicuous to impressed above, inconspicuous to prominulous below; veins inconspicuous on either side. *Flowers* 1 per bract; mature lower bracts 3.5—7 × 0.7—4 mm; pedicel 4—17 mm; sepals 3—6.5 mm long; petals (0—) 2 (—4), 3—9 × 1.5—3 mm; stamens 7—30; carpels in ♂ flowers 1—3 (rarely in a single flower absent), in ♀ flowers 1 (—3) with 11—24 ovules. *Fruits* up to 14 × 7 × 6 mm; seeds black.

DISTRIBUTION. New Guinea: Wissel Lakes to Kubor Ra.

ECOLOGY. Open subalpine (sometimes marshy) vegetation, rarely subalpine shrubberies; 3000—3800 m altitude.

DISCUSSION. The collections from Mt Wichmann, Mt Giluwe, and the Kubor Range are very uniform; those from Lake Habbema and the Wissel Lakes have wider leaves and a more conspicuous nervation. The latter specimens constitute a transition to *subpittosporoides* by their leaf form, habit (up to 3 m high), and habitat (also in shrubberies). *Subalpina* differs from *reducta* in minor details only: dimensions of all parts, a slightly sharper angle between the nerves and the midrib, and generally more carpels (see also p. 284). Both to the SW. and the SE. the present entity is barely separable from *versteegii*. The specimen *Eyma 4807* is not separable from *Vink 17420* which is distinctly a narrow-leaved form of *montis-wilhelmi*.

In specimens from East New Guinea the young leaves are apparently glaucous on either side, but in specimens from West New Guinea no trace of this glaucescence was found.

NEW GUINEA. West. Wissel Lakes, Enarotali-Koegapa-Egogitoagapa: *Eyma 4807*, ♂ (BO, L). Lake Habbema: *Brass 10671*, 3000 m alt., ♀, fr (A, BO, L), *9068*, 3225 m alt., ♂, fr (A, BM, BO, K, L, LAE), *9536*, 3300 m alt., ♂, fr (A, BO, L). Mt Wichmann, 3000 m alt.: *Pulle 976*, ♂ (B, BO, K, L, U). — East. Mt Giluwe: *Schodde 1739*, 3200 m alt., fr (A, CANB, K, L, LAE), *1932*, 3650 m alt., ♂ (A, CANB, K, L, LAE). Kubor Ra.: Mt Kinkain, *Vink 16071*, 3590 m alt., ♂, ♀, fr (AD, BO, CANB, L, LAE, PNH, RSA, S, SING); Mt Kantz, *16275*, 3680 m alt., ♂, fr (A, B, CANB, CHR, K, L, LAE, MEL), *16138*, 3800 m alt., ♂, ♀, fr (A, CANB, K, L, LAE); Mt Milyin Kolyin, *Pullen 5157*, 3790 m alt., ♂ (CANB, L).

Provisionally, the scrappy collection *Cooper 21*, ♀ (L) from Mt Carstensz, 3700 m alt., is inserted here.

entity 2. 'subalpina'.

Shrub or treelet (1.2—) 2—3 m high. *Leaves* scattered; blade obovate to obovate-oblong, (1.5—) 2—4.5 × 0.6—1.6 cm, base cuneate, apex acute to obtuse, rarely rounded, often mucronulate, subcoriaceous, petiole 2—7 mm; nerves at 20°—50° to the midrib, inconspicuous to impressed above, prominulous, sometimes inconspicous, below; veins inconspicous on either side. *Flowers* 1 per bract; mature lower bracts 7—11 × 3—4 mm; pedicel 11—25 mm; sepals 5—8.5 mm long; petals 2 (or 3), 7—10 × 3—5 mm; stamens 8—23; carpels in ♂ flowers 2—5, in ♀ flowers 2—5 with 26—46 ovules. *Fruits* up to 13 × 5 × 4 mm; seeds black.

DISTRIBUTION. New Guinea: Mt Wilhelm.

ECOLOGY. Open subalpine vegetation, rarely in subalpine shrubberies; 3350—4175 m altitude.

Wade & McVean, Mt Wilhelm Studies I, 1969, found this entity in old landslip vegetation (*Monostachya oreoboloides — Schoenus curvulus* association), in Tussock Grassland (*Danthonia vestita* — *Deyeuxia brassii* association; their plate 16), and in Short Alpine Grassland (*Festuca papuana* — *Siphula 'themnoides'* association; their plate 19), in all cases with low constancy.

DISCUSSION. See p. 284, 287. The young leaves are apparently glaucous on either side.

NEW GUINEA. East. Mt Wilhelm, east slope, 3350—4175 m alt.: *J. A. R. Anderson 18*, fr (K, LAE), *Barrett 12*, ♂ (K, LAE), *Borgmann 367*, ♂, ⚥, fr (L, LAE), *Brass 29924*, ♀, fr (A, CANB, K, L, LAE, US), *30163*, ♀, fr (A, CANB, K, L, LAE, PNH, US), *Havel NGF 17437*, ♂, ♀, fr (K, L), *Hoogland & Pullen 5702*, fr (A, BM, CANB, K, L, LAE, US), *5757*, ♂ (BM, CANB, K, L, LAE, PNH, US), *Keogh s.n.*, fr (LAE), *Robbins 689*, ♂, fr (A, CANB, L, LAE), *Sayers & Millar NGF 19866*, fr (K, L), *Semple & Rayner s.n.*, fr (MEL), *Van Balgooy 225*, ♂, fr (CANB, L, LAE, RSA, WELT), *226*, ♀, fr (CANB, L, LAE), *289*, ♀ (AD, C, CANB, CHR, L, LAE, PNH), *290*, ♂ (L), *369*, ♂ (CANB, L, LAE), *370*, ♀, fr (B, CANB, K, L, LAE, MEL, SING), *373*, ♀, fr (BISH, FI, L, LAE), *374*, ♂ (CANB, L, LAE, S, Z), *571*, ♀, fr (BO, CANB, L, LAE, NSW), *Walker ANU 5115*, ♀, fr (K, L), *5116*, ♂ (L), *Womersley NGF 8965*, ♂, fr (A, CANB, K, L, LAE), *24821*, ♂ (L), *Womersley & Osborn NGF 15354*, ♂, ♀, fr (BM, CANB, L, LAE, NSW); south slope, 3800 m alt.: *Van Balgooy 816*, ♂ (CANB, L, LAE, P); north slope, 4100 m alt.: *Van Balgooy 915*, ♂ (A, CANB, L, LAE).

entity 3. 'buxifolia' — *Drimys buxifolia* Ridley, Trans. Linn. Soc. London II, 9 (1916) 13; A. C. Smith, J. Arn. Arb. 23 (1942) 419; o.c. 24 (1943) 134. — *Drimys parviflora* Ridley, l.c. 12; A. C. Smith, o.c. (1943) 136. — *Bubbia parviflora* (Ridley) Burtt, Hook. Ic. Pl. 34 (1936) t. 3315, p. 3. — *Tasmannia buxifolia* (Ridley) A. C. Smith, Taxon 18 (1969) 288. — *Tasmannia parviflora* (Ridley) A. C. Smith, l.c.

TYPIFICATION. *D. buxifolia: Boden Kloss s.n.* (BM). *D. parviflora: Boden Kloss s.n.* (BM).

Shrub. *Leaves* scattered; blade obovate, 1.2—2.5 × 0.5—1.2 cm, base cuneate to acute, apex broadly rounded to obtuse, coriaceous; petiole 2—3 mm; nerves at 40°—60° to the midrib, prominulous to faint above, prominulous below; veins inconspicuous above, faint to inconspicuous below. *Flowers* 1 per bract; pedicel 8—14 mm; sepals 3—4 mm long; petals 4 or 5, 3—4 × 2 mm; stamens 16—20; carpels in ♂ flowers 2—4, ♀ flowers unknown. *Fruits* unknown.

DISTRIBUTION. New Guinea: Mt Carstensz.

ECOLOGY. 2530—3350 m altitude.

DISCUSSION. The types of both species mentioned above are exact matches for each other and there is no reason to regard them as separate taxa.

Buxifolia is a more-petalled form of the Lake Habbema facies of *reducta*.

NEW GUINEA. West. Mt Carstensz: camps XI—XII, 2530—3350 m alt.: *Boden Kloss s.n.*, ♂ (BM, type of *Drimys parviflora*); camps XIII—XI: *Boden Kloss s.n.*, ♂ (BM, type of *Drimys buxifolia*, K).

entity 4. 'versteegii' — *Drimys versteegii* Diels, Nova Guinea 14 (1924) 77; A. C. Smith, J. Arn. Arb. 24 (1943) 134.

TYPIFICATION. *D. versteegii: Pulle (leg. Versteeg) 2412* (B).

Shrub or treelet 2—4.5 m high. *Leaves* scattered; blade obovate, 0.6—2.1 × 0.4—1.0 cm, base cuneate to acute, apex broadly rounded to obtuse, (sub)coriaceous; petiole 1—4 mm; nerves at 40°—70° to the midrib, impressed to inconspicuous above, prominulous to inconspicuous below; veins inconspicuous above, very faint to inconspicuous below. *Flowers* 1 per bract; mature lower bracts 3—6.5 × 1—5 mm; pedicel 4—15 mm;

sepals 3—6 mm long; petals 2 (—4), 3.5—8 × 1.5—3.5 mm; stamens 9—32; carpels in ♂ flowers 1—5, in ♀ flowers 2—5 with 7—20 ovules. *Fruits* up to 9 × 3 × 2.5 mm; seeds black.

DISTRIBUTION. New Guinea: Mt Hubrecht (S. of Mt Wilhelmina) an SE. part of eastern side of the island.

ECOLOGY. Shrubberies, forests, and forest borders; 2740—3680 m altitude.

DISCUSSION. The type collection is slightly different from the material from SE. New Guinea in its coarser leaves.

Versteegii is very close to *reducta* from which it differs in habit, habitat, and prominence of nervation; it is also very close to *montis-wilhelmi* of which it is a small-leaved outlyer. In fact, *versteegii* connects *reducta* and *montis-wilhelmi*, but it is absent from the localities where the latter occur both (see also *sub montis-wilhelmi*).

NEW GUINEA. West. Mt Wilhelmina complex, Mt Hubrecht, 3100 m alt.: *Pulle (leg. Versteeg) 2412*, ♂ (B, BO, K, L, U). — East. Morobe Dist., Mt Dickson, 3500 m alt.: *Hartley 12968*, ♂ (L). Above Bakaia, *c.* 15 miles SE. of Garaina, 274 0m alt.: *Hartley 12796*, ♂ (CANB, L), *12800*, ♀ (L). Central Dist., Mt Albert Edward: *Van Royen NGF 30101*, 3350 m alt., ♀ (A, K, L), *Brass 4239*, 3680 m alt., ♂ (A, BM, BO, K, L, US), *4322*, 3680 m alt., ♂, fr (A, BM, BO, K, US). Wharton Ra., Murray Pass, 2840 m alt.: *Brass 4602*, ♂ (BO). Musgrave Ra.: *MacGregor s.n. (NSW 68529)*, ♀ (NSW). Mt Knutsford: *MacGregor s.n.*, ♀ (L), *ibidem (MEL 5394)*, ♂ (MEL). Summit Owen Stanley Ra.: *MacGregor s.n. (MEL 5396)*, ♂, ♀ (MEL).

entity 5. 'pittosporoides' — *Drimys pittosporoides* Diels, Nova Guinea 14 (1924) 76; A. C. Smith, J. Arn. Arb. 24 (1943) 135. — *Tasmannia pittosporoides* (Diels) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. pittosporoides: Lam 2167* (B).

Shrub. *Leaves* scattered; blade obovate, 2.0—3.5 × 1.0—2.0 cm; base abruptly narrowly rounded, apex obtuse to broadly rounded, coriaceous; petiole 1—2 mm; nerves at 40°—60° to the midrib, prominulous on either side; veins faint to inconspicuous on either side. *Flowers* 1 per bract; mature lower bracts *c.* 10 × 7.5 mm; only buds known; petals 2 (rarely 3); stamens 19—28; carpels in ♂ flowers 3—6, ♀ flowers unknown. *Fruits* unknown.

DISTRIBUTION. New Guinea: Mt Doorman.

ECOLOGY. Open subalpine vegetation; 3250 m altitude.

DISCUSSION. This entity is narrowly related to *subpittosporoides* and is distinguished from the latter by the form of the leaf base only. Like *reducta* and *subalpina* this is a type from the open subalpine vegetations. See also *sub beccariana.*

NEW GUINEA. West. Mt Doorman, 3250 m alt.: *Lam 2167*, ♂ (B, BO, K, L, U).

entity 6. 'subpittosporoides'.

Shrub 2—4 m high. *Leaves* scattered; blade obovate to obovate-elliptic, 1.5—4.2 × 0.6—2.2 cm, base cuneate to acute, rarely obtuse, apex rounded to obtuse, rarely emarginate or acute and mucronulate, coriaceous; petiole 1—5 mm; nerves at 40°—60° to the midrib, prominulous or impressed to inconspicuous above, prominulous to inconspicuous below; veins faint to inconspicuous on either side. *Flowers* 1 per bract; mature lower bracts 6.5—10 × 2—7.5 mm; pedicel (1.5—) 3—11 mm; sepals 4—4.5 mm long; petals 2, 5.5—6 × 1.7—2 mm; stamens 19—24; carpels in ♂ flowers 1 (or 2), in ♀ flowers 1 (or 2) with 20—40 ovules. *Fruits* up to 13 × 7 × 6 mm; seeds black.

Distribution. New Guinea: Mt Wilhelmina.

Ecology. Subalpine shrubberies up to the timberline; 3800—3900 m altitude (according to Brass, J. Arn. Arb. 22, 1941, 327, 328, up to 4050 m alt.).

Discussion. The material, brought together in this entity, is not very uniform. The relative width of the leaves varies even between different sheets of the same collection. The available specimens form an uninterrupted series of intergrades; of these *10111* and *10309* are closest to *pittosporoides* (except for the leaf base) and *10303* and *10126* are closest to the Mt Wichmann facies of *reducta*.

Papillata differs from *subpittosporoides* in overall height and in its densely papillate epidermis on the lower side of the leaves.

See also p. 287.

New Guinea. West. Mt Wilhelmina: *Brass & Meijer Drees 10126*, 3800 m alt., ♂ (A, BO, L), *10303*, 3800 m alt., ♀, fr (A, BO, K, L), *10309*, 3800 m alt., fr (A, BO, L), *10111*, 3900 m alt., fr (A, BM, BO, L, LAE).

entity 7. 'papillata'.

Shrub *c.* 0.5 m high. *Leaves* scattered; blade obovate to obovate-spathulate, 1.0—2.6 × 0.6—1.2 cm, base cuneate to acute, apex rounded to obtuse, coriaceous, lower epidermis densely papillate; petiole 1—3 mm; nerves at 30°—60° to the midrib, prominulous or minutely impressed above, prominulous to very faint below, veins inconspicuous above, prominulous to inconspicuous below. *Flowers* 1 (rarely 2) per bract; mature lower bracts 6—7 × 3—5 mm; pedicel 10—25 mm; sepals 4.5—5.5 mm long; petals 2 (rarely 3), 6.5—7.5 × 2—3 mm; stamens 15—22; carpels in ♂ flowers 1—3, ♀ flowers unknown. *Fruits* unknown.

Distribution. New Guinea: Star Mts.

Ecology. Subalpine shrubberies; *c.* 3300—3400 m altitude.

Discussion. See *sub subpittosporoides*.

New Guinea. West. Star Mts, Mt Antares: *Nicolas 21*, 3300 m alt., ♂ (L), *Kalkman 4504*, 3380 m alt., ♂ (L).

entity 8. 'crassipes'.

Shrub (candelabriform) 2—3.5 m high. *Leaves* scattered; blade elliptic to obovate, 1.8—6.5 × 1.0—4.2 cm, base acute to obtuse (to rounded), apex (subacute to) obtuse to rounded, (firmly) coriaceous, with strongly peppery taste; petiole 2—5 mm; nerves at 40°—60° to the midrib, prominent to prominulous above (impressed when very young), prominent below; veins prominulous to inconspicuous on either side. *Flowers* 1 per bract; mature lower bracts 9—11.5 × 4.5—6 mm; pedicel 6—27 mm; sepals 8—8.5 mm long; petals 2, 8—11 × 3—4 mm; stamens 5—16; carpels in ♂ flowers 3—5, in ♀ flowers 2—5 with 29—52 ovules. *Fruits* up to 13 × 5 × 4 mm; seeds black.

Distribution. New Guinea: Mt Wilhelm.

Ecology. Subalpine shrubberies or edges thereof; 3535—3800 m altitude.

Discussion. See *sub montis-wilhelmi* and p. 285. *Van Balgooy 180* has both purely male and female flowers as well as bisexual ones; however, the male flowers have large carpels showing a female influence.

NEW GUINEA. East. Mt Wilhelm: *Wade ANU 7321*, 3535 m alt., fr (L), *Brass 30100*, 3750 m alt., fr (A, CANB, K, L, LAE, US), *Van Balgooy 776*, 3750 m alt., fr (CANB, L, LAE), *179*, 3800 m alt., ♂ (A, CANB, K, L, LAE), *180*, 3800 m alt., ♂, ⚥, ♀, fr (CANB, L, LAE).

DOUBTFUL. Mt Wilhelm, 3700 m alt.: *Van Balgooy 281*, ♂ (CANB, L, LAE), probably hybrid with *9. montis-wilhelmi*.

entity 9. 'montis-wilhelmi' — *Drimys montis-wilhelmi* Hoogl., Blumea Suppl. 4 (1958) 225, f. 1. — *Tasmannia montis-wilhelmi* (Hoogl.) A. C. Smith, Taxon 18 (1969) 289.

TYPIFICATION. *D. montis-wilhelmi: Hoogland & Pullen 5674* (CANB).

Shrub or treelet 1—6 m high. *Leaves* scattered; blade obovate to obovate-oblong, 1.0—5.5 × 0.5—2.5 (watershoots and shade forms 1.5—6.8 × 0.7—2.7) cm, base cuneate to obtuse, rarely broadly rounded, apex rounded or obtuse to rectangular, rarely acute and then sometimes mucronulate, stiffly chartaceous to subcoriaceous, not glaucous; petiole 1—7 mm; nerves at 35°—80° to the midrib, prominulous to very faint or impressed above (impressed when very young), prominulous below; veins prominulous to inconspicuous on either side. *Flowers* 1 per bract; mature lower bracts 4—9 × 2—3 mm; pedicel 5—22 mm; sepals 3—7 mm long; petals 2 (—4), 5—10 × 2—4 mm; stamens 12—31; carpels in ♂ flowers 2—5, in ♀ flowers 2—6 with 6—20 ovules. *Fruits* up to 10 × 6 × 5 mm; seeds black.

DISTRIBUTION. New Guinea: Mt Ambua to Mt Amungwiwa.

ECOLOGY. Lower montane forest, mossy forest, subalpine shrubberies or edges thereof; 2440—3800 m altitude.

Wade & McVean, Mt Wilhelm Studies I, 1969, found this entity in Cloud Forest (*Amaracarpus brassii—Elaeocarpus azaleifolius—Podocarpus pilgeri* association) with very low constancy, through the Lower Subalpine Forest (*Amaracarpus caeruleus—Pittosporum pullifolium—Pteris* association) until it reached a high constancy in the Upper Subalpine Forest (*Dimorphanthera microphylla—Rhododendron gaultheriifolium—Trochocarpa dispersa* association).

DISCUSSION. The material of this entity is rather homogeneous.

The leaf size shows a tendency to become smaller from Mt Ne in the west to Mt Amungwiwa in the east, irrespective of differences in altitude. This is illustrated by the means of the ten largest leaves (including the petiole) of each collection, related to the longitude:

47.5 × 17.0 mm Mt Ne	3210 m alt. 143°08′ EL
59.5 × 20.9 mm Mt Ne	3220 m alt. 143°08′ EL
45.6 × 14.7 mm Mt Ne	3250 m alt. 143°08′ EL
55.5 × 19.9 mm Mt Ne	3320 m alt. 143°08′ EL
39.1 × 15.6 mm Mt Ne	3340 m alt. 143°08′ EL
41.0 × 14.3 mm Mt Ambua	3380 m alt. 143°08′ EL
38.3 × 11.9 mm Mt Ambua	3380 m alt. 143°08′ EL
34.5 × 14.0 mm Mt Ambua	3490 m alt. 143°08′ EL
34.8 × 15.1 mm Mt Ambua	3515 m alt. 143°08′ EL
44.5 × 15.8 mm Mt Ambua	3555 m alt. 143°08′ EL
36.6 × 13.6 mm Mt Ambua	3555 m alt. 143°08′ EL
30.3 × 12.9 mm Mt Ambua	3555 m alt. 143°08′ EL
40.1 × 15.8 mm Mt Sugarloaf	3110 m alt. 143°44′ EL

39.9 × 16.2 mm	Mt Giluwe	3505 m alt.	143°53′ EL
35.9 × 12.7 mm	Mt Giluwe	3505 m alt.	143°53′ EL
45.9 × 14.2 mm	Mt Hagen	2440 m alt.	144°05′ EL
42.4 × 15.0 mm	Mt Hagen	3350 m alt.	144°05′ EL
32.7 × 12.6 mm	Kubor Ra.	3505 m alt.	144°30′ EL
37.5 × 13.4 mm	Kubor Ra.	3570 m alt.	144°30′ EL
29.1 × 10.3 mm	Kubor Ra.	3600 m alt.	144°30′ EL
39.7 × 13.4 mm	Mt Wilhelm	3300 m alt.	145°05′ EL
35.9 × 13.1 mm	Mt Wilhelm	3300 m alt.	145°05′ EL
32.3 × 12.2 mm	Mt Wilhelm	3500 m alt.	145°05′ EL
32.3 × 11.8 mm	Mt Wilhelm	3560 m alt.	145°05′ EL
31.4 × 12.4 mm	Mt Wilhelm	3750 m alt.	145°05′ EL
29.5 × 13.7 mm	Mt Wilhelm	3800 m alt.	145°05′ EL
25.0 × 9.0 mm	Mt Michael	3300 m alt.	145°18′ EL
28.3 × 10.9 mm	Mt Piora	3200 m alt.	146°02′ EL
21.9 × 9.2 mm	Mt Amungwiwa	3475 m alt.	146°40′ EL

(Shade forms and watershoots have been left out from this list; this only holds for the mountains Ambua and Ne where I collected myself, the labels of the other collections do not give the relevant information).

Following this tendency the eastern collections of *versteegii* exactly fit this picture:

17.5 × 5.6 mm	Mt Dickson	3505 m alt.	147°08′ EL
15.5 × 4.1 mm	Bakaia	2740 m alt.	147°17′ EL
14.2 × 5.2 mm	Bakaia	2740 m alt.	147°17′ EL
20.2 × 7.7 mm	Mt Alb. Edward	3350 m alt.	147°24′ EL
20.5 × 8.2 mm	Mt Alb. Edward	3680 m alt.	147°24′ EL
16.4 × 7.0 mm	Mt Alb. Edward	3680 m alt.	147°24′ EL
17.5 × 6.4 mm	Murray Pass	2840 m alt.	147°24′ EL

(The *MacGregor* collections are too fragmentary to be of value for this comparison).

The distinction between *montis-wilhelmi* and *versteegii* has been made more or less arbitrarily: the small- and dull-leaved specimens with nearly invisible venation have been placed in *versteegii*.

One collection from Mt Wilhelm (*Van Balgooy 270*) bridges a large part of the morphological distance to the local facies of *heteromera*.

The Kubor Ra. collections cited as doubtful differ from large-leaved specimens from Mt Ne in their thicker leaves and larger flowers on more robust pedicels only. Although deviating from the general variability pattern of *montis-wilhelmi* by these features, this group is not separable from the latter; it also constitutes a transition between *montis-wilhelmi* and *crassipes*.

The collections from the Huon Peninsula cited as doubtful differ in a less distinct venation and a tendency towards strongly recurved margins. They are kept separate from the main body of the entity to keep the variability within reasonable limits. *Vink 17420* connects this group with the entity proper and is intermediate between the latter and *reducta* (e.g. *Eyma 4807* with less distinct venation, *Brass 10671* with more distinct venation) as well.

See also *sub fistulosa* and *beccariana*.

From the close relationships of the present entity with the entities *reducta*, *versteegii*, and *crassipes* it could be concluded that it has a central position in the pattern of affinities. Entity *coriacea* has a similar position amongst the large-leaved entities with more than 1 flower per bract. I am convinced, however, that this is an overestimation due to the accidental coincidence of the distributional areas of these entities with the area of more intensive collecting. A higher collecting density in the highlands of West New Guinea will certainly reveal similar patterns, reducing the relative importance of these entities within the variability pattern.

NEW GUINEA. East. Mt Ambua: *Vink 17415*, 3340 m alt., shade form, st (L), *17418*, 3380 m alt., st (L), *17420*, 3380 m alt., st (L), *17440*, 3490 m alt., fr (CANB, L, LAE), *17380*, 3515 m alt., ♂ (CANB, L, LAE), *17392*, 3555 m alt., ♂ (L), *17393*, 3555 m alt., fr (CANB, L, LAE), *17394*, 3555 m alt., ♂ (CANB, L, LAE). Mt Ne: *Vink 17275*, 3120 m alt., shade form, st (CANB, L, LAE), *17160*, 3130 m alt., shade form, st (CANB, L, LAE), *17108*, 3155 m alt., shade form, st (CANB, L, LAE), *17113*, 3210 m alt., fr (CANB, L, LAE), *17114*, 3220 m alt., st (CANB, L, LAE), *17115*, 3250 m alt., fr (CANB, L, LAE), *17121*, 3340 m alt., ♂ (CANB, L, LAE). Mt Giluwe, 3505 m alt.: *Schodde 1839*, ♂ (CANB, K, L, LAE), *1916*, ♂, ♀, fr (A, CANB, K, L, LAE). Mt Sugarloaf, 3110 m alt.: *Hoogland & Schodde 7231*, fr (BM, BO, CANB, L, LAE, NSW, PNH, US). Tomba, Mt Hagen, 2440 m alt.: *Robbins 293*, ♀ (CANB, LAE). Mt Hagen, 3350 m alt.: *Robbins 347*, fr (A, BM, CANB, L, LAE). Kubor Ra.: *Pullen 5080*, 3570 m alt., ♂, ♀, fr (A, CANB, K, L); Minj-Nona Div., 3415 m alt.: *Pullen 248*, ♀ (CANB, LAE); Mt Kinkain, 3530 m alt.: *Pullen 220*, ♂ (CANB, LAE); Mt Aas, 3505 m alt.: *Pullen 5100*, fr (A, CANB, K, L). Mt Wilhelm: *Stauffer 5664*, ♀ (L), *Van Balgooy 399*, 3300 m alt., ♂ (CANB, L, LAE), *400*, ♀ (CANB, L, LAE), *Hoogland & Pullen 5674*, 3500 m alt., ♂ (BM, CANB, K, L, LAE, NSW, PNH, US), *Brass 30061*, 3560 m alt., ♀, fr (A, CANB, K, L, LAE, US), *Van Balgooy 182*, 3750 m alt., ♀, fr (CANB, L, LAE), *181*, 3800 m alt., ♂ (CANB, L, LAE). Mt Michael, 3300 m alt.: *Brass & Collins 31281*, ♀, fr (K, L, LAE, US). Mt Piora, 3200 m alt.: *Henty & Carlquist NGF 16547*, ♂ (A, CANB, K, L, RSA). Mt Amungwiwa, S. of Wau, 3475 m alt.: *Womersley NGF 18000*, y fr (CANB, K, L, LAE).

DOUBTFUL. Kubor Ra.: Mt Aas, 3505 m alt., *Pullen 5142*, ♂ (CANB, K, L); Mt Kinkain, 3570 m alt., *Pullen 5098*, y fr (A, CANB, K, L). Mt Wilhelm, 3600 m alt.: *Van Balgooy 270*, ♂ (CANB, L, LAE). Saruwaged Ra.: Mt Sarawaket, 2740 m alt., *Clemens 7406*, ♂ (A, B); Tempanpan, 3410 m alt., *Hoogland 9867*, fr (CANB, K, L); Gimdoh, 3440 m alt., *Hoogland 9910*, fr (CANB, K, L). Samanzing, 2400—2700 m alt.: *Clemens 9523*, ♂ (A).

entity 10. 'giluwe'.

Shrub 0.7—3.5 m high. *Leaves* scattered; blade obovate to obovate-oblong, 0.7—7 × 0.4—2.5 cm, base cuneate, apex acute to obtuse to rounded, rarely emarginate, chartaceous, *in vivo* lower side glaucous; petiole 1.5—10 mm; nerves at (45°—) 55°—80° (—90°) to the midrib, prominulous above, prominent to prominulous below; veins prominulous to faint on either side. *Flowers* 1 per bract; mature lower bracts 4—8 × 0.5—2.5 mm; pedicel 2—18 mm; sepals 2.2—4 mm long; petals 2 (—5), 4—8 × 1.5—2 mm; stamens 12—18; carpels in ♂ flowers 2 or 3, in ♀ flowers 2—6 with 3—11 ovules. *Fruits* up to 4 × 3 × 2.5 mm; seeds black.

DISTRIBUTION. New Guinea: Western and Southern Highlands Districts.

ECOLOGY. Midmountain forest, mossy forest, shrubberies; 2590—3375 m altitude.

DISCUSSION. For relationships with other entities see pp. 290, 299.

NEW GUINEA. East. Taylor's Camp, Porgera Div., 20 miles NW. of Laiagam, 2740 m alt.: *Robbins 3420*, ♀ (CANB). Mt Ambua: *Frodin NGF 28152*, *28243*, 2760 m alt., ♀ (K, L), *Vink 17450*, 3155 m alt., ♂ (CANB, L, LAE), *17414*, 3300 m alt., ♂ (CANB, L, LAE), *17315*, *17328*, 3340 m alt., ♀, fr (CANB, L, LAE), *17411*, 3375 m alt., ♀, fr (CANB, L, LAE). Mt Ne: *Vink 17109*, *17110*, 3155 m alt., ♀, fr (CANB, L, LAE), *17527*, 3180 m alt., ♂ (CANB, L, LAE). Mt Kerewa: *Gillison NGF 25202*, 2950 m alt., fr (A, K, L), *Vink 17103*, 3150 m alt., ♀, fr (CANB, L, LAE), *17105*, 3165 m alt., ♀, fr (CANB, L, LAE), *17107*, 3165 m alt., ♂ (CANB, L, LAE), *17062*, 3365 m alt., ♂ (CANB, L, LAE). Mt Giluwe: *Schodde 1679*, 2590 m alt., ♂, ♀, fr (CANB, L, LAE), *1999*, 2680 m alt., ♂ (CANB, K, L, LAE).

entity 11. 'lamii' — *Drimys lamii* Diels, Nova Guinea 14 (1924) 77; A. C. Smith, J. Arn. Arb. 24 (1943) 136. — *Tasmannia lamii* (Diels) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. lamii:* lectotype: *Lam 1871* (B); syntype: *Lam 1928* (BO, L).

Shrub *c.* 2 m high. *Leaves* scattered; blade obovate (to obovate-oblong), 1.5—4 × 0.5—1.5 cm, base cuneate, apex rounded, rarely obtuse, coriaceous, lower side apparently glaucous; petiole 5—6 mm; nerves at 60°—80° to the midrib, prominulous to faint on either side; veins faint to inconspicuous on either side. *Flowers* 1 per bract; mature lower bracts *c.* 3.5 × 1.5 mm; pedicel 8—12 mm; sepals 3.5—4.5 mm long; petals 5 or 6, 4.5—8 × 1.2—2 mm; stamens 18—23; carpels in ♂ flowers 2 or 3; ♀ flowers unknown. *Fruits* unknown.

DISTRIBUTION. New Guinea: Mt Doorman.

ECOLOGY. Open montane vegetation or mossy forest; 2480—2900 m altitude.

DISCUSSION. This entity is closely related to *nettoti*, from which it differs in its habit and the texture of its leaves only. *Lamii* is better delimited from *fistulosa* (which occurs also on Mt Doorman) in having a wider angle between nerves and midrib, principally flat leaves with only the margins recurved, less closely set leaves, and narrower petals. For the relations with *giluwe* see p. 290.

NEW GUINEA. West. Mt Doorman: *Lam 1928*, 2480 m alt., ♂ (BO, L), *1871*, 2900 m alt., ♂ (B, BO, K, L).

entity 12. 'nettoti'.

Shrub 0.2—0.3 m high. *Leaves* scattered; blade obovate, 1.5—4 × 0.7—1.5 cm, base cuneate, apex rounded to obtuse, (stiffly) chartaceous; petiole 2—5 mm; nerves at 60°—90° to the midrib, prominulous on either side; veins faint but distinct on either side. *Flowers* 1 per bract; mature bracts not seen; pedicel 8—20 mm; sepals *c.* 4 mm long; petals (?2—) 6—9, 5—8 × 0.7—1.5 mm; stamens 15—22; carpels in ♂ flowers 2 or 3, in ♀ flowers 2—6 with 3—10 ovules. Mature *fruits* unknown, immature ones up to 5 × 3 × 2 mm; seeds light brown.

DISTRIBUTION. New Guinea: Nettoti Range.

ECOLOGY. In moss cushions in open scrub or mossy *Podocarpus-Xanthomyrtus* forest; 1900—2100 m altitude.

DISCUSSION. The immature seeds of *Van Royen & Sleumer 7936* are definitely of the same type as those of *cordata* with a light brown epidermis consisting of flattened cells. Below the immature fruits of this specimen I could detect 2 petal scars only.

For the relation to *lamii*, see there.

A minute form of this entity (or deserving a separate status?) might be *Hartley 12747:* 15—30 cm high, in mossy forest, blades 0.4—0.6 × 0.2—0.3 cm, apex sharply acuminate, acumen up to 1 mm long, petals 4—6, stamens 7 or 8, in ♂ flowers 1 carpel. This specimen could also be regarded as an acuminately leaved, more-petalled form of *vaccinioides*.

NEW GUINEA. West. Nettoti Ra.: *Van Royen & Sleumer 7475*, 1920 m alt., ♂ (L), *7936*, 1920 m alt., ♂, y fr (CANB, K, L), *7972*, 2100 m alt., ♂ (L).

DOUBTFUL. East. Above Bakaia, *c.* 15 m. SE. of Garaina, 2740 m alt.: *Hartley 12747*, ♂ (CANB, L).

entity 13. 'fistulosa' — *Drimys fistulosa* Diels, Nova Guinea 14 (1924) 78; A. C. Smith, J. Arn. Arb. 24 (1943) 135. — *Tasmannia fistulosa* (Diels) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. fistulosa:* lectotype: *Lam 1615* (B); syntype: *Lam 1653* (L).

Shrub 0.5—1.5 m high. *Leaves* scattered, closely set; blade obovate-elliptic to obovate-oblong, strongly recurvate, 0.8—2.2 × 0.3—1.0 cm, base cuneate, apex (acute to) obtuse to rounded, coriaceous; petiole 1—5 mm; nerves at 30°—60° to the midrib, faint to inconspicuous on either side; veins very faint to inconspicuous above, inconspicuous below. *Flowers* 1 per bract; mature lower bracts *c.* 5.5 × 4 mm; pedicel 12—15 mm; sepals 5—7 mm long; petals 7—11, 5.5—9.5 × 2.7—4 mm; stamens 31—34; carpels in ♂ flowers 2—6, in ♀ flowers *c.* 6. *Fruits* unknown.

DISTRIBUTION. New Guinea: Mt Doorman.

ECOLOGY. Open subalpine vegetation; 3250—3500 m altitude.

DISCUSSION. This entity is characterized by its strongly recurvate leaves and its large number of petals. Apparently it occupies a habitat comparable to those of *reducta* and *subalpina*, replacing these entities on Mt Doorman.

Probably related specimens have been listed as 'doubtful'. This material is scrappy and originates mostly from an area at a large distance from Mt Doorman. It shows clearly, however, that the character of the recurvate leaves cannot be used for delimitation:

a) *Lam 1630* has short, broadly obovate leaves with recurved margins; it could represent a trend towards the 2-petalled *pittosporoides* or *subpittosporoides*.

b) *MEL 5407*, with 7 petal scars, possesses slightly thinner leaves with a more distinct nervation — often impressed above — but it could certainly be placed in *fistulosa*. *MEL 5406*, with 7 petal scars, has the same type of leaves, but these are less closely set, less recurvate (margins strongly recurved), and attain a larger size (up to 5 × 1.3 cm). *MacGregor s.n.* in L (sheet *959.182—253*) is apparently a duplicate of *MEL 5406;* a bud of it contained 7 petals. *MEL 5408*, with 2 petals, has leaves of the same type as *MEL 5406*, but again the margins are less strongly recurved.

Clemens 9523, with 2 petals, matches well with *MEL 5408. Clemens 7406*, with 2 petals, definitely belongs to the same taxon as *Clemens 9523* but it has flat leaves or the leaf margins are only slightly recurved. On the other hand, it is closely related to *montis-wilhelmi*, e.g. *Robbins 293* from which it differs only by a less pronounced nervation and a slightly smaller leaves. These two *Clemens* collections were already placed as doubtful under *montis-wilhelmi.*

This series of collections with leaves from recurvate to flat is divided into two halves by the difference in the number of petals. As was already demonstrated elsewhere, this character is also of no use for delimitation.

NEW GUINEA. West. Mt Doorman: *Lam 1615*, 3250 m alt., ♂, ♀ (B, BO, K, L, U), *1653*, 3500 m alt., ♂ (L).

DOUBTFUL. West. Mt Doorman, 3280 m alt.: *Lam 1630*, ♀ (L). — East. Mt Knutsford: *MacGregor s.n. (MEL 5406)*, ♀ (MEL), *(MEL 5408)*, ♂ (MEL), *(HLB 959.182—253)*, ♂ (L). Mt Victoria: *MacGregor s.n. (MEL 5407)*, ♀ (MEL).

entity 14. 'microphylla' — *Drimys microphylla* A. C. Smith, J. Arn. Arb. 23 (1942) 418; o.c. 24 (1943) 134, f. 3 f—i. — *Tasmannia microphylla* (A. C. Smith) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. microphylla: Brass 12006* (A).

Epiphytic shrub 1—2 m high. *Leaves* scattered; blade obovate, 0.5—1.0 × 0.2—0.5 cm; base cuneate to acute, apex broadly rounded, subcoriaceous; petiole 1—2 mm; nerves at

40°—60° to the midrib, inconspicuous above, faint to inconspicuous below; veins inconspicuous on either side. *Flowers* 1 per bract; mature bracts unknown; pedicel 4—8 mm; sepals 2—3 mm long; petals 4—6, 3—5 × 0.6—1.3 mm; stamens 12—18; carpels in ♂ flowers (0 or) 1 (or 2); ♀ flowers unknown. *Fruits* up to *c.* 8 × 4 × 2 mm; seeds black.

DISTRIBUTION. New Guinea: Idenburg River.
ECOLOGY. On tall trees in mossy forest; 1800 m altitude.
DISCUSSION. For the relationships with *myrtoides* and *elongata* see *sub myrtoides.*
The present entity has in *vaccinioides* its counterpart amongst the entities with 2 petals. Although the number of petals is the only distinguishing character, *microphylla* and *vaccinioides* are kept separate to avoid obscuring the relationships in the series *microphylla—myrtoides—elongata.*

NEW GUINEA. West. Idenburg R., 15 km SW. of Bernhard Camp, 1800 m alt.: *Brass 12006*, ♂, fr (A, BO, K, L, LAE).

entity 15. 'vaccinioides' — *Drimys vaccinioides* Ridley, Trans. Linn. Soc. London II, 9 (1916) 13, t. 1, f. 1—6; A. C. Smith, J. Arn. Arb. 24 (1943) 134. — *Tasmannia vaccinioides* (Ridley) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. vaccinioides: Boden Kloss s.n.* (BM).

Epiphytic or terrestrial shrub up to 0.5 m high. *Leaves* scattered; blade obovate to obovate-oblong, 0.5—0.8 × 0.15—0.2 cm, base cuneate, apex rounded, stiffly chartaceous; petiole 1—2 mm; nerves at 40°—60° to the midrib, inconspicuous above, very faint to inconspicuous below; veins inconspicuous on either side. *Flowers* 1 per bract; mature lower bracts *c.* 1—1.2 × 0.2—0.7 mm; pedicel 4—7 mm; sepals 1.6—2 mm long; petals 2 (or 3), 3—5 × 0.6—1 mm; stamens 11—13; carpels in ♂ flowers 0—3; ♀ flowers unknown. *Fruits* unknown.

DISTRIBUTION. New Guinea: Mt Carstensz to Star Mts.
ECOLOGY. Mossy forest; 2000—3200 m altitude.
DISCUSSION. See *sub microphylla.* The above description is entirely based on material from Mt Antares.

NEW GUINEA. West. Mt Carstensz, 3200 m alt.: *Boden Kloss s.n.*, ♂ (BM). Star Mts, Mt Antares, 2000 m alt.: *Kalkman & Van Zanten 4441*, ♀ (CANB, L, LAE).

entity 16. 'myrtoides' — *Drimys myrtoides* Diels, Bot. Jahrb. 54 (1916) 241; A. C. Smith, J. Arn. Arb. 24 (1943) 135. — *D. myrtoides* var. *gracilis* Diels, o.c. 242. — *Tasmannia myrtoides* (Diels) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. myrtoides: Ledermann 12877* (B). *D. myrtoides* var. *gracilis: Ledermann 8430* (B).

Epiphytic or terrestrial shrub 0.5—1 m high. *Leaves* scattered; blade obovate to oblong, 0.8—3.5 × 0.3—1.2 cm, base cuneate, apex (acutishly) rounded, chartaceous to thinly coriaceous; petiole 1—3 mm; nerves at 30°—60° to the midrib, prominulous to inconspicuous on either side as are the veins. *Flowers* 1 per bract; mature lower bracts 2.5—4 ×

1.5—2 mm; pedicel 10—12 mm; sepals 3—5 mm long; petals 4—9, (4—) 5—11 × 2—5.5 mm; stamens 18—41; carpels in ♂ flowers 1—3, in ♀ flowers 2 or 3 with *c.* 9 or 10 ovules. *Fruits* unknown.

DISTRIBUTION. New Guinea: Sepik District.

ECOLOGY. Forests; 800—2070 m altitude.

DISCUSSION. Although the type specimen is more robust in all its parts and has more stamens (38—41 against 18—26) than the other collections, these differences are small and do not necessitate a further subdivision as was done by Diels.

Myrtoides seems to be a larger form of *microphylla* which is also epiphytic. As the latter was collected at 1800 m altitude, it cannot be regarded as a simple altitudinal phenotype of *myrtoides*. On the other hand there is a close connection between *myrtoides* and the larger-leaved *elongata*, also collected both epiphytic and terrestrial in the same altitidinal range: 750—1650 m. The differences between these entities are mainly based on dimensions, e.g.:

	diam. of flowers	leaf blades
microphylla	0.5—1 cm	0.6—1.0 × 0.3—0.5 cm
myrtoides	1.5—2 cm	0.8—3.5 × 0.3—1.2 cm
elongata	3.5—4 cm	1.5—4 × 0.7—2.3 cm

NEW GUINEA. East. Torricelli Mts, 800 m alt.: *Schlechter 14508*, ♀ (BO), *20068*, ♂, ♀ (K, P). Mt Somoro, 1370 m alt.: *Darbyshire 331*, ♀ (CANB). Felsspitze, 1400—1500 m alt.: *Ledermann 12877*, ♂ (B). Hunstein Mts, 1050 m alt.: *Ledermann 8430*, ♂ (B).

ex litt., probably all lost in B: environs of Mt Peripatus: *Schultze Jena 294*. Felsspitze: *Ledermann 11424*, 1050 m alt.; *12812*, *12996*, *13059 a*, 1400—1500 m alt. Schraderberg, 2070 m alt.: *Ledermann 11722*.

entity 17. 'elongata' — *Drimys elongata* Ridley, Hook. Ic. Pl. 31 (1916) t. 3051; Trans. Linn. Soc. London II, 9 (1916) 12; A. C. Smith, J. Arn. Arb. 24 (1943) 135. — *Tasmannia elongata* (Ridley) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. elongata: Boden Kloss s.n.* (K), camp VIc.

Shrub or epiphyte 0.5 m high. Leaves scattered; blade obovate, 1.5—4 × 0.7—2.3 cm, base cuneate to acute, apex broadly rounded, stiffly chartaceous; nerves at 25°—55° to the midrib, prominulous to faint on either side as are the veins. *Flowers* 1 per bract; mature bracts unknown; pedicel 20—30 mm; sepals 5—7.5 mm long; petals 5—10, 12—23 × 5—11 mm; stamens 20—39; carpels in ♂ flowers 1 or 2, ♀ flowers unknown. *Fruits* unknown.

DISTRIBUTION. New Guinea: Jabi Mts to Mt Carstensz.

ECOLOGY. Recorded from forest; according to Ridley between 750 and 1650 m altitude.

DISCUSSION. The three collections available match very well. I consider them to represent large forms of *myrtoides*, but as intermediates are unknown I have kept *elongata* and *myrtoides* separate. See *sub myrtoides.*

NEW GUINEA, West. Jabi Mts, S. of Geelvink Bay: *Janowski 322*, ♂ (BO, L). Mt Carstensz: camp VIc, *Boden Kloss s.n.*, ♂ (BM, K); camp III, *Boden Kloss s.n.*, ♂ (K).

entity 18. 'acutifolia' — *Drimys acutifolia* Pulle, Nova Guinea 8 (1912) 633; Diels, Nova Guinea 14 (1924) 76; A. C. Smith, J. Arn. Arb. 24 (1943) 139. — *Tasmannia acutifolia* (Pulle) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. acutifolia:* lectotype: *von Römer 1044* (L); syntype: *von Römer 1045* (BO, L).

Shrub 1.5—5 m high. *Leaves* scattered; blade obovate to obovate-oblong, 3.5—9.0 × 0.9—2.6 cm, base cuneate, apex acute to 2 cm cuspidate, (stiffly) chartaceous; petiole 3—12 mm; nerves at 40°—70° to the midrib, prominulous to faint above, prominulous below; veins prominulous to very faint on either side. *Flowers* 1—5 per bract; mature lower bracts 5—5.5 × 1.5—2.7 mm; pedicel 7—44 mm; sepals 3—5.5 mm long; petals 2 (—5), 3.5—7.5 × 1—3 mm; stamens 20—41; carpels in ♂ flowers 1—5, in ♀ flowers 4—8 with 10—25 ovules. *Fruits* up to 10 × 5 × 4 mm; seeds black.

DISTRIBUTION. New Guinea: Wissel Lakes to Mt Hellwig.

ECOLOGY. Primary and ?secondary forests; 1100—2500 m altitude.

DISCUSSION. Amongst the 52 flowers dissected five contained 3—5 petals.

The material is rather uniform; the collections from Mt Perameles and Mt Hellwig have slightly narrower leaves than those from the other localities.

This entity is closely related to *chartacea* which has larger leaves, and to *reticulata* which has less acuminate leaves with a more conspicuous dense venation.

NEW GUINEA. West. Wissel Lakes: between Motito and Moenajepa, 1820 m alt., *Vink & Schram BW 8757*, ♂, ♀ (L, LAE); Boebeiro, 1750—1810 m alt., *Eyma 4424*, ♂, fr (BO, K, L, PNH). Nassau Mts, 2500 m alt.: *Docters van Leeuwen 10868*, ♀, fr (BO, L). Mt Wilhelmina complex: Mt Perameles, 1100 m alt., *Pulle 482*, ♀ (B, BO, K, L, U), *483*, ♂ (BO, K, L); Mt Hellwig: *von Römer 1044*, ♂ (L), *1045*, ♂ (BO, L).

entity 19. 'beccariana' — *Drimys beccariana* Gibbs, Arfak (1917) 133, f. 9; Diels, Nova Guinea 14 (1924) 75; A. C. Smith, J. Arn. Arb. 24 (1943) 139. — *Drimys arfakensis* Gibbs, l.c., 135; A. C. Smith, o.c. 23 (1942) 423; 24 (1943) 136. — *Tasmannia beccariana* (Gibbs) A. C. Smith, Taxon 18 (1969) 288. — *Tasmannia arfakensis* (Gibbs) A. C. Smith, l.c.

TYPIFICATION. *D. beccariana: Gibbs 5651* (BM). *D. arfakensis: Gibbs 5533* (BM).

Shrub 1—4 m high. *Leaves* scattered; blade obovate to obovate-oblong, 4—12 × 1—4 cm, base cuneate to acute, apex rounded, obtuse, or obtusely acuminate, acumen up to 1 cm long, coriaceous, not glaucous; petiole 3—10 mm; nerves at 30°—65° to the midrib, prominulous on either side, sometimes double-crested above; veins prominulous to inconspicuous on either side. *Flowers* 1—6 per bract; mature lower bracts 4—6 × 2.5—3 mm; pedicel 17—45 mm; sepals 4—7 mm long; petals (0—) 2 (or 3), 6—11 × 1.2—4 mm; stamens 18—44; carpels in ♂ flowers (0 or) 1—4, in ♀ flowers 2—11 with 10—20 ovules. *Fruits* up to 6 × 4 × 3 mm; seeds black.

DISTRIBUTION. New Guinea: Vogelkop Peninsula to Wissel Lakes.

ECOLOGY. Primary or secondary montane forests; 920—2500 m altitude.

DISCUSSION. This entity is closely related to *robusta* and *coriacea;* it has generally smaller and narrower leaves with an often more rounded apex. It should be noted that *Sleumer & Vink BW 14132 (robusta)* and *14146 (beccariana)* have been collected in the same forest edge. The collection *Van Royen & Sleumer 7420* is placed in *beccariana*, but could also have been placed in *robusta* or in *coriacea*.

Except for the length and width and for the leaf base, the leaves of *Gjellerup 1204 (beccariana)* and of *Lam 2167 (pittosporoides)* are very similar, but these two entities differ also in the number of flowers per bract.

In *Versteegh BW 3083* nearly all inflorescences have exclusively solitary flowers; only rarely a florescence with 3 flowers was found.

Beccariana differs from *buffelhoorn* in the number of petals and in the number of flowers per bract. It is connected with *obovata* by the following series of collections:

Sleumer & Vink BW 14146	*beccariana*
Vink & Schram BW 8843	*beccariana*
Brass 10570	*obovata*
Brass 11295	*obovata*

Drimys arfakensis was described from an aberrant specimen of *Driyms beccariana*, the ♀ flowers containing staminodes ('12—14 ligulate petals', Gibbs); the real petals are 2 in number and much wider than the staminodes.

NEW GUINEA. West. N. Vogelkop Peninsula: E. Tokhiri Ra., 1250 m alt., *Van Royen & Sleumer 6885*, fr (K, L); Mt Nettoti, *Van Royen & Sleumer 7420*, 1750 m alt., ♀ (K, L), *7877*, 1920 m alt., ♂, ♀, fr (K, L), *7960*, 2100 m alt., ♂ (K, L). Arfak Mts: Anggi Gita Lake, 2100 m alt., *Versteegh BW 278*, y fr (CANB, L, LAE); Mt Misjnuk, 2150 m alt., *Sleumer & Vink BW 14075*, ♂ (CANB, L, LAE); SW. Ridge, *Gibbs 5533*, ♀ (BM); Mt Kobreimot, 2300 m alt., *Sleumer & Vink BW 14146*, ♂, fr (CANB, L, LAE), 'Mt Koebré', *Gibbs 5651*, ♂, ♀ (BM); near Anggi Lakes, *c.* 2500 m alt., *Gjellerup 1204*, ♂ (B, L). Wandammen Peninsula: Wondiwoi Mts, 920 m alt., *Koster BW 13707*, ♂, ♀ (BISH, CANB, L, LAE). Wissel Lakes: Monauglito, S. of Moenajepa, 2300 m alt., *Vink & Schram BW 8843*, st (CANB, L, LAE).

DOUBTFUL. Wissel Lakes: Enarotali, 1780 m alt., *Versteegh BW 3083*, y fr (CANB, L, LAE).

entity 20. 'buffelhoorn'.

Shrub up to 3 m high. *Leaves* scattered; blade obovate, 5.5—10 × 2—4 cm, base cuneate, rarely abruptly obtuse, apex broadly rounded to obtuse, (sub)coriaceous; petiole 2—6 mm; nerves at 40°—70° to the midrib, prominulous on either side; veins prominulous to faint on either side. *Flowers* 1 per bract; mature lower bracts 10—12 × 3—5 mm; pedicel 35—45 mm; sepals 6—8 mm long; petals 5 or 6, 7—9 × 2—3.5 mm; stamens 23—37; carpels in ♂ flowers 1—3, ♀ flowers unknown. *Fruits* up to 5 × 3 × 2 mm (immature?); seeds black.

DISTRIBUTION. New Guinea: Waigeo Island.

ECOLOGY. Shrubbery; 800—860 m altitude.

DISCUSSION. This entity is closely related to *coriacea* and *beccariana* (see there).

NEW GUINEA. Waigeo Island, Mt Buffelhoorn: *Van Royen 5178*, 800 m alt., ♂ (CANB, L), *Cheesman s.n.*, 860 m alt., fr (BM).

entity 21. 'robusta'.

Shrub *c.* 2 m high. *Leaves* scattered; blade obovate to obovate-oblong, 8—20 × 2.5—6.5 cm, base cuneate to acute, apex obtuse to acuminate, acumen up to 1 cm long, sometimes rounded, firmly coriaceous; petiole 7—25 mm; nerves at 35°—55° to the midrib, prominulous on either side, sometimes double-crested above; veins prominulous to very faint on either side. *Flowers* 1—11 per bract; mature lower bracts 19—23 × 3—12 mm; pedicel 23—36 mm; sepals 5—7 mm long; petals 2 (—4), 6—10 × 1.5—2.5 mm; stamens 24—40; carpels in ♂ flowers 1—5, ♀ flowers unknown, ovules counted from fruits: 23—33. *Fruits* up to 11 × 6 × 6 mm; seeds black.

DISTRIBUTION. New Guinea: Arfak Mts.

ECOLOGY. Forest edges; 2000—2300 m altitude.

DISCUSSION. This entity is merely a more robust form of the Mt Hellwig population of *coriacea*. Even the character of the double-crested nerves is present. It differs only in the thicker and larger leaves and in the more robust branchlets and terminal buds. It should be placed in the same entity as the Mt Hellwig specimens of *coriacea* but I have refrained from doing this to keep the variability of *coriacea* within reasonable limits.

NEW GUINEA. West. Arfak Mts: trail to Anggi Gita, 2000 m alt., *Kostermans 2311*, ♂, fr (A, BO, L); Anggi Gita Lake, 2000 m alt., *Kostermans 2388*, ♂ (BO, L); Testega—Anggi Gigi, 2200 m alt., *Stefels BW 2030*, st (L); Mt Kobreimot, 2300 m alt., *Sleumer & Vink BW 14132*, fr (A, BISH, BO, CANB, K, L, LAE).

entity 22. 'coriacea' — *Drimys coriacea* Pulle, Nova Guinea 8 (1912) 634; Diels, Nova Guinea 14 (1924) 75; A. C. Smith, J. Arn. Arb. 24 (1943) 140. — *Drimys dictyophlebia* Diels, l.c.; A. C. Smith, l.c. — *Tasmannia coriacea* (Pulle) A. C. Smith, Taxon 18 (1969) 289. — *Tasmannia dictyophlebia* (Diels) A. C. Smith, l.c.

TYPIFICATION. *D. coriacea:* lectotype: *von Römer 1251 (nec 1281)* (L), syntype: *von Römer 1209* (L). *D. dictyophlebia: Pulle 845* (B).

Shrub or treelet 1.5—13 m high. *Leaves* scattered; blade obovate to obovate-oblong, 5.5—23.5 × 2—11 cm, base cuneate, rarely obtuse, narrowly truncate, or broadly rounded, apex acute to acuminate, acumen up to 2 cm long, rarely obtuse or rounded, (sub)coriaceous; petiole 5—30 mm; nerves at (35°—) 50°—70° (—80°) to the midrib, prominulous and sometimes double-crested above, prominulous to prominent below; veins prominulous on either side, sometimes impressed above. *Flowers* 1—7 per bract; mature lower bracts 11—42 × 3—15 mm; pedicel 12—45 mm; sepals 4—8 mm long; petals (1 or) 2 (or 3), 4—13 × 2—4 mm; stamens (13—) 19—109; carpels in ♂ flowers 1—10, in ♀ flowers 3—8 with 10—32 ovules. *Fruits* up to 13 × 9 × 8 mm; seeds black.

DISTRIBUTION. New Guinea: Wissel Lakes to Mt Dayman.

ECOLOGY. Lower montane forest, *Nothofagus* forest, mossy forest, reported once from secondary forest and once from *Agathis* forest; (700—) 1800—3150 (—3240) m altitude.

DISCUSSION. The material from Mt Hellwig is slightly different from the other collections by its generally more coriaceous leaves and the often double-crested nervation on the upper side of the latter.

The entity is rather variable and has been separated artificially from related ones. In general *coriacea* can be characterized by robust branches, large terminal buds, large (sub) coriaceous leaves, and large fruits. Several series of collections connect it nicely with other entities and I presume that the absence of such series towards some other entities is due to undercollecting of especially the western part of New Guinea.

As appendices of *coriacea* two groups of specimens are listed. They differ from the main body of *coriacea* by relatively narrower leaves, less robust branches, smaller terminal bud, and smaller fruits. Against each other they are characterized by:

'*A*': *in sicco* a dense light coloured venation;
'*B*': *in sicco* a venation not or only partially differing in colour from the tissue between the veins.

These differences are only trivial, but they are congruent with the flavone/flavonol ratio and they point to different relationships: '*A*' to shorter leaves with a distinct reticulate venation *(reticulata)*, '*B*' to similar leaves with nervation and venation with the same colour as the tissue between the veins *(obovata)*.

Three instances of series connecting *coriacea* with other entities are given:

1)	*Saunders 760*	*coriacea*
	Brass 31126	*coriacea*
	Brass 29582	*coriacea B*
	Brass 29130	*coriacea B*
	NGF 11041	*coriacea B*
	Eyma 5384	*coriacea B*
	Kanehira & Hatusima 13785	*obovata*
2)	*Saunders 760*	*coriacea*
	Schodde 1690	*coriacea*
	Pullen 2723	*coriacea A*
	Carr 14061	*coriacea A*
	Brass 9491	*?reticulata*
	Brass 10246	*reticulata*
	Brass 11294	*reticulata*
	Eyma 4486	*reticulata*
	v. Royen & Sleumer 5937	*reticulata*
3)	*Saunders 760*	*coriacea*
	Hoogland & Pullen 6119	*coriacea*
	NGF 16564	*heteromera*
	Schodde 1880	*heteromera*

In *Hoogland & Schodde 7246*, ♂, ♀, and ⚥ flowers were present; these contained many irregular structures such as intermediates between stamens and carpels. In the ♀ flowers the carpels were arranged in the same way as stamens in ♂ flowers.

number of:									
sepals	2	2	2	2	2	2	2	2	2
petals	2	4	2	3	2	2	2	2	2
stamens	49	39	47	40	24	25	25	12	—
carpels	4	5	6	7	8	8	18	14	35
ovules/carpel	—	—	—	—	8	7	14	23	8
	♂				⚥				♀

In *Pulle 1024*, *Vink 17033*, and *17175* several leaf bases are broadly rounded. *Hartley 12771* has 1 flower per bract.

See also *sub chartacea*, *heteromera*, *polymera*, and *densifolia*.

NEW GUINEA. West. Mt Wichmann, 3000 m alt.: *Pulle 1024*, ♂ (L). Hellwig Mts: *von Römer 1209*, ♂ (L), *1251 (nec 1281)*, y fr (BO, L), *Pulle 845*, 1900 m alt., ♂ (B, BO, K, L, U), *595*, 2500 m alt., ♀, y fr (BO, K, L, U), *577*, 2500 m alt., ♂ (B, BO, K, L), *958*, 2600 m alt., ♂ (BO, K, L, U), *959*, ♂, ♀, y fr (BO, K, L, U). — East. Hindenburg Ra., Mt Amdutakin: *Vink 17566*, 2460 m alt., ♂ (CANB, L, LAE), *17615*, 2460 m alt., ♀ (CANB, L, LAE), *17553*, 2480 m alt., ♂ (CANB, L, LAE), *17594*, 2780 m alt., ♂ (CANB, L, LAE). Yobobos, source of Lagaip R., 2740 m alt.: *Hoogland & Schodde 7533*, ♂, ♀, fr (BM, CANB, L, LAE, NSW, PNH). Kepilam, Lagaip R., 2440 m alt.: *Hoogland & Schodde 7246*, ⚥ (CANB, LAE), *7246*, fr (BM, CANB, L, LAE, NSW). Londau, Upper Ambum R., 2440 m alt.: *Robbins 3055*, ♂ (CANB, LAE). Sirunki, slopes of Kabanunt, 2925 m alt.: *Walker ANU 835A*, ♀ (CANB, L). Wabag—Laiagam Rd, 2740 m alt.: *Womersley NGF 15218*, fr (CANB, K, L, LAE). Tomba: *Robbins 243*, 2195 m alt., ♂, fr (A, BM, CANB, K, L, LAE, US), *Hoogland & Pullen 6029*, 2650 m alt., ♀ (A, CANB, L, LAE, US), *6119*, 2750 m alt., fr (A, BM, CANB, L, LAE, US). Welp R., S. of Mt Hagen, 2440 m alt.: *Simonett 188*, fr (LAE). E. slopes Mt Hagen, 2440 m alt.: *Robbins 193*, ♀ (A, CANB, L, LAE). E. rim of Mt Oga, 12 miles E. of Mt Hagen Station, 2590 m alt.: *Pullen 133*, fr (A, BM, CANB, K, L, LAE, PNH, US). Kubor Ra., Minj-Nona Divide: *Pullen 5396*, 2650 m alt., fr (CANB, K, L), *264*, 2740 m alt., ♀, fr (A, BM, CANB, L, LAE), *5056*, 3240 m alt., fr (CANB), *Saunders 760*, 2740 m alt., fr (A, BM, CANB, K, L, LAE, US). Lei, SE. foot Mt Ambua, 2760 m alt.: *Frodin NGF 28153*, ♂ (L). Ibiwara, between Mt Ambua and Mt Ne, 2690—2740 m alt.: *Vink 16915*, ♀ (CANB, L, LAE), *16927*, fr (CANB, L, LAE), *16928*, st (L), *16929*, ♂ (CANB, L, LAE), *16968*, ♀, fr (CANB, L, LAE), *16987*, ♂ (CANB, L, LAE), *17033*, st (CANB, L, LAE). Mt Ne: *Vink 17245*, 2840 m alt., fr (CANB, L, LAE), *Frodin NGF 26977*, 2880 m alt., fr (L), *Vink 17240*, 2880 m alt., ♂ (CANB, L, LAE), *17189*, *17189A*, 2900 m alt., ♀, fr (CANB, L, LAE), *17175*, 3120 m alt., st (L), *17159*, 3140 m alt., fr (CANB, L, LAE), *17111*, 3155 m alt., st (CANB, L, LAE). Pass between Mt Ne and Mt Kerewa, 2890 m alt.: *Vink 17185*, ♂ (CANB, L, LAE). Mt Kerewa: *Vink 17092*, 3000 m alt., ♀ (CANB, L, LAE), *17097*, 3015 m alt., ♂ (CANB, L, LAE), *17077*, 3120 m alt., ♀ (L), *17102*, 3150 m alt., st (L). Mt Giluwe: *Schodde 2087*, 2530 m alt., fr (CANB, L), *1988*, *2680* m alt., fr (A, CANB, K, L, LAE). Mt Wilhelm, Waimambuno, 2740 m alt.: *Saunders 821*, ♂ (A, CANB, L, LAE). Mt Otto: *Brass 31126*, 2400 m alt., ♀ (LAE), *30886*, 2680 m alt., fr (LAE).

DOUBTFUL. Morobe Dist., above Bakaia, 15 miles SE. of Garaina, 2590 m alt.: *Hartley 12771*, ♂ (CANB, L).

APPENDIX A. East. Sirunki, slopes of Kabanunt, 2925 m alt.: *Walker ANU 835*, fr (A, CANB, L). Porget logging area, Merimanta, 12 miles N. of Wabag, 2100—2400 m alt.: *Womersley NGF 11347*, fr (A, CANB, L, LAE). Kupalis, nr Wabag: *Flenley ANU 2372*, 2440 m alt., ♂ (CANB), *2364*, 2560 m alt., st (CANB, L). Ridge NE. of Yaki R., 2440 m alt.: *Hoogland & Schodde 6890*, fr (A, CANB, K, L, LAE, NSW). Mendi valley, above Kiburu, 1920 m alt.: *Schodde 1377*, fr (A, CANB, K, L, LAE). Anga valley, nr Ebenda, 2010 m alt.: *Schodde 1476*, fr (A, CANB, L, LAE). SW. slope Mt Giluwe, 2590 m alt.: *Schodde 1690*, fr (A, CANB, K, L, LAE). Onim, 10 miles N. of Ialibu Patrol Post, 2130 m alt.: *Pullen 2723*, fr (CANB). Lala R., 1675 m alt.: *Carr 14061*, ♂ (A, BM, K, L). Maneau Ra, Mt Dayman, 2150 m alt.: *Brass 22733*, fr (A, CANB, K, L, LAE).

APPENDIX B. West. Wissel Lakes, nr Digatara Pass: *Eyma 5384*, ♂ (BO, L). Idenburg R., Bernhard Camp, 700 m alt.: *Brass 13704*, fr (A, BO, L, LAE). — East. Mannasat, Cromwell Mts, 2315 m. alt.: *Hoogland 9388*, fr (CANB, K, L). Mt Shungol: *Hartley (leg. Sayers) 12536*, 2130 m alt., ♂ (CANB, L), *Womersley NGF 19360*, 2440 m alt., fr (CANB, L).Wagau, 1830 m alt.: *Sayers NGF 21624*, ♂, ♀, (BM, L), *21627*, ♀ (BM). Wau—Edie Ck: *Womersley & Thorne NGF 12840*, 1830 m alt., fr (BM, CANB, L, LAE, NSW, RSA), *Womersley & Brass NGF 11041*, 2040 m alt., fr (A, CANB, L, LAE, NSW), *Sayers NGF 21208*, 3050 m alt., fr (L). Mt Kaindi: *Brass 29130*, 2195 m alt., fr (A, CANB, K, L, LAE, US), *29582*, 2250 m alt., fr (A, CANB, K, L, LAE, US), *Hartley 11818*, 2400 m alt., fr (CANB, L). Wau: *Millar NGF 23626*, fr (L). Skindewai, Wau-Salamaua Rd, 1675 m alt.: *Womersley & Millar NGF 8446*, ♀, fr (A, CANB, L, LAE, NSW, SING).

entity 23. 'obovata' — *Drimys obovata* A. C. Smith, J. Arn. Arb. 23 (1942) 424; 24 (1943) 140. — *Drimys subreticulata* Kan. & Hat., Bot. Mag. Tokyo 57 (1943) 151, f. 21. — *Tasmannia obovata* (A. C. Smith) A. C. Smith, Taxon 18 (1969) 289.

TYPIFICATION. *D. obovata: Brass 11295* (A). *D. subreticulata:* lectotype: *Kanehira & Hatusima 13935* A); syntype: *Kanehira & Hatusima 13785* (BO).

Shrub 2—8 m high. *Leaves* scattered; blade obovate to obovate-oblong, 7—16 × 1.5—6 cm, base cuneate, apex obtusely rounded to acuminate, acumen up to 1 cm long, subcoriaceous; petiole 5—15 mm; nerves at 40°—60° to the midrib, prominulous on either side; veins prominulous to faint on either side. *Flowers* 1—5 per bract; mature bracts unknown; pedicel 4—7 mm; sepals 4—6.5 mm long; petals 2 (—5), 6—10 × 1.5—2 mm; stamens 23—61; carpels in ♂ flowers 1—4, ♀ flowers unknown. Immature *fruits* up to 6 × 4 × 3 mm.

DISTRIBUTION. New Guinea: Arfak Mts and Lake Habbema.

ECOLOGY. Mossy forest or Fagaceous forest; 1900—2800 m altitude.

DISCUSSION. Entity *obovata* is merely a continuation of *coriacea*, especially of the material cited under 'Appendix B' and can only be delimited from it by its *in sicco* more yellowish green to yellowish brown and thinner leaves.

The material from the Baliem Valley forms a transition to *hatamensis*. See also *sub beccariana* and *chartacea*.

I examined six flowers from the lectotype of *Drimys subreticulata*. Of these four contained 2 petals, one countained 4 petals, and the sixth flower had 5 petals; the original description reads: '*petala alba 4 vel 5*.'

NEW GUINEA. West. Arfak Mts, Anggi Gigi, Iray, 1900 m alt.: *Kanehira & Hatusima 13785*, y fr (BO), *13935*, ♂ (A, L). Lake Habbema: *Brass 11312*, 2200 m alt., y fr (BO, K, L, LAE), *11295*, 2350 m alt., ♂ (A, BO, L, LAE), *10567*, 2800 m alt., ♂ (A, BO, K, L, LAE), *10570*, 2800 m alt., ♂ (A, BO, L).

DOUBTFUL. Arfak Mts, 2140 m alt.: *Gibbs 5959*, fr (BO). Mt Hubrecht, 3100 m alt.: *Pulle (leg. Versteeg) 2418*, ♂ (K, L). Baliem Valley, Wiligimaan, 2000 m alt.: *Versteegh BW 12554*, ♀, fr (CANB, L).

entity 24. 'chartacea'.

Shrub 1—5 m high. *Leaves* scattered; blade obovate to obovate-oblong, 8—19 × 2—6 cm, base cuneate, apex acuminate, acumen up to 2.5 cm long, chartaceous; nerves at 35°—65° to the midrib, prominulous on either side; veins prominulous to faint on either side. *Flowers* 1—3 per bract; mature lower bracts 9—16 × 4—9 mm; pedicel 5—25 mm; sepals 4—6 mm long; petals 2, 4—11 × 1.2—3 mm; stamens 21—50; carpels in ♂ flowers 1—4, in ♀ flowers 3 or 4 with 14—28 ovules. *Fruits* up to 5 × 5 × 4 mm; seeds black.

DISTRIBUTION. New Guinea: Swart Valley to Mt Dayman.

ECOLOGY. Lower montane forest, *Nothofagus* forest; 1200—2360 m altitude.

DISCUSSION. In comparison with *coriacea* this entity is characterized by chartaceous, rather narrow, long-acuminate leaves, rather slender branches, and small fruits. It is, however, inseparable from the former as is demonstrated by a series of collections like:

v. Royen & Sleumer 6113	*chartacea*
Ridsdale c.s. NGF 33104	*chartacea*
Henty NGF 20861	*? chartacea*
Hoogland 9321	*? chartacea*
Hoogland 9223	*? chartacea*
Sayers NGF 19838	*? chartacea*
Hoogland & Pullen 6119	*coriacea*

The entity *obovata* has thicker leaves, *in sicco* yellow to brown, whereas the leaves of *chartacea* are light to dark green (although occasionally light brown). This pair of entities is also connected by a series of collections:

v. Royen & Sleumer 5879	*chartacea*
Cheesman 74	*chartacea*
Ledermann 12927	*chartacea*
Kanehira & Hatusima 13785	*obovata*

The material from the Huon Peninsula differs from *chartacea* by its nervation which is more prominent on the lower leaf surface and has a tendency to become impressed on the upper surface. *Hoogland 9388, 22 B. coriacea*, from the same area, differs in the same way from the rest of its entity, thus showing that obviously a genetic relation between this material exists. See also p. 291.

New Guinea. West. Swart Valley, Kadubaka, 1600—2000 m alt.: *Bergman 256, 272, 347,* ♂ (S). Cycloop Mts: *Mayr 517,* y fr (BO), *Cheesman 74,* y fr (BM), *Van Royen & Sleumer 5879,* 1240 m alt., ♂ (K, L, LAE), *Van Royen 5126,* 1380 m alt., ♂ (L, LAE), *Van Royen & Sleumer 6113,* 1340 m alt., ♂, ♀, fr (K, L, LAE). Okwalimkan R., 1220 m alt.: *Ridsdale c.s. NGF 33104,* fr (L). Star Mts: Sibil valley, 1200—1300 m alt., *Kalkman & Tissing 4230,* ♂ (CANB, L); Mt Antares, 1570 m alt., *Kalkman 4302,* fr (BM, CANB, L, LAE, PNH). — East. Atup Ck, nr Telefomin, 2130 m alt.: *Henty NGF 20930,* ♂ (L). Torricelli Mts, 1550 m alt.: *Darbyshire 468,* ♂ (A, CANB, K, L, LAE). Felsspitze: *Ledermann 12927,* ♀ (L, U), *12929,* ♀ (B, BM, K). Tari Subdist., Tigibi, 1570 m alt.: *Vink 16816,* fr (CANB, L, LAE), *16816A,* seedling (L), *16820,* fr (CANB, L, LAE), *16853,* fr, with runners (L). Mt Dayman, 2050 m alt.: *Brass 22813,* fr (A, CANB, K, L, LAE).

Doubtful. West. Okwalimkan R., 1220 m alt.: *Ridsdale & Galore NGF 33168,* fr (L). Star Mts, Mt Antares, 2360 m alt.: *Kalkman 4463,* fr (BM, CANB, L, LAE, PNH). — East. Suongot, nr Telefomin, 1980 m alt.: *Henty NGF 20861,* fr (L). Hindenburg Ra., Mt Amdutakin, 2150 m alt.: *Vink 17543,* st (CANB, L, LAE). Sewe, Saidor Subdist., 2285 m alt.: *Sayers NGF 19838,* fr (L). Saruwaged Ra.: *Clemens 911,* 1000—1500 m alt., ♂ (L), *2387,* 1350 m alt., fr (Z), *4625,* 1770 m alt., ♂ (A), *8940,* 1830 m alt., fr (B). Mt Rawlinson: *Hoogland 9223,* 1456 m alt., fr (K, L), *9321,* 2165 m alt., fr (K, L).

entity 25. 'heteromera'.

Shrub or treelet 0.3—11 m high. *Leaves* scattered; blade elliptic-obovate, obovate, or obovate-oblong, 3.5—18 × 0.5—6.5 cm, base cuneate to obtuse, apex (obtuse to) acuminate, acumen up to 2 cm long, chartaceous to subcoriaceous, lower side sometimes glaucous; petiole 2—20 mm; nerves at 60°—90° to the midrib, prominulous (sometimes impressed) above, prominent to prominulous below; veins prominulous to inconspicuous above, prominulous below. *Flowers* 1 or 1—7 per bract; mature lower bracts 6.5—15 × 3.5—6 mm; pedicel 5—35 mm; sepals 4—7 mm long; petals (0—) 2 (—6), 5—14 × (1—) 1.5—8 mm; stamens 15—43; carpels in ♂ flowers 1—6, in ♀ flowers 1—8 with 10—41 ovules. *Fruits* up to 11 × 6 × 6 mm; seeds black.

Cytology. One chromosome count: $2n = 28$ *(Borgmann 58).* Probably this is erroneous for $2n = 26$ (see Ehrendorfer *c.s.*, Taxon 17, 1968, 338).

Distribution. New Guinea: Southern Highlands District to Morobe District.

Ecology. Montane (*Castanopsis*-, *Nothofagus*-, Coniferous-) forest, mossy forest, subalpine shrubbery; forest margins; 2000—3700 m altitude.

Wade & McVean, Mt Wilhelm Studies I, 1969, found this entity in the Lower Subalpine Forest (*Amaracarpus caeruleus—Pittosporum pullifolium—Pteris* association) with low constancy.

Discussion. This entity is a rather heterogeneous group of specimens with as common characters the rather wide angle between nerves and midrib and the usually acuminate leaf apex. In general the nerves are distinctly connected near the margin as in *polymera;* in *coriacea* this feature is less marked, several connections being more or less equally prominent.

Some of the material is very close to *coriacea,* other specimens look quite different, but a whole series of intermediates is present. In general the leaves of *heteromera* are smaller than those of *coriacea* and *obovata,* the nervation is more pronounced than in *hatamensis,* and the number of petals is lower than in *polymera.*

The following list serves to demonstrate the intricate relationships. With 'matching' is meant that the specimens look very similar.

coriacea		*heteromera*		*polymera*
Schodde 2087	→	*Schodde 1880*		
		│		
		Hoogl. & Schodde 7080		
		│		
		Pullen 5058	→	*Saunders 738*
		↾ *Hartley 11724*	→	*Brass 29603*
		Pullen 312		
		↾ *Pullen 5330*		
Robbins 193	≢	*Robbins 192*	→	*Hoogland & Schodde 7671* (2—5 petals)
		│		
Robbins 3055	≠	*Robbins 3082*		
Walker ANU 835A			≠	*Walker ANU 806*

Same locality, not same alt., matching: →
Same locality, not same alt., not matching: ≠
Same locality, same alt., not matching: ≢
Closely related specimens of *heteromera*:

From this list it can be concluded that

a) large differences within *heteromera* are bridged by a series of intermediates (e.g. *Schodde 1880*: leaves up to 13 × 4.5 cm, *Robbins 3082*: leaves up to 4.5 × 2 cm, nervation more prominent);

2) the number of petals, used to delimit *heteromera* from *polymera*, is inadequate for delimitation as it separates otherwise similar material and intermediate numbers are quite common;

3) local differences are obscured by the variability in a wider area.

For a further discussion of the variability and of another way of subdividing the material, see p. 295.

Brass 4506 ('doubtful') has seeds of the yellowish brown type.

In several ♀ collections flowers with staminodes were found: *Brass 29880, 30171, Millar NGF 14644*, all from Mt Wilhelm. These sterile stamens were present in numbers of 1—8 per flower.

In the enumeration of specimens the subdivision given on p. D *78* has been indicated between brackets.

NEW GUINEA. East. Wabag Subdist., Ambum-Marimuni Divide, 3140 m alt.: *Robbins 3082* (d), ♀, fr (CANB). Ridge N. of Birap, 2835 m alt.: *Flenley ANU 2786* (d), fr (CANB, K, L). Wapu R., Mt Sugarloaf, 2900 m alt.: *Hoogland & Schodde 7080* (b), fr (A, BM, CANB, L, LAE, US). Tari Subdist., Wauwe, 2560 m alt.: *Gillison NGF 25220* (b), light form, fr (A, K, L). Mt Ambua: *Vink 17451* (b), 3155 m alt., fr (CANB, L, LAE), *17310* (b), 3300 m alt., fr (CANB, L, LAE), *17312* (b), 3300 m alt., ♀, fr (CANB, L, LAE), *17316* (b), 3300 m alt., ♂ (CANB, L, LAE), *17413* (b), 3340 m alt., st (CANB, L, LAE), *17279* (b), 3390 m alt., ♂ (CANB, L, LAE), *17442* (b), 3490 m alt., fr (CANB, L, LAE), *17443* (b), 3490 m alt., fr (CANB, L, LAE). Lei, SE. foot Mt Ambua, 2760 m alt.: *Frodin NGF 28240, 28241* (b), fr (K, L). Ibiwara, 2700 m alt.: *Vink 16917* (b), st (L), *16930* (b), light form, fr (CANB, L, LAE). S. foot Mt Ne, 2980 m alt.: *Vink 17177, 17177A* (b), fr, st (CANB, L, LAE). Pass between Mt Ne and Mt Kerewa, 2980 m alt.: *Vink 17157* (b), light form, ♀, fr (CANB, L, LAE). Mt Giluwe: *Schodde 1880* (b), 3050 m alt., ♀, fr (A, CANB, K, L, LAE), *Coode & Waring NGF 29991* (b), 3200 m alt., ♂ (K, L). E. slopes Mt Hagen, 2440 m alt.: *Robbins 192* (d), ♂ (A, CANB, L, LAE). Welp R., S. slope Mt Hagen, 2620 m alt.: *Simonett 199* (d), fr (LAE). Kubor Ra., Minj-Nona Divide: *Pullen 5330* (b), 2835 m alt., fr (CANB, K, L), *5175* (b), 2910 m alt., ♀, fr (CANB, K, L), *5058* (b), 3070 m alt., ♀, fr (CANB, K, L). Mt Autu, 6 miles NNE. of Nondugl

2375 m alt.: *Simonett 135*, st (LAE). Kuaki R., Toromambuno, base of Mt Wilhelm, 2740 m alt.: *Pullen 312* (c), ♀, fr (A, CANB, L, LAE). Mt Wilhelm: *Brass 30291* (c), 2770 m alt., ♂ (A, CANB, K, L, LAE, PNH, US), *Borgmann 58* (a), 3400 m alt., ♂ (L, LAE), *Van Balgooy 839* (a), 3450 m alt., ♂ (CANB, L, LAE), *Womersley NGF 8947* (a), 3500 m alt., ♀, fr (A, BM, CANB, K, L, LAE, NSW, SING), *24820* (a), 3500 m alt., ♀ (L), *Hoogland & Pullen 5670* (a), 3500 m alt., ♂, ♀, fr (A, BM, CANB, K, L, LAE, PNH, US), *Womersley NGF 24802* (a), 3535 m alt., ♀ (K, L), *Brass 29831* (a), 3560 m alt., ♀, fr (A, CANB, K, L, LAE, PNH, US), *29880*, ♂, ♀, fr (A, CANB, K, L, LAE, US), *30171* (a), ♀ (A, CANB, K, L, LAE, US), *Van Balgooy 260, 638* (a), 3560 m alt., ♀ (CANB, L, LAE), *262* (a), 3560 m alt., ♂ (CANB, L, LAE), *Womersley NGF 15319* (a), 3600 m alt., ♀ (L), *Vandenberg NGF 35078* (a), 3600 m alt., fr (L), *Millar NGF 14644* (a), 3660 m alt., ♀, fr (BM, CANB, K, L, LAE, NSW), *Van Balgooy 282* (a), 3700 m alt., ♂ (CANB, L, LAE). Kratke Mts, Mt Elandora, 2530 m alt.: *Brass & Collins 32155* (a), ♂, ♀, fr (A, CANB, K, L, LAE, PNH, US). Mt Michael, 3100—3290 m alt.: *Brass & Collins 31293* (a), ♀ (A, CANB, K, L, LAE, PNH, US). Mt Piora, 3200 m alt.: *Henty & Carlquist NGF 16564* (a), ♂ (CANB, L, LAE, RSA). Finisterre Mts, Naho-Rawa Divide, Sewe, 2440 m alt.: *Sayers NGF 21373*, ♂ (BM, L), *21397*, fr (BM, L), *21399*, ♀ (BM, L), *21400*, fr (BM, L). Mt Shungol: *Hartley (leg. Sayers) 12551* (d), ♀ (CANB, L). Edie Ck: *Van Royen NGF 16022* (d), 2010 m alt., ♂, ♀ (CANB, L, LAE), *Hartley 11724* (d), 2130 m alt., ♀ (CANB, L). Mt Awormange, E. of Woitape, 2835 m alt.: *Van Royen NGF 20370*, ♂ (K, L). Rd Woitape-Kosipi, 1980 m alt.: *Van Royen NGF 20228*, ♂, fr (K, L).

DOUBTFUL. Saruwaged Ra., below Belum, nr Goliteng Camp: *Clemens 5247* (e), ♂, fr (A). Mt Rawlinson, 2165 m alt.: *Hoogland 9320* (e), fr (K, L). Above Bakaia, 15 miles SE. of Garaina, 2740 m alt.: *Hartley 12803*, ♂ (CANB, L). Mt Yule: *MacGregor s.n. MEL 5409, 5417*, ♂ (MEL), *5415, 5416*, fr (MEL), *5418*, st (MEL). Murray Pass, Wharton Ra., 2840 m alt.: *Brass 4506*, ♂, fr (A, BM, US). Mt Victoria: *MacGregor s.n. MEL 5405*, ♀ (MEL). Mt Musgrave, 2800 m alt.: *MacGregor s.n. MEL 5400*, ♀ (MEL), *5401*, ♂ (MEL). The Gap, 2440 m alt.: *Carr 13727*, ♂ (BM, CANB, K, L, SING), *15259*, ♂ (A, BM, CANB, K, L, SING). Near summit Owen Stanley Ra.: *MacGregor s.n. MEL 5399*, ♀ (MEL). Mt Obree, 2440 m alt.: *Lane Poole s.n.*, ♂ (A).

entity 26. 'polymera'.

Shrub or treelet 1—9 m high. *Leaves* scattered; blade obovate to (ob)lanceolate, 3—10 × 1—3.5 cm, base cuneate to acute, apex obtuse to acuminate, acumen up to 1.5 cm long, (sub)coriaceous, lower side often glaucous; petiole 2—12 mm; nerves at 50°—90° to the midrib, prominulous above, prominent to prominulous below; veins prominulous to inconspicuous on either side. *Flowers* 1—4 per bract; mature lower bracts 3.5—5 × 1—1.3 mm; pedicel 7—26 mm; sepals 2—7 mm long; petals (3 or) 4—7 (—9), 3—10.5 × 0.5—4 mm; stamens 13—54; carpels in ♂ flowers (0 or) 1—8, in ♀ flowers 3—9 with 2—25 ovules. *Fruits* up to 5 × 4 × 3 mm (immature?); seeds black.

DISTRIBUTION. New Guinea: Wissel Lakes to Mt Kaindi.

ECOLOGY. Montane (*Nothofagus*-, mossy-) forest, subalpine shrubbery; 1800—3410 m altitude.

DISCUSSION. In this entity are represented the leaf types (as indicated by prominence of nervation and venation) which are also present in parts of the entities *heteromera* and *reticulata*, although some specimens have no match in either of these. The material from western New Guinea resembles *reticulata*, that from eastern New Guinea usually resembles *heteromera*. *Hoogland & Pullen 5610* has very narrow leaves, but is connected to the rest of the material by *Hoogland & Pullen 5613* from the same locality and altitude.

The single character distinguishing *polymera* from *heteromera* and *reticulata* is the number of petals, although this character becomes useless in quite a number of specimens. Specimens without any 2-petalled flowers have been placed in *polymera*, those with at least part of the flowers 2-petalled in *heteromera*.

See also *sub heteromera*, *cordata*, and p. 295.

Brass 29603 has leaves very similar to, though smaller than, those of *22 B. coriacea.*

In the enumeration of specimens the subdivision given on p. 299 has been indicated between brackets.

NEW GUINEA. West. Wissel Lakes: Boebeiro, *Eyma 5088*, ♂ (BO, L); Mt Digitara, *Eyma 5378*, ♀ (A, BO, K, L). Idenburg R., Bernhard Camp: *Brass 11857*, 1800 m alt., ♂ (BO, L, LAE), *12149*, 1800 m alt., ♀ (A, BO, L), *12494*, 2150 m alt., ♂ (A, BO, L, LAE). — East. Wabag—Laiagam Rd, 2740 m alt.: *Womersley NGF 15232* (d), fr (CANB, K, L, LAE). Sirunki, ridge of Andyuku, 2865 m alt.: *Walker ANU 806* (d), ♂ (A, CANB, L). Kubor Ra.: Nona-Minj Divide, 3270 m alt., *Vink 16019* (b), ♂ (CANB, L, LAE); Mt Kinkain, 3410 m alt., *Saunders 738* (b), ♀ (A, CANB, L, LAE). Kerigomna Camp, 3000 m alt.: *Hoogland & Pullen 5610* (b), ♀ (A, BM, CANB, K, L, LAE, US), *5613* (b), ♂ (A, BM, CANB, L, LAE, US). Saruwaged Ra.: Mt Enggom, 2440 m alt., *Van Royen NGF 16137* (e), ♂ (CANB, L, LAE); above Boana, 2100 m alt., *Clemens 8431* (e), fr (B); Ulap trail, *Clemens 41166* (e), ♂ (A); Bog Meadow Camp, *c.* 3000 m alt., *Clemens 5665A* (e), ♂, fr (A, B). Cromwell Mts, Mannasat, 2345 m alt.: *Hoogland 9528* (e), fr (K, L). Mt Kaindi: *Brass 29603*, 2250 m alt., ♂ (K, L, LAE, US), *29712* (d), 2300 m alt., ♂ (LAE), *Womersley NGF 19361* (d), 2440 m alt., fr (A, K, L).

DOUBTFUL. East. W. Highlands Dist., Yobobos grassland area, 2740 m alt.: *Hoogland & Schodde 7671* (d), ♂ (BM, BO, CANB, L, LAE, NSW, PNH).

entity 27. 'reticulata' — *Drimys reticulata* Diels, Bot. Jahrb. 54 (1916) 242; A. C. Smith, J. Arn. Arb. 23 (1942) 423; 24 (1943) 137. — *Drimys cyclopum* Diels, Nova Guinea 14 (1924) 76; A. C. Smith, o.c. 24 (1943) 139. — *Tasmannia reticulata* (Diels) A. C. Smith, Taxon 18 (1969) 288. — *Tasmannia cyclopum* (Diels) A. C. Smith, o.c., 289.

TYPIFICATION. *D. reticulata: Ledermann 12433* (B). *D. cyclopum: Gjellerup 549* (B).

Shrub or treelet (sometimes epiphytic) 1.5—10 m high. *Leaves* scattered; blade obovate to obovate-oblong, 4—10 × 1.5—3 cm, base cuneate, apex acute to acuminate, acumen up to 1 cm long, subcoriaceous to chartaceous; petiole 3—10 mm; nerves at 50°—60° to the midrib, prominulous on either side as are the veins. *Flowers* 1—5 per bract; mature lower bracts *c.* 7 × 4 mm; pedicel 12—18 mm; sepals 3—5 mm long; petals 2, 5—8 × 1.2—3 mm; stamens 15—43; carpels in ♂ flowers 1—3, ♀ flowers unknown, ovules counted from fruits: 2—5. *Fruits* up to 7 × 5 × 4.5 mm; seeds black to brown, rarely with a very short funiculus (in the latter case the placenta considerably enlarged).

DISTRIBUTION. New Guinea: Wissel Lakes to Sepik District.

ECOLOGY. Forests or small clearings in forests; 1400—2800 m altitude.

DISCUSSION. This entity consists of specimens with rather small, narrow leaves with a conspicuous reticulate venation which often is very dense. Relationships are with *acutifolia* and *polymera* (see there) and with *heteromera* (through *Brass 9491*). See also p. 288.

In *Ledermann 12433* the placenta is strongly enlarged in fruit and the seeds (of the black type) have a short funiculus. In *Brass 10246* and *9491* the seeds are of the brown type, in *Van Royen & Sleumer 5937* and *Brass 9362* of the black type. No correlation of the type of seed with any other character could be found.

NEW GUINEA. West. Wissel Lakes, S. of Lake Paniai, 1750 m alt.: *Eyma 4486*, ♂ (BO). Cycloop Mts: *Van Royen & Sleumer 5937*, 1600 m alt., fr (K, L, LAE), *Gjellerup 549*, 1800 m alt., ♂ (B, BO, K, L, U). Lake Habbema: *Brass 11294*, 2350 m alt., ♂ (A, BO, K, L, LAE), *10246*, 2800 m alt., fr (A, BM, BO, K, L, LAE). — East. Sepik Dist., Felsspitze, 1400—1500 m alt.: *Ledermann 12433*, fr (B).

DOUBTFUL. West. Lake Habbema, 3225 m alt.: *Brass 9362*, fr (A, BO, L), *9491*, fr (A, BM, BO, L, LAE).

entity 28. 'hatamensis' — *Drimys hatamensis* Becc., Malesia 1 (1877) 185; Parment., Bull. Sc. Fr. & Belg. 27 (1896) 227, 301; v. Tiegh., J. de Bot. 14 (1900) 276 (*sphalm.: hamatensis*); Diels, Bot. Jahrb. 54 (1916) 242; A. C. Smith, J. Arn. Arb. 23 (1942) 425; 24 (1943) 140. — *Tasmannia hatamensis* (Becc.) A. C. Smith, Taxon 18 (1969) 289.

TYPIFICATION. *D. hatamensis: Beccari s.n.* (isotype in BM).

Shrub 1—5 m high. *Leaves* scattered; blade obovate to obovate-oblong or obovate-spathulate, 3.5—14 × 1—3.5 cm, base cuneate to acute, apex obtuse to acuminate, acumen up to 1 cm long, chartaceous to subcoriaceous; petiole 2—12 mm; nerves at 35°—70° to the midrib, prominulous to faint or impressed above, prominulous to faint below; veins faint to inconspicuous on either side. *Flowers* 1—5 per bract; mature lower bracts 8—13 × 2—5 mm; pedicel 3—38 mm; sepals 3.5—6 mm long; petals 2 (—4), 3.5—7 × 1—3 mm; stamens 17—43; carpels in ♂ flowers 2—7, in ♀ flowers *c.* 4—6 with 4—14 ovules. *Fruits* up to 7 × 4.5 × 3 mm (immature); seeds brown (only known from *Sleumer & Vink BW 14243*).

DISTRIBUTION. New Guinea: Vogelkop Peninsula, Nassau Mts.

ECOLOGY. Open scrub or primary forest; 1700—2500 m altitude.

DISCUSSION. *Hatamemsis* forms a link between several entities and is, except for the small differences with the other entities, primarily circumscribed as a group of closely related specimens from the Vogelkop Peninsula. Many of these specimens could have been grouped with other entities without much hesitation, but the regional grouping would have been lost in that case.

Docters van Leeuwen 10835 forms a connection with *acutifolia.*

Van Royen 3894 connects *hatamensis* with *obovata.*

Van Royen & Sleumer 7113 is very similar to *Kalkman 4302 (chartacea).*

The present entity is also closely related to *heteromera.*

In considering the relationships with and the delimitation from the other entities the type of seed could not be used as only one collection has (submature) fruits.

NEW GUINEA. West. Tamrau Mts, path from Sudjak to Mt Kusemun, 840 m alt.: *Van Royen & Sleumer 7781*, ♂ (BISH, BO, CANB, K, L). Wamsuf Massiv, 1100—1400 m alt.: *Van Royen & Sleumer 7113*, ♂, ♀ (BISH, CANB, K, L). Nettoti Ra., 1920—1940 m alt.: *Van Royen & Sleumer 7413*, ♂ (BO, CANB, K, L, RSA), *7876*, ♂ (CANB, K, L), *7852*, ♂ (BO, CANB, K, L, US), *Versteegh BW 10375*, ♂ (CANB, L, LAE). Arfak Mts: Hatam, *Beccari s.n.*, y fr (BM); Mt Antop nr Minjambau, 1750 m alt., *Versteegh BW 12613*, ♂ (L); Anggi Gita, *Kostermans 2080*, ♂, ♀ (A, BO, K, L, SING), *2278*, 2000 m alt., ♂, ♀ (A, BO, L), *Sleumer & Vink BW 14062*, 1860 m alt., ♂ (L); Anggi Gigi, Mt Gwamongga, 2150 m alt., *Sleumer & Vink BW 14243*, fr (L). Nassau Mts, 2500 m alt.: *Docters van Leeuwen 10835*, ♂ (BO).

DOUBTFUL. West. Nettoti Ra., 1700 m alt.: *Versteegh BW 10417*, ♂ (A, CANB, L, LAE), *Van Royen 3894*, ♀ (CANB, L). Arfak Mts, Anggi Gita, bivouac Noordpool, 1875 m alt.: *Stefels BW 2011*, st (L).

entity 29. 'macrantha' — *Drimys macrantha* A. C. Smith, J. Arn. Arb. 23 (1942) 422; 24 (1943) 137. — *Tasmannia macrantha* (A. C. Smith) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. macrantha: Brass 4519* (A).

Shrub 2—5 m high. *Leaves* scattered; blade obovate, sometimes obovate-oblong, 3—10 × 1.5—3.5 cm, base cuneate to acute, apex acuminate, sometimes acute, acumen up to 1 cm long, (sub)coriaceous; petiole 3—10 mm; nerves at 45°—70° to the midrib, prominulous (double-crested) above, prominent to prominulous below; veins prominulous to faint (often double-crested) above, prominulous below. *Flowers* 1 per bract; mature lower bracts 15—30 × 5—9 mm; pedicel 20—35 mm; sepals 7—9 mm long; petals 4—11, 9—16 × 2—5.5 mm; stamens 18—66; carpels in ♂ flowers 2—4, in ♀ flowers 2—9 with *c.* 23—26 ovules. *Fruits* up to 10 × 5.5 × 4 mm; seeds black.

DISTRIBUTION. New Guinea: Mt Dickson to Wharton Range.

ECOLOGY. Forest borders, shrubberies; 2700—3500 m altitude.

DISCUSSION. This entity is characterized by its coarse leaves with double-crested nervation, its solitary flowers, and its high number of petals. Within New Guinea it has the closest affinities with *rosea* (which has rounded leaf bases) and with *coriacea* (which is 2-petalled). Its leaves recall also strongly those of *beccariana* (2-petalled). However, *macrantha* differs from all these entities by its solitary flowers. On the other hand, *macrantha* is inseparable from the material from Borneo.

NEW GUINEA. East. Mt Dickson, 3500 m alt.: *Hartley 12972*, fr (CANB, L). Above Bakaia, 15 miles SE. from Garaina, 2740 m alt.: *Hartley 12764*, ♂ (CANB, L). Mt Awormange, E. of Woitape, 2835 m alt.: *Van Royen NGF 20385*, ♂ (K, L). S. slope of West Dome, Mt Albert Edward, 3415 m alt.: *Van Royen NGF 30100*, ♀ (L). Wharton Ra., Murray Pass, 2840 m alt.: *Brass 4519*, ♂, fr (A, BM, K, L, US).

entity 30. 'densifolia' — *Drimys densifolia* Ridley, Trans. Linn. Soc. London II, 9 (1916) 12; A. C. Smith, J. Arn. Arb. 24 (1943) 140. — *Tasmannia densifolia* (Ridley) A. C. Smith, Taxon 18 (1969) 289.

TYPIFICATION. *D. densifolia*: *Boden Kloss s.n.* (BM).

Shrub. *Leaves* scattered; blade obovate, 8—12 × 2.5—4.5 cm, base acute and minutely, sharply auriculate, auricles 1—2 × 1 mm, deltoid and acute, or base abruptly and narrowly rounded, apex acuminate, acumen *c.* 0.7 cm long, coriaceous; petiole 2—5 mm; nerves at 45°—60° to the midrib, prominulous on either side; veins prominulous to faint on either side. *Flowers* 1—7 per bract; mature lower bracts *c.* 8—15 × 6 mm; pedicel 12—35 mm; sepals 5—6 mm long; petals 2, 5—8 × 1.5—2 mm; stamens 20—35; carpels in ♂ flowers 1—3, in ♀ flowers 5—9 with 4—16 ovules. *Fruits* unknown.

DISTRIBUTION. New Guinea: Wissel Lakes, Mt Carstensz.

ECOLOGY. ?2900—3350 m altitude.

DISCUSSION. The entity *densifolia* is merely a representative of *coriacea* with minutely auriculate leaf bases.

NEW GUINEA. West. Wissel Lakes, bivouac Voorrug—Voortop—bivouac foot (? Mt Dejai), 2900—1800 m alt.: *Eyma 5028*, ♂, ♀ (BO, L). Mt Carstensz, 3200—3500 m alt.: *Boden Kloss s.n.*, ♂ (BM).

entity 31. 'rosea' — *Drimys rosea* Ridley, Trans. Linn. Soc. London II, 9 (1916) 11; A. C. Smith, J. Arn. Arb. 24 (1943) 136. — *Drimys grandiflora* Ridley, l. c.; A. C. Smith, o.c., 137. — *Tasmannia rosea* (Ridley) A. C. Smith, Taxon 18 (1969) 288. — *Tasmannia grandiflora* (Ridley) A. C. Smith, l.c.

TYPIFICATION. *D. rosea: Boden Kloss s.n.* (BM), camps XII—XIII. *D. grandiflora: Boden Kloss s.n.* (BM), camp XIII.

Shrub. *Leaves* sessile to subsessile, pseudoverticillate to scattered; blade obovate to obovate-oblong, 3.5—10 × 1.5—4.5 cm, base narrowly to broadly rounded, sometimes minutely auriculate, apex (rounded to) obtuse to acuminate, acumen up to 0.7 cm long, coriaceous; petiole 0—3 mm; nerves at 35°—70° to the midrib, prominent to prominulous on either side; veins prominulous on either side. *Flowers* 1—3 per bract; mature lower bracts *c.* 9—11 × 2—6 mm; pedicel 15—65 mm; sepals 5.5—12 mm long; petals 5—9, 5.5—17 × 2—8 mm; stamens 26—54; carpels in ♂ flowers 1—8, in ♀ flowers *c.* 10—15 with *c.* 18—25 ovules. *Fruits* unknown.

DISTRIBUTION. New Guinea: Wissel Lakes to Mt Hellwig.

ECOLOGY. 2500—3200 m altitude.

DISCUSSION. This entity differs from *cordata* only in its smaller leaves with less coarse nerves which are placed closer together and at a smaller angle to the midrib; in addition, the leaf base is narrower and more rounded instead of distinctly cordate to auriculate. This refers especially to the Mt Carstensz collections. In the other collections the leaf base is still narrower and the leaves are shortly petioled. In *Eyma 5205* (L) the leaves recall strongly those of the Mt Hellwig collections of *coriacea* which also have a slight tendency towards narrowly rounded leaf bases.

The entity *pachyphylla* differs in its scattered petiolate leaves with acute to obtuse bases. See also *sub verticillata* and p. 286, 289.

The leaves of the type of *grandiflora* have a cuneate to narrowly auriculate base as in *densifolia*; those of the latter, however, are petiolate and the flowers are 2-petalled. In the type of *grandiflora* the lower side of the leaves (and even the calyx) is strongly bluish white; one twig of the type of *rosea* has a similar but thinner cover, the other twigs lack this coating.

NEW GUINEA. West. Wissel Lakes, slope of Mt Moetaro: *Eyma 5205*, ♂, ♀ (BO, L). Mt Carstensz: camps XII to XIII, *c.* 3050 m alt., *Boden Kloss s.n.*, ♂ (BM, K); Bijertsberg, 3200—3600 m alt., *Wissel 180*, ♂ (BO, L); camp XII, 3200 m alt., *Boden Kloss s.n.*, ♂ (BM, K). Mt Hellwig, 2500 m alt.: *Pulle 585*, ♂ (BO, L).

entity 32. 'cordata'.

Scrambling shrub 1—4 m high. *Leaves* pseudoverticillate or subopposite, sessile; blade obovate, 3—21 × 2—10 cm, base cordate to broadly auriculate, auricles 0.3—2 cm long, apex obtuse to acuminate, acumen up to 1.5 cm long, (sub)coriaceous; nerves at 60°—90° to the midrib, nerves and veins prominent to prominulous on either side, less distinct in coriaceous leaves. *Flowers* 1—5 per bract; mature lower bracts 9—12 × 5—7 mm; pedicel 20—70 mm; sepals 7—12 mm long; petals 5—9, 7.5—17 × 2.5—6.5 mm; stamens 31—63; carpels in ♂ flowers 2—6, in ♀ flowers 7—13 with 7—28 ovules. *Fruits* up to 15 × 6 × 5 mm; seeds yellowish brown.

CYTOLOGY. One chromosome count: *2n = 28 (Borgmann 78)*. Probably this is erroneous for *2 n = 26* (see Ehrendorfer, *c.s.*, Taxon 17, 1968, 338).

DISTRIBUTION. New Guinea: Eastern and Western Highlands Districts.

ECOLOGY. Montane-, *Nothofagus*-, and mossy forests; subalpine shrubbery; 2530—3415 m altitude.

Wade & McVean, Mt Wilhelm Studies I, 1969, found this entity represented in the Cloud Forest (*Amaracarpus brassii* — *Elaeocarpus azaleifolius* — *Podocarpus pilgeri* association) with the highest constancy class; occasionally only it was found in the Lower Subalpine Forest (*Amaracarpus caeruleus* — *Pittosporum pullifolium* — *Pteris* association); l.c. pp. 62, 68, *Drimys rosea* under 'lianes'.

DISCUSSION. For the relationships between *cordata* and *rosea*, see p. 286.

Both specimens cited as 'doubtful' have more-petalled non-solitary flowers and the same type of leaves as *cordata*; the leaves, however, are petioled, cuneate at the base and less strictly pseudoverticillate. The relations between these specimens and *cordata* are emphasized by the occurrence of the same (rare) type of yellowish brown seed in both groups. Thus the difference between *cordata* and the rest of *D. piperita* is reduced to the form of the leaf base which was already discussed on p. *Drimys* 286.

NEW GUINEA. East. Wabag Subdist., SE. ridge of Yaki valley, nr Poio, 2895 m alt.: *Hoogland & Schodde 6978*, ♂ (CANB, L, LAE). N. of Birap, Wabag, 2835 m alt.: *Flenley ANU 2785*, st (L). Waghi Divide: *Womersley NGF 5199*, ♂, ♀ (BO, CANB, K, L, LAE, SING); Mt Ormogadzin, W. of Mt O Dan, 3200 m alt., *Van Royen NGF 18377*, ♂ (L). Kubor Ra.: Minj-Nona Divide, *Vink 16038*, 3250 m alt., fr (CANB, L, LAE), *Pullen 237*, 3415 m alt., fr (CANB); Mt Kinkain, 3415 m alt., *Saunders 725*, fr (CANB, LAE). Near Keglsugl airstrip, 2530 m alt.: *Womersley NGF 8894*, ♂ (CANB, K, L, LAE). Mt Wilhelm: *Sayers & Millar NGF 19876*, 2740 m alt., ♂, fr (L), *Borgmann 78*, 3000 m alt., ♂ (L, LAE), *Walker ANU 27*, 3050 m alt., ♂ (LAE), *Brass 30215*, 3170 m alt., ♂ (LAE), *30697*, 3180 m alt., ♂ (CANB, K, L, LAE, US), *Van Balgooy 668*, 3250 m alt., ♂ (CANB, L, LAE), *Hoogland & Pullen 5733*, 3350 m alt., fr (CANB, L, LAE), *Van Royen NGF 15123*, 3350 m alt., ♀ (LAE), *Van Balgooy 220*, 3350 m alt., ♀, fr (CANB, L, LAE), *221*, 3350 m alt., ♂ (CANB, L, LAE).

DOUBTFUL. East. Mt Otto: *Brass & Collins 31044*, 3300 m alt., fr (K, L, LAE, US), *Brass 30982*, 3400 m alt., ♂ (US).

entity 33. 'verticillata' — *Drimys verticillata* Pulle, Nova Guinea 8 (1912) 633; Diels, Nova Guinea 14 (1924) 78; A. C. Smith, J. Arn. Arb. 24 (1943) 136. — *Tasmannia verticillata* (Pulle) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. verticillata:* lectotype: *von Römer 1214* (L); syntype: *von Römer 1318* (L).

Shrub 1—1.5 m high. *Leaves* pseudoverticillate or nearly so; blade obovate, 3—8 × 1.5—3 cm, base cuneate to acute, apex broadly rounded to acuminate, acumen up to 0.5 cm long, chartaceous to coriaceous; petiole 3—7 mm; nerves at 45°—75° to the midrib, prominulous above, prominent to prominulous below; veins prominulous to inconspicuous above, prominulous below. *Flowers* 1—3 per bract; mature lower bracts *c.* 4.5 × 2 mm; pedicel 10—25 mm; sepals 3—5 mm long; petals 4—7, 3.5—10 × 0.7—2 mm; stamens 14—29; carpels in ♂ flowers 1—3, in ♀ flowers 4—9. *Fruits* unknown.

DISTRIBUTION. New Guinea: Mt Hellwig.

ECOLOGY. Primary forests; 1800—2600 m altitude.

DISCUSSION. In *verticillata* the leaves are thinner and the flowers are smaller than in *rosea;* moreover, the leaf bases are cuneate to acute whereas these are rounded in *rosea.* The pseudoverticillate leaves and the large number of petals, however, show the relations of the present entity with *rosea* and *cordata. Pulle 585 (rosea),* also from Mt Hellwig, is more or less intermediate between *verticillata* and *rosea* because of its narrow, though ultimately rounded, leaf base.

NEW GUINEA. West. Mt Hellwig: near Bijenkorf bivouac, 1800—1900 m alt., *Pulle 734*, ♂ (BO, K, L, U), *735*, ♀ (B, BO, K, L, U); *von Römer 1214*, 2000 m alt., ♂ (L), *1318*, 2000 m alt., ♀ (L), *Pulle 918*, 2600 m alt., ♂ (BO, K, L, U).

DOUBTFUL. West. Wandammen Peninsula, Wondiwoi Mts, 920 m alt.: *Koster BW 13700*, ♂ (L).

entity 34. 'pachyphylla' — *Drimys pachyphylla* Diels, Nova Guinea 14 (1924) 78; A. C. Smith, J. Arn. Arb. 24 (1943) 136. — *Tasmannia pachyphylla* (Diels) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. pachyphylla: Lam 1812* (B).

Shrub 0.7—1.5 m high. *Leaves* scattered; blade obovate (to elliptic), 1.5—4 × 1—2.5 cm, base acute to obtuse, apex obtuse to rounded, sometimes mucronulate, coriaceous; petiole 3—5 mm; nerves at 45°—70° to the midrib, prominent to prominulous on either side (double-crested above); veins prominulous to faint on either side (thickest ones double-crested above). *Flowers* 1—3 per bract; mature lower bracts *c.* 4—4.5 × 3—4 mm; pedicel 10—12 mm; sepals 3—4 mm long; petals 5 or 6, 3—5 × 0.7—2.5 mm; stamens *c.* 12; carpels in ♂ flowers 2 or 3, in ♀ flowers 2—6 with 2—6 ovules. Only very young *fruits* known; seeds of black type.

DISTRIBUTION. New Guinea: Mt Doorman.

ECOLOGY. *c.* 3260 m altitude.

DISCUSSION. The isotype in L has flowers with 8—10 staminodes and fertile carpels.

No specimens intermediate between *pachyphylla* and other entities are known, but the former is clearly closely related to the entities *coriacea*, *rosea*, and *macrantha*.

NEW GUINEA. West. Mt Doorman, 3260 m alt.: *Lam 1707*, old ♀ (BO, L), *1812*, ♂, ♀ (B, BO, K, L, U).
DOUBTFUL. East. Mt Amungwiwa, S. of Wau, 3475 m alt.: *Womersley NGF 17958*, ♂ (LAE).

entity 35. 'oligandra' — *Drimys oligandra* A. C. Smith, J. Arn. Arb. 23 (1942) 420; 24 (1943) 135. — *Drimys tenuiflora* Kanehira & Hatusima, Bot. Mag. Tokyo 57 (1943) 153, f. 22. — *Tasmannia oligandra* (A. C. Smith) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. oligandra*: *Brass 12975* (A). *D. tenuiflora*: *Kanehira & Hatusima 13408* (BO, isotype).

Shrub *c.* 1 m high, also epiphytic. *Leaves* scattered; blade elliptic- to obovate-oblong, 2.5—5 × 0.5—1.5 cm, base cuneate, apex sharply acute and ultimately rounded to acuminate, acumen up to 0.8 cm long, chartaceous to subcoriaceous; petiole 1—3 mm; nerves at 40°—70° to the midrib, prominulous to very faint above, prominulous to faint below; veins very faint to inconspicuous on either side. *Flowers* 1 (rarely 1—3) per bract; mature lower bracts *c.* 3—4 × 1—1.3 mm; pedicel 15—21 mm; sepals 1.5—3 mm; petals 0—7, 2.5—4 × 0.7—1.3 mm; stamens 4—20; carpels in ♂ flowers 1—7; ♀ flowers unknown. *Fruits* unknown.

DISTRIBUTION. New Guinea: Arfak Mts, Bernhard Camp.

ECOLOGY. 1300—1800 m altitude.

DISCUSSION. The flowers of the type material of *D. oligandra* have no petals or only one petal is present (*fide* Smith, 1942, l.c.) which is a rare feature. Otherwise this specimen is very close to the type of *D. tenuiflora* which has 5—7 petals, so I have put both specimens together in the present entity, considering the former as aberrant (with also a very low number of stamens).

The type of *D. tenuiflora* is very close to *nettoti*, that of *D. oligandra* is less closely related to *rubiginosa*.

Van Royen NGF 18148 has only 2 petals which brings this material within the relationship of *acutifolia*. But this is also an aberrant specimen, having bisexual flowers with 1—6 stamens and 2 or 3 carpels, each with 15—25 ovules.

Van Royen & Sleumer 7084 has seed of the orange-brown type, *Van Royen NGF 18148* has seed of the black type.

NEW GUINEA. West. Arfak Mts, track from Anggi Lakes to Momi, 1800 m alt.: *Kanehira & Hatusima 13408*, ♂ (A, BO, L). Idenburg R., Bernhard Camp, 1300 m alt.: *Brass 12975*, ♂ (A, BO, L).
DOUBTFUL. West. Tokhiri Ra., Aifat R. valley, 1300—1400 m alt.: *Van Royen & Sleumer 7084*, fr (CANB, K, L, LAE). — East. Waghi-Jimmi Divide, N. of Nondugl, 2195 m alt.: *Van Royen NGF 18148*, ⚥, fr (CANB, K, L).

entity 36. 'rubiginosa' — *Drimys rubiginosa* A. C. Smith, J. Arn. Arb. 23 (1942) 420; 24 (1943) 135. — *Tasmannia rubiginosa* (A. C. Smith) A. C. Smith, Taxon 18 (1969) 288.

TYPIFICATION. *D. rubiginosa: Brass 12629* (A).

Shrub 0.3—1.5 m high. *Leaves* scattered; blade obovate-elliptic to obovate, 1.5—5 × 0.5—2.5 cm, base acute, apex obtuse to broadly rounded, (sub)coriaceous; petiole 2—5 mm; nerves at 30°—70° to the midrib, prominulous (and sometimes double-crested above) to faint on either side; veins prominulous to inconspicuous on either side. *Flowers* 1—6 per bract; pedicel 8—17 mm; sepals 2—3.5 mm long; petals 2, 3—6 × 0.6—2 mm; stamens in ♂ flowers 9—26, in ⚥ flowers *c.* 3—5; carpels in ♂ flowers 1—5, in ⚥ flowers 1 (or more?), with *c.* 2—5 ovules, in ♀ flowers *c.* 2—4 with *c.* 13—20 ovules. *Fruits* up to 7 × 3 × 2.5 mm; seeds black.

DISTRIBUTION. New Guinea: Vogelkop Peninsula to Mt Wilhelmina.

ECOLOGY. Mossy forest; 1900—3225 m altitude.

DISCUSSION. The material brought together here is not very homogeneous. The type collection has its nerves at a wide angle to the midrib and the connection between them near the margin is as prominent as the nerves themselves; in the other collections this angle is narrower and the connection is usually less prominent than the nerves.

The relationships with the other entities are not very clear. The leaves of *Docters van Leeuwen 10844* strongly recall those of *elongata*. The Nettoti collection differs from *nettoti*, apart from the number of petals, in minor details only: the angle between nerves and midrib, and the texture of the leaves.

NEW GUINEA. West. Vogelkop Peninsula, Mt Nettoti, 1900 m alt.: *Van Royen & Sleumer 8077*, ⚥, fr (L). Nassau Mts, 2500 m alt.: *Docters van Leeuwen 10844*, ♂ (BO). Mt Wilhelmina, Lake Habbema, 3225 m alt.: *Brass 9104*, ♂ (A, L). Idenburg R., Bernhard Camp, 2150 m alt.: *Brass 12629*, ♀, y fr (A, BO, L).

New Guinean material not placed in one of the entities:

Brass 4046, 4124, 22861; Clemens 6870, 7563; Docters van Leeuwen 10846; Hartley 11203; Hoogland 9510, 9603, 9629; Hoogland & Pullen 5933; Hoogland & Van Deusen 9640; Kalkman 4450, 4474; Lam 1573.

Australian entities.

KEY TO THE AUSTRALIAN ENTITIES

1.a. Lower side of leaves densely papillate (× 30 magnification necessary); petals (apparently) absent . . . **37. 'apetala'**
b. Lower side of leaves not papillate; petals present 2
2.a. Apex of leaves acuminate (rarely acute); nerves in the middle of the blade at an angle of 30°—50° to the midrib; *in sicco* bark of branchlets smooth to striate or finely ribbed . . . . **38. 'membranea'**
b. Apex of leaves acute to obtuse or rounded; nerves in the middle of the blade at an angle of (7°—) 10°—30° to the midrib; *in sicco* bark of branchlets (papillose to) colliculate . . **39. 'xerophila'**

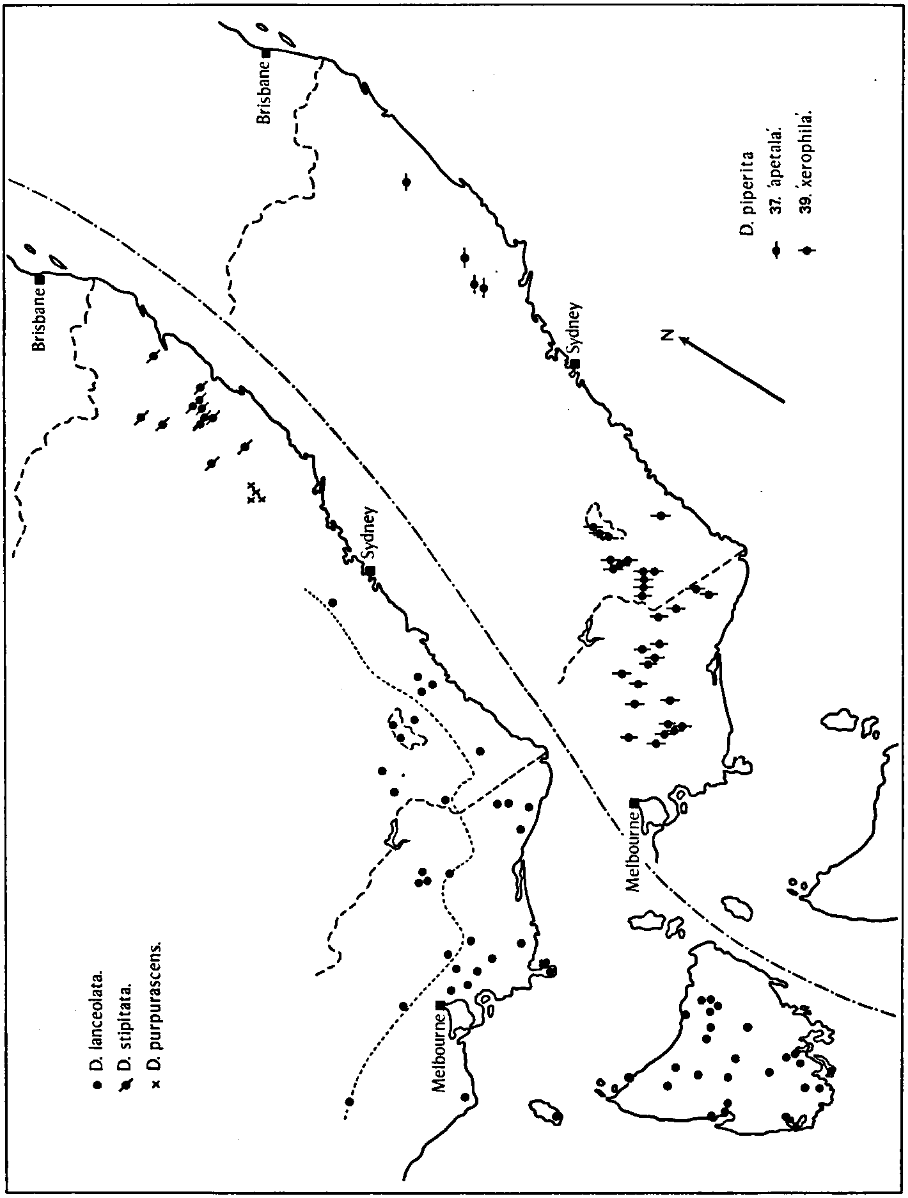

Fig. 33. Distribution of specimens studied.

entity 37. 'apetala' — *Drimys lanceolata* (*non* Baillon) Fraser & Vickery, Proc. Linn. Soc. NSW 62 (1937) 288. — **Fig. 34 e.**

Treelet *c.* 2 m high; bark of branchlets papillose to colliculate. *Leaves* scattered; blade obovate-lanceolate (1.0—) 2.0—8.5 × (0.2—) 0.5—1.5 cm, base cuneate, apex acute or narrowly rounded, sometimes mucronulate, stiffly chartaceous to subcoriaceous; lower epidermis densely papillate; petiole 0.5—2 mm; nerves at 15°—30° to the midrib, prominulous to very faint or minutely impressed above, prominulous to very faint below; veins minutely impressed to inconspicuous above, inconspicuous below. *Flowers* 1 per bract; pedicel 3—12 mm; petals apparently none; stamens 13 or 14; carpels in ♂ flowers 1, in ♀ flowers 1 or 2 with 6—12 ovules. *Fruits* up to 7 × 5 × 3.5 mm; seeds black.

DISTRIBUTION. Australia: Barrington Tops, New South Wales (fig. 33).

ECOLOGY. 1200—1550 m altitude.

DISCUSSION. The description is based on rather poor material and should be emended when more flowering material becomes available.

In three male flowers, several old female flowers, and a number of young fruits I found neither petals nor their scars. From the old female flowers I got the impression that the carpels are inserted laterally, thus replacing the petals. Only one terminal bud of the right age to check the ontogeny was available. The young flowerbuds in it had their sepals in the sagittal plane as in *D. piperita*. The floral apex was dorsiventrally extremely flattened and carried, inserted *above* its base, one or two primordia in a *pseudolateral* position. It could not be verified whether these primordia represented petals or carpels; further investigation is needed.

If additional collections reveal that the petals are always lacking and their positions are not filled by stamens or carpels, this entity deserves specific status. If, however, the petals are replaced by stamens or carpels, or if the petals are present in (part of) these collections, this entity has to remain in *D. piperita*.

The bark of the branchlets and the leaves recall strongly those of *xerophila*, but in *xerophila* the lower leaf epidermis lacks the papillae.

AUSTRALIA. New South Wales. Guy Fawkes: *Trapnell A72*, fr (CANB, K). Camp Manning R.: *Burbidge 05*, fr (CANB). Upper Gloucester R., 1200 m alt.: *Earp 11*, fr (NSW). Barrington Tops: *Boorman s.n.*, 1550 m alt., ♂, y fr (MEL, NSW), *Fraser & Vickery NSW 68397*, old ♀ fl (NSW), *Schodde 3227*, 1500 m alt., fr (A, AD, CANB, L).

entity 38. 'membranea' — *Drimys membranea* F. v. M., Fragm. 5 (1866) 175; Parment., Bull. Sc. Fr. & Belg. 27 (1896) 227, 302 *(sphalm.: membranacea)*; Bailey, Queensl. Fl. 1 (1899) 18; Bot. Bellenden-Ker Exp. in Dept. Agr. Queensl., Rep. Gouv. Sc. Exp. Bellenden-Ker Ra. (1899) 30 *(sphalm.: membranacea)*; Pilger in E. & P., Nat. Pfl. Fam., Nachtr. 3 (1908) 108 *(sphalm.: membranacea)*; C. T. White, Contr. Arn. Arb. 4 (1933) 28; A. C. Smith, J. Arn. Arb. 24 (1943) 127. — *Tasmannia membranea* (F. v. M.) A. C. Smith, Taxon 18 (1969) 287. — **Fig. 34 d.**

TYPIFICATION. *D. membranea: Dallachy s.n.* (MEL, *MEL 5588*), head of Mackay R.

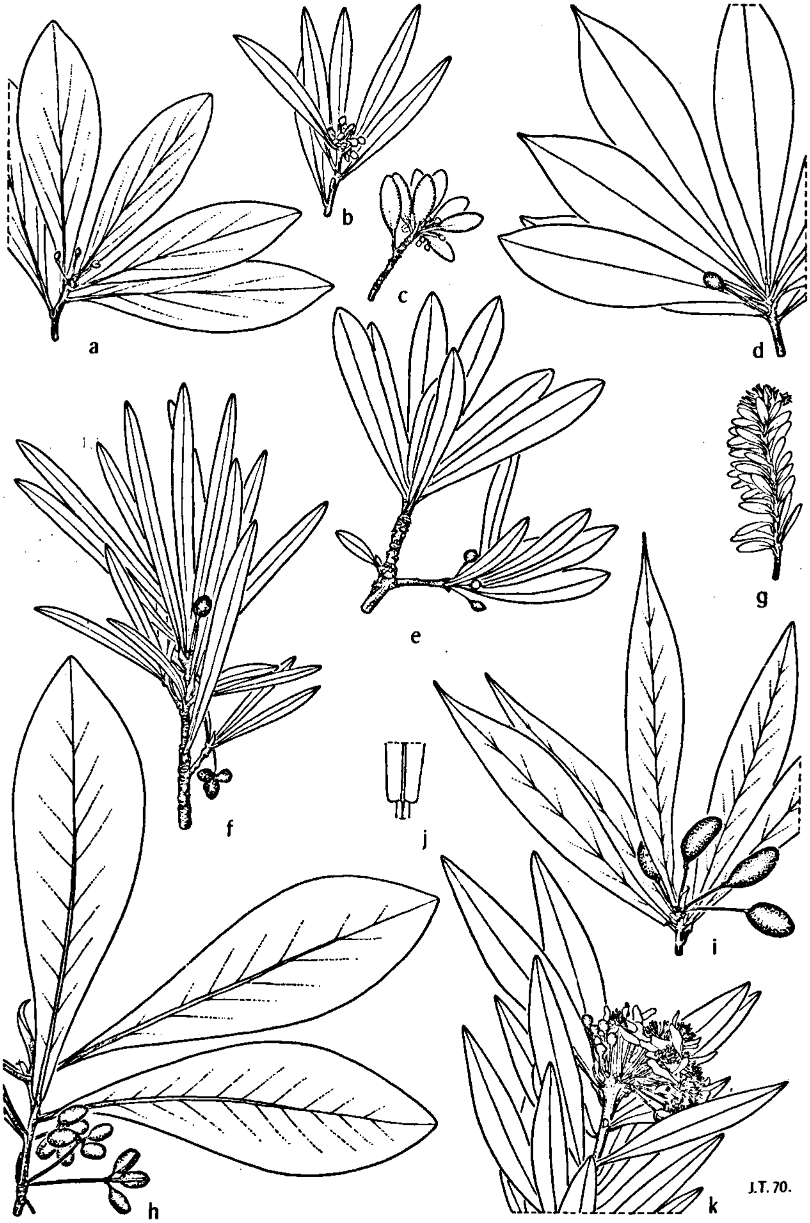

Fig. 34. Habits, × ½. — a—c. *Drimys lanceolata.* — d. *Drimys piperita*, entity *38. membranea.* — e. *ibidem*, entity *37. apetala.* — f & g. *ibidem*, entity *39. xerophila.* — h. *Drimys purpurascens.* — i & j. *Drimys insipida;* leaf base × 1½. — k. *Drimys stipitata.* — (a. *Schodde 3408;* b. *Schodde 3399*; c. *Eichler 16732;* d. *L. S. Smith 11187;* e. *Schodde 3227;* f. *Burbidge & Gray 6412;* g. *Stauffer 5449;* h. *Schodde 3212;* i & j. *Smith & Hotchkiss 5002;* k. *Hoogland 8604*).

Shrub or tree 1.5—10 m high; bark of branchlets smooth to striate or finely ribbed. *Leaves* scattered; blade obovate to lanceolate or linear-lanceolate, 3—17 × 0.8—4 cm, base cuneate, apex (acute to) acuminate, acumen up to 2 cm, chartaceous to coriaceous, lower surface often glaucous; petiole 1—13 mm; nerves at 30°—55° to the midrib, prominulous to faint on either side; veins prominulous to inconspicuous on either side. *Flowers* 1 per bract; ♂ *flowers:* pedicel 7—36 mm; sepals 4—7 mm long; petals 2, 6—13 × 1.5—4.5 mm; stamens 30—62; carpels 1 or 2 (or 3); ♀ *flowers:* pedicel 6—23 mm; sepals 3—6 mm long; petals 2 (rarely 1), 3.5—10 × 1.5—4.5 mm; carpel solitary, with 7—36 ovules, sometimes distal part of both placentas abortive. *Fruits* up to 10 × 8 × 5 mm, placentas sometimes distinctly enlarged; seeds black.

DISTRIBUTION. Australia: northern Queensland (fig. 32).

ECOLOGY. In rain forests, often in the less dense parts, or in low mossy forest; recorded altitudinal range: 500—1525 m. Data on flowering and fruiting insufficient. Apparently the young leaves appear after fruiting.

DISCUSSION. The present entity shows a tendency towards the development of septate pulpa in the fruit, thus displaying the close relationship with *Drimys insipida.* A full evaluation of this tendency is impossible as collections with ripe fruits are very scarce.

Within *membranea* the material shows a wide variation, the extremes being: *a)* chartaceous, rather narrow leaves with a glaucous lower surface; *b)* (sub)coriaceous, rather wide leaves without a trace of glaucescence. Type *a* occupies the southern part of the distributional area, type *b* is more apparent in the northern part. In the centre both types are present and in one case the material *(Brass 18275, 18300)* suggests here an altitudinal relation between both types, type *a* being the one from the lower altitudes. This needs further confirmation.

AUSTRALIA. Queensland. Big Table-land, *c.* 17 miles S. by E. of Cooktown: *L. S. Smith 11187,* fr (A, K, L). Mt Finnegan, 1140 m alt.: *Brass 20130,* st (A). Thornton Pass, 1220—1525 m alt.: *Brass 2291,* ♀ (A). Davies Ck, 15 miles WSW. of Cairns: *L. S. Smith 12070,* 610 m alt., y fr (K), *Volck 3314,* ♂, ♀ (K, L). Gadgarrah, Peeramon, 800 m alt.: *Kajewski 1065,* fr (A, K, P). Mulgrave R.: *Bailey NSW 68509,* y fr (NSW). Bellenden Ker: *Brass 18275,* 500 m alt., fr (A, K, L), *18300,* 1525 m alt., fr (A, K, L), *Johnson s.n.,* ♂, ♀, y fr (MEL), *C. T. White s.n.,* fr (A, NSW). Mt Bartle Frere: *Johnson s.n.,* ♂ (MEL), *Kajewski 1291,* 1600 m alt., ♂ (A, BM, K, P, S). Ascent Graham Ra.: *Dallachy s.n.,* ♂ (MEL). Mt Koolman For. Res., 7 miles S. of Ravenshoe, 885 m alt.: *Schodde 3293,* y fr (CANB, L). Head of Mackay R.: *Dallachy s.n.,* ♂ (B, MEL). Rockingham Bay: *Dallachy s.n.,* ♂, ♀ (BM, BO, FI, K, MEL, NSW, P, PNH, U). Seaview Ra.: *Dallachy s.n.,* ♂, ♀ (MEL). Mt Spec Ra., nr Paluma: *Gittins 603,* ♂, ♀ (NSW). 'Coast Ranges': *Dallachy s.n.,* ♂ (MEL). Bank of Freshwater Ck above Mt Koble: *Flecker (6925),* ♂ (AD). N. Qld, without locality: *Jones H. N. 1493,* ♂ (CANB).

entity 39. 'xerophila' — *Drimys xerophila* Parment., Bull. Sc. Fr. & Belg. 27 (1896) 225, 299; A. C. Smith, J. Arn. Arb. 24 (1943) 128 *(sphalm.: xerophylla) in synon.;* Willis, Vict. Nat. 73 (1957) 188. — *Drimys xerophila* Parment. [or *D. aromatica* (R. Br. *ex* DC.) F. v. M.?] var. *alpina* F. v. M. *ex* Parment., o.c., 226, 231, 300, 337. — *Drimys lanceolata* (Poiret) Baillon var. *parvifolia* Vickery, Proc. Linn. Soc. NSW 62 (1937) 83. — *Drimys vickeriana* A. C. Smith, o.c. 130, f. 3 a—e. — *Tasmannia vickeriana* (A. C. Smith) A. C. Smith, Taxon 18 (1969) 287. — **Fig. 34 f, g.**

TYPIFICATION. *D. xerophila: von Mueller s.n.* (P), Australian Alps. *D. xerophila* var. *alpina: von Mueller s.n.* (P), Baw Baw Ranges. *D. lanceolata* var. *parvifolia: Staer s.n. (NSW 68477)* (NSW), Upper Yarra, Vict. *D. vickeriana: Luehmann & French s.n.* (A), Mt Mueller. See also remarks under *D. lanceolata.*

Shrub or treelet 0.5—3 m high; bark of branchlets (papillose to) colliculate. *Leaves* scattered; blade obovate- to linear-lanceolate, rarely lanceolate, 0.6—10 × 0.2—2.5 cm, base cuneate, apex acute to rounded, (thinly) coriaceous; petiole 1—5 mm; nerves at (7°—) 10°—30° (—35°) to the midrib, prominulous to inconspicuous on either side or minutely impressed above; veins inconspicuous (rarely prominulous) on either side. *Flowers* 1 per bract; mature lower bracts 3.5—12 × 2.5—5 mm; pedicel 3—17 mm; ♂ *flowers:* sepals 2.5—7.5 mm long; petals 2 (—5), 2—9 × 0.6—2.5 mm; stamens 6—26; carpels (0 or) 1 or 2; ♀ *flowers:* sepals 2—4.5 mm long; petals 2 (or 3), 2—4.5 × 0.7—2 mm; carpels 1—5 with 2—7 ovules. *Fruits* up to 8 × 7 × 5 mm; seeds black.

CYTOLOGY. As *D. lanceolata* was not collected on Mt Kosciusko, Hotchkiss's reference to it in Proc. Linn. Soc. NSW 80 (1955) 47 ('slope between the road and the Snowy River about half a mile from Charlotte's Pass') apparently concerns the present entity; the count was $n = 13$.

DISTRIBUTION. Australia: Australian Capital Territory to Victoria (fig. 33).

ECOLOGY. In boggy, moist, or dry places in *Eucalyptus* forest, in alpine grasslands, and in rocky terrain; 1200—1850 m alt. Flowers (Nov. —) Dec.—Febr. (—Apr.), fruits Jan.—May. Young leaves appear together with the flowerbuds or only slightly later.

DISCUSSION. The present entity is strikingly similar to *Drimys lanceolata* in its foliage and in several localities both taxa apparently share the same habitat. The principal difference is in the position of the sepals and petals. Additional characters, more easily recognized, are: in *xerophila* the outer bract always encloses the terminal bud — after opening of the terminal bud the inner bracts usually become longer and outsize the outer bracts before dropping off — whereas in *D. lanceolata* the outer bract encloses the terminal bud only in early stages and is soon outsized by the inner ones (fig. 31a). In *xerophila* the ribs descending from the leaf bases are *in sicco* indistinct, in *D. lanceolata* these are strongly pronounced. The (aggregate) fruit of *xerophila* is usually composed of more than one carpel, each generally longer than wide and with the stigmatic crest not descending to its base; in *D. lanceolata* the fruit is (usually) monocarpellate, generally slightly wider than long, provided with a median furrow and with a stigmatic crest nearly reaching to its base. The young foliage of *xerophila* appears together with the flowerbuds when the terminal bud opens, or lags slightly behind and unfolds when the flowers are in anthesis; in *D. lanceolata* the young foliage unfolds after flowering.

The similarity in foliage and the variability in number of petals in both taxa have often led to the inclusion of *xerophila* in the descriptions of *D. lanceolata* in literature.

The maximum leaf length of the collections (including the petiole) decreases from the eastern to the western localities: 46—98 mm in A.C.T. and 69—100 mm on Mt Ellery to 14—25 mm on Mt Baw Baw. Inadequate labelling of the majority of the material prevents the relation of this observation to possible differences in habitat and/or altitudinal range.

AUSTRALIA. New South Wales. Little Peppercorn Plain, SW. of Brindabella Ra., 1350 m alt.: *Walker ANU 1244*, ♂ (CANB). Monaro Dist.: *Le Seouf NSW 68431*, ♂ (NSW). Kiandra: *Austr. Drug Co NSW 68427*, st (NSW), *Betche s.n.*, y fr (B, NSW), *Vickery NSW 68435*, ♀ (NSW); Sawyers Hill, *Constable NSW 68420*, fr (L). Cabramurra: *C. W. E. Moore 3186*, st (CANB). Upper Tumut Gorge, nr Junction Shaft, 1675 m alt.: *Filmer NSW 68433*, st (NSW). Hill View, Adaminaby: *Locker NSW 68423*, ♂ (NSW). Tumut Pond: *Newman NSW 68400*, st (NSW). Happy Jacks Plains, 1500 m alt.: *Eichler 19017*, fr (AD, L), *Thompson NSW 68421*, st (NSW). Mt Kosciusko: The Kerries, *Gittins NSW 68414*, ♂, ♀ (NSW); Bett's Camp, 1750 m alt., *Eichler 13599, 13600*, ♀ (AD, L); Perisher Ck, 1555 m alt., *Johnson & Constable NSW 18679*, y fr (K, NSW); Daners Gap, 1675 m alt., *Hoogland & Schodde 8442*, ♂ (CANB, L, NSW); Kamel Spur, *J. M. Whaite NSW 68411*, ♂ (NSW); Chalet, *Skottsberg 160*, y fr (S); The Paralyzer, *Briggs s.n.*, fr

(PNH, US); *Andrews NSW 68434*, st (NSW), *Forsyth NSW 68426*, ♂ (NSW), *Helms 6*, ♂ (NSW), *Maiden & Forsyth NSW 68424*, ♂ (L), *Vickery NSW 68425*, 1830 m alt., ♂ (NSW). Junction Spencer's Ck & Snowy R.: *Briggs s.n.*, fr (RSA, US). Snowy R.: *Helms 813*, fr (A, C, US). Tuross R.: *Harnett NSW 68432*, st (NSW). — Australian Capital Territory. Cotter R. Dist., vicinity Bendora, 1370 m alt.: *Schodde 1278*, fr (AD, CANB, L, NSW). Bendora Ck, Mt Franklin Rd: *Burbidge 1768*, fr (CANB). Parrott Rd—Bendora: *Burbidge & Gray 6412*, fr (CANB, L). Wark's Rd: *Gray 5119*, fr (CANB). Mt Coree, 1250 m alt.: *Constable NSW 68419*, st (NSW). Bulls Head—Mt Franklin, 1370 m alt.: *Pullen 2457*, ♀ (CANB, K, L, MEL, NSW). Mt Franklin—Mt Ginini, 1650 m alt.: *Pullen 2461*, ♂ (CANB, K, L, MEL, NSW). Mt Ginini: *Burbidge & Gray 4544*, fr (CANB), *McKee 10132*, 1500 m alt., fr (CANB), *Pullen 94*, 1525 m alt., y fr (CANB), *3841*, 1650 m alt., fr (CANB, L, NSW). Mt Gingera: *Gray 5219*, fr (CANB), *C. W. E. Moore 2515*, fr (CANB); Stockyard Ck, *Burbidge 1743*, ♂ (CANB). Mt Gingera—Blackfellow's Gap: *Burbidge & Gray 6392, 6394*, fr (CANB, L). Mt Murray: *Gray 5156*, ♂ (CANB). Tidbinbilla, 1525 m alt.: *Cambage 4271*, st (NSW). Kangaroo Flats, Tidbinbilla Ra.: *Adam: 1638*, ♂ (CANB). — Victoria. Mt Torbreck nr Thornton, 1525 m alt.: *Willis MEL 5530*, fr (MEL). Mt Buller: *Soues MEL 5523, 5549*, st (MEL), *von Mueller MEL 5541*, st (MEL); The Bluff, 1720 m alt., *Muir 967*, ♂ (MEL). Mt Speculation, head of Catherine R., 1615 m alt.: *Willis MEL 5529*, ♂ (MEL). Mt Buffalo: *Weindorfer MEL 5526*, ♂ (MEL), *Krette NSW 68422*, y fr (NSW). Mt Hotham: *French MEL 5540*, st (MEL), *Walter MEL 5542*, st (MEL); Razorback, 1675 m alt., *H. J. Ashton 249*, ♂ (MEL), *250*, ♀ (MEL). Cobrunga: *Williamson MEL 5521*, st (MEL). Bogong High Plains: *H. J. Ashton 242*, 1770 m alt., ♀, fr (MEL), *Skewes MEL 5525*, 1615 m alt., ♂ (MEL), *Willis s.n.*, 1615 m alt., ♂ (MEL, NSW). Upper Mitta Mitta R.: *Campbell MEL 5543*, st (MEL). Cobberas Mts, 1525—1825 m alt.: *von Mueller MEL 5536*, ♂, ♀ (MEL). Wombargo Ra., Wulgulmerang, 1525 m alt.: *Willis MEL 5527*, ♂ (MEL). Head of Delegate R., 1220 m alt.: *Merrah MEL 5546*, st (MEL). Mt Ellery: *Purdie 299*, st (MEL), *Walter MEL 5538*, ♂ (MEL), *Willis MEL 5528*, 1280 m alt., ♂ (MEL). Upper Yarra: *Staer NSW 68477*, ♂ (NSW). Thomson—Yarra Divide: *Eichler 18941*, y fr (AD, L). The Tors between Mt Baw Baw and St Phillack, 1495 m alt.: *Willis MEL 5504*, fr (MEL). Mt Baw Baw: *Eichler 18934*, ♂ (AD, L), *Gates MEL 5519*, ♂, fr (MEL), *Semmens MEL 5503*, fr (MEL), *Stauffer 5449*, 1500 m alt., ♂ (A, K, L), *von Mueller s.n.*, ♂ (P), fr (US). Mt Mueller: *French s.n.*, 1220 m alt., fr (A, CANB, FI, L, MEL, SING, Z), *Luehmann & French s.n.*, 1525 m alt., ♂ (A, BM, FI, MEL), *Melvin MEL 5509*, st (MEL). Mt Erica: *Sutton 25*, ♂ (K), *Zinzendorfer MEL 5507*, ♂ (MEL). Mt Wellington: *von Mueller MEL 5535* (MEL). 'NE. Mts': *Frost MEL 5505*, ♂ (MEL). 'Austr. Alps': *von Mueller s.n.*, st (P). 'Vict. Alps': *Walter s.n.*, ♂ (BM, CANB, MEL). Summit of Coast Ra.: *French MEL 5539*, y fr (MEL). Gippsland: *French NSW 1857*, fr (MEL, NSW). Haiduign Ra.: *von Mueller MEL 5537*, fr (MEL).

Incertae sedis:

Drimys angiensis Kanehira & Hatusima, Bot. Mag. Tokyo 57 (1943) 150, f. 20. *Type: Kanehira & Hatusima 13410 (non vidi)* — Probably to be placed somewhere near *chartacea* or *hatamensis*.

FOSSILS

1. **Drimys americana** Chaney & Sanborn, Carn. Inst. Wash. Pub. 439 (1933) 69, pl. 12 f. 2, 3 (*Eocene*, Oregon).
2. **Drimys antarctica** Dus., Wiss. Ergeb. Schwed. Südpolar-Exp. 3^{3} (1916) 5, t. 2 f. 13 (*age uncertain*, Seymour Isl.).

EXCLUDED FROM THE WINTERACEAE

1. *Drimys pseudo-lancea* Poit. *ex* Baillon, Adansonia 8 (1868) 168, *nom. in synon.* of **Oxandra laurifolia** A. Rich. (Annon.).
2. *Drimys lancea* Poit. *ex* Baillon, l.c.; Hist. Pl. 1 (1868), *nom. in synon.* of **Oxandra lanceolata** (Sw.) Baillon (Annon.).
3. *Drimys muelleri* Parment., Bull. Sc. Fr. & Belg. 27 (1896) 227, 300, pl. 10 f. 36, 37 = **Persoonia gunnii** Hook. *f.*, Lond. J. Bot. 6 (1847) 283, (Prot.), according to Willis, Vict. Nat. 73 (1957) 190 [Type: *C. Glover s.n.* (P), Mt Victoria, Tasmania].
4. *Drimys intermedia* Parment., o.c., 223, 224, *sphalm.* for *Drimys muelleri* Parment.
5. *Drimys vascularis* Parment., o.c., 229, 306 = **Cinnamodendron axillare** (C. G. Nees) Endl. *ex* Walp., Rep. 1 (1842) 398, (Canell.) [Type: *Martius s.n.* (P), Brasil]. Det.: H. Sleumer.
6. *Drimys oblonga* S. Moore, J. Bot. 55 (1917) 302 = **Hypsophila halleyana** F. v. M., Vict. Nat. 3 (1877) 168, (Celastr.), according to Dandy, J. Bot. 71 (1933) 45.

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INDEX

- *Bubbia parviflora* (Ridley) Burtt 320
- Cinnamodendron axillare (Nees) Endl. *ex* Walp. 351
- Drimys J. R. & G. Forst. 235, 302
  - div. *1* Miers 235
  - div. *2* Miers 303
  - div. *3* Miers 303
  - div. *4* Miers 303
  - sect. Drimys 303
  - sect. *Drimys* DC. 235
  - sect. *Eudrimys* DC. 235, 304
  - sect. *Eudrimys* v. Tiegh. 235, 304
  - sect. *Sarcodrimys* Baill. 303
  - sect. Tasmannia (R. Br. *ex* DC.) F. v. M. 303
  - sect. *Winterana* Baill. 303
  - *acutifolia* Pulle 329
  - † americana Chaney & Sanborn 351
  - *angiensis* Kan. & Hat. 351
  - † antarctica Dus. 351
  - *arfakensis* Gibbs 330
  - *aromatica* (R. Br. *ex* DC.) F. v. M. 304
    - var. *alpina* F. v. M. *ex* Parment. 349
    - var. *aromatica* Parment. 305
    - var. *pedunculata* Maiden 309
  - *axillaris* J. R. & G. Forst. 239
    - var. *colorata* (Raoul) Kirk 241
  - *beccariana* Gibbs 330
  - *brassii* A. C. Smith 318
  - *buxifolia* Ridley 320
  - *colorata* Raoul 241
  - *coriacea* Pulle 332
  - *cyclopum* Diels 339
  - *densifolia* Ridley 341
  - *dictyophlebia* Diels 332
  - *dipetala* (R. Br. *ex* DC.) F. v. M. 311
  - *elongata* Ridley 329
  - *fistulosa* Diels 326
  - *grandiflora* Ridley 341
  - *hatamensis* Becc. 339
  - insipida (R. Br. *ex* DC.) Druce 310
  - *intermedia* Parment. 351
  - *lamii* Diels 325
  - *lancea* Poit. *ex* Baillon 351
  - lanceolata (Poir.) Baill 304
    - var. *parvifolia* Vickery 349
  - *lanceolata* (*non* Baill.) Fraser & Vickery 347
  - *macrantha* A. C. Smith 340
  - *membranea* F. v. M. 347
  - *microphylla* A. C. Smith 327
  - *montis-wilhelmi* Hoogl. 323
  - *muelleri* Parment. 351
  - *myrtoides* Diels 328
    - var. *gracilis* Diels 328
  - *oblonga* S. Moore 351
  - *obovata* A. C. Smith 334
  - *oligandra* A. C. Smith 344
  - *pachyphylla* Diels 343
- Drimys
  - *parviflora* Ridley 320
  - piperita Hook. *f.* 314
    - 'acutifolia' 329
    - 'apetala' 347
    - 'beccariana' 330
    - 'buffelhoorn' 331
    - 'buxifolia' 320
    - 'chartacea' 335
    - 'cordata' 342
    - 'coriacea' 332
    - 'crassipes' 322
    - 'densifolia' 341
    - 'elongata' 329
    - 'fistulosa' 326
    - 'giluwe' 325
    - 'hatamensis' 339
    - 'heteromera' 336
    - 'lamii' 325
    - 'macrantha' 340
    - 'membranea' 347
    - 'microphylla' 327
    - 'montis-wilhelmi' 323
    - 'myrtoides' 328
    - 'nettoti' 326
    - 'obovata' 334
    - 'oligandra' 344
    - 'pachyphylla' 343
    - 'papillata' 322
    - 'pittosporoides' 321
    - 'polymera' 338
    - 'reducta' 318
    - 'reticulata' 339
    - 'robusta' 331
    - 'rosea' 341
    - 'rubiginosa' 345
    - 'subalpina' 319
    - 'subpittosporoides' 321
    - 'vaccinioides' 328
    - 'versteegii' 320
    - 'verticillata' 343
    - 'xerophila' 349
  - *pittosporoides* Diels 321
  - *pseudo-lancea* Poit. *ex* Baillon 351
  - purpurascens Vickery 308
  - *reducta* Diels 318
  - *reticulata* Diels 339
  - *reticulata* Hook. *f.* 314
  - *rosea* Ridley 341
  - *rubiginosa* A. C. Smith 345
  - stipitata Vickery 309
  - *subreticulata* Kan. & Hat. 334
  - *tenuiflora* Kan. & Hat. 344
  - *traversii* (Buchanan) Kirk 243
  - *vaccinioides* Ridley 328
  - *vascularis* Parment. 351

Drimys
  versteegii Diels 320
  verticillata Pulle 343
  vickeriana A. C. Smith 349
  xerophila Parment. 349
    var. *alpina* F. v. M. *ex* Parment. 349
    var. *aromatica* Parment. 305
  xerophylla Parment. 349
Hymenanthera traversii Buchanan 243
Hypsophila halleyana F. v. M. 351
Oxandra lanceolata (Sw.) Baill. 351
  laurifolia A. Rich. 351
Persoonia gunnii Hook. *f.* 351
Pseudowintera Dandy 235
  axillaris (J. R. & G. Forst.) Dandy 239
    var. *colorata* (Raoul) A. C. Smith 243
    var. *typica* A. C. Smith 239
  colorata (Raoul) Dandy 241
  traversii (Buchanan) Dandy 243
Tasmannia R. Br. *ex* DC. 303
  acutifolia (Pulle) A. C. Smith 330
  arfakensis (Gibbs) A. C. Smith 330
  aromatica R. Br. *ex* DC. 304
  beccariana (Gibbs) A. C. Smith 330
  brassi (A. C. Smith) A. C. Smith 318
  buxifolia (Ridley) A. C. Smith 320
  coriacea (Pulle) A. C. Smith 332
  cyclopum (Diels) A. C. Smith 339
  densifolia (Ridley) A. C. Smith 341
  dictyophlebia (Diels) A. C. Smith 332
  dipetala R. Br. *ex* DC. 310
  elongata (Ridley) A. C. Smith 329
  fistulosa (Diels) A. C. Smith 326
  grandiflora (Ridley) A. C. Smith 341
  hatamensis (Becc.) A. C. Smith 339
Tasmannia
  insipida R. Br. *ex* DC. 310
  lamii (Diels) A. C. Smith 325
  lanceolata (Poir.) A. C. Smith 305
  macrantha (A. C. Smith) A. C. Smith 340
  membranea (F. v. M.) A. C. Smith 347
  microphylla (A. C. Smith) A. C. Smith 327
  monticola A. Rich. 310
  montis-wilhelmi (Hoogl.) A. C. Smith 323
  myrtoides (Diels) A. C. Smith 328
  obovata (A. C. Smith) A. C. Smith 334
  oligandra (A. C. Smith) A. C. Smith 344
  pachyphylla (Diels) A. C. Smith 343
  parviflora (Ridley) A. C. Smith 320
  piperita (Hook. *f.*) Miers 314
  pittosporoides (Diels) A. C. Smith 321
  purpurascens (Vickery) A. C. Smith 308
  reticulata (Diels) A. C. Smith 339
  rosea (Ridley) A. C. Smith 341
  rubiginosa (A. C. Smith) A. C. Smith 345
  stipitata (Vickery) A. C. Smith 309
  vaccinioides (Ridley) A. C. Smith 328
  verticillata (Pulle) A. C. Smith 343
  vickeriana (A. C. Smith) A. C. Smith 349
Wintera Murr. 235, 302
Wintera v. Tiegh. 235
  sect. *Euwintera* v. Tiegh. 244
  sect. *Pleurowintera* v. Tiegh. 235
  axillaris (J. R. & G. Forst.) Forst. *f.* 239
  colorata (Raoul) v. Tiegh. 243
  monogyna v. Tiegh. 243
  terminalis v. Tiegh. 244
  traversii (Buchanan) Cockayne 243
Winterania lanceolata Poir. 304