

CONTRIBUTION TO THE PAPUASIAN FLORA:
NOTES ON THE ECOLOGY AND TAXONOMY OF
THE VACCINIOIDEAE OF THE BULLDOG ROAD,
MOROBE DISTRICT PAPUA NEW GUINEA

S. P. VANDER KLOET

Department of Biology
Acadia University
Wolfville, N.S. B0P 1X0

Twenty one species of Vaccinioideae, including two new species, were collected at 10 sites along the Bulldog Road, Papua New Guinea. The highest species diversity and abundance occurred above 2600 msm, an altitude which coincides with the beginning of the cloud forest in this area. Dimorphanthera was the most ubiquitous and abundant genus whilst Vaccinium was quite rare. One new species, Vaccinium morobense, is described.

INTRODUCTION

The Hebert Expedition in 1975 towards Mt. Kumbak, Morobe Province, Papua New Guinea afforded me an opportunity to observe and describe the distribution of Vaccinioideae from Wau (1800 msm) to Edie Creek (2250 msm) and thence along the Bulldog Road to the height of land (3010 msm). This Road was constructed during World War II by Australian Troops who, on completion, promptly abandoned it; it was scarcely ever used by vehicles and is now destroyed by erosion, being overgrown in many places.

In North America such disturbed ground, provided the substrate is acid, is usually invaded by Vaccinium and other ericaceous genera (Camp 1942, 1945). Moreover, it is the species which are established in natural, undisturbed habitats in the area that occupy this disturbed ground. Hall (1959) found that in blueberry fields developed from woodlots, Vaccinium myrtilloides Michx. had the highest frequency of abundance since it tolerates shade and therefore persists in second growth forests, whilst in blueberry fields developed from abandoned meadows, V. angustifolium Ait. was more prevalent.

Likewise Sleumer (1965) observed the invasion of Rhododendron and Vaccinium on disturbed ground including the gold mine tailings at Edie Creek; he noted that the epiphytic Vaccinioideae may become terrestrial at the forest borders and at higher altitudes (Sleumer 1967). If the Vaccinioideae are as intolerant of shade as Camp (1942) has argued, the persistence of the group in the primary montane forests is impossible unless the several species have the epiphytic habit as part of their adaptive strategy, or else the species are restricted to subalpine shrub-beries (or become part of the transitional assemblages which migrate from landslip to landslip, or else become ruderal).

METHODS

My objective was to carefully search at regular intervals a disturbed section of the Bulldog track and its adjoining primary forests especially for epiphytic Vaccinioideae - a task carried out during August 1975 when I systematically searched for Vaccinioideae along a 20 km section of this track, going from an elevation of 2000 msm (07°33'S/146°41'E) to the height of land at 3010 msm, with sampling points every 2 km. Vouchers have been deposited at LAE*, A, and ACAD. Types are at A.

RESULTS and DISCUSSION

Twenty one species of Vaccinioideae representing 5 genera were collected at the 10 sites. The highest species diversity and abundance occurred above 2600 msm (Table 1), an altitude which coincides with the beginning of the cloud or moss forest in this area. At the height of land (3010 msm) 2 small outcroppings were present which did not seem to be fire-induced barrens and on which only Vaccinium amblyandrum F.V.M. and V. finisterrae Schltr. were present; the bulk of the vegetation was Bryophyta and Epacridaceae.

Two species, V. molle J.J.S. and V. horizontale Sleumer, were exclusively found on disturbed ground, especially on the gold mine tailings at Edie Creek, ie they were behaving as Nomads (sensu van Steenis 1958). Vaccinium acrobacteatum K. Sch. was a strict epiphyte in the lower montane forests, but Brass (1941 p. 307, as V. adenanthum) has reported this species on sand at the mouth of the Bele Valley. Diplycosia morobeënsis Sleumer is also strongly epiphytic; only once at 2850 msm along the margin of the cloud forest did I see it as a weak terrestrial shrub.

The remaining species were not only present in transitional communities and disturbed sites such as dead fall, stumps, hedges, and edges, but were also members of more stable communities. Within the thickest primary moss forests from 2650 to 2850 msm, Vaccinium finisterrae Schltr., Agapetes brassii Sleumer, and Diplycosia morobeënsis Sleumer were epiphytic; Dimorphanthera denticulifera Sleumer was a scrambling or weakly erect understory shrub; Vaccinium carneolum Sleumer was an understory tree at 2850 msm in these moss forests.

Dimorphanthera is the most ubiquitous and abundant genus in the dense ericaceous shrubberies that occur along the track above 2600 msm as well as in glades and ravines whilst Vaccinium is quite rare in the Rhododendron shrubberies which occur on the outcroppings, mass wastage slopes, and track verges above 2650 msm. Gaultheria pullei J.J.S. is common in these Rhododendron shrubberies.

All these species of Vaccinioideae were in flower during August, but pollinators were scarce. Vaccinium molle J.J.S. was visited by Apis spp and corollas of Dimorphanthera ingens (Sleumer) Stevens and Vaccinium carneolum Sleumer contained weevils and thrips but whether these actually pollinate is a moot point. Kevan (1972) presents evidence from the Canadian high Arctic that they do. Birds and moths are probably important pollinators of Rhododendron spp (Stevens 1976), but the evidence for the Vaccinioideae is largely circumstantial. Species from three

*acronyms from Index Herbariorum, Holmgren & Keuken (1974).

Table 1. Elevational distribution and flower color of Vaccinoideae along the Bulldog track, PNG. 1st column (abundance): + rare; 1 occasional; 2 common; 3 abundant. 2nd column (flower density): + flowers sporadically; ∞ small flowers (<10 mm); ∞ large flowers (>10 mm); 3 masses of bloom.

Taxa	Flower color	Sample point																			
		1	2	3	4	5	6	7	8	9	10										
<u>Vaccinium molle</u>	cream																				
<u>V. horizontale</u>	red		2,1	+ ,1	+ ,+	+ ,1	+ ,+	+ ,+	+ ,+												
<u>V. cyclopense</u>	red	+ ,+	1 ,+																		
<u>V. reticulato-venosum</u>	red	+ ,+	+ ,+																		
<u>V. amblyandrum</u>	white																				
<u>V. finisterrae</u>	red																				
<u>V. myrsinoides</u>	red																				
<u>V. carneolum</u>	red																				
<u>V. morobense</u>	red																				
<u>V. acrobacteatum</u>	red																				
<u>Dimorphanthera anchorifera</u>	red	+ ,+	2 ,+																		
<u>D. denticulifera</u>	red																				
<u>D. amplifolia</u>	red																				
<u>D. calodon</u>	red																				
<u>D. ingens</u>	white																				
<u>D. albida</u>	white																				
<u>Agapetes brassii</u>	yellow-red																				
<u>A. vitis-idaea</u>	yellow-red																				
<u>A. prostrata</u>	yellow-red																				
<u>Diplycosia morobeënsis</u>	white																				
<u>Gaultheria pullei</u>	white																				
	m s m	2250								2600										2750	3000

sections of Dimorphanthera are known to be visited by birds (see Sleumer 1967; Stevens 1976, 1977; also D. calodon Sleumer, below). The predominant flower color of these Vaccinioideae is red which according to Kevan (1972) is insect yellow, orange, or black. Only where Dimorphanthera albida Stevens and D. ingens (Sleumer) Stevens were massed did white stand out.

In short, most of the Vaccinioideae that occur along the Bulldog track have populations in more stable communities which are not necessarily adjacent to the ruderal populations. Frequency of occurrence is, however, quite low in the primary moss forests as compared to numbers along the track. Dimorphanthera is a notable exception to this trend; it is both abundant in glades and along the track at 2850 msm. The Vaccinioideae are, therefore, just as opportunistic in Papua New Guinea as they are in North America with the notable exception that several species can retreat (or migrate) into the trees ie become epiphytic rather than face local extinction in the encroaching primary moss forests.

SYSTEMATIC LIST

1) Vaccinium molle J.J. Smith.

Erect, crown-forming, terrestrial shrub 0.3-5 m high, common on gold mine tailings (pH 4.5-5.1, organic content <10%) and outcroppings at Edie Creek; rare but ubiquitous on disturbed ground elsewhere on the track, but absent from the highest elevations. Seedlings were observed among clumps of grass and in Lycopodium mats. Although the species was still flowering, the first ripe berries of the current season were collected in late August. The pale yellow pubescent berries contained many small pale brown seeds (8 mg/100 seeds), which germinated quickly in 12 to 14 d but were extremely susceptible to damping off.

2) Vaccinium cyclopense J.J. Smith.

Trailing shrub found twice in moss carpets on roadside cliffs near Edie Creek; absent elsewhere. Flowering during August but fruiting sparsely; berry mauve, containing many small brown seeds (12 mg/100 seeds) which germinated readily in 25 to 30 d, but seedlings were very susceptible to damping off.

3) Vaccinium horizontale Sleumer.

Erect, crown-forming, terrestrial shrub 2 to 3 m high, very rare, only 3 plants seen on gold mine tailings at Edie Creek and one along the track at 2500 msm. Fruiting and flowering simultaneously during August. Berries black, somewhat shiny, 1 cm in diameter, and quite astringent; each berry contained 1 to 7 large seeds which germinated readily in 30 to 40 d.

4) Vaccinium reticulato-venosum Sleumer.

Scandent, scrambling, partially erect shrub 2 to 3 m high, margin of Nothofagus forest, Mt. Kaindi, Edie Creek Road; very rare.

5) Vaccinium amblyandrum F.V. Mueller.

Erect, creeping, or scrambling terrestrial shrub (3)30 to 50(90) cm high, rhizomes sometimes superficial then forming extensive creeping

mats, sometimes the rhizomes are subterranean then the plant forms extensive colonies; occasionally caespitose and scrambling especially on rotting tree stumps. Locally abundant above 2600 msm especially on outcroppings and slip slopes; massed along both sides of the track above 2800 msm; occasionally it occurs in open Rhododendron shrubberies. Soil often coarse and water logged (pH 4.1-5.0; organic content <12%). This species flowered sporadically throughout August, but no ripe fruit was observed.

6) Vaccinium finisterrae Schltr.

Slender erect, or scrambling terrestrial, or rarely an epiphytic shrub, 30 to 100 cm high. Occasional from 2600 msm to the height of land in a variety of habitats, viz an epiphyte in moss forests, along the margin of the track where it is associated with Vaccinium amblyandrum; an understory shrub in Rhododendron shrubbery; on exposed slip slopes and outcroppings. This species was in full flower during August; no ripe fruit was observed.

7) Vaccinium myrsinoides Schltr.

Erect terrestrial shrub 60 to 250 cm high, usually quite rare and seen only between 2600 and 2850 msm where it occurred along the margin of the track and rims of mass wastage slopes. This species was also flowering profusely during August but fruiting sparsely; berries dull and black, containing ca 6 small seeds which germinated after 40 d.

8) Vaccinium carneolum Sleumer.

Small tree or erect crown-forming terrestrial shrub 1.5 to 5 m high, common to occasional in disturbed habitats or as an understorey tree in the moss forests from 2650 msm to the height of land; in flower during August, ripe fruit absent.

9) Vaccinium morobense Vander Kloet sp nov (Fig 1, 2).

A speciebus aliis Vaccinii Malesianae in folia obovata usque ad 2 cm longo margine integra, pilis multicellularibus glandulosis subcapitatis, inflorescentia axillari cum 2 ad 5 floribus, axe usque ad 12 mm longo floribus versus apicem ortis, bracteae deciduae, ovario pseudo 10-loculare, flore urceolato, filamentis pilosis, et antheris pilis multicellularibus glandulosis praeditis, differt.

Frutex usque ad 1.5 m altus. Ramulus juventute circa 0.8 mm in transverso, angulatus (angulis e basibus petiolorum decurrentibus), pilis unicellularibus curvatis et multicellularibus glandulosis subcapitatis praeditis; perulae gemmarum late ovatae, 0.6 and 0.8 mm longae. Petiolus 1.5 ad 2 mm longus; lamina obovata 1.2 ad 1.9 cm longa et 0.45 ad 0.8 mm lata, apice rotundata, basi cuneata, margine integra recurvata prope basem glandulis duabus instructa, supra pilis unicellularibus super costam pilis multicellularibus super et prope costam praedita, infra pilis paucis multicellularibus pagina tota praedita, costa supra leviter elevata vel depressa infra leviter elevata, nervis lateralibus pari uno prope basem ortis, nervis aliis parvioribus supra obscuris vel planis infra planis. Inflorescentiae subcorymbosae, floribus 2 ad 5 versus apicem axis ortis, axibus 2 ad 12 mm longis pilis (perpaucis) multicellularibus et interdum unicellularibus praeditae; bracteae mos deciduae, oblongo-ovatae, circa 2.5 mm longae; pedicelli 5-8 mm longi cum calycibus articulati,

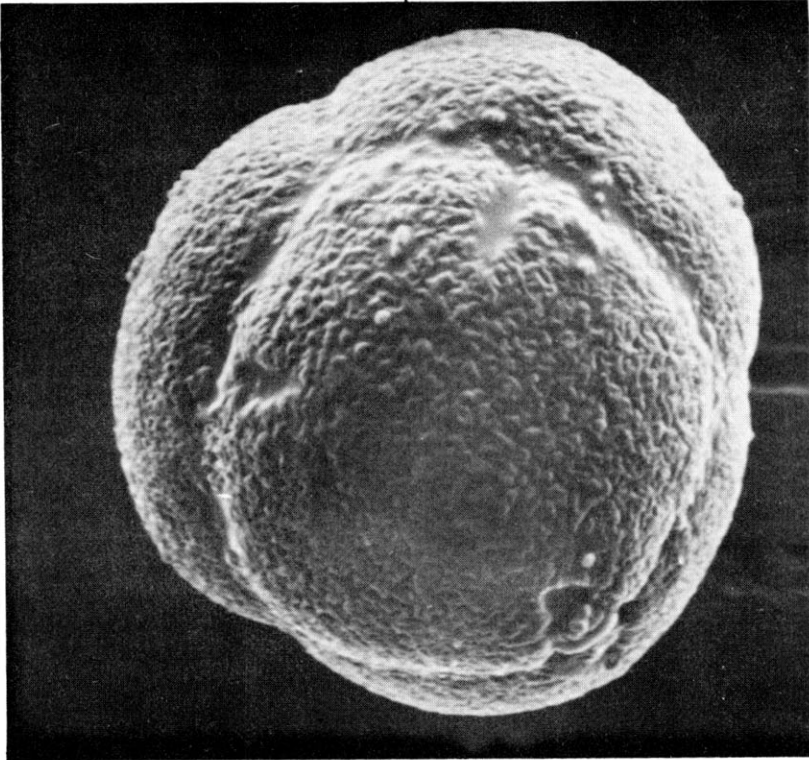


Fig 1. Scanning electron micrograph of a pollen tetrad from Vaccinium morobense sp nov (Vander Kloet 164875).

pilis multicellularibus praesertim versus apices praediti, bracteolis haud cognitis. Tubus calycis 1.5 ad 1.9 mm longus versus basem pilis multicellularibus praeditus, lobis 5 triangularibus 0.9 ad 1.4 mm longis fissus marginibus haud glanduliferis apicibus cirris pilorum unicellulorum praeditis; corolla urceolata testaceo-rubra vel rubra (lobis albis) circa 7 mm longa et 4.5 mm lata (ad orem circa 2.5 mm lata), extus glaber intus pilis unicellularibus prope basem excepta praedita, ad orem papillata, lobis 5 triangularibus circa 0.6 mm longis fissa; stamina 10, ecalcarata, filamentis 2.5 ad 2.8 mm longis pilis densis unicellularibus praeditis, antheris thecis 1.6 ad 2 mm longis, papillatis, basibus rotundatis, tubulis quam thecis leviter angustioribus circa 0.8 mm longis, laevibus, sed pilis multicellularibus glandulosis versus apices praeditis, poris subobliquis terminatis; ovarium inferum pseudo 10-loculare; discus glaber; stylus circa 5.5 mm longus, glaber, tumidus, prope apicem angustatum, stigmatibus leviter expanso. Fructus immaturus circa 4.7 mm longus et 4.3 mm latus.

Type: Papua New Guinea, Morobe District, Wau Region, Bulldog Road, 2600 msm, Aug. 1975, Vander Kloet 164875 (holotype, A).

Distribution: Morobe Province, Papua New Guinea.

Additional specimen seen: Papua New Guinea. Morobe, Bulldog Road, 2500 msm, Vander Kloet 36875(A).

Ecology: Vaccinium morobense is sometimes a clump forming shrub growing on steeply sloping ground or old tree stumps in montane forest, often growing with other Ericaceae. Flowering specimens have been collected in August.

Vaccinium morobense can readily be distinguished from other species of the genus by its small, obovate leaf blades, its indumentum of crisped unicellular and small, stalked, subcapitate glandular hairs, its few-flowered, subcorymbose inflorescence, deciduous bracts, falsely 10-locular ovary, densely pilose filaments and ecalcarate anthers with multicellular, eglandular hairs.

Like other Malesian-Southeast Asian species of the genus, Vaccinium morobense has a superficial phellogen (Vander Kloet 164875), but it is

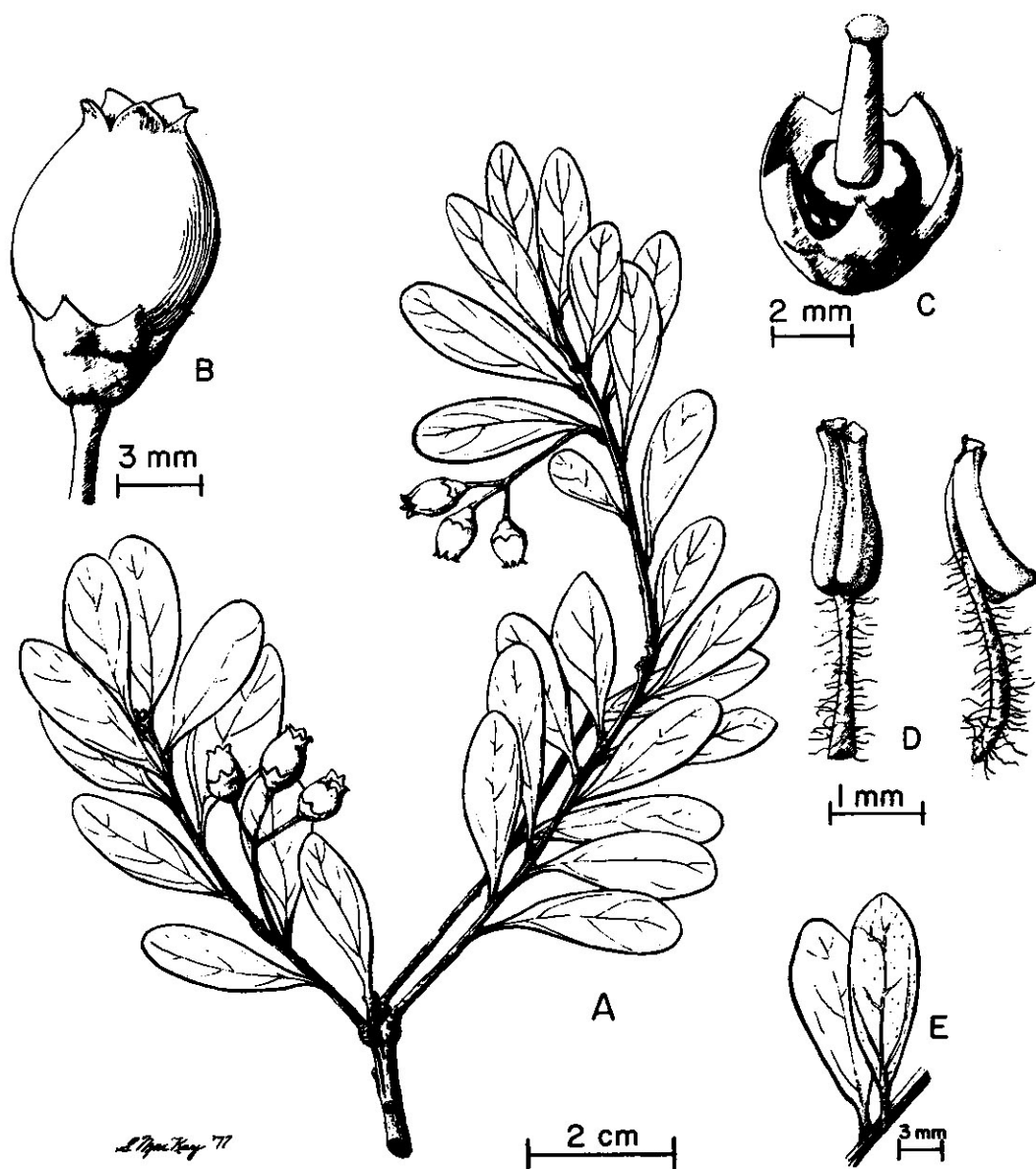


Fig 2. Vaccinium morobense sp nov (A) habit (Vander Kloet 36875); (B) flower; (C) ovary, disk and style; (D) stamens; (E) leaves (Vander Kloet 164875).

difficult to assign it to a section. In general facies it is very like the microphyllous species placed in § Oarianthe Sleumer, but it differs in its inflorescence, which has a distinct axis and bears 2 to 5 flowers. Members of § Oarianthe sometimes have a very short inflorescence axis, but there is only a single flower. In addition, glandular hairs on the anthers appear to be unknown in § Oarianthe (Sleumer 1967), although they may have been overlooked. Vaccinium morobense is provisionally included in § Bractaeta Nakai in which the inflorescences have well developed axes; a number of Malesian species in this section have anthers with glandular hairs or points. Vaccinium morobense keys out as V. longiporum in Sleumer (1967), but may readily be separated from that species on lamina shape and size (obovate, rounded at the apex, and less than 2 cm long in V. morobense; elliptic (lanceolate) caudate, acuminate at the apex, and at least 5 cm long in V. longiporum) and inflorescence size (2-5 flowers vs 5-10 flowers).

10) Vaccinium acrobacteatum K. Schumann.

Erect or scrambling epiphytic shrub 2 to 5 m high, occasional in crotches of massive Nothofagus and Lithocarpus trees from 2400 to 2800 msm. Some of these crotches contained more than 50 cm³ of peaty material. Shrubs were either flowering or fruiting during August. Berries purple to black, 4 to 8 mm in diameter; many seeds (22 mg/100 seeds) few of which germinated after 25 to 35 d; seedlings stout, main axis has a "zig-zag" growth pattern; both young leaves and stem densely glandular (Fig 3).

11) Dimorphanthera anchorifera J.J. Smith (including D. brassii Sleumer).

Scandent, scrambling or arching terrestrial shrub 1 to 3 m high, common in the Edie Creek area along forest edges, rotting tree trunks, on dead fall, and along woodlot margins. Not seen elsewhere. Flowering and fruiting sparsely in August: berries purple, 10 to 14 mm in diameter; outer layer tough, 2 mm thick, neatly incised by birds which remove sap and seeds. These seeds are quite small (7 mg/100 seeds), triangular, and are almost fused together within the locule; fresh seeds germinate readily after 20 to 30 d; seedlings prostrate, stem develops in a zig-zag pattern, young leaves becoming cordate and densely glandular (Fig 4).

12) Dimorphanthera denticulifera Sleumer.

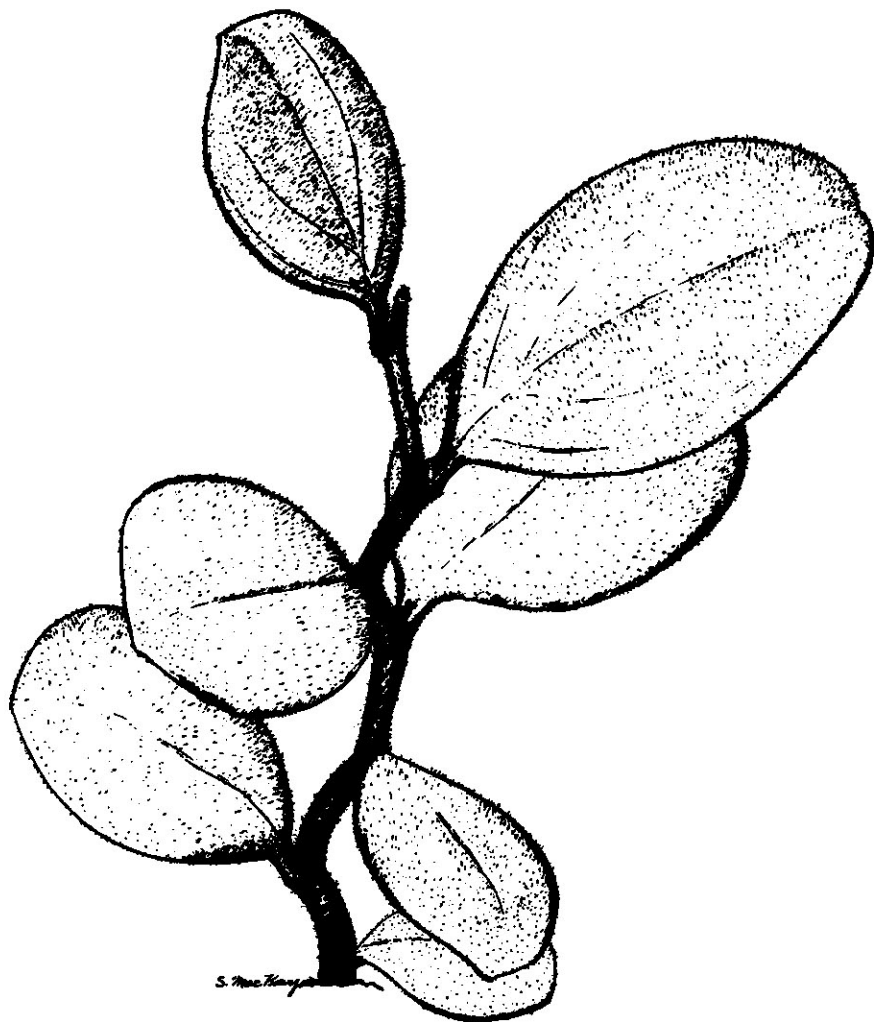
Weakly erect or scrambling terrestrial shrub 3 to 5 m high, stems up to 10 cm in diameter, common from 2600 msm to 2850 msm in ericaceous shrubberies or as an understory shrub in the moss forests. Flowers during August.

13) Dimorphanthera amplifolia (F.v.M.) Stevens.

Arching or stiffly erect terrestrial shrub 1.5 to 4 m high, rare at lower elevations, but becoming locally common along the track and in ericaceous shrubberies from 2600 msm to 2850 msm. In full flower during the first week of August. The color of the inflorescence was quite variable: sometimes the axis, calyx, and corolla are brick red; at other times the calyx is white, the corolla red, the style green, and the stamens purple.

14) Dimorphanthera calodon Sleumer.

Erect or straggling terrestrial shrub 2 to 3 m high, occasional along the margin of the track or in dense ericaceous shrubbery above 2500 msm. This species was in full flower during the first 2 wk of August. The local people are said to place snares in front of the tubular corollas in order to trap the birds which pollinate this species.



1 cm

Fig 3. Seedling of Vaccinium acrobacteatum K. Schumann (ex open pollinated seed; Vander Kloet 86874).

15) Dimorphanthera albida Stevens.

Erect, terrestrial shrub 1 to 3 m high, frequent in the dense ericaceous shrubberies at 2850 m. This species was in full bloom in the early part of August, which may have resulted in overestimating its relative abundance since its entire inflorescence is white.

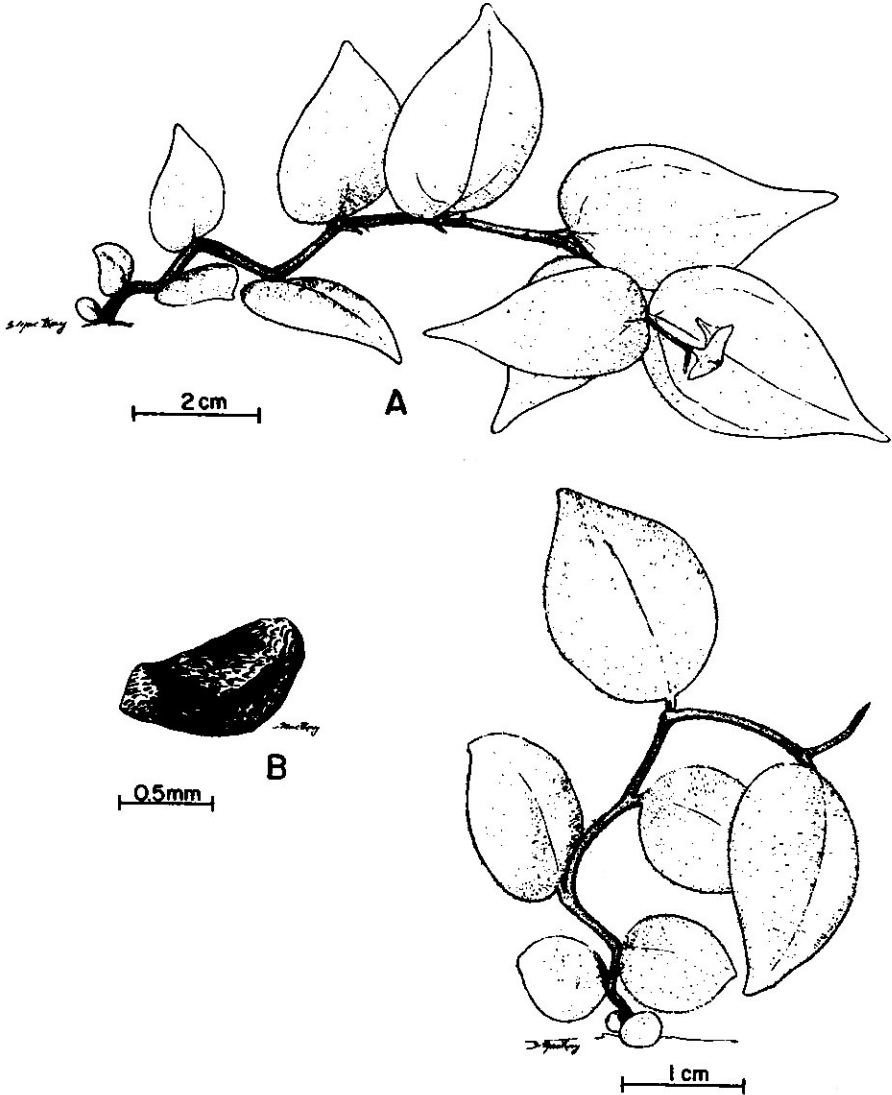


Fig 4. A. seedlings of Dimorphanthera anchorifera J.J.S. (ex open pollinated seed (B) Vander Kloet 715874).

16) Dimorphanthera ingens (Sleumer) Stevens.

Erect or scrambling terrestrial shrub 1 to 3 m high, common to frequent above 2500 msm in dense ericaceous shrubberies, on land slips, margin of the moss forest or in open tree fern communities. This species was in full bloom during the early part of August. Major and minor stamens examined were quite similar in size and shape and the major observed difference lies in the arrangement of the tubules: the 5 minor anthers have tubules which clasp together whilst the major anthers have spreading tubules which touch (Fig 5) alternate major stamens.

17) Agapetes brassii Sleumer ssp serratifolia Stevens.

Erect, scrambling, scandent terrestrial or epiphytic shrub 2 to 3 m high, common and locally abundant above 2700 msm. At 2850 msm in the moss forests almost every large tree had a few scrambling vines of this taxon growing along the trunk or in crotches of these trees. It also sometimes grows massed in ericaceous shrubbery. This species was in full flower during August and was the most common vaccinioid epiphyte in the moss forests at 2850 msm. These specimens agree with ssp serratifolia except in flower color which was yellow-red (ssp serratifolia was described as having pale purplish-dirty white corollas).

18) Agapetes vitis-idaea Sleumer.

Stiffly erect, colonial, terrestrial shrub 10 to 30(90) cm high, locally common above 2700 msm associated with Vaccinium amblyandrum. In full flower during August, corolla and calyx reddish-white and pentagonal.

19) Agapetes prostrata Stevens.

Creeping terrestrial shrub, rhizomes superficial, twigs 2 to 5 cm high, seen once in a thick moss carpet on a steep clay bank just off the track at 2700 msm. Beginning to flower in mid-August. This represents a second locality for this species which previously was known only from two collections (one sterile) from Mt. Amungwiwa (Stevens 1972).

20) Diplycosia morobeënsis Sleumer.

Epiphytic, rarely terrestrial, weakly erect colonial shrub 40 to 60 cm high, in crotches of trees from 2250 to 2850 msm; the 10 fallen trunks I examined had at least one or two colonies growing on them and one Nothofagus tree recently fallen had the shrub already reorienting itself with several shoots becoming erect. This species was fruiting and flowering sparsely during August but the few terrestrial shrubs at the margin of the forests were sterile.

21) Gaultheria pullei J.J. Smith

Slender, sometimes arching, usually erect terrestrial shrub 10 cm to 2 m high, strongly aromatic. Most plants were in flower and a few were flowering and fruiting simultaneously. Common above 2600 msm on mass wastage slopes, in fern communities and along the margin of the track in ericaceous shrubberies. Pseudoberries black, each locule contained large quantities of small seeds (6 mg/100 seeds) which germinated readily after storage of one year at 1°C but not when fresh.

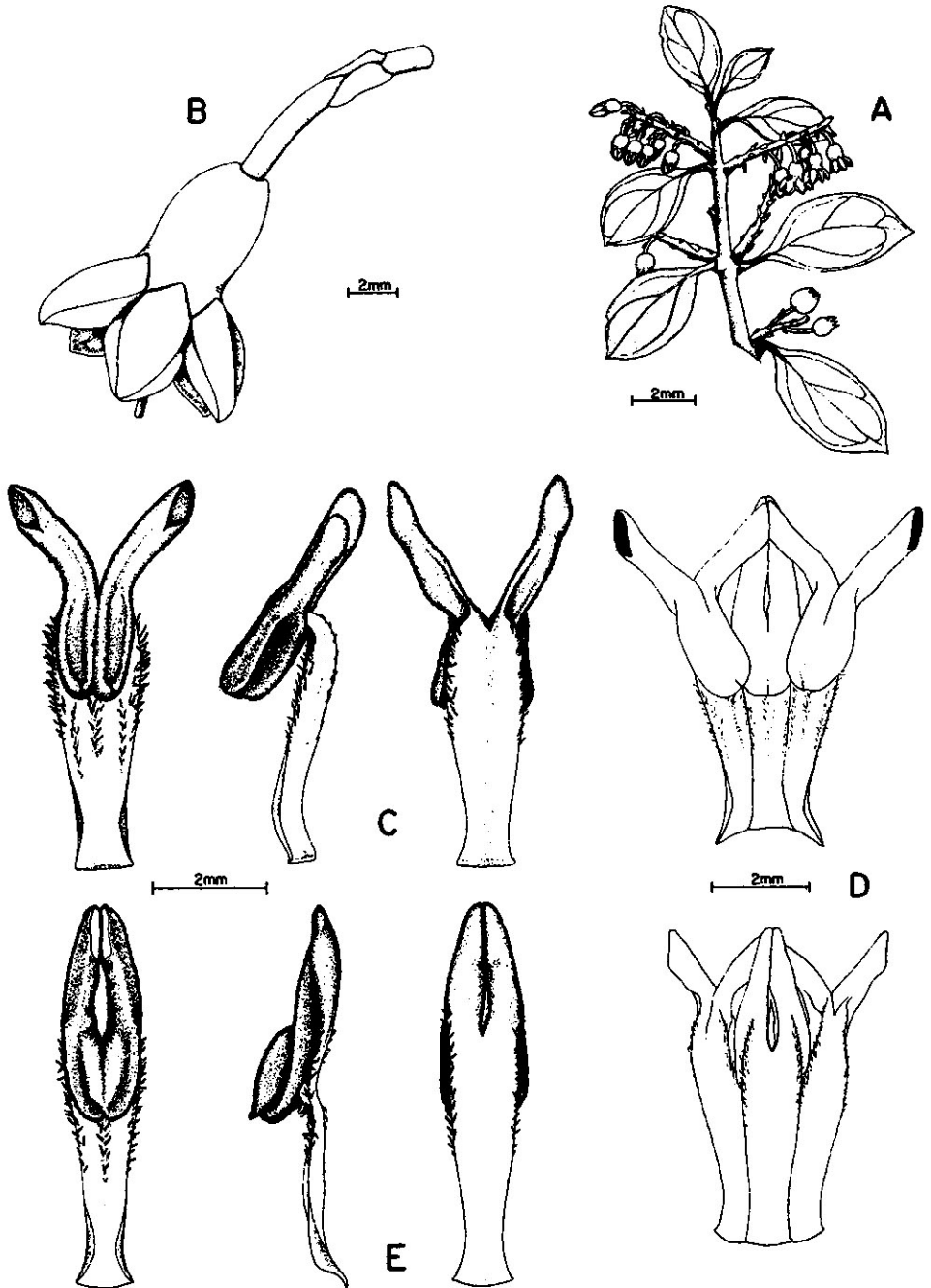


Fig 5. *Dimorphanthera ingens* (Sleumer) Stevens. (A) habit; (B) flower; (C) major stamens; (D) configuration of stamens; (E) minor stamens.

ACKNOWLEDGEMENTS

I thank Paul Hebert for inviting me to join the expedition and supplying the necessary logistics; I am indebted to Peter Stevens for correcting or verifying my identifications, emending the manuscript, and finally for the type description of Vaccinium morobense. The figures were executed by Suzanne MacKay and Pauline Crouch.

REFERENCES

- BRASS, L.J. 1941. The 1938-39 expedition to the Snow Mountains, Netherlands New Guinea. J. Arnold Arbor. 22:271-342.
- CAMP, W.H. 1942. On the structure of populations in the genus Vaccinium. Brittonia, 4:189-204.
- CAMP, W.H. 1945. The North American blueberries with notes on other groups of Vacciniaceae. Brittonia, 5:203-75.
- HALL, I.V. 1959. Plant populations in blueberry stands developed from abandoned hayfields and woodlots. Ecology, 40:742-43.
- KEVAN, P.G. 1972. Insect pollination of high Arctic flowers. J. Ecol. 60:831-47.
- SLEUMER, H. 1965. The role of Ericaceae in the tropical montane and subalpine forest vegetation of Malaysia. In: Symposium on Ecological Research in Humid Tropics Vegetation, Kuching, Sarawak, 1963. Sponsored by Govt. of Sarawak and UNESCO Science Cooperation Office for Southeast Asia. 376 pp.
- SLEUMER, H. 1967. The Ericaceae. In: Flora Malesiana, Vol. 6, (ed C.G.G.J. van Steenis), pp. 469-914. Wolters-Noordhoff Pub., Groningen, Netherlands.
- STEENIS, C.G.G.J. van. 1958. Rejuvenation as a factor judging the status of vegetation types: the biological nomad theory. In: Symposium on Tropical Vegetation, Kandy, Ceylon, 1956, pp. 212-18. Study of Tropical Vegetation; Proceedings. UNESCO, Paris.
- STEVENS, P.F. 1972. Notes on the infrageneric classification of Agapetes. Notes R. Bot. Gard. Edinburgh, 32:13-28.
- STEVENS, P.F. 1976. The altitudinal and geographical distribution of flower types in Rhododendron section Vireya, especially in the Papuan species, and their significance. Bot. J. Linn. Soc. 72:1-33.
- STEVENS, P.F. 1977. Additional notes on Dimorphanthera (Ericaceae). J. Arnold Arbor. 58:437-44.