Handbooks of the FLORA OF PAPUA NEW GUINEA

Volume I

Edited by

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MELBOURNE UNIVERSITY PRESS
on behalf of the
Government of Papua New Guinea

Melbourne University Press
PO Box 278, Carlton South, Victoria 3053, Australia

First published 1978
Reprinted 1995

Printed in Malaysia by SRM Production Services Sdn. Bhd.

National Library of Australia Cataloguing-in-Publication entry

Handbooks of the Flora of Papua New Guinea. Volume 1.
Index
ISBN 0 522 84095 7
1. Botany — Papua New Guinea. I. Henty, E.E., ed.
581.995

TO ALL BOTANISTS

WHOSE CONTRIBUTIONS, BOTH GREAT AND SMALL,

PROVIDE THE BACKGROUND FOR THIS HANDBOOK

Contents

Foreword

In Papua New Guinea our way of life is closely integrated with the plant and animal life of the country. Our predecessors depended upon the richness of the forest, oceans and rivers for their daily food, clothing, building materials, tools, weapons and medicines. During some eighty years of colonial rule new life styles were introduced and adopted by our people. However, in our village life we were never far removed from the natural resources which continued to supply many of our needs.

During World War II and the succeeding years the economic value of our natural resources has been recognized. Forest resources for sawn timber, plywood and chips and the wealth of our grasslands for grazing by animals are the most apparent avenues of development. To effectively develop industries using these natural resources demands that we have a detailed knowledge of the kind of plants, be they trees or herbs, growing in our country.

A small botanical section established during the war became the basis of our present National Herbarium and Botanic Garden. Collections have increased from fewer than 2000 specimens in 1946 to about 230 000 in 1975. These continue to grow as field investigations of our plant life are carried out.

Simple curation of such collections, important though it is, is superseded in value to the community by the production of printed books which can be read and studied by all who desire knowledge.

John S. Womersley has spent over twenty-nine years working in Papua New Guinea as chief botanist for the government. It is indeed pleasing that he has been able to complete the organization of the text and illustrations for Volume I of the *Handbooks of the Flora of Papua New Guinea.* We hope that the guidelines and models established by Mr Womersley in conjunction with the staff of Melbourne University Press will provide the basis for publication of successive volumes of this work which is essential for the development of our natural resources.

I would like to compliment all those who have assisted in preparing this volume, particularly our artists, two of whom are national officers. A number of the contributing authors have left the Division of Botany and Mr Womersley, who has compiled and edited this volume, retires from the end of 1975. I extend my appreciation to all concerned in the initiation of a project that will immensely benefit Papua New Guinea.

J. L. AUNA
Director of Forests

December 1975
Lae, Papua New Guinea

Acknowledgements

There are many persons, some resident in Papua New Guinea, others living and working overseas, who have given encouragement and support to the initiation of the *Handbooks of the Flora of Papua New Guinea.* All must however stand aside in my expression of gratitude to the late J. B. McAdam, who at the time of his death in 1959 was Director of Forests in Papua New Guinea. McAdam joined the New Guinea Public Service before World War II and established forestry in Wau. During the years of the war he commanded an Army Forestry Company with headquarters at Lae. Here, in extremely primitive conditions, a small herbarium and wood collection were established under Lieutenant Lindsay Smith of the Queensland Herbarium. Dr H. Dadswell of the CSIR Division of Forest Products and C. T. White, Queensland Government Botanist, both participated in the training courses in basic botany given to officers and men in the Forestry units.

In 1946 McAdam was developing the post-war Forest Department. His foresight during the war in establishing a small herbarium was carried on by securing the appointment of a Forest Botanist in August of that year. While the botany of the forest was to be our primary consideration for many years, McAdam stated forthrightly that the Forest Botanist position, the herbarium and associated library should be more broadly based and that the position should be equivalent to that of Government Botanist. This it has been my privilege to do. The opportunity to commence the publication of the *Handbooks of the Flora of Papua New Guinea* is a direct product also of the enthusiasm and support of my colleagues and personal friends, now all deceased, C. T. White, H. E. Dadswell and L. S. Smith.

The provision through the Australian grant to Papua New Guinea of adequate funds to allow for the development of the botanical collections, the construction in 1964–5 of the National Herbarium at Lae, the extensive purchases for the botanical library and the staffing by botanists has made this present volume possible. Botanists who worked at Lae include A. G. Floyd, P. van Royen, D. G. Frodin, C. E. Ridsdale, M. J. E. Coode, P. F. Stevens, D. B. Foreman and the present staff who are W. R. Barker, N. M. U. Clunie, B. J. Conn, J. R. Croft and E. E. Henty. I would like particularly to mention Ted Henty who joined the Herbarium staff in 1955 and has been a staunch supporter of our work. He has contributed greatly to the present volume of the *Flora* but even more so by his ready assistance at all times in the day-to-day running of the National Herbarium.

I must also thank all those staff members who, over the years, have contributed to the valuable collections of the National Herbarium (now exceeding 230 000) which are the basis upon which this *Flora* is being

compiled. Among these are D. Fryar, M. F. C. Jackson, J. Buderus, A. N. Millar, and many others. They are joined by a wide circle of friends who, by their efforts, have added valuable collections to the herbarium. I must thank N. E. G. Crutwell for collecting from eastern Papua; members of the Australian National University Department of Biogeography, led by Prof. Donald Walker, for collections from Mt Wilhelm; staff of Bishop Museum Field Station, subsequently Wau Ecology Institute, who, led by Dr Lindsay Gressitt, have made collections from many parts of the country; the Biology Department of the University of Papua New Guinea, from which collections made by D. G. Frodin, A. N. Millar and others have been received.

Particular mention must be made of the botanists who came to Papua New Guinea with the Archbold Expeditions. Of these L. J. Brass is well known, having himself collected probably 35 000 specimens. Since the early 1950s, at the request of the Administration of Papua New Guinea, the CSIRO Division of Land Resource and Regional Survey had carried out land-use surveys over much of the accessible land. Botanists including R. D. Hoogland, R. Schodde, R. Pullen, P. Darbyshire and others have made large collections during these surveys. T. G. Hartley, working on the Phytochemical Survey for the CSIRO Division of Chemical Research, collected over 3000 specimens. I must also thank all those botanists from overseas countries who have visited Papua New Guinea and whose collections contribute to the vast number of specimens now available. To all those mentioned and the even greater number not identified by name, our grateful thanks for your worthwhile contributions.

Field work in Papua New Guinea can be tedious and at times unpleasant. Botanists could not have achieved the success they have without the support of our Papua New Guinean friends. Some contribute continuously and are employed in the Division of Botany. Their names are recorded in the collections. Others, employed locally and casually, are not recorded for posterity but their contribution, be they carrier, camp cook or general labourer, is well known.

The art work in this volume has been produced by artists of the Division of Botany—Damaris Pearce, Faye Owner, Janet Furmage, Terry Nolan, Semeri Hitinuc and Taikika Iwagu. Mr Hitinuc and Mr Iwagu are now permanent staff members of the Division of Botany.

I must acknowledge my personal indebtedness, with that of our staff and the many visitors, to the secretarial staff of the Division of Botany, particularly Mrs Sue Osborn. Mrs Osborn is well-known for her friendly help and advice to visiting botanists. Her assistance and support were invaluable in the preparation of Volume I of the *Flora*. Our typists must also be thanked for tedious work well done.

We appreciate the assistance given by the directors and staff of overseas herbaria who have facilitated our work by providing loans and library material and in other helpful ways. I would particularly mention here S. L. Everist (Brisbane), Dr Hj. Eichler (Canberra), Dr D. Churchill (Melbourne), Dr L. Johnson (Sydney) and the directors of the herbaria at Kew, Leiden, New York and the Arnold Arboretum.

To the director of the Department of Forests and my departmental colleagues I express my thanks for assistance and advice. In particular I

would thank the drafting section for help with reproduction of drawings, a task now happily being done well by Taho Kepogameng within the Division of Botany.

To those who remain unnamed I must also express my thanks in bringing to fruition this first volume of the *Handbooks of the Flora of Papua New Guinea.*

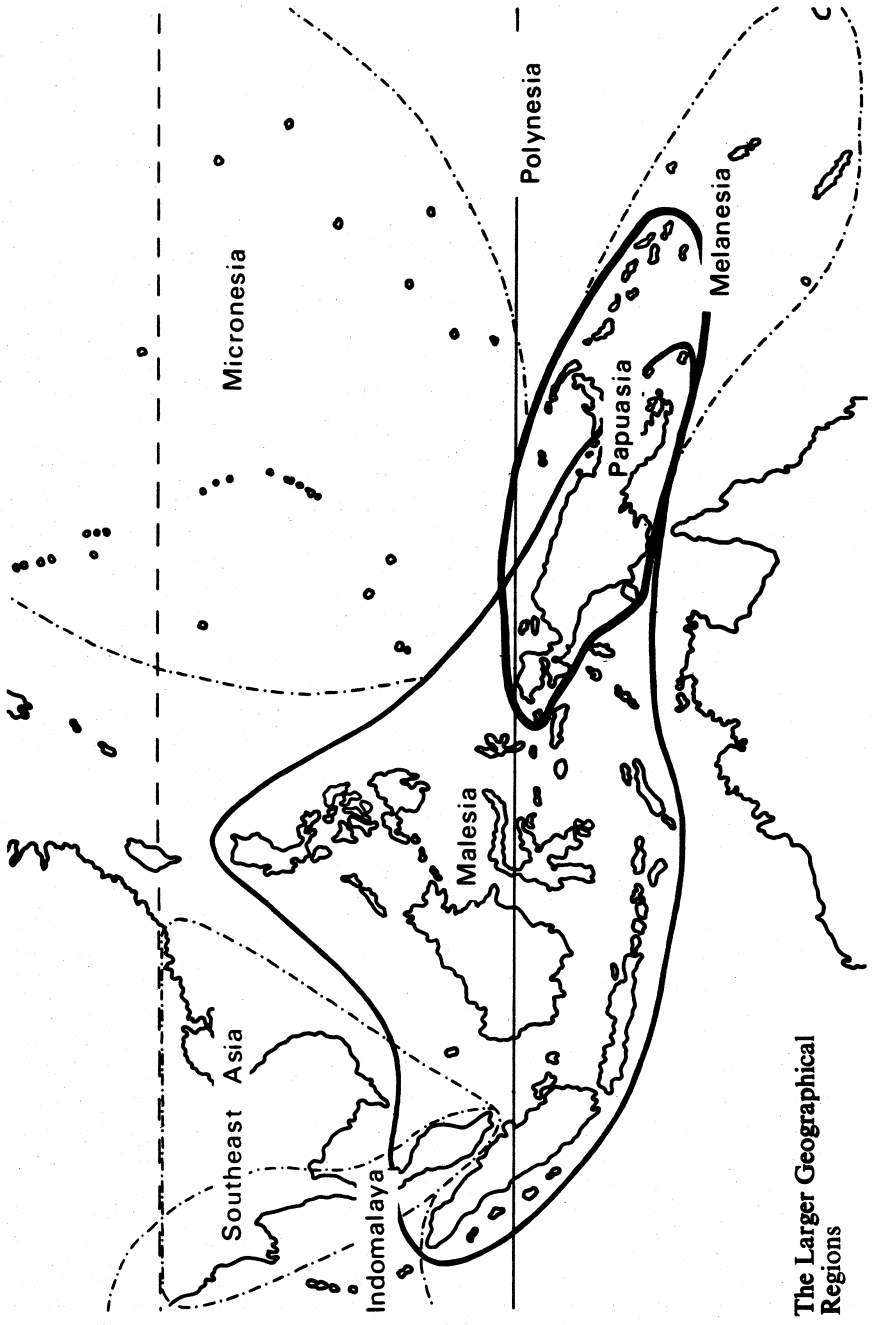
Introduction

The island of New Guinea and the adjacent island groups of the western Pacific possess a flora of large size by virtue of the great variety in climatic zones and topography. This area—extending from the Vogelkop peninsula in the west to the islands of the Solomon Islands, but not Santa Cruz—may conveniently be described as Papuasia (see map). Politically this large area includes the Indonesian province of Irian Jaya (western New Guinea), Papua New Guinea, which includes the Bismarck Archipelago and Bougainville, and the Solomon Islands. The approximate land area is Irian Jaya 414 384 sq. km, Papua New Guinea except Bougainville 456 822 sq. km, Bougainville, 10 644 sq. km, and the Solomon Islands 28 784 sq. km.

The flora of this region can be conservatively estimated as being in excess of 20 000 species. At the time of writing, there are only a few treatments of groups of plants of this flora, most of which appear in obscure journals or books not available to the public. It is therefore our objective to provide in a readily available form a series of volumes entitled the *Handbooks of the Flora of Papua New Guinea*. While the title circumscribes the area somewhat narrowly, the *Flora* will include, as far as collections permit, Irian Jaya and the Solomon Islands excluding Santa Cruz. It is not intended that field work will be undertaken outside Papua New Guinea in support of taxonomic studies for the *Flora*.

A map of Southeast Asia shows the areas covered by the terminology used in the *Flora*. A second map shows the regions being used in the *Flora* to locate distributions. For Irian Jaya the regions are quite arbitrary, having been determined in conjunction with our colleagues from Leiden as providing a meaningful dissection of the country for floristic purposes. In Papua New Guinea many of the boundaries are those of the political provinces. However, in some cases the separation of provinces has little floristic meaning, for example that of the Chimbu and Eastern Highlands Provinces, which here remain combined as the Eastern Highlands district. The contrary is provided in the case of the Milne Bay Province where the islands are separated as Papuan Islands from the eastern portion of the mainland which is called Milne Bay. It is not proposed to amend these floristic regions when political changes are made in the boundaries of the provinces.

The *Flora* comprises descriptive treatments of each plant family and includes a family description, key to genera occurring in Papuasia, description of each genus, key to the species in Papuasia and description of each species, ecological and usage notes and an outline of the known distribution in Papuasia of each species. Any relevant information regarding a species occurring outside Papuasia is recorded from published literature or



The Larger Geographical Regions

herbarium collections seen. Wherever possible the descriptions are based on herbarium specimens examined by the author in the preparation of each family account. Distribution data are likewise supported by specimens. Putative distributions are reported as such.

The editor intends that each genus be illustrated from material collected in Papuasia and that in large genera distinctive and representative species be illustrated on the approximate basis of an illustration for each six species. These illustrations are prepared by the botanical artists at Lae.

Measurements in the *Flora* are metric. In general, measurements of less than one centimetre are given in millimetres, and measurements of 10 mm or more in centimetres or metres. This may be modified where measurements varying around 1 cm are compared. For example, in a genus of 4 species, calyx lobes could be 6, 8, 10 and 15 mm long. In this instance all measurements would be given in millimetres, not the last two as 1 cm and 1·5 cm. Heights of trees are quoted in metres, diameters in centimetres. The diameter is measured at breast height, approximately 1·3 m above ground level, and denoted as d.b.h. Where buttresses ascend above breast height, the diameter above the buttresses (d.a.b.) is given.

The family concept used in the *Flora* follows, in general, Engler and Prantl since this system is used in the Papua New Guinea National Herbarium. Certain modifications of convenience have been adopted, for example the family Guttiferae is accepted to include Hypericum. A listing of the families currently accepted is in appendix 1.

Literature citations are kept to a minimum with emphasis on key references which give the serious student access to the technical literature. The more significant of the general works which can be referred to for information relative to the wider Southeast Asia area are provided in appendix 2. Synonyms which have been used in pertinent literature or are likely to be encountered in literature relating to Papuasia are cited. In the case of generic transfers the basionym is included.

Taxonomic studies for the *Flora* are being undertaken by botanists working at Lae. Taxonomists in other centres who have completed revisions for *Flora Malesiana* or other projects are also contributing to this series. Where the taxonomic study reveals facts requiring technical publication of new species or varieties, or nomenclatural notes, such papers will be published in appropriate journals, preferably in the *Contributions from Herbarium Australiense*. In the course of preparing any revision, the author will assemble a list of collections and their identification. These lists will be published in the technical papers but not in the *Flora*. Herbaria and persons having access to the collections may obtain copies of these identification lists from the National Herbarium, Lae.

The practising forester in the tropics learns to recognize tree species by a diversity of characters which are not necessarily related to the purely taxonomic features. These field characters can become very personalized in that an individual observer develops for himself a set of observations which may defy exact definition in writing but enable rapid recognition of species. Among these characters are bark and wood colours, exudates, scents, the venation shape and colour of fallen leaves and even the flaking pattern of the bark. Presence of certain birds or bat-roosting areas are indicative of

the presence of certain species. In the *Flora* we hope to include as much of this practical information as possible. Seedlings are poorly known for many of our forest trees and urgent studies are necessary to identify the seedling stages of the commercially and ecologically significant species. Where such information is available, this will be included. The absence of such information should be an incentive to resident foresters, botanists and others who can collect seed from identified trees to germinate this seed and describe the seedlings.

Abbreviations, Latin Words, Symbols

auct. non . . .	(*auctoris non* . . .) of a single author not . . .
auctt. non . . .	(*auctorum non* . . .) of two or more authors not . . .
c.	(*circa, circiter*) about
cf.	(*confer*) compare
d.a.b.	diameter above buttresses
d.b.h.	diameter at breast height
E.	English
ed.	edition
et	and
ex	from
f.	figure
ic.	(*icon*) illustration
nom. illeg.	(*nomen illegitimum*) illegitimate name
non	not
pl.	plate
p.p.	(*pro parte*) in part, partly
pt	part
sens. lat.	(*sensu lato*) in the broad sense
sens. str.	(*sensu stricto*) in the narrow sense
ser.	series
sp.	species (singular)
spp.	species (plural)
ssp.	subspecies
syn.	synonym
t.	(*tabula*) plate
var.	variety
vars	varieties
$\times$	hybrid
$\times$	by; e.g. 5 $\times$ 4 cm: measuring 5 cm long and 4 cm wide
$\pm$	(*plus minusve*) more or less
$>$	more than
$<$	less than
$=$	the same as

THE VEGETATION

N. M. U. Clunie

The New Guinea mainland and surrounding islands possess an extraordinarily rich flora and a great diversity of vegetation types that parallel the diverse physiography of the lands and the resulting climates that prevail. A high proportion (some three-quarters) of the land area has a forest cover, most of it evergreen rain forest. Seasonally dry areas support distinctive and characteristic vegetations. The large rivers have extensive flood-plains that are inundated seasonally, and, where drainage is impeded for long periods, vast swamplands occur. Above the treeline on the highest mountains communities of dwarfed herbs extend to the wind-battered and occasionally snow-covered peaks.

Man has influenced and modified the original vegetation of considerable areas from the sea coast to well above the highest level of normal human habitation at about 2600 m. Large areas of cultivation, plantation and regrowth occur, but man's greatest impact is seen in the extensive anthropogenic grasslands of the drier lowlands and populous mountain valleys. In addition to human influence, natural phenomena appear to have exerted a profound influence upon the stability of the rain forests. There is compelling evidence from palynological studies of major changes in climate and the associated altitudinal migration of vegetation types within the past 12 000 to 25 000 years. Earthquakes and associated landslips, volcanic activity, wind storms, and the erosive action of water have exerted a major impact upon quite vast areas of rain forest in recent times, resulting in a considerable proportion of forest that must be regarded as seral rather than climax in nature.

The major types of vegetation are described in three altitudinal zones: lowland, montane and subalpine. The boundaries between these broad vegetation zones generally are not sharply defined, nor do the zones have precise altitudinal limits but vary locally in response to changes in topography and climate. On isolated mountains or ranges the vegetation zones are often quite markedly depressed. The transition from lowland to montane coincides with a broad change in the floristics and structure of the rain forest that commonly occurs between 1000 m and 1400 m above sea level. Subalpine vegetation replaces the montane forest in the region of the tree limit at about 3800–3900 m.

LOWLAND VEGETATION

Coastal Vegetation

SUBMERGED LITTORAL VEGETATION. Marine algae, particularly the larger seaweeds, are less common than on temperate shores and, apart from the slimes formed by Cyanophyceae on accreting mud-banks and the crustose coralline algae on exposed areas of coral reef, do not form conspicuous communities. Meadows of seagrasses, notably *Thalassia*, *Enhalus*, *Halophila* and *Cymodocea*, occur on mud-flats and on sand in shallow water. These are the grazing areas of the marine mammal, the dugong.

MANGROVE VEGETATION. Largely a forest vegetation growing between the level of high-water spring tides and around mean sea level, generally on sheltered shores where silt accumulates. The most extensive development of mangrove is on the southern coast of the mainland. Extensive mangrove forest, often many kilometres wide, occurs in the estuaries of the large rivers, notably the deltas of the Purari and Fly Rivers, the Murik Lakes near the mouth of Sepik, and the mouth of the Ramu.

There is commonly a more or less distinctive zonation of mangrove types in the transition from salt to brackish water: a seaward zone of *Sonneratia alba* or *Avicennia* spp.; a zone of *Rhizophora* forest; a zone of *Bruguiera* forest usually developing inwards from the *Rhizophora* species on better-drained soils, the tall trees (to 30 m) intermingled farther inland with *Xylocarpus* and *Heritiera*; a zone of *Ceriops*-dominated thicket sometimes developing on well-drained soils; a landward fringe, the most variable zone of the mangrove swamp, with different species (*Bruguiera gymnorrhiza*, *Xylocarpus granatum*, *Heritiera littoralis*, *Lumnitzera littorea*, *Camptostemon schultzii*, and others), depending on the type of substrate. The palm *Nypa fruticans* forms a closed community up to 10 m high in some tidal estuaries subject to daily inundation by brackish water.

Mangrove vegetation commonly has only one tree or shrub layer forming a dense canopy. Inland the mangrove swamps are bordered by beach or swamp vegetation, while along rivers they pass into riparian vegetation.

BEACH VEGETATION. An herbaceous cover, the *Ipomoea pes-caprae* association, a common feature of the strand on accreting coasts throughout the tropics, occurs on sandy beaches above the drift line. Common components are the leguminous creepers *Ipomoea pes-caprae*, *Canavalia maritima* and *Vigna*, succulents including *Sesuvium*, grasses such as *Ischaemum muticum*, *Stenotaphrum micranthum*, *Thuarea involuta* and *Lepturus repens*, and sedges including *Cyperus pedunculatus* and *Fimbristylis*. Landwards this association may include small shrubs such as *Clerodendron inerme*, *Morinda citrifolia*, *Wedelia biflora* and *Vitex*.

The beach dyke generally supports a forest community, termed the *Barringtonia* association, which comprises a few species, notably *Barringtonia asiatica*, *Terminalia catappa* and *Hernandia nymphaeifolia*, locally mixed with or replaced by *Calophyllum inophyllum*, *Aegiceras*, *Cerbera*, *Thespesia*, *Hibiscus tiliaceus*, *Pandanus tectorius*, and others. A local variation of the

beach forest is dominated by *Casuarina equisetifolia*. The *Barringtonia* association is confined generally to a strip some 30–200 m wide. Where the beach-line is retreating and the herbaceous vine cover is absent, the large trees of the *Barringtonia* association commonly overhang the water.

LITTORAL FOREST. A mid-height (20–30 m), moderately dense forest confined to coastal sandy beach plains which are generally well drained but with parts inundated during the wet season. Where a pattern of beach ridges and swales has been preserved, the forest presents a strip pattern, the forest on ridges and plains being taller and of different floristic composition to that of the swales. Large areas occur on the southwest and southeast coasts of Papua, and on the west coast of Bougainville. Common canopy trees are *Pterocarpus indicus*, *Terminalia* spp., *Planchonia papuana*, *Sarcocephalus coadunata*, *Derris indica*, *Syzygium* spp., *Melaleuca* spp. and *Acacia* spp. (in southwestern Papua). Palms characteristically are common in the shrub and lower tree layers.

Swampland Vegetation

HERBACEOUS SWAMP VEGETATION. Herbaceous swamps form an edaphic climax in more or less stagnant, permanent river back-plain swamps on peat or organic muck. The communities comprise a mixture of sedges including the tall sedge *Thoracostachyum sumatranum*, grasses, herbs such as the fleshy *Hanguana malayana*, and ferns.

Swamp grassland may represent either an edaphic climax or an early seral stage in the development of forest, the latter often arrested by burning. A mid-height (1–2 m) grassland comprising species such as *Leersia hexandra*, *Oryza* sp., *Hymenachne pseudointerrupta*, *Echinochloa stagnina*, and *Panicum paludosum* is best developed in slowly moving water and forms extensive tracts notably on the swampy flood-plains of the Fly and Sepik Rivers. A tall swamp grassland usually dominated by *Saccharum robustum*, *Phragmites karka* (each up to 6 m tall), *Coix lachryma-jobi* (to 2 m) and *C. gigantea* occurs in shallower water on permanent or intermittently dry swamp. A low creeping grass, *Pseudoraphis spinescens*, is characteristic of intermittent swamp, forming extensive swards on the lower reaches of the Bensbach and Morehead Rivers, probably because of destruction of taller grasses and sedges by deer.

In deeper swamp and bordering open water, submerged and floating aquatic herbs including Nymphaeaceae, *Lemna*, *Azolla* and *Pistia* commonly occur as a mosaic of locally dominant species. On the drier margins grasses become more prominent, *Pandanus*, sago palms and scattered small trees are established and there is a transition to swamp savanna and swamp woodland.

TREE AND PALM SWAMP WOODLAND. Swamp woodland and palm forest are extensive in near-permanent shallow swamp associated with the flood-plains of large rivers such as the Purari, Sepik, Lakekamu and Mambare. Several distinctive community-types are widespread.

Sago palms (*Metroxylon sagu*) vegetation is widespread in coastal swamps and along flat valley floors up to about 1200 m. It is best developed in shallow swamp that is flooded for several months of the year. Gradations occur

from dense, almost pure stands of *Metroxylon*, reaching 15–20 m, to swamp woodland consisting of a rather dense layer of taller trees and an understorey of sago. *Pandanus* spp. may form dense, pure stands up to 8 m tall, as in the flood-plains of the middle Sepik River.

Swamp woodlands dominated by such trees as *Carallia brachiata*, *Syzygium*, *Campnosperma* and locally (coastal monsoonal areas) *Exoecaria agallocha* and *Melaleuca* spp., in an open canopy at generally less than 20 m, form extensive communities. These grade into swamp forest or open forest on plains as drainage and aeration improve and the trees assume a taller stature and higher stocking density.

SWAMP FOREST. Swamp forests occur on low-lying back-plains, old scroll ridges, and deltas of the larger rivers, extensive communities occurring in the middle and lower courses of the Fly, Strickland, Turama, Purari and Sepik Rivers.

Swamp forest is rich in species, although one or a few often predominate locally. Common canopy components include *Campnosperma brevipetiolata*, *Syzygium* spp., *Terminalia canaliculata*, *Sarcocephalus coadunata* and *Myristica hollrungii* (in deltas). The canopy is typically of rather even height at 20–30 m, sometimes with wide-crowned emergents reaching 40 m. Characteristic of the lower strata are *Pandanus* spp., *Metroxylon sagu*, *Barringtonia* spp., *Diospyros* spp., *Alstonia spatulata*, *Garcinia* spp., *Gynotroches axillaris* and, in monsoonal areas, *Carallia brachiata* and *Acacia* spp.

Towards the coast, elements tolerant of brackish conditions including *Camptostemon schultzii*, *Heritiera littoralis*, *Inocarpus fagiferus*, *Sapium* sp. and *Dolichandrone spathacea*, may enter the swamp forest communities which eventually grade into mangrove vegetation.

An interesting swamp forest, probably seral in nature, dominated by *Terminalia brassii*, commonly in association with *Campnosperma*, occurs mainly in the southwest of Bougainville.

Lowland Rain Forest

Where an ever-wet climate (rainfall about 2500 mm or more per annum, and with 150 mm or more each month) prevails, rain forest, in its most luxuriant form, covers all lowland areas other than locations with more or less permanent stagnant or running water, skeletal soils and rock, and areas cleared by man. There is little evidence that the lowland rain forest comprises discrete associations; rather it appears to form a complex mosaic of tree species, wherein, in response to historical and ecological circumstances, usually imperfectly understood, various species may attain local dominance or pre-eminence.

Floristically the lowland rain forest is extraordinarily rich, particularly in tree species. The canopy and subcanopy include over 80 genera with probably more than 1200 species of trees. Measures of 1864 trees of girth in excess of 30 cm, in four 0·8-ha plots lying 600–1125 m above sea level in rain forest in the Northern Province (Paijmans, 1970), yielded 392 species with 37 per cent of species occurring as a single individual only, and only 7 per cent of species represented by 11 or more individuals. This indicates a floristic richness well

above the average recorded in tropical rain forest, and equivalent to the richest rain forest of Borneo and the Malay Peninsula.

Structurally the rain forest communities are complex. The upper canopy commonly stands at 30–45 m but tends to decrease in stature (to about 25–30 m) with increasing altitude and is often lower in the islands. It is markedly uneven, and emergents to 40 or 50 m, including the strangling figs (*Ficus* spp.), are common. Canopy trees generally have tall, straight boles and are commonly buttressed. There is a striking variety of crown shape, branching habit, and size and colour of leaves. There is commonly an irregular structure throughout all layers and distinct synusiae are rarely apparent. The lower tree strata are usually rather open. Tall palms are common, particularly at lower altitude, and some, such as *Gulubia* and *Gronophyllum*, may penetrate the canopy at up to 30 m. The shrub layer has a very variable cover, common components including the fan palms, *Licuala*, tall gingers and Marantaceae. The herb layer consists mainly of ferns in great diversity and tree and rattan palm seedlings, or *Elatostema*. Woody lianes, fleshy climbers and climbing ferns are common, particularly at lower altitude. Climbing rattans are always present, but dense only in openings. Epiphytes, mainly orchids and ferns, are most common in the crowns of canopy trees.

There is a general change in the composition and structure of the lowland rain forest with increasing altitude; the variation is often gradual and continuous but it is convenient to recognize two broad categories of rain forest related to altitude, within each of which there is a broad spectrum of variation in community types.

LOWLAND ALLUVIAL FORESTS. This type of forest occurs on alluvial plains and gently sloping hill fans that are well drained or flooded infrequently or for short periods only. On well-drained deep soils the canopy is well over 30 m high with emergents reaching 50 m or more.

The forest is characteristically rich in species composition. Trees almost invariably present in the canopy are *Pometia pinnata*, *Octomeles sumatrana*, *Ficus* spp., *Alstonia scholaris* and *Terminalia* spp. Other genera commonly represented are *Pterocarpus*, *Artocarpus*, *Canarium*, *Planchonella*, *Elaeocarpus*, *Celtis*, *Albizia*, *Cryptocarya*, *Dracontomelon*, *Dysoxylum*, *Syzygium*, *Vitex*, *Spondias* and *Intsia*. Common genera in the subcanopy include *Myristica*, *Diospyros*, *Gnetum*, *Protium*, *Horsfieldia*, *Dendrocnide*, *Kibara* and *Pimeleodendron*.

In disturbed areas young woody regrowth is commonly dominated by *Kleinhovia*, *Macaranga* and *Althoffia*, whilst characteristic trees predominant in later seral stages include *Cananga*, *Endospermum*, *Canarium*, *Euodia*, *Sterculia*, *Laportea*, and *Pimeleodendron*.

Where the water table is generally higher, as on alluvial plains subjected to frequent short-lived floodings and on back-plains subject to prolonged wet-season inundation, the forest is more open and of lower stature. The frequent occurrence of such trees as *Planchonia papuana*, *Bischofia javanica*, *Terminalia complanata*, *Cananga odorata*, *Teysmanniodendron bogoriense*, *Intsia bijuga*, *Sarcocephalus coadunata* and *Vitex cofassus* is indicative of poor drainage and a high water table for prolonged periods. Frequently flooded sites support a high frequency of emergent *Octomeles sumatrana*

and an abundance of *Kleinhovia hospita* in the lower storeys.

On a smaller scale, mainly in New Britain, *Eucalyptus deglupta* colonizes mixed loamy, sandy and coarser alluvial deposits, forming fine seral stands.

LOWLAND HILL FORESTS. These comprise the largest area of lowland forests, covering the undulating and hilly lowlands and the foot-hills and lower slopes of the ranges. The forest canopy is generally more even and lower (25–30 m), and more closed (closure 60–80 per cent) than in alluvial forests. The forest, particularly at lower altitudes, is rich in species and floristically very mixed. Frequent canopy trees throughout are *Pometia*, *Canarium*, *Cryptocarya*, *Terminalia*, *Anisoptera*, *Syzygium*, *Ficus*, *Celtis*, *Dysoxylum* and *Buchanania*. Some genera, such as *Koompassia*, *Dillenia*, *Eucalyptopsis* and *Hopea* are common to abundant locally but absent from other areas. *Araucaria* occurs as scattered emergents (to 70 m) in many localities and may form dense stands.

Factors such as altitude, amount and distribution of rainfall, steepness of slope, position on the slope, and soil type may influence the structure and floristics of the forest. Deciduous elements such as *Garuga floribunda*, *Brachychiton carruthersii*, *Intsia bijuga*, *Terminalia* spp., *Protium macgregorii* and *Sterculia* spp., assume prominence in the canopy in areas of lower rainfall with a marked dry season, as inland from the central southern coast. Strongly deciduous forest, with *Gyrocarpus americanus*, *Bombax ceiba* and sometimes *Acacia* sp. prominent, is restricted to coastal, mainly limestone hills.

Species that frequently grow gregariously to form relatively pure and often quite extensive stands include *Casuarina papuana* on shallow stony soils from sea level to well above 1400 m, and dipterocarps *Hopea papuana* and *Hopea* spp. from sea level to about 450 m in the more eastern sector of the mainland, and *Anisoptera thurifera* as on well-drained ridge tops in coastal Morobe. Emergent *Albizia falcataria* usually indicates old secondary forest. With increasing altitude, lower montane elements such as *Castanopsis*, *Lithocarpus*, *Elaeocarpus* and *Sloanea* become prominent, and the number of species in the canopy tends to decrease. *Castanopsis acuminatissima* may form dense, almost monospecific forest on ridge crests and upper slopes from about 500 m upwards.

Unless the local topography causes sudden changes, there is a gradual transition from the lowland to the mountain-type forests between about 1000 and 1400 m.

Dry Evergreen Forest and Woodland

Dry evergreen forest occurs in a relatively low-rainfall area (1800–2500 mm) on well to imperfectly drained low hilly terrain marginal to rain forest inland from the Gulf of Papua. It differs from lowland rain forest floristically and structurally in having a lower and more open canopy, a generally smaller leaf size, more woody lianes, and fewer fleshy climbers, rattans, epiphytes, tree palms and pandans. Prominent among canopy trees are Myrtaceae, particularly species of *Tristania*, *Syzygium*, *Rhodamnia* and *Xanthostemon*, *Acacia* spp., *Maranthes*, *Mangifera*, Rutaceae including *Flindersia* and *Halfordia* and Proteaceae including *Grevillea* and *Oreocallis*.

Woodland largely replaces marginal forest subjected to frequent fires, and

occurs naturally on sites where adverse climatic or soil conditions have prevented the development of forest. Woodland has a low and open canopy comprising mostly trees of the forest type it replaces or grades into, and usually a dense shrub layer and abundant thin, woody climbers.

Savanna

Savanna vegetation, which comprises an open tree layer over a ground cover of grasses or grass-like plants, is confined mostly to the south of the central range in low-rainfall areas (less than 2600 mm per annum) with a marked dry season (several consecutive months with less than 100 mm). Much of the savanna arises from destruction of forest or woodland by fire or man, is maintained by repeated burning, and would revert to forest if seasonal burning were discontinued. Three main types of lowland savanna occur.

EUCALYPT SAVANNA. The most common type, occurring most extensively along the central southern coast and extending into the intermontane valleys in the central range some 150 km east of Port Moresby. The tree layer comprises one or more of the species *Eucalyptus alba*, *E. confertiflora*, *E. papuana* and *E. tereticornis*, with only the latter species extending into the inland valleys and north of the central range. The ground layer is dominated by mid-height grasses, the most frequent of which are *Themeda australis* and *Imperata cylindrica*. A characteristic grass is *Cymbopogon globosus*. The boundary of eucalypt savanna with forest is usually sharp and relatively stable, and within mature forest eucalypts are present only near the forest edge.

MELALEUCA SAVANNA. This is characteristic of seasonally inundated or water-logged plains and fluctuating river back-swamps, although it also grows on permanently dry hilly terrain. It is most extensive in southwestern Papua New Guinea. Most frequent dominants are *Melaleuca cajuputi*, *M. leucadendron* and *M. viridiflora*, all of which tolerate burning, prolonged inundation and periodic drought. Individual stands consist predominantly of one species. On dry to seasonally wet terrain the ground cover comprises mid-height to tall grasses such as *Themeda* spp. while swamp savanna commonly has a ground layer of tall *Phragmites*.

MIXED SAVANNA. This type occurs on undulating to flat terrain varying from permanently dry to seasonally water-logged or inundated in southwestern Papua New Guinea. The most frequent of the many genera of trees include *Tristania*, *Melaleuca*, *Acacia*, *Xanthostemon* and *Eucalyptus* (but not *E. alba*). Shrubs are relatively tall and dense, and the grasses *Imperata cylindrica*, *Ophiuros tongcalingii* and *Ischaemum barbatum* are common in the ground layer. With increasing wetness there is a gradation into low *Melaleuca–Banksia–Grevillea* savanna.

Albizia procera and *Sarcocephalus coadunata*, both susceptible to fire as seedlings, may establish as the dominant tree layer in a savanna-type vegetation on grassland where regular burning is disrupted: this type is found mainly to the north of the central range.

Shrub Vegetation

A dense scrub of shrubs up to 6 m tall, usually with scattered low trees is found on many sites where harsh climatic or unfavourable edaphic conditions preclude the development of forest or woodland. Where the climate is strongly monsoonal, scrub occurs on coastal limestone hills, beach ridges, and periodically inundated, often alkaline plains. In coastal monsoonal scrub *Hibiscus tiliaceus*, *Thespesia populnea*, *T. populneoides*, *Desmodium umbellatum* and, on periodically inundated terrain, *Pluchea indica* are common. Climbers include *Flagellaria indica*, *Carissa* and *Justicia*. Scrub dominated by *Sinoga lysicephala*, in mosaic with low sedge-grassland, covers large areas of seasonally inundated plains in southwestern Papua New Guinea.

Grassland

Grassland, which is largely man-induced and maintained by burning, occurs at all altitudes over a wide range of conditions. Trees and shrubs are normally present and, as the tree density increases, grassland grades into savanna. It is useful to distinguish two very broad categories: swamp grassland (described under 'Swampland vegetation') and grassland on permanently dry to periodically inundated terrain. A mid-height, mainly tussocky grassland is the main type and is widespread on hilly terrain. The main dominants are *Imperata cylindrica* (kunai) on areas that have a recent history of cultivation and on relatively deep and well-drained soils and *Themeda australis* (kangaroo grass) which is characteristic of monsoonal areas and sites that have shallow or gravelly soils. *Heteropogon contortus* is prominent in the driest areas. Fire-resistant trees and shrubs such as *Antidesma* are commonly present and *Cycas* occurs locally, sometimes in large numbers.

Tall grassland (to over 1·5 m) whose main dominants usually include *Saccharum spontaneum*, *Imperata cylindrica*, and *Ophiuros tongcalingii*, occurs in areas with moister soils as on the deep and fine-textured soils of lowland plains subject to brief seasonal inundation, on alluvial fans and undulating terrain, and on foot-slopes and seepages.

Low grassland with a high, sometimes dominant, sedge component covers extensive areas on flat to very gently undulating terrain in southwestern Papua New Guinea. Common grasses include *Germainia capitata*, *Eriachne* sp. and *Ischaemum barbatum*, and the most common sedges are *Schoenus* spp.

MONTANE VEGETATION

Swampland Vegetation

HERBACEOUS SWAMPLAND. Low swamp grassland is widespread above about 1800 m, covering bogs and intermontane basins, valley floors and depressions. Frequent dominants include *Agrostis reinwardtii* (above about 2000 m) and *Arundinella furva* (about 1800–3000 m). Other common components include *Panicum paludosum* (to about 1700 m), *Leersia* and *Isachne* spp. The tall (to 5 m) *Phragmites karka* forms occasional large stands on flat valley floors to over 2500 m above sea level. Sedges are important in the ground cover on

wetter sites, with the mid-height sedge *Machaerina rubiginosa* often dominant between 1500 and 2500 m.

SWAMP FOREST. Swamp forest dominated by conifers occurs locally in shallow depressions in valley floors and may fringe sedge bogs in intermontane basins above about 1700 m. Common dominants, which may form almost monospecific stands, include the conifers *Dacrydium*, *Podocarpus* and *Dacrycarpus*. Myrtaceae are often prominent and may dominate the subcanopy locally.

Montane Rain Forest

Montane rain forest, which is distinctive in floristics and structure, replaces the lowland rain-forest formation generally between 1000 and 1400 m above sea level. Only rarely is the transition abrupt, and transitional forest types are common. Montane rain forest occurs throughout the main ranges, clothing most mountain slopes to between 3000 m and the tree line at about 3900 m, but is commonly replaced by anthropogenic grassland, swamp, and garden in the high intermontane basins and valleys.

The montane rain forests differ from their lowland counterpart in both physiognomy and floristics. The canopy generally is lower (usually 20–30 m) and more even in height, and closure is greater and more regular. Tree density is often very high. Trees are predominantly of smaller girth, buttressing is less conspicuous, and trunks are often low-branched. The number of tree species is very much lower. Many lowland families such as the Sapotaceae, Dipterocarpaceae, Annonaceae, Bombacaceae and Barringtoniaceae have only a few representatives, if any, and other, more temperate families such as Fagaceae, Lauraceae, Elaeocarpaceae, Cunoniaceae and the Coniferae assume prominence. The shrub layer is commonly denser but highly variable. Palms and climbing rattans are rare; woody lianes are less abundant. Scrambling bamboo (*Nastus*) is widespread but rarely dense except in openings. Pteridophytes and mosses are richer and more numerous and tree ferns (*Cyathea*, *Dicksonia*) often conspicuous in the shrub layer and subcanopy. Pandans are common. Epiphytic mosses, ferns and orchids are richly developed and tend to become more abundant with increasing altitude.

The montane rain forests are a complex mosaic of community-types in which various species may attain local dominance or pre-eminence in response to historical and ecological circumstances that are poorly understood. There is however a general change in floristics and structure of the communities correlated with increase in altitude, and it is convenient to distinguish three broad categories of forest: lower, middle, and upper mountain forest.

LOWER MOUNTAIN FOREST. The lower mountain forests contain a large number of canopy tree species commonly forming communities of very mixed species dominance. Frequent canopy trees include the oaks *Castanopsis acuminatissima* and *Lithocarpus* spp., Elaeocarpaceae (*Elaeocarpus*, *Sloanea*), Lauraceae (*Cryptocarya*, *Litsea*), *Syzygium*, *Calophyllum*, *Elmerrillia*, *Weinmannia* and, somewhat less frequent, conifers including *Podocarpus amarus* and *Araucaria*. Quite commonly one or more species predominates to form distinctive forest types such as oak forest with *Castanopsis* or, less extensively, *Lithocarpus* dominant, and the tall (to 40 m), dense stands of hoop pine

(*Araucaria cunninghamii*) which may cover large areas as on Mt Suckling and in the Goropu Mountains. *Agathis* is a distinct physiognomic dominant locally, usually in small stands, and descends to as low as 400 m on New Britain.

Common components in young regrowth stages include tree ferns (*Cyathea*), *Alphitonia incana*, *Homalanthus*, *Dodonaea viscosa*, *Weinmannia*, *Wendlandia*, *Saurauia*, *Eurya* and *Olearia*; *Castanopsis*, *Lithocarpus*, *Euodia* and *Elaeocarpus* are often prominent in older regrowth.

Many of the characteristic dominants of the lower mountain forests, such as the oaks and *Araucaria*, seldom occur in sufficient numbers to give special character to the forests above about 2200 m. Between about 1800 and 2200 m there is a transition, seldom abrupt, to the middle mountain forests.

MIDDLE MOUNTAIN FOREST. The middle mountain forests are characterized by dominance of the southern beeches (*Nothofagus* spp.), mixed hardwoods such as Cunoniaceae (*Schizomeria*, *Opocunonia*, *Weinmannia*), *Syzygium*, *Ilex*, *Elaeocarpus*, *Cryptocarya* and *Galbulimima*, and the conifers *Podocarpus*, *Dacrycarpus*, *Phyllocladus*, *Dacrydium*, *Papuacedrus* and, very locally, *Falcatifolium*. These components may form vast tracts of mixed forest. *Nothofagus* spp. tends to grow gregariously, forming relatively pure stands on sites such as ridge crests and upper slopes or, commonly, extensive tracts of beech forest as on the Nakanai plateau of New Britain. *Nothofagus* is rarely an important forest component above about 2700 m. Conifers assume increasing importance at higher altitudes and in many places above 2400 m dominate the canopy and emergent tree layers.

Common subcanopy and shrub components include *Cryptocarya*, *Cinnamomum*, *Xanthomyrtus*, *Symplocos*, *Prunus*, *Rapanea*, *Schuurmansia*, *Acronychia*, *Eurya*, *Bubbia*, *Pandanus* and, at higher altitudes, *Drimys*, *Olearia* and *Carpodetus*. Ericaceae (*Rhododendron*, *Vaccinium*, *Dimorphanthera*) are common, particularly as epiphytes.

The structure of the forest is influenced by topography and climate. Gentle slopes and plateaux may support tall (to 35 m) forest, while on exposed high crests and upper slopes the forest is often dwarfed to less than 20 m and the trees crooked and gnarled.

UPPER MOUNTAIN FOREST (sometimes termed subalpine forest). From about 3000 to 3400 m above sea level upwards to the tree limit at about 3900 m, a forest of gnarled and much-branched trees with thin stems and flat, twiggy crowns commonly forms a dense canopy 7 to 15 m high. The shrub layer is open. Mosses and epiphytic orchids are less common than in the middle mountain forests, probably as a result of less frequent and shorter periods of cloud cover. The forest is poor floristically. The tallest trees commonly are conifers, particularly *Dacrycarpus*, *Papuacedrus*, *Podocarpus brassii*, and *Phyllocladus*. Lower tree and shrub components include *Rapanea*, *Prunus*, *Olearia*, *Amaracarpus*, *Schefflera*, *Coprosma*, *Drimys*, *Symplocos*, *Mearnsia*, *Pittosporum* and Ericaceae (*Rhododendron*, *Vaccinium*). Towards the tree limit the trees are shrub-like, and the forest either grades into a dense shrubbery in which Ericaceae are predominant or opens out to form a low woodland with *Dacrycarpus compactus* at times emergent to 15 m even near the tree limit.

Intermontane Grassland

Grassland, which is largely man-induced and maintained by burning, is widespread and extensive in the populous high-level valleys. Short to mid-height tuft or bunch grasses such as *Ischaemum barbatum*, *Imperata*, *Arundinella*, *Ophiuros* and, on drier sites, *Themeda australis* occupy the valley basins of the central highlands. Tall grassland (locally to 5 m), with *Miscanthus floridulus* dominant, covers large tracts of recently abandoned garden land between about 1500 and 2500 m, particularly in the Western Highlands. *Imperata cylindrica* is a common co-dominant. Above about 2500 m the grassland is generally lower and more tussocky with *Danthonia archboldii* and *Deschampsia klossii* the main dominants.

SUBALPINE VEGETATION

Upwards from the natural tree limit at around 3900 m low shrub or herbaceous communities predominate. The transition from closed forest may be gradual but is commonly abrupt, and there is evidence that much of the subalpine grassland and perhaps shrub communities are fire-induced. Low shrubs, many of which have small, leathery, appressed leaves with inrolled edges, are common, either in thickets or scattered among the dominant grasses, to well above the tree limit, but with increasing altitude they decrease in height and frequency. Common shrubs include the heaths, both Ericaceae (*Vaccinium*, *Rhododendron*, *Dimorphanthera*, *Gaultheria*) and Epacridaceae (*Styphelia*, *Trochocarpa*), *Olearia*, *Coprosma* and *Gonocarpus*. Mid-height tussock grassland, with *Deschampsia klossii* a common dominant, gives way to low grassland in which dwarf grasses such as the cushion-forming *Monostachya oreoboloides* and species of *Poa*, *Festuca*, and *Danthonia* predominate and mountain herbs are common. Cycad-like tree ferns (*Cyathea atrox*, *C. gleichenioides*), are locally abundant in grassland. Sedges are important on wetter sites and commonly predominate on bogs and fens.

With increasing altitude, lichens, bryophytes and mountain herbs assume greater significance in the vegetation. On the summit areas of the highest mountains, above about 4200 m, communities of small compact herbs, including *Ranunculus*, *Gentiana*, *Eriocaulon*, *Potentilla*, *Poa* and *Parahebe*, and mats of bryophytes occur on the frost-sorted soils of the slopes. Perpetual snow is restricted to the highest peaks of western New Guinea.

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AMARANTHACEAE

A. Kanis

Herbs, rarely shrubs or woody climbers. Leaves opposite or alternate, without stipules, simple. Inflorescences racemose or ± paniculate, of single flowers or cymose flower clusters, with persistent bracts. Flowers bisexual or unisexual, usually with 2 bracteoles; tepals (3–)5, free; stamens (3–)5, opposite tepals, filaments usually ± joined at base, usually with interposed (pseudo-)staminodes, anthers 1- or 2-celled; ovary superior, 1-celled, with 1(–many) basal ovules often pendent from erect funicle. Fruit usually a nut, sometimes a capsule or berry.

Distribution: > 60 genera with *c.* 900 species throughout the world, chiefly in the tropics and subtropics, particularly in America. 10 genera with 24 species are represented in Papuasia, of which 3 genera and possibly 14 species have been introduced.

Literature: C. A. Backer (1949), Amaranthaceae, *Fl. Males.* ser. 1, **4**: 69–98. A. Kanis (1972), A review of the Amaranthaceae in Papuasia, *Contr. Herb. Aust.* **1**: 3–18.

KEY TO GENERA

1. Leaves alternate
 2. Fruits always 1-seeded and dry
  3. Bracts, bracteoles and tepals distinctly hairy outside; flowers bisexual; stigmas 2, capitate, on branched style; erect perennial herbs ..... AERVA
  3. Bracts, bracteoles and tepals glabrous; flowers unisexual; stigmas 2–3(–4), elongate, ± filamentous, sessile; erect, ascending or prostrate annual herbs ..... AMARANTHUS
 2. Fruits 2–many-seeded, if partly 1-seeded then usually berries
  4. Fruit a membranous circumscissile capsule; stigma 1, capitate, on filamentous style; annual herbs ..... CELOSIA
  4. Fruit a berry; stigmas 2–4, usually recurved, ± sessile; perennial herbs, shrubs or woody climbers ..... DEERINGIA
1. Leaves opposite
 5. Inflorescences paniculate; flowers minute, *c.* 1·5 mm long, unisexual (in Papuasia female only); leaves broadly ovate with acuminate apex to obcordate, sometimes deeply bilobed ..... IRESINE
 5. Inflorescences apparently unbranched; flowers 2·5 mm long or more, bisexual; leaves narrower, never obcordate
  6. Inflorescences slender, rather lax towards base, > 4 cm long; older flowers or flower clusters distinctly reflexed
   7. Flowers in shortly stalked clusters of 1–3, older ones accompanied by bundles of pungent, *c.* 2 mm long hooks; bracteoles not spiniform though sometimes rather long-acuminate ..... CYATHULA

7. Flowers single, sessile, without pungent hooks; bracteoles firmly spiniform with short wings at base.....ACHYRANTHES
6. Inflorescences compact, 0·5–4 cm long; flowers or flower clusters never distinctly reflexed
8. Bracteoles keeled, with a dorsal crest at least in upper part, 6 mm long or more; staminal filaments almost completely joined into tube of same length as tepals; stigmas 2, filamentous.....GOMPHRENA
8. Bracteoles neither keeled nor crested, 4 mm long or less; staminal filaments joined only at base into cup or short tube distinctly shorter than tepals; stigma 1, capitate
9. Outer tepals with strong midrib, often accompanied by 2 convergent strong nerves in lower part, 2·5–5 mm long; flower clusters 1–3 per leaf axil, ± globose at least when young.....ALTERNANTHERA
9. Outer tepals with 3–5 strong straight parallel nerves over almost full length, 2–2·5 mm long; flower clusters 1(–2) per leaf axil, conical when young....PSILOTRICHUM

ACHYRANTHES L.

Perennial herbs; stem and branches strongly ribbed, ± quadrangular, swollen above nodes, with soft white hairs, especially on fertile parts. Leaves opposite, ± hairy. Inflorescences terminal, sometimes also lateral, unbranched, lengthening during flowering, becoming lax towards base; bracts acuminate, not pungent, membranous, glabrous; bracteoles firmly spiniform with short membranous wings at base. Flowers bisexual, sessile, reflexed after flowering together with their bracts and bracteoles; tepals 5, glabrous, spreading only during flowering; stamens 5, filaments joined at base, alternating with interposed truncate staminodes, anthers 2-celled; ovary with 1 pendent ovule, obovoid, notched around short style; stigma capitate. Fruit a thin-walled nut, falling with perianth and bracteoles; seed ellipsoid.

Distribution: An essentially palaeotropical genus with *c.* 6 species, some of which are as yet unsatisfactorily defined. 2 rather polymorphic and widely distributed species can be distinguished in Papuasia.

Ecology: Dispersal of the ± weedy species is facilitated by the stiff perianth and spiny bracteoles that remain attached to the nuts.

KEY TO SPECIES

1. Inflorescences terminal only; membranous wings of bracteoles attached lengthwise to spiny part, sometimes breaking away laterally in old flowers; tepals with 3 or more conspicuous nerves, green with pale margin.....**A. aspera**
1. Inflorescences both terminal and in upper leaf axils; membranous wings of bracteoles laterally free from spiny part; tepals with only 1 distinct nerve, pale, often tinged violet during flowering.....**A. bidentata**

Achyranthes aspera L. *Sp. Pl.* 204 (1753). **Fig. 1.**

A. grandifolia Moq. (1849).

Erect, stiff herb to 1·25 m tall. Leaves with 3–10(–15) mm long petiole; lamina ovate to obovate, 3–10(–12) × 1–5(–6) cm, rounded to acute, sometimes slightly acuminate at apex, acute or a little tapering at base, ± densely hairy or glabrous except on nerves. Inflorescences terminal, usually 5–20 cm long including peduncle, to 40(–75) cm long when fruiting; bracts 2·5–3·5 mm

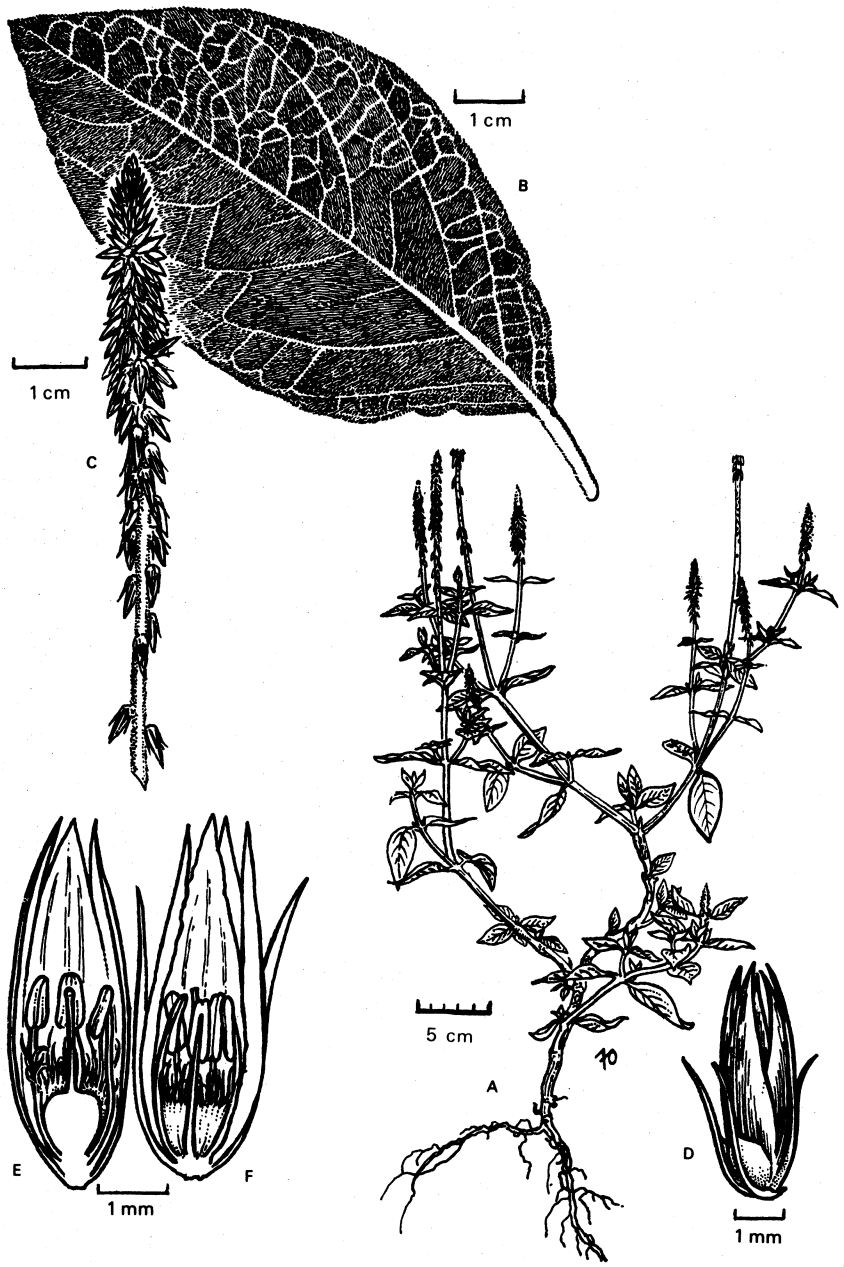


Fig. 1 **Achyranthes aspera** L. (A) plant (B) leaf (C) inflorescence (D) flower, outer view (E) flower, longitudinal section (F) flower, nearer tepals removed

long; bracteoles 3–4 mm long, ± straight and appressed to perianth, wings 1–1·5 mm long, attached lengthwise to spine, sometimes breaking away laterally in older flowers. Tepals lanceolate, 3·5–5 mm long, to 6·5 mm after flowering, green with pale margins, with 3 or more conspicuous nerves, acute at apex, hardening and becoming pungent; staminal filaments 2·5–3·5 mm long from base of cup; staminodes ± crenulate, with long-fringed dorsal scale attached just below apex; ovary *c.* 1 mm long, with 1–2 mm long style. Fruit 2·5–2·8 mm long; seed *c.* 1·5 mm long.

Distribution: Pantropical though principally palaeotropical; probably introduced near coastal settlements throughout Papuasia.

Ecology: A weed of dry open places, such as roadsides and gardens, especially in areas subject to a dry season, at 0–200(?) m altitude.

Achyranthes bidentata Bl. *Bijdr. Fl. Ned. Ind.* 545 (1826).

Erect or ascending, ± flaccid herb to 1 m tall. Leaves with 5–15(–30) mm long petiole; lamina lanceolate, sometimes ovate, 5–15(–20) × 1–6(–8) cm, long-acuminate at apex, acute to obtuse at base, ± densely hairy. Inflorescences terminal and in upper leaf axils, usually 4–12 cm long including peduncle, to 30(–45) cm long when fruiting; bracts 3–4 mm long; bracteoles 4–5 mm long, ± recurved at apex, wings *c.* 1 mm long, attached to wide base of spine but laterally free. Tepals lanceolate, 4·5–6 mm long, to 7 mm after flowering, rather unequal, pale but often tinged violet during flowering, thinly membranous with 1 distinct nerve, acute at apex but not becoming pungent; staminal filaments 2–2·5 mm long from base of cup; staminodes irregularly dentate, without dorsal scale; ovary *c.* 1 mm long, with 0·5–1·5 mm long style. Fruit 2–2·5 mm long; seed *c.* 1·5 mm long.

Distribution: Palaeotropical; probably indigenous throughout Papuasia.

Ecology: In primary and secondary forests, but also as a weed of shady places, at 250–2100 m altitude.

AERVA Forsk.

Perennial herbs; stem and branches terete, with white woolly hairs. Leaves alternate (elsewhere also opposite or whorled), ± densely hairy. Inflorescences (in Papuasia) essentially lateral and sessile, compact, higher ones often forming a compound terminal inflorescence; bracts and bracteoles membranous, hairy outside. Flowers bisexual (elsewhere also unisexual), sessile; tepals 5, hairy outside; stamens 5, filaments joined at base, alternating with interposed shorter subulate staminodes, anthers 2-celled; ovary with 1 pendent ovule, broadly ovoid, narrowing into short style; stigmas minute. Fruit a thin-walled nut, 1-seeded, falling with perianth, bursting irregularly (elsewhere also circumscissile); seed reniform.

Distribution: An old-world genus of *c.* 10 species, extending from the tropical into the temperate regions. 1 widely distributed species is found in Papuasia.

Aerva lanata (L.) Schultes *Syst. Veg.* ed. 16, **5**: 564 (1819). **Fig. 2.**

Erect herb to 1 m tall; branches ascending from near base. Leaves with 2–3(–5) mm long petiole; lamina elliptic to obovate, 1–2 × 0·5–1·2 cm, to 5 × 2·5 cm on main stem, obtuse or rounded at apex, acute or attenuate at base, ± densely clothed below with appressed long soft white hairs, shorter and much thinner above. Inflorescences mostly 2–5 per node, cylindrical, 3–6(–15) mm long, easily breaking up when fruiting; bracts and bracteoles *c.* 1 mm long, acuminate, ± hairy outside. Tepals ovate, *c.* 1·5 mm long, obtuse, sometimes mucronate at apex, membranous, densely hairy outside, 3 inner ones green along midrib; stamens to 1 mm long; ovary to 0·5 mm long; style *c.* 0·3 mm long, filamentous, branched in upper half, with 2 capitate stigmas. Fruit ± compressed, *c.* 1 mm across; seed erect, *c.* 0·7 mm long, shiny black.

Distribution: From Africa through India to Malesia. In Papuasia collected in the Digul (near Merauke) and Central districts; also recorded from the Aru Islands.

Ecology: A weed of dry open places at low altitudes, probably restricted to areas with a pronounced dry season.

ALTERNANTHERA Forsk.

Perennial herbs; stems usually many and much-branched, terete or ± quadrangular, ± hairy. Leaves opposite, glabrous or ± hairy. Inflorescences lateral, usually 1–3 per axil, sessile, short, compact; bracts and bracteoles dry-membranous, glabrous or hairy outside. Flowers bisexual, sessile; tepals 5 (rarely more), with distinct midrib at least in 3 outer ones, ± hairy outside; stamens 5, sometimes 2 with ± reduced anthers, filaments joined at base, sometimes forming small tube, alternating with interposed staminodes, anthers 1-celled; ovary with 1 pendent ovule, subglobose; style short; stigma capitate. Fruit a thin-walled nut, falling with perianth and sometimes with bracteoles; seed lens-shaped.

Distribution: A pantropical and -subtropical genus with *c.* 170 species, strongly centred in the Americas. 1 indigenous and 2 originally American species are found in Papuasia.

KEY TO SPECIES

1. Tepals ± equal, shortly acuminate, with only 1 distinct nerve, 2·5–3 mm long; bracts and bracteoles shortly acuminate, *c.* 1 mm long; stems with only 2 rows of hairs lengthwise and single rows across nodes; hairs woolly, smooth ..... **A. sessilis**

1. Tepals distinctly unequal, acuminate or awned, 3 outer ones with 3(–5) distinct nerves in lower half, 3 mm long or more, 2 inner ones much smaller; bracts and bracteoles acuminate or awned, *c.* 2 mm long or more; stems usually evenly hairy at least on younger parts; hairs rather straight, minutely denticulate (use high magnification!)

2. Bracts, bracteoles and tepals not pungent, with long white hairs dispersed on outside, those on 2 outermost tepals projecting slantingly upwards from midrib; leaves densely hairy when young, glabrescent, green or variegated ..... **A. bettzickiana**

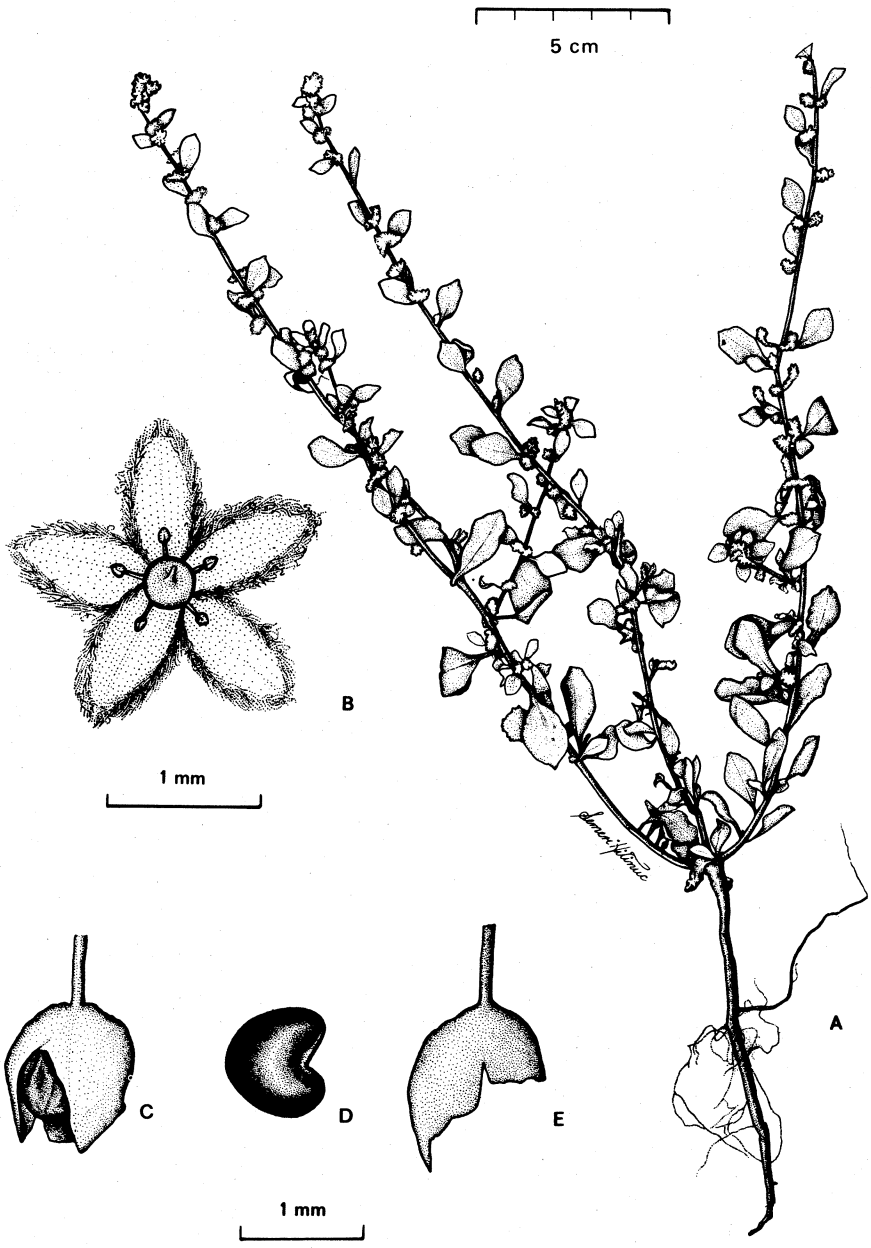


Fig. 2 **Aerva lanata** (L.) Schultes (A) plant (B) flower (C) fruit during dehiscence (D) seed (E) remnant of fruit

2. Bracts and especially 2 outermost tepals pungent; bracts and bracteoles glabrous, 3 outer tepals with hair tufts restricted to base, projecting perpendicularly sideways, 2 inner ones with a central tuft on outside; leaves glabrous or nearly so, never variegated ..... **A. pungens**

Alternanthera bettzickiana (Regel) Nichols. *Ill. Dict. Gard.* **1**: 59 (1885).
A. manillensis auct. non (Walp.) Kanis: Kanis (1972).

Erect or ± decumbent herb to 50 cm tall; stems often rooting at nodes, younger parts ± quadrangular with furrows on 2 opposite sides, clothed with soft appressed hairs, terete towards base, glabrescent but less so on ribs and nodes. Leaves with 1–2 cm long, ± hairy petiole; lamina ovate or elliptic to oblanceolate, 2–6 × 0·5–3 cm, acute to obtuse, finely mucronate at apex, ± attenuate at base, green or variegated with red, pink or yellow, clothed with fine hairs when young, glabrescent. Inflorescences subglobose, 5–8 mm long, white, turning straw-coloured; bracts 2–3 mm long, strongly acuminate but not pungent, with long white hairs outside; bracteoles similar, somewhat shorter. Tepals sometimes > 5, ovate, acuminate but not pungent, unequal, 3 outer ones with 3 distinct convergent nerves in lower half, 2 outermost (abaxial) ones largest, 3–4 mm long, with long white hairs along midrib projecting slantingly upwards, 2 inner ones smallest, strongly concave; filaments 0·5–1 mm long from base of cup, anthers equally long or longer, sometimes 1 or 2 ± reduced and sterile; staminodes linear, longer than filaments, fimbriate at apex; ovary with subconical, *c.* 0·5 mm long style. Fruit obovoid, somewhat compressed laterally; seed *c.* 1 mm long.

Distribution: Originally from South America, introduced in the palaeotropics and -subtropics. In Papuasia known from several districts in eastern New Guinea and from New Ireland.

Ecology: Occurring as a weed in moist habitats at 0–2000 m altitude.

Notes: The ornamental form introduced in about the middle of this century probably does not produce seed, but it is likely that a fertile form was accidentally brought in after about 1960, spreading rapidly from centres like Port Moresby and Lae.

Alternanthera pungens Kunth *Nov. Gen. Sp.* **2**: 206 (1818). **Fig. 3.**
A. repens (L.) Link (1821) non Gmel. (1791).

Prostrate or ± ascending herb; stems to 50 cm long, often rooting at nodes, terete, hard, younger parts clothed with appressed white hairs, glabrescent. Leaves of a pair unequal in size, with 2–5 mm long petiole; lamina elliptic to obovate, 1–3(–4) × 0·5–1·5(–2) cm, obtuse or rounded at apex, ± attenuate at base, glabrous or thinly hairy above and on nerves beneath. Inflorescences subglobose to ovoid, 5–10(–15) mm long, yellowish-green, turning straw-coloured; bracts *c.* 4 mm long, strongly acuminate and pungent, glabrous; bracteoles similar but less pointed, somewhat smaller. Tepals strongly acuminate, very unequal, 3 outer ones with 3 distinct convergent nerves in lower half, with hair tufts projecting perpendicularly

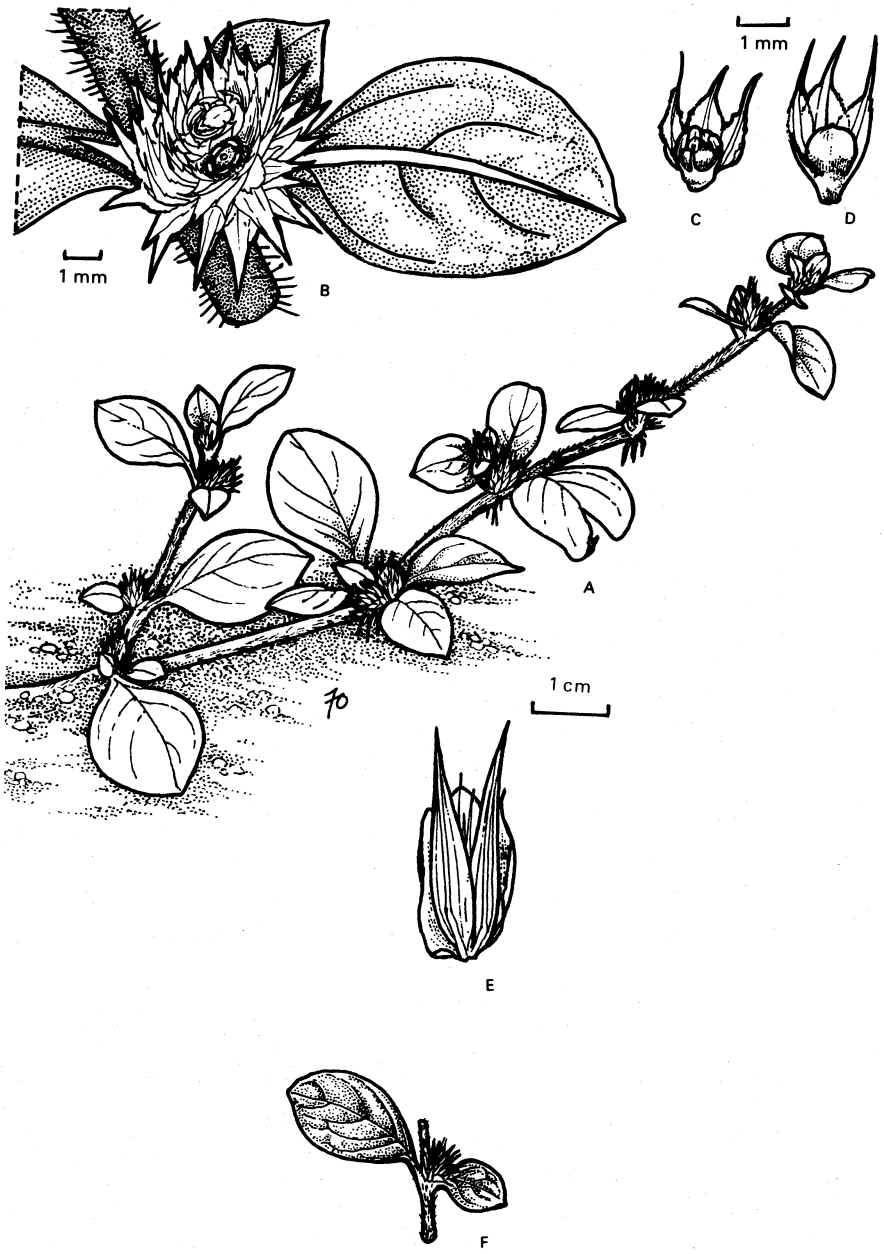


Fig. 3 **Alternanthera pungens** Kunth (A) branch (B) part of stem with flower-cluster (C) flower (D) maturing fruit, some tepals of flower removed (E) side view of flower (F) side view of leaf-pair with flower-cluster

sideways from base, otherwise glabrous, 2 outermost (abaxial) ones narrowly triangular, *c.* 5 mm long, hardening and becoming pungent, adaxial one ovate, *c.* 3 mm long, not pungent, 2 inner ones smallest, strongly concave, with central hair tuft on outside; filaments 0·5–0·8 mm long from base of cup, anthers much shorter, all fertile; staminodes broad, much shorter than filaments, entire to irregularly dentate at apex; ovary small, with very short cylindrical style. Fruit broadly obovoid, laterally compressed, ± notched around style; seed *c.* 1 mm across.

Distribution: Originally from South America, introduced in the palaeotropics and -subtropics. In Papuasia known since the middle of this century from the Jayapura district in western New Guinea and the Morobe and Central districts in eastern New Guinea; probably rather localized.

Ecology: A weed of dry open habitats at 0–750(?) m altitude.

Alternanthera sessilis (L.) DC. *Cat. Hort. Monspel.* 77 (1813). **Fig. 4.**

A. tenuissima Suess. (1939); *A. sessilis* var. *tenuissima* (Suess.) Backer (1949). *A. nodiflora* auctt. non R. Br.: K. Sch. & Laut. (1900); *A. denticulata* auct. non R. Br.: S. Moore (1923).

Prostrate, ± ascending herb; stems to 1 m long, ± terete, with greenish woolly hairs in 2 longitudinal rows and single rows across nodes. Leaves with 1–5(–10) mm long petiole; lamina elliptic or obovate to narrowly oblanceolate, 1–7·5(–15) × 0·2–1·5(–3) cm, acute, obtuse or rounded at apex, ± attenuate at base, glabrous or thinly hairy. Inflorescences subglobose to cylindrical, 5–10(–15) mm long, shiny, ± pinkish-white, flowers falling successively from base upwards; bracts to 1 mm long, ± shortly acuminate, glabrous; bracteoles similar, somewhat larger. Tepals ovate, subequal, 2·5–3 mm long, shortly acuminate, dry-membranous, glabrous or ± hairy, with 1 distinct nerve, sometimes obscurely 3-nerved at base; filaments *c.* 0·8 mm long from base of cup, anthers much shorter, only 3 developed; staminodes stiffly filiform, as long as filaments or shorter, entire; ovary small with very short cylindrical style. Fruit broadly obovoid, much compressed laterally and distinctly notched around style; seed *c.* 1·5 mm across.

Distribution: Pantropical but possibly palaeotropical in origin; throughout Papuasia.

Ecology: In open, moist or inundated habitats at 0–2000 m altitude; also occurring as a weed at roadsides and in plantations and gardens.

Uses: Reportedly smoked as a medicine in the Baliem Valley (Snow Mountains).

Notes: Partly submersed plants are usually more robust, the stems becoming hollow and thereby floating.

AMARANTHUS L.

Annual herbs; stem and branches ± angular, ± glabrous. Leaves alternate, glabrous or ± hairy on nerves. Inflorescences of lateral flower clusters (cymes), mostly forming lateral and/or terminal compound inflorescences;

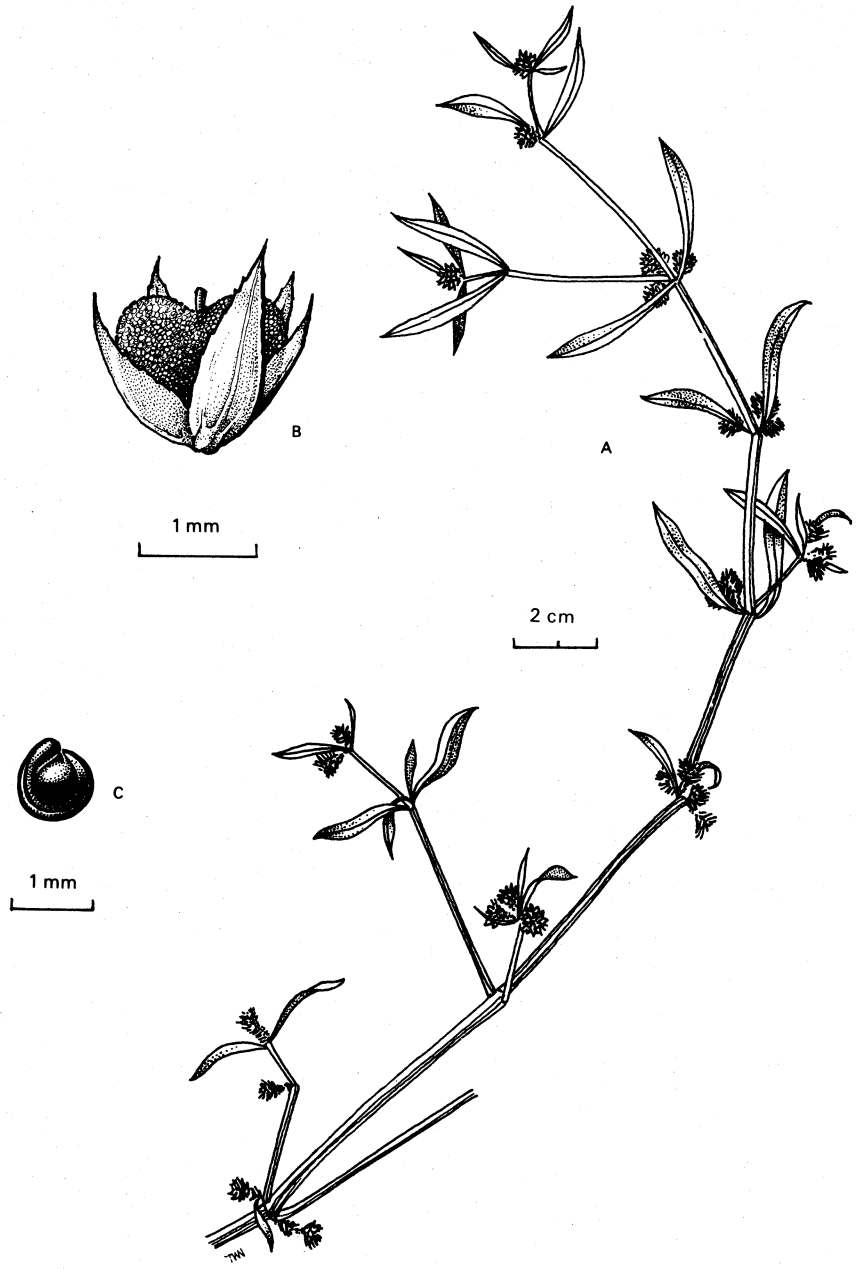


Fig. 4 **Alternanthera sessilis** (L.) DC. (A) branch (B) fruit within tepals (C) seed

bracts and bracteoles dry-membranous, glabrous, sometimes awned, rarely spiny. Flowers unisexual, sessile; tepals 3–(4–)5, membranous, glabrous; stamens as many as tepals, filaments free, anthers 2-celled; staminodes absent; ovary with 1 sessile ovule, often present in reduced form in male flowers; stigmas (2–)3(–4). Fruit a 1-seeded circumscissile capsule, or a nut falling with perianth and bursting irregularly; seed ± lenticular, shiny dark brown or rarely yellowish-white.

Distribution: A genus with *c.* 50 species, mostly in the tropics and subtropics of both hemispheres but also in the temperate zones. In Papuasia 9 species have been found, one of these possibly being indigenous.

Uses: The genus is important in Papuasian native agriculture insofar as 4 of its species are ± commonly grown as green vegetables. Its cultivation as a grain crop is not known in the region.

KEY TO SPECIES

1. Mature fruits not opening by circumscission, usually falling entirely with perianth
 2. Tepals 5 in most female flowers; fruits usually with smooth light-coloured conical beak, distinct from wrinkled darker main body ..... **A. interruptus**
 2. Tepals 3 in most female flowers; fruits without distinct top part, entirely wrinkled or smooth
  3. Ripe fruits rather smooth; leaf-blades ovate to obovate, 1–3 cm long ..... **A. lividus**
  3. Ripe fruits distinctly wrinkled; leaf-blades ± trullate, 3–7(–10) cm long .... **A. viridis**
1. Mature fruits opening by circumscission, upper part falling with seed, lower part persisting with perianth
 4. Tepals 3 per flower, distinctly awned and strongly recurved like bracts, 3–5 mm long in female flowers ..... **A. tricolor**
 4. Tepals 5 per flower (occasionally 3 or 4 in some male flowers), ± mucronate, 1·5–2·5 mm long in female flowers
  5. Tepals about equal in length, perianth ± incurved against ripe fruit
   6. All flower clusters unarmed, awns of all bracts < 2 mm long; flowers mostly female, only initial one of each cluster male ..... **A. dubius**
   6. Flower clusters in leaf axils with 1 or 2 spines (metamorphosed bracts) 5–20 mm long; flowers all female in lower clusters, all male in upper clusters ..... **A. spinosus**
  5. Tepals distinctly unequal in length, perianth ± spreading away from ripe fruit
   7. Bracts mucronate, shorter than perianth, about as long as wrinkled dark fruit ..... **A. leptostachyus**
   7. Bracts long-awned, overall equal to or slightly longer than perianth, shorter than smooth pale fruit
    8. Tepals ± recurved in fruit, with distinctly overlapping margins, inner ones obtusely spathulate; stigmas divergent, ± recurved, widened at base and together forming 3-sided saddle ..... **A. caudatus**
    8. Tepals straight in fruit, margins not or hardly overlapping, inner ones acutely oblanceolate, stigmas erect, straight, slender at base and attached to short cylindrical beak ..... **A. cruentus**

Amaranthus caudatus L. *Sp. Pl.* 990 (1753).

Erect herb to 0·8(–1·5) m tall; stem angular, single or branched, often ± flaccid in upper part, ± hairy at first, glabrescent, ± tinged purple. Leaves with 0·5–1·5 cm long (probably often longer) petiole; lamina ovate to lanceolate, sometimes ± trullate, 2–4 × 0·7–1·6 cm (probably often larger), obtuse to acute, mucronate at apex, acute to ± attenuate at base, ± tinged purple along margin, nerves pale beneath. Inflorescences of flower clusters

arranged in lateral and terminal, dense compound spikes, sometimes branched, often drooping, especially the relatively long, 1–2(–3) cm wide, terminal spikes; bracts broadly ovate, long-awned, overall equal to or slightly longer than perianth. Tepals 5, ± recurved in fruit, with distinctly overlapping margins, outer ones obovate, acuminate, *c.* 2·5 mm long, inner ones spathulate, obtuse to emarginate, shortly mucronate, slightly shorter. Fruit ovoid, slightly exceeding perianth, circumscissile; stigmas 3, recurved, 0·7–1 mm long, widened at base and together forming 3-sided saddle; seed 1–1·3 mm across.

Distribution: Of South American origin, occurring throughout the tropics as well as more temperate regions. In Papuasia probably recently introduced and once collected in the Western Highlands district (Upper Kaugel Valley, 1968).

Ecology: Only known from cultivation at *c.* 2200 m altitude.

Uses: In Papuasia only cultivated as a green vegetable. Grown as a grain crop in parts of tropical America, Africa and continental Asia. Strongly coloured forms are cultivated elsewhere as ornamentals.

Notes: The species probably originated by selection from material belonging to *A. quitensis* Kunth during a long period of domestication. Specimens may remain rather small and may not develop the ± typical drooping inflorescences. The Papuasian material is remarkable for its yellowish-white seeds. This characteristic is favoured in grain crops elsewhere.

Amaranthus cruentus L. *Syst. Nat.* **2**: 1279 (1759).

A. paniculatus L. (1763); *A. hybridus* var. *paniculatus* (L.) Uline & Bray (1894). *A. hybridus* auct. non L.: Kanis (1972) p.p.

Erect herb to 1·2(–2) m tall; stem angular, often branching in upper part, glabrous or ± hairy on younger parts, ± tinged purple. Leaves with 1–7·5 cm long petiole; lamina ovate to lanceolate, (2–)10–15(–30) × (1–)3–6(–12) cm, often somewhat acuminate towards narrowly obtuse or emarginate, finely mucronate apex, acute or ± attenuate at base, ± hairy on midrib, tinged purple beneath. Inflorescences of flower clusters arranged in lateral, often branched, compound spikes, upper ones aggregated in ± dense, stiff terminal panicles, (5–)15–25(–40) cm long; bracts broadly ovate, long-awned, overall about as long as perianth. Tepals 5, ± spreading in fruit, straight, outer ones ± oblong, acute, *c.* 2 mm long, inner ones oblanceolate and rather smaller. Fruit ovoid with short cylindrical beak, longer than perianth, circumscissile; stigmas 3, erect, 0·5–1 mm long, slender at base; seed 1–1·3 mm across.

Distribution: Of Central American origin, occurring throughout the tropics as well as more temperate regions. In Papuasia throughout the central highlands of western and eastern New Guinea.

Ecology: Probably associated exclusively with areas under cultivation at 1200–2200 m altitude.

Uses: In mainland New Guinea only cultivated as a green vegetable. Specimens from the region usually do not have strongly coloured inflorescences like the purple ones grown as ornamentals elsewhere. The seeds are always dark brown, unlike the pale seeds preferred in Central American grain crops.

Notes: The species presumably originated by selection from material belonging to *A. hybridus* L. during many centuries of cultivation. Individual plants (escapees?) may develop into small, though fertile, specimens < 30 cm high and with strongly reduced leaves and inflorescences.

Amaranthus dubius Thell. *Fl. Adv. Montpell.* 203 (1912).

A. hybridus auct. non L.: Kanis (1972) p.p.

Erect herb to 1·2 m tall; stem angular, often branching from base upwards, subglabrous, green or ± tinged purple. Leaves with 1–5 cm long petiole; lamina ovate or ± trullate, (2–)3–8(–10)×(1–)2–5(–6) cm, obtuse or ± emarginate, shortly mucronate at apex, shortly attenuate at base, green. Inflorescences of flower clusters arranged in lateral, sometimes branched, compound spikes, upper ones aggregated in rather lax terminal panicles, 10–20(–25) cm long, erect or drooping at apex; bracts broadly ovate, long-awned, distinctly exceeding perianth. Flowers mostly female, only initial one in each cluster male; tepals 5, ± incurved in fruit, equally *c.* 2 mm long, outer ones oblong to obovate, acute, inner ones obovate to spathulate, obtuse. Fruit ovoid, about as long as perianth, circumscissile; stigmas 3, *c.* 1 mm long, widened at base, often somewhat recurved; seed 1–1·2 mm across, rather flat.

Distribution: Of Central American origin, occurring mainly throughout the tropics. Introduced into Papuasia.

Ecology: Occurring as a weed in plantations, garden areas and secondary vegetation, at 0–1300 m altitude.

Uses: Cultivated as a green vegetable, probably in several districts.

Notes: The species has presumably arisen as an allopolyploid hybrid of *A. spinosus* L. and either *A. hybridus* L. or *A. quitensis* Kunth. It was introduced into eastern Papuasia before World War II. In 1959 it was recorded as a recent introduction from the Star Mountains in western New Guinea.

Amaranthus interruptus R. Br. *Prodr.* 414 (1810).

Euxolus interruptus (R. Br.) Moq. (1849).

Erect or ± decumbent herb to 60(–120) cm tall; stem angular, sometimes ± flexuous, often branching from base upwards, subglabrous. Leaves with 0·5–2·5(–4) cm long petiole; lamina ovate, rarely ± trullate, 1·5–4(–6)×0·7–2(–3) cm, obtuse to rounded, often slightly emarginate, shortly mucronate at apex, cuneate or ± attenuate at base, glabrous, lateral nerves prominent beneath. Inflorescences of lateral flower clusters, single or arranged in compound spikes, upper ones aggregated in erect compound terminal spikes, sometimes with a few branches at base, initially ± compact, growing rather lax, 3–15(–30) cm long; bracts ovate, mucronate, shorter than perianth. Tepals mostly 3 in male flowers, mostly 5 in female flowers, narrowly

spathulate, *c.* 1·5 mm long, somewhat accrescent in fruit, shortly mucronate, green with pale margin. Fruit ellipsoid with broadly conical beak, about as long as perianth, indehiscent or bursting irregularly, wrinkled, rather dark, but beak smooth and distinctly paler; stigmas 2(–3), erect, *c.* 0·4 mm long; seed *c.* 1 mm across, rather thick.

Distribution: Indigenous in northern Australia; in Papuasia introduced near coastal settlements in the Central district (Port Moresby and Rigo), New Britain (Blanche Bay?) and Guadalcanal (Pt Cruz near Honiara).

Notes: Probably accidentally introduced, the species was recorded from the region in the last quarter of the nineteenth century and again in 1945 (Guadalcanal).

Amaranthus leptostachyus Benth. *Fl. Aust.* **5**: 214 (1870).

Erect herb to 50 cm tall; stem angular, often branching from base upwards, subglabrous, Leaves with 0·3–1(–6) cm long petiole; lamina ovate or ± trullate, 1–3(–4) × 0·5–2(–2·5) cm, obtuse or rounded, finely mucronate at apex, ± attenuate at base, lateral nerves prominent below, glabrous or thinly hairy on nerves beneath. Inflorescences of lateral flower clusters, single or arranged in compound spikes, upper ones aggregated in ± lax, compound terminal spikes, 5–15 cm long; bracts ovate, mucronate, shorter than perianth. Tepals (3–)4–5, ± spathulate, *c.* 2 mm long in male flowers, *c.* 1·5 mm long in female flowers, not accrescent in fruit, acuminate, distinctly mucronate, pale with green midrib. Fruit ellipsoid with short conical beak, longer than perianth, circumscissile, ± finely pustular; stigmas 2–3, erect or recurved, *c.* 0·4 mm long; seed to 1 mm across.

Distribution: Indigenous in northern Australia. In Papuasia introduced near coastal settlements in the Milne Bay district (Orangerie Bay).

Notes: As in the case of the previous species, probably accidentally introduced and only recorded from the region in the last quarter of the nineteenth century.

Amaranthus lividus L. *Sp. Pl.* 990 (1753). **Fig. 5.**

Ascendent or erect herb to 80 cm tall; stem angular, ± flexuous, often branching from base upwards, subglabrous. Leaves with 0·3–2·5 cm long petiole; lamina ovate to obovate, often ± rhombic, 1–3(–4) × 0·3–1·5(–2) cm, obtuse or ± retuse, mucronate at apex, cuneate or ± attenuate at base, lateral nerves prominent beneath, glabrous, sometimes ± tinged purple. Inflorescences of lateral flower clusters, single or arranged in compound spikes, upper ones aggregated in terminal compound spikes or panicles, 1–10 cm long; bracts ovate, acute, distinctly shorter than perianth. Tepals 3, linear or narrowly spathulate, 1–1·5 mm long, somewhat accrescent in fruit, shortly mucronate, green or tinged purple with pale margins. Fruit ellipsoid, acute, somewhat longer than perianth, indehiscent or bursting irregularly, rather smooth and pale; stigmas 2–3, erect, *c.* 0·5 mm long; seed 1–1·2 mm across.

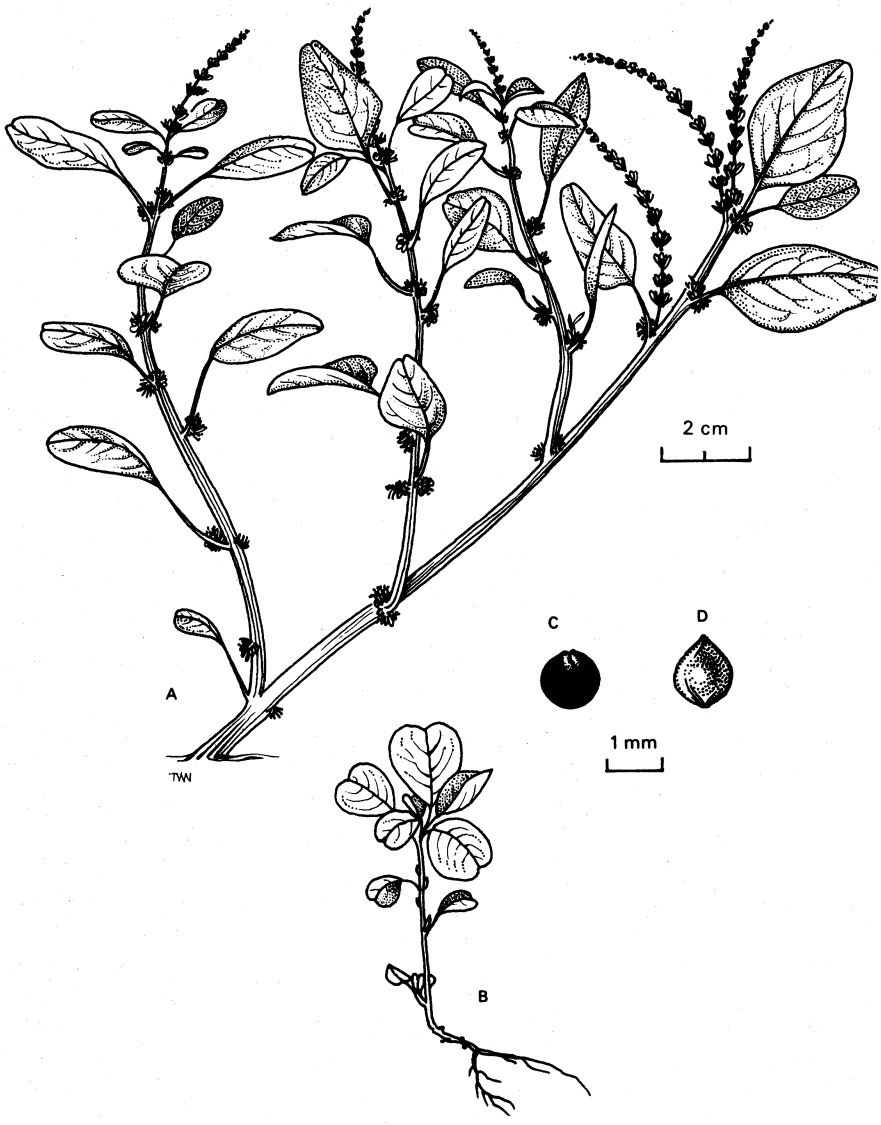


Fig. 5 **Amaranthus lividus** L. (A) plant (B) young plant (C) seed (D) fruit

Distribution: Possibly of Mediterranean origin, occurring world-wide from the tropics to the warmer temperate regions. In Papuasia introduced into the highlands districts.

Ecology: Occurring as a weed along roads, in clearings and plantations, at 1200–2000 m altitude.

Uses: Reportedly eaten as a green vegetable in the Eastern Highlands district but only once recorded as a crop plant.

Notes: The species is rather polymorphic but the Papuasian specimens all appear to match the description of ssp. *polygonoides* (Moq.) Thell. It was probably accidentally introduced near Aiyura in the Eastern Highlands district in or shortly before 1954, spreading westward along the highway.

Amaranthus spinosus L. *Sp. Pl.* 991 (1753). **Fig. 6.**

Erect or decumbent herb to 1 m tall; stem terete or ± angular, branching from base upwards, subglabrous, ± tinged purple. Leaves with 0·5–10 cm long petiole; lamina ovate to lanceolate, sometimes ± trullate, 2–7(–10) ×0·6–3(–4) cm, acute to slightly retuse, often shortly mucronate at apex, ± attenuate at base, glabrous or slightly hairy on nerves when young. Inflorescences of lateral flower clusters, single or arranged in compound spikes, upper ones aggregated in terminal compound spikes or panicles, 3–10(–15) cm long, often ± drooping at apex; bracts generally ovate, mucronate, as long as perianth or shorter, 1 or 2 bracts of flower clusters in leaf axils spiniform, pungent, 0·5–2 cm long. Flowers all female in lower clusters, all male in upper clusters; tepals 3 in male flowers, 5 in female flowers, narrowly spathulate, *c.* 2 mm long, somewhat accrescent in fruit, shortly mucronate, green or ± tinged purple with pale margins. Fruit ellipsoid, somewhat longer than perianth, circumscissile, lower part smooth upper part ± pustular; stigmas 2–3, ± recurved, widened at base, 1·2–1·5 mm long; seed 1–1·2 mm across, rather compressed.

Distribution: Probably of American origin, occurring world-wide from the tropics to the warmer temperate regions. In Papuasia introduced near coastal settlements in New Britain (Blanche Bay) and the Morobe district (Finschhafen); also collected well inland (Bulolo, Morobe district).

Ecology: Occurring as a garden weed at 0–600(?) m altitude.

Notes: Populations with non-circumscissile fruits have been found elsewhere, but are unknown from Papuasia. An unarmed form of this species was originally described from northeastern New Guinea, but the material concerned probably belonged to *A. viridis* L.

Amaranthus tricolor L. *Sp. Pl.* 989 (1753).

A. melancholicus L. (1753); *A. gangeticus* L. (1759); *A. melancholicus* var. *tricolor* (L.) Moq. (1849); *A. blitum* 'forma monstrosa phyllomanica' K. Sch. (1887); *A. melancholicus* forma *phyllomanica* K. Sch. & Laut. (1900). *A. oleraceus* auctt. non L.: Warb. (1891); *A. caudatus* auct. non L.: Val. (1907).

Ascendent or erect herb to 1·5 m tall; stem angular, often branching

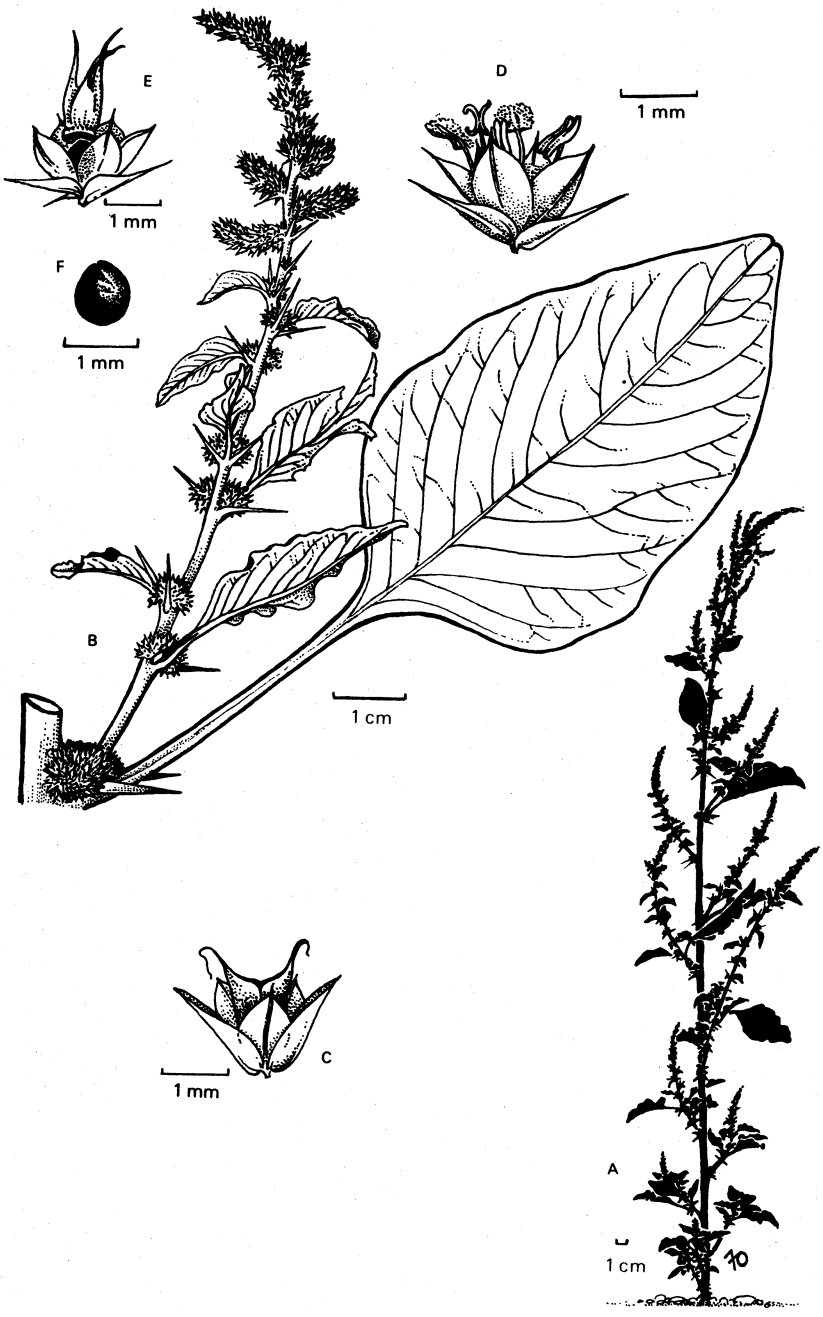


Fig. 6 **Amaranthus spinosus** L. (A) habit (B) leaf with flowering branch (C) fruit in situ (D) flower (E) dehiscence of fruit (F) seed

in upper part, glabrous or thinly hairy on younger parts. Leaves with 1–5(–10) cm long petiole; lamina ovate or ± trullate to linear-lanceolate 5–25 × 2–6 cm, acute to retuse or emarginate at apex, cuneate or ± attenuate at base, glabrous or thinly hairy on nerves, green or ± tinged purple, sometimes variegated with bright red and yellow. Inflorescences of lateral flower clusters, single or arranged in compound spikes, upper ones often aggregated in terminal compound spikes, to 30 cm long; bracts ovate, long-awned, as long as perianth or shorter. Tepals 3, ovate, long-awned, strongly recurved, 3–5 mm long, somewhat accrescent in fruit, green or ± tinged purple, with pale margins. Fruit ellipsoid with short ± cylindrical beak, shorter than perianth, circumscissile below middle, rather smooth; stigmas 3, ± recurved, 2–2·5 mm long; seed 1–1·2 mm across, rather thick.

Distribution: Indigenous in tropical continental Asia and Malesia, introduced into other tropical to warm-temperate regions of both hemispheres. Possibly indigenous throughout Papuasia.

Ecology: Occurring as a weed in clearings, plantations and gardens, probably also in more open natural habitats, at 0–2200 m altitude.

Uses: Widely grown as an ornamental and reported as a green vegetable crop from the Eastern Highlands, Madang and Morobe districts as well as New Britain (Gazelle Peninsula) and Bougainville Island.

Notes: Several varieties and forms have been described within this species, which is very variable in habit and foliage. Some Papuasian specimens, approaching an original wild form, are smaller and have ± ascendent stems. The cultivars, also occurring as escapees, are usually erect and taller, often having a more luxurious development of the upper leaves, making a compound terminal inflorescence less apparent. Ornamentals usually have colourful variegated leaves.

Amaranthus viridis L. *Sp. Pl.* 1405 (1763).

A. gracilis Desf. (1804); ?*A. spinosus* forma *inermis* Laut. & K. Sch. (1900). *A. caudatus* auct. non L.: H. J. Lam (1927).

Erect or ± decumbent herb to 75 cm tall; stem terete or ± angular, branching from base upwards, subglabrous. Leaves with 1–7 cm long petiole; lamina ovate or ± trullate, 2–8 × 1–6 cm, acute to retuse at apex, cuneate or ± attenuate at base, glabrous or sparsely hairy on nerves. Inflorescences of lateral flower clusters, single or arranged in compound spikes, upper ones aggregated in terminal compound spikes or panicles, 4–12 cm long; bracts ovate, shortly mucronate, shorter than perianth. Tepals 3(–4), linear to narrowly spathulate, *c.* 1·5 mm long, somewhat accrescent in fruit, shortly mucronate, green with pale margins. Fruit ellipsoid with short conical beak, distinctly longer than perianth, indehiscent or bursting irregularly, strongly wrinkled; stigmas 2–3, ± erect, *c.* 0·3 mm long; seed 1–1·2 mm across, rather thick.

Distribution: Of unknown origin, occurring world-wide in the tropics and subtropics. Throughout Papuasia; also reported from the Aru Islands.

Ecology: Occurring as a weed in gardens and waste places, also in secondary vegetation, at 0–2000 m altitude.

Uses: Not often reported from cultivation, this species might well be the one most widely eaten as a green vegetable, especially in areas where local agricultural methods are not well developed.

CELOSIA L.

Annual herbs; stem and branches strongly ribbed, glabrous. Leaves alternate, glabrous. Inflorescences terminal or lateral, simple or branched, compact or interrupted; bracts and bracteoles membranous, 1-nerved, glabrous. Flowers bisexual, sessile; tepals 5, glabrous, spreading during flowering; stamens 5, filaments joined at base, often alternating with interposed staminodes, anthers 2-celled; ovary with many ovules; style filamentous; stigma capitate, slightly lobed. Fruit a circumscissile capsule; seeds reniform-lenticular.

Distribution: A genus of *c.* 60 species, occurring mainly in the subtropical and temperate zones of America and Africa. 1 cosmopolitan species is found in Papuasia.

Celosia argentea L. *Sp. Pl.* 205 (1753). **Fig. 7.**
C. cristata L. (1753).

Erect herb to 1·5(–2) m tall; stem green or ± tinged red, often much-branched, branches often only tufts of very small leaves. Leaves with 2–20 mm long petiole; lamina ± narrowly lanceolate to oblanceolate, 4–18 × 0·7–3 (–6·5) cm, acute or acuminate at apex, acute or ± tapering at base. Inflorescences mostly solitary and simple, sometimes paired or branched, usually conical when young, lengthening during flowering and becoming cylindrical below, 2–10(–20) × 0·7–1·3 cm, on 1–20 cm long peduncles; bracts and bracteoles lanceolate, 3–7 mm long, acute, mucronate. Tepals lanceolate, 6–10 mm long, acute, mucronate, shiny white, initially ± tinged pink towards apex; staminal cup 1·5–2 mm high, free parts of filaments 2·5–3 mm long, anthers narrowly oblong; staminodes minute. Fruit obovoid, *c.* 3·5 mm long with 3–5 mm long style, ± tinged purple towards stigma; seeds (1–)3–7(–9), *c.* 1·5 mm across, black.

Distribution: Possibly of Indian origin, presently of world-wide distribution in tropical as well as more temperate regions. Throughout Papuasia.

Ecology: Often occurring as a weed in dry open places such as roadsides and waste lands, as well as stream beds, from sea level to 1200(–1800) m altitude.

Uses: Commonly cultivated as an ornamental, occasionally used as a vegetable (East Sepik district) and for dyeing nets (Madang district).

Notes: The inflorescences of cultivated specimens are frequently somewhat loose and tail-like, bearing sterile flowers in the upper part. The terminal inflorescence is often ± deformed and shaped like a cock's-comb with a

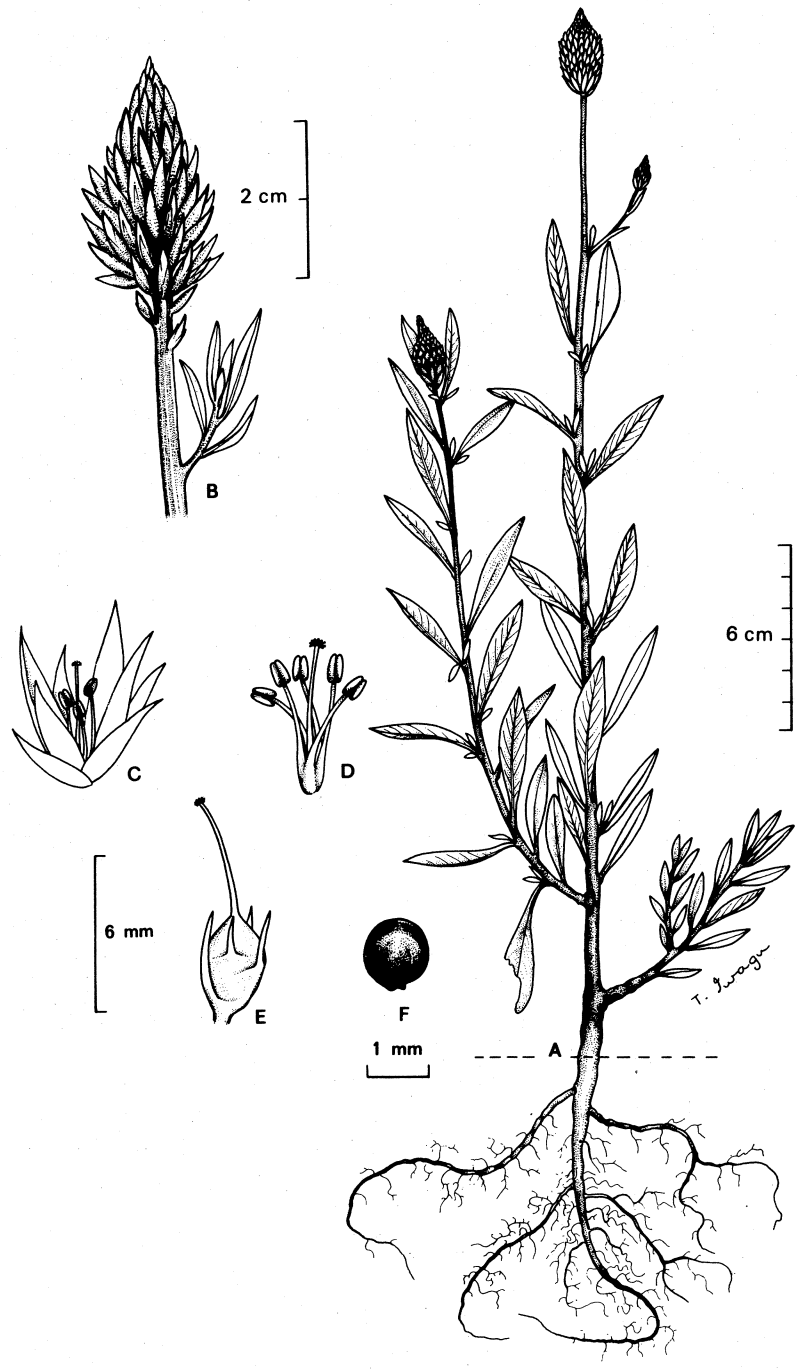


Fig. 7 **Celosia argentea** L. (A) plant (B) inflorescence (C) flower (D) stamens and pistil (E) fruit with stamen remnants (F) seed

sinuous crest. Its colour is usually ± purplish-red, sometimes orange or yellow. These forms could be referred to var. *cristata* (L.) Kuntze.

CYATHULA Bl.

Perennial herbs; stem and branches ± angular, ± densely hairy. Leaves opposite, ± hairy. Inflorescences terminal, sometimes also lateral, compact, becoming lax from base, of shortly stalked flower clusters also comprising bundles of spiny hooks (deformed sterile flowers); bracts and bracteoles membranous, hairy outside; clusters and subtending bracts reflexed after flowering, the latter persistent. Flowers bisexual; tepals 5, 3–5-nerved, with long hairs outside; filaments joined at base, alternating with shorter interposed staminodes; anthers 2-celled; ovary with 1 pendent ovule; style filamentous; stigma capitate. Fruit 1-seeded, indehiscent, those of one cluster falling as a whole together with tepals, bracteoles and spiny hooks.

Distribution: An originally palaeotropical, mainly African genus of *c.* 25 species. 1 widely distributed species is found in Papuasia.

Ecology: Dispersal is facilitated by the spiny hooks of the flower clusters which fall as a whole when containing ripe fruits.

Cyathula prostrata (L.) Bl. *Bijdr. Fl. Ned. Ind.* 549 (1826). **Fig. 8.**

C. geniculata auct. non Lour.: Miq. (1858); *Pupalia atropurpurea* auct. non (Lamk.) Moq.: F. Muell. (1886).

Erect or ascending herb to 50(–100) cm tall; stem ± tinged red, much-branched, thickened and often rooting at nodes. Leaves with 2–12 mm long petiole; lamina ± narrowly rhombic, often ± abruptly narrowed below middle, 1·5–10(–15) × 1–5(–7) cm, acute to obtuse, finely mucronate at apex, obtuse to acute, often ± attenuate at base, with stiff appressed hairs especially on nerves, ± tinged red especially beneath and on nerves. Inflorescences mostly solitary, sometimes accompanied by lateral ones in uppermost leaf axils, conical when young, lengthening during flowering and becoming lax below, 5–25(–40) cm long including peduncle; primary bracts ovate to lanceolate, 1–2 cm long, acutely acuminate; clusters with 1–3 fertile flowers and some sterile ones. Tepals lanceolate, 2–3 mm long, distinctly mucronate, membranous, pale green with white hairs outside; filaments *c.* 1 mm long, anthers globular, minute; staminodes ± ligulate, minute. Fruit obovoid, *c.* 1·5 mm long with 1 mm long style.

Distribution: Palaeotropical, probably introduced into tropical America. Throughout Papuasia; also recorded from the Aru Islands.

Ecology: In primary and secondary forests, also as a weed in moist shady places, at 0–1200(–2000) m altitude.

DEERINGIA R. Br.

Perennial herbs, shrubs or woody climbers; stems ± angular when young. Leaves alternate, ± glabrous. Inflorescences lateral, sometimes also terminal, simple or branched; bracts and bracteoles membranous, glabrous. Flowers

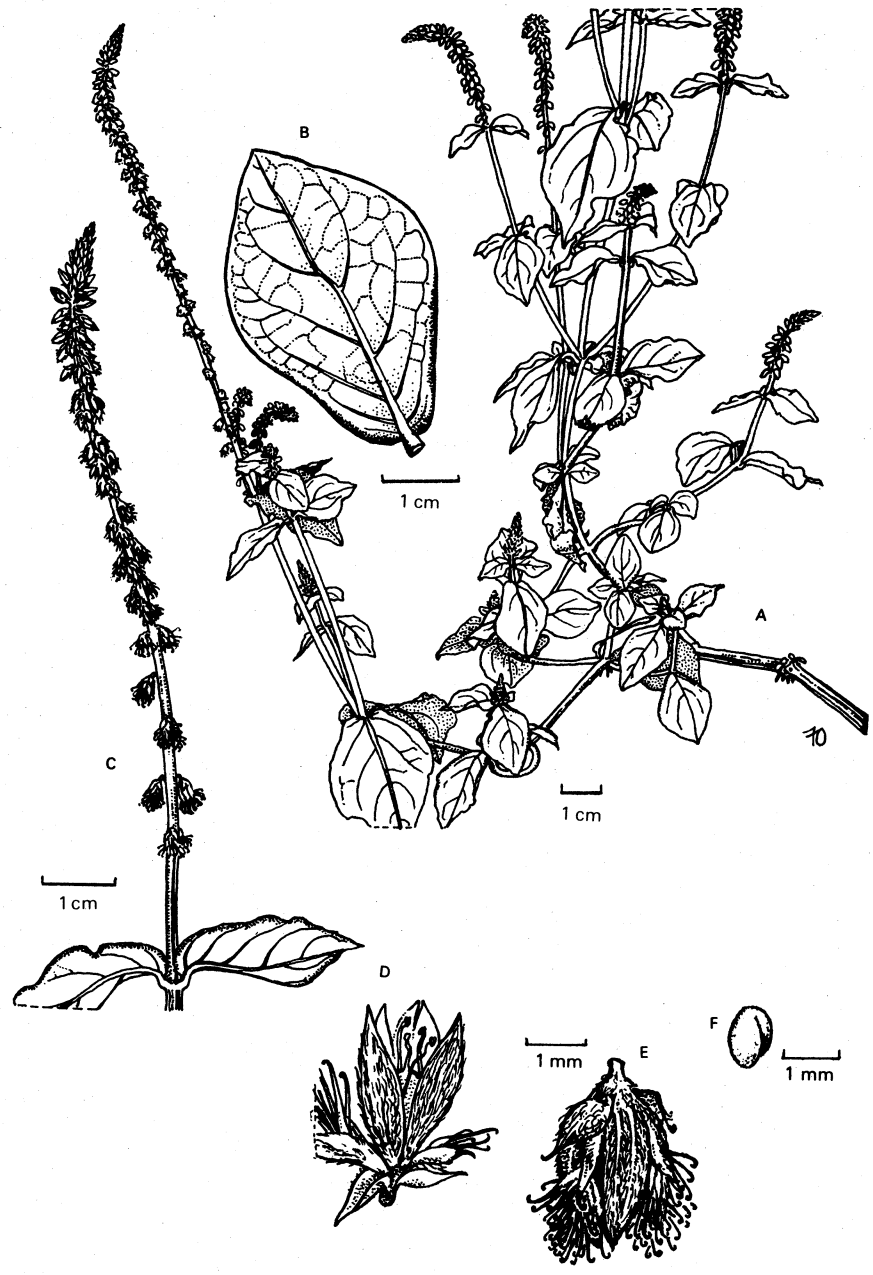


Fig. 8 **Cyathula prostrata** (L.) Bl. (A) part of plant (B) leaf, underside (C) inflorescence (D) flowers, hermaphrodite, centre, with two sterile flowers (E) flower-cluster (F) seed

bisexual or (functionally) unisexual, sessile or shortly stalked; tepals (4–)5, glabrous, persistent; stamens (4–)5, filaments ± joined at base, anthers 2-celled, oblong; staminodes absent or only in female flowers; ovary with few to many ovules, stigmas 2–3(–4), ± sessile. Fruit a berry with reniform seeds.

Distribution: An essentially tropical genus of *c.* 7 species, occurring in Madagascar and from India and southern China to northeastern Australia. 3 species are indigenous in Papuasia.

KEY TO SPECIES

1. Climber or scandent shrub; inflorescences terminal and lateral; berries red, with 1–5(–9) seeds; free parts of staminal filaments several times longer than joined basal parts
2. Lateral inflorescences racemose, 5–40 cm long, sometimes with 1 divergent branch at base; flowers bisexual; tepals ± reflexed in fruit; fruit 4–7 mm across, with 1–5(–9) seeds; scandent shrub or low climber..... **D. amaranthoides**
2. Lateral inflorescences paniculate, 5–20 cm long; flowers functionally unisexual; tepals appressed in fruit; fruit 3–4 mm across, with 1–2 seeds; tall climber.... **D. arborescens**
1. Herb or soft shrub, usually erect; inflorescences lateral only; berries white, with many seeds; free parts of staminal filaments about as long as joined basal parts.. **D. polysperma**

Deeringia amaranthoides (Lamk.) Merr. *Interpr. Rumph. Herb. Amb.* 211 (1917).

D. celosioides R. Br. (1810), nom. illeg.; *D. indica* Retz. ex Bl. (1826); *D. baccata* (Retz.) Moq. (1849).

Scandent shrub or climber to 2·5(–5) m tall; young stems finely appressed pubescent, glabrescent. Leaves with 0·5–3 cm long petiole; lamina ovate to lanceolate, (2·5–)4–12(–16) × (1–)2–5(–8) cm, ± acutely acuminate, with ± caducous mucro at apex, rounded to acute, often ± attenuate at base, glabrous or very sparsely hairy when young. Inflorescences racemose, ± lax, simple when lateral and (5–)10–25(–40) cm long including peduncle, often compound when terminal and to 75 cm long; bracts ± triangular, 1–1·5 mm long, bracteoles ± ligulate, *c.* 1 mm long. Flowers bisexual, malodorous, on *c.* 0·5 mm long pedicels; tepals ovate, 1·5–2·5 mm long, obtuse, tinged red with white margins, reflexed in fruit; staminal filaments 1·5–3 mm long, joined at base for *c.* 0·3 mm. Berry globose or obovoid, 4–7 mm across, bright red, with 3 recurved stigmas; seeds 0–5(–9), *c.* 1·2 mm across, smooth, black.

Distribution: Occurring from India to southern China to northeastern Australia. In Papuasia so far only recorded from the Vogelkop district in western New Guinea, and the East Sepik, Madang, Morobe and Central districts in eastern New Guinea.

Ecology: In primary and secondary monsoonal or rain forests, often along forest edges and near water courses or swampy localities, also on ridges, sometimes on weathered limestone, at 0–1200 m altitude.

Deeringia arborescens (R. Br.) Druce *Rep. Bot. Exch. Club Br. Isles* 619 (1917).

D. altissima (Moq.) F. Muell. (1860).

Liana of forest canopy; young stems often densely clothed with short

brown hairs, glabrescent. Leaves with 1–4 cm long petiole; lamina ovate to lanceolate, (5–)7·5–15(–20) × (2–)4–7·5(–10) cm, acutely, often ± abruptly, acuminate at apex, rounded or obtuse, often ± attenuate at base, often clothed with short brown hairs when young, glabrescent especially between nerves. Inflorescences lateral and terminal, paniculate, 5–20 cm long including peduncle; branches to 7 cm long; bracts and bracteoles ovate, *c.* 1 mm long, the latter slightly smaller, acute to rounded. Flowers sessile, unisexual, male flowers apparently bisexual; tepals ovate, *c.* 1·5 mm long, obtuse, appressed to ripe fruit, those in male flowers to 2 mm long, white; stamens slightly exceeding perianth, sterile ones in female flowers slightly shorter, filaments only shortly joined at base; ovary ± globose, sterile ones in male flowers conical. Berry globose, 3–4 mm across, red, with 3 recurved stigmas; seeds 1–2, *c.* 1 mm across, densely and finely warty, black.

Distribution: Recorded from the southeastern Celebes and the southern Moluccas as well as from northeastern Australia. In Papuasia only collected from Saibai Island in the Torres Strait, the Central district (Isuarava) in Papua, and Bougainville.

Ecology: In primary and secondary rain forests at 0–1200 m altitude.

Deeringia polysperma (Roxb.) Moq. in DC. *Prodr.* **13**(2): 236 (1849). **Fig. 9.**
D. indica Zoll. ex Moq. (1849), non Retz. ex Bl. (1826).

Herb or soft shrub to 2 m tall, usually erect, sometimes decumbent or scrambling; stems often ± hairy on younger parts, glabrescent. Leaves with 1–5 cm long petiole; lamina lanceolate, (5–)8–20(–25) × (2–)3–7(–8·5) cm, acute or acuminate at apex, acute or attenuate at base, subglabrous, finely warty on both surfaces. Inflorescences lateral, racemose, simple or with single branch, sometimes apparently paired, 2–6 cm long, occasionally longer and becoming rather lax; bracts acutely ovate, *c.* 1·5 mm long, bracteoles more obtuse, *c.* 1 mm long. Flowers bisexual, sessile; tepals obtusely obovate, 2–2·5 mm long, to 3 mm long when appressed to ripe fruit, green with white margins; staminal filaments 1·5–2 mm long, joined in lower half. Berry globose or slightly depressed, 3–5 mm across, white, with 2–3 straight stigmas; seeds usually 20 or more, *c.* 9·8 mm across, finely warty, black.

Distribution: Occurring throughout Malesia; possibly throughout most of Papuasia, but so far only recorded from the Vogelkop and Jayapura districts in western New Guinea, the Morobe, Gulf, Central, Northern and Milne Bay districts in eastern New Guinea, and New Britain in the Bismarck Archipelago.

Ecology: In primary and secondary rain forests, usually in moist places, often near water courses or swampy localities, also along tracks, at 0–1000 m altitude.

GOMPHRENA L.

Annual herbs; stems ± quadrangular, ± hairy. Leaves opposite, ± hairy. Inflorescences terminal, sessile, subglobose at first, ± lengthening during

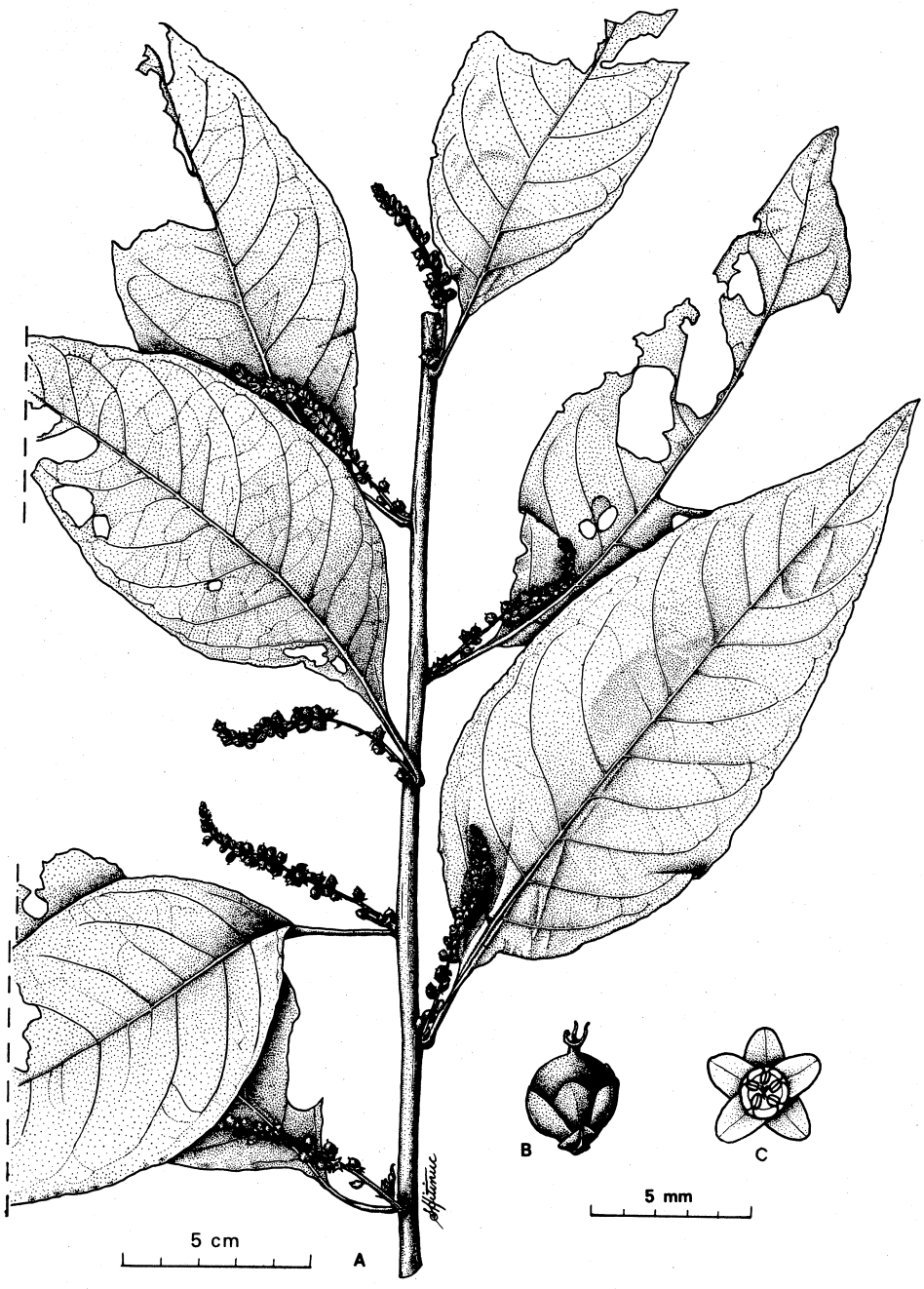


Fig. 9 **Deeringia polysperma** (Roxb.) Moq. (A) stem with inflorescences (B) fruit (C) flower

flowering; bracts and bracteoles dry-membranous, glabrous, bracteoles keeled with dorsal crest, longer than bracts. Flowers bisexual, sessile; tepals 5, hairy outside; stamens 5, filaments almost completely joined into tube, anthers 1-celled, alternating with staminodial lobes of about equal length; ovary with 1 pendent ovule; style and 2 stigmas enclosed by staminal tube. Fruit 1-seeded, falling unopened with perianth and bracteoles.

Distribution: A neotropical genus of *c.* 90 species, some of which have been introduced into the palaeotropics and subtropics. 2 introduced species are found in Papuasia.

Notes: *c.* 15 indigenous Australian species have been referred to *Gomphrena*, probably erroneously, by Bentham and others, but none of these is known from Papuasia.

KEY TO SPECIES

1. Influorescences *c.* 1 cm across, initially ± globose, becoming cylindrical and to 5 cm long; bracteoles with narrow dorsal crest in upper part only, ending ± abruptly below apex, white, sometimes yellow towards apex ..... **G. celosioides**
1. Inflorescences *c.* 2 cm across, initially depressed-globose, becoming ovoid and to 3 cm long; bracteoles with distinct dorsal crest from base, exceeding apex, deep purple, pink or white ..... **G. globosa**

Gomphrena celosioides Mart. *Beitr. Amaranth.* 93 (1825). **Fig. 10.**

Erect or ascending herb; stems to 30 cm long, with white hairs, often branched from base, highest internodes usually much longer than lower ones. Leaves with up to 1 cm long, ± winged petiole, upper leaves ± sessile; lamina ± lanceolate, 1·5–5(–8) × 0·5–1·5 cm, acute to obtuse, mucronate at apex, acute at base, ± glabrous above, ± hairy beneath. Inflorescences solitary, initially globose, *c.* 1 cm across, becoming cylindrical and to 5 cm long, ultimately losing flowers from base upwards; bracts ovate, 3–4 mm long, acute, mucronate; bracteoles lanceolate, *c.* 6 mm long, acute, with narrow denticulate dorsal crest in upper part only, ending ± abruptly below apex, white or yellow towards apex. Tepals lanceolate, *c.* 5 mm long, acute, white, densely hairy outside in lower half; staminal tube slightly shorter than perianth, free lobes obtuse to acute. Fruit ovoid, laterally compressed, 1·5–2 mm long; seed similarly shaped but with distinct edge, smooth, shiny black.

Distribution: Originally a neotropical species, now occurring widely throughout the tropics; introduced into Papuasia towards the middle of this century, spreading mainly from centres like Jayapura in western New Guinea as well as Lae and Port Moresby in eastern New Guinea.

Ecology: A weed of dry open places, often along roads or near wharfs and airfields at low altitudes.

Gomphrena globosa L. *Sp. Pl.* 224 (1753).

Erect herb, or decumbent at base and rooting at nodes; stems to 60 cm long, thickened above nodes, often tinged red, with soft hairs on younger parts, glabrescent. Leaves with 1–1·5 cm long petiole, upper leaves ± sessile;

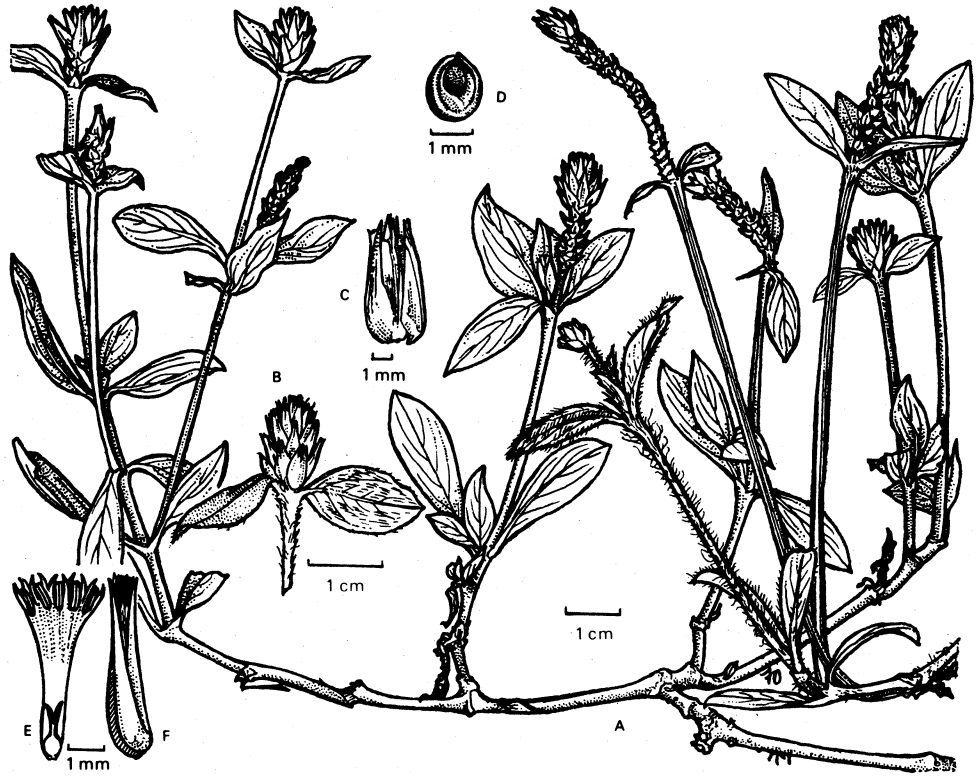


Fig. 10 **Gomphrena celosioides** Mart. (A) part of old plant (B) inflorescence (C) flower (D) seed (E) staminal tube, opened to show pistil (F) flower, partly dissected

lamina elliptic or obovate to lanceolate or oblanceolate, 4–8(–15) × 1·5–3·5(–6) cm, obtuse to acute, distinctly mucronate at apex, obtuse to ± attenuate at base, thinly hairy on either side. Inflorescences usually solitary, sometimes 2 or 3 close together, initially ± depressed-globose, *c.* 2 cm across, becoming ovoid and to 3 cm long; bracts ovate, 3–6 mm long, acute to acuminate; bracteoles lanceolate, with dentate dorsal crest from base and exceeding apex, 7–12 mm long, deep purple, pink or white. Tepals lanceolate, *c.* 6 mm long, yellow, ± tinged purple, with white hairs outside; staminal tube about as long as perianth, free lobes obtuse to rounded. Fruit ovoid, *c.* 2·5 mm long; seed ± reniform, rather thick, with distinct funicle along one side, shiny brown.

Distribution: Originally a neotropical species, now occurring widely throughout the tropics and subtropics. Introduced into Papuasia before this century, mainly near coastal settlements.

Ecology: Occurring as a weed on waste lands but possibly not fully naturalized, at 0–600(?) m altitude.

Uses: Ornamental.

IRESINE Browne

Perennial herbs; stems angular, ± hairy. Leaves opposite, sparsely hairy. Inflorescences terminal, sometimes also lateral, paniculate, many-flowered; bracts and bracteoles membranous, glabrous. Flowers unisexual, ± sessile; tepals 5, ± hairy outside; stamens 5, in female flowers minute and staminodial, in male flowers filaments joined at base, usually alternating with interposed staminodes, anthers 1-celled; ovary with 1 pendent ovule, absent in male flowers; style very short; stigmas 2. Fruit 1-seeded, not opening.

Distribution: An American genus of *c.* 70 species, some of which have been introduced elsewhere. 1 species is found in Papuasia.

Iresine herbstii Hook. f. *Gard. Chron.* 654, 1206 (1864). **Fig. 11.**

Erect or ascending herb; stem often much-branched, initially hairy, glabrescent except on thickened nodes. Leaves with 1–5 cm long petiole; lamina broadly ovate to obovate, often almost orbicular, often ± bilobed, (2–)4–8(–15) × (1·5–)3–7(–8) cm, acuminate to ± deeply emarginate at apex, truncate to ± attenuate at base, ± fleshy, dark purplish-red or green with paler or yellow zones along nerves. Panicles 1–3-branched, often in upper leaf axils as well as terminal, (5–)10–40(–60) cm long including peduncle; rachis and branches purplish-red; bracts acutely ovate, *c.* 1 mm long, pale green or yellowish-white, persistent; bracteoles similar, slightly larger. Flowers female only (in Papuasia); tepals acutely lanceolate, *c.* as long as bracteoles, pale green or yellowish-white, hairy outside near base; staminodes ± triangular, minute; ovary depressed-globose, glabrous, stigmas ± sessile. Fruit not produced (in Papuasia).

Distribution: Originally a South American species, now widely introduced elsewhere. In Papuasia reported since 1960 from the Western and Eastern

Fig. 11 **Iresine herbstii** Hook. f. (A) sterile branch (B) part of panicle (C) apex of branch with flowers (D) flower

Highlands, Madang, Morobe, Central and Milne Bay districts in eastern New Guinea.

Ecology: In Papuasia propagated vegetatively only, but well established in moist, shady places like river crossings, at 500–2500 m altitude.

Uses: A common ornamental in mountain areas, reported once as a vegetable from the Madang district (Simbai).

PSILOTRICHUM Bl.

Annual herbs; stem angular, ± hairy at nodes. Leaves opposite, glabrous. Inflorescences terminal, sometimes also lateral, solitary or in pairs, conical, lengthening during flowering; bracts and bracteoles membranous, glabrous. Flowers bisexual, sessile; tepals 5, with conspicuous parallel nerves, glabrous; stamens 5, filaments joined at base, anthers 2-celled; staminodes absent; ovary with 1 pendent ovule; style short; stigma capitate. Fruit 1-seeded, falling unopened with perianth and bracteoles.

Distribution: A palaeotropical genus with 14 mostly African species. 1 Asian species occurs in Papuasia.

Psilotrichum ferrugineum (Roxb.) Moq. in DC. *Prodr.* **13**(2): 279 (1849). **Fig. 12.**

P. trichotomum Bl. (1826).

Erect or ascending herb; stem often much-branched from base, to 50 cm long, often with rather long and slender internodes, often ± tinged purple. Leaves with 2–5(–10) mm long petiole; lamina elliptic or lanceolate to obovate, or oblanceolate (0·7–)1–3(–7·5) × (0·3–)0·5–1(–2) cm, obtuse to acute, mucronate at apex, acute to attenuate at base. Inflorescences usually terminal and solitary, occasionally lateral or paired, rather compact and conical at apex, lengthening during flowering, 0·5–1·5 cm long, with up to 1 cm long peduncle, lower flowers falling successively; rachis with white hairs; bracts acutely ovate, *c.* 1 mm long, persistent; bracteoles similar but smaller, ultimately falling. Tepals acutely lanceolate, 2–2·5 mm long, with 3–5 strong straight nerves; staminal filaments thin, 0·5–0·8 mm long from base of cup, anthers minute. Fruit compressed-ellipsoid, 1–1·5 mm long with *c.* 0·5 mm long style; seed *c.* 1 mm long, shiny, brownish-black.

Distribution: A Southeast Asian and Malesian species. In Papuasia only known from the Madang, Morobe, Northern and Milne Bay districts in eastern New Guinea, but possibly more widely distributed.

Ecology: A species of moist places in forests as well as open grasslands, on clayey or peaty soils, often along tracks or ditches, at 0–1200(?) m altitude. Sometimes a locally common weed but otherwise possibly rather rare.

EXCLUDED SPECIES

The genus *Pupalia* Juss. has been recorded erroneously for Papuasia through

P. lappacea (L.) Juss. (syn.: *P. atropurpurea* (Lamk.) Moq.). This was based on misidentifications of collections correctly referred to *Cyathula prostrata* (L.) Bl.

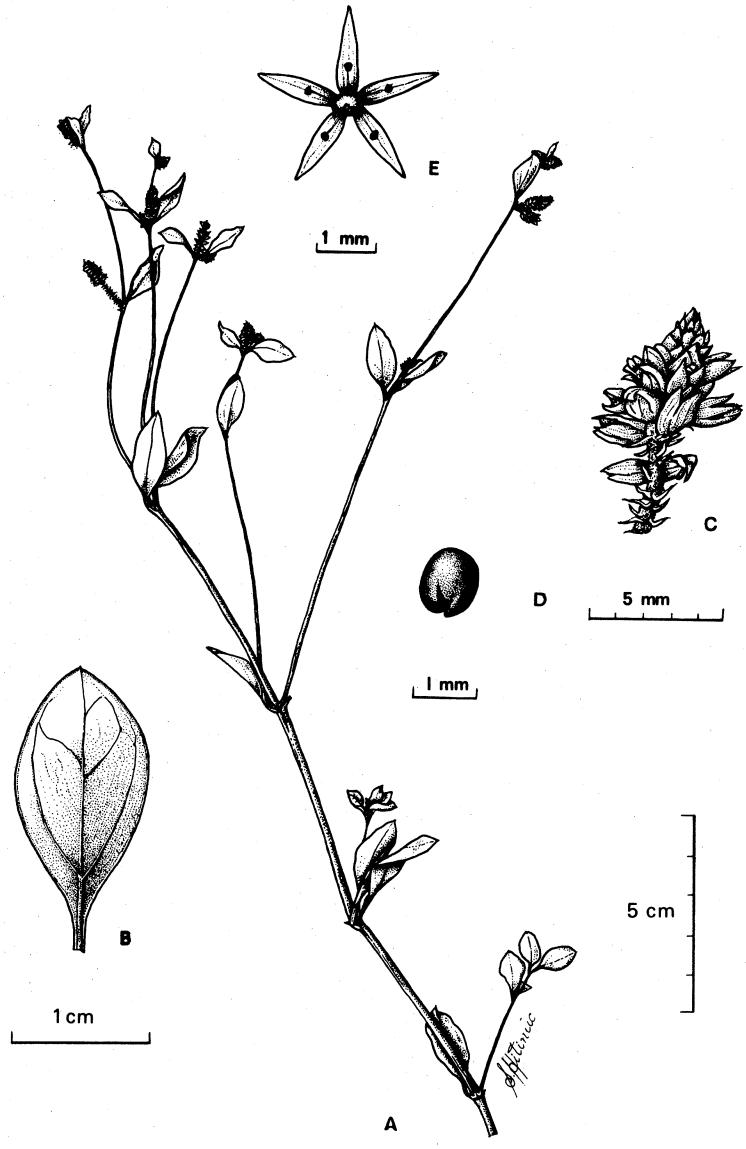


Fig. 12 **Psilotrichum ferrugineum** (Roxb.) Moq. (A) part of plant (B) leaf, upper surface (C) old inflorescence (D) seed (E) flower

COMBRETACEAE

M. J. E. Coode

Trees, shrubs or woody climbers. Stipules none. Leaves verticillate, opposite, spirally arranged or rarely alternate, often with domatia, margin entire (in Papuasia). Inflorescence a spike (branched or not), raceme or panicle. Flowers bisexual or male, 4–5-merous, regular; bisexual flowers (in Papuasia) sessile, ovary surmounted by calyx tube, with 4–5 calyx lobes (rarely more), tube often merging imperceptibly with ovary, tubular to cup-shaped and sometimes clearly differentiated into lower part containing disc and expanded upper part; male flowers similar (in Papuasia) but ovary sterile, thin and resembling a pedicel. Petals 4–5, inserted near mouth of calyx tube. Stamens usually twice as many as calyx lobes, (7–)8–10(–11), inserted inside calyx tube, usually exserted. Disc intrastaminal, sometimes absent. Ovary inferior, 1-celled with 2–6 pendulous ovules. Style 1, free (except in *Quisqualis*), stigma 1. Fruit drupaceous or dry, usually indehiscent, often ridged, angled or winged, sessile or stipitate; pericarp thin and papery, or leathery or fleshy. Seed 1.

Distribution: 18 genera with *c.* 450 species distributed throughout the tropics and subtropics; 2 genera circumtropical (*Combretum* and *Terminalia*). 3 genera indigenous, the fourth probably indigenous but perhaps introduced and completely naturalized (*Quisqualis*).

Literature: M. J. E. Coode (1969a), *Kew Bull.* **23**: 299; (1969b), *Manual of the Forest Trees of Papua and New Guinea*, pt 1 (rev.), Combretaceae, 1–86; (1973), Notes on Terminalia L. (Combretaceae) in Papuasia, *Contr. Herb. Aust.* **2**: 1–33. A. W. Exell (1954), Combretaceae, *Fl. Males.* ser. 1, **4**(5): 533–89. T. C. Whitmore (1966), *Guide to the Forests of the British Solomon Islands*, 54–8.

KEY TO GENERA

1. Trees or shrubs, with or without petals; leaves spirally arranged or alternate
 2. Flowers with petals; trees or shrubs of mangrove.....LUMNITZERA
 2. Flowers without petals; forest trees, sometimes coastal.....TERMINALIA
1. Climbers or scramblers with petals; leaves verticillate or opposite
 3. Ovary and calyx together > 5 cm long.....QUISQUALIS
 3. Ovary and calyx together much shorter.....COMBRETUM

COMBRETUM Loefl.

Woody climbers (in Papuasia). Leaves opposite or verticillate, petiolate. Flowers bisexual, pentamerous or tetramerous, sessile (in Papuasia, fruits

Fig. 13 **Combretum constrictum** (Benth.) Rawson (A) flowering twig (B) individual flower

may become stalked), in elongate sometimes branched spikes (in Papuasia). Disc present. Ovules 2–6. Fruits 4–5-winged or ridged, in Papuasia indehiscent.

Distribution: *c.* 250 species throughout the tropics, most abundant in Africa. 4 species indigenous in Papuasia; 1 further species (African), *C. constrictum* (Benth.) Rawson, **Fig. 13,** a commonly cultivated shrub in Papua New Guinea, may be distinguished by the scarlet flowers set all round the axis in dense spikes (cf. *C. goldieanum* F. Muell., **Fig. 14,** in which the flowers are set on one side only).

Notes: Throughout this account measurements are taken from dried material. According to Exell the floral parts shrink considerably on drying.

KEY TO SPECIES

1. Flowers and fruits tetramerous; inflorescence scaly or glabrous; petals ± glabrous
 2. Calyx lobes short and broad, < 1 mm long, often obscure..... **C. acuminatum**
 2. Calyx lobes triangular, usually 1·5 mm or more long..... **C. tetralophum**
1. Flowers and fruits pentamerous; inflorescence with simple hairs; petals hairy
 3. Leaves in opposite pairs; fruit wings thin and flexible, 6–7 mm broad; calyx cup deep, 6–7 mm long..... **C. goldieanum**
 3. Leaves (2–)3–4 in a whorl; fruit wings narrow, stiff, *c.* 3 mm broad; calyx cup much shallower, usually not > 1 mm..... **C. trifoliatum**

Combretum acuminatum Roxb. *Fl. Ind.* (ed. Carey) **2**: 228 (1832); Exell *Fl. Males.* ser. 1, **4**: 538 (1954), f. 2c.

Climbers, probably evergreen. Young parts with minute scales, later ± glabrous. Leaves elliptic to oblong, 10–18 × 4–8 cm, acute at tip, tapering at base. Inflorescence solitary, unbranched, axillary, rarely ± paniculate, ± densely scaly to glabrous, bearing 20–50 sessile flowers. Ovary 1–1·5 mm long. Calyx tube cup-shaped, greenish, *c.* 2 mm long, 2–3 mm diameter, hairy inside; lobes very short (1 mm long) to almost absent. Petals very small, narrow, 0·5–1 mm long, ± glabrous, yellow. Stamens 8, 3–5 mm long, inserted at same level. Style 5–6 mm. Fruit sessile, densely scaly (especially when young) and with short hairs, 3·5–6·5 × 1–2 cm, 4(–5)-ridged (not yet collected in Papuasia).

Distribution: Known from three collections from the Digul district in western New Guinea and from the Western district of Papua. Extends throughout Malesia, and southern Asia as far west as Ceylon.

Ecology: Riverine or flood-plain forests. Exell suggests the fruits are waterborne.

Combretum goldieanum F. Muell. *Descr. Not. Pap. Pl.* pt 4, 66 (1876); Exell *Fl. Males.* ser. 1, **4**: 537 (1954), f. 2b. **Fig. 14.**

Deciduous climbers. Young parts appressed-hairy. Leaves elliptic to ovate-elliptic, 9–17 × 5·5–11 cm, acute to ± obtuse at tip, broadly tapered to rounded to sometimes cordate at base. Inflorescences often produced before leaves, usually solitary and unbranched in axils of fallen leaves,

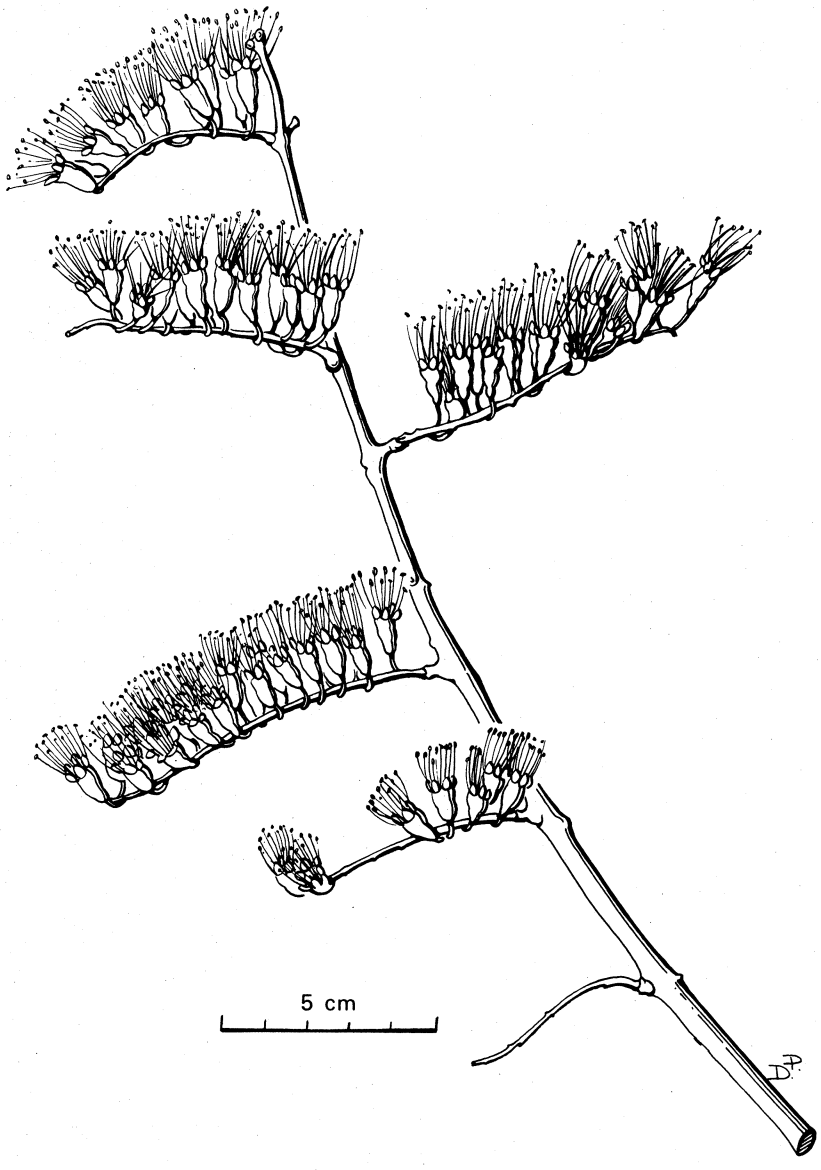


Fig. 14 **Combretum goldieanum** F. Muell. The plant is leafless when in flower

bearing *c.* 60 flowers on one side like a tooth-brush, appressed-hairy throughout. Ovary 3–5 mm long, with very pedicel-like appearance in flower; after rest of flower fallen, basal part lengthens and forms distinct stalk *c.* 3 mm long while tip develops into fruit. Calyx tube 6–9 mm long, top $\frac{2}{3}$ distinguished as a narrowly conical tube above lower $\frac{1}{3}$ which fused to nectary disc, with broad, very short calyx lobes at end, long hairs inside. Petals white, oblong, *c.* 2·5 × 1 mm, blunt, densely hairy outside, glabrous inside. Stamens 10; filaments conspicuous, exserted, red, straight, to 2 cm long, inserted at two levels in tube. Style red, *c.* 2 cm long overall. Fruit usually broadly 5-winged, almost as broad as long, 1·5–2 cm long with narrow central part containing seed.

Distribution: Commonest in the Central district of Papua, with two collections from each of the Northern and Milne Bay districts.

Ecology: Savanna woodlands and monsoon forests, at low altitude.

Notes: A very showy climber, suitable for growing in areas with a distinct dry season and moderate rainfall.

Combretum tetralophum C. B. Clarke in Hook. f. *Fl. Br. India* **2**: 454 (1878); Exell *Fl. Males.* ser. 1, **4**: 541 (1954), f. 4.

C. acuminatum auct. non Roxb.: K. Sch. & Hollr. (1889) and other later authors.

Climbers, probably evergreen. Young parts minutely scaly, scales sometimes hidden by dense soft hairs. Leaves usually opposite, occasionally in whorls of 3, elliptic or ovate-elliptic, 8–12 × 4–6 cm, acute at tip, tapering to rounded at base. Inflorescences simple and solitary in axils of current leaves or becoming terminal and branched, each branch bearing 20–40 flowers, scaly throughout though scales on rachis sometimes hidden by hairs. Ovary 2·5–4 mm long. Calyx 2·5–4 mm long overall, with short conical base containing nectary disc, and cup-like tip, with 4 triangular, acute calyx lobes 1·5–2 mm long, scaly outside, hairy inside. Petals white, narrowly oblanceolate, glabrous, to 3 × 1 mm. Stamens 8; filaments 3–4 mm long, exserted. Style 3–4 mm long. Fruit sessile, ovoid to ellipsoid, with 4 stiff, broad-based flanges, 2·2–3 × *c.* 1·5 cm, densely and minutely scaly.

Distribution: Scattered. Known from the Jayapura district of western New Guinea, from the East Sepik, West Sepik, Madang and Morobe districts of northeastern New Guinea and from the Western district of Papua. There is also one specimen from New Britain, the only record of *Combretum* from the Bismarck Archipelago. Widely distributed in Malesia, Southeast Asia and Micronesia (Carolines).

Ecology: Riverine or swampy habitats in lowland forest.

Combretum trifoliatum Vent. *Choix. Pl.* t. 58 (1808); Exell *Fl. Males.* ser. 1, **4**: 537 (1954), f. 2a, 3.

Climber, probably evergreen. Young parts with dense, usually ± appressed, brown hairs, soon becoming ± glabrous. Leaves (2–)3–4 in a whorl, lanceolate,

ovate to ± elliptic, often relatively narrow, 7–19 × 3–5 cm, usually acute at **tip, broadly tapered** to rounded at base. Inflorescence a terminal or sometimes **axillary panicle, each** bearing 20–50 flowers. Ovary 1–1·5 mm long, quickly **extending to 3 mm** in some older flowers, with dense, grey hairs. Calyx **tube open cup-shaped**, *c.* 1·5 mm long and 2 mm in diameter, hairy outside, **with** ± triangular acute calyx lobes *c.* 1 mm long. Petals narrow, 1·5 mm, hairy all round. Stamens 10, filaments 2·5–3 mm long. Style *c.* 4 mm long. Fruit sessile, brown, glabrous, 25–30 × 9–12 mm; narrowly ellipsoid with 5 distinct rounded flanges or thick wings.

Distribution: In western New Guinea known from the Idenburg River in the Jayapura district (collected once) and from the Digul district. Collected several times in both the East Sepik district of northeastern New Guinea and the Western district of Papua.

Ecology: Riverine forest, flood-plains, rarely in regrowth; lowlands.

NAMES EXCLUDED

Combretum flavo-virens Laut. *Nova Guinea* **8**: 847 (1912) is now known to be *Prunus dolichobotrys* (Laut. & K. Sch.) Kalkm. of the Rosaceae.

LUMNITZERA Willd.

Evergreen trees or shrubs. Leaves spirally arranged, fleshy, nerves indistinct, oblanceolate to obovate, rounded at tip and tapered into petiole. Flowers bisexual, pentamerous, in short racemes or spikes, with 2 persistent ± triangular bracteoles adnate to ovary, ovary and calyx tube not clearly differentiated. Petals glabrous. Disc small or absent. Ovules 2–5. Fruit indehiscent, ± compressed, obtusely angled, crowned by persistent calyx.

Distribution: 2 species ranging from Polynesia to tropical Asia and East Africa respectively.

Ecology: Trees or shrubs of mangrove swamps, tidal rivers and estuaries, mostly on the landward side of the mangrove, often above high-tide level. In some places *Lumnitzera* forms a pure community.

KEY TO SPECIES

Exell (1954), p. 587, discusses at length methods of separating inadequate material of the two species.

1. Petals red, shortly clawed; staminal filaments twice as long as petals; inflorescences terminal; knee-shaped pneumatophores usually present..... **L. littorea**
1. Petals white (rarely pink?), sessile; staminal filaments as long as or only slightly longer than petals; inflorescences axillary; knee-shaped pneumatophores absent... **L. racemosa**

Lumnitzera littorea (Jack) O. Voigt *Hort. Suburb. Calc.* 39 (1845); Exell *Fl. Males.* ser. 1, **4**: 586 (1954), f. 31, 32, 33. **Fig. 15.**

Pyrrhanthus littoreus Jack (1822).

Trees to 25 m tall, usually less. All parts glabrous except for calyx margins and anthers. Leaves oblanceolate to obovate, 3–8 × 1–2·5 cm, rounded at

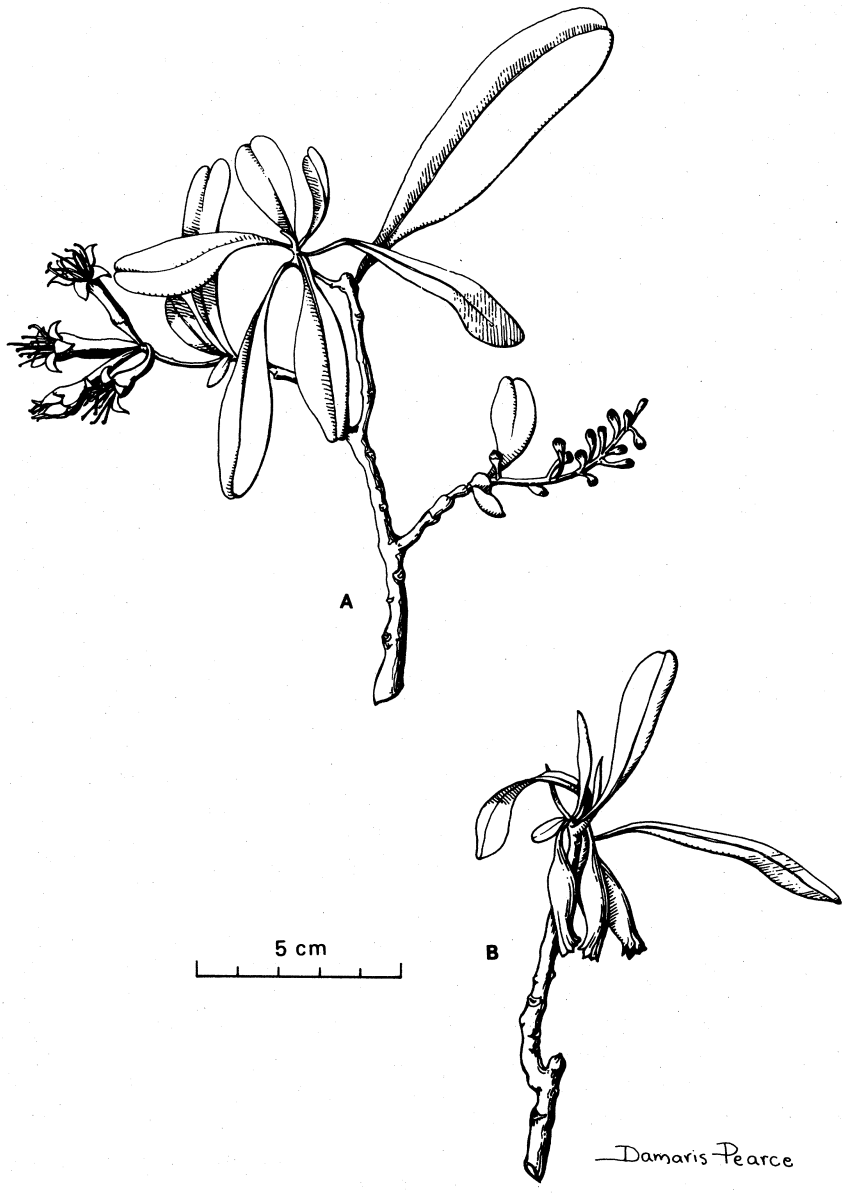


Fig. 15 **Lumnitzera littorea** (Jack) O. Voigt (A) flowering twig (B) fruiting twig

tip, tapered at base. Inflorescence bearing 5–15 flowers on pedicels *c.* 5 mm long. Ovary narrowly conical below for 8–15 mm, expanded above into calyx tube with short broad calyx lobes. Petals *c.* 4 × 2 mm. Staminal filaments to 1·2 cm long, red. Style *c.* 1 cm long. Fruit narrowly ellipsoid, ± smooth, 25 × 5 mm overall (pedicel *c.* 5 mm, persistent calyx *c.* 5 mm, neither clearly differentiated from central fruit body), corky-woody.

Field characters: Sometimes with stilt-roots. Old bark brown to grey, deeply fissured or scaly, with thick fibrous red, pink or straw-coloured inner bark.

Distribution: Only one collection seen from western New Guinea, near Manokwari in the Vogelkop district. In northeastern New Guinea known from the Morobe district, in Papua from the Western, Central, Northern and Milne Bay districts and in the Bismarck Archipelago from New Britain and Manus. Common throughout the Solomons. Despite the patchy distribution, it is likely to be found wherever suitable ecological sites occur. The species extends from tropical Asia to northern Australia and Polynesia.

Ecology: Generally a small to medium-sized tree in the drier part of the mangrove formation, usually above normal high water mark.

Uses: The wood is dark grey, hard, durable and fine-grained. In Malaysia this species is widely used wherever small timbers can be profitably worked. Reported to be durable both in sea water and when used as tramway sleepers or house-posts.

Lumnitzera racemosa Willd. *Neue Schr. Ges. Naturf. Fr. Ber.* **4**: 187 (1803); Exell *Fl. Males.* ser. 1, **4**: 588 (1954), f. 1b.

Shrubs or small trees to 8 m tall. Young parts with minute hairs. Leaves oblanceolate or obovate, 3–6 × 1–2 cm, rounded at tip, tapering at base, often with minute hairs at first, usually finally glabrous. Inflorescences solitary, spicate in axils of current leaves, bearing (1–)3–7 flowers. Ovary ± cylindrical, 6–8 mm, expanded above into calyx with short broadly ± triangular calyx lobes. Petals *c.* 4 × 1 mm. Staminal filaments about as long as petals, white. Style *c.* 4–5 mm long. Fruit narrowly ovoid, 11–13 × *c.* 4 mm including persistent calyx which sometimes appears to close up again in fruit, sessile (in Papuasia).

Distribution: Known from one specimen at Merauke in the Digul district of western New Guinea, from one in the Morobe district in northeastern New Guinea, and throughout Papua except the Papuan Islands. Not yet known from the north coast of mainland New Guinea, nor from the Bismarck Archipelago and the Solomons but recorded from Polynesia, also from northern Australia, throughout Malesia, tropical Asia, Madagascar and tropical East Africa.

Ecology: Generally this species is little more than a tall shrub on tidally inundated mud-flats (apparently rare in Papuasia).

Uses: The timber is similar to that of *L. littorea* but of even smaller dimensions.

Notes: Only two specimens in Lae have fruit. More are needed to confirm

that fruits of *L. racemosa* are always sessile in Papuasia, since Exell states that older specimens in fruit become difficult to separate from *L. littorea.*

QUISQUALIS L.

Differs from *Combretum* in having style fused to one inner face of calyx tube. In Papuasia calyx tube very much longer and petals larger and more showy than those of any Papuasian species of *Combretum.* The stamens inserted at two levels; ovules 3–4 in Papuasia; fruits indehiscent.

Distribution: c. 17 species of which 8 are African, 8 Asiatic with 1, *Q. indica,* widespread in old-world tropics.

Quisqualis indica L. *Sp. Pl.* 556 (1762); Exell *Fl. Males.* ser. 1, **4**: 547 (1954), f. 1d, 7, 8, 9. **Fig. 16.**

Climber. Young parts hairy. Leaves opposite or subopposite, ovate-elliptic, 8–13 × 4–6 cm, acute at tip, rounded at base, ± hairy at first, sometimes finally glabrous. Inflorescences terminal and axillary, sometimes forming a leafy panicle, each branch bearing 20–30 pentamerous flowers in axils of linear to ovate-acuminate bracts, which may persist or fall quickly. Ovary 3–6 mm long, hairy. Calyx tube 5–7 cm long, ± appressed-hairy outside, very gradually expanding at tip into calyx cup with acute calyx lobes 1–2 mm long ± reflexed at anthesis. Petals oblong, 10–15 × 3–4 mm, obtuse, with rather silky hairs outside, minute hairs inside, white at first, turning pink to red. Stamens *c.* 7 mm long. Free part of style *c.* 1·5 cm long. Fruit dark brownish, ± ellipsoid, with 5 stiff flanges or thick wings, acute at tip, ± rounded at base, sessile.

Field characters: The flowers open in the evening and are at first white but turn red on the second day.

Distribution: The species is probably native to Papuasia, but it could have been introduced. Apart from those specimens obviously collected near gardens, there are several collections from apparently remote areas (nearly always in riverine forest), the Digul district of western New Guinea, the Sepik districts (?introduced by Malay bird-of-paradise shooters) of north-eastern New Guinea and the Western district of Papua; there is also a collection from the Hoskins area of New Britain.

Ecology: A large climber found along the margins of primary forest, along river banks or in secondary forest. Plants spread by root-suckers.

Uses: A striking ornamental.

Notes: A second species *Quisqualis mussaendifolia* (Engl. & Diels) Exell has recently (1973) been introduced to horticulture in Papua New Guinea.

TERMINALIA L.

Trees. Leaves spirally arranged (alternate or subopposite in *T. brassii*), often crowded in tufts at tips of branchlets, often with domatia, frequently with

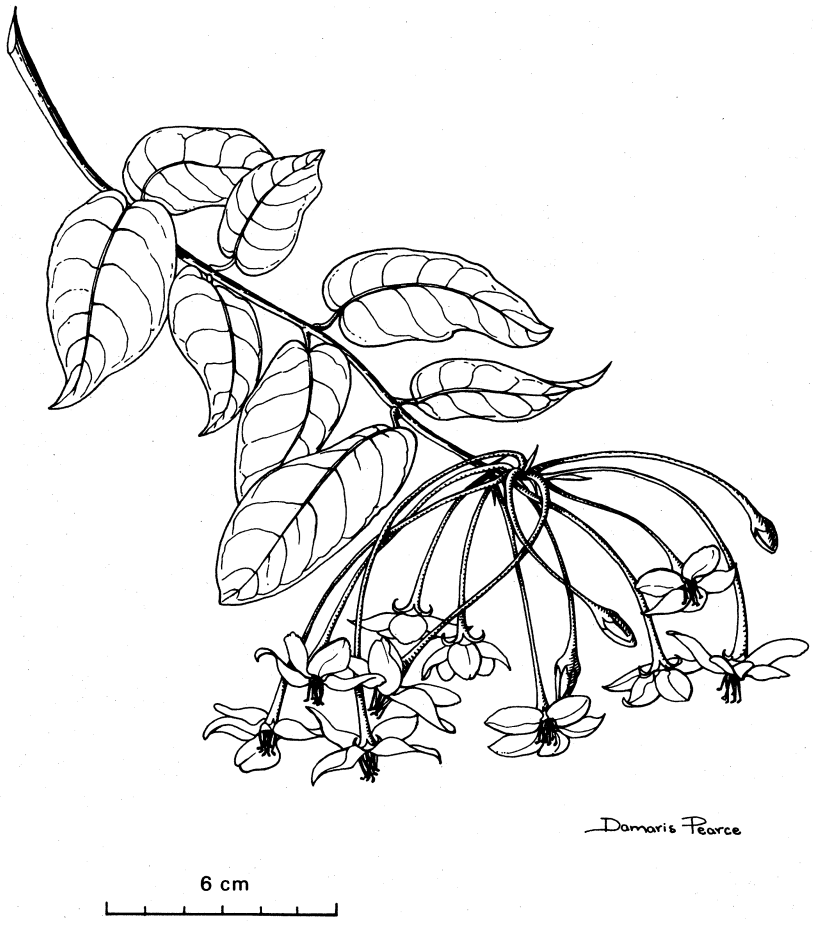


Fig. 16 **Quisqualis indica** L.

2 or more glands at or near base of leaf-blade or on petiole. Flowers usually pentamerous, rarely showy, usually in axillary spikes with male flowers towards tip and bisexual flowers towards base, more rarely spikes branched and terminal, or terminal and axillary. Calyx lobes usually triangular, rarely ovate (*T. oreadum*). Petals none. Disc present, densely hairy. Ovules usually 2. Fruit indehiscent, sessile, fleshy and drupaceous, often 2–5-winged or dry with 2 or more papery or leathery wings; seeds contained in ± dense, hard stone. Cotyledons usually 2 (to 5 in *T. kaernbachii* and *T. megalocarpa*).

Field characters: Often emergent forest trees, frequently buttressed or stilt-rooted.

Branching in *Terminalia* is characteristic, the pattern being found ± sporadically in other genera and often known as '*Terminalia*' or 'pagoda' type branching, **Fig. 17.** There is a main vertical leader. Each branch that grows from this leader does so rapidly and at a wide angle from it. As its growth slows, it turns upwards at the end. From its lower side, just at the bend, 1 or more branches arise, to grow out as other twigs which will follow the same course of turning up at the end and branching in their turn. Each branch then consists of a relatively long, leafless portion with a short terminal part with ± congested, spirally arranged leaves.

The leaves on the vertical leader shoots are usually noticeably larger than the rest. At least in the young stages, the principal lateral branches of the tree arise in whorls. The leader finally stops growing, and the upper branch whorls lengthen and become massive so that in mature trees the crown is usually flat or slightly domed.

The bark is usually vertically fissured, yellow-brown to greyish-brown. Underbark is often red. Inner bark is fibrous, often with fibres interlocking, reddish or yellowish in the outer layers, frequently yellow in the inner layers and in the cambium. The bark contains tannin, giving the characteristic bluish stain when cut with a steel axe or knife.

Most species of *Terminalia* are deciduous, usually about once a year. Leaf fall is often sudden, occurring during a few days. Development of new foliage is equally rapid, often following immediately upon leaf fall or even coinciding. In some trees, however, the leaves fall more gradually, from top to bottom; in others 1 or more branches lose all their leaves, the other branches following a few days later. Flowering frequently occurs with the development of the new foliage.

Distribution: Terminalia is found throughout the tropics and subtropics. There are said to be *c.* 200 species.

Ecology: Mostly lowland forests, often in flat or periodically flooded areas. A few species are found in savanna or monsoon woodland or in mid-altitude forests to 2000 m.

Wood: Pale yellowish or cream-coloured in the sap-wood, usually brown or red-brown in the heart-wood.

Native names: In northeastern New Guinea the name 'talis' is often used to cover species of *Terminalia*. Similarly the Kwara'ae names 'ama', 'amafoe', 'amarodo' cover more than one species in the Solomon Islands. Less certain,

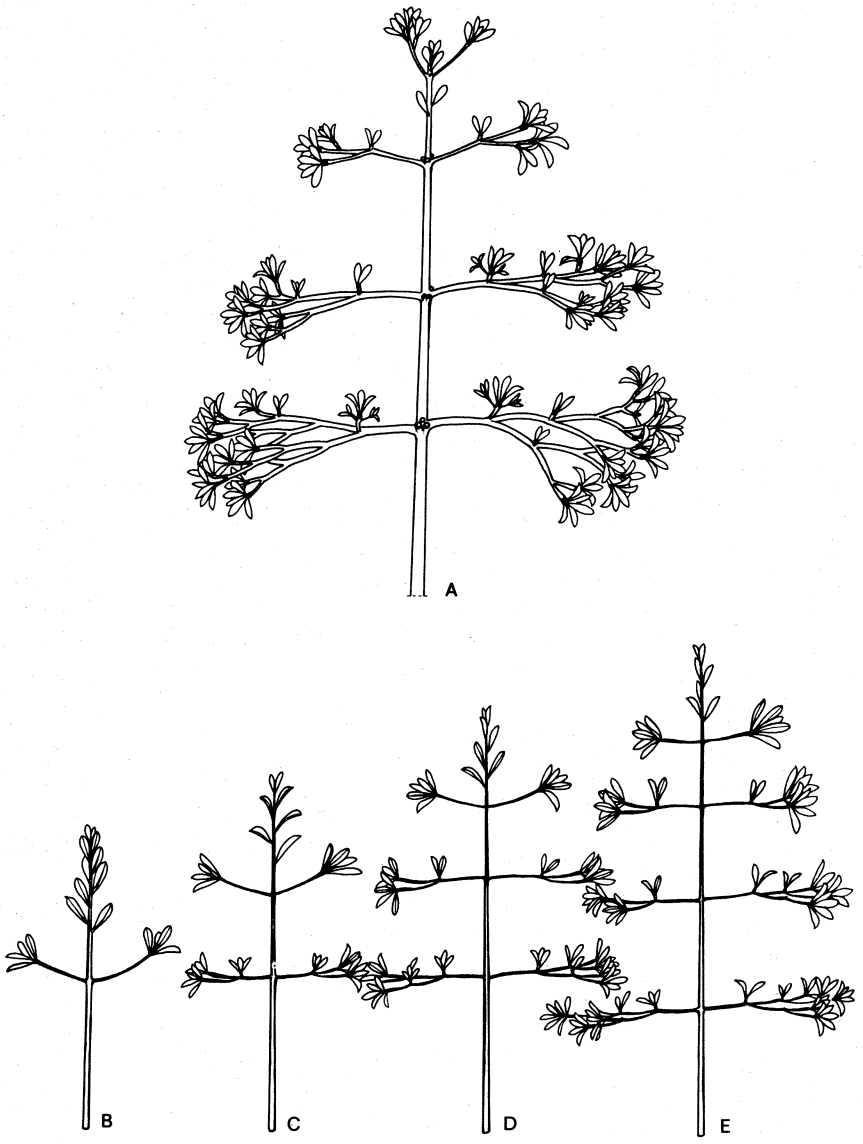


Fig. 17 *Terminalia*-type branching (A) tree with well-developed lateral branching and commencement of crown formation (B) juvenile with first lateral branch (C) juvenile tree with commencement of tertiary branching (D, E) development of tertiary branching on lower limbs and further sub-tertiary branchlets

the names 'gahwah', 'ga'uw', 'gaurah' are known from various languages of the Northern and Milne Bay districts of Papua and may refer to several species.

Notes: Fruits are very variable in size and shape and are of diagnostic value and essential to determine most of the species, **Figs 18–22.**

In Coode (1969b) there is a key to the species based on vegetative material together with a further, if less up-to-date, treatment of the Papuasian species with some wood descriptions and photomicrographs.

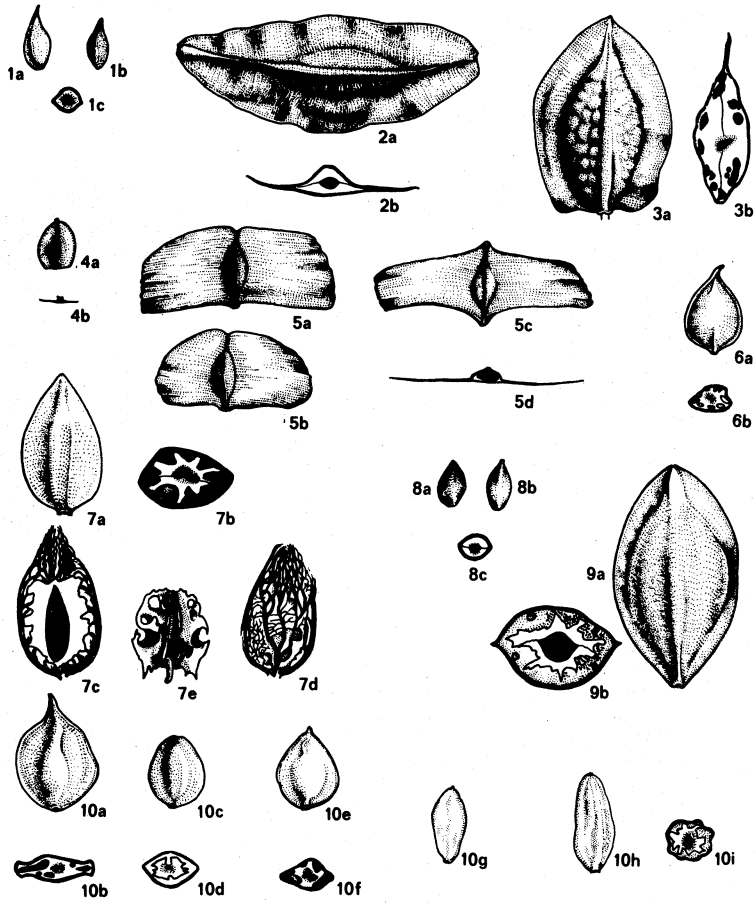


Fig. 18 *Terminalia* fruits 1. **T. archboldiana** Exell (1a) fruit in spirit (1b) dried fruit (1c) cross-section of 1b. 2. **T. archipelagi** Coode (2a) dried fruit (2b) cross-section of 2a 3. **T. avicapitis** Coode (3a) dried fruit (3b) cross-section of 3a, one wing missing. 4. **T. brassii** Exell (4a) dried fruit (4b) cross-section of 4a. 5. **T. calamansanai** (Blanco) Rolfe (5a–c) dried fruits, three different forms (5d) cross-section of dried fruit. 6. **T. calogemma** Coode (6a) dried fruit (6b) cross-section of 6a. 7. **T. canaliculata** Exell (7a) dried fruit (7b) cross-section of 7a (7c) inner face of half-stone, dried from rotting material (7d) outer face of 7a with fibres attached (7e) as 7d with fibres removed. 8. **T. capitulata** Exell (8a–b) dried fruit (8c) cross-section of 8a. 9. **T. catappa** L. (9a) dried fruit (9b) cross-section of 9a. 10. **T. complanata** K. Sch. (10a, c, e, g, h) dried fruits, various forms (10b, d, f, i) cross-sections of 10a, c, e, h respectively

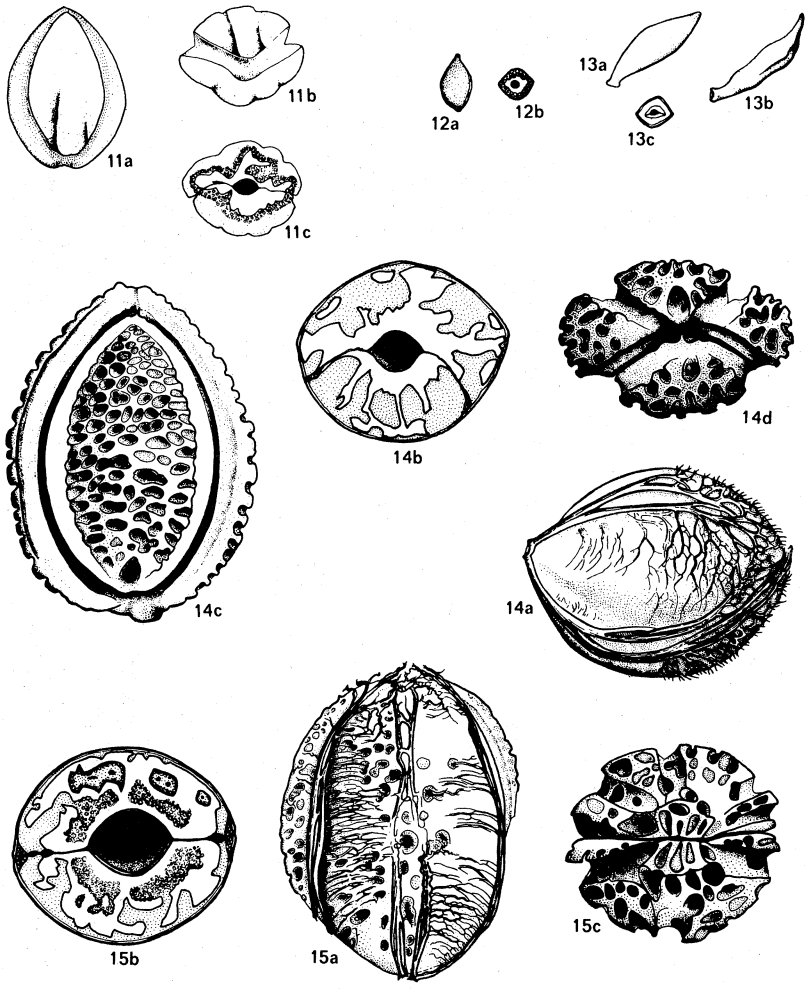


Fig. 19 *Terminalia* fruits 11. **T. copelandii** Elm. (11a–b) two views of dried stone with flesh rotted away (11c) cross-section of dried stone. 12. **T. crassifolia** Exell (12a) dried fruit (12b) cross-section of 12a. 13. **T. eddowesii** Coode (13a) fruit in spirit (13b) dried fruit (13c) cross-section of 13a. 14. **T. impediens** Coode (14a) dried fruit with flesh half-rotted before collection (14b) cross-section of 14a (14c–d) two views of dried stone with flesh and fibres rotted away. 15. **T. kaernbachii** Warb. (15a) dried fruit with flesh half-rotted before collection (15b) cross-section of 15a (15c) dried stone with flesh and fibres rotted away, end view

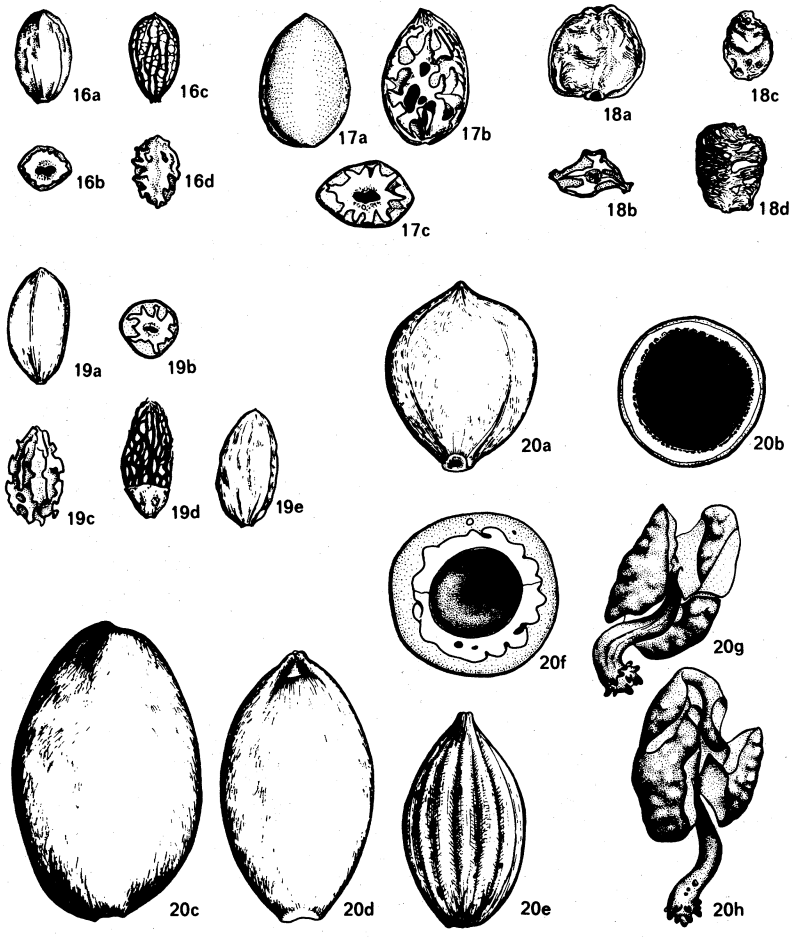


Fig. 20 *Terminalia* fruits 16. **T. katikii** Coode (16a) dried fruit (16b) cross-section of 16a (16c) dried stone with some fibres still attached (16d) as 16c with fibres removed. 17. **T. longespicata** Sloot. ssp. **longespicata** (17a) fruit in spirit (17b) stone with fibres removed (17c) cross-section of 17a. 18. **T. longespicata** ssp. **sogerensis** (Bak. f.) Coode (18a) dried fruit (18b) cross-section of 18a (18c) stone with fibres removed (18d) fibre network removed from one face of stone. 19. **T. macadamii** Exell (19a) fruit in spirit (19b) cross-section of 19a (19c) stone with fibres removed (19d) half-rotted fruit (19e) dried fruit. 20. **T. megalocarpa** Exell (20a) dried fruit in mainland form (20b) cross-section of 20a (20c–d) dried fruit of Solomon Island form (20e) stone of Solomon Island form (20f) cross-section of 20c–d (20g–h) embryo from 20c–d, in this case showing three cotyledons

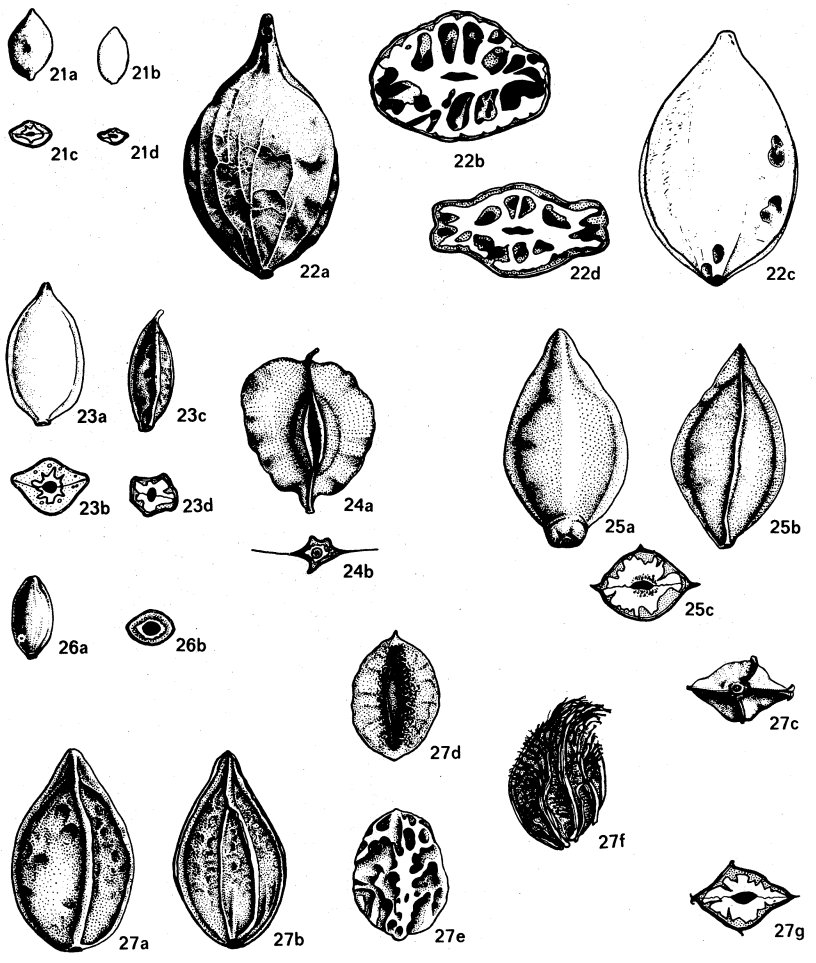


Fig. 21 *Terminalia* fruits 21. **T. microcarpa** Decne (21a) fruit in spirit (21b) dried fruit (21c–d) cross-section of 21a and 21b respectively. 22. **T. morobensis** Coode (22a) dried fruit from Vanimo (22b) cross-section of 22a (22c) dried fruit from Morobe district (22d) cross-section of 22c. 23. **T. oreadum** Diels (23a) fruit in spirit (23b) cross-section of 23a (23c) dried fruit (23d) cross-section of 23c. 24. **T. rerei** Coode (24a) dried fruit (24b) cross-section of 24a. 25. **T. rubiginosa** K. Sch. (25a–b) two views of dried fruit (25c) cross-section of dried fruit. 26. **T. samoensis** Rech. (26a) dried fruit (26b) cross-section of 26a. 27. **T. sepicana** Diels (27a–c) three views of dried fruit (27d) half-stone, inner face (27e) outer face of 27d (27f) half-rotted fruit with fibres attached to stone (27g) cross-section of 27a

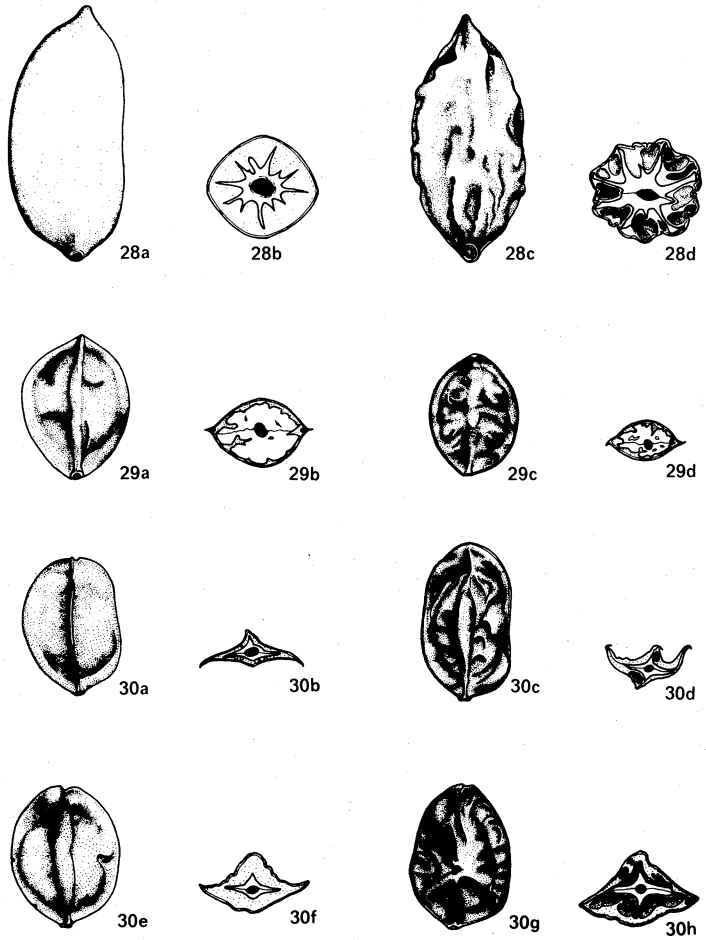


Fig. 22 *Terminalia* fruits 28. **T. solomonensis** Exell (28a) fruit in spirit (28b) cross-section of 28a (28c) dried fruit (28d) cross-section of 28c. 29. **T. steenisiana** Exell (29a) fruit in spirit (29b) cross-section of 29a (29c) dried fruit (29d) cross-section of 29c. 30. **T. whitmorei** Coode (30a) immature fruit in spirit (30c) dried immature fruit (30e) mature fruit in spirit (30g) dried mature fruit (30b, d, f, h) cross-sections of 30a, c, e, g respectively

KEY TO SPECIES

Based on fruiting material, excluding *T. slooteniana* (not seen) and *T. citrina* (doubtful record).

1. Fruits with thin wings, each as broad as or broader than ovary, not succulent when ripe
 2. Leaves ± alternate, scattered along slender twigs; inflorescences usually branched; fruits 9–14 mm long, longer than broad ..... **T. brassii**
 2. Leaves spirally arranged at apices of stout twigs, inflorescence unbranched; fruits larger, or broader than long
  3. Fruits much broader than long ..... **T. calamansanai**
  3. Fruits as long as broad or longer
   4. Leaves 5–7 × 2·5–3·5(–4) cm on slender petioles ..... **T. avicapitis**
   4. Leaves much larger, on stout petioles
    5. Fruit 1–1½ times longer than broad; leaves hairy beneath
     6. Leaves almost sessile, tapering towards subcordate base; petioles eglandular ..... **T. whitmorei**
     6. Leaves petiolate, tapering right to base; petioles biglandular ..... **T. rerei**
    5. Fruit 1½–2 times longer than broad; leaves glabrous ..... **T. archipelagi**
1. Fruits with thick wings, flanges or ridges, never as broad as ovary, often succulent when ripe
 7. Fruits with 2–5 flanges, occasionally wing-like (sometimes ripe fruits will fill out and obscure flanges that are visible in most other stages and in dried state, e.g. *T. catappa* and *T. sepicana*)
  8. Fruits with 2 flanges or thick ridges only
   9. Leaves 5–11 × 2·5–5·5 cm
    10. Leaves crowded at tips of twigs, leaf-scars crowded and prominent below current leaves; fruit ± orbicular or broadly ellipsoid, 2·5–3·5 × *c.* 2 cm ..... **T. steenisiana**
    10. Leaves more laxly arranged, leaf-scars present but not prominent or crowded; fruit ovoid, 5–6 × *c.* 4 cm ..... **T. avicapitis**
   9. Leaves 15–30 × 6–15 cm
    11. Leaves broadly obovate, subcordate at base ..... **T. catappa**
    11. Leaves elliptic or obovate, tapering at base ..... **T. clemensae**
  8. Fruits with subsidiary flanges or ridges in addition to 2 main flanges
   12. Leaves with conspicuous brown hairs beneath, often (but not always) with close-set venation, nerves 1 per 1 cm ..... **T. rubiginosa**
   12. Leaves with inconspicuous greyish hairs beneath or glabrous, never with close-set venation, nerves 1 per 1·5 cm ..... **T. sepicana**
 7. Fruits unflanged though often strongly compressed
  13. Fruits strongly flattened (when fully ripe, flesh may fill out but when young and when dried, clearly compressed, flesh contracting back onto flattened woody skeleton)
   14. Leaves with canals above veins (best seen in thin section), often translucent in transmitted light but sometimes opaque in old leaves. Fine leaf venation at ± right-angles to midrib. Fruits ± flattened-ovoid 3·5–4 × 2–3 cm ..... **T. canaliculata**
   14. Leaves without canals. Fine venation and fruits various
    15. Fruits flattened-ovoid, (5–)5·5–6(–7) × 3·5–4·5 × 2–2·5 cm ..... **T. morobensis**
    15. Fruits smaller
     16. Leaves ± sessile; fruits *c.* 4 × 3 cm ..... **T. whitmorei**
     16. Leaves petiolate; fruits smaller or relatively narrower
      17. Leaves fairly large (6–16 × 6–13 cm), suborbicular or broadly obovate; trees of coral coasts ..... **T. samoensis**
      17. Leaves smaller, obovate or elliptic or narrower; inland trees
       18. Leaves and inflorescences crowded at twig tips; buds glossy-hairy (reddish in dried material) ..... **T. calogemma**
       18. Leaves and inflorescences scattered or loosely clustered at twig tips; buds variously hairy, not glossy-hairy
        19. Fruits elliptic or oblong in outline; leaves small, 3–6 × 1–4 cm, glabrous and densely crowded; highlands (1100–)1500–2000 m ..... **T. oreadum**
        19. Fruits ovate, broadly elliptic to suborbicular in outline; leaves larger or scattered along twigs, hairy; lowlands, sometimes to 1300 m

20. Fruits ovate to elliptic in outline, often pointed, 11–13 × 5–6 mm; leaves with silky appressed hairs above when young, hairs never reddish..... **T. microcarpa**
20. Fruits broadly elliptic to suborbicular in outline, rarely pointed, larger or at least broader; leaves sometimes hairy above, usually with reddish or brownish hairs beneath
21. Leaves with red hairs when young at least, usually persistently so, often with crowded venation (13–17 pairs of nerves)..... **T. longespicata**
21. Leaves finally sparsely hairy or ± glabrous, with yellowish, greyish or brownish hairs at first, with generally fewer nerves..... **T. complanata**

13. Fruits not, or little, flattened
22. Fruits small, < 2 cm long
23. Leaves mostly < 8 × 4 cm; flowers and fruits absent from basal ½ to ⅔ of inflorescence
24. Leaves glabrous at maturity; fruit unflattened, ovoid..... **T. archboldiana**
24. Leaves hairy at maturity; fruit slightly flattened, lateral margins sharp-angled..... **T. capitulata**
23. Leaves mostly 8–12 cm long, often exceeding 5 cm in width; flowers and fruits present in lower parts of inflorescence
25. Leaves broadly obovate, 1·4–1·7 times longer than broad; fruits not flattened..... **T. crassifolia**
25. Leaves obovate, not broadly so, 1·7–2·2 times longer than broad; fruits (or at least stones) strongly flattened..... **T. microcarpa**
22. Fruits > 2 cm long, often much larger
26. Leaves large, 22–36 cm long, ± sessile or on short thick petioles
27. Leaves with many close nerves, (20–)23–30 pairs or more..... **T. copelandii**
27. Leaves with fewer pairs of nerves
28. Stones with 2 unequal 'valves' (seen in cross-section); embryos with 2 cotyledons; leaves usually glabrous or, if hairy, usually with a subcordate base.. **T. impediens**
28. Stones with 2 equal 'valves'; embryo with 3–4 cotyledons; leaves always with reddish-brown hairs beneath, cuneate (never subcordate) at base.. **T. kaernbachii**
26. Leaves smaller, petioles distinct and ± slender
29. Fruits 5 cm or more long
30. Fruits with green or yellow flesh outside a comparatively thin-walled shell enclosing very large embryo; with 3–4(–5) very thick cotyledons; leaves with long slender petioles (2–5 cm), leaf tip generally acute..... **T. megalocarpa**
30. Fruits with red stringy flesh outside very thick shell enclosing smaller embryo with 2 thin cotyledons; leaves on petioles usually not exceeding 2 cm, leaf tip generally obtuse..... **T. impediens**
29. Fruits < 5 cm long
31. Fruits 5–6 mm broad, very narrowly ellipsoid..... **T. eddowesii**
31. Fruits at least 1 cm broad, ellipsoid
32. Leaves hairy beneath; fruits 2–3·5 cm long
33. Leaves with red hairs beneath; fruits 2·9–3·5 × 1·5–1·7 cm..... **T. macadamii**
33. Leaves with grey hairs beneath; fruits 2·1–2·7 × 1·2–1·4 cm..... **T. katikii**
32. Leaves glabrous or nearly so; fruits 4–5 cm long..... **T. solomonensis**

Terminalia archboldiana Exell *Brittonia* **2**: 137 (1936); *Fl. Males.* ser. 1, **4**: 583 (1954), f. 30; Coode *Contr. Herb. Aust.* **2**: 2 (1973). **Fig. 18, 1a–c, Fig. 23.**

Trees to 30 m, often less. Young parts often appressed-hairy. Leaves with petioles 1–3(–7) mm; blades obovate or rhombic-obovate, 5–8 × 2–4 cm, mostly pointed with tip itself ± blunt, leathery, glabrous and shiny dark green above, paler and usually glabrous beneath, nerves 4–5 pairs, never very prominent and often even less so and more distant near apex, often with domatia at midrib. Inflorescences few-flowered, slender and bare of flowers in lower ½ or ⅔, 4–5 cm long. Flowers small, *c.* 4 mm long overall, not > 12

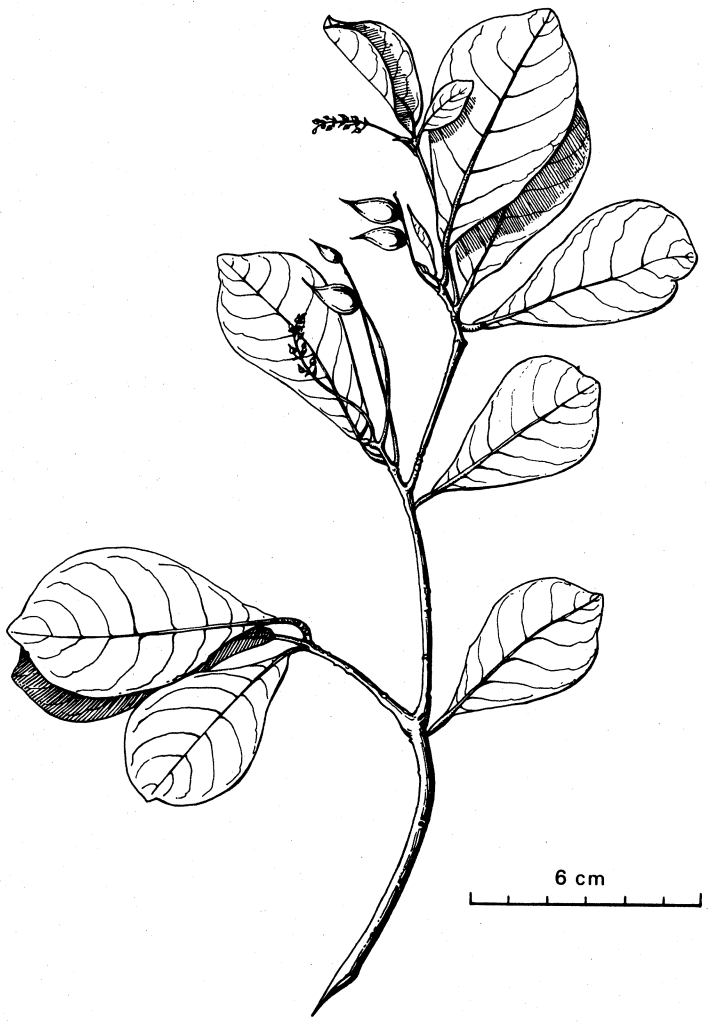


Fig. 23 **Terminalia archboldiana** Exell

per spike. Fruits 1–2 per spike, ovoid, not flattened, pointed, *c.* 10–16 × 6–7 mm, red when ripe.

Distribution: Frequent in the Central district of Papua. A single collection is known from near Vanimo in the West Sepik district of northeastern New Guinea.

Ecology: Rain forest, often in relict patches, or gallery forest in savanna.

Notes: Distinctive in flower or fruit (the absence of flowers in the basal half of the inflorescence is a character shared only with *T. capitulata*), but not easily separable from some forms of *T. microcarpa* when sterile. Not usually cut as mill logs.

Terminalia archipelagi Coode *Kew Bull.* **23**: 299 (1969), f. 1, 2; *Contr. Herb. Aust.* **2**: 2 (1973). **Fig. 18, 2a–b, Fig. 24.**

Trees to 55 m tall. Twigs thick, often exuding gum. Leaves clustered at twig tips, sessile or shortly petiolate, obovate, 20–60 × 5–19 cm, tips acute, gradually tapering to base, glabrous. Flowering spikes to 15 cm long, flowers very large for the genus, 8–15 mm long, glabrous outside, exserted filaments 13–16 mm long, straight style 25–30 mm long. Fruits 1 to several per spike, 7–9·5 × 3·5–4 cm, glabrous, flattened, broadly winged all round, wings undulate, *c.* 1·1–1·5 cm wide, never succulent, flatter on one side of ovary than other.

Field characters: Often strikingly emergent, usually buttressed, often with flying buttresses and stilt-roots as well (very variable). Bark often yielding copious jelly-like exudate. Branches ± whorled, angled upwards, often forming an irregular canopy unlike mature trees of other species of *Terminalia*. Sapling leaves to 70 cm long with strongly undulate margins and reddish domatia on main veins; saplings may remain unbranched for some height, 3–4 m at least.

Distribution: Known only from the Bismarck Archipelago—from West New Britain, northwestern New Ireland, New Hanover and Manus.

Ecology: Low altitude rain forest; often dominant.

Native names: 'lai-lai' (Namanee Island south of Kavieng); 'e-raule' (New Hanover).

Notes: Used as a sawn timber.

Terminalia avicapitis Coode *Contr. Herb. Aust.* **2**: 3 (1973), f. 1. **Fig. 18, 3a–b.**

Tree to 30 m tall. Very young parts appressed-hairy, later glabrous. Leaves laxly clustered towards ends of slender twigs; petioles 5–8 mm, slender; blades obovate, 8–15 × 2·5–4·5 cm, tip obtuse, sometimes bluntly acuminate, tapering at base, glabrous or with sparsely appressed hairs beneath. Flowers unknown. Fruits apparently 1 per spike, ovoid, 5–5·5 × 3·9–4·5 cm, flattened, broadly winged, wings 9–13 mm broad, stiff, flat or undulate, glabrous, central fruit-body elliptic in cross-section, 2–3 cm wide × 1–1·5 cm deep.

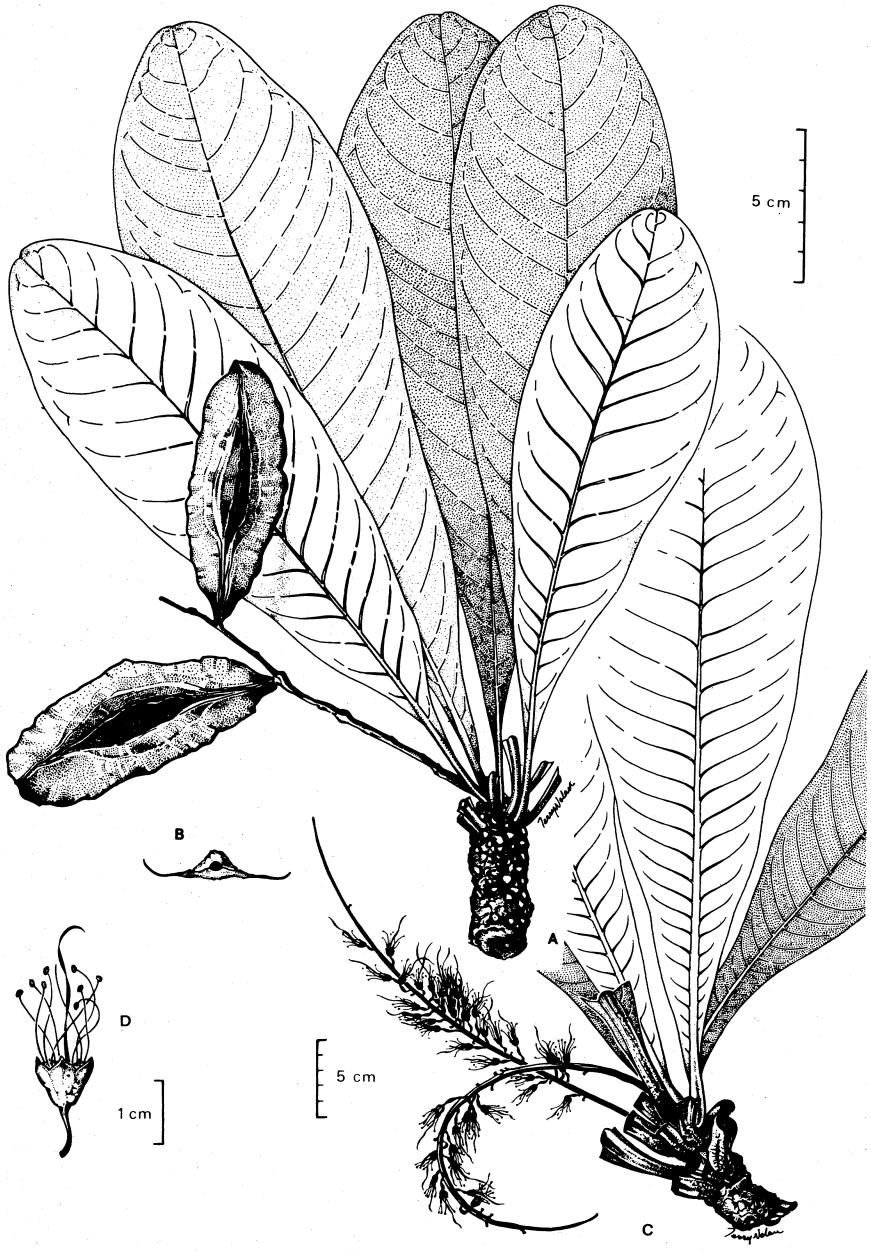


Fig. 24 **Terminalia archipelagi** Coode (A) leafy twig with fruits (B) cross-section of fruit (C) leafy twig with flowers (D) flower

Distribution: So far known from two specimens only, both from the Vogelkop district in western New Guinea.

Notes: Differs from the other species with comparable winged fruits (*T. archipelagi*, *T. rerei* and probably *T. slooteniana*) in having small leaves with slender petioles.

Terminalia brassii Exell *J. Bot. Lond.*, **73**: 134 (1935); *Fl. Males.* ser. 1, **4**: 554 (1954), f. 10; Coode *Contr. Herb. Aust.* **2**: 5 (1973). **Fig. 18, 4a–b, Fig. 25.**
T. kajewskii Exell (1935).

Large trees to *c.* 50 m tall. Twigs ± slender, hairy or ± glabrous. Leaves alternate or subopposite, scattered along twigs with no tendency to clumping; petioles 5–12 mm usually with 2 prominent glands; blades narrowly oblong to elliptic, (7–)10–15(–18) × 3–6 cm, usually gradually narrowed and pointed at tip, rounded or subcordate at base, glabrous or hairy, lateral nerves in 20–35 pairs. Inflorescence a terminal or axillary panicle with 2–6 branches off main axis, 7–14 cm long. Flowers 2–5 mm long overall, densely hairy outside, apparently mostly bisexual. Fruits usually ± elliptic in outline, 9–14 × 5–11 mm with 2 well-developed papery wings and 3 subsidiary flanges or crests, crowned at apex with remains of calyx, golden yellow.

Field characters: Crown large, domed or with several domed tiers; foliage itself fairly diffuse. The crowns are very distinctive, pale green and mushroom-shaped, when seen from the air. The trees are usually flange-buttressed, often with stilt-roots dividing into 'fingers' terminally. Bark flaky-scaly light brown, coming off spirally in long loose strips, large lenticular pustules arranged in patches, underbark greenish-brown, inner bark light brown to white, stringy, with smell of grapes.

Distribution: Known only from the Bismarck Archipelago (East New Britain, southern New Ireland) and the Solomon Islands.

Ecology: Usually found in fresh-water swamps where it can form large stands, or beside rivers where the seedlings can grow on sand and gravel and withstand violent flooding. Occasionally found in drier areas where it may not be conspicuously buttressed or stilt-rooted.

Native names: 'mere' (Danfu area, southern New Ireland); 'homba' (Buin area, Bougainville); 'dafo' (Kwara'ae, Solomon Islands).

Uses: The timber is useful for light construction, mouldings, interior finishing, veneers, but extraction is difficult because of the wet conditions.

Wood: The wood differs from the other species in having a few very large vessels and exclusively uniseriate rays.

Notes: The stripping bark, buttresses and stilt-roots of this species are very distinctive; the leafy twig differs from other *Terminalia* species in the alternate, scattered leaves, often with large petiolar glands, paniculate inflorescences and small papery-winged fruits.

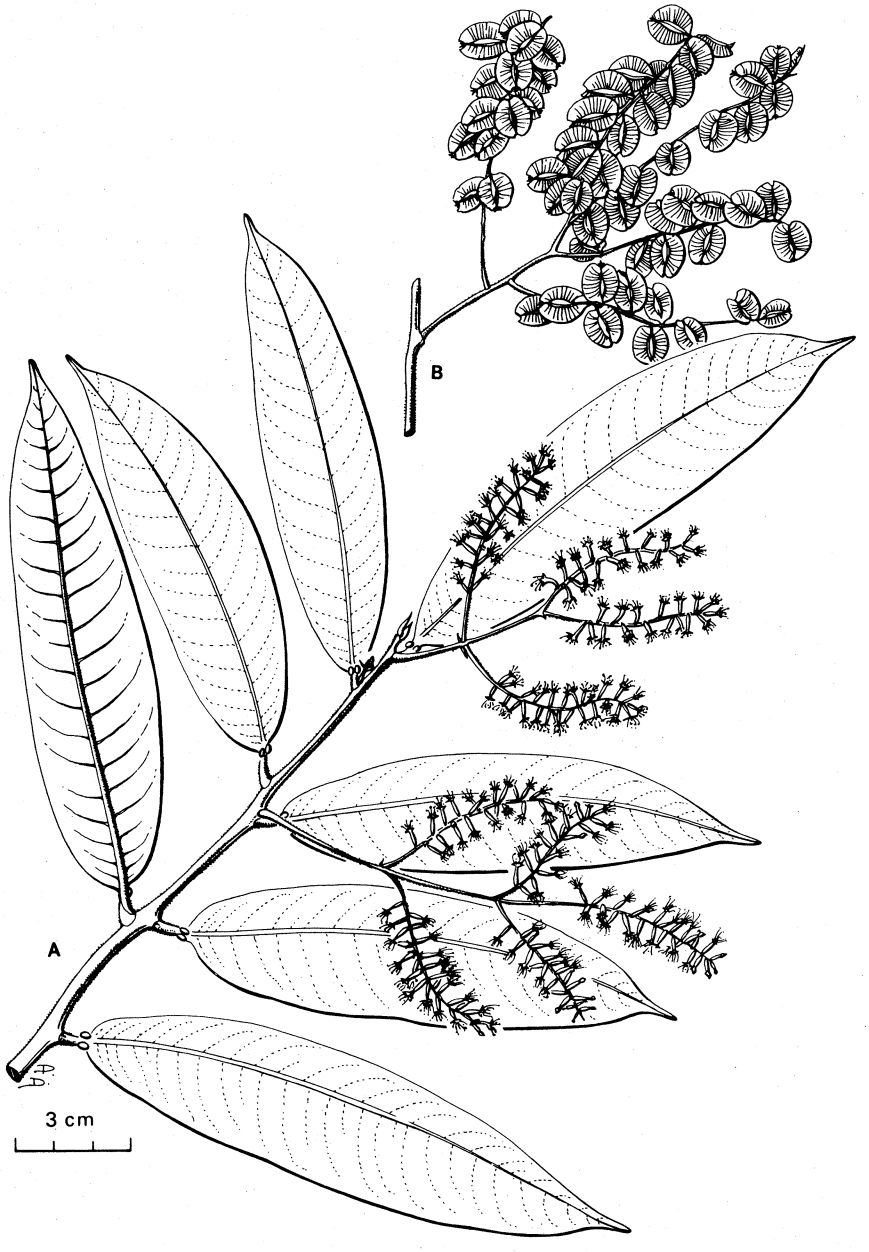


Fig. 25 **Terminalia brassii** Exell (A) leafy twig with flowers (B) fruiting inflorescence

Terminalia calamansanai (Blanco) Rolfe *J. Linn. Soc. Bot.* **21**: 310 (1884); Exell *Fl. Males.* ser. 1, **4**: 556 (1954), f. 11, 12; Coode *Contr. Herb. Aust.* **2**: 5 (1973). **Fig. 18, 5a–d, Fig. 26.**

Trees to 40 m tall. Twigs minutely hairy or ± glabrous. Leaves clustered at tips of twigs; petioles straight, slender, 3–6·5 cm; blades obovate, 8·5–16 × 3·8–8 cm, tip broadly acute to rounded or sometimes acuminate, tapering at base, thin, glabrous. Flowers *c.* 3 mm long overall, hairy outside; calyx lobes reflexed, acute. Fruit flattened and very broadly winged, much broader than long, 2–5 cm across × 1·2–2·2 cm long, with hard, ± ellipsoid central body and parallel-veined papery wings (nerves running at right-angles to fruit axis); fruit very variable in size and in extent to which wings curve forward.

Field characters: Tall trees, often emergent, slender for their height, with plank-like buttresses to 10 m. Crown fairly diffuse, periodically withering vivid orange. Bark fawn-coloured, finely scaly, fissured.

Distribution: In Papuasia known from a single collection in the Gulf district of Papua, from one in the Rabaul area of East New Britain, from New Ireland in the Bismarck Archipelago, and throughout the Solomon Islands. To the west it may occur in the Vogelkop district and throughout Malesia (except Sumatra, Java and associated islands) as far as Burma and Thailand.

Ecology: Lowland forest, apparently not very selective in its habitat, from ridges, valley sides or bottoms.

Native names: 'kako', 'kwako' or 'sualisialo' (Solomon Islands).

Wood: T. calamansanai and *T. megalocarpa* are the only *Terminalia* species in Papuasia with distinct pale wavy lines of confluent parenchyma in the wood, easily seen in cross-section without a lens. Their ranges are known so far to overlap only in the Solomon Islands and perhaps in the Gulf district of Papua.

Notes: Although very distinct in fruit, herbarium specimens in flower or sterile are sometimes indistinguishable from *T. solomonensis* or *T. megalocarpa.* The illustration in E. J. H. Corner's *Wayside Trees of Malaya,* vol. 2, pl. 46 (1952) as *T. pyrifolia,* enlarged in Exell (1954), p. 557, shows the characteristic form of the tree particularly well.

Terminalia calogemma Coode *Contr. Herb. Aust.* **2**: 7 (1973), f. 2. **Fig. 18, 6a–b.**

T. hypargyrea auct. non K. Sch. & Laut.: Exell p.p. (1954).

Deciduous trees to 27 m tall, usually less. Buds and youngest twigs with silky hairs, copper-coloured when dried. Leaves crowded at twig tips; petioles 8–12 mm, slender, appressed-hairy, hairs sometimes silky; blades obovate, 6–11(–15) × 3–5·5(–7) cm, tip usually obtuse, sometimes bluntly acuminate, base tapered, with fine but conspicuous appressed hairs above when very young, hairs later inconspicuous, generally with ± persistent appressed hairs beneath, on nerves especially, sparse ones elsewhere. Inflor-

Fig. 26 **Terminalia calamansanai** (Blanco) Rolfe

escences crowded in axils of leaves, 5–11 cm long, rachis with ± dense, short hairs, bearing numerous flowers. Flowers greenish-cream-coloured, *c.* 2·5 mm long, hermaphrodite flowers confined to basal half, ovary hairy, calyx lobes glabrous. Fruits broadly ellipsoid, distinctly beaked, 1·8–2·2 × 1·4–1·6 cm (excluding beak 3–5 mm), flattened.

Distribution: All the specimens come from the southern part of the Digul district in western New Guinea and adjacent areas of the Western district of Papua as far north as Lake Daviumbu.

Ecology: Rain forest, gallery forest or monsoon forest at low altitudes.

Notes: T. calogemma combines features of *T. microcarpa* (leaf shape), *T. complanata* (leaf nervation and indumentum) and *T. longespicata* (fruit). It differs from all three in the leaves crowded at twig tips and in the glossy copper-coloured hairs on the vegetative buds. *T. complanata* and *T. microcarpa* (both subspecies) have been found in the same general area, but not from the same localities; *T. longespicata* has not yet been found in the Western district.

Terminalia canaliculata Exell *Blumea* **7**: 327 (1953); *Fl. Males.* ser. 1, **4**: 581 (1954), f. 30; Coode *Contr. Herb. Aust.* **2**: 8 (1973). **Fig. 18, 7a–e, Fig. 27.**
T. beccarii Exell (1953); (1954), f. 23.

Partly deciduous tree to 30 m tall. Leaves clustered towards twig tips; petioles 1·1–3·2 cm; blades obovate to elliptic, 8–15 × 2–8 cm, tip obtuse and often acuminate, ± tapering at base, appressed-hairy when young, later glabrous, lateral veins characteristically curving round towards apex, fine veins closely set, mostly parallel to each other and ± at right-angles to midrib; large canals above veins, canals often visible on upper surface of dried leaf as depressed channels and translucent in transmitted light at least when young. Inflorescences often erect, 10–18 cm long. Flowers *c.* 4 mm long overall, glabrous or with sparse appressed hairs outside. Fruits ovate in outline, flattened, unwinged, 3·5–4 × 2–3 cm, stone deeply sculptured and surrounded by fibrous flesh.

Distribution: Throughout the lowlands of mainland New Guinea with 1 specimen from southern New Britain.

Ecology: Rain forest, often in swampy areas.

Notes: Thin sections of leaf lamina are sometimes necessary to check the presence of canals in old opaque leaves.

Terminalia capitulata Exell *Blumea* **7**: 322 (1953); *Fl. Males.* ser. 1, **4**: 583 (1954), f. 30; Coode *Contr. Herb. Aust.* **2**: 9 (1973). **Fig. 18, 8a–c, Fig. 28.**

Trees *c.* 16 m tall. Twigs slender, densely hairy when young. Leaves ± clustered; petioles 3–7 mm, hairy; blades broadly obovate, 2·5–3·5(–4·5) × 1·8–2·7 cm, obtuse at tip, abruptly tapered or rounded at base, with dense red-brown silky hairs at first, mostly becoming glabrous above, persistently hairy beneath. Inflorescence slender, 2·5–4 cm long; flowers all borne in cluster at tip or occasionally scattered a little below (not > 7 mm from) tip. Flowers *c.* 4 mm long overall, with acute calyx lobes, with dense brownish

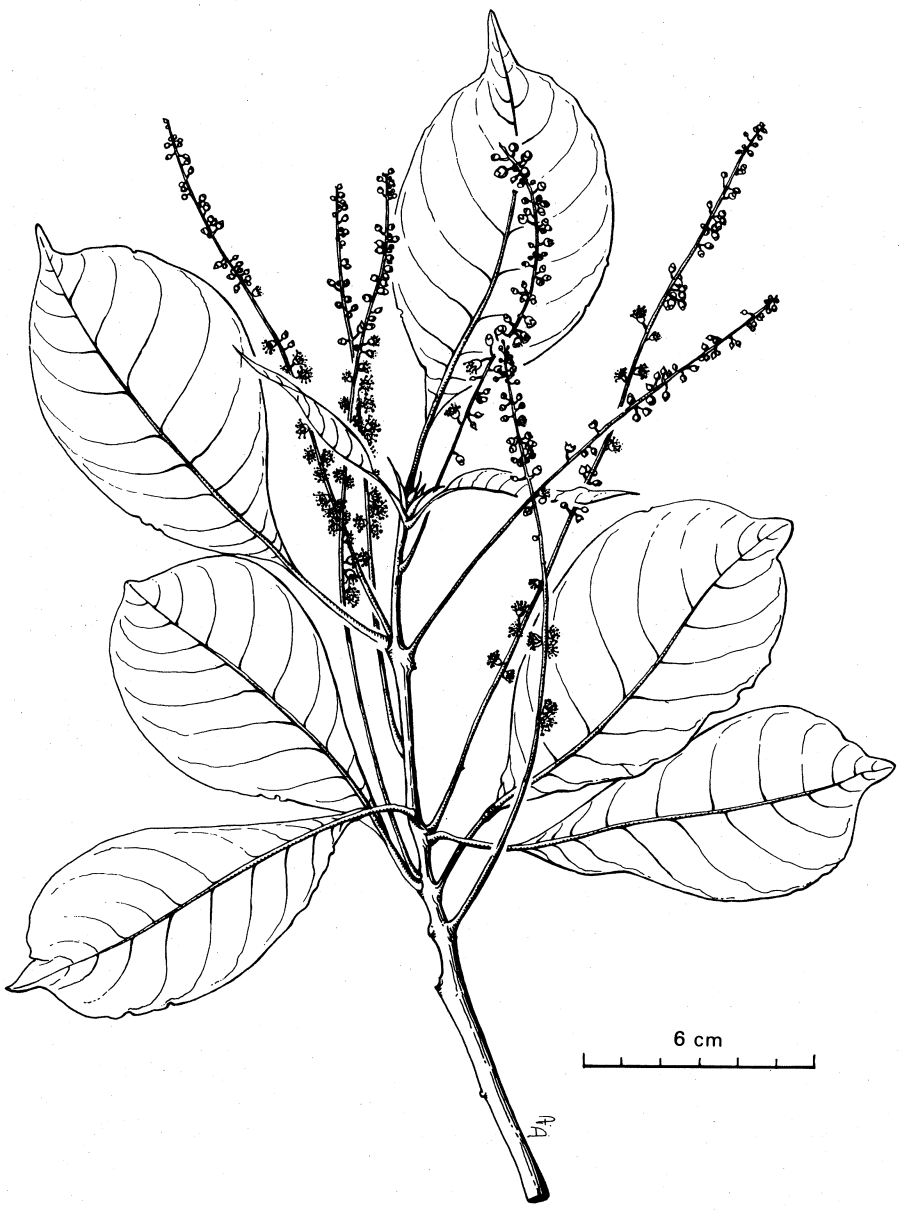


Fig. 27 **Terminalia canaliculata** Exell

Fig. 28 **Terminalia capitulata** Exell

hairs outside. Fruit ovoid, 10–12 × 7–8 × 5–6 mm, slightly flattened, acute at tip, ± silky-hairy, purplish, usually 1 per inflorescence.

Distribution: Known from only three collections, one from the Baliem River (Snow Mountains) in western New Guinea, one from Lake Kopiago (Western Highlands) in northeastern New Guinea, and one from Lake Kutubu (Southern Highlands) in Papua.

Ecology: Forest at 700–1700 m.

Notes: Most similar to *T. archboldiana* but easily distinguished by its hairy leaves.

Terminalia catappa L. *Syst. Nat.* ed. 12, **2**: 674 (err. 638) (1767); Exell *Fl. Males.* ser. 1, **4**: 566 (1954), f. 17, 18; Coode *Contr. Herb. Aust.* **2**: 9 (1973). **Fig. 18, 9a–b, Fig. 29.**

Trees to 40 m (usually much less). Twigs moderately thick (7 mm) to thick (15 mm), ± appressed-hairy when young. Leaves crowded at twig tips; petioles to 1·5 cm; blades broadly obovate, sometimes elliptic-obovate, 17–29 × 10–15 cm, obtuse or acute, usually subcordate at base, young leaves with soft appressed brown hairs, glabrous or virtually so when mature, with 6–9 pairs of lateral nerves. Flowers white or cream-coloured, *c.* 3–5 mm long overall, glabrous or with short hairs outside. Fruit ± ellipsoid, somewhat flattened, usually surrounded (particularly towards tip) by stiff flange, 5·5–7 × 3–4 cm, smooth and glabrous when dry; when quite ripe, red (rarely yellow) flesh sometimes fills out and obscures flanges.

Field characters: Larger specimens are sometimes buttressed to 3 m; trunk straight or in its normal coastal habitat more usually twisted; young trees straight, with branches distinctly whorled and horizontal. The leaves, as in many other species of *Terminalia*, turn a brilliant red before falling; the tree is temporarily quite bare of leaves which fall twice a year in some seasonal climates.

Distribution: Throughout tropical Asia, northern Australia and Polynesia. It is now widely planted throughout the tropics. In Papuasia it has been collected from most coastal regions.

Ecology: A very characteristic coastal tree, common on sandy or rocky beaches, often with *Barringtonia asiatica* and *Calophyllum inophyllum.* Also found on river banks, probably confined to the tidal zone.

Uses: The timber is of some value for furniture and house and boat building, but logs are usually too small or twisted to convert to lumber commercially. Cultivated trees provide good shade and are to be seen in many coastal towns throughout Papua New Guinea. The falling leaves can be a niusance; the trees tend also to grow rather large. The kernel of the fruit is edible but not used in Papuasia to the same extent as in parts of Asia; it produces a fatty oil similar to almond oil.

Terminalia clemensae Exell *Blumea* **7**: 324 (1953); *Fl. Males.* ser. 1, **4**: 560 (1954), f. 13, 14.

No more is known of this species than is in Exell (1954), p. 560. His

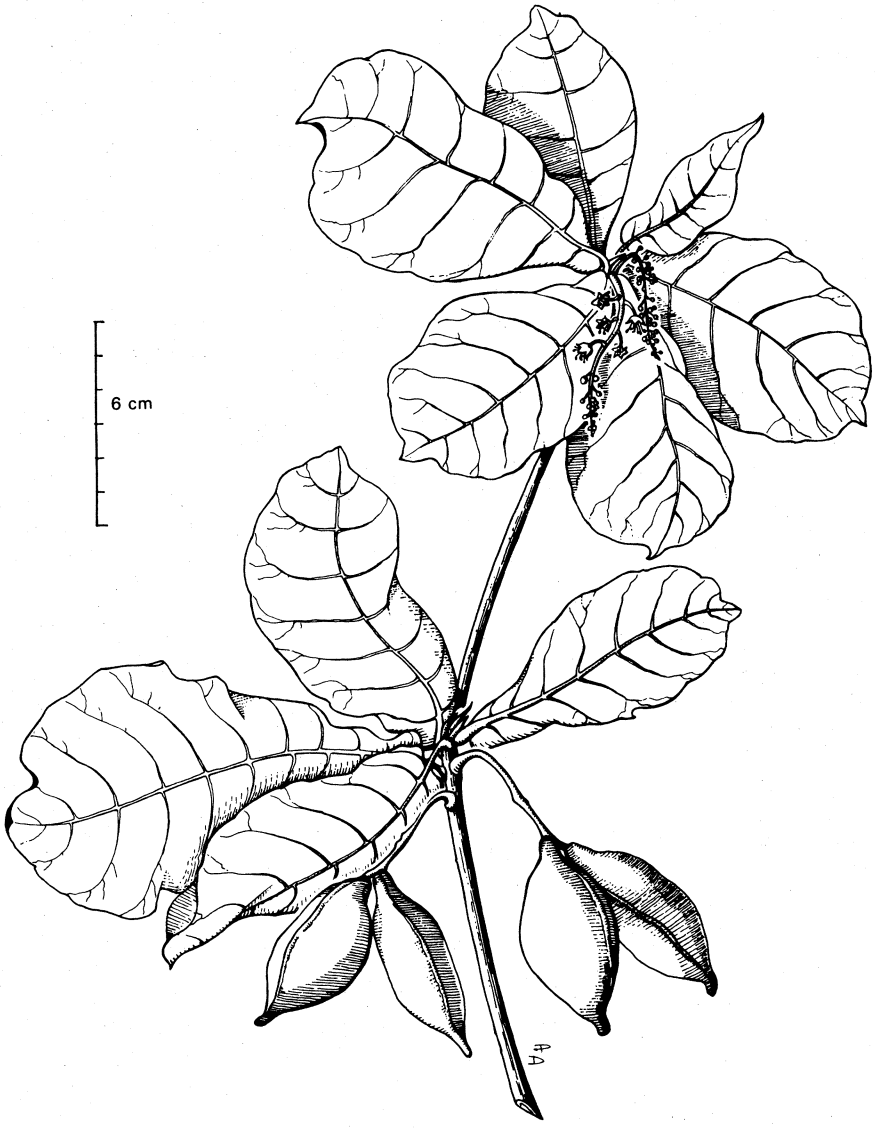


Fig. 29 **Terminalia catappa** L.

description follows:

Tree. Leaves coriaceous, shiny above, glabrous, elliptic 20 × 8 cm, rounded or shortly acuminate at the tip, cuneate at the base; nerves 12–14 pairs; petiole glabrous, 1·5–2 cm. Flowers not known. Fruit very woody, probably adpressed-hairy when young (traces of indumentum remain), almost glabrous or glabrous when mature, compressed ovoid-ellipsoid or compressed ellipsoid, 6–7 × 3–4 × 1·5–1·8 cm, narrowly circumalate, wing rigid, 4 mm broad, showing in cross-section an irregular mass of sclerenchyma enclosing a few small scattered air-chambers.

Distribution: Only known from the type, a fallen branch brought in by a native collector in the Huon Peninsula of the Morobe district.

Notes: The fruit resembles a large fruit from *T. catappa*, and the leaves are rather similar to those of *T. megalocarpa* or *T. solomonensis*.

Terminalia complanata K. Sch. in K. Sch. & Hollr. *Fl. Kais. Wilh. Land* 83 (1889); Exell *Fl. Males.* ser. 1, **4**: 563 (1954), f. 14, 15. **Fig. 18, 10a–i, Figs 30, 31.**

Trees to 45 m tall. Leaves scattered along slender twigs with little or no tendency to clustering, at least in fertile collections; petiole 7–15 mm, slender; blades most often elliptic but also obovate or oblong, 5–11(–13) × 1·5–5 cm, usually acute and often acuminate at tip, tapering at base, with sparse appressed hairs above when young, hairs quickly falling; reddish or yellow hairs beneath especially on nerves, hairs often persisting, nerves often rather many for the length, (7–)9–15 pairs. Inflorescences 7–14 cm long, usually solitary in axils of upper leaves but sometimes with subtending leaves undeveloped, thus appearing ± paniculate. Flowers 1·5–2 mm long overall, hairy outside; calyx lobes less hairy or glabrous. Fruits elliptic or ± orbicular in outline, fleshy, red and somewhat flattened when fully ripe, distinctly flattened in young or fallen (flesh quickly decomposes) fruit and when dried, often with thickened margin, 1·4–2·1 × 1·1–1·9 cm, silky-hairy when young, ± glabrescent.

Field characters: The crown becomes very large, spreading, umbrella-shaped; the foliage may be fairly dense or diffuse. The bole is usually buttressed, the buttresses simple or much-branched.

Distribution: In western New Guinea known from the Vogelkop, Geelvink Bay and Jayapura districts; in northeastern New Guinea from the East Sepik and Madang districts and from the Morobe district where it seems particularly common; also the Southern Highlands, Western and Milne Bay districts of Papua, the Papuan Islands and throughout the Bismarck Archipelago and Solomon Islands. There is a specimen from northern Queensland and a specimen from the Moluccas which is probably this species.

Ecology: Lowland forest often in swampy areas, also at higher altitudes, from sea level to 1500 m.

Uses: The wood is among the more useful of the *Terminalia* species and has been sawn for flooring and light construction. Interior finishing, mouldings

Fig. 30 **Terminalia complanata** K. Sch. (A) leafy twig with flowers and fruits (B, C) fruits

Fig. 31 **Terminalia complanata** K. Sch. (A) leafy twig with fruits (B) cross-section of fruit (C) flowering twig (D) transverse view of flower (E) horizontal view of flower

and veneers are other uses.

Notes: The species is very variable and seems to be giving rise to local races throughout its range, forming, with *T. longespicata*, a variable complex. *T. oreadum* may have originated here. Other variants, differing mainly in leaf size and shape, are known, but more collections are needed before decisions can be made about their taxonomic status.

Terminalia copelandii Elm. *Leafl. Phil. Bot.* **5**: 1759 (1913); Exell *Fl. Males.* ser. 1, **4**: 579 (1954), f. 27, 28, 29. **Fig. 19, 11a–c, Fig. 32.**

T. catappoides C. T. White & Francis (1927), f. 13.

Trees recorded to 25 m but probably often much larger. Twigs thick, leaf-scars prominent. Leaves clustered at twig tips, sessile or very shortly petiolate, obovate 22–36 × 9–13 cm (but probably also much larger), obtuse at tip and sometimes slightly apiculate, subcordate at base, with (20–) 23–30 or more nerves set at *c.* 80° to midrib, sparsely hairy or glabrous. Inflorescences 22–30 cm long, many-flowered. Flowers whitish, 2–6 mm long overall (male flowers often with very slender 'pedicels'), hairy or ± glabrous outside; calyx teeth acute, usually glabrous. Fruit 3·5–6 × 2·2–3 cm, ovoid or ellipsoid, slightly flattened.

Field characters: Reported to have many large buttresses.

Distribution: Curiously disjunct on present evidence. Sumatra, Borneo, Philippines, Lesser Sunda Islands, Celebes, Moluccas. In Papuasia known from a few collections in western New Guinea from Salawati Island in the Vogelkop district, the Mamberamo River on the borders of the Geelvink Bay and Jayapura districts, and several from Adi Island in the Fakfak district. In Papua a single collection from each of the Western and Gulf districts, although Lane-Poole apparently collected many from the Gulf. There are two collections from the Solomon Islands, one from Bougainville and one from Malaita.

Ecology: Lowland forest.

Uses: The timber is said to be similar to that of *T. catappa.*

Notes: The large, ± sessile, many-nerved leaf is the best character by which to tell this species. The long inflorescence with small flowers will also distinguish it from *T. archipelagi*, *T. catappa* and *T. kaernbachii* but not always from *T. impediens.* The kernel is said to be edible but there is some doubt about the true nature of the fruit; specimens at Kew and Leiden herbaria show great variation. Fruits from Sumatra and Borneo are very corky and much smaller than the one New Guinea fruit seen. Lane-Poole originally described his fruit as 'a hard corrugated nut . . . 7·5 × 4·5 cm . . . very easily confounded with *T. okari*' (= *T. kaernbachii*), which is much larger than Exell's measurements given above. More material, particularly flowers and fruits from the same tree, is needed.

Terminalia crassifolia Exell *J. Arnold Arbor.* **20**: 319 (1939); Exell *Fl. Males.* ser. 1, **4**: 569 (1954), f. 19. **Fig. 19, 12a–b, Fig. 33.**

Small trees with horizontal branching. Leaves clustered at twig tips;

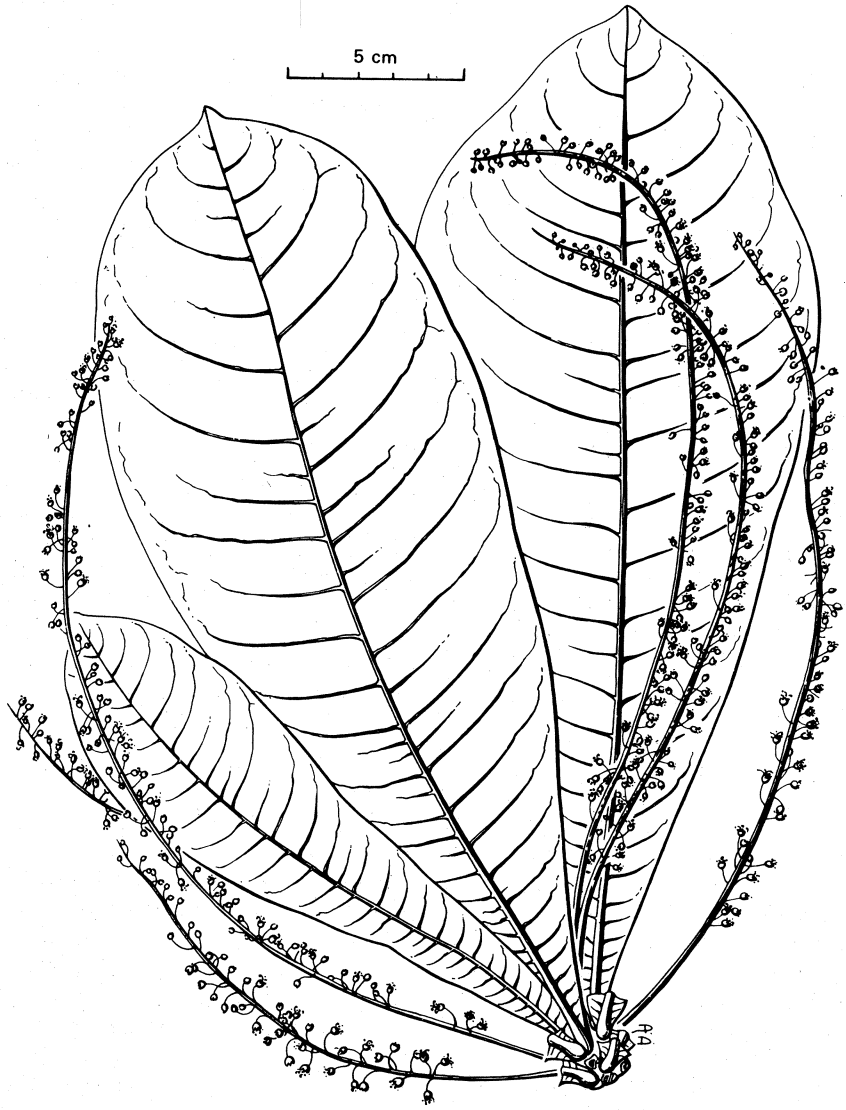


Fig. 32 **Terminalia copelandii** Elm.

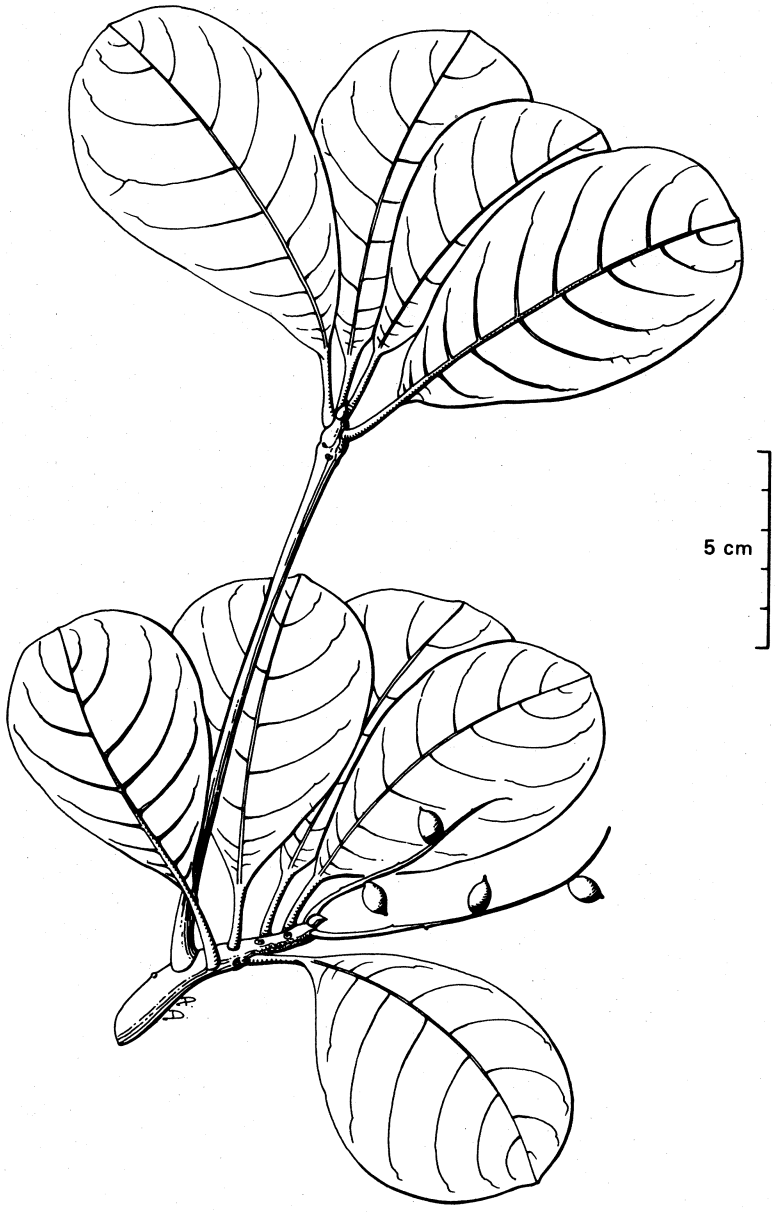


Fig. 33 **Terminalia crassifolia** Exell

petioles 1·3–2 cm; blades leathery, obovate to broadly so, 9–12 × 5·5–7 cm, obtuse at tip, tapering at base, glabrous or sparsely hairy at most. Flowers *c.* 4 mm long overall, lower receptacle hairy, upper receptacle and calyx lobes ± glabrous. Fruit ovoid, *c.* 1·5 × 1 cm, hard when ripe (thus not changing much on drying), purplish, slightly compressed, pointed.

Distribution: Still known only from Mabaduan in the Western district of Papua.

Notes: T. crassifolia may be part of *T. subacroptera* Domin of northern Australia, which may also include *T. insularis* C. T. White from Thursday Island.

Terminalia eddowesii Coode *Contr. Herb. Aust.* **2**: 13 (1973), f. 3. **Fig. 19, 13a–c.**

Trees 13–20 m tall. Twigs glabrous at anthesis. Leaves ± in rosettes; petioles 2·5–3·5 cm with some fine appressed indumentum; blades elliptic to narrowly obovate, (12–)15–23 × 6–9·5 cm, tip acute, often acuminate, tapering at base, virtually glabrous. Inflorescences (10–)12–20 cm long. Flowers *c.* 4 mm long, insufficiently known, with appressed, ± silky hairs outside, calyx lobes *c.* 1 mm, hairy. Fruits often 4 (or more) per spike, red when ripe, very narrowly ellipsoid, 20–28 × *c.* 5–6 mm, narrowed base or stipe, tip elongated into beak, often curved, not compressed; when dry showing some surface irregularities.

Distribution: Known only from the Central district of Papua. There are several collections.

Ecology: Riverine or lowland rain forest.

Notes: Given in Coode (1969b), p. 75, as sp. nov. 1. The fruit is distinct from other *Terminalia* species, being relatively narrower than any other in Papuasia. In flower, however, it would probably be indistinguishable from *T. solomonensis* and *T. megalocarpa* in the herbarium.

Terminalia impediens Coode *Kew Bull.* **23**: 308 (1969), f. 6; *Contr. Herb. Aust.* **2**: 14 (1973). **Fig. 19, 14a–d, Fig. 34.**

Trees to 42 m tall. Twigs usually fairly massive. Young parts sometimes hairy. Leaves clustered at twig tips, shortly petiolate, obovate, 15–25(–45) × 5–12(–20) cm (much larger in saplings), acute or more usually obtuse at tip, tapering to subcordate at base, glabrous or with reddish-brown hairs particularly beneath, which may or may not persist, often purplish beneath flushing leaves (colour not due to hairs). Inflorescences 10–30 cm long. Flowers *c.* 7 mm long overall with calyx lobes usually glabrous outside. Fruit red and fibrous-fleshy outside when ripe, 7–9 × 3·5–6 cm with massive woody stone splitting on germination into 2 manifestly unequal parts. Cotyledons 2, edible.

Field characters: Often buttressed; the presence of the tree is often betrayed by the old or split shells of the large stones lying on the forest floor. The purplish undersides of flushing leaves is very characteristic.

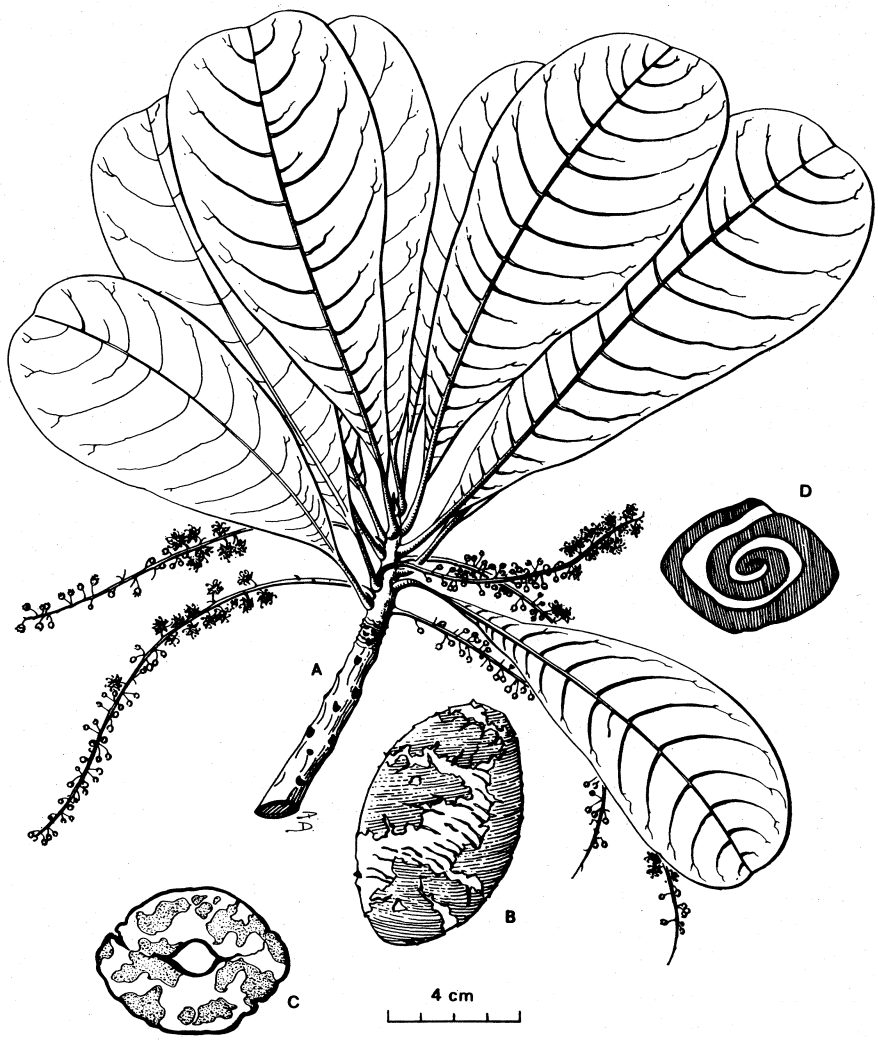


Fig. 34 **Terminalia impediens** Coode (A) leafy twig with inflorescences (B) old fruit (C) transverse section of fruit (D) section of embryo showing two only coiled cotyledons

Distribution: Sterile specimens from western New Guinea are known which probably belong to *T. impediens*. Certainly identified specimens are known from the West Sepik, East Sepik, Madang and Morobe districts of northeastern New Guinea and from the Gulf and Central districts of Papua.

Ecology: Lowland forest; often preserved in garden areas.

Uses: Other than the very palatable kernels, no use has been recorded for this species, although the large size would presumably make it a potentially useful timber tree.

Native names: 'al' (Madang district, Usino); 'galip' (general Pidgin name, applied also to other edible nuts).

Notes: T. impediens differs from *T. kaernbachii* in the usually subcordate leaf bases, by the often longer inflorescences with ± glabrous flowers, by the embryo with only 2 cotyledons, and by the fruit splitting into 2 manifestly unequal portions. From *T. copelandii* it is distinguished by the fewer-nerved usually petiolate leaves and larger flowers, and from *T. slooteniana* in the much larger, unwinged, unflanged fruits.

Terminalia kaernbachii Warb. *Bot. Jb.* **18**: 201 (1893); Exell *Fl. Males.* ser. 1, **4**: 581 (1954), f. 28, 29; Coode *Contr. Herb. Aust.* **2**: 15 (1973). **Fig. 19, 15a–c, Fig. 35.**

T. okari C. T. White (1922).

Trees 20–30 m tall. Twigs ± massive, hairy when young. Leaves clustered at twig tips; petioles *c.* 2 cm; blades obovate, sometimes narrowly so, 15–28 × 6–13 cm, thick, usually acute at tip, tapering at base, petioles and leaf undersurface with persistent reddish-brown hairs, venation prominent beneath and often correspondingly depressed above. Flowers in erect spikes; typically with buds globular, usually densely hairy, 8–10 mm long overall, with calyx lobes triangular, *c.* 2 mm, densely hairy, *c.* 10 mm across calyx cup and with style to 20 mm long. Fruits large, ellipsoid, slightly flattened, 9–11 × 6–8 × 5–6 cm, coated with short reddish-brown hairs when young, becoming fleshy, ± glabrous and red when ripe, containing a massive woody stone, splitting on germination into 2 ± equal halves with the edible seed (okari nut) within. Cotyledons 3–4, thin and typical of the genus in form.

Field characters: Buttresses usually present. Young leaves flush yellow-green with the brown hairs conspicuous. The discarded or fallen stones are easily seen on the forest floor as in *T. impediens*.

Distribution: Undoubted records of wild *T. kaernbachii* are known from the Morobe district (south of the Markham Valley), and from the Western, Gulf, Central and Northern districts of Papua. There are specimens from western New Guinea and the Aru Islands which may belong here, but fruit is needed to confirm the identification. There appear to be genuinely wild trees in the Solomon Islands (Fauro, New Georgia, San Cristobal).

Ecology: Lowland forest but usually encountered as village trees or as single specimens preserved in garden areas.

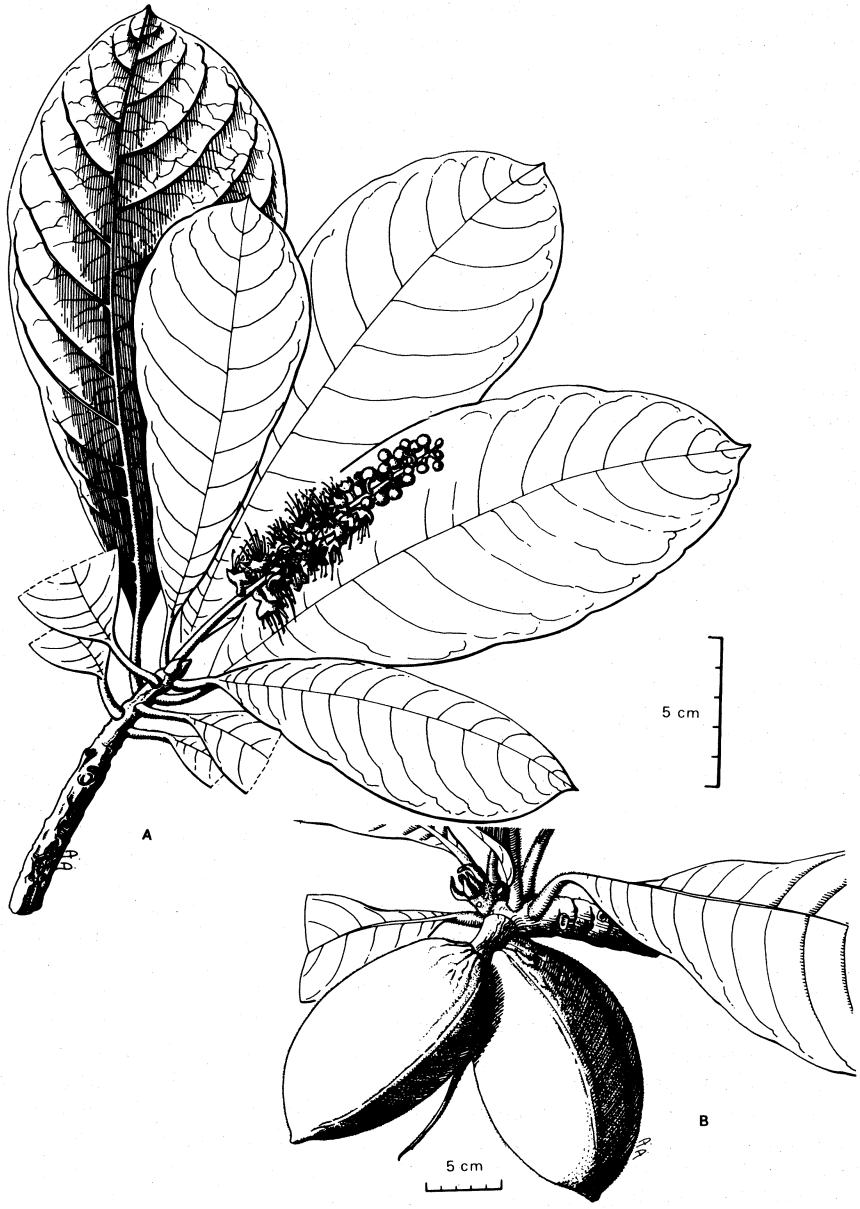


Fig. 35 **Terminalia kaernbachii** Warb. (A) leafy twig with inflorescence (B) leafy twig with fruits

Uses: Apart from the excellent edible nut, the wood has been used successfully for furniture. It is usually excluded from timber purchases on account of its usefulness to the local people.

Native names: 'okari' (general in Papua) 'galip' (general in Pidgin, also covers *T. impediens* and other edible nuts such as *Canarium indicum*).

Notes: Flowering specimens, particularly those seen from western New Guinea, could be confused with *T. katikii* or *T. morobensis*; fruit has to be seen in confirmation. In much of the Morobe district and throughout the Madang, East Sepik and West Sepik districts this species appears to be replaced by *T. impediens*.

Terminalia katikii Coode *Contr. Herb. Aust.* **2**: 17 (1973), f. 4. **Fig. 20, 16a–d.**

Trees to 40 m tall. Leaves ± clustered; petioles (1·5–)1·8–2·2 cm; blades obovate, (10–)13–17 × 7–9·5 cm, obtuse or acute at tip, tapering to abruptly narrowing at base, often with pair of glandular, elongate pits on underside, making base appear subcordate, with greyish hairs throughout, sparser yet usually persisting above, denser beneath and on petioles. Inflorescence 7–9 cm long, with grey hairs. Flowers 6·5–7 mm long, calyx lobes triangular, with dense silvery-grey hairs throughout; stamens and style conspicuously exserted, to 10–12 mm long. Fruits ellipsoid, 21–27 × 12–14 × 9–12 mm, slightly or not flattened, sparsely hairy, red and thinly fleshy when ripe.

Field characters: Buttresses often present; the crown has a greyish appearance.

Distribution: Known in flower or sterile from the Jayapura district of western New Guinea, and from the East Sepik district of northeastern New Guinea. These specimens match the fruiting collections from the Madang district well.

Ecology: Lowland forest often in swampy areas.

Notes: Given in Coode (1969b), p. 77, as sp. nov. 2. It differs from *T. macadamii* in the greyish, not red, leaf hairs, the slightly smaller fruits and much larger flowers.

Terminalia longespicata Sloot. *Bijdr. Combret.* 19 (1919), emended and amplified by Sloot. *Bull. Jard. Bot. Btzg.* ser. 3, **6**: 29 (1924); Exell *Fl. Males.* ser. 1, **4**: 564 (1954), f. 16. **Figs 36, 37.**

Trees 15–45 m tall. Young parts with dense red-brown hairs. Leaves loosely clustered towards twig tips; petioles 1–1·8(–2·1) cm; blades elliptic, sometimes broadly so, to oblong, 8–13 × 4–6 cm, acute or subobtuse at tip, tapering at base, glabrous or with sparse appressed hairs above, reddish or brownish hairs beneath, particularly on nerves. Spikes grouped together at twig tips, subtending leaves often falling early, malformed, or absent (thus inflorescences appear paniculate), 10–15 cm, many-flowered. Flowers *c.* 2–3 mm long overall, densely hairy outside. Fruits variable.

Two subspecies can be recognized:

1. Leaves with 13–20 pairs of nerves; fruits flattened, ellipsoid-ovoid, 3·5–4 × 2·5 × 1·5 cm, lateral margin thick, without a beak. . ssp. **longespicata**
1. Leaves with 8–12 pairs of nerves; fruits flattened, ovoid-ellipsoid or

Fig. 36 **Terminalia longespicata** ssp. **longespicata** Sloot.

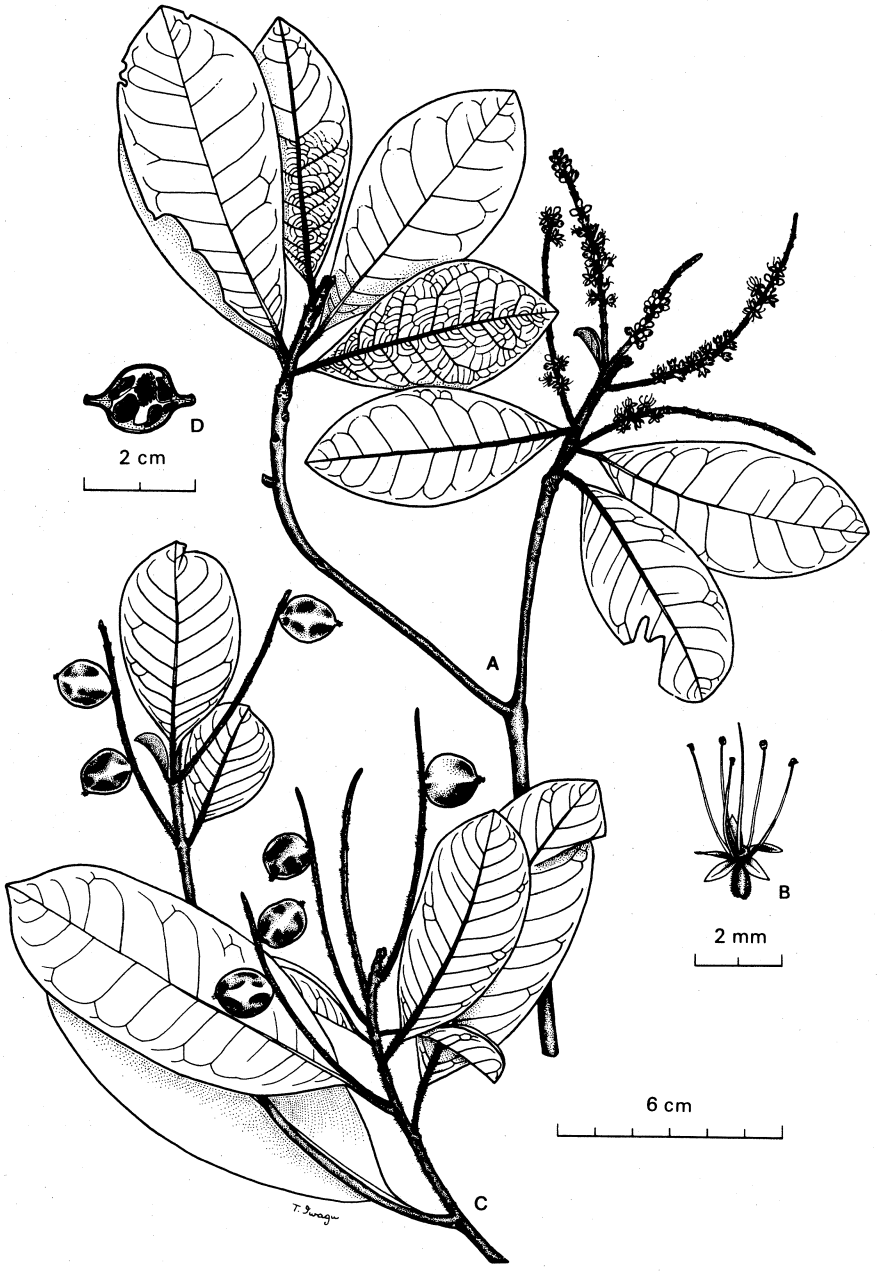


Fig. 37 **Terminalia longespicata** Sloot. ssp. **sogerensis** (Bak. f.) Coode (A) flowering twig (B) flower in detail (C) fruiting twig (D) fruit in cross-section

suborbicular, to 2·8×3·5×1·2 cm (i.e. sometimes broader than long), often less, often with thin almost wing-like margins and apical beak (at least when young).....ssp. **sogerensis**

ssp. **longespicata. Fig. 20, 17a–c; Fig. 36.**
T. phaeoneura Diels (1922).
Differs from ssp. *sogerensis* in the characters given in the key.

Distribution: Known from the Vogelkop and Fakfak districts of western New Guinea, and from the West Sepik, East Sepik and Madang districts of northeastern New Guinea.

Ecology: Lowland forest often by rivers, or in swampy land.

Notes: Rather variable in leaf size, venation and hairiness. There are specimens intermediate between this subspecies and ssp. *sogerensis* and *T. complanata.* The variation is discussed in Coode (1973), p. 11.

ssp. **sogerensis** (Bak. f.) Coode *Contr. Herb. Aust.* **2**: 19 (1973). **Fig. 20, 18a–d; Fig. 37.**
T. sogerensis Bak. f. (1923).
Apart from the characters given in the key, ssp. *sogerensis* often has the fruit surface (even when fresh, becoming more noticeable when dried) obviously knobbly.

Distribution: Principally in northeastern New Guinea from the West Sepik, Madang, Morobe and Western Highlands districts. Also known from the Central district of Papua.

Ecology: Lowland forest, sometimes in swampy land.

Notes: To some extent ssp. *sogerensis* is intermediate between ssp. *longespicata* and *T. complanata*, with the fruits and hairs more similar to the former and leaf venation to the latter.

Terminalia macadamii Exell *Blumea* **7**: 324 (1953); *Fl. Males.* ser. 1, **4**: 571 (1954), f. 14; Coode *Contr. Herb. Aust.* **2**: 19 (1973). **Fig. 20, 19a–e; Fig. 38.**
Trees 20–40 m tall. Young parts with dense red-brown hairs. Leaves loosely bunched at twig tips; petioles (1–)2–2·5 cm; blades elliptic or obovate (8·5–)11–15(–18)×(4·5–)6–9(–12) cm, obtuse or acute, sometimes acuminate, at tip, tapering at base, leathery when mature, dark green above, with red or brown hairs beneath, particularly on nerves. Flowers 3–5 mm long overall, with calyx lobes reflexed, with dense reddish hairs outside. Fruit oblong-ellipsoid, scarcely flattened, red and slightly fleshy when mature, flesh often contracting onto irregularly sculptured stone on drying 2·9–3·5×1·5–1·7 cm.

Field characters: The dense reddish hairs colour the whole crown brownish. Buttresses often present.

Distribution: Known from the Morobe district of northeastern New Guinea and from the Northern and Milne Bay districts of Papua.

Fig. 38 **Terminalia macadamii** Exell

Ecology: Lowland forest.

Notes: Generally distinct enough and easy to identify by the leaves with red hairs beneath, the long petioles and the smooth oblong fruit. See also *T. katikii*, which has much larger flowers and grey hairs.

Terminalia megalocarpa Exell *J. Bot., Lond.* **73**: 132 (1935); Coode *Contr Herb. Aust.* **2**: 19 (1973). **Fig. 20, 20a–h; Figs 39, 40.**

T. solomonensis Exell p.p. (1935); Whitmore (1966).

Variable, probably evergreen, from small village trees to 15 m to large forest trees *c.* 40 m tall. Young parts minutely hairy, quickly becoming glabrous. Leaves ± clustered at twig tips, often ± pendulous; petioles 3–7 cm; blades elliptic or sometimes obovate, 9–18 × 5–9 cm, tip acute or obtuse, base cuneate, glabrous. Inflorescence axis appressed-hairy. Flowers *c.* 2 mm long, hairy calyx lobes with grey hairs outside, yellow inside. Fruit large, 4–8 cm long, ellipsoid or subglobose, with green or yellow flesh outside a relatively thin-shelled stone containing a large embryo with (2–)3–4(–5) thick cotyledons twisted in a short spiral.

Field characters: Old leaves die yellow in this species, at least in cultivation. Also the leaves tend to fall continually, so the tree is never truly deciduous. In drier climates this may not be so.

Distribution: Known in northeastern New Guinea from the south of the Morobe district. In Papua it is known definitely from the Central and Milne Bay districts and Papuan Islands; sterile or flowering specimens from the Western district are known. Absent from the Bismarck Archipelago, but found throughout the Solomon Islands.

Ecology: Lowland forests; often (at least in the Solomon Islands) planted in or preserved around villages.

Uses: The outer flesh of the fruit is edible and well-known in the Solomon Islands.

Native names: 'to-oma' (Kwara'ae, widespread in the Solomon Islands).

Notes: It may not be possible to tell *T. megalocarpa* from *T. solomonensis*, *T. eddowesii* and *T. calamansanai* when only flowering or sterile material is available. The only possible way seems to be to cut a section of the twig and look at the junction of pith and wood. If relatively organized gum-canals are absent, the species is probably *T. megalocarpa* (the pith usually breaks away from the wood irregularly); if present, probably one of the other three species is involved. Twig wood is insufficiently mature to show clearly the presence or absence of confluent parenchyma; see *T. calamansanai* for comments on the wood structure.

So far all specimens seen from the Solomons and the Trobriands have had fruits much larger than broad, with yellow flesh; the specimens from the mainland have almost spherical fruits, with green flesh. It is possible that the larger Solomons/Trobriands form has arisen by selection, for there is no record so far of the round green form being eaten on the mainland.

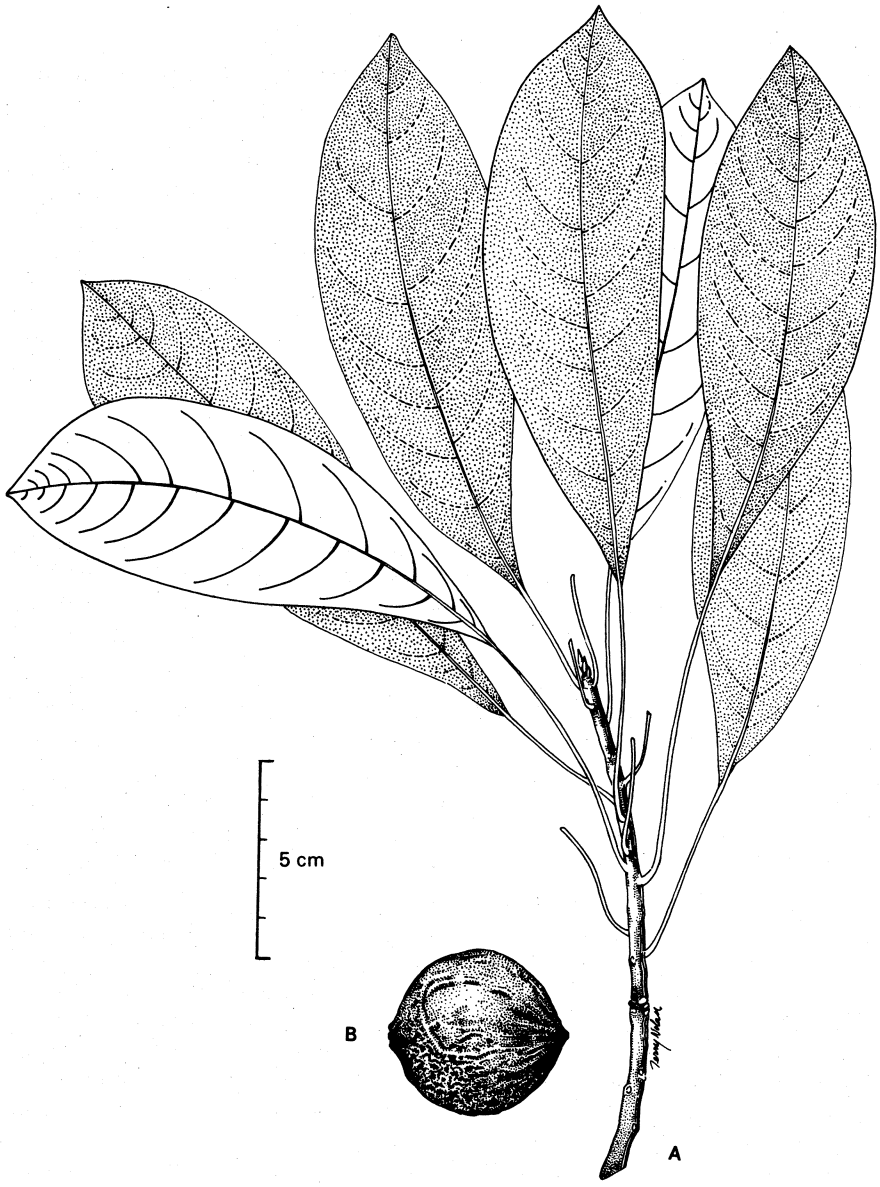


Fig. 39 **Terminalia megalocarpa** Exell Form with narrow leaves and almost globular fruits (A) leafy twig (B) whole fruit

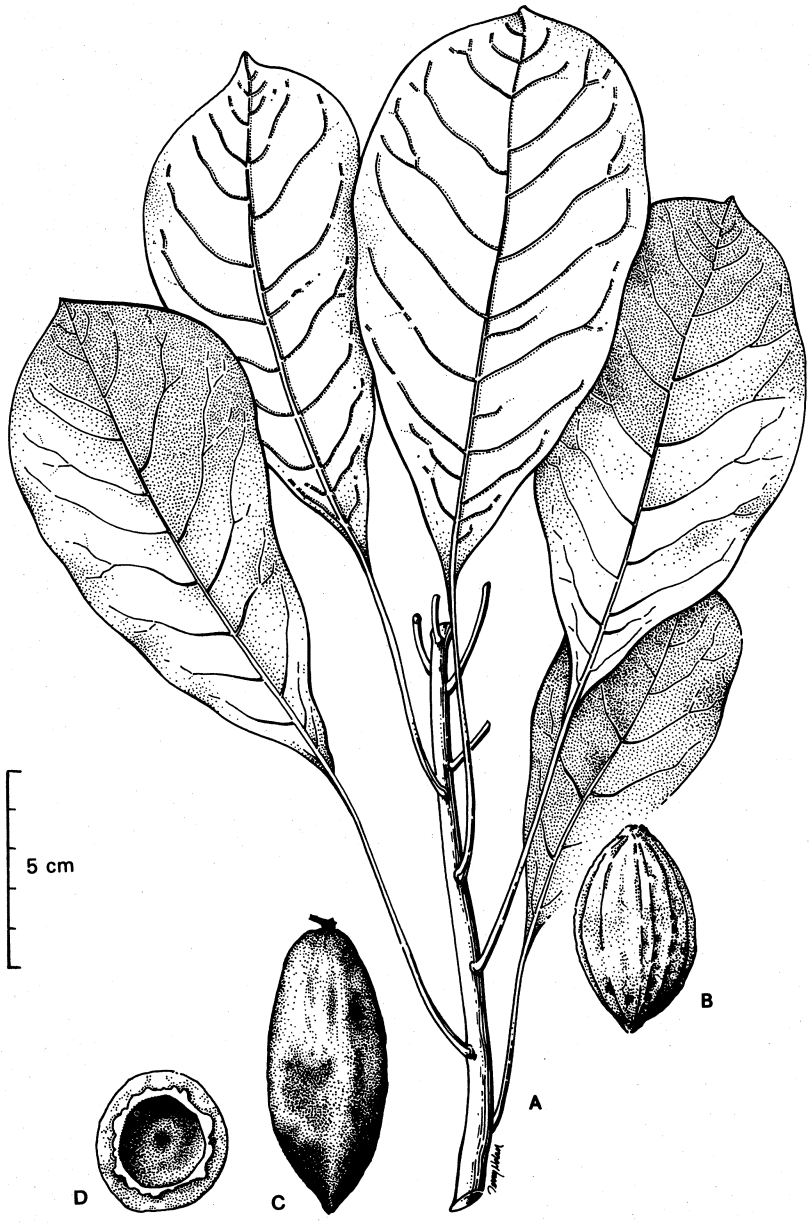


Fig. 40 **Terminalia megalocarpa** Exell Form with obovate leaves and elongate fruits (A) leafy twig (B) fruit with flesh removed (C) whole fruit (D) fruit in cross-section

Terminalia microcarpa Decne *Nouv. Ann. Mus. Hist. Nat. Paris* **3**: 457 (1834); Exell *Fl. Males.* ser. 1, **4**: 562 (1954)—extensive synonymy. **Fig. 21, 21a–d; Figs 41, 42.**

Trees 10–45 m tall. Twigs ± slender. Leaves loosely clustered or scattered; petioles 6–17 mm long; blades obovate to elliptic, sometimes narrowly so, 6–12 × 3–6 cm, tip obtuse, sometimes bluntly acuminate, base tapering, with various types of hairs. Flowers *c.* 3 mm long overall, ovary densely hairy, calyx lobes ± reflexed and glabrous. Fruit often seen when immature, flattened-ovoid, 11–13 × 5–6 mm, pointed at tip, greenish, with appressed silky hairs; ripe fruits often ± ellipsoid to 14 × 9 mm when fresh, fleshy and red, often blunt at tip, when dried shrinking to dimensions and shape of immature fruit; flower parts sometimes persistent at fruit tip.

Two subspecies can be recognized:

1. Leaves narrowly obovate to obovate, with dense and persistently greyish felty hairs ..... ssp. **incana**
1. Leaves obovate to elliptic, with appressed silky hairs above when very young, very sparse hairs beneath, ultimately glabrous .... ssp. **microcarpa**

ssp. **incana** Coode *Contr. Herb. Aust.* **2**: 22 (1973). **Fig. 41.**

T. hypargyrea auctt. non K. Sch. & Laut.: Exell p.p. (1954); Coode (1969b).

Trees 10–25 m tall. Young parts with dense appressed silky hairs or grey hairs, hairs persistent. Leaf-blades narrowly obovate, often pointed when young (at flowering stage), 6–11 × 3–4 cm, broadening to 5–6 cm in fruiting stage when usually bluntly pointed or obtuse; tapering at base, upper surface with dense silky hairs at first, hairs sparser but usually persistent in old leaves, dense short persistent hairs beneath; grey- or silvery-green.

Field characters: The crown has a characteristic grey- or silvery-green appearance.

Distribution: Known from the Merauke area of the Digul district in western New Guinea, and from the Central and Milne Bay districts of Papua. There are specimens from Kassam Pass on the borders of the Morobe and Eastern Highlands districts that may belong here.

Ecology: Savanna woodlands or monsoon forests with a dry season.

Notes: This description covers the very characteristic greyish-green *Terminalia* found in the savanna woodlands around Port Moresby and elsewhere in the Central and Milne Bay districts. The persistent pale short felty indumentum on the underside of the leaf is distinct. This *Terminalia* has been known as *T. hypargyrea* for many years, though there has always been doubt over the application of a name based on a specimen from the rain forest in the Ramu Valley to what are usually savanna or dry forest trees. Although the two subspecies, as normally found, are very different from each other, seed of the type of ssp. *incana* is growing at Lae in much wetter conditions than its normal habitat. While the leaves are certainly somewhat hairier than in ssp. *microcarpa*, the foliage is green, not silvery-grey. Furthermore the fruits of the two subspecies are identical. It thus seems inadvisable to treat the two as species.

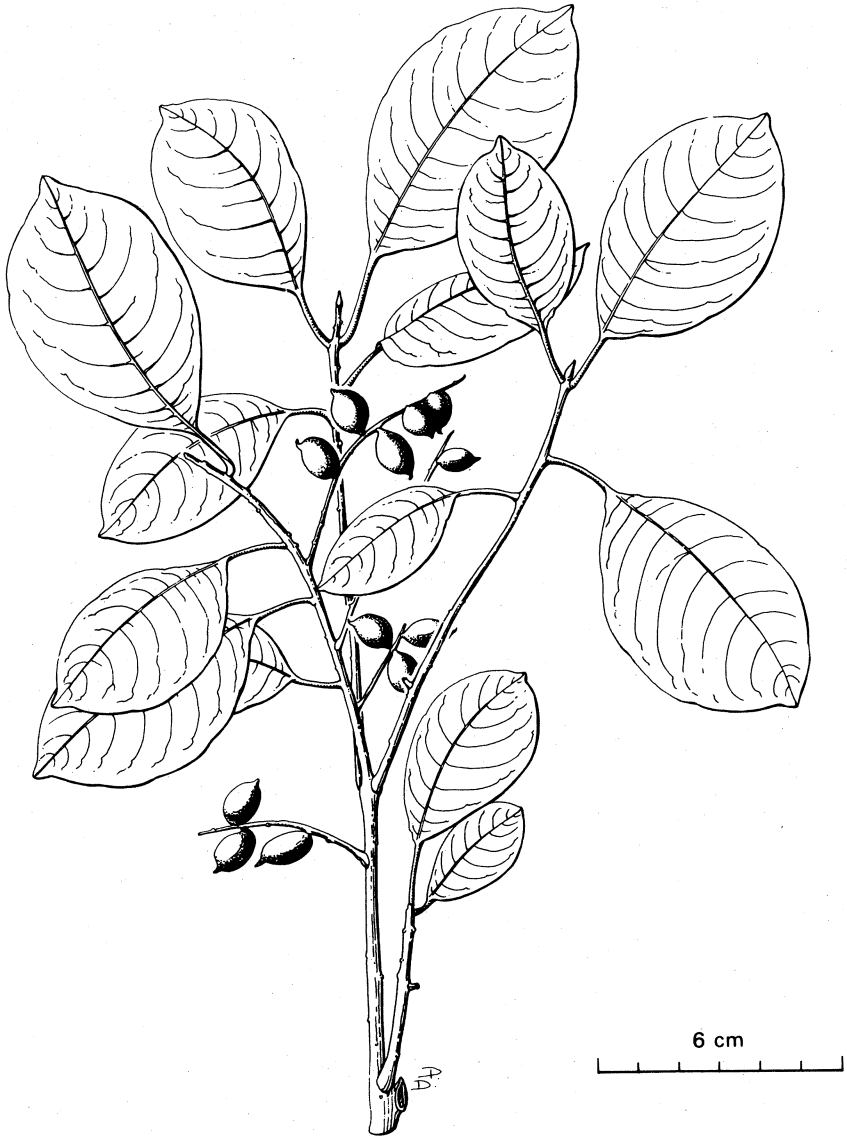


Fig. 41 **Terminalia microcarpa** Decne ssp. **incana** Coode

Fig. 42 **Terminalia microcarpa** Decne ssp. **microcarpa** (A) leafy twig with fruit (B) single leaf (C) fruit

ssp. **microcarpa. Fig. 42.**

T. hypargyrea K. Sch. & Laut. (1901); *T. foveolata* C. T. White & Francis ex Lane-Poole (1925), (1927), f. 12.

Trees to 45 m. Twigs slender, minutely hairy at first, later glabrous. Leaf-blades obovate or sometimes elliptic, 7–12 × 3·5–6 cm, usually acuminate, though apex may be blunt, upper surface densely clothed with appressed silky hairs when young, persistent at least until leaves are full size, but becoming glabrous finally, undersurface with sparse appressed hairs; old leaves leathery.

Field characters: Crowns often immense, spreading, fairly diffuse, foliage green, branches often drooping at the ends. Buttresses often present, sometimes very large.

Distribution: In western New Guinea specimens from the Vogelkop, Geelvink Bay and Jayapura districts are known, and from northeastern New Guinea known from the West Sepik, East Sepik, Madang and Morobe districts. Doubtful specimens from New Britain and Bougainville are known. Outside New Guinea the range includes the Philippines, Borneo, Java, Timor and the Celebes but apparently not the Malay peninsula or Sumatra.

Ecology: Lowland rain forests.

Terminalia morobensis Coode *Contr. Herb. Aust.* **2**: 23 (1973), f. 5. **Fig. 21, 22a–d.**

Trees to 25 m tall. Young parts densely hairy. Twigs thick, rough with leaf-scars. Leaves clumped at twig tips; petioles 1·5–2 cm, robust; blades obovate, (15–)17–25 × 8–11 cm, obtuse or acute at tip, tapering at base, hairs appressed and sparse above, mainly on nerves, denser and ± velvety beneath and prominent on nerves, yellow-brown. Inflorescence 8–15 cm long, axis with dense reddish-brown hairs, with *c.* 50 flowers. Flowers covered with dense silvery hairs (drying yellowish), bisexual flowers near base larger than male ones, *c.* 1·3 cm long including calyx, filaments and style exserted 1·2–1·4 cm further. Fruits *c.* 1 per spike, (5–)5·5–6(–7) × 3·5 × 2–2·5 cm, ovate in outline, acuminate or acute, flattened, with thick obscure double ridge running around margin of stone, not always visible from outside, flesh thin and not shrinking much on drying.

Field characters: Simple buttresses present to 1 m.

Distribution: Known from the Mimika district of western New Guinea, from the West Sepik and Morobe districts of northeastern New Guinea and from the Gulf district of Papua; only six collections in all. There are other, sterile, collections from western New Guinea that may belong here.

Ecology: Lowland rain forest.

Notes: Although quite distinct in fruit, in flower it is impossible to separate from forms of *T. kaernbachii* that have a brown, not red, indumentum.

Terminalia oreadum Diels *Bot. Jb.* **57**: 429 (1922); Exell *Fl. Males.* ser. 1, **4**: 560 (1954), f. 14. **Fig. 21, 23a–d; Fig. 43.**

Trees 15–50 m. Leaves somewhat scattered but also tending to cluster at

Fig. 43 **Terminalia oreadum** Diels (A) leafy twig with inflorescences and flowers (B) twig with fruits (C) fruit

twig tips; petioles 3–10 mm; blades obovate or elliptic, 3–6 × 1–4 cm, apex ± acute, cuneate at base, sometimes with silky hairs when very young, glabrescent, with 4–6 pairs of nerves. Inflorescences 7–10 cm, rachis often relatively stout; flower buds ovoid, pointed. Flowers relatively showy, ovary 2–3 mm, sericeous, calyx tube 2–3 mm long, ± glabrous; calyx lobes ovate or long-triangular, 2–3 mm long. Fruits oblong or oblong-ellipsoid, 2·5–3·5 cm long, often pointed or beaked (at least when dry), flattened, sometimes developing angles or ridges when dry.

Distribution: Known from one collection from the Jayapura district of western New Guinea, and from the East Sepik, Western and Eastern Highlands districts of northeastern New Guinea. There is also a specimen from the Central district of Papua.

Ecology: A conspicuous component of the mid-montane forest in the Eastern Highlands, they are among the largest trees found in these forests. The altitude range is 1500–1900 m.

Notes: Although in its typical form *T. oreadum* is quite distinct from *T. complanata* (not only in the large flowers, but also in the leaves), there are a few intermediates between the two species which suggests that *T. oreadum* may have arisen in the highlands from the widespread lowland *T. complanata.* Furthermore sapling leaves of *T. oreadum* are very much like those of *T. complanata.*

Terminalia rerei Coode *Kew Bull.* **23**: 303 (1969), f. 3. **Fig. 21, 24a–b; Fig. 44.**

Trees to 25 m tall. Twigs thick, probably exuding gum at cut surface, roughened with old leaf-scars. Leaves clustered at twig tips; petioles 2·5–3 cm with 2 glands midway, glabrous; blades obovate, 20–23(–27) × 8–11 cm, obtuse at tip, tapering at base, minutely hairy beneath, at least at first. Flowers unknown. Fruits several per inflorescence spike, 3–4 × 3–4 cm, with broad, often crisped wing 1–1·5 cm wide, and with remains of hypanthium often persisting as spike; central portion containing ridged seed, flatter on one side than other.

Field characters: Crown heavy-limbed, 'stag-headed'.

Distribution: Solomon Islands. The distribution of this species was given wrongly in Coode (1969b), p. 61, although rightly on map 5. It is known from San Cristobal, not Malaita, and Guadalcanal.

Notes: T. rerei can be grouped with *T. archipelagi*, on account of the broadly winged fruit, from which it can be distinguished by the petiolate leaves and the fruit being not much longer than broad. None of the field data suggests that the species has the complex array of buttresses and stilt-roots of *T. archipelagi*, but the description 'stag-headed' suggests that the crown may be of the same irregular 'juvenile' form.

Terminalia rubiginosa K. Sch. in K. Sch. & Hollr. *Fl. Kais. Wilh. Land* 84 (1884); Exell *Fl. Males.* ser. 1, **4**: 562 (1954), f. 15; Coode *Contr. Herb. Aust.* **2**: 25 (1973). **Fig. 21, 25a–c; Fig. 45.**

Trees to 40 m tall. Young twigs with dense rust-coloured to red hairs.

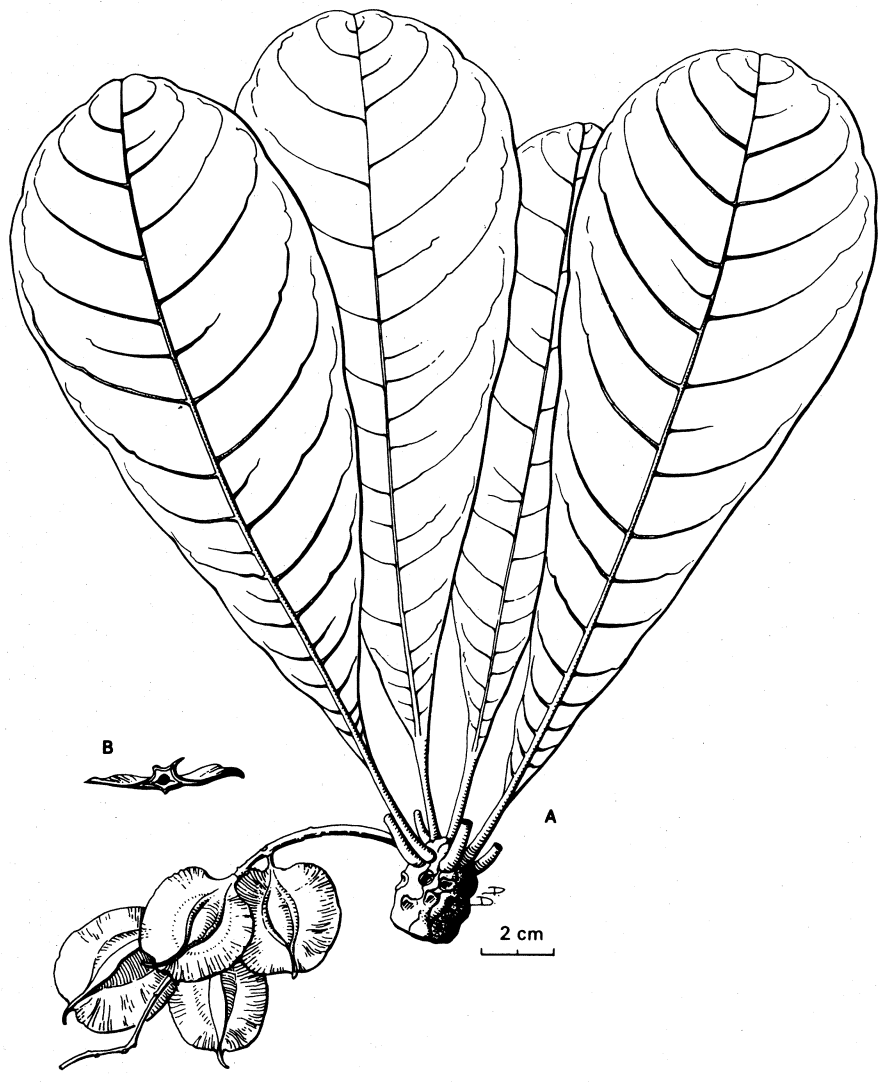


Fig. 44 **Terminalia rerei** Coode (A) leafy twig with fruits (B) fruit in cross-section

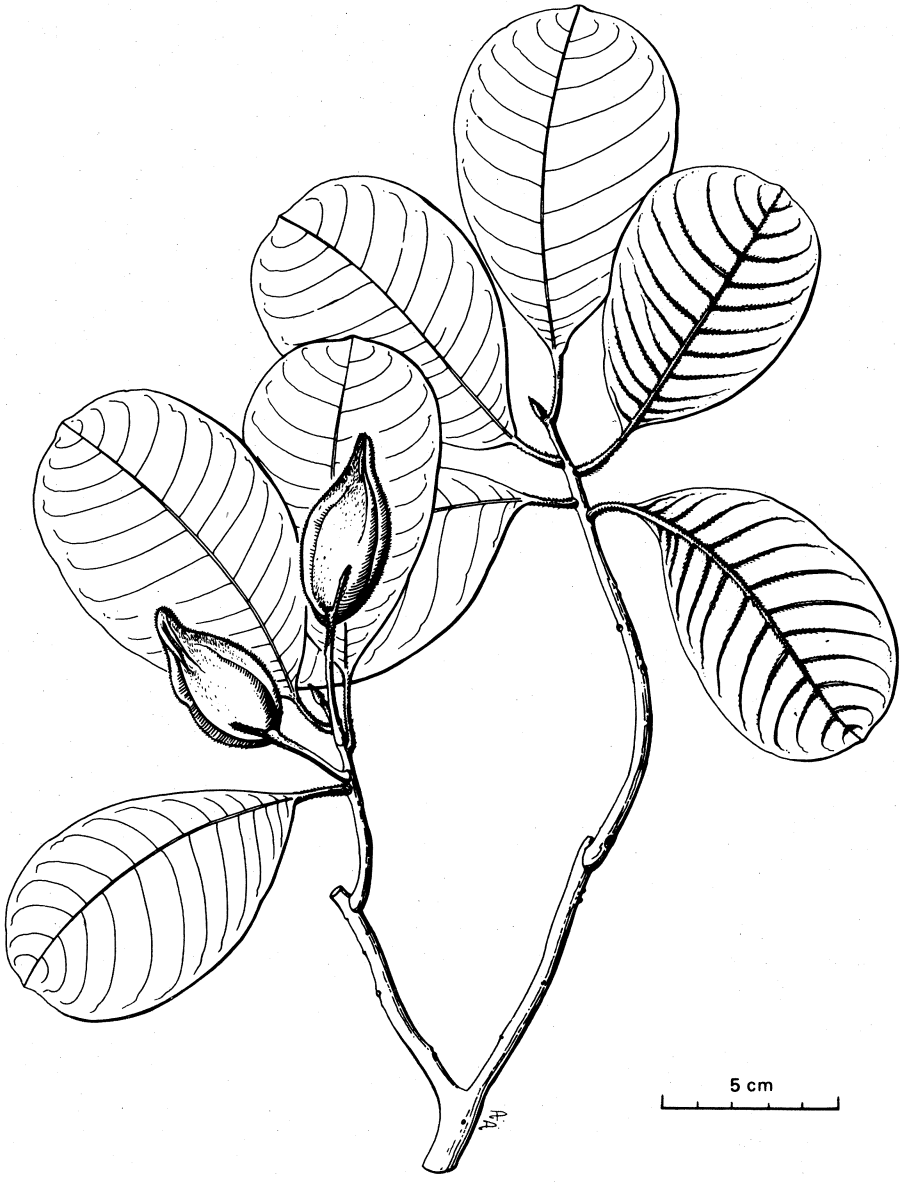


Fig. 45 **Terminalia rubiginosa** K. Sch.

Leaves usually laxly grouped at twig tips but with a few scattered elsewhere; petioles *c.* 1 cm or less; blades obovate to broadly so, 7–13 × 5–8 cm, tip obtuse, base tapering, becoming leathery with age, typically glabrous and drying greyish above, nerves with rust-coloured hairs beneath, nerves often many (7–13 pairs) and densely crowded, young leaves densely clothed with appressed silvery or golden hairs above, which usually wear away completely. Flowers 2–3 mm long, densely hairy outside; calyx lobes hairy outside, sparsely hairy or glabrous inside. Fruit ovoid to ellipsoid to subglobose 3–5 × 2·5–3 cm with at least 2, often 3–5, well-developed flanges which run out at tip into a point, with green and rust-coloured hairs at first, probably turning red and glabrous when ripe.

Distribution: Known from several collections from the Vogelkop and also from the Jayapura, Fakfak and Digul districts of western New Guinea. In northeastern New Guinea known certainly from the Morobe district (although the type is said to come from the East Sepik district). It is found throughout Papua including the islands, but excluding the Gulf, where it presumably occurs.

Ecology: Lowland rain forest.

Notes: Distinguished from *T. sepicana* by the brown hairs beneath the leaves and often more crowded nerves. There are some intermediate specimens. Normally a lowland species. There are specimens from the Eastern Highlands and Morobe districts (1500–1800 m) which may be seen in future to merit recognition as a variety—they have smaller leaves with denser, almost felty hairs.

Terminalia samoensis Rech. *Fedde, Rep.* **4**: 229 (1907); Exell *Fl. Males.* ser. 1, **4**: 568 (1954), f. 14; Coode *Contr. Herb. Aust.* **2**: 26 (1973). **Fig. 21, 26a–b; Fig. 46.**

T. saffordii Merr. (1914).

Trees to 20 m, often much smaller. Young parts ± appressed-hairy, usually quickly glabrous. Leaves clustered at twig tips; petioles slender, 1–2 cm; blades suborbicular to broadly obovate, (6–)9–16 × 6–13 cm, obtuse at tip, tapering to rounded, rarely subcordate, at base, with sparse silky hairs when young, glabrous and leathery when old. Flowers 5–6 mm long, glabrous outside or with a few hairs on lower part. Fruits flattened and green when young, becoming red, fleshy and swollen when ripe (drying flattened), 2–2·5 × 1–1·5 cm, sessile, to 6 per inflorescence.

Field characters: Often not much more than a wind-stunted shrub.

Distribution: In Papuasia known from the Papuan Islands (evidently common), from New Ireland and in the Solomon Islands from the Mortlock Islands (Bougainville district) and from San Cristobal. Probably it occurs on many other islands.

Ecology: Coral coasts, often in very exposed positions. Scattered over a wide area of the Southwest Pacific.

Uses: An attractive small tree which could be of use as an ornamental in

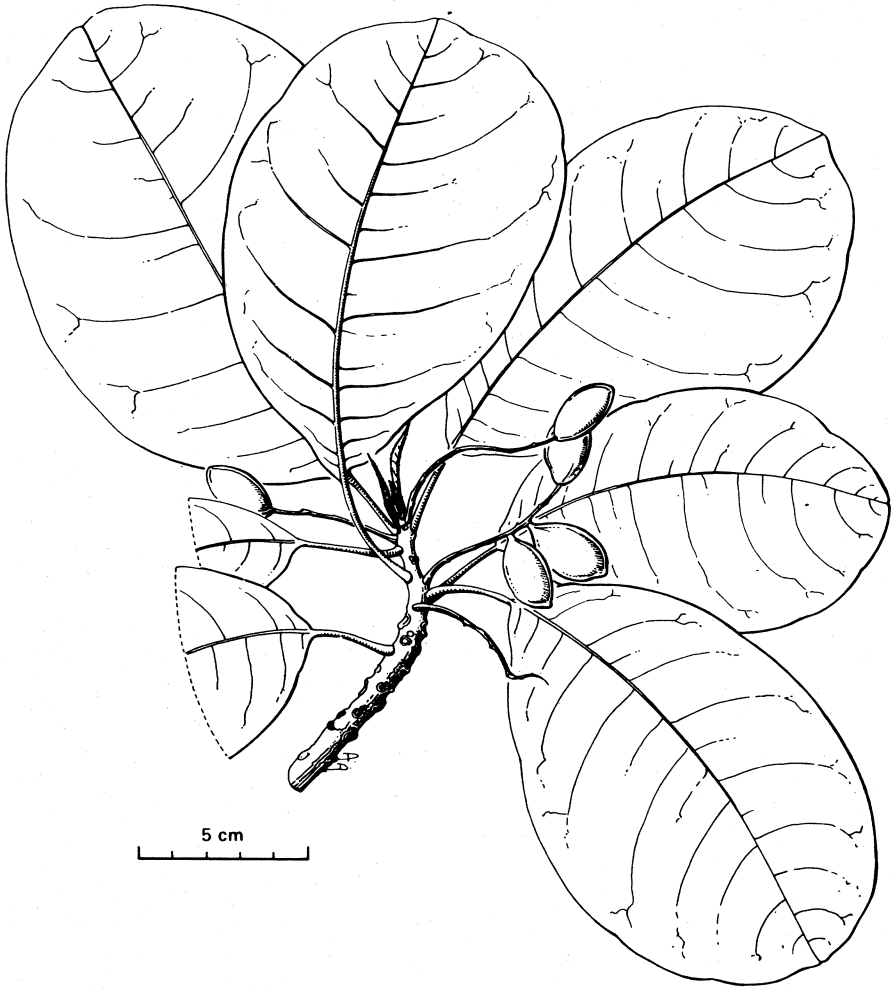


Fig. 46 **Terminalia samoensis** Rech.

coral coast areas.

Notes: Authorities differ on whether *T. samoensis* is the same as the earlier *T. littoralis* Seem. from farther east.

Terminalia sepicana Diels *Bot. Jb.* **57**: 429 (1922); Exell *Fl. Males.* ser. 1, **4**: 562 (1954), f. 14; Coode *Contr. Herb. Aust.* **2**: 27 (1973). **Fig. 21, 27a–g; Fig. 47.**

Trees 25–40 m tall. Leaves clustered in loose rosettes at twig tips; petioles generally < 2 cm long; blades obovate, 8·5–15 × 4–8 cm, usually obtuse at tip, tapering at base, often with dense silky hairs above when young, and yellow to brown hairs beneath, usually rapidly becoming quite glabrous, leathery at least when old. Flowers 3–4 mm long, with calyx lobes hairy outside. Fruit 1–3 per spike, 4–6 × 2·5–4·5 cm, attaining full length when still green and producing (3–)4–5 strongly developed flanges, typically with 2 lateral flanges at least running out into a point; reddening and becoming fleshy when ripe, often with subsidiary flanges filling out and disappearing (leaving 2 laterals) and occasionally found with very ripe fruit unwinged and ellipsoid, in this state very difficult to tell from *T. solomonensis*.

Field characters: Often buttressed. Crown tiered and dense.

Distribution: Apparently absent from the mainland of western New Guinea, there being one probable specimen from Japen Island in the Geelvink Bay district. Known from the West Sepik district, common in the Madang and Morobe districts, and known from the Western Highlands district of northeastern New Guinea. It is also found in the New Britain and New Ireland districts of the Bismarck Archipelago, and throughout the Solomon Islands.

Ecology: Lowland rain forest, often in swampy areas.

Notes: On New Ireland and in the Solomon Islands the species often has relatively narrower and thinner leaves but agrees well in other respects with the mainland form. See also the discussion under *T. rubiginosa*. *T. sepicana* seems to be replaced by *T. rubiginosa* in western New Guinea and Papua.

Terminalia slooteniana Exell *Blumea* **7**: 323 (1953); *Fl. Males.* ser. 1, **4**: 559 (1973), f. 13.

No more is known of this species than is in Exell (1954), p. 559. A shortened description after Exell follows. Tree, 25 m. Young branchlets thick, glabrous. Petiole glabrous 1–2 cm, with 2 glands (sometimes inconspicuous) at or near tip. Leaves crowded at ends of branchlets, spathulate, oblanceolate or narrowly obovate-elliptic, 10–20 × 4–8 cm, rounded at tip, tapering and decurrent at base into petiole, glabrous; nerves 9–12 pairs. Flowers unknown. Fruit glabrous, suborbicular to broadly elliptic in outline, 7·5 × 6 × *c.* 3 cm, circumalate with stiff narrow wing 2–4 mm broad, closely resembling small tortoise in shape.

Distribution: Known with certainty only from the Fakfak district of western New Guinea. Three other collections, all sterile, may belong here, two from the Vogelkop and one from the Jayapura district.

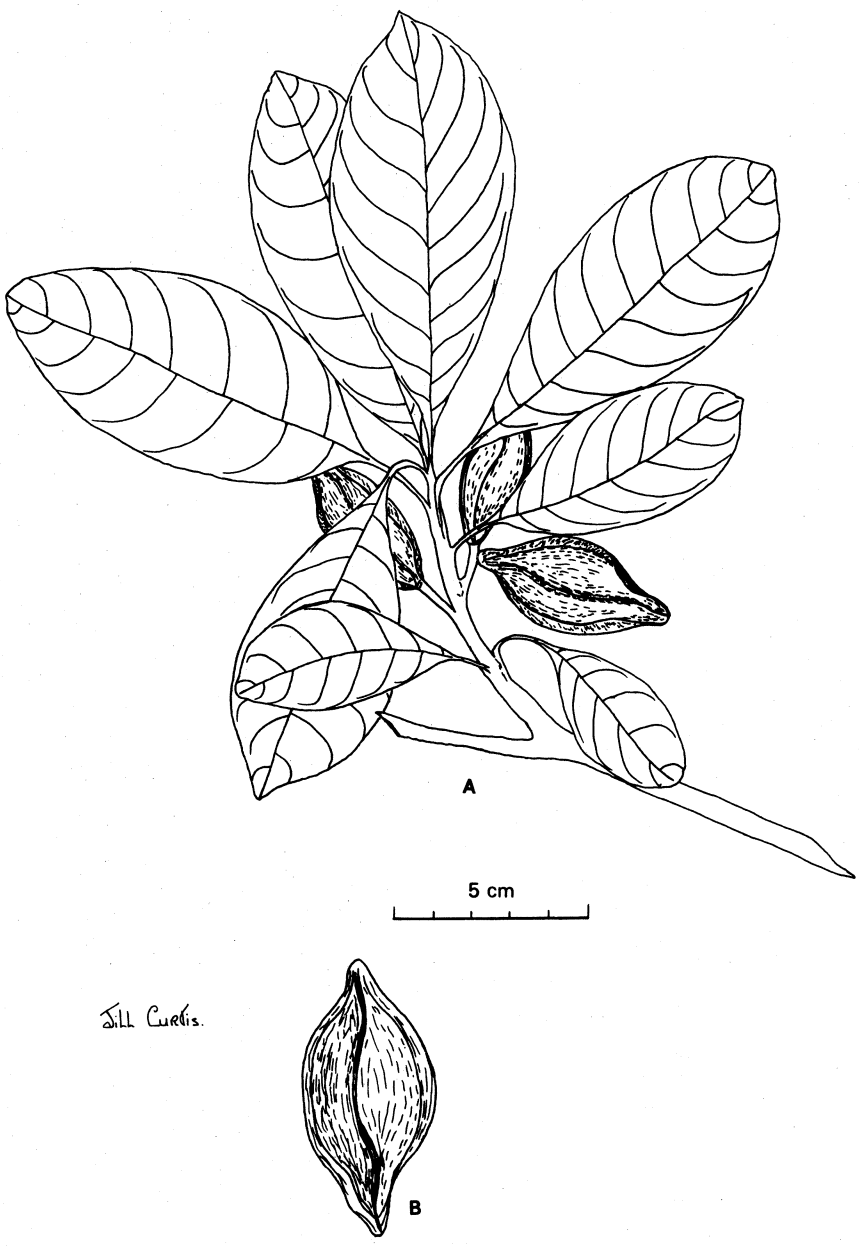


Fig. 47 **Terminalia sepicana** Diels (A) leafy twig and fruits (B) fruit

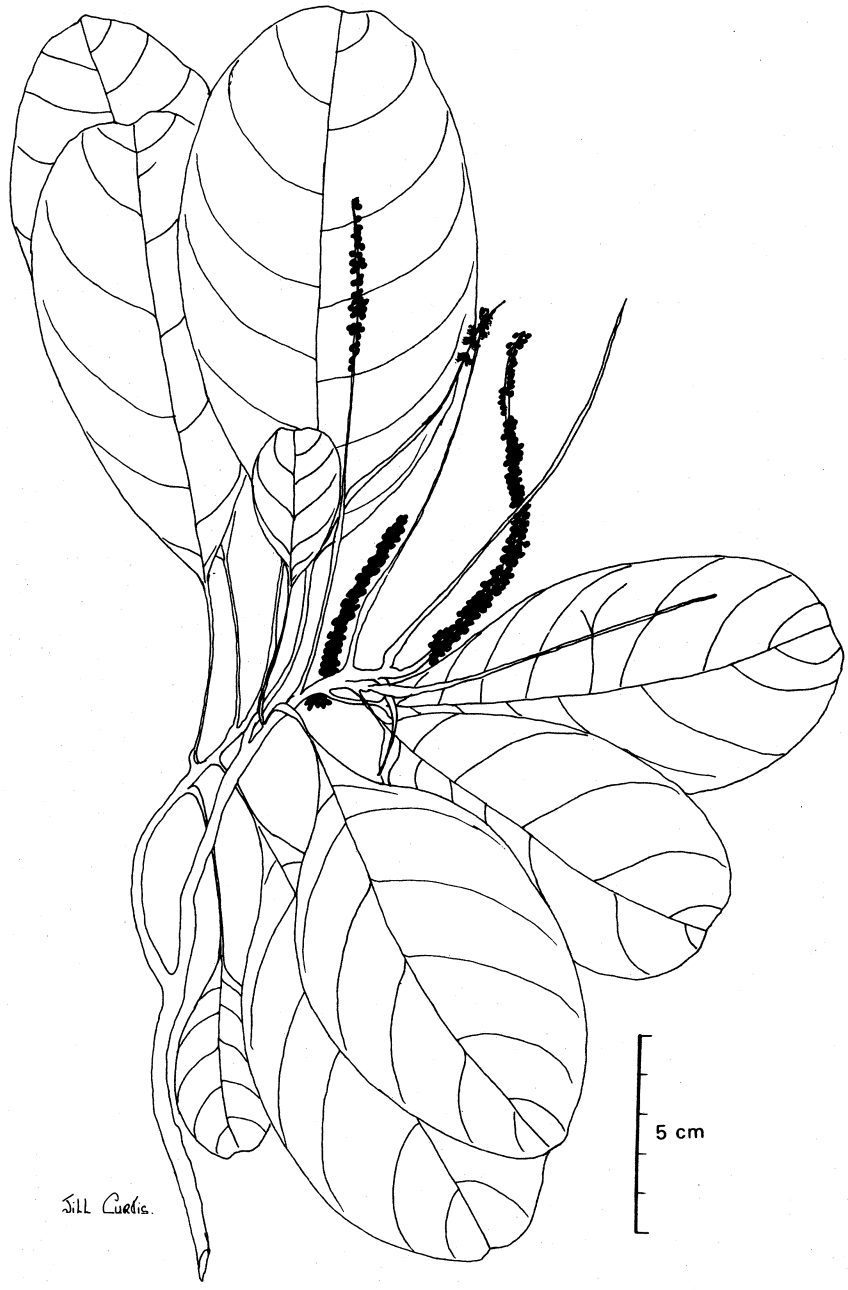


Fig. 48 **Terminalia solomonensis** Exell

Ecology: Lowland forest.

Notes: The fruit must be very distinct. The description and Exell's suggestion that it be related to *T. supitiana* Kds from the Celebes indicates that it is probably most like *T. archipelagi* of the species considered here.

Terminalia solomonensis Exell *J. Bot., Lond.* **73**: 132 (1935); *Fl. Males.* ser. 1, **4**: 571 (1954), f. 23; Coode *Contr. Herb. Aust.* **2**: 28 (1973). **Fig. 22, 28a–d; Fig. 48.**

T. papuana Exell (1936), (1954), f. 22, 23; *T. lundquistii* Exell (1953), (1954), f. 22, 23.

Trees 25–45 m tall. Leaves generally in clusters at twig tips; petioles 2–3 cm, often curved or ± sigmoid, glabrous, often biglandular near middle; blades ± elliptic, 10–18 × (5–)6–9 cm, tip ± obtuse, usually tapering at base, old leaves glabrous, typically leathery, young leaves sometimes sparsely and minutely hairy at most. Flowers *c.* 3 mm long, hairy outside, calyx lobes hairy outside. Fruit ellipsoid, 4–5 × 2–3·5 cm, smooth and unwrinkled though occasionally slightly 3-angled or flattened on one side, red and firmly fleshy when ripe, the flesh contracting onto the sculptured stone when dry.

Field characters: Often with a few, usually simple and plank-like, buttresses to 4 m from the ground; bole sometimes fluted. Outer bark usually grey-brown and shedding in large flakes, sometimes only fissured, occasionally reddish.

Distribution: Apparently not common in western New Guinea, being known only from the Jayapura (Idenburg River) and Mimika districts. In north-eastern New Guinea known from the Madang and Morobe districts, and in Papua from the Central (and Northern?) district. It is common on New Britain, known from New Ireland and found throughout the Solomon Islands. *T. celebica* Exell from the Celebes may be the same species.

Ecology: Lowland forests, but also found to *c.* 1200 m.

Uses: First indications are that the timber splits too easily to be of real use. Further investigation is needed. The species is common in parts of New Britain and has been cut fairly extensively there.

Notes: See discussion under *T. megalocarpa*, from which *T. solomonensis* is difficult to distinguish in flower. There also seems no certain way to distinguish *T. eddowesii* from *T. solomonensis* in flower. In fruit there is no difficulty. There are specimens from Long Island (Madang district) which have very small fruits and perhaps represent a variety of *T. solomonensis.*

Terminalia steenisiana Exell *Blumea* **7**: 327 (1953); *Fl. Males.* ser. 1, **4**: 560 (1954), f. 14; Coode *Contr. Herb. Aust.* **2**: 29 (1973). **Fig. 22, 29a–d; Fig. 49.**

Trees to 20 m tall. Twigs with slender long shoots; short shoots a little more robust and pitted with condensed leaf-scars. Young parts with ± sparse appressed hairs. Leaves clustered in tight rosettes at twig tips; petioles 1–1·5 cm, slender; blades obovate, 6–11 × 3–5·5 cm, usually acute at tip,

Fig. 49 **Terminalia steenisiana** Exell (A) leafy twig with flowering inflorescences (B) leafy twig with fruits (C) cross-section of fruit

tapering at base, when very young with silky appressed hairs which quickly wear away. Flowers 5–6 mm, glabrous outside with white calyx teeth. Disc conspicuous, orange. Fruits broadly elliptic or circular in outline, 2·5–3·5 × *c.* 2 cm, flattened strongly with two wide flanges laterally, red and somewhat succulent when ripe.

Distribution: One specimen with rather large fruits known from the Western district of Papua; all the other specimens are from the Central district.

Ecology: Lowlands, usually in scrub or monsoon forests.

Wood: One of the few *Terminalia* species from Papuasia with distinct wood, having rays generally of two distinct widths—low uniseriate rays, and taller rays 2–5(–6) cells wide.

Notes: Through the Western district specimen, *T. steenisiana* appears to resemble *T. avicapitis* more than any other in Papuasia. The tightly rosetted leaves, flattened fruits and longer inflorescence with more flowers distinguish this species from *T. archboldiana* with which it may be confused when not in fruit.

Terminalia whitmorei Coode *Kew Bull.* **23**: 306 (1969), f. 5; *Contr. Herb. Aust.* **2**: 30 (1973). **Fig. 22, 30a–h; Fig. 50.**

Trees generally < 20 m. Twigs with condensed leaf-scars. Young parts densely hairy, hairs ± persistent. Leaves tightly clustered at twig tips; petioles (0–)3–10 mm, ± stout, hairy; blades obovate, (10–)12–20 × (4·5–)6·5–9 cm, usually acute at tip, tapering to minutely subcordate base, nerves prominent and hairy beneath, (10–)12–15 pairs. Flowers 3–4 mm, glabrous outside with calyx lobes *c.* 1·5 mm long, white. Fruits ± flattened-ovoid; often collected in juvenile state, when with 2 very pronounced thin, wide wings, often a third smaller wing; flesh later fills out these wings so final product compressed, red, fleshy, ovate in outline, to 4 × 3 cm, shrivelling considerably on drying.

Distribution: Known only from Santa Isabel and the Guadalcanal group (including the Nggelas or Florida Islands) in the Solomon Islands.

Ecology: So far recorded for secondary forest on coralline slopes; low altitudes.

Notes: The smaller hairy leaves with acute tips, usually > 11 nerves and the shrivelling fruit distinguish this species from *T. catappa.* The short petioles and tightly clustered leaves, and the unflanged mature fruit distinguish it from *T. sepicana.* The stamens number 7–11, not –16 as in the original description.

DOUBTFUL RECORDS

Terminalia citrina (Gaertn.) Roxb. ex Flem. in *As. Res.* **11**: 183 (1810); Exell *Fl. Males.* ser. 1, **4**: 555 (1954).

Myrobalanus citrinus Gaertn. (1791).

A single sterile specimen (*Brass & Versteegh* 14019) was collected from the

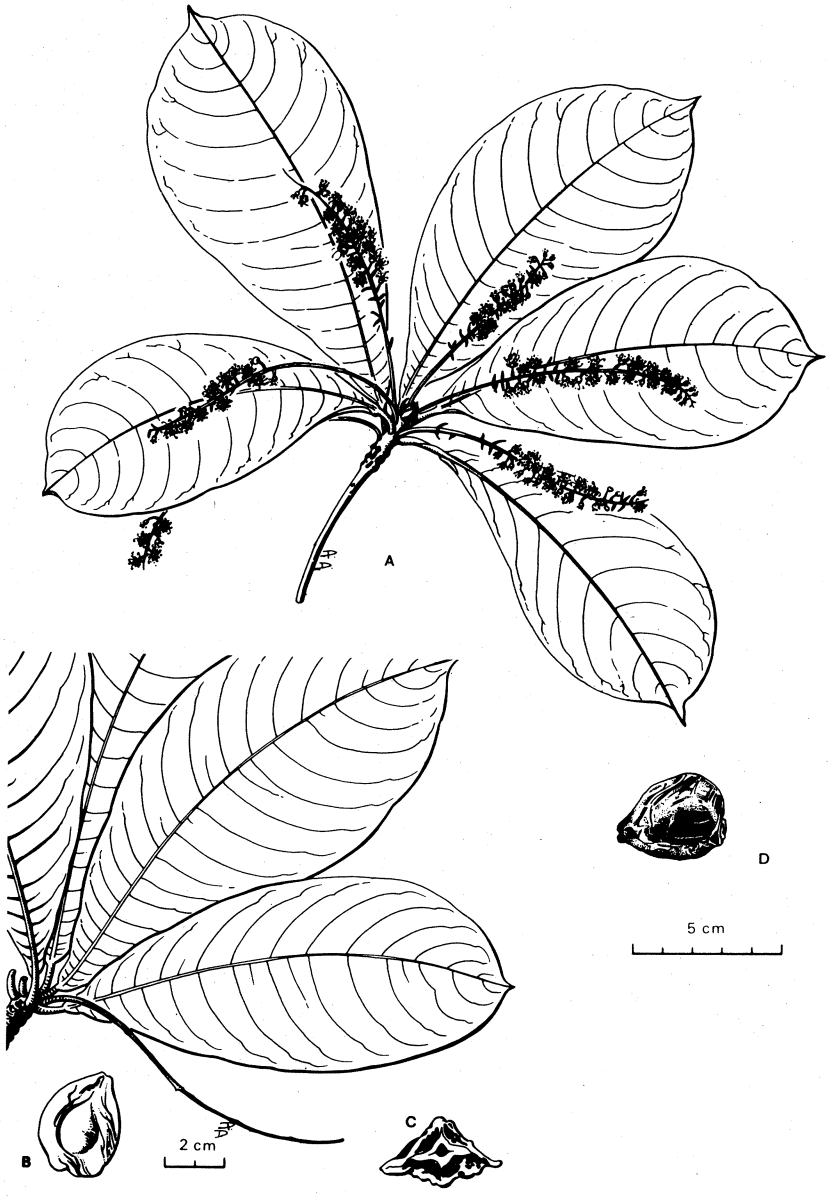


Fig. 50 **Terminalia whitmorei** Coode (A) leafy twig with flowering inflorescences (B) leafy twig with fruit (C) fruit in cross-section (D) loose fruit

Idenburg River in western New Guinea; a duplicate has been seen. It is doubtful whether it is a *Terminalia* at all, but until it is confidently identified as something else, the record must stand. The species is distinguished by its terminal panicles bearing flowers that are probably all hermaphrodite; the fruits are unwinged which distinguishes it from *T. brassii*, the only other *Terminalia* recorded from Papuasia with panicles.

Terminalia trinervia Laut. & K. Sch. = *Bennettia trinervia* (Laut. & K. Sch.) Gilg in the Flacourtiaceae, itself listed by Sleum. *Fl. Males.* ser. 1, **5**: 64 (1954) as insufficiently known.

CATALOGUE OF ILLUSTRATIONS OF PAPUASIAN TERMINALIA

Probably no other genus of Papuasian plants is so profusely illustrated as is *Terminalia*. This catalogue provides a ready reference to the location of these illustrations. Fruits, fruit sections and distribution maps, unless accompanied by a more general drawing, have not been included. Appropriate references to these are given in the text. 'Ibid.' as used in this catalogue means 'in this publication'.

T. archboldiana	ibid. Fig. 23; *For. Man.* pt 1, rev. f. 1
T. archipelagi	*Kew Bull.* **23**: 300, 301 (1969), f. 1, 2
	ibid. Fig. 24; *For. Man.* pt 1, rev. f. 2, 3
T. avicapitis	*Contr. Herb. Aust.* **2**: 4 (1973), f. 1
T. brassii	ibid. Fig. 25; *For. Man.* pt 1, rev. f. 4
T. calamansanai	*Fl. Males.* ser. 1, **4**: 557 (1954), f. 11
	ibid. Fig. 26; *For. Man.* pt 1, rev. f. 5
T. calogemma	*Contr. Herb. Aust.* **2**: 6 (1973), f. 2
T. canaliculata	ibid. Fig. 27; *For. Man.* pt 1, rev. f. 6
T. capitulata	ibid. Fig. 28; *For. Man.* pt 1, rev. f. 7
T. catappa	*Fl. Males.* ser. 1, **4**: 566, 567 (1954), f. 17, 18
	ibid. Fig. 29; *For. Man.* pt 1, rev. f. 8
T. complanata	ibid. Figs 30, 31; *For. Man.* pt 1, rev. f. 9
T. copelandii	*Fl. Males.* ser. 1, **4**: 580 (1954), f. 27
	ibid. Fig. 32; *For. Man.* pt 1, rev. f. 10
	As *T. catappoides* White & Francis *Proc. R. Soc. Qd* **38**: 249 (1927), f. 13
T. crassifolia	ibid. Fig. 33; *For. Man.* pt 1, rev. f. 11
T. eddowesii	*Contr. Herb. Aust.* **2**: 12 (1973), f. 3
	For. Man. pt 1, rev. f. 29
T. impediens	*Kew Bull.* **23**: 309 (1969), f. 6
	ibid. Fig. 34; *For. Man.* pt 1, rev. f. 13
T. kaernbachii	ibid. Fig. 35; *For. Man.* pt 1, rev. f. 14, 15
T. katikii	*Contr. Herb. Aust.* **2**: 16 (1973), f. 4
T. longespicata	*Fl. Males.* ser. 1, **4**: 565 (1954), f. 16
ssp. *longespicata*	ibid. Fig. 36; *For. Man.* pt 1, rev. f. 16
ssp. *sogerensis*	ibid. Fig. 37;
T. macadamii	ibid. Fig. 38; *For. Man.* pt 1, rev. f. 17
T. megalocarpa	ibid. Fig. 39, 40; *For. Man.* pt 1, rev. f. 18, 19

T. microcarpa	
ssp. *incana*	ibid. Fig. 41; *For. Man.* pt 1, rev. f. 20
ssp. *microcarpa*	ibid. Fig. 42; *For. Man.* pt 1, rev. f. 12
T. morobensis	*Contr. Herb. Aust.* **2**: 24 (1973), f. 5
	For. Man. pt 1, rev. f. 30
T. oreadum	ibid. Fig. 43; *For. Man.* pt 1, rev. f. 21
T. rerei	*Kew Bull.* **23**: 304 (1973), f. 3
	ibid. Fig. 44; *For. Man.* pt 1, rev. f. 22
T. rubiginosa	ibid. Fig. 45; *For. Man.* pt 1, rev. f. 23
T. samoensis	ibid. Fig. 46; *For. Man.* pt 1, rev. f. 24
	As *T. saffordii*, *Merr. Bot. Mag., Tokyo* **51**: 912 (1937), f. 67
T. sepicana	ibid. Fig. 47; *For. Man.* pt 1, rev. f. 25
T. solomonensis	ibid. Fig. 48; *For. Man.* pt 1, rev. f. 26
T. steenisiana	ibid. Fig. 49; *For. Man.* pt 1, rev. f. 27
T. whitmorei	*Kew Bull.* **23**: 306 (1969), f. 5
	ibid. Fig. 50; *For. Man.* pt 1, rev. f. 28

CORYNOCARPACEAE

D. B. Foreman

Small to medium-sized trees, evergreen, glabrous. Leaves alternate, simple, entire, stipules absent. Inflorescence terminal, sometimes lateral. Flowers bisexual, regular, pedicellate; sepals 5, free, imbricate, persistent; petals 5, joined to base of sepals, imbricate; stamens 5, attached to base of petals; staminodes 5, alternating with stamens; ovary superior, 1–2-locular; styles 1–2, free; ovule 1, pendulous, anatropous; bracts present, persistent. Fruit drupaceous; seed 1, without endosperm.

Distribution: 1 genus with 4 species in New Zealand, New Caledonia, the New Hebrides, northern Queensland, Papuasia and the Aru Islands.

Literature: C. G. G. J. van Steenis (1951), Corynocarpaceae, *Fl. Males.* ser. 1, **4**: 262–4.

CORYNOCARPUS Forst. & f.

Trees, often with branches in pseudowhorls. Leaves ± clustered towards twig tips, midrib sunken in groove above. Calyx deeply 5-lobed, outer 2 smallest, similar to petals. Petals 5, inserted at margin of disc-like receptacle, slightly thinner than sepals. Stamens 5, filaments flattened or terete, slightly thickened towards base; anthers dorsifixed, dehiscing lengthwise. Staminodes petal-like, dentate in upper half. Disc glands 5, ovoid to ellipsoid, borne on staminodes. Ovary initially 2-celled with 1 cell soon becoming aborted.

Distribution: 4 species, 1 occurring in New Zealand and the nearby islands, 1 in New Caldeonia, 1 in the New Hebrides, and 1 extending from northern Queensland to Papuasia and the Aru Islands.

Corynocarpus cribbianus (F. M. Bail.) L. S. Sm. in *Proc. R. Soc. Qd* **67**: 31 (1956). **Fig. 51.**

Cyanocarpus cribbiana F. M. Bail. (1897); *Helicia cribbiana* (F. M. Bail.) F. M. Bail. (1901); *Corynocarpus australasica* C. T. White (1933); Steen. (1951), f. 1.

Small to medium-sized tree 4–20 m tall. Twigs ± angular to ± terete. Petiole sulcate, 1–5 cm long; lamina elliptic-oblong, broadly elliptic, oblong to broadly ovate, 9–26 × 3–13 cm, tip acute to acuminate, base ± rounded to cuneate, nerves 8–11 pairs, curved and anastomosing near margin, impressed above, raised and prominent beneath, midrib sunken above, raised and very prominent beneath, reticulations ± dense, slightly raised on both surfaces. Inflorescence a panicle, ± broadly pyramidal, to 20 cm long,

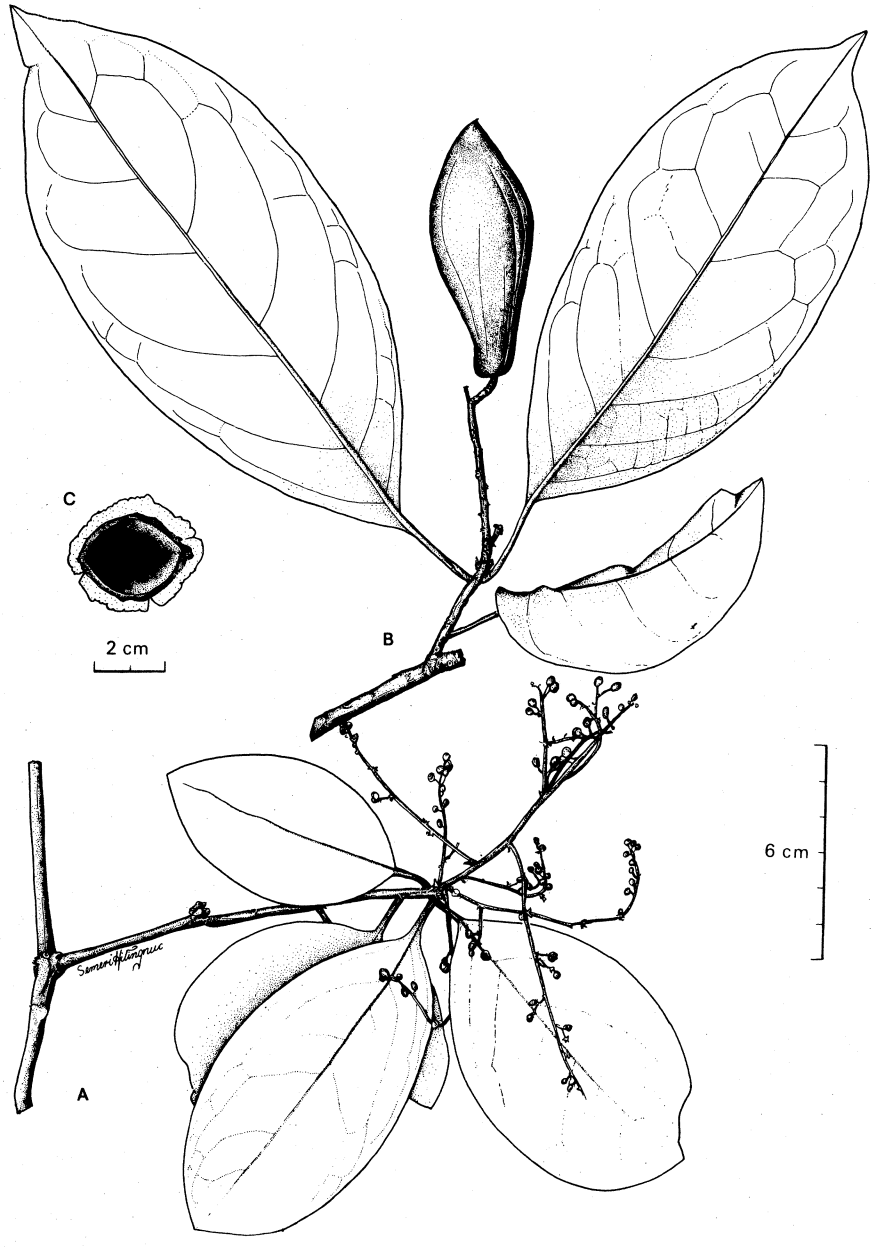


Fig. 51 **Corynocarpus cribbianus** (F. M. Bail.) L. S. Sm. (A) flowering twig (B) fruiting twig (C) cross-section of dried fruit

bracts persistent, 1–2 mm long. Flowers with pedicels 2·5–4·5 mm long, fragrant, whitish, sometimes becoming slightly rose-coloured; sepals 2·5–3·5 × 2 mm; petals 2·5–4 × 1·5 mm; anthers *c.* 0·75 mm long, filaments terete, 1·5–2·5 mm long; staminodes obovate-oblong 2·5–3 mm long; disc glands ovoid, *c.* 1 mm long; ovary *c.* 1 mm high; style 1, *c.* 1 mm long. Fruit a drupe, pendulous, subglobular to ± pyriform, 5–9 × 3–6 cm, exocarp smooth, thin, turning pinkish when mature; mesocarp white, fleshy; endocarp 1–2 mm thick, fibrous.

Field characters: Bole straight or crooked, buttresses mostly absent. Bark weakly fissured, grey to grey-brown, underbark cream-coloured to light brown, wood cream-coloured to light brown.

Distribution: In northern Queensland, throughout Papuasia and extending to the Aru Islands.

Ecology: In well-drained primary or secondary rain forest, in lower montane, montane or mixed oak forest from sea level to 2750 m altitude. Flowering and fruiting throughout the year.

Notes: The fruit has a rather pleasant taste and has been reported to be edible. The leaves of this species are rather variable, particularly specimens from the Solomon Islands which tend to have longer petioles and larger leaves than those from mainland New Guinea.

DATISCACEAE

J. R. Croft

Dioecious, evergreen or deciduous, often buttressed trees, without latex. Leaves simple, entire or denticulate, often lepidote or hairy, spirally arranged. Stipules absent. Inflorescence elongate, bracteate, caducous spikes or panicles, solitary, axillary or apically fasciculate. Flowers unisexual, rarely polygamous, generally isomerous, actinomorphic, valvate. Male flowers with 4–9 sepals, connate into a lobed tube or free and unequal; petals free or absent; stamens episepalous; anthers basifixed; rudimentary ovary present or absent. Female flowers without petals; sepals connate above ovary or free; rudimentary stamens absent; styles mostly inserted opposite calyx lobes on margin of calyx tube; ovary inferior, 1-celled, parietal placentation, abundant ovules. Fruit a capsule, dehiscing apically or laterally.

Distribution: 3 genera with 4 species. *Datisca* with 1 species in Asia and 1 in western Central America. *Octomeles* and *Tetrameles* with 1 species each in the Malesian and Papuasian region and northern Australia.

Notes: Airy Shaw (1965) considers that the 2 Malesian genera constitute the family Tetramelaceae, *Datisca* alone remaining in the Datiscaceae. This view is not supported by the anatomical studies of Davidson (1973).

Literature: H. K. Airy Shaw (1965), Diagnoses of new families, new names etc. for the seventh edition of Willis's "Dictionary", *Kew Bull.* **18**(2): 267–9. C. Davidson (1973), An anatomical and morphological study of the Datiscaceae, *Aliso* **8**: 49–110, f. 1–139. C. G. G. J. van Steenis (1953), Datiscaceae, *Fl. Males.* ser. 1, **4**(4): 382–7, f. 1–6.

KEY TO GENERA

1. Evergreen. Leaves lepidote, petiole obtusely 5-angled. Inflorescence solitary, axillary. Male flowers 6–8-merous, petals present. Capsules dehiscing laterally . . . OCTOMELES
1. Deciduous. Leaves hairy, petiole terete. Inflorescence apically fasciculate on leafless twigs. Male flowers 4–5-merous, petals absent. Capsules dehiscing apically . . . TETRAMELES

OCTOMELES Miq.

Tall, evergreen, buttressed tree. Twigs thick, 3-angled at apex. Flush and inflorescence lepidote-glabrescent. Leaves roundish-cordate; groups of pitted domatial glands in axils of nerves on undersurface, numerous smaller ones along veins. Petiole obtusely 5-angled. Flowers sessile, 5–8-merous, in axillary spikes. Male flowers campanulate; sepals and petals triangular; stamens

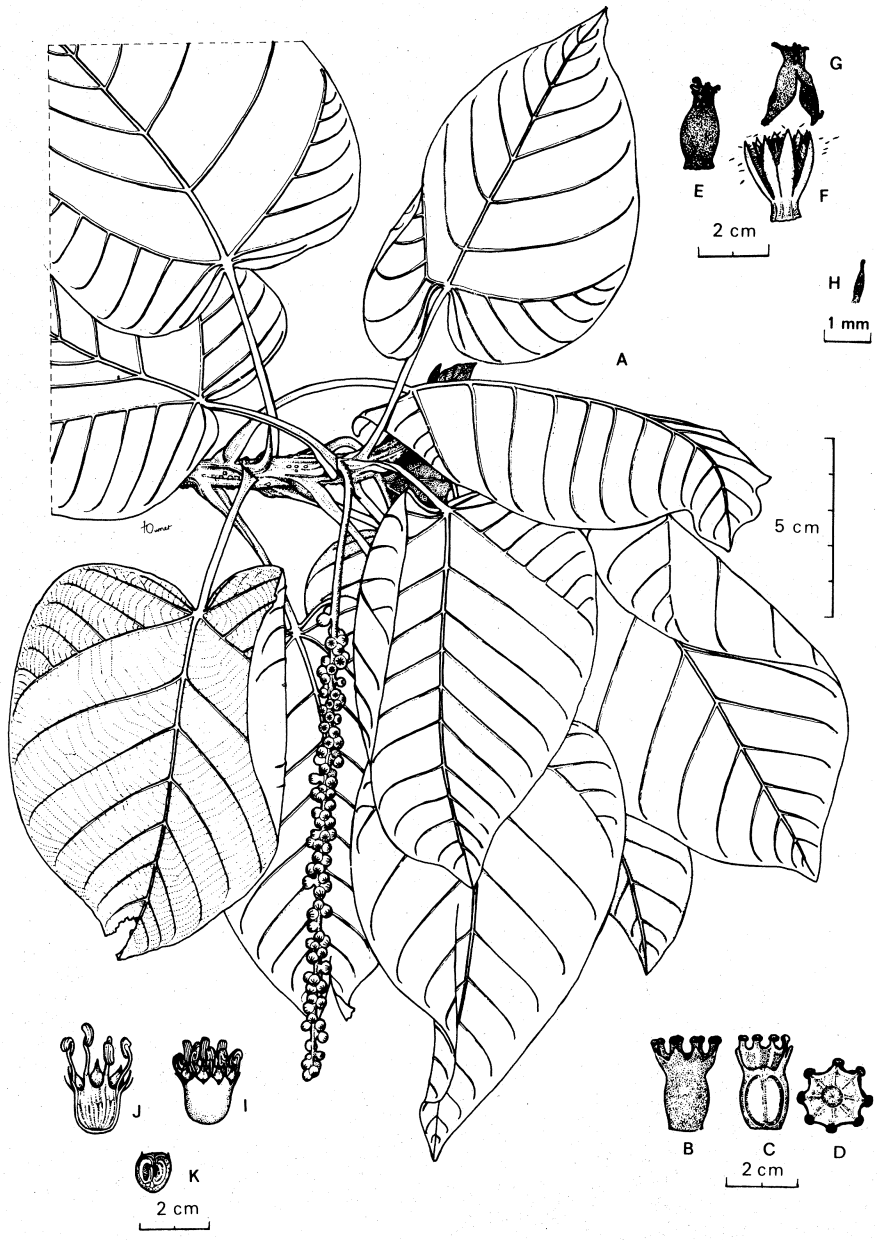


Fig. 52 **Octomeles sumatrana** Miq. (A) inflorescence, unopened flowers on leafy twig (B) female flower (C) female flower in longitudinal section (D) female flower, apical view (E) mature fruit (F) persistent endocarp (G) shed calyx and exocarp (H) seed (I) male flower (J) male flower in longitudinal section (K) male bud in longitudinal section

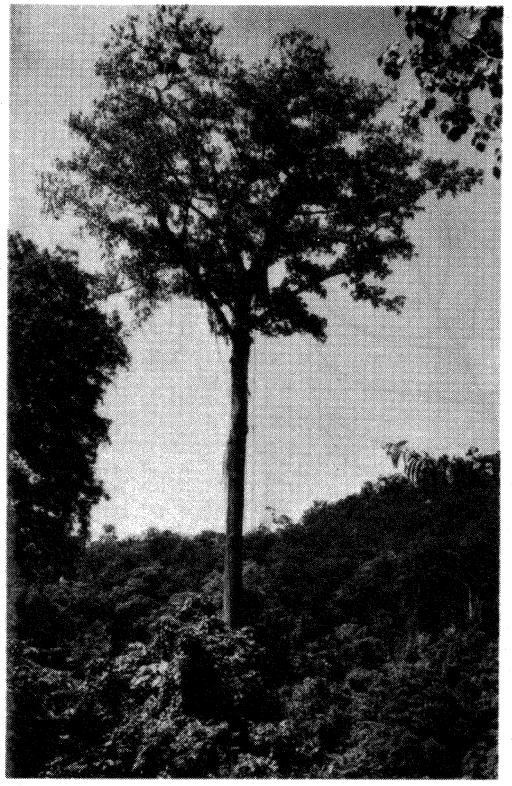


Fig. 53 **Octomeles sumatrana** Miq.
Bole and crown, Morobe district

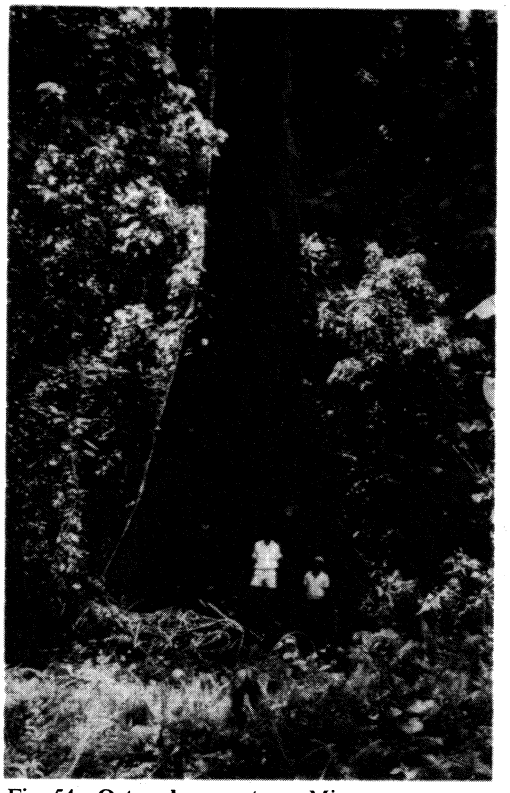


Fig. 54 **Octomeles sumatrana** Miq.
Lower bole and buttresses, Morobe district

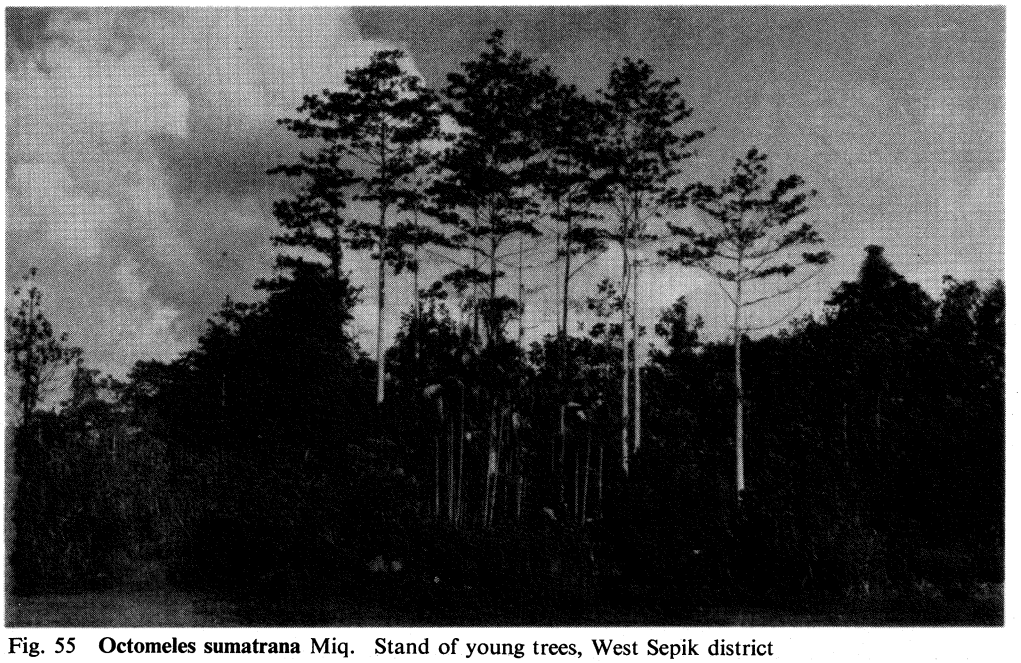


Fig. 55 **Octomeles sumatrana** Miq. Stand of young trees, West Sepik district

strongly incurved in bud with large reniform inward-facing anther on thick filament. Female flowers without petals, deeply campanulate with thickened calyx tube enveloping ovary; calyx lobes acutely triangular; styles 5–8, short, thick, flattened, capitate, inserted opposite calyx lobes. Capsule urceolate, dehiscing laterally, shedding longitudinally ruptured exocarp and calyx; endocarp persistent, pale, horny, splitting from top. Seeds fusiform, copious.

Distribution: Malesia and Papuasia except in the Malay peninsula, Java and the Lesser Sunda Islands; 1 species.

Ecology: Lowland tropical rain forest often near river banks; seedlings frequently establish on river sand banks.

Octomeles sumatrana Miq. *Fl. Ind. Bat. Suppl.* 336 (1861). **Figs 52–55.**
O. moluccana Teysm. & Binn. ex Hassk. (1866).

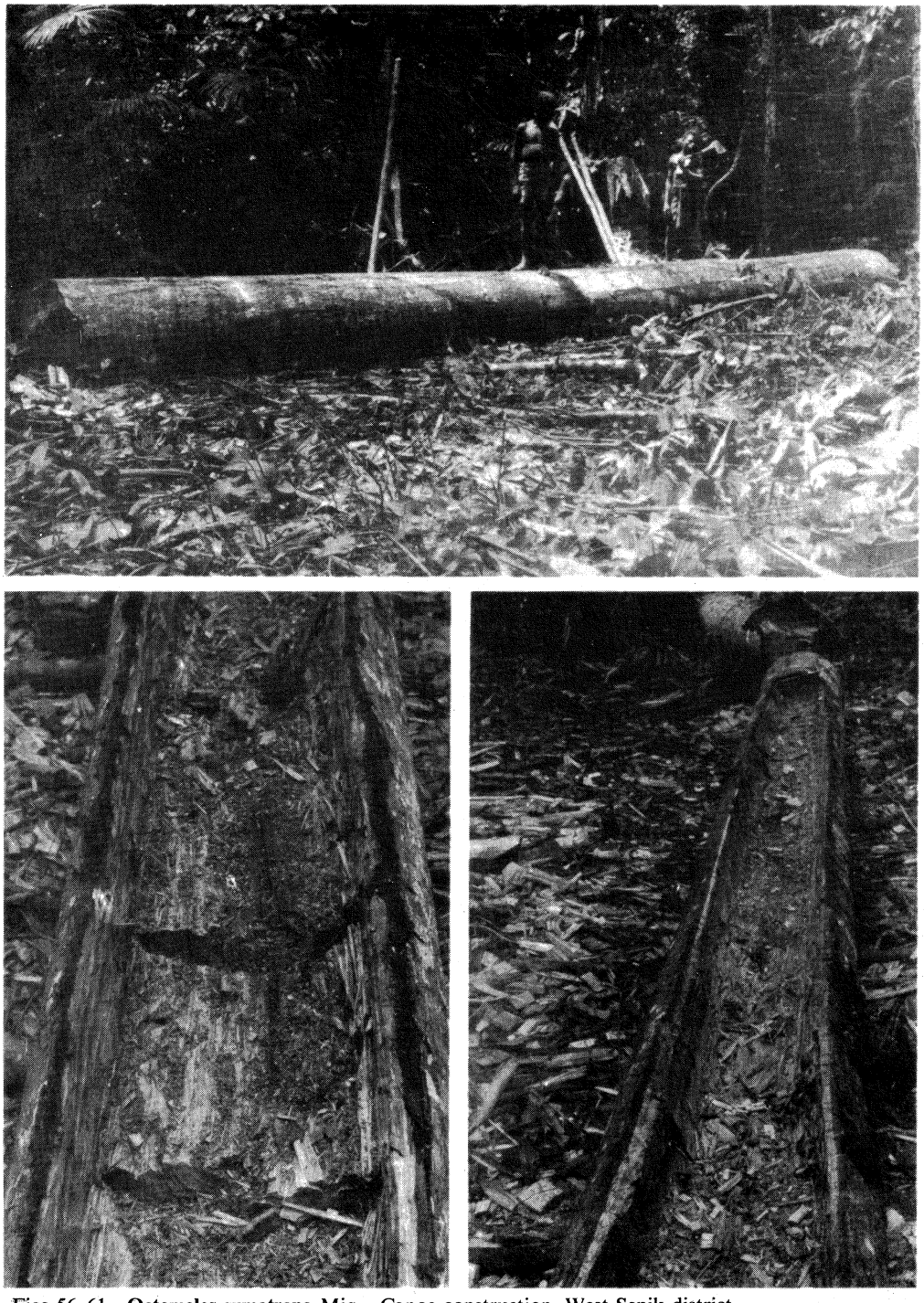
Tree to 75 m tall, bole diameter to 2 m above buttresses. Leaves glabrous, round, broadly ovate to cordate, acuminate, ± entire, 12–30 × 6–23 cm, those of young trees or suckers often much larger. Nervation with 5–7 nerves radiating from junction of petiole and lamina and 5–8 pairs of nerves branching from central nerve. Petiole obtusely 5-angled, 6–30 cm long. Male spikes 20–60 cm long; bracts lanceolate, acute, 2 mm long; flowers 4–5 × 5 mm; calyx lobes ovate, triangular, acute, 2 mm long; petals triangular, 3 mm long with incurved subulate appendage forming descending column in bud; stamens 4 mm long, filament thick, anther 2 mm long. Female flowers 5 cm long, in spikes 8–12 cm; ovary 1–2 mm high, free calyx tube 2–4 mm, lobes broadly triangular, 1 × 2 mm; styles 1–2 mm long, fleshy, thick, flattened with stigma 0·5 mm high, 1 mm diameter. Fruiting spikes 15–40 cm long on 10–20 cm long peduncles. Capsule 1·2 cm long. Endocarp splitting nearly to base, *c.* 1 cm long. Seeds 1 × 0·2 mm.

Field characters: Clear bole to 40 m, generally cylindrical and straight. Buttresses thin, wide-spreading, straight or slightly concave, 5–10 × 6 m. Pagoda-type branching in young trees, crown open, semi-globular when mature. Bark grey to grey-brown, fissured, 2–4 cm thick, often pustular outer bark, greenish underbark, yellowish inner bark rapidly turning brown when cut, no exudate, unpleasant smell. Wood soft, coarse-grained, brittle; sapwood off-white, heart-wood pale brown-grey or yellow-brown; no smell when dry but rather unpleasant when wet.

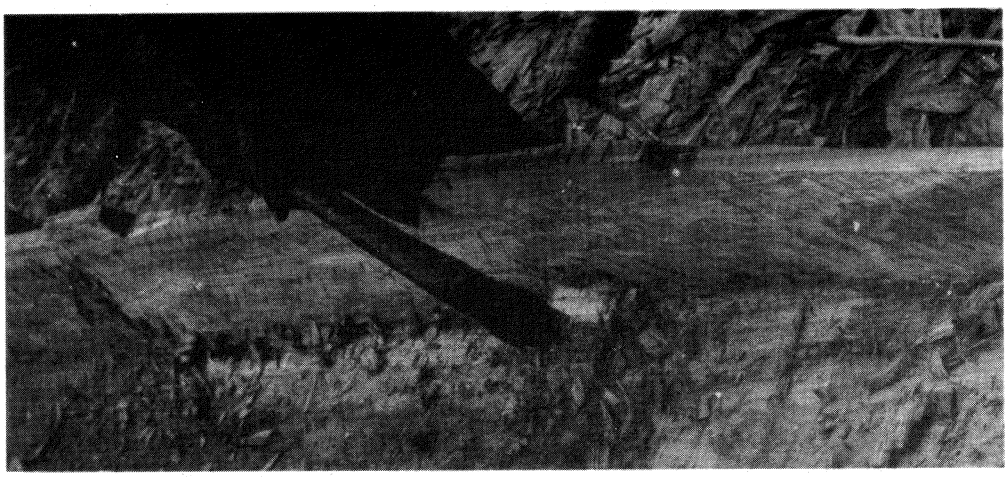
Distribution: In Papuasia from the Vogelkop district to Santa Isabel, where the tree is frequently locally common. Also in Sumatra and the Philippines.

Ecology: A seral species of lowland rain forest (to 1000 m). Fast-growing, often in gregarious even-aged stands along rivers. May be found in flower and fruit ± throughout the year.

Uses: A non-durable timber used for interiors, packing, coffin-boards, veneer for backs and cores of plywood, match-boxes. Favoured by indigenes for canoe building. **Figs 56–61.**



Figs 56–61 **Octomeles sumatrana** Miq. Canoe construction, West Sepik district



TETRAMELES R. Br.

Tall, deciduous, buttressed tree. Leaves round to cordate-ovate, acuminate; margin entire to denticulate or serrulate; undersurface densely covered with simple hairs, upper surface with sparse simple hairs; petiole terete. Inflorescence fasciculate, peduncled, pendulous spikes or panicles; rachis tomentose; flowers shortly pedicellate to almost sessile, solitary or in groups of 2 or 3, without petals. Male flowers tetramerous in simple or few-branched spikes; calyx tube short, oblong to ovate lobes, equal or not, sometimes alternating with a few smaller, narrower lobules; stamens 4, inserted opposite sepals on margin of cup-shaped receptacle; filaments thin; rudimentary ovary disc-shaped or cross-like if present. Female flowers tetramerous or pentamerous, in panicles; lower part of calyx connate with ovary, slightly 4-angled, glandular, hairy; upper part cup-shaped with 4 triangular lobes; styles 4–5, erect, persistent, inserted opposite calyx lobes on margin of calyx throat, with an obliquely inserted, inward-facing, spathulate stigmatic surface. Capsule splitting apically with 4 triangular valves curving inwards forming a roundish apical pore.

Distribution: Ceylon, through Southeast Asia and Malesia; absent from Borneo and the Philippines; recently collected in northern Australia; 1 species.

Ecology: Restricted to tropical lowland rain forests with ± pronounced dry season.

Tetrameles nudiflora R. Br. in Benn. *Pl. Jav. Rar.* 79 (1838). **Fig. 62.**
T. horsfieldii Steud. (1841); *T. grahamiana* Wight (1853).

Tree to 45 m tall; above buttresses, bole diameter to 2 m. Leaves round to broadly cordate-ovate, acuminate, almost entire to denticulate, 10–25 × 9–20 cm, upper surface ± glabrous, undersurface hairy especially on nerves and smaller veins. Nervation generally palmate with 5–7 radial nerves and 3–5 additional pairs of nerves branching from central nerve; petiole terete, 3–7(–20) cm long. Leaf-scars prominent, 5–8 mm diameter. Male flowers slightly fragrant; panicles 10–20 cm long; bracts spathulate, hairy, 1 mm long; pedicels glabrous, subsessile to 1 mm long; calyx 1·5–2 mm high; filaments 0·5–4 mm, terete, tapering to apex; anthers rounded, 0·5 mm diameter. Female flowers sessile, 3–5 mm long; spikes 8–20 cm long; calyx sparsely hairy; tube 2–3·5 mm long; calyx lobes triangular, ± acute, 0·5–1 mm long; styles 4 (rarely 5), 1–2·5 mm, stigmatic surface spathulate and grooved on inner surface. Capsule globular, urceolate, 4–5 mm high. Seeds 1 mm long.

Field characters: Clear bole 20–35 m, sinuous, often deeply fluted, buttresses thin, to 5 × 4 m. Main branches thick, gnarled, rather irregular. Crown thin, spreading. Bark nearly smooth, grey, often pustular; smooth, dark grey when growing in the open; 5–25 mm in section; underbark mottled red and green; inner bark brown-yellow with an unpleasant smell; no exudate. Wood soft, cream-coloured to pale brown, darkening slightly on exposure. No heartwood distinguishable.

Distribution: India and Ceylon, through Malesia and to northern Queensland. In Papuasia not yet collected outside mainland New Guinea; scattered from

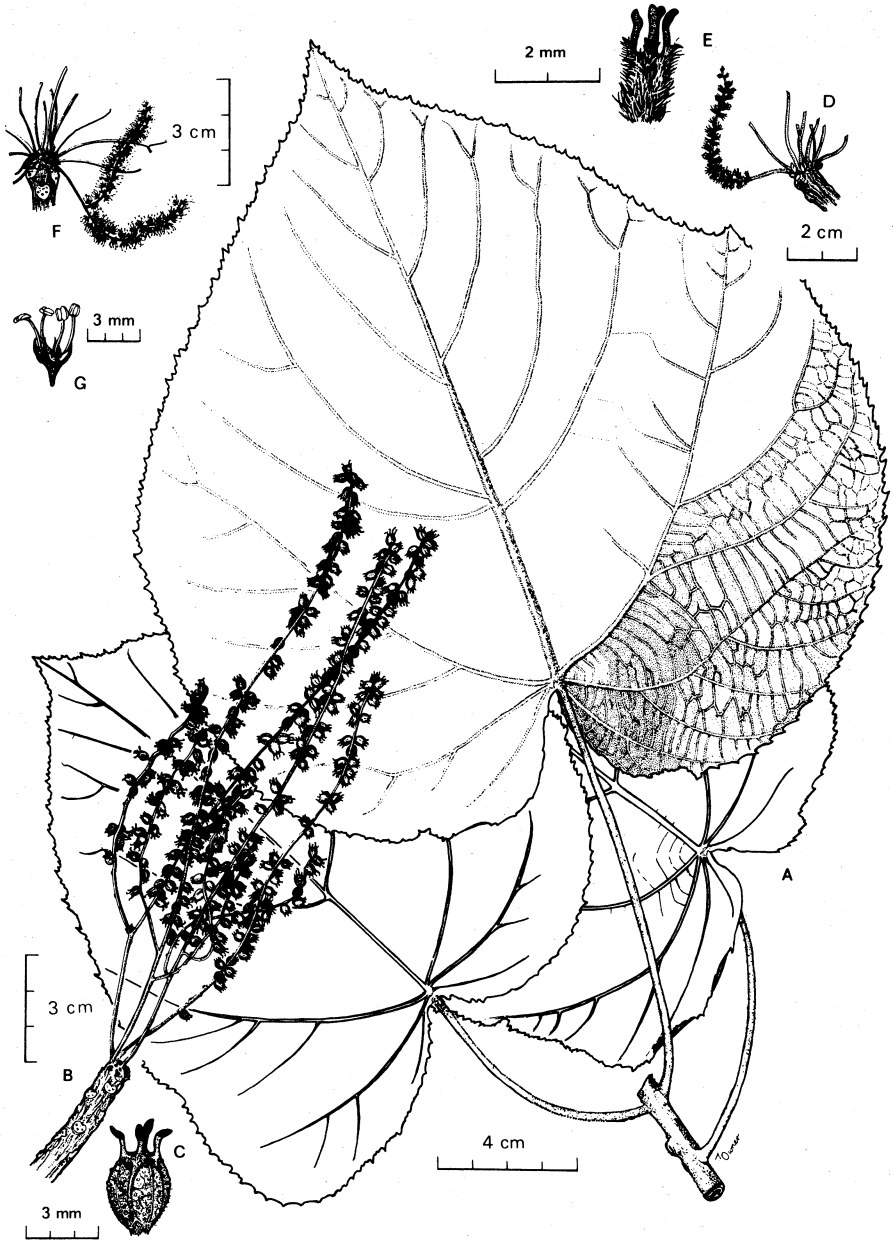


Fig. 62 **Tetrameles nudiflora** R. Br. (A) leafy twig (B) apical inflorescence with mature fruit (C) mature fruit (D) female inflorescence (E) female flower (F) male inflorescence (G) male flower

the Vogelkop to the Northern and Central districts; usually rare but occasionally locally common.

Ecology: ± restricted to lowland areas (to 700 m) with a pronounced dry season. Sheds leaves and sets buds in the dry season. Preference for limestone soils. Flowers August to February.

Uses: A weak, non-durable timber used for cases, boxes, weatherboards, veneer, interior trim. Said to be favoured by indigenes for dugout canoes (van Steenis, 1953).

EUPOMATIACEAE

J. R. Croft

Evergreen shrubs or small trees without latex. Leaves simple, entire, alternate; stipules absent. Flowers bisexual, actinomorphic, solitary or in groups of 2 or 3, lateral or axillary; petals and sepals united to form entire, conical, deciduous calyptra; stamens perigynous, the many inner ones sterile, petaloid, the fewer outer ones fertile, narrower; carpels many, immersed in receptacle, styles shortly projecting from areolate upper surface; ovules ventrally attached, several in each carpel. Fruit a berry.

Distribution: 1 genus with 2 species. Mainland New Guinea and east coast of Australia as far south as eastern Victoria.

Literature: A. T. Hotchkiss (1955), Geographical distribution of the Eupomatiaceae, *J. Arnold Arbor.* **36**: 385–96, f. 1–3. J. Hutchinson, (1964), *The Genera of Flowering Plants*, vol. 1, Eupomatiaceae; 108–9. J. C. Th. Uphof (1959), Eupomatiaceae, in A. Engler, and K. Prantl, *Die Naturlichen Pflanzenfamilien* ed. 2, vol. 17a(2): 173–6, f. 41–2.

EUPOMATIA R. Br.

Evergreen shrubs or small trees. Twigs thin, striate, with soft pith. Leaves glabrous, oblong-elliptic; margins entire, slightly recurved; apex acuminate; base attenuate; petiole short, slightly channelled; nerves curving towards tip and anastomosing at margins. Flowers bisexual, solitary or in groups of 2 or 3, on short peduncles, lateral or axillary, without petals; perianth consolidated into conical, deciduous calyptra; outer row of stamens linear-lanceolate, erect and spreading, longer than inner petaloid staminodes, with longitudinal outward-facing anthers, acuminate connective, filaments dilated at base; many inferior carpels sunk into expanded receptacle with styles shortly projecting from flat areolate upper surface, stigmas almost adnate to this surface. Fruit a succulent, truncate, urceolate-turbinate berry, persistent base of calyptra forming narrow, projecting rim; 1–2 seeds per loculus, copious ruminate endosperm.

Distribution: 2 species—*Eupomatia laurina* R. Br. on mainland New Guinea and along the east coast of Australia to eastern Victoria, *Eupomatia bennettii* F. Muell. restricted to the central and northern east coast of Australia.

Ecology: Understorey shrubs and trees of lowland rain forests.

Eupomatia laurina R. Br. *App. Flin. Voy.* **2**: 597, t. 2 (1814). **Fig. 63.**

Shrubs or small trees to 10 m high but generally $<$ 5 m. Bole diameter

Fig. 63 **Eupomatia laurina** R. Br. (A) twig with flowers and flower buds (B) fruit

to 10 cm. Twigs striate, with large soft pith. Leaves entire, oblong-elliptic, thin, apex acuminate, base attenuate, 7–25 × 2·5–6 cm, glossy, dark green above, ± glaucous beneath; 7–17 pairs of lateral nerves, slightly raised on upper surface, more so beneath, arching towards tip and anastomosing at margins. Flowers pale green, globose in bud, apices rounded, acute or slightly acuminate, rufous, tomentose, glabrescent, 10–15 mm diameter; peduncle 5–20 mm; pseudoperianth whitish, sometimes pinkish; stamens ± linear-lanceolate, 6–9 mm long, anthers linear, connective with acumen 0·5 mm long; filament dilated at base, 2–3 mm long; staminodes ovate, acute, 3–7 mm long, broadly attached to receptacle. Fruit urceolate, succulent, pale green, 15–20 mm diameter. Chromosome number: 2N = 20.

Field characters: Erect or arching understorey shrub or tree. Branches slender, arching downwards. Bark 5 mm thick, smooth, dark brown to almost black, sometimes with irregular papery scales, underbark straw-coloured, darkening on exposure, no exudate. Wood straw-coloured with prominent, medullary rays. Flowers sweetly scented.

Distribution: East coast of Australia and eastern half of mainland New Guinea where it is known to be locally common in widely scattered localities from the Jayapura district to the Central district. It has been most frequently collected from the Morobe district.

Ecology: Lowland rain forest (to 1250 m), sloping or well-drained ground. Flowers from November to March and fruits from April to June. Flowers pollinated by beetles.

EXCLUDED SPECIES

Eupomatia belgraveana F. Muell. (1887) = *Galbulimima belgraveana* (F. Muell.) Sprague in the family Himantandraceae.

HIMANTANDRACEAE

J. R. Croft

Aromatic evergreen trees, sometimes slightly buttressed, without latex. Leaves simple, entire, alternate, spirally arranged, glaucous and shiny above with lepidote indumentum beneath and on petiole, often extending onto twigs, and especially dense on young shoots. Stipules absent. Flowers bisexual, actinomorphic, solitary, axillary, lepidote in bud; petals absent, corolla and calyx each forming a deciduous calyptra; stamens and staminodes numerous, spirally arranged on conical receptacle, 1 or more rows of staminodes each side of several rows of stamens, anthers linear, outward-facing, at base of stamens; carpels numerous, free, becoming fused, ovary superior, lepidote on outer surface, globose, narrowing apically into plume-like style, single locule with solitary, ventrally attached ovule; fruit a succulent, lepidote syncarp.

Distribution: 1 genus with 1 species, from the Moluccas into Papuasia and the northeastern coast of Australia.

Literature: I. W. Bailey, C. G. Nast and A. C. Smith (1943), The family Himantandraceae, *J. Arnold Arbor.* **24**: 190–206, t. 1–6. A. A. Bullock (1957), Galbulimima versus Himantandra, *Kew Bull. 1957*, 409. P. van Royen (1959), Himantandraceae, *Nova Guinea, Bot.* **10**(9): 127–35, f. 1–5, t. 10. A. C. Smith (1942), A nomenclatural note on the Himantandraceae, *J. Arnold Arbor.* **23**: 366–8.

Notes: The name of the sole genus in this family has been the subject of much taxonomic argument in the past. The name *Himantandra* is now considered illegitimate according to the rules of nomenclature. Because of its widespread use, it was proposed for conservation but was rejected.

GALBULIMIMA F. M. Bail

Aromatic evergreen trees with a compact crown, sometimes slightly buttressed. Twigs ± terete, sometimes angled, lepidote. Leaves chartaceous to coriaceous, ovate, elliptic or oblong; margin entire, slightly recurved; lamina glossy, glabrous above, lepidote below; apex rounded to acuminate, sometimes slightly retuse; base obtuse; penninerved, nerves anastomosing towards margin, slightly raised on both surfaces; petiole channelled above, densely lepidote. Flowers bisexual, solitary, axillary on peduncle with 2 small bracts; calyptrate calyx and corolla lepidote, irregularly circumscissile, rupturing near base; stamens and staminodes fleshy, narrowly oblong, tapering to apex and slightly dilated at base; 20–23 outer staminodes, 13–130 stamens, 13–20 inner staminodes. Carpels spirally arranged on conical receptable,

plumose styles free at first, later cohering into a gelatinous mass. Fruit fleshy, lepidote, ± globose with a solitary flattened seed in each locule.

Distribution: 1 species, from the Moluccas, mainland New Guinea, New Britain and the northeast coast of Australia.

Ecology: Canopy or subcanopy trees of submontane rain forest, sometimes descending to the foot-hills of the lowland regions.

Galbulimima belgraveana (F. Muell.) Sprague *J. Bot., Lond.* **60**: 138 (1922). **Fig. 64.**

Eupomatia belgraveana F. Muell. (1887); *Himantandra belgraveana* F. Muell. nom. invalid. (1890); *Galbulimima baccata* F. M. Bail. (1894); *Himantandra belgraveana* (F. Muell.) Diels (1912); *Himantandra baccata* (F. M. Bail.) Diels (1917); *Himantandra nitida* Bak. f. & Norman (1923); *Himantandra parviflora* Bak. f. & Norman (1923); *Galbulimima nitida* Sprague (1923); *Galbulimima parviflora* Sprague (1923).

Tree to 35 m tall, to 60 cm diameter above buttresses. Buttresses, if present, to 3 m high, 1 m wide, 5–20 cm thick. Twigs, underside of leaves, petioles, inflorescence and fruit densely to sparsely covered with copper-coloured peltate scales, which tend to overlap. Leaves otherwise glabrous, papillose, glossy, yellow-green to dark green, entire, slightly recurved margins, ovate, oblong or elliptic, (5–)6–16 × (2–)3–8 cm; apex rounded, obtuse, acute or acuminate, sometimes slightly retuse; base obtuse, acute or ± attenuate; midrib deeply sulcate above, strongly raised beneath, venation embossed on both surfaces, 8–20 pairs of nerves ascending towards apex; petiole 1–2·5 cm long. Flowers globose to ovoid in bud, 1–2 × 1–1·5 cm prior to anthesis; peduncle 1–2·5 cm long with bracts 2–3 mm long; stamens and staminodes white, linear-lanceolate, 1–2 mm wide, 5–15 mm long, stamens sometimes reaching 2·5 cm long, stamens and outer staminodes reflexed, inner staminodes ± erect, anthers 1–2 mm long, 1–2 cm from base of stamens; ovary lepidote, 1–2 mm long. Fruit 1·5–3 cm diameter, persistently scaly, reddish, fleshy, resinous smell; a single flattened seed in each carpel. Chromosome number: 2N = 24.

Field characters: Bole straight and cylindrical, flanged or occasionally buttressed at base. Crown densely compact. Outer bark grey to greyish-brown, often scaly and pustular; underbark mottled greenish to yellowish-brown, inner bark pale brown rapidly changing to red-brown when exposed; bitter taste and resinous smell. Sap-wood and heart-wood white to pale straw-colour.

Distribution: The Moluccas and Papuasia. In Papuasia widely known from the Vogelkop through to the Milne Bay district and New Britain. Most collection localities are in the highland regions.

Ecology: A tree often contributing to the canopy, at an altitude of 1200–2700 m, especially in *Nothofagus* forests, but collections are known from as low as 5 m. Flowers and fruit can be expected throughout the year.

Uses: A timber suitable for light construction, moulding and interior work. The bark is rich in alkaloids and is chewed by the members of some New Guinea highland tribes to induce hallucinations.

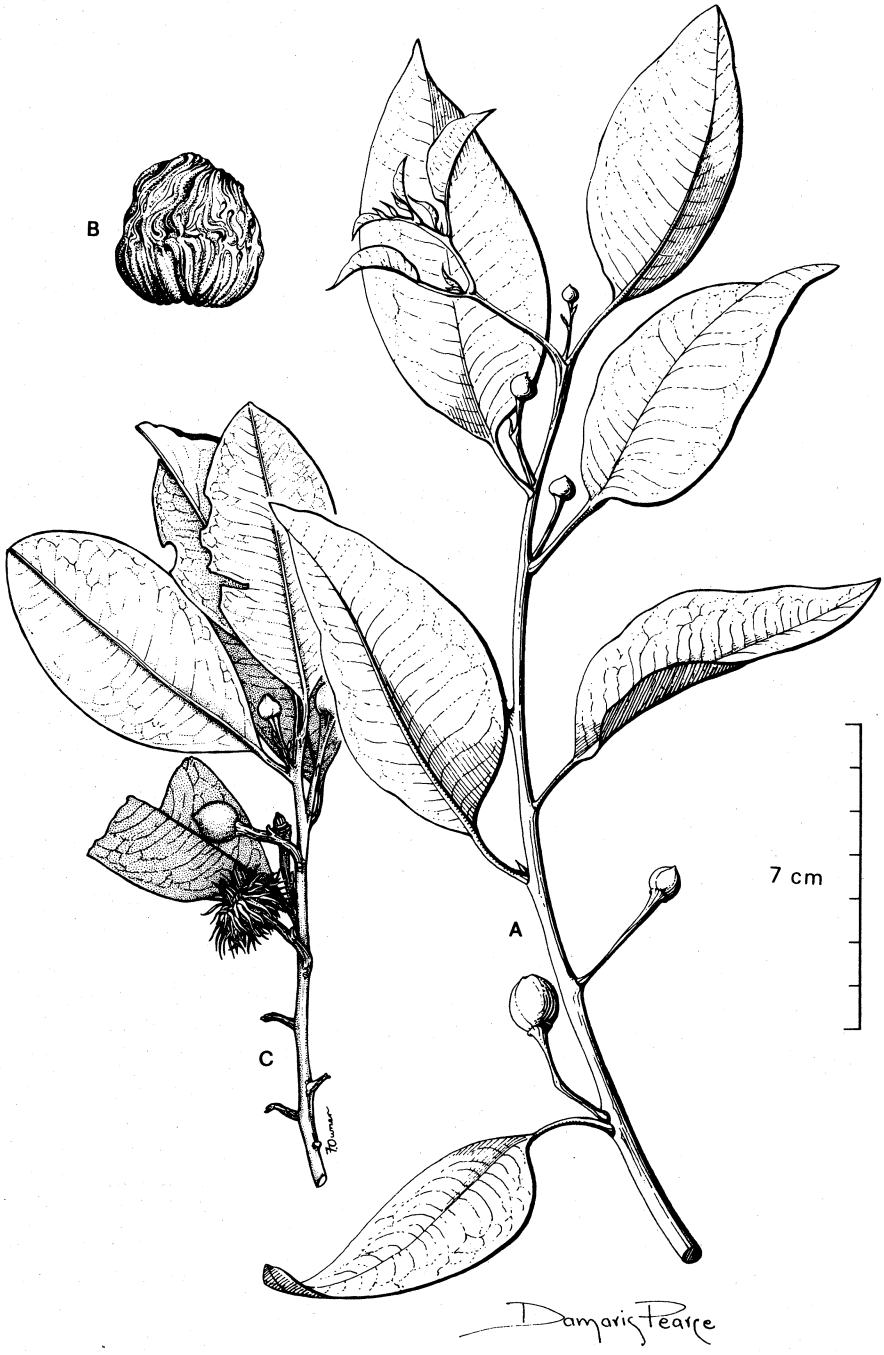


Fig. 64 **Galbulimima belgraveana** (F. Muell.) Sprague (A) twig with flower buds (B) fruit (C) twig with flower and buds

MAGNOLIACEAE

J. R. Croft

Aromatic evergreen shrubs or large trees without latex; not buttressed or only slightly so. Leaves simple, entire, alternate, spirally arranged, pennineved, hirsute or glabrous. Stipules large, enclosing young buds, caducous, leaving annular scars. Flowers bisexual, actinomorphic, solitary, terminal or axillary; perianth segments free, imbricate, 6 or more, in several whorls, outer one may simulate a calyx; stamens free, numerous, spirally arranged on lower part of conical receptacle; anthers linear, bilocular, dehiscing by inward-facing longitudinal slits, connective produced into short appendage; carpels numerous, sessile, free, concrescent, at least at base, spirally arranged on upper part of conical receptacle, unilocular, placentation basal, style simple, solitary. Fruit syncarpic.

Distribution: 12 genera with *c.* 210 species. Southeast Asia and Central America. In Papuasia 2 genera with 1 species each.

Literature: J. E. Dandy (1927), The Genera of Magnolieae *Kew Bull. 1927* 257; (1964), Magnoliaceae, in J. Hutchinson, *The Genera of Flowering Plants*, **1**: 50–7. P. van Royen (1965), *Manual of the Forest Trees of Papua and New Guinea*, pt 6, Magnoliaceae, 7–19.

KEY TO GENERA

1. Inflorescence axillary. Fruit dehiscing along dorsal suture. Stipules free from petiole. Petiole ± terete in section, finely grooved above ..... ELMERRILLIA
1. Inflorescence terminal. Fruit circumscissile, upper portions falling away. Stipules adnate to petiole. Petiole flat above with stipule scar extending to base of lamina, forming a slight ligule ..... TALAUMA

Note: The oriental plant *Michelia champaca* is widely grown as an ornamental and can be separated from *Elmerrillia* by the possession of stipitate ovaries and latrorsely dehiscing anthers.

ELMERRILLIA Dandy

Large aromatic trees without exudate, bole flanged at base or slightly buttressed. Twigs terete, pustular, densely hirsute (younger ones) to glabrous. Leaves spirally arranged, oblong to elliptic, hirsute-glabrescent beneath, secondary nerves curving towards apex and anastomosing at margin, tertiary venation well developed, areolate; petiole ± terete, channelled above, hirsute-glabrescent. Stipules large, enveloping buds, glabrous to densely hirsute, free from petiole, caducous. Flowers solitary or occasionally in pairs, axillary; peduncles hirsute to glabrous with caducous spathulate

bracts leaving annular scars, 1 at base of peduncle, 1 immediately below receptacle and 1 about midway along which sometimes absent; perianth segments 9–17, oblong to obovate, reflexed in full flower. Fruit a syncarp of 1-seeded follicles.

Distribution: *c.* 7 species. Malesia from Borneo and the Philippines to New Guinea. 1 species in Papuasia, from mainland New Guinea and New Britain.

Elmerrillia papuana (Schltr) Dandy *Kew Bull. 1927*, 216. **Fig. 65.**

Talauma papuana Schltr (1913); *Michelia forbesii* Bak. f. (1923); *Elmerrillia papuana* (Schltr) Dandy, var. *adpressa* Dandy (1928); *E. papuana* (Schltr) Dandy, var. *glaberrima* Dandy (1928); *E. sericea* C. T. White (1929).

Trees to 33 m tall. Twigs ± terete, irregularly pustular when older with ± regularly placed stipular scars 1–4 cm apart. Young twigs, stipules, petioles, peduncles, inflorescence bracts and abaxial surface of leaves often glaucous, glabrous to densely covered with olivaceous to ferrugineous hairs 0·5–1·5 mm long. Stipules ± linear, tapering towards apex, slightly falcate, 2·5–10 cm long, 5–8 mm wide at base, free from petiole, completely encircling stem, caducous leaving distinct annular scar. Leaves elliptic, oblong, slightly ovate or slightly obovate, 8–31 × 3·5–11·5 cm; apex acute, attenuate or obtusely acuminate; base acute to slightly attenuate, sometimes truncate; midrib slightly raised to slightly sulcate above, very prominent beneath; nerves 12–20 pairs, prominent on both surfaces, more so below, angled and curved towards apex, anastomosing at margin, venation well developed, reticulate, more prominent on upper surface; petiole ± terete, 1·5–3·5 cm long, finely sutured along adaxial surface. Flowers axillary, solitary or occasionally in pairs with one much more developed than other, enclosed in 2–3 spathulate caducous bracts, prior to anthesis buds 1·5–2 cm long, peduncle 1·5–2·5 cm long; perianth segments 12–18, oblong to obovate, 20–30 × 5 mm, getting gradually smaller towards centre, white to cream-coloured; anthers yellow, numerous (*c.* 30), linear, 1 cm long, erect, surrounding gynoecium, ovaries superior on elongated receptacle. Fruit 4–10 cm long, a syncarp of 1-seeded follicles, peduncle 3–6 cm long; follicles green, glabrous, pustular, dehiscing along dorsal suture to expose pink, red or orange seed 5 mm diameter.

Field characters: Bole straight or crooked to 20 m, with diameter to 1·2 m at breast height. Slight, low buttresses may be present. Crown large and spreading. Bark to 2 cm thick; outer bark light grey with brown blotches peeling off in large flakes, craterous, pustular, smoother in younger trees; inner bark green with brown patches; underbark straw-coloured, turning brown on exposure with spicy odour and no exudate. Heartwood pale brown, clearly defined from straw-coloured sapwood, persistent spicy smell.

Distribution: Restricted to Papuasia and the eastern Moluccas. In Papuasia the species is locally common from the Vogelkop to the Milne Bay district and New Britain. Not yet recorded from the Papuan Islands, Manus, New Ireland, Bougainville or the Solomon Islands.

Ecology: Found 5–1600(–2600?) m in lowland to submontane rain forest and occasionally in regrowth. May be locally common and gregarious.

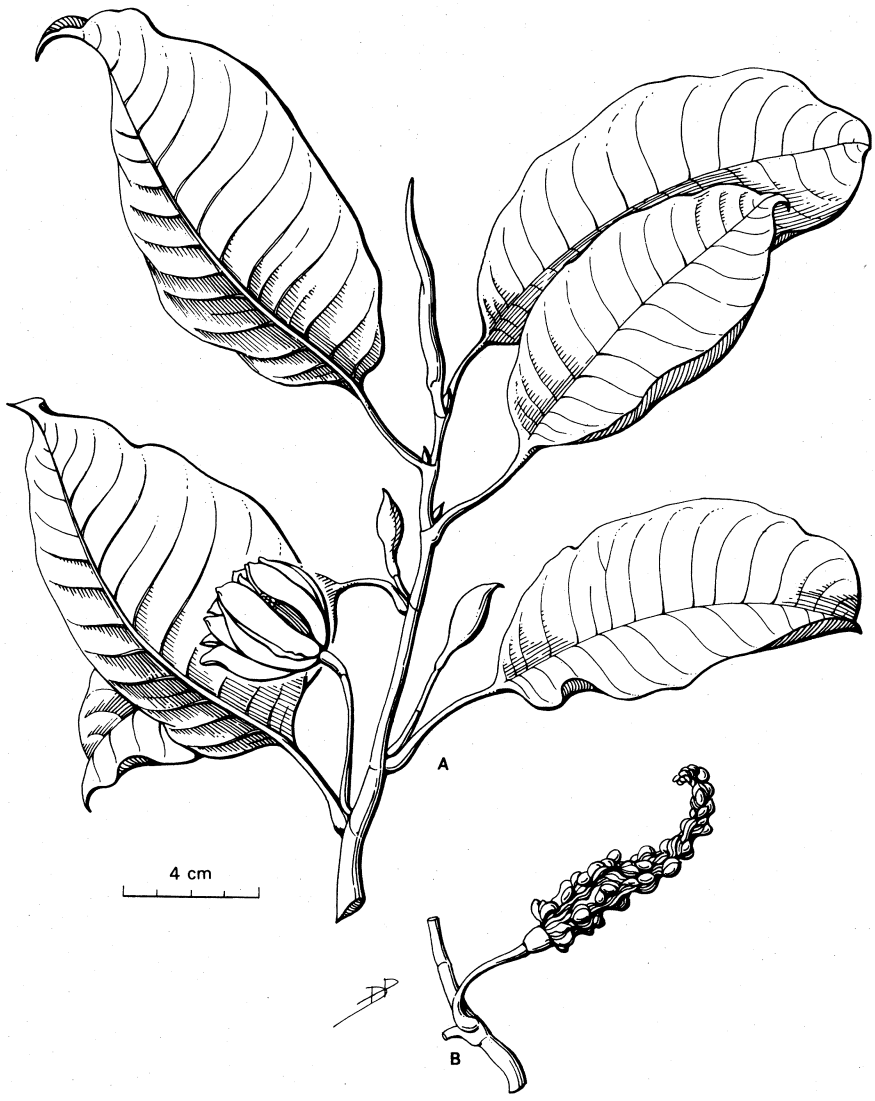


Fig. 65 **Elmerrillia papuana** (Schltr) Dandy (A) flowering leafy shoot (B) fruiting twig

Flowers and fruit have been collected throughout the year. Flowers sometimes support a population of beetles that act as pollinators.

Uses: A durable timber suitable for veneer, high-grade furniture, boat building, moulding, light construction.

Notes: The three varieties recognized by Dandy (1927, 1928) on the basis of degrees of hairiness are not regarded as being sufficiently distinct to be maintained. A common character of the specimens from higher altitudes is persistently dense hairiness, but this is occasionally found in the lowlands, as are glabrous specimens in the highlands. A similar increase in hairiness and darkness of colour is observed in *Commersonia bartramia* (Sterculiaceae) which has a distribution similar to that of *Elmerrillia papuana.*

TALAUMA Juss.

Tree or shrub. Twigs terete with annular stipular scars, younger ones densely covered with appressed hairs. Leaves alternate, spirally arranged, entire, ovate to elliptic, apex acute to slightly attenuate, base acute or slightly attenuate; stipules caducous, adnate to petiole; petiole flattened on upper surface with stipular scar extending to base of lamina, lateral nerves arching towards apex, anastomosing at margin, tertiary venation well developed, areolate. Flowers solitary, terminal; peduncle with dense appressed hairs, with several annular bract scars; bracts spathulate; perianth segments 9, trimerous, outer 3 larger and more broadly attached at base; stamens with linear anthers and acuminate connective; ovary superior, elongate, concrescent, tapering into style. Fruit a syncarp of circumscissile capsules, upper portions falling away exposing 1–2 seeds in each carpel.

Distribution: c. 40 species, Eastern Himalayas to Southeast Asia and Malesia, and tropical America and West Indies. In Papuasia 1 species from the eastern Moluccas to mainland New Guinea.

Ecology: Understorey of submontane rain forests, sometimes a canopy tree.

Talauma oreadum Diels *Bot. Jb.* **54**: 240 (1916). **Fig. 66.**

Aromadendron oreadum (Diels) Kan. & Hat. (1943).

Shrub or tree to 20 m tall, mostly *c.* 10 m, fertile as low as 3 m. Twigs terete, with sparse appressed hairs; glabrescent, irregular pustular, sometimes slightly glaucous. Young foliage and stipules with indumentum of yellowish appressed hairs. Stipules adnate to petiole, 1–2 cm long, caducous leaving oblique annular scars on stem and a ridge along edge of flattened adaxial surface of petiole forming a slight ligule at junction with lamina. Leaves narrowly elliptic to broadly oblong or slightly ovate or obovate, 10–35 × 3–14 cm; apex acute to broadly acuminate, base acute to slightly attenuate; midrib prominent on both surfaces, more so beneath; nerves 12–18 pairs, prominent on both surfaces, angled and curving towards apex, anastomosing at margin, veins forming a well-developed reticulum, prominent on both sides. Inflorescence terminal, solitary, peduncle with dense appressed hairs with several bract scars; bracts spathulate, 2–2·5 cm long, appressed hirsute

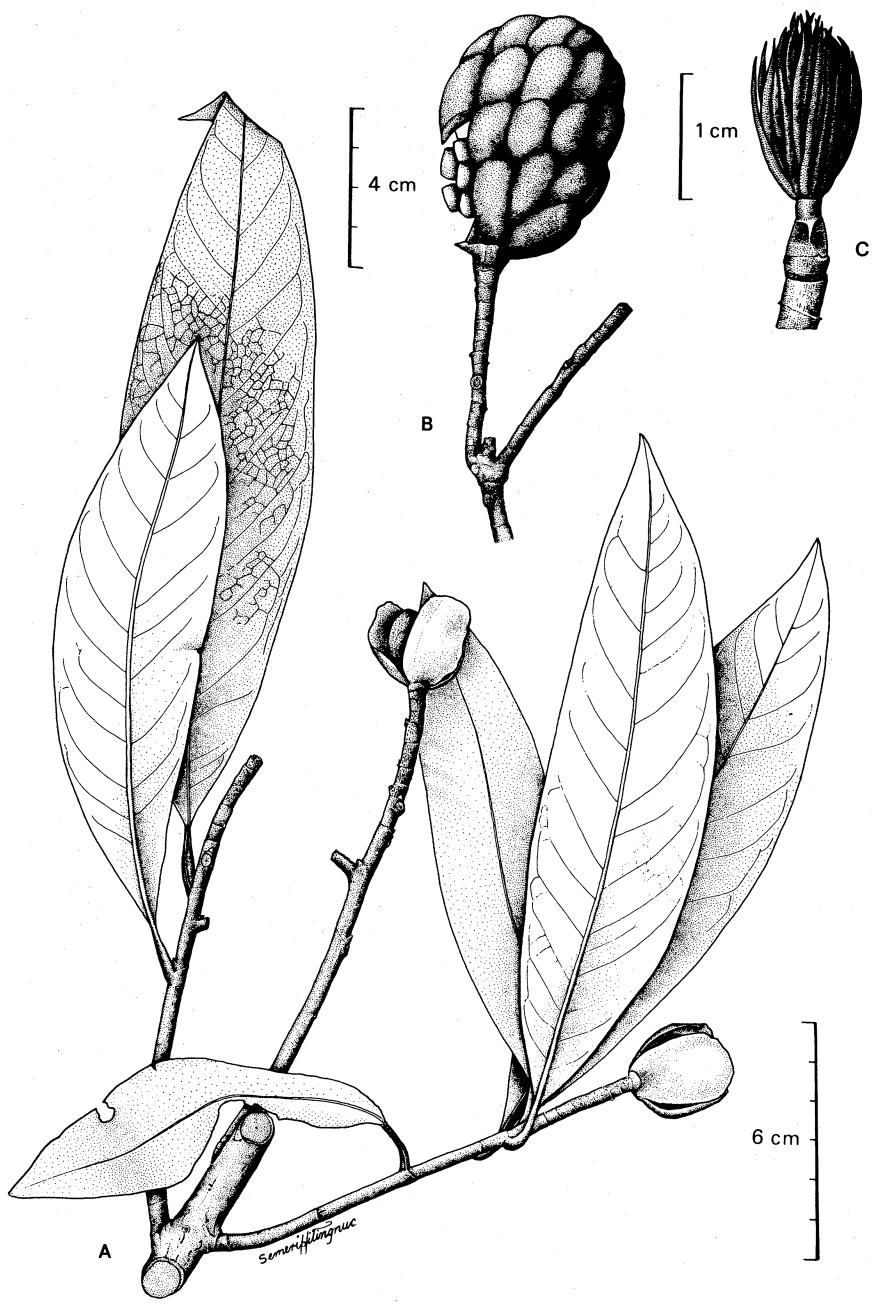


Fig. 66 **Talauma oreadum** Diels (A) flowering leafy shoot (B) ripe fruit (C) flowers with petals removed

on outside; glabrous inside; perianth segments glabrous, white to cream-coloured, outer 3 broadly oblong, 2–2·5 × 1–1·5 cm, 5–7 mm wide at base, arranged around ultimate annular scar, inner 6 oblong to obovate, 12–20 × 7–10 mm, 2 mm wide at base, inner 3 smaller than outer 3, spirally arranged; stamens yellow, numerous (*c.* 40–70), 1–1·5 cm long, spirally arranged; carpels glabrous, spirally arranged on gynophore, 7 mm long, tapers into style 5 mm long. Fruit ± spherical syncarp, 4–6 cm diameter; carpids red, pustular, 1–1·5 cm long, each containing 1–2 seeds, 7–10 mm diameter.

Field characters: Straight and slender bole to 30 cm diameter and 15 m long, but generally much smaller. Buttresses absent. Crown small. Leaves medium to dark green above, lighter below. Outer bark grey with slight vertical fissures; underbark green, inner bark cream-coloured. Wood straw-coloured.

Distribution: Morotai in the Moluccas, and the highlands of mainland New Guinea as far east as Aseki in the Morobe district. So far it has not been recorded for the Owen Stanley Range, the Bismarck Archipelago and the Solomons.

Ecology: Occurs in the understorey of submontane rain forests mostly 1200–2200 m but may be found as low as 450 m where cold air drainage may be a contributing factor. Flowers and fruit throughout the year, usually both on the same tree. Pollinated by beetles.

Uses: No commercial uses.

EXCLUDED SPECIES

Talauma papuana Schltr (1913) = *Elmerrillia papuana* (Schltr) Dandy (1927)

ADDITIONAL MAGNOLIACEAE OF HORTICULTURAL IMPORTANCE

The genus *Michelia*, differing from *Elmerrillia* in having a stipitate gynoecium and latrorse or sublatrorse as opposed to introrse anthers, is commonly grown as an ornamental. *M. alba* L. has white flowers and *M. champaca* DC. has cream-coloured flowers darkening to orange. The fruit of both these species dehisces along a dorsal suture to reveal the bright pink seeds.

MELIACEAE

P. F. Stevens

CHISOCHETON Bl.

Tree. Leaves alternate, pinnate, leaflets opposite, rachis terminated by bud which produces new pairs of leaflets for most of life of leaf. Indumentum of small, glandular hairs and unbranched or stellate eglandular hairs. Plants always(?) dioecious; inflorescences axillary, spicate to paniculate, sometimes epiphyllous or cauliflorous. Flowers articulated with pedicel or branchlets, above point of articulation sometimes a pseudopedicel; calyx ± entire; petals 3–6, aestivation valvate or alternative, rarely imbricate or quincuncial, connate at base and sometimes adnate to staminal tube; staminal tube cylindrical, sometimes slightly expanded or contracted at mouth, margin entire to deeply lobed; anthers inserted within tube, 4–12, usually locellate, antherodes somewhat more slender; ovary 2–8-locular, in Papuasia loculi usually with single ovule, disc small, annular or absent; style long; stigma ± discoid, in pistillode ovary sometimes absent and style sunk in disc. Fruit loculicidal, sometimes rather belatedly, 2–6(–8)-seeded, stipitate or rostrate, rarely ridged; pericarp spongy, woody or ± coriaceous, sometimes with white sap; seeds with sarcotesta or arillode, arillode partly free or not, hilum large; cotyledons large, collateral or superposed in Papuasian species.

Distribution: From India and Malaya to the New Hebrides and Australia (Queensland); possibly to 50 species.

Ecology: Often quite common in the lowland rain forest with a few species in lower montane habitats. A number of species have ants living in the stems and sometimes also in the main inflorescence axis and the leaf rachis.

Notes: The indumentum in most species (in Papuasia) consists of unbranched generally straight hairs. In *Chisocheton longistipitatus* and *C. stellatus* the indumentum consists of small 4-armed stellate hairs. These are sometimes obscure; a good lens or binocular microscope is necessary to be certain about the hairs. Male and female flowers and inflorescences are often rather similar; the sexes are dealt with separately only in those cases where they are markedly different. Anthers in male and female flowers are practically indistinguishable and the ovaries in male flowers are sometimes as large as those in female flowers.

Chisocheton is a difficult genus, and in the Bismarck Archipelago and the Solomon Islands especially it has proved impossible to satisfactorily name the bulk of the material (see notes after *C. schumannii*). It is fairly easy to separate groups of specimens on the mainland. These are recognized as species here but future work may lead to a considerable reduction in their

number. Sterile or fruiting material is often difficult or impossible to identify to a species.

Literature: H. Harms (1942), Meliaceae Novae, in L. Diels *Beiträge zur Flora von Papuasien*, no. 36; *Bot. Jb.* **72**: 151–269. P. F. Stevens (1975), A review of *Chisocheton* in Papuasia, *Contr. Herb. Aust.* **11**: 1–55 (1975).

KEY TO SPECIES

Note: The character 'leaf rachis prominently ridged, upper surface flattened' must be observed on the rachis between two leaflet pairs that have stopped growing. A young rachis may dry in all sorts of unexpected ways.

1. Inflorescences epiphyllous
 2. Leaflets with ± dense suberect to erect hairs, petiolules 3–6 mm long; buds (1–)2·5–3 mm across ..... **C. pohlianus**
 2. Leaflets with sparse appressed hairs, petiolules (5–)10–23 mm long; buds 3 mm across ..... **C. tenuis**
1. Inflorescences not epiphyllous
 3. Plant with stellate hairs
  4. Inflorescence velutinous; flower buds *c.* 2·5 mm across; style glabrous .... **C. stellatus**
  4. Inflorescence indumentum obscure; flower buds usually 1–1·5(–2) mm across; style with dense, short hairs ..... **C. longistipitatus**
 3. Plant with straight hairs
  5. Inflorescences from defoliate axils (leaflets when dry with tertiary venation raised on both sides; buds 1–1·7 mm across) ..... **C. morobeanus**
  5. Inflorescences from foliate axils
   6. Leaf rachis prominently ridged or winged, upper surface flattened
    7. Inflorescence axis 3·5–12 cm long, flattened; buds 3–4 mm across, petals 1·4–2·3 cm ..... **C. pachyrhachis**
    7. Inflorescence axis 8–45 cm long, ± terete; buds 2–2·7 mm across, petals 7·5–12 mm ..... **C. novoguineensis**
   6. Leaf rachis channelled to terete
    8. Inflorescence axis to 8 cm long, flowers dense; buds *c.* 4 mm across, indumentum never of long, erect hairs or velutinous
     9. Leaflets with dense, ± crisped, short hairs on midrib above; buds 3·5 mm across, anthers *c.* 3 mm ..... **C. lasiocarpus**
     9. Leaflets with at most sparse appressed hairs above; anthers < 2 mm . **C. formicarum**
    8. Inflorescences usually > 8 cm long, if less, flowers not dense and/or buds *c.* 2 mm across; indumentum various
     10. Leaflets with finely raised tertiary venation on upper surface; buds 0·7–1·3 mm across; fruits angled ..... **C. sapindinus**
     10. Leaflets with obscure tertiary venation above; fruits not angled
      11. Leaflets above with erect or crisped hairs, at least on midrib
       12. Leaflets with appressed hairs beneath; flowers always(?) pentamerous ..... **C. versteegii**
       12. Leaflets with erect hairs beneath; flowers only exceptionally pentamerous
        13. Staminal tube sericeous outside, petals *c.* 7 mm long ..... **C. montanus**
        13. Staminal tube not sericeous outside, petals > 8 mm long
         14. Leaflet base shallowly cordate (leaflets 23–40 cm long; dried fruit *c.* 1·5 cm across); bud width unknown ..... **C. schlechteri**
         14. Leaflet base acute to rounded
          15. Flowers large; buds 3–5 mm across, calyx > 2 mm, petals 10·5–15 mm, anthers 2–2·5 mm; fruit 2·5–3 cm across ..... **C. trichocladus**
          15. Flowers relatively small; buds 0·8–1·5 mm across, calyx < 2 mm, petals < 1·1 cm, anthers 1·5 mm; fruit 1·5–2 cm across ..... **C. sayeri**
      11. Leaflets above with appressed hairs, often appearing glabrous
       16. Leaflets above with midrib deeply sunken; buds 2·5–3·5 mm across, staminal tube with lobes to 3 mm long ..... **C. ceramicus**

16. Leaflets above with midrib slightly sunken to slightly raised; staminal tube hardly lobed
17. Inflorescences at first backwardly directed, very long (to 1·2 m), lateral branches few, < 5 cm long; buds 7·5 mm across..... **C. schoddei**
17. Inflorescences patent or ascending, shorter, with more and usually relatively longer lateral branches
18. Leaflets subcoriaceous; inflorescences < 12 cm long, branches narrowly ascending, few-flowered; buds 2·5–3 mm across..... **C. caroli**
18. Not as above
19. Flower buds < 1·5 mm across and 1·2 cm long; leaflets usually < 20 cm long
20. Flower buds to 1·5 mm across, petals *c.* 1·2 cm long; fruit spherical, hairs all of one length..... **C. gliroides**
20. Flower buds generally narrower, 0·8–1·5 mm across, petals 1 cm long; fruits ellipsoid to obovoid, hairs of varying lengths..... **C. sayeri**
19. Flower buds > 1·5 mm across, if less, leaflets > 20 cm long
21. Inflorescences ± villous, long (*c.* 50 cm), lateral branches short, patent, to 5 cm long; flower buds unknown, mature fruit with sparse indumentum ..... **C. novobritannicus**
21. Inflorescences not villous, with relatively longer, usually ascending, lateral branches; fruit with dense indumentum
22. No glabrous zone immediately below anthers on inside of staminal tube; flowers often pentamerous; calyx erect; buds 3 mm across. **C. schumannii**
22. Short glabrous zone immediately below anthers on inside of staminal tube; calyx ± spreading to suberect
23. Style usually hairy for its entire length; buds 2–2·7 mm across; fruit ovoid..... **C. novoguineensis**
23. Style glabrous at top; buds 1·5–5·5 mm across, fruit spherical ..... **C. weinlandii**

Chisocheton caroli Harms *Bot. Jb.* **72**: 181 (1942). **Fig. 67.**

Tree to 30 m tall, d.b.h. to 25 cm. Twigs 2–4·5 mm across, terete, with appressed hairs when young. Leaf base swollen, not ridged; rachis to 45 cm long, 1–3 mm thick, terete, with appressed hairs when young, 1–9-jugate, 1·5–5 cm between leaflet pairs; petiolules 4–8 mm, ± swollen; lamina ovate to elliptic, 7–20 × 2·5–7·5 cm, apex acuminate, base narrowly acute to shortly decurrent, asymmetric, thinly coriaceous, with sparse appressed hairs when young but ± glabrescent, especially above, midrib above slightly raised, beneath prominently raised, lateral veins 6–9 pairs, flat above, raised beneath, tertiary venation rather obscure above, prominulous beneath. Inflorescences from upper foliate axils, paniculate, main axis to 11 cm, 1-branched, branches to 2 cm, few-flowered, rather narrowly spreading; bracts to 2 mm, narrowly triangular. Flowers sessile, pseudopedicel obscure or to 1·5 mm long; calyx erect, not closely enclosing corolla, green, *c.* 3 mm long, margin entire or very shallowly lobed, with appressed hairs outside, glabrous inside; corolla aestivation alternative, petals 4, white, ligulate, *c.* 10 × 2·5 mm, glabrous apart from sparse appressed hairs outside at tips; staminal tube 8 × 1·5 mm, apex shallowly lobed, inside with dense retrorse hairs from 3·5 mm below anthers to almost bottom of tube; anthers 5–9, inserted 2 mm below apex of tube, *c.* 1·8 mm long, locellate, almost basifixed, connectives glabrous; ovary (in female flower) 4-locular, *c.* 3 × 2 mm, with rather short dense hairs, disc obscure; style to 6 mm, with short ascending hairs to near top; stigma 1 mm across. Fruit red, dehiscent, ± spherical

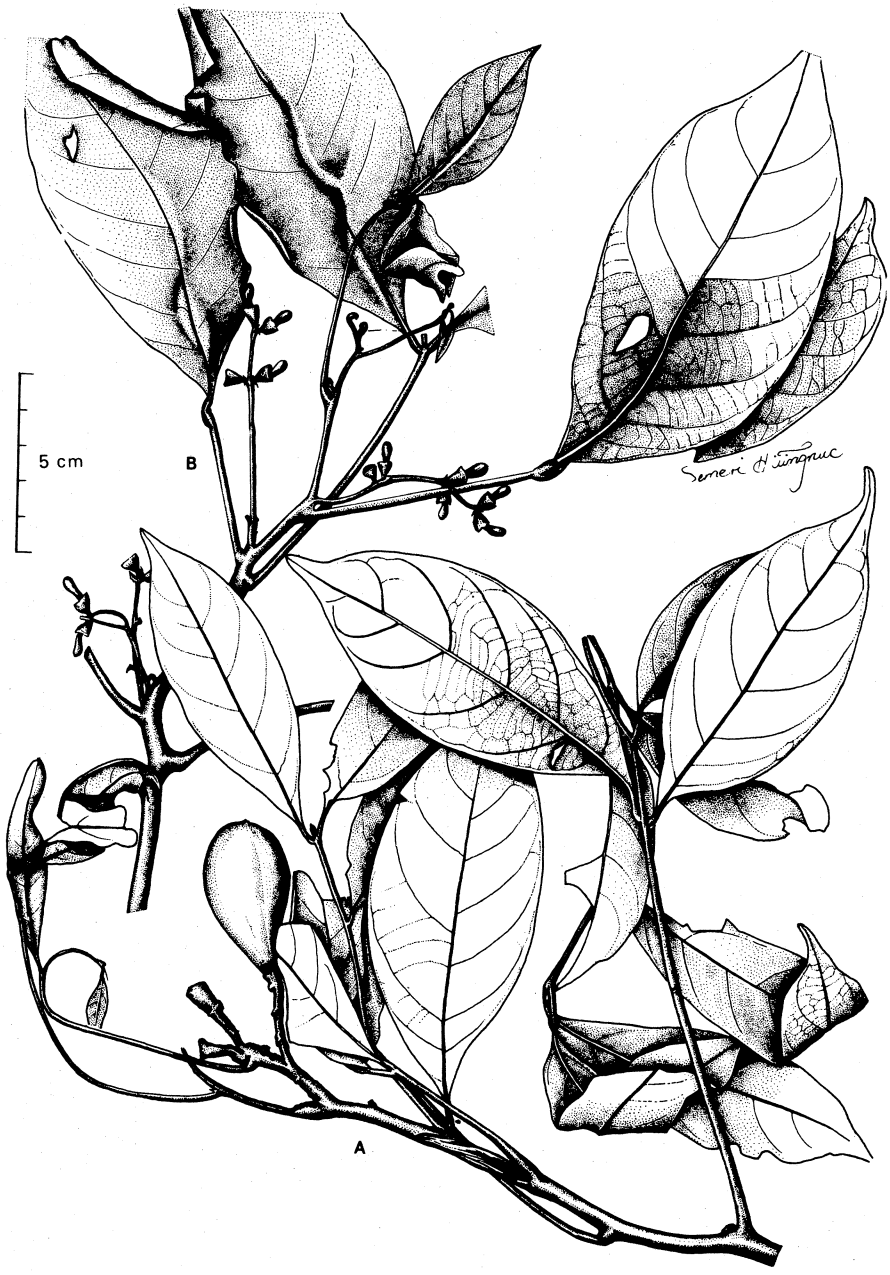


Fig. 67 **Chisocheton caroli** Harms (A) mature twig with foliage and fruiting inflorescence (B) juvenile foliage and flowering inflorescence

to ellipsoid, to 4 cm diameter, hairs dense, not obviously of different lengths; pericarp fibrous, thick.

Field characters: Bark grey-brown with vertical cracks, flaking; underbark red; inner bark pale brown to light red. Wood straw-coloured.

Distribution: Known from the West Sepik and East Sepik districts in north-eastern New Guinea and the Gulf district of Papua.

Ecology: At *c.* 120–1500 m altitude in primary rain forest on hills.

Notes: C. caroli is a poorly known species. Its rather thick, somewhat coriaceous leaflets are distinctive and unlike those of any other species; its small, few-flowered inflorescences are approached by those of poorly grown specimens of *C. schumannii* and *C. weinlandii* although its calyx is more like that of the latter species. In neither species are the inflorescence branches so narrowly ascending.

Chisocheton ceramicus (Miq.) C. DC. *Mon. Phan.* **1**: 533 (1878). **Fig. 68.**
Schizocheton ceramicum Miq. (1868); *C. peekelianus* Harms (1928); *C. doctersii* Harms (1942); *C. pachycalyx* Harms (1942).

Tree to 30 m tall, d.b.h. to 30 cm. Twigs terete, 4–12 mm thick, minutely sericeous when young. Leaf base not much swollen, smooth; leaf rachis terete, to 1·2 m long, 2·5–5 mm thick, minutely sericeous when young, to 17-jugate, 3–9 cm between leaflet pairs; petiolule 6–11 mm, little swollen, concave above; lamina ovate to suboblong, (4–)10–32 × (2·7–)5·5–13·5 cm, apex acute to shortly acuminate, base obtuse to rounded, asymmetric, chartaceous, minutely sericeous when young, indumentum most persistent on midrib and main veins beneath, midrib above sunken, beneath prominent, raised, lateral nerves (5–)9–18 pairs, ± flat above, raised beneath, tertiary venation usually obscure above, flat to prominulous beneath. Inflorescences from upper leaf axils, paniculate, main axis to 50 cm, 2(–3)-branched, branches to 25 cm long, ascending to widely spreading; bracts *c.* 0·4 mm, triangular. Flowers with pedicel 0·5–5 mm, pseudopedicel 2·5–3 mm; calyx 2·5–5 mm, thick, margin obscurely 5-lobed, with dense, short, silky hairs outside and inside; corolla not adnate to staminal tube, aestivation valvate, petals 4–6, usually 5, yellowish-white to greyish or pinkish, ± ligulate to narrowly oblong, 13–18 × 2–3 mm, with thickened and incurved projection at apex, with short, silky hairs outside, glabrous inside; staminal tube 11 × 1·5 mm, apex (4–)5(or 6)-lobed, lobes 2·5–4 mm long, truncate to retuse, tube and lobes densely sericeous inside and outside except at apex and base, inside also in middle of lobes; anthers 4–6, usually 5, inserted at base of lobes, 2·8–3·8 mm long, locellate, dorsifixed (attached 0·5–1 mm from base of anther), connective with ascending hairs; ovary ± conical, 2–3-locular, 1·5 × 1·2 mm, densely hairy, 5-ridged, disc at base obscure; style 8–10 mm long, 5-ridged, densely hairy except top 1 mm; stigma 0·75 mm across. Fruit red to orange-red, ± flattened globose, to 4 × 3·2 cm, stipe 10–15 × *c.* 5 mm, drying wrinkled, sericeous; pericarp (in fresh material) 8 mm across, spongy, with white sap, reddish lines indicate future points of dehiscence; seeds 1–3, flattened ellipsoid to reniform, *c.* 3·2 × 2·5 × 1·4 cm, sarcotesta

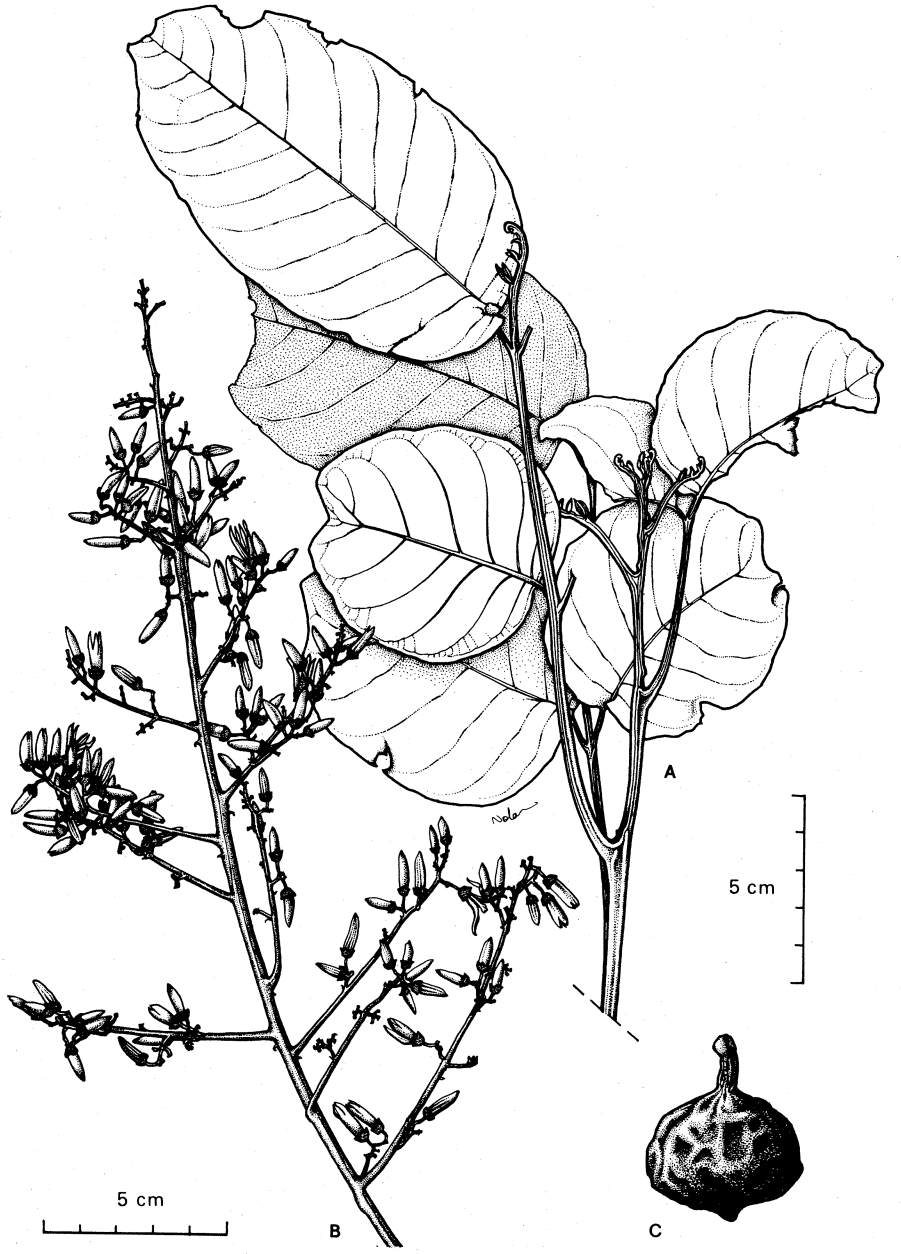


Fig. 68 **Chisocheton ceramicus** (Miq.) C. DC. (A) foliage-bearing twig (B) flowering inflorescence (C) mature fruit

2 mm thick on inner side, orange execpt for white area of attachment, perforated by small hole at middle of outer surface; cotyledons collateral.

Field characters: Trunk often with plank buttresses to 2 m tall. Outer bark red-brown or brown, sometimes grey, often with shallow fissures, fibrous, flaking in irregular strips leaving pock-marks; underbark mottled pink and fleshy red; inner bark pale pinkish, quickly turning brownish or reddish on exposure, unpleasant smell often reported; exudate infrequent, whitish. Wood white to straw-coloured, with thin wavy bands of soft tissue.

Distribution: Java. In Papuasia widespread in most lowland areas but not known from the Solomon Islands. Collected from the Vogelkop, Jayapura and Fakfak districts in western New Guinea; in northeastern New Guinea, Papua and the Bismarck Archipelago known from all lowland areas apart from the Western and Manus districts and the Papuan Islands; also known from the Southern Highlands district.

Ecology: From sea level to 700 m altitude, a sometimes common tree in primary or secondary lowland rain forest.

Local uses: Used for house building in the East Sepik and in the construction of ceremonial houses (Bona, Southern Highlands).

Notes: The first pair of leaflets on the rachis is often very much smaller and relatively broader than the others.

Without flowers or fruits this species is sometimes difficult to tell apart from *C. longistipitatus*. However, that species tends to have more lateral veins in its leaflets which are more oblong in shape and more broadly rounded at the base. *C. longistipitatus* has very small, 4-armed, stellate hairs on its leaves (a lens is needed to see them); *C. ceramicus* has simple appressed hairs. This is the most reliable way of telling leaves of the two species apart. The fruits of *C. ceramicus* dry wrinkled but are otherwise quite similar to those of *C. longistipitatus*, which dry smooth. In addition a fine raised line on the fruit of *C. longistipitatus* indicates the future point of dehiscence; this line is not found in *C. ceramicus*.

Chisocheton formicarum Harms *Bot. Jb.* **72**: 182 (1942).

Tree to 5 m tall, d.b.h. to 3 cm. Twigs terete, 8 mm across, glabrous when old. Leaf base swollen, ridged, upper part sharply joining stem; rachis to 70 cm long, 3·5–4·5 mm across, terete, glabrescent, to 5-jugate, 7–13 cm between leaflet pairs; petiolule 6–12 mm, ± swollen; lamina elliptic to suboblong, 17–29 × 8·5–13·5 cm, apex and base acute, slightly asymmetric, chartaceous, glabrescent above, persistent appressed hairs along midrib beneath, midrib above flat to slightly raised, beneath raised, prominent. lateral nerves 10–13 pairs, flat above, raised beneath, tertiary venation obscure above, clear but only slightly raised beneath. Inflorescences from upper foliate axils, paniculate, main axis to 6 cm, 2-branched, lateral branches to 4 cm, rather widely spreading, flowers congested; bracts *c.* 1·5 mm long, triangular. Female flowers unknown; flowers sessile; calyx moderately spreading, 1·2–1·8 mm long, margin entire, with sparse appressed hairs outside, glabrous inside; corolla adnate to bottom of staminal tube,

aestivation alternative, petals 4, pink, ± ligulate, to 17×2·5 mm, glabrous except for sparse appressed hairs outside towards tips; staminal tube to 14×2 mm, apex ± entire, glabrous outside, inside with sparse to dense erect hairs from near base to 2 mm below anthers, anthers 8 (or 9), inserted 2 mm below top of tube, 1·4–1·7 mm long, locellate, nearly basifixed, connectives glabrous; ovary (in male flowers) *c.* 1 mm tall, densely hairy, disc 0·4 mm tall, glabrous; style 1·4 cm, with hairs only at very base; stigma to 1 mm across. Fruit unknown.

Field characters: Outer bark reddish-brown, with shallow longitudinal fissures; inner bark brown. Wood cream-coloured.

Distribution: Little collected; known from the Jayapura district (western New Guinea) and the West Sepik district (northeastern New Guinea).

Ecology: At 10–60 m altitude in primary or secondary rain forest. The twigs harbour ants.

Chisocheton gliroides Stevens *Contr. Herb. Aust.* **11**: 13 (1975). **Fig. 69.**

Tree to 21 m tall, d.b.h. to 25 cm. Twigs terete, 2·5–4·5 mm thick, when young with small sparse appressed hairs. Leaf base slightly swollen; rachis to 35 cm long and 2–3·5 mm thick, ± terete but flattened on top near bases of leaflets, to 6-jugate, 3·5–8(–12) cm between leaflet pairs; petiolule 3·5–6·5(–10·5) mm, slightly swollen; lamina ovate to elliptic, 10–18(–24)× 3·7–7 cm, apex acute to obscurely acuminate, base acute, slightly asymmetric, chartaceous, with sparse appressed hairs on midrib above and on midrib and main veins beneath, midrib above flat, beneath raised, 7–13 pairs of lateral veins, ± level above, raised beneath, tertiary venation obscure above, prominulous and finely raised beneath. Inflorescences from foliate axils, glabrescent, paniculate, main axis to 40 cm, 1 (or 2?)–branched, lateral branches to 4 cm, patent, usually only in upper half of inflorescence; bracts narrowly triangular, *c.* 1 mm long. Only female flowers known; flowers sessile; calyx slightly spreading, 2 mm long, margin entire, outside with appressed hairs, inside glabrous; corolla not adnate to staminal tube, aestivation alternative or imbricate, petals 4, red, ligulate, *c.* 12×1·7 mm, glabrous apart from sparse hairs at top outside; staminal tube white, 11×1 mm, slightly lobed, with sparse hairs at midpoint in middle of tube on both sides, anthers 6 or 7, inserted *c.* 2·5 mm below apex, *c.* 1·3 mm long, locellate, connective glabrous, almost basifixed; ovary 3–4-locular, 2×1·3 mm, with dense hairs; style 9 mm long, with appressed hairs its entire length; stigma 0·6 mm across. Fruit orange, dehiscent, flattened globose, 1·2×1·5 cm, with dense rather short hairs not obviously of different lengths; pericarp fibrous.

Field characters: Bark dark grey to grey-brown, fibrous, undersurface dark brown; inner bark pale brown. Wood pale brown.

Distribution: Two collections have been made from near Abau in the Central district of Papua.

Ecology: At 60–240 m altitude in well-drained primary rain forest.

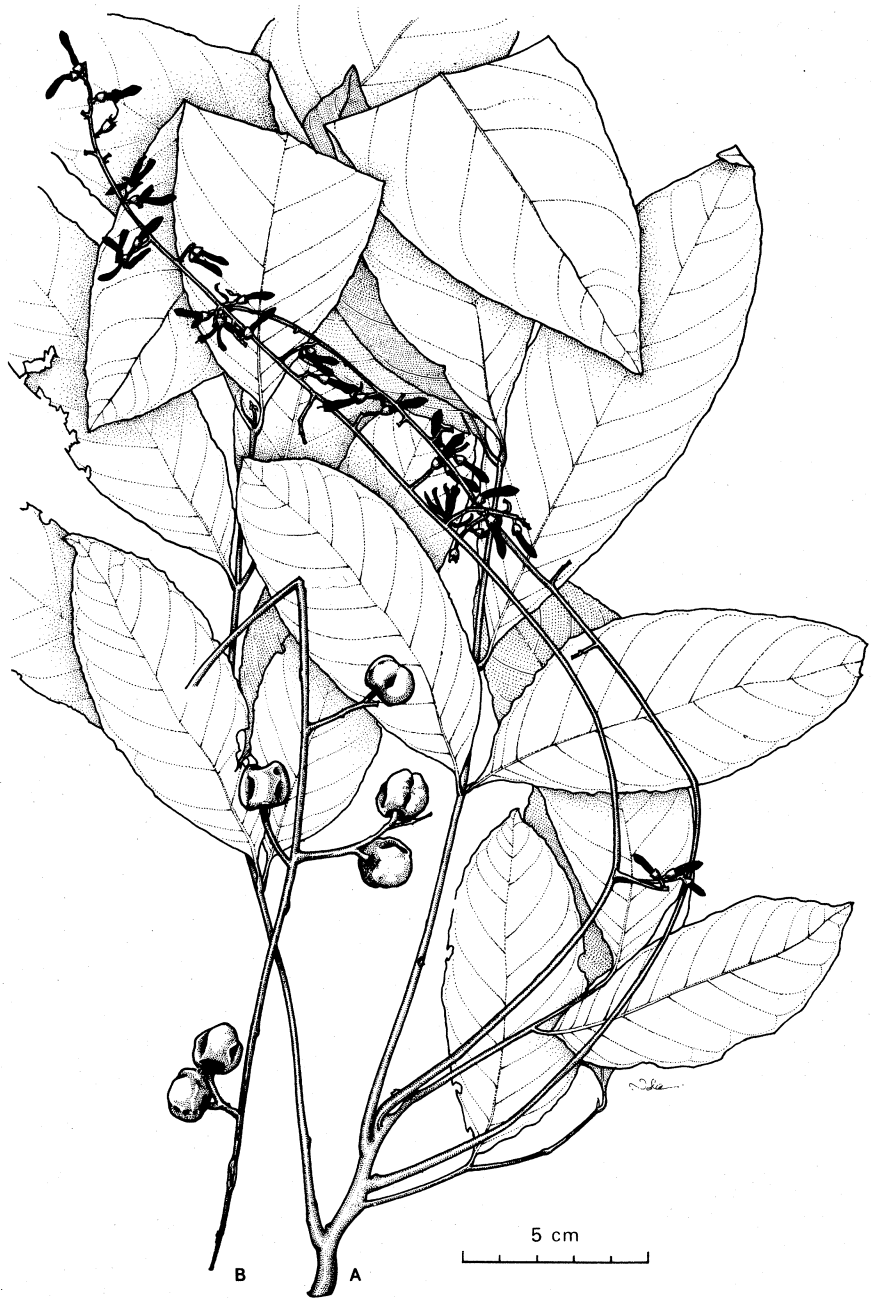


Fig. 69 **Chisocheton gliroides** Stevens (A) twig with mature foliage and inflorescence (B) fruiting inflorescence

Chisocheton lasiocarpus (Miq.) Val. *Bull. Dept Agr. Ind. Neerl.* **10**: 25 (1907).

Dysoxylum lasiocarpum Miq. (1868).

Tree to 12 m tall. Twigs terete, 8 mm across, puberulent. Leaf base swollen, ridged; rachis to 1·5 m long, 4 mm across, terete, persistently puberulent, 5(–9)-jugate, 9–14 cm between leaflet pairs, petiolule 4–6 mm, slightly swollen; lamina ovate to oblong, 14–36 × 7–13 cm, apex acuminate, base acute to broadly cuneate, very slightly asymmetric, chartaceous, midrib and main veins densely puberulent above, sometimes also with appressed hairs, appressed hairs more prominent beneath, midrib slightly raised above, prominently raised beneath, lateral veins 11–21 pairs, ± flat above, raised beneath, tertiary venation obscure to prominulous above, visible but flat beneath. Inflorescences from upper leaf axils, paniculate, puberulous, main axis 3–7 cm, 1–branched or not, branches to 1 cm, ascending, flowers dense; bracts *c.* 1 mm long, triangular. Only male flowers known; flowers sessile, calyx broadly spreading, 2 mm long, margin entire, puberulous outside, glabrous inside; corolla adnate to base of staminal tube, aestivation alternative, petals 4, white, ligulate to narrowly spathulate, 22 × 2–3·5 mm, puberulous outside, glabrous inside; staminal tube 16 × 2·3 mm, margin shallowly lobed, glabrous outside, with dense retrorse hairs inside from *c.* 2·5 mm below anthers to almost bottom; anthers 7–8, inserted *c.* 4 mm below top of tube, 3–3·5 mm long, locellate, sub-basifixed, connective with ascending hairs; ovary 2 × 1 mm, with dense long hairs, disc 0·5 mm tall, glabrous; style 14·5 mm long, with hairs for more than half its length; stigma 1 mm across. Fruit (immature) red, 2·5 × 1·3 cm, 4-locular, densely hairy, hairs obviously of different lengths; pericarp fibrous.

Distribution: Known from only two collections, one made somewhere along the south coast of western New Guinea (Digul/Mimika/Fakfak area) and the other from the southern part of the Vogelkop district (Steenkool).

Ecology: There are ants in the twigs.

Notes: This species is most easily separated when sterile from *C. novoguineensis* and *C. pachyrhachis* by its puberulent midribs and main veins. *C. novoguineensis* has a terete leaf rachis but that of *C. pachyrhachis* is angled. The inflorescence axis of *C. lasiocarpus* seems to be little-branched and terete, that of the other two species is more branched and in *C. pachyrhachis* is flattened at base. There are floral differences too; the style of *C. novoguineensis* is glabrous and the hairs on the inside of the staminal tube of *C. pachyrhachis* form a rather narrow band.

Chisocheton longistipitatus (F. M. Bail.) L. S. Sm. *Proc. R. Soc. Qd* **70**: 29 (1959). **Fig. 70.**

Castanospora longistipitata F. M. Bail. (1899); *Chisocheton polyanthus* Harms (1901).

Tree to 39 m tall, d.b.h. to 75 cm. Twigs terete, 4–8 mm across, drying ± striate when young, indumentum farinose (hairs stellate). Leaf base little swollen, smooth; rachis to 1 m long, 2–4·5 mm across, terete or somewhat flattened on top with rounded ridge decurrent from each petiolule, ±

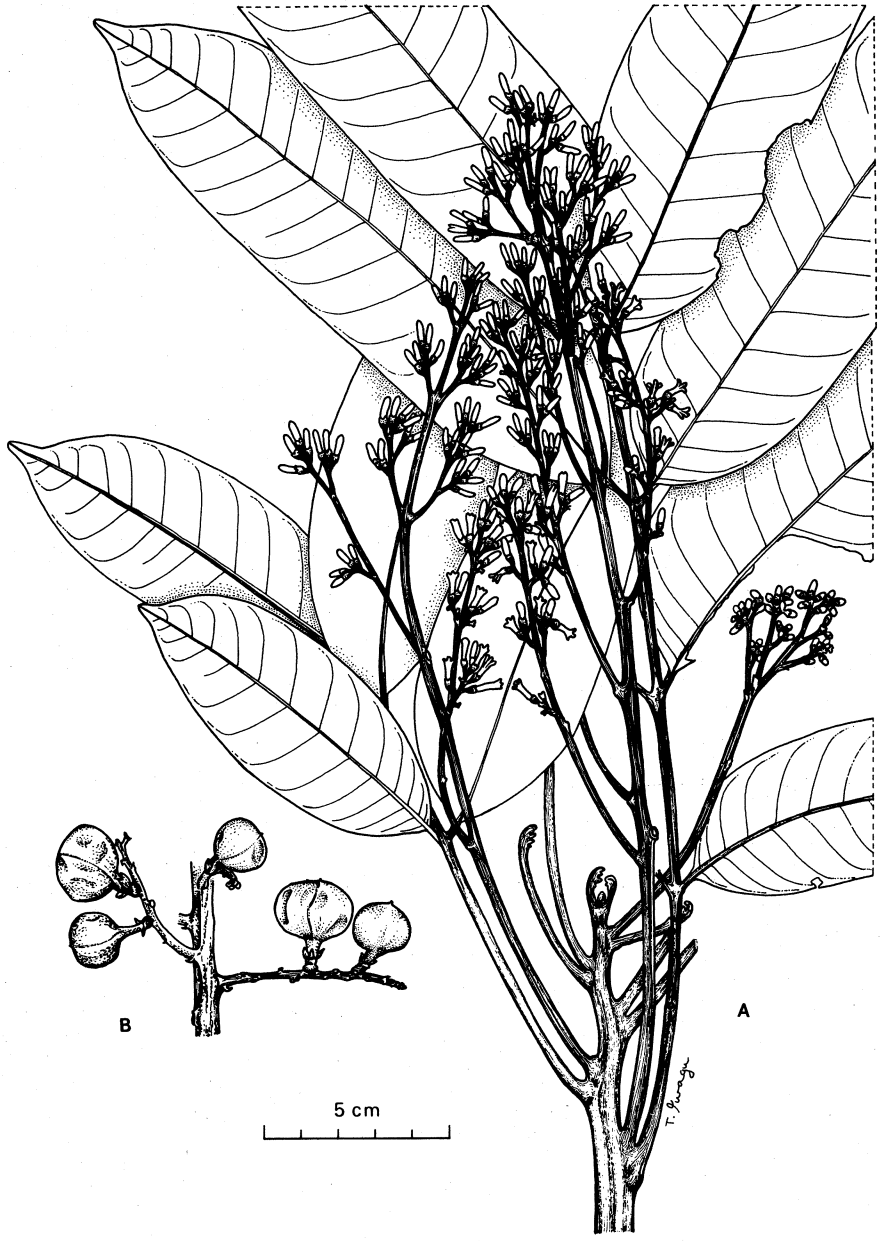


Fig. 70 **Chisocheton longistipitatus** (F. M. Bail.) L. S. Sm. (A) twig with mature foliage and flowering inflorescence (B) fruits

farinose, to 18-jugate, (2–)6–11 cm between leaflet pairs, growing point of leaf usually with several pairs of unexpanded leaves *c.* 1 cm long; petiolule 4–8 mm, not or little swollen, channelled on top; lamina oval or elliptic to suboblong, 9–32 × 4·2–13 cm, apex obtusely pointed to acuminate, base cuneate to rounded, asymmetric, chartaceous, indumentum inconspicuous except sometimes on midrib beneath, farinose, midrib above sunken, beneath prominent, raised, lateral nerves 9–24 pairs, flat to slightly sunken above, raised beneath, tertiary venation rather obscure above, subobscure to minutely raised beneath. Inflorescences from foliate axils, paniculate, main axis to 40 cm long, 3–4-branched, branching profuse, main lateral branches to 10 cm, ascending, all parts covered with farinose indumentum; bracts to 1 mm, narrowly triangular. Flowers fragrant, sessile, pseudopedicel to 0·5 mm; calyx dirty greenish-brown, cup-shaped, closely investing corolla, 1·5–3 mm long, irregularly lobed, lobes to 1 mm long, densely farinose outside, less so inside; corolla not adnate to staminal tube, aestivation valvate, petals usually 5, pale green to yellowish, ligulate, *c.* 6–7 × 0·4–0·7(–1) mm, with small downwardly pointing projection at shortly thickened tip, densely farinose indumentum outside, glabrous inside; staminal tube 6 × 0·6(–1) mm, usually 5-lobed, lobes 1·4–1·8 × 0·3–0·5 mm, apex ± retuse, ascending hairs outside except at bottom and at tips of lobes, hairs inside ascending to ± erect, not at bottom nor on lobes; anthers usually 5, inserted in angles of lobes, 0·8–1·3 mm, not clearly locellate, basifixed, connective with ascending hairs; ovary 2–3-locular, to 0·6 × 0·4 mm, densely farinose, disc glabrous, 0·5 mm tall, conspicuous; style to 4 mm, with farinose indumentum except for glabrous top third or quarter; stigma 0·4 mm across. Fruit orange, ± spherical, 3–3·5 cm long, smooth when dry, covered with farinose indumentum, fine ridges indicating future points of dehiscence, stipe 1–2 cm; pericarp spongy; seeds 1–3, flattened reniform to ovoid, to 2·5 × 1·8 cm; cotyledons collateral.

Field characters: Trunk sometimes spurred or buttressed to 2 m. Outer bark brown, scaly and with fine cracks; underbark pale brown to flesh-coloured; inner bark straw-coloured at first, turning red-brown. Wood pale brown to straw-coloured with conspicuous bands of parenchyma; often reported as being hard and tough. Twigs sometimes with slight white exudate.

Distribution: Australia (Queensland). Within Papuasia scattered—western New Guinea (Jayapura and Vogelkop districts), northeastern New Guinea (one collection from Madang and West Sepik districts, several from Morobe district but mostly around Bulolo), Papua (Northern and Milne Bay districts, one collection each), Bismarck Archipelago (New Britain) and scattered in the Solomon Islands (Bougainville, Choiseul, Santa Isabel and Rennell).

Ecology: At 10–1000 m altitude, a very locally common tree of primary rain forest. The twigs are sometimes inhabited by ants.

Notes: Dried leaves and fruits of this species are sometimes similar to those of *C. ceramicus*. For their distinguishing characters see the latter species.

The 'farinose indumentum' of the description is in fact made up of very small, four-armed hairs; the hairs on the style and the inside of the calyx have

lost some of their arms, while those of the staminal tube are simple. A strong lens is needed to see this.

Chisocheton montanus Stevens *Contr. Herb. Aust.* **11**: 18 (1975). **Fig. 71.**

Tree to 8 m tall, d.b.h. to 24 cm. Twigs terete, 1·5–2·5 mm across, drying striate, velutinous when young. Leaf base becoming slightly swollen and ridged; rachis to 75 cm long and 1·5–2·5 mm across, terete, ± persistently velutinous, 1–13-jugate with 2·5–6 cm between leaflet pairs; petiolule 3–6·5 mm, not or slightly swollen, velutinous; lamina obovate, elliptic or oblong, 4·5–30 × 2·5–8·5 cm, apex shortly acuminate, base acute to cuneate, slightly asymmetric, chartaceous, (sericeo-)velutinous on both surfaces when young, hairs persisting on midrib and main veins above and on whole leaf surface beneath, midrib and lateral veins flat above, raised beneath, 7–15 pairs of lateral veins, tertiary venation obscure above, prominulous and finely raised beneath. Inflorescence from upper foliate axils, sometimes subtending leaf not developed, velutinous, paniculate, 1-branched, main axis 4–18 cm long, branches to 2·5 cm, patent; bracts subulate, to 3 mm long. Female flowers unknown; flowers with faint sweet scent, sessile; calyx erect, 3–3·75 mm long, margin entire, outside sericeo-velutinous, inside glabrous; corolla not adnate to staminal tube, aestivation alternative or imbricate, petals 3 or 4, yellowish, ligulate to suboval, *c.* 7 × 2 mm, sericeous outside, glabrous inside; staminal tube 6 × 2·75 mm, slightly narrowed at both ends, apex ± entire, outside sericeous, sometimes glabrous at very bottom, inside glabrous or with a few hairs near base; anthers 6, rarely 5, inserted 3 mm below apex of tube, 1·2–1·5 mm long, locellate, almost basifixed, connective glabrous or with a few ascending hairs; ovary 4-locular, 1 × 0·5 mm, with dense hairs, disc obscure; style to 6 mm long, glabrous or with hairs in lower half; stigma 0·3 mm across. Mature fruits unknown.

Field characters: Branches not widely spreading. Outer bark dark brown, undersurface black; underbark dull reddish-brown to straw-coloured; inner bark straw-coloured, darkening to brown on exposure. Wood straw-coloured.

Distribution: Northeastern New Guinea. Four collections made in the eastern part of the Eastern Highlands district.

Ecology: At 1450–1830 m altitude in sometimes disturbed montane forest.

Local uses: Used in houses, fences, gardening sticks, etc. (Okapa).

Notes: The leaflets first produced by the leaf are very much smaller than those later produced. This helps to separate sterile material of this species from that of *C. pohlianus* where the difference in size of leaflets on the same leaf is less.

Chisocheton morobeanus Harms *Bot. Jb.* **72**: 185 (1942). **Fig. 72.**

Tree to 37 m tall, d.b.h. to 1·5 m. Twigs 5–7 mm across, terete or slightly flattened, with appressed hairs when young, glabrescent. Leaf base swollen, not ridged; rachis to 1·2 m long, 2·5–5 mm thick, terete, with short appressed

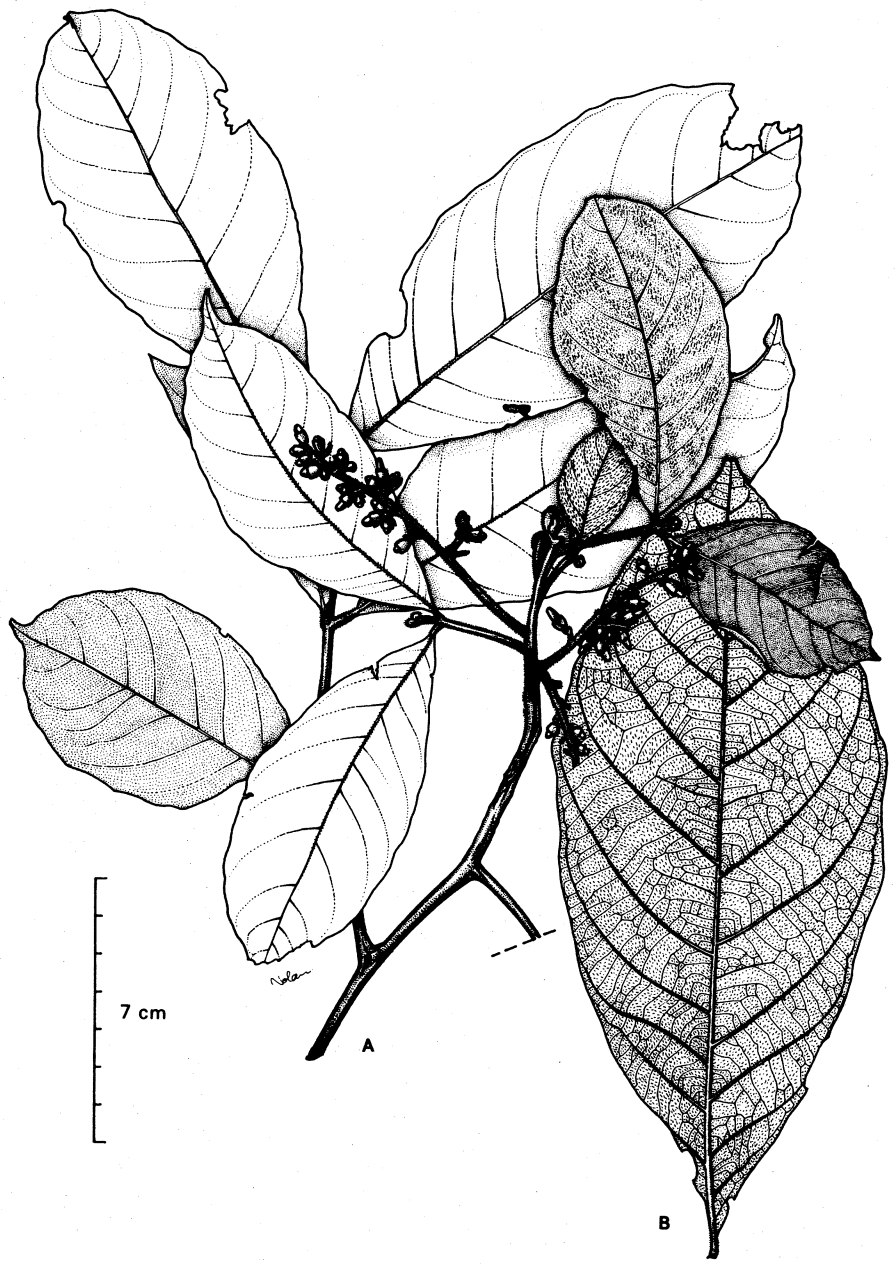


Fig. 71 **Chisocheton montanus** Stevens (A) twig with mature foliage and inflorescence (B) underside of mature large leaflet

hairs when young, glabrescent, to 15-jugate, 3–13 cm between leaflet pairs; petiolule 6–12 mm, swollen; lamina ovate to elliptic or oblong, (6–)10–42 × (2·2–)5·5–14 cm, apex acuminate, base acute to rounded, finally very shortly decurrent, slightly asymmetric, chartaceous to thinly coriaceous, appressed hairs on both sides of leaf inconspicuous, but most abundant on midrib and main veins, midrib flat above, prominent beneath, raised, lateral veins 6–14 pairs, level above, raised beneath, tertiary venation prominulous and raised above and beneath. Inflorescences from below leaves or sometimes axillary, borne 3–8 together on stout, common axis to 3 cm long, paniculate, main axis to 45 cm, 2(–3)-branched, branches to 9 cm long, widely diverging or recurved; bracts *c.* 0·75 mm, narrowly triangular. Flowers sweetly scented; pedicels to 2·5 mm, pseudopedicel 1 mm; calyx spreading, not closely investing corolla, 1–1·5 mm tall, margin entire to obscurely lobed, with short appressed hairs outside, especially towards margin, glabrous inside; corolla white, adnate to base of staminal tube, imbrication quincuncial, imbricate or alternative, petals 3–5, usually 4, ligulate to narrowly spathulate, 12–18 × 2–5 mm, glabrous or with sparse appressed hairs outside towards tips; staminal tube to 15 × 1 mm, lobes 6–9, ± spreading, to 2·5 × 0·8 mm, apex retuse to 3-lobed, tube glabrous outside or with ascending hairs towards top, inside with ± ascending hairs from near bottom to 2–3 mm below anthers; anthers 6–9, inserted in angles of lobes, 1·5–2·2 mm long, locellate, sub-basifixed, connective with dense ascending hairs; ovary 3–4-locular, to 1·4 × 0·9 mm, densely hairy, disc glabrous, 0·3 mm tall; style to 1·4 cm, with ascending hairs for three-quarters of its length; stigma 0·8 mm across. Fruit red, dehiscent, ± spherical, to 5 × 6 cm, subglabrous, stipe 1–1·5 cm; when fresh to 8 cm diameter; pericarp orange, to 1·2 cm across, with white sap; seeds 3–4, slightly curved ellipsoid, *c.* 6 × 2·5 cm, arillode orange, to 2·5 mm thick, completely surrounding seed but very thin towards middle of outer surface of seed, free on outer surface, testa brown; cotyledons superposed.

Field characters: Trunk usually buttressed, buttresses to 3 m tall, bole fluted to 10 m or more. Outer bark grey to brown, sometimes mottled, smooth, with pustules, sometimes vertically cracked, peeling by irregular flakes which leave pock-marks, undersurface blackish-purple to red-brown; underbark cream-coloured; inner bark cream-coloured, fibrous, soft, darkening on exposure, sometimes with watery exudate, transient sweet smell reported. Wood white or straw-coloured to light brown, with concentric rings of soft tissue.

Distribution: In Papuasia quite common, but scattered, throughout the lowlands of mainland New Guinea and the Bismarck Archipelago; in western New Guinea collected only in the Vogelkop and Jayapura districts, in northeastern New Guinea not yet collected from the West Sepik district but known from the Western Highlands district, in Papua known only from the Central and Northern districts. The final rank of this species may have to be changed, but it is impossible to be certain without a monographical study. There is some rather surprising infraspecific variation in inflorescence type in some non-Papuasian species.

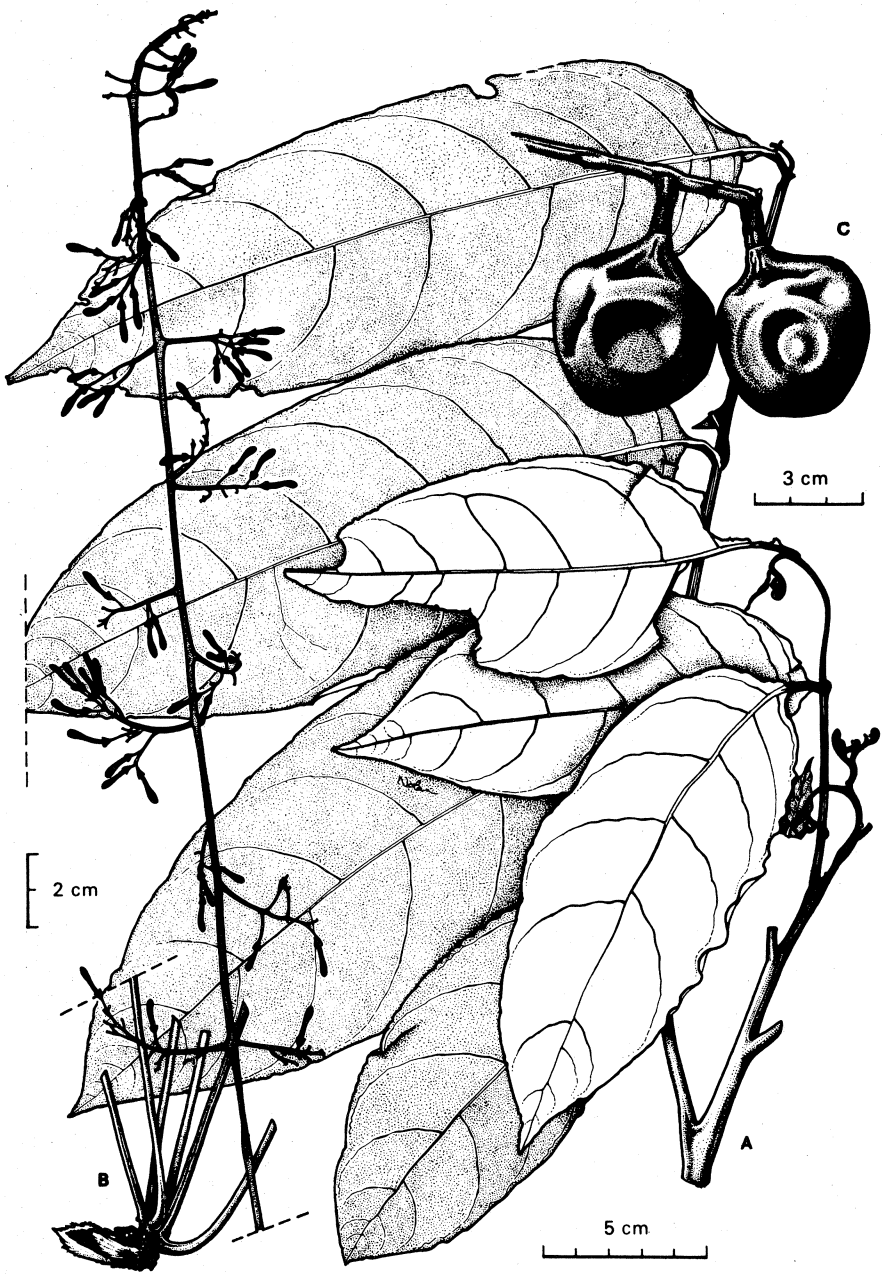


Fig. 72 **Chisocheton morobeanus** Harms (A) twig with mature and young foliage (B) base and portion of inflorescence (C) mature fruit

Ecology: At 50–1300 m altitude in well-drained primary, rarely secondary, rain forest, rarely in swamp forests and not on steep slopes.

Local uses: Used as a fish poison: bark beaten and put in water in confined pools in reef stuns fish for several hours (Kuanua, New Britain).

Notes: Although the leaflet size and shape of this species varies a great deal, it is easily recognized, even when sterile, by the very clear venation of the leaflets. No other species of *Chisocheton* in Papuasia has several inflorescences coming together from a common axis borne in an axil behind the leaves.

Chisocheton novobritannicus Stevens *Contr. Herb. Aust.* **11**: 22 (1975). **Fig. 73.**

Tree to 13 m tall, d.b.h. to 20 cm. Twigs 6 mm across, terete, ± villous when young with hairs to 1 mm long. Leaf base swollen, slightly ridged; rachis to 1·25 m long, 5 mm across, terete, ± villous when young, sometimes becoming glabrous, to 11-jugate, 9–16 cm between leaflet pairs; petiolule 5–12 mm, often swollen; lamina ovate to oblong, 13–37 × 6·5–15 cm, apex acute to acuminate, base cuneate to rounded, slightly asymmetric, chartaceous, usually glabrous above, sometimes a few persistent suberect hairs on midrib, ± numerous hairs on midrib and main veins beneath and also sometimes on leaf surface, midrib flat to slightly sunken above, beneath raised, prominent, lateral veins 10–17 pairs, flat above, raised beneath, tertiary venation obscure above, prominulous beneath. Inflorescences from foliate axils, paniculate, ± villous, main axis to 80 cm, 2-branched, branches directed backwards or at right-angles to main axis, to 2 cm long, flowers congested; bracts *c.* 1 mm long, triangular. Flowers sessile, articulated with branches, pseudopedicel obscure or to 1 mm long; calyx ± broadly spreading, 1·5–2 mm long, margin entire, with spreading to suberect hairs outside, glabrous inside; corolla adnate to base of staminal tube, aestivation alternative, petals 4, white, oblanceolate or ligulate, 16 × 1·5–4 mm, glabrous or with a few sparse hairs outside at apex of petals; staminal tube 14 × 1·5–2 mm, shallowly lobed at apex, glabrous outside, inside with dense or sparse spreading hairs in lower part; anthers 8–9, inserted 2·5–3 mm below apex of tube, 1·5–2·5 mm long, locellate, almost basifixed, connective glabrous; ovary (in male flowers) small, disc 0·4 mm tall, glabrous; style 1·4 cm long, with dense ascending hairs on lower half; stigma 0·7 mm across. Fruit dull rust-colour, globose, apex flattened, 4-locular, to 3·2 cm diameter, 4-sulcate, with rather sparse short hairs except in sulci where also some longer hairs; pericarp fibrous; seeds flattened-ellipsoid, *c.* 20 × 11 × 8 mm, inner part with arillode; cotyledons superposed.

Field characters: Outer bark mottled grey-green; underbark flame-coloured; inner bark straw-coloured. Wood pale brown.

Distribution: Known only from the southwestern part of New Britain.

Ecology: From sea level to 150 m altitude in primary or secondary rain forest.

Notes: The flowers of *C. novobritannicus* are similar to those of the form of *C. weinlandii* on New Britain, but the much larger leaves, long, narrow inflorescence and fruit with rather sparse indumentum separate the two.

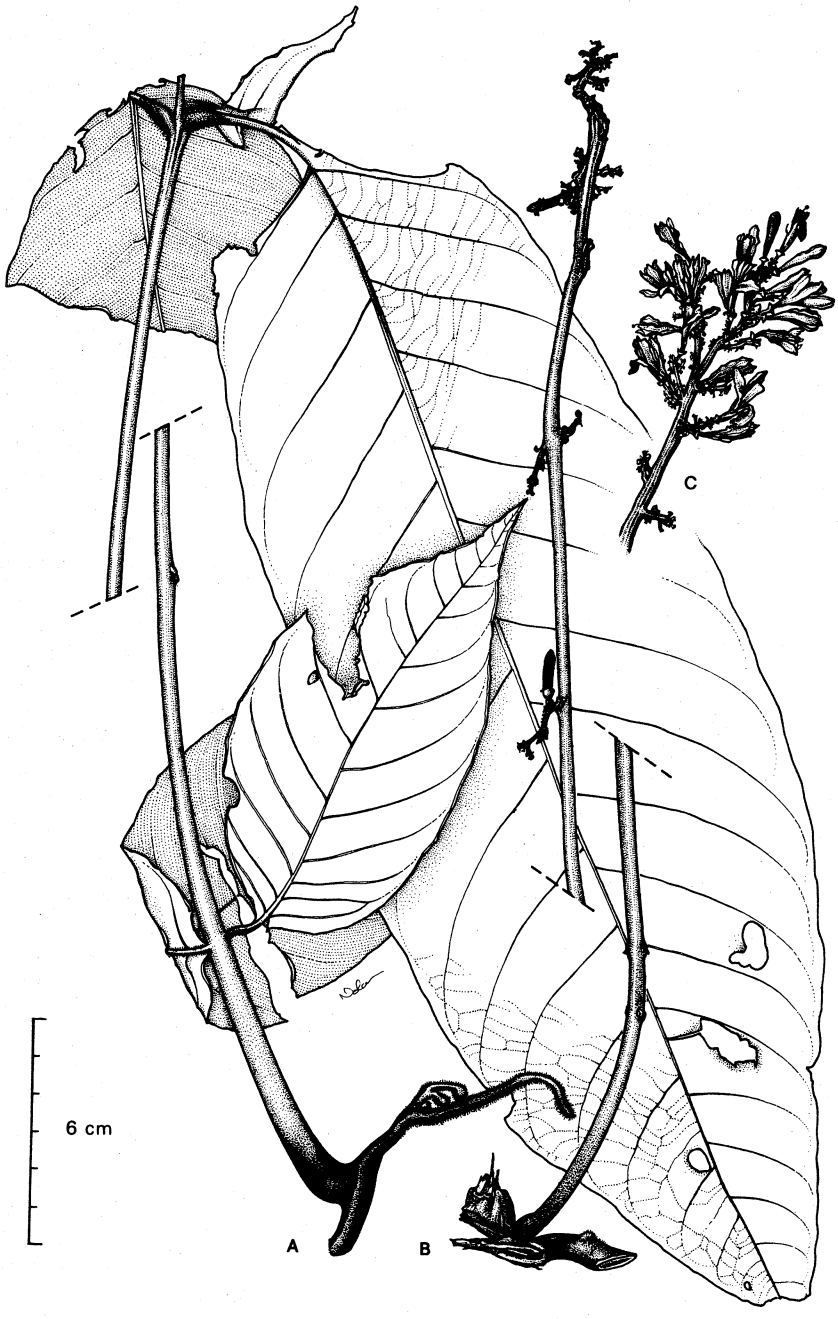


Fig. 73 **Chisocheton novobritannicus** Stevens (A) twig with sectioned mature leaf (B) twig with sections of inflorescence (C) portion of inflorescence with open flowers

Chisocheton novoguineensis C. DC. *Bull. Herb. Boiss.* Ser. 2, **3**: 169. (1903).
C. forbesii C. DC. (1903); *C. biroi* auct. non Harms (1905); *Dasycoleum forbesii* Bak. f. & Norman (1923); *C. myrmecophilus* Merr. & Perry (1940).

Tree to 12 m tall. Twigs 5–9 mm thick, with rounded ridges decurrent from petiole, with appressed hairs when young. Leaf base swollen, ridged, upper part rising abruptly from stem; rachis to 65 cm long, (2–)4–6 mm thick, ± flattened on top with rounded to acute ridge decurrent from each petiolule, hairs appressed, inconspicuous, to 11-jugate, (3·5–)6–13 cm between leaflet pairs; petiolule 7–12 mm, slightly swollen, appressed hairy at first; lamina ovate to oblong, 8–39 × 6–14 cm, apex ± acuminate, base acute, chartaceous, glabrous above or with short appressed hairs on midrib and main veins, beneath likewise, and sometimes also on leaf surface, midrib above flat to slightly raised, beneath prominent, raised, lateral veins 7–19 pairs, ± flat above, raised beneath, tertiary venation obscure above, prominulous beneath. Inflorescences from upper leaf axils, paniculate, main axis 8–45 cm long, 1–3-branched, branches to 20 cm long, usually patent, sometimes ascending; bracts *c.* 0·5 mm, narrowly triangular. Flowers with pedicel to 0·5 mm, pseudopedicel obscure, stout; calyx cup-shaped, 1–1·7 mm, margin usually ± entire, rarely deeply lobed, outside puberulous, inside glabrous; corolla adnate to base of staminal tube, aestivation alternative or imbricate, petals 4, pinkish-white to white, ligulate or subspathulate, 7–12 × 1·5–2·5 mm (female) or 9 × 0·7 mm (male), with sparse appressed hairs outside, especially towards top, glabrous inside; staminal tube 8–11 × 1·5–2 mm (female) or 7 × 0·5 mm (male), apex not or only obscurely lobed, glabrous outside, inside with erect, ascending or retrorse hairs in bottom half to two-thirds; anthers 5–9, inserted to 3 mm below top of tube, 1–2·5 mm long, locellate, ± basifixed, connective glabrous; ovary (3–)4-locular, 2 × 1·7 mm (female) or 1 mm (male), with dense subappressed hairs, disc obscure; style 4–5 mm (female), with appressed hairs its whole length, or *c.* 6·5 mm (male), with appressed hairs for *c.* two-thirds its length; stigma 0·75 mm across, usually with sparse hairs in bottom part in female. Fruit ovoid, red, dehiscent, with 4 slightly raised longitudinal lines, to 3·2 × 2 cm, apex pointed, with dense short hairs not obviously of different lengths; from spirit material pericarp 2 mm thick, fibrous; seeds ± triangular in transverse section, arillode on 2 inner faces 1 mm across; cotyledons superposed.

Distribution: Known from the Morobe district of northeastern New Guinea and the Central district of Papua.

Ecology: At (100–)600–1500 m altitude in primary or secondary lower montane rain forest. The twigs often contain ants.

Notes: In its somewhat flattened and ridged leaf rachis *C. novoguineensis* is similar to *C. pachyrhachis*, but the inflorescence is much longer and the hairs on the style much shorter.

Chisocheton pachyrhachis Harms in K. Sch. & Laut. *Schutzgeb.* 382 (1901).
C. gjellerupii Harms (1942).

Tree to 15 m tall. Twigs terete, 6–8 mm across, glabrous, with ant holes. Leaf base swollen, ridged, upper edge rising sharply from stem; rachis to

1 m long, 4–6 mm across, top ± flat, with raised line or wing decurrent from each petiolule base, rounded below, with sparse appressed hairs when young, 2–6-jugate, 8–16 cm between pairs of leaflets; petiolule 5–10 mm, swollen; lamina ovate to oblong, (9·5–)17–34 × (5·5–)10–16 cm, apex acute, base cuneate, slightly asymmetric, chartaceous, sometimes inconspicuous appressed hairs on lower part of midrib above, midrib beneath with appressed hairs or minutely puberulous, midrib above flat, beneath prominent, raised, lateral veins 11–17, flat above, raised beneath, tertiary venation obscure above, clear and flat to slightly raised beneath. Inflorescences from upper foliate axils, paniculate, main axis 3·5–12 cm, flattened at base, to 2-branched, branches to 4 cm, ascending, flowers dense; bracts 2–3 mm long, triangular. Female flowers unknown; flowers ± sessile, pseudopedicel obscure, stout; calyx erect to slightly spreading, 2–4 mm, with small appressed hairs outside, glabrous inside, margin entire; corolla slightly fused to base of staminal tube, aestivation imbricate or alternative, petals 3–4, white to reddish, ± ligulate, 14–22 × 3–4·5 mm, with small appressed hairs outside, glabrous inside; staminal tube to 20 × 3 mm, apex shallowly lobed, glabrous or almost so outside, inside usually with band of ± ascending hairs to 7 mm wide, 2–6 mm below anthers and 2–5 mm from bottom, sometimes almost glabrous; anthers 9–12, inserted to 3·5 mm from top of tube, 2–3·3 mm long, locellate, sub-basifixed, connective glabrous or with ascending hairs; ovary 4–6-locular, 2 × 1·7 mm, densely hairy, disc 0·3–0·9 mm tall, glabrous; style 1–1·8 cm long, with dense ascending hairs in bottom two-thirds or almost to top; stigma 1–1·3 mm across. Fruit red, dehiscent, globose, *c.* 2·7 × 3 cm, hairs of different lengths; pericarp fibrous; seed black; arillode on inner surface, dirty pale orange to pink; cotyledons superposed.

Field characters: Outer bark grey-brown, flaky; inner bark pink.

Ecology: From sea level to 1000 m altitude; an understorey tree in primary forest on foot-hills. The twigs are inhabited by ants.

Distribution: In western New Guinea known from Jayapura and somewhat doubtfully from the Vogelkop district; in northeastern New Guinea known from the West Sepik, East Sepik, Madang and Morobe districts.

Notes: There are several specimens from the Vogelkop district which perhaps approach *C. lasiocarpus* or *C. weinlandii*, but much more collecting is needed to clarify the situation.

Chisocheton pohlianus Harms in Diels *Ber. Deut. Bot. Ges.* **35**: 341 (1917), Abb. 1. **Fig. 74.**

Tree to 8 m tall, d.b.h. to 6 cm. Twigs 2–4 mm across, terete, puberulous to velutinous at first, glabrescent. Leaf base swollen, smooth, upper edges rising sharply from stem; rachis 8–60(–200) cm long, 1–3·5(–6·5) mm across, terete, ± velutinous when young, 2–9(–28)-jugate, 3–9 cm between leaflet pairs; petiolule 3–6 mm, sometimes slightly swollen; lamina ovate to lanceolate or elliptic, 5–14·5(–22) × 3·2–5·5(–7) cm, apex acuminate, base acute, very slightly asymmetric, chartaceous to thinly coriaceous, margin repand or not, velutinous when young, glabrescent except for midrib and

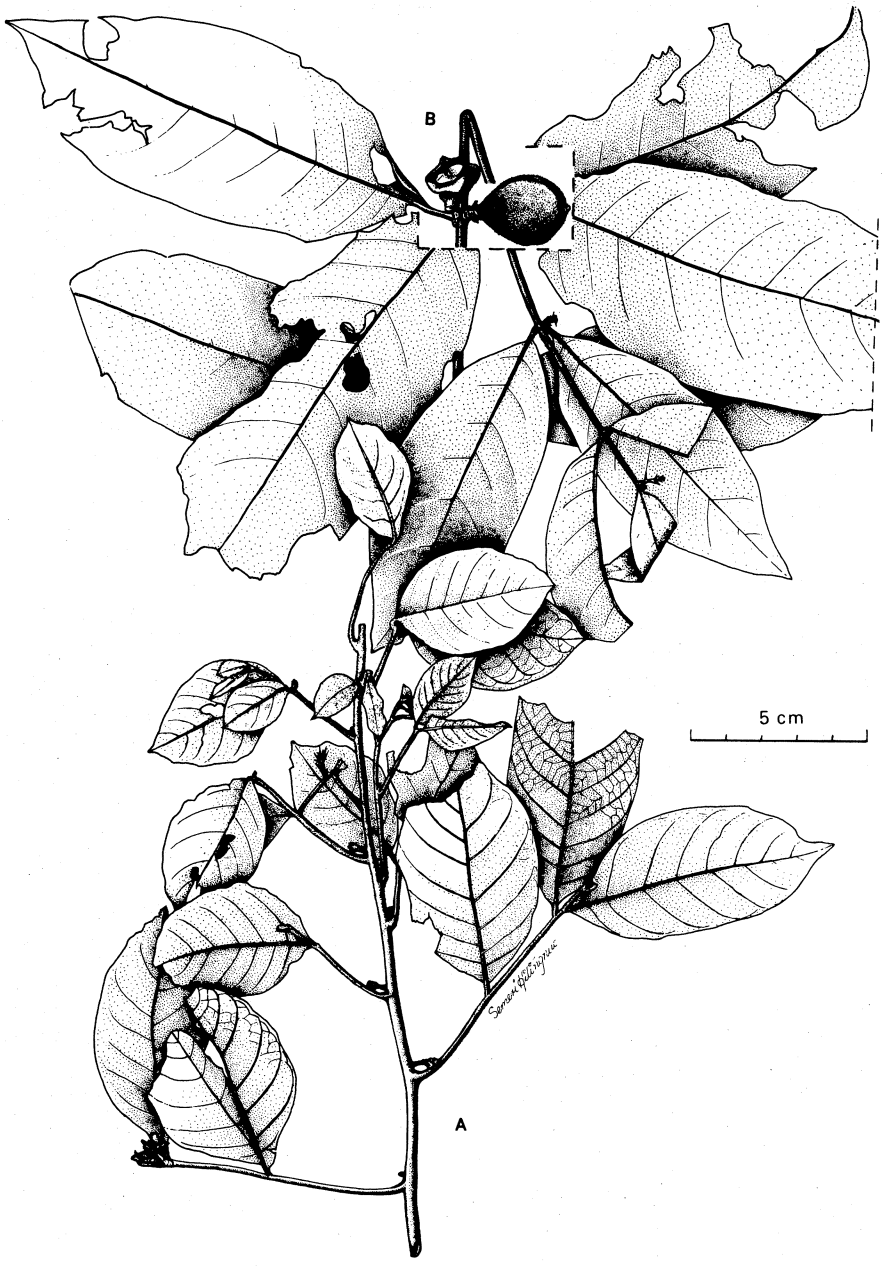


Fig. 74 **Chisocheton pohlianus** Harms (A) twig with young leaves (B) leaf with inflorescence arising between leaflet pairs; flowers and fruit

main veins above, sometimes persistently velutinous beneath, midrib flat to slightly raised above, beneath raised, prominent, lateral veins 7–13 pairs, slightly sunken above, raised beneath, tertiary venation obscure above, ± prominulous beneath. Inflorescences usually adnate to leaf rachis and appearing as groups of flowers on usually unbranched shoots to 5 cm long between leaflets, apparently also sometimes axillary; flowers sometimes congested; bracts 1·2–3·5 mm, triangular to subulate, velutinous. Flowers sessile; calyx erect, closely surrounding corolla, green to red, 3–3·5 mm, margin obscurely lobed, with short dense hairs outside, glabrous inside; corolla not or hardly adnate to staminal tube, aestivation valvate, imbricate or quincuncial, petals usually 4, rarely 3, white to pink, ligulate, to 10 × 2 mm, glabrous or puberulent to velutinous outside, glabrous inside; staminal tube 9 × 1·5 mm, slightly broader at top, obscurely lobed, with sparse appressed hairs outside, glabrous or with retrorse hairs below anthers inside; anthers (4–)6–7, inserted 3 mm below top, 1·5–2·5 mm long, locellate, basifixed, connective glabrous or with dense, ascending hairs; ovary 3–4-locular, *c.* 1 mm tall, densely hairy, disc very small; style to 8 mm, glabrous or with ascending hairs its entire length except at very top; stigma 0·7 mm across. Fruit red, dehiscent, subovoid to elliptic, to 4 × 2·5 cm, hairs of different lengths; pericarp fibrous.

Field characters: Outer bark dark grey, smooth; inner bark straw-coloured; 'formic smell in blaze' once reported. Wood straw-coloured.

Distribution: Northeastern New Guinea—East Sepik, Western Highlands and Eastern Highlands districts.

Ecology: At 600–1800 m altitude in lower montane forest, often with *Castanopsis* or in advanced secondary forest.

Notes: C. pohlianus is a rather variable species both in its vegetative and floral parts.

Chisocheton sapindinus Stevens *Contr. Herb. Aust.* **11**: 29 (1975). **Fig. 75.**

Tree to 6 m tall, d.b.h. to 10 cm. Twigs terete, 1·5–2 mm across, with sparse appressed hairs at first but soon glabrescent. Leaf base hardly swollen, smooth; rachis terete, to 45 cm long and 1–2 mm across, soon glabrescent, to 9-jugate, 2–6·5 cm between leaflet pairs; petiolule 4–10 mm, not swollen; lamina ovate to elliptic, (4–)7·5–15·5 × (2–)3·3–6·3 cm, apex acuminate, base cuneate to acute, sometimes obscurely decurrent, asymmetric, thinly coriaceous, when young with sparse appressed hairs, soon glabrescent, midrib and venation prominent and raised both above and beneath, lateral nerves 5–20 pairs. Inflorescences from foliate axils, paniculate in male plants, main axis 2–65 cm, 1- (rarely not or 2-) branched, branches to 3 cm long, patent, in female plants racemose, 5–20(–60) cm long, flowers few, congested at end of inflorescence; bracts 1 mm, subulate. Flowers with pedicel to 2 mm long; calyx erect, not closely investing corolla, 1·7–2·5 mm long, entire or (usually) with incision to 1 mm deep, glabrous or with sparse appressed hairs outside; corolla weakly adnate to base of staminal tube, aestivation alternative, petals 4, ligulate, white to pale reddish-green, 13 × 1 mm when fresh (female) or 10·5 × 0·7 mm (male), glabrous or with very few appressed hairs outside

Fig. 75 **Chisocheton sapindinus** Stevens (A) twig with leaf and inflorescence (B) fruit at maturity, dehiscing

at top; staminal tube white, 12·5 × 1 mm when fresh (female) or 10 × 0·7 mm (male), apex shallowly lobed, glabrous; anthers 4–6, inserted *c.* 1·5 mm below apex of tube, 0·7 mm long, locellate, almost basifixed; connectives glabrous or with ascending hairs; in female flowers ovary 0·7 mm long, with dense hairs, in male flowers ovary very small, disc 0·3 mm tall; style 8·5 mm long, slender, with hairs in bottom half; stigma 0·3 mm across. Fruit red, fusiform, dehiscent, to 6·5 × 2·5 mm, with 3 longitudinal ridges, glabrous; pericarp (in spirit material) *c.* 3·5 mm thick, fibrous; seeds flattened-ellipsoid, to 3 × 1·8 × 1·1 cm, testa black, arillode on inner surface, orange, with narrow free margin overlying testa; cotyledons superposed.

Field characters: Outer bark dark grey-brown to light brown or grey, sometimes mottled, smooth or finely cracked; inner surface black; underbark reddish-pink or straw-coloured; inner bark straw-coloured, sometimes with somewhat unpleasant smell rather like garlic. Wood straw-coloured, tough.

Distribution: Known with certainty only from the Morobe district of north-eastern New Guinea (Oomsis, Buso and near Garaina); one collection possibly of this species from Ower's Corner on the Kokoda Trail, Central district, Papua.

Ecology: At 60–800 m altitude in primary forest, sometimes dominated by *Castanopsis* or *Anisoptera.*

Notes: The small leaflets with distinct venation on both surfaces distinguish this species from all others in New Guinea even when sterile; the ridged fruits are equally distinctive. Collectors have confused this tree with the Sapindaceae because of its rather leathery leaflets and 3-ridged fruits.

Chisocheton sayeri (C. DC.) Stevens *Contr. Herb. Aust.* **11**: 32 (1975). **Fig. 76.**
Dasycoleum sayeri C. DC. (1903).

KEY TO VARIETIES

1. Flowers in bud 9–10 mm long, anthers 4–6(–7), style to 0·15 mm thick . . . . . var. **sayeri**
1. Flowers in bud *c.* 11·5 mm long, anthers 6–8, style 0·25 mm thick . . . . . var. **pilosus**

var. **sayeri**

C. archboldianus Merr. & Perry (1940); *C. erythranthus* Merr. & Perry (1940); *C. acariaeanthus* Harms (1942); *C. graciliflorus* Harms (1942); ?*C. leptopetalus* Harms (1942); *C. erythrocarpus* auct. non Hiern (1872); *C. pohlianus* auct. non Harms (1913); *C. schumannii* auct. non C. DC. (1910).

Tree or shrub to 15 m tall, d.b.h. to 30 cm. Twigs terete, 2–3·5 mm across, subglabrous to velutinous when young. Leaf base slightly swollen, ridged or not; rachis to 25(–75) cm long, 1–2 mm across, terete, indumentum variable, to 9(–12)-jugate, 3–7(–12) cm between leaflet pairs; petiolule 4–8 mm long, hardly swollen; lamina ovate to narrowly elliptic or suboblong, (5–)7·5–20(–42·5) × (2·8–)3·8–6·5(–9) cm, apex acuminate, base acute to cuneate, asymmetric, chartaceous, indumentum varying from small, inconspicuous appressed hairs to velutinous on midrib and main veins above and over whole undersurface of leaf, midrib above flat, beneath

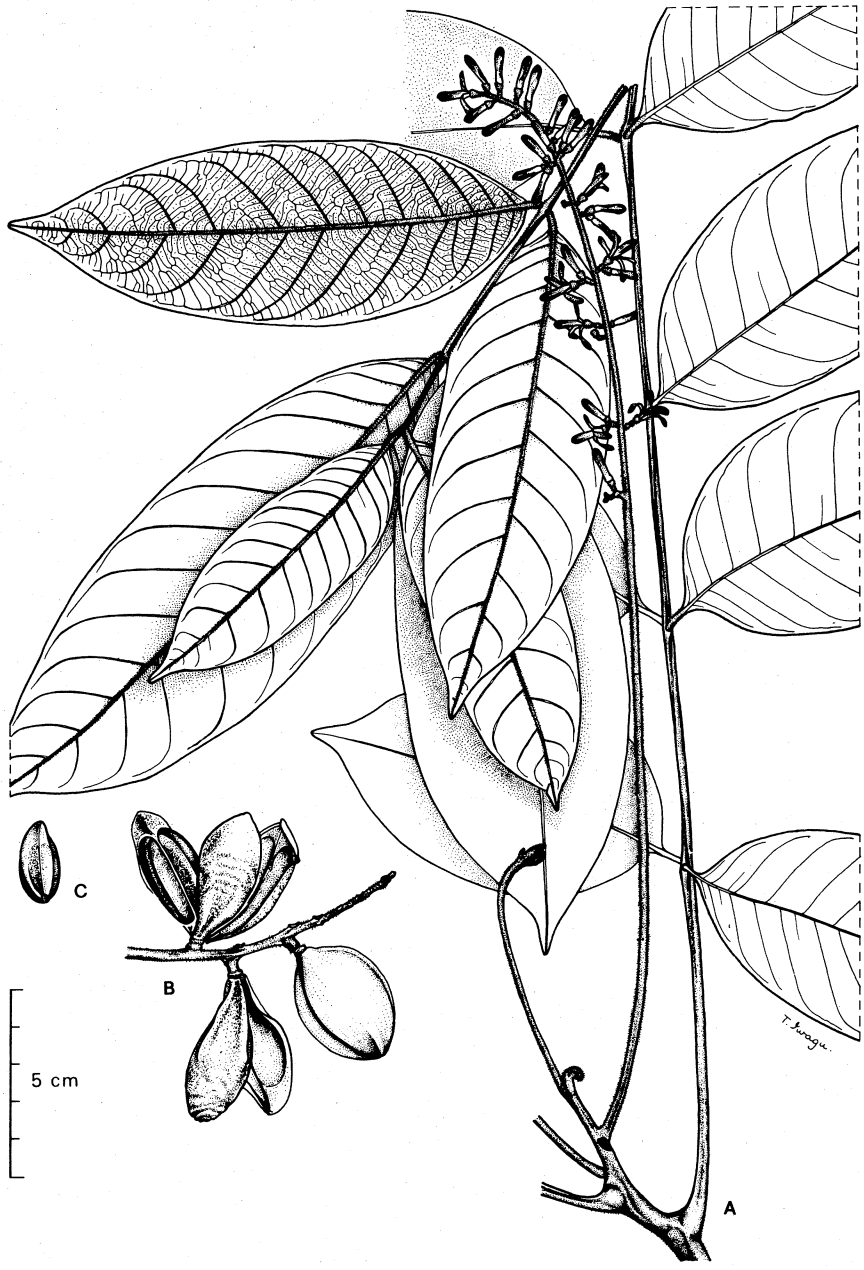


Fig. 76 **Chisocheton sayeri** (C. DC.) Stevens (A) twig with mature foliage and inflorescence (B) inflorescence with mature dehiscing fruit (C) seed

prominent, raised, lateral veins 7–14 pairs, flat above, raised beneath, tertiary venation obscure above, prominent and slightly raised beneath. Inflorescences from foliate axils, 2–70 cm long, not or 1-branched (female), 1–2-branched (male), branches in female to 11·5 cm long, patent, in male to 15 cm long, patent to ascending, flowers congested or not; bracts to 1·5 mm long, narrowly triangular. Flowers sessile or with pedicel to 2·5 mm long; calyx erect, 1–1·5 mm tall, margin entire or with small teeth, indumentum outside variable, inside glabrous; corolla free from or slightly adnate to base of staminal tube, aestivation alternative or imbricate, petals 3–5, usually 4, white to pinkish, ligulate to spathulate, 8–10 × 1–1·5 mm, sparse appressed hairs outside especially towards top, glabrous inside; staminal tube to 10 × 0·7 mm, entire or shallowly lobed, outside glabrous or with sparse ascending hairs, inside glabrous or with ± dense hairs from *c.* 1 mm below anthers to near bottom; anthers 4–6(–7), inserted 1·3–1·8 mm below top, 0·7–1·2(–1·5) mm long, prominently locellate or not, almost basifixed, connective glabrous; ovary 3–5-locular, orange, to 1 mm long in female flowers, with long hairs, in male flowers disc 0·2 mm tall, glabrous on sides, ovary none; style to 9·5 mm long and 0·15 mm thick with long ascending hairs in bottom two-thirds; stigma to 0·5 mm across. Fruit dehiscent, red to orange, ellipsoid to obovoid, to 2·8 × 2·5 cm, densely covered in hairs of obviously different lengths; pericarp fibrous; seeds 2–4, flattened-ovoid, 19 × 11 × 6 mm, testa black, arillode on inner surface, red; cotyledons collateral or superposed.

Field characters: Outer bark black to grey and brown mottled, smooth or shallowly fissured, with lenticels; inner bark pale brown to straw-coloured. Wood straw-coloured.

Distribution: A single collection each from the Geelvink Bay district, the Southern Highlands district, and the Bismarck Mountains, Madang district. *C. sayeri* var. *sayeri* is apparently quite common in the area from the Morobe district in northeastern New Guinea to the Milne Bay district in southeastern Papua. A single collection is known from Normanby Island (Papuan Islands).

Ecology: At 30–1500 m altitude in usually well-drained primary rain forest.

Notes: A very heterogeneous variety. It has proved impossible to divide the material up in any satisfactory way since the variation in many of the characters is ± independent. Specimens from southeastern Papua have narrower, often more lanceolate, leaflets than the others; also some plants from this area have no branches on the lower 30 cm or so of the inflorescence. The indumentum on all parts of the plant is well developed. Some specimens from the Morobe and Central districts differ from the others in having a combination of moderately well-developed indumentum on the plant, ± oblong leaflets, prominently locellate anthers and pedicellate flowers only moderately congested on the inflorescence. In the Northern and part of the Morobe and Central districts there is dimorphism of the inflorescence which is correlated with the sex of the plant; elsewhere in the range of the variety this dimorphism, if it occurs, must be different from that described above.

var. **pilosus** (C. DC.) Stevens *Contr. Herb. Aust.* **11**: 36 (1975).
C. pilosus C. DC. (1910).

Indumentum of long hairs as in var. *sayeri*; leaflets *c.* 28×7·5 cm. Inflorescence 12 cm long, lateral branches *c.* 3 cm, patent, flowers congested. Flowers (in bud) 11·5×1·5 mm; anthers 6–8; style 10·5 mm long, 0·25 mm thick.

Distribution: Known only from the Digul/Mimika district boundary in western New Guinea and from the Gulf district of Papua.

Chisocheton schlechteri Harms *Bot. Jb.* **72**: 188 (1942). **Fig. 77.**

Tree *c.* 9 m tall, d.b.h. to 5 cm. Twigs *c.* 4 mm across, shortly velutinous. Leaf base swollen, hardly ridged; rachis to 65 cm long, 3–5 mm across, terete, velutinous, 3–8-jugate, 8–10 cm between leaflet pairs; petiolule stout, 5–7 mm, velutinous; lamina elliptic to suboblong or sublanceolate, 23–40× 9–15 cm, apex long-acuminate, base emarginulate, hardly asymmetric, chartaceous, above glabrescent except on midrib, beneath velutinous, midrib flat above, beneath raised, prominent, lateral nerves *c.* 10 pairs, flat above, raised beneath, tertiary venation obscure above, raised beneath. Inflorescences axillary, 6–20 cm long, branches short, flowers clustered at ends, bracts *c.* 2 mm long. Pedicel *c.* 2 mm, calyx 3–4 mm, cup-shaped, ± entire, pubescent outside, glabrous inside; corolla adnate to base of staminal tube, petals 3–4, ligulate, *c.* 15×2·2 mm, with appressed hairs outside especially towards tip, glabrous inside; staminal tube *c.* 12×2·3 mm, margin subentire, glabrous outside, inside with band of suberect hairs 4–5 mm wide in middle; anthers 7–8, inserted *c.* 1·5 mm below top of tube, 1 mm long, locellate, sub-basifixed, connective glabrous; style (not seen) reported to be hirsute below and glabrous above. Fruit (immature) obovoid, 3×1·6 cm, 4-locular, densely sericeous hairy, hairs obviously of different lengths; pericarp fibrous; seed with arillode on inner surface; cotyledons superposed.

Distribution: Known from two collections only made < 75 km apart on the Waria River and at Buso, both in the Morobe district in northeastern New Guinea.

Ecology: At 60–150 m altitude in rain forest.

Notes: Similar in some respects both to *C. sayeri* and *C. trichocladus*, in leaf size more like the latter and in fruit more like the former, while in flower it is intermediate. Its leaflet base distinguishes it from both.

Chisocheton schoddei Stevens *Contr. Herb. Aust.* **11**: 38 (1975). **Fig. 78.**

Tree to 12 m tall, d.b.h. to 15 cm. Twigs 7–8 mm thick, ± terete, pubescent when young. Leaf base little swollen, slightly ridged; rachis to 1·25 m long, 3–5 mm across, ± terete when mature (when young drying flattened or ± channelled on upper surface), pubescent when young, to 8-jugate, *c.* 10 cm between leaflet pairs; petiolule 4–8 mm, not swollen; lamina broadly ovate to oblong, 13–36(–40)×6·5–14·5(–20) cm (sometimes first pair only 4·3× 3·1 cm), apex shortly acuminate, base rounded to subcordate, chartaceous, sparse appressed hairs on upper surface, more numerous beneath, midrib

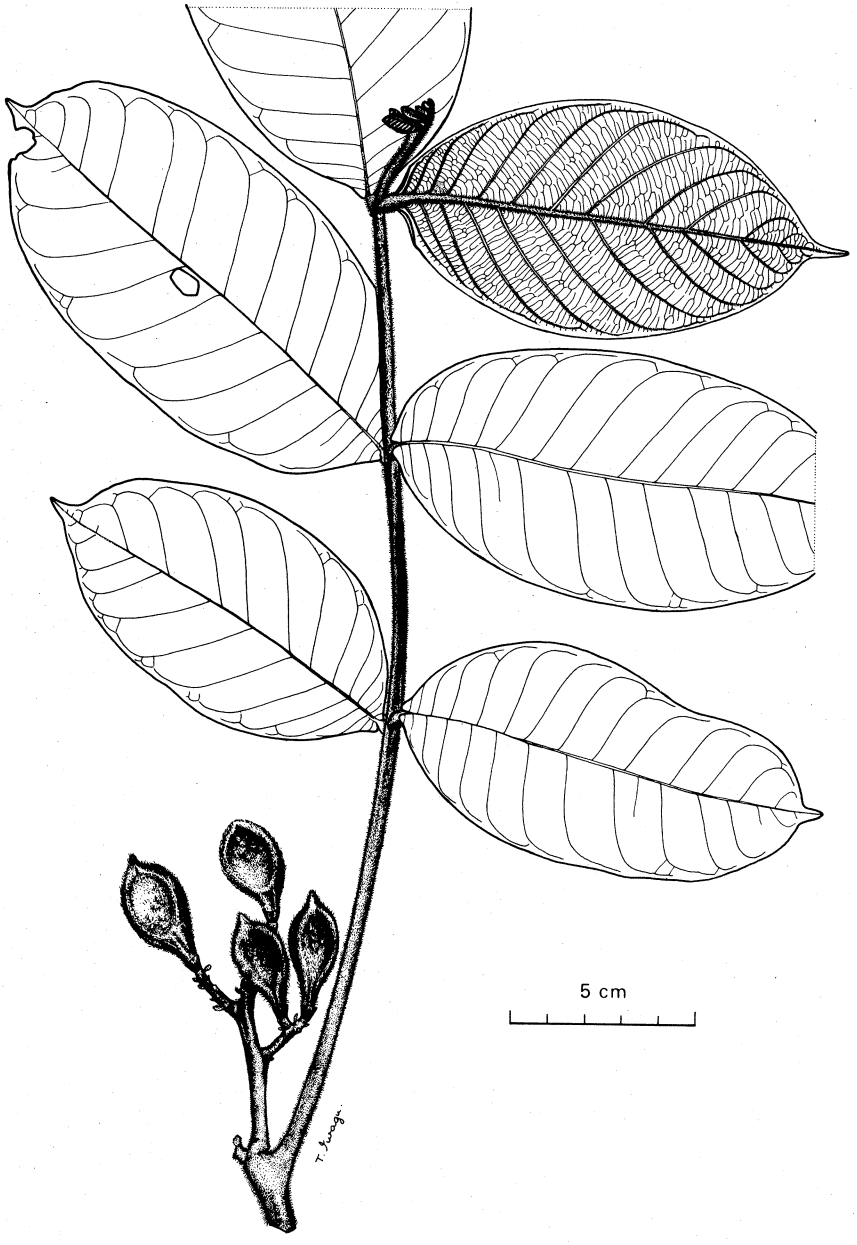


Fig. 77 **Chisocheton schlechteri** Harms Mature foliage and sub-mature fruit

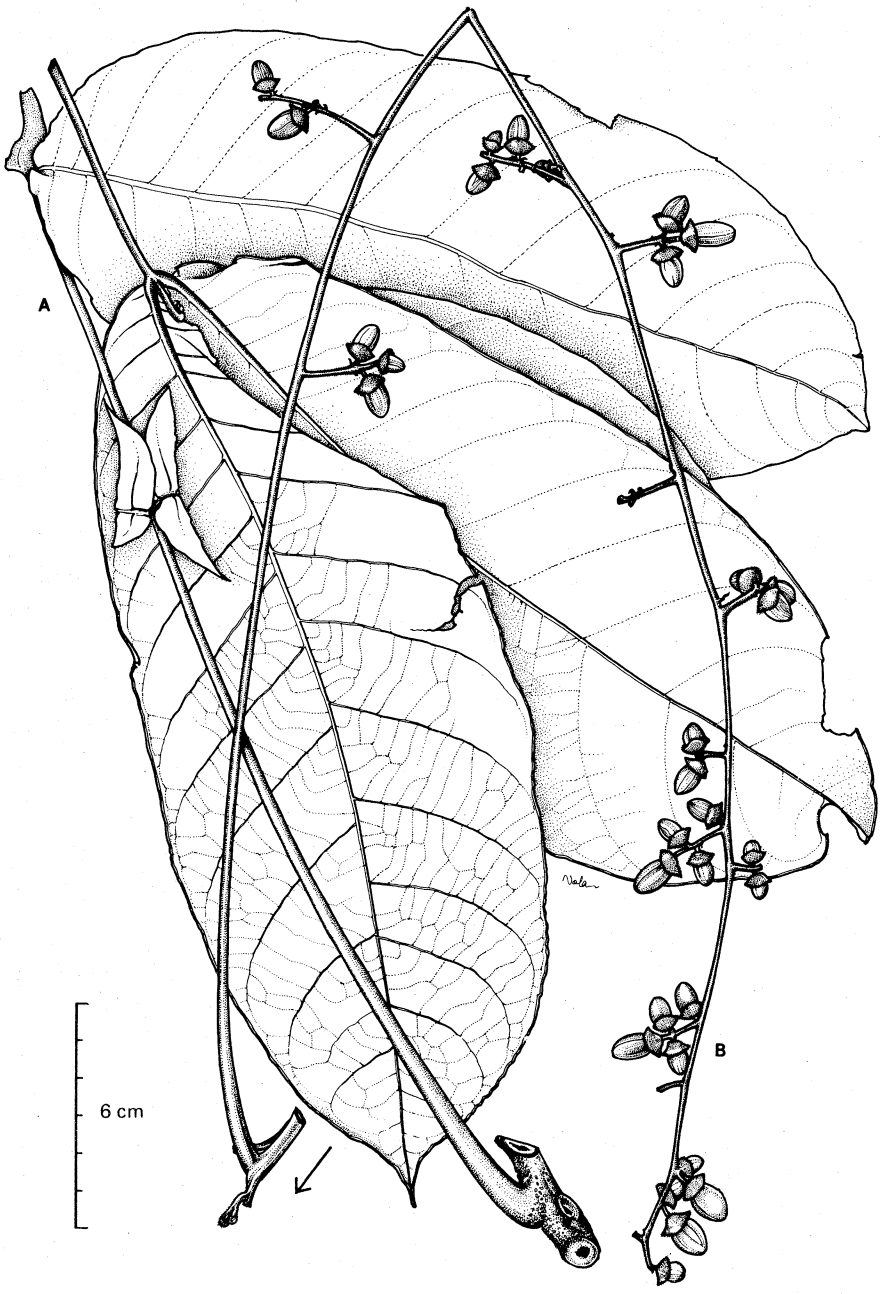


Fig. 78 **Chisocheton schoddei** Stevens (A) mature foliage (B) flowering inflorescence

flat to slightly raised above, beneath raised, prominent, lateral nerves 8–14 pairs, ± flat above, raised beneath, tertiary venation obscure to prominulous above, prominulous beneath. Inflorescences from foliate axils, paniculate, with appressed hairs, main axis to 1·2 m, at very base flattened and backwardly directed, 1-branched, lateral branches distant, < 5 cm long, patent; bracts *c.* 2 mm long, broadly ovate. Flowers sessile; calyx narrowly spreading, 5–6·5 mm long, margin entire, with appressed hairs outside, glabrous inside; corolla not adnate to staminal tube, aestivation alternative, quincuncial or imbricate, petals (4–)5–6, red outside, white to greenish-white inside, ± ligulate to elliptic, to 17 × 7 mm, with appressed hairs outside, glabrous inside; staminal tube 12 × 5 mm (female) or × 4 mm (male), apex shallowly lobed or entire, outside with sparse appressed hairs except at top and bottom, inside with dense retrorse hairs from 0·5–2 mm below anthers to almost bottom; anthers 10–12, inserted 5 mm below top of tube, 2·5–3 mm long, locellate, basifixed, connective glabrous or with ascending hairs; ovary 4–8-locular, 4·75 × 3·75 mm (female) or 1 × 1 mm (male), densely hairy, disc absent; style to 9 mm long, with ascending hairs for its entire length or glabrous near top; stigma to 1·4 mm across. Fruit red, flattened-globose, *c.* 4 × 5 cm, hairs dense, not obviously of different lengths, sulcate; pericarp fibrous; seeds orange.

Field characters: Outer bark brown to green-grey, often mottled, smooth or furrowed; inner bark yellowish-white to pale brown; sapwood straw-coloured.

Distribution: Six collections have been made from the Gulf and Central districts of Papua.

Ecology: At 20–180 m altitude in primary, rarely secondary, rain forest, forest sometimes seasonally dry. The fruits are reported to be eaten by hornbills.

Chisocheton schumannii C. DC. *Nova Guinea* **8**: 425 (1910). **Fig. 79.**

Melioschinza macrophylla K. Sch. (1889); *Chisocheton macrophyllus* (K. Sch.) Harms (1896), non King (1895); ?*C. lauterbachii* Harms (1901).

Tree to 20 m tall, d.b.h. to 45 cm. Twigs 3·5–4·5 mm across, terete, with sparse appressed hairs when young. Leaf base swollen, ridged, upper edge joining stem abruptly; rachis to 70 cm long, 1·5–3·5 mm thick, terete, with sparse appressed hairs when young, to 11-jugate, 5–7 cm between leaflet pairs; petiolule 3–7 mm, becoming swollen; lamina ± elliptic to suboblong, 8·5–25 × 4·8–8·3 cm, apex acute, base acute to rounded, slightly asymmetric, chartaceous, with scattered to dense appressed hairs when young, hairs persisting only on midrib above and midrib and main veins beneath; midrib flat above, beneath prominent, raised, lateral veins 6–14 pairs, flat above, raised beneath, tertiary venation obscure above, flat to slightly raised beneath. Inflorescences from upper leaf axils, paniculate, main axis to 30 cm, 1–2-branched, branches to 8 cm long, often almost patent; bracts to 1·5 mm long, narrowly triangular. Flowers with stout pedicels to 3 × 0·75–1·5 mm, pseudopedicel to 1·5 mm; calyx cup-shaped, closely appressed to corolla, yellow-green, 2–3 mm long, margin entire, outside with appressed hairs,

Fig. 79 **Chisocheton schumannii** C. DC. (A) fruiting inflorescence (B) twig with foliage and flowering inflorescence

inside glabrous; corolla ± adnate to base of staminal tube, aestivation quincuncial or alternative, sometimes imbricate, petals white to pinkish, ± ligulate, 5, sometimes 4 or 6, 8–12·5 × 2·3–3 mm, sparse appressed hairs towards tips outside, glabrous inside; staminal tube 7·5–8·5 × 2–3·5 mm, apex shallowly lobed, sparsely hairy outside in top half, dense retrorse hairs inside from immediately below anthers to almost base; anthers 10–12, inserted 2·5 mm below top of tube, 1·8–2·4 mm long, locellate, almost basifixed, connectives glabrous to sparsely hairy; ovary 4–5-locular, in female flower 2 × 1·8 mm, in male 1·5 × 0·6 mm, densely hairy, glabrous, disc at base 0·2–0·4 mm tall; style to 5·5 mm, densely hairy for most of its length; stigma to 1 mm across. Fruit orange, ± spherical, *c.* 3 × 3 cm, low, raised lines indicating future points of dehiscence, densely hairy, hairs not obviously of different lengths; pericarp fibrous; seeds *c.* 2·2 × 1·3 × 1·1 cm, triangular in cross section, arillode to 2 mm thick on inner 2 surfaces; cotyledons superposed.

Field characters: Outer bark grey to grey-brown, rather fibrous, undersurface brown to blackish-brown; underbark pink; inner bark straw- to dull flesh-coloured, darkening on exposure. Wood white to straw-coloured.

Distribution: The northern part of mainland New Guinea; collected from the Jayapura, West Sepik, East Sepik and Madang districts.

Ecology: To 60 m altitude in often rather poorly drained lowland rain forest. Twigs sometimes with ants.

Notes: This species is related to *C. weinlandii*; specimens of the two species which do not have flowers are difficult to tell apart. The infructescence of *C. schumannii* seems to be a little shorter than that of *C. weinlandii* and the lateral branches are shorter and leave the main axis more nearly at right-angles; however, poorly grown infructescences of *C. weinlandii* are similar to those of *C. schumannii.*

Most of the specimens of *Chisocheton* from the Bismarck Archipelago and from the Solomon Islands are close to *C. schumannii* (and also to *C. weinlandii*), but the variation pattern is very complex and in part is the exact opposite to the variation pattern on the mainland. Until *Chisocheton* there is better known, no definite name can be given to these specimens, but they may be referred to as *C. schumannii* sens. lat.

Chisocheton stellatus Stevens *Contr. Herb. Aust.* **11**: 43 (1975). **Fig. 80.**

Tree to 30 m tall, d.b.h. to 40 cm. Twigs ± terete, 6 mm across, velutinous (hairs stellate, 4-armed, sometimes obscure). Leaf base hardly swollen, smooth, rachis to 30 cm long and 3–4·5 mm across, channelled both on top and sides, velutinous, to 9-jugate, 2–6 cm between leaflet pairs; petiolule 4–8 mm, not swollen, channelled on top; lamina oval to oblong, 8·5–17 × 5·5–8·5 cm, ± rounded at apex, obscurely acuminate, base rounded, slightly asymmetric, chartaceous, both sides with stellate hairs, sometimes velutinous beneath, midrib above depressed, beneath prominent, raised, lateral veins 7–18 pairs, flat or slightly depressed above, raised beneath, tertiary venation obscure above, slightly raised beneath. Inflorescences from foliate axils,

Fig. 80 **Chisocheton stellatus** Stevens Twig with mature foliage, and inflorescence in bud

paniculate, main axis to 30 cm long, velutinous, 1-branched, branches to 4 cm long, patent or widely ascending; bracts triangular, *c.* 1 mm long. Female flowers unknown; flowers sessile; calyx erect, 1·3–1·7 mm long, margin shallowly 5-lobed, outside with short, dense stellate indumentum, inside hairs on upper half of calyx only; corolla free from staminal tube, aestivation valvate, petals 5, rarely 6, ligulate-oblong, white or yellowish-green, 4–5·5 × 0·8–1 mm, outside with short dense stellate hairs, inside glabrous; staminal tube 3·5–4 × 0·8–1·5 mm, with 5 (rarely 6) lobes *c.* 1 mm long and retuse at apex, outside with ascending hairs in middle part, inside with hairs just below anthers; anthers 5 (rarely 6), inserted 1·2 mm below apex of tube, 0·8–1·0 mm long, hardly locellate, connective with ascending hairs, almost basifixed; ovary bilocular, 0·3 × 0·2 mm, with dense hairs, disc 0·4–0·8 mm tall, glabrous; style 2·7–3 mm long, glabrous or with hairs at bottom; stigma 0·4 mm across. Fruit unknown.

Field characters: Trunk buttressed to 1 m. Outer bark brown, flaky or not; inner bark reddish-brown to yellowish. Sap-wood white to straw-coloured.

Distribution: Not much collected, being known from the Geelvink Bay (one collection) and Jayapura (three collections) districts in western New Guinea, and a single collection made from the Gogol forestry area, Madang district, northeastern New Guinea.

Ecology: At 70–150 m altitude in primary or secondary rain forest.

Chisocheton tenuis Stevens *Contr. Herb. Aust.* **11**: 46 (1975). **Fig. 81.**

Tree to 8 m tall, d.b.h. to 7·5 cm. Twigs 2·5–4 mm across, terete when young with a few small appressed hairs, soon glabrescent. Leaf base swollen, slightly ridged; rachis terete, to 30 cm long and 2–2·75 mm thick, soon glabrescent, 2–7-jugate, leaflet pairs 3–8 cm apart; petiolule (5–)10–23 mm long, swollen at base; lamina obovate or elliptic, 7·5–21 × 3·3–8 cm, apex acute or slightly acuminate, base acute, slightly asymmetric, chartaceous, when young with a few small appressed hairs, soon glabrescent (midrib excepted), midrib and main veins above flat or slightly raised, raised beneath, 6–12 pairs lateral veins, fine venation ± obscure above, beneath prominulous, slightly raised. Inflorescences epiphyllous with rather few-flowered branches to 9 cm long arising between leaflet pairs; bracts subulate, to 1·5 mm long. Female flowers unknown; pedicel 3–11 mm long; calyx erect, not closely surrounding the corolla, 3–4 mm long, margin often with single split to 2 mm long, outside with appressed hairs, inside glabrous; corolla not adnate to staminal tube, aestivation alternative, petals 4, pinkish-orange, almost ligulate, 7·5 × 1·2–2·2 mm, outside with appressed hairs, inside glabrous; staminal tube 6·5 × 1 mm, ± entire at apex, outside with appressed hairs except at top and bottom, inside with ascending hairs from 1 mm below anthers to 1 mm above base; anthers 7 or 8, inserted 3 mm below top, 1·8–2 mm long, locellate, almost basifixed, with a few ascending hairs from connective; ovary 0·5 mm long, with dense hairs, disc small; style 5·5 mm long with ascending hairs except in top one-third; stigma 0·5 mm across. Fruit red, fusiform, dehiscent, *c.* 6 × 2 cm, sparsely or moderately hairy, longer and shorter hairs mixed; pericarp fibrous; seeds 3–4, flattened-

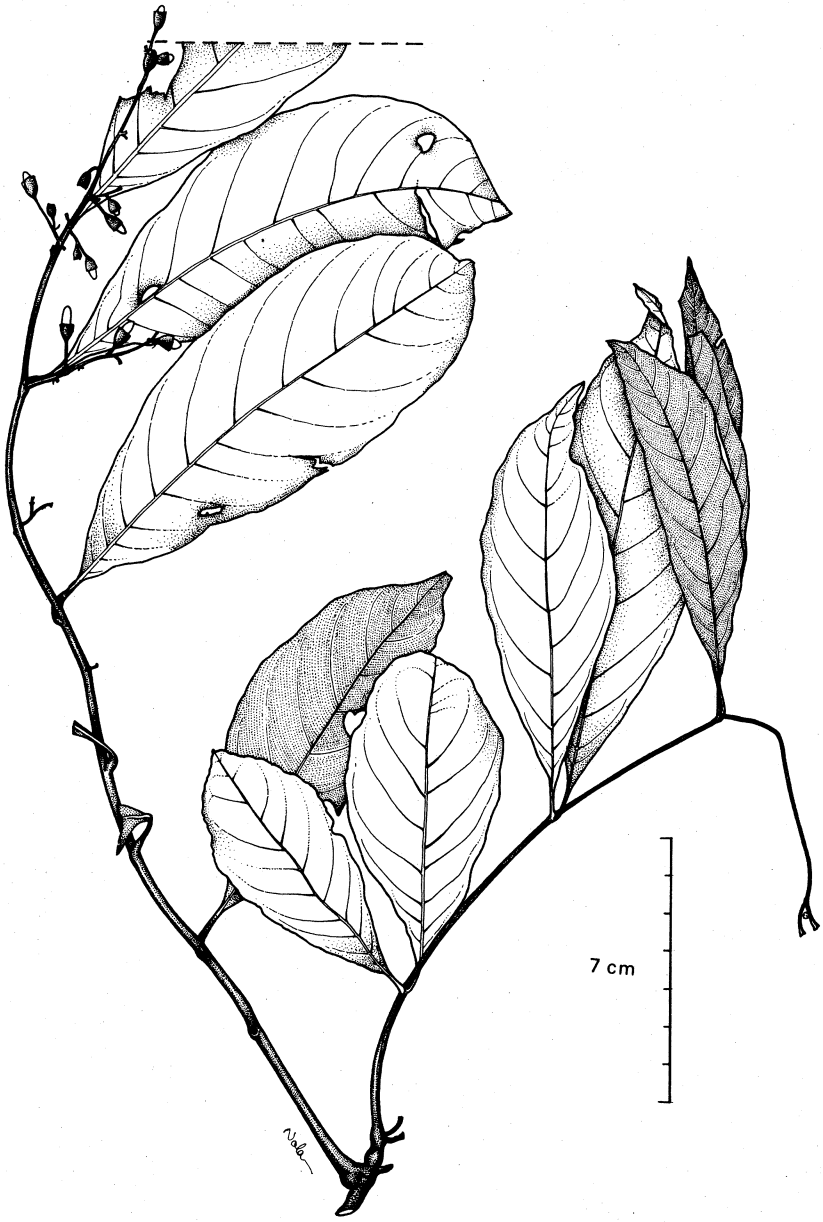


Fig. 81 **Chisocheton tenuis** Stevens Leafy twig with flowering inflorescences

ellipsoid, 18 × 10 × 5 mm, arillode on inner surface with narrow free margin overlying testa; cotyledons superposed.

Field characters: Branches angled upwards. Bark pale yellow-brown, vertically cracked, underbark cream-coloured; inner bark straw-coloured. Wood pinkish straw-coloured.

Distribution: Northeastern New Guinea—known from the Eastern Highlands (Kassam Pass) and Morobe districts, doubtfully also from the West Sepik district.

Ecology: At (30–)1200–1700 m altitude in lower montane forest.

Notes: It is not absolutely certain that the specimen from the West Sepik district, which was collected at 30 m, belongs to this species; its fruits are less prominently hairy than those of the specimens from the Morobe district. The description of the seeds is taken from this West Sepik specimen.

Chisocheton trichocladus Harms *Bot. Jb.* **72**: 189 (1942).

Tree to 20 m tall, d.b.h. to 50 cm. Twigs terete, 3–5 mm across, ± persistently tomentose. Leaf base slightly to moderately swollen, smooth, upper edge usually not rising sharply from stem; rachis to 35 cm long, 1·5–2·5 mm across, terete, ± tomentose, to 5-jugate, 4–10 cm between leaflet pairs; petiolule 1·5–8 mm, hardly or not swollen; lamina subovate to oblong or elliptic, (5·5–)11–21(–26) × (3·3–)5·5–9(–12) cm, apex acute to acuminate, base acute to rounded, slightly asymmetric, chartaceous, transiently tomentose above except on midrib and main veins where hairs ± persistent, sparsely to sub-densely tomentose beneath, midrib flat to slightly raised above, prominent and raised beneath, lateral veins 8–15 pairs, flat above, raised beneath, tertiary venation obscure above, prominulous beneath. Inflorescences from foliate axils, tomentose, paniculate, main axils (4·5–)10–40 cm, 1–2-branched, branches to 9 cm long, usually fairly widely ascending, flowers not congested; bracts to 1·7 mm long, narrowly triangular. Female flowers unknown; flowers sweet-smelling; pedicel to 5 mm long, pseudopedicel to 1 mm; calyx green, moderately spreading, 2–3(–4) mm long, margin entire, ± tomentose outside, glabrous inside; corolla ± free from staminal tube, aestivation alternative, rarely imbricate, petals 4, rarely 3, white, ligulate, 10·5–15·5 × 1–4 mm, outside tomentose to with sparse appressed hairs, inside glabrous; staminal tube 9–14·5 × 1·2–1·8 mm, shallowly lobed at top, glabrous or with sparse appressed hairs outside, inside with dense retrorse hairs from 1 mm below anthers to near bottom of tube; anthers 6–9, inserted to 3 mm below top of tube, 2–2·5 mm long, locellate, sub-basifixed, connective glabrous, ovary 3–4-locular, to 2 × 0·6 mm, dense hairs 1 mm long, disc 0·4 mm tall, glabrous; style to 1·2 cm long, densely hairy for two-thirds to its entire length, stigma to 1 mm across. Fruit red, broadly obovoid, 3·2 × 2·8 cm, hairs obviously of different lengths; pericarp fibrous, thick; seeds (dry) flattened-ellipsoid, 16 × 9 × 7 mm, arillode on inner surface; cotyledons superposed.

Field characters: Trunk sometimes with buttresses to 1 m tall. Outer bark blackish to grey or red-brown, sometimes cracked and flaking. Inner bark

straw-coloured, on exposure turning brownish. Wood straw-coloured to white.

Distribution: Scattered. In western New Guinea known from the Vogelkop and Jayapura districts, in northeastern New Guinea from the West Sepik and Madang districts, in the Bismarck Archipelago from New Britain, and in the Solomon Islands from Bougainville and Choiseul.

Ecology: From sea level to 150 m altitude in primary or advanced secondary rain forest, sometimes by streams.

Notes: There is considerable variation in the hairiness of plants of this species and also in the width of the petals. However, all plants have erect hairs on at least the main veins of the leaflets below and the buds are cylindrical in shape.

A number of specimens of *Chisocheton* from the Solomon Islands have leaves like those of *C. trichocladus*. However, several of the specimens in flower have very different flowers. These specimens, as well as fruiting specimens, with densely hairy leaves, are best called *C. schumannii* sens. lat.; see under that species.

Chisocheton versteegii C. DC. *Nova Guinea* **8**: 424 (1910).

Tree to 2·5 m tall. Twigs terete. Leaf base slightly swollen, ridged; rachis to 36 cm long, 3·5 mm across, terete, with appressed hairs when young, 4-jugate, *c.* 9 cm between leaflet pairs; petiolule 1 cm, swollen; lamina suboblong to obovate, 20×8 cm, apex acuminate, base narrowly acute, slightly asymmetric, chartaceous, midrib and main veins puberulous above, beneath with sparse appressed hairs; midrib slightly raised above, raised beneath, lateral veins 9 pairs, flat above, prominent beneath, tertiary venation obscure above, prominulous beneath. Inflorescences from axils of leaves, paniculate, main axis to 30 cm, 1-branched, branches to 6 cm, ascending; bracts to 1 mm, triangular. Female flowers unknown; flowers ± sessile; calyx spreading, not closely investing corolla, 3 mm long, margin entire, with short appressed hairs outside, glabrous inside; corolla adnate to base of staminal tube, imbrication quincuncial, petals 5, ± ligulate, to 10×1·5 mm, glabrous or with very sparse appressed hairs at top outside; staminal tube 9×1·2 mm, margin entire, minutely puberulous on outside, inside densely puberulous from below anthers to bottom; anthers 5 or 6, inserted 2·5 mm below top of tube, 1·8 mm long, locellate, sub-basifixed, connectives with dense ascending hairs; ovary 1 mm, indistinct, disc very small, glabrous; style 8·5 mm, with dense ascending hairs for most of its length; stigma 0·5 mm across. Fruit unknown.

Distribution: Known only from the type specimen collected from the Noord River (at the Digul/Mimika boundary in western New Guinea).

Chisocheton weinlandii Harms in K. Sch. & Laut. *Nachtr.* **3**: 283 (1905). **Fig. 82.**

C. multijugis C. DC. (1910); *C. multijugis* var. *glabrior* C. DC. (1910);

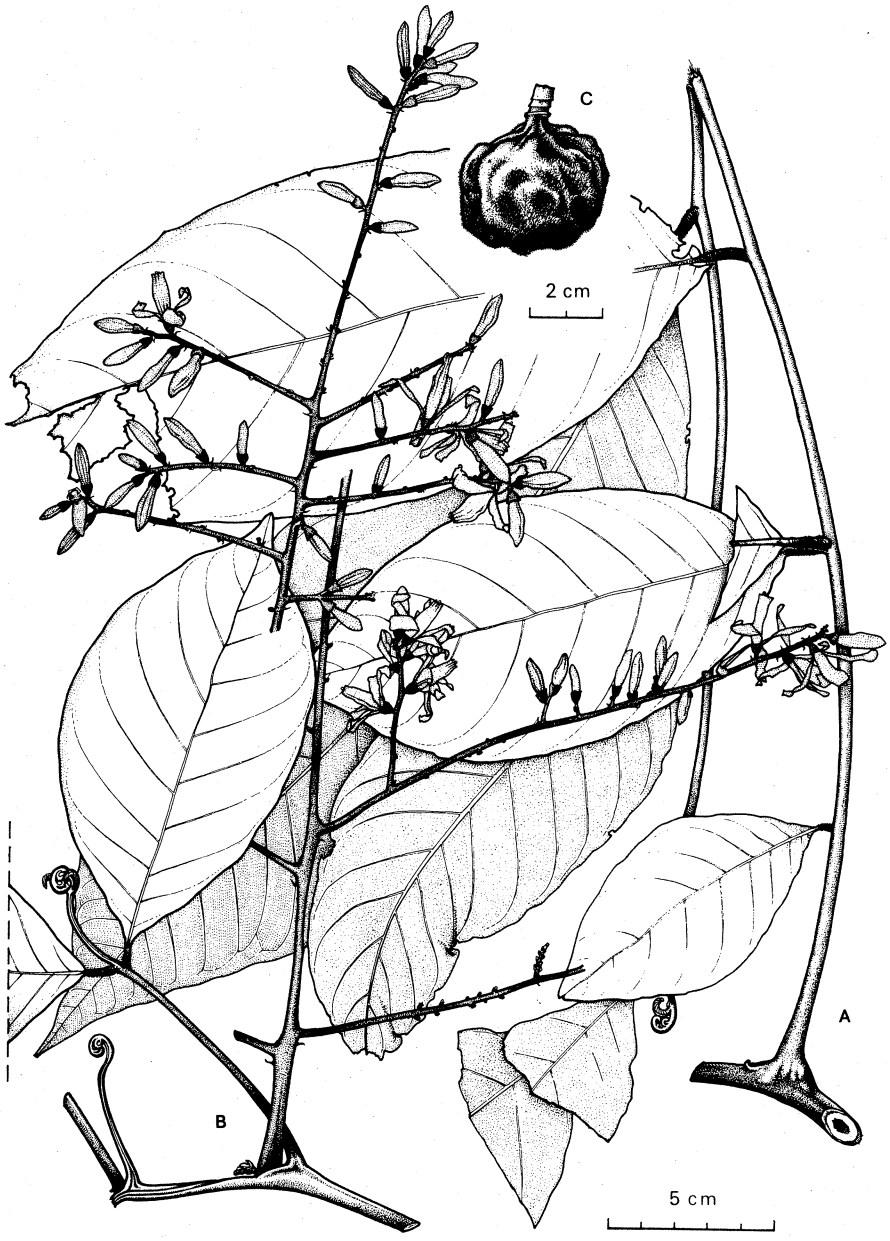


Fig. 82 **Chisocheton weinlandii** Harms (A) twig with immature leaf with apical curled portion (B) twig with inflorescence (C) fruit

C. frutescens C. DC. (1914); *C. boridianus* Harms (1942); *C. eurycalyx* Harms (1942).

Tree to 33 m tall, d.b.h. to 60 cm. Twigs 3–8 mm across, terete, glabrescent. Leaf base swollen, ridged, upper part joining stem very abruptly; rachis to 1·2 m long, 2–5 mm thick, terete or slightly flattened above, glabrescent, to 11-jugate, 4–10(–16) cm between leaflet pairs; petiolule 6–13 mm, swollen; lamina ovate, elliptic or oblong to obovate, (6·5–)13–44 × (3·5–)6–16(–23) cm, apex ± bluntly acuminate, base acute to rounded, slightly asymmetric, chartaceous, usually with appressed hairs on midrib above and midrib and main veins beneath, midrib slightly raised to flat above, prominently raised beneath, lateral veins 8–15 pairs, flat to slightly sunken above, raised beneath, tertiary venation obscure above, minutely raised beneath. Inflorescences from foliate axils, paniculate, main axis 6–60 cm, 1–2-branched, branches to 10 cm, usually diverging at about 70° from main axis; bracts to 3 mm long, narrowly triangular to subulate. Flowers sessile or almost so, sometimes with pseudopedicel to 2 mm long; calyx green, usually widely spreading, 2·5–4 mm long, margin entire, with appressed hairs outside, glabrous inside, corolla adnate to very base of staminal tube, imbrication usually alternative, petals 4 (or 5), white, often turning pink with age, ± ligulate to elliptic, (10–)17–23 × (2–)3–5 mm, at least sparsely hairy towards top outside, glabrous inside; staminal tube *c.* 15 × 4·5 mm (female) or × 3 mm (male), margin shallowly lobed, usually sparsely hairy outside, inside with dense, usually retrorse, hairs from 1–2(–3) mm below anthers to almost bottom of tube, rarely glabrous; anthers (5–)9–12(–18), inserted 3 mm below top of tube, 2–3 mm long, locellate, almost basifixed, connective glabrous or with ascending hairs; ovary orange, to 4 × 3·5 mm (female, smaller in male), densely hairy, (3–)4–(5–)-locular, glabrous disc at base to 0·3 mm tall; style to 1·4 cm, with hairs at least half its length; stigma to 1·5 mm across. Fruits red, dehiscent, ± flattened-globular, to 3·2 × 3·3 cm, hairs not obviously of different lengths, stipe usually inconspicuous, to 5 mm; seeds (fresh) ± triangular in section, 2 × 1·3 cm, black on outer surface, red arillode 2 mm across on 2 inner sides, white where attached to axis; cotyledons superposed.

Field characters: Bole sometimes buttressed to 0·5 m. Outer bark dark brown to grey-brown, finely cracked, coming off in flakes and somewhat pock-marked, undersurface blackish to dark brown; underbark pale brown to light yellow; inner bark light brown, darkening on exposure, with a slightly sweet smell. Wood straw-coloured, with prominent parenchyma bands.

Distribution: Throughout the lowlands of mainland New Guinea; also common on New Britain (Bismarck Archipelago).

Ecology: From sea level to 1300 m altitude in primary or secondary rain forest. Twigs often with ants; ants sometimes also in leaf and inflorescence stalks.

Notes: A variable species. Specimens from the Digul/Mimika boundary (western New Guinea) and the Western, Gulf and Central districts (Papua) often have narrower leaves than the others, with narrowly acute bases, the calyx in bud is erect and the buds are rather narrowly tubular. However,

these specimens cannot be formally recognized since there are numerous intermediates between them and the more typical form, especially in Papua.

NAMES INSUFFICIENTLY KNOWN

C. biroi Harms in K. Sch. & Laut. *Nachtr.* **3**: 283 (1905).

Harms compared this to *C. lauterbachii* (= *C. schumannii*) and *C. weinlandii*, but said that it differed from the former in its shorter pedicel and from the latter in its smaller flowers (the corolla was reported as being only 9–10 mm long) which had a much less conspicuous indumentum. *C. biroi* is perhaps a synonym of *C. weinlandii* sens. str.

C. lamekotensis Harms in Diels *Ber. Deut. Bot. Ges.* **10**: 276 (1928).

This belongs to *C. schumannii* sens. lat.

C. ledermannii Harms *Bot. Jb.* **72**: 184 (1942).

This is probably related to *C. trichocladus*, but its leaflets are very small for that species (5–12 × 4–4·5 cm; range for *C. trichocladus* (5·5–)11–21(–26) × (3·3–)5·5–9(–12) cm) and are emarginulate or slightly cordate at the base (in *C. trichocladus* acute to rounded).

C. oreophilus Harms *Bot. Jb.* **72**: 185 (1942).

The leaflets were described as being to 33 × 15 cm and the inflorescence 20 cm long with branches to 5 cm. The plant was myrmecophilous.

C. toricelliensis Harms *Bot. Jb.* **72**: 188 (1942).

In the description Harms noted that the midrib and main veins on both sides of the leaflet were prominulous. The description of the flowers agrees fairly well with that of *C. morobeanus*; however, the inflorescences are described as being axillary; no mention is made of their being borne behind the leaves.

EXCLUDED SPECIES

C. sogerensis Bak. f. *J. Bot., Lond.* (suppl.) **61**: 8 (1923).

Harms (1942) thought that this was perhaps a species of *Dysoxylum*. It is a synonym of *D. variabile* Harms (including also *D. nymanianum* Harms), a widespread and very variable species.

MYRISTICACEAE

(excluding HORSFIELDIA)

D. B. Foreman

Trees and shrubs, dioecious, rarely monoecious. Leaves simple, entire, alternate, glabrous or not. Stipules absent. Inflorescence axillary (in all New Guinea genera), racemose, rarely cymose, paniculate to capitulate. Bracts present but mostly caducous, bracteoles present or not. Flowers with 2–3(–5)-lobed perianth cup. Stamens 8–40; filaments completely joined into column or disc, very rarely joined at base only; anthers bilocular, free or ± fused to column, dehiscing lengthwise by slits, ovary superior, sessile, unilocular; style absent or very short; stigmas 2, ± connate, rarely expanded into dentate disc; ovule 1, anatropous, attached near base of loculus. Fruit mostly dehiscing into 2 valves; pericarp fleshy to slightly woody. Seed 1, covered partly or entirely by fleshy, brightly coloured, undivided or ± deeply divided aril; endosperm ruminate or not; embryo small, straight, at base of seed. **Figs 83, 84.**

Distribution: The family is widely distributed throughout the tropics. In the tropical areas of Central and South America there are 5 genera with *c.* 100 species, in tropical Africa and Malagasy 6 genera with *c.* 30 species, and in the Asian region 4 genera with *c.* 150 species. No genus or species is common to any two areas.

Notes: The majority of species in Papuasia are small to medium-sized trees but some are > 40 m tall. The straight, mast-like trunks with whorled branches are very characteristic. Mostly they are understorey trees, but the tallest ones may form part of the upper canopy or even be emergent.

The majority of species are to be found in lowland rain forest, sometimes under quite swampy conditions. Other species are to be found on mountains to 2300 m altitude and under a wide range of climate, habitat and soil.

Literature: The most recent work done on the Asian genera is that of J. Sinclair, and references to his work are given under the appropriate genera. D. B. Foreman (1974), Notes on *Myristica* Gronov. (Myristicaceae) in Papuasia, *Contr. Herb. Aust.* **9**: 35–43.

KEY TO GENERA (fruiting)

1. Aril lobed, or nearly so, to base of seed
 2. Twigs smooth, undersurface of leaves glabrous, whitish; aril lobed nearly to base of seed ..... GYMNACRANTHERA
 2. Twigs striate, undersurface of leaves sometimes whitish, glabrous or with tomentum; aril lobed to base of seed ..... MYRISTICA
1. Aril entire or lobed at apex only
 3. Aril entire, completely covering seed, may be slightly folded at top; leaf reticulations

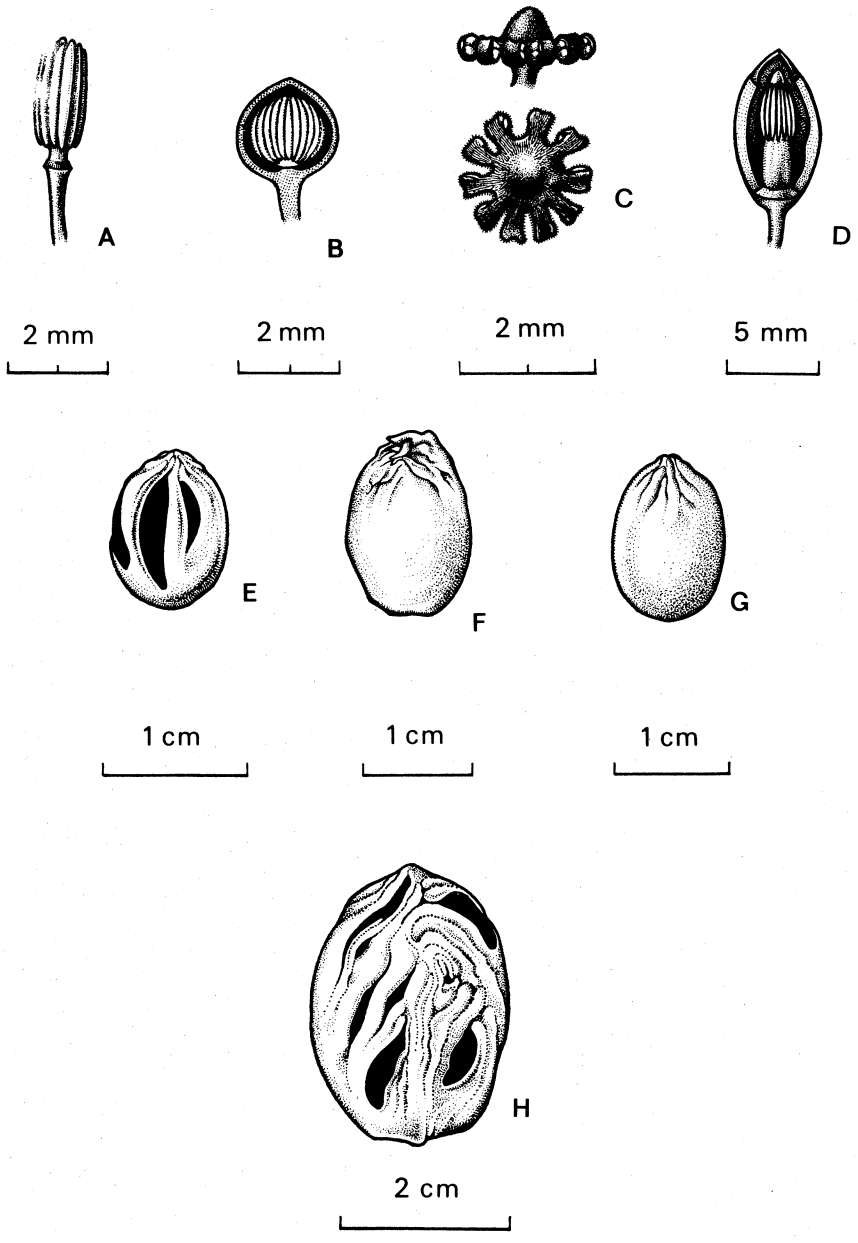


Fig. 83 *Gymnacranthera* (A) united filaments (E) seed with aril divided almost to the base; *Horsfieldia* (B) stamens free in the flower (F) aril entire, completely covering the seed; *Knema* (C) peltate disc below which the stamens are attached (G) aril almost completely covering the seed, lobed at apex; *Myristica* (D) flower with column to which the stamens are dorsally attached (H) seed with laciniate aril

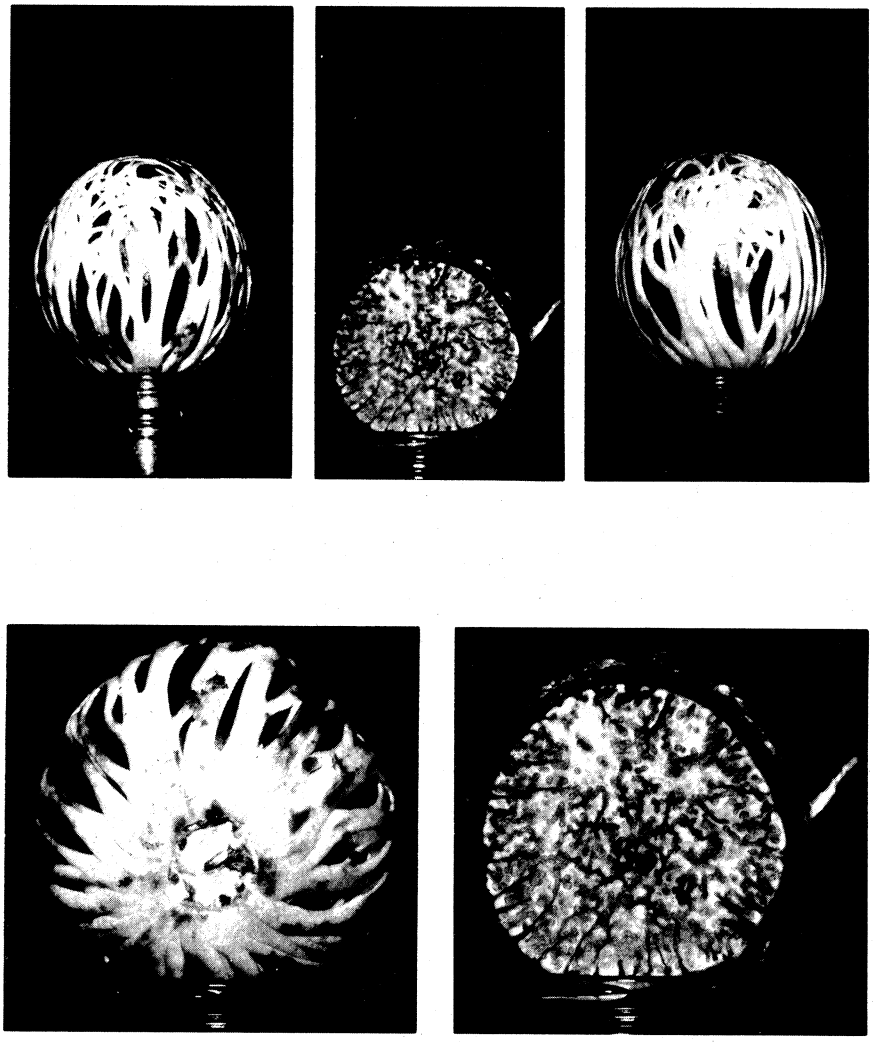


Fig. 84 **Myristica womersleyi** J. Sinclair Actual size of seed is 5·8× 6·2 cm. Note aril divided almost to the base and ruminate endosperm of the seed

usually not forming dense network above.....HORSFIELDIA
3. Aril lobed at top only; leaf reticulation forming dense network above.....KNEMA

KEY TO GENERA (male flowers)

1. Inflorescence axis a woody, scar-covered knob, persistent, producing flowers more than once, bracteoles present
2. Leaves with dense network of reticulations above; flowers with stalked peltate or triangular disc with stamens attached to it by their bases.....KNEMA
2. Leaves without dense network of reticulations above; flowers with stalked column with stamens attached to it by their backs.....MYRISTICA (in part)
1. Inflorescence axis not a short, woody, scar-covered knob; not persistent, producing flowers only once; bracteoles present or absent
3. Stamens fused into elongated column, stalked or sessile, anthers free at apex or not; bracteoles present or not
4. Anthers not free at their apex, column stalked, often with sterile apical portion; bracteoles present.....MYRISTICA (in part)
4. Anthers free at their apex, column sessile or with very short stalk; bracteoles absent .....GYMNACRANTHERA
3. Androecium (stamens) globose or cup-shaped, nearly always sessile, stamens fused by their backs to column, free at apex or not; bracteoles absent.....HORSFIELDIA

GYMNACRANTHERA Warb.

Small to medium-sized trees. Twigs not striate or angled. Leaves glabrous, whitish or glaucous beneath, few almost invisible reticulations; nerves arching near margins. Inflorescence axillary or in axils of fallen leaves, paniculate; bracts falling off at early stage; bracteoles absent. Flowers urceolate, 3-toothed, teeth acute. Male flowers with filaments joined into oblong column; anthers elongated and covering column; female flowers with stigma minutely bilobed, sessile. Fruit never very large. Aril segmented almost to base. **Fig. 83 A, E.**

Distribution: 6 species, 4 with recognizable varieties. 1 species is confined to southern India; the remainder are Malesian. In Papuasia the genus is represented by a single species.

Literature: J. Sinclair (1958), The genus *Gymnacranthera* (Myristicaceae) in Malaysia, *Gdns' Bull., Singapore* **17**: 96–120.

Gymnacranthera paniculata (DC.) Warb. var. **zippeliana** (Miq.) J. Sinclair *Gdns' Bull., Singapore* **17**: 108 (1958), f. 3. **Fig. 85.**

Myristica zippeliana Miq. (1865); *Gymnacranthera zippeliana* (Miq.) Warb. (1897).

Tree 10–25 m tall. Twigs smooth and glabrous. Petiole *c.* 1 cm long; leaf-blade lanceolate, elliptic or oblanceolate 10–22 × 4–8 cm, tip acute or acuminate, base acute or slightly rounded, papery, shiny dark green above, whitish beneath, nerves and midrib clearly defined on undersurface but not prominent, sunken above. Male inflorescence branched, to 11 cm long, minutely hairy, becoming ± glabrous, flowers numerous, on pedicels 2·5–3 mm long. Male flowers 3 × 1·5–2 mm, minutely pubescent, yellow, column *c.* 2 mm long with 8 anthers. Female inflorescence usually shorter than male one and with fewer branches. Female flowers similar to male ones,

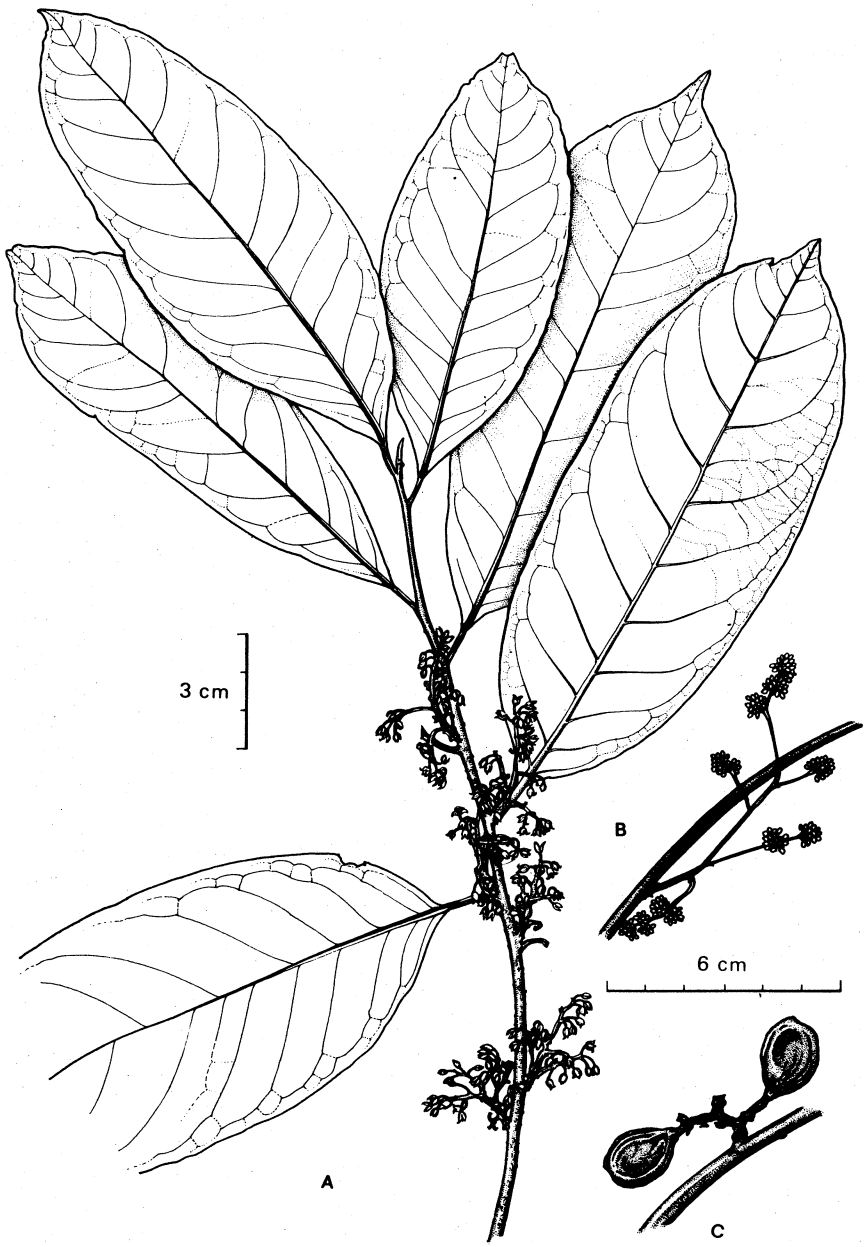


Fig. 85 **Gymnacranthera paniculata** (DC.) Warb. var. **zippeliana** (Miq.) J. Sinclair (A) flowering twig, female flowers (B) male flowers (C) fruits

ovary 2 mm long with rust-coloured tomentum. Fruits ± oblong, orange or yellowish-green, 2–3 × 1·5 cm. Seed dark brown. Aril red.

Field characters: Bark greyish to medium brown, smooth to slightly rough; sap reddish.

Distribution: Widely distributed throughout western New Guinea, north-eastern New Guinea, Papua and the Bismarck Archipelago but not extending to the Solomon Islands nor appearing to be present in the monsoon forest areas of Papua.

Ecology: Common along streams and also on ridges at low altitudes, to 1060 m, in lowland rain forest usually as an understorey tree.

Notes: Very similar to *G. paniculata* var. *paniculata* which occurs in the Philippines and North Borneo and has smaller leaves and globose rather than oblong fruits. *G. paniculata* var. *zippeliana* is often found flowering and fruiting when quite small.

KNEMA Laut.

Small to medium-sized trees. Twigs striate at least in older parts. Leaves glaucous beneath, glabrous or not, nerves distinctly arching at margin, reticulations forming close network distinct on both surfaces or faint above but always distinct beneath. Inflorescence axillary or from axils of fallen leaves, axis forming short, woody tubercles to 1·7 cm long covered with scars; bracts falling at early stage; bracteoles present. Flowers in clusters on tubercles. Male flowers globose; filaments joined and forming a peltate or triangular disc, usually with short stalk or nearly sessile; anthers free, attached around disc by their bases, sessile or on short filament. Female flowers urceolate and somewhat larger than male ones; stigma disc-shaped, lobed. Fruit usually stalked, sometimes almost sessile. Aril segmented at apex only. **Fig. 83 C, G.**

Distribution: c. 37 species with 13 varieties from India to Burma, Thailand, Indo-China, Malaysia, Philippines, Morotai and western New Guinea. The greatest number of species is recorded from the Malay peninsula and Borneo.

Ecology: In lowland rain forest usually at low altitude.

Literature: J. Sinclair (1961), The genus *Knema* (Myristicaceae) in Malaysia and outside Malaysia, *Gdns' Bull., Singapore* **18**: 102–327.

Knema tomentella (Miq.) Warb. *Monog. Myrist.* 588 (1897); J. Sinclair *Gdns' Bull., Singapore* **18**: 277 (1961), f. 24.

Tree 5–12 m tall. Twigs striate, with rust-coloured pubescence. Petiole 1 cm long; leaf-blade lanceolate, oblong-lanceolate, elliptic-lanceolate or slightly obovate, 7–25 × 2–7 cm, tip acute, acuminate or less often obtuse, base acute to ± rounded, glabrous above, with short rust-coloured tomentum on midrib below, becoming glabrous. Pedicels *c.* 3 mm long. Male flowers 2·5–3 mm long, covered with rust-coloured tomentum, staminal disc flat with 6–9 stalked anthers. Female flowers 6–8 mm long, ovary tomentose, stigma bilobed. Fruit covered with rust-coloured tomentum, obovoid or subglobose,

2–2·5 × 1·8 cm; stalk 5–10 mm long.

Field characters: Outer bark brownish-grey, smooth; inner bark reddish; sap red, copious.

Distribution: Collected once from the Vogelkop district in western New Guinea; otherwise known from the Philippines, Celebes and Moluccas.

Ecology: The western New Guinea collection is from along a rivulet at 10 m altitude.

MYRISTICA Gronov.

Trees 5–45 m tall. Twigs striate, sometimes swollen and inhabited by ants. Stilt-roots sometimes present. Leaves coriaceous or chartaceous, glabrous or with easily removed indumentum of hairs and/or scales underneath. Inflorescence axillary, either a panicle with flowers in cymes or subumbels at end of branches or short woody knob, simple or with 2–3 branches covered with scars, occasionally both types combined with smooth basal portion and apical parts covered with scars. Bracts present, small and falling early. Bracteoles usually persisting and embracing base of flower. Flowers pedicellate, urceolate, campanulate or ± tubular, glabrous, or hairy outside, usually 3-toothed, teeth reflexed. Androecium forming column with 8–30 anthers joined by their backs to column. Ovary globose or subglobose, glabrous or hairy; style absent, stigma minutely bilobed. Fruit globose, subglobose, ovoid or oblong, glabrous or hairy, pericarp usually fairly thick and fleshy but firm when fresh. Aril red, orange or yellow, divided to base of seed; seed brown to almost black, ± shiny; albumen ruminate. Germination hypogeal. **Figs 83 D, H; 84.**

Distribution: Widely distributed, occurring from India and Indo-China, throughout Malesia to northern Australia, the New Hebrides, Fiji, Samoa and the Carolines. There are *c.* 70 species of which 37 occur in Papuasia. Of this number, 2 are known only from the Solomon Islands, 3 only from western New Guinea, 14 from Papua New Guinea, and the remainder are ± widely distributed throughout the area.

Ecology: Although most species are found in the lowland rain-forest areas, some species are restricted to the narrow coastal belt, while others are to be found at altitudes above 2000 m. *Myristica* spp. occur over a wide range of soil types and habitats.

Dispersal mechanisms remain virtually unknown although seeds have been found in the crops of birds of paradise and fruit pigeons; small animals such as rodents are also probably involved. It is known that some fruits, and also some seeds (usually only with the aril attached), float for a considerable length of time, while others sink.

Field characters: Bark light to dark grey, sometimes almost black, smooth and finely fissured to ± rough and scaly, underbark reddish-brown, inner bark whitish. Exudate pinkish to red, usually watery, slight or abundant, sometimes reported as being sticky. Wood off-white, soft, easy to cut, usually not differentiated into heartwood and sapwood, stains orange-brown rapidly after cutting.

Uses: The wood is very soft and subject to attack by borers and fungus and would probably be best utilized in the chip industry. Some species, such as *M. umbrosa*, *M. chrysophylla* and *M. fatua* var. *ingens*, would be suitable for cultivation as ornamentals since the foliage and fruits of these particular species are quite attractive. The seeds of *M. womersleyi* are very aromatic and are a possible source of spice and oil.

Native names: No attempt has been made to list the numerous native names applied to various *Myristica* species in Papuasia. Sinclair (1968) gives a great many native names; Whitmore (1966) gives the Kwara'ae names for the Solomon Islands species.

Germination and seedlings: Several species of *Myristica* have now been successfully grown at the Lae Botanic Garden.

Germination is hypogeal (i.e. the cotyledons remain beneath the soil surface), with the seed coat rupturing at the basal end.

The seedling usually has 5 or 6 alternate, scale-like leaves which gradually become larger towards the apical region until the first juvenile leaves are produced. These differ from the adult leaves only in size.

The time taken for germination varies from species to species. Seeds of *M. globosa* germinated in about 2 weeks. *M. fragrans* usually takes 4–6 weeks. The longest period of germination so far recorded was for *M. fatua* var. *ingens* which took nearly 4 months to germinate.

As far as can be seen the embryos do not vary much from species to species, but more work is needed to confirm this.

Literature: D. B. Foreman (1974), Notes on *Myristica* Gronov. (Myristicaceae) in Papuasia, *Contr. Herb. Aust.* **9**: 35–44. J. Sinclair (1968), The genus *Myristica* in Malesia and outside Malesia, *Gdns' Bull., Singapore* **23**: 1–540.

KEY TO SPECIES

1. Leaves with easily removed indumentum of yellowish, cinnamon-coloured, silvery or whitish-yellow scales on undersurface
2. Hairs as well as scales present on undersurface of leaves
3. Inflorescence a panicle with several branches; scales on undersurface sometimes silvery as well as yellowish; hairs brown, persisting along midrib; male flowers ± subglobose, large, to 7–10 × 5–7 mm. Fruit oblong-ovoid, covered with short dark brown hairs ..... **M. markgraviana**
3. Inflorescence axis a woody, scar-covered knob, simple or bifurcate, scales usually 1 colour, flowers mostly ellipsoid, not subglobose
4. Reticulations on leaves absent or barely visible; nerves straight or curving slightly; secondary nerves absent, inconspicuous if present; tomentum wherever it occurs short, 1 mm or less long
5. Hairs on undersurface of leaves not abundant and often absent; scales sparse and soon disappearing, nerves on undersurface often not raised, usually reddish against paler background ..... **M. buchneriana**
5. Hairs on undersurface usually abundant but quite short, 0·5–1 mm long; scales abundant, dark yellowish, usually persisting, nerves distinct and usually raised beneath ..... **M. fatua** and vars
4. Reticulations on leaves very distinct, deeply impressed above or at least clearly defined on both surfaces; nerves curving widely, always prominent; secondary nerves present, numerous and conspicuous; tomentum wherever it occurs dense, hairs 1·3 mm long

6. Hairs wherever they occur dark brown or rust-coloured; flowers large, to 10–17 × 3–7 mm, stalked; hairs on fruit usually short, 0·5–2 mm long
7. Leaves ± subcordate or rounded at base, densely tomentose on undersurface; twigs hairy for considerable distance down twigs, to 20 cm; male flowers 15–17 × 5 mm, female flowers 10 × 7 mm, densely hairy, ± inflated; fruit 7 × 3·3–4·4 cm, densely hairy ..... **M. fusca**
7. Leaves rounded at base but not subcordate, tomentose on undersurface, becoming ± glabrous; twigs becoming glabrous or hairy for short distance down twigs only; male flowers 10 × 3–4 mm, female flowers 10 × 6 mm, not inflated, not so densely hairy (those of *M. womersleyi* not yet seen); fruit 6–9 cm in diameter, tomentum darker than above and less dense
8. Hairs on undersurface of leaf < 1 mm long; confined to nerves and midrib, disappearing with age, scales yellowish or sometimes silvery, tending to disappear with age; petiole 1·7–2·5 cm long; seed not aromatic ..... **M. sphaerosperma**
8. Hairs on undersurface of leaf 1–2 mm long, more dense and uniformly spread over entire undersurface of leaf, persistent; scales dark brown, becoming greyish with age; petioles 1–1·3 cm; seed strongly aromatic ..... **M. womersleyi**
6. Hairs wherever they occur yellowish or golden brown, darkening with age, hairs persistent or not; male and female flowers smaller than above, ± sessile; hairs on fruit 3–5 mm long ..... **M. chrysophylla** and vars

2. Scales present only on undersurface of leaves
9. Reticulations numerous, usually on both surfaces of leaves, impressed above; scales yellowish, sparse, often absent altogether, nerves curving widely
10. Fruiting axis often forked; reticulations fine, visible on both surfaces but not raised beneath, secondary nerves numerous; twigs blackish; male flowers tubular .. .. **M. cucullata**
10. Fruiting axis not forked; reticulations distinct, often raised beneath, nerves raised beneath, secondary nerves may or may not be present; twigs usually not blackish; male flowers ± ellipsoid ..... **M. sphaerosperma**
9. Reticulations less numerous, often absent especially above; scales yellowish, usually present; nerves ± straight
11. Leaves usually small, 8–15 × 3–7 cm
12. Fruit 2·5–3 × 1–1·5 cm, male flowers small, 3–5 × 2–2·5 mm ..... **M. lepidota**
12. Fruit and male flowers larger than above
13. Fruit thick-walled; leaves ± elliptic
14. Leaves 4–15 × 3–5 cm; petiole 10–15 × 1–2 mm; fruit ellipsoid, 5·5–7 × 3·3–4 cm, apex oblique ..... **M. crassipes**
14. Leaves 13–15 × 6·5–7 cm; petiole 25–40 × 2 mm; fruit obovoid, 7 × 3·3–4 cm, apex not oblique ..... **M. archboldiana**
13. Fruits thin-walled; leaves narrowly elliptic or lanceolate .. **M. fatua** var. **papuana**
11. Leaves usually larger than above, 11–32 × 4–15 cm
15. Petiole 6–15 mm long
16. Venation prominent and well defined on undersurface of leaf; petiole 1–1·5 cm long
17. Fruit ovoid, 3 × 2·5 cm, base narrowed into short pseudostalk .... **M. flosculosa**
17. Fruit ± ellipsoid, 3·3–6·5 × 3–5 cm, base rounded or slightly narrowed, pseudostalk absent ..... **M. fatua** var. **papuana**
16. Venation not prominent or well defined on undersurface of leaf; petiole 6–15 mm long ..... **M. buchneriana**
15. Petiole 2–6 cm long
18. Fruit small, ± subglobose, 2 × 1·5 cm, stalk very slender, 15–18 × 2 mm .... **M. pedicellata**
18. Fruit larger than above, fruiting stalk stouter
19. Nerves fine, only slightly raised beneath; indumentum usually present on young leaves, older leaves becoming ± glabrous; blade 10–20 × 4–7 cm; petiole usually 2–2·5 cm long ..... **M. tenuivenia**
19. Nerves usually prominent and raised beneath; indumentum covering entire surface and persistent or may be present on young leaves only; petioles to 6 cm long; leaves usually larger than above

20. Fruits covered with short, dark brown hairs; nerves fine but quite prominent; petioles to 6 cm long; indumentum usually on young leaves only or persistent along midrib ..... **M. petiolata**
20. Fruit covered with yellowish or medium brown indumentum; nerves raised beneath and prominent; petiole usually < 4 cm long; indumentum usually present and covering entire undersurface ..... **M. fatua** and vars

1. Leaves without easily removed indumentum of yellowish, cinnamon-coloured, silvery or whitish-yellow scales on undersurface
21. Hairs sometimes present on young leaves
22. Fruit subglobose, 4–5 cm in diameter, covered with dark brown hairs; leaves whitish beneath, hairs confined to midrib ..... **M. uncinata**
22. Fruit ovoid, flattened at base, $3 \times 2{\cdot}5$ cm, covered with medium brown hairs; leaves not whitish beneath, hairs covering entire undersurface at first, later $\pm$ glabrous ..... **M. inopinata**
21. Hairs absent
23. Inflorescence axis not woody, 1–8 cm long, sometimes flattened, elongated, producing flowers only once, female inflorescence less branched and usually shorter than male one
24. Male inflorescence axis not branched
25. Leaves 6–13 cm long, not silvery beneath, aromatic in all parts, twigs $\pm$ smooth, not native, always cultivated ..... **M. fragrans**
25. Leaves usually larger than above, silvery beneath, seed only slightly aromatic, twigs rough with pustular lenticels, native of New Guinea but also planted ..... **M. argentea**
24. Male inflorescence axis branched
26. Leaves 6–12 cm long, fruit 2–3·5 cm long, pseudostalk usually present
27. Leaves oblong to ovate with rounded, subcordate or cordate base, $8–32 \times 5–12$ cm; nerves $\pm$ distinct; fruit oblong, to 4 together, $3{\cdot}5 \times 1{\cdot}5$ cm, pseudostalk 3–4 mm long ..... **M. schleinitzii**
27. Leaves lanceolate or narrowly elliptic, base acute or slightly rounded, $6–16 \times 1{\cdot}8–4$ cm; nerves faint on both surfaces; fruit not known ..... **M. rosselensis**
26. Leaves and fruit larger than above, pseudostalk present or not
28. Leaves mostly 16–30 cm long
29. Leaves $18–30 \times 5{\cdot}5–10{\cdot}5$ cm; often pale grey beneath, fruit with distinctive uncinate tip, 4–6 cm long, covered with dark brown hairs ..... **M. uncinata**
29. Leaves mostly $16–30 \times 5–11$ cm; not pale grey beneath; fruit not as above
30. Leaves mostly panduriform; primary and secondary nerves faint; fruit oblong, becoming glabrous, base narrowed into short pseudostalk, with small cup-like receptacle at top of pedicel where it joins fruit ..... **M. garciniifolia**
30. Leaves oblong-lanceolate or ovate-lanceolate; primary nerves more distinct, secondary nerves few; fruit ovoid, $3 \times 2{\cdot}5$ cm, densely hairy, flattened at base, no pseudostalk or cup-like receptacle present ..... **M. inopinata**
28. Leaves mostly larger than above
31. Primary nerves prominent, especially beneath, secondary mostly absent
32. Leaves $23–54 \times 8–16$ cm, leaves drying reddish-brown above, whitish beneath, fruit $6{\cdot}5–9 \times 4{\cdot}5–6$ cm, covered with fine short uniform medium brown hairs ..... **M. umbrosa**
32. Leaves $21–45 \times 5–17$ cm, drying olivaceous above, light brown beneath, nerves distinctive reddish-brown, fruit $5–5{\cdot}5 \times 2{\cdot}3–2{\cdot}5$ cm, with dense reddish-brown tomentum with rather shaggy appearance ..... **M. sepicana**
31. Primary nerves more slender than above, secondary nerves usually present
33. Leaf base rounded or subcordate, blade $32–56 \times 11–16{\cdot}5$ cm, nerves raised on upper surface, slightly raised beneath, mostly faint, midrib broad and well defined, raised on both surfaces ..... **M. neglecta**
33. Leaf base mostly acute or bluntly acute, blade $22–42 \times 6{\cdot}5–11$ cm, nerves not raised above, slightly raised beneath, usually drying with glossy waxy appearance above, midrib sunken above, raised below ..... **M. hooglandii**
23. Inflorescence axis rarely $>$ 3 cm long, main axis a short, woody, scar-covered knob, producing flowers more than once, sometimes basal portion smooth and upper parts scar-covered, female inflorescence similar to male one

34. Fruit with dense tomentum; leaves 12–24 × 3·5–10 cm; nerves 12–18 pairs
35. Leaves glaucous beneath; nerves drying reddish-brown often faint beneath, impressed above; fruit 4 × 1·8–2 cm, covered with short medium to dark brown hairs ..... **M. buchneriana**
35. Leaves drying ± same colour above and below; nerves well defined and raised beneath; fruit to 2·5–3·3 × 2 cm, covered with golden brown hairs 3–5 mm long.. ..... **M. chrysophylla** var. **entrecasteauxensis**
34. Not as above
36. Leaves with cordate, subcordate or emarginate bases (especially oldest and largest leaves)
37. Twigs with 2 lines running from petiole base to petiole base expanded into raised wings or not, twigs sometimes swollen and inhabited by ants; fruits to 3·5 × 2·8 cm
38. Leaf-blade 20–35 × 5–13 cm; 2 lines on twigs not expanded into wings, twigs not swollen and inhabited by ants; fruit minutely hairy at first, later ± glabrous, 3–6·5 × 2–4·5 cm ..... **M. hollrungii**
38. Leaf-blade 20–40 × 7–20 cm; 2 lines on twigs raised into wings, twigs swollen and inhabited by ants; fruits minutely hairy, 1·5–5 × 1·3–2·5 cm.. **M. subalulata**
37. Twigs without 2 lines running from petiole base to petiole base, not inhabited by ants; fruit 7–8·5 × 5·5–7·5 cm ..... **M. kajewskii**
36. Leaves not cordate, subcordate or emarginate at base
39. Fruit globose or ellipsoid, tip ± rounded or pointed, base rounded, pseudostalk absent; inflorescence mostly simple, less often 1–3 short branches; bracteole or its scar at junction of pedicel and perianth; male flowers not usually tubular
40. Leaves mostly 5–15(–20) × 1–7·5 cm; veins usually not prominent; 2 raised lines not present on apical portion of twigs; male flowers small, 2–5 × 2–3 mm
41. Primary nerves slender, fine, usually slightly raised beneath, most visible beneath, noticeably curved
42. Leaves small and narrow, 5–11 × 1–3 cm; fruit ellipsoid, 1·8–2 × 1–1·2 cm... ..... **M. concinna**
42. Leaves larger and broader than above, 8–20 × 2·5–7·5 cm; fruit subglobose, globose or ellipsoid, 1·5–5 × 1·5–2·5 cm
43. Fruit globose or subglobose, 1·5–2·5 cm diameter; leaves 8–17 × 3–5·5 cm, usually drying darker above than beneath ..... **M. globosa**
43. Fruit globose when young, becoming ellipsoid, 5 × 2·5 cm; leaves 10–20 × 2·5–7·5 cm, usually drying pale above and beneath ..... **M. insipida**
41. Primary nerves very fine, not raised and often invisible beneath, usually straight ..... **M. lancifolia** and vars
40. Leaves larger, to 15–40 × 3·5–15 cm, veins prominent; apical portion of twigs with or without 2 raised lines; male flowers large, 5–15 × 3–5 mm
44. Twigs with 2 raised lines running from petiole base to petiole base; fruits 1·5–6·5 × 1·2–4·5 cm
45. Twigs swollen and inhabited by ants, 2 lines raised into wings; fruit 1·5–5 × 1·2–2·5 cm, ± sessile or with stalk to 15 mm long ..... **M. subalulata**
45. Twigs not swollen and inhabited by ants, 2 lines clearly defined but not raised into wings; fruit usually larger than above, 3–6·5 × 2–4·5 cm, always stalked
46. Leaf-blade 20–35 × 5–13 cm, base rounded or sometimes acute (especially young leaves), usually drying a light colour above and beneath, not glossy; fruit ± ellipsoid, apex often pointed; male flowers ± glabrous. **M. hollrungii**
46. Leaf-blade 11–26(–32) × 3·5–9 cm, base rounded or often acute, usually drying darker above than beneath, often glossy; fruit subglobose, 3·8–6 × 3–5·5 cm, apex not pointed; male flowers densely hairy ..... **M. sulcata**
44. Twigs without 2 raised lines running from petiole base to petiole base; fruit large, 6–8·5 × 5·5–7·5 cm
47. Fruit spherical, 6 cm or more in diameter, covered with short rust-coloured hairs, pericarp smooth; male flowers ± ellipsoid, pedicels 8–10 × 1 mm..... ..... **M. sphaerosperma**
47. Fruit ± subglobose, 7–8·5 × 5·5–7·5 cm, covered with short pale brown hairs,

becoming glabrous, pericarp often warted; male flowers ± subglobose, pedicel 3×1–1·5 mm, flattened.....**M. kajewskii**

39. Fruit ovoid, narrowly ellipsoid, ellipsoid or obovoid-ellipsoid, often ± pointed at both ends, pseudostalk usually present; inflorescence simple or split into 2 equal branches; bracteole or its scar 1–3 mm down pedicels; male flowers tubular
48. Leaves very narrowly lanceolate, 17–22 cm×2–3 mm, nerves distinctly looped near margin; fruit fusiform, 4·5×*c.* 1·3 cm, pointed at both ends, base narrowed into pseudostalk.....**M. ensifolia**
48. Leaves mostly elliptic or elliptic-lanceolate or oblong, interarching at margins distinct or not; fruit not as above
49. Fruiting stalk slender (5–)10–35×0·5–2 mm
50. Fruit cylindrical, 3×1 cm; leaves covered beneath with closely appressed whitish scales; pseudostalk absent.....**M. cylindrocarpa**
50. Fruit not cylindrical; scales absent; pseudostalk present or not
51. Twigs slender, 1 mm thick at top; leaves ± elliptic, often with distinct drawn-out tip; petiole slender, 1·5–2 mm thick; fruit pendulous, mostly single or in pairs, 4–7×1·3–2·5 cm, pericarp thin, stalk 5–25 mm long.....**M. tubiflora**
51. Twigs stouter, 2 mm thick at top; leaves variable, apex bluntly acute or shortly acuminate; petiole stouter, 2–3 mm thick; fruit not pendulous, mostly in pairs on forked peduncle, 3–7×1·5–3 cm, pericarp thick, stalk 10–23×2 mm
52. Male flowers to 25×3 mm; leaves 8–23×6–10 cm, nerves usually quite prominent; fruit ± subglobose or broadly ellipsoid, to 7×3 cm, not noticeably drawn out at ends, short pseudostalk may be present.....**M. cornutiflora**
52. Male flowers to 10×3–4 mm; leaves 6–15×3–6 cm, nerves faint; fruit narrowly ellipsoid, 3–5×1·5–2·3 cm, drawn out at both ends, pseudostalk usually present; fruit may be hairy when young.....**M. longipes**
49. Fruiting stalk stout, 5–17×4–7 mm
53. Fruit ellipsoid, thick-walled, with oblique apex; leaves elliptic, 4–15×1·5–5 cm.....**M. crassipes**
53. Fruit not as above; leaves broadly elliptic to oblong, 11–23×4–9 cm
54. Leaves broadly elliptic, less often elliptic-lanceolate, drying reddish-brown, secondary nerves neither numerous nor prominent; fruit ± ovoid, 3×2–2·5 cm, with short pseudostalk.....**M. flosculosa**
54. Leaves oblong or oblong-elliptic, drying pale yellowish or blackish-brown, secondary nerves numerous and usually well defined but not raised; fruit broadly to narrowly ellipsoid 3–6×2–3·5 cm, rounded at both ends.....**M. cucullata**

Myristica archboldiana A. C. Sm. *J. Arnold Arbor.* **22**: 73 (1941); J. Sinclair *Gdns' Bull., Singapore* **23**: 329 (1968), f. 47.

Tree to 30 m tall. Twigs glabrous, rough with longitudinal fissures lower down. Petiole 20–40×2 mm; leaf-blade elliptic-oblong, 13–15×6·5–7 cm, tip ± acuminate, base rounded or slightly subcordate, ± chartaceous or slightly coriaceous, glabrous above, with minute appressed greyish scales beneath, midrib and nerves impressed above, midrib raised beneath, nerves slightly raised, fine, becoming invisible towards margins, no secondary nerves or reticulations visible on either surface. Flowers unknown. Fruit obovoid, 7×4 cm, with rust-coloured pubescence. Stalk *c.* 25×5 mm. Seed 3×1·3 cm.

Field characters: Bole straight, crown moderately dense.

Distribution: At present known only from the Western district of Papua.

Ecology: In forest on low ridges and flat areas at altitude 100 m.

Notes: In leaf alone this species is rather similar to *M. tenuivenia* but its fruits are about twice as long.

Myristica argentea Warb. *Bot. Jb.* **13**: 311 (1891); J. Sinclair *Gdns' Bull., Singapore* **23**: 235 (1968), f. 20.

Myristica finschii Warb. (1897) p.p.

Tree to 40 m tall. Twigs glabrous, covered with numerous raised lenticels. Petiole 1·5–2 cm long; leaf-blade elliptic-lanceolate or oblong-lanceolate, 10–25 × 4–10 cm, tip acuminate, base ± acute, glabrous above, covered with minute silvery scales beneath, nerves sunken above, raised and prominent beneath. Male inflorescence 2–5 cm long, often forked once, branches covered with scars of fallen bracts and pedicels at their tips. Male flowers with slender pedicels, 1–1·3 cm long, bracteoles falling off at early stage; perianth 7–11 × 5 mm, ± glabrous. Female inflorescence 1–1·5 cm long, main axis simple or branched once. Female flowers with slender pedicels, 8–10 mm long; perianth 10–12 × 5–6 mm, narrowed at apex, ovary flask-shaped, 7 × 3–4 mm, covered with minute brown hairs. Fruit ± ellipsoid, to 8·5 × 5·5 cm, glabrous; stalk 1–3 cm. Seed 3·5–4 cm.

Field characters: Stilt-roots sometimes present.

Distribution: Confined to western New Guinea, mainly in the Vogelkop district.

Ecology: In primary forest on sandy clay at 250 m altitude.

Notes: Commonly called 'Papuan nutmeg'. It is occasionally cultivated in western New Guinea since the aril is quite aromatic, the nut less so. The nut is said to be used medicinally, mostly in Java.

Myristica buchneriana Warb. *Bot. Jb.* **13**: 311 (1891); J. Sinclair *Gdns' Bull., Singapore* **23**: 321 (1968), f. 44. **Fig. 86.**

Tree 10–30 m tall. Twigs slender, apical parts covered with rust-coloured pubescence, becoming glabrous. Petiole 10–15 cm × 2–3 mm; leaf-blade lanceolate or ovate-lanceolate, 14–21 × 4·5–8 cm, tip acute, base ± rounded, glaucous beneath, sometimes sparingly covered with minute yellow scales and hairs, nerves not prominent, reticulations invisible. Male inflorescence axis a woody knob 5–8 mm long, usually simple. Male flowers with pedicels 4–5 mm long, perianth 8–10 × 4–5 mm with appressed rust-coloured tomentum outside. Female inflorescence axis similar to male one. Female flowers with pedicels 5 mm long; perianth ovoid, 8 × 5 mm, with dense rust-coloured tomentum. Fruit ellipsoid or obovoid, 4 × 1·8–2 cm, rust-coloured tomentum, base narrowed. Stalk 10 × 6 mm. Seed 2·5 × 1·2 cm.

Distribution: Mostly in northeastern New Guinea from Jayapura in western New Guinea to the Milne Bay district and Papuan Islands in Papua.

Ecology: Frequently found on ridge tops at 300–1300 m altitude.

Myristica chrysophylla J. Sinclair *Gdns' Bull., Singapore* **23**: 254 (1968), f. 26.

Tree to 21 m tall. Twigs with dense golden hairs, becoming glabrous; leaf-blade oblong, 16–42 × 5–13 cm, tip acuminate or acute, base ± acute

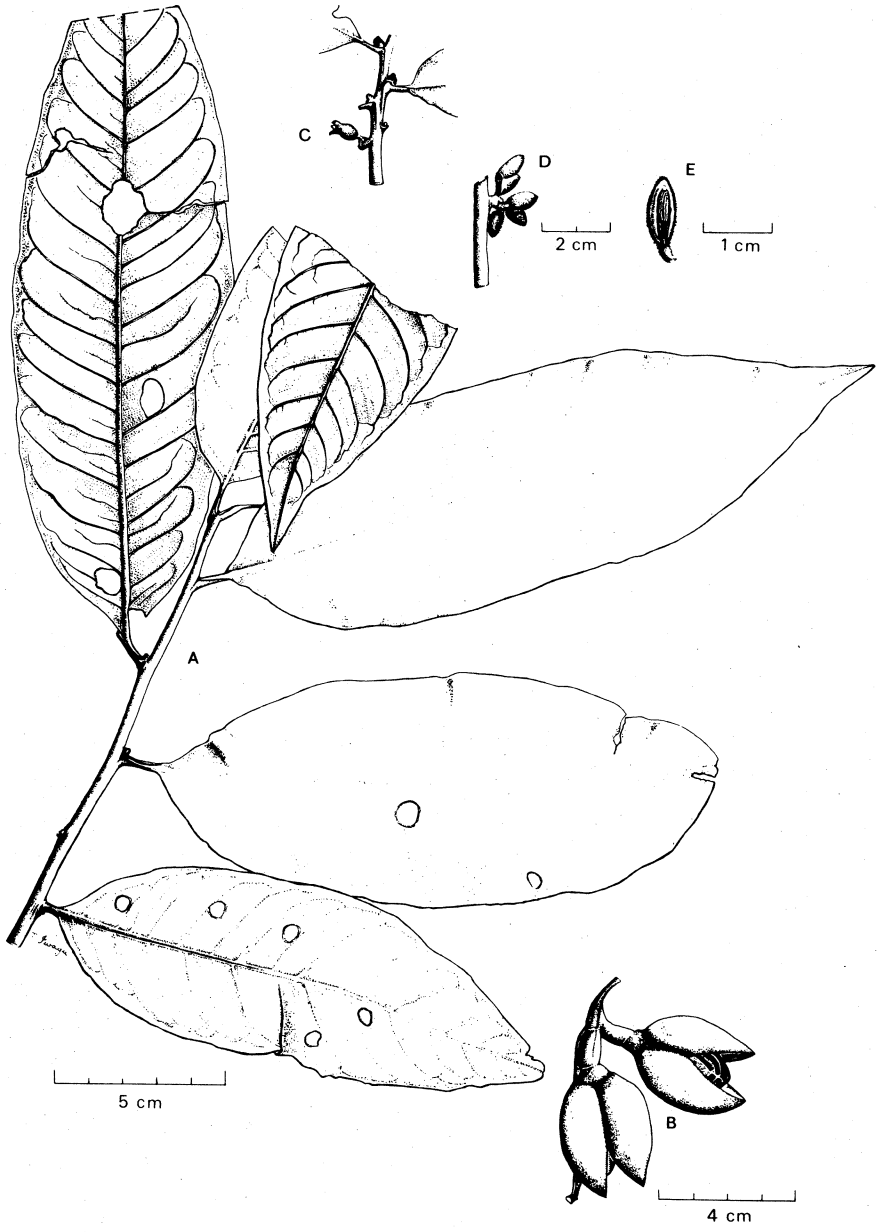


Fig. 86 **Myristica buchneriana** Warb. (A) leafy twig (B) fruit (C) female flower (D) male flower (E) male flower with part of perianth removed to show staminal column

to rounded and subcordate, glabrous above, covered with a dark yellowish or brownish-yellow indumentum of minute scales and 1–3 mm long hairs, sometimes becoming ± glabrous, nerves, midrib and reticulations deeply impressed above, raised beneath. Inflorescence axis a woody knob covered with yellowish hairs. Male flowers ± sessile, tubular, 7–8 × 3 mm, covered in mass of yellow hairs. Female flowers similar to male ones, ± sessile, perianth urceolate, 7 × 3 mm. Fruit ± sessile, subglobose, 2–2·3 cm in diameter or oblong-ovoid, to 3·3 × 2 cm, covered with golden or medium brown hairs 3–5 mm long.

Two varieties are recognized as occurring in New Guinea.

KEY TO VARIETIES

1. Leaves covered beneath with a dense, persistent indumentum; fruit subglobose..... .....var. **chrysophylla**
1. Leaves becoming glabrous, indumentum if present sparse; fruit oblong-ovoid..... .....var. **entrecasteauxensis**

var. **chrysophylla**

Leaves to 42 × 18 cm, indumentum on undersurface of leaves persistent, present even on older leaves, nerves very deeply impressed, giving bullate appearance to leaves. Fruit subglobose, 2–2·3 cm in diameter.

Distribution: Morobe district in northeastern New Guinea, and the adjacent Northern district of Papua.

Ecology: In lowland rain forest to 370 m altitude, usually on slopes or ridges.

var. **entrecasteauxensis** J. Sinclair *Gdns' Bull., Singapore* **23**: 257 (1968), f. 27.
Myristica fatua Houtt. var. *morobensis* J. Sinclair (1968), f. 35.

Differs from var. *chrysophylla* in having smaller leaves, 16–23 × 5–7 cm, with nerves and reticulations less deeply impressed and leaves becoming ± glabrous when older. Fruit oblong-ovoid, 3·3 × 2 cm.

Distribution: Morobe district of northeastern New Guinea, Central district and the Papuan Islands (D'Entrecasteaux Islands) of Papua.

Ecology: In lowland rain forest on slopes and ridges.

Notes: There are variations in leaf shape, some specimens with ± rounded leaf bases and others with ± acute ones. Otherwise there is little variation within var. *entrecasteauxensis.*

Myristica concinna J. Sinclair *Gdns' Bull., Singapore* **23**: 375 (1968), f. 62.

Tree to 15 m tall. Twigs glabrous. Petiole slender, *c.* 10 × 2 mm; leaf-blade narrowly elliptic, 5–11 × 1–3·5 cm, tip acute or acuminate, base acute, glabrous above and beneath, midrib usually reddish and quite distinct from paler undersurface of leaf, veins fine, not clearly defined above, usually not very prominent beneath. Male inflorescence axis a woody knob 2–3 mm long. Male flowers with pedicels 0·5–2 mm long; perianth ± cylindrical, 4–5 × 1–2 mm, covered with appressed hairs. Female flowers unknown. Fruit

ellipsoid or oblong, 1·8–2 × 1·2 cm, soon becoming glabrous. Stalk slender' 3–5 mm long. Seed oblong, pale brown when dry.

Distribution: Known from the Gulf and Northern districts of Papua.

Ecology: In primary rain forest on ridges and in valleys from sea level to 120 m.

Notes: A small, rather graceful tree which has the narrowest leaves and smallest fruits of any known *Myristica* in Papuasia.

Myristica cornutiflora J. Sinclair *Gdns' Bull., Singapore* **23**: 348 (1968), f. 53, 54. **Fig. 87.**

M. gracilipes J. Sinclair (1968), f. 49.

Tree to 12 m tall. Twigs glabrous. Petiole 15–26 × 2–3 mm; leaf-blade elliptic or oblong-elliptic, 8–24 × 6–10 cm, tip ± acute, base ± acute, glabrous above and beneath, nerves impressed above, clearly defined beneath, secondary nerves sometimes present, reticulations not clearly defined. Male inflorescence main axis 1·5–3·5 cm long, divided into 2 branches covered with scars at their tips, whole inflorescence drooping. Male flowers with pedicels 20× up to 1 mm; perianth to 25 × 3 mm. Female flowers with pedicel 10 × 1 mm; perianth *c.* 1 cm long, swollen at base to 3–4 mm broad and tapered to 1·5–2 mm at top. Fruit solitary or in pairs, ellipsoid to subglobose, to 7 × 3 cm, glabrous, base narrowed into short pseudostalk. Stalk 1–1·5 cm long, ending in cup-like receptacle.

Field characters: Small buttresses are sometimes present.

Distribution: Known from the Geelvink Bay and Digul districts of western New Guinea, the West Sepik district of northeastern New Guinea, and the Southern Highlands, Western and Central districts of Papua.

Ecology: Usually on ridges at 50–830 m altitude in advanced secondary or primary rain forest.

Notes: The long, relatively narrow flowers of this species are very characteristic.

Myristica crassipes Warb. in K. Sch. & Laut. *Fl. Deutsche Schutzgeb. Südsee* 326 (1900); J. Sinclair *Gdns' Bull., Singapore* **23**: 353 (1968), f. 55.

M. firmipes J. Sinclair (1968), f. 56.

Tree to 27 m tall. Twigs glabrous or covered with minute hairs. Petiole 10–15 × 1–2 mm; leaf-blade ± elliptic or narrow elliptic, 4–15 × 3–5 cm, tip acute, base ± acute, glabrous above, covered beneath with very thin indumentum of whitish-yellow scales, becoming glabrous, midrib and veins sunken above, raised beneath, mostly clearly defined but not prominent, reticulations almost invisible. Male inflorescence axis mostly simple, to 2·5 cm long, covered with scars, smooth basal portion sometimes present. Male flowers minutely hairy; pedicels 3–8 mm long, slender; perianth ± tubular, 5–10 × 1–3 mm, bracteole small, situated *c.* 2 mm below base of perianth. Female inflorescence and flowers: only immature flowers seen but mature female flowers probably similar to male ones. Fruit ellipsoid or obovoid-ellipsoid, 5·5–7 × 3·3–4 cm, pericarp thick-walled, slightly warted,

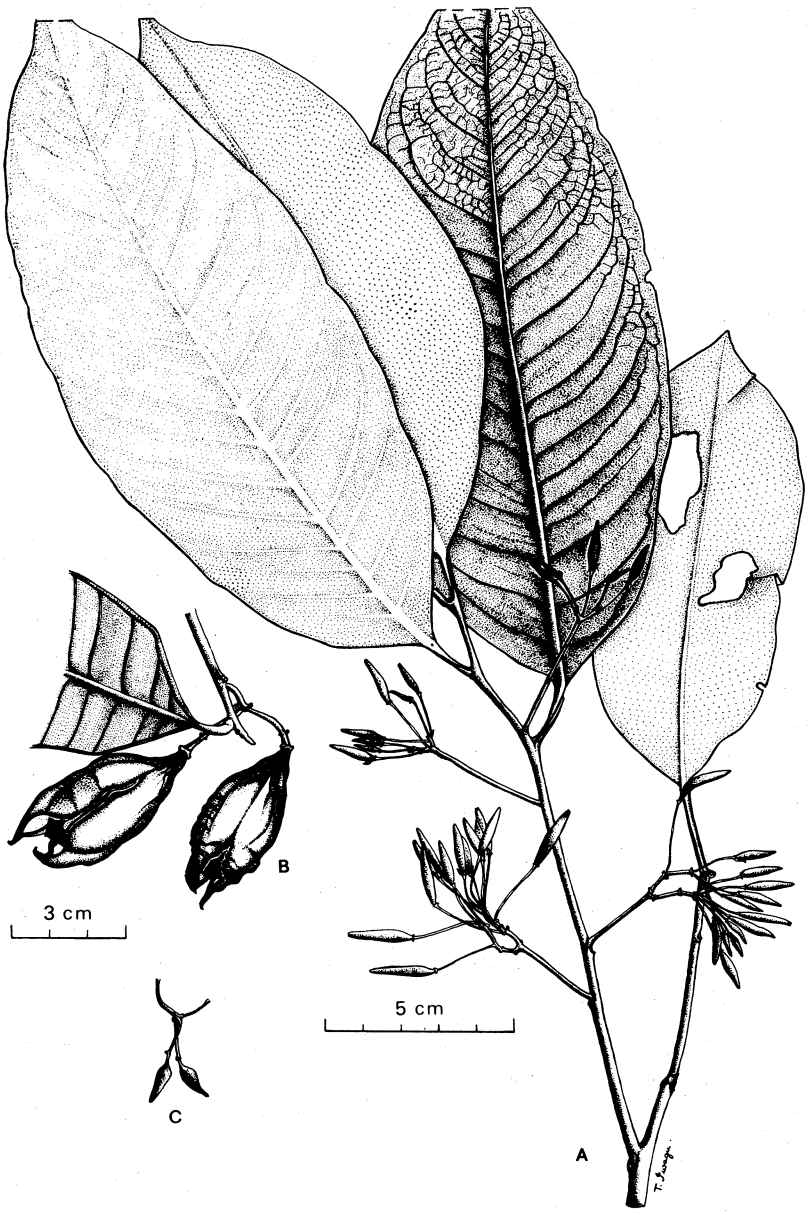


Fig. 87 **Myristica cornutiflora** J. Sinclair (A) twig with male flowers (B) fruit (C) female flowers

with oblique apex. Stalk 10–15 × 7 mm. Seed to 3·5 × 1·5 cm, slightly fragrant.

Field characters: Bole sometimes spurred at base.

Distribution: Known from the West Sepik, East Sepik, Morobe and Western Highlands districts of northeastern New Guinea, and the Western, Central and Northern districts of Papua.

Ecology: On ridges and slopes to 1520 m altitude, in secondary or primary forest.

Myristica cucullata Markgr. *Bot. Jb.* **67**: 166 (1935); J. Sinclair *Gdns' Bull., Singapore* **23**: 364 (1968), f. 60.

Tree to 25 m tall. Twigs glabrous, blackish-grey. Petiole to 15 × 2–3 mm, usually drying black; leaf-blade ± oblong or oblong-elliptic 15–25 × 4–9 cm, tip acute or obtuse, base ± rounded, glabrous, midrib lying in groove above, raised beneath, nerves sunken above, flat or only slightly raised beneath, their light brown colour contrasting with the somewhat paler colour of dried leaf-blade, reticulations may or may not be visible. Male inflorescence axis a short, simple or divided woody knob. Male flowers with pedicels 6–7 mm long, slender; perianth *c.* 10 × 3–6 mm, oblong-ovoid, covered with light brown hairs, bracteole triangular, at first almost enclosing young flower. Female inflorescence similar to male one. Female flowers with pedicels 6 mm long, slender; perianth flask-shaped, 7 mm long, narrowing sharply towards top. Fruit ovoid, to 6 × 3·5 cm, becoming glabrous. Stalk to 15 × 4 mm. Seed ± ovoid, *c.* 3·5 × 1·8 cm.

Distribution: Known from the Jayapura and Snow Mountains districts of western New Guinea, the West Sepik, Morobe and Eastern Highlands districts of northeastern New Guinea and the Central district of Papua.

Ecology: Found in forest at 560–2030 m altitude.

Notes: There is considerable variation in the leaves of this species, mainly in texture and width.

Myristica cylindrocarpa J. Sinclair *Gdns' Bull., Singapore* **23**: 337 (1968), f. 50.

Small tree to 6 m tall. Twigs glabrous, smooth in apical parts but becoming rough when older. Petioles 10 × 1·5–2 mm; leaf-blade ± elliptic, 10–15 × 3–6·5 cm, ± acute at tip and base, glabrous above, beneath covered with minute appressed whitish scales, midrib and main nerves sunken above, raised beneath. Male and female flowers not known. Fruit single or in pairs, rarely to 4 together, cylindrical, 3 × 1 cm, minutely hairy. Stalk to 7 × 1 mm. Seed 20 × 8 mm.

Distribution: Known from the Madang district of northeastern New Guinea and the Central district of Papua.

Ecology: In lowland rain forest which may be subject to seasonal inundation, to 135 m altitude.

Notes: Appears to be most closely related to *M. tubiflora* but the fruit has

an elongated pseudostalk and the stalk is somewhat stouter.

Myristica ensifolia J. Sinclair *Gdns' Bull., Singapore* **23**: 232 (1968), f. 48.

Small tree 1·5 m tall. Young twigs glabrous, 2-angled. Petiole 8–10 × 2 mm; leaf-blade very narrowly elliptic 17–22 × 2–3 cm, tip acute or acuminate, base acute, ± glabrous above and beneath, midrib sunken above, raised beneath, nerves sunken above, raised beneath, forming distinct loops towards margins, no reticulations visible. Male and female flowers unknown. Fruits elongated, 4·5 × 1·3 cm, light brown pubescent, with base narrowed into pseudostalk, tip acute.

Distribution: Known from a single fruiting collection from the Fly River, Western district, Papua.

Ecology: Ridge forest at 80 m altitude.

Myristica fatua Houtt. *Nat. Hist. Pl.* **2**(3): 337 (1774); J. Sinclair *Gdns' Bull., Singapore* **23**: 268 (1968), f. 30.

Tree to 37 m tall. Twigs usually covered with short hairs, later glabrous, 2 lines sometimes present on twigs particularly near tips. Petioles 8–40 mm long; leaf-blade variable, glabrous above, covered beneath by cinnamon-coloured, rust-coloured, yellowish or medium brown scales and sometimes hairs, midrib and nerves sunken above, raised beneath, reticulations usually faint if visible. Inflorescence a woody, scar-covered knob. Flowers various, covered with short, brown pubescence. Fruit various.

KEY TO VARIETIES

1. Fruit broader than long, acorn-shaped; leaves covered beneath with dark yellowish-brown indumentum ..... var. **quercicarpa**
1. Fruit ± globose or longer than broad; indumentum not as above
 2. Leaves ovate-oblong, often broadest below middle, 10–20 × 7–9 cm, base subcordate; fruit ± sessile ..... var. **subcordata**
 2. Leaves broadest above or at middle, 13–35 × 4–13 cm, base ± acute, rounded or rarely subcordate; fruit stalked
  3. Fruit large, ± globose, to 11 × 10 cm, aril small, covering only basal part of seed; indumentum yellowish, particularly on young leaves ..... var. **ingens**
  3. Fruit not globose, usually longer than broad, to 6·5 × 5 cm, aril surrounding seed; indumentum medium brown to cinnamon-coloured
   4. Leaves ± oblong, petiole 20–40 × 4·5–5 mm, indumentum medium brown, fruit 5·5–6 × 3 cm covered with short dark brown hairs ..... var. **morindiifolia**
   4. Leaves variable, 13–35 × 4–13 cm, petiole 1–3 × 2–3·5 cm; indumentum usually cinnamon-coloured, fruit 3·3–6·5 × 3–5 cm, covered with short rust-coloured hairs ..... var. **papuana**

var. **ingens** Foreman *Contr. Herb. Aust.* **9**: 37 (1974), f. 1.

Myristica fatua Houtt. var. *morindiifolia* (Bl.) J. Sinclair (1968) p.p.

Twigs often noticeably ridged, terminal bud well developed, covered with short brown hairs. Petiole 20–35 × 4–6 mm, becoming blackish and deeply furrowed when dry; blade ± oblong, 25–43 × 10–15 cm, tip acute, base ± rounded, indumentum on undersurface yellowish, oldest leaves ± glabrous. Male flowers with stout pedicels 3–5 mm long, perianth ± globose, to

5×4 mm. Female flowers similar to male ones but stouter. Fruit ± globose, **to 10–11×9–10 cm,** covered with short brown hairs, pericarp to 2·5 cm thick **and fleshy. Stalk** *c.* 2–3·5×1 cm. Seed ± ovoid, rounded at both ends, **4·5×3·5 cm, dark** brown, shiny; aril small, only partially covering seed.

Field characters: Occurs as a canopy tree. Crown narrow, open, relatively sparse.

Distribution: Known from the Eastern and Western Highlands of northeastern New Guinea.

Ecology: Often found by small mountain streams on slopes in primary or secondary forest at 1200–1600 m altitude.

Notes: The fruit of this nutmeg rank among the biggest recorded for the genus throughout its entire range and certainly are the biggest of the known Papuasian species. This variety is also peculiar in having a very small aril.

var. **morindiifolia** (Bl.) J. Sinclair *Gdns' Bull., Singapore* **23**: 286 (1968), f. 34.
Myristica morindiifolia Bl. (1837).

Twigs smooth, covered with short rust-coloured hairs. Petiole 20–40× 4·5–5 mm; leaf-blade ± oblong or elliptic-oblong, 24–45×9–15 cm, tip ± acute, base ± rounded or slightly subcordate, indumentum yellowish to dark brown. Flowers to 5×5 mm, male ones slightly smaller than female ones, pedicels 3 mm long, stout. Fruit ellipsoid, 5·5–6×3 cm, covered with short brown hairs; aril dark red, broadly segmented and surrounding seed.

Field characters: Stilt-roots sometimes present, especially in swampy areas.

Distribution: Vogelkop, Mimika and probably Digul districts in western New Guinea, the Western district in Papua, and the coastal areas of New Britain.

Ecology: In swamp forest, often growing by streams, in lowland rain forest to 60 m altitude.

Notes: The distribution is rather scattered. However, all the collections match well. Var. *morindiifolia* is not as distinct a variety as some other varieties of *M. fatua*, and its status is still not certain. It tends to grade into both var. *subcordata* and var. *papuana.*

var. **papuana** Markgr. *J. Arnold Arbor.* **10**: 77, 214 (1929); J. Sinclair *Gdns' Bull., Singapore* **23**: 294 (1968), f. 37. **Fig. 88.**

Myristica finschii Warb. (1897) p.p.; *Myristica sericea* Warb. (1897); *Myristica multinervia* A. C. Sm. (1941); *Myristica procera* A. C. Sm. (1941); *Myristica platyphylla* A. C. Sm. (1941); *Myristica fatua* Houtt. var. *platyphylla* (A. C. Sm.) J. Sinclair (1968).

Twigs with 2 faint lines sometimes visible near top. Petiole 1–3×2·3–3·5 cm; leaf-blade lanceolate, oblanceolate, oblong or obovate, 13–35×4–13 cm, tip ± acute, often bluntly so, base ± pointed to rounded and slightly subcordate in larger leaves, indumentum thin, usually cinnamon-coloured.

Fig. 88 **Myristica fatua** Houtt. var. **papuana** Markgr. (A) leafy twig (B) fruit (C) fruit with part of pericarp removed to show seed surrounded by aril (D) male flowers

Inflorescence 5–10 mm long. Male flowers with pedicels 6–10 × 1·5–2 mm; perianth ± tubular, 6–11 × 4 mm. Female flowers similar to male ones, pedicels 5 × 2–4 mm; perianth urceolate, 3–6 × 4 mm. Fruit ± ellipsoid, 3·3–6·5 × 3–5 cm, covered with short rust-coloured hairs. Stalk 5–10 × 3–5 mm. Seed ± ellipsoid, 2·5–4 × 1·5–2 cm.

Field characters: Stilt-roots are sometimes present. The amount of indumentum on the undersurface of the leaves varies greatly with age, the oldest leaves being sometimes almost glabrous.

Distribution: Widely distributed throughout the lowland areas of Papuasia but apparently absent from monsoon areas of Papua.

Ecology: In primary and secondary rain forest, to *c.* 600 m altitude, under a wide range of habitats usually on well-drained sites on ridges and slopes.

Notes: Var. *papuana* is the most common and widespread variety of *M. fatua* found in Papuasia and is quite variable in leaf size and shape. However, a complete range of intermediates exists and it is impossible to separate satisfactorily the various forms seen.

var. **quercicarpa** J. Sinclair *Gdns' Bull., Singapore* **23**: 302 (1968), f. 38D–F.

Twigs covered with dark yellowish hair, glabrous lower down. Petiole *c.* 12 × 2–3 mm; leaf-blade ± oblong or obovate, 15–18 × *c.* 7 cm, tip shortly acuminate, base ± rounded or bluntly acute, indumentum dark yellowish. Flowers unknown. Fruit broader than long, 1·3–2 × 1·8–2·5 cm, flattened at base, tip pointed, covered with dark yellowish hairs. Stalk 13 × 3 mm. Seed ± ellipsoid, to 1·5 × 1·2 cm.

Distribution: Known from the Northern district and the adjoining Milne Bay district of Papua.

Ecology: In rain forest at 50–100 m altitude.

Notes: The flowers are unknown and are needed to confirm the status of this variety. The flattened fruits are very unusual.

var. **subcordata** (Bl.) Miq. *Ann. Mus. Bot. Lugd. Bat.* **2**(1): 46 (1865) p.p.; J. Sinclair *Gdns' Bull., Singapore* **23**: 307 (1968), f. 38A–C.

Myristica subcordata Bl. (1837).

Twigs similar to var. *morindiifolia* but more slender. Petiole 8–10 mm long; leaf-blade ovate-oblong, 10–20 × 7–9 cm, tip ± acute, base rounded and subcordate, indumentum medium brown. Inflorescence axis 1 cm long. Male flowers with pedicels 3 mm long; perianth ± tubular, 5–6 × 2·5 mm. Female flowers ± similar to male ones with pedicels *c.* 2 mm long; perianth campanulate, 8 × 5 mm. Fruit ± ellipsoid, 3·5–5 × 2–2·5 cm, densely covered with dark rust-coloured hairs, ± sessile.

Distribution: Known from the Vogelkop, Jayapura and Digul districts in western New Guinea.

Ecology: Primary rain forest.

Notes: This variety is quite close to var. *morindiifolia* but differs in having ovate-oblong leaves and a subcordate leaf base, and the fruit is smaller.

Myristica flosculosa J. Sinclair *Gdns' Bull., Singapore* **23**: 359 (1968), f. 58, 59.

Tree to 15 m tall. Twigs smooth, reddish-brown, at first covered with fine light brown hairs, later glabrous. Petiole 10–15×3 mm; leaf-blade elliptic, oblong-elliptic or elliptic-lanceolate, 11–23×4–9 cm, tip acute or acuminate, base acute, undersurface covered with minute pale yellowish scales, midrib lying in groove above, raised beneath, nerves sunken above, raised and prominent beneath, reticulations ± invisible. Male inflorescence a scar-covered knob to 5 mm long. Male flowers with pedicels 6–8 mm long; perianth ± tubular, to 10×2 mm, ± glabrous, bracteole *c.* 1 mm below base of perianth on pedicel. Female inflorescence similar to male one. Female flowers 6–8 mm long; perianth 5–6×3–3·5 mm, ± glabrous. Fruit single or in pairs, ± ovoid, 3×2·5 cm, base formed into short pseudostalk. Stalk 10×4 mm.

Distribution: Known from the Northern and Milne Bay districts of Papua and from the Eastern Highlands district of northeastern New Guinea.

Ecology: In forest to 1538 m altitude.

Myristica fragrans Houtt. *Nat. Hist. Pl.* **2**(3): 333 (1774); J. Sinclair *Gdns' Bull., Singapore* **16**: 361 (1958), f. 29; **23**: 225 (1968).

Tree 4–6 m tall with all parts aromatic. Twigs glabrous, light brown to greyish-brown. Petiole *c.* 1 cm long; leaf-blade elliptic to oblong-lanceolate, 6–14×3·5–6·5 cm, tip acute to slightly acuminate, base acute, glabrous, coriaceous, drying grey-green to olivaceous above, subglaucous beneath, midrib slightly raised above, raised and prominent beneath, drying reddish-brown, nerves 8–11 pairs, sunken above, raised and prominent beneath, drying a similar colour to midrib, slender and ± disappearing towards margin, reticulations lax, rather faint. Male and female inflorescences often occurring on same tree or not, both glabrous, axillary, with flowers in umbellate cymes; main axis 1–1·5 cm long, usually unbranched, pedicels 1–1·5 cm long, glabrous; bracteole minute. Flowers fragrant, light yellow, glabrous, to 1 cm long, ellipsoid, with 3 teeth which become reflexed. Fruit broadly pyriform, yellow, glabrous, 6–9 cm long with distinct line of dehiscence, pericarp fleshy. Aril red and very laciniate. Seed brown, highly aromatic.

Distribution: Originally from Ambon and Banda Islands in the Moluccas but now widely distributed throughout Malaysia and New Guinea. In Papua New Guinea it is being grown successfully at the Lae Botanic Garden and at several agricultural research stations throughout the country.

Notes: M. fragrans yields 2 spices—mace which comes from the dried aril, and nutmeg which comes from the dried seed. In Malaya, jellies and sweetmeats are made from the pericarp. The seeds also yield various oils which are used variously in perfumery and in medicine, mostly externally. The oil contains a narcotic and poisonous drug, myristicin.

Myristica fusca Markgr. *Bot. Jb.* **67**: 158 (1935); J. Sinclair *Gdns' Bull., Singapore* **23**: 259 (1968), f. 25.

Tree to 30 m tall. Twigs densely covered with short rust-coloured hairs, becoming glabrous. Petiole 10–18 × 5 mm, covered with short brown hairs; leaf-blade mostly oblong or oblong-ovate, 18–28 × 17–12 cm, tip acute, base rounded or subcordate, glabrous above or midrib sometimes with a few short brown hairs, undersurface quite covered with short brown hairs, midrib lying in groove above, raised beneath, nerves sunken above, raised beneath, closely spaced, curved near margin, reticulations distinct on both surfaces. Inflorescence a woody scar-covered knob to 1 cm long, sometimes with smooth basal portion, covered with short brown hairs. Male flowers with pedicels to 1 cm long, covered with short brown hairs; perianth, 15–17 × 5 mm, covered with short brown hairs, bracteole very small, situated at base of perianth. Female inflorescence similar to male one. Female flowers covered with short brown hairs, with pedicels *c.* 8 × 3 mm; perianth 10 × 5 mm, similar to male one. Fruit ellipsoid, 7 × 4 cm, densely covered with rust-coloured hairs at first but becoming glabrous. Stalk 10 × 5 mm. Seed 3·5 × 1·8 cm.

Field characters: Buttresses to 1 m high have been recorded.

Distribution: Known from the Jayapura district of western New Guinea and the adjoining West Sepik and Madang districts of northeastern New Guinea.

Ecology: In primary rain forest at 100–800 m altitude.

Notes: M. fusca is somewhat similar to *M. womersleyi* and *M. sphaerosperma*, all three species having a similar dark brown indumentum on the undersurface of the leaves. However, it can be distinguished from these species by the ellipsoid fruit and the longer, denser hairs on the perianth.

Myristica garciniifolia Warb. *Monog. Myrist.* 525 (1897), t. 19; J. Sinclair *Gdns' Bull., Singapore* **23**: 196 (1968), f. 13.

Tree to 25 m tall. Twigs smooth and glabrous. Petiole to 20 × 4 mm; leaf-blade ± oblong or obovoid, 16–30 × 5–11 cm, tip ± bluntly acute, base rounded or subcordate, glabrous, midrib flat above, raised beneath, nerves faint above and beneath, reticulations invisible. Male inflorescence glabrous, main axis to 4 cm long with 2–3 branches, tips of which covered with scars. Male flowers ± glabrous, with pedicels 5–8 × 1 mm; perianth ellipsoid, 5–6 × 3 cm, glabrous when old. Stalk 10–15 × 4–5 mm. Seed *c.* 3·5 × 1·5 cm.

Field characters: Small buttresses may be present.

Distribution: In primary or secondary forest usually close to the coast to 350 m altitude.

Notes: Similar to *M. schleinitzii* but more robust with larger, tougher leaves and bigger flowers and fruits. It occurs in a similar habitat to *M. schleinitzii* but can also be found some distance inland whereas *M. schleinitzii* is essentially a coastal tree.

Myristica globosa Warb. *Monog. Myrist.* 540 (1897), t. 19, f. 1, 2; J. Sinclair *Gdns' Bull., Singapore* **23**: 378 (1968), f. 63.

Myristica baeuerlenii Warb. (1897); *Myristica chalmersii* Warb. (1897); *Myristica salomonensis* Warb. (1897); *Myristica tristis* Warb. (1897); *Myristica schumanniana* Warb. (1900).

Tree to 35 m tall. Twigs slender, glabrous, usually drying reddish-brown. Petiole slender, 8–15 mm long; leaf-blade elliptic to almost lanceolate, 8–17 × 3–5·5 cm, tip acute or bluntly acuminate, base ± acute, glabrous, midrib sunken above, slightly raised beneath, nerves fine, sunken above, slightly raised beneath, reticulations very faint. Male inflorescence axis a woody, scar-covered knob 2–5 mm long. Male flowers with filiform pedicels, 5–6 mm long; perianth ± ellipsoid, 5 × 3 mm, minutely hairy outside. Female inflorescence similar to the male one. Female flowers with filiform pedicels, 5–7 mm long; perianth urceolate, *c.* 6 × 4 mm, minutely hairy outside. Fruit globose or subglobose, *c.* 1·5–2·8 cm in diameter, minutely hairy. Stalk 5–7 × 3 mm. Seed slightly aromatic.

Field characters: Small buttresses often present.

Distribution: Widely distributed from the Moluccas to the Solomon Islands. Throughout the lowland areas of Papuasia but apparently absent from the monsoon forests of Papua.

Ecology: Lowland forest from sea level to *c.* 1200 m altitude.

Notes: One of the few species of *Myristica* that is widespread and reaches any great size. It shows little variation despite its wide range.

Myristica hollrungii Warb. *Monog. Myrist.* 490 (1897), t. 19, f. 1, 2; *Gdns' Bull., Singapore* **23**: 405 (1968), f. 68, 69.

Myristica heterophylla K. Sch. (1889) p.p.; *Myristica albertisii* Warb. (1897); *Myristica euryocarpa* Warb. (1900).

Tree to 36 m tall. Twigs glabrous, 2 raised lines running from petiole base to petiole base. Petiole to 30 × 3–4 mm; leaf-blade ± oblong, 20–35 × 5–13 cm, tip acute or acuminate, base ± rounded or subcordate, glabrous, midrib and veins flat, sunken above, raised beneath, nerves ± parallel and equidistant, reticulations visible on both surfaces. Male inflorescence axis a woody, scar-covered knob, 30 × 5 mm, simple or with up to 5 branches, smooth basal portion to 3–5 mm long sometimes present. Male flowers with pedicels 6 mm long; perianth ± subglobose, 5 × 4 mm, ± glabrous. Female inflorescence similar to male one. Female flowers similar to male ones but with shorter, thicker pedicels. Fruit ± ellipsoid, 3–6 × 2–4 cm, becoming glabrous when mature. Stalk 5 × 4 mm. Seed 3 × 1·5 cm or slightly bigger.

Field characters: Stilt-roots have been recorded in this species as well as buttresses.

Distribution: Common in many lowland areas of mainland New Guinea and also on New Britain and New Ireland.

Ecology: In lowland rain forest by rivers and streams, sometimes in swampy or mangrove communities; it sometimes occurs to 920 m altitude.

Notes: Commonly called the 'mangrove nutmeg'. In some respects it is similar to *M. subalulata* but lacks the ant-inhabited swellings in the twigs and also has larger fruits.

Myristica hooglandii J. Sinclair *Gdns' Bull., Singapore* **23**: 156 (1968), f. 7. **Fig. 89.**

Myristica carrii J. Sinclair (1968), f. 8.

Tree to 21 m tall. Twigs ± smooth, minutely hairy when young but becoming glabrous. Petiole 20–30 × 3 mm; leaf-blade oblong-elliptic, 22–42 × 6·5–11 cm, tip and base ± acute, ± glossy on upper surface when dry, becoming whitish on undersurface, glabrous, midrib and nerves sunken above, midrib raised beneath, nerves raised but not prominent, reticulations ± invisible. Inflorescence with flattened main axis, 10–12 cm long. Male flowers with pedicels 1·3–1·5 cm long; perianth ovoid-ellipsoid, 13–16 × 8–10 mm, minutely hairy, perianth lobes to half the length of perianth. Female flowers ovoid-globose, *c.* 8 mm in diameter, covered with fine short hairs. Fruit ± oblong, 6–7 × to 5 cm, ± glabrous. Stalk 1 cm long. Seed to 3·5 × 1·2 cm.

Distribution: Known from the Northern and Milne Bay districts and the Papuan Islands in Papua, the Morobe district in northeastern New Guinea, and Manus Island in the Bismarck Archipelago.

Ecology: In rain forest on slopes and well-drained areas at 25–270 m altitude.

Myristica inopinata J. Sinclair *Gdns' Bull., Singapore* **23**: 199 (1968), f. 14.

Tree 20 m tall. Twigs smooth, covered with short rust-coloured hairs. Petiole 20 × 3–4 mm, tomentose at first, becoming glabrous; leaf-blade oblong-lanceolate or ovate-lanceolate, 16–27 × 7–10 cm, tip bluntly pointed, base ± subcordate, covered beneath with short pale brown hairs, becoming glabrous. Male inflorescence with smooth main axis 1–2 cm long, either simple or with 2 short branches, covered with short pale brown hairs. Male flower covered with short brown hairs, with pedicels 4·5 mm long; perianth ± tubular, to 10 × 5 mm. Female inflorescence shorter than male one, main axis 4–5 mm long, covered with pale brown hairs. Female flowers with short stout pedicels, covered with pale brown hairs; perianth urceolate, 9 × 7 mm. Fruit ± ovoid, *c.* 3 × 2·5 cm, covered with short, medium brown hairs, flattened at base. Stalk 10 × 5 mm.

Distribution: Known only from the Papuan Islands.

Ecology: In rain forest on ridges to 150 m altitude.

Myristica insipida R. Br. *Prodr.* 400 (1810); J. Sinclair *Gdns' Bull., Singapore* **23**: 369 (1968), f. 61.

Myristica buchneriana non Warb. (1891), C. T. White (1950 and in Walker 1948, 1962); *Myristica guadalcanalensis* J. Sinclair (1968), f. 57, nom. invalid.

Tree to 20 m tall. Twigs smooth, glabrous. Petiole 10–15 × 2 mm; leaf-blade ± elliptic, lanceolate or oblong-lanceolate, 10–20 × 2·5–7·5 cm, tip acute or ± rounded, glabrous, usually noticeably paler beneath, midrib

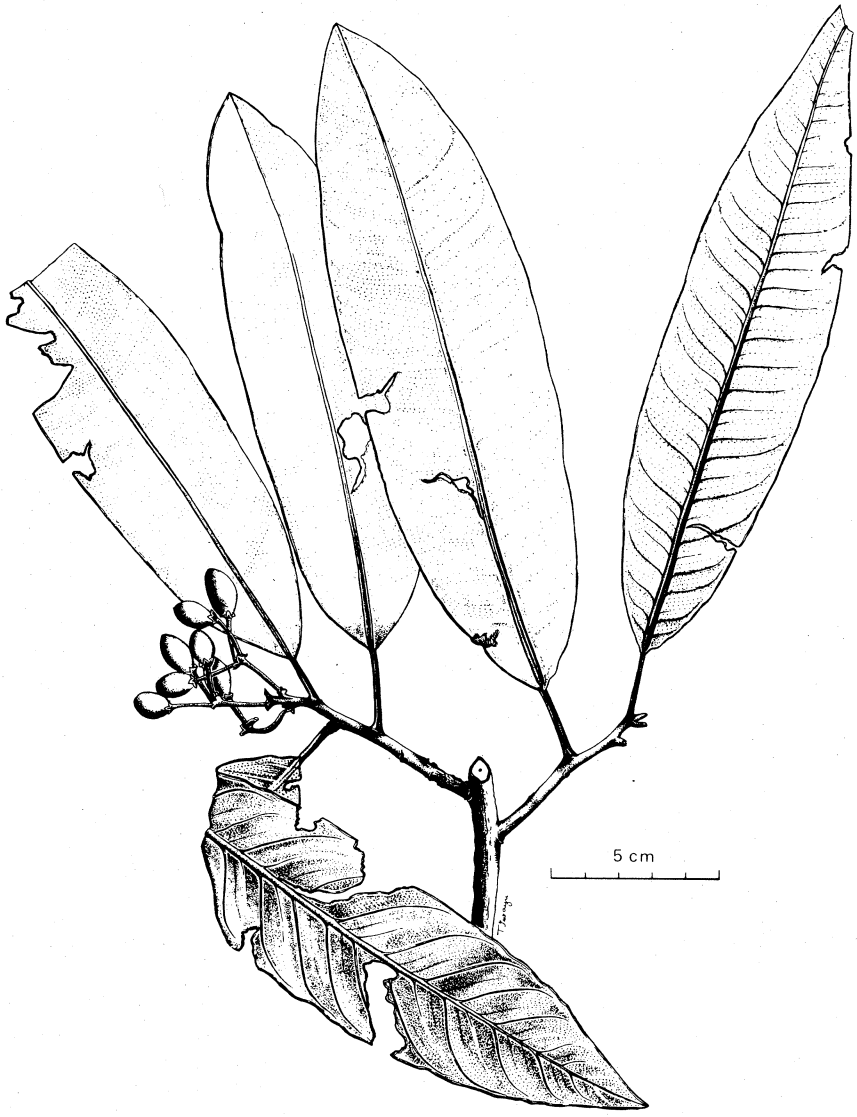


Fig. 89 **Myristica hooglandii** J. Sinclair Twig with male flowers

sunken above and prominent beneath, nerves faint on both surfaces. Male inflorescence a woody scar-covered knob to 5 mm long. Male flowers covered with short closely matted hairs, pedicels 2–3 mm long; bracteole small, appressed to base of perianth; perianth ± tubular, 3–5 mm long, pale brown. Female inflorescence similar to male one but only 1–3 mm long. Female flowers covered with indumentum similar to male ones, with pedicels to 3 mm long, slender; bracteole small, situated *c.* 1 mm below top of pedicel; perianth ± tubular, 4×2·8 mm. Fruit ± ellipsoid, to 5×2·5 cm, top rounded, base slightly narrowed, covered with minute hairs at first, becoming glabrous. Stalk to 10×3·5 mm. Seed ± ellipsoid, to 3×1·3 cm.

Distribution: Known from the Lesser Sunda Islands, the southern coast of New Guinea, coastal areas of northern Australia and the Solomon Islands.

Ecology: Coastal dune forests, usually not very far inland and usually at low altitudes.

Myristica kajewskii A. C. Sm. *J. Arnold Arbor.* **22**: 68 (1941); J. Sinclair *Gdns' Bull., Singapore* **23**: 412, 512 (1968), f. 70. **Fig. 90.**

Myristica cerifera A. C. Sm. (1941).

Tree 10–25 m tall. Twigs stout, becoming rough when older, glabrous. Petiole 20–50×3–4 mm, drying blackish and becoming deeply channelled; leaf-blade ± oblong, 17–35×6–12 cm, tip ± acute, base rounded, glabrous, midrib and veins sunken above, raised and prominent beneath, reticulations faint. Male inflorescence a woody scar-covered knob 10–20×5–6 mm, simple or divided once. Male flowers covered with very short closely matted hairs; pedicels ± flattened, *c.* 3×1·5 mm; perianth ± subglobose, thick-walled 6–8×5–6 mm. Female inflorescence similar to male one, *c.* 7×6 mm. Female flowers similar to male ones, pedicels very short and stout; perianth 6–7×5–6 mm. Fruit ± subglobose, 7–8·5×5·5–7·5 cm, pericarp sometimes warted, slightly hairy at first but becoming glabrous. Stalk 5–20 mm. Seed 4×2 cm, slightly aromatic.

Field characters: Stilt-roots have been recorded in this species.

Distribution: Throughout the Solomon Islands.

Ecology: In lowland rain forest on ridges and in flat areas, at times found at the edge of mangrove swamps, from sea level to 1200 m altitude.

Myristica lancifolia Poir. in Lamk. *Encycl. Meth. Bot.* Suppl. 4 = **12**: 35 (1816); J. Sinclair *Gdns' Bull., Singapore* **23**: 456 (1968), f. 79.

Myristica papuana Scheff. (1876).

Trees to 30 m tall. Twigs smooth and glabrous. Petiole 8–30×2–3 mm; blade narrowly lanceolate, lanceolate or elliptic, 8–18×2–7 cm, tip ± acute, base ± acute or ± rounded, glabrous, midrib and veins sunken above, slightly raised beneath, midrib usually clearly defined but veins often faint. Male inflorescence a woody scar-covered knob, simple or divided once, sometimes with smooth basal portion. Male flowers covered with closely matted or sometimes shaggy hair, sometimes almost glabrous; pedicels slender, 2–5 mm long; perianth ± tubular, 4–6×2–3 mm. Female in-

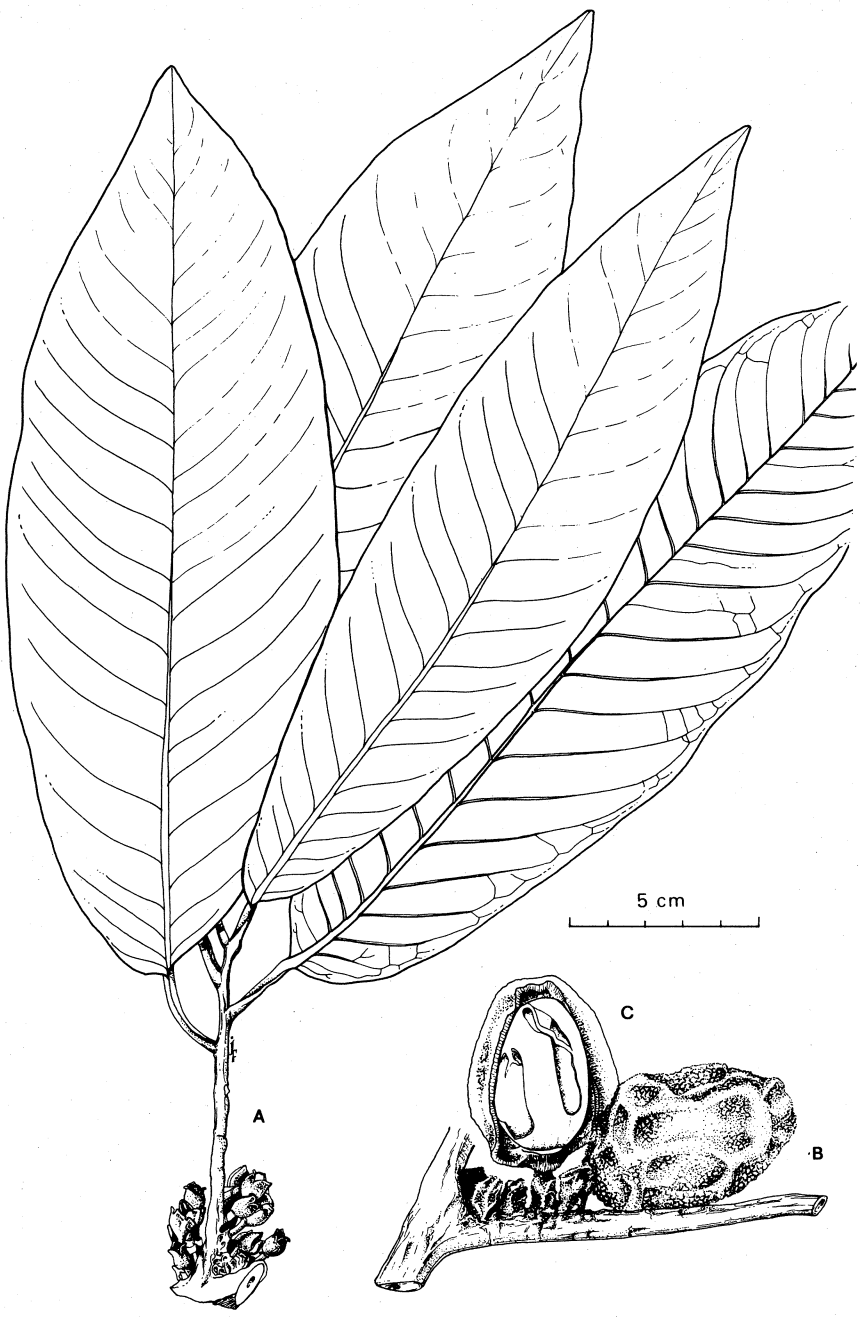


Fig. 90 **Myristica kajewskii** A. C. Sm. (A) twig with male flowers (B) fruit (C) fruit with part of the pericarp removed to show aril surrounding the seed

florescence similar to male one. Female flowers similar to male ones; pedicels 2–5 mm long, slender; perianth ± ovoid, 3–8×2–4 mm. Fruit variable.

KEY TO VARIETIES

1. Fruits ± subglobose, 1·6–1·8×1·4–1·5 cm; male inflorescence axis simple or sometimes bifurcate; leaves lanceolate to broadly lanceolate.....var. **lancifolia**
1. Fruits ellipsoid, larger than above; male inflorescence axis always bifurcate, not simple; leaves lanceolate, narrowly lanceolate or spathulate
2. Fruit 3–4×1·5–1·8 cm; male inflorescence always bifurcate; male flowers covered with shaggy hairs *c.* 1 mm long; leaves lanceolate, margins not thickened or revolute.....var. **bifurcata**
2. Fruit 4·7–5.5×2·3–2·5 cm; male inflorescence axis simple; male flowers not covered with shaggy hairs; leaves narrowly lanceolate or spathulate, margins thickened and revolute.....var. **clemensii**

var. **bifurcata** J. Sinclair *Gdns' Bull., Singapore* **23**: 460 (1968), f. 80.

Petiole 1·5–2 cm long; leaf-blade lanceolate, 8–18×2·5–7 cm. Male inflorescence bifurcate. Male flowers covered with shaggy 1 mm long hairs, pedicels *c.* 2 mm long; paerinth ± tubular, *c.* 4×3 mm. Female inflorescence simple. Female flowers with pedicels *c.* 5 mm long; perianth 5×3–4 mm. Fruit ellipsoid, 3–4×1·5–1·8 cm. Stalk 8×3 mm.

Distribution: The Moluccas, possibly the Celebes and once recorded from the Vogelkop district in western New Guinea.

var. **clemensii** (A. C. Sm.) J. Sinclair *Gdns' Bull., Singapore* **23**: 463 (1968), f. 81.

Myristica clemensii A. C. Sm. (1941).

Petiole *c.* 1 cm long; leaf-blade narrowly lanceolate or spathulate, 10–17× 2–4·5 cm, margins often thickened and revolute. Inflorescence axis simple. Male flowers glabrous or minutely hairy, pedicels slender, *c.* 5 mm long; perianth ± tubular, 5–6×2–3 mm. Female flowers with pedicels *c.* 5 mm long; perianth *c.* 8×4 mm. Fruit ± ellipsoid, 4·7–5·5×2·3–2·5 cm. Stalk 8–10 mm.

Field characters: Stilt-roots have been reported.

Distribution: Known from the Morobe district in northeastern New Guinea, the Western and Central districts of Papua, and New Britain.

Ecology: In rain forest on slopes and ridges to 760 m altitude.

var. **lancifolia**

Petiole 8–15 mm long; leaf-blade lanceolate to broadly lanceolate, 8–16× 2–6 cm, tip ± acute, base ± acute to ± rounded. Male inflorescence usually simple, occasionally bifurcate. Male flowers covered with short pale brown tomentum, pedicels *c.* 3 mm long; perianth 4–5×1·8–2 mm. Female flowers similar to male ones, pedicels 2–3 mm long, perianth 3×2–2·5 mm. Fruit ± subglobose, 1·6–1·8×1·4–1·5 cm.

Distribution: Known from the Vogelkop, Geelvink Bay and Jayapura districts in western New Guinea, the East Sepik and Madang districts of northeastern New Guinea, and the Western, Gulf and Central districts of Papua.

Ecology: In primary and secondary forest, often by streams, sea level to 300 m altitude.

Myristica lepidota Bl. *Rumphia* **1**: 183 (1837), t. 57; J. Sinclair *Gdns' Bull., Singapore* **23**: 265 (1968), f. 29.

Tree to 35 m tall. Twigs slender, glabrous. Petiole slender, 1–1·5 cm long; leaf-blade elliptic or lanceolate, 9–14 × 3–4·5 cm, tip acuminate, base acute, covered beneath with minute yellowish-brown scales, midrib and veins sunken above, raised beneath, reticulations if present usually faint. Male inflorescence a small woody knob 2–3 × 2 mm. Male flowers covered with short brown hairs; pedicels slender, 2–3 mm long; perianth ± tubular, 3–5 × 2–2·5 mm. Female inflorescence axis usually very short. Female flowers covered with short closely matted brown hairs; pedicels slender, 2 mm long; perianth campanulate, 3 × 2·5 mm. Fruit ± obovoid, 2·5–3 × 1–1·5 cm, minutely hairy. Stalk stout, 4–5 × 4–5 mm.

Distribution: Known from the Vogelkop, Fakfak and Mimika districts in western New Guinea and the adjacent Aru Islands.

Ecology: In primary forest, usually at low altitudes but to 1200 m.

Notes: At first sight this species could be confused with *M. globosa.* However, it has yellowish-brown scales on the undersurface of the leaf, obovoid rather than globose fruits, and hairier flowers.

Myristica longipes Warb. *Monog. Myrist.* 535 (1897); *Gdns' Bull., Singapore* **23**: 343 (1968), f. 52.

Myristica resinosa Warb. (1897); *Myristica warburgii* K. Sch. (1905); *Myristica pachyphylla* A. C. Sm. (1941).

Tree to 20 m tall. Twigs glabrous, finely striate. Petiole 10–15 × 2–3 mm; leaf-blade variable in shape and texture, elliptic-lanceolate, ovate-elliptic, obovate-elliptic, 6–15 × 3·5–6 cm, tip acuminate and drawn out or bluntly acute, base acute or ± rounded, glabrous, midrib and nerves sunken above, midrib raised and prominent beneath, nerves slightly raised and faint, reticulations visible on upper surface, very faint or invisible beneath. Male inflorescence with slender, smooth main axis 5–35 mm long, with 2 scar-covered branches. Male flowers minutely hairy with pedicels 5–6 mm long, slender; perianth ± tubular, to 10 × 2–3·5 mm, pubescent, bracteole falling off at early stage. Female inflorescence similar to male one but main axis usually shorter. Female flowers pubescent, pedicels 8 mm long; perianth flask-shaped, 7 × *c.* 3–4 mm. Fruit spindle-shaped, 3–5 × 1·5–2·3 cm, minutely hairy at first, becoming glabrous, pointed at both ends, narrowed at base into pseudostalk to 7 mm long. Stalk to 2·3 cm long ending in small cup-like receptacle. Seed ellipsoid, 3 × *c.* 1·5 cm.

Distribution: Known from the Jayapura district of western New Guinea, the West Sepik, Morobe, Western and Eastern Highlands districts of north-eastern New Guinea, and the Southern Highlands, Western, Central and Milne Bay districts of Papua.

Ecology: On mountain slopes of mainland New Guinea at 460–2000 m altitude.

Myristica markgraviana A. C. Sm. *J. Arnold Arbor.* **22**: 66 (1941); J. Sinclair *Gdns' Bull., Singapore* **23**: 221 (1968), f. 18.

Myristica philippensis non Lamk. (1791), Markgr. (1935).

Tree to 30 m tall. Twigs at first minutely hairy, soon becoming glabrous; leaf-blade ± elliptic, 16–23 × 6–10 cm, tip ± acute, base ± acute to obtuse, glabrous above, covered beneath with cinnamon-coloured or silvery scales and short brown hairs which are easily removed, midrib and veins sunken above, raised beneath, secondary nerves if present not well developed, reticulations faint or invisible. Male inflorescence a loosely branched panicle, to 6 cm long, covered with short dark brown hairs. Male flowers covered with short dark brown hairs; pedicels 7–10 mm long; perianth ± subglobose in bud, 7–10 × 5–7 mm, bracteole closely appressed to one side of flower and *c.* half its length. Female inflorescence similar to male one but shorter and less branched. Female flowers similar to male ones, perianth ovoid, 7 × 7 mm. Fruit ellipsoid or ovoid, to 5 × 3·5 cm, rounded at base, tip ± pointed, covered with short dense brown hairs. Stalk 10 × 5–7 mm. Seed 3·5 × 2 cm.

Field characters: Small buttresses sometimes present on old trees.

Distribution: Known from the Madang and Morobe districts in northeastern New Guinea, and the adjoining Northern district of Papua.

Ecology: In rain forest at 180–920 m altitude, on slopes and ridges.

Myristica neglecta Warb. *Monog. Myrist.* 542 (1897), t. 17, f. 1–3; J. Sinclair *Gdns' Bull., Singapore* **23**: 154 (1968), f. 6.

Tree 25 m tall. Twigs glabrous, stout, finely striate. Petiole 40–45 × 5–6·5 mm, deeply channelled when dry; leaf-blade ± oblong, 32–56 × 11–16·5 cm, tip acute, base rounded to slightly subcordate, glabrous, midrib prominent, base to 4 mm broad, raised on both surfaces; veins slightly raised on upper surface when dry, slightly raised beneath but not prominent, reticulations almost invisible. Inflorescence axis 1·5–2 cm long. Male flowers covered with minute greyish or brownish hairs; pedicels 1–1·4 × 1·5 cm; perianth ellipsoid, 13–15 × 6–8 mm, bracteole 1–3 mm below base of perianth. Female flowers similar to male ones but more swollen at base of perianth, and with somewhat shorter and thicker pedicel. Fruit ± subglobose, 5·5 × 6 cm, minutely hairy, pericarp 1 cm thick. Stalk 10 × 4 mm. Seed 3 × 2·5 cm.

Field characters: Unbuttressed tree with a narrow crown.

Distribution: Known only from western New Guinea, from the Vogelkop and Digul districts (the latter near the border with the Western district in Papua).

Notes: This species is best recognized by its very large leaves with a very prominent midrib and faint venation.

Myristica pedicellata J. Sinclair *Gdns' Bull., Singapore* **23**: 324 (1968), f. 45.

Tree to 30 m high. Twigs glabrous, strongly ridged to finely striate. Petiole 20–25 × 2–2·5 mm thick; leaf-blade narrowly oblong or lanceolate, 13–20 × 4–6 cm, tip shortly acuminate, base ± rounded, undersurface

covered with minute, appressed cinnamon-coloured scales, midrib sunken above, raised beneath, nerves sunken above, only slightly raised beneath, reticulations invisible. Inflorescence axis a woody, scar-covered knob 3–5 mm long. Flowers unknown. Fruit subglobose, 2×1·5 cm, covered with minute brown hairs. Stalk slender, 15–18×2 mm.

Field characters: Stilt-roots and low buttresses present.

Distribution: Known only from the original collection from the Madang district of northeastern New Guinea.

Ecology: On river terraces, at *c.* 100 m altitude, in *Pometia-Celtis* forest.

Myristica petiolata A. C. Sm. *J. Arnold Arbor.* **22**: 69 (1941); J. Sinclair *Gdns' Bull., Singapore* **23**: 478, 513 (1968), f. 85.

Tree to 18 m tall. Twigs glabrous, longitudinally striate. Petiole 25–60× 3 mm; leaf-blade oblong, oblong-elliptic or oblong-lanceolate, 18–25× 3·5–12 cm, tip bluntly acute, base ± rounded, glabrous above, covered beneath at first with thin indumentum of cinnamon-coloured scales, later glabrous, midrib sunken above, raised beneath, nerves sunken above, slightly raised beneath, reticulations mostly invisible. Male inflorescence simple or bifurcate, to 2·5 cm long, basal portion smooth, 5–10 mm long. Male flowers covered with short closely matted dark brown hair; pedicel short, stout; perianth subglobose, 5–6×5 mm; bracteole *c.* 2·5 mm long, situated at base of perianth. Female flowers unknown. Fruit ellipsoid, 3·5×2·3 cm, covered with dark brown hairs. Stalks 5×4·5 mm.

Distribution: Known from the Solomon Islands only.

Ecology: On hillsides and ridge tops to 300 m altitude.

Myristica rosselensis J. Sinclair *Gdns' Bull., Singapore* **23**: 205 (1968), f. 16.

Tree to 25 m tall. Twigs slender, glabrous. Petiole slender, 1–1·5 cm long; leaf-blade lanceolate, 6–16×1·8–4 cm, tip ± acute, base ± rounded, glabrous, midrib sunken above, raised beneath, nerves fine on both surfaces, at times almost invisible. Male inflorescence paniculate, main axis 4–6 cm long, secondary branches *c.* 2 cm long, covered with scars at tips. Male flowers minutely hairy, with slender pedicels 4–5 mm long; perianth 5–6×2–3 mm, bracteole 1 mm long, at base of flower. Female inflorescence axis simple, 1·5–2 cm long. Female flowers ± glabrous, pedicels 4×1 mm; perianth urceolate, 4–6×3 mm, bracteole very small. Fruit unknown.

Distribution: Known only from the Louisiade Archipelago, Papua.

Ecology: On ridges in rain forest at 100–300 m altitude.

Myristica schleinitzii Engl. *Bot. Jb.* **7**: 455 (1886); J. Sinclair *Gdns' Bull., Singapore* **23**: 202 (1968), f. 15. **Fig. 91.**

Myristica mas non Rumph. (1741), Labill. (1799); *Myristica sphanogheana* non Miq. (1865), K. Sch. (1887); *Myristica faroensis* Hemsl. (1891).

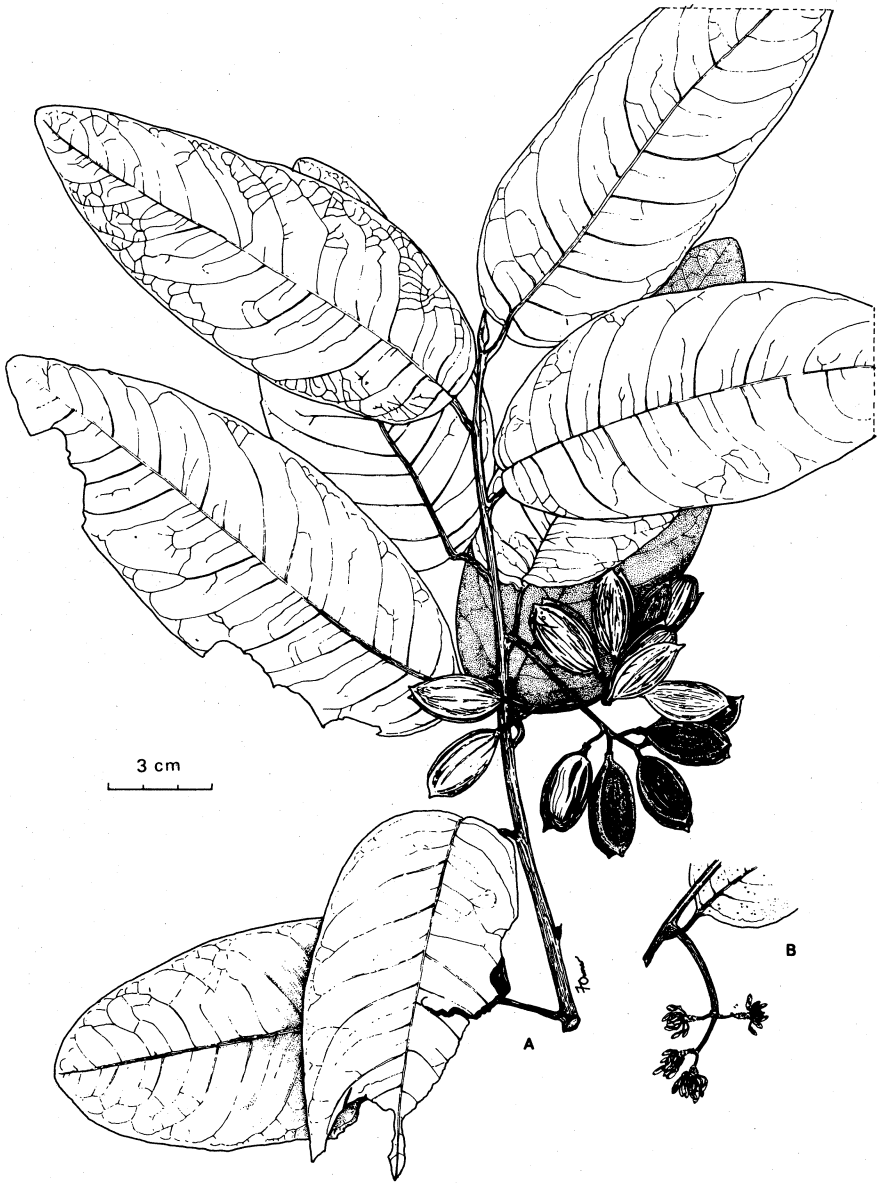


Fig. 91 **Myristica schleinitzii** Engl. (A) twig with mature fruit (B) male flowers

Tree to 15 m tall. Twigs slender, glabrous. Petiole 1–2 cm long; leaf-blade oblong or often ovate, 8–32 × 5–12 cm, tip obtuse, base rounded or cordate, rarely acute, glabrous, often drying pale yellowish-green above, glaucous beneath; midrib sunken above, raised beneath, nerves sunken above, slightly raised beneath, reticulations invisible. Male inflorescence with main axis 5–7 cm long, glabrous, 1–2 pairs of branches 2–20 mm long, tips of branches covered with scars. Male flowers covered with short closely matted hairs, pedicels slender, *c.* 5 mm long; perianth ± oblong, 5–6 × 2·5 mm long. Female inflorescence with fewer and shorter branches than the male one; flowers similar to male ones; pedicels stouter than male ones, 2–4 mm long; perianth urceolate, 4–6 × 3 mm. Fruit ± ellipsoid, 3·5 × 1·5 cm, glabrous, yellowish, base narrowed into pseudostalk 3–4 mm long. Stalk slender, 2–2·5 cm long. Seed *c.* 3 × 1 cm.

Field characters: Stilt-roots sometimes present.

Distribution: Known from the West Sepik, East Sepik, Madang and Morobe districts of northeastern New Guinea, the Milne Bay district and Papuan Islands of Papua, the Bismarck Archipelago and the Solomon Islands.

Ecology: Found mainly near the coast at low altitudes often in association with *Calophyllum* and *Intsia.*

Myristica sepicana Foreman *Contr. Herb. Aust.* **9**: 40 (1974), f. 2.

Tree 4·5–29 m tall. Twigs glabrous except terminal bud which covered with light brown appressed hairs, striate, becoming fissured with age. Petiole drying dark brown, prominently channelled, 12–20 × 2·5–5 mm; leaf-blade oblong to oblong-obovate, 21–45 × 5–17 cm, tip bluntly acute, base cuneate, chartaceous, glabrous, drying olivaceous above, light brown beneath, nerves and midrib drying distinctive reddish-brown, midrib slightly raised and prominent above, raised and very prominent beneath, nerves 15–22 pairs, ± equidistant, sunken above, raised beneath, ± straight in lower two-thirds, then curved towards and briefly along margin, reticulations faintly visible, lax above, invisible beneath, a few secondary nerves sometimes present. Male inflorescence a panicle, densely pubescent, main axis 3·5 cm long, laxly branched, branches alternate, 2·5 cm long, dichotomously branched at ends in fascicles of 4–6 flowers with pedicels *c.* 1 cm long, bracteoles not seen. Male flowers 5–7 × 4–5 mm, ± subglobose in bud, densely pubescent, split *c.* half way down into acute perianth lobes. Female flowers not known. Infructescence stout, densely tomentose, brown, to 6·5 cm long, with 4–6 fruits. Fruit densely and persistently tomentose, reddish-brown, ± ellipsoid, 5–5·5 × 2·3–2·5 cm. Seed medium brown. Aril red. Stalk stout, 1 cm long.

Field characters: Bark brown, finely fissured, inner bark light brown.

Distribution: Known at present only from the West Sepik and East Sepik districts of northeastern New Guinea.

Ecology: On ridges and ridge sides sometimes beside streams in primary and secondary lowland rain forest at 60–300 m altitude.

Myristica sphaerosperma A. C. Sm. *J. Arnold Arbor.* **22**: 71 (1941); J. Sinclair *Gdns' Bull., Singapore* **23**: 247 (1968), f. 23.

Myristica brassii A. C. Sm. (1941); J. Sinclair (1968), f. 22.

Tree to 25 m tall. Twigs glabrous, striate to slightly ridged. Petiole 15–25 × 4 mm; leaf-blade oblong or elliptic-oblong, 16–32 × 6–11·5 cm, tip ± acuminate, base rounded, glabrous above, covered with silvery or cinnamon-coloured scales beneath, becoming glabrous when older, midrib sunken above, raised beneath, nerves sunken above, raised beneath, reticulations barely visible. Male inflorescence a short woody, unbranched, scar-covered knob. Male flowers covered with dark brown, closely matted, short hairs; pedicels 8–10 mm long; perianth ± ellipsoid, 10 × 3–4 mm, bracteole *c.* 2 mm long, at base of perianth. Female inflorescence similar to male one. Female flowers similar to male ones but hairs of indumentum slightly longer; pedicels 5–10 mm long; perianth 10 × 6 mm, broadest at base. Fruit ± spherical, *c.* 6 cm in diameter, covered with fine short hairs. Stalk 15 × 5–7 mm. Seed ± spherical, to 3·5 cm in diameter.

Distribution: Known from the Vogelkop and Jayapura districts of western New Guinea, and the Morobe and Western Highlands districts of northeastern New Guinea.

Ecology: On ridges and slopes at 800–2150 m altitude.

Myristica subalulata Miq. *Ann. Mus. Bot. Lugd. Bat.* **2**(1): 47 (1865); J. Sinclair *Gdns' Bull., Singapore* **23**: 386 (1968), f. 64, 65.

Myristica myrmecophila Becc. (1884); *Myristica heterophylla* K. Sch. (1889) p.p.; *Myristica bialata* Warb. (1891); *Myristica costata* Warb. (1893); *Myristica velutina* Markgr. (1935).

Small tree to 12 m tall. Twigs glabrous, often hollow and swollen, 2 raised lines running from petiole base to petiole base and often extended into thin, narrow wings. Petiole 7–20 mm long; leaf-blade oblong or obovate, 20–40 × 7–20 cm, tip bluntly acute or shortly acuminate, base ± rounded, subcordate or in young or small leaves sometimes ± acute, glabrous, midrib sunken above, raised beneath, nerves sunken above, raised beneath, clearly defined, reticulations almost invisible. Male inflorescence a woody scar-covered knob 5–20 × 5 mm, short smooth basal portion sometimes present. Male flowers covered with fine, short, closely matted hairs; pedicels slender, 1–15 mm long; perianth 13 × 3–5 mm, bracteole triangular, falling off at early stage. Female inflorescence similar to male one but shorter. Female flowers covered with closely appressed rust-coloured hairs; pedicels 2–10 × 2–3 mm; perianth 7–10 × 5–6 mm. Fruit usually subglobose but occasionally becoming elongated, 1·5–5 × 1·2–2·5 cm, covered with short fine rust-coloured hairs. Stalk often short, 3 × 3 mm, but to 15 × 2–3 mm. Seed ± ellipsoid, 2 × 1·3 cm.

Field characters: Stilt-roots often present, especially under wet conditions. The swellings of the twigs which are so characteristic of this species are often inhabited by small black ants.

Distribution: Widely distributed from the Kai Islands and the Moluccas, throughout New Guinea and New Britain but not extending to the Solomon Islands.

Ecology: In primary, secondary or disturbed forest, in swamps, on slopes and ridges, sea level to 2200 m altitude.

Notes: Specimens from the highlands often have smaller leaves than those from the lowlands and also lack the conspicuous ant-inhabited swellings, although small swellings can usually be found on older twigs.

Myristica sulcata Warb. *Monog. Myrist.* 538 (1897), t. 19, f. 1, 2; J. Sinclair *Gdns' Bull., Singapore* **23**: 396 (1968), f. 66.

Myristica anceps Warb. (1897); *Myristica undulatifolia* J. Sinclair (1968).

Tree to 43 m tall, but often found as smaller trees to 25 m tall. Twigs glabrous, with 2 raised lines running from petiole base to petiole base but not extended into wings. Petiole 1·5–2·5 cm long; leaf-blade elliptic, oblong-elliptic or obovoid, 14–26(–32)×3·5–9 cm, tip ± rounded, then acutely acuminate at tip, base rounded or acute, margins occasionally inrolled when dry, glabrous, midrib and nerves sunken above, raised beneath reticulations faint. Male inflorescence a woody scar-covered knob 3–5 mm long. Male flowers pubescent, pedicels slender, 5–7 mm long; perianth 4–5×2 mm, bracteole small, falling off early. Female inflorescence similar to male one. Female flowers similar to male ones, pedicels 3–4 mm long; perianth *c.* 3×3 mm. Fruit ± subglobose, 3·8–6×3–5·5 cm, minutely hairy at first, becoming almost glabrous. Stalk 10×5 mm. Seed 2·5×2 cm.

Field characters: Buttresses and stilt-roots sometimes present.

Distribution: Known from the Vogelkop, Jayapura and Digul districts of western New Guinea, the Madang and Morobe districts of northeastern New Guinea and throughout Papua except the Western district.

Ecology: In primary and secondary rain forest at low altitudes to 1600 m, on slopes and in low-lying areas.

Notes: Some collections have a very marked inrolling of the leaf margins and give the impression of having teeth. This effect is sometimes seen in other species and is undoubtedly due to distortions caused by drying.

Myristica tenuivenia J. Sinclair *Gdns' Bull., Singapore* **23**: 327 (1968), f. 46.

Tree to 25 m tall. Twigs covered with rust-coloured hairs at apex, becoming glabrous lower down, finely striate. Petiole 2–3 cm long; leaf-blade oblong or panduriform, 10–20×4–7 cm, tip obtusely acute, base ± rounded, covered beneath with minute rust- or cinnamon-coloured scales, becoming glabrous when older, midrib and nerves sunken above, raised beneath, reticulations invisible. Male inflorescence and flowers unknown. Female inflorescence a woody, scar-covered knob 2–3 mm long. Female flowers covered with closely matted rust-coloured hairs; pedicels 1–2 mm long, stout; perianth urceolate, 4–5×3 mm. Fruit ± ellipsoid or ovoid, 3·5–4×2·5–3 cm, covered with short rust-coloured hairs. Stalk 5–8 mm long. Seed slightly aromatic.

Distribution: Known from Misima and Rossel Islands in the Papuan Islands, Papua.

Ecology: In lowland rain forest on slopes to 300 m altitude.

Myristica tubiflora Bl. *Rumphia* **1**: 182 (1837), t. 56; J. Sinclair *Gdns' Bull., Singapore* **23**: 339 (1968), f. 51.

Tree to 20 m tall. Twigs glabrous, slender. Petiole slender, 8–15 mm long; leaf-blade elliptic or elliptic-lanceolate, 6–15 × 2–6 cm, tip acute or acuminate, base ± acute, glabrous, midrib and nerves impressed above, raised beneath, reticulations invisible. Male inflorescence slender, simple or divided once, main axis smooth, to 1·5 cm long, with scar-covered tip 1–12 mm long. Male flowers ± glabrous or covered with short, minute hairs, pedicels 8–10 mm long, filiform; perianth tubular, 8–12 mm, bracteole small, situated *c.* half way along pedicel. Female inflorescence similar to male one but shorter, main axis to 5 mm long. Female flowers similar to male ones, pedicels very variable in length, 5–40 mm long, filiform; perianth ± tubular, *c.* 8 × 3 mm. Fruit narrowly ellipsoid, 4–7 × 1·3–2·5 cm, ± pendulous, base narrowed into long pseudostalk, tip acute. Stalks 5–25 mm long, slender, ending in small cup-like receptacle. Seed ellipsoid, 3 × 1·5 cm, aromatic.

Distribution: Widely distributed throughout mainland New Guinea except the highlands areas.

Ecology: In rain forest on slopes or in low-lying areas, sea level to 1550 m altitude.

Myristica umbrosa J. Sinclair, *Gdns' Bull., Singapore* **23**: 147 (1968), f. 4.

Tree to 26 m tall. Twigs dark brown, pubescent, becoming glabrous lower down, ± smooth to striate. Petiole 1–4 cm long, deeply channelled when dry; blade oblong or oblong-elliptic, 23–53 × 8–16 cm, tip acute, base ± acute to rounded, glossy above, covered with whitish minute scales beneath, midrib prominent and raised on both surfaces, nerves sunken above, raised beneath, usually drying light reddish-brown, contrasting with paler background, reticulations invisible. Male inflorescence with flattened main axis 3·5 cm long, laxly branched, pubescent. Male flowers pubescent, pedicels *c.* 1 cm long; perianth ± subglobose, *c.* 5–7 × 4–5 mm. Female inflorescence similar to male one but stouter. Female flowers ± similar to male ones, pedicels *c.* 3·5 mm long; perianth 7·5–8 × 6 mm. Fruit ± subglobose, 6·5–9 × 4·5–6 cm, tip ± pointed, covered with short dark brown hairs. Stalk 5–10 × *c.* 5 mm. Seed to 4·5 × 3 cm.

Field characters: Stilt-roots have been recorded, particularly on trees in swampy areas.

Distribution: Known from the West Sepik and Morobe districts in north-eastern New Guinea, and the Northern and Central districts in Papua.

Ecology: In rain forest to 200 m altitude, on slopes, often found at the edge of mangrove swamps.

Myristica uncinata J. Sinclair *Gdns' Bull., Singapore* **23**: 150 (1968), f. 5. **Fig. 92.**

Tree 30 m tall. Twigs dark brown, pubescent, often striate, becoming glabrous lower down; terminal bud hook-shaped, densely covered with closely appressed dark brown hairs. Petiole 1·5–2 cm long; leaf-blade oblong,

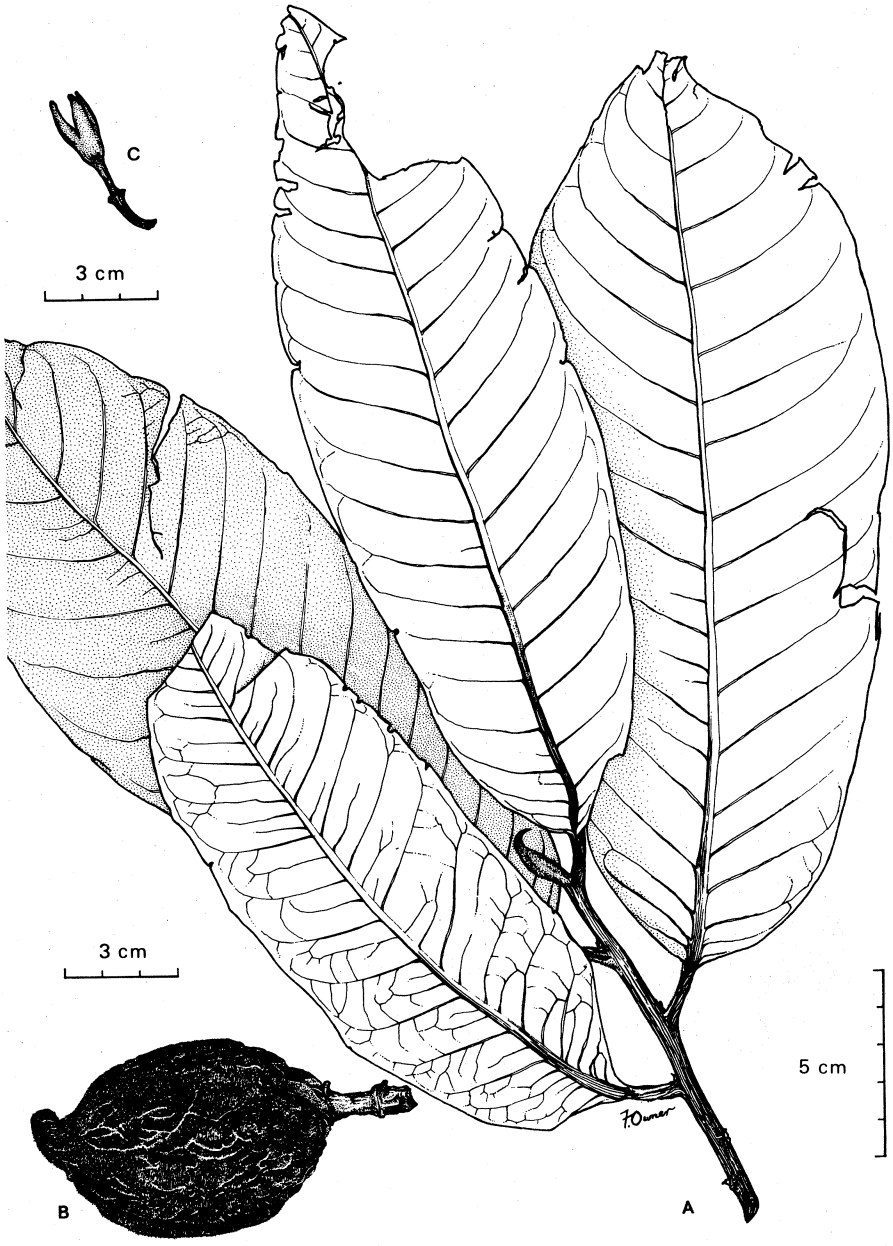


Fig. 92 **Myristica uncinata** J. Sinclair (A) leafy twig, note well-defined apical bud (B) fruit (C) female flower

Fig. 93 **Myristica womersleyi** J. Sinclair (A) twig with young fruit (B) fruit with part of pericarp removed to show seed and highly divided aril

18–30 × 5·5–10·5 cm, tip acute, base rounded, glabrous except for some 1–2 mm long hairs on lower midrib, midrib prominent and slightly raised on both surfaces, nerves slender and ± sunken above, more prominent and raised beneath, reticulations invisible. Male inflorescence unknown. Female flowers with pedicels 1 cm long, hairy; perianth ellipsoid in bud, 20 × 5–7 mm, covered with dark brown hairs to 2 mm long, split *c.* half way down into 3 lobes which become highly reflexed. Fruit ± subglobose, 4–6 cm in diameter, covered with medium or dark brown hairs. Stalk 25 × 4–5 mm. Seed oblong, 3·5 × 2·3–2·5 cm.

Distribution: Known from three collections all from near Boridi in the Central district, Papua.

Ecology: In forest at 1385 m altitude.

Myristica womersleyi J. Sinclair *Gdns' Bull., Singapore* **23**: 249 (1968), f. 24. **Figs 84, 93.**

Tree to 27 m tall. Twigs rust-coloured, tomentose, terminal bud striate, elongated, tomentose. Petiole 1–1·3 cm long; leaf-blade ± oblong, 14–20 × 5·5–9 cm, tip bluntly acute, base ± rounded, glabrous above, covered beneath with brown hairs and scales, becoming glaucous when older, midrib and veins sunken above, raised and prominent beneath, reticulations visible on both surfaces. Flowers not known. Fruit globose, 6–9 cm in diameter, pericarp covered with short dark brown hairs. Stalk 5 × 5 mm. Seed globose, 5·5 × 5 cm, intensely aromatic; aril divided into numerous narrow segments.

Distribution: Known from Mt Michael and Mt Piora in the Eastern Highlands district, northeastern New Guinea.

Ecology: In mid-montane forest at 2000–2330 m altitude.

Notes: Although restricted in its distribution, this species is apparently quite common in the areas where it occurs. In the Mt Piora area the seed is used as a bait in kapul (possum) traps. The seed is a possible source of spice and oil.

OCHNACEAE

A. Kanis

Small to medium-sized trees. Leaves alternate, stipulate, simple. Inflorescences lateral and/or terminal, thyrsoid or paniculate, with many bracts at base; pedicels jointed. Flowers regular, bisexual or polygamous; sepals 5, free or ± joined at base, imbricate, persistent; petals 5, free, contorted, deciduous; staminodes absent or 5–many; stamens 10 or 5; ovary superior, either of 5 free carpels with 1 ovule each or 3 fused carpels with many ovules; styles fused. Fruit either of drupelets or a many-seeded capsule.

Distribution: *c.* 30 genera with *c.* 250 species throughout the tropics. 2 genera, belonging to different subfamilies, are represented in New Guinea, 1 extending into the Bismarck Archipelago and the Solomon Islands.

Literature: A. Kanis (1968), A revision of the Ochnaceae of the Indo-Pacific area, *Blumea* **16**: 1–83.

KEY TO GENERA

1. Leaves in 2 rows; inflorescences small, umbel-like in appearance; staminodes absent; stamens 10; fruit of 1–5 drupelets on a swollen torus.....BRACKENRIDGEA
1. Leaves spirally arranged; inflorescences large, paniculate; staminodes 5–many; stamens 5; fruit a capsule with many small, winged seeds.....SCHUURMANSIA

BRACKENRIDGEA A. Gray

Trees with spreading monopodial branches. Stipules small, ± laciniate, caducous. Leaves in 2 rows, equally dispersed; margins entire (possibly ± dentate in saplings); lateral veins strongly curved towards tip, often some from base parallel to margins, higher ones joining successively. Inflorescences lateral and terminal, thyrsoid (though umbelloid in appearance), of shortened, sessile cymes; axis usually continuing vegetatively after fruiting; bracts small, ± laciniate, caducous. Flowers bisexual; torus half-globose; sepals 5; petals 5, white; staminodes absent; stamens 10; carpels 5, free, each with 1 ovule. Fruit of 1–2(–5) obovoid drupelets, purplish-red, turning blackish when ripe, on distinctly enlarged, purplish-red torus and pedicel; seed curved, almost ring-shaped.

Distribution: *c.* 9 species throughout the tropics of the old world, 2 in Africa, 2 in Malagasy, 4 in the Malesian area, 1 in Queensland and Fiji. 1 species is endemic to New Guinea.

Ecology: Dispersal is mainly by birds, attracted to the black fruit contrasting with the red torus and calyx. The drupelets are capable of floating because

of 2 air-filled spaces between inner and outer fruit wall.

Brackenridgea forbesii Tiegh. *Ann. Sc. Nat. Bot.* ser. 8, **16**: 395 (1902). **Fig. 94.**

Tree to 30 m tall; bole diameter to 55 cm. Stipules to 6×1 mm. Leaves with 3–5 mm long petiole; lamina lanceolate, 5–15×1·5–5 cm, acute to acuminate at apex, acute or a little tapering at base, stiff, glossy above. Inflorescences of varying number of 3(–5)-flowered cymes; rachis 2–5(–10) mm long; bracts to 2×2 mm. Flowers with *c.* 5 mm long pedicel; torus *c.* 0.3 mm high, 0·7 mm across; sepals ovate to elliptic, *c.* 4×1·5 mm; petals oblanceolate, *c.* 4×1 mm, acute at apex; filaments *c.* 1·5 mm long, as long as anthers; ovaries *c.* 0·6×0·5 mm; style *c.* 2 mm long. Fruit with up to 1 cm long pedicel; torus to 2·5 mm high, 4 mm across; drupelets to 6×5 mm.

Field characters: Bole cylindrical, straight, sometimes a little fluted or with small buttresses. Bark dark reddish or greyish-brown outside, ± peeling with small fibrous flakes. Outer bark 1–2 mm thick; inner bark 3–5 mm thick, pinkish- or reddish-brown; sapwood cream-coloured or pale brown; heartwood dull pinkish or reddish-brown, very hard.

Distribution: Endemic to New Guinea, rather scattered and collected from the Vogelkop, Jayapura and Digul districts in western New Guinea, the Morobe district in northeastern New Guinea and the Western and Central districts in Papua.

Ecology: From sea level to 750(–1000) m altitude in primary evergreen forests, on flat ground to steep slopes, on clay, sand or peat, but probably always on rather poor or ultra-basic soils. Sparsely distributed.

SCHUURMANSIA Bl.

Trees with umbelloid, sympodial branching; branches with soft pith, often hollow. Stipules small, ± ciliate, caducous. Leaves spirally arranged, in tufts; margins ± recurved, with small glandular dots; lateral veins straight, curving and joining near margins. Inflorescences terminal, paniculate, ultimately dying off. Flowers bisexual or polygamous; torus small, inconspicuous; sepals 5, sometimes tinged purple; petals 5, white, cream-coloured, pink or purplish-red; staminodes 5–many in 1 or 2 whorls, stamens joined at base with inner staminodes; ovary 3-carpellate, 1-celled, with many ovules. Fruit a spindle-shaped, acuminate capsule, turning dark brown, opening lengthwise by 3 slits; seeds many, small, winged like 2-bladed propellers.

Distribution: 3 species restricted to the Malesian area, 1 endemic to Luzon in the Philippines; 2 species in New Guinea, 1 extending into the Bismarck Archipelago and the Solomon Islands.

Literature: A. Kanis (1961), Sertulum Papuanum 4. The genus *Schuurmansia* Blume (Ochnaceae), *Nova Guinea, Bot.* **6**: 63–72.

Fig. 94 **Brackenridgea forbesii** Tiegh. (A) leafy twig with inflorescences (B) fruits (C) open flower

KEY TO SPECIES

1. Style as long as ovary or longer; stigma pointed or slightly capitate; leaves lanceolate to oblanceolate, slightly tapering at base, with distinct petiole..... **S. elegans**
1. Style half as long as ovary or shorter; stigma 3-lobed; leaves oblanceolate, distinctly tapering towards base, with relatively short, often rather indistinct petiole..**S. henningsii**

Schuurmansia elegans Bl. *Mus. Bot. Lugd. Bat.* **1**: 178 (1850), t. 32.
S. parviflora Ridl. (1916).

Treelet or tree to 15(–20) m tall; bole diameter to 10(–15) cm. Stipules to 4×2·5 mm. Leaves with 1·5–6 cm long petiole; lamina lanceolate to oblanceolate, 10–30×2·5–10 cm, rounded to ± acuminate at apex, slightly tapering at base; lateral veins *c.* 1·5 mm apart (protruding cell walls of epidermis causing fine striation parallel to nerves in dried specimens). Inflorescences 10–25 cm long, many-flowered; bracts to 2×2 mm. Flowers with 3–6 mm long pedicel; sepals elliptic to obovate, 3–6×1·5–4 mm, yellowish-green; petals obovate, 4–8×2–5 mm; outer staminodes 0–many, linear, *c.* 1 mm long; inner staminodes 15–25, linear to spatulate, 2·5–5 mm long, with distinct nerve; filaments 1–2 mm long, about as long as anthers, connective distinctly protruding; ovary ± ovoid, 1·5–3×1·2–2 mm; style *c.* as long as and widening into ovary; stigma small, pointed or capitate. Capsule to 25×5 mm; seeds with *c.* 3 mm long wings.

Field characters: Bole slender, unbuttressed, sometimes with low stilt-roots. Bark brown. Outer bark thin; inner bark red outside, otherwise reddish-brown; wood pinkish-yellow or dark straw-coloured.

Distribution: Borneo, ?Mindanao, Celebes, Moluccas. In Papuasia rather common in the Vogelkop district, also in the Geelvink Bay and Mimika districts in western New Guinea, and the Western (upper Ok Tedi) and Gulf districts in Papua.

Ecology: From sea level to 1000(–2100) m altitude in primary and secondary evergreen forests, on flat ground to steep slopes, in fresh-water swamps and on ridges, on clay or more sandy or rocky soils. Scattered or locally common in disturbed habitats. Probably rarely flowering under a closed canopy.

Schuurmansia henningsii K. Sch. in *Bot. Jb.* **9**: 210 (1888). **Fig. 95.**
S. bamleri K. Sch. & Laut. (1901); *S. bamleri* var. *longifolia* Laut. (1905); *S. gilgiana* Laut. (1905); *S. microcarpa* Capit. (1910); *S. rauwolfioides* Hallier f. (1913); *S. longifolia* (Laut.) Gilg (1925); *S. crassinervia* Gilg (1925); *S. lophiroides* Gilg (1925); *S. oreophila* Gilg (1925); *S. schlechteri* Gilg (1925); *S. coriacea* A. C. Sm. (1941); *S. montana* A. C. Sm. (1941); *S. grandiflora* A. C. Sm. (1941).

Treelet or tree to 15(–20) m tall; bole diameter to 15(–20) cm. Stipules to 5×3 mm. Leaves with up to 4 cm long petiole; lamina oblanceolate, 6–85×1·5–15 cm, obtuse to acuminate at apex, distinctly tapering towards base; lateral veins 2–7 mm apart. Inflorescences 7–65 cm long; bracts usually very small, sometimes larger and transitional to leaves. Flowers with 2–5 mm long pedicel; sepals elliptic to obovate, 3–5×1·5–3 mm, green or purplish; petals obovate, 4–7·5×1·5–4 mm; outer staminodes 0–many, with *c.* 1 mm

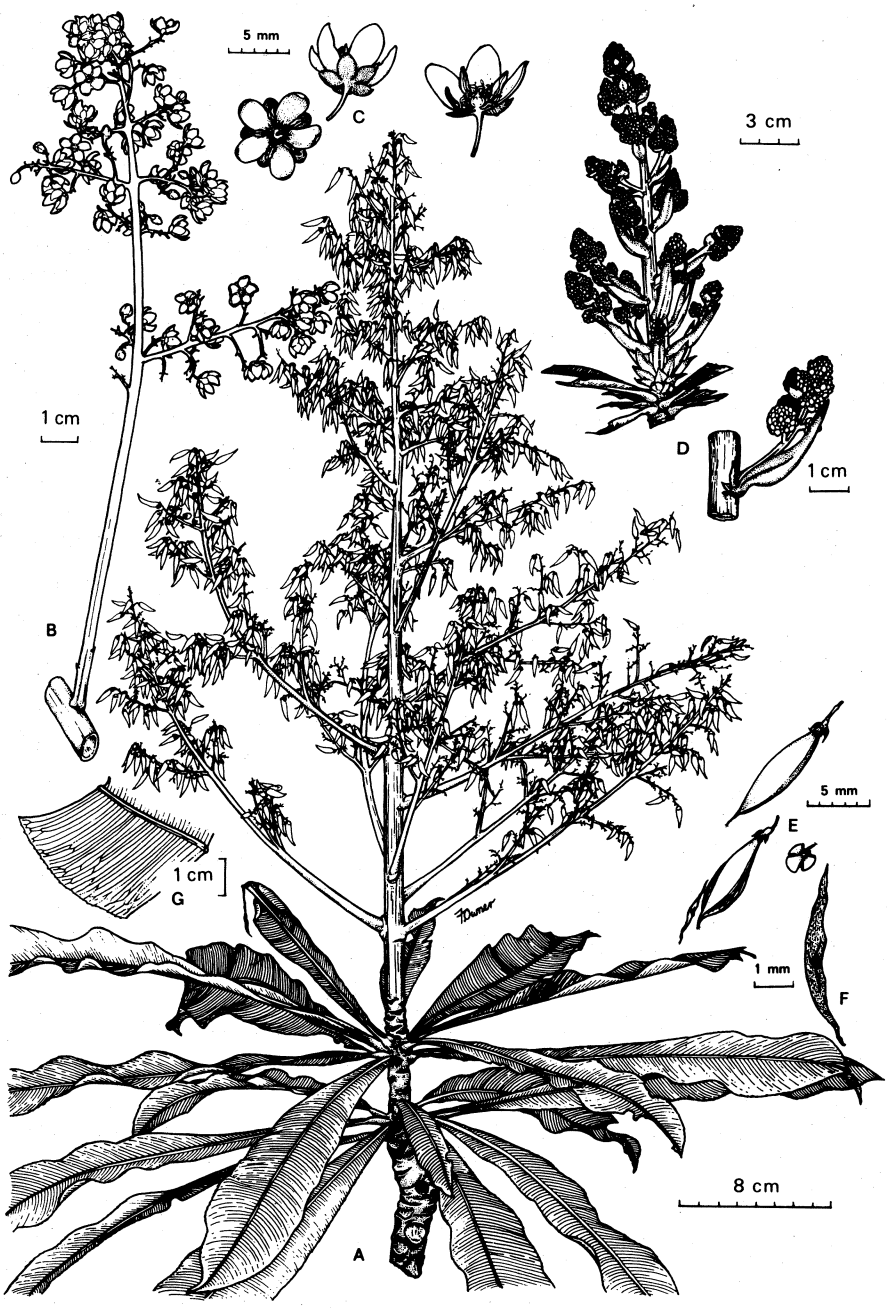


Fig. 95 **Schuurmansia henningsii** K. Sch. (A) inflorescence, in immature fruit, terminal on leafy branch (B) inflorescence branch in flower (C) open flower, face and rear view and section (D) inflorescence branch in bud with bracts (E) fruit (F) seed (G) leaf reticulation, enlarged

long hairs; inner staminodes 5–30, linear, to 2 mm long; filaments to 0·5 mm long, half as long as anthers or less; ovary ± globular to ovoid, slightly 3-lobed, *c.* 3×2 mm, much smaller in functionally male flowers; style cylindrical, to 1 mm long; stigma 3-lobed. Capsule to 15×7·5 mm; seeds with *c.* 2·5 mm long wings.

Field characters: Bole slender, unbuttressed, sometimes with stilt-roots to 1 m high. Bark brown, often greyish or with grey patches, ± smooth or shallowly fissured, sometimes with pustular, corky lenticels. Outer bark pale brown, thin; inner bark ± mottled green outside, otherwise cream-coloured or pinkish, ± distinctly layered with brownish streaks, to 5 mm thick; sapwood cream- or straw-coloured; heartwood pale brown, ± reddish, with distinct rays of different widths, medium hard and dense; pith often mouldered.

Distribution: Moluccas. In Papuasia rather common throughout most districts, but possibly absent south of the foot-hills of the central cordilleras in the Mimika and Digul districts of western New Guinea, and the Western district of Papua; throughout the Solomon Islands; not yet collected on Choiseul, Malaita or the Rennell Group.

Ecology: From sea level to 3000 m altitude in primary and secondary evergreen forests, on landslides and margins of anthropogenous grasslands, on flat ground to steep slopes, sometimes in swampy localities, on clay or more sandy and rocky soils. Scattered or locally common in open, often disturbed habitats.

Notes: This species is notably polymorphic and several ecotypes occur throughout its distributional area. The sizes of leaves and inflorescences appear to decrease rather regularly with increasing altitudes. Trees with very large leaves and conspicuous stipules are found on ultra-basic soils.

POLYGONACEAE

E. E. Henty

Herbs or shrubs, sometimes scandent; stems often swollen at nodes. Leaves simple, spirally arranged; usually sheath present, with ocrea. Flowers axillary and terminal, regular, mostly bisexual, if unisexual the plants monoecious or dioecious; pedicels usually articulate; perianth lobes 4–6, imbricate, free or shortly connate, persistent, often accrescent; stamens 4–9, free or basally connate, anthers 2-celled, longitudinally dehiscent; disc often glandular; ovary superior, 1-celled, with solitary basal ovule; styles 2–3, free or connate at base. Fruit a nut, trigonous or lenticular, rarely globose, enclosed in persistent perianth or not; embryo excentric, curved or straight, surrounded by mealy endosperm.

Distribution: *c.* 40 genera with *c.* 800 species, world-wide but mainly in north-temperate regions. In New Guinea 4 genera, 1 represented only by an imported ornamental which sometimes runs wild. Rhubarb (*Rheum rhaponticum* L.) is sometimes cultivated here at median altitudes.

Literature: C. A. Backer and R. C. Bakhuizen van den Brink (1963), Polygonaceae, *Flora of Java* **1**: 219–26 (rev. B. H. Danser). B. H. Danser (1927), Die Polygonaceen Niederlandisch-Ostindiens, *Bull. Jard. Bot. Btzg.* ser. 3, **8**: 117–261; (1940), Note on the Muehlenbeckias of New Guinea and Queensland, *Bull. Jard. Bot. Btzg.* ser. 3, **16**: 324–8.

KEY TO GENERA

1. Climbing plant with tendrils ..... ANTIGONON
1. Tendrils absent
  2. Perianth 6-lobed; in fruit 3 outer lobes much smaller than inner ones ..... RUMEX
  2. Perianth 5-lobed, lobes subequal or outer ones larger
    3. Flowers separately male and female; styles 3 with ± fringed stigmas; shrubs or ± woody climbers ..... MUEHLENBECKIA
    3. Flowers bisexual; styles 2 or 3, free or connate at base, with capitate stigmas; herbs, rarely somewhat woody at base ..... POLYGONUM

ANTIGONON Endl.

Climbing perennial herbs and sub-shrubs. Ocreas almost lacking. Flowers bisexual, in fascicles combined into axillary racemes; tepals 5, in 2 whorls, 3 outer ones larger than inner ones, accrescent after anthesis and enclosing fruit; stamens 7–9, united at base to short tube; styles 3, with capitate stigmas. Fruit trigonous.

Distribution: *c.* 8 species native to tropical America. In Papuasia 1 introduced as an ornamental.

Antigonon leptopus Hook. & Arn. *Bot. Beech.* 308 (1841) t. 69; Danser, *Bull. Jard. Bot. Btzg.* **3**: 16 (1927), *f.* 17. **Fig. 96.**

Herbaceous climber. Leaves petiolate, ovate-triangular, 5–10 cm long, apex acute, base shallowly cordate. Flowers in axillary racemes and panicles, rachis often produced to a branched tendril. Perianth white or pink, 7–8 mm long, after anthesis accrescent to 15 mm, becoming greenish, ± membranous, venation reticulate. Fruit ovoid-conical, brown, shining, 8–10 mm long.

Distribution: Native to Mexico; introduced throughout the tropics as an ornamental.

Ecology: Cultivated in lowland regions; sometimes found wild at roadsides, particularly on banks and cutting-faces.

Notes: Domestic poultry eat the fruits. Common name (E.): corallita.

MUEHLENBECKIA Meissn.

Erect or scandent shrubs or sub-shrubs, monoecious or dioecious. Leaves spiral, petiolate or sessile, with ocrea. Flowers small, in clusters in axils of small, leaf-like or scarious, stem-sheathing bracts, clusters in lax, axillary or terminal pseudospikes, simple or paniculate; perianth deeply 5-lobed, lobes subequal or outer 3 slightly larger; in male flowers, 8 (rarely fewer) stamens, gynaeceum rudimentary or absent; in female flowers, stamens small and imperfect, or abortive, ovary 3-angled with 3 short styles and ± fringed or lobed stigmas. Nut trigonous or ± globose, enclosed in persistent perianth.

Distribution: c. 15 species in Australia, Papuasia, New Zealand and South America. In Papuasia 3–4 species.

KEY TO SPECIES

1. Stems ± compressed, ultimate branches completely flattened to phylloclades; leaves fugaceous ..... **M. platyclada**
1. Stems terete with normally persistent leaves
   2. Scandent shrub; leaves ± oval with cuneate base..... **M. monticola**
   2. Half-woody climber; leaves ovate-triangular with a ± truncate base..... **M. zippelii**

Muehlenbeckia monticola Pulle *Nova Guinea* **8**: 625 (1912); Danser *Nova Guinea* **14**: 335 (1927), t. 40. **Fig. 97.**

Scandent shrub, climbing to at least 10 m; stems glabrous, upper ones slender, twining, ± 4-angled, longitudinally ribbed; twigs and petioles often reddish. Leaves ovate or elliptic to obovate, 10–40 × 5–20 mm, apex rounded to acute, base ± cuneate, glabrous, shining; petioles slender, 3–10 mm long, articulated at base; sheaths obsolete or nearly so; ocreas membranous, fragile, with 2–3 prominent nerves, 4–10 mm long, obliquely truncate; usually much shorter on side towards leaf, but this arrangement not constant. Flowering branches erect, short; pseudospikes 3–10 cm long, singly in upper axils and in small terminal panicles; bracts *c.* 1 mm long, funnel-shaped, 2–3-flowered; pedicels longer. Perianth white, *c.* 2 mm long, divided about half way into elliptic-acute lobes, ± hairy on back; stigmas lobed. Fruiting perianth to 2·5 mm long, herbaceous; fruit trigonous, to 3–5 mm long × 2 mm wide, black, wrinkled.

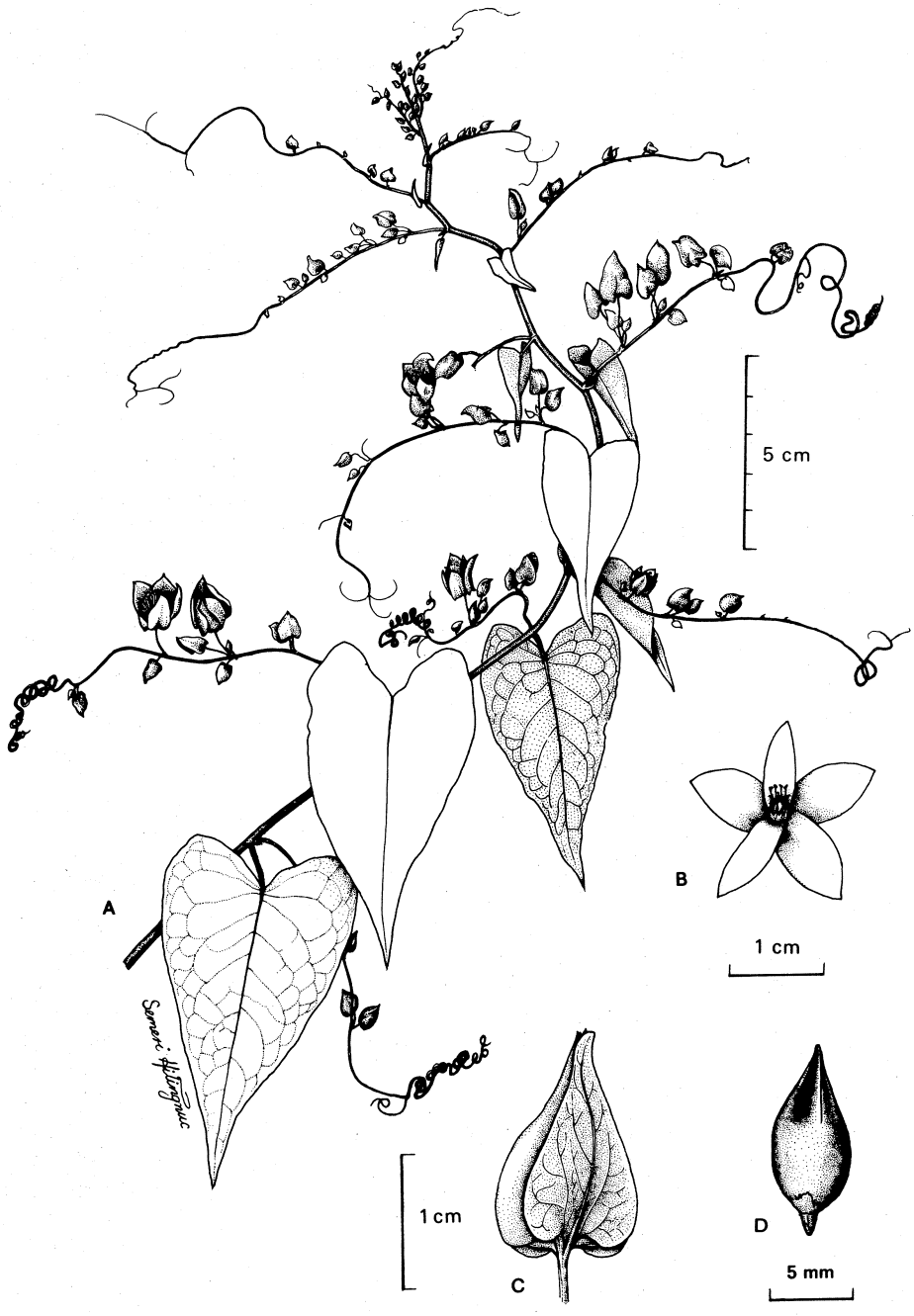


Fig. 96 **Antigonon leptopus** Hook. & Arn. (A) flowering branch (B) flower (C) fruiting calyx (D) fruit

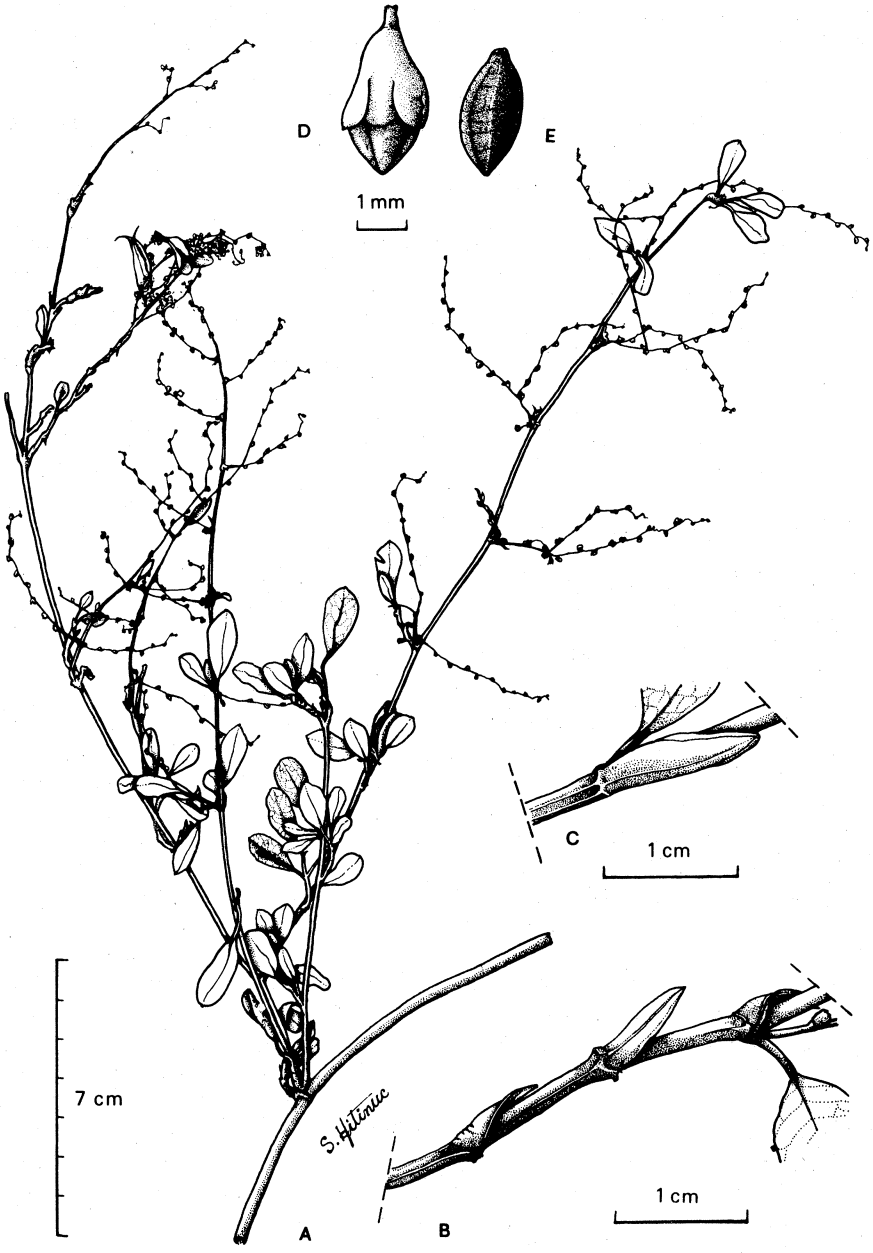


Fig. 97 **Muehlenbeckia monticola** Pulle (A) fertile branch (B) section of stem showing varied development of ocreas (C) leaf base with ocrea (D) fruiting calyx (E) fruit

Distribution: Endemic to Papuasia; collected from most mainland districts and from western New Guinea, but not from the islands.

Ecology: In forest, often prominent in disturbed areas, at 1500–3000 m altitude.

Muehlenbeckia platyclada (F. Muell.) Meissn. *Bot. Zeit.* **23**: 313 (1865). **Fig. 98.**

Coccoloba platyclada F. Muell. (1863); *Calacinum platycladum* Macbride (1927).

Shrub to *c.* 4 m tall, lower stems rounded or ± compressed, much-branched; twigs completely flattened to phylloclades, nodes marked by transverse lines. Leaves sessile, fugacious, 2–4 cm long, narrowly lanceolate, base cuneate; sheath lacking; ocrea very short, membranous. Flowers in small bracteate clusters, alternately on opposite edges of twigs; perianth white, *c.* 2 mm long, divided ± half way, lobes obtuse; stigmas fringed. Fruiting perianth 4–5 mm long, red, succulent; fruit *c.* 3 mm long, trigonous, dark brown, shining.

Distribution: Native to Papuasia; introduced elsewhere as an ornamental and perhaps to other Pacific islands as a ritual plant.

Ecology: Mostly collected at altitudes between 1500 and 2500 m in grassland (particularly in steep and rocky situations) and abandoned garden areas; also reported as epiphyte on trees.

Uses: Cultivated as an ornamental. It seems to have ritual significance to the local people, and plants which appear to occur naturally may often have been deliberately planted.

Muehlenbeckia zippelii (Meissn.) Danser *Bull. Jard. Bot. Btzg.* ser. 3, **16**: 325 (1940). **Fig. 99.**

Polygonum zippelii Meissn. (1865); Danser (1927), f. 16; *M. rhyticarya* F. Muell. (1866); *M. rhyticarpa* F. Muell. (1890).

Glabrous climber, herbaceous from woody base. Petioles slender, 1–2 cm long; leaf-blades ovate-triangular, to 4 cm long, acute to acuminate, base truncate or slightly sagittate, much smaller and more acuminate near branch tips; ocreas 6–10 mm long, slightly obliquely truncate (a little longer on side nearest leaf), brown, membranous, strongly nerved, fragile, usually soon split to base or torn by emergence of side-shoots. Pseudospikes simple or compound, in upper axils and terminal; bracts amplexicaul, 1–2 mm long, obliquely truncate with prominent vein, 2–4-flowered. Flowers separately male and female; perianth *c.* 2 mm long, deeply lobed, greenish or yellowish; in male flowers, 6–8 stamens and very small rudimentary ovary; in female flowers, 6–8 staminodes with small white anthers, ovary slightly 3-lobed, stigmas plumose. Perianth accrescent after anthesis, completely enclosing fruit, lobes membranous or succulent. Fruit rounded-trigonous, *c.* 4×3 mm, black, tuberculate with transverse wrinkles.

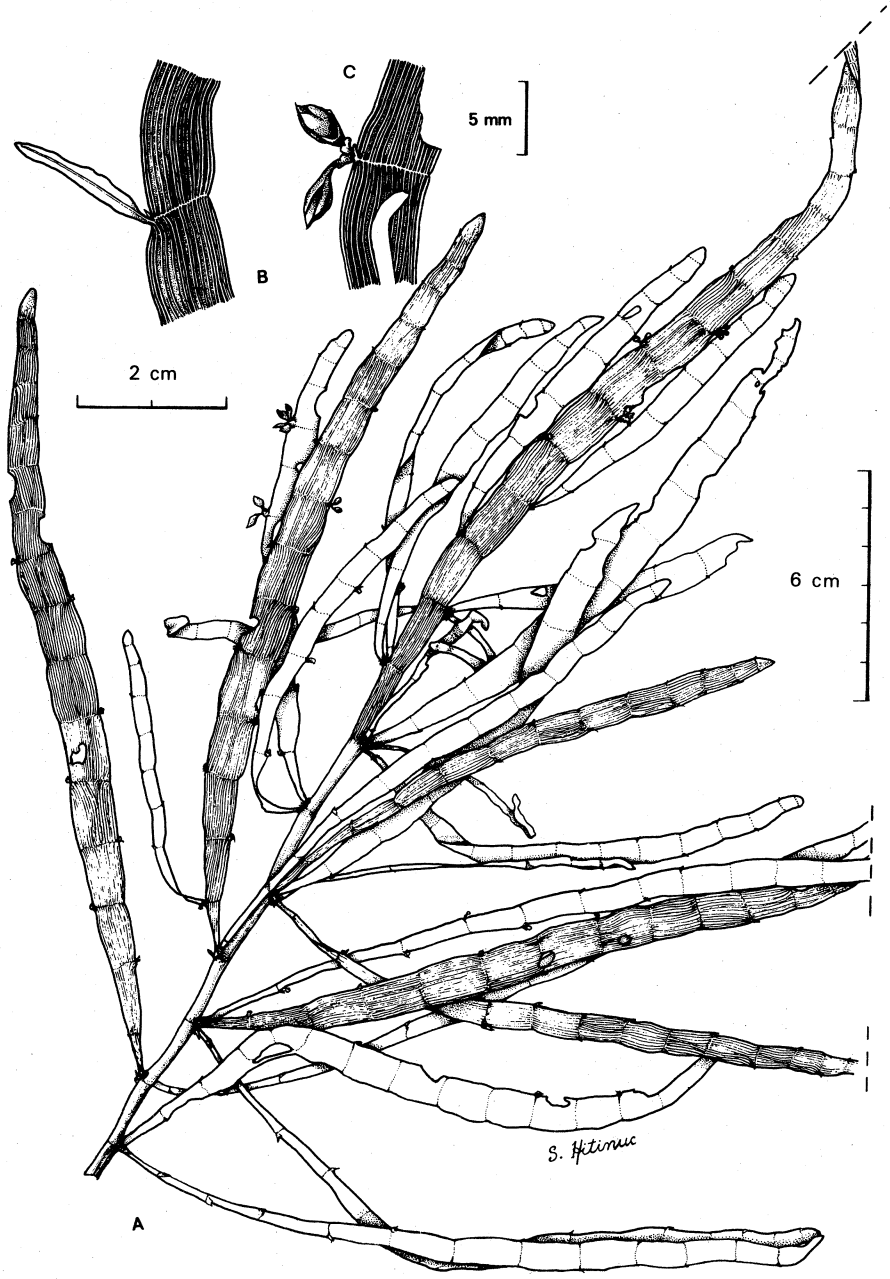


Fig. 98 **Muehlenbeckia platyclada** (F. Muell.) Meissn. (A) stem and branches (B) branch node with leaf (C) branch node with young fruits

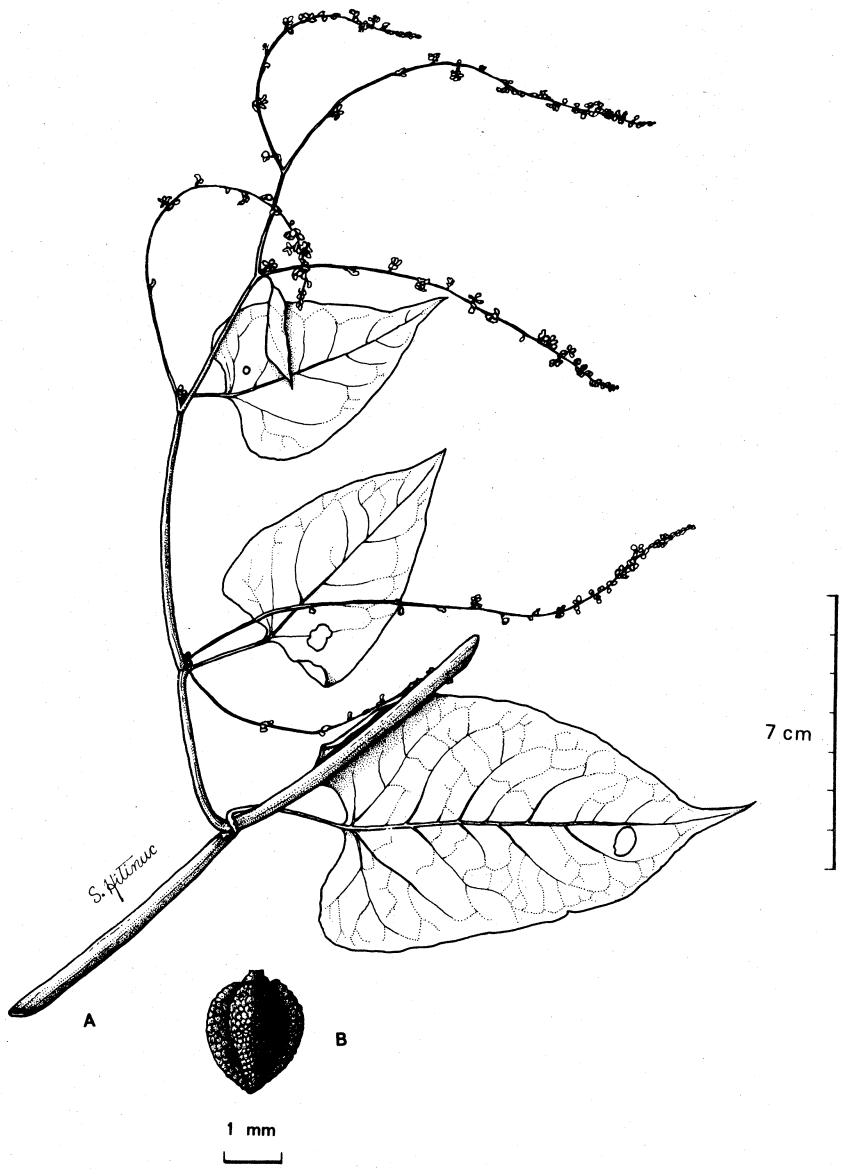


Fig. 99 **Muehlenbeckia zippelii** (Meissn.) Danser (A) flowering twig (B) fruit

Distribution: Australia, and Papuasia in the Fakfak (at Triton Bay, the type locality) and Western districts.

Ecology: At forest margins, in savannas and garden regrowth, in areas of seasonal rainfall, at low altitudes.

NAME UNACCOUNTED FOR

M. gracillima Meissn. in DC. *Prodr.* **14**: 145 (1856).

Reported by Mueller (*Descr. Not. Pap. Pl.* **1**: 60 (1875)) as collected by d'Albertis on the Fly River. Danser (1940), p. 326, regards the determination as doubtful; ripe fruits are not present on the specimen, and in other respects this species resembles *M. zippelii*, though smaller.

POLYGONUM L.

Perennial and annual herbs or rarely sub-shrubs, creeping to erect or scandent. Leaves spiral, long-petiolate to almost sessile; sheaths ± developed; ocreas well developed, longitudinal nerves often produced beyond apex, as bristles; leaves and other parts often glandular and acrid. Flowers bisexual or by abortion unisexual, shortly stalked, in fascicles in axils of bracts, bracteate fascicles arranged in pseudospikes, which may be solitary or form compound inflorescences. Perianth deeply divided, tepals 5, greenish, white or pink, subequal, after anthesis sometimes accrescent and succulent; stamens 4–9; ovary trigonous with 3 styles or compressed with 2 styles; stigmas capitate. Fruit trigonous or lenticular, sometimes subglobose, often apiculate.

Distribution: A cosmopolitan genus, most developed in north-temperate regions. Authors have not agreed on interpretation of generic limits, and groups such as Persicaria and Cephalophilum are regarded as sections by some, but recognized as genera by others on what seem minor differences. The number of species in *Polygonum* may therefore vary, according to interpretation, from *c.* 50 to *c.* 300. In New Guinea 13 or more species occur, mostly at median altitudes. Several species are weeds of cultivation, and some are dangerous to livestock.

Notes: The genus is a very 'natural' one in that species have many points of resemblance. At the same time vegetative characters may vary greatly within species. This has led to the description of many subspecies and varieties, which are often difficult to define. Hooker (*Flora of British India*) summed up this situation when he wrote, of *P. chinense*, 'a polymorphous plant, of which the following forms may show the extent of variation, but are not approximately constant, nor do they comprise all the departures from any assumed type that could be defined by words, which would be a great many'.

KEY TO SPECIES

1. Ocrea with distinct green border
   2. Border expanded to a broad salviform leaf-like collar; leaves deltoid, slightly peltate; climber with prickly stems; fruits globose..... **P. perfoliatum**
   2. Border not much expanded; leaves ovate to lanceolate, rounded to cordate at base; decumbent to erect with softly pubescent stem; fruits flattened flask-shape.. **P. orientale**

1. Ocrea not different at apex
 3. Pseudospikes elongate, lax or dense, cylindrical
  4. Fruit flattened flask-shaped, with 2 flat or slightly convex faces and rounded edges; ocrea without bristles at apex, or with a few, very short and fine
   5. Fruit at least 3 mm long; lower stems 5 mm thick or more; leaves, young stems and inflorescence axes uniformly and usually densely hairy..... **P. attenuatum**
   5. Fruit *c.* 2 mm long; stems slender; leaves rarely pubescent; stems and axes with a few scattered hairs..... **P. lapathifolium**
  4. Fruit trigonous or lenticular, edges sharp, at least near apex; ocrea usually with well-developed bristles at apex
   6. Fruits all or mostly lenticular; styles 2..... **P. minus**
   6. Fruits all or mostly trigonous; styles 3
    7. Stems moderately stout (3–4 mm); ocreas usually with dense appressed hairs, with stout, long (1–2 cm) apical bristles; pseudospikes fairly dense and stout. **P. barbatum**
    7. Stems slender; ocreas with scattered surface hairs and fine apical bristles not > 1 cm long; pseudospikes slender, lax
     8. Ocrea bristles 5–10 mm long; bracts densely ciliate; stems *c.* 3 mm thick..... **P. longisetum**
     8. Ocrea bristles to 3 mm long, very fine; bracts sparsely ciliate; stems not > 2 mm thick..... **P. decipiens**
 3. Pseudospikes short, compact, globose to ovate
  9. Leaf margins bearing short stiff bristles; usually downward-pointing bristles on midribs beneath; ring of downward-pointing appressed stiff bristles on base of each sheath; often a few strong downward-pointing bristles on stem
   10. Leaves 4 cm long or more; ocreas 1·5 cm long or more; fairly robust decumbent plants..... **P. strigosum**
   10. Leaves not > 1 cm long; ocreas not > 7 mm long; very small creeping plants..... **P. benguetense**
  9. Leaf margins smooth; midribs, sheaths and stems glabrous or with soft, patent hairs
   11. Petiole not winged; fruiting perianth ± succulent; ocrea very obliquely truncate, 3–4 cm long..... **P. chinense**
   11. Petiole ± winged; fruiting perianth scarious or herbaceous
    12. Leaf-blade entire, apex obtuse to acute, base ± cuneate; petiole winged the whole length to a uniform width; ocrea obliquely truncate, 3–10 mm long.. **P. nepalense**
    12. Leaf-blade often lobed at base or, if not lobed, base truncate or very obtuse-angled; apex acute to acuminate; petiole often ± winged near top only, or winged whole length and margin lobed; ocrea transversely truncate, 1 cm long or longer..... **P. runcinatum**

Polygonum attenuatum R. Br. *Prodr.* 420 (1810); Danser *Bull. Jard. Bot. Btzg.* ser. 3, **8**: 162 (1927), f. 5. **Fig. 100.**

Perennial herb; decumbent, flowering stems to 1 m high, lower stems stout (to 1 cm thick), rooting; upper stems with ± dense appressed hairs. Leaves shortly petiolate, lanceolate, blades 10–20× up to 3 cm wide, apex acute to acuminate, base cuneate, both surfaces with short hairs, often very dense on underside; sheaths rather loose, short, glabrous; ocreas 1·5–2 cm long, striate, with scattered appressed hairs, transversely truncate, often with fine bristles, 2–3 mm long, from apex. Inflorescence a terminal panicle of 2–4 pseudospikes, axes ± densely hairy; pseudospikes *c.* 6 cm long, fairly dense; bracts funnel-shaped, obliquely truncate with short cilia on margins, 4–6-flowered. Perianth white; stamens usually 6; styles 2. Fruit flattened flask-shaped, with flat or slightly convex faces and rounded edges, diameter *c.* 3 mm, with apical spike almost 1 mm long, black, shining.

Distribution: Eastern Indonesia to Australia. Collected in widely scattered localities in Papuasia; not reported east of mainland New Guinea.

Fig. 100 **Polygonum attenuatum** R. Br. (A) upper part of plant (B) fruit

Ecology: In seasonal and permanent swamps, at lake and river margins, in forest, from sea level to *c.* 1000 m.

Uses: Reported to have been used as a substitute for tobacco.

Polygonum barbatum L. *Sp. Pl.* 362 (1753); Danser *Bull. Jard. Bot. Btzg* ser. 3, **8**: 145 (1927), f. 2. **Fig. 101.**

Herbaceous perennial; stems thick (> 5 mm) near base, creeping and rooting; above more slender, spreading to erect, to *c.* 1 m high, much-branched, glabrous or with upward-pointing stiff hairs. Leaves lanceolate, 10–20 cm long, apex acute, base cuneate or rarely rounded, ± appressed-hairy on both surfaces, more so beneath, not conspicuously dotted with glands, petioles short; sheaths short, usually covered with closely appressed, upward-pointing hairs; ocreas 1–2 cm long, transversely truncate, with long (1–2 cm) stout bristles from apex. Inflorescence apical, of several rather dense pseudospikes, mostly 4–7 cm long; axis glabrous or nearly so; bracts funnel-shaped, obliquely truncate with ciliate margins; pedicels longer than bracts. Perianth white or pink, 1·5–2 mm long; stamens 6(–7); ovary trigonous, styles 3. Fruit trigonous (sometimes a few lenticular), acute at apex, *c.* 2 mm long × 1·2 mm wide, black, shining, closely enclosed by persistent perianth.

Distribution: Africa, southern Asia, Malesia, Australia, Solomon Islands; widespread in Papuasia.

Ecology: A moisture-loving plant, occurring from near sea level to at least 2000 m. At the lower altitudes, in ditches, swamps, river and lake margins, but at higher elevations often at roadsides, and as a weed in pastures, cultivated land and plantations.

Uses: Reported to yield an indigo-like dye.

Polygonum benguetense Merr. *Philip. J. Sc.* Bot. **10**: 301 (1915).

Herb, probably perennial, decumbent, not more than a few cm high; stems slender, 1 mm thick or less, 4-angled, with many short, appressed to somewhat spreading, upward-pointing stiff hairs, mostly on the angles; also patent glandular hairs, mostly just below inflorescence. Leaves ovate-triangular, not > 1 cm long; short hairs on margins and beneath on midribs, upward-pointing towards apex, downward-pointing near base; sheaths very short, with downward-pointing stiff hairs to 1·5 mm long; ocreas rather loose, *c.* 7 mm long, obliquely truncate, with appressed upward-pointing hairs mainly on nerves. Inflorescence terminal, of 3–6 crowded bracts each subtending 1 flower; bracts funnel-shaped, apex acute, a few cilia from upper margin. Styles 2. Fruit lenticular, oval in outline, 2·3 mm × 1·8 mm, brown, shining.

Distribution: Type from the Philippines; Papuasia in the Snow Mountains district (Lake Habbema).

Ecology: 'With mosses and small sedges on low shore of lake'; altitude *c.* 3000 m.

Fig. 101 **Polygonum barbatum** L. (A) upper part of plant (B) ocrea (C) fruit

Polygonum chinense L. *Sp. Pl.* 363 (1753). **Fig. 102.**

Straggling perennial, often woody at base, decumbent or supported on other vegetation and climbing to 2–3 m. Stem to 1 cm thick at base, above slender, often reddish, glabrous or bearing a few soft hairs. Leaves mostly 4–10 cm long, ± ovate, apex acute or acuminate, base truncate, glandular, glabrous above, a few crimped hairs along midrib beneath; petioles *c.* 1 cm long, bearing a few crimped hairs, sometimes with pair of reniform basal auricles; sheaths short, glabrous or with sparse soft hairs; ocreas to 4 cm long, glabrous or nearly so, very obliquely truncate, shortest on side towards leaf, apex ± attenuate. Inflorescence apical, rather diffuse, corymbose, upper axes bearing simple and glandular spreading hairs; pseudospikes compact, globose, *c.* 5 mm across; bracts ovate, usually acute, *c.* 3 mm long, each subtending 1 to several flowers; pedicels shorter than bracts. Perianth white or pink, 2–3 mm long, after anthesis becoming succulent, berry-like, to 5 mm long, at maturity black, sweetish; stamens 6; styles 3. Fruit trigonous with broadly elliptic faces, 2–1·5 mm long, dull black, pitted.

Distribution: Southern Asia, Malesia; in Papuasia throughout the New Guinea mainland and on Bougainville; not reported from New Britain, New Ireland, Manus or the Solomon Islands.

Ecology: In forest, particularly in natural clearings, and in regrowth, abandoned gardens and at roadsides, mostly at altitudes 1000–2500 m.

Polygonum decipiens R. Br. *Prodr.* 420 (1810).

P. minus Benth. p.p. (1870); *P. minus* Huds. ssp. *decipiens* (R. Br.) Danser (1927).

Herb, probably perennial, erect, or ascending to 1 m among other vegetation. Stems slender, glabrous. Leaves shortly petiolate, narrowly lanceolate to narrowly oblong, apex acute to acuminate, base cuneate, dotted with glands, a few appressed hairs along margins, more dense on midribs beneath, few or none on upper surfaces; sheaths and ocreas bearing short upward-pointing appressed hairs; ocreas 6–10 mm long, transversely truncate, with fine apical bristles *c.* 2 mm long. Pseudospikes terminal, solitary, slender, 1–2 cm long; bracts obliquely truncate, with a few short cilia, 2–4-flowered. Perianth pink, *c.* 2 mm long; stamens 6; styles 3. Fruit trigonous, dark brown, shining, *c.* 2 mm long.

Distribution: Australia; Papuasia in the Snow Mountains (Lake Habbema), Western Highlands and Central districts.

Ecology: Swampy localities at altitudes 2500–3000 m or more; rare.

Polygonum lapathifolium L. *Sp. Pl.* 360 (1753).

Herb, decumbent or erect, to 1 m high, annual or perennial; stems slender, glabrous or nearly so. Leaves shortly petiolate, lanceolate, to 12 cm long, apex acute, base narrowly cuneate, glandular, almost glabrous on our specimens; sheaths short; ocreas about 2 cm long, glabrous or with a few appressed hairs, transversely truncate, sometimes with a few apical cilia. Inflorescence apical; pseudospikes cylindrical, dense, solitary or ± paniculate;

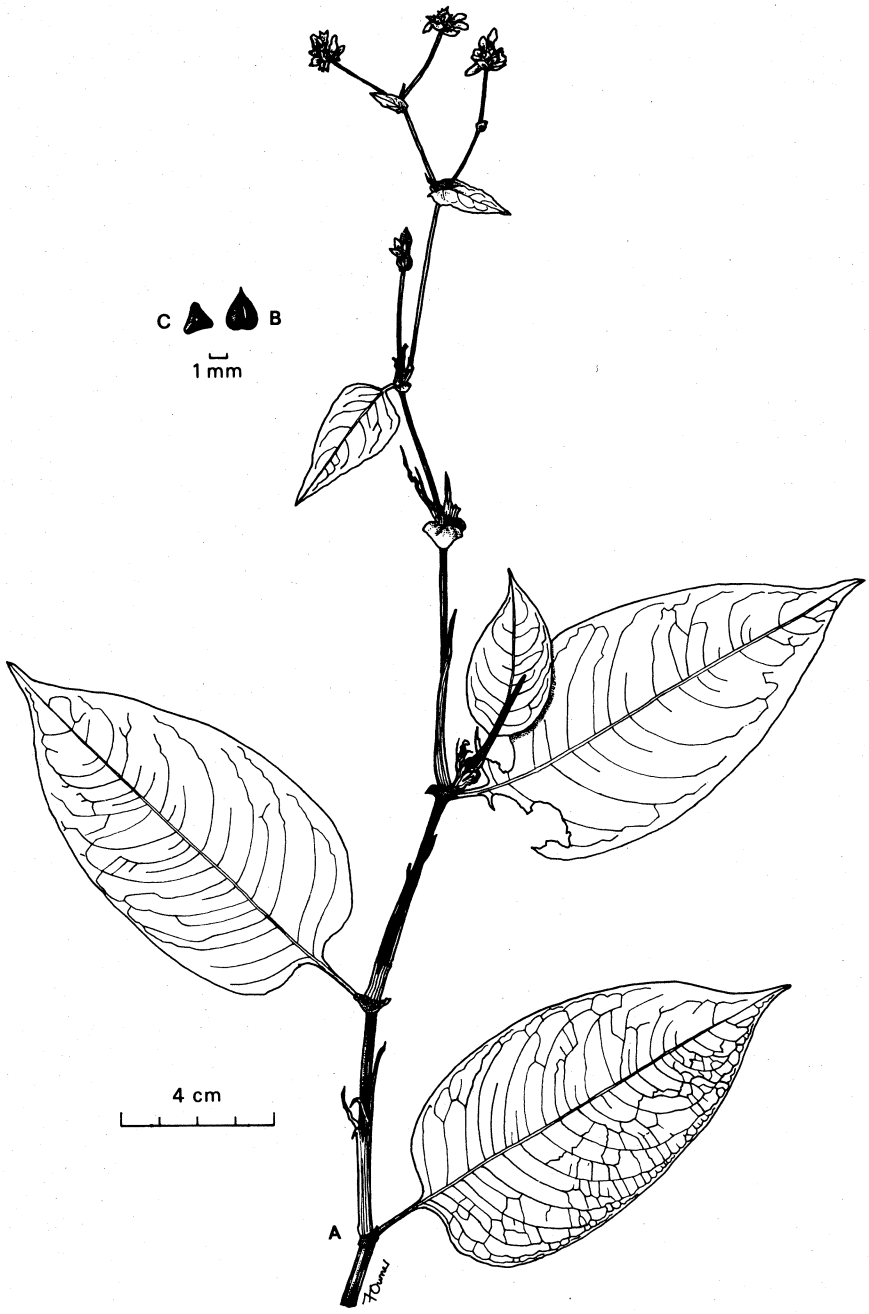


Fig. 102 **Polygonum chinense** L. (A) upper part of plant (B) fruit from the side (C) fruit from the base

axes glabrous; bracts ovate, acute or acuminate, not or very slightly ciliate. Perianth usually pinkish, ± glandular; styles 2. Fruit flattened flask-shape, with flat or slightly concave, oval or circular faces and rounded edges, *c.* 2 mm long, brown or black, usually shining; sometimes a few trigonous fruits.

Distribution: Temperate and subtropical regions of Europe, Asia and Africa; Japan, Malesia, Australia; naturalized in America; rare, possibly a recent introduction, in Papuasia in the Snow Mountains and Eastern Highlands districts of New Guinea.

Ecology: In Papuasia so far found only above 1500 m; 'common in old ditches' (Baliem River); 'roadside' (lower slopes of Mt Wilhelm).

Notes: Acrid and irritating, a smartweed; suspected of causing dermatitis and death of cattle.

Polygonum longisetum DeBr. in Miq. *Pl. Jungh.* 307 (1854); Danser *Bull Jard. Bot. Btzg.* ser. 3, **8**: 170 (1927), f. 7.

Annual herb, decumbent or ascending, 30 cm to 1 m high. Stems slender. Leaves lanceolate, 6–12 cm long, shortly petiolate or sessile; apex acute to acuminate, base cuneate to somewhat rounded; dotted with glands, glabrous or with sparse appressed hairs, particularly on margins and along thicker nerves beneath; sheath very short, strongly nerved; ocreas sparsely pubescent with stiff upward-pointing appressed hairs, apex truncate, with fine stiff bristles *c.* 5 mm long. Inflorescence apical, of a few pseudospikes together, paniculate, axes glabrous; bracts funnel-shaped, margin ciliate. Perianth white to pink; styles 3. Fruit trigonous, a little under 2 mm long, dark brown to black, shining.

Distribution: Southern Asia, Malesia; in Papuasia widespread but not common, not reported east of mainland New Guinea.

Ecology: In swamps and wet forest, at low altitudes; a weed of cultivation at median altitudes (*c.* 2000 m).

Polygonum minus Huds. *Fl. Angl.* ed. 1, 148 (1762). Danser *Bull. Jard. Bot. Btzg.* ser. 3, **8**: 174 (1927), f. 8–10. **Fig. 103.**

Perennial herb, prostrate, decumbent or ascending to *c.* 1 m; stems very slender (*c.* 1 mm thick) to fairly stout (4 mm), glabrous or nearly so. Leaves shortly petiolate, lanceolate to almost linear, mostly 5–12 cm long; dotted with glands, with upward-pointing appressed hairs on petioles, margins and larger nerves, sometimes lacking on upper surface and sparse beneath, rarely dense on and between nerves on both surfaces; sheaths short, glabrous to with dense appressed hairs; ocreas tubular, 8–20 mm long, strongly nerved, clothed sparsely to very densely with appressed hairs, transversely truncate, with fine but stiff bristles, 5–10 mm long (rarely shorter, to 1 mm) from apex. Inflorescence apical, of 1 to several lax to fairly dense pseudospikes, 1–6 cm long; bracts funnel-shaped, obliquely truncate, ciliate on margins, 3–6-flowered. Perianth white or pink, 1·5–2 mm long, increasing to *c.* 2·5 mm after anthesis; stamens 6; styles 2. Fruit lenticular with strongly convex

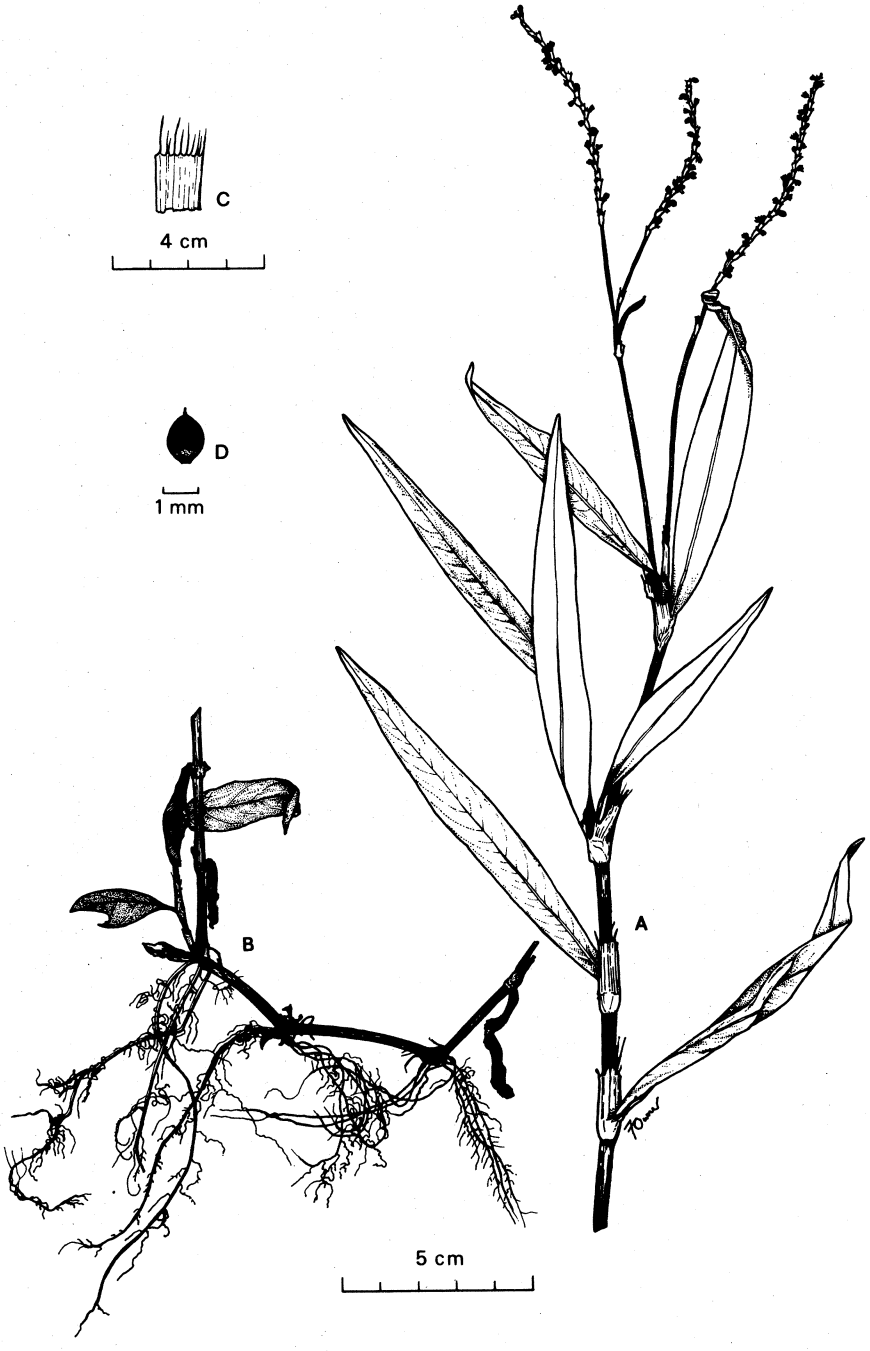


Fig. 103 **Polygonum minus** Huds. (A) upper part of plant (B) part of stem near base (C) ocrea (D) fruit

elliptic faces, rather sharp-angled near apex (sometimes a few trigonous), 1·5–2 × 1–1·2 mm, black or dark brown, shining.

Distribution: Europe, Asia, Malesia, Australia, Solomon Islands, ranging from temperate to tropical regions; widespread in Papuasia.

Ecology: Found from sea level to an altitude of 2500 m. At the lower levels a plant of distinctly wet situations, such as swamps, ditches, stream and lake margins, but at higher altitudes also a weed of cultivation, plantations and pastures.

Notes: The species is very variable, and a number of forms, varieties and subspecies have been described by various workers, including Danser (1927, p. 147). Specimens corresponding to 3 of Danser's subspecies are among our Papuasian material of *P. minus*, but intermediate forms occur.

A smartweed; recorded as a fish poison in Australia; considered harmful to livestock.

Polygonum nepalense Meissn. *Mon. Gen. Polygon. Prodr.* 84, t. 7, ic. 2 (1826). **Fig. 104.**

P. microcephalum var. *papuanum* Warb. (1893); *P. alatum* Buch.-Ham. ex Spreng. (1827).

Annual herb, stems slender (1–2 mm), prostrate or decumbent, to 30 cm high (rarely 1 m), branching from base and rooting, often reddish, bearing on upper parts patent glandular hairs. Leaf-blades pale green often with central darker patch, 1–5 cm long, ovate or rhombic, apex acute, base ± cuneate, running into winged petiole; petiole length variable in relation to leaf length, upper leaves sessile; wing of petiole also variable in width, but always distinct for whole length, with entire ± parallel margins, never lobed; base of wing cordate-amplexicaul; blades and wings densely dotted with glands, blades with a few patent crisped hairs, wings glabrous or nearly so; sheaths short (some on upper stems longer), glabrous or with a few soft, downward-pointing hairs; ocreas glabrous, rather loose, 3–10 mm long, obliquely truncate, shortest on side nearest leaf, often split by development of side branches. Inflorescence apical, usually of a few pseudospikes arising together on long peduncles, peduncles usually with dense glandular hairs; pseudospikes con pact, capituliform, 5–10 mm in diameter; bracts ovate to ovate-lanceolate, 1-flowered; pedicels much shorter than bracts. Perianth at anthesis pink, after accrescent, finally scarious, much longer than the fruit. Fruit lenticular or rarely trigonous, *c.* 2 mm long, dark brown to black, finely rugose.

Distribution: Southern Asia, Abyssinia, South Africa (?introduced), Malesia; widespread in highland regions of mainland New Guinea, not reported from the islands.

Ecology: Occurring at altitudes from 1200 to > 3000 m, in disturbed forest, regrowth and abandoned gardens, at roadsides, and as a weed in gardens and plantations.

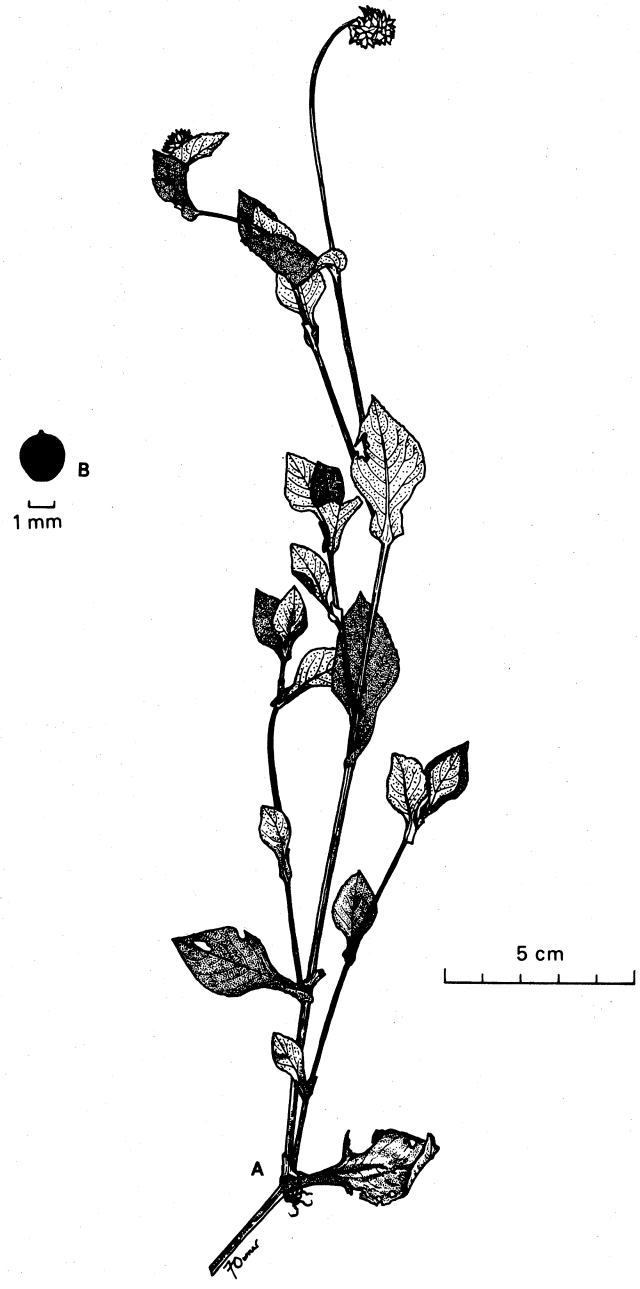


Fig. 104 **Polygonum nepalense** Meissn. (A) upper part of plant (B) fruit

Polygonum orientale L. *Sp. Pl.* 362 (1753). **Fig. 105.**

Herbaceous annual or perennial, usually ascending from prostrate base, to 1 m high; stem thick (1–1·5 cm) below, more slender (3 mm) above, often densely covered with greyish patent hairs. Leaves ovate to lanceolate, 5–15 cm long, apex acute to acuminate, base cuneate to cordate, glandular and pubescent on both surfaces, hairs patent on nerves, ± appressed between them; petioles 1–10 cm long, densely pubescent; sheaths short, strongly veined, with dense appressed hairs; ocreas *c.* 1 cm long, upper border green, spreading, the whole pubescent with ± appressed hairs, ciliate on margin. Pseudospikes dense, 5–10 cm long, several together in terminal paniculate inflorescence; bracts very oblique, hairy, with ciliate margins, crowded and sometimes imbricate, 3–6-flowered; pedicels much longer than bracts. Perianth white or pinkish, *c.* 2 mm long, in fruit increasing to > 3 mm; stamens mostly 6; styles 2. Fruit flattened flask-shaped, sides broadly rounded, faces slightly concave to slightly convex or with small central bulge, ± circular in outline, apiculate, *c.* 3 mm long × 2·5 mm or more wide, dark brown, shining.

Distribution: Southern and eastern Asia, Malesia, Australia; in Papuasia only on the southern side of New Guinea in the Western and Central districts.

Ecology: In swamps, both permanent and seasonal (able to survive dry season), at low altitudes.

Notes: A smartweed, very irritant; dangerous to livestock and considered responsible for deaths of cattle.

Polygonum perfoliatum L. *Sp. Pl.* 521 (1762). **Fig. 106.**

Annual or perennial; stem herbaceous, rambling or climbing for 2 m or more, angular, with stout recurved prickles along angles, otherwise glabrous. Leaves deltoid, slightly peltate, 2–8 cm across, often with recurved bristles on margin and on main nerves beneath; petioles slender, longer than width of blades, bearing recurved prickles; sheath obsolete; ocrea tube not more than a few mm long, margin leaf-like, spreading, salviform, 1–2 cm across. Pseudospikes terminal and axillary; rachis armed with recurved bristles; lower bracts deltoid, leafy, 3–5 mm across, upper ones scarious, ovate, pointed, *c.* 2 mm long; flowers 1 to many in fascicles. Perianth white or pink, *c.* 3 mm long, after anthesis becoming berry-like, finally blue, sweetish. Fruit almost globose, 3 mm across, black, shining.

Distribution: Asia from India to Korea, Taiwan, Malesia; in Papuasia reported from western New Guinea only.

Ecology: Wet open situations, forest regrowth, mainly at 1000–1750 m altitude.

Uses: The mature fruits are used as beads.

Polygonum runcinatum D. Don *Prodr. Fl. Nepal.* 73 (1825); Danser *Bull. Jard. Bot. Btzg.* ser. 3, **8**: 205 (1927), f. 12. **Fig. 107.**

Perennial herb, ± woody at base; stems branching, prostrate, procumbent

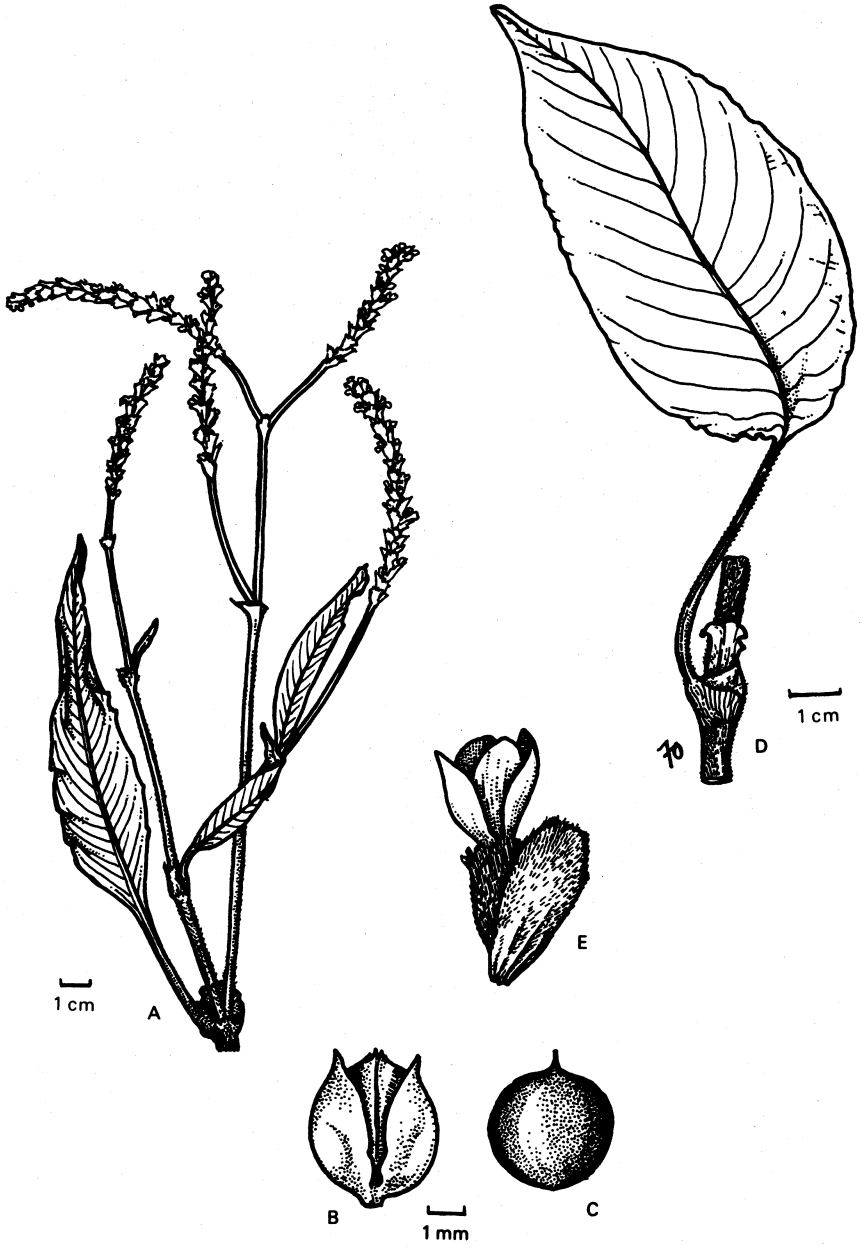


Fig. 105 **Polygonum orientale** L. (A) apex of stem with inflorescences (B) fruiting perianth (C) fruit (D) part of stem with leaf and ocrea (E) flowers

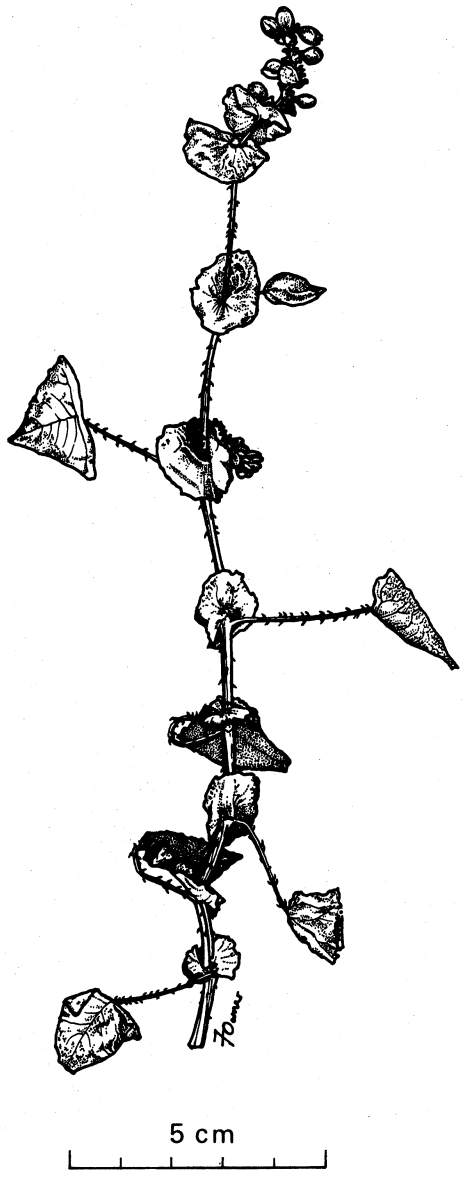


Fig. 106 **Polygonum perfoliatum** L. Upper part of plant in fruit

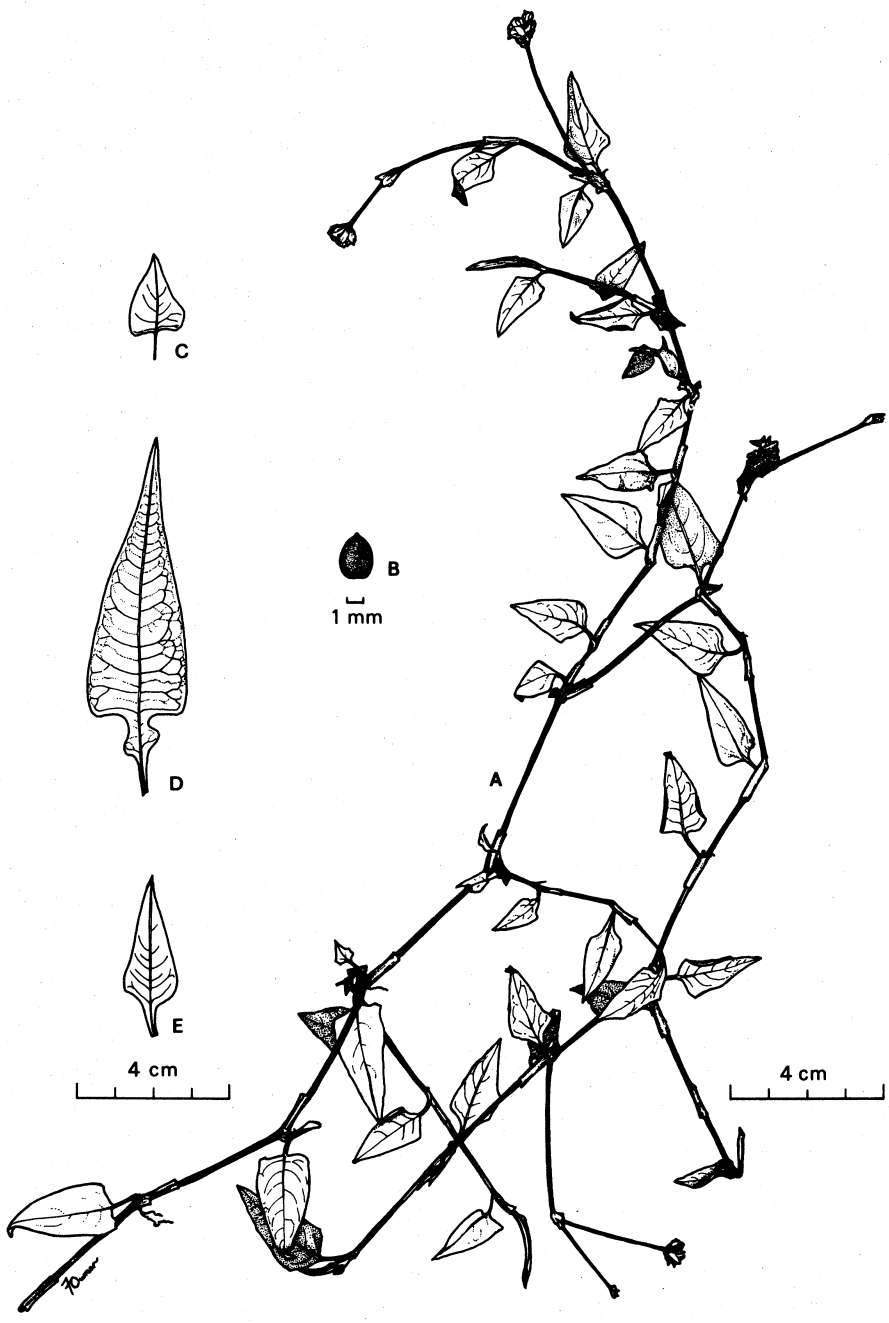


Fig. 107 **Polygonum runcinatum** D. Don (A) upper part of plant (B) fruit (C. D. E) leaves from different specimens

or climbing on other vegetation to 1 m high, often rooting from lower sections, fairly stout (4 mm thick) to slender (< 1 mm), often reddish. Leaves very variable in shape and size; blades 1–10 cm long, triangular, with truncate base, or rhombic, with obtuse-angled base or ± hastate, with pair of basal auricles; petiole rarely much > *c.* 1 cm long, sometimes lacking in upper leaves, ± winged by extension of lamina in upper part, not or very slightly winged below, often with pair of ± reniform basal auricles; sheaths 1–2 mm long, ocreas 1 cm long or more, not ciliate from upper margin; often soft, ± crimped hairs on ocreas, petioles and beneath midribs; blades dotted with glands. Pseudospikes short, ± globose, mostly 5–8 mm across, long-pedunculate, singly or in pairs from upper axils, or forming small, lax, terminal cymose inflorescence; peduncle glandular-hairy; flowers solitary in the bracts; pedicels very short; perianth greenish-white; anthers mostly 6. Fruit mostly lenticular, a few trigonous, mucronate, *c.* 2·5 × 1·5 mm, brown or black, smooth, shining, closely enclosed by parchment-like perianth.

Distribution: Asia from India to China and south to Thailand, Taiwan, in Malaysia from Sumatra to New Guinea; widespread in mainland New Guinea but not reported from the islands.

Ecology: In forest, mainly in natural clearings and at streamsides and roadsides, at altitudes from *c.* 2000 m to at least 3500 m. Sometimes a weed of gardens and plantations, particularly on peaty soil.

Polygonum strigosum R. Br. *Prodr.* 420 (1810); Danser *Bull. Jard. Bot. Btzg.* ser. 3, **8**: 227 (1927), f. 15. **Fig. 108.**

Perennial herb, decumbent or supported on other plants, to 1 m high; upper stems somewhat angular, often with stiff downward-pointing bristles on and between angles, sometimes also stellate-hairy. Leaves oblong to lanceolate, acute or acuminate, at base ± sagittate or sometimes slightly hastate, 3–6 cm long, glabrous or hairy (rarely densely) on upper surface; beneath appressed or ± spreading hairs on midrib, sometimes dense (then also on smaller veins) and interspersed with stellate hairs, rarely very few and short; margins often densely furnished with short stiff bristles, mostly upward-pointing, but often near base downward-pointing; petioles 1·5–3 cm long, with stiff downward-pointing or ± patent bristles, very short to 2 mm or more long, dense or only a few near apex; sheaths short, bearing ring of firmly appressed, downward-pointing stiff hairs; ocreas obliquely truncate, 1·5–2·5 cm long, ± ciliate on upper margins, surface nearly glabrous to densely covered with appressed, downward-pointing hairs, 1–1·5 mm long, sometimes a few upward-pointing and also stellate hairs. Inflorescence terminal, once or twice dichotomously branched, upper axes glandular-hairy; pseudospikes short, ± ovate, *c.* 1 cm long; bracts usually 1-flowered, ovate, margins ciliate with simple and glandular hairs, sometimes stellate-hairy on surface. Perianth white or pinkish; stamens usually 5; styles 2 (usually) or 3. Fruit lenticular with strongly convex faces, or rarely trigonous, 2·5 mm long, brown, shining.

Distribution: Tropical Asia, Malesia, Australia; widespread in Papuasia and collected from most mainland districts, not reported from the islands.

Fig. 108 **Polygonum strigosum** R. Br. (A) upper part of plant (B) part of stem with leaf and ocrea

Ecology: A plant of wet, lightly shaded situations; streamsides, lake margins, grassy swamps, roadside ditches, and a weed in gardens and plantations, from *c.* 1000 m to at least 3000 m.

Notes: A number of New Guinea collections have been determined as *P. dichotomum* Bl. This species is distinguished from *P. strigosum* mainly by the characters of the indumentum; on New Guinea material, at least, it has not been possible to find a reliable distinguishing character.

NAMES UNACCOUNTED FOR

P. cumingianum Gandoger (*P. celebicum* Danser) is reported (Danser, 1927, p. 167) from the north coast of West New Guinea. On the description, it is not easy to distinguish from *P. attenuatum.*

P. paniculatum Bl. (*P. polyanthos* DeBr.) and *P. pubescens* Bl. are recorded by Mueller (*Descr. Not. Pap. Pl.* pt 4, 59 (1876)) without locality, presumably near Port Moresby.

RUMEX L.

Annual or perennial herbs, often acid. Leaves spirally arranged, or lower leaves in a basal rosette; sheaths short, ocreas well developed. Inflorescence racemose or paniculate; flowers bisexual, monoecious or dioecious, stipitate, articulate on arched pedicels, in bracteate fascicles, which may be many-flowered forming partial whorls. Tepals in 2 whorls of 3; outer whorl small, not much accrescent after anthesis; inner whorl finally much-enlarged, enclosing the fruit; stamens 6; ovary trigonous; styles 3, short, with large dissected stigmas. Fruit sharply trigonous.

Distribution: 170–200 species (according to interpretation), cosmopolitan but mostly in north-temperate regions. 2 species in Papuasia, 1 a recent introduction.

KEY TO SPECIES

1. At least one of inner (larger) tepals, in fruit, with prominent basal boss; margins of tepals slightly toothed, some of teeth mucronate..... **R. crispus**
1. None of tepals with basal boss; margins of tepals armed with strong hooked spines... ..... **R. brownii**

Rumex brownii Campd. *Monogr. Rumex* **64**: 81 (1819); Danser *Bull. Jard. Bot. Btzg.* ser. 3, **8**: 131 (1927), f. 1.

Rumex fimbriotus R. Br. (1810) non Poir.

Erect perennial herb, 70 cm to 1 m high, much-branched or with several stems from base; sometimes stem weak and sprawling. Leaf-blades elongate-hastate, narrowed above basal lobes, to lanceolate; blades of basal leaves 10 cm long or more, on slender petioles to 15 cm long; stem leaves smaller, petioles much shorter; sheaths very short; ocreas brown, scarious, to 5 cm long on lower stems, very obliquely truncate. Inflorescence terminal; fascicles few-flowered, widely spaced along leafless erect axis; pedicels *c.* 1 mm long

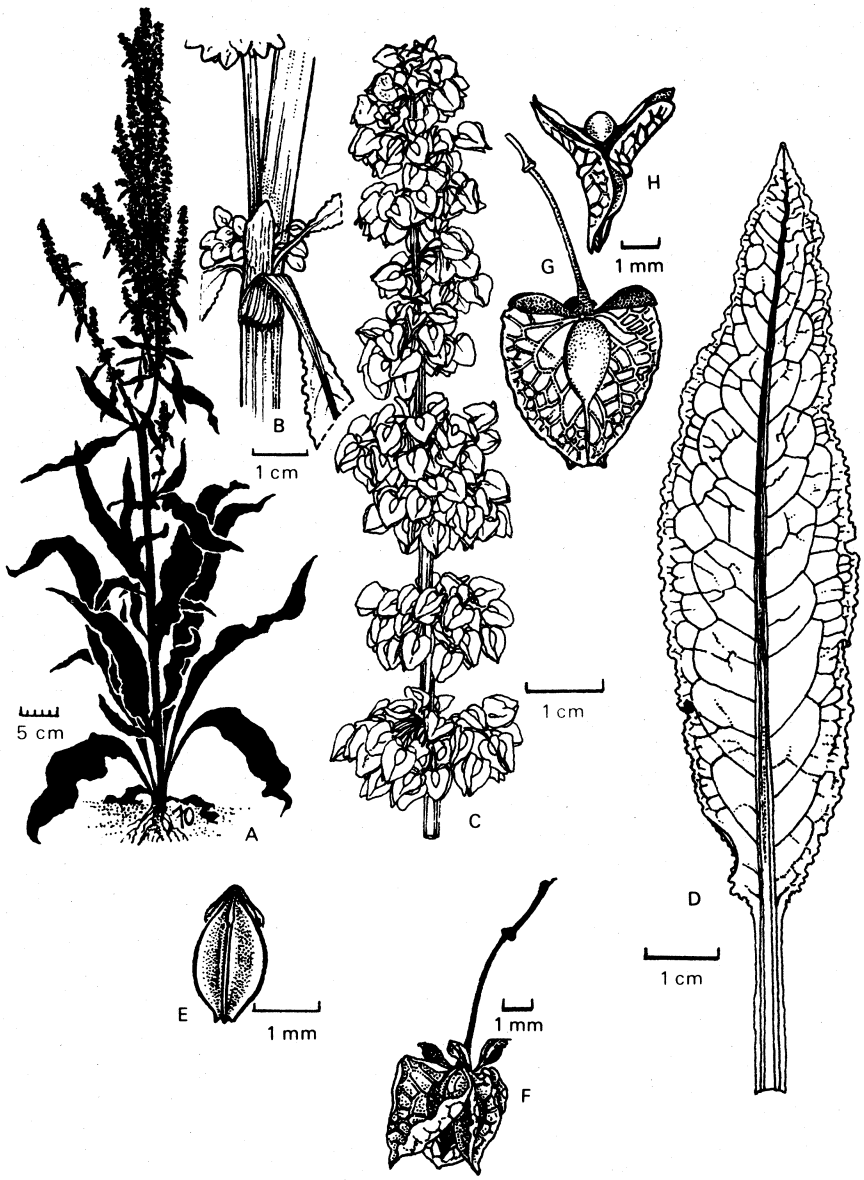


Fig. 109 **Rumex crispus** L. (A) habit (B) leaf base and ocrea (C) part of inflorescence (D) leaf (E) fruit (F) calyx in early fruiting stage (G) mature calyx, lateral view (H) mature calyx from the apex

to articulation, flower on stipe *c.* 2 mm long; 3 outer tepals *c.* 0·5 mm long, acuminate; inner tepals *c.* 1 mm long at anthesis, in fruit 3–4 mm long including terminal spine, rhombic, armed at margin with hooked spines, enclosing fruit. Fruit to 2·5 mm long, brown, shining.

Distribution: Australia to Java; in Papuasia widespread in mainland mountain regions, including western New Guinea.

Ecology: In open, usually somewhat disturbed, localities, at 2000 m to > 3000 m altitude; creek-banks in grassland, roadsides, gardens.

Rumex crispus L. *Sp. Pl.* 335 (1753); Danser *Bull. Jard. Bot. Btzg.* ser. 3, **8**: 125 (1927), f. 1. **Fig. 109.**

Perennial herb; tap-root ± tuberous, with rosette of leaves from crown; flowering stem erect, to 1 m high or more. Blades of basal leaves lanceolate, to 25 cm long, apex obtuse to acute, base cuneate to slightly cordate; petioles to 5 cm long; stem leaves smaller, above ± sessile; sheaths short; ocreas to 3 cm long, obliquely truncate, soon broken and shredded to fibres. Inflorescence paniculate, usually dense, narrow; fascicles many-flowered, rather closely set on ± erect axes; pedicels 1–3 mm long to articulation; stipes to 5 mm long; at anthesis outer tepals 0·5–1 mm long, inner tepals 1–1·5 mm; in fruit outer tepals *c.* 1·5 mm long, inner tepals 3–4 mm, broadly ovate to almost circular, margin entire or with a few small teeth near base, these sometimes mucronate; at least 1 inner tepal in each flower with prominent oval boss on back at base. Fruit *c.* 2·5 mm long, brown, shining.

Distribution: Native to old-world temperate regions, now almost cosmopolitan as a weed. In Papuasia so far only found in the Eastern Highlands district.

Ecology: A weed of pastures and cultivation; in Papuasia at altitudes of *c.* 1700 m.

Notes: Harmful to livestock, causing dermatitis and gastric disturbances. Common name (E.): curled dock.

Glossary

(dimin. = diminutive; pl. = plural)

a-: prefix meaning 'without', as in **asepalous**, without sepals
abaxial: on the side of a lateral organ away from the axis
abscission: cutting off
accrescent: increasing in size with age, as fruit and floral parts when enlarging after or during the flowering period
acicular: needle-shaped
acropetal: produced in succession towards the apex
acroscopic: looking towards the summit
actinomorphic: with the parts radially symmetric
aculeate: prickly
acuminate: tapering into a long point; *Fig. 111A*
acute: distinctly and sharply pointed; *Fig. 111A*
adaxial: on the side of a lateral organ next to the axis
adherent: of two dissimilar parts or organs touching each other connivently but not grown or fused together
adnate: united to an organ of a different kind, as sepals to petals
adventitious: arising irregularly or in an unusual position, as roots from stems, or buds from parts other than the leaf axils
aestivation: the manner in which the parts of a flower are folded up before expansion
alate: having wings or wing-like appendages
allopolyploid: a polyploid organism to which two different species have each contributed one or more sets of chromosomes; hence **allopolyploidy**
alternate: placed singly at different levels along an axis; *Fig. 112*
alveolate: deeply, closely pitted
amplexicaul: clasping the stem
anastomosis: union of one vein with another
anatropous (ovule): inverted, with the micropyle close to the point of attachment
androecium: the stamens collectively
androgynous: having staminate flowers and pistillate flowers in the same inflorescence
angiosperms: the flowering plants; plants having their ovules enclosed in an ovary; hence **angiospermous**, belonging to the angiosperms
annual: completing its life cycle within one year
anther: the pollen-bearing part of a stamen
anthesis: the act of flowering; the time when pollen is shed
apicula: a sharp and short but not stiff point in which a leaf may end; hence **apiculate**; *Fig. 111A*

applanate: flattened out or horizontally expanded
appressed: lying flat for the whole length closely against the supporting organ
arcuate: curved or arched, ± strongly
areole: a space in any reticulated surface, e.g. a space between anastomosing veins; hence **areolate**
aril: an expansion of the stalk of the ovule, arising from the placenta and enveloping the seed, often brightly coloured and membranous or succulent; hence **arillate**
aromatic: possessing a spicy smell
articulate: with one or more joints or points of separation
attenuate: gradually narrowed, tapered
auricle: an ear-shaped appendage or lobe; hence **auriculate**
awn: a stiff or bristle-like projection often from the tip or back of an organ; hence **awned**
axil: the upper angle formed between two organs, as between a leaf and a stem
axile: belonging to the axis, as of placentae attached to the axis of a several-loculed ovary (**axile placentation**)
axillary: occurring in the axil
axis: the main or central line about which the organs of a plant or parts of an organ develop. Often used as the main stem or central longitudinal support; pl. **axes**

barbate: bearded; provided with tufts of long weak hairs
basifixed: attached by the base
basipetal: produced in succession from the apex towards the base
basiscopic: looking towards the base
bi-: prefix meaning 'two'
biconvex: both surfaces with curvature directed away from the centre
bifid: dividing into two parts, usually to about half way
bilateral: of, on, or with two sides
bipartite: divided almost to the base into two parts
bipinnate: doubly pinnate; *Fig. 113*
biseriate: arranged in two rows
bisexual: of flowers, with both sexes together and functional
bract: a usually ± modified leaf, especially one subtending a flower or a flower cluster; dimin. **bracteole**, **bractlet**; hence **bracteate**, **bracteolate**
bullate: with the surface puckered

caducous: falling early
caespitose: tufted or matted
calyptra: any cap-like covering on a flower or fruit
calyx: the outer, usually greenish, whorl of a flower, sometimes tubular and sometimes composed of free parts called sepals
campanulate: bell-shaped
canaliculate: longitudinally channelled or grooved
capitate: like a head; in a dense ± rounded cluster; dimin. **capitellate**
capitiform: shaped like a head, somewhat globose
capsule: a simple, dry, dehiscent fruit, formed by the union of two or more carpels and usually several- to many-seeded; hence **capsular**

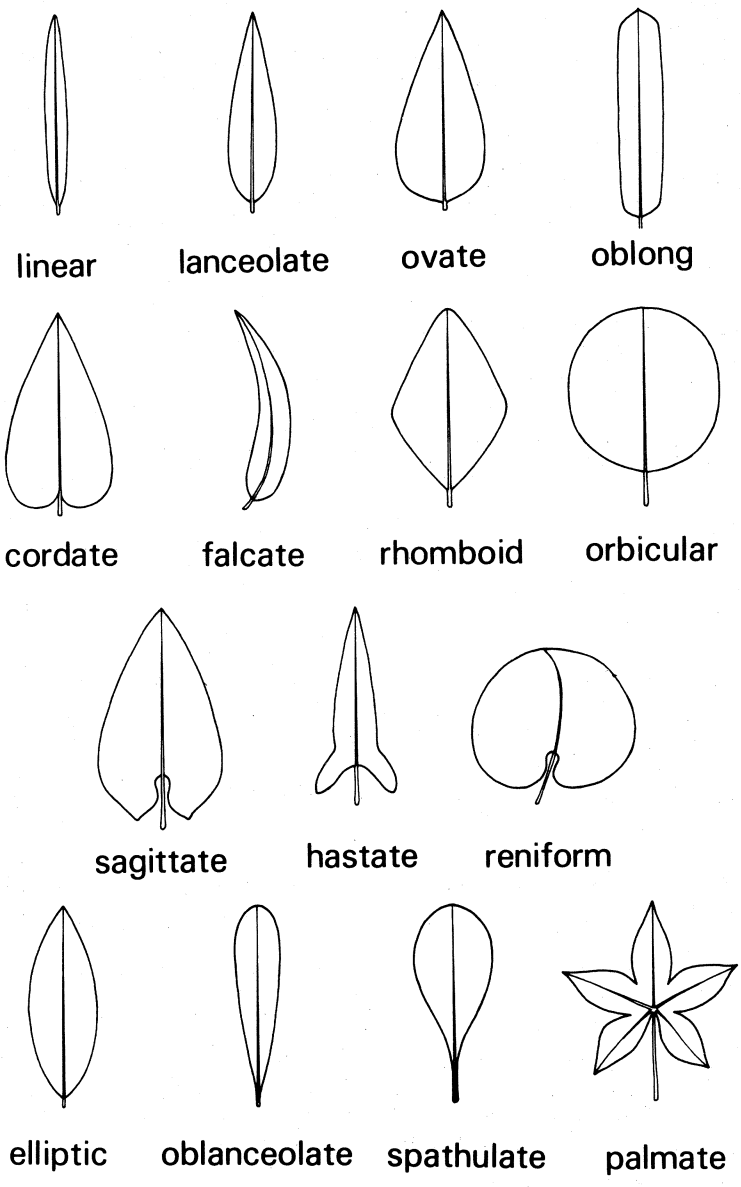
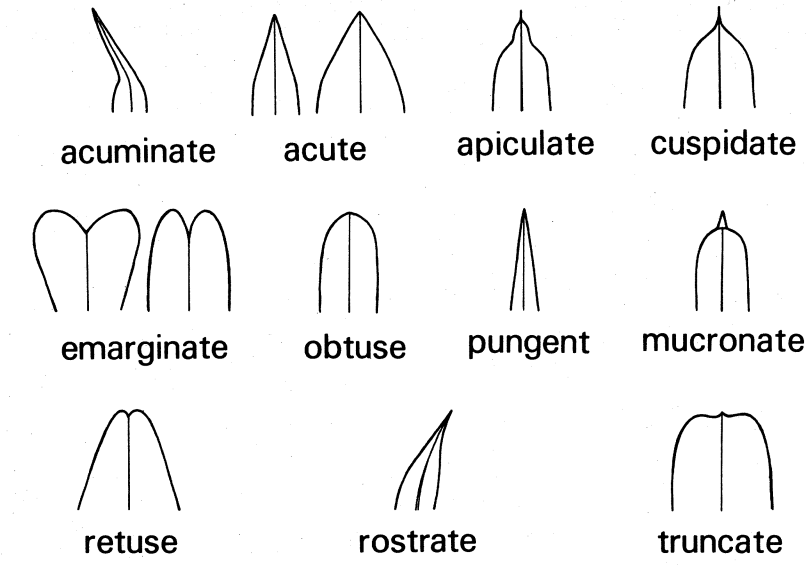
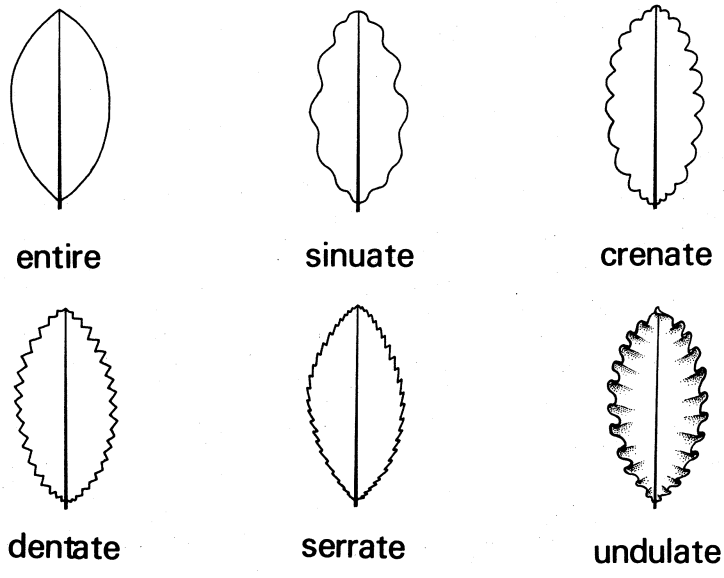


Fig. 110 Leaf shapes

carpel: a unit of the female part of a flower, consisting of an ovule-bearing ovary, receptive stigma, and often a stalk-like style between them; a female sporophyll
caudate: excessively acuminate, so that the point is long and weak; tailed
cauliflorous: producing flowers from the old wood
cauline: belonging to the stem
centrifugal: tending outwards or developing from the centre outwards
centripetal: tending inwards or developing towards the centre from without
chalaza: the part of the ovule where the nucellus joins the integuments
chartaceous: of thin, papery texture
chromosomes: deeply staining thread-like bodies found in all cell nuclei, the number usually constant for a given species
ciliate: with marginal hairs or bristles
cinnamonic: like cinnamon, yellowish-brown, fragrant or aromatic
circinate: coiled, with the apex innermost; *Fig. 115*
circumscissile: dehiscing as if cut completely around, the top valve coming off like a lid
cirrhose: tendril-like, with a slender, coiled or wavy tip
cladode: a flattened stem resembling a leaf in form and function
clavate: club-shaped; thickened towards the apex
cleistogamic: of a flower that remains closed and is self-pollinated
coalescent: unifying by growth
coherent: descriptive of two or more similar parts or organs of the same series touching one another ± adhesively but not fused
collateral: standing side by side
colleter: mucilaginous hairs (on the buds of many phanerogams) that secrete gum
colpate: of a pollen grain when having a longitudinal groove or opening in the outer wall
column: a structure formed by the union of stamens, style and stigmas, or of stamens
compound: composed of several ± similar parts, as opposed to simple; *Fig. 113*
compressed: flattened
concolorous: uniform in colour, as upper and lower surfaces of a leaf
concrescence: the growing together of organs or parts
conduplicate: folded together lengthwise, as leaves when folded along the midrib, with the upper surface within; *Fig. 115*
confluent: blending or running together
congested: crowded
connate: united, congenitally or subsequently
connective: the staminal tissue connecting the two lobes of an anther
connivent: converging together; usually of two or more organs with their bases separated and their apices approaching one another
contiguous: touching but not fused
contorted: twisted; of perianth parts in bud, each part with one edge overlapping, the other overlapped; *Fig. 115*
convolute: rolled together longitudinally; *Fig. 115*
cordate: heart-shaped, with a basal notch; *Fig. 110*; dimin. **cordulate**



A. Leaf apices



B. Leaf margins

Fig. 111 (A) leaf apices and (B) leaf margins

coriaceous: leathery
corolla: the inner, often showy, whorl of the perianth, sometimes tubular, sometimes composed of free parts called petals; hence **corolloid**, resembling a corolla
corymb: a ± flat-topped raceme, the long-pedicelled outer flowers opening first; *Fig. 114*
costa: a rib, especially the midrib or other strong nerve of a leaf; pl. **costae**; hence **costate**
cotyledon: an embryonic leaf of a seedling, already present in the seed
crater: bowl; hence **craterous, crateriform**
crenate: with shallow rounded teeth; *Fig. 111B*; dimin. **crenulate**
crested: possessing an elevated line or ridge on the summit of an organ
cucullate: hood-shaped, hooded
cuneate: wedge-shaped; with straight sides converging at the base
cupule: a structure, often woody and cup-like, that subtends female flowers and later fruit
cusp: a sharp, rigid point; hence **cuspidate**, with the apex abruptly narrowed to a point; *Fig. 111A*
cyme: inflorescence of determinate or centrifugal development (i.e. oldest flowers innermost) tending to be broad and flat; hence **cymose**; *Fig. 114*

decumbent: lying along the ground with the tip ascending
decurrent: extending downwards, as when leaf-blades are prolonged beyond their insertion and thus run down the stem
decussate: in pairs alternately at right-angles; *Fig. 112*
deflexed: bent sharply downwards
dehiscent: opening or splitting; hence **dehiscence**
deltoid: broadly triangular
dentate: with sharp teeth perpendicular to the margin; *Fig. 111B*; dimin. **denticulate**
depressed: flattened from above
determinate: definite, or limited in extent; as of an inflorescence in which the terminal flower opens first and growth of the axis is arrested, or of growth when the season's growth ends with a bud
diadelphous: of stamens, in two groups
dichasium: a cyme in which the branches are opposite and ± equal in length; hence **dichasial**
dichlamydeous: of flowers with a perianth composed of distinct calyx and corolla
dichotomous: forking into two equal branches
diffuse: of open or straggling growth
digitate: with the parts spreading from a centre like the fingers of a hand
dioecious: male and female elements on different individuals
disc: an enlargement of the floral receptacle or of coalescent nectaries, often fleshy or glandular
discolorous: with the two surfaces (of a leaf) unlike in colour
dissected: deeply divided, or cut into many segments
distal: towards the free, as opposed to the attached or proximal, end of an organ

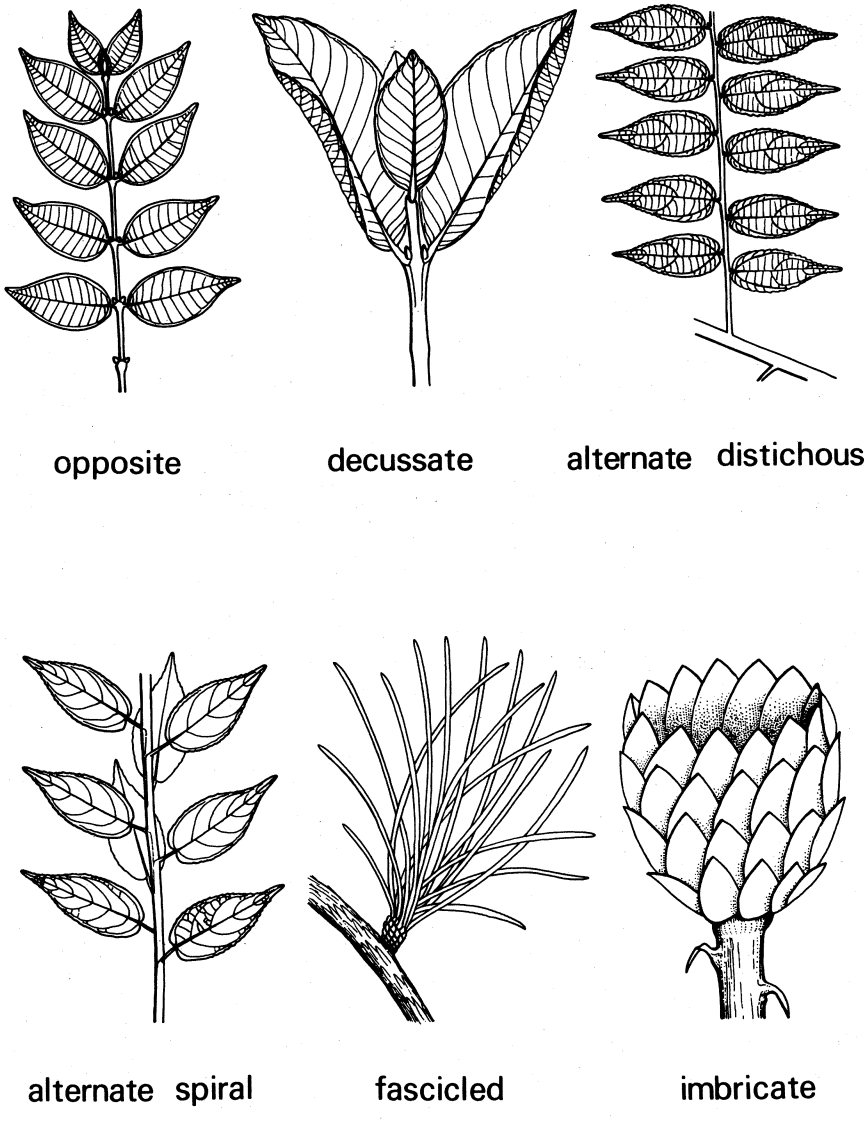


Fig. 112 Leaf arrangement

distichous: in two rows; *Fig. 112*
divaricate: spreading at a very wide angle; extremely divergent
divergent: spreading away from one another
domatia: hair-tufted pits usually located on the abaxial surface of leaves in the axils of the primary nerves
dorsal: relating to the back, the side away from the axis
dorsifixed: attached by the back, especially of anthers
dorsiventral: with distinct upper and lower surfaces
drupe: a simple, fleshy fruit with a single seed enclosed in a bony covering (endocarp); a stone fruit; hence **drupaceous**

e- or **ex-**: prefix meaning 'lacking'
ebracteate: without bracts
echinate: beset with prickles; dimin. **echinulate**
effuse: spreading loosely
ellipsoid: of a solid object, elliptic in section or outline
elliptic: in the shape of an ellipse; longer than wide and with rounded ends; *Fig. 110*
elongate: drawn out in length
emarginate: notched, usually at the extremity; *Fig. 111A*; dimin. **emarginulate**
embossed: having a slight central nodule
embryo: the rudimentary plant in the seed
endocarp: the inner layer of the fruit wall (pericarp), lying next to the seed
endosperm: nutritive material or tissue outside the embryo, present in some seeds
entire: with an unbroken or even margin; without teeth or other indentations; *Fig. 111B*
entomophilous: applied to flowers that are pollinated by insects
epicorolline: inserted upon the corolla
epidermis: the outermost cellular layer or covering of a plant below the cuticle; hence **epidermal**
epigeal: above ground, especially of cotyledons
epigynous: borne on the ovary; of floral parts as stamens and perianth when arising level with or above the top of the ovary which is adnate to the surrounding receptacle
epipetalous: borne on the petals or corolla
epiphyllous: borne on leaves or leaf-like organs
epiphyte: an organically independent plant growing upon another plant and not connected to the ground
equitant: conduplicate and overlapping in two or more ranks; *Fig. 115*
erose: with an irregular margin, as if bitten
-escent: suffix meaning 'inclined to be' or 'becoming'
exalbuminous: destitute of albumen, used only of seeds when the embryo occupies the entire cavity within the testa
excurrent: running out beyond the margin or apex, as a vein extending beyond the leaf-blade into a point
exine: the outer coat of a pollen grain
exocarp: the outermost of the three layers forming the wall or pericarp of a fruit

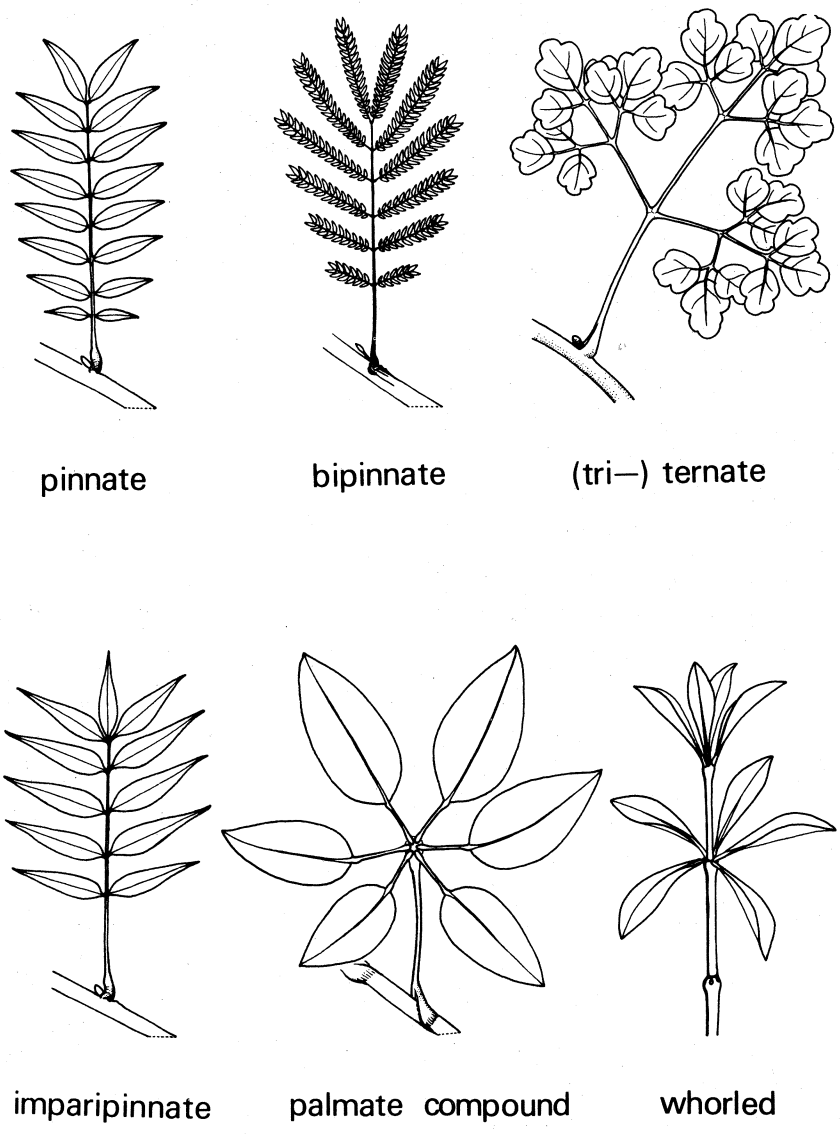


Fig. 113 Leaf types and arrangement

explanate: spread out flat
exserted: projecting beyond
extrorse: directed outwards; used of anther dehiscence

falcate: strongly curved like a sickle; *Fig. 110*
farinose: having a mealy appearance
fascicle: a close cluster or bundle; *Fig. 112*
fastigiate: of branches, erect and clustered
ferrugineous: rust-coloured
fertile: producing seed, spores, or pollen capable of germination; of a specimen or plant having flowers and/or fruits
fibrillose: finely fibrous
filament: any thread-like body, especially the stalk of the stamen bearing the anther
filiform: thread-shaped
fimbriate: fringed; dimin. **fimbrillate**
fistular: cylindrical and hollow; hence **fistulate, fistulose**
flaccid: limp, not rigid
flexible: easily bent but recovering the original form
flexuous: having a wavy zigzag form
flush: a sequence of rapid vegetative growth, often involving the expansion of leaves and the shoot extremities
foliaceous: leaf-like
foliar: pertaining to leaves or leaf-like parts
foliate: leaved, clothed with leaves
follicle: a dry fruit formed from one carpel and dehiscing along one side; hence **follicular**
free: not adhering, the reverse of adnate
fruit: a ripened ovary containing seeds; often used to include adherent parts such as fleshy receptacle
fugacious: falling very early, as some petals and sepals
fulvous: yellow, tawny
funicle: the stalk of an ovule attaching it to the ovary wall or placenta
furcate: forked
furrowed: with ± parallel, usually longitudinal, grooves or channels
fusiform: spindle-shaped; of a solid, ± swollen in the middle and narrowed to both ends

gamopetalous: with the petals united, at least at the base
gamosepalous: with the sepals united, at least at the base
glabrescent: becoming glabrous or hairless (at maturity)
glabrous: without hairs or scales
gland: an organ or part that secretes oil, resin, or other liquid; hence **glandular**, bearing glands or of the nature of a gland
glaucous: of a distinctly bluish-green colour; hence **glaucescent**, slightly glaucous or becoming so
globose: almost spherical
glomerule: a very dense cluster; hence **glomerulate**

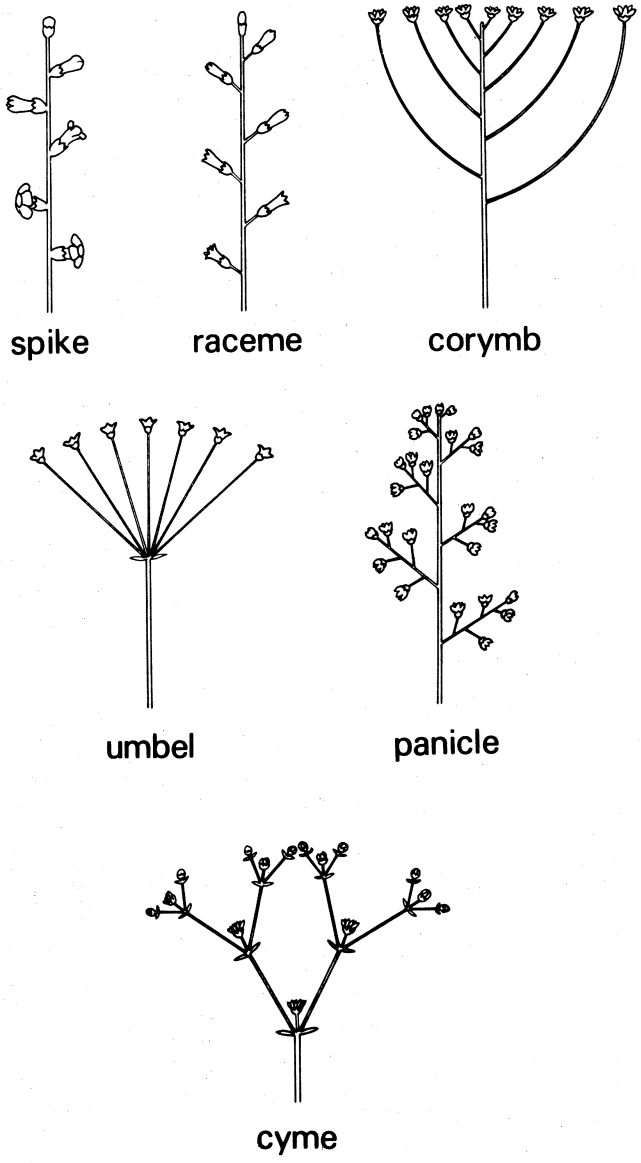


Fig. 114 Inflorescence types

gymnosperms: plants having their ovules borne naked or unprotected; the conifers or cone-bearing plants and their allies; hence **gymnospermous**
gynoecium: the female part of a flower comprising one or more carpels
gynophore: a stalk or stipe on which an ovary or fruit is elevated above the level of attachment of the perianth

habit: the general appearance of a plant
habitat: the kind of place in which a plant grows
hastate: having the shape of an arrow-head, but with the basal lobes pointed or narrow and spreading at a wide angle; *Fig. 110*
herb: any vascular plant that is not woody; hence **herbaceous**
hermaphrodite: possessing both male (stamens) and female (carpels) elements in the same flower
hetero-: prefix meaning 'dissimilar'
heteroblastic: with two or more distinct kinds of shoot; used especially when the shoots of older plants differ from those of younger stages
hilum: the scar on the seed marking the place of attachment of its stalk
hirsute: with distinct hairs, often rather stiff or bristly
hispid: bearing stiff or rigid spreading bristles; dimin. **hispidulous**
hyaline: thin and translucent
hybrid: the offspring of parents of differing taxonomic identity
hypanthium: an enlargement or development of the floral axis, sometimes cup-shaped or tubular, with the floral organs arising from its upper margin
hypocotyl: the axis of an embryo or seedling below the cotyledons and above the radicle
hypogeal: below ground, especially of cotyledons
hypogynous: borne below the ovary; of floral parts where the perianth and stamens arise below the ovary

imbricate: with overlapping edges (as shingles on a roof); *Fig. 112*. In aestivation, used of a calyx or corolla where one piece must be wholly internal and one wholly external, or overlapping at the edge only; *Fig. 115*
imparipinnate: pinnate, but with the petiole terminated by a single leaflet or tendril; *Fig. 113*
impressed: sunk below the level of the surface
incised: cut sharply, sometimes irregularly, and rather deeply; hence **incisure**
indehiscent: not splitting open
indeterminate: not terminated absolutely, as an inflorescence in which no flower ends the axis of the flower cluster
indumentum: any covering of a plant surface, especially pubescence
induplicate: with the margins bent inwards, and the external face of these edges, applied to each other, without twisting; *Fig. 115*
inferior: situated below another organ or part; an inferior ovary is surrounded by and fused with the receptacle and so is below the insertion of the perianth
inflexed: turning sharply inwards
inflorescence: a collection of flowering parts including peduncle, pedicels, bracts and flowers, or the arrangement of the flowers
infructescence: the arrangement of fruits, or a collection of fruiting parts including peduncle, pedicels, bracts and fruit

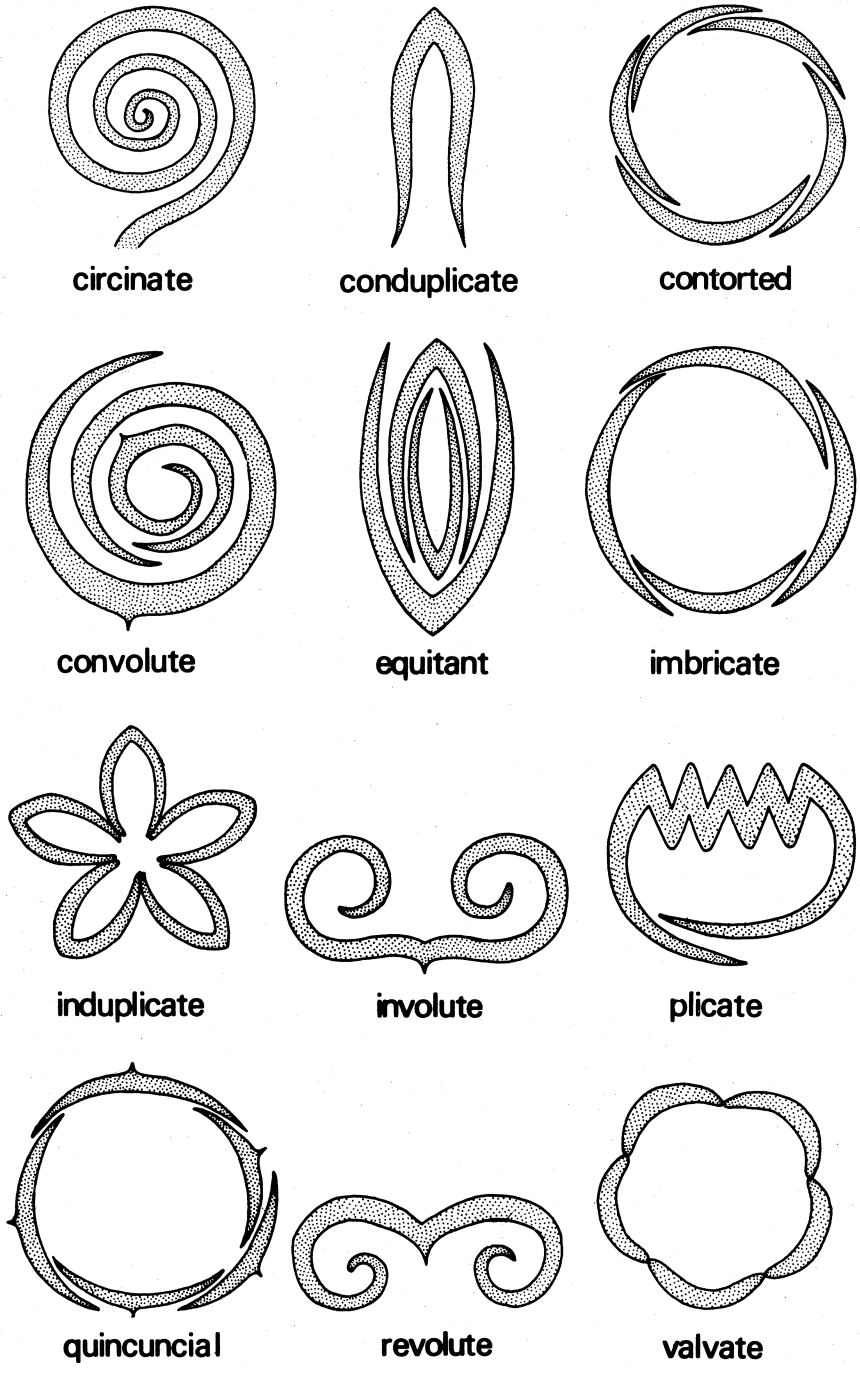


Fig. 115 Some modifications of aestivation and vernation

innovation (shoot): a vigorous shoot which carries on the further growth of the plant
inserted: attached to or growing upon; hence **insertion**, the place or mode of attachment
integument: a covering, especially the covering of an ovule
internode: the portion of a stem between two adjacent nodes
introrse: facing inwards or towards the axis
invest: clothe
involucre: one or more whorls of bracts, often calyx-like, subtending an inflorescence
involute: rolled inwards or to the upper (adaxial) side; *Fig. 115*
iso-: prefix meaning 'equal'
isomerous: with the elements of successive cycles equal in number, as when a flower has an equal number of sepals, petals, and stamens

lacerate: with an irregular or ragged margin, as though torn
laciniate: deeply, usually irregularly divided into very narrow, pointed segments
lacuna: a gap, used of a space enclosed by, but free from, veins; hence **lacunose**
lamellar: composed of thin plates
lamina: a thin, flat organ or part, especially the expanded portion or blade of a leaf; pl. **laminae**; hence **laminate**; dimin. **lamella, lamellate**
lanceolate: lance-shaped; of a leaf several times longer than wide with greatest breadth at about one third from base tapering gradually to apex and more rapidly to base; *Fig. 110*
lateral: a side member, part or object
latex: a milky juice drying to a rubber-like consistency
latrorse: directed towards the sides
lax: loosely arranged or distantly placed
leaflet: one element of a compound leaf
lenticel: a corky spot or line on young bark functioning as a stoma; hence **lenticellate**
lenticular: shaped like a $\pm$ circular biconvex lens
lepidote: clad in small, scurfy scales
liane: a woody climbing plant; hence **lianoid**
ligneous: woody
ligule: a strap-shaped body; hence **ligulate**
liguliform: tongue-shaped or strap-shaped
limb: the upper, expanded portion of a calyx or corolla of united parts, as contrasted with the lower narrow part called the tube
lingulate: tongue-shaped
linear: long and narrow with parallel margins; *Fig. 110*
lobe: a partial division of a leaf or other organ, especially when rounded; hence **lobed, lobate**; dimin. **lobule, lobulate**
locellate: (of anthers) divided by septa into secondary compartments.
locule: a compartment or cavity of an organ

maculate: spotted or blotched with another colour
median: belonging to the middle

membranous: thin, soft, flexible, and ± translucent
-merous: suffix indicating the number of parts or floral organs as in 4–5-merous, having the sepals, petals, etc., in whorls of 4–5
mesocarp: the middle layer of the fruit wall (pericarp)
micropyle: the minute opening in the integuments of an ovule through which the pollen grain or tube enters, becoming a pit-like mark on the mature seed
microspore: (1) the smaller-sized spore or simple asexual reproductive body in plants with two kinds of spores; (2) sometimes applied to the pollen grain
midrib: the main or central vein of a leaf or similar organ
monadelphous: stamens, all united by their filaments into a tube or column
monoecious: male and female elements separate but on the same individual
monopodial: of a stem in which growth is continued from year to year by the same apical growing point
monotypic: having only one representative, as a genus with only one species
mucilage: vegetable gelatine belonging to the amylose group of carbohydrates, of slimy consistency; hence **mucilaginous**
mucro: a short, sharp tip or excurrent midrib; hence **mucronate**; *Fig. 111A*
muricate: rough, with short and hard tubercular excrescences
myrmecophilous: ant-loving; of plants that are inhabited by ants and offer specialized shelters or food for them

naked: of a part lacking bracts or appendages, or of a flower lacking a perianth
navicullariform: boat-shaped
nectary: a gland exuding a sweet fluid called nectar, commonly occurring in insect-pollinated flowers
nerve: a strand of conducting and usually strengthening tissue in a leaf or similar structure
node: a point on a stem where leaves or branches are attached
nodose: knotty or knobby; dimin. **nodulose**
nodule: a small, ± spherical swelling; hence **nodular**
nucellus: the inner tissue of an ovule, enclosing the embryo sac and surrounded by the integuments
nut: a simple, dry, indehiscent fruit with one seed and with a hard, woody wall; dimin. **nutlet**

ob-: prefix meaning 'inverted', as in 'obconical'
obconical: inversely conical, cone attached at the narrower end
oblanceolate: inverted lanceolate, as a leaf broader at the distal third than at the middle, and tapering towards the base; *Fig. 110*
oblique: with sides unequal
oblong: longer than broad, with parallel margins and rounded ends; *Fig. 110*
obovate: reversed ovate, the distal end the broader
obovoid: of a solid body, obovate in outline
obtuse: blunt or rounded at the end; *Fig. 111A*
ocrea: a tubular stem-sheathing extension of the leaf base; a tubular stipule
olivaceous: olive-coloured, a yellowish-green darkened with black
opposite: of a pair of organs arising at the same level on opposite sides of the axis; *Fig. 112*
orbicular: rounded or circular in outline; *Fig. 110*

orthostichy: a vertical row
orthotropous: of an erect ovule (its axis in a straight line with the funicle), the micropyle remote from the placenta
oval: broadly elliptic, narrowing somewhat from the middle to rounded ends
ovary: the part of the carpel that encloses the ovules
ovate: with an outline resembling the longitudinal section of an egg, attached by the broader end; *Fig. 110*
ovoid: of a solid body with an ovate outline
ovule: the structure containing the egg (ovum), which after fertilization develops into the seed

palmate: radially lobed or divided, as fingers of a hand; *Figs 110, 113*; hence **palmatifid, palmatisect**
pandurate: fiddle-shaped; ± obovate, but with a 'waist'
panicle: an elongate inflorescence with compound branching; *Fig. 114*; hence **panicled, paniculate**
papilla: a small, superficial, rounded projection; pl. **papillae**; hence **papillose**, covered with papillae
parenchyma: a tissue of thin-walled, little-differentiated cells
parietal: pertaining to the wall, as parietal placentation when the ovules are borne on the walls of the ovary
partite: deeply divided
patent: spreading
pauci-: prefix meaning 'few'
pedicel: the stalk of a single flower; hence **pedicellate**
peduncle: the main stalk supporting an inflorescence, or the stalk of a solitary flower; hence **pedunculate**
peltate: attached by the lower surface, not by the margin
pendent: hanging down from its support
pendulous: hanging
penniform: with ribs, the upper segments confluent at the apex
penninerved: pinnately veined
pentamerous: with organs or parts in multiples of five
per-: prefix meaning 'very' or 'all over'
perennial: with life cycle of more than two years
perfect: of flowers with both male and female elements present and functional
perfoliate: of a sessile leaf or bract completely encircling the axis, with the stem apparently passing through it
perianth: the floral envelopes, calyx or corolla, or both
pericarp: the wall of the fruit (ripened ovary)
perigynous: surrounding the ovary; of floral parts as where perianth and stamens arise from the edge of a ± cup-shaped receptacle, surrounding but free from the ovary
perula: the scale of a leaf-bud
perulate: bearing scales
petal: one of the leafy expansions or units of the corolla, when completely free; hence **petaloid**, resembling a petal
petiole: the stalk of a leaf; hence **petiolate**
petiolule: the stalk of a leaflet; hence **petiolulate**

phanerogam: a seed-plant or spermatophyte, as opposed to a cryptogam such as a fern which reproduces by asexual spores; sometimes restricted to plants with flowers in which stamens and pistils are distinctly developed
phylloclade: a ± flattened stem functioning as a leaf
phyllotaxy: the arrangement of leaves or floral envelopes on an axis
piliferous: bearing hairs
pilose: hairy, usually with long and distinct hairs
pinna: a primary division of a pinnate leaf; dimin. **pinnule**
pinnate (leaf): with leaflets arranged each side of a common petiole; *Fig. 113*
pistil: the female reproductive part of a flower, occupying a central position; hence **pistillate**, of flowers with gynoecium but without functional stamens
pistillode: a sterile pistil, often reduced or modified
placenta: the place or part in an ovary where the ovules are attached; pl. **placentae**
placentation: the arrangement of the placentae within the ovary; e.g. axile, free central, parietal
plicate: folded into pleats, usually lengthwise; *Fig. 115*
-plinerved: of a leaf when the lateral nerves emerge from the midrib a little above its junction with the petiole
plumose: feather-like
plumule: the primary shoot-bud of an embryo
pneumatophore: used of air-vessels of any description
pollen: the microspores or fertilizing dust-like cellular powder produced by the anthers of angiosperms or gymnosperms
pollination: the transfer of pollen to the receptive surface of the female organ
polyandrous: with an indefinite number of stamens
polygamous: bearing unisexual and bisexual flowers on the same plants, or on different plants of the same species
polymorphic: of several forms
polypetalous: with a corolla of free petals
polyploid: a plant with a chromosome complement of more than two sets of the basic (monoploid) number
polysepalous: with a calyx of free sepals
procumbent: lying on the ground but not rooting
prominent: standing out beyond some other part; dimin. **prominulous**
prostrate: trailing on the ground
protandrous: with the anthers shedding pollen before the stigmas of the same flower are receptive
protogynous: with the stigma receptive before the pollen is shed in the same flower
protoplasm: the viscous living substance of the cell including the cell membranes
proximal: towards the attached, as opposed to the free or distal, end of an organ
pseudo-: prefix meaning 'false'
puberulent: minutely pubescent, the hairs soft and very short, scarcely visible to the unaided eye
puberulous: slightly hairy
pubescent: covered with hairs, especially soft, downy hairs

punctate: covered with dots or pits
punctiform: in the form of a dot or point; reduced to a mere point
pungent: (1) ending in a rigid and sharp point; *Fig. 111A*; (2) acrid to the taste
pustule: low projection like a blister or pimple, but larger than a papilla

quincuncial: (1) arranged in a quincunx; (2) in aestivation, partly imbricated of five parts, two being exterior, two interior, and the fifth having one margin exterior and the other interior; *Fig. 115*
quincunx: (1) an arrangement like the five on dice, four at the corners and one in the centre; (2) in five ranks

raceme: an indeterminate or centripetal inflorescence, unbranched, with lengthened axis, and stalked flowers; *Fig. 114*; hence **racemose**
rachis: the axis of a pinnately compound leaf or of an inflorescence; pl. **rachides**; dimin. **rachilla**
radicle: the primary root of an embryo
receptacle: the often ± expanded top of the stalk on which the flower or flower-head is borne
recurved: curved downwards or backwards
reclinate: turned or bent downwards upon some other part
reflexed: bent sharply backwards
regular: uniform or symmetric in shape or structure; of a flower, actinomorphic
reniform: kidney-shaped; *Fig. 110*
replicate: turned or folded back upon itself so that the upper and lower parts come together
reticulate: in network
retrorse: directed downwards or backwards
retuse: the apex rounded and with a small notch; *Fig. 111A*
revolute: rolled back from the edge or tip so as to expose the upper (adaxial) surface and conceal the undersurface; *Fig. 115*
rhizome: a modified underground stem, usually growing horizontally; hence **rhizomatous**
rhomboid: ± diamond-shaped; *Fig. 110*
rosette: a group of organs radiating from a centre; used especially where the lowest internodes of a stem are very short with numerous ± overlapping leaves which may be appressed to the soil; hence **rosulate**
rostrate: with a beak; *Fig. 111A*
rotundate: rounded, almost circular
rudimentary: arrested at an early stage of development
rufous: reddish, of all shades
rugose: wrinkled; dimin. **rugulose**
ruminate: looking as though chewed
runcinate: pinnately and rather sharply incised with the lobes directed backwards

sac: a pouch-like structure; hence **saccate**
sagittate: shaped like an arrow-head; *Fig. 110*

salverform (salviform): of a calyx or corolla with a slender tube abruptly expanded into a flat limb
scabrid, scabrous: rough to the touch because of minute, hard projections; dimin. **scabridulous, scaberulous**
scalariform: having markings suggestive of a ladder
scale: any small, ± leaf-like organ, often dry and membranous
scandent: climbing, usually without special climbing organs
scarious: thin and dry, and ± translucent
sclerenchyma: a tissue of cells with immensely thickened walls, often with their protoplasm lost
scurfy: covered with minute scales
seed: the reproductive body formed from a fertilized ovule, and comprising an embryo, with or without endosperm, and a surrounding protective coat
semi-: prefix meaning 'half'
sepal: one of the separate parts of a free-membered calyx or outer whorl of floral leaves; hence **sepaloid, sepalous**
septum: a partition or cross-wall; pl. **septa**; hence **septate**, divided by internal transverse partitions
sere: the developmental stages or succession of community types through which the vegetation in an area passes before reaching an ultimate state of equilibrium with the climate and major geological features of the area; hence **seral**
sericeous: clothed with soft, straight, appressed hairs
serrate: sharply toothed like a saw, the teeth pointing forwards; *Fig. 111B*; hence **serrature**; dimin. **serrulate**
sessile: without a stalk
seta: a fine bristle-like structure; hence **setaceous, setose**; dimin. **setulose**
sheath: a ± tubular structure surrounding an organ or part
simple: of one piece or series
sinuate: deeply waved; *Fig. 111B*
sinuous: deeply or very deeply waved
sinus: the gap or recess between two lobes or segments
spathulate: spoon-shaped; *Fig. 110*
spike: an unbranched, ± elongate, indeterminate inflorescence with sessile flowers; *Fig. 114*; hence **spicate**, like a spike, or disposed in a spike
spine: a stiff woody process with sharp point; hence **spinose, spinous**; dimin. **spinulose**
spiniform: thorn-like
sporophyll: a leaf-like or foliaceous organ bearing reproductive parts or organs, i.e. pollen or ovules
spur: a slender sac-like or hollow protuberance from the calyx or corolla, often secreting nectar; hence **spurred**
squamose: scaly or scale-like
stamen: the male organ of a flower, composed of an anther with pollen sacs and its supporting stalk or filament; hence **staminate**, of flowers with stamens but without functional carpels
staminode: a sterile stamen, often reduced or modified
stellate: star-shaped

sterile: barren; not producing seed, spores or pollen capable of germination
stigma: the part of the carpel receptive to pollen, generally terminal on the style; hence **stigmatic**
stilt-roots: oblique adventitious roots from the stem
stipate: pressed together, crowded
stipe: a stalk or support, e.g. of a gynoecium or carpel
stipule: one of a pair of appendages (scarious, membranous or leaf-like) sometimes developed at the base of a petiole or, with sessile leaves, on either side of the point of attachment to the stem; hence **stipulate**
stolon: a ± horizontal stem rooting at the nodes but at least partly above ground
stoma: a pore in the epidermis (especially of leaves) through which gases diffuse; pl. **stomata**
stria: a fine longitudinal line or minute ridge; pl. **striae**; hence **striate**
strophiole: an aril-like but hard appendage of some seeds, at or near the micropyle; hence **strophiolate**
style: the sometimes elongate part of some carpels between the ovary and the stigma; hence **stylar**
sub-: prefix meaning 'somewhat', 'slightly' or 'not quite', as in **suborbicular**, nearly round
suberose: corky in texture
subtend: occur immediately below, as a bract subtending a flower
subulate: awl-shaped, but tapering upwards
sucker: a vegetative shoot of underground origin
sulcus: a furrow or groove; pl. **sulci**; hence **sulcate**, longitudinally grooved
superior: situated above another organ or part; a superior ovary is free from the receptacle, with the perianth and stamens inserted below or around it
suture: a seam or line as formed at the junction of two margins
sympetalous: with the petals partly or completely joined
sympodium: an axis made up of the basal portions of several branches; the apex of each branch dies or ends in an inflorescence, and growth is continued by activity of an axillary bud; hence **sympodial**
synandrium: an androecium with the anthers coherent
syncarpous: having the carpels joined to one another

tendril: a slender, twining part of cauline or foliar origin by which a climbing plant may secure itself
tepal: an individual member of the perianth
terete: circular in transverse section, cylindrical and usually tapering
ternate: arranged or divided in threes; *Fig. 113*
tessellate: in chequer-work pattern or squares
testa: the outer coat of a seed
tetra-: prefix meaning 'four'
tetrad: a group of four
tetramerous: with organs or parts in multiples of four
thyrse: a compact, ± cone-shaped panicle; hence **thyrsoid**
tomentum: a dense woolly or matted covering of soft, ± appressed hairs; hence **tomentose**

torus: the receptacle of a flower; that portion of the axis on which the parts of the flower are inserted
tri-: prefix meaning 'three'
trichome: a hair-like outgrowth of the epidermis
trigonous: a solid body, triangular in cross-section, with the edges rounded
trullate: shaped like a bricklayer's trowel
truncate: having the base or apex flattened as though cut off; *Fig. 111A*
tube: (1) any hollow elongated body or part of an organ; (2) the united, ± cylindrical part of a calyx or corolla of joined parts
tuber: a swollen, usually subterranean part of a stem or root; hence **tuberous**
tubercle: a small wart-like swelling
tuberculate: beset with knobby projections or excrescences
tubular: apparently cylindrical and hollow; descriptive of corollas that have a well-developed tubular portion but little or no limb portion
turbinate: top-shaped

umbel: an inflorescence, properly indeterminate, often flat-topped or umbrella-shaped, with the flowers on pedicels arising from a common centre (the top of the peduncle); *Fig. 114*; hence **umbelliform, umbellate**
umbonate: bearing a protuberance in the centre
undulate: with the margin waved in a plane at right-angles to the surface; *Fig. 111B*
uni-: prefix meaning 'single'
uniseriate: arranged in a single row or series
unisexual: of flowers with only one sex functional
urceolate: hollow and contracted at the mouth like an urn or pitcher

valvate: (1) opening by doors or valves, as in many dehiscent fruits and some anthers; (2) in aestivation when the parts of a flower bud meet exactly without overlapping; *Fig. 115*
variegated: irregularly coloured in patches
vascular: related to or furnished with vessels
vein: a strand of conducting and usually strengthening tissue in a leaf or similar part
velutinous: covered with fine, soft, ± patent hairs
venation: the arrangement of veins
vernation: the arrangement of leaves in the vegetative bud
verrucose: with a warty or nodular surface
versatile: attached by the middle and free to swing, as some anthers
verticillate: in a circle or whorled about an axis
vesicle: a small bladder or cavity filled with air or fluid; hence **vesicular**, blistered on the surface
vessel: a duct or articulated tube usually comprised of many cells but rendered continuous by the ± complete absorption of the intervening transverse walls
vestigial: reduced to a rudiment
villous (villose): clad in long, soft hairs not matted together
villus: a long weak hair; pl. **villi**

viscid: sticky (of surfaces)
viscous: slow flowing, often sticky

whorl: an arrangement of three or more similar parts or organs at the same level about an axis; hence **whorled**; *Fig. 113*
wrinkled: rugose, creased; in aestivation or vernation when the parts are folded up irregularly in every direction

zygomorphic: having only one plane of symmetry

Appendix 1

CENSUS OF FAMILIES OF FLOWERING PLANTS AND GYMNOSPERMS FOR PAPUA NEW GUINEA

Acanthaceae
Aizoaceae
Alangiaceae
Alismataceae
Amaranthaceae
Amaryllidaceae
Anacardiaceae
Annonaceae
Apocynaceae
Aponogetonaceae
Aquifoliaceae
Araceae
Araliaceae
Araucariaceae
Aristolochiaceae
Asclepiadaceae
Balanophoraceae
Balsaminaceae
Batidaceae
Begoniaceae
Bignoniaceae
Bixaceae
Bombacaceae
Boraginaceae
Bromeliaceae
Burmanniaceae
Burseraceae
Butomaceae
Byblidaceae
Callitrichaceae
Campanulaceae
Cannaceae
Capparidaceae
Caprifoliaceae
Cardiopteridaceae
Caricaceae
Caryophyllaceae
Casuarinaceae
Celastraceae
Centrolepidaceae
Ceratophyllaceae
Chenopodiaceae
Chloranthaceae
Clethraceae
Cochlospermaceae
Combretaceae
Commelinaceae
Compositae
Connaraceae
Convolvulaceae
Coriariaceae
Cornaceae
Corsiaceae
Corynocarpaceae
Crassulaceae
Cruciferae
Crypteroniaceae
Cucurbitaceae
Cunoniaceae
Cupressaceae
Cycadaceae
Cyperaceae
Daphniphyllaceae
Datiscaceae
Dichapetalaceae
Dilleniaceae
Dioscoreaceae
Dipterocarpaceae
Droseraceae
Ebenaceae
Elaeagnaceae
Elaeocarpaceae
Elatinaceae
Epacridaceae
Ericaceae
Eriocaulaceae
Erythroxylaceae
Euphorbiaceae
Eupomatiaceae
Fagaceae
Flacourtiaceae
Flagellariaceae
Gentianaceae
Geraniaceae
Gesneriaceae
Gnetaceae
Gonystylaceae
Goodeniaceae
Gramineae
Guttiferae
Haemodoraceae
Haloragaceae
Hamamelidaceae
Hanguanaceae
Hernandiaceae
Himantandraceae
Hydrocharitaceae
Icacinaceae
Iridaceae
Juglandaceae
Juncaceae
Juncaginaceae
Labiatae
Lauraceae
Lecythidaceae
Leeaceae
Leguminosae
Lemnaceae
Lentibulariaceae
Liliaceae
Linaceae

Loganiaceae
Loranthaceae
Lythraceae
Magnoliaceae
Malpighiaceae
Malvaceae
Marantaceae
Melastomataceae
Meliaceae
Menispermaceae
Monimiaceae
Moraceae
Moringaceae
Musaceae
Myoporaceae
Myricaceae
Myristicaceae
Myrsinaceae
Myrtaceae
Najadaceae
Nepenthaceae
Nyctaginaceae
Nymphaeaceae
Ochnaceae
Olacaceae
Oleaceae
Onagraceae
Opiliaceae
Orchidaceae
Orobanchaceae
Oxalidaceae
Palmae
Pandanaceae
Passifloraceae
Pentaphragmataceae
Philydraceae
Phytolaccaceae
Pinaceae
Piperaceae
Pittosporaceae
Plantaginaceae
Plumbaginaceae
Podocarpaceae
Podostemaceae
Polygalaceae
Polygonaceae
Pontederiaceae
Portulacaceae
Potamogetonaceae
Primulaceae
Proteaceae
Rafflesiaceae
Ranunculaceae
Restionaceae
Rhamnaceae
Rhizophoraceae
Rosaceae
Rubiaceae
Rutaceae
Sabiaceae
Santalaceae
Sapindaceae
Sapotaceae
Saurauiaceae
Saxifragaceae
Scrophulariaceae
Simaroubaceae
Solanaceae
Sonneratiaceae
Sparganiaceae
Stackhousiaceae
Staphyleaceae
Stemonaceae
Sterculiaceae
Stylidiaceae
Styracaceae
Symplocaceae
Taccaceae
Theaceae
Thymelaeaceae
Tiliaceae
Trimeniaceae
Triuridaceae
Tropaeolaceae
Turneraceae
Typhaceae
Ulmaceae
Umbelliferae
Urticaceae
Valerianaceae
Verbenaceae
Violaceae
Vitaceae
Winteraceae
Xyridaceae
Zannichelliaceae
Zingiberaceae
Zygophyllaceae

Appendix 2

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BOTANICAL NAMES

COMMON AND VERNACULAR NAMES

Set in Times New Roman type