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A TAXONOMIC REVISION OF THE GENUS GRAMMITIS SWARTZ (GRAMMITIDACEAE: FILICALES) IN NEW GUINEA

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SUMMARY

A taxonomic revision of the fern genus *Grammitis* Swartz (Grammitidaceae) in New Guinea has been made, in which 64 species belonging to 14 species groups are recognised. Forty-five species are endemic to New Guinea and 21 species are hitherto undescribed. Problems in generic classification are outlined and the morphological characters used in the delimitation and description of the species and species groups are discussed. A bracket key to species and a multi-access key to species groups are provided for identification. For each species there is a complete citation of nomenclature, an illustration of a complete plant together with details of part of a frond, a full description and a summary of habitat, vegetation type and altitude. All of the specimens examined are cited, giving locality, altitude, date, collector and number, and herbaria in which the collection has been seen. The distribution of each species is mapped within New Guinea and the distribution of non-endemic species beyond New Guinea is also shown. Maps of each non-endemic species group are given which outline the distribution of all members.

Following the taxonomic account the geographical affinities and distribution of the species and species groups both within and beyond New Guinea are investigated. The presence of five distribution patterns for the non-endemic species and species groups is established and the existence of a central core of distribution within New Guinea is outlined. Some aspects of ecological distribution in New Guinea are considered and the wider ecological tolerance of some non-endemic species, compared with endemic species, is suggested.

Finally, the means by which the speciation of *Grammitis* in New Guinea may have been promoted is discussed.

1. INTRODUCTION

1.1. Family classification

The family Grammitidaceae was recognised as distinct from the Polypodiaceae just over forty years ago (Ching, 1940). Ching's spelling 'Grammitaceae' is an error and although it is occasionally still spelt in this way (e.g. Pichi Sermolli, 1977), this must be corrected to Grammitidaceae to agree with the type genus *Grammitis* Swartz and its derivation. Subsequent authors of major classifications followed Ching in maintaining the family (Holttum, 1947; Crabbe et al., 1975; Pichi Sermolli, 1977) with the exception of Copeland (1947). It is treated as a separate family in modern regional fern floras of the Old World (Allan, 1961; Brownlie, 1969, 1977; Copeland, 1960; DeVol, 1975; Holttum, 1955; Schelpe, 1970; Schelpe & Diniz, 1979) but in recent New World floras it is kept as a subfamily of Polypodiaceae (Proctor, 1977) or the genera are included in Polypodiaceae without comment (Vareschi, 1969).

The family Grammitidaceae is distinguished from the Polypodiaceae by the usually free veins which never have included veinlets, the sporangial stalk of one row of cells for most of its length, and chlorophyllous trilete spores.

Ching's (1940) circumscription of the family contained *Grammitis* (with which *Ctenopteris* Blume ex Kunze was synonymised, and, by description, *Xiphopteris* Kaulf. also), *Calymmodon* C. Presl, *Acrosorus* Copel., *Prosaptia* C. Presl, *Holcosorus* T. Moore, *Cochlidium* Kaulf., *Scleroglossum* v.A.v.R., *Nematopteris* v.A.v.R. and *Oreogrammitis* Copel. *Holcosorus* is now regarded as a relative of *Crypsinus* C. Presl and allied genera in Polypodiaceae (Crabbe et al., 1975; Pichi Sermolli, 1977). The

other genera are still included in Grammitidaceae together with some additional genera. There is agreement on the inclusion of *Glyphotaenium* J. Smith and *Adenophorus* Gaud. (syn. *Amphoradenium* Desv.) (e.g. Crabbe et al., 1975; Pichi Sermolli, 1977), but disagreement over the treatment of the loxogrammoid genera *Anarthropteris* Copel., and *Loxogramme* (Blume) C. Presl. Ching (1940) placed *Loxogramme* in a separate monotypic family, the Loxogrammaceae (*Anarthropteris* was not described until seven years later; Copeland, 1947). Subsequently *Loxogramme* has been kept in Polypodiaceae together with *Anarthropteris* (Copeland, 1947) or without mention of *Anarthropteris* (Holttum, 1947), included in Grammitidaceae (Crabbe et al., 1975, following Christensen, 1938), or placed in Loxogrammaceae (Pichi Sermolli, 1977).

Once the loxogrammoid ferns are removed there is agreement on the twelve genera of Grammitidaceae (e.g. Crabbe et al., 1975 and Pichi Sermolli, 1977). *Ctenopteris, Grammitis* and *Xiphopteris* occur in both the Old World and New World, while *Acrosorus, Adenophorus, Calymmodon, Nematopteris, Oreogrammitis, Prosaptia* and *Scleroglossum* are found only in the Old World and *Cochlidium* and *Glyphotaenium* are restricted to the New World.

These twelve genera have been accepted uncritically in modern classifications in the Old World although there are some problems with their delimitation, especially in defining *Ctenopteris, Grammitis* and *Xiphopteris*. In New World floristic accounts these three genera and *Glyphotaenium* are usually treated as *Grammitis*, but *Cochlidium* is kept separate (e.g. Proctor, 1977).

The problem of generic delimitation is the result of the poor state of taxonomic knowledge of the family. No family monograph has ever been prepared and only three genera (two of them very small) have been monographed on a world scale. These are *Adenophorus* (Bishop, 1974), *Cochlidium* (Bishop, 1978) and *Grammitis* (Copeland, 1952a). Regional revisions have been made of several genera: *Ctenopteris* in America (Copeland, 1956), *Xiphopteris* in America (Copeland, 1952b), *Grammitis* (including *Ctenopteris, Glyphotaenium* and *Xiphopteris*) in Ecuador (Morton, 1967), *Grammitis* section *Grammitis* in America (Bishop, 1977), and *Grammitis* in Australia (Parris, 1975) and in New Zealand (Parris & Given, 1976).

The small genera *Acrosorus, Calymmodon* and *Scleroglossum* (with which *Nematopteris* should be united) are well-defined. The monotypic *Oreogrammitis* has recently been synonymised with *Grammitis* (Parris, 1980). The relationship of the species and species groups of the remaining genera *Adenophorus, Cochlidium, Ctenopteris, Glyphotaenium, Grammitis, Prosaptia* and *Xiphopteris* need investigating before any of them can be circumscribed with confidence. Bishop's generic descriptions of *Adenophorus* (1974) and *Cochlidium* (1978) would cover unrelated species currently placed elsewhere in Grammitidaceae and illustrate the problems of defining genera without a comprehensive knowledge of the family. *Grammitis, Ctenopteris* and *Xiphopteris* as presently construed are based upon the degree of dissection of the fronds which provides an arbitrary and unsatisfactory means of definition. It would be premature and confusing, however, to change their delimitation without a detailed study of all the species involved, as the three genera appear to be linked by several

groups of species which require critical study. Natural hybrids are also known between *Ctenopteris* and *Grammitis* (Copeland, 1952a & 1960; Parris, 1977 & in press). In both the examples of intergeneric hybridisation which I have examined the parent species and the hybrid had the same types of hairs. The distribution of various hair types in the family therefore may be useful in determining relationships.

In planning to resolve the problems in the family at the generic level it seemed best to commence with a study of *Grammitis*, potentially the most easily definable of the larger genera, in New Guinea, the area of its greatest species richness and ecological diversity.

1.2. Taxonomic history of Grammitis

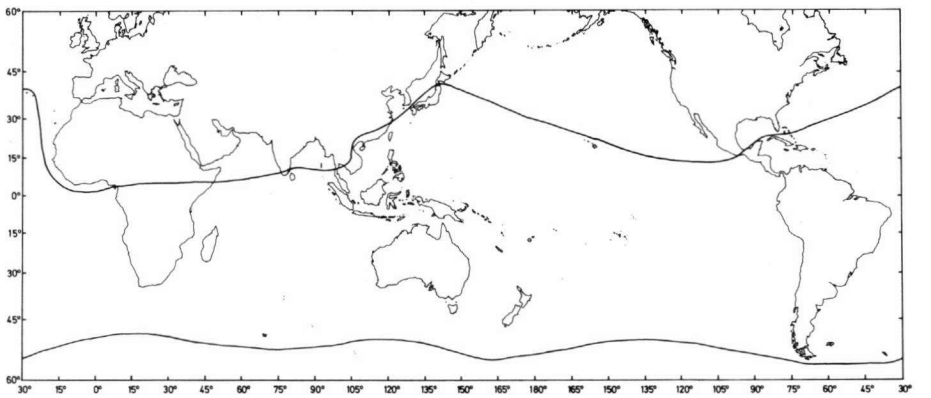
The genus *Grammitis* was described by Swartz (1801) and originally included six species: *G. linearis* Swartz [= *G. graminea* (Swartz) Copel.], *G. marginella* (Swartz) Swartz, *G. myosuroides* (Swartz) Swartz [= *Xiphopteris myosuroides* (Swartz) Kaulf.], *G. serrulata* (Swartz) Swartz [= *X. serrulata* (Swartz) Kaulf.; *Cochlidium serrulatum* (Swartz) L.E. Bishop], *G. graminoides* (Swartz) Swartz [= *C. graminoides* (Swartz) Baker] and *G. lanceolata* Swartz [= *Loxogramme lanceolata* (Swartz) C. Presl]. Two of his species are still maintained in *Grammitis*, three are now included elsewhere in Grammitidaceae and one is now best regarded as belonging to the Polypodiaceae rather than to the Grammitidaceae. *Grammitis* was originally separated from the similarly exindusiate *Polypodium* L. by the artificial distinction of having the sporangia scattered in a straight line rather than congested in a rotund sorus.

In most subsequent classifications, however (e.g. Hooker, 1862–63; Hooker & Baker, 1865–68; Christensen, 1906 & 1934), *Grammitis* was synonymised with *Polypodium*. Smith (1875) maintained *Grammitis*, but retained only one of Swartz's original species, although he included eleven other species still accepted as *Grammitis* and three now regarded as members of other genera of Grammitidaceae. Ching's (1940) establishment of the family Grammitidaceae heralded a widespread acceptance of *Grammitis* as a genus, but the present generic concept owes much to Copeland. In Genera Filicum (1947) he maintained *Ctenopteris, Grammitis* and *Xiphopteris* as distinct genera rather than merging them into *Grammitis* and retained the same generic delimitation for his monograph (1952a). His generic limits have been followed by most workers in the Old World, but in the New World the three genera are usually combined.

Here I follow Copeland's concept of *Grammitis* (1947, 1952a) and regard it as a genus of at least 160 species widespread in tropical and south temperate regions, but uncommon in north temperate regions. The northern and southern limits of the distribution of *Grammitis* are shown in map 1. A description of the genus and more precise details of its distribution are given in the taxonomic section.

Since the publication of Copeland's monograph (1952a) various floristic treatments and regional accounts of *Grammitis* have been published (see above). These have superseded Copeland's monograph for various reasons. Copeland prepared his monograph in the Philippines just before the outbreak of the Second World War and

was unwilling to borrow type material from England because of the uncertainty of mail delivery at the time (Copeland in litt. at British Museum, Nat. Hist.). Some of his new species must now be synonymised with older species whose types he did not examine. Copeland's taxonomic judgement appears somewhat erratic and although some of his regional treatments in the monograph accord well with those of later workers, in other regions, e.g. Australia and New Zealand, he did not describe any new species although he examined collections later referred to new species and he synonymised species regarded as distinct by later workers. The monograph was completed in 1939, but was not published until 1952 and in some countries very much more material has been collected since Copeland examined available collections.



Map 1. Northern and southern limits of *Grammitis* distribution.

For New Guinea Copeland's account in the monograph is generally sound, but there are problems with synonymy because he did not examine the numerous relevant type specimens held at Kew and the British Museum. In addition, a very large amount of new material has been collected in New Guinea in the last forty years, and it is obvious when using the monograph that many new species await description.

There are two main reasons why so many species of *Grammitis* in New Guinea are undescribed. First, New Guinea is very rich in fern species belonging to numerous genera, especially those of montane areas such as *Grammitis* because there is much high land. Many of these species appear to be local endemics of limited distribution. Second, until the Second World War plant collections were made either by missionaries working from a small number of settlements or by a few major expeditions from abroad. However, over the last thirty years much of Papua New Guinea has become accessible to botanists and now many collections are made by resident botanists or overseas specialists working with them. There have been comparatively few *Grammitis*

collections made in Irian Jaya, formerly Dutch New Guinea, since the Second World War. The localities where specimens of *Grammitis* have been collected are shown in map 72 which clearly indicates the greater number of collecting sites in Papua New Guinea (east of latitude 141° east) compared with Irian Jaya.

1.3. Aims

A taxonomic revision of *Grammitis* in New Guinea using Copeland's (1952a) concept of the genus is made and various aspects of the geographical and ecological distribution of species groups and species are considered. With the taxonomic revision as a basis for assessing relationships between species, the role of geography and ecology in distribution is discussed together with the means by which the speciation of *Grammitis* in New Guinea may have been promoted. Much ecological information has been provided by my fieldwork in New Guinea in 1971–72, 1977, 1980 and 1981.

2. TAXONOMIC TREATMENT

2.1. Introduction

2.1.1. Materials and methods

This revision is based on the New Guinea collections of the herbaria cited in the Acknowledgements together with my own herbarium (BSP) and that of J.R. Croft, Lae, Papua New Guinea (CROFT) (the abbreviations are those of Holmgren, Keuken and Schofield, 1981, except for BSP, CROFT and BULOLO, the latter for Forestry College Herbarium, Bulolo, Papua New Guinea). It has included all type material from New Guinea and the specimens cited upon which other records for New Guinea have been based. Type material of all except one of the published species names of *Grammitis* from Southeast Asia has also been examined. Information on extra-New Guinea distribution and extra-New Guinea species is from collections in BM, BO, BSP, CGE, K and SING. Distributions cited are based upon specimens examined unless otherwise stated.

The species are arranged in species groups which are placed in an order reflecting possible relationships. With the present state of knowledge of Grammitidaceae it is premature to propose formal ranking for these groups. Each species group name is taken from the first described species within it. The species within each group are arranged according to their relationships, which are based upon morphological similarities.

For each species there is an illustration of a whole plant together with details of the lamina hairs, lateral veins and sori. For the former there is a scale representing 1 cm and for the latter a scale representing 1 mm. The descriptions are based on dried material (only from New Guinea) of mature fertile fronds, i.e. with fully developed sporangia containing ripe spores, unless otherwise specified. The summaries of habitat, vegetation type and altitude are based on information from herbarium sheets

and supplemented for many species by my own field notes. In Irian Jaya the localities have been assigned to one of five arbitrary divisions; Waigeo I., Vogelkop Peninsula, Japen I., Cyclops Mounts and Central Irian Jaya. Papua New Guinea localities are arranged in administrative districts. Place names are spelt and located according to the Gazetteer of Papua New Guinea (1974)* and the Gazetteer of Indonesia and Portuguese Timor, 2nd edition (1968)**. Names not in either of these are spelt and located according to the Gazetteer (no. 2) of New Guinea and Nearby Islands (1943)***. Names not in any gazetteer are spelt as on collectors' labels and located either according to the labels or to various maps. Some names which have been frequently used in publications on New Guinea plants but which have been changed in the gazetteers are listed in Appendix 1 together with their equivalents used here. The distribution of each species in New Guinea is mapped, as is the external distribution of non-endemic species and the distribution of each species group and its component species. In the maps showing the distribution of non-endemic species solid circles represent specimens examined and open circles represent literature records. All the New Guinea maps are based on specimens examined. Native names are given when known. Finally, notes are provided on infraspecific variation and relationships.

2.1.2. Characters used in the delimitation and description of New Guinea species

Measurements not followed by a specified dimension are of length. Measurements are cited as follows: the figures in brackets are the range, while the two figures between them represent one standard deviation each side of the mean. Wherever possible, ten measurements of each character were made from each collection.

Rhizome — The term rhizome is used for the part of the plant which produces the fronds and roots, regardless of whether it is erect (where it may be termed a stock) or creeping. The diameter is given, both with scales and without scales. Erect or ascending rhizomes may bear the short broken-off remains of old stipe bases mixed in with the scales and these are included in the measurements of 'diameter including scales'. The rhizome may be erect, ascending, short-creeping or long-creeping and may vary in this character within a species. Occasionally it is branched. Very occasionally an erect or ascending rhizome may be very long (up to 2 cm is normal) and then its length is given. The distance apart at which stipes are produced is given for short and long-creeping rhizomes; the former has the stipes up to and including 2 mm apart, the latter has the stipes 3 mm or more apart. Only one species (*G. merrillii*), occasionally produces a few horizontal stems each with a new plant at its tip. This means of vegetative reproduction is known elsewhere in Grammitidaceae, e.g.

* Gazetteer of Papua New Guinea, Papua Place Names Committee, Central Mapping Bureau, Department of Lands, Survey and Mines, Port Moresby, Papua New Guinea (1974).

** Gazetteer of Indonesia and Portuguese Timor, 2nd ed., United States Board of Place Names, Office of Geography, Department of the Interior, Washington D.C. 20240, U.S.A. (1968).

*** Gazetteer (no. 2) of New Guinea and Nearby Islands, Hydrographic Office, U.S. Navy Department, H.O. Misc. No. 10,882 (1943).

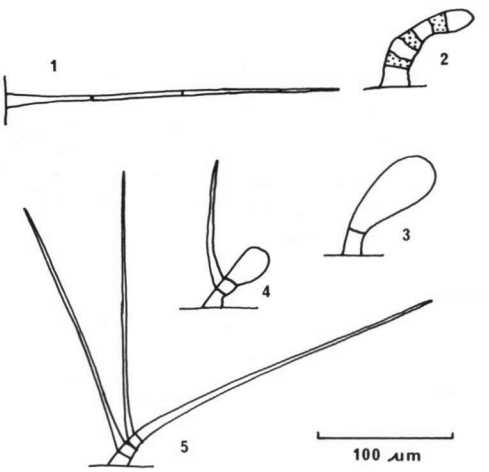


Fig. 1. Stipe and lamina hair types (all to same scale); 1. simple eglandular hair; 2. catenate simple eglandular hair; 3. simple clavate-glandular hair; 4. forked hair with one branch clavate-glandular and one branch eglandular; 5. forked hair with all branches eglandular.

Adenophorus pinnatifidus Gaud. [syn. *A. sarmentosus* (Brack.) K.A. Wilson] (Wilson & Rickson, 1966) and in *Xiphopteris bryophylla* (v.A.v.R.) Parris, but in no other species of *Grammitis*.

Scales — These are absent in very few species, but may be small and rather difficult to see in other species which have many stipe hairs without removing the stipe bases. The scales are usually much more clearly visible when the rhizome is creeping. Their length and width are given. They may be ovate to narrowly lanceolate, acute to obtuse or apiculate at apex and in colour range from pale yellow-brown through pale to dark red-brown to greyish brown and dark brown. Only one species (*G. demissa*) has scales with numerous marginal hairs and only one (*G. dolichosora*) has the cells of the scales with several complete and incomplete cross-walls (see fig. 31). A few species have the scales clathrate, i.e. appearing latticed; in most cases the exterior cell walls are similar in colour to the interior cell walls but paler. A few species have iridescent scales.

Stipe and stipe hairs — Length and width of the stipe are given, together with the presence or absence of stipe hairs and their density, angle to stipe, colour, type and length. The sequence of terminology with increasing density is as follows: occasional (less than 1 per mm), sparse (1–2 per mm), scattered (3–5 per mm), frequent (6–10 per mm), dense (more than 10 per mm). The angle of the hairs to the stipes varies from deflexed to more or less patent and the colour of the hairs ranges from whitish through red-brown to blackish. Several different types of hair may occur (see fig. 1); simple eglandular, catenate simple eglandular, simple clavate-glandu-

lar, forked with one branch clavate-glandular and one eglandular, and forked with all branches eglandular. All hairs are more common in young fronds and are deciduous to varying degrees with age. Simple eglandular hairs are found in most species; these hairs are in fact multicellular although the few cell walls (up to nine) are only visible when the hairs are very young and they are obscured by the development of pigmentation in the outer cell walls as the hairs age. This type of hair is usually persistent at least until the frond is mature. Catenate simple eglandular hairs are clearly multicellular (up to ten cells) with the outer walls more or less translucent but the inner ones thickened and coloured red-brown. The outer wall of each cell is often somewhat sunken or flattened at right angles to that of the cells immediately above and below it, giving the hair a rather chain-like appearance; hence the term catenate. This may possibly be an artifact of drying. Catenate hairs are often persistent at least until the frond is mature. Simple clavate-glandular hairs are multicellular with up to eight cells but usually fewer and often only two, the terminal cell being much larger than the others and club-shaped. They are usually found only on the young unrolling fronds and rarely persist. Forked hairs with one branch clavate-glandular and one eglandular are found only in one species (*G. demissa*) and persist at least until the frond is mature. Forked eglandular hairs have two to four branches and are found in only one species group. Sometimes fungal infections of old fronds are described as hairs. On the specimens examined these are very short, blackish, and rather regularly spaced.

Lamina and lamina hairs — Some species have the stipe and lamina held at right angles to each other when grown under rather exposed conditions. A few species may have the lamina partly inrolled over the sori. Length and width of the lamina are given. In a few species the growth of the lamina is probably indefinite. The shape of the lamina varies from spathulate through oblanceolate, linear-elliptic and lanceolate to linear. The apex may be obtuse, acute or acuminate and the base cuneate to long-attenuate. The margin is often entire, but may be rather deeply crenate (the teeth up to 6 mm long). Some species have the lamina shallowly crenate towards the base but elsewhere entire. The texture of the lamina ranges from membranous to coriaceous or spongiose. The types of lamina hair, their degrees of persistence and their distribution in species groups are the same as described for the stipe hairs and the definitions used for density are similar but relate to mm^2. The comment on fungal infections being mistaken for stipe hairs is equally applicable to lamina hairs.

Lamina midvein and lateral veins — The midvein is often prominent to a greater or lesser degree on the lower surface of the lamina. Whether it is concolorous with or darker than the lamina depends on the texture of the lamina, i.e. species with the midvein darker usually have a thin-textured more or less translucent lamina. The lateral veins are always much more easily visible in living plants than in herbarium specimens and care must be exercised when using the key in the field or on fresh material because of this. In only a few species are the lateral veins not visible in fresh material. The visibility of the veins in dried material can be ascertained by holding a frond up to daylight or room lighting. A few drops of absolute alcohol on young fronds of dried material will clear them temporarily and enable the veins to be seen

when the frond is held up to a light source. Very coriaceous fronds can be cleared by soaking in 6% potassium hydroxide solution. In the key and the descriptions the branching of the lateral veins always refers to fertile veins. Sterile veins are often less branched. Fertile lateral veins are rarely simple, usually once or twice forked and occasionally up to nine times forked. At the first forking the first branch is directed towards the frond apex (in only one species, *G. excelsa*, is it directed towards the frond base) and this first upper branch of the lateral vein always bears a sorus in fertile veins. Sometimes other branches also bear sori. The upper lateral vein branch may or may not extend beyond the sorus when the latter is mature and may be more or less as long as or much shorter than the other branches. The endings of the branches are sometimes marked by small hydathodes on the upper surface of the lamina. These hydathodes are not necessarily found in all plants of a species. In a few species they each produce a white scale. The lateral veins are usually free but occasionally anastomose near the margin. Only one species (*G. dictymioides*) has fairly frequent marginal anastomosing and only one species (*G. clemensiae*) sometimes has a commisural vein parallel to the midvein bearing the sorus.

Sori — Length and width are given. Often the sori are more or less circular in outline, but they are sometimes narrowly oblong and occasionally curved along the first upper branch of the lateral vein. They are either parallel to or oblique to the midvein. Usually the sori are on the surface of the lamina although sometimes they are slightly sunken in shallow depressions in the lamina and sometimes deeply sunken in steep-sided pits which may have a prominent rim. The ripe sporangia always protrude beyond these depressions and pits, often obscuring them completely. At maturity the sori may be discrete, contiguous or confluent. To some extent the spacing of the sori is dependent upon environmental conditions and within the same species they are more likely to be discrete when the plants are growing in continually moist conditions in deep shade and the lamina is well-developed. In contrast, plants in more exposed conditions are more likely to have smaller fronds with contiguous or confluent sori. The sori are usually in one row on each side of the midvein, but a few species with much-branched lateral veins may have up to four rows of sori on each side of the midvein. The position of the rows of sori on the lamina ranges from throughout the lamina but not immediately below the apex or above the base, to more or less apical. In most species they are nearer the midvein than the margin, but they are sometimes midway between them. The number of sori in each row is between 1 and 150.

Sporangia — The length of sporangia is given, measured from mature, slightly opened ones mounted in distilled water. In many species the sporangia bear a few rigid hairs apically near the annulus. In these species they are not present on every sporangium and they are frequently found mainly on the first-developed sporangia in a sorus. These hairs may provide some protection against insect grazing. The later-developing sporangia may well be given similar protection by the dehisced remains of the older sporangia. The number, colour and length of the sporangial hairs is given, but it must be borne in mind that these hairs may be lacking in old fronds which

have lost the first-formed sporangia. When the sporangia are described as glabrous this refers to the earliest-developed ones. The number of indurated cells in the annulus ranges from 7 to 17 but is most commonly 10 to 12. Except where otherwise noted the sporangia are 64-spored.

Spores — The diameter of spores mounted in distilled water is given. There is often a very large range of spore size within each species, excluding the small pale non-chlorophyllous spores present in small numbers in many species which were not measured.

2.2. Taxonomy

2.2.1. Generic nomenclature and description

GRAMMITIS

Grammitis Swartz, Schrader's J. Bot. 2, 1800 (1801) 17; Copel., Gen. Fil. (1947) 210; Philip. J. Sci. 80 (1952) 93. — Lectotype species: *G. marginella* Swartz, designated by Christensen, Index Filicum (1906) xlix.

Grammitis sect. *Chilopteris* C. Presl, Tentamen (1836) 208. — *Mecosorus* sect. *Chilopteris* Klotzsch, Linnaea 20 (1847) 405.

Mecosorus Klotzsch, Linnaea 20 (1847) 404, p.p.

Austrogramme Fourn., Ann. Sci. Nat. Bot. Ser. 5, 18 (1873) 278, p.p.

Polypodium sect. *Grammitastrum* Fourn., Ann. Sci. Nat. Bot. Ser. 5, 18 (1873) 282. — *Grammitis* sect. *Grammitastrum* Morton, Contr. U.S. Nat. Herb. 38 (1967) 89.

Oreogrammitis Copel., Philip. J. Sci. C 12 (1917) 64.

Grammitis subg. *Melanoloma* Copel., Philip. J. Sci. 80 (1952) 253.

Small ferns, usually epiphytic, sometimes terrestrial or rupestral, usually of mossy forest. *Rhizome* erect to short- or long-creeping, nearly always bearing scales which occasionally possess marginal hairs, are occasionally clathrate or iridescent, or rarely have cells with several complete or incomplete cross-walls. *Stipes* glabrous or bearing hairs which are usually simple eglandular but which may also be catenate simple eglandular, simple clavate-glandular, forked with all branches glandular or forked with one branch clavate-glandular and one eglandular; rarely with a few scales present at the stipe base. Lamina spathulate, oblanceolate to lanceolate or linear, usually entire but sometimes crenate, membranous to coriaceous, glabrous or with hairs like those of the stipe; scales absent; lateral veins usually forked, free or with occasional marginal anastomosing, rarely with a soral vein parallel to the midvein linking the lateral veins. *Sori* exindusiate, borne on the first upper branch of the lateral vein and occasionally on other vein branches, more or less circular to linear in outline, rarely coenosoroid, parallel to or oblique to the midvein, usually on the surface of the lamina, sometimes slightly sunken in shallow depressions or deeply sunken in steep-sided pits in the lamina, discrete to confluent at maturity, usually in one row on each side of the midvein but sometimes in up to four rows on each side, from nearly throughout the lamina to only in its apex, usually nearer the midvein than the mar-

gin, occasionally midway between them or nearer the margin than the midvein. *Sporangia* glabrous or with rigid hairs, the stalk with one row of cells for most of its length, the annulus with 7 to 21 indurated cells. *Spores* with chlorophyll, globose-tetrahedral, trilete, sometimes germinating within the sporangium. Gametophyte elongate. Chromosome number n = 36, 37 (Löve, Löve & Pichi Sermolli, 1977).

A genus of at least 160 species, in South India, Ceylon, Vietnam, China, Taiwan, Japan, Malesia, Australasia, Micronesia, Melanesia, Polynesia, Central and South America, West Indies, South Atlantic and South Indian Ocean islands, Azores, tropical and southern Africa and Madagascar.

The genus *Grammitis* as here circumscribed contains two sections, sect. *Grammitis* which is characterised by a black border to the lamina, and sect. *Grammitastrum* (Fourn.) Morton which lacks this black border. All of the New Guinea species belong to sect. *Grammitastrum.*

2.2.2. Conspectus of the species and species groups of Grammitis in New Guinea

1. G. adspersa group
   - G. pseudaustralis subgroup
     1. G. demissa
   - G. adspersa subgroup
     2. G. adspersa
     3. G. viridula
     4. G. glossophylla
2. G. sumatrana group
     5. G. sumatrana
     6. G. torricelliana
3. G. caespitosa group
     7. G. frigida
     8. G. caespitosa
     9. G. loculosa
     10. G. taeniophylla
     11. G. dictymioides
     12. G. pleurogrammoides
     13. G. interrupta
4. G. fasciata group
     14. G. fasciata
     15. G. graminifolia
     16. G. crenulata
     17. G. subfasciata
     18. G. padangensis
5. G. ceratocarpa group
     19. G. ceratocarpa
     20. G. salticola
6. G. setosa group
     21. G. archboldii
     22. G. impressa
     23. G. tuberculata
     24. G. scabristipes
7. G. reinwardtii group
     25. G. reinwardtii
     26. G. hirtiformis
     27. G. curtipila
     28. G. knutsfordiana
     29. G. hispida
8. G. mesocarpa group
     30. G. mesocarpa
     31. G. papuensis
     32. G. inconstans
9. G. hirtella group
   - G. reducta subgroup
     33. G. imberbis
     34. G. tenuis
     35. G. reducta

G. oblanceolata subgroup
- 36. G. oblanceolata
- 37. G. meijer-dreesii
- 38. G. clavipila

G. lasiosora subgroup
- 39. G. coredrosora
- 40. G. silvicola
- 41. G. ahenobarba

10. G. intromissa group
- 42. G. debilifolia
- 43. G. nigropaleata
- 44. G. tomaculosa
- 45. G. intromissa
- 46. G. reptans
- 47. G. trogophylla
- 48. G. murrayana
- 49. G. trichopoda
- 50. G. subreticulata
- 51. G. merrillii

(G. intromissa group)
- 52. G. parva
- 53. G. habbemensis
- 54. G. montana
- 55. G. excelsa
- 56. G. rupestris
- 57. G. collina
- 58. G. ornatissima

11. G. mollipila group
- 59. G. mollipila
- 60. G. crinifera

12. G. clemensiae group
- 61. G. clemensiae

13. G. locellata group
- 62. G. locellata
- 63. G. pseudolocellata

14. G. dolichosora group
- 64. G. dolichosora

2.2.3. Bracket key to the species of Grammitis in New Guinea

KEY TO THE SPECIES

1 a. Either stipe hairs with broad bases or lamina hairs on small conical projections 2
b. Stipe and/or lamina glabrous or hairs not as above 3
2 a. Broad-based hairs always on stipe, lamina hairs never on small conical projections . . . . . **24. G. scabristipes**
b. Broad-based hairs occasionally on stipe, lamina hairs always on small conical projections . . . . . **23. G. tuberculata**
3 a. White scales on at least some vein endings on the upper surface of the lamina 4
b. No white scales on vein endings on the upper surface of the lamina 6
4 a. Hairs on lamina margin and midvein below mostly tufted, up to 8-nate, much longer than those of the lamina undersurface . . . . . **59. G. mollipila**
b. Hairs on lamina margin and midvein below solitary or binate, about as long as those on the lamina undersurface, or lamina undersurface glabrous 5
5 a. Rhizome short to long-creeping; lamina hairs only on margin; lateral veins invisible in transmitted light . . . . . **21. G. archboldii**
b. Rhizome erect; lamina hairs on midvein beneath and margin, sometimes upper and lower surface also; lateral veins visible in transmitted light **58. G. ornatissima**

6 a. Lamina with two or more rows of sori on each side of the midvein, sometimes the second row only partly (but more than half) complete 7
b. Lamina with one row of sori on each side of the midvein, occasionally with fragments (less than half) of a second row 11
7 a. Lamina hairs only on margin, or sometimes also on midvein beneath 8
b. Lamina hairs on margin, midvein beneath and lower surface of lamina (sometimes lost from lower surface except amongst sori) 9
8 a. Stipe hairs (0.3–)0.8–1.6(–2.0) mm; lamina entire ..... **21. G. archboldii**
b. Stipe hairs 0.1–0.3(–0.6) mm; lamina often crenate ..... **5. G. sumatrana**
9 a. Lamina hairs up to 0.3 mm ..... **6. G. torricelliana**
b. Lamina hairs more than 0.6 mm 10
10 a. Lamina 0.8–1.3 cm wide, lamina hairs 0.7–1.5 mm; 1st branch of lateral vein directed towards lamina apex ..... **50. G. subreticulata**
b. Lamina 1.4–2.6 cm wide, lamina hairs 1.5–3.0 mm; 1st branch of lateral vein directed towards lamina base ..... **55. G. excelsa**
11 a. Sori sunken in steep-sided pits which may have a slightly prominent rim (remove sporangia!) 12
b. Sori on surface of lamina or slightly sunken in shallow open depressions without a slightly prominent rim (remove sporangia!) 23
12 a. Lamina less than 3 cm; stipe more than twice as long as lamina **13. G. interrupta**
b. Lamina more than 3 cm; stipe shorter than or about as long as lamina ... 13
13 a. Longest sori narrowly elliptic in outline, each oblique to the midvein 14
b. Longest sori more or less circular to elliptic or oblong in outline, each parallel or oblique to the midvein 15
14 a. Lamina hairs less than 0.1 mm or absent ..... **62. G. locellata**
b. Lamina hairs 0.5–0.8 mm ..... **63. G. pseudolocellata**
15 a. Stipe hairs (0.4–)1.0 mm or longer 16
b. Stipe glabrous or with hairs 0.1–0.3 mm 18
16 a. Stipe hairs more than 2.0 mm; soral pits with slightly prominent rim **53. G. habbemensis**
b. Stipe hairs up to 2.0 mm; soral pits without slightly prominent rim 17
17 a. Stipe less than half as long as lamina ..... **22. G. impressa**
b. Stipe about as long as or longer than lamina ..... **54. G. montana**
18 a. Inside edge of soral pits with scattered hairs (remove sporangia!) **11. G. dictymioides**
b. Inside edge of soral pits glabrous 19
19 a. Soral pits irregularly spaced, absent from numerous lateral veins in fertile part of frond; lamina thinly coriaceous ..... **10. G. taeniophylla**
b. Soral pits regularly spaced, on almost every lateral vein in fertile part of frond; lamina markedly coriaceous 20
20 a. Stipe glabrous ..... **12. G. pleurogrammoides**
b. Stipe with hairs 0.2–0.3 mm 21

21 a. Upper surface of lamina with sparse to moderately frequent hairs **27. G. curtipila**
b. Upper surface of lamina glabrous or with occasional hairs 22
22 a. A small hydathode occasionally at each vein ending on upper surface of lamina; sori not immediately below lamina apex . . . . . **8. G. caespitosa**
b. A small hydathode often at each vein ending on the upper surface of the lamina; sori usually immediately below lamina apex . . . . . **9. G. loculosa**
23 a. Rhizome scales ciliate . . . . . **1. G. demissa**
b. Rhizome scales glabrous or rarely absent 24
24 a. Lamina crenate, sometimes only at base 25
b. Lamina entire 45
25 a. Stipe glabrous or with hairs up to 0.3 mm (rarely with an occasional hair up to 0.6 mm) 26
b. Most, if not all, stipe hairs more than 0.3 mm 34
26 a. Lateral veins visible in transmitted light 27
b. Lateral veins invisible in transmitted light 30
27 a. Stipe glabrous . . . . . **35. G. reducta**
b. Stipe with hairs 28
28 a. Hairs of lamina undersurface medium to dark red-brown . . **6. G. torricelliana**
b. Hairs of lamina undersurface whitish to very pale brown 29
29 a. Stipe more than 1 cm . . . . . **38. G. clavipila**
b. Stipe 1 cm or less . . . . . **2. G. adspersa**
30 a. Lamina 1–2 mm wide . . . . . **34. G. tenuis**
b. Lamina more than 3 mm wide 31
31 a. Stipe with moderately frequent to dense hairs 0.1–0.3(–0.6) mm; lamina (6–) 10–18(–26) mm wide 32
b. Stipe glabrous or with an occasional hair c. 0.2 mm; lamina (3–)5–7(–8) mm wide 33
32 a. Lamina undersurface glabrous . . . . . **5. G. sumatrana**
b. Lamina undersurface with hairs . . . . . **6. G. torricelliana**
33 a. Stipe much less than 1/3 as long as lamina . . . . . **16. G. crenulata**
b. Stipe at least 1/2 as long as lamina . . . . . **33. G. imberbis**
34 a. Most fertile lateral veins 2–3-forked 35
b. Most fertile lateral veins 1-forked (or rarely some unbranched) 38
35 a. Lamina hairs occasional, ascending, usually on margin, occasionally also on midvein below . . . . . **21. G. archboldii**
b. Lamina hairs more or less patent, more frequent or also on lamina undersurface including amongst sori 36
36 a. Rhizome erect . . . . . **58. G. ornatissima**
b. Rhizome short to long-creeping 37
37 a. Lamina hairs 0.5–1.0 mm, frequent on all parts . . . . . **29. G. hispida**
b. Lamina hairs (0.4–)0.8–2.6(–4.5) mm, occasional to frequent, usually on upper surface, margin, midvein beneath and amongst sori, sometimes also on lower surface . . . . . **28. G. knutsfordiana**

38 a. Upper branch of lateral vein much shorter than lower 39
b. Upper branch of lateral vein as long as lower branch or a little shorter . . . 40
39 a. Lamina more than 25 cm . . . . . **58. G. ornatissima**
b. Lamina less than 20 cm . . . . . **25. G. reinwardtii**
40 a. Lateral veins invisible in transmitted light, slightly prominent on both surfaces of lamina when dried . . . . . **32. G. inconstans**
b. Lateral veins visible in transmitted light, not prominent on the upper surface of the lamina and very occasionally slightly prominent at their base on the lower surface of the lamina 41
41 a. All lamina hairs less than 0.4 mm, pale yellow-brown . . . . . **40. G. silvicola**
b. Some, if not all, lamina hairs more than 0.5 mm, pale to dark red-brown or pale yellowish red-brown 42
42 a. Stipe more than 2.5 cm; sori at least 2 mm; at more than 3000 m alt. **37. G. meijer-dreesii**
b. Stipe less than 2.5 cm; sori less than 2 mm; at less than 2500 m alt. 43
43 a. Each lateral branch ending not marked by a small hydathode on the upper surface of the lamina; rhizome scales absent . . . . . **39. G. coredrosora**
b. Each lateral branch ending usually marked by a small hydathose on the upper surface of the lamina; rhizome scales present 44
44 a. Lamina hairs medium to dark red-brown . . . . . **36. G. oblanceolata**
b. Lamina hairs pale yellowish red-brown . . . . . **41. G. ahenobarba**
45 a. Many adjacent sori fused (examine young frond) . . . . . **61. G. clemensiae**
b. Sori not fused (or occasionally two adjacent sori fused) 46
46 a. All or most fertile lateral veins forked twice or more 47
b. All or most fertile lateral veins 1-forked 70
47 a. Stipe glabrous 48
b. Stipe with hairs, or if stipe absent then basal 1 cm of lamina with hairs . . . 50
48 a. Lamina glabrous . . . . . **14. G. fasciata**
b. Lamina with hairs on margin, sometimes also on midvein below 49
49 a. Lamina hairs 0.2–0.3(–0.5) mm, on margin and midvein below; sori in middle 1/4–1/2 of lamina . . . . . **30. G. mesocarpa**
b. Lamina hairs (0.1–)0.3–0.6(–0.8) mm, only on margin; sori in upper 1/6–1/2 of lamina . . . . . **18. G. padangensis**
50 a. Lamina hairs only on midvein below and/or margin 51
b. Lamina hairs on undersurface of lamina including amongst sori, usually on midvein below and margin also, or on upper surface of lamina 56
51 a. Cells of rhizome scales with several complete and incomplete cross-walls (see fig. 31) . . . . . **64. G. dolichosora**
b. Cells of rhizome scales without cross-walls 52
52 a. All or most stipe hairs more than 0.8 mm 53
b. All or most stipe hairs 0.8 mm or less 54
53 a. Lamina hairs only on margin . . . . . **21. G. archboldii**
b. Lamina hairs on margin and midvein below . . . . . **28. G. knutsfordiana**

54 a. Stipe hairs 0.1–0.3(–0.6) mm ..... **5. G. sumatrana**
b. Stipe hairs 0.4–0.8(–1.0) mm 55
55 a. Lamina hairs on margin and midvein below ..... **30. G. mesocarpa**
b. Lamina hairs only on margin ..... **18. G. padangensis**
56 a. Hairs only on midvein below and amongst sori, not or very occasionally on lamina undersurface 57
b. Hairs widespread on lamina undersurface 58
57 a. Stipe less than 2 cm; lamina more than 5 mm wide ..... **25. G. reinwardtii**
b. Stipe more than 2 cm; lamina less than 5 mm wide ..... **20. G. salticola**
58 a. All stipe hairs 0.1–0.2 mm ..... **6. G. torricelliana**
b. All or most stipe hairs more than 1.0 mm 59
59 a. Stipe hairs whitish to pale yellow 60
b. Stipe hairs pale to medium or dark red-brown 61
60 a. Lamina 2.7–3.5 × 0.4–0.5 cm; spores (37–)38–43(–44) mm; at c. 2840 m alt. ..... **48. G. murrayana**
b. Lamina (1.8–)4.1–8.9(–11.5) × (0.4–)0.5–0.7(–0.8) cm; spores (25–)29–35(–42) mm; from 3400–3900 m alt. ..... **49. G. trichopoda**
61 a. Hairs of margin and midvein below c. 2.5–3.5 mm, solitary to 5-nate, hairs of lamina undersurface solitary, 0.5–2.0(–4.0) mm ..... **60. G. crinifera**
b. Hairs of margin and midvein not markedly different in type and length from those of lamina undersurface 62
62 a. All lamina hairs 1 mm or less ..... **29. G. hispida**
b. At least some lamina hairs more than 1 mm 63
63 a. Lateral veins slightly prominent on either or both surfaces of lamina when dried ..... **28. G. knutsfordiana**
b. Lateral veins not prominent on surface of lamina when dried 64
64 a. All stipe and lamina hairs less than 2.0 mm 65
b. Some, if not most, stipe and lamina hairs more than 2.0 mm 67
65 a. Lamina more than 14 cm ..... **50. G. subreticulata**
b. Lamina less than 13 cm 66
66 a. Stipe more than 3 cm ..... **49. G. trichopoda**
b. Stipe less than 2 cm ..... **57. G. collina**
67 a. Stipe and lamina hairs frequent to moderately dense .... **43. G. nigropaleata**
b. Stipe and lamina hairs sparse to moderately frequent 68
68 a. Lamina hairs medium red-brown ..... **45. G. intromissa**
b. Lamina hairs dark red-brown 69
69 a. Lamina more than 25 cm ..... **58. G. ornatissima**
b. Lamina less than 15 cm ..... **44. G. tomaculosa**
70 a. Upper branch of lateral vein shorter than lower branch 71
b. Upper branch of lateral vein about as long as lower branch 83
71 a. All or most lamina hairs more than 1.0 mm 72
b. All lamina hairs less than 0.8 mm or lamina glabrous 76
72 a. Lateral veins invisible in transmitted light 73
b. Lateral veins visible in transmitted light 74

73 a. Hairs amongst the sori longer than elsewhere on the lamina . . **56. G. rupestris**
b. Hairs amongst the sori about as long as those elsewhere on the lamina **25. G. reinwardtii**
74 a. Lamina more than 25 cm . . . . . **58. G. ornatissima**
b. Lamina less than 20 cm 75
75 a. Lamina hairs occasional to sparse; lamina (2–)3–5(–6) mm wide **26. G. hirtiformis**
b. Lamina hairs scattered to frequent; lamina (3–)4–8(–9) mm wide **25. G. reinwardtii**
76 a. Lateral veins visible in transmitted light 77
b. Lateral veins invisible in transmitted light 79
77 a. Lamina hairs pale to dark red-brown, moderately frequent to sparse on upper surface of lamina . . . . . **27. G. curtipila**
b. Lamina hairs whitish to very pale red-brown, or if pale to dark red-brown, absent from upper surface of lamina 78
78 a. Lamina less than 10 cm . . . . . **2. G. adspersa**
b. Lamina at least 12 cm . . . . . **3. G. viridula**
79 a. Cells of rhizome scales with several complete and incomplete cross-walls (see fig. 31) . . . . . **64. G. dolichosora**
b. Cells of rhizome scales without cross-walls 80
80 a. Stipe hairs at least 1 mm . . . . . **19. G. ceratocarpa**
b. Stipe hairs c. 0.1–0.2 mm or absent 81
81 a. Stipe glabrous or with occasional hairs; lamina hairs occasional on midvein below . . . . . **3. G. viridula**
b. Stipe hairs scattered to moderately frequent; lamina hairs at least on margin and midvein below 82
82 a. Lamina coriaceous, hairs on midvein below all simple eglandular, solitary to 3-nate . . . . . **27. G. curtipila**
b. Lamina membranous, hairs on midvein below both simple eglandular and 1–2-forked with all branches eglandular . . . . . **4. G. glossophylla**
83 a. Stipe glabrous (if stipe absent, then base of midvein on lamina undersurface glabrous) 84
b. Stipe with hairs (if stipe absent, then base of midvein on lamina undersurface with hairs) 94
84 a. Lamina glabrous 85
b. Lamina with hairs 89
85 a. Lateral veins visible in transmitted light 86
b. Lateral veins invisible in transmitted light 87
86 a. Lamina less than 4 cm . . . . . **35. G. reducta**
b. Lamina more than 7 cm . . . . . **38. G. clavipila**
87 a. Lamina less than 8 cm . . . . . **61. G. clemensiae**
b. Lamina more than 9 cm 88

88 a. Rhizome scales ovate to broadly ovate, obtuse, less than 3 mm **14. G. fasciata**
b. Rhizome scales lanceolate to narrowly lanceolate, subacute to acute, more than 3 mm ..... **17. G. subfasciata**
89 a. All or most lamina hairs more than 0.5 mm ..... **61. G. clemensiae**
b. All or most lamina hairs less than 0.5 mm 90
90 a. Lamina at least 2 mm wide 91
b. Lamina 1–2 mm wide 92
91 a. Lamina (2–)3–4(–5) mm wide ..... **15. G. graminifolia**
b. Lamina (3–)4–11(–17) mm wide ..... **17. G. subfasciata**
92 a. Lamina hairs 0.1–0.2 mm, on margin only ..... **34. G. tenuis**
b. Lamina hairs 0.2 mm or longer, at least on both margin and midvein below . 93
93 a. Lamina at least 3 cm ..... **31. G. papuensis**
b. Lamina less than 2 cm ..... **51. G. merrillii**
94 a. Lamina glabrous 95
b. Lamina with hairs 97
95 a. Stipe hairs up to 0.3 mm ..... **7. G. frigida**
b. Stipe hairs at least 0.5 mm 96
96 a. Lamina more than 7 cm ..... **19. G. ceratocarpa**
b. Lamina up to 7 cm ..... **61. G. clemensiae**
97 a. Lamina hairs only on margin, or on margin and midvein below 98
b. Lamina hairs elsewhere on lamina, not restricted to margin and midvein below 104
98 a. All or most of lamina hairs more than 0.7 mm ..... **36. G. oblanceolata**
b. All lamina hairs 0.7 mm or less 99
99 a. Cells of rhizome scales with several complete and incomplete cross-walls (see fig. 31) ..... **64. G. dolichosora**
b. Cells of rhizome scales without cross-walls 100
100 a. Stipe hairs at least 1.0 mm ..... **19. G. ceratocarpa**
b. Stipe hairs 0.8 mm or less 101
101 a. Stipe hairs more than 0.5 mm ..... **30. G. mesocarpa**
b. Stipe hairs less than 0.5 mm 102
102 a. Hairs of lamina margin blackish, ascending ..... **15. G. graminifolia**
b. Hairs of lamina margin translucent with red-brown cross-walls, more or less patent 103
103 a. Lamina (2–)3–5(–7) mm wide; in upper montane to subalpine vegetation types ..... **7. G. frigida**
b. Lamina 1–2 mm wide; in midmontane forest ..... **34. G. tenuis**
104 a. All stipe hairs less than 0.4 mm ..... **7. G. frigida**
b. All or most stipe hairs 0.5 mm or longer 105
105 a. Lateral veins visible in transmitted light 106
b. Lateral veins invisible in transmitted light 116
106 a. All lamina hairs 1.0 mm or less 107
b. All or at least some lamina hairs more than 1.0 mm 109

107 a. Stipe hairs 1.0 mm or longer . . . . . **41. G. ahenobarba**
b. Stipe hairs 0.5–1.0 mm 108
108 a. Hairs on all parts of lamina . . . . . **39. G. coredrosora**
b. Hairs only on lower surface of lamina and midvein below . . . **40. G. silvicola**
109 a. Rhizome scales absent (dissect out stipe bases!) . . . . . **52. G. parva**
b. Rhizome scales present 110
110 a. Lamina hairs frequent 111
b. Lamina hairs occasional to moderately frequent 112
111 a. Rhizome scales dark brown . . . . . **42. G. debilifolia**
b. Rhizome scales medium red-brown . . . . . **47. G. trogophylla**
112 a. Lamina (2–)3–5 mm wide 113
b. Lamina (4–)5 to at least 7 mm wide 114
113 a. Lamina obtuse at apex; both lamina surfaces usually glabrous
36. G. oblanceolata
b. Lamina acute to acuminate at apex; hairs occasional on both surfaces of lamina . . . . . **57. G. collina**
114 a. Lamina hairs dark red-brown . . . . . **44. G. tomaculosa**
b. Lamina hairs medium red-brown 115
115 a. Rhizome more or less erect to short-creeping, producing stipes up to 2 mm apart; rhizome scales (0.7–)1.0–2.0(–2.2) mm . . . . . **45. G. intromissa**
b. Rhizome short to long-creeping, producing stipes up to 13 mm apart; rhizome scales (1.8–)2.0–3.4(–3.5) mm . . . . . **49. G. trichopoda**
116 a. All or most stipe hairs less than 1.0 mm 117
b. All or most stipe hairs more than 1.0 mm 118
117 a. Stipe (1–)3–18(–31) mm . . . . . **61. G. clemensiae**
b. Stipe 1–2 mm or absent . . . . . **56. G. rupestris**
118 a. Lamina hairs mainly amongst sori, occasional on margin and scattered on midvein below, not elsewhere on lamina surface . . . . . **20. G. salticola**
b. Hairs on all parts of lamina 119
119 a. Rhizome scales dark brown or dark red-brown 120
b. Rhizome scales pale to medium red-brown 123
120 a. Lamina (2–)3–5 mm wide . . . . . **42. G. debilifolia**
b. Lamina (4–)5 to at least 8 mm wide 121
121 a. Stipe hairs moderately dense and lamina hairs frequent . **43. G. nigropaleata**
b. Stipe and lamina hairs sparse to moderately frequent 122
122 a. Lamina 3.2–19.1(–40.0+) cm; lamina hairs medium red-brown
45. G. intromissa
b. Lamina (1.6–)1.9–6.1(–12.1) cm; lamina hairs dark red-brown
44. G. tomaculosa
123 a. Stipe and lamina hairs frequent . . . . . **47. G. trogophylla**
b. Stipe and lamina hairs scattered to moderately frequent 124
124 a. Lamina (1–)2–3(–4) mm wide . . . . . **61. G. clemensiae**
b. Lamina (4–)5 mm or more wide 125

125 a. Lamina hairs dark red-brown 126
b. Lamina hairs medium red-brown 127
126 a. Lateral veins not prominent on the lower surface of lamina when dried; lamina hairs (0.5–)1.5–3.7(–4.0) mm . . . . . **44. G. tomaculosa**
b. Lateral veins slightly prominent on the lower surface of lamina when dried; lamina hairs 1.0–2.5 mm . . . . . **46. G. reptans**
127 a. Rhizome more or less erect to short-creeping, producing stipes up to 2 mm apart; rhizome scales (0.7–)1.0–2.0(–2.2) mm . . . . . **45. G. intromissa**
b. Rhizome short to long-creeping, producing stipes up to 13 mm apart; rhizome scales (1.8–)2.0–3.4(–3.5) mm . . . . . **49. G. trichopoda**

2.2.4. Multi-access key to the species groups of Grammitis in New Guinea

This method of identification presents the more outstanding features of a group in a single formula and should prove useful in indicating relationships and aiding identification of material which might prove difficult with the bracket key.

Instructions for use — Character states are provided for each of eight groups. Select the appropriate letter from each of these groups and write down the eight letter formula. Trace the formula in the following alphabetically arranged index. When the formula covers more than one species group, the additional diagnostic remarks should serve to distinguish them. These should be worked through in order. The combination of characters in these notes relates only to that species group and will not occur in any succeeding group sharing the same formula. The species is mentioned where the formula applies only to that member of a species group. Where no species is mentioned the formula applies to two or more members of a group. The tables of characters of taxonomic importance for the species within each species group, together with the descriptions and illustrations, should then enable specific identification or confirmation to be made.

CHARACTER STATES

Group 1

A Forked hairs present on stipe and/or lamina.
B Forked hairs absent from stipe and lamina.

Group 2

C Simple eglandular hairs absent from stipe (although *catenate* simple eglandular hairs may occasionally be present).
D All or most simple eglandular hairs on stipe less than 1 mm.
E All or most simple eglandular hairs on stipe more than 1 mm.

Group 3

F Simple eglandular hairs absent from lamina (although *catenate* simple eglandular hairs may occasionally be present).
G All or most simple eglandular hairs on lamina less than 1 mm.
H All or most simple eglandular hairs on lamina more than 1 mm.

Group 4

I Fertile lateral veins usually 1-forked.
J Fertile lateral veins usually at least 2-forked.

Group 5

K Lateral vein branch which bears the sorus about as long as the other lateral vein branches.
L Lateral vein branch which bears the sorus shorter than the other lateral vein branches.

Group 6

M Sori more or less circular to elliptic in outline.
N Sori narrowly elliptic to oblong in outline.

Group 7

O Sori on surface of lamina or in shallow depressions.
P Sori sunken in steep-sided pits in the lamina.

Group 8

Q Sori in two complete rows.
R Sori in more than two complete rows.

MULTI-ACCESS KEY TO SPECIES GROUPS

ACGILMOQ 1, G. adspersa group
ADGILMOQ 1, G. adspersa group (1, G. demissa)
BCFIKMOQ 1. Lamina shallowly crenate towards base – 9, G. hirtella group
2. Lamina more than 20 cm long – 4, G. fasciata group (14, G. fasciata)
3. Lamina less than 20 cm long – 9, G. hirtella group
BCFIKMPQ 3, G. caespitosa group (13, G. interrupta)
BCFIKNPQ 3, G. caespitosa group (13, G. interrupta)
BCFJKMOQ 4, G. fasciata group (14, G. fasciata)
BCGIKMOQ 1. Hairs on lamina margin ascending – 4, G. fasciata group (15, G. graminifolia)
2. Lamina less than 2 cm long – 10, G. intromissa group (51, G. merrillii)
3. Lamina more than 3 cm long – 8, G. mesocarpa group
BCGIKMPQ 3, G. caespitosa group (12, G. pleurogrammoides)

BCGIKNPQ 3, G. caespitosa group (12, G. pleurogrammoides)
BCGILMOQ 3, G. fasciata group
BCGJKMOQ 8, G. mesocarpa group (30, G. mesocarpa)
BCGJKMPQ 3, G. caespitosa group (11, G. dictymioides)
BCGJKNPQ 3, G. caespitosa group (11, G. dictymioides)
BCGJLMOQ 4, G. fasciata group (18, G. padangensis)
BDFIKMOQ 3, G. caespitosa group (7, G. frigida)
BDFIKMPQ 1. Stipe hairs 0.1–0.2 mm, pale to dark red-brown – 3, G. caespitosa group (8, G. caespitosa)
2. Stipe hairs 0.2–1.0(–2.0) mm, pale yellow-brown to pale red-brown – 13, G. locellata group (62, G. locellata)
BDFIKNPQ 13, G. locellata group (62, G. locellata)
BDFILMPQ 1. Stipe hairs 0.1–0.2 mm, pale to dark red-brown – 3, G. caespitosa group (8, G. caespitosa)
2. Stipe hairs 0.2–1.0(–2.0) mm, pale yellow-brown to pale red-brown – 13, G. locellata group (62, G. locellata)
BDFILNPQ 13, G. locellata group (62, G. locellata)
BDFJKMPQ 13, G. locellata group (62, G. locellata)
BDFJKNPQ 13, G. locellata group (62, G. locellata)
BDFJLMPQ 13, G. locellata group (62, G. locellata)
BDFJLNPQ 13, G. locellata group (62, G. locellata)
BDGIKMOQ 1. Cells of rhizome scales with several complete and incomplete cross-walls – 64, G. dolichosora
2. Sori longitudinally fused – 61, G. clemensiae
3. Veins visible in transmitted light; lamina crenate towards base – 9, G. hirtella group
4. Veins visible in transmitted light; lamina entire – 10, G. intromissa group (49, G. trichopoda)
5. Hairs amongst sori much longer than those elsewhere on lamina – 10, G. intromissa group (56, G. rupestris)
6. Hairs absent from amongst sori or, if present, the same length as those elsewhere on the lamina – 8, G. mesocarpa group
BDGIKMPQ 3, G. caespitosa group
BDGIKNOQ 1. Lamina entire; cells of rhizome scales with several complete and incomplete cross-walls – 64, G. dolichosora
2. Lamina crenate; cells of rhizome scales without cross-walls – 8. G. mesocarpa group (32, G. inconstans)
BDGIKNPQ 3, G. caespitosa group (10, G. taeniophylla)
BDGILMOQ 1. Hairs amongst sori much longer than those elsewhere on the lamina – 10, G. intromissa group (56, G. rupestris)
2. Hairs absent from amongst sori or, if present, the same length as those elsewhere on the lamina – 7, G. reinwardtii group
BDGILMPQ 3, G. caespitosa group (8, G. caespitosa)
BDGILNOQ 7, G. reinwardtii group (27, G. curtipila)

BDGJKMOQ 1. Cells of rhizome scales with several complete and incomplete cross-walls – 64, G. dolichosora
2. Stipe hairs medium to dark red-brown – 8, G. mesocarpa group (30, G. mesocarpa)
3. Stipe hairs whitish to pale yellow-brown – 10, G. intromissa group (48, G. murrayana)

BDGJKNOQ 64, G. dolichosora

BDGJIMOQ 1. Lamina hairs only on margin – 4, G. fasciata group (18, G. padangensis)
2. Lateral veins always prominent on dried lamina – 7, G. reinwardtii group (28, G. knutsfordiana)
3. Lateral veins not or rarely very slightly prominent on dried lamina – 10, G. intromissa group

BDGJLMOQ 2, G. sumatrana group

BDGJLMOR 1. Lamina hairs less than 0.7 mm – 2, G. sumatrana group
2. Lamina hairs more than 0.7 mm – 10, G. intromissa group (51, G. subreticulata)

BDGJLMPQ 6, G. setosa group (22, G. impressa)

BDGJLNOR 2, G. sumatrana group (5, G. sumatrana)

BDHIKMOQ 1. Sori longitudinally fused – 61, G. clemensiae
2. Lamina crenate and veins invisible in transmitted light – 8, G. mesocarpa group (32, G. inconstans)
3. Lamina hairs on margin and midvein below scattered – 9, G. hirtella group (36, G. oblanceolata)
4. Lamina hairs on margin and midvein below moderately frequent – 10, G. intromissa group

BDHIKNOQ 8, G. mesocarpa group (32, G. inconstans)

BDHILMOQ 1. Hairs amongst sori much longer than elsewhere on the lamina – 10, G. intromissa group (56, G. rupestris)
2. Hairs absent from amongst sori or, if present, the same length as those elsewhere on the lamina – 7, G. reinwardtii group

BDHJKMOQ 10, G. intromissa group (48, G. murrayana)

BDHJLMOQ 1. Stipe hairs dark red-brown – 7, G. reinwardtii group (25, G. reinwardtii)
2. Stipe hairs pale yellow to medium red-brown – 10, G. intromissa group (49, G. trichopoda)

BDHJLMOR 10, G. intromissa group (50, G. subreticulata)

BDHJLMPQ 6, G. setosa group (22, G. impressa)

BEGIKMOQ 1. Lateral veins invisible in transmitted light – 5, G. ceratocarpa group (19, G. ceratocarpa)
2. Hairs moderately frequent on upper surface of lamina – 10. G. intromissa group
3. Hairs absent or rare on upper surface of lamina – 9, G. hirtella group

BEGIKMPQ 10, G. intromissa group (54, G. montana)
BEGIKNPQ 10, G. intromissa group (54, G. montana)
BEGILMOQ 1. Hairs of lamina margin and midvein below up to 8-nate – 11, G. mollipila group (59, G. mollipila)
2. Hairs of lamina margin and midvein below solitary – 7, G. reinwardtii group
BEGJLMOQ 1. Hairs of lamina margin and midvein below up to at least 5-nate – 11, G. mollipila group
2. Lateral veins prominent on both surfaces of dried lamina and lamina hairs frequent on all parts of the lamina – 7, G. reinwardtii group (29, G. hispida)
3. Sori ± circular to oblong in outline – 6, G. setosa group
4. Sori ± circular to elliptical in outline – 10, G. intromissa group
BEGJLMOR 1. Sori ± circular to oblong in outline – 6, G. setosa group (21, G. archboldii)
2. Sori ± circular to elliptical in outline – 10, G. intromissa group (50, G. subreticulata)
BEGJLMPQ 1. Sori ± circular to elliptic in outline, in pits without a slightly prominent rim – 6, G. setosa group (22, G. impressa)
2. Sori ± circular to narrowly elliptic in outline, in pits with a slightly prominent rim – 13, G. locellata group (63, G. pseudolocellata)
BEGJLNOQ 6, G. setosa group (21, G. archboldii)
BEGJLNOR 6, G. setosa group (21, G. archboldii)
BEGJLNPQ 13, G. locellata group (63, G. pseudolocellata)
BEHIKMOQ 1. Hairs scattered to frequent on upper surface of lamina – 10, G. intromissa group
2. Veins invisible in transmitted light and rhizome short to long-creeping – 5, G. ceratocarpa group (20, G. salticola)
3. Veins visible in transmitted light and rhizome erect or occasionally short-creeping – 9, G. hirtella group
BEHIKMPQ 1. Hairs of lamina on conical projections – 6, G. setosa group (23, G. tuberculata)
2. Hairs of lamina not on conical projections – 10, G. intromissa group
BEHIKNPQ 10, G. intromissa group (54, G. montana)
BEHILMOQ 1. Hairs of lamina margin and midvein below up to 8-nate – 11, G. mollipila group
2. Lamina less than 20 cm long – 7, G. reinwardtii group
3. Lamina more than 25 cm long – 10, G. intromissa group (58, G. ornatissima)
BEHJKMOQ 5, G. ceratocarpa group (20, G. salticola)
BEHJLMOQ 1. Hairs of lamina margin and midvein below up to at least 5-nate – 11, G. mollipila group
2. Sori ± circular to oblong in outline – 6, G. setosa group

(BEHJLMOQ) 3. Lateral veins prominent on either surface of dried lamina – 7, G. reinwardtii group (28, G. knutsfordiana)
4. Hairs sparse to frequent on lower surface of lamina – 10, G. intromissa group
5. Hairs absent or occasional on lower surface of lamina – 7, G. reinwardtii group (25, G. reinwardtii)

BEHJLMOR 1. Lamina hairs only on margin – 6, G. setosa group (21, G. archboldii)
2. Hairs on margin, midvein, amongst sori and on lamina surface – 10, G. intromissa group (50, G. subreticulata)

BEHJLMPQ 1. Hairs of stipe up to 4 mm long, lateral veins ± visible in transmitted light – 10, G. intromissa group (53, G. habbemensis)
2. Hairs of stipe up to 3 mm long, lateral veins invisible in transmitted light – 6, G. setosa group

BEHJLNOQ 6, G. setosa group

BEHJLNOR 6, G. setosa group (21, G. archboldii)

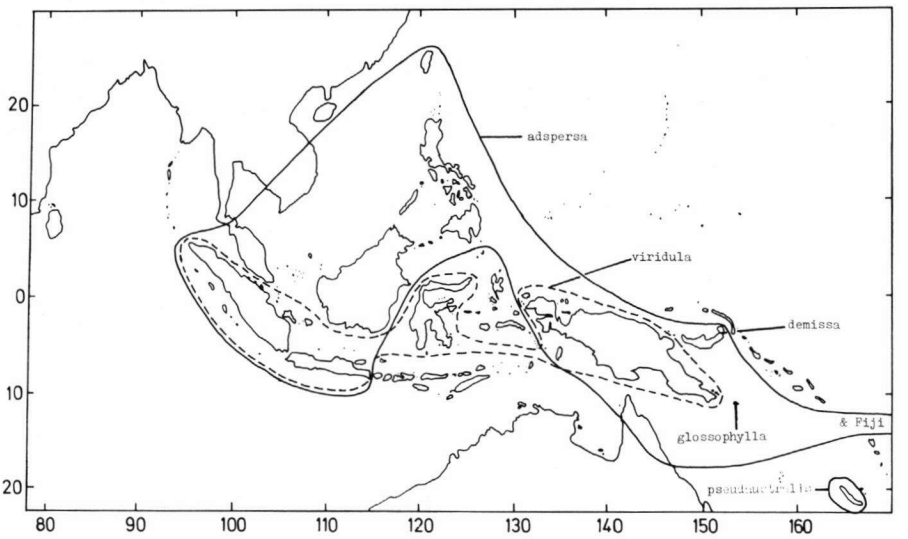
2.2.5. Accounts of species groups and species

1. G. adspersa group — Species 1–4
Figs. 2, 3; maps 2–5; table 1

Rhizome erect to short-creeping; scales lanceolate to narrowly lanceolate, pale to medium red-brown, glabrous or with numerous marginal hairs, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* sometimes absent, glabrous or with whitish to medium red-brown simple eglandular hairs up to 0.8 mm, sometimes with similar but 1-forked hairs, which may have one branch clavate-glandular and one eglandular, and simple clavate-glandular hairs. *Lamina* entire or shallowly crenate, membranous, with whitish to dark red-brown simple eglandular hairs up to 1 mm and similar but 1–3-forked hairs on midvein below, sometimes with 1-forked hairs with one branch clavate-glandular and one eglandular on the margin, and simple clavate-glandular hairs; lateral veins often visible in transmitted light, usually 1-forked (rarely simple), the upper branch shorter than the lower one, each branch ending marked by a small hydathode on the upper surface of the lamina. *Sori* ± circular to broadly elliptic in outline, on surface of lamina or slightly sunken in broad shallow depressions, in two rows.

Epiphytes, probably always in lower montane and midmontane forest. Distribution from Sumatra and mainland Southeast Asia to Taiwan, Australia, New Caledonia and Fiji with four species in New Guinea, two of which are endemic, one in Northeast I. and one in Southeast I.

The *G. adspersa* group may be divided into two subgroups. That of *G. pseudaustralis* Fourn., containing *G. demissa*, is characterised by having rhizome scales with



Map 2. *G. adspersa* species group.

marginal hairs and is restricted to New Caledonia and New Guinea (Northeast I. only). That of *G. adspersa*, together with *G. viridula* and *G. glossophylla*, possesses glabrous rhizome scales and has the range of the species group with one species endemic in Southeast I.

The forked hairs distinguish this species group from all others in New Guinea but are not unique to it. They are found in the austral species group of *G. billardieri* Willd., in some New World species of *Grammitis*, in *Scleroglossum* and in some members of *Ctenopteris*. Rhizome scales with marginal hairs are known in other (not closely related) Old World *Grammitis* taxa, in *Prosaptia* and in some species of *Ctenopteris*.

The extra-New Guinea member of this group is *G. pseudaustralis*.

1. Grammitis demissa Parris, *sp. nov.* – Fig. 2; map 4.

G. adspersae affinis sed squamis ad marginem pilis praeditis et stipitibus et laminis pilis 1-furcatis uno ramo clavato-glanduloso vestitis differt. — *Rhizoma* squamis inclusis 2–4 mm diam., squamis exclusis 0.5–1.0 mm diam., erectum vel breviter repens, eramosum, stipites per spatia minus quam 1 mm emittens; squamae 1.0–2.0 mm longae, 0.2–0.3 mm latae, lanceolatae, ad apicem acutae, mediae rubriusculo-brunneis 0.1–0.2 mm longis vestitis, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 0.2–0.7(–1.0) cm longus, 0.1–0.2 mm latus, pilis simplicibus eglandulosis 0.5–0.8 mm longis moderate numerosis plus minusve patentibus pallidis luteolo-brunneis et pilis paucis similibus sed 1-furcatis interdum uno ramo clavato-glanduloso vestitus. *Lamina* (2.0–)2.8–4.2(–5.2+) cm longa, 0.3–0.4 cm lata, lineari-elliptica, ad apicem subacuta, ad basem attenuata vel cuneata, leviter crenulata, lobis ad 0.2 mm longis, membranacea, pilis simplicibus eglandulosis 0.1–1.0 mm longis plus minusve patentibus pallidis luteolo-brunneis per

Table 1. Characters of taxonomic importance within the *G. adspersa* species group in New Guinea.

Characters	*G. demissa*	*G. adspersa*	*G. viridula*	*G. glossophylla*
Rhizome scales	with numerous marginal hairs	glabrous	glabrous	glabrous
Stipe hairs	simple eglandular; forked with one branch clavate-glandular and one eglandular; forked with all branches eglandular	simple eglandular; forked with all branches eglandular	absent or simple eglandular	simple eglandular
Lamina in cm	(2.0–)2.8–4.2(–5.2+) × 0.3–0.4	(1.5–)2.9–6.7(–9.7) × (0.2–)0.3–0.5(–0.6)	12.0–19.8 × 0.7–0.8	c. 11.0 × 0.7
Lamina hairs	simple eglandular mod. frequent on all parts of lamina; forked with one branch clavate-glandular and one eglandular occ. on margin	simple eglandular occ. to scattered on all parts of lamina or just on undersurface of lamina and midvein below	occ. simple eglandular on midvein below	simple eglandular mod. frequent on margin and midvein on both surfaces of lamina
Spores in μm	(17–)20–22	(17–)21–33(–36)	19–27(–30)	(30–)31–35(–37)

laminam plerumque moderate numerosis, pilis paucis similibus sed 1–2-furcatis ad medio-venam infernam et pilis paucissimis similibus sed 1-furcatis uno ramo clavato-glanduloso ad marginem vestita; medio-vena ad paginam infernam laminae paulo prominens et pagina inferna laminae concolor vel fuscatior; venae laterales plus minusve in luce transmissa, parum prominentes in pagina infera laminae ubi siccatae, 1-furcatae, ramus superus brevissimus, non ultra sorum procurrens, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 0.7–1.2 mm longi, 0.4–1.1 mm lati, in ambitu plus minusve circulares, ad superficiarem infernam laminae adornati, plus minusve contigui ubi maturi, in 2 serialibus, 1 utroque medio-venae in ½ vel ¾ superno laminae, in quoque seriali (16–)17–28(–32) sori medio-venam quam marginem multo proximiores. *Sporangia* (140–)145–165(–170) μm longa, plerumque glabra, aliquando pilo solitario pallido luteolo-brunneo rigido 210–300 μm longo praedita; cellulae induratae annuli (9–)10–12(–13). *Sporae* (17–)20–22 μm diam. — Typus: *LAE 58480*, 2.vi.1973, crater rim of North Son, Hoskins Subdistrict, West New Britain District, Papua New Guinea (K; iso L, LAE).

Rhizome 2–4 mm diam. including scales, 0.5–1.0 mm diam. without scales, erect to short-creeping, unbranched, producing stipes less than 1 mm apart; scales 1.0–2.0 × 0.2–0.3 mm, lanceolate, acute at apex, medium red-brown, with numerous pale red-brown hairs 0.1–0.2 mm on margin, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.2–0.7(–1.0) cm × 0.1–0.2 mm, with moderately frequent ± patent pale yellow-brown simple eglandular hairs 0.5–0.8 mm with occasional similar but 1-forked hairs sometimes with one branch clavate-glandular. *Lamina* (2.0–)2.8–4.2(–5.2+) × 0.3–0.4 cm, linear-elliptic, subacute at apex, attenuate to cuneate at base, shallowly crenate with teeth to 0.2 mm long, membranous, with moderately frequent ± patent pale yellow-brown simple eglandular hairs 0.1–1.0 mm on all parts of the lamina, occasional similar but 1–2-forked hairs on the midvein below and very occasional similar but 1-forked hairs with one branch clavate-glandular and one eglandular on the margin; midvein rather prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins ± visible in transmitted light, slightly prominent on the lower surface of the lamina when dried, 1-forked, the upper branch very short and not extending beyond the sorus, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 0.7–1.2 × 0.4–1.1 mm, ± circular in outline, on surface of lamina, ± contiguous when mature, in two rows, one on each side of the midvein in the upper ½–¾ of lamina, each row with (16–)17–28(–32) sori, much nearer the midvein than the margin. *Sporangia* (140–)145–165(–170) μm, usually glabrous, occasionally with a solitary pale yellow-brown rigid hair 210–300 μm; indurated cells of annulus (9–)10–12(–13). *Spores* (17–)20–22 μm diam.

Distribution. New Guinea.

W. NEW BRITAIN. North Son, LAE 58480 (K, L, LAE).

Ecology. Epiphyte on underside of leaning tree trunk; in lower montane forest (including *Calophyllum, Casuarina, Podocarpus*, Cunoniaceae); at 900 m.

Note. *G. demissa* is related to *G. pseudaustralis* of New Caledonia, which also has ciliate scales, but differs in its obtuse fronds, shorter lamina hairs and more frequently branched hairs on the margin and midvein below.

Fig. 2. *G. adspersa* group; *G. pseudaustralis* subgroup and *G. adspersa* subgroup. – 1. *G. demissa* (1), isotype, *LAE 58480* (LAE); 2. *G. viridula* (3), *Lam 1968* (L).

2. Grammitis adspersa (Blume) Blume – Fig. 3; maps 3, 4.

G. adspersa (Blume) Blume, Flora Javae 2 (14 April 1830) 115; Copel., Philip. J. Sc. 80 (1952) 214. – *Polypodium adspersum* Blume, Enum. Pl. Javae (1828) 123. – Lectotype: *Blume s.n.*, 'crescit in sylvis montosis Javae supra arbores' (L; iso L).

Polypodium sessilifolium Hook., Sp. Fil. 4 (1863) 168, non Liebm. (1849). – *G. sessilifolia* J. Sm., Hist. Fil. (1875) 181, pro *P. sessilifolium* Hook., non Liebm. – Lectotype: *Cuming 222*, Luzon, Philippines (K; iso BM, CGE).

Polypodium subevenosum Baker in Hook. & Baker, Syn. Fil. (8 Nov. 1867) 320. – *G. subevenosa* C. Chr. & Tard.-Blot, Not. Syst. (Paris) 8 (1939) 179. – Type: *Mactier s.n.*, Penang, Malaya (K, holo; E).

Polypodium paucisorum Copel., Philip. J. Sc. C 2 (1907) 137. – Lectotype: *Merrill 5964*, Mt Halcon, Mindoro, Philippines, on mossy trees, alt. 180–240 m (MICH).

Polypodium malaicum v.A.v.R., Malayan Ferns (1909) 577, nom. nov. pro *P. sessilifolium* Hook., non Liebm. – *G. malaica* Tagawa, Acta Phytotax. Geobot. 8 (1939) 173, superfl. nom. illeg. pro *G. sessilifolia* J. Sm.

G. leonardii Parris, Bot. J. Linn. Soc. 70 (1975) 38. – Type: *Brass 20075*, Mt Finnegan, Northeast Queensland, Australia (BRI, holo; A).

Polypodium pleurogrammoides sensu Brause, Bot. Jahrb. 56 (1920) 180, quoad *Ledermann 12739.*

Illustrations: Blume, Flora Javae 2 (1830) pl. 48, f. 2; Hook., Sp. Fil. 4 (1863) pl. 272A as P. sessilifolium; Copel., Philip. J. Sc. C 2 (1907) pl. 3b as P. paucisorum; Copel., Philip. J. Sc. 80 (1952) 215, f. 78; Holttum, Fl. Malaya ed. 2, 2 (1968) 217, f. 111; Parris, Bot. J. Linn. Soc. 70 (1975) 42, f. 5A & B as G. leonardii.

Rhizome 1.0–2.5 mm diam. including scales, 0.5–1.0 mm without scales, ± erect, c. 1.0–3.0 cm long, unbranched; scales (1.0–)1.6–2.8(–3.0) × (0.2–)0.3–0.5(–0.6) mm, lanceolate to narrowly lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.1–0.3 cm × 0.2–0.5 mm, with sparse to scattered ± patent whitish to very pale brown simple eglandular hairs 0.1–0.2 mm, sometimes with similar but 1–2-forked hairs sparse to scattered, and ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* (1.5–)2.9–6.7(–9.7) × (0.2–)0.3–0.5(–0.6) cm, linear-oblanceolate to linear-oblanceolate, acute to obtuse at apex and cuneate to long-attenuate at base, entire or shallowly crenate, the teeth to 0.5 mm long, ± membranous, with occasional to scattered ± patent whitish to very pale brown simple eglandular hairs 0.1–0.4 mm on all parts, or just on the undersurface of lamina and midvein below, similar but 1–3-forked hairs occasional on midvein below and ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins usually visible in transmitted light, 1-forked, the upper branch terminating in the sorus or extending a little beyond it but always shorter than the lower branch, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.0–2.0 × 0.5–1.5 mm, ± circular in outline, on the surface of the lamina or slightly sunken in broad shallow depressions, discrete to contiguous when mature, in two rows, one on each side of the midvein in the middle or upper ½–¾ of the lamina, each row with (2–)3–21(–31) sori, nearer the midvein than the margin. *Sporangia* (120–)160–200(–240) μm,

with (1–)2–6(–8) whitish to pale red-brown rigid hairs (80–)105–158(–170) μm, indurated cells of annulus (7–)10–12(–14). *Spores* (17–)21–33(–36) μm diam.

Distribution. Mainland Southeast Asia, peninsular Malaysia, Sumatra, Borneo, Java, Taiwan (fide DeVol, 1975), Philippines, New Guinea, Australia and Fiji.

VOGELKOP PENINSULA. Anggi Gita, Kostermans 2221 (BO).

E. SEPIK. Felsspitze, Ledermann 12739 (B, BM). Mt Hunstein, Hoogland & Craven 10943 (CANB), 10994 (CANB, LAE).

MOROBE. Near Aseki, Parris & Croxall 9178 (BSP).

MILNE BAY. Fergusson I., Ailuluai, NGBF 1016 (E, LAE), Croft 487B (CROFT, LAE). Mt Dayman, Armit 15 (K).

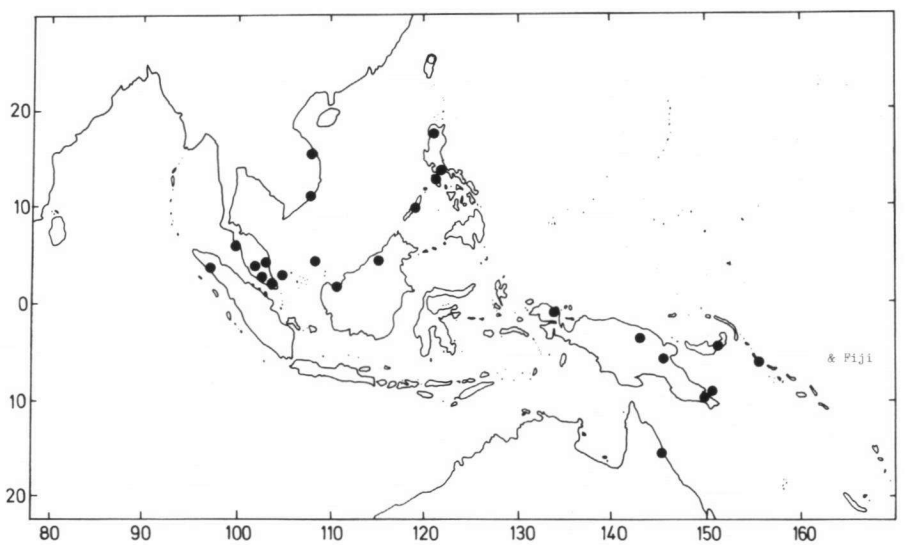
E. NEW BRITAIN. Mt Sule, NGF 13186 (K, L).

BOUGAINVILLE. L. Loloru, Schodde & Craven 3896 (LAE).

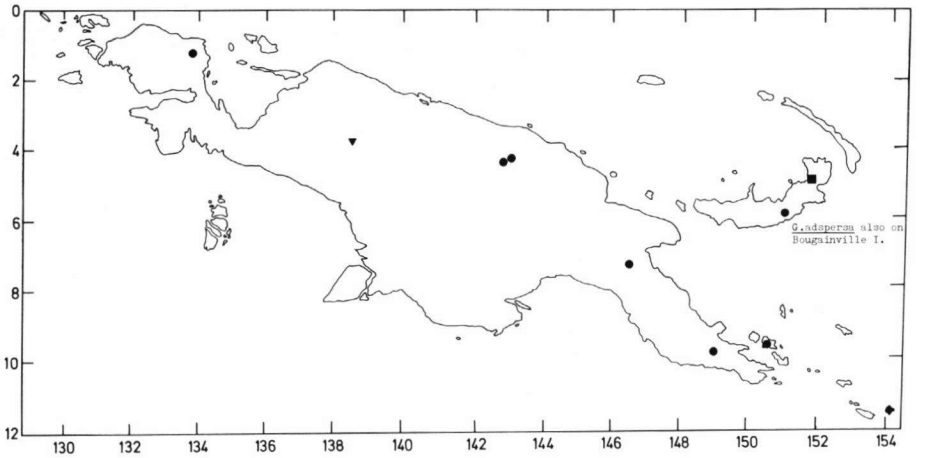
Ecology. Occasionally growing with *G. oblanceolata*. Low epiphyte on slender tree trunks in lower montane and midmontane forest (including *Nothofagus* with thick undergrowth of *Nastus*); from 610 to 2740 m.

Notes. A collection from Irian Jaya (Geelvink Bay, mountains south of Nabire, 100–400 m, 1929, *Schonian 144*, B) may belong here. It has the characteristic forked hairs, but differs from other New Guinea material in its simple fertile veins and glabrous sporangia. The altitude of 2740 m on Mt Dayman (*Armit 15*) is suspect as this species is elsewhere not known above 2150 m.

G. adspersa is distinguished from all other New Guinea species of *Grammitis* except *G. viridula* and *G. glossophylla* by its branched hairs. *G. viridula* is larger, grows at high altitudes and has hairs only on the midvein of the mature lamina, while *G. glossophylla* is larger with the lamina more densely hairy.



Map 3. *Grammitis adspersa* (2).



Map 4. ■ *Grammitis demissa* (1), ● *G. adspersa* (2), ▼ *G. viridula* (3), ◆ *G. glossophylla* (4).

3. Grammitis viridula (v.A.v.R.) Parris – Fig. 2; maps 4, 5.

G. viridula (v.A.v.R.) Parris, Fern Gaz. 12 (1980) 118. – *Polypodium viridulum* v.A.v.R., Nova Guinea 14 (1924) 41; Copel., Philip. J. Sc. 80 (1952) 167. – Lectotype: *Lam 1853* (L).
Polypodium subfasciatum sensu v.A.v.R., Nova Guinea 14 (1924) 44, quoad *Lam 1968.*
G. subfasciata sensu Copel., Philip. J. Sc. 80 (1952) 170, quoad *Lam 1968.*

Rhizome 2–3 mm diam. including scales, c. 1 mm diam. without scales, erect to ascending, up to c. 5.3 cm long, unbranched; scales 2.0–4.0 × 0.4–0.7 mm, lanceolate to narrowly lanceolate, acute at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* absent or 0.2–0.6 cm × c. 0.4 mm, glabrous or with occasional ± patent pale to medium red-brown simple eglandular hairs c. 0.1 mm. *Lamina* 12.0–19.8 × 0.7–0.8 cm, linear-elliptic, acute at apex, attenuate to long-attenuate at base, entire, membranous, with occasional ± patent pale to dark red-brown simple eglandular hairs 0.1–0.2 mm and very occasional similar but 1-forked hairs on the midvein below, and scattered ± appressed pale red-brown simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein ± prominent on the lower surface of the lamina, concolorous with or slightly darker than it; lateral veins ± visible in transmitted light, 1-forked, the upper branch sometimes extending beyond the sorus, shorter than the lower branch, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.2–2.5 × 0.7–1.7 mm, ± circular to broadly elliptic in outline, each oblique to the midvein, on the surface of the lamina or slightly sunken in broad shallow depressions, discrete when mature, in two rows, one on each side of the midvein in the upper ¾ of the lamina, each row with 27–37 sori, nearer the midvein than the margin. *Sporangia*

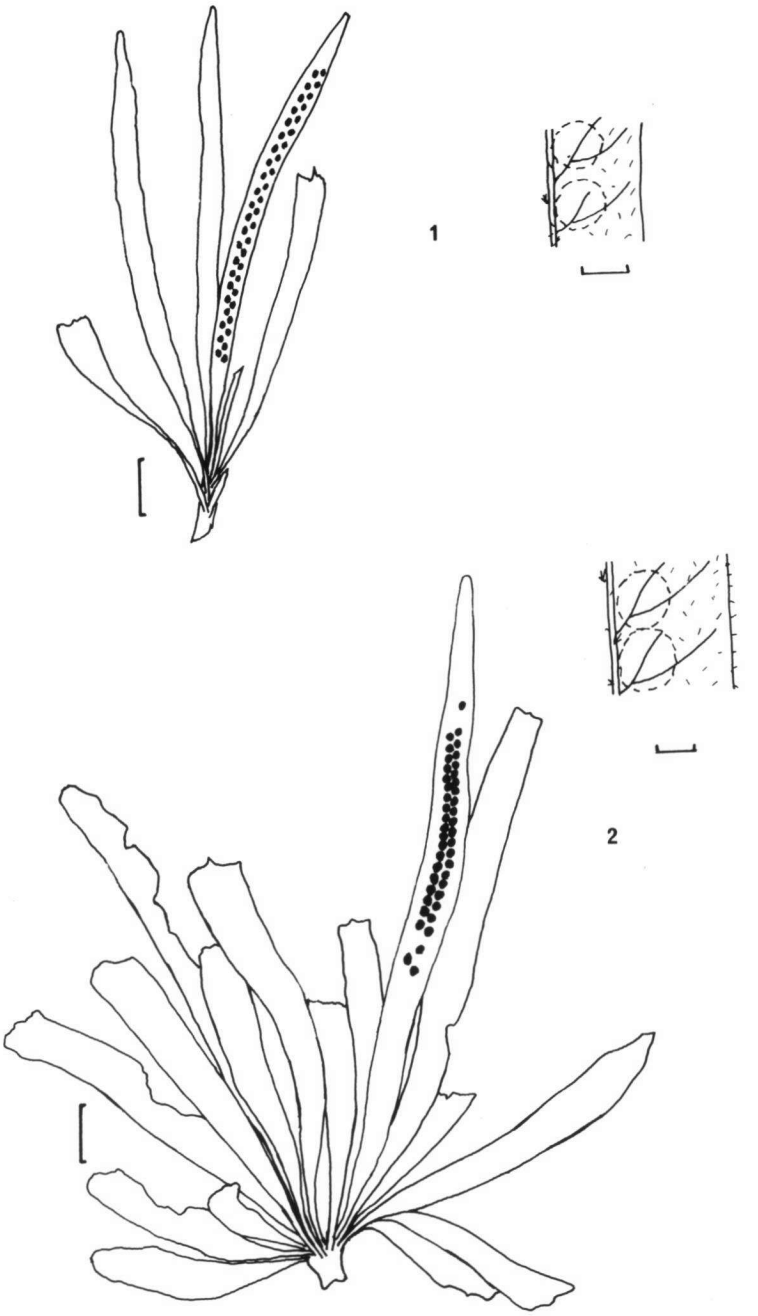


Fig. 3. *G. adspersa* group; *G. adspersa* subgroup. – 1. *G. adspersa* (2), *Schodde & Craven 3896* (LAE); 2. *G. glossophylla* (4), holotype, *Brass 28495* (L).

(170–)181–212(–230) μm, with 1–5 pale to medium red-brown rigid hairs 130–150 μm; indurated cells of annulus (8–)9–10(–11). *Spores* 19–27(–30) μm diam.

Distribution. Sumatra, Java, Celebes and New Guinea.

CENTRAL IRIAN JAYA. Near summit, Ngga Simanggela, Lam 1853 (L), 1968 (BO, L).

Ecology. Epiphyte in montane forest; at about 2500 m.

4. Grammitis glossophylla Parris, *sp. nov.* – Fig. 3; map 4.

Differt a G. adspersa lamina longiore et pilis moderate numerosis ad marginem et medio-venam in pagina supera et pagina inferna laminae. — *Rhizoma* squamis inclusis c. 6 mm diam., squamis exclusis c. 1 mm diam., plus minusve erectum, eramosum; squamae c. 2.0 mm longae, c. 0.4 mm latae, lanceolatae, ad apicem acutae, pallidae rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. Stipes 0.4–0.5 cm longus, 0.4–0.6 mm latus, pilis simplicibus eglandulosis 0.1–0.2 mm longis moderate numerosis plus minusve patentibus pallidis vel mediis rubriusculo-brunneis vestitus. *Lamina* c. 11.0 cm longa, c. 0.7 cm lata, lineari-elliptica, ad apicem subacuta, ad basem anguste cuneata, integra, membranacea, pilis simplicibus eglandulosis 0.1–1.0 mm longis plus minusve patentibus pallide vel obscure rubriusculo-brunneis ad marginem et medio-venam infernam et supernam moderate numerosis, in pagina inferna et superna laminae et praesertim in frondibus juvenis prope marginem sparsis, pilis paucissimis similibus sed 1–2-furcatis ad medio-venam infernam vestita; medio-vena ad paginam infernam laminae prominens, pagina inferna laminae concolor; venae laterales in luce transmissa non manifestae, 1-furcatae, ramus superus parum ultra sorum procurrens et quam ramum inferum brevior, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 1.5–2.2 mm longi, 1.2–2.0 mm lati, in ambitu plus minusve circulares, in depressionibus vadosis apertis parum impressi, contigui ubi maturi, in 2 serialibus, 1 introque medio-venae in ½ superno laminae sed non prope apicem, in quoque seriali 20–29+ sori, medio-venam quam marginem proximiores. *Sporangia* (190–)194–212(–220) μm longa, glabra; cellulae induratae annuli (10–)11–12. *Sporae* (30–)31–35(–37) μm diam. — Typus: *L.J. Brass 28495*, 19.x.1956, south slopes of Mt Rossel, Rossel I., Milne Bay District, Papua New Guinea (L).

Rhizome c. 6 mm diam. including scales, c. 1 mm diam. without scales, ± erect, unbranched; scales c. 2.0 × 0.4 mm, lanceolate, acute at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.4–0.5 cm × 0.4–0.6 mm, with moderately frequent ± patent pale to medium red-brown simple eglandular hairs 0.1–0.2 mm. *Lamina* c. 11.0 × 0.7 cm, linear-elliptic, subacute at apex, narrowly cuneate at base, entire, membranous, with ± patent pale to dark red-brown simple eglandular hairs 0.1–0.2 mm moderately frequent on margin and midvein on both surfaces of the lamina, scattered on the upper and lower surfaces of the lamina and especially near the margin in young fronds, and similar but 1–2-forked hairs very occasional on the midvein below; midvein prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch extending a little beyond the sorus, shorter than the lower branch, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.5–2.2 × 1.2–2.0 mm, ± circular in outline, very slightly sunken in shallow open depressions, contiguous when mature, in two rows, one on each side of the midvein in the upper ½ of the lamina but not immedia-

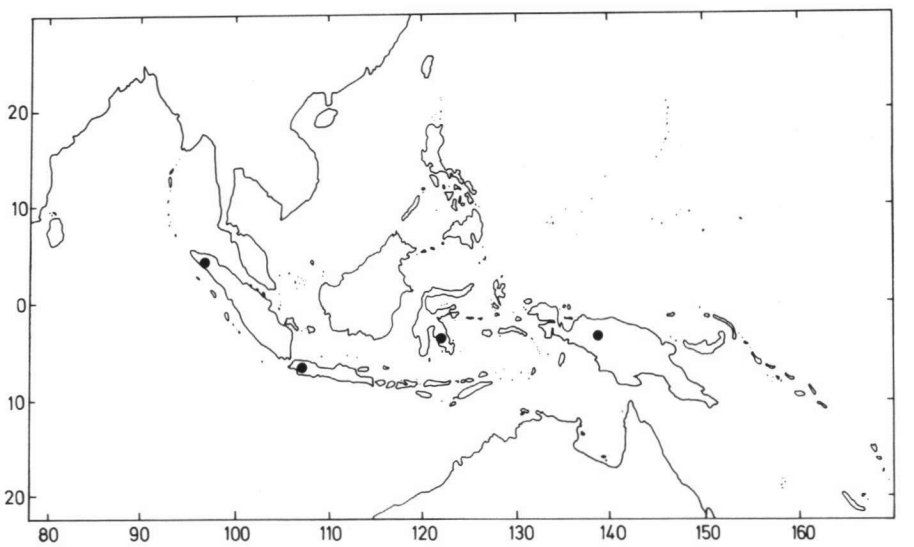
tely below the apex, each with 20–29+ sori, nearer the midvein than the margin. *Sporangia* (190–)194–212(–220) μm, glabrous; indurated cells of annulus (10–)11–12. *Spores* (30–)31–35(–37) μm diam.

Distribution. New Guinea.

MILNE BAY. Mt Rossel, Rossel I., Brass 28495 (L).

Ecology. Epiphyte in ridge forest; at 700 m.

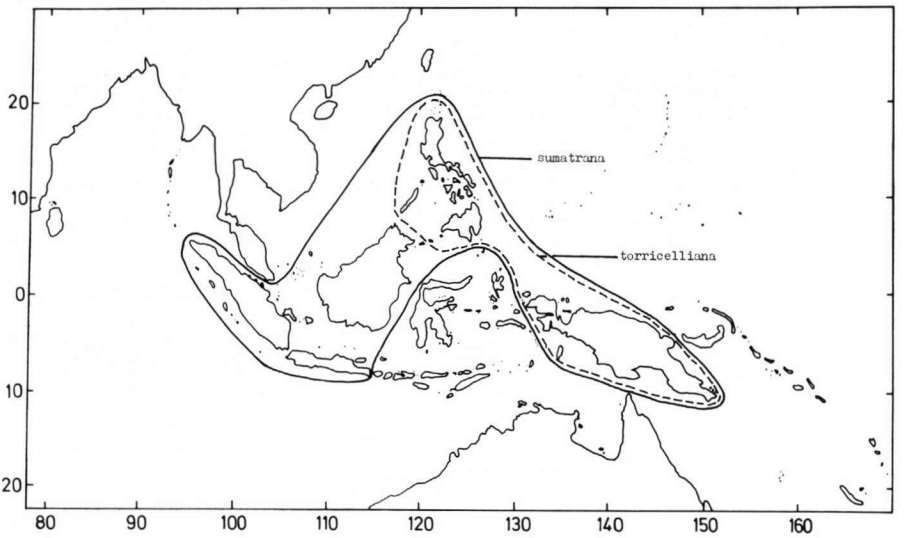
Note. *G. glossophylla* is closely related to *G. adspersa* and may best be regarded as an island endemic derived from it.



Map 5. *Grammitis viridula* (3).

2. G. sumatrana group — Species 5–6
Figs. 4, 5; maps 6–9; table 2

Rhizome erect to long-creeping; scales ovate-lanceolate to lanceolate, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* with pale to dark red-brown simple eglandular hairs up to 0.6 mm. *Lamina* entire or crenate, coriaceous, with medium to dark red-brown simple eglandular hairs up to 0.7 mm and simple clavate-glandular hairs; lateral veins usually invisible in transmitted light, 2–9-forked, the first upper branch shorter than the others, each branch ending marked by a small hydathode on the upper surface of the lamina. *Sori* ± circular to oblong in outline, on surface of lamina in (2–)4–8 rows.



Map 6. *G. sumatrana* species group.

Epiphytic or rupestral, in lower montane to subalpine forest and subalpine shrubland. Distribution from Sumatra to New Guinea with two species in New Guinea, neither of which is endemic.

This species group is possibly linked with *Ctenopteris* (see under *G. sumatrana* for further discussion).

5. Grammitis sumatrana (Baker) Copel. – Fig. 4; maps 7, 8.

G. sumatrana (Baker) Copel., Philip. J. Sc. 56 (1935) 105; ibid. 80 (1952) 181. – *Polypodium sumatranum* Baker, J. Bot. (London) 18 (1880) 214. – Type: *Beccari 448*, Mt Singalan, Sumatra (K, holo; BM, holo fragm.; BO).

Polypodium subpleiosorum Racib., Pterid. Buitenzorg (1898) 89. – Lectotype: *Raciborski s.n.*, Salak West, Java (BO).

Polypodium pleiosoroides Copel. in Perkins, Fragm. Fl. Philip. (1905) 189. – Philippines (PNH, n.v., probabiliter destructus).

Polypodium serraeforme Brause, Bot. Jahrb. 49 (1912) 36, non (Wall. ex Hook.) J. Sm. (1941). – Lectotype: *Schlechter 18142* (B; lecto fragm. BM; UC).

Polypodium subrepandum Brause, Bot. Jahrb. 49 (1912) 37. – *G. subrepanda* Copel., Philip. J. Sc. 80 (1952) 183. – Lectotype: *Schultze Jena (26) 16* (B).

Polypodium biseriale Ridley, Trans. Linn. Soc. London (Bot.) 2, 9 (1916) 260, non Baker (1867). – Lectotype: *Boden Kloss s.n.*, Mt Carstensz, Camps VIII to IX, 4900 to 5500 ft (BM).

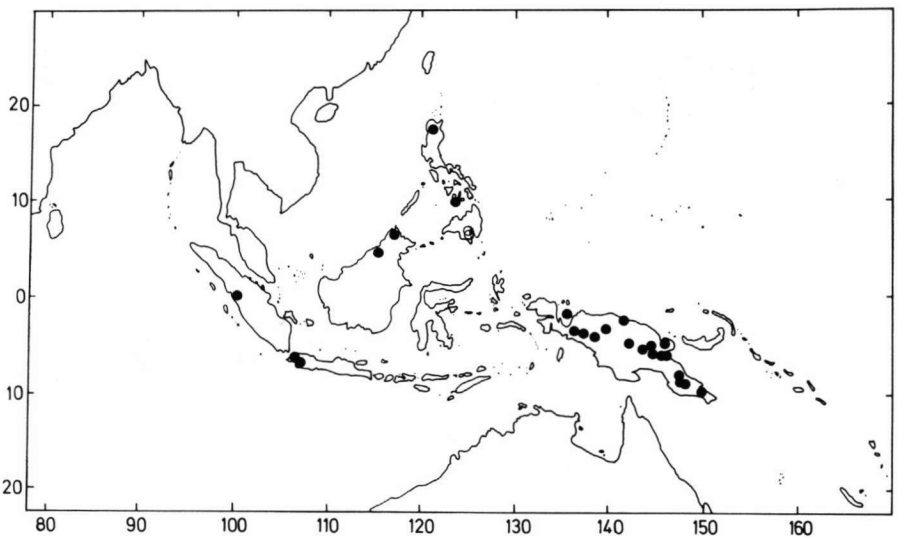
Polypodium carstenszense Ridley, Trans. Linn. Soc. London (Bot.) 2, 9 (1916) 260; Copel., Philip. J. Sc. 80 (1952) 185. – Lectotype: *Boden Kloss s.n.*, Mt Carstensz, Camps XI to XIV, 7500 to 10,500 ft (BM; iso K).

Polypodium brauseanum v.A.v.R., Malayan Ferns Suppl. (1917) 521, nom. nov. pro *P. serraeforme* Brause, non (Wall. ex Hook.) J. Sm.
Polypodium hirtellum sensu Brause, Bot. Jahrb. 56 (1920) 180, quoad *Ledermann 11699* p.p.
Illustrations: Brause, Bot. Jahrb. 49 (1912) 31, f. 2d as P. serraeforme; Copel., Philip. J. Sc. 80 (1952) 182, f. 52 et 183, f. 53 as G. subrepanda.

Rhizome 4–9 mm diam. including scales, 2–3 mm diam. without scales, short to long-creeping, sometimes branched, producing stipes 1–7 mm apart; scales (1.6–)2.6–4.8(–6.2) × (0.3–)0.5–1.1(–1.7) mm, usually lanceolate, occasionally ovate-lanceolate, acute to obtuse at apex, usually pale red-brown, sometimes medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.2–)2.2–6.0(–10.4) cm × (0.4–)0.6–1.0(–1.3) mm, with moderately frequent to dense ± patent pale to dark red-brown simple eglandular hairs 0.1–0.3(–0.6) mm. *Lamina* (7.5–)10.9–18.5(–25.6) × (0.6–)1.0–1.8(–2.6) cm, linear-lanceolate to linear-oblanceolate, acute to acuminate at apex and cuneate (sometimes unequally) to attenuate at base, usually crenate, the teeth up to 6.0 mm long, sometimes entire, coriaceous, with scattered to moderately frequent ± patent to ascending medium to dark red-brown simple eglandular hairs (0.1–)0.2–0.4(–0.7) mm on margin and occasionally on midvein below, similar but binate hairs also on margin, and occasional ± appressed very pale brown simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein ± prominent on the lower surface of the lamina, concolorous with or darker than it; lateral veins invisible in transmitted light, slightly prominent on the lower surface when dried, 2–9-forked, the inner 1–8 branches usually each with a sorus and extending only a little beyond it, the outer branches longer and without sori, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* (0.7–)1.0–2.2(–3.3) × (0.4–)0.8–

Table 2. Characters of taxonomic importance within the *G. sumatrana* species group in New Guinea.

Characters	*G. sumatrana*	*G. torricelliana*
Stipe length in cm	(1.2–)2.2–6.0(–10.4)	0.6–1.7
Lamina	usually crenate, the teeth up to 6.0 mm long; sometimes entire	entire to slightly crenate, the teeth up to 0.5 mm long
Lamina hairs (simple eglandular)	scattered to mod. frequent on margin and occ. on midvein below	sparse to scattered on margin, midvein and lamina below, scattered on midvein above, occ. on lamina above
Spores in μm	(22–)26–44(–59)	(40–)41–50(–54)



Map 7. *Grammitis sumatrana* (5).

1.6(–2.1) mm, ± circular to oblong in outline, each oblique to the midvein, on the surface of the lamina, usually all discrete but occasionally a few confluent when mature, in (2–)4–8 rows, (1–)2–4 on each side of the midvein and sometimes only partly complete, almost throughout the lamina to only in the upper ½, the innermost row on each side near the midvein. *Sporangia* (180–)207–264(–330) μm, with 1–4 (–6) medium to dark red-brown rigid hairs (80–)109–177(–270) μm; indurated cells of annulus (7–)9–12(–15). *Spores* (22–)26–44(–59) μm diam.

Distribution. Sumatra, Borneo, Java, Philippines and New Guinea.

JAPEN I. Mt Oudia, Central Ra., Cheesman 1419 (BM).

CENTRAL IRIAN JAYA. Danau-danau Wissel, Eyma 4690 (BO, L), 4691 (BO, K, L). Punjak Sukarno, Boden Kloss s.n. (BM), s.n. (BM, K). Danau Habbema, Brass 9266 (BM, BO, GH, K, L, LAE, MICH), 10630 (GH, L, MICH), 10820 (BO, GH, L, MICH), 21117 (GH), 11241 (BM, GH, L, LAE, MICH, UC), 11599 (GH, MICH). Su. Taritatu, Brass 12215 (BM, BO, GH, L, MICH, UC), 12884 (GH, MICH).

CYCLOPS MTS. Ifaar to Ormu, van Royen & Sleumer 5970 (L).

W. SEPIK. Folongonom, LAE 67505 (LAE). Mt Amdutakin, Vink 17576 (L, LAE). 65 km S. of Tami R. mouth, Schultze Jena (26) 16 (B).

E. SEPIK. Hollrungsberg, Ledermann 11699 (B).

W. HIGHLANDS. Baiyer-Jimi divide, Parris & Croxall 9297 (BSP, LAE). Kum Forest, Mt Hagen, Parris & Croxall 4702 H 172, 8157 (both BSP, LAE). Minj-Nona divide, Kubor Ra., Pullen 5014 (CANB, L, LAE), Vink 16030 (L). Mt Hagen, Parris & Croxall 4699 H 80, 8090 (both BSP, LAE).

ENGA. Ibiwara, Kalkman 4644 (L), 4677 (L), Vink 17017 (B, L, LAE). Mt Ambua, Kalkman 5086 (L).

S. HIGHLANDS. Mt Giluwe, Parris & Croxall 5819, 5845, 5912, 8220 (all BSP, LAE).

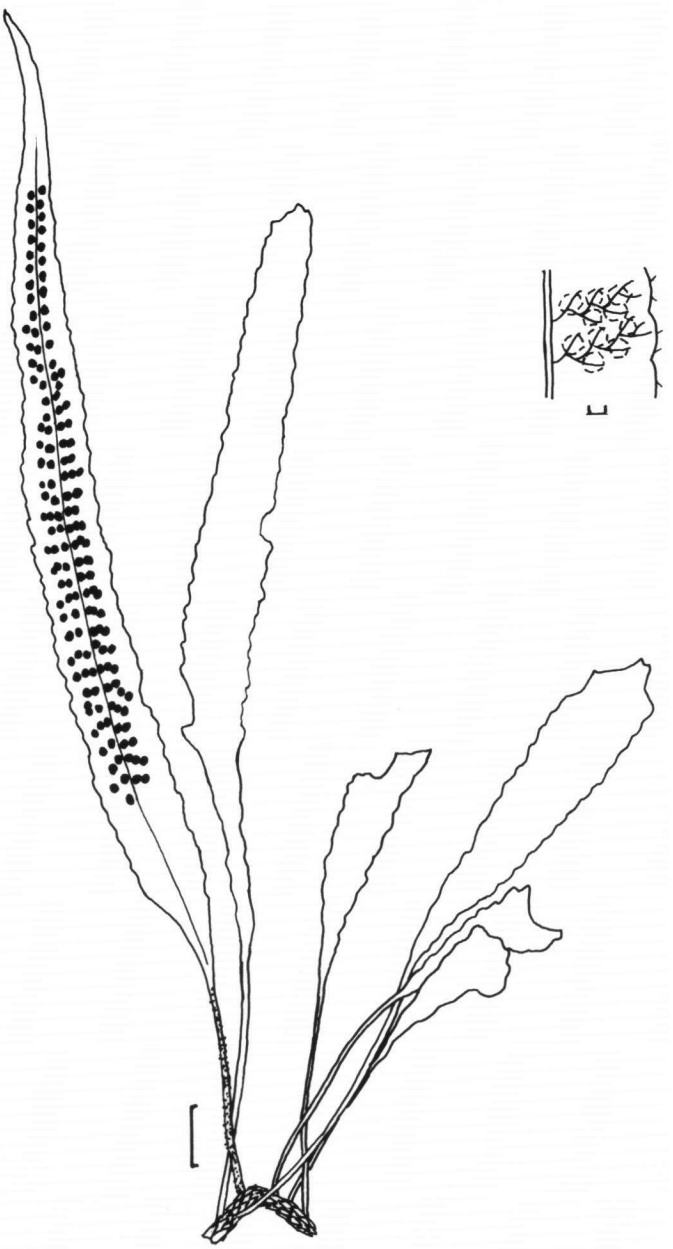


Fig. 4. *G. sumatrana* group. – *G. sumatrana* (5), *Parris & Croxall 8157* (BSP).

E. HIGHLANDS. Fatima R., Marafunga, Grubb & Edwards 160 (CGE, LAE), LAE 51106 (K, LAE). Kortumi, NGF 6729 (LAE). Marafunga, Stone 9997 (LAE). Mt Michael, Johns 1305 (BULOLO). Mt Piora, Croft 80 (BSP, CROFT, LAE). Waisa, Jermy 5141, 5142 (both BM).

MADANG. Butemu, Jermy 3838 (BM). Bouwao, Jermy 4655–4660 (all BM). Finisterre Mts, Schlechter 18142 (B, BM, UC). Mt Gelu, Werner 19 (BM, UC). Mt Schrader, Ledermann 12168 (B). Sewe to Tregbury Pass, Walker 8697, 8699–8702 (all BM). Wagai, Jermy 4865 (BM).

MOROBE. Edie Creek, Isimel 10 (BULOLO), Jermy 3492, 3495–3501, 3520–3522 (all BM), Ron 12 (BULOLO), Walker 7601–7621 (all BM). Ekuti Ra., Palis 15 (BULOLO), Parris & Croxall 6002, 7978 (both BSP, LAE), Unkau 64 (BULOLO). Matap, Clemens 40991, 40992, s.n. (all MICH). Mt Kaindi, Brass 29697 (US), Madring 17 (BULOLO), Nakaike 62 (LAE), Willmott 45 (BULOLO). Mt Kaisinik, Nakaike 173, 181 (both LAE). Skindewai, NGF 8414 (BRI, LAE). Spreader divide, NGF 42418 (LAE).

CENTRAL. Abios, Woitape, Nakaike 600 (LAE). Efogi, LAE 61870 (K, L, LAE). L. Myola, NGF 34916 (LAE). Mt Kenevi, LAE 65286 (LAE). Mt Tafa, Brass 5089 (BM, NY). Woitape, Kanai 752858 (LAE), Nakaike 495 (LAE). Woitape to Kosipi, NGF 20231 (LAE).

MILNE BAY. Mt Dayman, Armit 31 (K), Brass 22294 (A, BM), 22340 (A, BM), 22486 (A, BM, CANB, L, LAE), 23139 (A, BM, CANB, L, LAE, US). Mt Keria, Cruttwell 1378 (K).

Ecology. More or less erect epiphyte, usually on trunks of trees, occasionally on *Pandanus* prop roots, sometimes on major tree branches (incl. *Saurauia*) and occasionally in the crowns of trees (incl. *Cyrtandra & Mischocarpus*), occasionally on rotten logs and tree-ferns (*Cyathea* spp.), usually in lower montane and midmontane forest (incl. *Castanopsis, Trema/Dimorphanthera, Nothofagus* and podocarp forest), sometimes in forest on limestone, rarely in secondary forest and in regrowth at forest margins, occasionally in upper montane forest, subalpine forest and subalpine shrubland (incl. Ericaceae, *Papuacedrus, Quintinia & Xanthomyrtus*), occasionally rupestral on boulders in streams; from 950 to 3350 m.

Notes. Possible hybrids between *G. sumatrana* and *Ctenopteris longiceps* (Rosenst.) Copel. have been found in the field (Parris, in press). *G. sumatrana*, with several rows of sori and usually crenate lamina, is an unusual species in *Grammitis* and may be a stabilised hybrid between a species of *Grammitis* such as *G. torricelliana* and a *Ctenopteris* in the same species group as *Ctenopteris longiceps*. Further investigation is needed.

G. sumatrana occasionally produces 32-spored and 16-spored sporangia, on the same plant as the more usual 64-spored sporangia.

6. Grammitis torricelliana (Brause) Parris – Fig. 5; maps 8, 9.

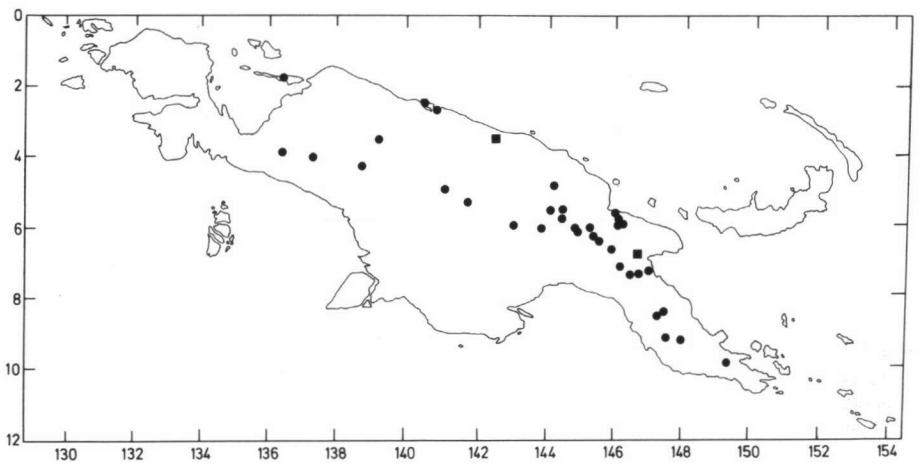
G. torricelliana (Brause) Parris, Fern Gaz. 12 (1981) 180. – *Polypodium torricellianum* [*torricellanum*] Brause, Bot. Jahrb. 49 (1912) 45; Copel., Philip. J. Sc. 80 (1952) 184. – Lectotype: *Schlechter 14347* (B).

G. microtricha Copel., Philip. J. Sc. 56 (1935) 105; ibid. 80 (1952) 222. – Lectotype: *Copeland s.n.*, Guinatilan (W. base of Mt Apo), Cotabato, Mindanao, Philippines, on mossy trunk, alt. 1000 m (MICH).

Illustrations: Brause, Bot. Jahrb. 49 (1912) 47, f. 3a; Copel., Philip. J. Sc. 56 (1935) pl. 11 as G. microtricha.

Rhizome 3–5 mm diam. including scales, 1 mm diam. without scales; ± erect to short-creeping, unbranched, producing stipes up to 2 mm apart; scales 1.0–5.0 × 0.3–0.6 mm, lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.4–1.7 cm × 0.4–0.7 mm, with moderately frequent to dense ± patent whitish to medium red-brown simple eglandular hairs 0.1–0.2 mm and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* (6.5–)7.9–15.9(–16.0) × (0.7–)0.8–1.2 cm, linear-elliptic to linear-oblanceolate, acute to acuminate at apex, attenuate at base, entire or very slightly crenate, the teeth up to 0.5 mm long, coriaceous, with sparse to scattered ± patent medium to dark red-brown simple eglandular hairs 0.1–0.3 mm on margin and on midvein and lamina below, scattered on midvein and occasional to absent on lamina above, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on lower surface of lamina and concolorous with it; lateral veins sometimes visible in transmitted light, forked 2–6 times, the inner 1–4 branches usually each with a single sorus and extending beyond it but not as long as the outer branches, the outer branches without sori, each branch ending marked by a small hydathode on the upper surface of the lamina, free or sometimes anastomosing, especially in the outer sori. *Sori* 1.0–1.5 × 1.0–1.5 mm, ± circular in outline, on surface of lamina, discrete to confluent when mature, in 2–8 rows, 1–4 on each side of the midvein and sometimes only partly complete, in upper 1/3–3/5 of lamina but not immediately below the apex, the innermost row on each side near the midvein. *Sporangia* (230–)247–285(–320) μm, with 1–4 medium red-brown rigid hairs 140–200 μm; indurated cells of annulus (9–)10–13(–15). *Spores* (40–)42–51(–58) μm diam.

Distribution. Philippines and New Guinea.



Map 8. ● *Grammitis sumatrana* (5), ■ *G. torricelliana* (6).

W. or E. SEPIK. Torricelli Mts, Schlechter 14347 (B).

MOROBE. Gurakor, Brass 29435 (CANB, K, L, LAE); Croft 921 & Marsh (BSP, CROFT, LAE).

Ecology. Rupestral in forest; alt. 640–1000 m.

Note. *G. torricelliana* is close to *G. sumatrana*, with similar stipe hairs and lateral vein branching, but differs in its rather less rigid hairs on the lower surface of the lamina. *G. sumatrana* usually grows at higher altitudes and usually has smaller spores, more deeply toothed fronds and longer stipes.

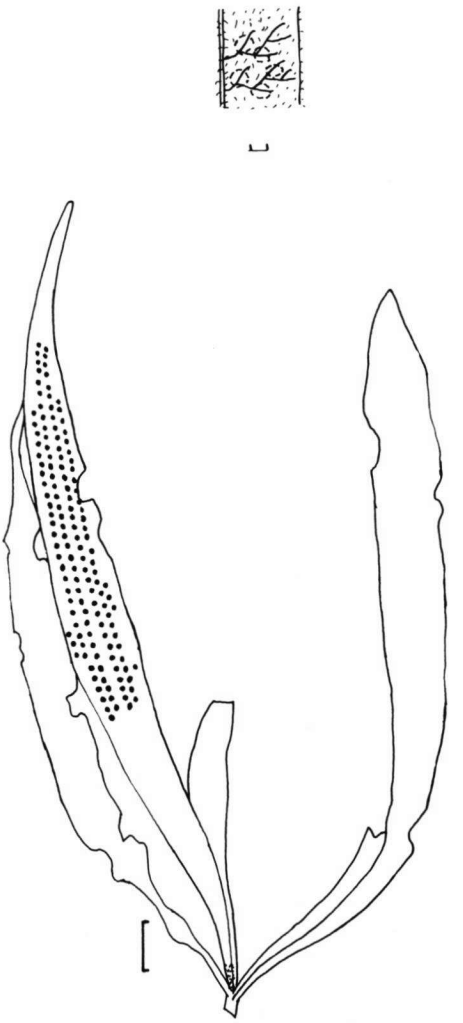
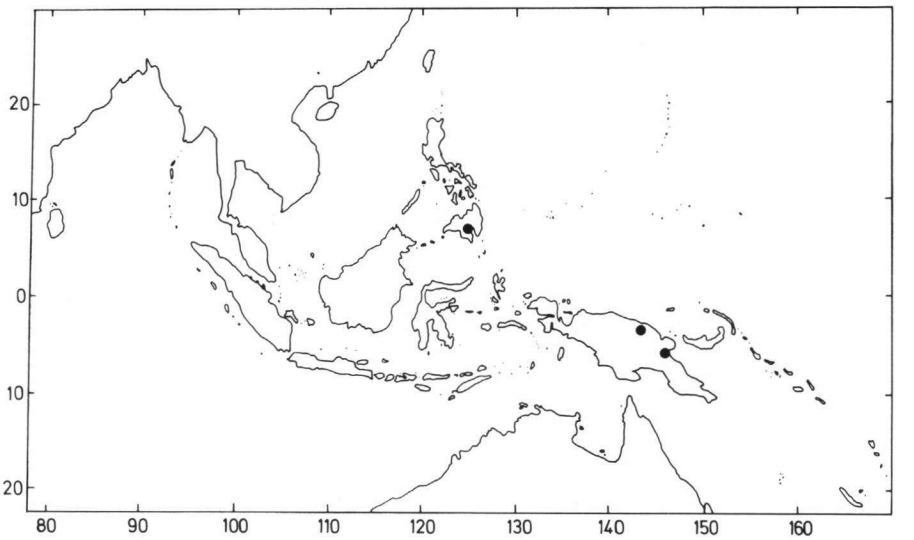
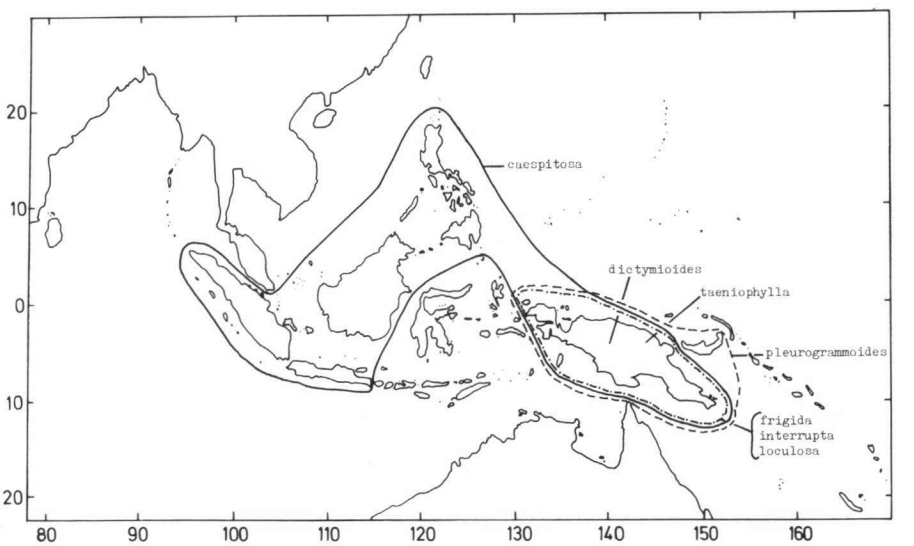


Fig. 5. *G. sumatrana* group. – *G. torricelliana* (6), lectotype, *Schlechter 14347* (B).



Map 9. *Grammitis torricelliana* (6).



Map. 10. *G. caespitosa* species group.

3. G. caespitosa group – Species 7–13
Figs. 6–8; maps 10–17; table 3

Rhizome erect to long-creeping; scales ovate-lanceolate to narrowly lanceolate, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* sometimes absent, glabrous or with whitish to dark red-brown simple eglandular hairs up to 0.4 mm, sometimes with similar catenate simple eglandular hairs and simple clavate-glandular hairs. *Lamina* entire or shallowly crenate, coriaceous, glabrous or with medium red-brown to blackish brown simple eglandular hairs up to 0.8 mm, catenate simple eglandular hairs and simple clavate-glandular hairs; lateral veins usually invisible in transmitted light, 1–3-forked, the upper branch of the first fork as long as or shorter than the lower branches, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina. *Sori* ± circular to oblong in outline, usually deeply sunken in steep-sided pits, sometimes on surface of lamina or slightly sunken in broad shallow depressions, in two rows.

Epiphytic or rupestral in lower montane to subalpine forest, subalpine shrubland, subalpine grassland and alpine heaths. Distribution from Sumatra to New Guinea with seven species in New Guinea, six of which are endemic, one throughout New Guinea, one throughout mainland New Guinea and Southeast I., two throughout mainland New Guinea, one in Irian Jaya Highlands and one in Sepik.

7. Grammitis frigida (Ridley) Copel. – Fig. 6; map 11.

G. frigida (Ridley) Copel., Univ. Calif. Publ. Bot. 18 (1942) 223. – *Polypodium frigidum* Ridley, Trans. Linn. Soc. London (Bot.) 2, 9 (1916) 259. – Lectotype: *Boden Kloss s.n.*, Mt Carstensz, Camps XIII–XIV, 10,500 to 12,500 ft (BM).

G. caricifolia Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 166. – Type: *Clemens s.n.*, Mt Sarawaket, Morobe District, 11,000 to 13,000 ft (MICH, holo).

G. plurisetulosa Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 174. – Type: *Brass 10109 & Meijer Drees* ('*Myer-Drees*') (MICH, holo; BO, BRI, GH, L, UC).

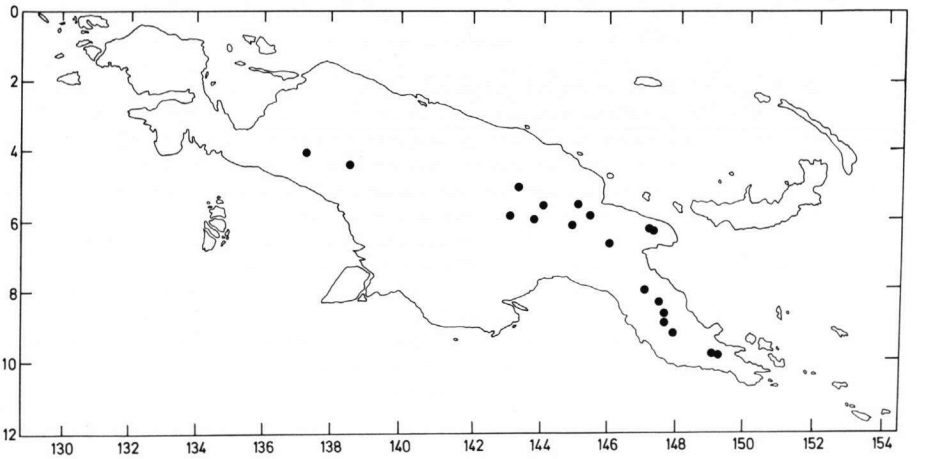
Polypodium caespitosum var. sensu C. Chr., Brittonia 2 (1937) 303, quoad *Brass 4257*.

Illustrations: Copel., Philip. J. Sc. 80 (1952) 166, f. 33 as G. caricifolia et 174, f. 42 as G. plurisetulosa.

Rhizome 3–6 mm diam. including scales, 1–2 mm diam. without scales, ± erect or short- to long-creeping, branched or not, producing stipes 1–5 mm apart, sometimes forming clumps; scales (1.7–)2.7–5.5(–8.4) × (0.2–)0.6–1.6(–2.4) mm, lanceolate to ovate-lanceolate, acute to obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.9–)2.1–5.9(–10.5) cm × (0.2–)0.3–0.6(–0.9) mm, with sparse to moderately frequent, ascending to ± patent medium red-brown simple eglandular hairs 0.1–0.3(–0.4) mm and similar catenate hairs scattered to absent, occasionally more frequent on the adaxial side of the stipe. *Lamina* (1.5–)3.9–10.3(–20.7) × (0.2–)0.3–0.5(–0.7) cm, linear-lanceolate to linear-oblanceolate, subacute to acuminate at apex and abruptly (often unequally) cuneate to attenuate at base, entire, coriaceous,

Table 3. Characters of taxonomic importance within the *G. caespitosa* species group in New Guinea.

Characters	*G. frigida*	*G. caespitosa*	*G. loculosa*	*G. taeniophylla*	*G. dictymioides*	*G. pleuro-grammoides*	*G. interrupta*
Stipe hairs (simple eglandular)	sparse to mod. frequent	sparse to mod. frequent	sparse to mod. frequent	sparse to mod. frequent	absent	absent	absent
Lamina hairs (simple eglandular)	us. absent, rarely occ. on midvein below	absent or occ. on margin or midvein below	occ. on margin	occ. on margin	scattered on inside edge of sorus pits	occ. on margin, absent or occ. on midvein below, absent or occ. on lamina below	absent
Sori	on surface of lamina or sl. sunken in depressions, regularly spaced	sunken in pits, regularly spaced	sunken in pits, regularly spaced	sunken in pits, irregularly spaced	sunken in pits, regularly spaced	sunken in pits, regularly spaced	sunken in pits, regularly spaced
Spores in μm	(25–)31–47 (–62)	(36–)39–55 (–70)	(33–)39–52 (–61)	(33–)38–45 (–50)	(42–)44–59 (–71)	(33–)37–47 (–52)	(32–)37–53 (–60)



Map 11. *Grammitis frigida* (7).

often glabrous, occasionally with sparse ± patent catenate simple eglandular hairs 0.1–0.3 mm on margin and midvein on both surfaces of lamina and sometimes also on lamina surface of young fronds, and occasional to scattered ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds, rarely with occasional ascending blackish simple eglandular hairs on the midvein below, sometimes the lamina margin inrolled and partly covering the sori; midvein rather prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, sometimes slightly prominent on the upper surface when dried, 1(–2)-forked, the upper branch sometimes extending beyond the sorus, nearly as long as the lower branch which is occasionally 1-forked, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* (1.0–) 1.6–3.4(–5.0) × (0.8–)1.2–2.2(–3.0) mm, ± circular to elliptic in outline, each oblique to the midvein, on the surface of the lamina or slightly sunken in broad shallow depressions, very rarely rather deeply sunken but the depressions not steep-sided, contiguous to confluent when mature, in two rows, one on each side of the midvein in the middle or upper 1/3–3/4 of the lamina but not immediately below the apex, each row with (1–)7–18(–29) sori, covering all of lamina undersurface between margin and midvein or slightly nearer the midvein than the margin. *Sporangia* (230–)250–312(–360) μm, with (1–)2–6(–8) medium red-brown rigid hairs (110–)161–242(–300) μm, sometimes glabrous; indurated cells of annulus (8–)9–13(–15). *Spores* (25–)31–47(–62) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Punjak Sukarno, Boden Kloss s.n. (BM). Ertsberg, Peg. Sukarno, ANU 10902 (BO, CANB). Punjak Trikora, Brass 9410 (BM, BO, GH, L, MICH), 9631 & Meijer Drees (GH, MICH), 9858, 9899 (both BM, BO, BRI, GH, L, MICH), 10037 (BM, BO, BRI, GH,

L, LAE, MICH, NSW), 10108 (BM, BRI, GH, L, MICH, UC), 10109 (BO, BRI, GH, L, MICH, UC), 10308 (BM, BO, BRI, GH, L, MICH), Versteeg 2533 (L).

W. SEPIK. Mt Capella, Star Mts, LAE 67394 (LAE), LAE 68063 (LAE), LAE 68105 (K, LAE). Mt Scorpion, Star Mts, LAE 65931 (LAE).

E. SEPIK. Mt Burgers, LAE 59749 (LAE).

W. HIGHLANDS. Mt Hagen, Parris & Croxall 4663 H 116 (BSP, LAE). Mt Kinkain, Kubor Ra., Vink 16095 (CANB, L, LAE).

ENGA. Mt Ambua, Kalkman 5087 (L).

S. HIGHLANDS. Mt Giluwe, Croft 709 & Marsh (LAE), Parris & Croxall 6330, 6388 (both BSP), Schodde 2075 (CANB).

CHIMBU. Mt Wilhelm, ANU 5170, 5239, 5240 (all CANB), 7288 (CANB, L, LAE), 7410 (LAE), van Balgooy 98 (CANB, L, LAE), 454 (L), Brass 30102 (LAE, US), 30147 (K, LAE, US), Nakaike 247, 327, 336, 348 (all LAE), NGF 47380a (K), Parris & Croxall 4665 H 231 (BSP, LAE), 4666 H 255 (BSP, LAE).

E. HIGHLANDS. Mt Otto, Brass 31036 & Collins (A, CANB, K, L, LAE, US). Mt Piora, Croft 107 (BSP, CROFT, LAE).

MOROBE. Clemens 6236 bis (L). Bolan Mts, Keysser B 33 (BM, S, UC), B 34 (S, UC). Gimdoh, Sarawaket Ra., Hoogland 9960 (CANB, L, LAE). Mt Sarawaket, 3660–4270 m, Clemens s.n. (MICH), 3350–3660 m, Clemens s.n. (MICH), 6231 (BM). Rawlinson Ra., c. 3660 m, Clemens s.n. (MICH, UC), 12379, 12380, 12446, 41393 (all MICH). Tempanpan, Sarawaket Ra., Hoogland 9842 (CANB, L, LAE).

CENTRAL. Mt Albert Edward, Brass 4257 (BM, GH, NY), Craven 2753 (LAE), LAE 61324 (K, L, LAE). Mt Kenevi, LAE 65089 (L, LAE). Mt Scratchley, Giulianetti s.n. (K). Mt Strong, NGF 46175 (CANB, K, L, LAE). Mt Victoria, LAE 61766 (K, L, LAE, NSW), MacGregor 33 (BM, K).

MILNE BAY. Goe, LAE 54427 (K, L, LAE, NSW).

Ecology. More or less erect to pendulous epiphyte usually on trees in upper montane forest (including coniferous forest) and subalpine forest, sometimes on shrubs (including *Vaccinium*) in subalpine shrubland and on tree-ferns (*Cyathea* spp.) in subalpine grassland, also rupestral in subalpine and alpine shrubland and grassland; from 2670 to 4380 m.

Notes. Vernacular name: pot'pot (Mendi language, Mt Giluwe).

G. frigida is closely related to *G. caespitosa* and may be a high altitude derivative of it. *G. frigida* never has its sori sunken in steepsided pits in the lamina as does *G. caespitosa*.

8. Grammitis caespitosa Blume – Fig. 6; maps 12, 13.

G. caespitosa Blume, Enum. Pl. Javae (1828) 115; Copel., Philip. J. Sc. 80 (1952) 219. – *Polypodium caespitosum* Mett., Ann. Mus. Bot. Lugd.-Bat. 2 (1866) 219. – Neotype: *Matthew s.n.*, G. Gede, Java (K).

Polypodium billardieri sensu Brause, Bot. Jahrb. 56 (1920) 178, quoad *Ledermann 11876*.

Illustrations: Blume, Flora Javae 2 (31 August 1829) pl. 47, f. 1.

Rhizome 2–4 mm diam. including scales, 1–2 mm diam. without scales, ± erect to short-creeping, unbranched, producing stipes up to 2 mm apart; scales (2.0–)2.3–3.3(–3.5) × (0.3–)0.4–0.7(–0.8) mm, lanceolate, acute at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls.

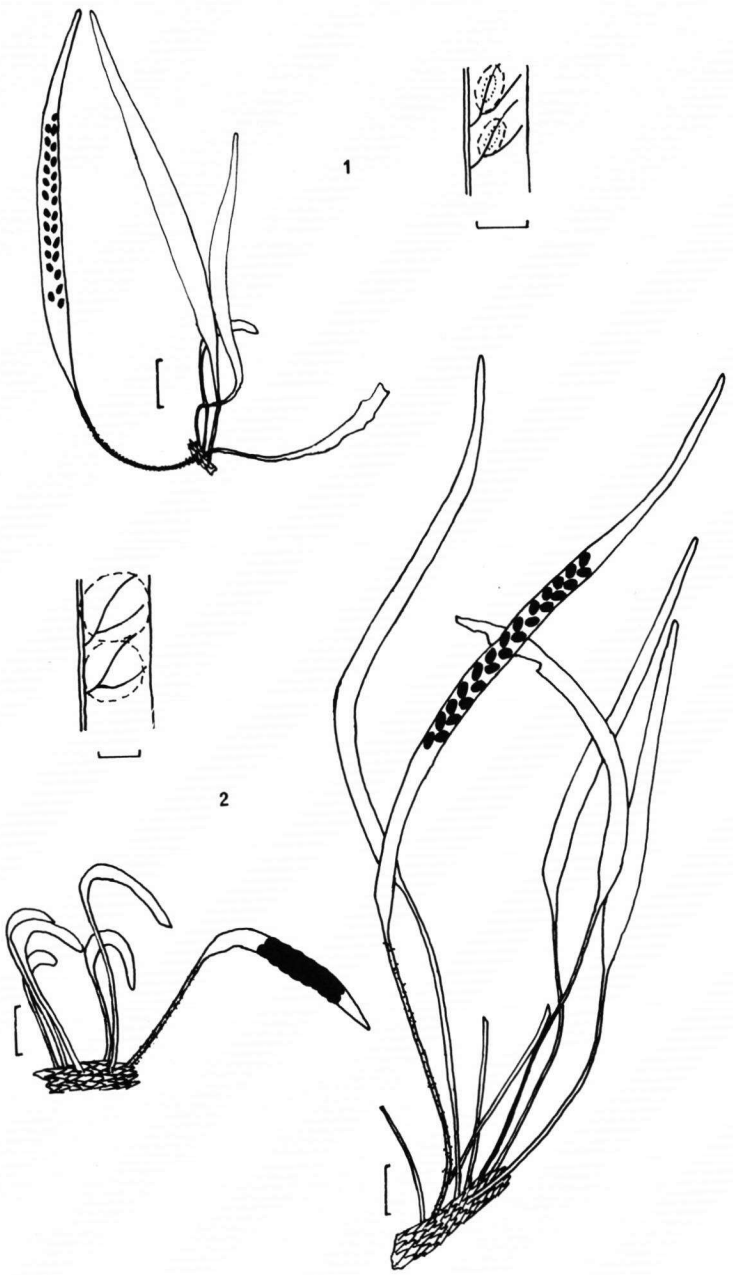
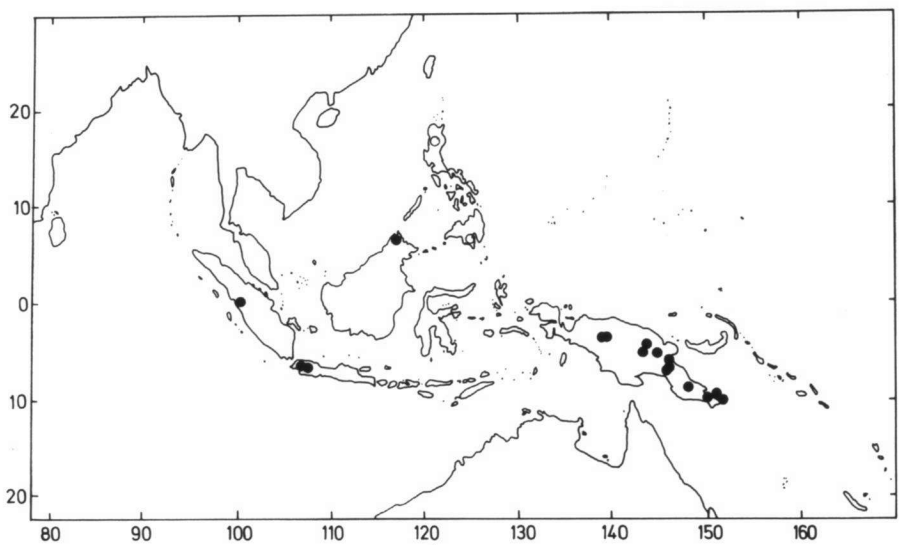
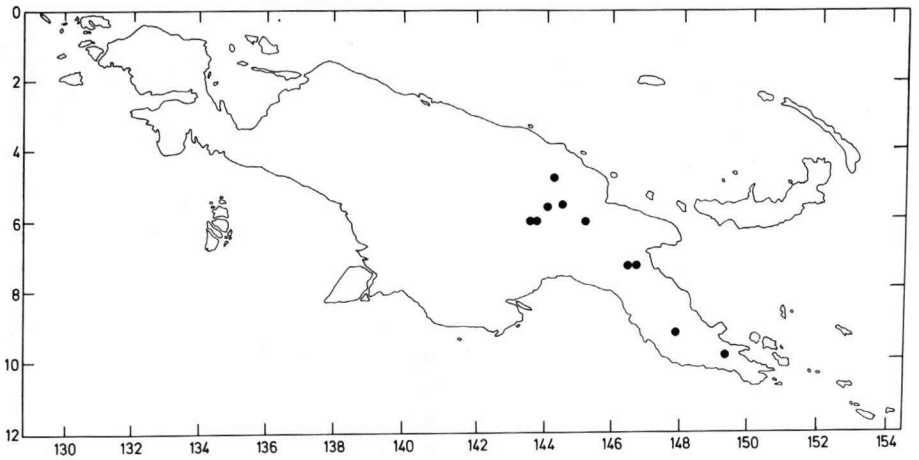


Fig. 6. *G. caespitosa* group. – 1. *G. caespitosa* (8), *Brass 22873* (LAE); 2. *G. frigida* (7); left, *Brass 30102* (LAE); right, *Brass 30147* (LAE).

Stipe (0.5–)0.9–1.9(–2.5) cm × 0.2–0.4 mm, with sparse to moderately dense ± patent pale to dark red-brown simple eglandular hairs 0.1–0.2 mm, and scattered pale brown simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* (3.2–)3.4–7.8(–15.2) × 0.2–0.4(–0.6) cm, linear-lanceolate to linear-oblanceolate, acute to acuminate at apex, cuneate (sometimes unequally so) to long-attenuate at base, entire, coriaceous, usually glabrous, sometimes with occasional to sparse ascending to ± patent medium to dark red-brown simple eglandular hairs 0.1–0.4 mm on margin and on the midvein below, rarely also occasional on the lamina above; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, sometimes slightly raised on the upper surface of the lamina when dried, 1-forked, the upper branch sometimes just extending beyond the sorus, sometimes ± as long as the lower branch, each branch ending occasionally marked by a small hydathode on the upper surface of the lamina, free. *Sori* (1.0–)1.4–2.2(–2.6) × (0.6–)0.7–1.5(–2.0) mm, ± circular to elliptic in outline, each parallel to or oblique to the midvein, deeply sunken in ± steep sided pits, which may have a slightly prominent rim, appearing slightly prominent on the upper surface of the lamina when dried, discrete to confluent when mature, in two rows, one on each side of the midvein in the upper or middle 1/3–2/3 of the lamina but not immediately below the apex, each row with (2–)8–22(–27) sori, ± midway between the margin and the midvein, sometimes covering all of lamina undersurface. *Sporangia* (260–)310–378(–420) μm, with (1–)2–4(–6) medium to dark red-brown rigid hairs (100–)117–213(–280) μm; indurated cells of annulus (9–)10–12(–14). *Spores* (36–)39–55(–70) μm diam.



Map 12. *Grammitis caespitosa* (8).



Map 13. *Grammitis caespitosa* (8).

Distribution. Sumatra, Borneo, Java, Philippines (the last fide Copeland, 1960) and New Guinea.

W. HIGHLANDS. Baiyer-Jimi divide, Parris & Croxall 9295 (BSP, LAE). Mt Hagen, Parris & Croxall 8080 (BSP, LAE). Tomba Pass, Parris & Croxall 8019, 8055 (both BSP).

S. HIGHLANDS. Near Mendi, Parris & Croxall 6366, 6367 (both BSP). Mt Giluwe, Parris & Croxall 8199 (BSP).

E. HIGHLANDS. Fatima R., Marafunga, Grubb & Edwards 176 (CGE, LAE), LAE 51109 (K, LAE).

MADANG. Mt Schrader, Ledermann 11876 (B).

MOROBE. Near Aseki, Parris & Croxall 7881, 7930 (both BSP, LAE). Ekuti Ra., Parris & Croxall 7980 (BSP, LAE). Mt Kaindi, Brass 29798 (US), Parris & Croxall 4680 L 161 (BSP, LAE).

CENTRAL. L. Myola, LAE 60503 (LAE).

MILNE BAY. Mt Dayman, Brass 22852 (LAE), 22873 (A, BM, CANB, L, LAE). Mt Suckling, Veldkamp & Stevens 5588 (L).

Ecology. Rarely growing with *G. subfasciata.* Usually epiphytic, often on upper branches of trees up to 10 m above ground, sometimes in moss cushions, sometimes on lianas and tree trunks, occasionally on low branches of young trees (including *Caldcluvia, Dimorphanthera* and *Saurauia*), occasionally rupestral on boulders in streams, in midmontane forest, usually of *Nothofagus*, sometimes of *Trema/Dimorphanthera*, occasionally in regrowth at forest margins and in secondary forest; from 1650 to 2600 m.

Notes. *G. caespitosa* differs from *G. loculosa* in its smaller frond size and in the sori being more towards the centre of the frond rather than immediately below the apex. The former occurs at generally higher altitudes in midmontane forest, the latter in lower montane (and possibly lowland) forest. On Mt Dayman both species have been collected, *G. loculosa* at 1550 m and *G. caespitosa* at 2230 m and 2250 m.

Three collections from Mt Wilhelm, Chimbu District (2770 m, 30.7.1959, *Brass 30805*, US; 2590–2740 m, 25.2.1965, *Jermy 5304, 5305*, both BM) have the sunken sori of *G. caespitosa* and the catenate lamina hairs of *G. frigida* and were collected at altitudes intermediate between the range of these two species. The Brass collection came from exposed high branches of a tree in forest, a characteristic habitat of *G. caespitosa*. The three collections differ from the majority of specimens of both *G. frigida* and *G. caespitosa*, however, in the very long-attenuate lamina base and may represent a distinct taxon.

There is no Blume material of this species at Leiden (W. Vink in litt.) and a collection at Kew labelled as a type of this species and said to be collected by Blume is in fact *G. graminea* (Swartz) Ching from Jamaica. The excellent plate of *G. caespitosa* in Blume's Flora Javae is not cited in the original description of the species. C.G. Matthew's specimen at Kew from G. Gede (probably the type locality) is here chosen as a neotype in preference to the Flora Javae plate.

9. Grammitis loculosa (v.A.v.R.) Copel. – **Fig. 7; map 14.**

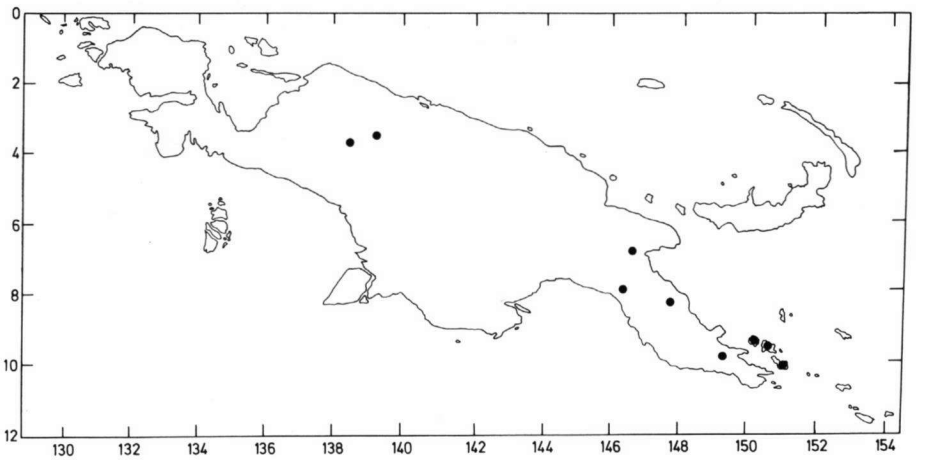
G. loculosa (v.A.v.R.) Copel., Univ. Calif. Publ. Bot. 18 (1942) 223: Philip. J. Sc. 80 (1952) 175. – *Polypodium loculosum* v.A.v.R., Nova Guinea 14 (1924) 42. – Lectotype: *Lam 1267* (L; lecto fragm. at BM).

Illustrations: Copel., Philip. J. Sc. 80 (1952) 175, f. 43.

Rhizome 3–4 mm diam. including scales, c. 1 mm diam. without scales, usually erect to ascending, occasionally short-creeping, unbranched, producing stipes up to 2 mm apart; scales (0.8–)1.3–3.1(–4.0) × (0.3–)0.4–0.6(–0.8) mm, ovate-lanceolate to narrowly lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipes* (0.1–)0.2–1.4(–2.5) cm × (0.2–)0.3–0.6(–0.7) mm, with sparse to moderately frequent ± patent dark red-brown simple eglandular hairs 0.1–0.2(–0.3) mm, sometimes more frequent on the adaxial side of the stipe. *Lamina* (3.3–)4.1–10.3(–14.7) × (0.2–)0.3–0.5(–0.6) cm, linear-oblanceolate to linear-elliptic, subacute to acuminate at apex, cuneate to long-attenuate at base, entire, coriaceous, with ascending dark red-brown to blackish simple eglandular hairs 0.1–0.2(–0.4) mm sparse to moderately frequent on lamina, midvein and margin of very young fronds but quickly lost and only a few retained on the margin of mature fronds, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, occasionally slightly prominent on the upper surface when dried, 1–2-forked, the upper branch extending beyond the sorus and as long as the lower branch, which is sometimes 1-forked, each branch ending often marked by a small hydathode on the upper surface of the lamina, free. *Sori* (1.0–)1.2–2.4(–3.0) × (0.5–)0.8–1.7(–2.0) mm, ± circular to elliptic in outline, each ± parallel or slightly oblique to the midvein, deeply sunken in steepsided pits which have a slightly prominent rim, appearing slightly prominent on the upper surface of the lamina,

usually contiguous to confluent, sometimes discrete when mature, in two rows, one on each side of the midvein in the upper 1/3–2/3 of the lamina, each row with (2–)4–23(–50) sori, nearer the midvein than the margin. *Sporangia* (210–)278–353(–430) μm, sometimes with 1–4 dark red-brown rigid hairs (130–)157–229(–260) μm; indurated cells of annulus (8–)10–12(–14). *Spores* (33–)39–52(–61) μm diam.

Distribution. New Guinea.



Map 14. *Grammitis loculosa* (9).

CENTRAL IRIAN JAYA. Near Su. Angolah, Lam 1267 (BM, L). Su. Taritatu, Brass 12734 (GH, MICH).

PAPUA. Unlocalised, Copland King 278 (NSW).

MOROBE. Gurakor, Brass 29490 (A, CANB, K, L, LAE, NY, US).

GULF. Lakekamu, Copland King 360 (NSW).

NORTHERN. Aikora, Copland King 58 (BM, BRI, NSW).

MILNE BAY. Agamoia to Ailuluai, Fergusson I., Brass 26094 (CANB, GH, K, L, LAE). Goodenough I., Brass 24584 (A, BM, LAE). Mt Dayman, Brass 23159 (A, BM, L, LAE). Normanby I., Brass 25807 (A, L), 25817 (GH, L, LAE).

Ecology. Usually epiphytic on high branches of trees, sometimes on the upper part of palm trunks, occasionally rupestral on boulders in streambeds, in lower montane forest (including oak forest); from 200 to 1700 m.

Notes. *G. loculosa* is closely related to *G. caespitosa*, but usually occurs at lower altitudes. *G. loculosa* usually has sori immediately below the lamina apex while in *G. caespitosa* they are well below the apex.

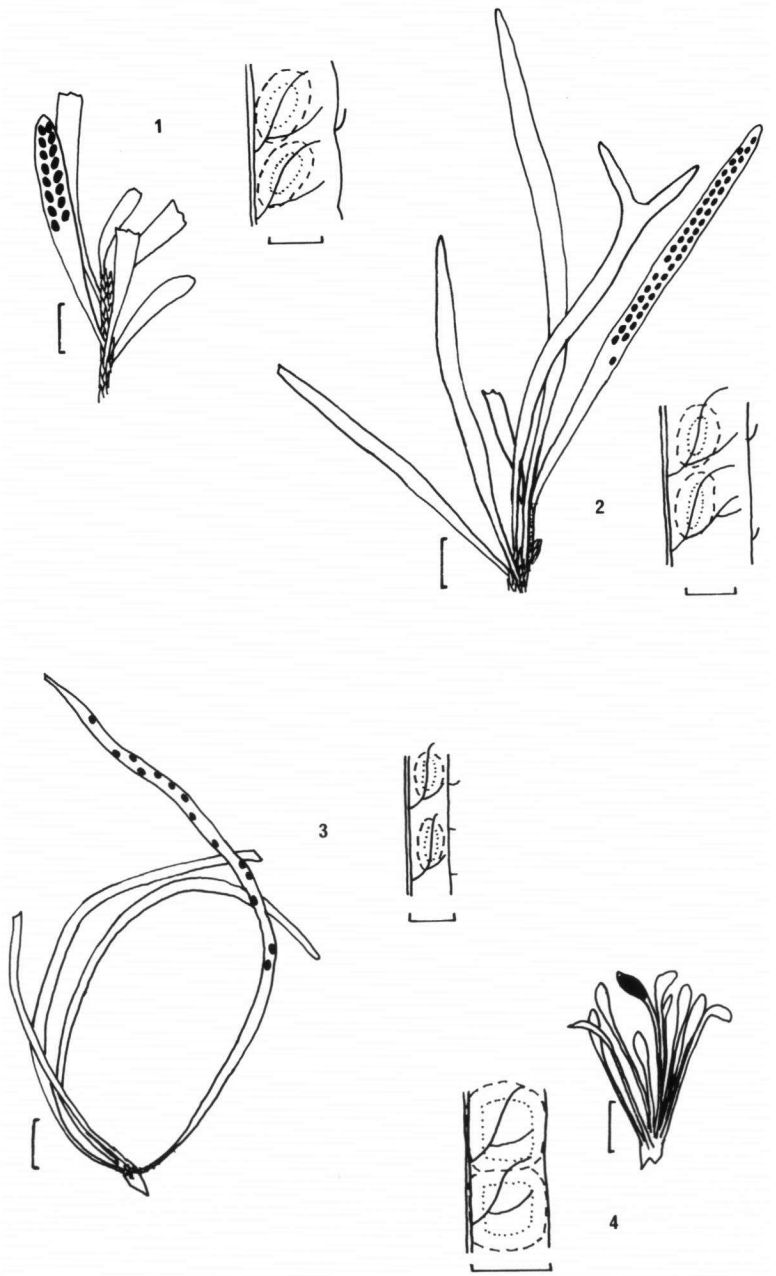


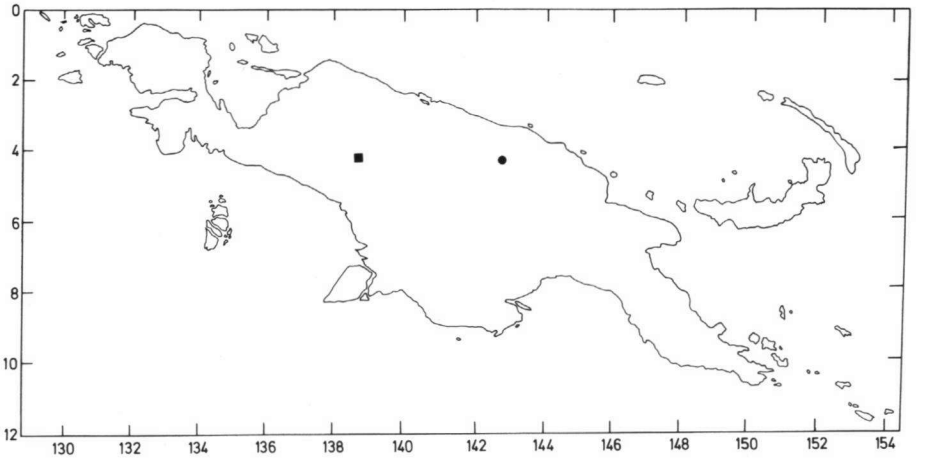
Fig. 7. *G. caespitosa* group. – 1. *G. pleurogrammoides* (12), lectotype, *Werner 22* (UC); 2. *G. loculosa* (9), *Brass 23159* (LAE); 3. *G. taeniophylla* (10), holotype, *Hoogland & Craven 11034* (LAE); 4. *G. interrupta* (13), *Brass 11863* (LAE).

10. Grammitis taeniophylla Parris, *sp. nov.* – Fig. 7; map 15.

G. loculosae similis sed soris irregulariter dispositis et lamina angustiori differt. — *Rhizoma* squamis inclusis 2–3 mm diam., squamis exclusis c. 0.5 mm diam., plus minusve erectum vel breviter repens, eramosum, stipites per spatia minus quam 1 mm emittens; squamae c. 1.5 mm longae, c. 0.5 mm latae, lanceolatae, ad apicem acutae, mediae rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 0.2–1.7 cm longus, 0.2–0.3 mm latus, pilis simplicibus eglandulosis c. 0.1 mm longis sparsis vel moderate numerosis plus minusve patentibus albidis vel pallidis rubriusculo-brunneis vestitus. *Lamina* (2.7–)4.3–14.1(–17.2) cm longa, 0.2–0.3(–0.5) cm lata, linearis vel lineari-oblanceolata, ad apicem subacuta, ad basem attenuata, integra vel leviter crenata, lobis ad 0.3 mm longis, tenuiter coriacea, pilis simplicibus eglandulosis 0.1–0.3 mm longis plus minusve patentibus obscure rubriusculo-brunneis ad marginem paucis vestita; medio-vena ad paginam infernam laminae non vel paulo prominens et pagina infera laminae concolor; venae laterales in luce transmissa interdum manifestae, 1-furcatae, ramus superus ultra sorum procurrens et fere longitudine ramum inferum aequans, rami terminales interdum in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 2.0–4.0 mm longi, 1.0–1.5 mm lati, in ambitu oblongi, ad medio-venam paralleli vel parum obliqui, in lacunis sine margine prominenti profunde impressi, discreti ubi maturi, secus laminam irregulariter dispositi et a venis lateralibus numerosis in parte fertili laminae carentes, in 2 serialibus, 1 utroque medio-venae in ½ vel ¾ superno laminae, in quoque seriali 6–20 sori plus minusve inter medio-venam et marginem aequidistantes. *Sporangia* (260–)267–307(–330) µm longa, plerumque glabra, aliquando pilis 2–4 pallidis rubriusculo-brunneis rigidus 130–190 µm longis praedita; cellulae induratae annuli 10–12(–13). *Sporae* (33–)38–45(–50) µm diam. — Typus: *R.D. Hoogland & L.A. Craven 11034*, 16.viii.1966, eastern ridge of Mt Hunstein (Sumset), Ambunti Subdistrict, East Sepik District, Papua New Guinea (LAE).

Rhizome 2–3 mm diam. including scales, c. 0.5 mm diam. without scales, ± erect to short-creeping, unbranched, producing stipes less than 1 mm apart; scales c. 1.5 × 0.5 mm, lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.2–1.7 cm × 0.2–0.3 mm, with sparse to moderately frequent ± patent whitish to pale red-brown simple eglandular hairs c. 0.1 mm. *Lamina* (2.7–)4.3–14.1(–17.2) × 0.2–0.3(–0.5) cm, linear to linear-oblanceolate, subacute at apex, attenuate at base, entire or shallowly crenate, the teeth to 0.3 mm long, thinly coriaceous, with occasional ± patent dark red-brown simple eglandular hairs 0.1–0.3 mm on margin; midvein not or slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins sometimes visible in transmitted light, 1-forked, the upper branch extending beyond the sorus and nearly as long as the lower branch, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* 2.0–4.0 × 1.0–1.5 mm, oblong in outline, each parallel or slightly oblique to the midvein, deeply sunken in steep-sided pits which lack a prominent rim, discrete when mature, rather irregularly spaced along the lamina and absent from numerous lateral veins in the fertile part of the lamina, in two rows, one on each side of the midvein in the upper ½–¾ of the lamina, each row with 6–20 sori, ± midway between the midvein and the margin. *Sporangia* (260–)267–307(–330) µm, usually glabrous, sometimes with 2–4 pale red-brown rigid hairs 130–190 µm; indurated cells of annulus 10–12(–13). *Spores* (33–)38–45(–50) µm diam.

Distribution. New Guinea.



Map 15. ● *G. taeniophylla* (10), ■ *G. dictymioides* (11).

E. SEPIK. Mt Hunstein, Hoogland & Craven 10996 (CANB), 11034 (LAE).

Ecology. Epiphyte on branches of trees in lower montane forest; from c. 1160 to c. 1530 m.

Note. *G. taeniophylla* is related to *G. loculosa*, but differs in having the sori irregularly spaced along the lamina and missing from numerous lateral veins. In *G. loculosa* the sori are regularly spaced throughout the fertile part of the lamina.

11. Grammitis dictymioides Copel. – Fig. 8; map 15.

G. dictymioides Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 175. – Type: *Brass 11848* (MICH, holo; BO, GH, L).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 176, f. 44.

Rhizome c. 7 mm diam. including scales, c. 2 mm diam. without scales, ± erect, unbranched; scales 4.1–7.5(–8.0) × 1.0–1.8(–2.0) mm, broadly lanceolate, acute to obtuse at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.1–0.2 cm × 0.5–1.1 mm, glabrous. *Lamina* (10.7–) 14.2–33.8(–35.5) × (0.4–)0.5–0.9(–1.0) cm, linear to linear-oblanceolate, acute at apex and long-attenuate at base, entire, coriaceous, with ± appressed medium red-brown simple eglandular hairs 0.3–0.7 mm scattered on inside edge of sorus pits and only visible on young fronds before the growing sporangia cover them, and very occasional on midvein between the sori; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 2–3-forked, the upper branch of the first fork extending beyond the sorus and as long as the lower branch, the lower branch 1–2-forked, the branch endings without

obvious hydathodes on the upper surface of the lamina, the branches frequently uniting near the margin, a few free. *Sori* 1.5–3.9(–4.3) × 0.8–1.6(–1.7) mm, elliptical to oblong in outline, deeply sunken in steepsided pits which lack a slightly prominent rim, each parallel to or slightly oblique to the midvein, usually discrete but sometimes confluent when mature, in two rows, one on each side of the midvein in the upper 1/3 of the lamina but not immediately below the apex, each row with (18–) 25–44(–47) sori, nearer the midvein than the margin. *Sporangia* (290–)321–398 (–440) μm, with 2 dark red-brown rigid hairs (160–)204–390 μm; indurated cells of annulus (11–)12–14(–15). *Spores* (42–)44–59(–71) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Danau Habbema, Brass 9059 (BO, L, MICH), 9375 (MICH, UC), 11848 (BO, GH, L, MICH).

Ecology. Epiphyte on upper parts of trees in upper montane and subalpine forest; at 3225 m.

Notes. The fronds are said to be bluish when fresh. *G. dictymioides* is a distinct species in its group with no obvious affinities.

12. Grammitis pleurogrammoides (Rosenst.) Copel. – Fig. 7; map 16.

G. pleurogrammoides (Rosenst.) Copel., Occ. Papers Bishop Mus. 15 (1939) 86; Philip. J. Sc. 80 (1952) 172. – *Polypodium pleurogrammoides* Rosenst., Feddes Repert. 5 (1908) 42. – Lectotype: *Werner 22* (UC; iso S).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 173, f. 40.

Rhizome 1.5–8.0 mm diam. including scales, 0.5–1.0 mm without scales, erect to ascending, up to 5.5 cm long, usually unbranched, rarely branched, sometimes forming clumps; scales (1.3–)2.1–5.3(–7.5) × (0.3–)0.4–0.8(–1.0) mm, lanceolate to narrowly lanceolate, ± acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* absent or 0.1–0.4 cm × 0.2–0.4 mm, glabrous. *Lamina* (1.8–)3.3–6.7(–9.5+) × (0.2–)0.3–0.5(–0.6) cm, linear-oblanceolate, obtuse to subacute at apex and usually long-attenuate, occasionally cuneate, at base, entire or very shallowly crenate, the teeth up to 0.2 mm long, coriaceous, with ± ascending dark red-brown to blackish-brown simple eglandular hairs 0.1–0.3(–0.4) mm usually solitary in the depressions at the base of each marginal tooth, sometimes slightly more frequent on the margin, occasional and sometimes absent on the midvein below and absent or very occasional on the undersurface of the lamina, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm and occasional ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds; midvein ± prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch extending beyond the sorus and ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* (0.7–)1.3–3.5(–5.0) × (0.5–)0.8–1.8(–2.5) mm, ± circular to oblong in out-

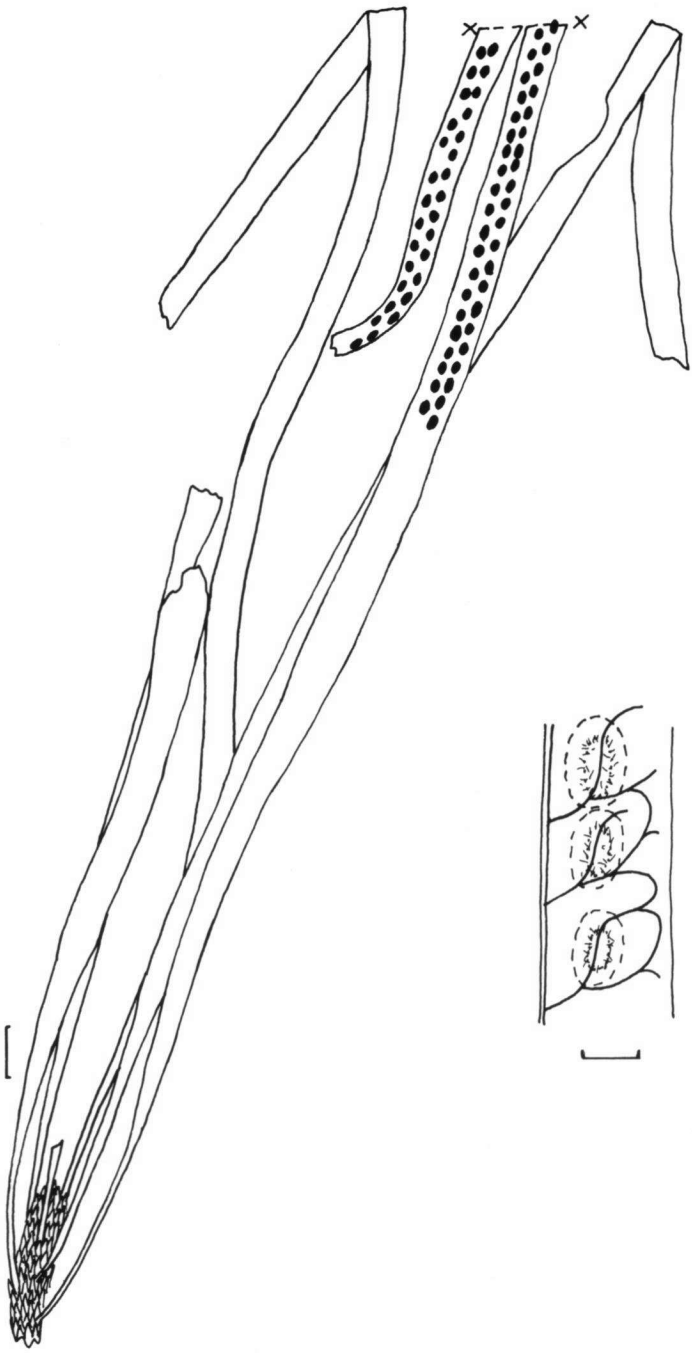
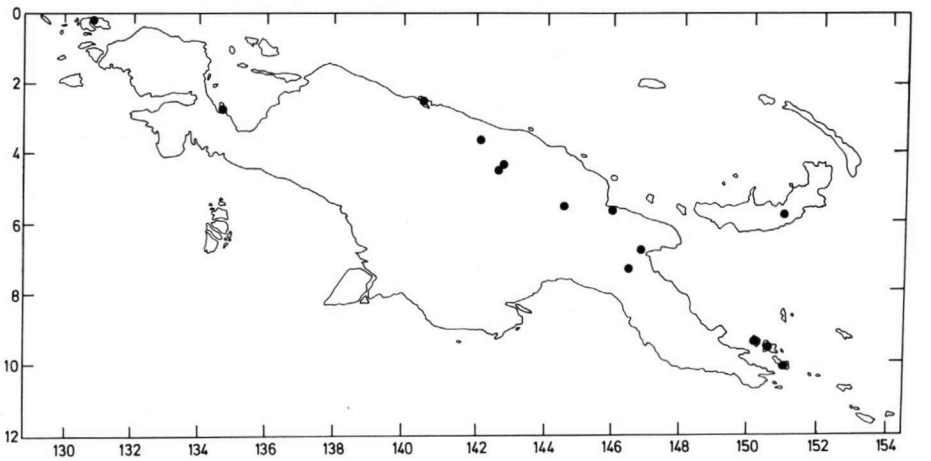


Fig. 8. *G. caespitosa* group. – *G. dictymioides* (11), holotype, *Brass 11848* (MICH).

line, each ± parallel or sometimes oblique to the midvein, deeply sunken in steep-sided pits which lack a slightly prominent rim, discrete to confluent when mature, in two rows, one on each side of the midvein in the upper ¼–¾ of lamina, each row with (3–)6–15(–24) sori, midway between the midvein and the margin or slightly nearer the midvein. *Sporangia* (220–)269–323(–360) μm, usually with 1–5(–6) medium to dark red-brown rigid hairs (110–)160–288(–400) μm, sometimes glabrous; indurated cells of annulus (8–)10–12(–15). *Spores* (33–)37–47(–52) μm diam.

Distribution. New Guinea.



Map 16. *Grammitis pleurogrammoides* (12).

WAIGEO I. G. Nok, van Royen 5175 (L).

VOGELKOP PENINSULA. Wandiwoi Mts, Mayr 309 (BO).

CYCLOPS MTS. Ifaar to Ormu, van Royen & Sleumer 5882, 5971 (both L).

W. SEPIK. Mt Somero, Darbyshire 318 (CANB, LAE).

E. SEPIK. Felsspitze, Ledermann 12444a (B). Mt Hunstein, Ledermann 11214 (B). Kameelsrucken, Ledermann 8855 (B). Lordberg, Ledermann 10119 (B).

W. HIGHLANDS. Baiyer-Jimi divide, Parris & Croxall 9296 (BSP, LAE).

MADANG. Bismarck Mts, Schlechter 18849 (B). Mt Gelu, Werner 22 (S, UC).

MOROBE. Near Aseki, Parris & Croxall 7933 (BSP). Ekuti Ra., Parris & Croxall 6270 (BSP). Matap, Clemens 40991 (MICH, US), 40992 (MICH), 41016 (MICH, UC). Oomsis Ridge, Herzog Ra., Parris & Croxall 5980 (BSP, LAE).

MILNE BAY. Agamoia to Ailuluai, Fergusson I., Brass 26094 (L). Goodenough I., Brass 24584 (BM). Mt Kilkerran, Ferguson I., LAE 71019 (LAE). Mt Solomonai, Normanby I., Croft 506 (CROFT, LAE).

E. NEW BRITAIN. Mt Sule, NGF 13186 (LAE).

Ecology. Rarely growing with *G. collina*. Epiphytic, usually on high branches and in the crowns of trees (including *Castanopsis acuminatissima*), occasionally in

moss cushions at the base of shrubs (including *Rhododendron*), usually in lower montane forest (including *Lithocarpus/Castanopsis* forest), sometimes in midmontane forest (including *Trema/Dimorphanthera* and *Nothofagus* forest), occasionally in secondary forest; from 800 to 2250 m.

Note. Vernacular name: tobungo (Wapi language, Miwaute).

13. Grammitis interrupta (Baker) Copel. – Fig. 7; map 17.

G. interrupta (Baker) Copel., Gen. Fil. (1947) 214; Philip. J. Sc. 80 (1952) 173. – *Monogramme interrupta* Baker, Ann. Bot. 5 (1891) 482. – *Pleurogramme interrupta* Christ, Farnkr. der Erde (1897) 55. – *Nematopteris interrupta* C. Chr., Dansk Bot. Arkiv 6 (1929) 31. – Type: *Macgregor s.n.*, Mt Yule, 7000 ft (K; iso BM).

Polypodium pyxidiforme v.A.v.R., Bull. Jard. Bot. Btzg II, 1 (1911) 28. – Lectotype: *de Kock 45* (BO; iso BM).

Illustrations: v.A.v.R., Nova Guinea 14 (1924) pl. 1c as Polypodium pyxidiforme; C. Chr., Dansk Bot. Arkiv 6 (1929) pl. 4, f. 8–12 as Nematopteris interrupta; Copel., Philip. J. Sc. 80 (1952) 173, f. 41 (but the marginal 'hairs' are of a fungal infection).

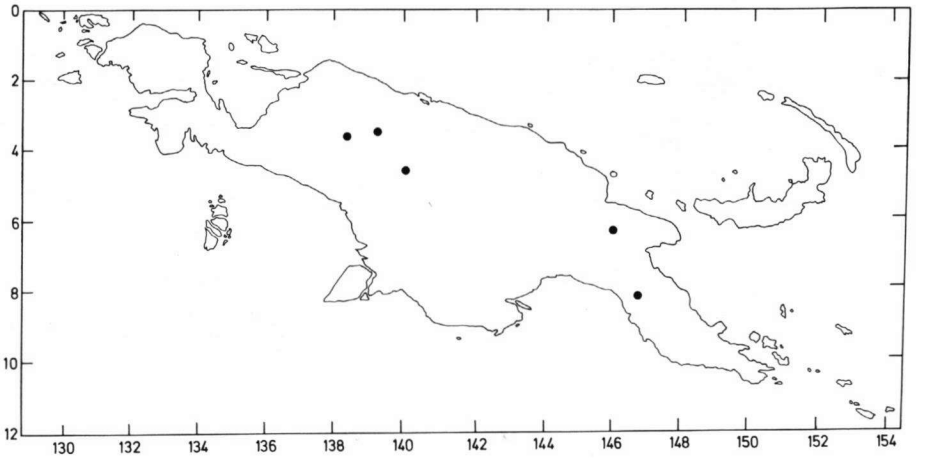
Rhizome 1.5–5.0 mm diam. including scales, 1–2 mm without scales, ± erect, up to 3 cm long, unbranched; scales 1.7–2.5(–3.0) × (0.3–)0.4–0.8(–0.9) mm, ovate-lanceolate to lanceolate, obtuse to acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (2.0–)3.2–7.0(–9.1) cm × (0.3–)0.4–0.8 mm, usually glabrous, occasionally with sparse ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling stipes. *Lamina* (2.0–)3.8–14.4(–29.0) × (1.0–)1.1–2.3(–3.0) mm, lanceolate to ovate, acute to obtuse at apex and attenuate at base, entire, coriaceous, usually glabrous, occasionally with sparse ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds (the hairs illustrated by Copeland (1952a) are of a fungal infection); midvein rather prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch scarcely extending beyond the sorus; ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* (0.8–)1.1–2.7(–3.0) × (0.4–)0.5–1.1 mm, elliptic to oblong in outline, each parallel to the midvein, deeply sunken in steep sided pits which lack a prominent rim, confluent when mature, in two rows, one on each side of the midvein throughout the lamina, each row with 2–7(–9) sori, covering all of lamina undersurface. *Sporangia* (290–)294–377 (–390) μm, usually glabrous, occasionally with 1–3(–4) dark red-brown rigid hairs (150–)173–256(–300) μm; indurated cells of annulus (8–)9–11(–12). *Spores* (32–)37–53(–60) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Danau-danau Wissel, Eyma 5142 (BO). Ngga Simanggela, Lam 1851 (BO, L, MICH), 1879 (BO), 1965 (BO, L). Su. Taritatu, Brass 11863 (BM, L, LAE, MICH), 12603 (L, MICH). Mt Goliath, de Kock 45 (BM, BO).

E. HIGHLANDS. Mt Elandora, Brass 32137 & Collins (US).

GULF. Mt Yule, Macgregor s.n. (BM, K).



Map 17. *Grammitis interrupta* (13).

Ecology. Epiphyte in montane forest or scrub; from 1800 to c. 2540 m.

Notes. The extremely reduced lamina, completely covered by the sori when mature and less than half as long as the stipe, distinguish *G. interrupta* from any other species of *Grammitis*. Its closest relative is *G. pleurogrammoides*.

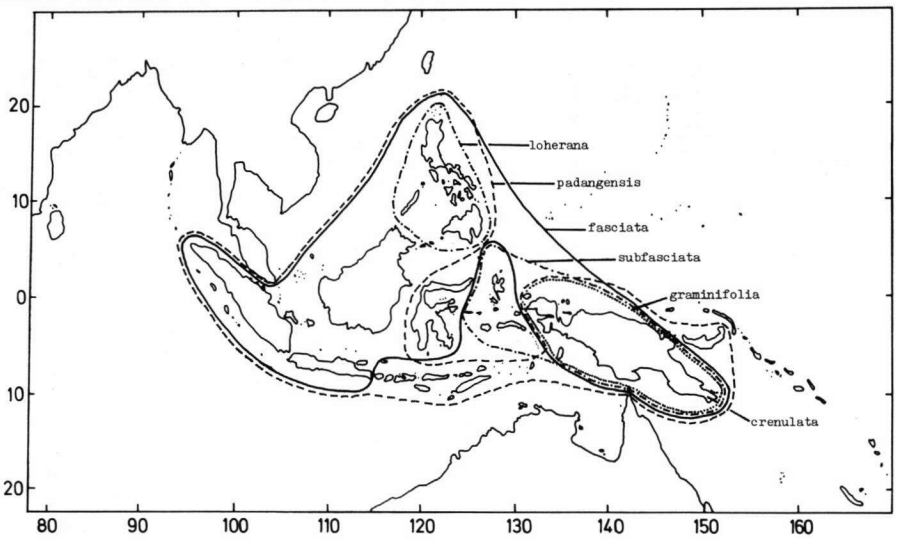
4. G. fasciata group – Species 14–18
Figs. 9–12; maps 18–25; table 4

Rhizome short to long-creeping; scales broadly ovate to narrowly lanceolate, pale to medium red-brown, greyish brown or dark brown, glabrous, sometimes iridescent and/or clathrate, the cells without cross-walls. *Stipe* sometimes absent, often glabrous or with occasional scales like those of the rhizome, or blackish brown simple eglandular hairs up to 1 mm or catenate simple eglandular hairs. *Lamina* entire or shallowly crenate, coriaceous, glabrous or with blackish to blackish brown simple eglandular hairs to 0.8 mm, catenate simple eglandular hairs and simple clavate-glandular hairs; lateral veins invisible in transmitted light, 1–4-forked, the first upper branch as long as or shorter than the lower branches, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina. *Sori* ± circular to elliptic in outline, on surface of lamina or slightly sunken in broad shallow depressions, in two rows.

Epiphytic, rupestral or terrestrial, in lowland rainforest, lower montane to subalpine forest, subalpine shrubland and subalpine grassland. Distribution from Sumatra to New Guinea with five species in New Guinea, two of which are endemic, one throughout mainland New Guinea, one in Southeast Pen.

Table 4. Characters of taxonomic importance within the *G. fasciata* species group in New Guinea.

Characters	*G. fasciata*	*G. graminifolia*	*G. crenulata*	*G. subfasciata*	*G. padangensis*
Rhizome scales	ovate to broadly ovate, obtuse, med. red-brown, sts clathrate and iridescent	ovate to lanceolate, us. obtuse, sts acute, pale to med. red-brown, sts clathrate and iridescent	ovate-lanceolate to lanceolate, acute, greyish brown, more or less clathrate, not iridescent	lanceolate to narrowly lanceolate, subacute to acute, pale to med. red-brown, sts clathrate, not iridescent	ovate to lanceolate, obtuse to acute, pale to med. red-brown, neither clathrate nor iridescent
Stipe hairs (simple eglandular)	absent	absent	absent	absent	absent or scattered
Lamina	entire	entire	crenate	entire	entire
Lamina width in mm	6–7(–11)	(2–)3–4(–5)	5–7(–8)	(3–)4–11(–17)	(4–)6–9(–14)
Lamina hairs (simple eglandular)	absent	occ. to sparse on margin	occ. on margin	absent or occ. on margin or midvein below	sparse to frequent on margin
Spores in μm	(27–)30–37(–42)	(26–)31–41(–47)	(37–)40–48(–53)	(28–)35–49(–54)	(21–)28–47(–70)



Map 18. *G. fasciata* species group.

This species group is possibly linked with *Ctenopteris*. Copeland (1952a, 1960) comments that some Philippine collections of Grammitidaceae appear to be intermediate between *C. curtisii* (Baker) Copel. (as *Polypodium decrescens* Christ) and *G. loheriana* (Christ) Copel. and notes (Copeland, 1960) that *G. loheriana* itself looks like a hybrid between *G. fasciata* and *G. curtisii*. More information is required on the relationships of this species group with *Ctenopteris* and *Xiphopteris* (see under *G. crenulata* for some further discussion).

The extra-New Guinea member of this group is *G. loheriana*.

14. Grammitis fasciata Blume – Fig. 9; maps 19, 20.

G. fasciata Blume, Enum. Pl. Javae (1828) 116; Copel., Philip. J. Sc. 80 (1952) 210. – *Polypodium fasciatum* C. Presl, Tentamen (1836) 180. – Lectotype: *Blume s.n.*, crescit in Javae monte vulcanico Gede, regionibus temperatis (L; iso BO, K, L).

Polypodium diminutum sensu Baker, J. Bot. (London) 28 (1890) 108, quoad Mt Knutsford loc.

G. integra sensu Copel., Philip. J. Sc. 80 (1952) 171, quoad *Brass 9358*.

Illustrations: Blume, Flora Javae 2 (14 April 1830) pl. 49, f. 1; Copel., Philip. J. Sc. 80 (1952) 211, f. 74.

Rhizome c. 4 mm diam. including scales, 1.5–2.0 mm diam. without scales, short- to long-creeping, unbranched, producing stipes 2–7 mm apart; scales 1.5–2.5 × 0.8–1.3 mm, ovate to broadly ovate, obtuse at apex, medium red-brown to dark brown, glabrous, sometimes clathrate and iridescent, the cells without cross-walls. *Stipe* (0.6–)1.3–4.3(–6.9) cm × (0.7–)0.8–1.2(–1.3) mm, glabrous. *Lamina* (20.2–)

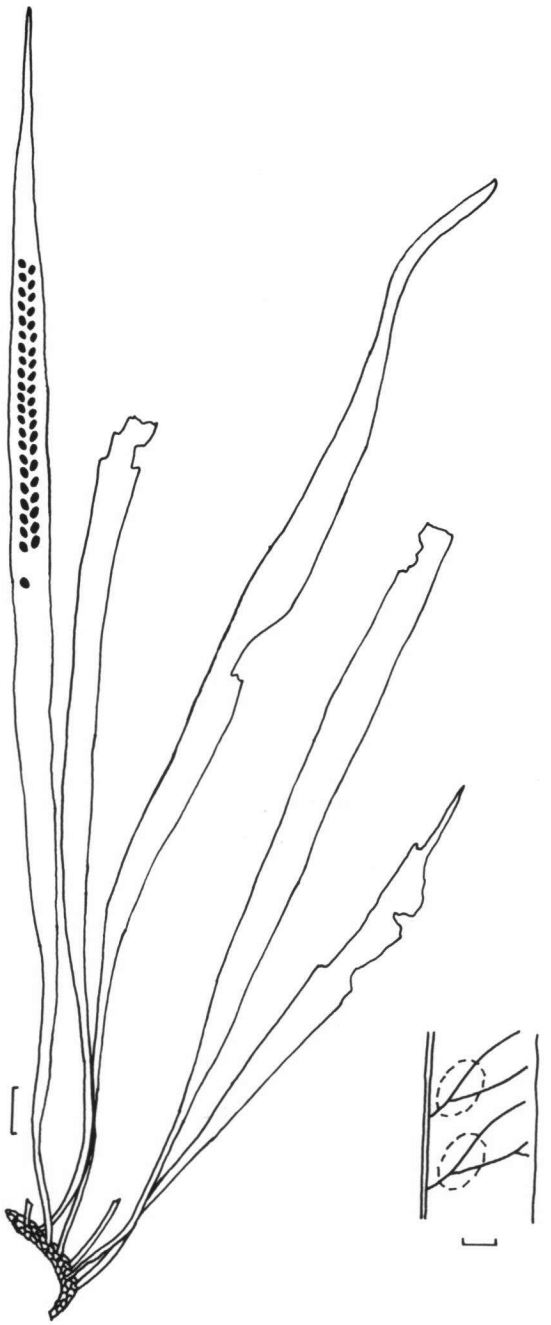


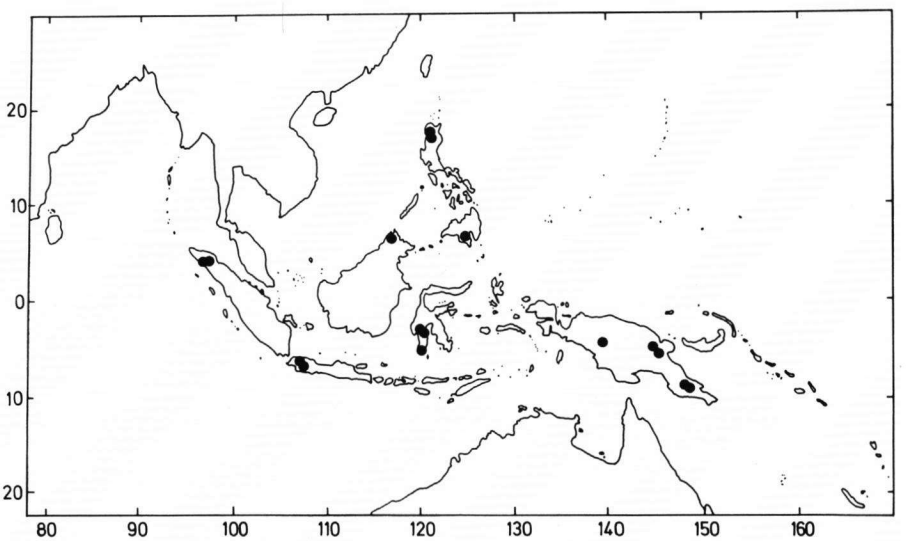
Fig. 9. *G. fasciata* group. – *G. fasciata* (14), *Brass 30695* (LAE).

23.9–34.5(–35.2) × (0.6–)0.7–1.1 cm, linear to linear-oblanceolate, acute to acuminate at apex and long-attenuate at base, entire, coriaceous, glabrous; midvein rather prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins invisible in transmitted light, sometimes slightly prominent on the lower surface when dried, 1–2-forked, the upper branch extending beyond the sorus and nearly as long as the lower branch which is sometimes 1-forked, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.5–2.7(–3.0) × (0.8–)1.1–2.1(–2.3) mm, elliptic in outline, each oblique to the midvein, on the surface of the lamina, discrete when mature, in two rows, one on each side of the midvein in the upper 1/2–1/3 of the lamina but not immediately below the apex, each row with (18–)24–42(–55) sori, nearer the midvein than the margin. *Sporangia* (240–)245–326(–330) μm, glabrous or very rarely with a solitary dark red-brown rigid hair c. 170 μm; indurated cells of annulus 10–13(–16). *Spores* (27–)30–37(–42) μm diam.

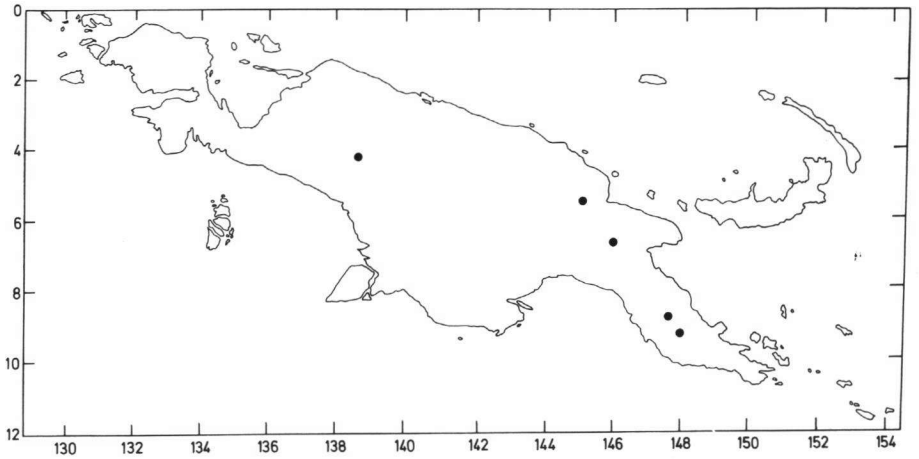
Distribution. Sumatra, Borneo, Java, Philippines, Celebes and New Guinea.

CENTRAL IRIAN JAYA. Danau Habbema, Brass 9358 (BM, BO, GH, L, MICH, UC).
CHIMBU. Mt Wilhelm, Brass 30695 (K, L, LAE, US).
E. HIGHLANDS. Mt Piora, Croft 84 (BSP, CROFT, LAE).
CENTRAL. Mt Knutsford, Macgregor 27 (K). Mt Kenevi, LAE 65093 (K, L, LAE).

Ecology. Epiphytic or terrestrial in upper montane forest (including mixed coniferous forest), sometimes at forest margin; from 3000 to 3300 m.



Map 19. *Grammitis fasciata* (14).



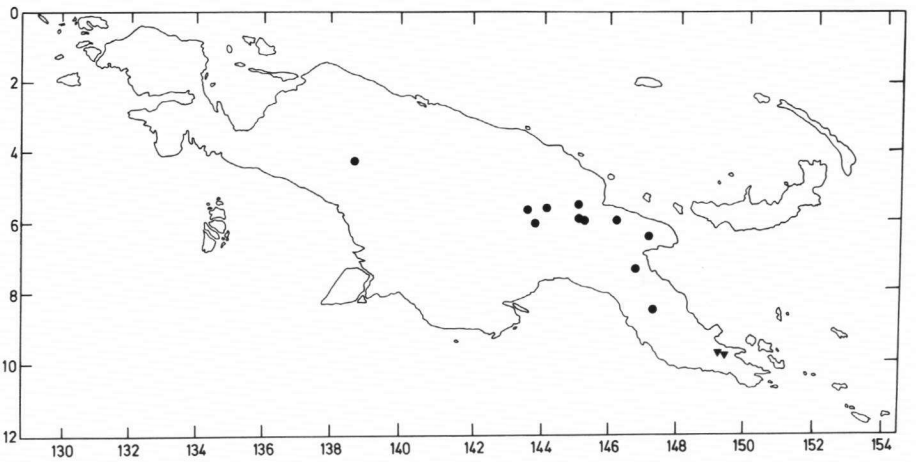
Map 20. *Grammitis fasciata* (14).

15. Grammitis graminifolia Copel. – Fig. 10; map 21.

G. graminifolia Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 169. – Type: *Brass 5092* (NY; iso BM, BO, BRI, GH).
Polypodium fasciatum sensu C. Chr., Brittonia 2 (1937) 304, quoad *Brass 5092*.
Illustrations: Copel., Philip. J. Sc. 80 (1952) 169, f. 37.

Rhizome 2–5 mm diam. including scales, 1–2 mm diam. without scales, usually long-creeping, occasionally short-creeping, unbranched, producing stipes 1.5–8.0 mm apart; scales (1.8–)2.2–4.2(–5.2) × 0.5–1.7(–2.8) mm, ovate to lanceolate, usually obtuse, sometimes acute at apex, pale to medium red-brown, glabrous, sometimes clathrate and iridescent, the cells without cross-walls. *Stipe* (0.2–)0.4–3.0(–5.0) cm × (0.4–)0.6–1.0(–1.2) mm, usually glabrous, occasionally glabrescent with sparse ± patent catenate simple eglandular hairs c. 0.1–0.2 mm on young fronds. *Lamina* (8.0–)15.7–26.9(–35.7) × (0.2–)0.3–0.4(–0.5) cm, linear to linear-oblanceolate, acute at apex and long-attenuate at base, entire, coriaceous, with occasional to sparse ascending blackish simple eglandular hairs 0.2–0.4(–0.6) mm on margin, occasionally with very sparse ± patent catenate simple eglandular hairs c. 0.1 mm on midvein below and occasionally with very sparse ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins invisible in transmitted light, sometimes raised on both surfaces or only on the upper surface when dried, 1-forked, the upper branch usually extending a little beyond the sorus and nearly as long as the lower branch, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* (1.0–)1.3–2.3 (–3.0) × (1.0–)1.1–1.9(–2.5) mm, ± circular in outline, on surface of lamina or

Fig. 10. *G. fasciata* group. – 1. *G. graminifolia* (15), *Brass 30610* (LAE); 2. *G. subfasciata* (17), *NGF 44467* (LAE).



Map 21. ● *Grammitis graminifolia* (15), ▼ *G. crenulata* (16).

slightly sunken in broad shallow depressions, discrete or contiguous when mature, in two rows, one on each side of the midvein in the upper 1/2–1/10 of lamina but not immediately below the apex, each row with (7–)14–31(–41) sori, ± midway between the margin and the midvein and often covering all of lamina undersurface. *Sporangia* (240–)279–330(–400) μm, glabrous; indurated cells of annulus (8–)10–13(–15). *Spores* (26–)31–41(–47) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Danau Habbema, Brass 9111 (GH, L, MICH, UC).

W. HIGHLANDS. Near Mt Giluwe, Parris & Croxall 9195 (BSP). Mt Hagen, Parris & Croxall 8071 (BSP).

ENGA. Yobobos grasslands, Hoogland & Schodde 7602 (CANB, L, LAE, NSW, US).

CHIMBU. Bomkan, upper Chimbu Valley, ANU 7650 (LAE). Mt Wilhelm, van Balgooy 654 (L), 657 (CANB, L, LAE), Brass 29972, 30610 (both A, CANB, K, L, LAE, NY, US), Nakaike 244 (LAE), NGF 8593 (A, BO, BRI, CANB, K, L, LAE, NSW, SING), Parris & Croxall 4672 H 232 (BSP, LAE). Sina Sina, Croft 544 (CROFT, LAE).

E. HIGHLANDS. Fatima R. Valley, NGF 22564 (L, LAE).

MADANG. Moro, Jermy 4219, 4246 (both BM).

MOROBE. Mt Kaindi, Brass 29773 (K, LAE). Samanzing, Clemens 9335 (B, GH, L).

CENTRAL. Mt Tafa, Brass 5092 (BM, BO, BRI, GH).

Ecology. Usually terrestrial (sometimes in moss cushions) or rupestral in montane to subalpine grassland or clearings in forest, sometimes epiphytic in montane forest, occasionally rupestral on boulders in streams or terrestrial on roadside banks; from 1770 to 3600 m.

Notes. Vernacular name: kamegam (Enga language, Kepilam).

G. graminifolia is a relative of *G. fasciata*, but can be distinguished from the latter by its narrower lamina with marginal hairs.

16. Grammitis crenulata Parris, *sp. nov.* – Fig. 11; map 21.

A G. subfasciata et speciebus affinibus margine leviter crenulata recedit. — *Rhizoma* squamis inclusis 4–5 mm diam., squamis exclusis c. 2 mm diam., breviter vel moderate longe repens, eramosum, stipites per spatia 2–3 mm emittens; squamae (2.8–)2.9–3.9(–4.2) mm longae, 0.7–1.1(–1.3) mm latae, lanceolatae vel lanceolato-ovatae, ad apicem acutae, cinereo-brunneae, glabrae, plus minusve clathratae sed non iridescentes, cellulae sine septis. *Stipes* 0.5–1.4(–1.8) cm longus, (0.4–)0.6–1.2 mm latus, interdum absens, glabrus. *Lamina* (17.0–)21.2–35.6(–38.8) cm longa, 0.5–0.7(–0.8) cm lata, lineari-oblanceolata, ad apicem subacutam, ad basem longe attenuata, leviter crenata, lobis ad 1.0 mm longis, coriacea, pilis simplicibus eglandulosis 0.3–0.6 mm longis ascendentibus atro-brunneis paucis ad marginem vestita; medio-vena plus minusve prominens in pagina infera laminae et quam paginam inferam laminae fuscatior, venae laterales in luce transmissa non manifestae, plerumque 1-furcatae, ramus superus interdum ultra sorum procurrens, quam ramum inferum brevior, ramus inferus interdum 1-furcatus, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 1.7–3.4(–4.0) mm longi, (0.9–)1.2–2.2(–2.3) mm lati, in ambitu plus minusve circulares vel elliptici, ad medio-venam obliqui, ad superficiarem inferam laminae adornati, discreti ubi maturi, in 2 serialibus, 1 utroque medio-venae in 1/4–1/6 superno laminae, in quoque seriali (15–)18–34(–35) sori, medio-venam quam marginem proximiores. *Sporangia* (270–)301–363(–400) μm longa, glabra; cellulae induratae annuli (9–)10–12(–14). *Sporae* (37–)40–48(–53) μm diam. — Typus: *L. J. Brass 22556*, 27.v. 1953, north slopes of Mt Dayman, Maneau Range, Milne Bay District, Papua New Guinea (BM; iso A, CANB, L, LAE).

Rhizome 4–5 mm diam. including scales, c. 2 mm diam. without scales, short to moderately long-creeping, unbranched, producing stipes 2–3 mm apart; scales (2.8–)2.9–3.9(–4.2) × 0.7–1.1(–1.3) mm, lanceolate to lanceolate-ovate, acute at apex, greyish brown, glabrous, ± clathrate but not iridescent, the cells without cross-walls. *Stipe* 0.5–1.4(–1.8) cm × (0.4–)0.6–1.2 mm, sometimes absent, glabrous. *Lamina* (17.0–)21.2–35.6(–38.8) × 0.5–0.7(–0.8) cm, linear-oblanceolate, subacute at apex, long-attenuate at base, shallowly crenate, the teeth up to 1.0 mm long, coriaceous, with occasional ascending blackish brown simple eglandular hairs 0.3–0.6(–0.7) mm on the margin; midvein ± prominent on the lower surface of the lamina and darker than it; lateral veins invisible in transmitted light, usually 1-forked, the upper branch sometimes extending beyond the sorus, shorter than the lower branch, which is occasionally 1-forked, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.7–3.4(–4.0) × (0.9–)1.2–2.2(–2.3) mm, ± circular to elliptic in outline, each oblique to the midvein, on the surface of the lamina, discrete when mature, in two rows, one on each side of the midvein in the upper 1/4–1/6 of lamina, each row with (15–)18–34(–35) sori, nearer the midvein than the margin. *Sporangia* (270–)301–363(–400) μm, glabrous; indurated cells of annulus (9–)10–12(–14). *Spores* (37–)40–48(–53) μm diam.

Distribution. New Guinea.

MILNE BAY. Mt Dayman, Brass 22556 (A, BM, CANB, L, LAE). Mayu 2, Mt Suckling, LAE 55545 (K, L, LAE). Mt Suckling, Veldkamp & Stevens 5525 (LAE), 5628 (L, LAE).

Ecology. Usually epiphytic or on logs, but occasionally terrestrial, in montane forests (including *Araucaria*); from 1900 to 3000 m.

Notes. *G. crenulata* has the aspect of a hybrid between *G. subfasciata* and *Xipho-*

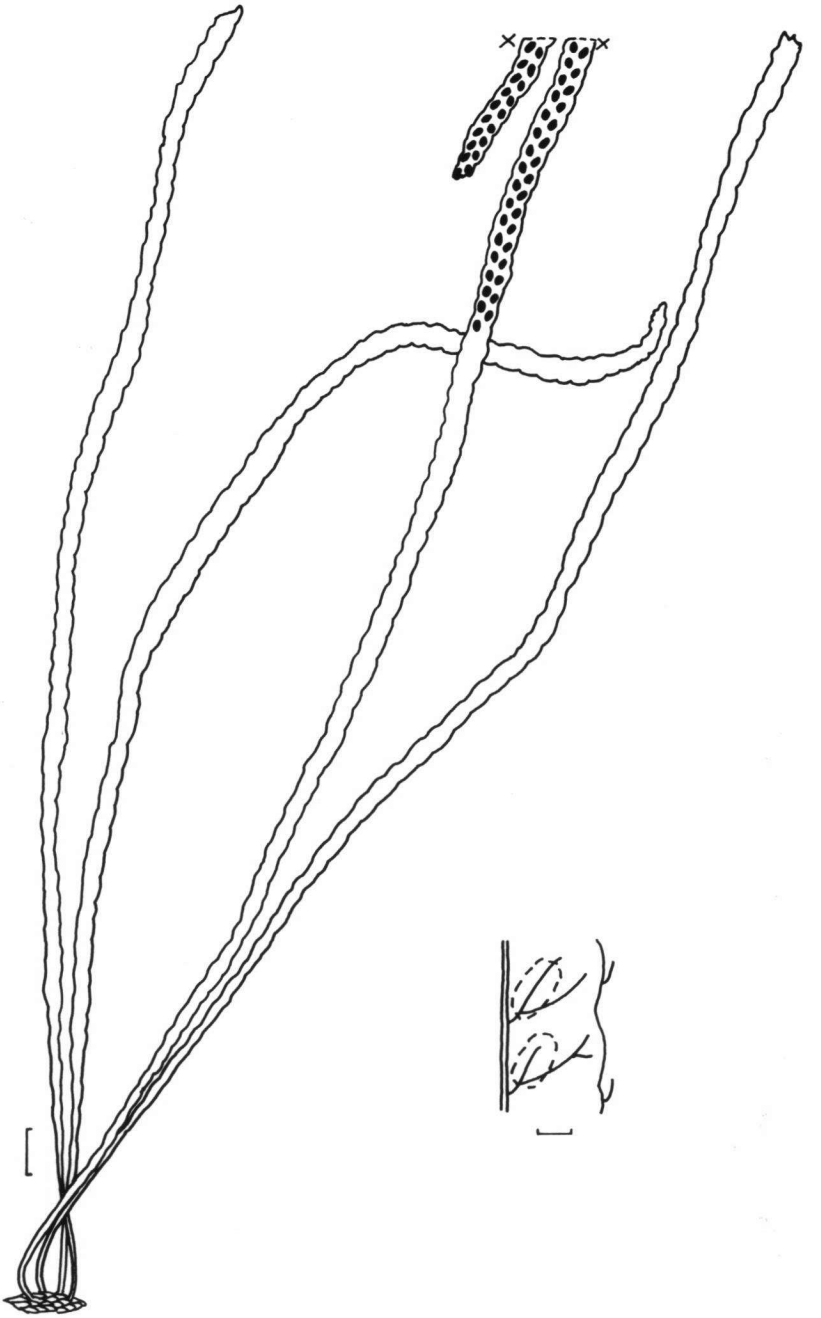
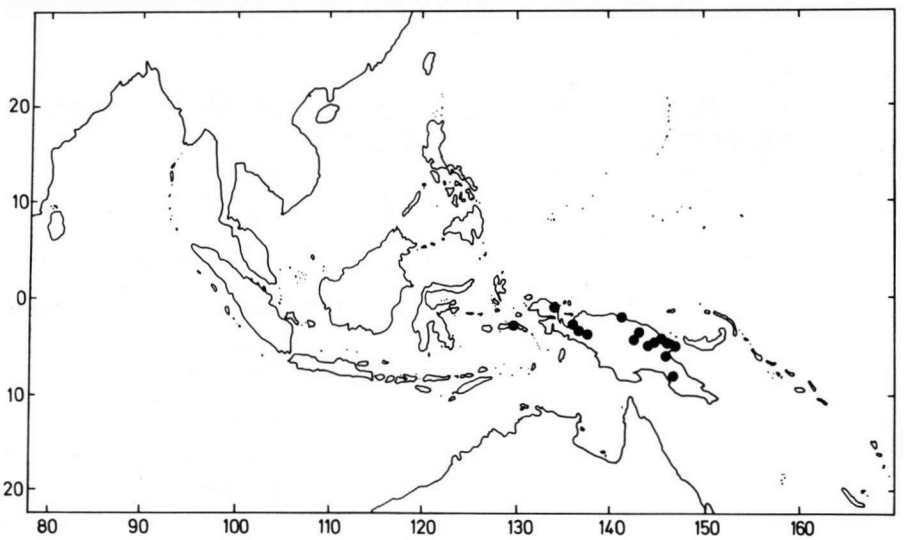


Fig. 11. *G. fasciata* group. – *G. crenulata* (16), isotype, *Brass 22556* (LAE).



Map 22. *Grammitis subfasciata* (17).

pteris conjunctisora (Baker) Copel. The latter has some features in common with some members of the *G. fasciata* species group such as a short-creeping rhizome, with lanceolate acute dark brown more or less clathrate scales, a glabrous lamina (14.8–) 17.1–26.1(–31.0) × (0.4–)0.6–1.0(–1.2) cm, a sporangial length of (260–)272–318(–340) μm and a spore diameter of (36–)39–51(–57) μm. The lamina of *Xiphopteris conjunctisora* is deeply pinnatifid to pinnate and this degree of dissection, together with the production of one to three sori per lobe or pinna, has led to its inclusion in *Xiphopteris* or *Ctenopteris*, but further study may show that it is more closely related to species here included in *Grammitis*.

17. Grammitis subfasciata (Rosenst.) Copel. – Fig. 10; maps 22, 23.

G. subfasciata (Rosenst.) Copel., Philip. J. Sc. 80 (1952) 170. – *Polypodium subfasciatum* Rosenst., Feddes Repert. 5 (1908) 41. – Lectotype: *Werner 25* (UC; iso S).

Polypodium integrum Brause, Bot. Jahrb. 49 (1912) 37. – *G. integra* Copel., Philip. J. Sc. 80 (1952) 171. – Lectotype: *Schultz Jena (26) 21* (B).

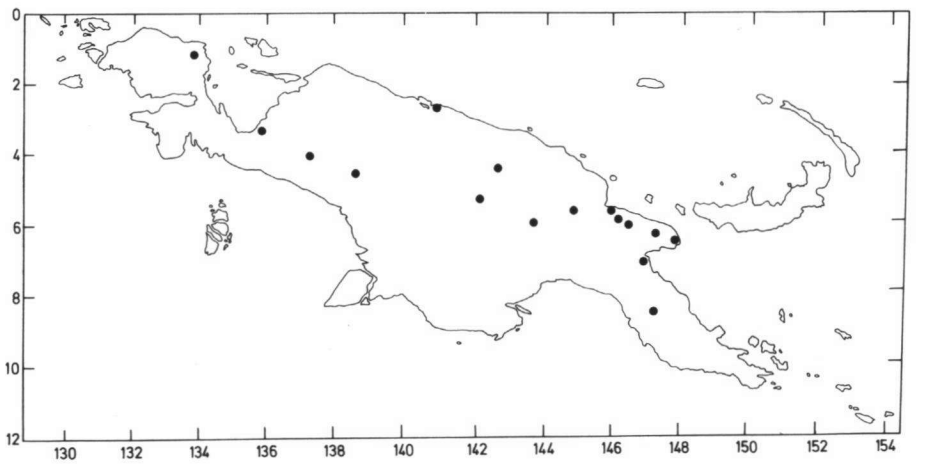
Polypodium fuciforme Rosenst., Nova Guinea 8 (1912) 726; Copel., Philip. J. Sc. 80 (1952) 203. – Lectotype: *von Römer 846* (BO).

Polypodium alcicorne Ridley, Trans. Linn. Soc. London (Bot.) 2, 9 (1916) 261, non Baker (1888); Copel., Philip. J. Sc. 80 (1952) 204. – Lectotype: *Boden Kloss s.n.*, Mt Carstensz, Camps III to VIII, 2500 to 4900 ft (BM; iso K).

Polypodium ceramicum v.A.v.R., Bull. Jard. Bot. Btzg III, 2 (1920) 168. – *G. ceramica* Ching, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 240; Copel., Philip. J. Sc. 80 (1952) 213. – Lectotype: *Kornassi 1505*, Ceram (BO; iso L).

Polypodium dichotomum Brause, Bot. Jahrb. 56 (1920) 190, non Houtt. (1783) nec Thunb. (1784); Copel., Philip. J. Sc. 80 (1952) 204. – Lectotype: *Ledermann 9246* (B; iso BM, S). Illustrations: Copel., Philip. J. Sc. 80 (1952) 170, f. 39 et 213, f. 76 as G. ceramica.

Rhizome 4–7 mm diam. including scales, 2–3 mm diam. without scales, short to long-creeping, sometimes branched, producing stipes 1–8 mm apart; scales (3.0–) 3.2–6.4(–9.1) × (0.3–)0.4–1.4(–2.1) mm, lanceolate to narrowly lanceolate, subacute to acute at apex, pale to medium red-brown, glabrous, sometimes clathrate but not iridescent, the cells without cross-walls. *Stipe* (0.1–)0.6–4.0(–8.0) cm × (0.6–) 0.7–1.3(–1.6) mm or absent, glabrous. *Lamina* (9.6–)18.3–31.3(–36.0) × (0.3–) 0.4–1.1(–1.7) cm, linear-oblanceolate to linear, occasionally dichotomously branched up to 7 times, acuminate to obtuse at apex and long-attenuate at base, entire, coriaceous, usually glabrous, sometimes with occasional ascending blackish brown simple eglandular hairs 0.2–0.4 mm on margin or midvein below; midvein rather prominent on the lower surface of the lamina and ± concolorous with it; lateral veins invisible in transmitted light, 1(–3)-forked, the upper branch usually extending beyond the sorus and ± as long as the lower branch or occasionally not extending beyond the sorus and shorter than the lower branch, occasionally the upper and lower branches each 1-forked, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* (0.8–)1.2–2.6(–3.8) × (0.7–)0.9–1.9 (–2.5) mm, ± circular to elliptic in outline, each oblique to the midvein, on the surface of the lamina or very slightly sunken in broad shallow depressions, discrete to contiguous when mature, in two rows, one on each side of the midvein in the upper 1/2–1/6 of the lamina, sometimes not immediately below the apex, on the ultimate and sometimes also the penultimate branches when the lamina is dichotomously branched, each row with (4–)9–31(–46+) sori, nearer the midvein than the margin. *Sporangia* (220–)278–332(–400) μm, often glabrous, sometimes with 1–4 dark



Map 23. *Grammitis subfasciata* (17).

red-brown rigid hairs (170–)191–300 μm; indurated cells of annulus (8–)10–12(–15). *Spores* (28–)35–49(–59) μm diam.

Distribution. Moluccas and New Guinea.

VOGELKOP PENINSULA. Anggi Gita, Gibbs 5971 (BM).

CENTRAL IRIAN JAYA. Mts S of Nabire, Schonian 2 (B). Punjak Sukarno, Boden Kloss s.n. (BM, K). Lorentz R., Hellwig Mts, Pulle 240 (BM), von Römer 846 (BO).

W. SEPIK. 65 km S of Tami R. mouth, Schultze Jena (26) 21 (B). Victor Emmanuel Ra., van Royen 11336, 11366 (both LAE).

E. SEPIK. Etappenberg, Ledermann 9246 (B, BM, S).

W. HIGHLANDS. Nondugl, NGF 4868 (BRI, CANB, K, LAE).

S. HIGHLANDS. Near Mendi, Parris & Croxall 6366 (BSP).

MADANG. Gubalau, Jermy 4384 (BM). Mt Gelu, Werner 25 (S, UC). Sewe to Tregbury Pass, Walker 8718–8720, 8831, 8835 (all BM).

MOROBE. New Yamap, NGF 44467 (K, LAE). Rawlinson Ra., Clemens 12449 (MICH, UC). Sattelberg, Clemens 7085 (BM, L). Wantoat, NGF 12602 (LAE).

CENTRAL. Mt Tafa, Brass 5095 (BM, BO, NY), Cheesman 201 (K).

Ecology. Rarely growing with *G. caespitosa*.

Usually an erect but sometimes pendulous epiphyte in the crowns of trees (including *Polyosma*), in moss cushions, or on rotten stumps and logs, sometimes terrestrial, occasionally rupestral on boulders in streambeds, usually in lower montane and midmontane forest (including *Nothofagus* and *Nothofagus-Podocarpus* forest) but sometimes in lowland rain-forest; from 50 to 2590 m.

Note. *G. subfasciata* is closely related to *G. fasciata*, but can be distinguished from the latter by its larger, narrower rhizome scales.

18. Grammitis padangensis (Baker) Copel. – Fig. 12; maps 24, 25.

G. padangensis (Baker) Copel., Philip. J. Sc. 80 (1952) 212. – *Polypodium padangense* Baker, J. Bot. (London) 18 (1880) 213. – Type: *Beccari s.n.*, Sumatra, Mt Singalan, 1700 m (K).

Polypodium stanleyanum Baker, J. Bot. (London) 28 (1890) 107. – *G. stanleyana* Copel., Philip. J. Sc. 80 (1952) 168. – Type: *Macgregor* [25] (K, holo; BM).

Polypodium durum Copel. in Elmer, Leafl. Philip. Bot. 3 (1910) 837. – Lectotype: *Elmer 11689*, Philippines, Mindanao, Mt Apo (MICH).

Polypodium ciliiferum v.A.v.R., Bull. Jard. Bot. Btzg II, 16 (1914) 32. – Lectotype: *Matthew 708*, Sumatra, Mt Sago (BO).

Polypodium trichocarpum v.A.v.R., Nova Guinea 14 (1924) 41. – Lectotype: *Lam 1683* (L; iso BM).

Polypodium trichocarpum var. *inerme* v.A.v.R., Nova Guinea 14 (1924) 42. – Lectotype: *Lam 1854* (BO; iso L).

Illustrations: Copel., Philip. J. Sc. 80 (1952) 168, f. 36 as G. stanleyana et 212, f. 75.

Rhizome 2–8 mm diam. including scales, 1–2 mm diam. without scales, usually long-creeping, occasionally short-creeping, sometimes branched, producing stipes 2–12 mm apart; scales (2.6–)4.0–7.2(–9.5) × (0.7–)1.2–2.6(–3.2) mm, ovate to lanceolate, obtuse to acute, sometimes apiculate at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.1–)

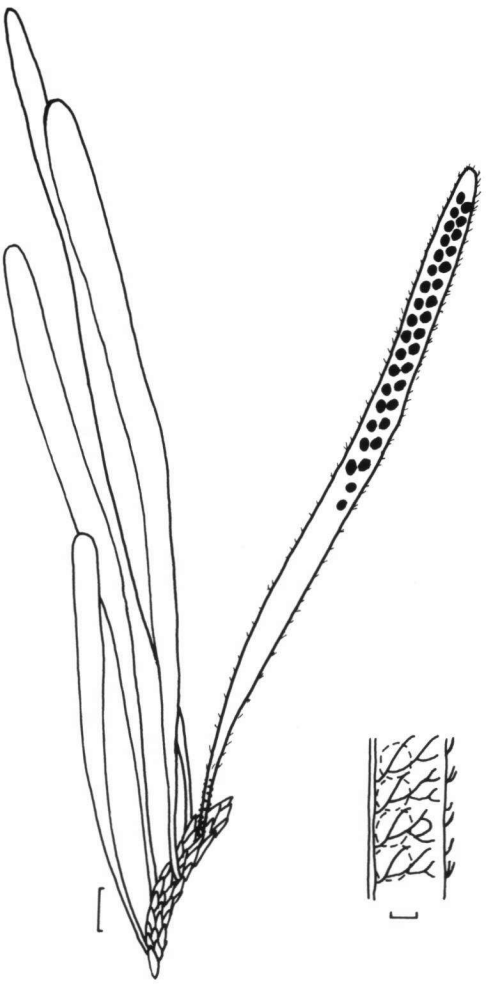
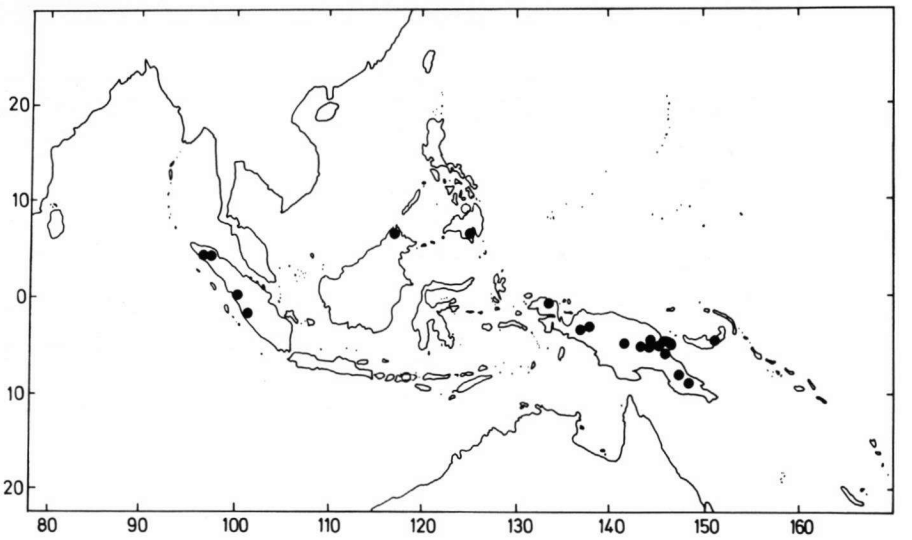


Fig. 12. *G. fasciata* group. – *G. padangensis* (18), *Pullen 5015* (LAE).

0.5–2.3(–3.4) cm × (0.4–)0.6–1.0(–1.2) mm, with scales similar to those of rhizome occasionally present at base and scattered ± patent to ± ascending blackish brown simple eglandular hairs 0.4–0.8(–1.0) mm, sometimes glabrous. *Lamina* (2.7–)6.1–12.5(–18.2) × (0.4–)0.6–0.9(–1.4) cm, linear-oblanceolate to spathulate-oblanceolate, acute to obtuse at apex and attenuate to long-attenuate at base, entire, coriaceous, with sparse to frequent ± ascending blackish brown simple eglandular hairs (0.1–)0.3–0.6(–0.8) mm and similar but binate hairs on margin, and oc-



Map 24. *Grammitis padangensis* (18).

casional ± patent, ± catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds; midvein rather prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, sometimes slightly prominent on the upper surface of the lamina when dried, (1–)2–3(–4)-forked, the upper branch of the first fork extending beyond the sorus and rarely 1-forked but not as long as the lower branch, which is usually 1–2-forked, each branch ending rarely marked by a small hydathode on the upper surface of the lamina, usually free but sometimes anastomosing near the margin. *Sori* (1.1–)1.9–3.9(–6.0) × (1.1–)1.6–3.0(–4.0) mm, ± circular to oval in outline, each oblique to the midvein, on surface of lamina or slightly sunken in shallow open depressions, discrete to confluent when mature, in two rows, one on each side of the midvein in the upper 1/6–1/2 of the lamina, each row with (1–)5–14(–19) sori, nearer the midvein than the margin. *Sporangia* (220–)253–312(–370) μm, with 1–5(–9) medium to dark red-brown rigid hairs (100–)127–248(–400) μm; indurated cells of annulus (7–)10–13(–15). *Spores* (21–)28–47(–70) μm diam.

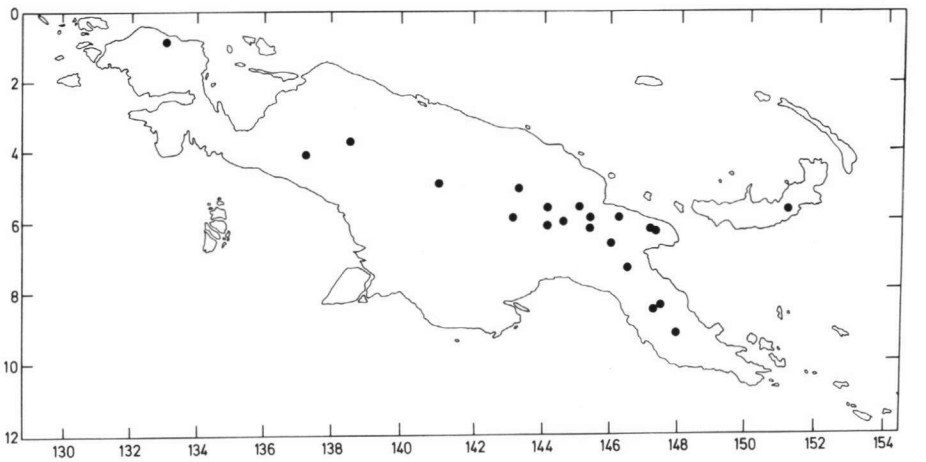
Distribution. Sumatra, Borneo, Java (fide Copeland, 1952a), Philippines, Lesser Sunda Islands (Sumbawa, fide Copeland, 1952a), New Guinea.

VOGELKOP PENINSULA. Mt Netoti, van Royen & Sleumer 8004 (L).

CENTRAL IRIAN JAYA. Punjak Sukarno, Boden Kloss s.n. (BM). Meren Valley, Punjak Sukarno, ANU 16133 (CANB). Ngga Simanggela, Lam 1693 (BM, L), 1854 (BO, L), 1966 (BO). Hellwig Mts, Pulle 2482 (BM, BO).

W. SEPIK. Mt Capella, Star Mts, Croft 17 (BSP, CROFT, LAE), LAE 66961 (LAE). Mt Scorpion, Star Mts, LAE 65928 (LAE), 68004 (K, LAE).

E. SEPIK. Mt Burgers, LAE 59748 (LAE), Veldkamp & Vinas 7550 (LAE).



Map 25. *Grammitis padangensis* (18).

W. HIGHLANDS. Minj-Nona divide, Kubor Ra., Pullen 5015 (CANB, K, L, LAE), Vink 16029 (CANB, L, LAE). Mt Kegum, Mt Hagen, Veldkamp & Vinas 7620 (LAE). Mt Kinkain, Kubor Ra., Vink 16094 (CANB, L, LAE).

ENGA. Mt Ambua, Kalkman 5065 (L, LAE). Tari Gap, Parris & Croxall 9438, 9439 (both BSP, LAE).

S. HIGHLANDS. Mt Ialibu, LAE 55860 (L, LAE).

CHIMBU. Mt Wilhelm, ANU 7095 (CANB, LAE), 10763 (CANB), 13068 (CANB, L, LAE), van Balgooy 246 (CANB, L, LAE), Brass 29984 (CANB, K, L, LAE, US), Nakaike 321, 342 (both LAE), NGF 8846 (A, BM, BRI, K, LAE, NSW), Parris & Croxall 4692 H 247 (BSP, LAE).

E. HIGHLANDS. Mt Michael, Johns 1298 (BULOLO), NGF 11463 (LAE). Mt Otto, NGF 47119 (LAE). Mt Piora, Croft 104 (BSP, CROFT, K, LAE), LAE 68169 (K, LAE).

MADANG. Mt Abilala, Jermy 4339 (BM).

MOROBE. Ekuti Ra., Parris & Croxall 6271, 7975 (both BSP). Gimdoh, Sarawaket Ra., Hoogland 9961 (CANB, LAE). Mt Sarawaket, Clemens s.n. (MICH). Rawlinson Ra., Clemens 12379a (MICH, UC), 12379c (L, MICH, UC), 12380 (MICH), s.n. (BO). Tempanpan, Sarawaket Ra., Hoogland 9804 (CANB, L, LAE).

CENTRAL. Mt Albert Edward, Brass 4258 (BM, BO, BRI, K, NY, US), Kanai 753625 (LAE). Mt Tafa, Cheesman 236 (K), s.n. (BM). NW of the Gap, Carr 15130 (K, L, LAE, NY). Owen Stanley Ra., Macgregor 25 (BM, K).

E. NEW BRITAIN. Mt Lululua, LAE 58420 (LAE).

Ecology. More or less erect epiphyte on trunks of trees (including *Olearia*), occasionally on branches, usually in subalpine forest, occasionally in midmontane forest (including *Nothofagus* forest) and upper montane forest, sometimes epiphytic in subalpine and alpine shrubland (including *Coprosma, Drimys, Papuacedrus, Quintinia Xanthomyrtus* and Ericaceae), occasionally epiphytic on tree-ferns (*Cyathea* spp.) in subalpine grassland, sometimes terrestrial or rupestral in montane or subalpine forest or in subalpine shrubland, occasionally rupestral in subalpine grassland; from 1830 to 3880 m.

Note. The affinities of *G. padangensis*, within the *G. fasciata* group, are not clear. It occasionally produces 32-spored and 16-spored sporangia, on the same plant as the more usual 64-spored sporangia.

5. G. ceratocarpa group – Species 19–20
Fig. 13; map 26; table 5

Rhizome short to long-creeping; scales ovate to broadly lanceolate, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* with medium to dark red-brown simple eglandular hairs 1.0–2.5 mm and simple clavate-glandular hairs. *Lamina* entire, coriaceous, glabrous or with dark red-brown to blackish simple eglandular hairs 0.4–1.5 mm and simple clavate-glandular hairs; lateral veins invisible in transmitted light, 1–3-forked, the first upper branch ± as long as or a little shorter than the others, each branch ending usually marked by a small hydathode on the upper surface of the lamina. *Sori* ± circular to elliptic in outline, on surface of lamina or slightly sunken in broad shallow depressions, in two rows.

Table 5. Characters of taxonomic importance within the *G. ceratocarpa* species group in New Guinea.

Characters	*G. ceratocarpa*	*G. salticola*
Lamina hairs (simple eglandular)	absent or occ., 0.4(–0.7) mm, on margin	1.0–1.5 mm, moderately frequent amongst sori, scattered on mid-vein below, occ. on margin
Spores in µm	(25–)30–43(–57)	(36–)40–49(–56)

Usually rupestral, but sometimes terrestrial, in subalpine forest or subalpine grassland. Restricted to New Guinea with only two species, one throughout mainland New Guinea, the other in Papua New Guinea Highlands.

This species group is possibly related to the *G. fasciata* and *G. setosa* groups.

19. Grammitis ceratocarpa Copel. – Fig. 13; map 26.

G. ceratocarpa Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 188. – Type: *Clemens 11349* (MICH, holo; MICH, UC).

Rhizome 1.5–4.0 mm diam. including scales, 0.5–1.5 mm diam. without scales, short- to long-creeping, unbranched, producing stipes 2–4 mm apart; scales (1.3–) 1.5–3.1(–4.0) × (0.5–)0.8–1.4(–1.9) mm, ovate to broadly lanceolate, obtuse to bluntly acute at apex, pale to medium red-brown, glabrous, neither clathrate nor iri-

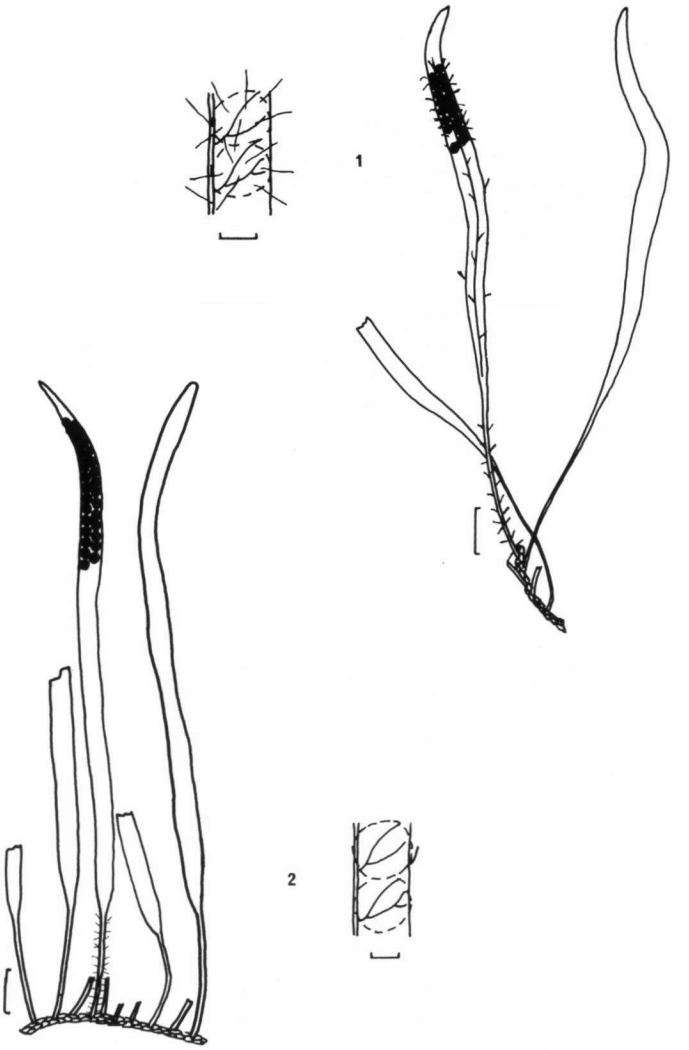


Fig. 13. *G. ceratocarpa* group. – 1. *G. salticola* (20), isotype, *Parris & Croxall 5943* (BSP); 2. *G. ceratocarpa* (19), *ANU 15173* (LAE).

descent, the cells without cross-walls. *Stipe* (1.4–)2.2–4.4(–6.0) cm × 0.5–0.7(–0.8) mm, with sparse to moderately frequent ± patent medium red-brown simple eglandular hairs 1.0–2.3 mm, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* (7.1–)8.8–14.2(–17.5) × (0.2–)0.3–0.5(–0.6) cm, linear, acute to subacute at apex and long-cuneate to attenuate at base, entire, coriaceous, glabrous or with occasional ascending black-

ish simple eglandular hairs 0.4(–0.7) mm on margin and occasional whitish to dark brown simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins invisible in transmitted light, sometimes slightly prominent on the upper surface when dried, usually 1-forked, the upper branch not usually extending beyond the sorus but nearly as long as the lower branch, which may be 1-forked, each branch ending marked by a small hydathode on the upper surface, free. *Sori* (1.5–)1.6–3.4(–4.0) × (1.0–)1.2–2.4(–2.8) mm, ± circular to elliptic in outline, each oblique to the midvein, slightly sunken in broad shallow depressions or on surface of lamina, contiguous to confluent when mature, in two rows, one on each side of the midvein in the upper 1/2–1/6 of lamina but not immediately below the apex, each row with (6–)10–23(–30) sori, covering all of lamina undersurface. *Sporangia* (200–)267–299(–350) μm, glabrous or occasionally with 1–4 medium red-brown rigid hairs (150–)164–270(–300) μm; indurated cells of annulus (10–)11–13(–15). *Spores* (25–)30–45(–57) μm diam.

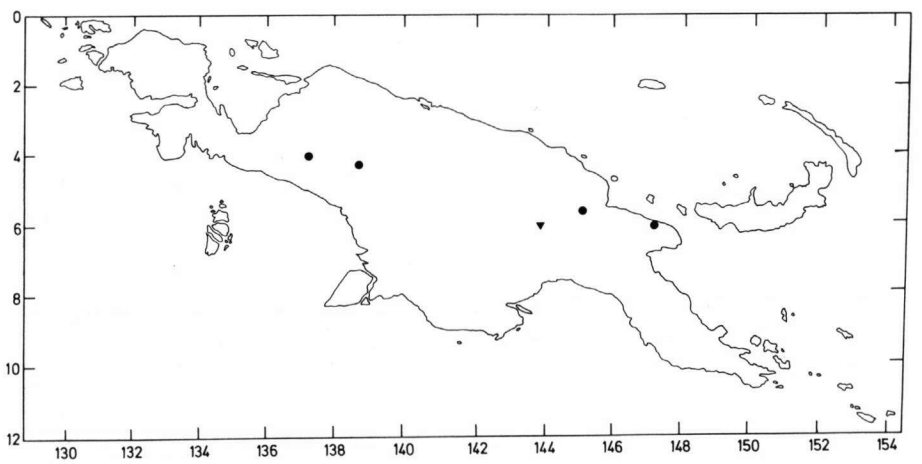
Distribution. New Guinea.

CENTRAL IRIAN JAYA. Ertsberg, Peg. Sukarno, ANU 10902 (BO, CANB). Punjak Trikora, Brass 9676 & Meijer Drees (GH, L, MICH).

CHIMBU. Mt Wilhelm, ANU 7053 (CANB, LAE), 13068 (CANB, L), 15173 (CANB, LAE), van Balgooy 654 (CANB, L, LAE), Brass 30102 (K), Nakaike 260 (LAE), NGF 15168 (LAE), Parris & Croxall 4670 (BSP).

MOROBE. Ulap trail, Clemens 11349 (MICH, UC).

Ecology. Usually rupestral, sometimes terrestrial, on peat and landslips in subalpine forest or in subalpine grassland, rarely epiphyte in subalpine forest; from c. 3000 to 3800 m.



Map 26. ● *G. ceratocarpa* (19), ▼ *G. salticola* (20).

20. Grammitis salticola Parris, *sp. nov.* – Fig. 13; map 26.

Ex affinitate G. ceratocarpa, a pilis ad paginam inferam medio-venae et inter soros distincta. – *Rhizoma* squamis inclusis 2–3 mm diam., squamis exclusis c. 1 mm diam., breviter vel moderate longe repens, eramosum, stipites per spatia 1–3 mm emittens; squamae 2.0–2.8 mm longae, 0.4–0.7 mm latae, late lanceolatae, ad apicem obtusae, pallidae vel mediae rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* (0.9–)1.8–4.2(–4.5) cm longus, 0.3–0.6 mm latus, pilis simplicibus eglandulosis 0.8–2.5 mm longis sparsis plus minusve patentibus mediis vel obscure rubriusculo-brunneis. *Lamina* (5.8–)7.0–10.0(–11.7) cm longa, (0.2–)0.3–0.4 cm lata, linearis, ad apicem acuta vel acuminata, ad basem longe attenuata, integra, coriacea, pilis simplicibus eglandulosis, 1.0–1.5 mm longis plus minusve patentibus obscure rubriusculo-brunneis inter soros moderate numerosis, ad medio-venam infernam sparsis et ad marginem paucis vestita; medio-vena ad paginam infernam paulo prominens et quam paginam infernam laminae fuscatior; venae laterales in luce transmissa non manifestae, 1–3-furcatae, ramus primus superus paulo ultra sorum procurrens, plus minusve longitudine ramum inferum aequens, interdum ramus superus et rami inferi 1-furcati, interdum rami terminales in pagina supera laminae paulis hydathodis manifesti liberi. *Sori* 1.3–2.7 mm longi, 0.7–2.1 mm lati, in ambitu plus minusve circulares vel elliptici, ad medio-venam obliqui, in depressionibus vadosis apertis parum impressi, confluentes ubi maturi praeter interdum soros infimos discretos, in 2 serialibus, 1 utroque medio-venae in 1/5 vel 1/2 superno laminae sed non prope apicem, in quoque seriali (2–)5–17(–20) sori, pagina inferna tota laminae tegentes. *Sporangia* (220–)246–306 μm longa, pilis 1–3 obscure rubriusculo-brunneis rigidis (200–)218–328(–360) μm longis praedita; cellulae induratae annuli (9–)11–13(–16). *Sporae* (36–)40–49(–56) μm diam. — Typus: *B.S. Parris & J.P. Croxall 5943*, 22.v.1977, northwest side of Mt Giluwe, Southern Highlands District, Papua New Guinea (K; iso BSP, LAE).

Rhizome 2–3 mm diam. including scales, c. 1 mm without scales, short to moderately long-creeping, unbranched, producing stipes 1–3 mm apart; scales 2.0–2.8 × 0.4–0.7 mm, broadly lanceolate, obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.9–)1.8–4.2(–4.5) cm × 0.3–0.6 mm, with sparse to scattered ± patent medium to dark red-brown simple eglandular hairs 0.8–2.5 mm. *Lamina* (5.8–)7.0–10.0(–11.7) × (0.2–)0.3–0.4 cm, linear, acute to acuminate at apex, long-attenuate at base, entire, coriaceous, with ± patent dark red-brown simple eglandular hairs 1.0–1.5 mm moderately frequent amongst the sori, sparse to scattered on midvein beneath and occasional on margin; midvein slightly prominent on the lower surface of the lamina and darker than it; lateral veins invisible in transmitted light, 1–3-forked, the upper branch of the first fork scarcely extending beyond the sorus and ± as long as the lower branch, sometimes both upper and lower branches 1-forked, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.3–2.7 × 0.7–2.1 mm, ± circular to elliptic in outline, each oblique to the midvein, slightly sunken in broad very shallow depressions, confluent when mature except occasionally the lowest sori in each row which may be discrete, in two rows, one on each side of the midvein in the upper 1/5–1/2 of the lamina, but not immediately below the apex, each row with (2–)5–17(–20) sori, covering all of lamina undersurface. *Sporangia* (220–)246–306(–310) μm, with 1–3 dark red-brown rigid hairs (200–)218–328(–360) μm; indurated cells of annulus (9–)11–13(–16). *Spores* (36–)40–49(–56) μm diam.

Distribution. New Guinea.

S. HIGHLANDS. Mt Giluwe, Parris & Croxall 5943 (BSP, K, LAE), Croft 709 & Marsh (BSP, CROFT, LAE).

Ecology. Rupestral on wet rock overhang in gorge in subalpine grassland; from c. 3300 to 3700 m.

Note. *G. salticola* is closely related to *G. ceratocarpa*, but differs in its longer more widely distributed lamina hairs.

6. G. setosa group – Species 21–24
Figs. 14, 15; maps 27–33; table 6

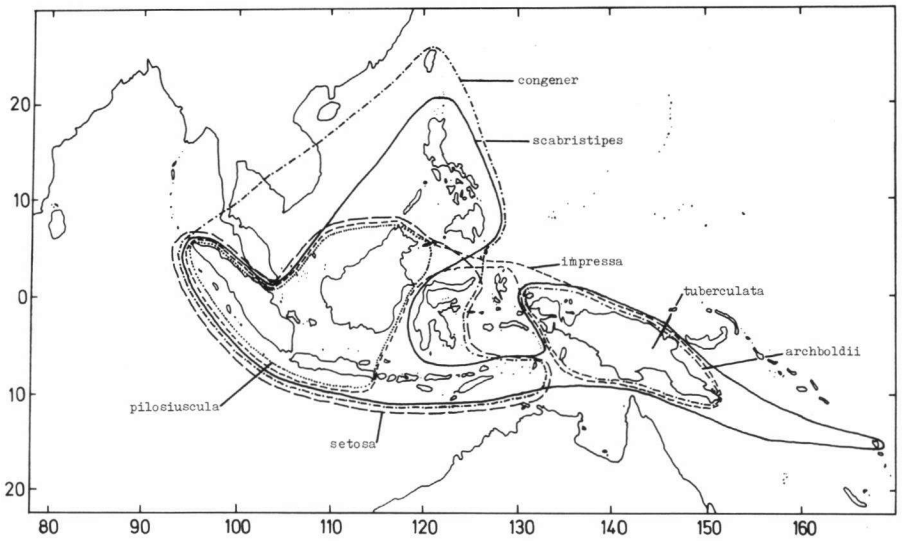
Rhizome erect to long-creeping; scales ovate-lanceolate to narrowly lanceolate, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* with medium to dark red-brown simple eglandular hairs 0.3–5.0 mm, sometimes markedly broadened at base, and catenate simple eglandular hairs. *Lamina* entire or crenate, coriaceous, with medium or dark red-brown to blackish simple eglandular hairs 0.3–3.0 mm which are sometimes on small conical laminar projections and simple clavate-glandular hairs; lateral veins usually invisible in transmitted light, 1–4-forked, the first upper branch shorter than or as long as the others, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina which sometimes bears a white scale. *Sori* ± circular to oblong in outline, on surface of lamina, slightly sunken in broad shallow depressions or sunken in steepsided pits, in 2(–4) rows.

Epiphytic, rupestral or terrestrial, in lowland rain-forest, lower montane to subalpine forest, subalpine shrubland and subalpine grassland. Distribution from Sumatra and mainland Southeast Asia to Taiwan and New Hebrides with four species in New Guinea, two of which are endemic, one to mainland eastern New Guinea (PNG, Mid-PNG and Southeast Pen.) and one to PNG Highlands.

The extra-New Guinea members of this group are *G. congener* Blume, *G. pilosiuscula* Blume and *G. setosa* Blume.

Table 6. Characters of taxonomic importance within the *G. setosa* species group in New Guinea.

Characters	*G. archboldii*	*G. impressa*	*G. tuberculata*	*G. scabristipes*
Stipe hairs	not broad-based	not broad-based	not broad-based	broad-based
Lamina hairs	not on conical projections	not on conical projections	on conical projections	not on conical projections
Sori	on surface of lamina or in depressions	sunken in pits	sunken in pits	on surface of lamina or in depressions
Spores in μm	(24–)27–37 (–48)	(28–)33–46 (–51)	(32–)39–51 (–60)	(22–)29–44 (–71)



Map 27. *G. setosa* species group.

21. Grammitis archboldii (C. Chr.) Copel. – Fig. 14; map 28.

G. archboldii (C. Chr.) Copel., Philip. J. Sc. 80 (1952) 186. – *Polypodium archboldii* C. Chr., Brittonia 2 (1937) 305. – Type: *Brass 4236* (BM, holo; BO, BRI, NY).
Polypodium mollipilum var. sensu C. Chr., Brittonia 2 (1937) 305.
Illustrations: Copel., Philip. J. Sc. 80 (1952) 186, f. 55.

Rhizome (2.0–)3.0–5.5(–7.0) mm diam. including scales, 1.0–2.5 mm diam. without scales, usually long-creeping, sometimes short-creeping, sometimes branched, producing stipes 1–9 mm apart; scales (2.1–)2.6–4.2(–5.6) × (0.5–)0.6–1.2(–1.5) mm, usually ovate-lanceolate, sometimes lanceolate, rarely ovate, ± obtuse to acute at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.2–)3.2–7.4(–9.8) cm × (0.3–)0.5–0.8(–0.9) mm, with sparse to moderately dense ± patent medium to dark red-brown simple eglandular hairs (0.3–)0.8–1.6(–2.0) mm, and occasionally with scattered ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* (6.2–)10.1–16.7(–23.5) × (0.4–)0.7–1.3(–1.6) cm, usually linear-lanceolate, sometimes linear-elliptic, acute to acuminate at apex, usually cuneate (sometimes unequally so), sometimes attenuate at base, entire or crenate, the teeth to 1.5 mm long, coriaceous, with occasional ascending blackish simple eglandular hairs (0.3–)0.4–1.1(–2.0) mm usually on margin only, occasionally also on midvein below and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein rather prominent on the lower surface of the lamina, concolorous with or slightly darker than it; lateral veins sometimes visible in trans-

mitted light, sometimes slightly prominent on either surface when dried, 2–4-forked, the upper branch of the first fork sometimes extending beyond the sorus but never as long as the lower branches, occasionally 1-forked, the lower branch 1–2-forked with the first of these branches sometimes bearing a sorus and extending beyond it, each branch ending marked by a rather small hydathode on the upper surface of the lamina which sometimes bears a white scale, free. *Sori* (0.8–)1.6–3.2(–4.7) × (0.6–)1.1–2.1(–2.5) mm, ± circular to oblong in outline, each oblique to the midvein, usually on the surface of the lamina or sometimes slightly sunken in broad shallow depressions, usually discrete but sometimes contiguous when mature, in two complete and sometimes two incomplete rows, one of each on each side of the midvein in the middle to upper ½–¾ of the lamina but not immediately below the apex, each complete row with (2–)13–27(–35) sori and nearer the midvein than the margin, the incomplete row outside it. *Sporangia* (180–)217–266(–320) μm, with (1–)2–5(–6) dark red-brown rigid hairs (90–)109–193(–250) μm; indurated cells of annulus (8–)10–12(–14). *Spores* (24–)27–37(–48) μm diam.

Distribution. New Guinea.

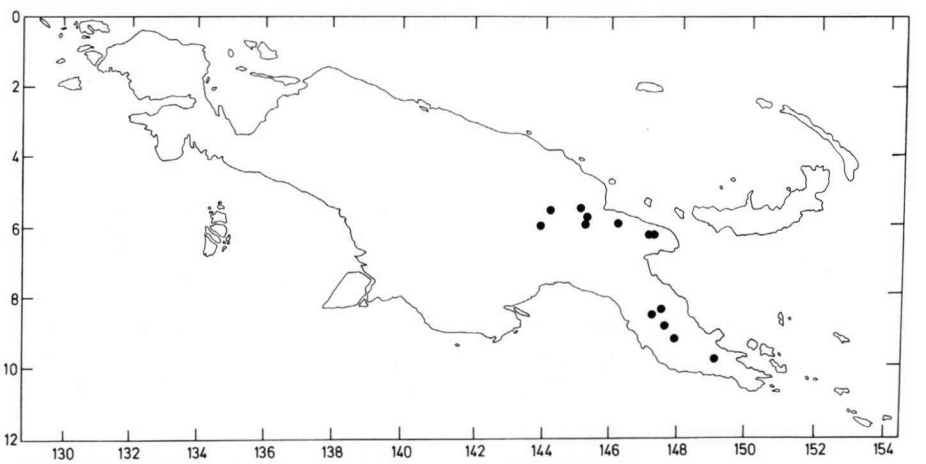
W. HIGHLANDS. Mt Hagen, Parris & Croxall 8092 (BSP, LAE). Tomba Pass, Parris & Croxall 8015 (BSP, LAE).

S. HIGHLANDS. Mt Giluwe, Parris & Croxall 9351 (BSP, LAE).

CHIMBU. Mt Kerigomna, Grubb & Edwards 275 (K). Mt Wilhelm, ANU 7535 (CANB, L, LAE), Brass 30102 (US), 30413 (A, CANB, K, L, LAE, NY, US), 30694 (K, LAE, US), 30744 (A, CANB, K, L, LAE, NY, US), 30803 (K, LAE), Hewson 152 (NSW), Jermy 5295, 5300, 5301, 5307 (all BM), LAE 75484 (LAE), Nakaike 388 (LAE), NGF 39623 (L, LAE), Parris & Croxall 4661 (BSP).

E. HIGHLANDS. Fatima R., Marafunga, LAE 51108 (K).

MADANG. Mt Abilala, Jermy 4304 (BM).



Map 28. *Grammitis archboldii* (21).

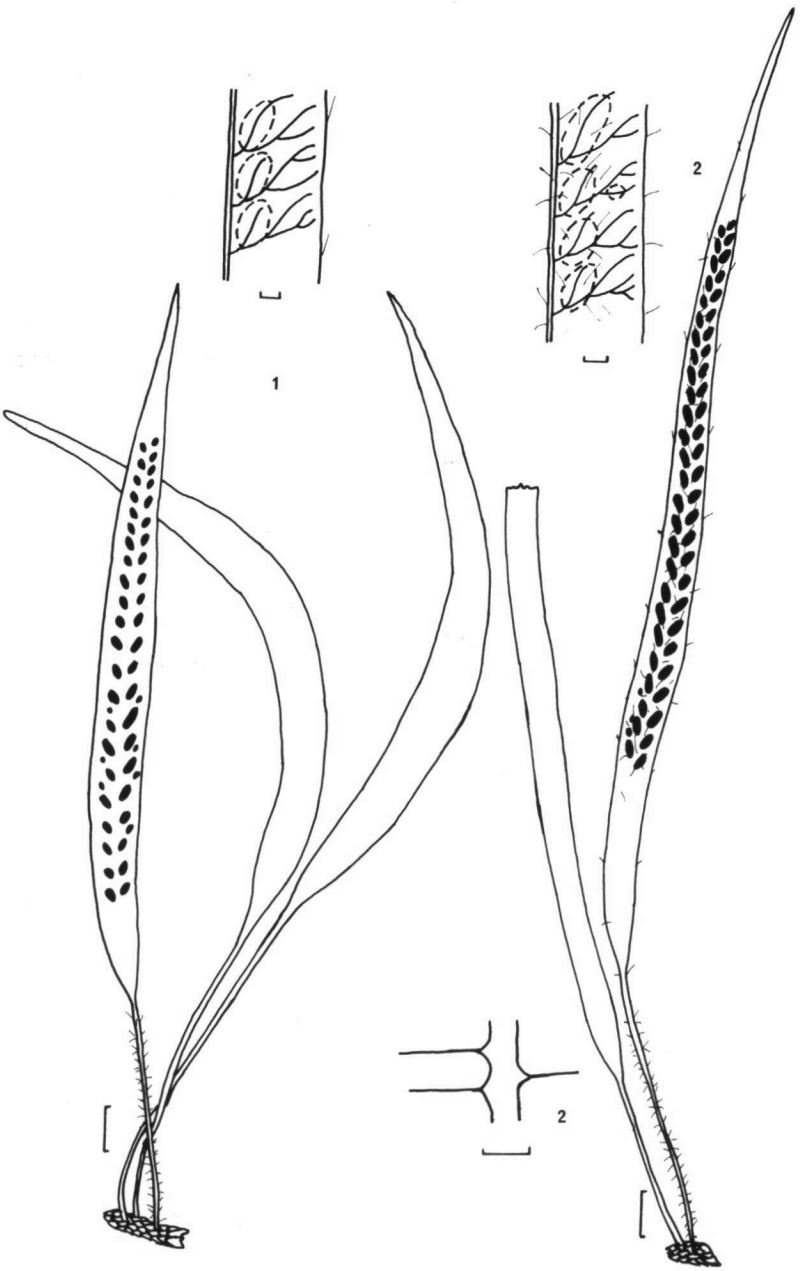


Fig. 14. *G. setosa* group. – 1. *G. archboldii* (21), *Brass 30413* (LAE); 2. *G. scabristipes* (24), *LAE 51481* (LAE); with detail of stipe hairs.

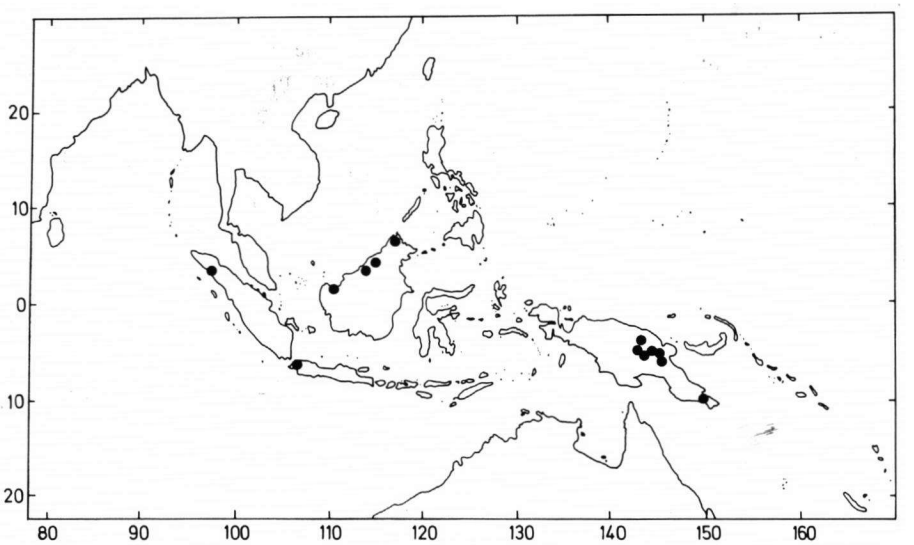
MOROBE. Bolan Mts, Bamler B2 (UC), Keysser 2 (S), B50 (MICH, S, UC). Mt Kumba, Bulldog Road, Fallen 362 (LAE). Rawlinson Ra., Clemens 12472 (MICH, UC).

CENTRAL. Abios, Woitape, Nakaike 600 (LAE). Mt Albert Edward, Brass 4236 (BM, BO, BRI, NY), 4259 (BM, NY), LAE 61386 (K, L, LAE), 61470 (K, L, LAE). Mt Kenevi, LAE 65108 (K, L, LAE, NSW). Mt Tafa, Brass 5093 (BM, BO, BRI, NY), Cheesman 202 (K). Mt Victoria, Isuani Grassland, LAE 61677 (BO, K, L, LAE, NSW, SING), van Royen 10881 (LAE), 10984 (LAE). Neon Basin, LAE 61556 (LAE).

MILNE BAY. Mt Suckling, Veldkamp & Stevens 5739 (L).

Ecology. Occasionally growing together with *G. scabristipes*. Usually epiphytic, usually 1–3 m above ground on tree trunks, less commonly on main branches (including *Mischocarpus*) and on tree-ferns (including *Dicksonia sciurus*), occasionally ± terrestrial with mosses in forest and rupestral in subalpine grassland or on boulders in streams in midmontane, upper montane and subalpine forest; from 2400 to 3800 m.

Note. *G. archboldii* is closely related to *G. scabristipes*, but is distinguished from it by the absence of broad-based stipe hairs.



Map 29. *Grammitis impressa* (22).

22. Grammitis impressa Copel. – Fig. 15; maps 29, 30.

G. impressa Copel., Philip. J. Sc. 80 (1952) 242. – Type: *Bartlett 7964A*, Sumatra, Tapianoeli, Habinsaram (US, holo; UC).

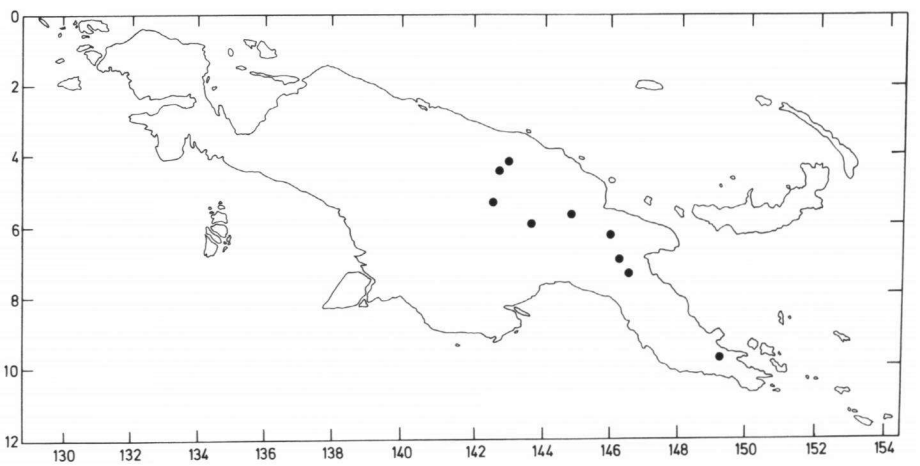
Polypodium locellatum sensu Brause, Bot. Jahrb. 56 (1920) 179.

Polypodium pubinerve sensu Brause, Bot. Jahrb. 56 (1920) 180, quoad *Ledermann 12817a*.

Illustrations: Copel., Philip J. Sc. 80 (1952) f. 95.

Rhizome 3–4 mm diam. with scales, c. 2 mm diam. without scales, erect to short-creeping, unbranched, producing stipes 1–2 mm apart; scales 2.2–4.0 × 0.3–0.8 mm, lanceolate, acute at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.5–)1.8–2.6(–3.0) cm × (0.3–)0.4–0.6(–0.7) mm, with occasional to moderately frequent ± patent dark red-brown simple eglandular hairs (0.4–)0.5–1.7(–2.0) mm. *Lamina* (5.2–)8.0–15.0(–17.1) × 0.5–0.9(–1.1) cm, linear-oblanceolate to linear-elliptic, subacute to obtuse at apex and cuneate to long-attenuate at base, entire, coriaceous, with ± patent dark red-brown simple eglandular hairs (0.5–)0.6–1.7(–2.0) mm occasional to moderately frequent on margin, midvein below and amongst the sori, occasionally scattered on lamina surface below; midvein rather prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, (1–)2-forked, the upper branch of the first fork extending beyond the sorus but shorter than the lower branches, the lower branch usually 1-forked, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* (1.0–)1.2–2.4(–3.0) × 1.0–1.9(–2.1) mm, ± circular to elliptic in outline, each slightly oblique to the midvein, sunken in steepsided pits which lack a slightly prominent rim, discrete to contiguous when mature, in two complete rows and sometimes with fragments (less than half) of two incomplete rows, one complete and one incomplete row on each side of the midvein in the middle or upper ½–¾ of the lamina, each complete row with (9–)15–39(–48) sori, nearer the midvein than the margin. *Sporangia* (160–)212–319(–370) μm, with 1–4(–5) medium to dark red-brown rigid hairs (140–)159–212(–240) μm; indurated cells of annulus (9–)10–12(–14). *Spores* (28–)33–46(–51) μm diam.

Distribution. Sumatra, Borneo, Java and New Guinea.



Map 30. *Grammitis impressa* (22).

E. SEPIK. April R., Ledermann 9720 (B). Felsspitze, Ledermann 12817a (B). Lordberg, Ledermann 10229 (B).

W. HIGHLANDS. Kopiago, NGF 37330 (LAE). Nondugl, NGF 4869 (A, BRI, CANB, K, NSW).

S. HIGHLANDS. Near Mendi, Parris & Croxall 5785 (BSP, LAE).

E. HIGHLANDS. Near Kainantu, LAE 72447 (LAE).

MOROBE. Near Aseki, Johns 3202 (BSP). Langimar R., NGF 42489 (LAE).

MILNE BAY. Mayu R., Mt Suckling, NGF 28840 (LAE).

Ecology. Usually epiphytic on trunks or branches of trees (including *Ficus*), occasionally terrestrial on streambanks or rupestral on mossy stones by streams, usually in lower montane forest (including oak forest), but sometimes in lowland rain-forest; from 165 to 1830 m.

Note. *G. impressa* is related to *G. scabristipes, G. setosa* and *G. tuberculata*; the sori sunken in steepsided pits distinguish it from these species.

23. Grammitis tuberculata Parris, *sp. nov.* – Fig. 15; map 31.

Species pilis in prominentibus parvis conicis laminae a congeneribus diversa. — *Rhizoma* squamis inclusis 2–4 mm diam., squamis exclusis c. 1 mm diam., plus minusve erectum, eramosum, stipitibus aggregatissimis; squamae 1.0–2.0 mm longae, 0.2–0.4 mm latae, lanceolatae vel anguste lanceolatae, ad apicem acutae, pallidae rubriusculo-brunneae, glabratae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* (2.5–)3.1–4.7(–5.2) cm longus, 0.2–0.5 mm latus, pilis simplicibus eglandulosis 1.0–3.0 mm longis moderate numerosis plus minusve patentibus mediis vel obscure rubriusculo-brunneis interdum ad basem latis vestitus. *Lamina* 8.0–15.5 cm longa, 0.4–0.9 cm lata, lineari-elliptica vel lineari-oblanceolata, ad apicem acuta, ad basem attenuata vel longe attenuata, integra, coriacea, pilis simplicibus eglandulosis 1.0–3.0 mm plus minusve patentibus mediis vel obscure rubriusculo-brunneis in prominentibus parvis conicis laminae per laminam, medio-vena ad paginam infernam laminae paulo prominens et pagina inferna laminae concolor; venae laterales plerumque in luce transmissa non manifestae, 1–2-furcatae, ramus superus ultra sorum procurrens et plus minusve longitudine ramum inferum aequans ubi 1-furcatae, ubi 2-furcatae ramus superus quam ramos inferos brevior, rami terminales in pagina supera laminae sine hydathodis manifestis, liberi. *Sori* 1.5–2.7 mm longi, 1.1–2.3 mm lati, in ambitu circulares vel ovales, ad medio-venam obliqui vel paralleli, in lacunis margine parum prominenti impressi, discreti ubi maturi, in 2 serialibus, 1 utroque medio-venae in 1/3–3/4 supero laminae, in quoque seriali 5–38+ sori plus minusve inter medio-venam et marginem aequidistantes. *Sporangia* (230–)261–320(–370) μm longa, pilis 1–3 obscure rubriusculo-brunneis rigidis (170–)223–519(–600) μm longis praedita; cellulae induratae annuli (8–)10–12(–13). *Sporae* (32–)39–51(–60) mm diam. — Typus: *Vink 17495*, 23.viii.1966, Lei River (south-east foot of Mt Ambua), Tari Subdistrict, Enga District, Papua New Guinea (L).

Rhizome 2–4 mm diam. including scales, c. 1 mm diam. without scales, ± erect, unbranched, the stipes very crowded; scales 1.0–2.0 × 0.2–0.4 mm, lanceolate to narrowly lanceolate, acute at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (2.5–)3.1–4.7(–5.2) cm × 0.2–0.5 mm, with moderately frequent ± patent medium to dark red-brown simple eglandular hairs 1.0–3.0 mm occasionally broadened at the base. *Lamina* 8.0–15.5 × 0.4–0.9 cm, linear-elliptic to linear-oblanceolate, acute at apex, attenuate to long-attenuate at base, entire, coriaceous, with sparse to moderately frequent ± patent medium to

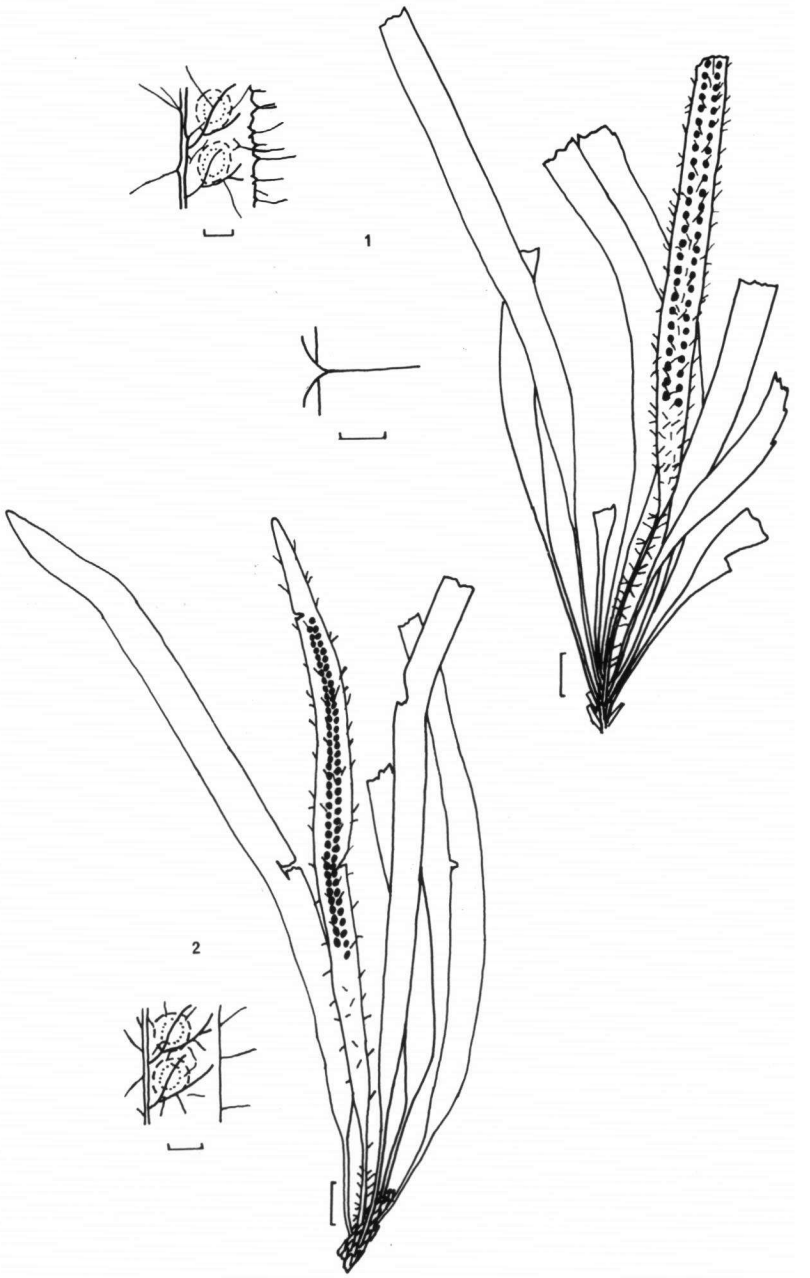
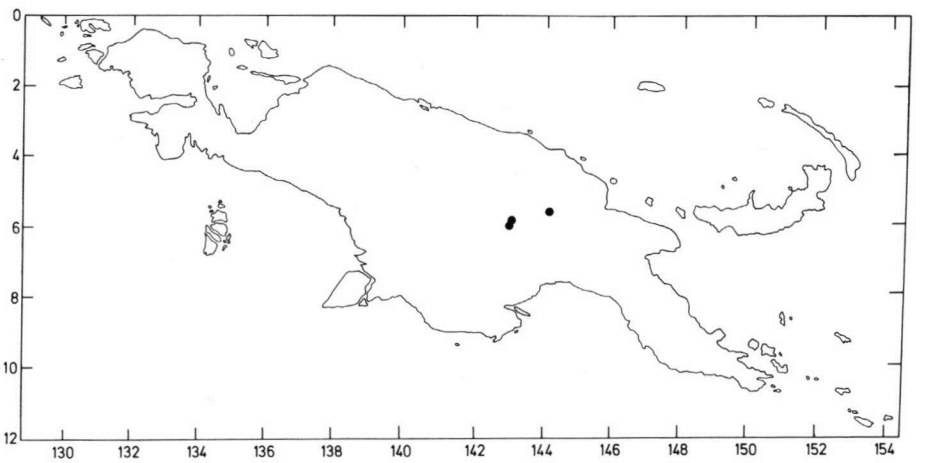


Fig. 15. *G. setosa* group. – 1. *G. tuberculata* (23), holotype, *Vink 17495* (L); 2. *G. impressa* (22), *NGF 42489* (LAE).

dark-red simple eglandular hairs 1.0–3.0 mm on small conical laminar projections on all parts of the lamina; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins usually invisible in transmitted light, 1–2-forked, the upper branch extending beyond the sorus and ± as long as the lower branch when the latter is not forked but shorter than it when it is forked, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.5–2.7 × 1.1–2.3 mm, ± circular to oval in outline, each parallel to or oblique to the midvein, sunken in steep-sided pits which may have a slightly prominent rim, discrete when mature, in two rows, one on each side of the midvein in the upper 1/3–3/4 of the lamina, each row with 5–38+ sori, ± midway between the midvein and the margin. *Sporangia* (230–)261–320(–370) μm, with 1–3 dark red-brown rigid hairs (170–)223–519(–600) μm; indurated cells of annulus (8–)10–12(–13). *Spores* (32–)39–51(–60) μm diam.

Distribution. New Guinea.



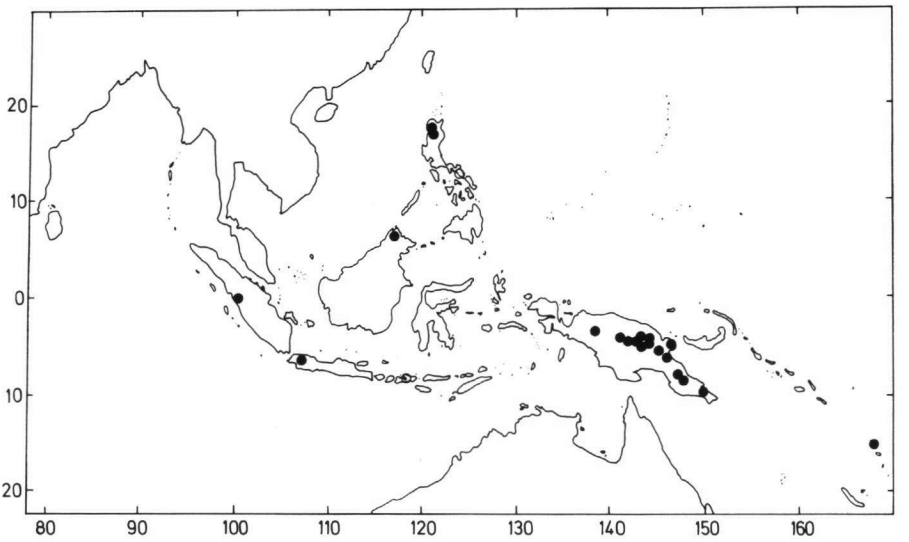
Map 31. *Grammitis tuberculata* (23).

W. HIGHLANDS. Mt Hagen, Parris & Croxall 8077 (BSP, LAE). Tomba Pass, Parris & Croxall 8014 (BSP).

ENGA. Ibiwara, Vink 17032 (L). Lei R., Tari, Vink 17495 (L). Tari Gap, Parris & Croxall 9459 (BSP, LAE).

Ecology. Epiphyte rather high up on tree trunks and branches in midmontane forest (including *Nothofagus* forest); from c. 2550 to 2780 m.

Notes. *G. tuberculata* is closely related to *G. scabristipes* and *G. impressa*, but can be distinguished from both by the presence of lamina hairs on small conical laminar projections.



Map 32. *Grammitis scabristipes* (23).

24. Grammitis scabristipes (Baker) Copel. – Fig. 14; maps 32, 33.

G. scabristipes (Baker) Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 178. – *Polypodium scabristipes* Baker, J. Bot. (London) 28 (1890) 108. – Type: *Macgregor 32* (K, holo).

Polypodium ludens Baker, Ann. Bot. 8 (1894) 129. – *G. ludens* Copel., Gen. Fil. (1947) 211. – Type: *Hancock 53a*, Java (K, holo).

Polypodium bulbotrichum Copel., Philip. J. Sc. 40 (1929) 309. – *G. bulbotricha* Copel., Philip. J. Sc. 46 (1931) 219; ibid. 80 (1952) 223. – Lectotype: *E.B. Copeland's Pteridophyta Philippensia Exsiccata 136*, Philippines, Luzon, Mountain province, Benguet, Mt Pulog (MICH; iso BM, BO, K, SING, UC).

G. limapes Copel., Philip. J. Sc. 46 (1931) 218; ibid. 80 (1952) 223. – *Polypodium limapes* C. Chr., Index Filicum Suppl. 3 (1934) 152. – Lectotype: *Copeland s.n.*, Java, G. Gede, Panggrango (MICH; iso BM, BO, UC).

G. novoguineensis Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 178. – Type: *Bamler B41* (UC, holo).

Polypodium diplosorum forma *grammitoides* Rosenst. ex Copel., Philip. J. Sc. 80 (1952) 178, nom. nud. in syn.

Illustrations: Copel., Philip. J. Sc. 80 (1952) 178, f. 47 et 179, f. 48 as G. novoguineensis et 223, f. 83 as G. limapes et 224, f. 84 as G. bulbotricha.

Rhizome 2–5 mm diam. including scales, 1–3 mm diam. without scales, short to long-creeping, sometimes branched, producing stipes 1–5 mm apart; scales (1.2–) 2.1–3.7(–5.0) × (0.4–)0.5–0.9(–1.4) mm, lanceolate to ovate-lanceolate, subacute to acute at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.7–)3.8–8.6(–13.2) cm × (0.4–)0.6–1.0

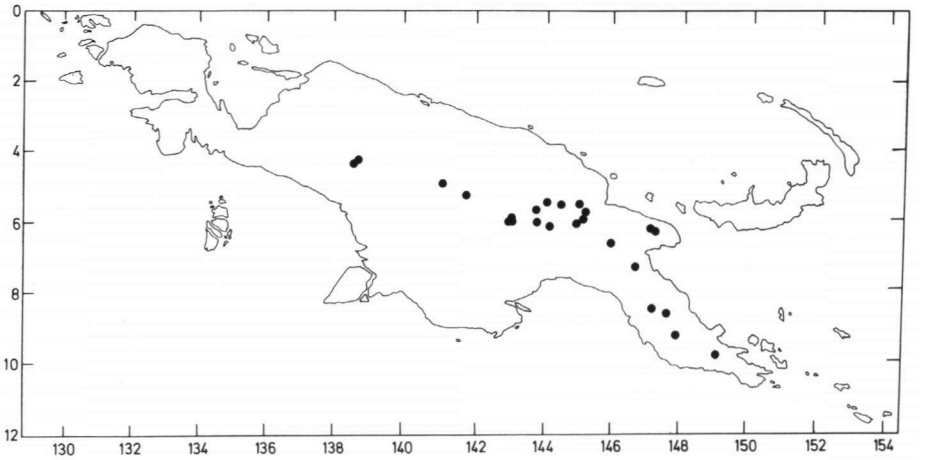
(–1.3) mm with scattered to moderately dense ± patent medium to dark red-brown simple eglandular hairs (0.7–)0.8–2.6(–5.0) mm markedly broadened at the base which is 0.1–0.3 mm high, the upper part of the hairs sometimes missing in old specimens so that only the broadened base remains on the stipe, and occasionally a few ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* (1.5–)9.8–20.4(–31.9) × (0.2–)0.5–1.0(–1.5) cm, linear-lanceolate to linear-oblanceolate, acute to acuminate at apex and cuneate to attenuate at base, entire or occasionally lobed, the lobes up to 2 cm long, coriaceous, with ± patent medium to dark red-brown simple eglandular hairs (0.3–)0.7–1.5(–3.0) mm moderately frequent to absent on the midvein of the upper surface of the lamina, sometimes moderately frequent on the margin, the midvein below and amongst the sori and scattered or absent on the lower surface of the lamina, sometimes very sparse on the margin and midvein beneath and absent from lamina undersurface, sometimes occasional on margin only, and occasional to scattered ± appressed whitish simple clavate-glandular hairs less than 0.1–0.2 mm on young unrolling fronds; midvein rather prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins invisible in transmitted light, occasionally slightly prominent on either surface when dried, 2–4-forked, the upper branch of the first fork usually extending a little beyond the sorus, rarely ± as long as the lower branch, the lower branch of the first fork 1–3-forked, sometimes the lower branch of the second fork bearing a sorus, rarely ± as long as the lower branch, the lower branch of the first fork 1–3-forked, sometimes the lower branch of the second fork bearing a sorus but extending beyond it, each branch ending marked by a small hydathode on the upper surface of the lamina which occasionally bears a white scale, free. *Sori* (1.3–)1.6–4.8(–9.0) × (0.8–)1.3–2.5(–3.2) mm, ± circular to oblong in outline, sometimes curved, each oblique to the midvein, usually on surface of lamina, occasionally slightly sunken in broad shallow depressions, discrete to contiguous when mature, in two complete and sometimes fragments (less than half) of two incomplete rows, one of each on each side of the midvein in the middle to upper 1/2–5/6 of the lamina but not immediately below the apex, each complete row with (2–)12–29(–48) sori and nearer the midvein than the margin, the incomplete row outside it. *Sporangia* (210–)231–297 (–380) μm, with 1–3(–5) medium to dark red-brown rigid hairs (100–)156–264 (–360) μm; indurated cells of annulus (8–)10–12(–16). *Spores* (22–)29–44(–71) μm diam.

Distribution. Sumatra, Borneo, Java, Philippines, Lesser Sunda Islands (Sumbawa, fide Copeland, 1952a), New Guinea and New Hebrides.

CENTRAL IRIAN JAYA. Danau Habbema, Brass 9102 (BM, BO, GH, L, LAE, MICH, NSW, UC), 11432 (GH, L, MICH). Punjak Trikora, Brass 9676, 9849 & Meijer Drees (both BO, GH, L, MICH), 9853 (BM, BO, GH, MICH).

W. SEPIK. Dagabulon, Star Mts, Veldkamp 6636 (LAE). Mt Amdutakin, Kalkman 5264 (L, LAE). Mt Scorpion, Star Mts, LAE 68006 (K, LAE).

W. HIGHLANDS. Baiyer-Jimi divide, Parris & Croxall 9194 (BSP). Minj-Nona divide, Kubor Ra., Pullen 5015 (CANB, LAE). Mt Hagen, Parris & Croxall 8093 (BSP, LAE). Mt Kinkain, Kubor Ra., Vink 16131a (L). Tomba Pass, Parris & Croxall 8016 (BSP, LAE).



Map 33. *Grammitis scabristipes* (24).

ENGA. Ibiwara, Vink 17017 (NSW), 17018 (L), 17030 (L, LAE). Mt Ambua, Kalkman 5065a (L), 5084 (L, LAE), NGF 28196 (K). Mt Kerewa, Vink 17056 (L). Tari, NGF 28368 (LAE). Tari Gap, Croft 551 (CROFT, LAE). The Sugarloaf, Hoogland & Schodde 7103 (A, CANB, L, LAE, NSW).

S. HIGHLANDS. Mt Ialibu, LAE 55861 (LAE). Mt Giluwe, Parris & Croxall 5818, 5911, 8201, 9358 (all BSP, LAE).

CHIMBU. Mt Kerigomna, Grubb & Edwards 275 (CGE, L, LAE). Mt Wilhelm, ANU 7535 (L), Brass 30413 (LAE, US), 30803 (K, LAE, US), Hewson 135, 152 (both NSW), Jermy 5300, 5305–5307, 5310 (all BM), NGF 47374, 47383 (both LAE), Parris & Croxall 4683 H 288 (BSP, LAE).

E. HIGHLANDS. Daulo Pass, Rau 85 (BULOLO). Fatima R., Marafunga, Grubb & Edwards 174 (CGE, LAE), LAE 51108 (K, LAE). Mt Michael, Johns 1298 (BULOLO). Mt Piora, Croft 88 (BSP, CROFT, K, LAE), NGF 16586 (K, L, LAE), 19026 (LAE).

MOROBE. Bolan Mts, Bamler B41 (UC), Keysser 41, 47 (both S). Edie Creek, Jermy 3493, 3494 (both BM), Walker 7638–7640 (all BM). Monkumbion, Sarawaket Ra., Hoogland 9759 (CANB), Gimdoh, Sarawaket Ra., Hoogland 9960 (CANB, L, LAE). Mt Sarawaket, Clemens s.n. (MICH). Rawlinson Ra., Clemens 12472bis (MICH). Upper Camp A, Clemens s.n. (MICH).

CENTRAL. Mt Kenevi, LAE 65220 (L, LAE). Mt Scratchley, LAE 51481 (K, LAE). Mt Tafa, Brass 5094 (BM, BO, GH, NY). Neon Basin, LAE 61556 (K). Owen Stanley Ra., Macgregor 32 (K).

MILNE BAY. Mt Suckling, Veldkamp & Stevens 5739 (L).

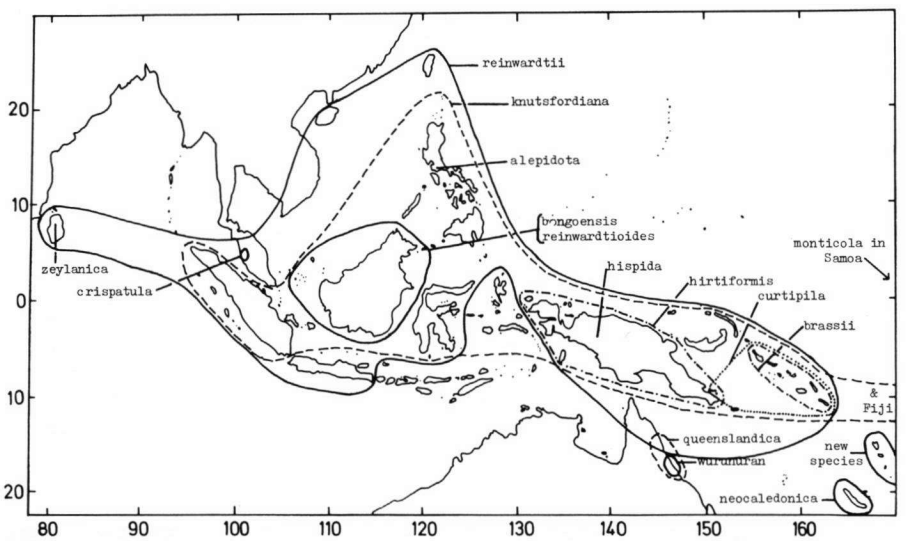
Ecology. Occasionally growing with *G. archboldii*. Erect to pendulous epiphyte usually on the trunks of trees but sometimes on high branches (including *Mischocarpus* and *Saurauia*), occasionally on tree-ferns (*Cyathea* spp., including *C. atrox*), in midmontane forest (including *Trema/Dimorphanthera, Nothofagus* and podocarp forest), upper montane forest, subalpine forest and subalpine shrubland, occasionally in secondary forest and forest on limestone or in subalpine grassland, sometimes terrestrial in montane to subalpine forests, rarely rupestral in caves, on landslips or on boulders in streams; from 2200 to 3800 m.

Notes. Vernacular name: mururu (Enga language, Poio).

The fronds are said to be bluish green when fresh (*Brass 9849*) but this colouration is certainly not characteristic of the species as I have seen it in the field. The density and length of the stipe hairs, the height of their broadened bases, the density, length and distribution of the lamina hairs, the shape of the sori and the presence of fragments of two additional rows of sori are variable in *G. scabristipes*, but the extremes of each state and intermediates between them in every combination were found in all the populations examined. *G. novoguineensis* was described from a large specimen with long sori and fragments of two extra rows of sori.

7. G. reinwardtii group – Species 25–29
Figs. 16, 17; maps 34–41; table 7

Rhizome erect to long-creeping; scales ovate to lanceolate, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* with pale yellow to dark red-brown simple eglandular hairs 0.2–4.0 mm. *Lamina* entire to crenate, membranous to coriaceous, with pale to dark red-brown simple eglandular hairs 0.2–4.5 mm, sometimes with stout pale yellow simple eglandular hairs up to 0.2 mm and simple clavate-glandular hairs; lateral veins sometimes visible in transmitted light, 1–3-forked, the first upper branch shorter than the lower ones, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina. *Sori* ± circular in outline, on surface of lamina or slightly sunken in broad shallow depressions, in two rows.



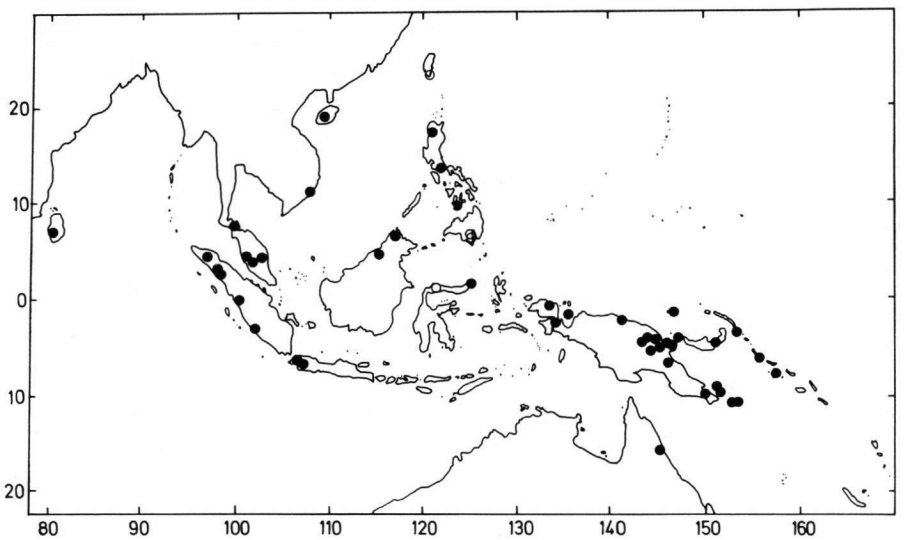
Map 34. *G. reinwardtii* species group.

Table 7. Characters of taxonomic importance within the *G. reinwardtii* species group in New Guinea.

Characters	*G. reinwardtii*	*G. hirtiformis*	*G. curtipila*	*G. knutsfordiana*	*G. hispida*
Lamina	entire to crenate	entire	entire	usually entire, sts crenate	sl. crenate
Lamina hairs (simple eglandular) in mm	scattered to frequent on margin, midvein below and amongst sori, absent or occ. to frequent elsewhere on lamina (0.3–) 0.7–2.3(–3.5)	occ. to sparse on margin, midvein below and amongst sori, sts sparse on midvein above and occ. on lateral veins below (0.5–)0.8–2.8(–4.5)	usually mod. frequent on all parts, sts sparse on lamina above, occ. on margin and mod. frequent on midvein below 0.2–0.3	occ. to frequent on margin, midvein below and amongst sori, sts also on lamina above, sts scattered on lateral veins below, sts frequent on both surfaces (0.4–) 0.8–2.6(–4.5)	frequent on both surfaces 0.5–1.0
Lateral veins	usually visible in transmitted light and sl. prominent on lower surface when dried, 1(–2)-forked, upper branch us. ending in sorus	visible in transmitted light and sl. prominent on both surfaces when dried, 1-forked, upper branch ending in sorus	usually invisible in transmitted light and not prominent on either surface when dried, 1-forked, upper branch sts extending beyond sorus	± visible in transmitted light and prominent on either or both surfaces when dried, 2–3-forked, upper branch sts extending beyond sorus	± visible in transmitted light and prominent on both surfaces when dried, 2–3-forked, upper branch sts extending beyond sorus
Spores in μm	(16–)25–37(–61)	(15–)21–29(–31)	(24–)27–37(–41)	(17–)21–36(–46)	(19–)21–31(–42)

Epiphytic, rupestral or terrestrial, in lower montane, midmontane and subalpine forest. Distribution from Ceylon to Taiwan, Australia and Samoa with five species in New Guinea, two of which are endemic, one to Irian Jaya Highlands and one to PNG Highlands.

The extra-New Guinea members of this group are *G. alepidota* M.G. Price, *G. bongoensis* (Copel.) Copel., *G. brassii* Copel., *G. crispatula* Holttum, *G. monticola* Sledge, *G. neocaledonica* Copel., *G. queenslandica* Parris, *G. reinwardtioides* Copel., *G. wurumuran* Parris, *G. zeylanica* Fée and one undescribed species.



Map 35. *Grammitis reinwardtii* (25).

25. Grammitis reinwardtii Blume – Fig. 16; maps 35, 36.

G. reinwardtii Blume, Enum. Pl. Javae Addend. (1828) [2]; Copel., Philip. J. Sc. 80 (1952) 236. – *Polypodium reinwardtii* C. Presl, Tentamen (1836) 180. – Lectotype: *Reinwardt s.n.*, Celebes, G. Klabat (L).

Polypodium sucklingianum Baker, Ann. Bot. 8 (1894) 128; Copel., Philip. J. Sc. 80 (1952) 187. – *G. sucklingiana* Parris, Fern Gaz. 12 (1980) 118. – Type: *Macgregor s.n.*, Papua New Guinea, Mt Suckling (K, holo).

Polypodium trichopodum var. *serratolobatum* Brause, Bot. Jahrb. 50 (1920) 179. – Lectotype: *Ledermann 11576* (B).

G. mariae Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 189. – Type: *Clemens 10251a* (MICH, holo).

G. matapensis Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 191. – Type: *Clemens 11176* (MICH, holo; BM, MICH, UC).

Polypodium hirtellum sensu Brause, Bot. Jahrb. 56 (1920) 180, quoad *Ledermann 8456, 10145, 11699 p.p. et 12660.*

Illustrations: Blume, Flora Javae 2 (14 April 1830) pl. 48, f. 1; Copel., Philip. J. Sc. 80 (1952) 190, f. 58 as G. mariae et 191, f. 60 as G. matapensis et 237, f. 93; Parris, Bot. J. Linn. Soc. 70 (1975) 42, f. 5, C & D.

Rhizome 1–5 mm diam. including scales, 0.5–1.0 mm without scales, ± erect to short-creeping, unbranched, producing stipes up to 2 mm apart; scales (0.6–)1.2–2.4 (–3.0) × (0.3–)0.4–0.7(–0.8) mm, ovate to lanceolate, acute to obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.1–)0.5–1.8(–2.6) cm × 0.2–0.4(–0.7) mm, with scattered to frequent ± patent pale to dark red-brown, occasionally pale yellow, simple eglandular hairs (0.4–)0.7–1.8(–3.0) mm. *Lamina* (1.5–)3.6–9.2(–15.5) × (0.3–)0.4–0.8(–1.0) cm, linear-lanceolate to linear-oblanceolate, subacute to acuminate at apex and cuneate to long-attenuate at base, entire to crenate, the teeth up to 4.0 mm long, membranous to slightly coriaceous, with ± patent medium to dark red-brown simple eglandular hairs (0.3–)0.7–2.3(–3.5) mm scattered to frequent on margin, midvein beneath and amongst the sori, sometimes shorter on the margin than elsewhere on the lamina, absent or occasional to frequent elsewhere on both surfaces of the lamina, sometimes similar but binate hairs scattered on margin, occasionally with very sparse appressed stout pale yellow simple eglandular hairs 0.1–0.2 mm on the lower surface of the lamina; midvein ± prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins usually visible in transmitted light, often slightly prominent on the lower surface when dried, 1(–2)-forked, the upper branch usually not extending beyond the sorus and much shorter than the lower branch, which is occasionally 1-forked, each branch ending occasionally marked by a small hydathode on the upper surface of the lamina, free. *Sori* (0.6–)1.0–1.8(–2.5) × (0.6–)0.8–1.6(–2.5) mm, ± circular in outline, on surface of lamina or very slightly sunken in broad shallow depressions, discrete to confluent when mature, in two rows, one on each side of the midvein in the middle to upper 1/2–4/5 of the lamina, each row with (1–)6–25(–52) sori, much nearer the midvein than the margin. *Sporangia* (150–)183–232(–260) μm, with 1–3(–6) usually medium to dark red-brown, occasionally pale yellow, rigid hairs (140–)190–332(–530) μm; indurated cells of annulus (7–)10–12(–15). *Spores* (16–)25–37(–61) μm diam.

Distribution. Ceylon, mainland Southeast Asia including peninsular Thailand, Hainan, peninsular Malaysia, Sumatra, Borneo, Java, Taiwan (fide De Vol, 1975), Philippines, Celebes, New Guinea, Australia and Solomon Islands.

VOGELKOP PENINSULA. Netoti Ra., van Royen & Sleumer 7969 (L). Wondiwoi Mts, Mayr 316 (BO).

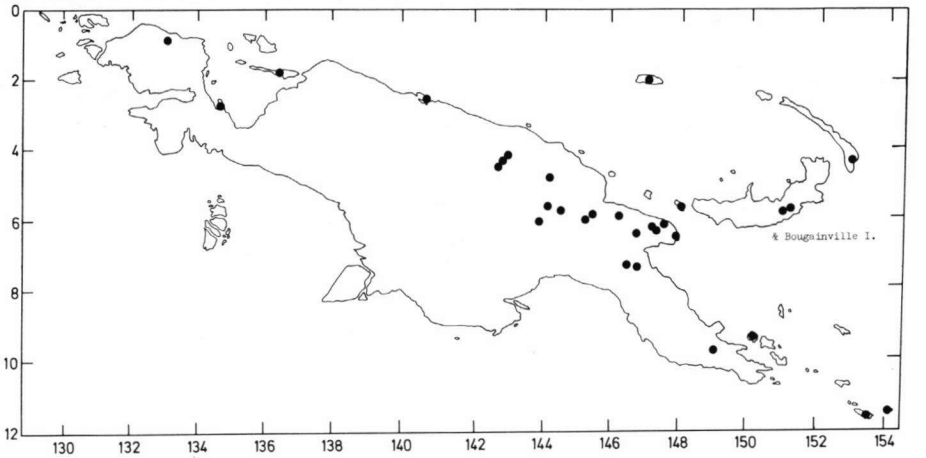
JAPEN I. Mt Oudia, Cheesman s.n. (BM).

CYCLOPS MTS. Mt Baboko, van Royen 3736 (L). Peg. Cycloop, Cheesman s.n. (BM).

E. SEPIK. Felsspitze, Ledermann 12660a (B), Hollrungsberg, Ledermann 11699 (B). Lehm R., Ledermann 11576 (B). Lordberg, Ledermann 10145 (B). Mt Hunstein, Ledermann 8456 (B), 11102 (B).

W. HIGHLANDS. Kum Forest, Mt Hagen, Parris & Croxall 8155 (BSP, LAE). Mt Hagen, Parris & Croxall 8148 (BSP). Tomba Pass, Parris & Croxall 8054 (BSP, LAE).

S. HIGHLANDS. Mt Giluwe, Parris & Croxall 8205 (BSP, LAE).



Map 36. *Grammitis reinwardtii* (25).

E. HIGHLANDS. Fatima R., Marafunga, LAE 51107 (K, LAE). Omahaiga, Mt Otto, Robbins 841 (CANB).

MADANG. Moro, Jermy 4108 (BM). Mt Schrader, Ledermann 11631a (B). Sewe, Jermy 3977 (BM). Sewe to Tregbury Pass, Walker 8617–8620, 8660–8664 (all BM).

MANUS. Mt Dremsel, Grether & Wagner 4186 (K, MICH).

MOROBE. Ekuti Ra., Parris & Croxall 7982 (BSP, LAE), Unkau 66 (BULOLO). Kawalong to Alambuban, Clemens s.n. (MICH). Mannahaset, Cromwell Mts, Hoogland 9657 (CANB). Marsh Meadow Camp, Clemens s.n. (BM). Matap, Clemens 11176 (BM, MICH, UC), 40969 (MICH, UC), 40992 (E, L, MICH, UC), 41018 (MICH). Mt Kaindi, Parris & Croxall 4682 L 162 (BSP, LAE), Parris 9548 (BSP, LAE). Ogao, Mt Sarawaket, Clemens 10251a (MICH). Rawlinson Ra., Clemens s.n., 12446a (both MICH). Rooke Umboi I., Bamler R 31 (BM, S, UC). Sattelberg, Keysser 287 (S).

MILNE BAY. Goodenough I., Brass 24587 (A, CANB, L). Mt Riu, Tagula I., Brass 27881 (A, K, L, LAE), Croft 787 (BSP, CROFT, LAE). Mt Suckling, Macgregor s.n. (K), Veldkamp & Stevens 5615 (L, LAE). Rossel I., Croft 806 (BSP, CROFT, LAE).

E. NEW BRITAIN. Mt Lululua, LAE 58392 (K, L, LAE). Mt Sule, NGF 13185 (K, L, LAE).

NEW IRELAND. Taron, Croft 212 & Sands (K), Croft 214 & Sands (BSP, CROFT, K, LAE).

BOUGAINVILLE. L. Loloru, NGF 31430 (LAE).

Ecology. Usually epiphytic, usually low on trunks of saplings or on slender low branches (including *Saurauia*), sometimes on trunks of larger trees and tree-ferns (*Cyathea*), occasionally in crowns of trees, rarely rupestral on rocks in streambeds, in lower montane and midmontane forests (including oak, *Eugenia, Nothofagus, Podocarpus, Rapanea, Rhododendron, Xanthomyrtus*), occasionally in secondary forest; from c. 400 to 3660 m.

Notes. A rather variable species varying in the depth of lamina lobing and the colour of the stipe hairs, but as the extremes of lobing may be found on the same plants and intermediates in hair colour occur in the same population it is not possible to maintain these extremes as distinct taxa. *Polypodium sucklingianum, P. trichopo-*

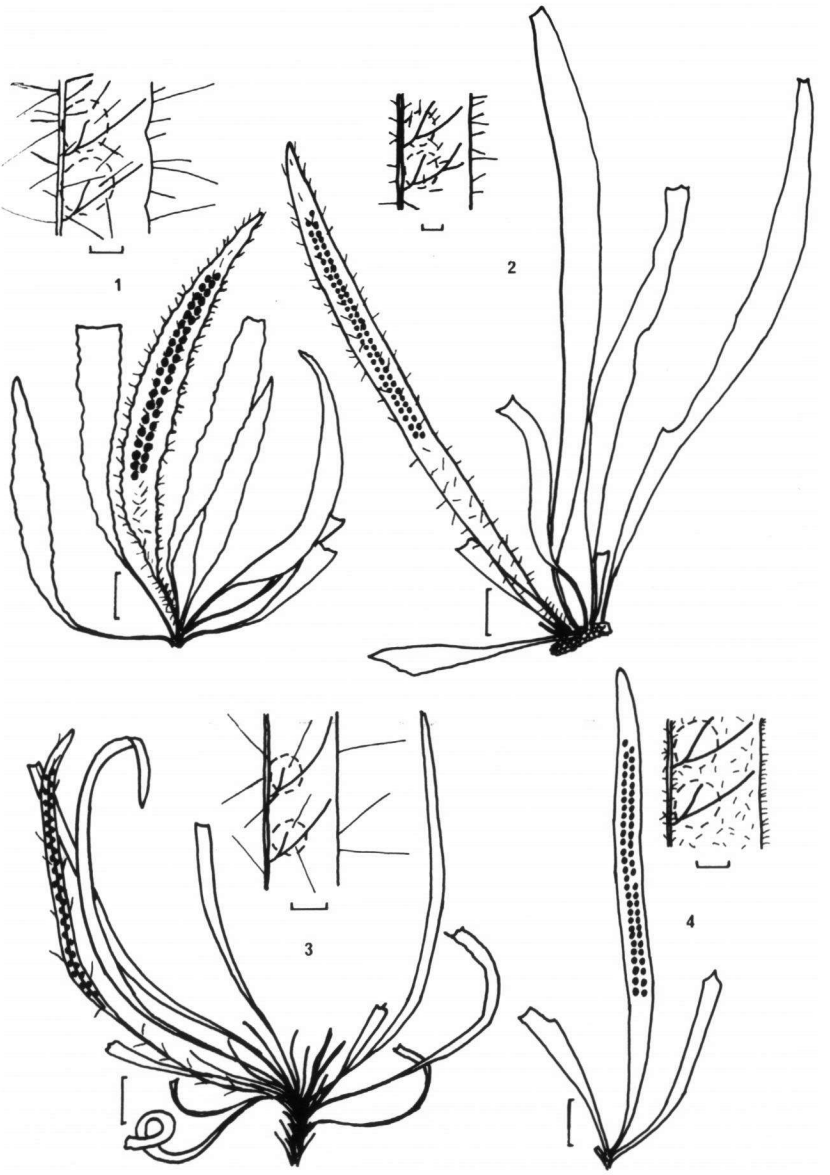


Fig. 16. *G. reinwardtii* group. – 1. *G. reinwardtii* (25), *Parris & Croxall 7982* (BSP); 2. *G. reinwardtii* (25), *Brass 27881* (LAE); 3. *G. hirtiformis* (26), isolectotype, *Keysser B 48* (UC); 4. *G. curtipila* (27), *Croft 527* (LAE).

dum var. *serratolobatum* and *G. mariae* were described from deeply lobed specimens and the type of *G. reinwardtii* is slightly crenulate. *G. matapensis* was based on plants with the lamina entire.

I have been unable to trace *Ledermann 11108*, recorded as *Polypodium hirtellum* by Brause in Bot. Jahrb. 56: 180 (1920), but presume that it belongs either to *G. reinwardtii*, as do the majority of specimens cited under this name, or to *G. sumatrana*.

26. Grammitis hirtiformis (Rosenst.) Copel. – Fig. 16; map 37.

G. hirtiformis (Rosenst.) Copel., Philip. J. Sc. 80 (1952) 190. – *Polypodium hirtiforme* Rosenst., Feddes Repert. 12 (1913) 176. – Lectotype: *Keysser B 48* (S; iso BM, UC).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 191, f. 59.

Rhizome 3–4(–8) mm diam. including scales, 0.5–2.0 diam. without scales, erect to short-creeping, producing stipes less than 1 mm apart, sometimes dividing to form a clump with the stipes very crowded; scales c. 10 × 0.3–0.5 mm, ovate to ovate-lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.7–)0.9–2.1(–2.8) cm × 0.2–0.3 mm, with scattered ± patent medium to dark red-brown simple eglandular hairs (0.7–)1.0–2.4(–2.5) mm. *Lamina* (4.4–)6.4–11.2(–15.2) × (0.2–)0.3–0.5(–0.6) cm, linear to very narrowly elliptic, subacute to acuminate at apex and long-attenuate at base, entire, membranous to coriaceous, with occasional to sparse ± patent medium to dark red-brown simple eglandular hairs (0.5–)0.8–2.8(–4.5) mm on margin and midvein below and amongst sori, sometimes also sparse on midvein above and occasional on the lateral veins below; midvein slightly prominent on the lower surface of the lamina, usually darker than but sometimes concolorous with it; lateral veins visible in transmitted light, slightly prominent on both surfaces of the lamina when dried and sometimes darker than it, 1-forked, the upper branch ending in the sorus, the lower branch usually at a markedly acute angle to the midvein and often curving upwards along the margin, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* (0.8–)0.9–1.7(–2.2) × (0.4–)0.8–1.6(–1.7) mm, ± circular in outline, on the surface of the lamina, discrete to contiguous when mature, in two rows, one on each side of the midvein in the middle 1/4–2/3 of the lamina, each row with (4–)9–25(–30) sori, much nearer the midvein than the margin. *Sporangia* (160–)179–219(–250) μm, with 1–5(–7) pale to dark red-brown rigid hairs (140–)183–455(–630) μm; indurated cells of annulus (8–)10–12(–15). *Spores* (15–)21–29(–31) μm diam.

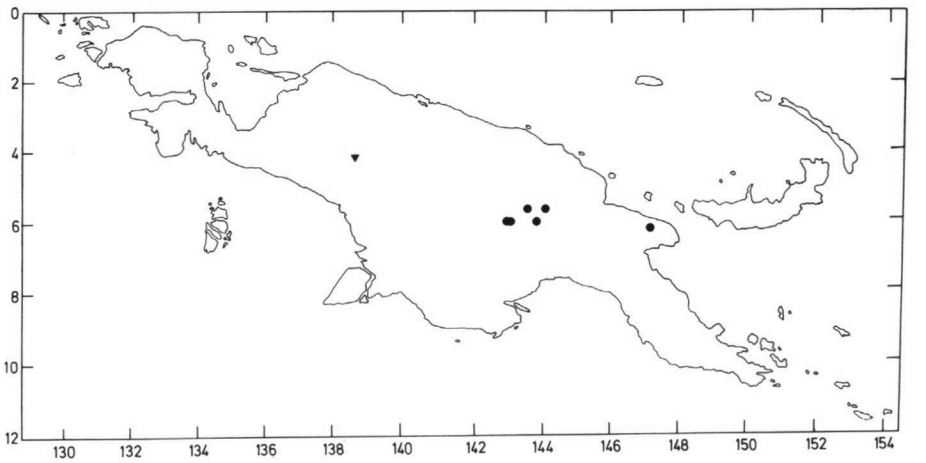
Distribution. New Guinea.

W. HIGHLANDS. Tomba Pass, Parris & Croxall 8018 (BSP, LAE).

ENGA. Ibiwara, Vink 16926 (L), 17020 (LAE). Tari Gap, Parris & Croxall 9460 (BSP, LAE). Yobobos grassland, Hoogland & Schodde 7677 (CANB, L, LAE).

S. HIGHLANDS. Mt Giluwe, Parris & Croxall 8252, 9320 (both BSP, LAE).

MOROBE. Bolan Mts, Keysser B 48 (BM, S, UC). Mt Sarawaket, Clemens 6233, 6236 (both BM).



Map 37. ● *Grammitis hirtiformis* (26), ▼ *G. hispida* (29).

Ecology. Epiphytic on branches or on tree-fern stems (including *Dicksonia sciurus*), in midmontane forest (including *Nothofagus*, coniferous and mixed forest); from 2500 to 2900 m.

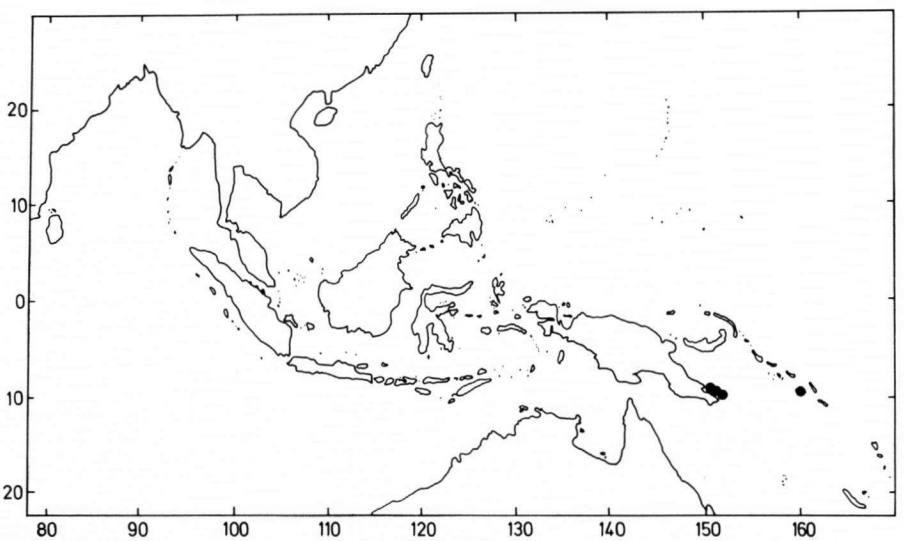
Notes. *G. hirtiformis* is a relative of *G. reinwardtii*, from which it is distinguished by its less frequent lamina hairs and usually narrower lamina.

27. Grammitis curtipila Parris, *sp. nov.* – Fig. 16; maps 38, 39.

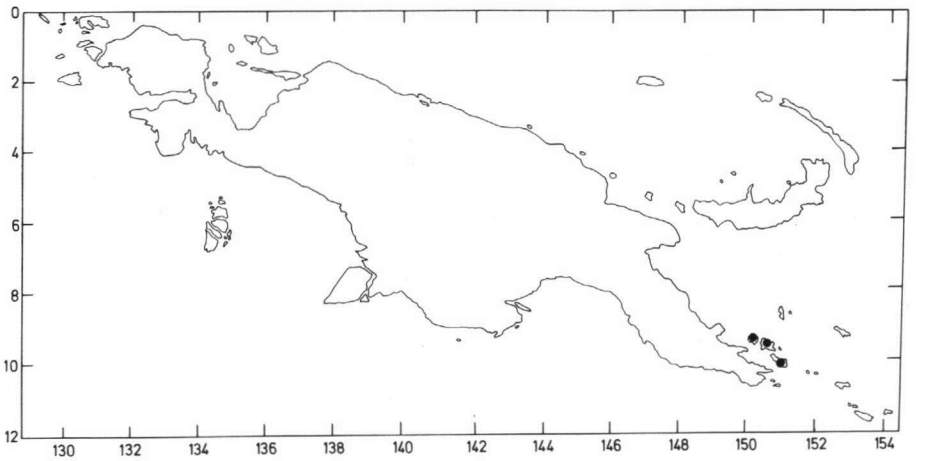
G. reinwardtii et G. brassii affinis; differt a prima pilis brevissimis, a secunda lamina coriacea et ramo infero venarum lateralium saepe ultra sorum procurrenti recedit. — *Rhizoma* squamis inclusis 2–5 mm diam., squamis exclusis c. 1 mm diam., plus minusve erectum, eramosum; squamae 1.3–5.0 mm longae, 0.3–0.7 mm latae, lanceolatae, ad apicem acutae, mediae rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 0.1–1.1(–1.4) cm longus, 0.3–0.6(–0.7) mm latus, pilis simplicibus eglandulosis c. 0.2 mm longis sparsis vel moderate numerosis plus minusve patentibus albidis vel pallidis vel obscure rubriusculo-brunneis vestitus. *Lamina* (4.5–)5.8–12.4(–14.6) cm longa, 0.4–0.7(–0.9) cm lata, lineari-elliptica vel lineari-oblanceolata, ad apicem subacutam, ad basem longe cuneata vel longe attenuata, integra, coriacea, pilis simplicibus eglandulosis 0.2–0.3 mm longis plus minusve patentibus pallidis vel obscure rubriusculo-brunneis moderate numerosis per laminam, interdum ad pagina supera laminae sparsis, ad marginem paucis et ad medio-venam inferam moderate numerosis, interdum pilis similaribus sed binatis vel ternatis ad medio-venam inferam sparsis vestita. medio-vena ad pagina infera laminae prominens et pagina infera laminae concolor; venae laterales interdum in luce transmissa manifestae, 1-furcatae, ramus superus non vel ultra sorum procurrens, quam ramum inferum semper brevior, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 1.0–2.0 mm longi, (0.5–)0.6–1.2(–1.3) mm lati, in ambitu plus minusve circulares vel oblongi, ad medio-venam obliqui, ad superficiarem inferam laminae adornati vel in lacunis vadosis sine margine prominenti impressi, discreti vel contigui ubi maturi, in 2 serialibus, 1 utroque medio-venae in 2/3 medio vel superno laminae sed non prope apicem, in quoque seriali (3–)10–37(–

42) sori, medio-venam quam marginem proximiores. *Sporangia* (160–)183–248(–280) μm longa, pilis 1–4 mediis vel obscure rubriusculo-brunneis rigidis 120–316(–360) μm longis praedita; cellulae induratae annuli (9–)10–12. *Sporae* (24–)27–37(–41) μm diam. — Typus: *L.J. Brass 25776*, 8.v.1956, Mt Pabinama, Normanby I., Milne Bay District, Papua New Guinea (K; iso A, CANB, L, LAE).

Rhizome 2–5 mm diam. including scales, c. 1 mm diam. without scales, ± erect, unbranched; scales 1.3–5.0 × 0.3–0.7 mm, lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.1–1.1(–1.4) cm × 0.3–0.6(–0.7) mm, with scattered to moderately frequent ± patent whitish or pale to dark red-brown simple eglandular hairs c. 0.2 mm. *Lamina* (4.5–)5.8–12.4(–14.6) by 0.4–0.7(–0.9) cm, linear-elliptic to linear-oblanceolate, subacute at apex, long-cuneate to long-attenuate at base, entire, coriaceous, with ± patent pale to dark red-brown simple eglandular hairs 0.2–0.3 mm usually moderately frequent on all parts of the lamina, sometimes sparse on upper surface of lamina and occasional on margin and moderately frequent on midvein below, sometimes similar but binate or ternate hairs scattered on midvein below; midvein rather prominent on lower surface of the lamina and concolorous with it; lateral veins occasionally visible in transmitted light, 1-forked, the upper branch extending beyond the sorus or not, always shorter than the lower branch, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.0–2.0 × (0.5–)0.6–1.2 (–1.3) mm, ± circular to oblong in outline, each oblique to the midvein, on the surface of the lamina or sunken in shallow pits which lack a prominent rim, discrete to contiguous when mature, in two rows, one on each side of the midvein in the middle



Map 38. *Grammitis curtipila* (27).



Map 39. *Grammitis curtipila* (27).

or upper 2/3 of lamina but not immediately below the apex, each row with (3–)10–37(–42) sori, nearer the midvein than the margin. *Sporangia* (160–)183–248(–280) μm, with 1–4 medium to dark red-brown rigid hairs 120–316(–360) μm; indurated cells of annulus (9–)10–12. *Spores* (24–)27–37(–41) μm diam.

Distribution. New Guinea and Solomon Islands.

MILNE BAY. Fergusson I., Mt Kilkerran, Croft 527 (CROFT, LAE). Goodenough I., Brass 24586 (A, L, LAE, US). Mt Pabinama, Normanby I., Brass 25776 (A, CANB, K, L, LAE).

Ecology. Epiphytic on tree trunks or rupestral on boulders in streams, in montane forest (including *Dacrydium* forest); from 750 to 1600 m.

Notes. The fronds of *G. curtipila* are said to be bluish-iridescent on the upper surface when fresh. *G. curtipila* is related to *G. brassii* Copel. from the Solomon I., but differs in having a much thicker textured lamina into which the sori are sometimes sunken and in having the upper branch of the lateral veins often extending beyond the sorus. *G. brassii* has the upper branches of the lateral veins very short and not extending beyond the sorus, like those of *G. reinwardtii*.

28. Grammitis knutsfordiana (Baker) Copel. – Fig. 17; maps 40, 41.

G. knutsfordiana (Baker) Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 201. – *Polypodium knutsfordianum* Baker, J. Bot. (London) 28 (1890) 107. – Type: *Macgregor 29* (K, holo).

Polypodium oleandroides Baker, Ann. Bot. 8 (1894) 128. – Type: *Macgregor s.n.*, Mt Suckling, 1892 (K, holo).

Polypodium warburgii Christ, Monsunia 1 (1900) 59. – Lectotype: *Warburg 17882*, Mt Sibella, Batjan, Moluccas (B).

Polypodium diplosoroides Rosenst., Nova Guinea 8 (1912) 724; Copel., Philip. J. Sc. 80 (1952) 187. – Lectotype: *von Römer 1167* (BO).

G. nigrosetosa Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 244. – Type: *Stresemann 404*, G. Fogha, N.W. Buru, Moluccas (L, holo).

G. stresemannii Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 244. – Type: *Stresemann 268*, G. Binaija, Ceram, Moluccas (L, holo).

Polypodium fasciatum sensu Ridley, Trans. Linn. Soc. London (Bot.) 2, 9 (1916) 259, quoad *Boden Kloss* spec.

Polypodium diplosorum var. sensu Brause, Bot. Jahrb. 56 (1920) 180, quoad *Ledermann 11781.*

Polypodium hookeri sensu v.A.v.R., Nova Guinea 14 (1924) 44, quoad *Lam 1941.*

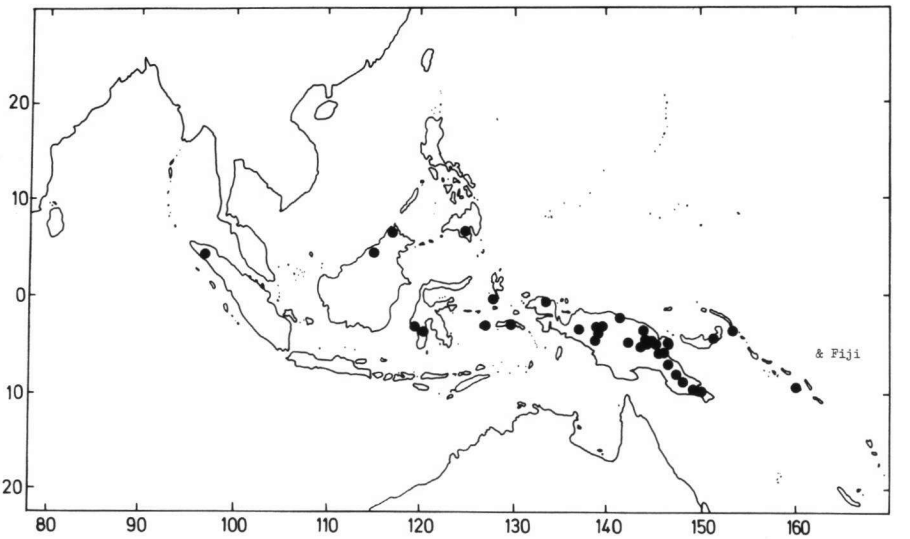
Illustrations: Copel., Philip. J. Sc. 80 (1952) 202, f. 72 et 244, f. 96 as G. nigrosetosa et 244, f. 97 as G. stresemannii.

Rhizome 2–4 mm diam. including scales, 1–2 mm diam. without scales, usually long-creeping, rarely short-creeping, usually unbranched, producing stipes 2–12 mm apart; scales (1.8–)2.5–3.9(–4.5) × (0.4–)0.7–1.5(–1.8) mm, ovate to lanceolate, acute to obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.3–)1.0–4.2(–8.8) cm × (0.3–)0.5–1.1(–1.4) mm, with sparse to dense ± patent to deflexed, medium to dark red-brown simple eglandular hairs (0.5–)1.0–3.0(–4.0) mm. *Lamina* (4.5–)9.4–21.4(–30.0) × (0.5–)0.7–1.1(–1.4) cm, linear-lanceolate to linear-oblanceolate, subacute to acuminate at apex and attenuate to long-attenuate at base, usually entire, sometimes shallowly crenate, the teeth up to 0.5 mm long, rather coriaceous, with ± patent medium to dark red-brown simple eglandular hairs (0.4–)0.8–2.6(–4.5) mm occasional to frequent on margin, midvein below and amongst sori, and sometimes also on upper surface of lamina, sometimes also scattered on the lateral veins below, or frequent on both surfaces of the lamina, and occasional ± appressed whitish to pale brown simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein rather prominent on the lower surface of the lamina and usually darker than it; lateral veins ± visible in transmitted light, prominent on either or both surfaces when dried, 2–3-forked, the upper branch of the first fork sometimes extending some distance beyond the sorus but always shorter than the lower branches, the lower branch of the first fork branched once or twice, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* (0.8–)1.1–2.9(–5.0) × (0.6–)1.1–2.1(–3.0) mm, ± circular in outline, on surface of lamina, discrete to contiguous, rarely confluent, when mature, in two rows, one on each side of the midvein, in upper 1/2 of lamina to throughout its length but not immediately below the apex, each row with (8–)13–40(–72) sori, much closer to the midvein than the margin. *Sporangia* (170–)193–290(–400) μm, with 1–3(–4) medium to dark red-brown rigid hairs (140–)170–338(–660) μm; indurated cells of annulus (9–)10–12(–15). *Spores* (17–)21–36(–46) μm diam.

Distribution. Sumatra, Borneo, Philippines, Celebes, Moluccas, New Guinea, Solomon Islands and Fiji.

VOGELKOP PENINSULA. Mt Netoti, van Royen & Sleumer 8181 (L).

CENTRAL IRIAN JAYA. Danau-danau Wissel, Eyma 5039 (BO). Peg. Sudirman, Leeuwen 10854 (BO, L, MICH). Punjak Sukarno, Boden Kloss s.n. (BM), s.n. (BM, K). Ngga Simanggela,



Map 40. *Grammitis knutsfordiana* (28).

Lam 1941 (BO). Danau Habbema, Brass 9376 (GH, L, MICH, UC). Mt Treub, Pulle 1076 (BM, BO, L). Hellwig Mts, Pulle 676 (BM, BO), von Römer 1167, 1317 (both BO). Su. Taritatu, Brass 12011 (GH, MICH), 12024 (GH), 12440 (GH, L, MICH), 12500 (BM, BO, GH, L, LAE, MICH, UC). Mt Antares, Star Mts, Kalkman 4464 (L).

W. SEPIK. Mt Capella, LAE 66964 (LAE).

WESTERN. Mt Bosavi, Jacobs 8909 (L, LAE).

W. HIGHLANDS. Kum Forest, Mt Hagen, Parris & Croxall 8154 (BSP). Minj-Nona divide, Kubor Ra., Pullen 5255 (CANB), Vink 16030A (L). Mt Hagen, Parris & Croxall 4673 H 121, 8147 (both BSP, LAE).

ENGA. Mt Ambua, Kalkman 5084 (LAE), NGF 28349 (L, LAE), Vink 17477 (L, LAE). Tari Gap, Parris & Croxall 9608 (BSP).

S. HIGHLANDS. Mt Giluwe, Parris & Croxall 8217 (BSP). Mt Ialibu, LAE 55864 (LAE, K).

E. HIGHLANDS. Haba'ina, Mt Piora, Coode 3877, Argent & Huys (K). Mt Elandora, Brass 32138 & Collins (LAE, US). Mt Michael, Johns 1298, 1317 (both BULOLO). Mt Otto, Brass 30898 (LAE).

MADANG. Mt Schrader, Ledermann 11781 (B). Wagai, Jermy 4845–4847 (all BM). Sewe to Tregbury Pass, Walker 8665 (BM).

MOROBE. Near Aseki, Parris & Croxall 7940 (BSP, LAE). Bolan Mts, Keysser B 67 (S, UC). Edie Creek, Afing 34 (BULOLO), Jermy 3511, 3519 (both BM). Ekuti Ra., Gawi 14 (BULOLO, LAE), Kog 15 (BULOLO, LAE), Parris & Croxall 6027, 7981 (both BSP, LAE). Mt Amungwiwa, van Royen 11144 (LAE). Mt Kaindi, Parris & Croxall 4678 L 184 (BSP, LAE), Parris 9574 (BSP, LAE). Mt Sarawaket, Clemens 6236 (L), 6236a (BM). Rawlinson Ra., Clemens 12449 (MICH), 41374 (MICH, US). Wau-Salamaua road, NGF 8711 (BRI, LAE).

CENTRAL. Mt Knutsford, Macgregor 29 (K). Mt Obree, Turner s.n. (BM). Mt Strong, NGF 46239 (K, LAE). Near Port Moresby, Clark s.n. (BM). N.W. of the Gap, Carr 15180 (BM).

MILNE BAY. Mayu R., Mt Suckling, LAE 55585 (K, L, LAE), 55585A (L, LAE). Mt Dayman, Armit s.n. (K), Brass 22582 (A, BM, CANB, L, LAE). Mt Suckling, Macgregor s.n. (K).

E. NEW BRITAIN. Mt Lululua, LAE 58388 (K, L, LAE). Nakanai Plateau, LAE 63290 (LAE). NEW IRELAND. Taron, Croft 302 (BSP, CROFT, LAE).

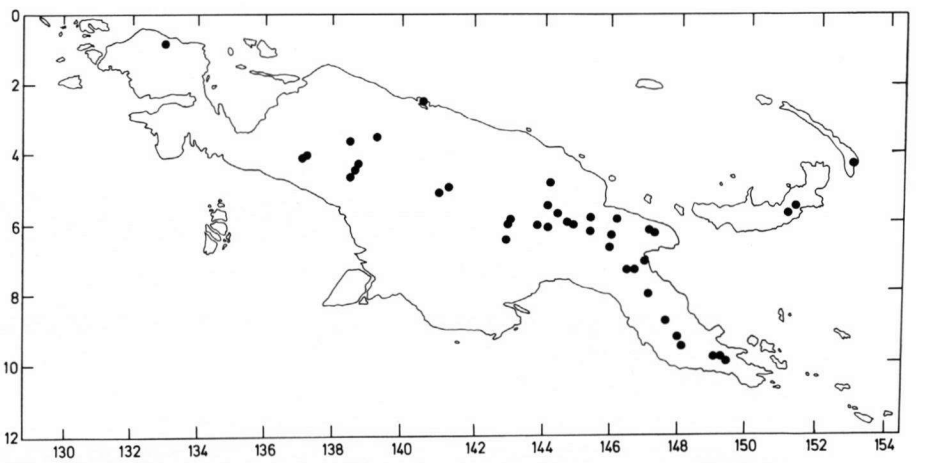
Ecology. Usually a more or less erect epiphyte, usually low on trunks of trees or on logs, occasionally terrestrial and rarely rupestral, in midmontane forest, including coniferous and particularly *Nothofagus* forest (including *N. resinosa* and *N. starkenborghii*), rarely in subalpine forest; from 760 to 3500 m.

Notes. *G. monticola* of Samoa is very close to *G. knutsfordiana*, but differs in its narrower, darker rhizome scales and undulate lamina margin.

The veins of *G. knutsfordiana* are sometimes darker than the lamina which may occasionally be variegated green and yellow when fresh. *G. hispida* is very close to *G. knutsfordiana* and may be no more than a form of it with very short hairs. More collections of *G. hispida* are needed to resolve its status. The collection from Danaudanau Wissel (*Eyma 5039*) approaches *G. hispida* in some hair characters. The density and distribution of lamina hairs is very variable in *G. knutsfordiana*. The extremes of density may form apparently distinct and altitudinally separated populations on some mountains, but with either the more densely hairy or the more sparsely hairy at higher altitudes. In other localities, however, intermediates and extremes can occur within the same population and it is not possible to treat the extremes as separate taxa.

29. Grammitis hispida Copel. – Fig. 17; map 37.

G. hispida Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 203. – Type: *Brass 10257* (MICH, holo; BM, BO, GH, K, L, LAE).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 203, f. 73.



Map 41. *Grammitis knutsfordiana* (28).

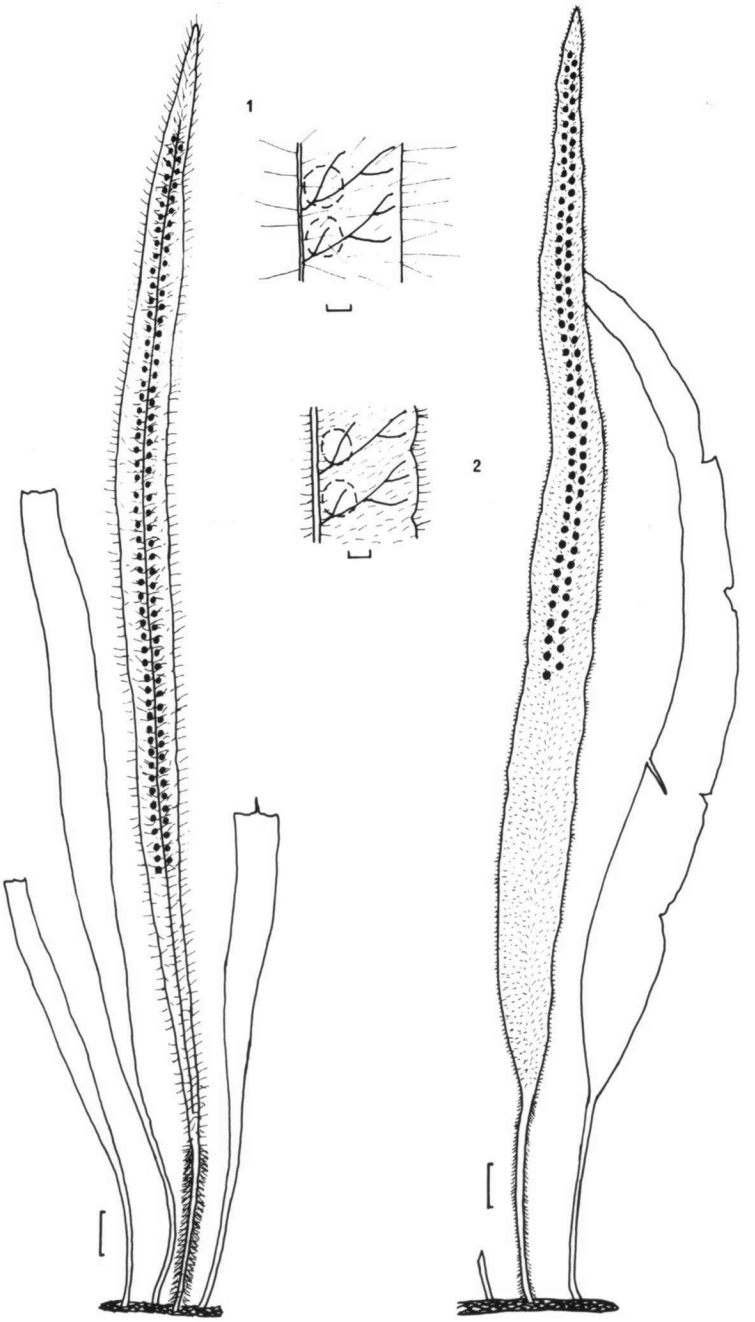


Fig. 17. *G. reinwardtii* group. – 1. *G. knutsfordiana* (28), *Brass 12500* (LAE), 2. *G. hispida* (29), isotype, *Brass 10257* (LAE).

Rhizome 3–4 mm diam. including scales, c. 1 mm without scales, long-creeping, unbranched, producing stipes 8–20 mm apart; scales 2.6–4.4 × c. 1.0 mm, ovate-lanceolate, subacute at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.5–)2.5–5.3(–6.4) cm × (0.9–)1.0–1.4 (–1.5) mm, with moderately dense ± patent to deflexed dark red-brown simple eglandular hairs 0.7–1.5 mm. *Lamina* (15.0–)16.7–26.1(–27.7) × (1.0–)1.2–1.6 cm, lanceolate to linear-lanceolate, acute at apex and attenuate at base, shallowly crenate, the teeth up to 0.7 mm, rather coriaceous, with ± patent dark red-brown simple eglandular hairs 0.5–1.0 mm frequent on both surfaces, especially on the midvein below; midvein rather prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins ± visible in transmitted light, prominent on both surfaces of the lamina when dried and darker than it, 2–3-forked, the upper branch of the first fork not or slightly extending beyond the sorus, shorter than the lower branches, the lower branch 1–2-forked, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1–2 mm diam., ± circular in outline, on surface of lamina, discrete when mature, in two rows, one on each side of the midvein in the upper ½–¾ of lamina but not immediately below the apex, each row with (22–)29–59(–63) sori, much nearer the midvein than the margin. *Sporangia* (180–)201–245(–260) μm, glabrous; indurated cells of annulus 10–13 (–16). *Spores* (19–)21–31(–42) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Danau Habbema, Brass 10257 (BM, BO, GH, K, L, LAE, MICH), 10284 (BM, BO, GH, L, MICH, UC).

Ecology. Terrestrial in montane forest; at 2800 m.

Note. Brass states that both his collections had fronds variegated green and white when fresh.

Table 8. Characters of taxonomic importance within the *G. mesocarpa* species group in New Guinea.

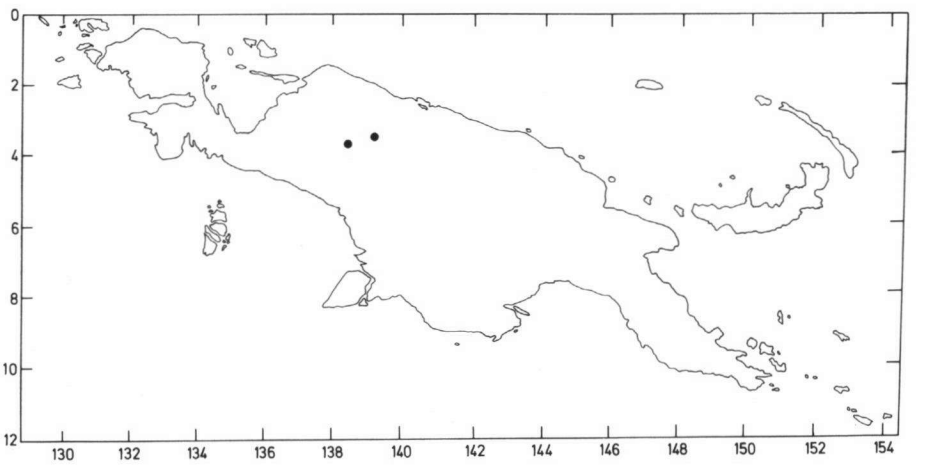
Characters	*G. mesocarpa*	*G. papuensis*	*G. inconstans*
Lamina	entire	entire	crenate
Lamina length in cm	(10.4–)10.8–16.2(–19.8)	(3.0–)3.8–6.6(–6.8)	4.6–5.1
Lamina hairs in mm (simple eglandular)	0.2–0.3	0.2–0.3	0.5–1.5
Position of sori on lamina	middle 1/4–1/2	upper 1/2	upper 1/2
Spores in μm	(36–)39–54(–61)	29–31	(30–)31–38(–43)

8. G. mesocarpa group – Species 30–32
Fig. 18; maps 42, 43; table 8

Rhizome erect to very short-creeping; scales broadly lanceolate to narrowly lanceolate, medium to dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* sometimes absent, either glabrous or with medium to dark red-brown simple eglandular hairs 0.5–1.0 mm. *Lamina* entire or crenate, coriaceous, with medium to dark red-brown simple eglandular hairs 0.2–1.5 mm and sometimes with simple clavate-glandular hairs; lateral veins invisible in transmitted light, 1–2-forked, the branches of ± equal length, the branch endings without obvious hydathodes on the upper surface of the lamina. *Sori* ± circular to elliptic or oblong in outline, on surface of lamina or slightly sunken in broad shallow depressions, in two rows.

Epiphytes in montane forest. Restricted to New Guinea with only three species, all in Irian Jaya Highlands.

This species group is possibly linked with *Xiphopteris* (see under *G. inconstans* for further discussion) and also with the *G. reinwardtii* and *G. hirtella* groups.



Map 42. *Grammitis mesocarpa* (30).

30. Grammitis mesocarpa (v.A.v.R.) Copel. – Fig. 18; map 42.

G. mesocarpa (v.A.v.R.) Copel., Philip. J. Sc. 80 (1952) 181. – *Polypodium mesocarpum* v.A.v.R., Nova Guinea 14 (1924) 42. – Lectotype: *Lam 1878* (iso BO, L; fragm. BM).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 181, f. 51.

Rhizome 6–8 mm diam. including scales, c. 2 mm diam. without scales, erect to ascending, unbranched; scales 3.2–4.0 × 0.3–0.8 mm, narrowly lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.2–)0.3–0.6(–0.7) cm × c. 0.4 mm, sometimes absent, with scattered ± patent medium red-brown simple eglandular hairs c. 0.8 mm, or glabrous. *Lamina* (10.4–)10.8–16.2(–19.8) × (0.3–)0.4–0.5(–0.6) cm, linear-lanceolate to linear-oblanceolate, acute to obtuse at apex and long-attenuate at base, entire, rather coriaceous, with ± patent medium to dark red-brown simple eglandular hairs 0.2–0.3(–0.5) mm and similar but binate hairs moderately frequent on margin and midvein below, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, slightly prominent on the lower or both surfaces when dried, 1–2-forked, all branches of ± equal length, the upper branch of the first fork extending beyond the sorus and ± as long as the lower, sometimes 1-forked, the lower branch of the first fork unbranched; the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* (1.4–)1.6–3.0(–3.5) × (1.0–)1.2–2.2(–2.5) mm, ± circular to elliptic in outline, each oblique to the midvein, on surface of lamina, contiguous to confluent when mature, in two rows, one on each side of the midvein in the middle ¼–½ of the lamina, each row with (8–)11–21(–28) sori, nearer the midvein than the margin. *Sporangia* (300–)321–384(–410) μm, with 2–4(–5) medium to dark red-brown rigid hairs (220–)236–315(–320) μm; indurated cells of annulus 9–12(–14). *Spores* (36–)39–54(–61) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Ngga Simanggela, Lam 1487 (BO), 1878 (BM, BO, L). Su. Taritatu, Brass 12009 (GH, MICH).

Ecology. Epiphytic in montane forest; from 1420 to 1800 m.

31. Grammitis papuensis (v.A.v.R.) Parris – **Fig. 18; map 43.**

G. papuensis (v.A.v.R.) Parris, Fern Gaz. 12 (1980) 118. – *Polypodium papuanum* Ridley, Trans. Linn. Soc. London (Bot.) 2, 9 (1916) 260, non Baker (1886). – *Polypodium papuense* v.A.v.R., Malayan Ferns Suppl. (1917) 521, nom. nov. pro *P. papuanum* Ridley, non Baker; Copel., Philip. J. Sc. 80 (1952) 189. – Lectotype: *Boden Kloss s.n.*, Mt Carstensz, Camp III, 2500 ft (BM).

Rhizome c. 3 mm diam. including scales, c. 0.5 mm diam. without scales, very short-creeping, producing stipes less than 1 mm apart; scales c. 2.5 × 0.7 mm, broadly lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.1–0.2 cm × c. 0.3 mm, glabrous. *Lamina* (3.0–)3.8–6.6(–6.8) × 0.1–0.2 cm, linear to linear-oblanceolate, subacute at apex and long-attenuate at base, entire, rather coriaceous, with sparse ± patent dark red-brown simple eglandular hairs 0.2–0.3 mm on margin and midvein, sometimes similar but binate hairs also present; midvein rather prominent on the lower surface

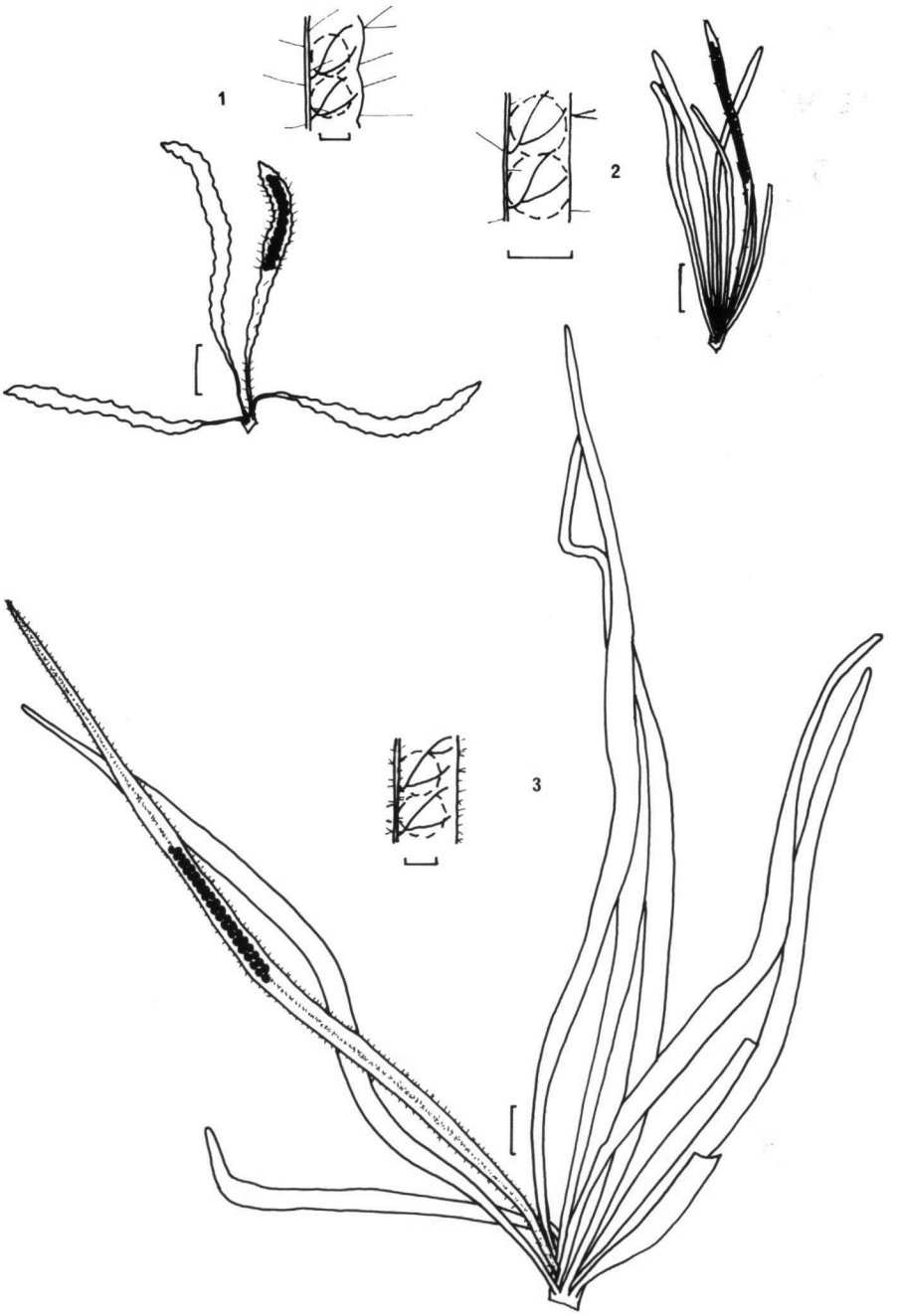


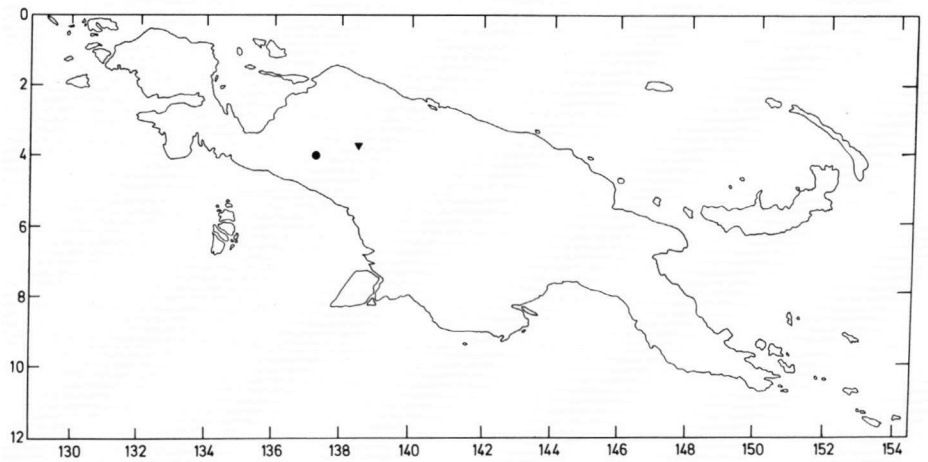
Fig. 18. *G. mesocarpa* group. – 1. *G. inconstans* (32), lectotype, *Lam 1882* (BO); 2. *G. papuensis* (31), lectotype, *Boden Kloss s.n.* (BM); 3. *G. mesocarpa* (30), isolectotype, *Lam 1878* (L).

of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch scarcely extending beyond the sorus, nearly as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.0–1.8 × 0.6–0.8 mm, ± circular to elliptic in outline, each ± parallel to the midvein, on surface of lamina or slightly sunken in broad shallow depressions and slightly prominent on the upper surface of the lamina, discrete to contiguous when mature, in two rows, one on each side of the midvein in the upper ½ of the lamina, each row with (3–)6–18 sori, covering all of the lamina undersurface. *Sporangia* (180–)191–221(–230) μm, usually glabrous or occasionally with 2 medium red-brown rigid hairs 240–280 μm; indurated cells of annulus (10–)11–12(–13). *Spores* 29–31 μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Punjak Sukarno, Camp III, Boden Kloss s.n. (BM).

Ecology. At 760 m.



Map 43. ● *Grammitis papuensis* (31), ▼ *G. inconstans* (32).

32. Grammitis inconstans (v.A.v.R.) Copel. – Fig. 18; map 43.

G. inconstans (v.A.v.R.) Copel., Philip. J. Sc. 80 (1952) 193. – *Polypodium inconstans* v.A.v.R., Nova Guinea 14 (1924) 43. – Lectotype: *Lam 1882* (BO).

Rhizome c. 4 mm diam. including scales, ± erect, unbranched; scales 1.0–1.5 × 0.5–0.7 mm, lanceolate to narrowly lanceolate, acute at apex, dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.5–0.9 cm × 0.3–0.4 mm, with scattered ± patent dark red-brown simple eglandular hairs 0.5–1.0 mm. *Lamina* 4.6–5.1 × 0.3–0.4 cm, linear-oblanceolate, acute at apex, at-

tenuate at base, crenate, the teeth to 0.8 mm, coriaceous, with ± patent dark red-brown simple eglandular hairs 0.5–1.5 mm scattered on the margin and midvein below in the soral region, otherwise occasional on the midvein below, sparse on the lamina and midvein on the upper surface, with similar but binate hairs sometimes on the margin; midvein rather prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, slightly prominent on both surfaces of the lamina when dried, 1-forked, the upper branch extending beyond the sorus, ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.0–2.0 × 0.8–1.0 mm, ± circular to oblong in outline, each parallel to the midvein, on the surface of the lamina, contiguous to confluent when mature, in two rows, one on each side of the midvein in the upper ½ of the lamina, each row with 12–13 sori, nearer the midvein than the margin. *Sporangia* (210–)225–271(–280) μm, with 1–3 dark red-brown rigid hairs 200–310 μm; indurated cells of annulus 10–11(–13). *Spores* (30–)31–38(–43) μm in diam.

Distribution. New Guinea.

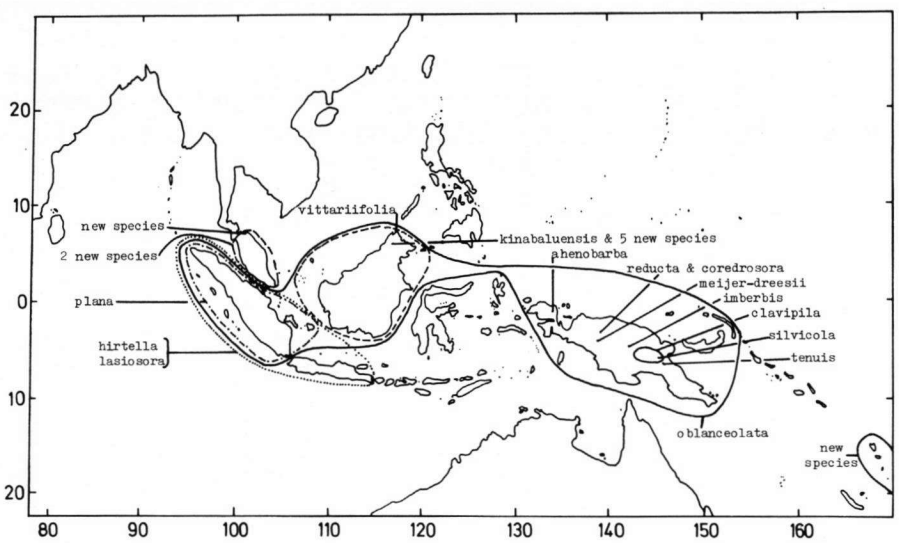
CENTRAL IRIAN JAYA. Ngga Simanggela, Lam 1882 (BO).

Ecology. Epiphyte in montane forest; at 1450 m.

Notes. A collection from Mt Scorpion, Star Mts, West Sepik District (3500 m, 21.v.1975, *Croft 51 & Hope*, BSP, LAE) may belong here, but differs in its longer lamina (up to 16.0 cm) with much less frequent lamina hairs and much larger sporangia, (370–)409–493(–510) μm, with longer rigid hairs, 610–1200 μm, and larger spores, (47–)50–58 μm diam. The vegetation type and altitude (subalpine shrubland at 3500 m) also differ from those of *G. inconstans*. In some respects, including lamina dissection, hair type and sporangia and spore size it resembles *Xiphopteris antipodalis* Copel., known only from the type collection from Danau Habbema, Irian Jaya. The relationship between this species and *G. inconstans* needs further study based upon more collections.

9. G. hirtella group – Species 33–41
Figs. 19–22; maps 44–49; table 9

Rhizome erect to short-creeping; scales lanceolate to narrowly lanceolate, pale to dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* glabrous or with pale yellow-brown to dark red-brown simple eglandular hairs 0.2–1.8 mm, catenate simple eglandular hairs and simple clavate-glandular hairs. *Lamina* entire or shallowly crenate especially towards base, membranous to coriaceous, glabrous or with pale yellow-brown to dark red-brown simple eglandular hairs 0.2–2.0 mm, catenate simple eglandular hairs and simple clavate-glandular hairs; lateral veins visible or not in transmitted light, usually 1-forked (rarely unbranched or 2-forked), the upper branch ± as long as the lower one, each branch end-



Map 44. *G. hirtella* species group.

ing sometimes marked by a small hydathode on the upper surface of the lamina. *Sori* ± circular to elliptic in outline, on surface of lamina or slightly sunken in broad shallow depressions, in two rows.

Epiphytic, rupestral or terrestrial, in lower montane, midmontane and subalpine forests and alpine heath and grassland. Distribution from Sumatra and Peninsular Thailand to New Hebrides with nine species in New Guinea, eight of which are endemic, one in Vogelkop Pen., three in Irian Jaya Highlands, one in the Star Mts, two in PNG Highlands, one in Mid-PNG.

The *G. hirtella* group in New Guinea may be divided into three subgroups. That of *G. reducta*, together with *G. imberbis* and *G. tenuis*, is characterised by the stipe glabrous or with only catenate simple eglandular hairs, the lamina glabrous or with the same type of hair as the stipe and also simple clavate-glandular hairs, rather coriaceous and the endings of the lateral veins without hydathodes. This subgroup is endemic to New Guinea, with one each of the three species in Irian Jaya Highlands, Star Mts and Mid-PNG. The subgroup of *G. oblanceolata*, together with *G. meijer-dreesii* and *G. clavipila*, has medium to dark red-brown simple eglandular hairs and/or catenate simple eglandular hairs and simple clavate-glandular hairs on the stipe and lamina, the lamina more or less membranous and the endings of the lateral veins sometimes marked by hydathodes. This subgroup occurs from Sumatra to New Hebrides, with one each of the two endemic species in Irian Jaya Highlands and PNG Highlands. The subgroup of *G. lasiosora* (Blume) Ching, containing *G. coredrosora, G. silvicola* and *G. ahenobarba* has pale yellow-brown to medium red-brown simple eglandular hairs on the stipe and lamina and simple clavate-glandular hairs on the lamina,

Table 9. Characters of taxonomic importance within the *G. hirtella* species group in New Guinea.

Characters	*G. imberbis*	*G. tenuis*	*G. reducta*	*G. oblanceolata*	*G. meijer-dreesii*
Rhizome scales	dark red-brown	medium red-brown	medium red-brown	pale to medium red-brown	medium red-brown
Stipe length in cm	(5.0–)5.4–9.8 (–11.7)	0.2–1.0	(0.1–)0.2–0.8 (–1.0)	(0.2–)0.6–2.0 (–2.4)	2.6–6.4
Stipe hairs (simple eglandular)	absent	absent	absent	sparse to mod. dense, medium to dark red-brown	mod. frequent, medium red-brown
Lamina in cm	(7.3–)8.3–12.7 (–13.7) × 0.3–0.4	5.1–12.5 × 0.1–0.2	(0.9–)1.2–2.8 (–3.2) × 0.1–0.2	(2.1–)2.3–7.5 (–13.6) × (0.2–) 0.3–0.5	6.0–16.0 × 0.7–0.8
Lamina hairs (simple eglandular)	absent	absent	absent	occ. to scattered on midvein below and margin, sts also on lamina below, rarely occ. on lamina above, medium to dark red-brown	mod. frequent amongst sori, elsewhere sparse on all parts, medium red-brown
Lateral veins in transmitted light	invisible	invisible	visible	visible	more or less visible
Spores in μm	(33–)34–41(–44)	(38–)41–50(–54)	(32–)35–44(–47)	(19–)22–29(–32)	(20–)21–27(–28)

Table 9 continued.

Characters	*G. clavipila*	*G. coredrosora*	*G. silvicola*	*G. ahenobarba*
Rhizome scales	medium to dark red-brown	absent	absent	pale red-brown
Stipe length in cm	(1.4–)1.8–4.0(–4.7)	(0.9–)1.0–1.6(–1.8)	0.7–1.7	0.6–0.9
Stipe hairs (simple eglandular)	absent	moderately dense, pale to medium red-brown	moderately frequent, pale yellow-brown	moderately frequent, pale red-brown
Lamina in cm	(8.0–)11.8–21.2(–24.5) × (0.4–)0.5–0.7	(3.1–)3.3–4.7(–5.0) × 0.2–0.3	3.7–4.2 × c. 0.2	6.0–6.6+ × c. 0.3
Lamina hairs	absent	moderately frequent on all parts, pale to medium red-brown	moderately frequent on lamina and midvein below, pale yellow-brown	sparse to moderately frequent on lamina and midvein below, pale yellowish red-brown
Lateral veins in transmitted light	visible	visible	visible	visible
Spores in µm	(21–)23–32(–42)	28–33	(30–)31–36(–37)	27–30

the lamina membranous and the endings of the lateral veins sometimes marked by hydathodes. This subgroup ranges from Sumatra to New Guinea, with one each of the three species endemic to New Guinea in Vogelkop Pen., Irian Jaya Highlands and PNG Highlands.

The extra-New Guinea members of this group are *G. hirtella* (Blume) Tuyama, *G. kinabaluensis* (Copel.) Copel., *G. lasiosora* (Blume) Ching, *G. plana* (v.A.v.R.) Parris, *G. vittariifolia* (C. Chr.) Parris, and nine undescribed species.

33. Grammitis imberbis Parris, *sp. nov.* – Fig. 19; map 45.

Differt a G. tenui et G. reducta stipite laminaque longioribus et squamis obscure rubriusculo-brunneis rhizomatis. — *Rhizoma* squamis inclusis 2–3 mm diam., squamis exclusis c. 0.5 mm diam., erectum vel breviter repens, eramosum, stipites per spatia minus quam 1 mm emittens; squamae c. 2.5 mm longae, c. 0.5 mm latae, lanceolatae, ad apicem acutae, obscure rubriusculo-brunneae, glabrae, non clathratae nec iridescentes; cellulae sine septis. *Stipes* (5.0–)5.4–9.8(–11.7) cm longus, 0.3–0.4 mm latus, pilis simplicibus eglandulosus catenatis minus quam 0.1 mm longis paucis plus minusve patentibus vestitus vel glabrus. *Lamina* (7.3–)8.3–12.7(–13.7) cm longa, 0.3–0.4 cm lata, lineari-oblanceolata, ad basem crenata, lobis ad 0.3 mm longis, coriacea, pilis simplicibus clavatis glandulosis minus quam 0.1 mm longis pallidis brunneis paucis in frondibus iuvenis evolutis vestita; medio-vena ad paginam inferam laminae prominens et pagina infera laminae concolor; venae laterales in luce transmissa non manifestae, 1-furcatae, ramus superus non vel ultra sorum procurrens, plus minusve longitudine ramum inferum aequans, rami terminales in pagina supera laminae sine hydathodis manifestis, liberi. *Sori* 1.3–2.3 mm longi, 0.9–1.8 mm lati, in ambitu plus minusve circulares vel elliptici, ad medio-venam paralleli, ad superficiarem inferam laminae adornati, discreti vel confluentes ubi maturi, in 2 serialibus, 1 utroque medio-venae in 1/3–1/2 superno laminae sed non prope apicem, in quoque seriali (5–)8–19 sori, pagina infera fere tota lamina tegentes vel parum medio-venam quam marginem proximiores. *Sporangia* (250–)264–302(–310) μm longa, glabra; cellulae induratae annuli 10–12(–13). *Sporae* (33–)34–41(–44) μm diam. — Typus: *LAE 65885*, 18.v.1975, summit ridge of Mt Scorpion, Star Mts, Telefomin Subdistrict, West Sepik District, Papua New Guinea (LAE).

Rhizome 2–3 mm diam. including scales, c. 0.5 mm diam. without scales, erect to short-creeping, unbranched, producing stipes less than 1 mm apart; scales c. 2.5 × 0.5 mm, lanceolate, acute at apex, dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (5.0–)5.4–9.8(–11.7) cm × 0.3–0.4 mm, with occasional ± patent catenate simple eglandular hairs less than 0.1 mm or glabrous. *Lamina* (7.3–)8.3–12.7(–13.7) × 0.3–0.4 cm, linear-oblanceolate, acute at apex, long-attenuate at base, crenate towards base, the teeth up to 0.3 mm long, coriaceous, with scattered pale brown simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein rather prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch extending beyond the sorus or not, ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.3–2.3 × 0.9–1.8 mm, ± circular to elliptic in outline, each ± parallel to the midvein, on the surface of the lamina, discrete to confluent when mature, in two rows, one on each side of the midvein in the upper 1/3–1/2 of the lamina but not immediately below the apex, each row with (5–)8–19 sori, covering nearly all of la-

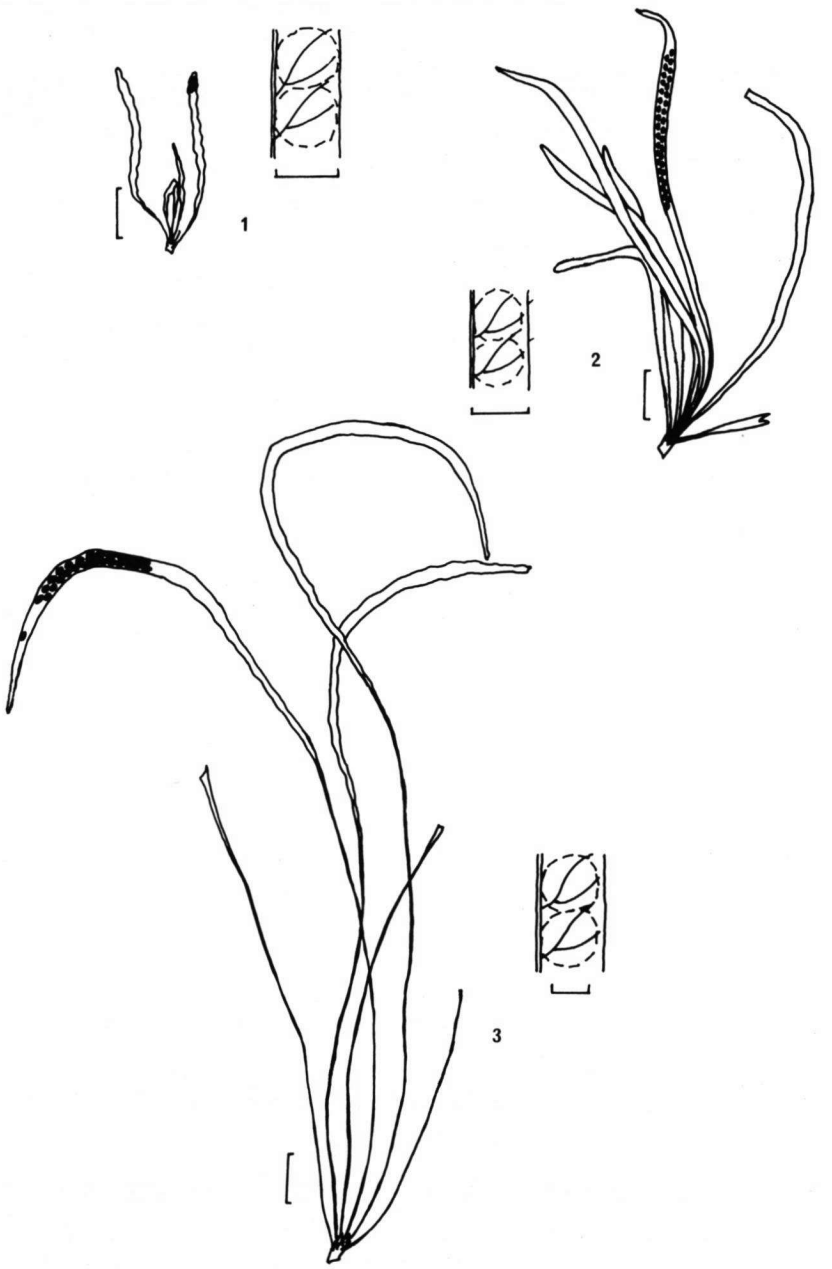


Fig. 19. *G. hirtella* group; *G. reducta* subgroup. – 1. *G. reducta* (35), lectotype, *Lam 1550* (BO); 2. *G. tenuis* (34), holotype, *Parris & Croxall 6040* (K); 3. *G. imberbis* (33), holotype, *LAE 65885* (LAE).

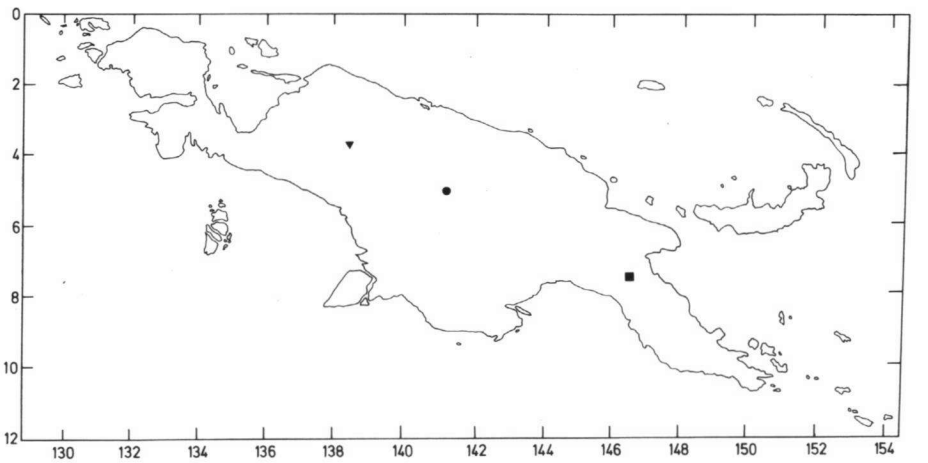
mina undersurface or slightly nearer the midvein than the margin. *Sporangia* (250–) 264–302(–310) μm, glabrous; indurated cells of annulus 10–12(–13). *Spores* (33–)34–41(–44) μm diam.

Distribution. New Guinea.

W. SEPIK, Mt Scorpion, Star Mts, LAE 65885 (LAE).

Ecology. Rupestral in rock crevices in alpine shrubland and grassland; at 3600 m.

Note. *G. imberbis* is related to *G. reducta* and *G. tenuis*, but can be distinguished from both by its longer stipes and also from the former by its larger lamina.



Map 45. ● *Grammitis imberbis* (33), ■ *G. tenuis* (34), ▼ *G. reducta* (35).

34. Grammitis tenuis Parris, *sp. nov.* – Fig. 19; map 45.

G. imberbi et G. reductae similis sed a prima stipite et lamina breviori, a secunda stipite et lamina longiore et venis lateralibus in luce transmissa non manifestis differt. — *Rhizoma* squamis inclusis 1–2 mm diam., squamis exclusis c. 0.5 mm diam., erectum vel ascendens, eramosum; squamae 2.0–2.8 mm longae, 0.3–0.8 mm latae, lanceolatae, ad apicem acutae, mediae rubrius-culo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 0.2–1.0 cm longus, 0.2–0.3 mm latus, pilis simplicibus eglandulosis catenatis c. 0.1 mm longis paucis vel sparsis plus minusve patentibus vestitus. *Lamina* 5.1–12.5 cm longa, 0.1–0.2 cm lata, linearioblanceolata, ad apicem acuta vel obtusa, ad basem longe attenuata, integra vel praesertim ad basem leviter crenata, lobis ad 0.3 mm longis, coriacea, pilis simplicibus eglandulosis catenatis 0.1–0.2 mm longis paucis vel sparsis ad marginem vestita; medio-vena ad paginam infernam laminae prominens et quam paginam infernam laminae parum fuscatior; venae laterales in luce transmissa non manifestae, interdum parum prominentes in pagina inferna laminae ubi siccatae, 1-furcatae, ramus superus non vel parum ultra sorum procurrens, plus minusve longitudine ramum inferum aequans, rami terminales in pagina supera laminae sine hydathodis manifestis, liberi. *Sori* 0.8–2.3 mm longi; 0.7–1.3 mm lati, in ambitu plus minusve circulares vel elliptici, plus minusve

ad medio-venam paralleli, ad superficiarem infernam laminae adornati vel in depressionibus vadosis apertis parum impressi, ad pagina supera laminae parum prominentes, discreti ubi maturi, in 2 serialibus, 1 utroque medio-venae in ½ medio vel superno laminae, in quoque seriali (5–)7–19 (–26) sori, medio-venam quam marginem parum proximiores. *Sporangia* (250–)268–318(–340) μm longa, pilis 1–5 obscure rubriusculo-brunneis 200–300 μm longis praedita; cellulae induratae annuli (7–)8–11(–12). *Sporae* (38–)41–50(–54) μm diam. — Typus: *B.S. Parris & J.P. Croxall 6040*, 29.v.1977, Watut-Aseki Divide, Ekuti Range, Morobe District, Papua New Guinea (K; iso BSP, LAE).

Rhizome 1–2 mm diam. including scales, c. 0.5 mm diam. without scales, erect to ascending, unbranched; scales 2.0–2.8 × 0.3–0.8 mm, lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.2–1.0 cm × 0.2–0.3 mm, with occasional to sparse ± patent catenate simple eglandular hairs c. 0.1 mm. *Lamina* 5.1–12.5 × 0.1–0.2 cm, linear-oblanceolate, acute to obtuse at apex, long-attenuate at base, entire to shallowly crenate, especially towards the base, the teeth up to 0.3 mm long, rather coriaceous, with occasional to sparse ± patent ± catenate simple eglandular hairs 0.1–0.2 mm on margin; midvein rather prominent on the lower surface of the lamina and slightly darker than it; lateral veins invisible in transmitted light, sometimes slightly prominent on the lower surface of the lamina when dried, 1-forked, the upper branch terminating in the sorus or extending just beyond it, ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 0.8–2.3 × 0.7–1.3 mm, ± circular to elliptic in outline, each ± parallel to the midvein, on the surface of the lamina or very slightly sunken in broad shallow depressions, slightly prominent on the upper surface of the lamina, discrete when mature, in two rows, one on each side of the midvein in the middle to upper ½ of the lamina, each row with (5–)17–19(–26) sori, slightly nearer the midvein than the margin. *Sporangia* (250–)268–318(–340) μm, with 1–5 dark red-brown rigid hairs 200–390 μm; indurated cells of annulus (7–)8–11(–12). *Spores* (38–)41–50(–54) μm diam.

Distribution. New Guinea.

MOROBE. Watut-Aseki Divide, Ekuti Ra., Parris & Croxall 6040 (BSP, K, LAE), 7974 (BSP, LAE).

Ecology. Low epiphyte on slender branches and sapling stems (including *Saurauia*), in and at margin of midmontane forest (including *Nothofagus* forest); from c. 2100 to c. 2250 m.

Note. *G. tenuis* is related to *G. reducta*, but can be distinguished by its larger size.

35. Grammitis reducta (v.A.v.R.) Copel. – Fig. 19; map 45.

G. reducta (v.A.v.R.) Copel., Philip. J. Sc. 80 (1952) 167. – *Polypodium reductum* v.A.v.R., Nova Guinea 14 (1924) 41. – Lectotype: *Lam 1550* (BO; iso BM, K, L, MICH, UC).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 167, f. 35.

Rhizome c. 2 mm diam. including scales, c. 0.5 mm diam. without scales, erect to ascending, unbranched, scales 1.0–1.3 × 0.1–0.2 mm, narrowly lanceolate, acute at

apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.1–)0.2–0.8(–1.0) cm × 0.1–0.3 mm, glabrous. *Lamina* (0.9–) 1.2–2.8(–3.2) × 0.1–0.2 cm, linear-oblanceolate, obtuse to subacute at apex and attenuate at base, entire or shallowly crenate, especially towards the base, the teeth up to 0.3 mm long, somewhat coriaceous, glabrous or with occasional ± appressed whitish simple clavate-glandular hairs 0.1–0.2 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and darker than it; lateral veins visible in transmitted light, occasionally slightly prominent on the upper surface of the lamina when dried, 1-forked, the upper branch extending beyond the sorus, ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.0–2.0 × 0.5–1.0 mm, ± circular to elliptic in outline, each ± parallel to the midvein, on surface of lamina, contiguous when mature, in two rows, one each side of the midvein in the upper 1/4–1/8 of the lamina, each row with 1–3(–4) sori, ± completely covering the lamina. *Sporangia* (210–) 218–242(–250) μm, with 1–4 medium to dark red-brown rigid hairs (110–)115–185(–200) μm; indurated cells of annulus 10–12(–14). *Spores* (32–)35–44(–47) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Ngga Simanggela, Lam 1549 (BO, L), 1550 (BM, BO, K, L, MICH, UC).

Ecology. Epiphyte in montane forest; at c. 1420 m.

36. Grammitis oblanceolata (Baker) Copel. – Fig. 20; maps 46, 47.

G. oblanceolata (Baker) Copel., Philip. J. Sc. 80 (1952) 166. – *Polypodium oblanceolatum* Baker, Ann. Bot. 8 (1894) 128. – Type: *Macgregor s.n.*, Mt Suckling (K, holo).

Polypodium sparsipilum Copel., Philip. J. Sc. C6 (1911) 139. – *G. sparsipila* Parris, Fern Gaz. 12 (1980) 118. – Lectotype: *Brooks 14*, Bengkarum, Borneo (MICH; iso BM).

G. brevisetulosa Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 192. – Type: *Clemens 40969* p.p. (MICH, holo).

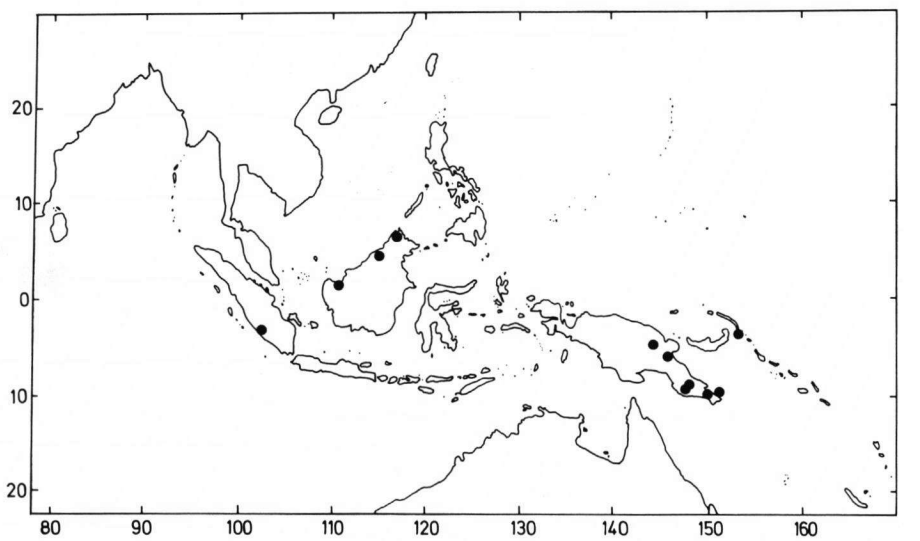
Illustrations: Copel., Philip. J. Sc. C6 (1911) pl. 23b as Polypodium sparsipilum; Copel., Philip. J. Sc. 80 (1952) 167, f. 34 et 192, f. 63 as G. brevisetulosa.

Rhizome 2–5 mm diam. including scales, 0.5–1.0 mm diam. without scales, usually ± erect, rarely short-creeping, unbranched, producing stipes less than 1 mm apart; scales 0.9–1.9(–2.3) × 0.2–0.4 mm, lanceolate, acute to obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.2–)0.6–2.0(–2.4) cm × 0.1–0.2(–0.3) mm, with sparse to moderately dense ± patent medium to dark red-brown simple eglandular hairs (0.2–) 0.5–1.3(–1.5) mm. *Lamina* (2.1–)2.3–7.5(–13.6) × (0.2–)0.3–0.5 cm, linear-lanceolate to linear-oblanceolate, ± obtuse at apex and usually attenuate, rarely cuneate, at base, sometimes entire, usually shallowly crenate especially towards the base, the teeth up to 0.7 mm long, membranous, with ± patent medium to dark red-brown simple eglandular hairs (0.5–)0.7–1.7(–2.0) mm occasional to scattered on

midvein below and margin and occasionally on lamina surface below, rarely occasional on lamina surface above, sometimes similar but binate hairs also present on the margin; midvein slightly prominent on the lower surface of the lamina, concolorous with or rarely darker than it; lateral veins visible in transmitted light, usually 1-forked, the upper branch usually extending beyond the sorus and ± as long as the lower branch, rarely the lower branch 1-forked, each branch ending usually marked by a small hydathode on the upper surface of the lamina, free. *Sori* (0.5–)0.6–1.3(–1.6) × (0.5–)0.6–1.1(–1.3) mm, ± circular in outline, on surface of lamina or very slightly sunken in broad shallow depressions, discrete when mature, in two rows, one on each side of the midvein in the upper 1/4–5/6 of lamina but not immediately below the apex, each row with (1–)4–18(–22) sori, usually nearer the midvein than the margin but sometimes midway between them. *Sporangia* (140–)149–191(–210) μm, with 2–7(–10) pale to medium red-brown rigid hairs (60–)97–162(–180) μm; indurated cells of annulus (8–)10–13. *Spores* (19–)22–29(–32) μm diam.

Distribution. Sumatra, Borneo and New Guinea.

W. HIGHLANDS. Kum forest, Mt Hagen, Parris & Croxall 4662 (BSP).
MOROBE. Near Aseki, Parris & Croxall 7935 (BSP, LAE). Matap, Clemens 40969 (MICH).
CENTRAL. Astrolabe Ra., Wakefield 1433 (BM). Lala R., Carr 14057 (BM, K, L).
NORTHERN. Alola, Carr 13665 (BM, CANB, K, L, LAE, MICH).
MILNE BAY. Ailuluai, Fergusson I., Croft 487 (CROFT, LAE), NGBF 1016 (BULOLO, E, K, L, LAE). Mt Kilkerran, Fergusson I., LAE 71019 (LAE). Mt Suckling, Macgregor s.n. (K).
NEW IRELAND. Taron, Croft 212 & Sands (BSP, CROFT, K, LAE), Croft 212a & Sands (CROFT).



Map 46. *Grammitis oblanceolata* (36).

Ecology. Occasionally growing with *G. adspersa*. Usually a low epiphyte on slender tree trunks in lower montane forest, sometimes in midmontane forest, occasionally terrestrial in cutover midmontane forest; from 610 to 2130 m.

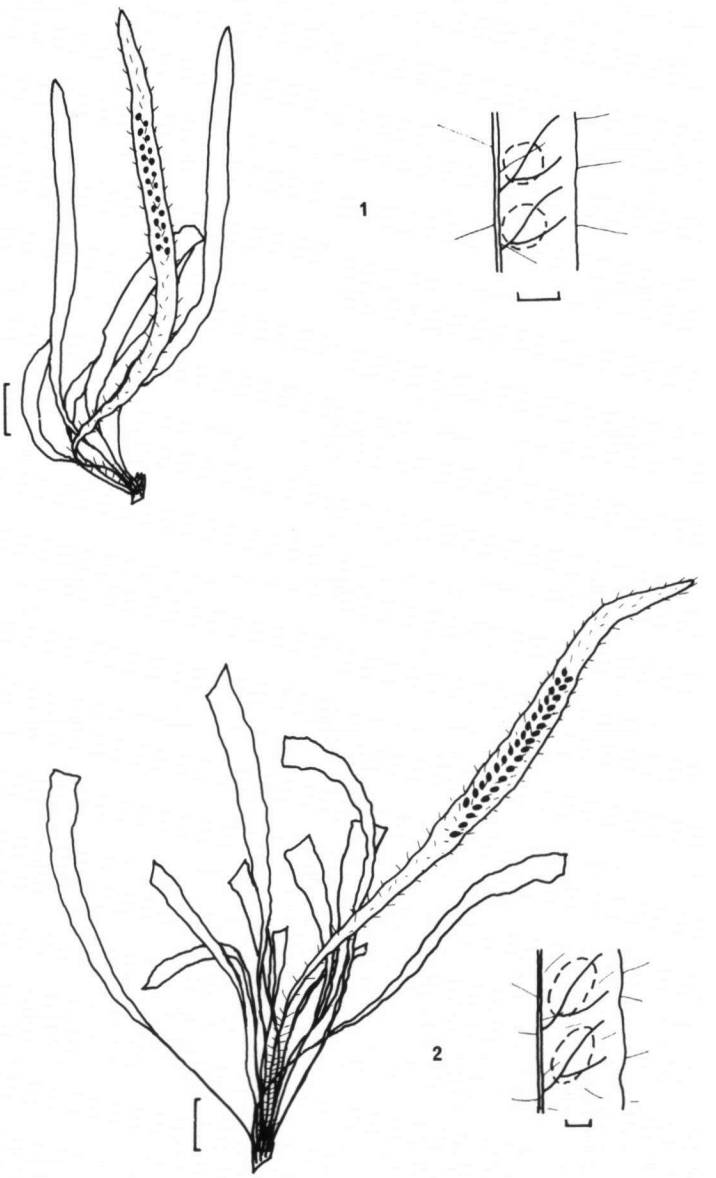
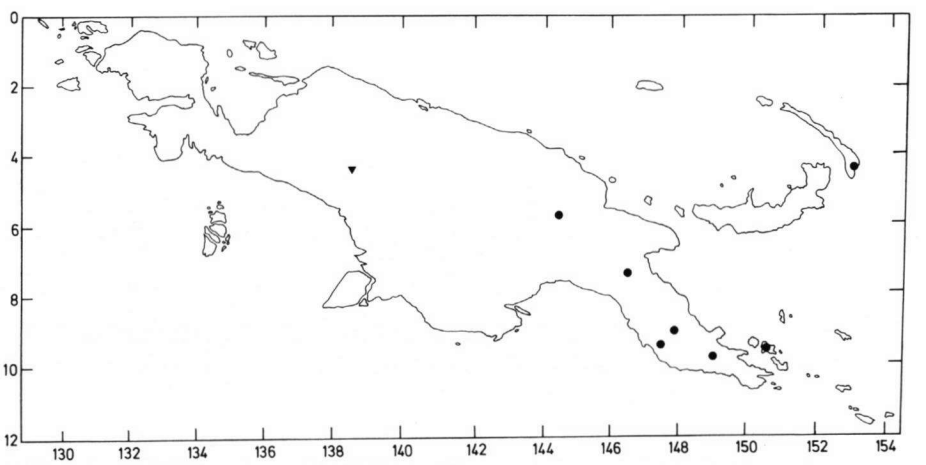


Fig. 20. *G. hirtella* group; *G. oblanceolata* subgroup. – 1. *G. oblanceolata* (36), *Croft 212 & Sands* (BSP); 2. *G. meijer-dreesii* (37), holotype, *Brass 9898 & Meijer Drees* (MICH).

37. Grammitis meijer-dreesii Copel. – Fig. 20; map 47.

G. meijer-dreesii ['*myer-dreesii*'] Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 223. – Type: *Brass 9898 & Meijer Drees* ['*Myer-Drees*'] (MICH, holo; BO, L).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 192, f. 62.

Rhizome 3–4 mm diam. including scales, c. 1 mm without scales, erect, unbranched; scales c. 0.5 × 0.2 mm, lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 2.6–6.4 cm × 0.2–0.4 mm, with moderately frequent ± patent medium red-brown simple eglandular hairs 1.0–1.8 mm, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm and very occasional ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* 6.0–16.0 × 0.7–0.8 cm, linear-elliptic to linear-lanceolate, obtuse at apex, long-attenuate at base, shallowly crenate, the teeth up to 0.8 mm long, membranous, with ± patent medium red-brown simple eglandular hairs 1.0–1.8 mm moderately frequent on young fronds but becoming sparse with age except amongst the sori, occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds, and very occasional ± patent catenate simple eglandular hairs up to 0.3 mm on the midvein below; midvein slightly prominent on the lower surface of the lamina and somewhat darker than it; lateral veins ± visible in transmitted light, 1-forked, the upper branch extending beyond the sorus, as long as or a little shorter than the lower branch, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 2.0–2.3 × 1.3–1.8 mm, ± circular to elliptic in outline, each oblique to the midvein, on surface of lamina, discrete to contiguous when mature, in two rows, one on each side of the midvein in the upper 5/6 of lamina but not immediately below the apex, each row with 12–19 sori, nearer the midvein than the margin. *Sporangia*



Map 47. ● *Grammitis oblanceolata* (36), ▼ *G. meijer-dreesii* (37).

170–200 μm, with 4 medium red-brown rigid hairs 330–380 μm; indurated cells of annulus 10–13(–14). *Spores* (20–)21–27(–28) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Punjak Trikora, Brass 9898 & Meijer Drees (BO, L, MICH).

Ecology. In moss in subalpine forest; at 3560 m.

Notes. Closely related to *G. oblanceolata*, from which it differs by its longer stipes, longer sori and longer sporangia. *G. oblanceolata* grows at much lower altitudes (610 to 2130 m) in lower montane and midmontane forest. A fragmentary collection from rock crevices at 3880 m on Peg. Sukarno, Central Irian Jaya (26.ii.1972, *ANU 16133*, CANB) may belong here, but has stipe hairs to 2.5 mm and larger sporangia, (280–)302–340(–360) μm, and spores, 31–37(–38) μm diam.

Copeland (1942, 1952a) spelt this epithet *'myer-dreesii'*, following the spelling on the labels printed for the relevant part of the 3rd Archbold Expedition's collections, but this is incorrect. 'Meyer Drees' would have been a more accurate transcription but the correct Dutch spelling is 'Meijer Drees'.

38. Grammitis clavipila Parris, *sp. nov.* – Fig. 21; map 48.

G. oblanceolatae et G. meijer-dreesiae affinis, a pilis simplicibus eglandulosis carentibus distincta. — *Rhizoma* squamis inclusis c. 4 mm diam., squamis exclusis c. 1 mm diam., erectum, interdum ramosum; squamae (1.2–)1.7–3.3(–3.7) mm longae, 0.2–0.3(–0.4) mm latae, lanceolatae vel anguste lanceolatae, ad apicem acutae, mediae vel obscure rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* (1.4–)1.8–4.0(–4.7) cm longus, 0.2–0.3 mm latus, pilis simplicibus clavatis glandulosis c. 0.1 mm longis paucis vel sparsis plus minusve appressis pallidis brunneis et pilis simplicibus eglandulosis catenatis 0.1–0.2 mm longis paucis vel sparsis plus minusve patentibus in frondibus iuvenis evolutis vestitus. *Lamina* (8.0–)11.8–21.2(–24.5+) cm longa, (0.4–)0.5–0.7 cm lata, lineari-elliptica vel lineari-oblanceolata, ad apicem obtusa, ad basem longe attenuata, ad basem leviter crenata vel per laminam crenata, lobis ad 0.5 mm longis, plus minusve membranacea, pilis simplicibus clavatis glandulosis c. 0.1 mm longis paucis vel sparsis plus minusve appressis pallidis brunneis ad marginem et medio-venam in frondibus iuvenis evolutis et pilis simplicibus eglandulosis catenatis c. 0.1 mm longis paucis plus minusve patentibus ad mediovenam in frondibus iuvenis evolutis vestita; mediovena ad paginam infernam laminae paulo prominens et pagina inferna laminae concolor vel fuscatior; venae laterales in luce transmissa manifestae, 1-furcatae, ramus superus ultra sorum procurrens, plus minusve longitudine ramum aequans, rami terminales in pagina supera laminae sine hydathodis manifestis, liberi. *Sori* 1.2–2.5 mm longi, 0.8–2.0 mm lati, in ambitu plus minusve circulares, ad superficiarem infernam laminae adornati, discreti ubi matures, in 2 serialibus, 1 utroque medio-venae in 1/3–3/4 superno laminae, in quoque seriali (14–)22–54(–62+) sori, medio-venam quam marginem proximiores. *Sporangia* (170–)190–228(–260) μm longa pilis 2–6 pallidis rubriusculo-brunneis (120–)131–211(–260) μm longis praedita; cellulae induratae annuli (8–)9–11(–12). *Sporae* (21–)23–34(–42) μm diam. — Typus: *Vink 17020*, 28.vi.1966, Ibiwara, Enga District, Papua New Guinea (L; iso LAE).

Rhizome c. 4 mm diam. including scales, c. 1 mm without scales, erect, sometimes branched; scales (1.2–)1.7–3.3(–3.7) × 0.2–0.3(–0.4) mm, lanceolate to narrowly lanceolate, acute at apex, medium to dark red-brown, glabrous, neither clathrate nor

Fig. 21. *G. hirtella* group; *G. oblanceolata* subgroup. – *G. clavipila* (38), holotype, *Vink 1 7020* (L).

iridescent, the cells without cross-walls. *Stipe* (1.4–)1.8–4.0(–4.7) cm × 0.2–0.3 mm, with occasional to sparse ± appressed pale brown simple clavate-glandular hairs c. 0.1 mm and occasional to sparse ± patent catenate simple eglandular hairs 0.1–0.2 mm on young unrolling fronds. *Lamina* (8.0–)11.8–21.2(–24.5+) × (0.4–)0.5–0.7 cm, linear-elliptic to linear-oblanceolate, obtuse at apex, long-attenuate at base, shallowly crenate towards the base, sometimes shallowly crenate throughout, the teeth up to 0.5 mm, ± membranous, with occasional to scattered ± appressed pale brown simple clavate-glandular hairs c. 0.1 mm on lamina and midvein on young unrolling fronds and occasionally on mature ones and occasional ± patent catenate simple eglandular hairs c. 0.1 mm on the midvein of young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins visible in transmitted light, 1-forked, the upper branch extending beyond the sorus, ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.2–2.5 × 0.8–2.0 mm, ± circular in outline, on surface of lamina, discrete when mature, in two rows, one on each side of the midvein in the upper 1/3–3/4 of the lamina, each row with (14–)22–54(–62+) sori, nearer the midvein than the margin. *Sporangia* (170–)190–228(–260) μm, with 2–6 pale red-brown rigid hairs (120–)131–211(–260) μm; indurated cells of annulus (8–)9–11(–12). *Spores* (21–)23–34(–42) μm diam.

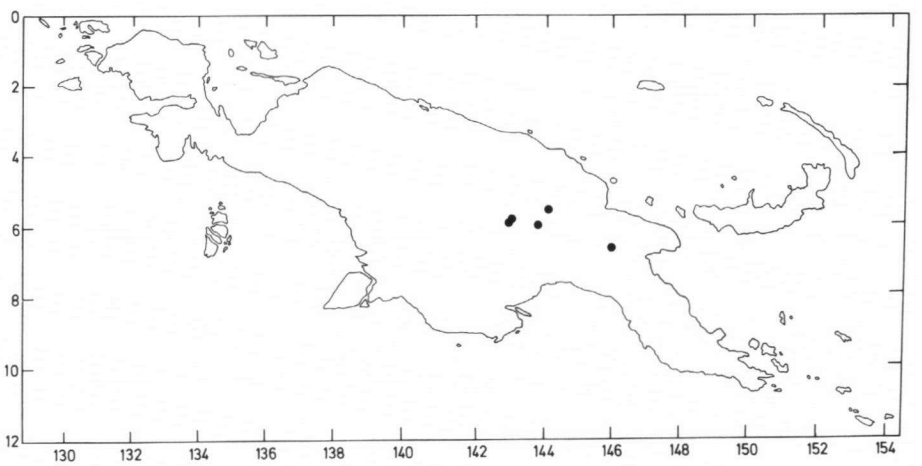
Distribution. New Guinea.

W. HIGHLANDS. Mt Hagen, Parris & Croxall 8121 (BSP, LAE).

ENGA. Ibiwara, Vink 17020 (L, LAE). Mt Ambua, Kalkman 5087 (L, LAE), Vink 17331 (L, LAE).

S. HIGHLANDS. Mt Giluwe, Schodde 1684 (CANB, L, LAE).

E. HIGHLANDS. Mt Piora, Croft 87 (BSP, CROFT, K, LAE).



Map 48. *Grammitis clavipila* (38).

Ecology. Pendulous epiphyte on trunks and branches of trees (including *Nothofagus*) in midmontane forest (including coniferous and *Nothofagus* forest); from 2590 to 3340 m.

Notes. Vernacular name: put (Mendi language).

G. clavipila is closely related to *G. oblanceolata* and *G. meijer-dreesii*, but differs in lacking the simple eglandular lamina hairs which these two species possess.

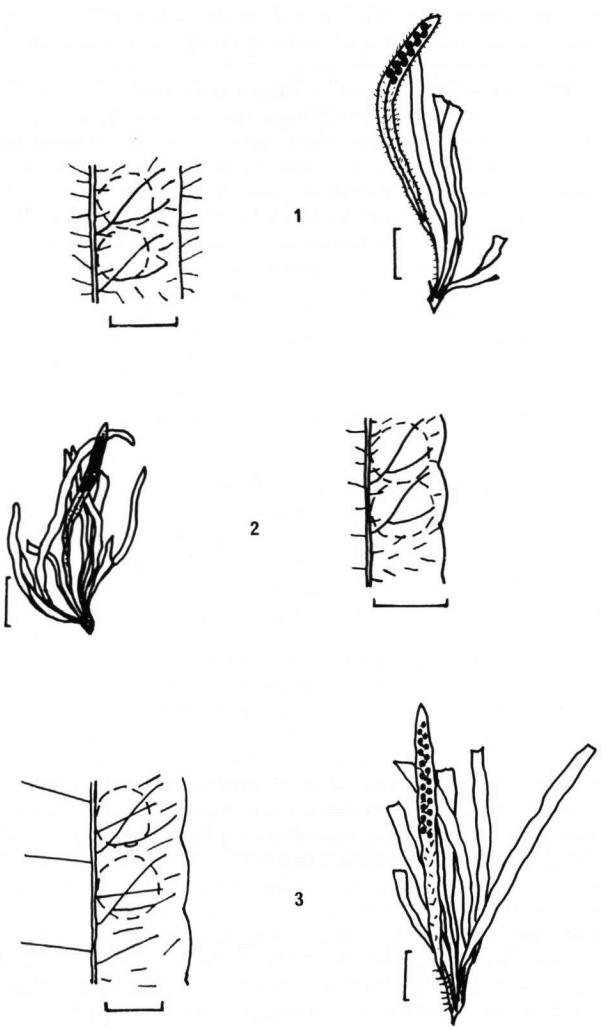


Fig. 22. *G. hirtella* group; *G. lasiosora* subgroup. – 1. *G. coredrosora* (39), isolectotype, *Lam 1550a* (L); 2. *G. silvicola* (40), isotype, *Croft 134* (BSP); 3. *G. ahenobarba* (41), holotype, *Gibbs 5551* (BM).

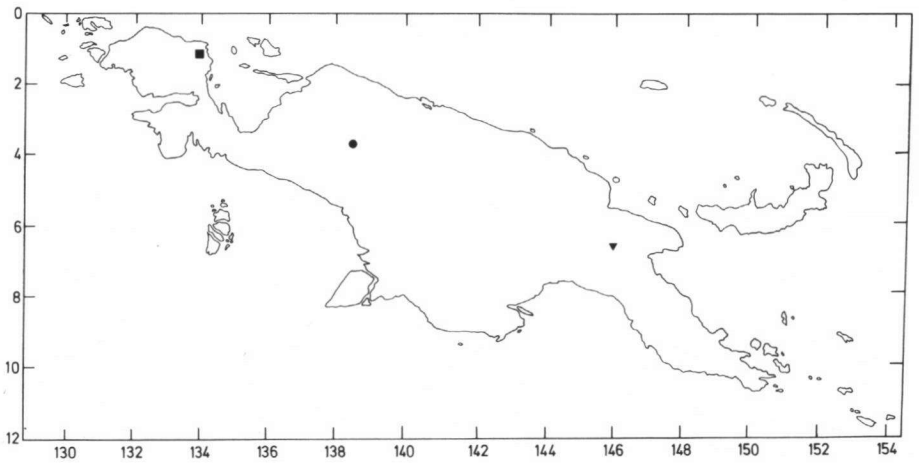
39. Grammitis coredrosora (v.A.v.R.) Copel. – Fig. 22; map 49.

G. coredrosora (v.A.v.R.) Copel., Philip. J. Sc. 80 (1952) 179. – *Polypodium coredrosorum* v.A.v.R., Nova Guinea 14 (1924) 44. – Lectotype: *Lam 1550a* (BO; iso BM, L).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 180, f. 49.

Rhizome c. 2 mm diam. including stipe bases, c. 0.5 mm diam. without stipe bases, erect, unbranched; scales absent. *Stipe* (0.9–)1.0–1.6(–1.8) cm × 0.1–0.2 mm, with moderately dense ± patent very pale to medium red-brown simple eglandular hairs 0.5–0.7 mm. *Lamina* (3.1–)3.3–4.7(–5.0) × 0.2–0.3 cm, linear-oblanceolate, ± acute at apex, attenuate at base, shallowly crenate towards base, the teeth up to 0.3 mm long, membranous, with ± patent pale to medium red-brown simple eglandular hairs 0.3–0.7 mm moderately frequent on all parts of the lamina; midvein slightly prominent on the lower surface of the lamina and slightly darker than it; lateral veins visible in transmitted light, slightly prominent towards their base on the lower surface of the lamina when dried, 1-forked, the upper branch extending beyond the sorus, ± as long as the lower one, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 0.7–1.2 × 0.7–1.1 mm, ± circular in outline, on surface of lamina, discrete to continuous when mature, in two rows, one on each side of the midvein in the upper 1/2–1/3 of lamina, each row with 4–6 sori, nearer the midvein than the margin. *Sporangia* (170–)182–208(–220) μm, with 1–2 pale to medium red-brown rigid hairs 250–360 μm; indurated cells of annulus 10–12. *Spores* 28–33 μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Ngga Simanggela, Lam 1550a (BM, BO, L).



Map 49. ● *Grammitis coredrosora* (39), ▼ *G. silvicola* (40), ■ *G. ahenobarba* (41).

Ecology. Epiphytic in forest; at c. 1420 m.

Notes. Copeland (1952a) described scales from the isolectotype in L, but I find none of this sheet, nor on the lectotype in BO.

G. coredrosora is related to both *G. silvicola* and *G. ahenobarba*, but unlike these two species it has hairs on the upper surface of the lamina.

40. Grammitis silvicola Parris, *sp. nov.* – Fig. 22; map 49.

Differt a G. coredrosora pilis pallidis luteolo-brunneis moderate numerosis in pagina infera laminae et medio-venae; a G. ahenobarba squamis rhizomatis carentibus recedit. — *Rhizoma* basibus stipitium inclusis 2–3 mm diam., basibus stipitium exclusis c. 0.5 mm diam., plus minusve erectum, eramosum; squamae absentes. *Stipes* 0.7–1.7 cm longus, c. 0.2 mm latus, pilis simplicibus eglandulosis 0.5–1.0 mm longis moderate numerosis plus minusve patentibus pallidis luteolo-brunneis vestitus. *Lamina* 3.7–4.2 cm longa, c. 0.2 cm lata, lineari-elliptica, ad apicem acuta vel obtusa, ad basem longe attenuata, leviter crenulata praesertim ad basem, lobis ad 0.5 mm longis, membranacea, pilis simplicibus eglandulosis 0.2–0.3 mm longis moderate numerosis plus minusve patentibus pallidis luteolo-brunneis in pagina infera laminae et medio-vena infera, et pilis simplicibus clavatis glandulosis minusquam 0.1 mm longis paucis plus minusve appressis in frondibus iuvenis evolutis vestita; medio-vena ad paginam inferam paulo prominens et quam paginam inferam laminae fuscatior; venae laterales in luce transmissa manifestae, interdum parum prominentes in pagina infera vel in pagina supera laminae ubi siccatae, interdum quam paginam inferam laminae parum fuscatior, plerumque 1-furcatae, interdum non furcatae, ramus superus vel ramus unus ultra sorum procurrens, plus minusve longitudine ramum inferum aequans, rami terminales interdum in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 1.0–1.5 mm longi, c. 0.1 mm lati, in ambitu plus minusve circulares, ad superficiarem inferam laminae adornati, discreti vel confluentes ubi maturi, in 2 serialibus, 1 utroque medio-venae in ½ superno laminae, in quoque seriali 7–11+ sori, medio-venam quam marginem proximiores, interdum pagina inferna tota laminae tegentes. *Sporangia* (170–)186–208(–210) µm longa, pilis 1–2 pallidis luteolo-brunneis vel pallidis rubriusculo-brunneis rigidis 200–210 µm longis praedita; cellulae induratae annuli 11–13. *Sporae* (30–)31–36(–37) µm diam. — Typus: *J.R. Croft 134*, 6.ix.1975, Mt Piora, Eastern Highlands District, Papua New Guinea (K; iso BSP, CROFT, LAE).

Rhizome 2–3 mm diam. including stipe bases, c. 0.5 mm diam. without stipe bases, ± erect, unbranched; scales absent. *Stipe* 0.7–1.7 cm × c. 0.2 mm, with moderately frequent ± patent pale yellow-brown simple eglandular hairs 0.5–1.0 mm. *Lamina* 3.7–4.2 × c. 0.2 cm, linear-elliptic, acute to obtuse at apex and long-attenuate at base, shallowly crenate especially towards the base, the teeth up to 0.5 mm long, membranous, with moderately frequent ± patent pale yellow-brown simple eglandular hairs 0.2–0.3 mm on lamina and midvein below, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and darker than it; lateral veins visible in transmitted light, sometimes slightly prominent on either surface when dried and sometimes slightly darker than the lamina, usually 1-forked, occasionally unbranched, the upper, or only, branch extending beyond the sorus, ± as long as the lower branch, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* 1.0–1.5 × c. 1.0 mm, ± circular in outline, on surface of lamina, discrete to confluent when mature, in two rows, one

on each side of the midvein in the upper ½ of the lamina, each row with 7–11+ sori, nearer the midvein than the margin, sometimes covering all of lamina undersurface. *Sporangia* (170–)186–208(–210) μm, with 1–2 pale yellow-brown to pale red-brown rigid hairs 200–210 μm; indurated cells of annulus 11–13. *Spores* (30–)31–36(–37) μm diam.

Distribution. New Guinea.

E. HIGHLANDS. Mt Piora, Croft 134 (BSP, CROFT, K, LAE).

Ecology. Epiphyte in montane forest; at 2400 m.

Notes. *G. silvicola* is related to *G. coredrosora* and *G. ahenobarba*, but is distinguished from the former by the glabrous upper surface of the lamina and from the latter by the absence of rhizome scales.

41. Grammitis ahenobarba Parris, *sp. nov.* – Fig. 22; map 49.

Ex affinitatibus G. coredrosora et G. silvicola, a praesentia squamarum rhizomatis distincta. – *Rhizoma* squamis inclusis c. 3 mm diam., squamis exclusis c. 1 mm diam., erectum, eramosum; squamae c. 1.0 mm longae, c. 0.1 mm latae, anguste lanceolatae, ad apicem acutae vel obtusae, pallidae rubriusculo-brunneae, glabrae, non clathratae vel iridescentes, cellulae sine septis. *Stipes* 0.6–0.9 cm longus, c. 0.2 mm latus, pilis simplicibus eglandulosis 1.0–1.2 mm longis moderate numerosis plus minusve patentibus pallidis rubriusculo-brunneis vestitus. *Lamina* 6.0–6.6+ cm longa, c. 0.3 cm lata, lineari-elliptica, ad apicem subacuta vel obtusa, ad basem attenuata, leviter crenulata, lobis ad 0.2 mm longis, membranacea, pilis simplicibus eglandulosis 0.2–0.5 mm longis sparsis vel moderate numerosis plus minusve patentibus pallidis luteolis rubriusculo-brunneis in pagina infera lamina et pilis simplicibus sed c. 1.0 mm longis in medio-vena infera vestita, medio-vena ad paginam inferam laminae paulo prominens et pagina infera laminae concolor; venae laterales in luce transmissa manifestae, 1-furcatae, ramus superus ultra sorum procurrens et plus minusve longitudine ramum inferum aequans, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 0.8–1.0 mm diam., in ambitu plus minusve circulares, ad superficiarem inferam laminae adornati, discreti vel contigui ubi maturi, in 2 serialibus, 1 utroque medio-venae in ½ superno laminae, in quoque seriali c. 11 sori, medio-venam quam marginem proximiores. *Sporangia* c. 180 μm longa, pilis c. 3 pallidis vel pallidissimis luteoli-brunneis rigidis 170–270 μm longis praedita; cellulae induratae annuli c. 12. *Sporae* 27–30 μm diam. — Typus: *L.S. Gibbs 5551*, xii.1913, Anggi Lakes, Vogelkop Peninsula, Irian Jaya (BM).

Rhizome c. 3 mm diam. including scales, c. 1 mm diam. without scales, erect, unbranched; scales c. 1.0 × 0.1 mm, narrowly lanceolate, acute to obtuse at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.6–0.9 cm × c. 0.2 mm, with moderately frequent ± patent pale red-brown simple eglandular hairs 1.0–1.2 mm. *Lamina* 6.0–6.6+ × c. 0.3 cm, linear-elliptic, subacute to obtuse at apex, attenuate at base, shallowly crenate with teeth up to 0.2 mm long, membranous, with sparse to moderately frequent ± patent pale yellowish red-brown simple eglandular hairs 0.2–0.5 mm on lamina undersurface and similar but c. 1.0 mm hairs on midvein below; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins visible in transmitted light, 1-forked, the upper branch extending beyond the sorus and ± as long as the

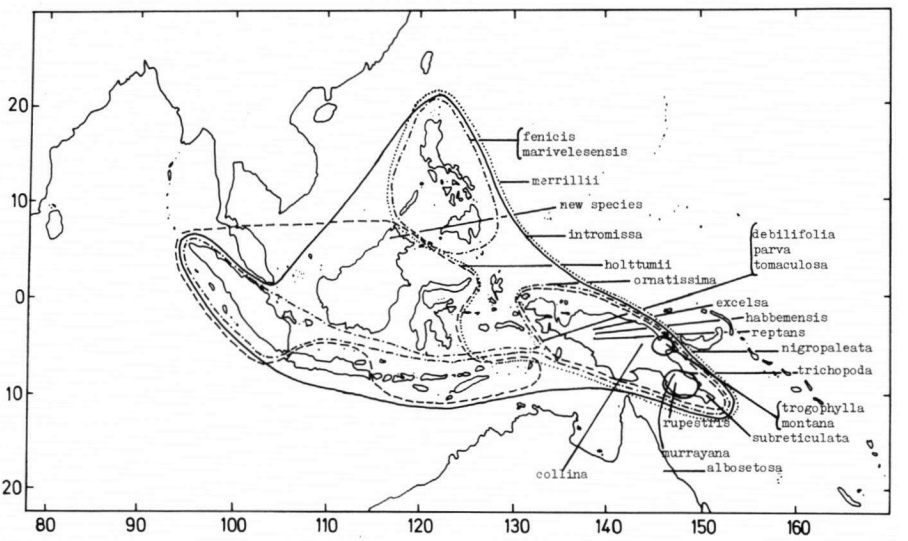
lower branch, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 0.8–1.0 mm diam., ± circular in outline, on surface of lamina, discrete to contiguous when mature, in two rows, one on each side of the midvein in the upper ½ of the lamina, each row with c. 11 sori, nearer the midvein than the margin. *Sporangia* c. 180 μm, with c. 3 pale to very pale yellow-brown rigid hairs 170–270 μm; indurated cells of annulus c. 12. *Spores* 27–30 μm diam.

Distribution. New Guinea.

VOGELKOP PENINSULA. Anggi Gita, Gibbs 5551 (BM).

Ecology. Epiphyte in montane forest; at 2130 m.

Note. The presence of rhizome scales distinguishes *G. ahenobarba* from its relatives *G. coredrosora* and *G. silvicola.*



Map 50. *G. intromissa* species group.

10. G. intromissa group – Species 42–58
Figs. 23–28; maps 50–63; table 10

Rhizome erect to long-creeping; scales rarely absent, ovate to narrowly lanceolate, pale red-brown to dark brown, glabrous, the cells without cross-walls, not or rarely clathrate, not or rarely slightly iridescent. *Stipe* rarely absent, with whitish, pale yellow or pale to dark red-brown simple eglandular hairs 0.4–5.5 mm, occasionally with catenate simple eglandular hairs and simple clavate glandular hairs. *Lamina* entire, rarely shallowly crenate, membranous to coriaceous or spongiose, with medium to

Table 10. Characters of taxonomic importance within the *G. intromissa* species group in New Guinea.

Characters	*G. debilifolia*	*G. nigropaleata*	*G. tomaculosa*	*G. intromissa*
Rhizome	more or less erect to short-creeping	more or less erect	erect to short-creeping	more or less erect to short-creeping
Rhizome scales	dark brown	dark brown	medium to dark brown	usually dark brown, occ. medium red-brown
Stipe hairs in mm (simple eglandular)	medium to dark red-brown, moderately dense, (1.0–)1.6–3.2(–3.5)	dark red-brown, moderately dense, (1.5–)3.0–4.2(–6.0)	dark red-brown, moderately frequent, (0.5–)1.1–3.5	pale to dark red-brown, sparse to moderately frequent, (0.7–)1.2–2.4(–3.0)
Lamina in cm	(2.8–)3.7–10.7(–24.0+) × (0.2–)0.3–0.5	(4.0–)6.0–12.8(–16.0) × (0.4–)0.5–0.8(–1.0)	(1.6–)1.9–6.1(–12.1) × (0.4–)0.5–0.9(–1.3)	3.2–19.1(–40.0+) × (0.4–)0.5–1.1(–1.6)
Lamina hairs in mm (simple eglandular)	medium to dark red-brown, scattered to frequent on all parts, (1.3–)2.3–4.5(–5.5)	dark red-brown, frequent on all parts, (1.0–)1.7–3.9(–4.5)	dark red-brown, moderately frequent on all parts or occ. sparse on lamina below, (0.5–)1.5–3.7(–4.0)	medium red-brown, scattered on both surfaces and more frequent on margin, or moderately frequent on all parts, (0.7–)1.2–3.0(–4.2)
Lateral veins	visible in transmitted light, 1(–2)-forked, 1st branch upward	invisible in transmitted light, 1–2-forked, 1st branch upward	usually invisible in transmitted light, 1–3-forked, 1st branch upward	usually visible in transmitted light, 1–2-forked, 1st branch upward
Sori	on surface of lamina in 2 rows	on surface of lamina in 2 rows	on surface of lamina in 2 rows	on surface of lamina in 2 rows
Spores in μm	(24–)27–36(–42)	(31–)36–54(–76)	(27–)32–44(–51)	(18–)23–35(–43)

Table 10 continued.

Characters	*G. reptans*	*G. trogophylla*	*G. murrayana*	*G. trichopoda*
Rhizome	short to long-creeping	more or less erect	more or less erect to short-creeping	short to long-creeping
Rhizome scales	medium red-brown	medium red-brown	medium red-brown	pale to medium red-brown
Stipe hairs in mm (simple eglandular)	medium red-brown, frequent, 1.0–2.0	medium red-brown, frequent, 1.3–2.2	whitish to pale yellow-brown, moderately frequent, 0.7–1.0	pale yellow to medium red-brown, occ. to moderately frequent, (0.4–)0.5–1.4 (–2.0)
Lamina in cm	c. 10.9 × 0.5	(4.7–)5.2–7.4(–8.1) × (0.3–)0.4–0.6(–0.7)	2.7–3.5 × 0.4–0.5	(1.8–)4.1–8.9(–11.5) × (0.4–)0.5–0.7(–0.8)
Lamina hairs in mm (simple eglandular)	dark red-brown, mod. frequent on all parts, 1.0–2.5	medium red-brown, frequent on all parts, 2.0–3.0	dark red-brown, mod. frequent on all parts or glabrescent except amongst sori, 0.7–2.0	medium red-brown, mod. frequent on all parts, (0.3–)0.8–1.8(–2.0)
Lateral veins	invisible in transmitted light, 1-forked, 1st branch upward	more or less visible in transmitted light, 1-forked, 1st branch upward	invisible in transmitted light, 2-forked, 1st branch upward	usually visible in transmitted light, 1–2-forked, 1st branch upward
Sori	on surface of lamina in 2 rows	on surface of lamina in 2 rows	on surface of lamina in 2 rows	on surface of lamina in 2 rows
Spores in μm	(33–)34–41(–42)	(40–)41–47(–50)	(37–)38–43(–44)	(25–)29–35(–42)

Table 10 continued.

Characters	*G. subreticulata*	*G. merrillii*	*G. parva*	*G. habbemensis*
Rhizome	short-creeping	erect to ascending	erect	erect
Rhizome scales	medium red-brown	pale red-brown	absent	medium red-brown
Stipe hairs in mm (simple eglandular)	medium to dark red-brown, mod. frequent, 0.3–1.5	absent	pale to medium red-brown, mod. dense, (0.5–)0.6–1.6 (–2.0)	medium red-brown, mod. dense, 2.3–4.0
Lamina in cm	14.5–21.0 × 0.8–1.3	1.0–1.4 × 0.1–0.2	(1.3–)1.4–3.7(–5.7) × 0.2–0.3	(9.2–)10.8–23.2(–25.0+) × (0.6–)0.7–0.9
Lamina hairs in mm (simple eglandular)	medium to dark red-brown, mod. frequent on midvein below and amongst sori scattered to sparse elsewhere on both surfaces, 0.7–1.5	dark red-brown, occ. to scattered on midvein above and below and lamina above, 0.2–0.5	medium to dark red-brown, mod. frequent on all parts, 0.9–2.7(–3.8)	medium red-brown, mod. frequent on all parts, 1.7–2.5
Lateral veins	more or less visible in transmitted light, 2–5-forked, 1st branch upward	invisible in transmitted light, 1-forked, 1st branch upward	visible in transmitted light, 1-forked, 1st branch upward	more or less visible in transmitted light, 1–2-forked, 1st branch upward
Sori	on surface of lamina in 2–4 rows	on surface of lamina in 2 rows	on surface of lamina in 2 rows	sunken in pits in 2 rows
Spores in μm	(31–)35–49(–57)	(26–)27–30(–32)	(17–)23–31(–36)	34–44(–50)

Table 10 continued.

Characters	*G. montana*	*G. excelsa*	*G. rupestris*	*G. collina*	*G. ornatissima*
Rhizome	short-creeping	short-creeping	erect	more or less erect	erect
Rhizome scales	medium red-brown	pale red-brown	dark red-brown	medium to dark red-brown	medium to dark red-brown
Stipe hairs in mm (simple eglandular)	dark red-brown, scattered, 1.0–2.0	medium red-brown, scattered, 3.0–4.0	dark red-brown, sparse to scattered, 0.4–0.8	medium to dark red-brown, scattered to frequent, 1.0–2.0	dark red-brown, moderately frequent, (1.0–)1.3–3.9(–5.0)
Lamina in cm	(1.6–)2.0–3.2(–4.0) × (0.2–)0.3–0.4 (–0.5)	40+ × 1.4–2.6	3.3–3.9 × c. 0.3	(5.8–)6.1–7.7(–7.8) × 0.3–0.5	(27.0–)31.3–57.3 (–65.5+) × (0.7–) 0.8–1.1
Lamina hairs in mm (simple eglandular)	dark red-brown, sparse on margin and midvein below, occ. on midvein above, 0.5–1.5	medium red-brown, scattered on all parts, 1.5–3.0	dark red-brown, mod. frequent on midvein below, margin and amongst sori, scattered on midvein above, 0.4–2.1, longest amongst sori	medium to dark red-brown, scattered to mod. frequent on margin, midvein below and amongst sori, occ. to scattered elsewhere on lamina above and below, (0.3–)0.8–1.5	dark red-brown, scattered to mod. frequent on all parts, (2.0–)2.6–5.2(–6.0)
Lateral veins	invisible in transmitted light, 1-forked, 1st branch upward	± visible in transmitted light, 5–9-forked, 1st branch downward	invisible in transmitted light, 1-forked, 1st branch upward	visible in transmitted light, 1(–2)-forked, 1st branch upward	visible in transmitted light, 1–2-forked, 1st branch upward
Sori	sunken in pits in 2 rows	on surface of lamina in 4–6 rows	on surface of lamina in 2 rows	on surface of lamina in 2 rows	on surface of lamina in 2 rows
Spores in μm	(38–)42–50(–53)	(34–)36–44(–50)	(33–)36–47(–50)	(47–)49–56(–59)	(33–)39–48(–52)

dark red-brown simple eglandular hairs 0.2–5.5 mm; lateral veins visible or not in transmitted light, 1–9-forked, the first upper branch shorter than or ± as long as the others, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina which sometimes bears a white scale. *Sori* ± circular to elliptic in outline, on surface of lamina, slightly sunken in broad shallow depressions or occasionally sunken in pits, in 2–6 rows.

Epiphytic, rupestral or terrestrial, in lower montane and midmontane forest, subalpine forest and subalpine grassland. Distribution from Sumatra to New Guinea with seventeen species in New Guinea, fourteen of which are endemic, one species in mainland New Guinea and Japen I., two in mainland New Guinea, three in Irian Jaya Highlands, one in PNG Highlands, three in Mid-PNG and four in Southeast Peninsula.

The extra-New Guinea members of this group are *G. albosetosa* (Bailey) Parris, *G. fenicis* Copel., *G. holttumii* Copel., *G. marivelesensis* Copel., and one undescribed species.

42. Grammitis debilifolia Copel. – Fig. 23; map 51.

G. debilifolia Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 191. – Type: *Brass 10036 & Meijer Drees* ['*Myer-Drees*'] (MICH, holo; BM, BO, GH, K, L, LAE, UC).

G. trogophylla sensu Copel., Philip. J. Sc. 80 (1952) 196, quoad *Brass 9855.*

Illustrations: Copel., Philip. J. Sc. 80 (1952) 191, f. 61.

Rhizome 2–3 mm diam. including scales, c. 1 mm diam. without scales, ± erect to short-creeping, unbranched, producing stipes < 1 mm apart; scales 1.5–2.5(–2.9) × (0.3–)0.5–1.1(–1.3) mm, ovate-lanceolate to lanceolate, obtuse to bluntly acute at apex, dark brown, glabrous, neither clathrate nor iridescent, the cells without crosswalls. *Stipe* 1.1–5.8(–8.6) cm × (0.1–)0.2–0.3(–0.4) mm, with moderately dense ± patent medium to dark red-brown simple eglandular hairs (1.0–)1.6–3.2(–3.5) mm. *Lamina* (2.8–)3.7–10.7(–24.0+) × (0.2–)0.3–0.5 cm, linear-elliptic to linear-oblanceolate, obtuse to acute at apex and long-attenuate at base, entire, membranous to slightly coriaceous, with ± patent medium to dark red-brown simple eglandular hairs (1.3–)2.3–4.5(–5.5) mm scattered to frequent on all parts; midvein slightly prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins ± visible in transmitted light, usually 1-forked, the upper branch often extending just beyond the sorus and nearly as long as the lower branch, occasionally the upper or lower branch 1-forked, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* (0.8–)1.0–1.8(–2.2) × (0.7–)0.9–1.7(–2.0) mm, ± circular in outline, on surface of lamina, discrete to confluent when mature, in two rows, one on each side of the midvein in the upper ½–¾ of the lamina, but not immediately below the apex, each row with (4–)9–20(–35) sori, often covering all of lamina between margin and midvein, otherwise nearer the midvein than the margin. *Sporangia* (170–)176–243(–280) μm, with 1–4 dark red-brown

rigid hairs (200–)239–839(–1400) μm; indurated cells of annulus (8–)10–12(–15). *Spores* (24–)27–36(–42) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Punjak Trikora, Brass 9855 & Meijer Drees (BM, BO, GH, MICH), 10036 (BM, BO, GH, K, L, LAE, MICH, UC).

W. SEPIK. Mt Capella, LAE 68107 (LAE).

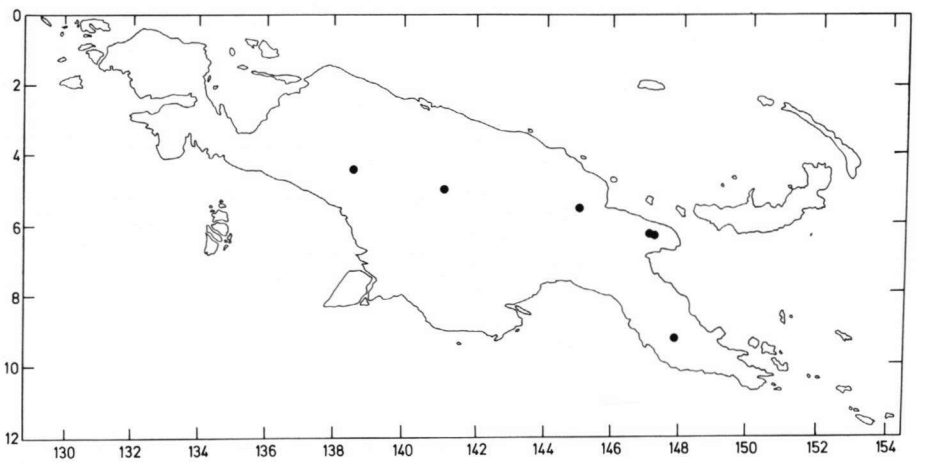
CHIMBU. Mt Wilhelm, ANU 7409 (LAE), Brass 29826 (LAE, US), Nakaike 339 (LAE), Parris & Croxall 4707 H 269 (BSP, LAE).

MOROBE. Rawlinson Ra., Clemens 12379 (MICH, UC), 12380, 12384, 12451 (all MICH). Mt Sarawaket, Clemens 7343 (BM).

CENTRAL. N.W. of the Gap, Carr 15130 (BM).

Ecology. Epiphyte on tree trunks in subalpine forest, sometimes in uppermontane forest, occasionally rupestral or terrestrial in subalpine grassland; 3000 to 3900 m.

Notes. *G. debilifolia* is closely related to *G. nigropaleata*, but probably always occurs at higher altitudes in different vegetation types and usually has narrower fronds.



Map 51. *Grammitis debilifolia* (42).

43. Grammitis nigropaleata Copel. – Fig. 23; map 52.

G. nigropaleata Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 198. – Type: *Clemens 41018* (MICH, holo; MICH, UC).

Illustrations: Copel., Philip. J. Sc. 80 (1952) 198, f. 69.

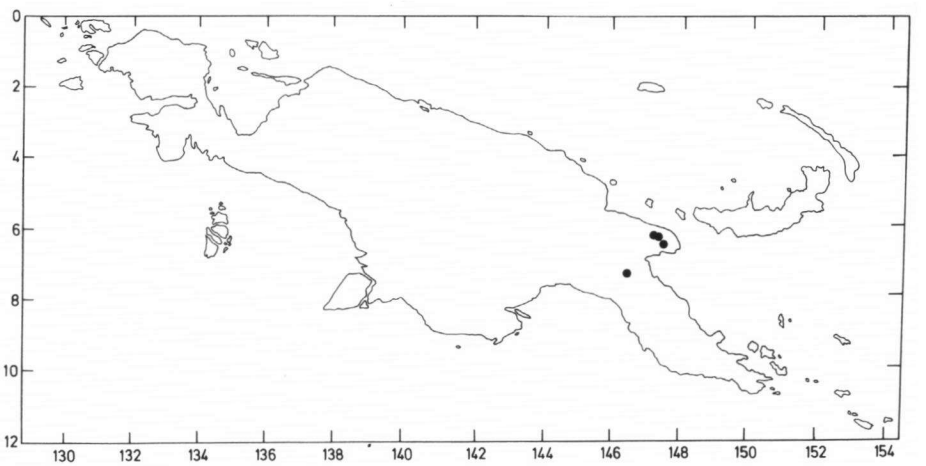
Rhizome 3–4 mm diam. including scales, c. 1 mm diam. without scales, short, ± erect, unbranched; scales (1.6–)1.9–2.9(–3.0) × (0.4–)0.5–0.7(–0.8) mm, lanceolate, acute at apex, dark brown, glabrous, ± clathrate but not iridescent, the cells

without cross-walls. *Stipe* (0.4–)1.1–3.1(–3.8) cm × (0.2–)0.3–0.6(–0.7) mm, with moderately dense ± patent dark red-brown simple eglandular hairs (1.5–)3.0–4.2(–6.0) mm. *Lamina* (4.0–)6.0–12.8(–16.0) × (0.4–)0.5–0.8(–1.0) cm, linear-oblanceolate, ± acute at apex and long-attenuate at base, margin sometimes partly inrolled over the sori, entire, coriaceous, with ± patent dark red-brown simple eglandular hairs (1.0–)1.7–3.9(–4.5) mm frequent on all parts of the lamina; midvein not prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1–2-forked, the upper branch of the first fork always extending beyond the sorus, and ± as long as the lower branch when the latter is not forked but markedly shorter than it when it is 1-forked, each branch sometimes marked by a small hydathode on the upper surface of the lamina. *Sori* (1.5–)1.8–3.4(–4.0) × (1.3–)1.4–3.4(–4.0) mm, ± circular in outline, on surface of lamina or very slightly sunken in shallow depressions, contiguous to confluent when mature, in two rows, one on each side of the midvein, in the upper or middle 1/3– 2/3 of the lamina but not immediately below the apex, each row with (6–)11– 21(–24) sori, nearer the midvein than the margin. *Sporangia* (220–)284–394(– 430) μm, with (1–)2–6(–8) dark red-brown rigid hairs (200–)397–909(–1110) μm; indurated cells of annulus (9–)10–13(–15). *Spores* (31–)36–54(–76) μm diam.

Distribution. New Guinea.

MOROBE. Ekuti Ra., Parris & Croxall 6269 (BSP). Matap, Clemens 40991 (MICH), 40992 (E, MICH), 41018 (MICH, UC). Mt Rawlinson, Hoogland & Craven 9352 (CANB, LAE). Mt Sarawaket, 3350–3660 m, Clemens s.n. (BM). Ogeranang, Clemens 4735 (BM). Rawlinson Ra., Clemens 12451 (UC).

Ecology. Epiphytic on tree trunks and high branches in midmontane forest (including *Nothofagus* forest); from 1700 to 3350 m.



Map 52. *Grammitis nigropaleata* (43).

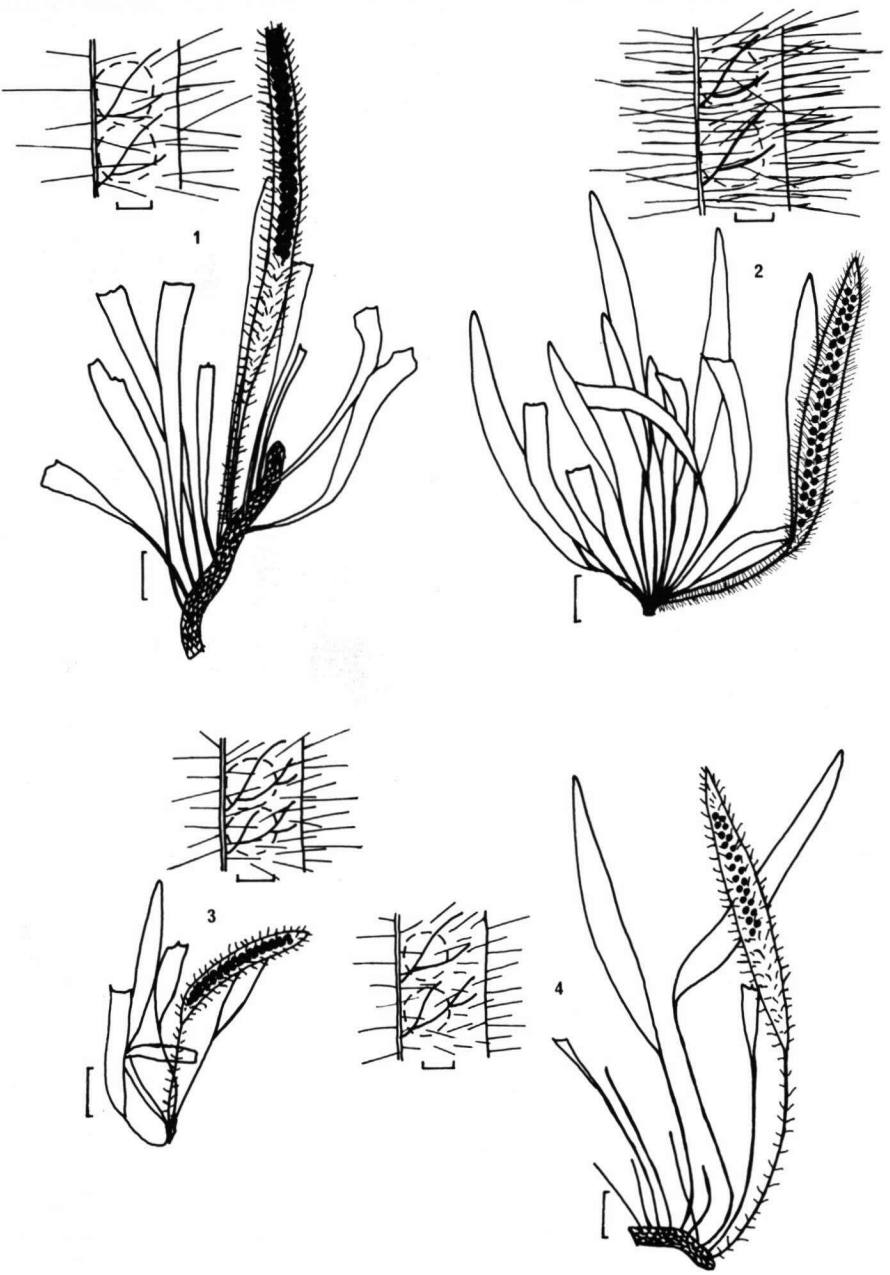


Fig. 23. *G. intromissa* group. – 1. *G. debilifolia* (42), isotype, *Brass 10036 & Meijer Drees* (LAE); 2. *G. nigropaleata* (43), holotype, *Clemens 41018* (MICH); 3. *G. tomaculosa* (44), isotype, *Brass 10042a & Meijer Drees* (L); 4. *G. intromissa* (45), *Parris & Croxall 8253* (BSP).

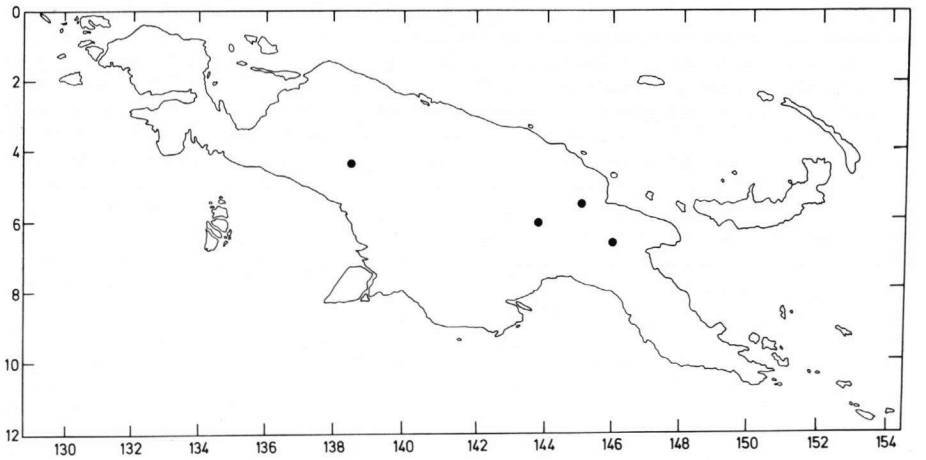
Note. The altitudes (3350–3660 m) noted on the Clemens collection from Mt Sarawaket may be incorrect. Some of Clemens' material was gathered by native collectors (van Royen, 1980) and it is not known how the altitudes of these collections were determined. In the absence of other evidence to the contrary it is best to regard *G. nigropaleata* as not occurring above 3000 m.

44. Grammitis tomaculosa Parris, *sp. nov.* – Fig. 23; map 53.

G. fasciculata sensu Copel., Philip. J. Sc. 80 (1952) 198, quoad *Brass 10042a & Meijer Drees.*

G. intromissae et speciebus affinibus similis: a G. debilifolia et G. nigropaleata pilis stipitis moderate numerosis, a G. intromissa, G. trogophylla et G. trichopoda pilis laminae obscure rubriusculo-brunneis, a G. reptanti, G. trogophylla, G. murrayana et G. trichopoda pilis stipitis obscure rubriusculo-brunneis differt. — *Rhizoma* squamis inclusis 6–7 mm diam., squamis exclusis 1–2 mm diam., erectum vel breviter repens, eramosum, stipites per spatia usque ad 1 mm emittens; squamae (1.8–)2.0–3.4(–4.0) mm longae, (0.4–)0.5–0.8(–0.9) mm latae, lanceolatae, ad apicem obtusae vel subacutae, mediae vel obscure rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* (1.1–)2.0–5.8(–8.9) cm longus, (0.2–)0.3–0.6(–0.7) mm latus, pilis simplicibus eglandulosis (0.5–)1.1–3.5 mm longis moderate numerosis, plus minusve patentibus obscure rubriusculo-brunneis vestitus. *Lamina* (1.6–)1.9–6.1(–12.1) cm longa, (0.4–)0.5–0.9(–1.3) cm lata, lineari-lanceolata vel lineari-oblanceolata, ad apicem acuta vel obtusa, ad basem cuneata, integra, coriacea, pilis simplicibus eglandulosis (0.5–)1.5–3.7(–4.0) mm longis plus minusve patentibus obscure rubriusculo-brunneis per laminam plerumque moderate numerosis vestita, interdum pilis similaribus ad marginem et ad medio-venam infernam et inter soros moderate numerosis sed ad paginam infernam laminae sparsis vestita; medio-vena ad paginam inferam laminae plus minusve prominens et pagina inferna laminae concolor; venae laterales in luce transmissa interdum manifestae, 1–2-furcatae, ramus superus ultra sorum procurrens et ramum inferum plus minusve longitudine aequans ubi 1-furcatae, ramus superus quam ramos inferos brevior ubi 2-furcatae, rami terminales in pagina supera laminae sine hydathodis manifestis et plerumque liberi sed interdum prope marginem anastomosantes. *Sori* (1.0–)1.2–2.6(–3.4) mm longi, 1.1–2.2(–3.0) mm lati, in ambitu plus minusve circulares, ad superficiarem inferam laminae adornati, discreti vel confluentes ubi maturi, in 2 serialibus, 1 utroque medio-venae ubique lamina vel in ½ superno laminae sed non prope apicem nec prope basem, in quoque seriali (1–)6–14(–20) sori medio-venam quam marginem proximiores. *Sporangia* (210–)213–319(–360) μm longa, pilis simplicibus eglandulosis 1–4(–6) mediis vel obscure rubriusculo-brunneis rigidis (250–)293–567(–800) μm longis praedita; cellulae induratae annuli (8–)10–12(–13). *Sporae* (27–)32–44(–51) μm diam. — Typus: *L.J. Brass 10042a et E. Meijer Drees*, ix.1938, north slopes of Mt Wilhelmina, Irian Jaya (BM; iso BO, GH, L, MICH).

Rhizome 4–7 mm diam. including scales, 1–2 mm diam. without scales, erect to short-creeping, unbranched, producing stipes up to 1 mm apart; scales (1.8–)2.0–3.4(–4.0) × (0.4–)0.5–0.8(–0.9) mm, lanceolate, obtuse to subacute at apex, medium to dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.1–)2.0–5.8(–8.9) cm × (0.2–)0.4–0.6(–0.7) mm, with moderately frequent ± patent dark red-brown simple eglandular hairs (0.5–)1.1–3.5 mm. *Lamina* (1.6–)1.9–6.1(–12.1) × (0.4–)0.5–0.9(–1.3) cm, linear-lanceolate to linear-oblanceolate, acute to obtuse at apex, cuneate at base, entire, coriaceous, with ± patent dark red-brown simple eglandular hairs (0.5–)1.5–3.7(–4.0) mm usually moderately frequent on all parts of lamina, occasionally moderately frequent on



Map 53. *Grammitis tomaculosa* (44).

margin, midvein below and amongst sori and sparse on the lower surface of the lamina; midvein ± prominent on the lower surface of the lamina and concolorous with it; lateral veins occasionally visible in transmitted light, 1–3-forked, the branch endings without obvious hydathodes on the upper surface of the lamina, usually free but sometimes anastomosing at the margin. *Sori* (1.0–)1.2–2.6(–3.4) × (0.8–)1.1–2.2(–3.0) mm, ± circular in outline, on surface of lamina, discrete to confluent when mature, in two rows, one on each side of the midvein throughout the lamina to only in its upper ½ but not immediately below the apex or above the base, each row with (1–)6–14(–20) sori, nearer the midvein than the margin. *Sporangia* (210–)213–319(–360) μm, with 1–4(–6) medium to dark red-brown rigid hairs (230–)293–567(–800) μm; indurated cells of annulus (8–)10–12(–13). *Spores* (27–)32–44(–51) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Punjak Trikora, Brass 10042a & Meijer Drees (BM, BO, GH, L, MICH).

S. HIGHLANDS. Mt Giluwe, NGF 40227 (K, L, LAE).

CHIMBU. Mt Wilhelm, ANU 5169 (CANB, L, LAE), 7407 (LAE), Nakaike 296, 329, 339, 340 (all LAE), NGF 47388 (LAE), Parris & Croxall 4706 H 267 (BSP, LAE).

E. HIGHLANDS. Mt Piora, Croft 100 (BSP, CROFT, K).

Ecology. Usually rupestral on the sides of rock holes in subalpine grassland, but occasionally epiphytic in subalpine forest; from 3400 to 4120 m.

Notes. A collection from the Morobe District (Upper Camp, 2440–2540 m, 20. ii.1939, *Clemens 9874*, MICH) may belong here. It has smaller scales (c. 1.5 × 0.3 mm) and medium red-brown stipe and lamina hairs like those of *G. trogophylla*, which is known only from Mt Sarawaket in Morobe District. In all other characters,

however, (including the density of hairs) it resembles *G. tomaculosa*, which is not known from the Morobe District.

45. Grammitis intromissa (Christ) Parris – Fig. 23; maps 54, 55.

G. intromissa (Christ) Parris, Fern Gaz. 12 (1981) 180. – *Polypodium intromissum* Christ, Verh. Naturf. Ges. Basel 11 (1896) 440; Copel., Philip. J. Sc. 80 (1952) 200. – Lectotype: *Sarasin 1368*, Celebes, Wawokaraeng (BASLE).

Polypodium setigerum Blume, Enum. Fl. Javae (1828) 123. – *G. setigera* Ching, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 241, non J. Sm. (1875). – Lectotype: *Blume s.n.*, Java, Gede (L; iso K, L).

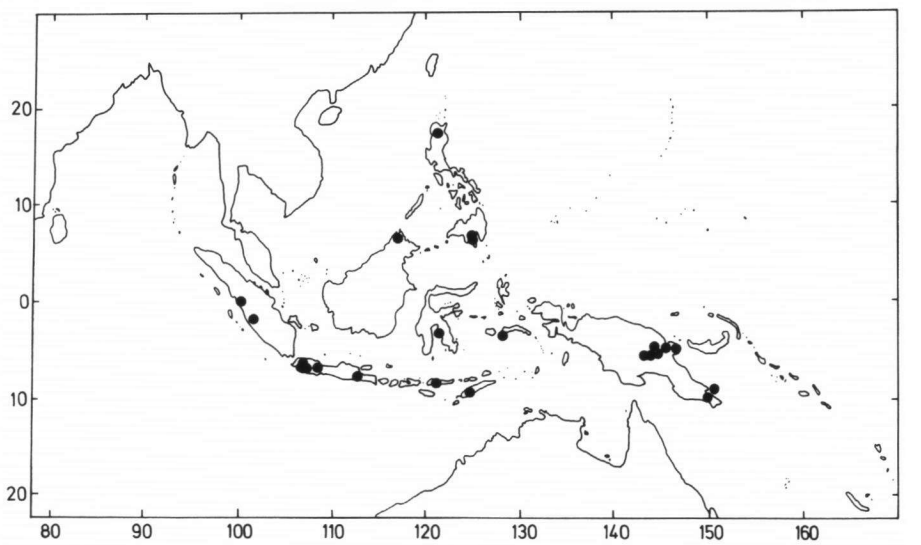
G. fasciculata Blume, Flora Javae 2 (31 August 1829) 112, superfl. nom. illegit. pro *Polypodium setigerum* Blume; Copel., Philip. J. Sc. 80 (1952) 198, excl. New Guinea coll. – *Polypodium fasciculatum* C. Presl, Tentamen (1836) 180, pro *G. fasciculata* Blume, nom. illegit., superfl. nom. illegit. pro *Polypodium setigerum* Blume.

Polypodium heanophyllum Copel., Philip. J. Sc. 40 (1929) 310. – Lectotype: *Copeland's Pteridophyta Philippensia Exsiccata 158* [sphalm. 185], Philippines, Mindanao, Mt Matutum (MICH; iso BM, K, SING).

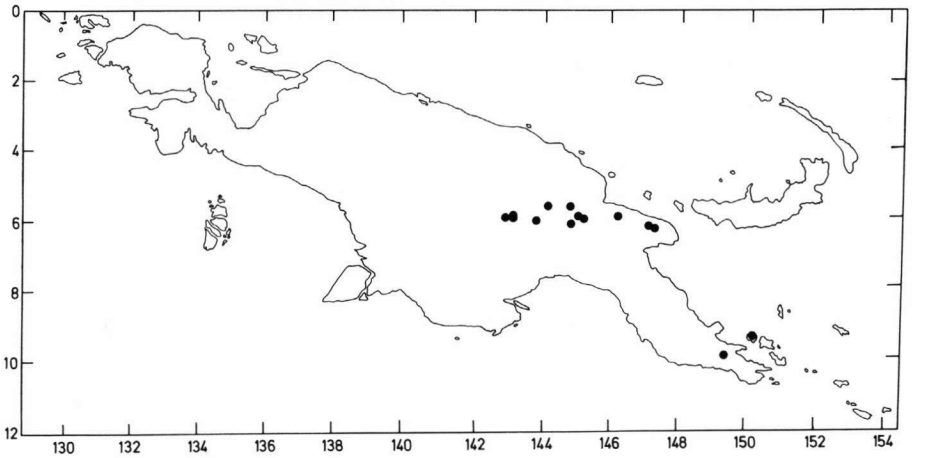
G. cyclosora Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 197. – Lectotype: *Clemens s.n.*, Mt Sarawaket, 11,000–12,000 ft (MICH).

Illustrations: Blume, Flora Javae 2 (31 August 1829) pl. 47, f. 2 as G. fasciculata; Christ, Ann. Jard. Bot. Btzg 15 (1897) pl. 15, f. 20 a & b as Polypodium intromissum; Copel., Philip. J. Sc. 80 (1952) 197, f. 67 as G. cyclosora et 199, f. 70 as G. fasciculata.

Rhizome 3–7 mm diam. including scales, 1–2 mm diam. without scales, ± erect to short-creeping, usually unbranched, producing stipes 0.5–2.0 mm apart; scales



Map 54. *Grammitis intromissa* (45).



Map 55. *Grammitis intromissa* (45).

(0.7–)1.0–2.0(–2.2) × 0.3–0.8 mm, ovate to narrowly lanceolate, obtuse at apex, usually dark red-brown, occasionally medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.9–)2.6–5.4(–6.5) cm × (0.2–)0.3–0.5(–0.8) mm, with sparse to moderately frequent ± patent pale to dark red-brown simple eglandular hairs (0.7–)1.2–2.4(–3.0) mm, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm and occasional ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling stipes. *Lamina* 3.2–19.1(–40.0+) × (0.4–)0.5–1.1(–1.6) cm, linear-lanceolate to linear-oblanceolate, obtuse to acuminate at apex, cuneate to attenuate at base, entire, membranous to somewhat coriaceous or spongiose, with ± patent medium red-brown simple eglandular hairs (0.7–)1.2–3.0(–4.2) mm scattered on both surfaces and more frequent on margin, or moderately frequent on all parts of the lamina, and similar but binate hairs sometimes present on the margin; midvein not or rather prominent on the lower surface of the lamina and concolorous with it; lateral veins usually visible in transmitted light, sometimes also visible in reflected light, 1–2-forked, the upper branch of the first fork extending beyond the sorus and ± as long as or a little shorter than the lower branch when the latter is not forked, but markedly shorter than it when it is 1-forked, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* (0.5–)1.0–2.0(–2.5) × (0.5–)0.9–1.9(–2.5) mm, ± circular in outline, on the surface of the lamina, usually discrete but sometimes contiguous when mature, in two rows, one on each side of the midvein throughout the lamina but not immediately below the apex or above the base, or only in the middle or upper ½, each row with (3–)7–32(–75) sori, nearer the midvein than the margin. *Sporangia* (150–)188–239(–290) μm, with 1–4(–6) pale to dark red-

brown rigid hairs (80–)210–394(–500) μm; indurated cells of annulus (8–)9–12 (–14). *Spores* (18–)23–35(–43) μm diam.

Distribution. Sumatra, Borneo, Java, Philippines, Celebes, Moluccas, Lesser Sunda Islands and New Guinea.

PAPUA. Lloyd & Womersley 2388 (MICH).

W. HIGHLANDS. Al R. near Nondugl, NGF 4807, 4994 (both BRI, CANB, NSW). Mt Hagen, Parris & Croxall 8072 (BSP, LAE). Tomba Pass, Parris & Croxall 8017 (BSP, LAE), Warapuri R., Wahgi-Jimi divide, NGF 18195 (BRI, CANB, K, L, LAE, NSW, SING).

ENGA. Mt Ambua, Vink 17391 (L, LAE). Mt Ne to Mt Kerewa, Vink 17141 (L, LAE). Tari, NGF 28368 (LAE). Tari Gap, Parris & Croxall 9610 (BSP).

S. HIGHLANDS. Mt Giluwe, Parris & Croxall 5817, 8253 (both BSP, LAE).

CHIMBU. Chimbu divide, NGF 6270 (BRI, LAE, NSW).

E. HIGHLANDS. Fatima R., Marafunga, Grubb & Edwards 174 (LAE), LAE 51107 (K, LAE).

MADANG. Moro, Jermy 4147 (BM). Mt Abilala, Jermy 4285 (BM). Sewe to Tregbury Pass, Walker 8635, 8637–8641 (all BM).

MOROBE. Matap, Clemens 40969 (MICH). Rawlinson Ra., Clemens 12341, 12446a (both MICH). Mt Sarawaket, Clemens 6234 (BM, L), s.n., 3350–3660 m (MICH), s.n., 3810 m (MICH), 41963 (MICH). Sattelberg, Clemens 6234 (BM, L).

MILNE BAY. Goodenough I., Brass 24512 (A, BM, CANB, L, LAE, US). Mt Dayman, Brass 22829 (A, BM, CANB, K, L, LAE, US).

Ecology. Usually a pendulous epiphyte on trunks of trees, sometimes also on tree-ferns (*Cyathea* spp. and *Dicksonia sciurus*), in midmontane forest (including *Nothofagus* and *Pandanus* forest), occasionally in lower montane forest or in secondary forest, occasionally rupestral or terrestrial on streambanks in forest or rupestral in subalpine grassland; from 1600 to 3810 m.

Notes. The fronds are a rather distinctive light greyish green when fresh.

G. intromissa is closely related to *G. debilifolia, G. nigropaleata, G. tomaculosa, G. reptans, G. trogophylla, G. murrayana* and *G. trichopoda. G. intromissa* varies greatly in lamina size and *G. cyclosora* was described from a small specimen of it. This species occasionally produces 32-spored sporangia, on the same plant as the more usual 64-spored sporangia.

46. Grammitis reptans Parris, *sp. nov.* – Fig. 24; map 56.

G. mollipila sensu Copel., Philip. J. Sc. 80 (1952) 195, quoad *Brass 9841 & Meijer Drees.*

G. intromissa et speciebus affinibus similis: praesertim rhizomate breviter vel longe repenti recedit sed etiam a G. debilifolia et G. intromissa squamis rhizomatis mediis rubriusculo-brunneis, a G. tomaculosa, G. murrayana et G. trichopoda pilis stipitis mediis rubriusculo-brunneis, a G. intromissa et G. trichopoda pilis laminae obscure rubriusculo-brunneis differt. — *Rhizoma* squamis inclusis 3–4 mm diam., squamis exclusis c. 1 mm diam., breviter vel longe repens, eramosum, stipites per spatia 2–4 mm emittens; squamae 2.1–2.3 mm longae, c. 0.8 mm latae, lanceolatae, ad apicem subacutae, mediae rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 1.5–2.0 mm longus, 0.6–0.7 mm latus, pilis simplicibus eglandulosis 1.0–2.0 mm longis moderate numerosis plus minusve patentibus mediis rubriusculo-brunneis vestitus. *Lamina* c. 10.9 cm longa, c. 0.5 cm lata, lineari-elliptica, ad apicem acuta vel acuminata, ad basem longe attenuata, integra, paulo coriacea, pilis simplicibus eglandulosis 1.0–2.5 mm longis mode-

rate numerosis plus minusve patentibus obscure rubriusculo-brunneis per laminam vestita; medio-venam ad paginam inferam laminae paulo prominens et pagina infera laminae concolor; venae laterales in luce transmissa non manifestae, parum prominentes in pagina infera laminae ubi siccatae, 1-furcatae, ramus superus ultra sorum procurrens et plus minusve longitudine ramum inferum aequans, rami terminales in pagina supera laminae sine hydathodis manifesti, liberi. *Sori* 1.5–2.0 mm longi, 1.0–1.5 mm lati, in ambitu plus minusve circulares, ad superficiarem inferam laminae adornati, confluentes ubi maturi, in 2 serialibus, 1 utroque medio-venae in ½ medio laminae, in quoque seriali 21+ sori, medio-venam quam marginem proximiores. *Sporangia* (290–)301–355 (–380) µm longa, pilis 1–3 obscure rubriusculo-brunneis rigidis 320–480 µm longis praedita; cellulae induratae annuli (9–)11–12. *Sporae* (33–)34–41(–42) µm diam. — Typus: *L.J. Brass 9841 & E. Meijer Drees*, ix.1938, 7 km northeast of Mt Wilhelmina, Irian Jaya (L; iso BO, GH, MICH).

Rhizome 3–4 mm diam. including scales, c. 1 mm without scales, short to long-creeping, unbranched, producing stipes 2–4 mm apart; scales 2.1–2.3 × c. 0.8 mm, lanceolate, subacute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 1.5–2.0 cm × 0.6–0.7 mm, with moderately frequent ± patent medium red-brown simple eglandular hairs 1.0–2.0 mm. *Lamina* c. 10.9 × 0.5 cm, linear-elliptic, acute to acuminate at apex and long-attenuate at base, entire, somewhat coriaceous, with ± patent dark red-brown simple eglandular hairs 1.0–2.5 mm moderately frequent on all parts of the lamina; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, slightly prominent on the lower surface of the lamina when dried, 1-forked, the upper branch extending beyond the sorus and ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.5–2.0 × 1.0–1.5 mm, ± circular in outline, on surface of lamina, confluent when mature, in two rows, one on each side of the midvein in the middle ½ of the lamina, each row with 21+ sori, nearer the midvein than the margin. *Sporangia* (290–)301–355(–380) µm, with 1–3 dark red-brown rigid hairs 320–480 µm; indurated cells of annulus (9–)11–12. *Spores* (33–)34–41(–42) µm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Punjak Trikora, Brass 9841 & Meijer Drees (BO, GH, L, MICH).

Ecology. Epiphyte in subalpine forest; at 3560 m.

47. Grammitis trogophylla Copel. – Fig. 24; map 56.

G. trogophylla Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 196. – Type: *Clemens s.n.*, Mt Sarawaket, 11,000–12,000 ft (MICH, holo).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 196, f. 66.

Rhizome c. 3 mm diam. including scales, c. 1 mm diam. without scales, ± erect, unbranched; scales c. 1.5 × 0.3 mm, lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 1.2–2.3 cm × 0.3–0.4 mm, with frequent ± patent medium red-brown simple eglandular hairs 1.3–2.2 mm. *Lamina* (4.7–)5.2–7.4(–8.1) × (0.3–)0.4–0.6(–0.7) cm, linear-

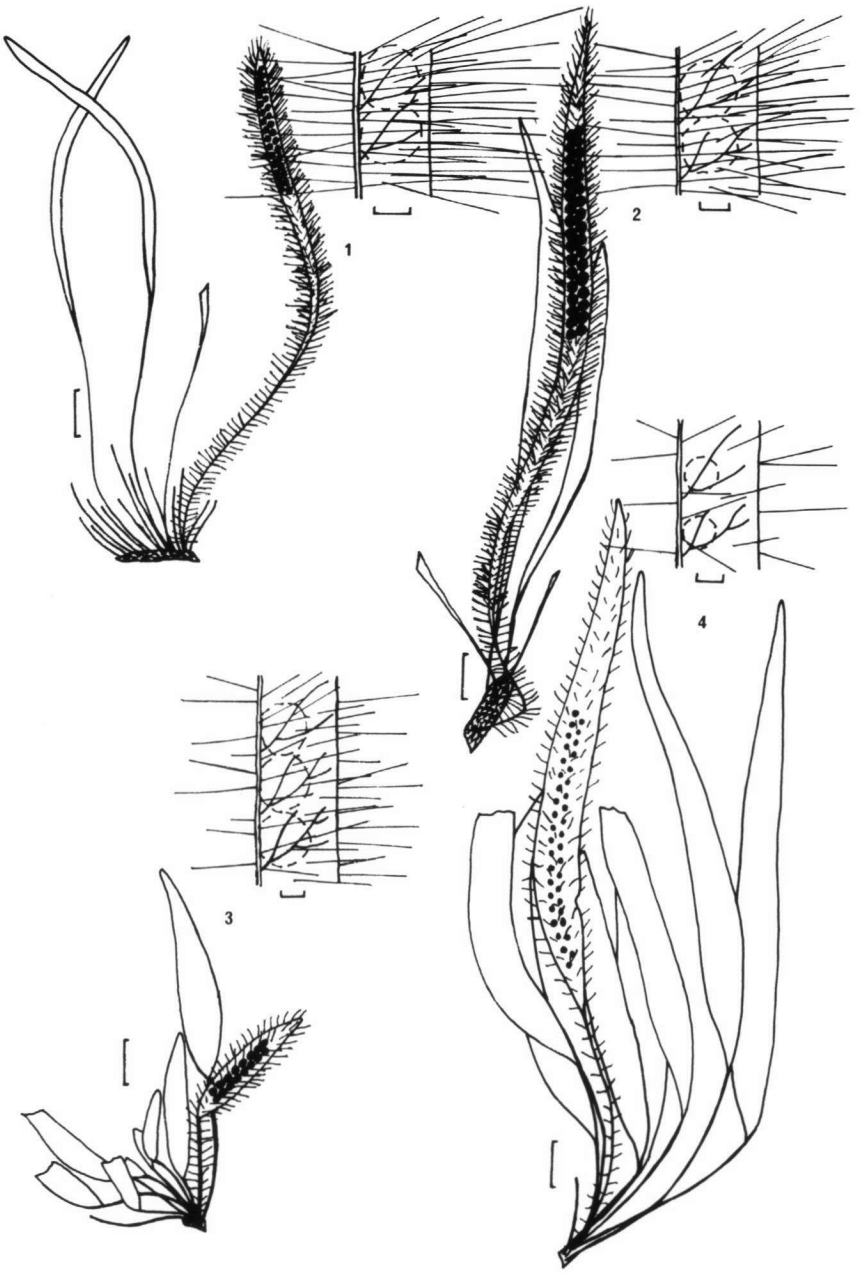


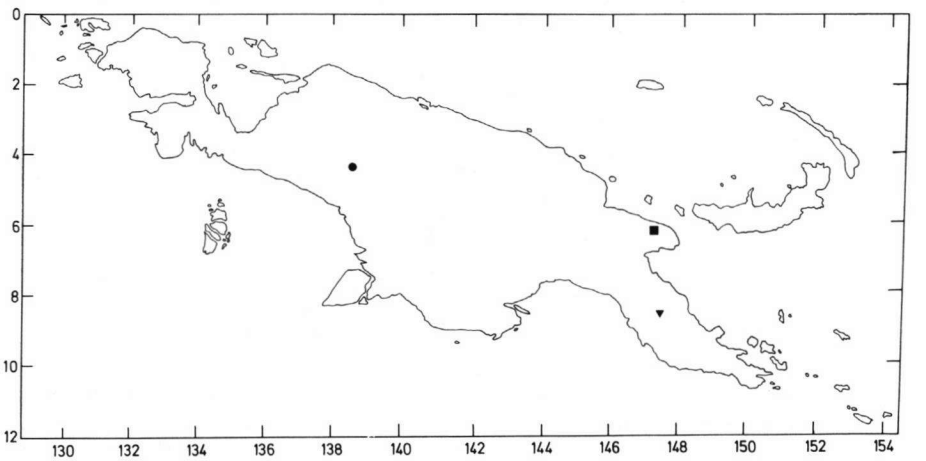
Fig. 24. *G. intromissa* group. – 1. *G. reptans* (46), isotype, *Brass 9841 & Meijer Drees* (MICH); 2. *G. trogophylla* (47), holotype, *Clemens s.n.* (MICH); 3. *G. murrayana* (48), holotype, *Brass 4726* (BM); 4. *G. trichopoda* (49), *LAE 54452* (LAE).

elliptic to linear-oblanceolate, acute at apex, long-cuneate to long-attenuate at base, entire, slightly coriaceous, with ± patent medium red-brown simple eglandular hairs 2.0–3.0 mm frequent on all parts; midvein rather prominent on the lower surface of the lamina and concolorous with it; lateral veins ± visible in transmitted light, 1-forked, the upper branch extending beyond the sorus and ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.3–2.7 × 1.0–1.8 mm, ± circular in outline, on the surface of the lamina, contiguous when mature, in two rows, one on each side of the midvein throughout the lamina but not immediately below the apex or above the base to only in the upper ½ of the lamina, each row with (3–)7–19 sori, nearer the midvein than the margin. *Sporangia* (220–)234–268(–280) μm, usually glabrous, sometimes with 1–2 medium red-brown rigid hairs 300–360 μm; indurated cells of annulus 11–14 (–16). *Spores* (40–)41–47(–50) μm diam.

Distribution. New Guinea.

MOROBE. Mt Sarawaket, Clemens s.n., 3350–3660 m (MICH).

Ecology. Between 3350 and 3660 m.



Map 56. ● *Grammitis reptans* (46), ■ *G. trogophylla* (47), ▼ *G. murrayana* (48).

48. Grammitis murrayana (C. Chr.) Copel. – Fig. 24; map 56.

G. murrayana (C. Chr.) Copel., Philip. J. Sc. 80 (1952) 200. – *Polypodium murrayanum* C. Chr., Brittonia 2 (1937) 304. – Type: *Brass 4726* (BM, holo; BRI).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 201, f. 71.

Rhizome 2–4 mm diam. including scales, c. 1 mm diam. without scales, ± erect to very short-creeping, possibly sometimes branched, producing stipes less than 1 mm

apart; scales 0.7–1.8 × c. 0.4 mm, ovate to lanceolate, acute to obtuse at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.9–)2.2–3.0(–3.2) cm × 0.2–0.4 mm, with moderately frequent ± patent whitish to pale yellow-brown simple eglandular hairs 0.7–1.0 mm. *Lamina* 2.7–3.5 × 0.4–0.5 cm, linear-elliptic, acute at apex and cuneate at base, entire, rather coriaceous, with ± patent dark red-brown simple eglandular hairs 0.7–2.0 mm moderately frequent on all parts of the lamina when young, especially on margin, midvein and amongst sori, sometimes glabrescent everywhere except amongst sori; midvein slightly prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins invisible in transmitted light, 2-forked, the upper branch of the first fork terminating in the sorus or extending beyond it and nearly as long as the lower branches, the lower branch 1-forked, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.0–2.0 × 1.0–1.5 mm, ± circular in outline, on surface of lamina, contiguous when mature, in two rows, one on each side of the midvein in the upper ½ of the lamina or throughout its length, but not immediately below the apex or above the base, each row with 6–18 sori, nearer the midvein than the margin. *Sporangia* (180–)194–220(–230) μm, with 2–4 medium red-brown rigid hairs 240–300 μm; indurated cells of annulus 10–12. *Spores* (37–)38–43(–44) μm diam.

Distribution. New Guinea.

NORTHERN. Murray Pass, Wharton Ra., Brass 4726 (BM, BRI).

Ecology. Rupestral on wet rocks by stream in grassland; at 2840 m.

Notes. *G. murrayana* is very closely related to *G. trichopoda*, but occurs at a lower altitude and has rather smaller fronds and somewhat larger spores. More collections of *G. murrayana* are needed to establish if these differences are constant.

49. Grammitis trichopoda (F. Mueller) Copel. – **Fig. 24; map 57.**

G. trichopoda (F. Mueller) Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 197. – *Polypodium trichopodum* F. Mueller, Trans. Roy. Soc. Victoria 1 (1889) 41; Baker, J. Bot. (London) 28 (1890) 107. – Lectotype: *Macgregor 28*, Mt Victoria (MEL; iso BM, K).

Illustrations: Copel., Philip. J. Sc. 80 (1952) 198, f. 68.

Rhizome 2–4 mm diam. including scales, c. 1 mm diam. without scales, short to long-creeping, sometimes branched and forming clumps, producing stipes up to 1.3 cm apart; scales (1.8–)2.0–3.4(–3.5) × (0.4–)0.6–1.1(–1.3) mm, ovate-lanceolate to lanceolate, ± obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (3.2–)4.3–6.9(–9.2) cm × (0.2–)0.3–0.4(–0.5) mm, with occasional to moderately frequent ± patent pale yellow to medium red-brown simple eglandular hairs (0.4–)0.5–1.4(–2.0) mm. *Lamina* (1.8–)4.1–8.9(–11.5) × (0.4–)0.5–0.7(–0.8) cm, linear-lanceolate to linear-oblanceolate, acute to obtuse at apex, cuneate to attenuate at base, entire, slightly coriaceous, with

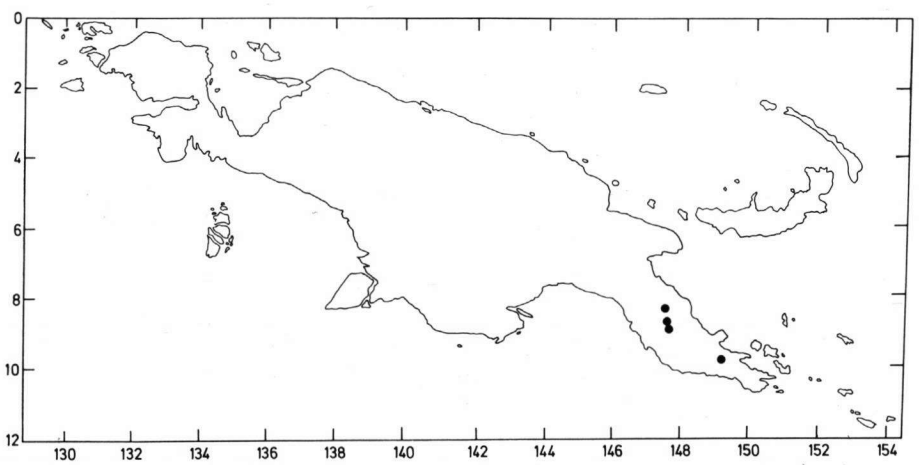
± patent medium red-brown simple eglandular hairs (0.3–)0.8–1.8(–2.0) mm moderately frequent on all parts and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins usually visible in transmitted light, sometimes very slightly prominent on the upper surface of the lamina when dried, 1–2-forked, the first upper branch extending beyond the sorus and ± as long as the lower branch when the latter is not forked, but shorter than it when it is 1-forked, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free or with occasional anastomosing near the margin. *Sori* (1.0–)1.3–2.4(–2.5) × (0.8–)0.9–2.0(–2.5) mm, ± circular in outline, on surface of lamina, discrete to confluent when mature, in two rows, one on each side of the midvein throughout the lamina to only in the upper 1/3 but not immediately below the apex or above the base, each row with (2–)9–20(–23) sori, nearer the midvein than the margin. *Sporangia* (180–)196–246(–280) μm, with (1–)2–5(–6) medium to dark red-brown rigid hairs (170–)229–398(–440) μm; indurated cells of annulus (9–)10–12(–14). *Spores* (25–)29–35(–42) μm diam.

Distribution. New Guinea.

CENTRAL. Mt Albert Edward, Brass 4260 (BM, BRI, GH, MICH, NY), Kanai 753579 (LAE), LAE 61432 (K, L, LAE). Mt Knutsford, Macgregor 28 (K). Mt Victoria, Macgregor 28 (BM, K, MEL), LAE 61763 (K, L, LAE), van Royen 11009 (LAE).

MILNE BAY. Goe, Mt Suckling, LAE 54427 (LAE), 54452 (E, K, LAE).

Ecology. Usually terrestrial or rupestral under overhanging rocks or in rock crevices, in subalpine forest, subalpine grassland or at the margin of subalpine grassland and forest, occasionally epiphytic on tree-ferns (*Cyathea* spp.) in subalpine grassland, from 3400 to 3900 m.



Map 57. *Grammitis trichopoda* (49).

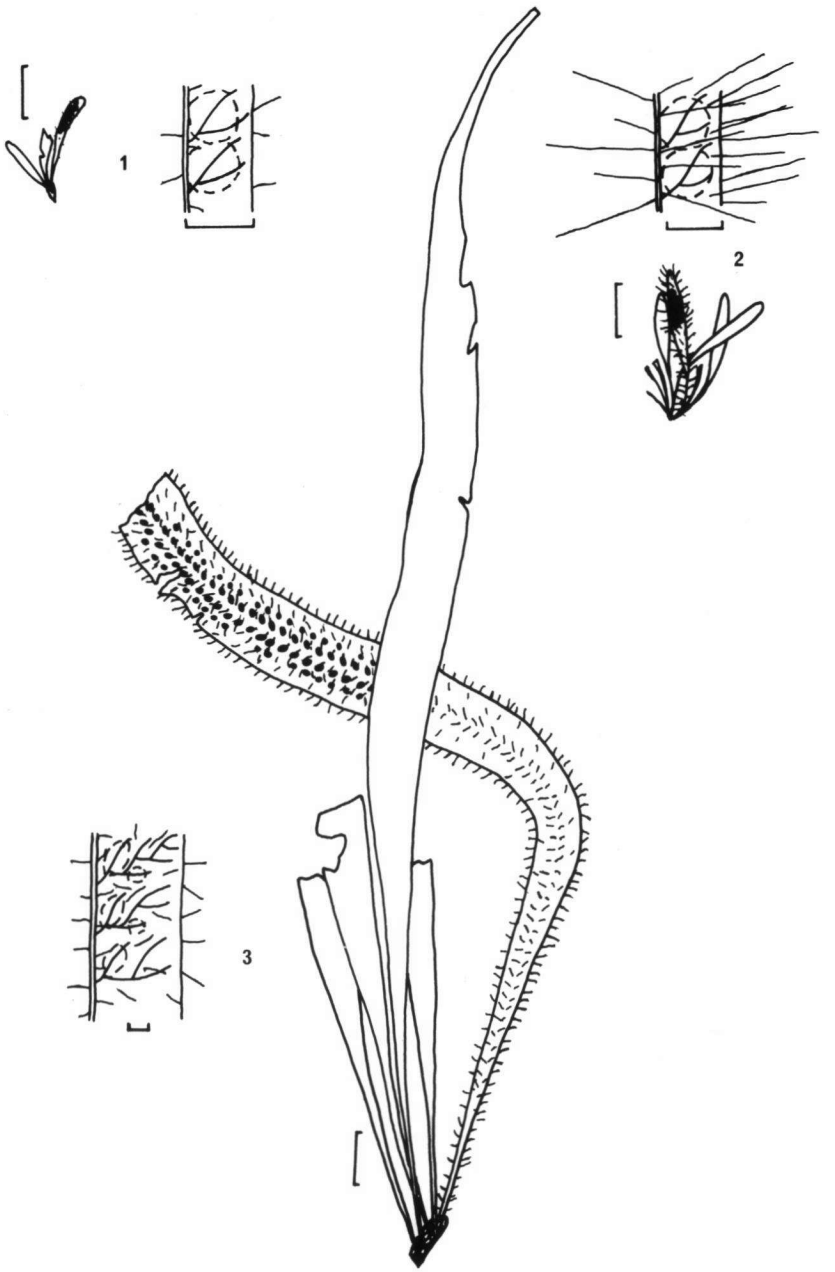
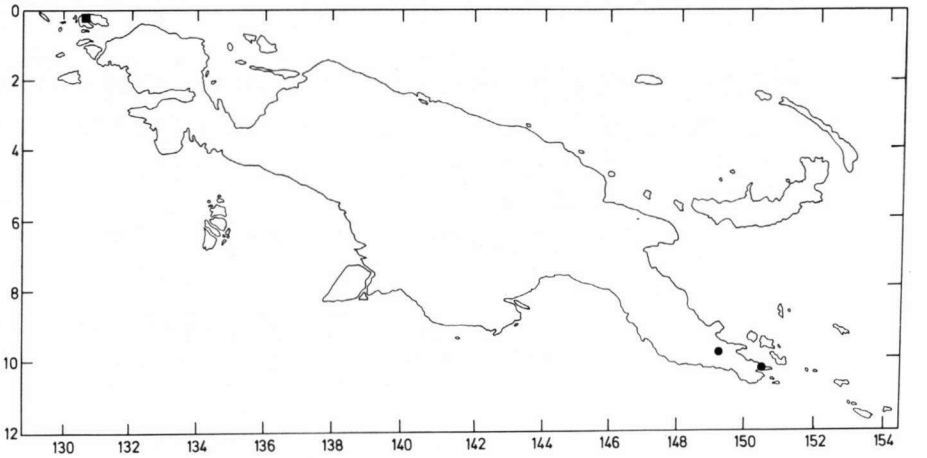


Fig. 25. *G. intromissa* group. – 1. *G. merrillii* (51), *Cheesman 1217* (BM); 2. *G. parva* (52), lectotype, *Schlechter 17156* (B); 3. *G. subreticulata* (50), lectotype, *Copland King 395* (MICH).

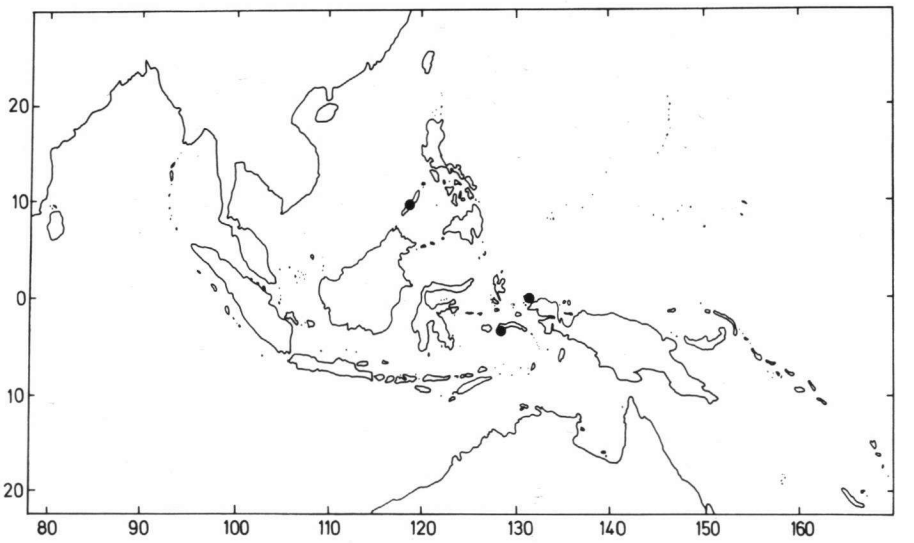


Map 58. ● *Grammitis subreticulata* (50), ■ *G. merrillii* (51).

50. Grammitis subreticulata (Copel.) Copel. – Fig. 25; map 58.

G. subreticulata (Copel.) Copel., Philip. J. Sc. 80 (1952) 185. – *Polypodium subreticulatum* Copel., Philip. J. Sc. C9 (1914) 6. – Lectotype: *Copland King 395* (coll. P.C. Shaw) (MICH; iso NSW, iso fragm. BM).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 185, f. 54.

Rhizome 2–3 mm diam. including scales, c. 1 mm diam. without scales, short-creeping, unbranched, producing stipes 1 mm or less apart; scales c. 1.3 × 0.5 mm, lanceolate, acute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 1.3–1.7 cm × 0.4–0.7 mm, with moderately frequent ± patent medium to dark red-brown simple eglandular hairs 0.3–1.5 mm. *Lamina* 14.5–21.0 × 0.8–1.3 cm, linear-elliptic to linear-lanceolate, acuminate at apex and long-attenuate at base, entire, somewhat coriaceous, with ± patent medium to dark red-brown simple eglandular hairs 0.7–1.5 mm, moderately frequent on margin, midvein below and amongst sori, scattered to sparse elsewhere on both surfaces of the lamina; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins ± visible in transmitted light, 2–5-forked, the sori borne on the first upper and often on the first lower branches which extend little beyond the sorus, the branches of the other forks longer, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 0.7–2.3 × 0.7–1.6 mm, ± circular to elliptic in outline, each oblique to the midvein, on surface of lamina, discrete when mature, in 2–4 rows, 1–2 on each side of the midvein in the middle to upper 1/2–2/3 of the lamina, the inner row on each side near the midvein. *Sporangia* (250–)270–312(–320) μm, usually glabrous, occasionally with a solitary medium red-brown rigid hair 230–320 μm: indurated cells of annulus (9–)10–13(–14). *Spores* (31–)35–49(–57) μm diam.



Map 59. *Grammitis merrillii* (51).

Distribution. New Guinea.

MILNE BAY. Taupota, Copland King 395 (coll. P.C. Shaw) (BM, MICH, NSW). Mayu R., Mt Suckling, NGF 28840 (K).

Ecology. Epiphyte on mossy branches of *Ficus* by a dry stream in lowland rain-forest; at 350 m.

Note. *G. subreticulata* is a taxonomically isolated species within the *G. intromissa* species group.

51. Grammitis merrillii (Copel.) Copel. – Fig. 25; maps 58, 59.

G. merrillii (Copel.) Copel., Philip. J. Sc. 80 (1952) 224. – *Polypodium merrillii* Copel., in Perkins, Fragm. Fl. Philip. (1905) 188. – Lectotype: *Merrill 754*, Paragua I. (Palawan), Philippines (US).

Rhizome c. 1 mm diam. including scales, c. 0.5 mm diam. without scales, erect to ascending, unbranched, sometimes ± clump-forming, occasionally stoloniferous; scales 1.0–2.2 × 0.2–0.8 mm, lanceolate, acute to subacute at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* absent or 0.1–0.2 cm × 0.2–0.3 mm, glabrous. *Lamina* 1.0–1.4 × 0.1–0.2 cm, linear-oblanceolate, obtuse at apex, long-attenuate at base, entire, coriaceous, with scattered to occasional ± patent dark red-brown simple eglandular hairs 0.2–0.5 mm on margin, midvein above and below and lamina surface above and similar but binate or ternate hairs occasional on the margin; midvein slightly prominent on the lower sur-

face of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch scarcely extending beyond the sorus, ± as long as the lower branch, the branch endings without obvious hydathodes, free. *Sori* 0.9–1.6 × 0.8–1.1 mm, ± circular in outline, on surface of lamina, contiguous when mature, in two rows, one on each side of the midvein below the lamina apex, each row with 1–6 sori, nearer the midvein than the margin. *Sporangia* (120–)134–180(–190) μm, with 1–4 yellow-brown rigid hairs 110–140 μm; indurated cells of annulus (7–)10–11. *Spores* (26–)27–30(–32) μm diam.

Distribution. Philippines, Moluccas and New Guinea.

WAIGEO I. Go, Mayalibit Bay, Cheesman 1217 (BM).

Ecology. Epiphytic on rotten wood.

Note. The affinities of *G. merrillii* within this species group are not clear.

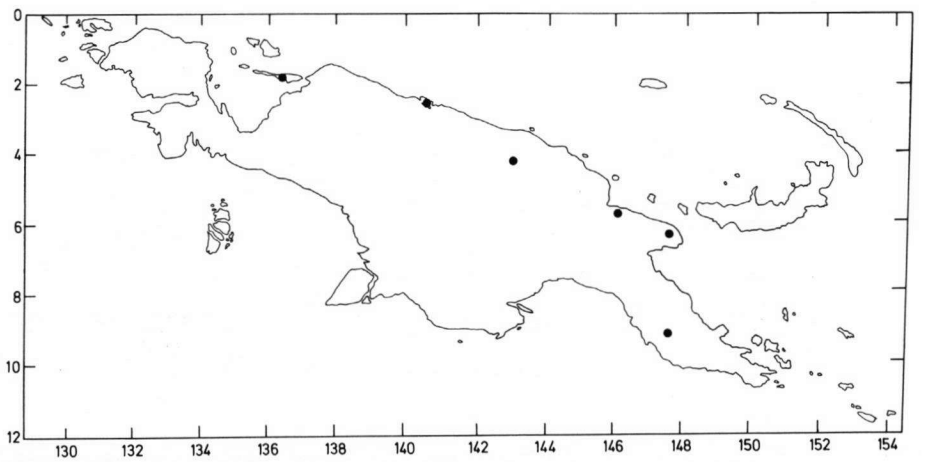
52. Grammitis parva (Brause) Copel. – Fig. 25; map 60.

G. parva (Brause) Copel., Gen. Fil. (1947) 211; Philip. J. Sc. 80 (1952) 180. – *Polypodium parvum* Brause, Bot. Jahrb. 49 (1912) 36. – Lectotype: *Schlechter 17156* (B; iso BM, K, L, MICH, UC).

Polypodium trichopodum sensu Brause, Bot. Jahrb. 56 (1920) 179, quoad *Ledermann 12973a.*

Illustrations: Brause, Bot. Jahrb. 49 (1912) 31, f. 2C as P. parvum; Copel., Philip. J. Sc. 80 (1952) 180, f. 50.

Rhizome 1.5–2.0 mm diam. including stipe bases, c. 0.5 mm diam. without stipe bases, erect, usually unbranched but occasionally forming clumps; scales absent. *Stipe* (0.4–)0.5–0.9(–1.0) cm × 0.1–0.2 mm, with moderately dense ± patent pale



Map 60. *Grammitis parva* (52).

to medium red-brown simple eglandular hairs (0.5–)0.6–1.6(–2.0) mm. *Lamina* (1.3–)1.4–3.7(–5.7) × 0.2–0.3 cm, linear-lanceolate to linear-oblanceolate, obtuse at apex and attenuate to long-attenuate at base, entire, membranous, with ± patent medium to dark red-brown simple eglandular hairs 0.9–2.7(–3.5) mm moderately frequent on all parts; midvein slightly prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins visible in transmitted light and often in reflected light, 1-forked, the upper branch extending beyond the sorus and ± as long as the lower branch, each branch ending sometimes marked by a small hydathode on the upper surface of the lamina, free. *Sori* (0.7–)0.8–1.6(–2.0) × (0.6–)0.8–1.4(–1.6) mm diam., ± circular in outline, on surface of lamina, contiguous when mature, in two rows, one on each side of the midvein in the upper 1/4–2/3 of the lamina, each row with 1–9(–14) sori, slightly nearer the midvein than the margin. *Sporangia* (150–)163–216(–280) μm, with 1–4 pale to dark red-brown rigid hairs (100–)190–330(–350) μm; indurated cells of annulus (9–)10–13(–17). *Spores* (17–)23–31(–36) μm diam.

Distribution. New Guinea.

JAPEN I. Mt Baduri, Aiam Ra., Cheesman s.n. (BM).
CYCLOPS MTS. Ifaar to Ormu, van Royen & Sleumer 5971 (L).
E. SEPIK. Felsspitze, Ledermann 12973 a & b (both BM).
MADANG. Finisterre Mts, Schlechter 18033 (B, UC).
MOROBE. Kani Mts, Schlechter 17156 (B, BM, K, L, MICH, UC).
CENTRAL. Boridi, Carr 13525 (BM, CANB, K, L, SING).

Ecology. Epiphyte on tree trunks in montane forest; from 310 to 1520 m.

Note. *G. parva* is another taxonomically isolated species within the *G. intromissa* species group.

53. Grammitis habbemensis Copel. – Fig. 26; map 61.

G. habbemensis Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 194. – Type: *Brass 10520* (MICH, holo; BO, GH, L).
Illustrations: Copel., Philip. J. Sc. 80 (1952) 194, f. 64 & pl. 5.

Rhizome c. 5 mm diam. including scales, 1–2 mm diam. without scales, erect, unbranched; scales c. 3.2 × 0.7 mm, ovate-lanceolate, subacute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.1–)1.5–2.7(–3.0) cm × 0.3–0.4 mm, with moderately dense ± patent medium red-brown simple eglandular hairs 2.3–4.0 mm. *Lamina* (9.2–)10.8–23.2(–25.0+) × (0.6–)0.7–0.9 cm, linear, acute to obtuse at apex, attenuate at base, entire, spongiose, with ± patent medium red-brown simple eglandular hairs 1.7–2.5 mm moderately frequent on all parts of the lamina; midvein not prominent on the lower surface of the lamina and concolorous with it; lateral veins ± visible in transmitted light, 1–2-forked, the upper branch of the first fork extending beyond the sorus and ± as long as the lower branch when 1-forked, extending beyond the sorus but shorter than the lower branch when the latter is 2-forked, the branch endings without obvious

hydathodes on the upper surface of the lamina, usually free, sometimes a few branches joining near the margin. *Sori* 1.0–2.0 mm diam., ± circular in outline, sunken in steep-sided pits which have a slightly prominent rim, discrete when mature, in two rows, one on each side of the midvein throughout the lamina, but not immediately below the apex or above the base, to only in the upper ½, each row with (4–) 31–43+ sori, nearer the midvein than the margin. *Sporangia* (290–)295–320(–330) μm, with 2–4 dark red-brown rigid hairs 240–330 μm; indurated cells of annulus 10–12. *Spores* 34–44(–50) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Danau Habbema, Brass 10520 (BO, GH, L, MICH).

Ecology. Pendulous epiphyte low on trees in upper montane forest; at 2840 m.

Notes. *G. habbemensis* may be a distant relative of *G. intromissa* and its allies, *G. debilifolia, G. nigropaleata, G. tomaculosa, G. reptans, G. trogophylla, G. murryana* and *G. trichopoda* and also of *G. montana.*

54. Grammitis montana Parris, *sp. nov.* – Fig. 26; map 61.

G. intromissa et speciebus affinibus similis sed soris in lacunis profunde impressis differt; a G. habbemensi pilis stipitis sparsis obscure rubriusculo-brunneis et pilis laminae obscure rubriusculo-brunneis ad marginem et medio-venam inferum sparsis et ad medio-venam superam paucis recedit. — *Rhizoma* squamis inclusis c. 5 mm diam., squamis exclusis 1–2 mm diam., breviter repens, eramosum, stipites per spatia minus quam 1 mm emittens; squamae 1.7–3.4 mm longae, 0.2–0.7 mm latae, lanceolatae, ad apicem acutae, mediae vel obscure rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* (2.8–)3.1–5.7(–7.0) cm longus, 0.2–0.3 mm latus, pilis simplicibus eglandulosis 1.0–2.0 mm longis sparsis plus minusve patentibus obscure rubriusculo-brunneis vestitus. *Lamina* (1.6–)2.0–3.2(–4.0) cm longa, (0.2–)0.3–0.4(–0.5) cm lata, lineari-elliptica vel lineari-lanceolata, ad apicem obtusa vel subacuta, ad basem cuneata vel longe attenuata, integra, tenuiter coriacea, pilis simplicibus eglandulosis 0.5–1.5 mm longis plus minusve patentibus obscure rubriusculo-brunneis ad marginem et medio-venam inferum sparsis et ad medio-venam superam paucis vestita; medio-vena ad paginam inferum laminae paulo prominens et pagina infera laminae concolor; venae laterales in luce transmissa non manifestae, 1-furcatae, ramus superus ultra sorum procurrens, plus minusve longitudine ramum inferum aequans, rami terminales in pagina supera laminae sine hydathodis manifestis, liberi. *Sori* 1.0–2.5 mm longi, 1.0–1.5 mm lati, in ambitu plus minusve circulares vel oblongi, ad medio-venam paralleli vel obliqui, in lacunis sine margine parum prominenti profunde impressi, confluentes ubi maturi, in 2 serialibus, 1 utroque medio-venae in ¼–¾ supero laminae, in quoque seriali (1–)3–10(–11) sori, medio-venam quam marginem proximiores vel inter marginem et medio-venam aequidistantes. *Sporangia* (290–)302–342(–370) μm, pilis 2–4 obscure rubriusculo-brunneis rigidis 220–300 μm longis praedita; cellulae induratae annuli (9–)12–14(–15). *Sporae* (38–)42–50(–53) μm diam. — Typus: *M.S. Clemens s.n.*, 16.vi.1939, Mt Sarawaket, Morobe District, Papua New Guinea (BM, iso MICH).

Rhizome c. 5 mm diam. including scales, 1–2 mm diam. without scales, short-creeping, unbranched, producing stipes less than 1 mm apart; scales 1.7–3.4 × 0.2–0.7 mm, lanceolate, acute at apex, medium to dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (2.8–)3.1–5.7(–7.0) cm ×

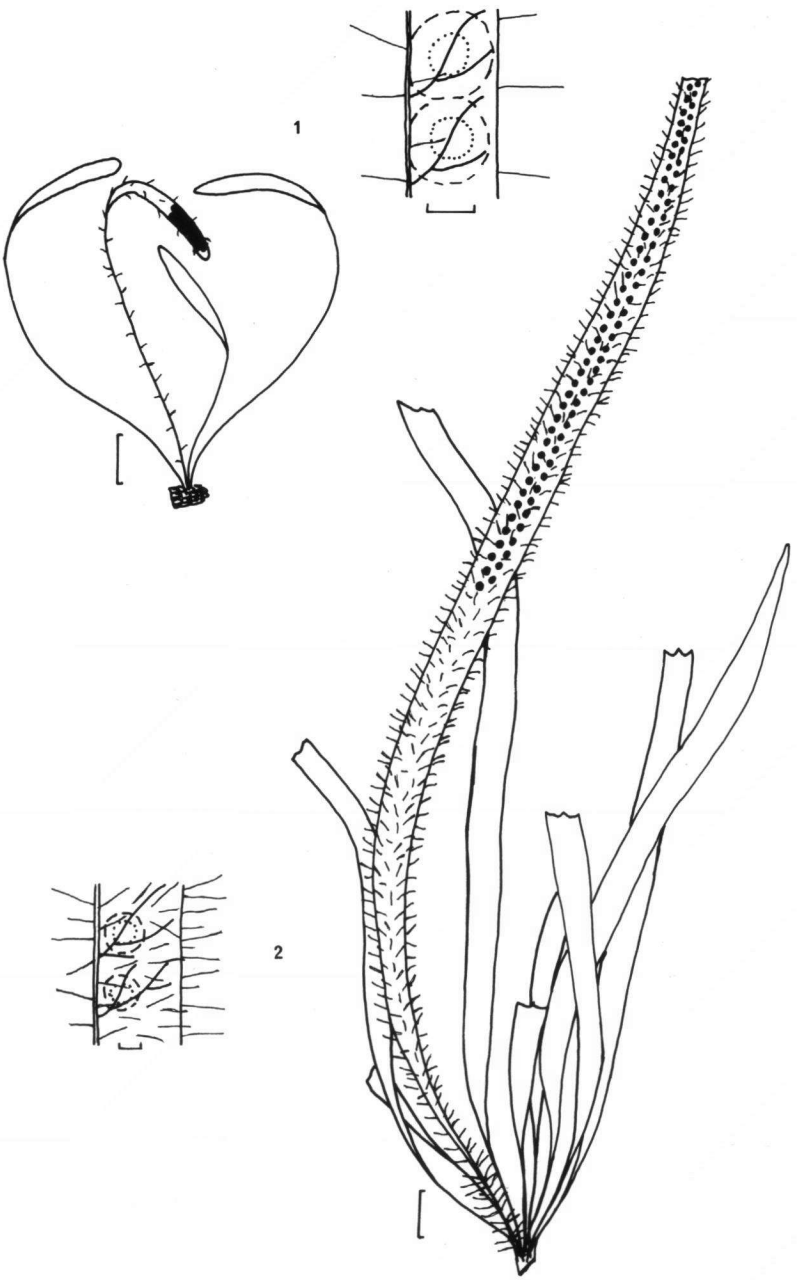


Fig. 26. *G. intromissa* group. – 1. *G. montana* (54), holotype, *Clemens s.n.* (BM); 2. *G. habbemensis* (53), holotype, *Brass 10520* (MICH).

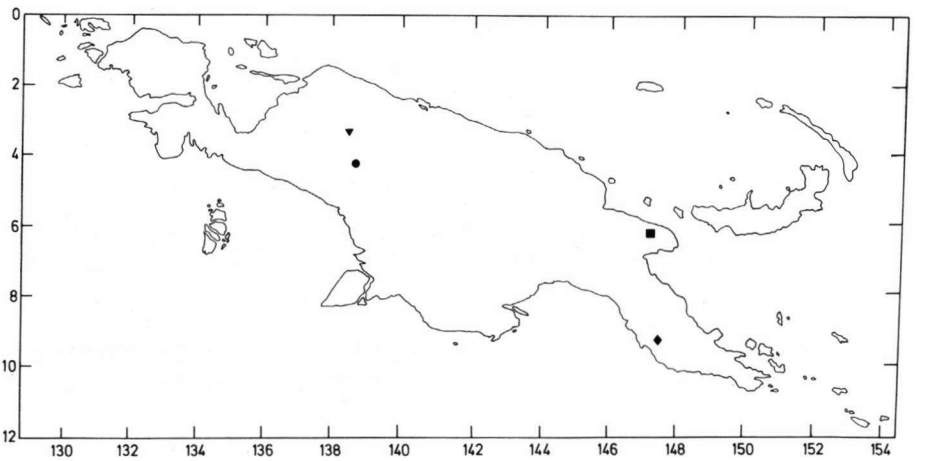
0.2–0.3 mm, with scattered ± patent dark red-brown simple eglandular hairs 1.0–2.0 mm. *Lamina* (1.6–)2.0–3.2(–4.0) × (0.2–)0.3–0.4(–0.5) cm, linear-elliptic to linear-lanceolate, obtuse to subacute at apex, cuneate to long-attenuate at base, entire, rather coriaceous, with ± patent dark red-brown simple eglandular hairs 0.5–1.5 mm sparse on margin and midvein below and occasional on midvein above; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch extending beyond the sorus and ± as long as the lower branch, the branch endings without obvious hydathodes on the upper surface of the lamina, free. *Sori* 1.0–2.5 × 1.0–1.5 mm, ± circular to oblong in outline, each parallel or oblique to the midvein, deeply sunken in steepsided pits without a slightly prominent rim, confluent when mature, in two rows, one on each side of the midvein in the upper ¼–¾ of lamina, each row with (1–)3–10(–11) sori, nearer the midvein than the margin or midway between them. *Sporangia* (290–)302–342(–370) μm, with 2–4 dark red-brown rigid hairs 220–300 μm; indurated cells of annulus (9–)12–14(–15). *Spores* (38–)42–50(–53) μm diam.

Distribution. New Guinea.

MOROBE. Mt Sarawaket, Clemens 10364 (MICH), s.n., 3810 m (BM, MICH).

Ecology. Rupestral in subalpine grassland; from 3660 to 3810 m.

Note. Superficially *G. montana* resembles *G. murrayana* and *G. trichopoda*, but is readily distinguished by its deeply sunken sori and the absence of hairs on the lamina surface.



Map 61. ● *Grammitis habbemensis* (53), ■ *G. montana* (54), ▼ *G. excelsa* (55), ◆ *G. rupestris* (56).

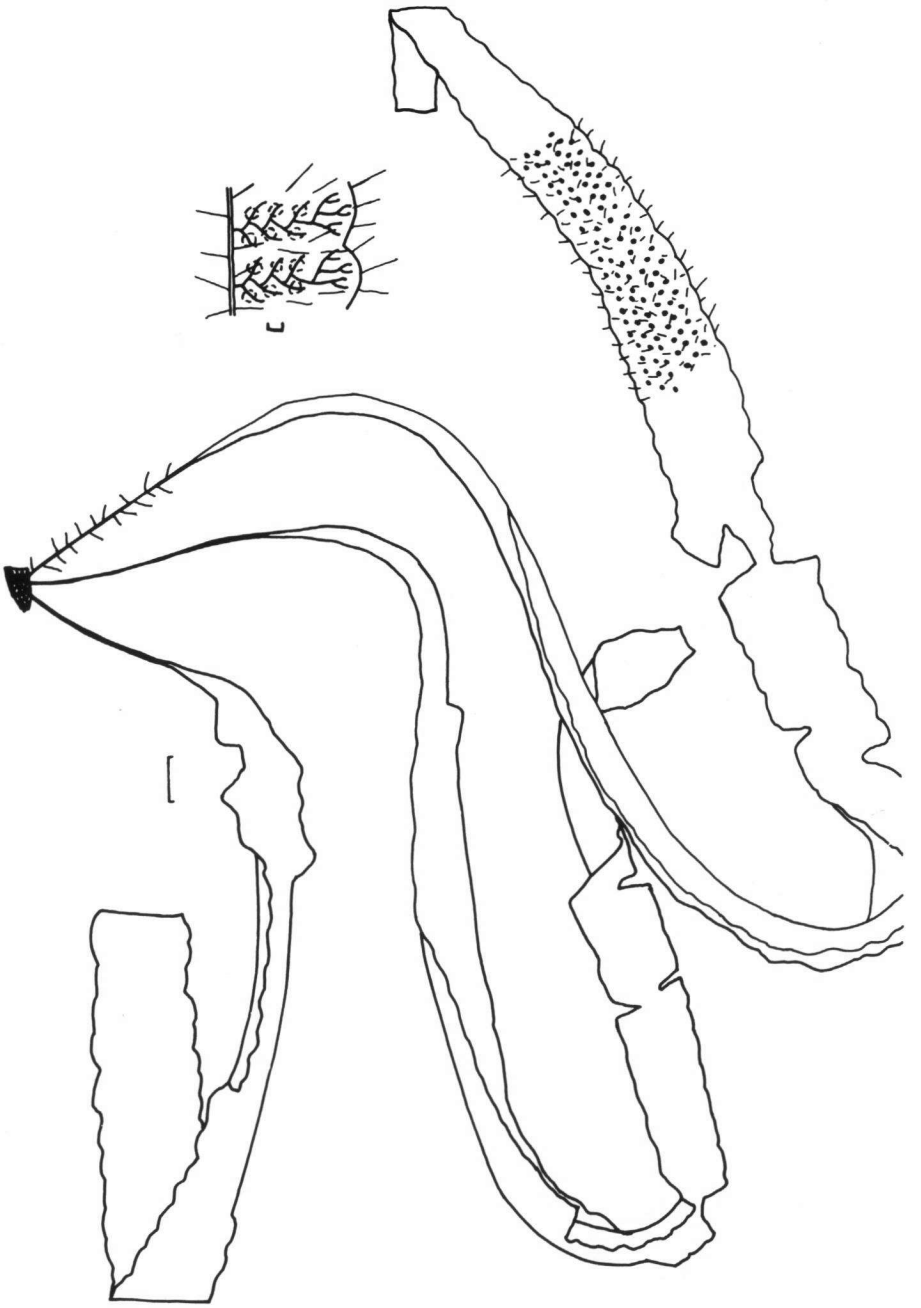


Fig. 27. *G. intromissa* group. – *G. excelsa* (55), holotype, *Bergman 416* (S).

55. Grammitis excelsa Parris, *sp. nov.* – Fig. 27; map 61.

In statura magna G. friderico-et-paulo similis, a squamis rhizomatis glabris differt; ramo primo venarum lateralium ad basem frondis descendenti a congeneribus diversa. — *Rhizoma* squamis inclusis 4–5 mm diam., squamis exclusis c. 1.5 mm diam., breviter repens, eramosum, stipites per spatia 1–2 mm emittens; squamae 3.5–3.8 mm longae, c. 0.8 mm latae, lanceolatae, ad apicem acutae, pallidae rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 3.6–8.3 cm longus, 0.6–0.7 mm latus, pilis simplicibus eglandulosis 3.0–4.0 mm longis sparsis plus minusve patentibus mediis rubriusculo-brunneis vestitus. *Lamina* 40+ cm longa, 1.4–2.6 cm lata, lineari-oblanceolata, ad apicem ignota, ad basem attenuata, integra vel crenata, lobis ad 3.0 mm longis, membranacea vel spongiosa, pilis simplicibus eglandulosis 1.5–3.0 mm longis sparsis plus minusve patentibus per laminam vestita; medio-vena ad paginam inferam laminae vix prominens et pagina infera laminae concolor; venae laterales in luce transmissa in frondibus iuvenis manifestae, interdum in frondibus veteribus in luce transmissa etiam manifestae, 5–9-furcatae, ramus primus ad basem frondis descendens, non ad apicem frondis ascendens, rami interiores 4–6-soriferi et ultra soros parum procurrentes sed non ad marginem attigentes nec furcati, rami non-soriferi saepe 1-furcati, ramulis plus minusve longitudine aequantibus, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* c. 1.0 mm diam., in ambitu plus minusve circulares, ad superficiarem inferam laminae adornati, probabiliter discreti ubi maturi, in 4–6 serialibus, 2–3 utroque medio-venae, probabiliter plus minusve ubique lamina, series intima utrinque medio-venam quam marginem proximior. *Sporangia* (210–)233–293(–310) μm longa, plerumque glabra, interdum pilis 1–2 pallidis vel mediis rubriusculo-brunneis tenuibus 270–320 μm longis praedita; cellulae induratae annuli 10–13. *Sporae* (34–)36–44(–50) μm diam. — Typus: *D. Bergman 416*, 30.iii.1958, Kadubaka, Swart Valley, Central Range, Irian Jaya (S).

Rhizome 4–5 mm diam. including scales, c. 1.5 mm diam. without scales, short-creeping, unbranched, producing stipes 1–2 mm apart; scales 3.5–3.8 × c. 0.8 mm, lanceolate, acute at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 3.6–8.3 cm × 0.6–0.7 mm, with scattered ± patent medium red-brown simple eglandular hairs 3.0–4.0 mm. *Lamina* 40+ × 1.4–2.6 cm, linear-oblanceolate, apex unknown, attenuate at base, entire to crenate, the teeth up to 3.0 mm long, membranous to spongiose, with ± patent medium red-brown simple eglandular 1.5–3.0 mm hairs scattered on all parts; midvein scarcely prominent on the lower surface of the lamina and concolorous with it; lateral veins visible in transmitted light in young fronds and sometimes also in old fronds, 5–9-forked, the first branch basiscopic rather than acroscopic, the inner 4–6 branches bearing sori and extending a little beyond them but not reaching the margin and not forked, the branches without sori each often 1-forked with each branchlet of ± equal length, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* c. 1.0 mm diam., ± circular in outline, on the surface of the lamina, probably discrete when mature, in 4–6 rows, 2–3 on each side of the midvein and probably ± throughout the length of the lamina, the innermost row on each side near the midvein. *Sporangia* (210–)233–293(–310) μm, usually glabrous, occasionally with 1–2 pale to medium red-brown slender hairs 270–320 μm; indurated cells of annulus 10–13. *Spores* (34–)36–44(–50) μm diam.

Distribution. New Guinea.

CENTRAL IRIAN JAYA. Kadubaka, Ilim Valley, Pegunungan Maoke, Bergman 416, 549 (both S).

Ecology. Between 1600 and 2000 m.

Notes. Although both collections are old and in rather poor condition, they represent a very distinct species. Superficially it resembles *G. friderici-et-pauli* (Christ) Copel. of Borneo and Celebes, but lacks the ciliate rhizome scales which characterise that species and also the white scales on the hydathodes of the upper surface of the lamina which it frequently possesses. *G. excelsa* is probably distantly related to *G. intromissa* and those species allied to it. The texture is very similar to that of *G. intromissa*, but the width of the fronds together with the much-branched lateral veins which result in 4 to 6 rows of sori amply distinguish it from all other members of this species group. The basiscopic first branch of the lateral veins is apparently unique in *Grammitis*.

56. Grammitis rupestris Parris, *sp. nov.* – Fig. 28; map 61.

G. collina similis; pilis stipitis brevioribus, statura minore, pilis laminae inter soros longissimis recedit. — *Rhizoma* squamis inclusis c. 2 mm diam., squamis exclusis c. 0.5 mm diam., erectum, eramosum; squamae c. 1.0 mm longae, c. 0.4 mm latae, late lanceolatae, ad apicem acutae, obscure brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* absens vel 0.1–0.2 cm longus, c. 0.5 mm latus, pilis simplicibus eglandulosis 0.4–0.8 mm longis sparsis plus minusve patentibus obscure rubriusculo-brunneis vestitus. *Lamina* 3.3–3.9 cm longa, c. 0.3 cm lata, lineari-elliptica vel lineari-oblanceolata, ad apicem subacuta, ad basem longe attenuata, integra, coriacea, pilis simplicibus eglandulosis 0.4–0.7 mm longis moderate numerosis plus minusve patentibus obscure rubriusculo-brunneis ad marginem et medio-venam inferam, pilis similibus 0.7–1.6 mm longis sparsis ad medio-venam superam et pilis similibus 1.0–2.0 mm longis moderate numerosis inter soros vestita; medio-vena ad paginam inferam laminae paulo prominens et pagina infera laminae concolor; venae laterales in luce transmissa non manifestae, 1–furcatae, ramus superus ultra sorum procurrens, longitudine ramum inferum aequans vel brevior, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 0.8–1.7 mm longi, 0.7–1.2 mm lati, in ambitu plus minusve circulares, ad superficiarem inferum laminae adornati, contigui ubi maturi, in 2 serialibus, 1 utroque medio-venae in ½ superno laminae sed non prope apicem, in quoque seriali 7–13 sori, medio-venam quam marginem proximiores. *Sporangia* (240–)251–293(–300) μm longa, plerumque glabra, interdum pilis 1–3 obscure rubriusculo-brunneis rigidis c. 300 μm longis praedita; cellulae induratae annuli 10–13(–14). *Sporae* (33–)36–47(–50) μm diam. — Typus: *N.A. Wakefield 1427*, 22.iii.1944, Narirogo Creek, Laloki River, Central District, Papua New Guinea (BM).

Rhizome c. 2 mm diam. including scales, c. 0.5 mm diam. without scales, erect, unbranched; scales c. 1.0 × 0.4 mm, broadly lanceolate, acute at apex, dark brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 0.1–0.2 cm × c. 0.5 mm or rarely absent, with sparse to scattered ± patent dark red-brown simple eglandular hairs 0.4–0.8 mm. *Lamina* 3.3–3.9 × c. 0.3 cm, linear elliptic to linear-lanceolate, subacute at apex, long-attenuate at base, entire, coriaceous, with ± patent dark red-brown simple eglandular hairs 0.4–0.7 mm moderately frequent on the midvein below and margin, similar hairs 0.7–1.6 mm scattered on the midvein on the upper surface of the lamina and similar hairs 1.0–2.1 mm moderately frequent amongst the sori; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the

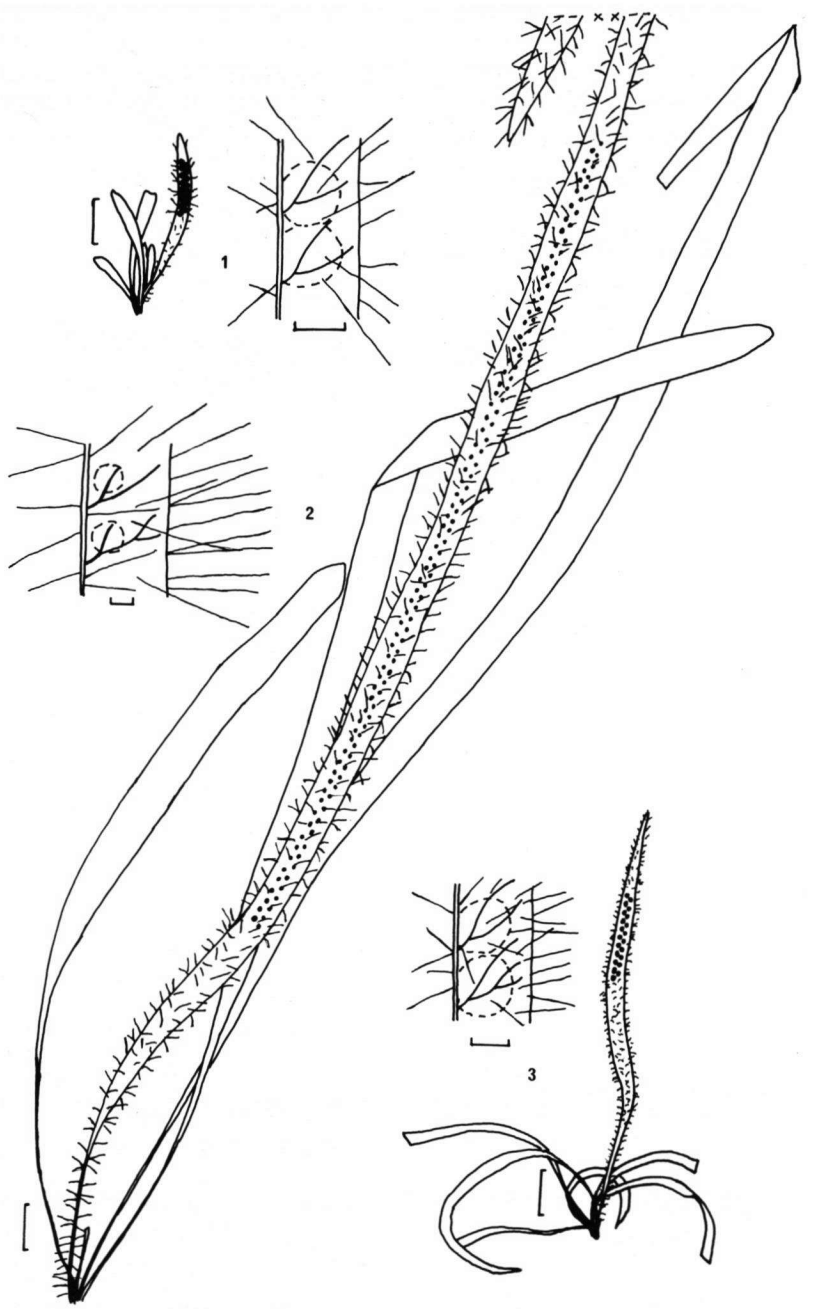


Fig. 28. *G. intromissa* group. – 1. *G. rupestris* (56), holotype, *Wakefield 1427* (BM); 2. *G. ornatissima* (58), isotype, *Werner 47* (E); 3. *G. collina* (57), holotype, *Parris & Croxall 9294* (K).

upper branch extending beyond the sorus, as long as the lower branch or somewhat shorter, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 0.8–1.7 × 0.7–1.2 mm, ± circular in outline, on surface of lamina, contiguous when mature, in two rows, one on each side of the midvein in the upper ½ of the lamina but not immediately below the apex, each row with 7–13 sori, nearer the midvein than the margin. *Sporangia* (240–)251–293(–300) μm, usually glabrous, occasionally with 1–3 dark red-brown rigid hairs c. 300 μm; indurated cells of annulus 10–13(–14). *Spores* (33–)36–47(–50) μm diam.

Distribution. New Guinea.

CENTRAL. Narirogo Creek, Laloki R., Wakefield 1427 (BM).

Ecology. Rupestral in sheltered rock cliffs; at 460 m.

Note. The affinities of *G. rupestris*, within the species group, are not obvious.

57. Grammitis collina Parris, *sp. nov.* – Fig. 28; map 62.

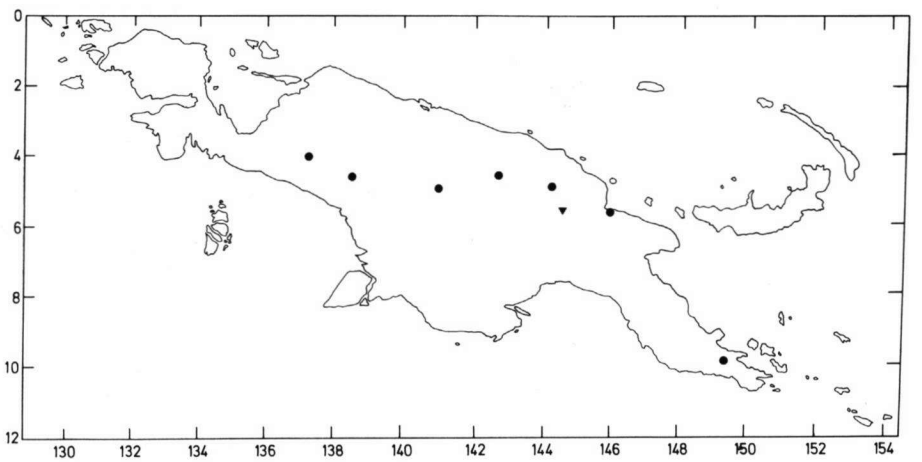
G. rupestris similis, pilis stipitis longioribus, statura maiore, pilis laminae longitudine aequantibus per laminam differt. — *Rhizoma* squamis inclusis 1.0–1.5 mm diam., squamis exclusis 0.5 mm diam.; plus minusve erectum; squamae 1.0–1.4 mm longae, 0.3–0.4 mm latae, lanceolatae, ad apicem acutae, mediae vel obscure rubriusculo-brunneae, glabrae, clathratae, non vel paulo iridescentes, cellulae sine septis. *Stipes* 0.6–0.7(–1.4) cm longus, 0.2–0.3 mm latus, pilis simplicibus eglandulosis 1.0–2.0 mm longis sparsis vel numerosis plus minusve patentibus mediis vel obscure rubriusculo-brunneis vestitus. *Lamina* (5.8–)6.1–7.7(–7.8) cm longa, 0.3–0.5 cm lata, lineari-oblanceolata, ad apicem acuta vel acuminata, ad basem longe attenuata, integra, tenuiter coriacea, pilis simplicibus eglandulosis (0.3–)0.8–1.5 mm longis plus minusve patentibus mediis vel obscure rubriusculo-brunneis ad marginem, medio-venam inferam et inter soros sparsis vel moderate numerosis, alibi in pagina supera et in pagina infera laminae paucis vel sparsis vestita; medio-vena ad paginam inferam laminae paulo prominens et pagina infera laminae concolor; venae laterales in luce transmissa manifestae, 1(–2)-furcatae, rami omnes longitudine aequantes, ramus primus superus ultra sorum procurrens, rami terminales in pagina supera laminae sine hydathodis manifestis, liberi. *Sori* 1.0–2.0 mm longi, 0.7–1.2 mm lati, in ambitu circulares vel elliptici, ad marginem paralleli vel obliqui, ad superficiarem inferum laminae adornati, discreti vel contigui ubi maturi, in 2 serialibus, 1 utroque medio-venae in 1/3–1/2 superno laminae sed non prope apicem, in quoque seriali (4–)6–15(–16) sori, medio-venam quam marginem proximiores. *Sporangia* (270–)280–312(–320) μm longa, pilis 1–4 mediis rubriusculo-brunneis rigidis 560–730 μm longis praedita; cellulae induratae annuli (8–)9–13(–14). *Sporae* (47–)49–56(–59) μm diam. — Typus: *B.S. Parris & J.P. Croxall 9224*, 7.ix.1981, Jimi Valley Road, Baiyer-Jimi divide, Western Highlands District, Papua New Guinea (K; iso BSP, LAE).

Rhizome 1.0–1.5 mm diam. including scales, 0.5 mm diam. without scales, ± erect; scales 1.0–1.4 × 0.3–0.4 mm, lanceolate, acute at apex, medium to dark red-brown, glabrous, clathrate, not or slightly iridescent, the cells without cross-walls. *Stipe* 0.6–0.7(–1.4) cm × 0.2–0.3 mm, with scattered to frequent ± patent medium to dark red-brown simple eglandular hairs 1.0–2.0 mm. *Lamina* (5.8–)6.1–7.7(–7.8) × 0.3–0.5 cm, linear-oblanceolate, acute to acuminate at apex and long-attenuate at base, entire, thinly coriaceous, with ± patent medium to dark red-brown simple eglandular hairs (0.3–)0.8–1.5 mm scattered to moderately frequent on margin,

midvein below and amongst sori, occasional to scattered elsewhere on the lamina above and below; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins visible in transmitted light, 1(–2)-forked, all branches ± equal in length, the first upper branch extending beyond the sorus, the branch endings not marked by hydathodes on the upper surface of the lamina, free. *Sori* 1.0–2.0 × 0.7–1.2 mm, ± circular to elliptic in outline, each parallel to or oblique to the midvein, on the surface of the lamina, discrete to contiguous when mature, in two rows, one on each side of the midvein in the upper 1/3–1/2 of the lamina but not immediately below the apex, each row with (4–)6–15(–16) sori, nearer the midvein than the margin. *Sporangia* (270–)280–312(–320) μm, with 1–4 medium red-brown rigid hairs 560–730 μm; indurated cells of annulus (8–)9–13(–14). *Spores* (47–)49–56(–59) μm diam.

Distribution. New Guinea.

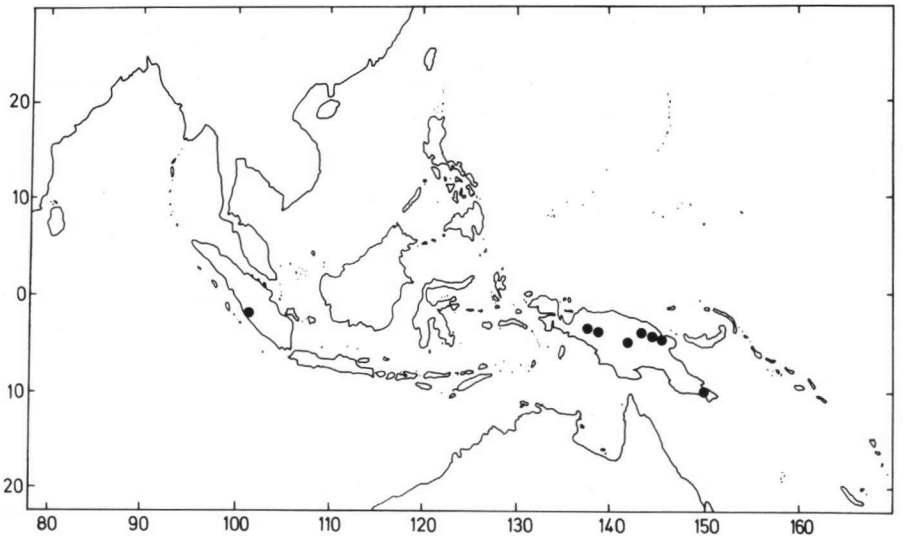
W. HIGHLANDS. Jimi Valley Road, Baiyer-Jimi divide, Parris & Croxall 9294 (BSP, K, LAE).



Map 62. ● *Grammitis ornatissima* (58), ▼ *G. collina* (57).

Ecology. Occasionally growing with *G. pleurogrammoides*. Epiphyte on trunks of trees (including ? Monimiaceae) in secondary midmontane forest (including *Trema* and *Dimorphanthera*); at 1730 m.

Notes. *G. collina* is superficially similar to *G. rupestris*, but differs in its longer fronds, longer stipe hairs and hairs of ± equal length on all parts of the lamina. The habitats and altitudes of the two species are also markedly different and they are probably not closely related.



Map 63. *Grammitis ornatissima* (58).

58. Grammitis ornatissima (Rosenst.) Copel. – Fig. 28; maps 62, 63.

G. ornatissima (Rosenst.) Copel., Philip. J. Sc. 80 (1952) 195. – *Polypodium ornatissimum* Rosenst., Feddes Repert. 5 (1908) 51. – Lectotype: *Werner 47* (UC; iso B, BM, E, S).

Polypodium ornatissimum var. *dichotomum* Brause, Bot. Jahrb. 56 (1920) 180. – Lectotype: *Ledermann 11809* (B; iso B, BM, S).

Polypodium hirtellum sensu Ridley, Trans. Linn. Soc. London (Bot.) II, 9 (1916) 259, quoad *Boden Kloss* spec.

Illustrations: Copel., Philip. J. Sc. 80 (1952) 195, f. 65.

Rhizome c. 4 mm diam. including scales, c. 1 mm diam. without scales, erect, unbranched; scales c. 0.7 × 0.3 mm, ovate, obtuse at apex, medium to dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.4–) 1.9–5.3(–6.0) cm × 0.2–0.4(–0.5) mm, with moderately frequent ± patent dark red-brown simple eglandular hairs (1.0–)1.3–3.9(–5.0) mm. *Lamina* (27.0–)31.3–57.3(–65.5+) × (0.7–)0.8–1.1 cm, linear, acute to obtuse at apex and attenuate at base, entire or shallowly crenate, the teeth up to 0.5 mm long, membranous, possibly sometimes of indefinite growth, with ± patent dark red-brown simple eglandular hairs (2.0–)2.6–5.2(–6.0) mm scattered to moderately frequent on all parts, similar but binate and ternate hairs also present on the margin; midvein slightly prominent on the lower surface of the lamina and concolorous with or darker than it; lateral veins visible in transmitted light, 1–2-forked, the upper branch of the first fork usually ending in the sorus and always shorter than the lower branch, the lower branch sometimes 1-forked, each branch ending usually marked by a small hydathode on the upper surface of the lamina which bears a white scale, free. *Sori* 1.0–

1.7 mm diam., ± circular in outline, on surface of lamina, discrete when mature, in two rows, one on each side of the midvein in the middle to upper 1/3–5/6 of the lamina, each row with (35–)48–132(–149) sori, nearer the midvein than the margin. *Sporangia* (210–)255–333(–410) μm, with 2 medium red-brown rigid hairs (230–)273–402(–460) μm; indurated cells of annulus (9–)10–12(–13). *Spores* (33–)39–48(–52) μm diam.

Distribution. Sumatra and New Guinea.

CENTRAL IRIAN JAYA. Punjak Sukarno, Boden Kloss s.n. (BM). Hellwig Mts, von Römer 734 (BO).
W. SEPIK. Star Mts, Croft 78 (BSP, CROFT, LAE).
E. SEPIK. Felsspitze, Ledermann 12448a (B, BM).
MADANG. Mt Gelu, Werner 47 (B, BM, E, S, UC). Mt Schrader, Ledermann 11809 (B, BM, S).
MILNE BAY. Mt Dayman, Brass 23218 (A, BM, LAE).

Ecology. Pendulous epiphyte sometimes high up in trees and sometimes in moss cushions in montane forest (including disturbed forest); from 1000 to 2000 m.

Notes. *G. ornatissima* may be a close relative of *G. intromissa* and its relatives. The white scales on the hydathodes may also indicate a link with the species group of *G. mollipila*.

Table 11. Characters of taxonomic importance within the *G. mollipila* species group in New Guinea.

Characters	*G. mollipila*	*G. crinifera*
Hairs of stipe and lamina margin	to 8-nate	to 5-nate
Hairs of lamina undersurface in mm	up to 1.0	up to 2.0(–3.0)
Hydathodes	at least some on each frond with a white scale on the upper surface	always without a white scale on the upper surface
Sporangia length in μm	(210–)236–315(–350)	(370–)378–452(–470)

11. G. mollipila group – Species 59–60

Fig. 29; map 64, table 11

Rhizome short-creeping; scales lanceolate-ovate to lanceolate, pale or dark red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe*

with dark red-brown up to at least 5-nate simple eglandular hairs 1–6 mm. *Lamina* entire, coriaceous or rather coriaceous, with dark red-brown up to at least 5-nate simple eglandular hairs 0.5–5.0 mm; lateral veins visible or not in transmitted light, 1–2-forked, the first upper branch shorter than the others, each branch ending marked by a small hydathode on the upper surface of the lamina which sometimes bears a white scale. *Sori* ± circular in outline, on surface of lamina, in two rows.

Epiphytic, rupestral or terrestrial, in upper montane to subalpine forest and subalpine grassland. Endemic to New Guinea with only two species, one in Irian Jaya Highlands, the other in mainland eastern New Guinea (PNG Highlands, Mid-PNG and Southeast Pen.).

This species group is possibly related to that of *G. intromissa.*

59. Grammitis mollipila (Baker) Copel. – **Fig. 29; map 64.**

G. mollipila (Baker) Copel., Univ. Calif. Publ. Bot. 18 (1942) 224; Philip. J. Sc. 80 (1952) 195. – *Polypodium mollipilum* Baker, J. Bot. (London) 28 (1890) 107. – Type: *Macgregor 31* (K; iso BM).

Rhizome 2–3 mm diam. including scales, 0.5–1.0 mm diam. without scales, short-creeping, sometimes branched and forming clumps, producing stipes less than 1 mm apart; scales c. 1.0 × 0.5 mm, lanceolate-ovate, obtuse at apex, dark brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.9–)1.6–5.6(–12.0) cm × 0.2–0.4 mm, with moderately frequent ± patent dark red-brown simple to 8-nate eglandular hairs (1.0–)1.6–3.6(–6.0) mm. *Lamina* (1.7–)3.8–13.6(–26.5+) × (0.2–)0.3–0.6(–1.0) cm, narrowly elliptic to linear, subacute to obtuse at apex and long-cuneate to attenuate at base, entire, rather coriaceous, with ± patent dark red-brown simple eglandular hairs (1.0–)2.3–4.7(–5.5) mm moderately frequent on the upper surface, margin and midvein below, similar but up to 8-nate hairs on margin and midvein below and similar but up to 1.0 mm hairs on the lower surface; midvein slightly prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins visible or not in transmitted light, 1–2-forked, the upper branch usually terminating in the sorus, sometimes extending a little beyond it but always shorter than the lower branch which is sometimes 1-forked, each branch ending marked by a small hydathode on the upper surface of the lamina which bears a white scale, free. *Sori* 1.0–2.4(–3.7) × (0.9–)1.0–2.0(–2.5) mm, ± circular to elliptic in outline, each oblique to the midvein, on surface of lamina, discrete to confluent when mature, in two rows, one on each side of the midvein in the upper 1/4–4/5 of lamina, each row with (2–)6–30(–60) sori, nearer the midvein than the margin or covering all lamina undersurface. *Sporangia* (210–)236–315(–350) μm, with (1–)2–4(–6) medium to dark red-brown rigid hairs (240–)558–1252(–1700) μm; indurated cells of annulus (9–)11–14(–17). *Spores* (25–)32–46(–58) μm diam.

Distribution. New Guinea.

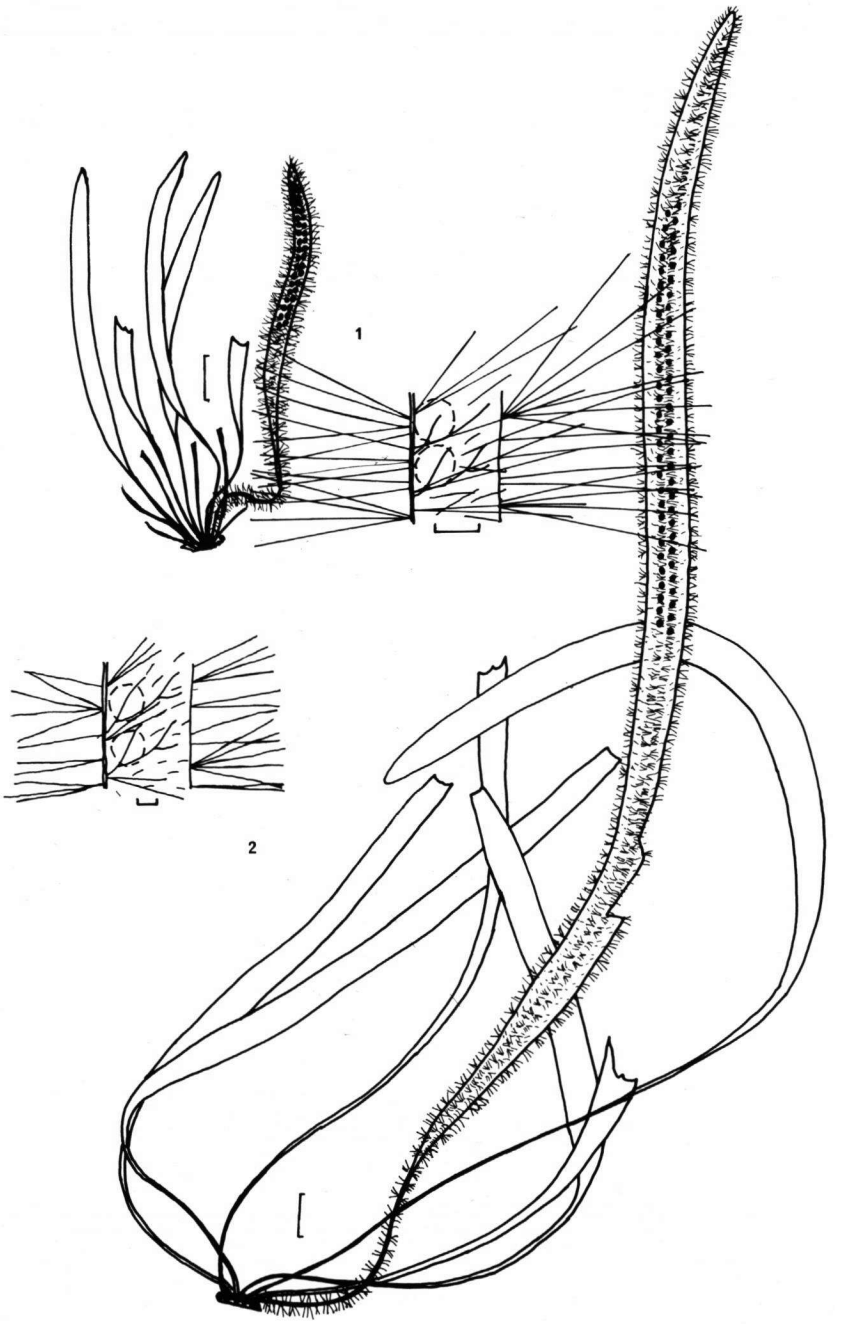
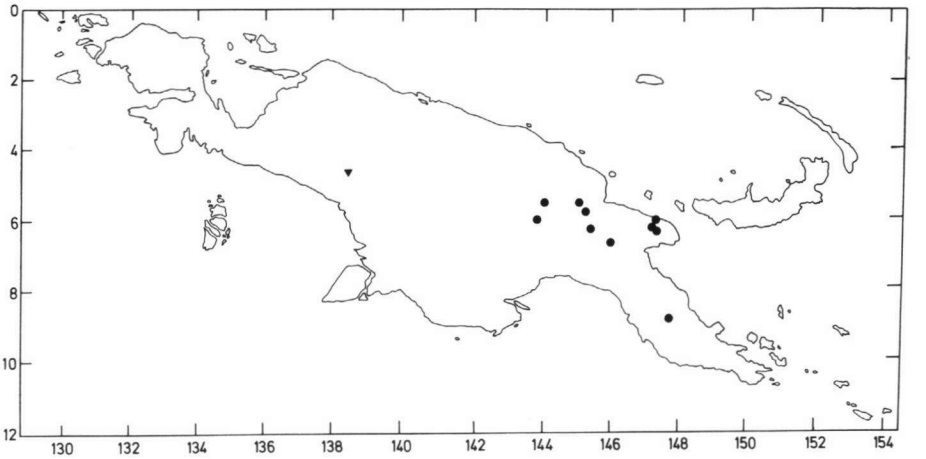


Fig. 29. *G. mollipila* group. – 1. *G. mollipila* (59), *Clemens 12451* (E); 2. *G. crinifera* (60), holotype, *Pulle 857* (L).



Map 64. ● *Grammitis mollipila* (59), ▼ *G. crinifera* (60).

W. HIGHLANDS. Mt Hagen, Parris & Croxall 4684 H 119 (BSP, LAE).

S. HIGHLANDS. Mt Giluwe, Croft 718 & Marsh (CROFT, LAE), Schodde 1935 (CANB, K, L, LAE, NSW, US), van Royen 11234 (LAE).

CHIMBU. Mt Kerigomna, Grubb & Edwards 284 (CGE, L, LAE). Mt Wilhelm, ANU 5138 (CANB, LAE), 7068 (CANB, L, LAE), van Balgooy 98 (L), 118 (B, CANB, L, LAE), 597 (CANB, L, LAE), 804 (B, CANB, L, LAE), Brass 29980 (K, L, LAE), 30153 (LAE, US), Briggs 3770 (NSW), Hewson 157 (BM, NSW), 214 (NSW), Hoogland & Pullen 5665 (CANB), 5690 (BM, CANB, L, LAE), Jermy 5446, 5449, 5460 (all BM), Nakaike 250, 320, 323, 350 (all LAE), NGF 15169 (BRI, L, LAE), 31671 (LAE), 39532 (L, LAE), 47378 (K, LAE), Parris & Croxall 4686 H 233, 4687 H 268 (both BSP, LAE).

E. HIGHLANDS. Mt Michael, Johns 1299 (BULOLO). Mt Piora, Croft 102 (BSP, CROFT, LAE).

MOROBE. Gimdoh, Sarawaket Ra., Hoogland 9964 (CANB, L, LAE). Rawlinson Ra., Clemens 12341 (MICH, UC), 12451 (E, MICH, UC), 41963 (MICH, UC). Ulap, Clemens 11348 (GH, MICH, UC).

CENTRAL. Owen Stanley Ra., Macgregor 31 (BM, K).

Ecology. More or less pendulous, usually rupestral or terrestrial in subalpine grassland, sometimes epiphytic or rupestral in upper montane to subalpine forest; from 3050 to 4000 m.

Note. Vernacular name: pinje (Laiagam village language).

60. Grammitis crinifera Parris, *sp. nov.* – Fig. 29; map 64.

Ex affinitate G. mollipila, a pilis stipitis et laminae solum usque ad quinatis, pilis in pagina infera laminae usque ad 2.0(–3.0) mm longis et pagina supera laminae squamis albis carenti distincta. — *Rhizoma* squamis inclusis c. 3 mm diam., squamis exclusis c. 1 mm diam., breviter repens, eramosum, stipites per spatia c. 1 mm emittens; squamae c. 2.5 × 0.5 mm, lanceolatae, ad apicem

obtusae, pallidae rubriusculo-brunneae, glabrae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 4.5–11.0 cm longus, 0.6–0.7 mm latus, pilis simplicibus eglandulosis 1.0–3.5 mm longis moderate numerosis plus minusve patentibus obscure rubriusculo-brunneis et pilis simplicibus sed binatis vel quinatis etiam moderate numerosis vestitus. *Lamina* c. 27.7 cm longa, c. 1.0 cm lata, lineari-oblanceolata, ad apicem acuta, ad basem longe attenuata, integra, coriacea, pilis simplicibus eglandulosis c. 2.5–5.5 mm longis moderate numerosis plus minusve patentibus obscure rubriusculo-brunneis ad marginem, medio-venam et laminam superam, medio-venam inferam, pilis similibus sed binatis vel quinatis ad marginem et medio-venam inferam, et pilis similibus sed 0.5–2.0(–4.0) mm longis ad paginam inferam laminae vestita; medio-vena ad paginam inferam laminae prominens, pagina infera laminae concolor; venae laterales plus minusve in luce transmissa manifestae et parum prominens in pagina infera laminae ubi siccatae, 2-furcatae, ramus primus superus ultra sorum procurrens sed quam duos ramos inferos brevior, rami terminales in pagina supera laminae paulis hydathodis manifesti, liberi. *Sori* 2.0–2.5 mm longi, 1.5–2.3 mm lati, in ambitu plus minusve circulares, ad superficiarem inferam laminae adornati, discreti ubi maturi, in 2 serialibus, 1 utroque medio-venae in ½ superno laminae, in quoque seriali 32+ sori, medio-venam quam marginem proximiores. *Sporangia* (370–)378–452(–470) μm longa, pilis 1–3 obscure rubriusculo-brunneis rigidis 220–400 μm longis praedita; cellulae induratae annuli (11–)12–14. *Sporae* ignotae. — Typus: *A.A. Pulle 857*, 31.xii.1913, summit of Mt Hellwig, Irian Jaya (L).

Rhizome c. 3 mm diam. including scales, c. 1 mm diam. without scales, short-creeping, unbranched, producing stipes c. 1 mm apart; scales c. 2.5 × 0.5 mm, lanceolate, obtuse at apex, pale red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 4.5–11.0 cm × 0.6–0.7 mm, with moderately frequent ± patent dark red-brown simple eglandular hairs 1.0–3.5 mm and similar but binate to quinate hairs also moderately frequent. *Lamina* c. 27.7 × 1.0 cm, linear-oblanceolate, acute at apex, long-attenuate at base, entire, coriaceous, with moderately frequent ± patent dark red-brown simple eglandular hairs c. 2.5–5.5 mm on lamina and midvein above, midvein below and margin, similar but binate to quinate hairs moderately frequent on margin and midvein below and similar but 0.5–2.0(–4.0) mm hairs on lamina below; midvein prominent on the lower surface of the lamina and concolorous with it; lateral veins ± visible in transmitted light and slightly prominent on the lower surface of the lamina when dried, 2-forked, the first upper branch extending beyond the sorus but shorter than the lower two branches, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* 2.0–2.5 × 1.5–2.3 mm, ± circular in outline, on surface of lamina, discrete when mature, in two rows, one on each side of the midvein in the upper ½ of the lamina, each row with 32+ sori, nearer the midvein than the margin. *Sporangia* (370–)378–452(–470) μm, with 1–3 dark red-brown rigid hairs 220–400 μm; indurated cells of annulus (11–)12–14. *Spores* unknown.

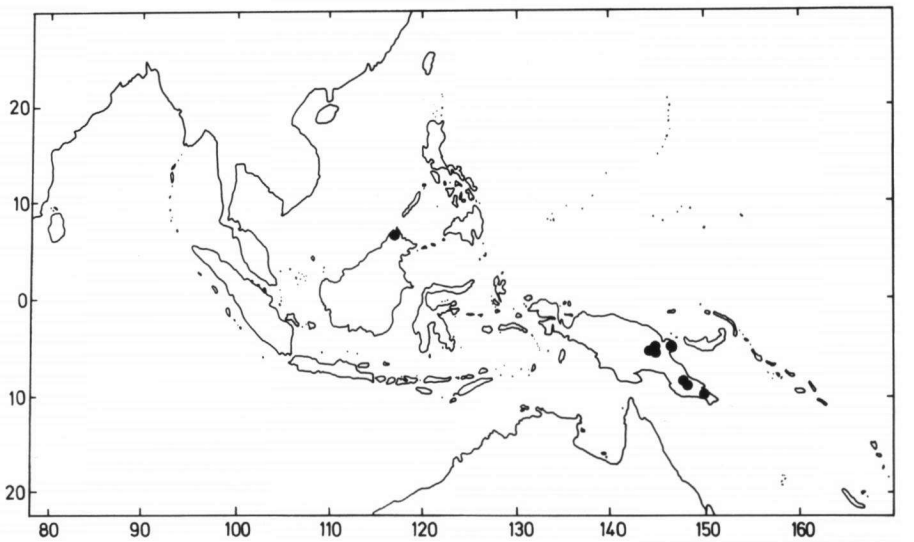
Distribution. New Guinea.

CENTRAL IRIAN JAYA. Summit of Mt Hellwig, Pulle 857 (L).

Ecology. At 2600 m.

Note. *G. crinifera* is closely related to *G. mollipila* and has the same type and arrangement of lamina hairs. It differs, however, in lacking white scales on the hydathodes and in having larger sporangia.

12. G. clemensiae group – Species 61
Only one species; see description, habitat and distribution below.



Map 65. *Grammitis clemensiae* (61).

61. Grammitis clemensiae (Copel.) Parris – **Fig. 30; maps 65, 66.**

G. clemensiae (Copel.) Parris, Fern Gaz. 12 (1980) 119. – *Oreogrammitis clemensiae* Copel., Philip. J. Sc. C 12 (1916) 64; C. Chr., Dansk Bot. Arkiv 6 (1929) 30. – Lectotype: *Clemens 10618*, p.p., Borneo, Mt Kinabalu (MICH; iso BM).
Illustrations: C. Chr., Dansk Bot. Arkiv 6 (1929) pl. 3, f. 7 as Oreogrammitis clemensiae.

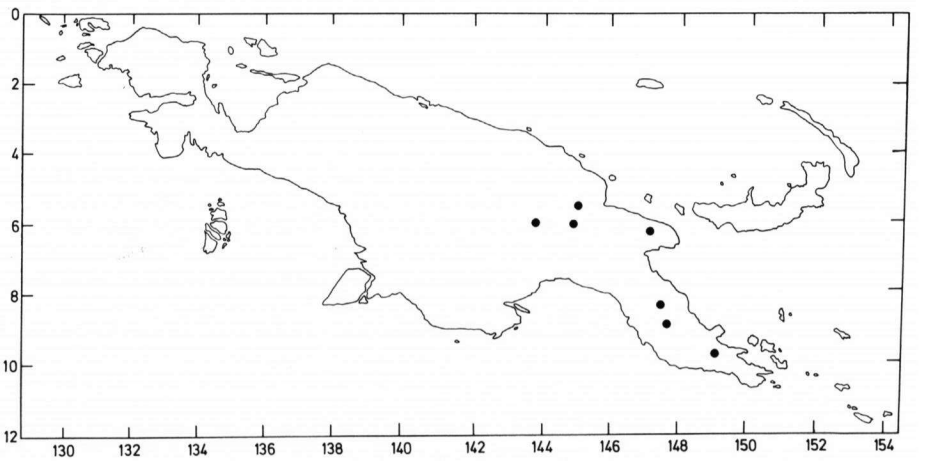
Rhizome 2–4 mm diam. including scales, 1–2 mm diam. without scales, short to moderately long-creeping, often branched and mat-forming, producing stipes 1–3 mm apart; scales (1.9–)2.4–3.6(–4.2) × (0.3–)0.4–0.8(–1.0) mm, usually lanceolate, sometimes ovate-lanceolate, usually acute but sometimes obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (0.1–)0.3–1.8(–3.1) cm × 0.2–0.3(–0.4) mm, usually with occasional to moderately frequent ± patent medium red-brown simple eglandular hairs (0.5–)0.6–1.0(–1.1) mm, and occasional ± appressed whitish simple clavate-glandular hairs less than 0.1 mm on young unrolling stipes, sometimes glabrous. *Lamina* (0.5–)0.7–3.4(–7.0) × (0.1–)0.2–0.3(–0.4) cm, narrowly oblanceolate, acute to obtuse at apex and attenuate to long-attenuate at base, the margin sometimes inrolled over lower surface and almost covering sori, entire, coriaceous, with ± patent medium red-brown simple eglandular hairs (0.3–)0.5–1.3(–1.5) mm on both surfaces and mar-

gin, especially amongst the sori, moderately frequent in most young fronds but some older fronds ± glabrescent; midvein slightly prominent on the lower surface of the lamina and concolorous with it; lateral veins invisible in transmitted light, 1-forked, the upper branch extending beyond the sorus and ± equal in length to the lower branch, some veins bearing the sori joined by a commisural vein parallel to the midvein where the lateral veins fork (see fig. 30), each branch ending marked by a small hydathode on the upper surface of the lamina; sori on surface of lamina, longitudinally fused in two rows, one on each side of the midvein in the upper ¼–½ of lamina, midway between midvein and margin, or with the lowest 3 sori on each side free, the free sori 2.5–2.8 × c. 1.0 mm, oblong in outline, each parallel to the midvein, sometimes covering all of lamina undersurface. *Sporangia* (220–)250–311(–370) μm, with 1–4(–6) usually red-brown, rarely whitish, rigid hairs (130–)243–442(–500) μm; indurated cells of annulus (9–)11–14(–17). *Spores* (32–)38–49(–57) μm diam.

Distribution. Borneo and New Guinea.

W. HIGHLANDS. Mt Milyin Kilyin, Kubor Ra., Pullen 5155 (CANB, LAE).
S. HIGHLANDS. Mt Giluwe, Coode 3704 & Wardle (LAE), LAE 55991 (K, L, LAE).
CHIMBU. Mt Wilhelm, ANU 5171, 5239, 7712 (all CANB), 13061 (CANB, LAE), van Balgooy 43 (B, CANB, LAE), 454 (CANB, L, LAE), Briggs 3771 (NSW), Hoogland & Pullen 5770 (BM, LAE), Jermy 5443 (BM), LAE 54882 (K, LAE), Nakaike 335, 336 (both LAE), Willis s.n. (LAE).
MOROBE. Mt Sarawaket, Clemens s.n. (MICH).
CENTRAL. Mt Albert Edward, LAE 61422 (K, LAE). Mt Victoria, LAE 61761 (LAE).
MILNE BAY. Mt Suckling, LAE 54479 (K, LAE).

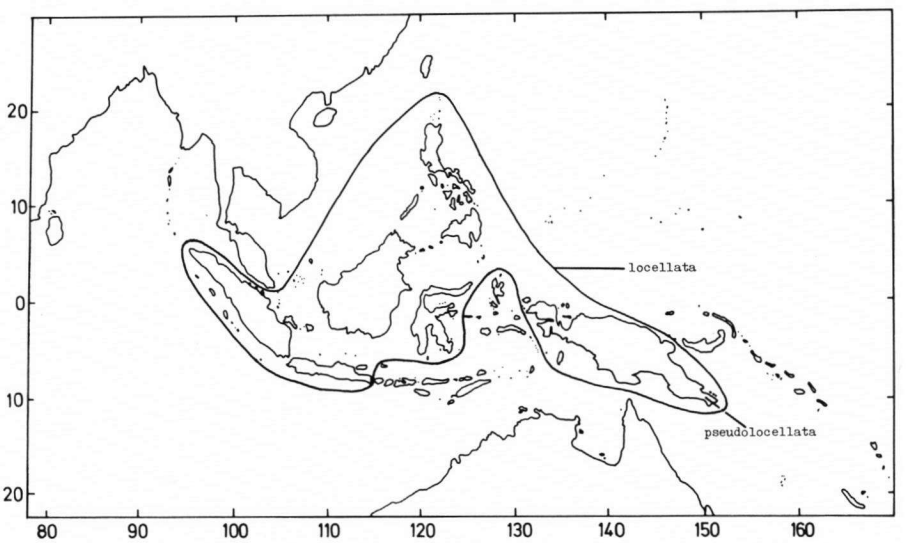
Ecology. Rupestral, usually on rockfaces, in crevices or under ledges, occasionally on rocks in alpine shrubland and grassland, 3500–4450 m altitude.



Map 66. *Grammitis clemensiae* (61).

Fig. 30. *G. clemensiae* group and *G. locellata* group. – 1. *G. clemensiae* (61), *van Balgooy 454* (LAE); 2. *G. pseudolocellata* (63), isotype, *Brass 22893* (L); 3. *G. locellata* (62); left, *Parris & Croxall 4696* (BSP); right, *Coode 3526* (LAE).

Notes. *G. clemensiae* was previously placed in a separate monotypic genus, *Oreogrammitis* Copel., because of its fused sori (Copeland, 1917). Collections from Mt Kinabalu, Sabah, Borneo (the type locality) show all degrees of soral fusion from complete to all sori (11 per row) discrete when young and confluent when mature, and the genus is not worthy of recognition. Fused sori are occasionally also found in the circumantarctic species *G. poeppigiana* (Mett.) Pichi Sermolli, to which *G. clemensiae* is not closely related. The genus *Scleroglossum* has fused sori, but *G. clemensiae* cannot be regarded as a link between *Grammitis* and *Scleroglossum* as postulated by Copeland (1917). Examination of the frond hairs shows *G. clemensiae* to be indubitably a *Grammitis* with no near relationship to *Scleroglossum*.



Map 67. *G. locellata* species group.

13. G. locellata group – Species 62–63
Fig. 30; maps 67–69; table 12

Rhizome erect to moderately long-creeping; scales ovate-lanceolate to narrowly lanceolate, pale to medium red-brown, rarely pale yellow-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* with pale yellow-brown to dark red-brown simple eglandular hairs 0.2–2.5 mm and sometimes catenate simple eglandular hairs. *Lamina* entire, coriaceous, glabrous or with medium red-brown simple eglandular hairs 0.5–0.8 mm, catenate simple eglandular hairs or simple clavate-glandular hairs; lateral veins sometimes visible in transmitted light, 1–3-forked, the first upper branch sometimes ± as long as the others, each branch ending some-

times marked by a small hydathode on the upper surface of the lamina. *Sori* oval to narrowly elliptic in outline, sunken in pits, in two rows.

Epiphytic or rupestral in midmontane, upper montane and subalpine forest and subalpine grassland and shrubland. Distribution from Sumatra to New Guinea with two species in New Guinea, one endemic to Southeast Pen.

Table 12. Characters of taxonomic importance within the *G. locellata* species group in New Guinea.

Characters	*G. locellata*	*G. pseudolocellata*
Stipe hairs in mm (simple eglandular)	often glabrescent, pale yellow-brown to pale red-brown, sparse to scattered, 0.2–1.0(–2.0)	medium to dark red-brown, scattered, 1.0–2.5
Lamina hairs (simple eglandular)	absent	occ. on margin and midvein below

62. Grammitis locellata (Baker) Copel. – **Fig. 30; maps 68, 69.**

G. locellata (Baker) Copel., Occ. Papers Bishop Mus. 15 (1939) 86; Philip. J. Sc. 80 (1952) 176. – *Polypodium locellatum* Baker, J. Bot. (London) 28 (1890) 108. – Type: *Macgregor 26* (K, holo; BM).

G. stenocrypta Copel., Philip. J. Sc. 46 (1931) 220; ibid. 80 (1952) 220. – *Polypodium stenocryptum* C. Chr., Index Filicum Suppl. 3 (1934) 158. – Lectotype: *Copeland s.n.*, Java, G. Gede, near Kandang Badak (MICH; iso BM, BO, UC).

G. stomatocarpa Copel., Univ. Calif. Publ. Bot. 18 (1942) 223; Philip. J. Sc. 80 (1952) 177. – Type: *Brass 9858a & Meijer Drees* (MICH, holo; BM, BO, BRI, GH, L).

Illustrations: Copel., Philip. J. Sc. 80 (1952) 177, f. 45 et 177, f. 46 as G. stomatocarpa et 220, f. 80 as G. stenocrypta.

Rhizome 3–8 mm diam. including scales, 1.5–2.0 mm without scales, ± erect to moderately long-creeping, unbranched, producing stipes 1–3 mm apart; scales (1.1–) 1.8–4.2(–6.7) × 0.3–0.9(–2.1) mm, narrowly lanceolate to lanceolate, acute to obtuse at apex, pale to medium red-brown or rarely pale yellow-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* (1.4–)2.9–8.9(–14.8) cm × (0.2–)0.3–0.5(–0.8) mm, with sparse to scattered ± patent pale yellow-brown to pale red-brown simple eglandular hairs 0.2–1.0(–2.0) mm, often glabrescent, and occasionally with sparse ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds. *Lamina* (2.0–)4.2–12.0(–20.6) × (0.2–)0.4–0.9(–1.4) cm, lanceolate to linear-lanceolate or linear-elliptic, subacute to acuminate at apex and cuneate to attenuate at base, entire, coriaceous, glabrous or with occasional ± ap-

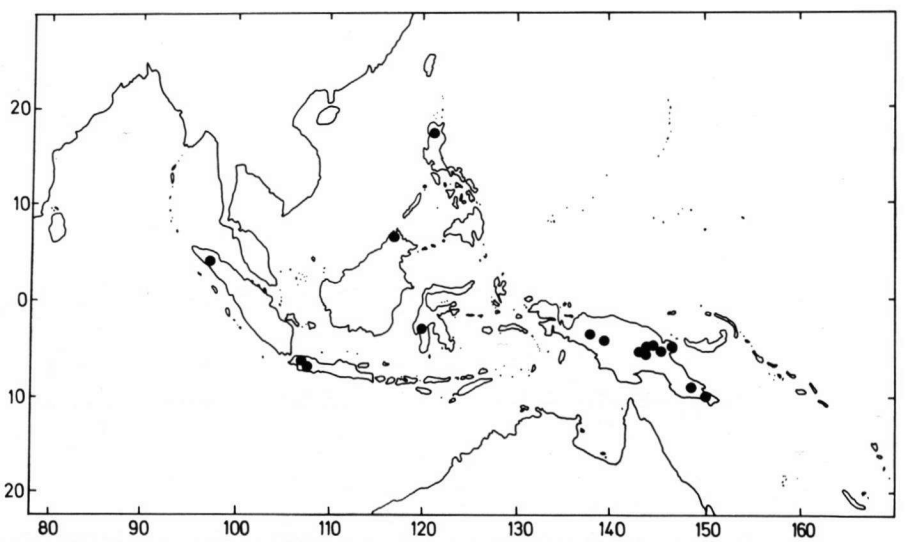
pressed pale to medium red-brown simple clavate-glandular hairs less than 0.1 mm and occasionally with sparse ± patent catenate simple eglandular hairs less than 0.1 mm on young unrolling fronds; midvein not or slightly prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins invisible in transmitted light, 1–3-forked, the upper branch of the first fork extending beyond the sorus and sometimes nearly as long as the lower branches, the lower branch often not forked, sometimes 1–2-forked, each branch ending occasionally marked by a small hydathode on the upper surface of the lamina, free. *Sori* (1.0–) 1.4–4.8(–9.0) × (0.2–)0.6–1.9(–4.0) mm, oval to narrowly elliptic, each oblique to the midvein, deeply sunken in narrow steepsided pits which may have a slightly prominent rim, usually discrete but occasionally contiguous or confluent when mature, in two rows, one on each side of the midvein in the upper or middle ½ of the lamina to throughout its length but not immediately below the apex or above the base, each row with (1–)7–20(–30) sori, ± midway between the midvein and the margin. *Sporangia* (200–)223–302(–350) μm, glabrous or sometimes with 1–4(–6) medium to dark red-brown rigid hairs (100–)147–227(–270) μm; indurated cells of annulus (9–)10–13(–14). *Spores* (23–)28–42(–52) μm diam.

Distribution. Sumatra, Borneo, Java, Philippines, Celebes and New Guinea.

CENTRAL IRIAN JAYA. Grasberg near Dajak weide, Punjak Sukarno, Wissel 158 (BO). Danau Habbema, Brass 9630 & Meijer Drees (GH, MICH, UC), 9858a (BM, BO, BRI, GH, L, MICH).

W. HIGHLANDS. Mt Hagen, Parris & Croxall 4695 H 113, 8123 (both BSP, LAE).

ENGA. Mt Ambua, Vink 17398 (L), 17400 (B, L, LAE). The Sugarloaf, Hoogland & Schodde 7011 (CANB).



Map 68. *Grammitis locellata* (62).

S. HIGHLANDS. Mt Giluwe, Coode 3526 (LAE), Croft 725 & Marsh (CROFT, LAE), Parris & Croxall 5935, 5936 (both BSP, LAE).

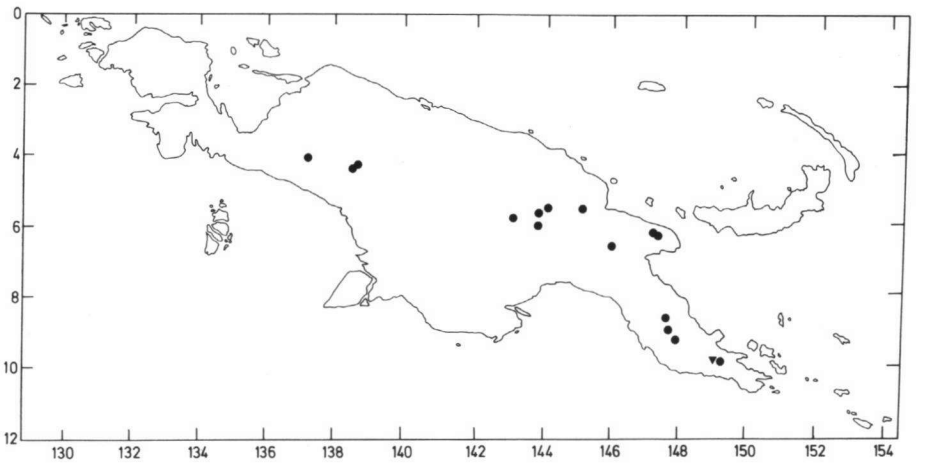
CHIMBU. Mt Wilhelm, ANU 7096, 7096a (both CANB, LAE), van Balgooy 98 (L), Brass 29836 (CANB, K, L, LAE, NY, US), Hoogland & Pullen 5659 (BM, CANB, L, LAE), Jermy 5450, 5451, 5456, 5459 (all BM), Nakaike 229, 248, 340, 349 (all LAE), NGF 47379 (K, LAE), 47382 (LAE), Parris & Croxall 4696 H 253 (BSP, LAE), Philipson 3478 (CHR, K, L), Semple & Rayner s.n. (MEL).

E. HIGHLANDS. Mt Piora, Croft 108 (BSP, CROFT, LAE), NGF 19026 (LAE).

MOROBE. Bolan Mts, Keysser B33 (UC), B34 (S, UC). Mt Sarawaket, Clemens 6236 (BM), s.n., 3350–3360 m (MICH). Rawlinson Ra., Clemens 12380 (MICH, UC).

CENTRAL. Mt Kenevi, LAE 65089 (K, L). Mt Scratchley, NGF 46307 (LAE). Mt Victoria, LAE 61702 (K, L, LAE), 61771 (K, L, LAE, NSW), Macgregor 26 (BM, K).

MILNE BAY. Goe, Mt Suckling, LAE 54426 (K, L, LAE).



Map 69. ● *Grammitis locellata* (62), ▼ *G. pseudolocellata* (63).

Ecology. Usually a low epiphyte on trunks of trees, usually in upper montane and subalpine forest, sometimes in midmontane forest and on tree-ferns (*Cyathea* spp.) and shrubs in subalpine grassland and shrubland, sometimes rupestral in subalpine forest or subalpine grassland; from c. 2850 to 3900 m.

Notes. The sori deeply sunken in elongate pits oblique to the midvein distinguish *G. locellata* from all other species of *Grammitis* in New Guinea except *G. pseudolocellata*, which differs in possessing longer and more persistent lamina hairs which are neither glandular nor catenate. The density, length and persistence of the stipe hairs and the size of the lamina and sori are rather variable in *G. locellata*. *G. stomatocarpa* was based on a large specimen with persistent hairs and long sori.

63. Grammitis pseudolocellata Parris, *sp. nov.* –Fig. 30; map 69.

G. locellata affinis, pilis stipitis mediis vel obscure rubriusculo-brunneis et pilis simplicibus eglandulosis laminae differt. — *Rhizoma* squamis inclusis c. 3 mm diam., squamis exclusis c. 1 mm diam., erectum vel breviter repens, eramosum, stipites per spatia usque ad 1 mm emittens, squamae 0.5–0.8 mm longae, c. 0.2 mm latae, ovato-lanceolatae vel lanceolatae, ad apicem subacutae, mediae rubriusculo-brunneae, non clathratae nec iridescentes, cellulae sine septis. *Stipes* 3.2–4.5 cm longus, c. 0.3 mm latus, pilis simplicibus eglandulosis 1.0–2.5 mm longis sparsis plus minusve patentibus mediis vel obscure rubriusculo-brunneis vestitus. *Lamina* (4.6–)5.4–9.8(–10.6) cm longa, (0.3–)0.4–0.6(–0.7) cm lata, lineari-lanceolata vel lineari-elliptica, integra, coriacea, pilis simplicibus eglandulosis 0.5–0.8 mm longis paucis plus minusve patentibus mediis rubriusculo-brunneis ad marginem et medio-venam inferam vestita; medio-vena ad paginam inferam laminae non prominens, pagina infera laminae concolor; venae laterales interdum in luce transmissa manifestae, 2–3-furcatae, ramus primus superus non ultra sorum procurrens, ramus inferus 1–2-furcatus, rami terminales in pagina supera laminae sine hydathodis manifestis, liberi. *Sori* 1.0–3.0 mm longi, 1.0–1.5 mm lati, in ambitu plus minusve circulares vel anguste elliptici, ad medio-venam obliqui, in lacunis interdum margine parum prominenti profunde impressi, discreti ubi maturi, in 2 serialibus, 1 utroque medio-venae per lamina sed non prope apicem nec prope basem, vel in ½ medio laminae, in quoque seriali (7–)8–23(–26) sori, inter marginem et medio-venam aequidistantes. *Sporangia* (220–)230–268(–290) μm longa, pilo solitario obscure rubriusculo-brunneo rigido, 150–310 μm longo praedita; cellulae induratae annuli (10–)11–12 (–14). *Sporae* (28–)30–34 μm diam. — Typus: *L.J. Brass 22893*, 12.vi.1953, north slopes of Mt Dayman, Maneau Range, Milne Bay District, Papua New Guinea (BM; iso A, L, LAE).

Rhizome c. 3 mm diam. including scales, c. 1 mm diam. without scales, erect to short-creeping, unbranched; producing stipes up to 1 mm apart; scales 0.5–0.8 × c. 0.2 mm, ovate-lanceolate to lanceolate, subacute at apex, medium red-brown, glabrous, neither clathrate nor iridescent, the cells without cross-walls. *Stipe* 3.2–4.5 cm × c. 0.3 mm, with scattered ± patent medium to dark red-brown simple eglandular hairs 1.0–2.5 mm. *Lamina* (4.6–)5.4–9.8(–10.6) × (0.3–)0.4–0.6(–0.7) cm, linear-lanceolate to linear-elliptic, acute at apex and cuneate to long-cuneate at base, entire, coriaceous, with occasional ± patent medium red-brown simple eglandular hairs 0.5–0.8 mm on margin and midvein below; midvein not prominent on the lower surface of the lamina, concolorous with it; lateral veins sometimes visible in transmitted light, 2–3-forked, the upper branch of the first fork not extending beyond the sorus, the lower branch 1–2-forked, the branch endings without obvious hydathodes, free. *Sori* 1.0–3.0 × 1.0–1.5 mm, ± circular to narrowly elliptic in outline, each oblique to the midvein, deeply sunken in steepsided pits which may have a slightly prominent rim, discrete when mature, in two rows, one on each side of the midvein throughout the lamina, but not immediately below the apex or above the base, or in the middle ½ of the lamina, each row with (7–)8–23(–26) sori, midway between the midvein and the margin. *Sporangia* (220–)230–268(–290) μm, with a solitary dark red-brown rigid hair 150–310 μm; indurated cells of annulus (10–)11–12(–14). *Spores* (28–)30–34 μm diam.

Distribution. New Guinea.

MILNE BAY. N. slopes of Mt Dayman, Brass 22893 (A, BM, L, LAE).

Ecology. Low epiphyte in montane forest; at 2250 m.

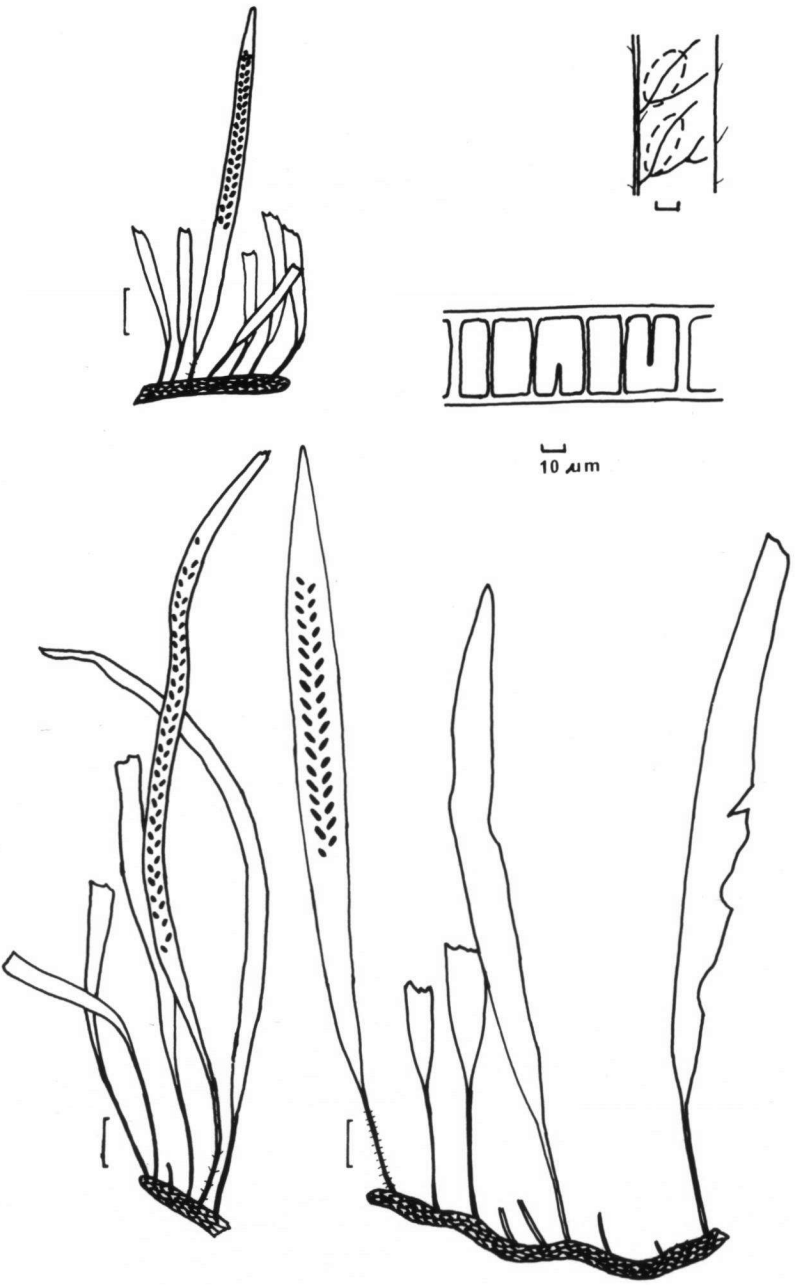


Fig. 31. *G. dolichosora* group. – *G. dolichosora* (64); top left, *Cheesman 1301* (BM); bottom left, *Lam 1518* (L); bottom right, *Parris & Croxall 7679* (BSP); with detail of cross-walls in a cell of a rhizome scale.

14. G. dolichosora group – Species 64
Only one species; see description, habitat and distribution below.

64. Grammitis dolichosora (Copel.) Copel. – **Fig. 31; maps 70, 71.**

G. dolichosora (Copel.) Copel., Philip. J. Sc. 80 (1952) 188. – *Polypodium dolichosorum* Copel., Philip. J. Sc. 1 (1906) Suppl. 159. – Lectotype: *Copeland 1524*, Philippines, Mindanao, Davao (MICH; iso K, UC).

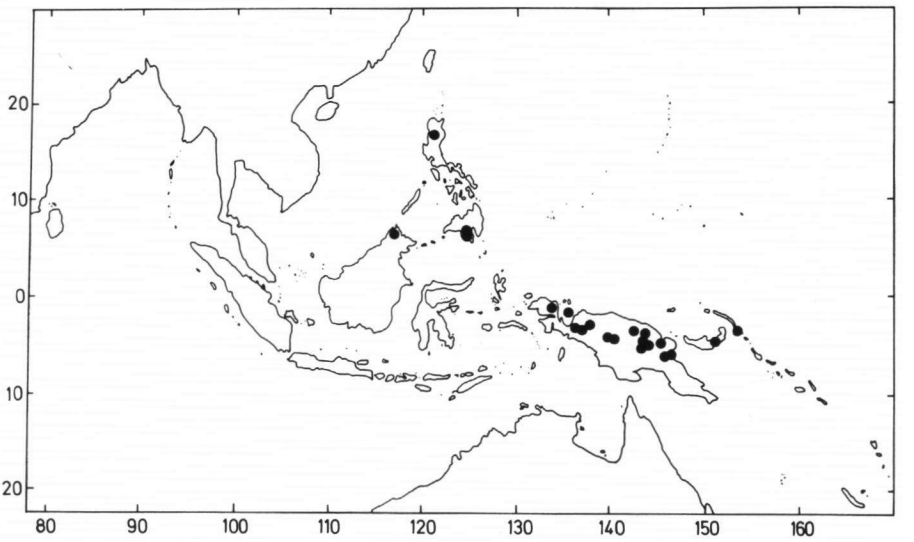
Polypodium ciliolatum v.A.v.R., Nova Guinea 14 (1924) 43. – *G. ciliolata* Copel., Philip. J. Sc. 80 (1952) 187. – Lectotype: *Lam 1518* (BO; iso L, SING).

G. frigida sensu Copel., Philip. J. Sc. 80 (1952) 170, quoad *Brass 10279, 11267 et 11272.*

Illustrations: Copel., Philip. J. Sc. 1 (1906) Suppl. pl. 16 as Polypodium dolichosorum; ibid. 80 (1952) 170, f. 38 as G. frigida et 188, f. 56 as G. ciliolata et 189, f. 57.

Rhizome 2–5 mm diam. including scales, 1–2 mm diam. without scales, usually long-creeping, occasionally short-creeping, usually unbranched, sometimes branched, producing stipes 2–20 mm apart; scales (2.3–)2.9–4.9(–6.0) × (0.4–)0.7–1.7(–2.4) mm, ovate to narrowly lanceolate, acute to obtuse at apex, pale to medium red-brown, glabrous, neither clathrate nor iridescent, each cell with several complete and incomplete cross-walls. *Stipe* (0.2–)1.5–3.7(–5.2) cm × (0.3–)0.5–0.9(–1.3) mm, with sparse to moderately frequent ± patent dark red-brown simple eglandular hairs (0.2–)0.5–1.1(–1.5) mm. *Lamina* (4.7–)9.4–17.4(–23.0) × 0.3–1.2(–1.4) cm, linear-lanceolate to linear-oblanceolate, obtuse to acuminate at apex, narrowly cuneate to long-attenuate at base, entire, rather coriaceous, with very sparse to scattered ± patent to ascending medium red-brown to blackish simple eglandular hairs 0.2–0.5(–0.7) mm on margin, similar but ± patent hairs very sparse to scattered on the midvein below and occasionally on the midvein and lamina above, similar but binate ± patent hairs occasional on the margin and scattered ± appressed pale red-brown simple clavate-glandular hairs less than 0.1 mm on young unrolling fronds; midvein rather prominent on the lower surface of the lamina and concolorous with or slightly darker than it; lateral veins invisible in transmitted light, sometimes slightly prominent on the upper surface of the lamina when dried, 1–2-forked, the upper branch usually extending beyond the sorus and ± as long as the other branch or branches, occasionally terminating within the sorus, the lower branch sometimes 1-forked, each branch ending marked by a small hydathode on the upper surface of the lamina, free. *Sori* (1.1–)1.5–3.2(–4.3) × (0.5–)0.9–1.8(–2.5) mm, ± circular to narrowly oblong in outline, sometimes curved, each oblique to the midvein, on surface of lamina or slightly sunken in broad shallow depressions, usually discrete but occasionally contiguous when mature, in two rows, one on each side of the midvein in the upper or middle ½–¾ of the lamina but not immediately below the apex, each row with (1–)11–31(–46) sori, nearer the midvein than the margin. *Sporangia* (150–)186–252(–290) μm, with 1–4(–6) dark red-brown rigid hairs (80–)104–177(–310) μm; indurated cells of annulus (7–)9–12(–16). *Spores* (19–)25–33 (–40) μm diam.

Distribution. Borneo, Philippines and New Guinea.



Map 70. *Grammitis dolichosora* (64).

VOGELKOP PENINSULA. Anggi Gita, Gibbs 5972 (BM), Kostermans 2210, 2211 (both BO).

JAPEN I. Mt Baduri, Aiam Ra., Cheesman 1301 (BM). Sarurai near Serui, Aet & Idjan 180 (BO, L).

CENTRAL IRIAN JAYA. Motito, Danau-danau Wissel, Vink & Schram BW 8693 (CANB, LAE). Peg. Sudirman, Leeuwen 10939 (BO, K, L). Ngga Simanggela, Lam 1518 (BO, L). Danau Habbema, Brass 10279 (BM, GH, K, L, LAE, MICH), 11267, 11272 (both BM, BO, GH, L, MICH). Okdenan-Oksibil R., Star Mts, Soegeng Reksodihardjo 558 (K, L). Mt Antares, Star Mts, Kalkman 4323 (CANB, L, LAE).

CYCLOPS MTS. Peg. Cycloop, Mayr 618 (BO).

E. SEPIK. Malu, Ledermann 10789C (B). Mt Hunstein, Ledermann 11246 (B), 11472 (B, BM).

W. HIGHLANDS. Kum Forest, Mt Hagen, Parris & Croxall 8156 (BSP, LAE).

ENGA. Poget logging area, Merimantu, NGF 11270 (BRI, CANB, K, L, LAE).

S. HIGHLANDS. Ialibu, NGF 40329 (LAE). Mt Giluwe, LAE 60945 (L, LAE), 63124, 63185, 63199 (all LAE), Mitchell 73 (BSP, CHR), Parris & Croxall 8209 (BSP, LAE). Onim, Rau 140 (BULOLO, LAE).

E. HIGHLANDS. Mt Elandora, Walker 9785–9792, 9802–9809, 9836–9845, 9900–9903 (all BM). Mt Michael, Johns 1314 (BULOLO). Suwaira, W side of Mt Elandora, Jermy 5169, 5173 (both BM).

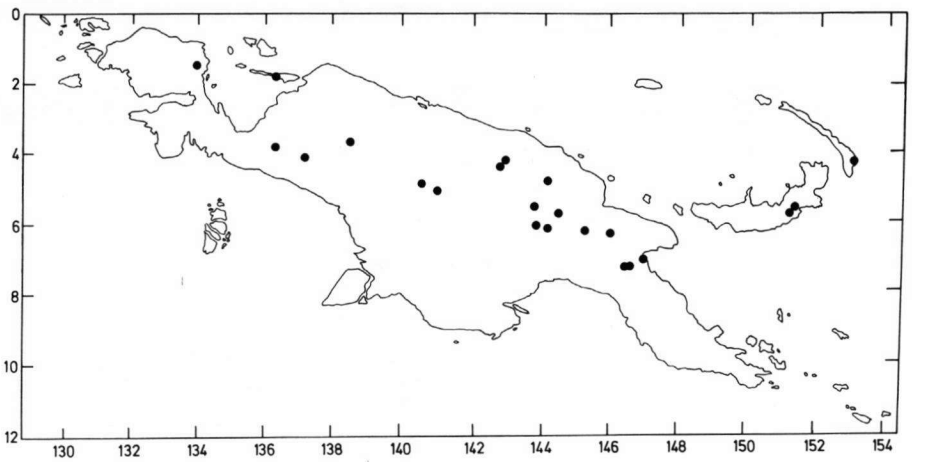
MADANG. Mt Schrader, Ledermann 11585, 11631a, 11748 (all B).

MOROBE. Near Aseki, Parris & Croxall 7939 (BSP, LAE). Bulldog trail, Edie Creek, Walker 7633, 7634, 7636 (all BM). Ekuti Ra., Parris & Croxall 6001, 6028, 7979 (all BSP, LAE). Kaisinik, Rau 107 (BULOLO, LAE). Mt Kaindi, Brass 29793 (US), Parris & Croxall 4709 L 164 (BSP, LAE), Parris 9547 (BSP, LAE), NGF 8710 (BRI, LAE).

W. NEW BRITAIN. Nakanai plateau, LAE 59707 (K, LAE), 63288 (LAE).

E. NEW BRITAIN. Mt Lululua, LAE 58239 (L, LAE).

NEW IRELAND. Taron, LAE 68368 (LAE).



Map 71. *Grammitis dolichosora* (64).

Ecology. Usually a low ± erect epiphyte on trunks and roots of trees (including *Nothofagus pullei* and *Pandanus*), sometimes in moss cushions, occasionally terrestrial or rupestral; in lower montane and midmontane forest, frequently of oak or *Nothofagus* (including *N. pullei, N. resinosa, N. starkenborghii*); from 310 to 3000 m.

Notes. Vernacular names: kombara (local name on Mt Giluwe), moena (local name at Danau-danau Wissel, Kapauko language).

A collection from Gurakor, Morobe District (640 m, 5.v.1959, *Brass 29434*, CANB, K, L, LAE, US) may belong here; it has rather short stipes (0.4–1.0 cm) and a somewhat shorter lamina, (4.5–)5.6–13.2(–15.5) cm, with slightly longer lamina hairs (up to 1.0 mm) and sporangia, (240–)255–311(–330) μm, and larger spores, (40–)41–45(–48) μm, but in other characters matches *G. dolichosora* exactly. The collection from Ngga Simanggela described as *Polypodium ciliolatum* has long slender fronds with moderately frequent lamina hairs, but this form intergrades with more typical material and is not worth retaining at any rank.

SPECIES DOUBTFULLY RECORDED

Grammitis lasiosora (Blume) Ching.

G. lasiosora (Blume) Ching, Bull. Fan Mem. Inst. Biol. Bot. 10 (1941) 240. – *G. pusilla* var. *lasiosora* Blume, Flora Javae 2 (31 August 1829) 110. – *Polypodium lasiosorum* Hooker, Sp. Fil. 4 (1863) 166.

Note. This species was recorded from New Guinea by Brause in Bot. Jahrb. 56 (1920) 180 (as *Polypodium lasiosorum*) without citation of specimens. It is a Javanese species and its presence in New Guinea is most unlikely. This record may refer to one of the species closely related to *G. lasiosora* in the *G. hirtella* species group.

SPECIES INSUFFICIENTLY KNOWN

Grammitis angustifolia Gilli.

G. angustifolia Gilli, Ann. Naturhist. Mus. Wien 81 (1978) 24.

Note I have not been able to examine the type of this species, but from the description it is apparently a member of the *G. fasciata* group and close to *G. fasciata, G. graminifolia* and *G. subfasciata.*

2.3. Discussion of taxonomy

Copeland (1952a) recognised 55 species of *Grammitis* from New Guinea, 15 of which were newly described in his monograph. I recognise 64 species here, 20 of which are new, and have synonymised 17 of Copeland's species including eight of his new ones. Four of his new species are synonymised with species described earlier whose types he had not examined and which he maintained as distinct, while I regard the other four as being within the range of variation of other species included in his account. One other species is synonymised with an earlier name used in the Malay-Asiatic regional treatment of the monograph. An additional nine species included by Copeland in his Malay-Asiatic account are also synonymised here. Four Malay-Asiatic species have now been recorded for New Guinea, as has *G. clemensiae*, which was regarded by Copeland as belonging to *Oreogrammitis* and not included in his monograph of *Grammitis*. Copeland made no infra-generic divisions below the rank of subgenus, but I have arranged the species here in 14 species groups, three of which are endemic to New Guinea.

Table 13 provides some information on endemicity, newly described species and those of limited distribution.

Grammitis is the second largest fern genus in New Guinea to be recently revised (table 14) and its high proportion of endemic taxa is similar to that of most other genera of more than 10 species.

A variety of characters has been used in the delimitation and description of species and species groups and it is appropriate to review and evaluate their utility.

Table 13. Number and percentage of endemic and non-endemic species, newly described species and species known only from one locality.

	Number of species	% of species
Species total	64	–
Endemic species	44	69
Non-endemic species	20	31
Newly described species	20	31
Species known from one locality	25	39

Table 14. Number of taxa (species, subspecies and varieties) and percentage endemic to New Guinea in recently revised fern genera of more than 10 species. Families and genera arranged according to Crabbe et al. (1975).

	Number of taxa	% endemic
Gleicheniaceae (Holttum, 1959, 1966)		
Sticherus	14	71
Grammitidaceae		
Grammitis	64	69
Cyatheaceae (Holttum, 1963, 1966)		
Cyathea	90	86
Dennstaedtiaceae (Kramer, 1971)		
Lindsaea	32	28
Thelypteridaceae (Holttum, 1982)		
Coryphopteris	24	75
Plesioneuron	35	89
Pneumatopteris	26	88
Sphaerostephanos	62	82
Pronephrium	14	43
Christella	11	27
Aspleniaceae		
Elaphoglossum (Holttum, 1978)	33	70

Hairs – The presence, density, colour, type and length of the hairs on the stipe and the lamina and the distribution of hairs on the lamina are amongst the most important characters both for identifying species and indicating their relationships. Simple eglandular hairs are found in the majority of *Grammitis* species in New Guinea (table 15) and because of their variety of density, colour, length and distribution they are the most useful taxonomically of the five types of hair found in the New Guinea species of *Grammitis*. It has been suggested (Bishop, 1974, 1978) that hair types may be important characters in the delimitation of genera within the Grammitidaceae. *Adenophorus* was defined by the presence of glandular paraphyses in the sori (Bishop, 1974). His paraphyses are the type of hair described here as simple clavate-glandular. This type of hair is widely distributed amongst the New Guinea species of *Grammitis* (table 15) and is absent from only one species group, but its presence is not consistent with species relationships defined by other morphological characters. These hairs occur on the young unrolling frond, including within the developing sorus and in one species, *G. clavipila*, they may persist until maturity. The presence of 2–8-celled hairs, which are identical to those described here as catenate, was thought to be an important character of *Cochlidium* and it was suggested that their presence indicated 'relationship of some superficially quite distinct plants' (Bishop, 1978). They occur in some members of six species groups of *Grammitis* in

Table 15. Distribution of hair types and hydathodes in New Guinea species of *Grammitis*.

Species group	Species	simple eglandular	catenate simple eglandular	simple clavate-glandular	forked with one branch clavate-glandular and one eglandular	forked with all branches eglandular	hydathodes
G. adspersa	G. demissa	×	–	–	×	×	×
	G. adspersa	×	–	×	–	×	×
	G. viridula	×	–	×	–	×	×
	G. glossophylla	×	–	–	–	×	×
G. sumatrana	G. sumatrana	×	–	×	–	–	×
	G. torricelliana	×	–	×	–	–	×
G. caespitosa	G. frigida	×	×	×	–	–	–
	G. caespitosa	×	–	×	–	–	× –
	G. loculosa	×	–	×	–	–	× –
	G. taeniophylla	×	–	–	–	–	× –
	G. dictymioides	×	–	–	–	–	–
	G. pleurogrammoides	×	×	×	–	–	–
	G. interrupta	–	×	–	–	–	–
G. fasciata	G. fasciata	–	–	–	–	–	×
	G. graminifolia	×	×	×	–	–	× –
	G. crenulata	×	–	–	–	–	×
	G. subfasciata	×	–	–	–	–	× –
	G. padangensis	×	×	×	–	–	× –
G. ceratocarpa	G. ceratocarpa	×	–	×	–	–	×
	G. salticola	×	–	–	–	–	× –
G. setosa	G. archboldii	×	×	×	–	–	×
	G. impressa	×	–	–	–	–	×
	G. tuberculata	×	–	–	–	–	–
	G. scabristipes	×	×	×	–	–	×
G. reinwardtii	G. reinwardtii	×	–	–	–	–	× –
	G. hirtiformis	×	–	–	–	–	–
	G. curtipila	×	–	–	–	–	×
	G. knutsfordiana	×	–	×	–	–	×
	G. hispida	×	–	–	–	–	–
G. mesocarpa	G. mesocarpa	×	–	×	–	–	–
	G. papuensis	×	–	–	–	–	–
	G. inconstans	×	–	–	–	–	–
G. hirtella	G. imberbis	–	×	×	–	–	–
	G. tenuis	–	×	–	–	–	–
	G. reducta	–	–	×	–	–	–
	G. oblanceolata	×	–	–	–	–	× –
	G. meijer-dreesii	×	×	×	–	–	×
	G. clavipila	–	–	×	–	–	–

Table 15 continued.

(G. hirtella	G. coredrosora	×	–	–	–	–	–
continued)	G. silvicola	×	–	×	–	–	× –
	G. ahenobarba	×	–	–	–	–	×
G. intromissa	G. debilifolia	×	–	–	–	–	–
	G. nigropaleata	×	–	–	–	–	× –
	G. tomaculosa	×	–	–	–	–	–
	G. intromissa	×	×	×	–	–	× –
	G. reptans	×	–	–	–	–	–
	G. trogophylla	×	–	–	–	–	–
	G. murrayana	×	–	–	–	–	–
	G. trichopoda	×	–	×	–	–	× –
	G. subreticulata	×	–	–	–	–	×
	G. merrillii	×	–	–	–	–	–
	G. parva	×	–	–	–	–	× –
	G. habbemensis	×	–	–	–	–	–
	G. montana	×	–	–	–	–	–
	G. excelsa	×	–	–	–	–	×
	G. rupestris	×	–	–	–	–	×
	G. collina	×	–	–	–	–	–
	G. ornatissima	×	–	–	–	–	× –
G. mollipila	G. mollipila	×	–	–	–	–	×
	G. crinifera	×	–	–	–	–	×
G. clemensiae	G. clemensiae	×	–	×	–	–	×
G. locellata	G. locellata	×	×	×	–	–	× –
	G. pseudolocellata	×	–	–	–	–	–
G. dolichosora	G. dolichosora	×	–	×	–	–	×

New Guinea (table 15) and there is no suggestion that they are indicative of relationship.

Veins – The lateral veins, in particular the number of times they are forked and the length of the vein branch bearing the sorus relative to that of the other vein branches, are also very important in identifying species and delimiting species groups. Also useful in identification is the visibility of the veins in transmitted light. Bishop (1978) used the presence of hydathodes as one of the important characters distinguishing *Cochlidium*, but in *Grammitis* in New Guinea (table 15) although hydathodes are found in all members of five species groups and are absent from all members of another species group, in the remaining eight groups they are absent from some species or even from some individuals of a species. White scales on the hydathodes may appear to be of use in assessing relationships as well as in identifying species, but they are known from four species in three species groups and in only one species are they always present.

Sori – Characters of the sorus such as the presence of more than two rows of sori and the sori being sunken in pits in the lamina are very useful in species identification. The first is found in both members of the *G. sumatrana* group, but also in four other species in two other species groups. The second occurs in twelve species in five species groups.

Spores – Spore diameter is sometimes useful for separating related species and can provide a check against misidentification. In several species, however, spore size is extremely variable and does not appear to be correlated with geography, altitude or vegetation type. In a few species 32- and 16-spored sporangia are produced on the same plant as the more usual 64-spored sporangia (*G. sumatrana* and *G. padangensis*, 32 and 16 spores; *G. intromissa*, 32 spores) and this may account for some of the variation in spore size of these species. Polyploidy may also be involved (although no polyploids have been recorded for *Grammitis* (Löve, Löve & Pichi Sermolli, 1977), but no New Guinea species of *Grammitis* has been cytologically examined. Measurements of spore size for species in other fern families do not show such a range and it would be most interesting to ascertain the cause of this variability in *Grammitis*.

Rhizome – The habit of the rhizome, whether erect, short-creeping or long-creeping, is sometimes used to separate closely related species. The same is true of the presence, shape and colour of the rhizome scales. The presence of marginal hairs and cells with complete and incomplete cross-walls in the rhizome scales provides immediate identification of *G. demissa* and *G. dolichosora* respectively.

Size – The length of the stipe and the length and width of the lamina serve to distinguish some species from their relatives. Although size is not considered an ideal character because it may vary with age and environmental conditions it appears to be reliable in separating some species.

Lamina – A crenate lamina is known in 17 species belonging to seven species groups, and all species in the *G. hirtella* group may have the base of the lamina crenate. In a few species, which may be of hybrid origin, the crenate margin is perhaps derived from a deeply pinnatifid or pinnate parent species, but in other species the depth and degree of marginal lobing is very variable within the same population and does not appear to be of hybrid origin. Sometimes the extreme forms have been treated as separate species (e.g. *G. mariae, G. matapensis* by Copeland (1952a), which are here reduced to *G. reinwardtii*).

Precise measurements of a large number of characters have not shown any clear infra-specific variation worthy of formal recognition. The variation in density and distribution of the lamina hairs in *G. knutsfordiana*, where the extremes sometimes form distinct populations which are altitudinally separated, would be deserving of taxonomic recognition if other populations which contain both extremes and also intermediates were not known. In other variable species such as *G. reinwardtii* and *G. scabristipes* the range of variation within the species is often found within a single population.

Twenty-five of the species recognised here are known only from one locality and all except five only from one collection; additional specimens may lead to changes of rank or synonymy of some species, e.g. *G. murrayana* and *G. hispida*. More material is needed, especially of the *G. mesocarpa* group, which is known only from four collections placed in three species and of some members of the *G. intromissa* group. This group contains eight closely related species (numbers 42 to 49) and an additional nine species which do not appear to be particularly closely related either to each other or to the other eight species. Five of these possibly unrelated species are known only

from one locality (four of them from only one collection) and more material is needed to determine whether or not they are correctly placed in the *G. intromissa* group.

The species maintained or described here are based upon unique characters or distinct combinations of characters which are usually combined with geographical or altitudinal isolation within their species group. It is possible that some of the 64 species, including some newly described, may, when further material of some species groups becomes available, be better regarded as allopatric subspecies.

3. GEOGRAPHY

3.1. Geographical affinities

Without exception the affinities of the New Guinea *Grammitis* flora are with Malesia (i.e., the political states of Indonesia, Malaysia, the Philippines and Papua New Guinea). The few species and species groups which extend to the islands of the west Pacific are eastward attenuations of this Malesian element. The three species groups of *Grammitis* which are endemic to New Guinea have characters in common with the more widely distributed species groups and may represent old local derivatives. The remaining eleven species groups have areas of distribution centred on Borneo, which is apparently an old and important region of speciation in the Grammitidaceae.

3.2. Geographical distribution

The distribution patterns of the species groups and species of New Guinea *Grammitis* fall into six broad categories.

The first is a basic triangular pattern which extends from Sumatra and the Philippines to New Guinea and includes Borneo and Java and fairly frequently Celebes also. It is shown by five species groups and six species (*G. sumatrana, G. caespitosa, G. fasciata, G. padangensis, G. intromissa, G. locellata*). None of these taxa occur in Malaya.

The second extends beyond the basic pattern to Ceylon in the west (*G. reinwardtii*), mainland southeast Asia and Taiwan in the northwest and north and Australia to the south (*G. adspersa, G. reinwardtii*, and the *G. setosa* species group) and to the Solomon Islands (*G. reinwardtii*, and the *G. setosa* and *G. hirtella* species groups), New Hebrides (*G. scabristipes*) or Fiji (*G. adspersa, G. knutsfordiana*) in the east. The *G. hirtella* species group is unusual in that it is apparently absent from the Philippines. Four species groups and four species have this pattern.

The third ranges from Sumatra to New Guinea (and sometimes includes Java), but does not reach the Philippines. It is shown by four species, *G. viridula, G. impressa, G. oblanceolata, G. ornatissima.*

The fourth includes the Philippines and/or Borneo and New Guinea; two species groups and four species have this pattern (*G. torricelliana, G. merrillii, G. clemensiae, G. dolichosora*).

The fifth includes New Guinea and only one adjacent region; it is shown by two species (*G. curtipila, G. subfasciata*).

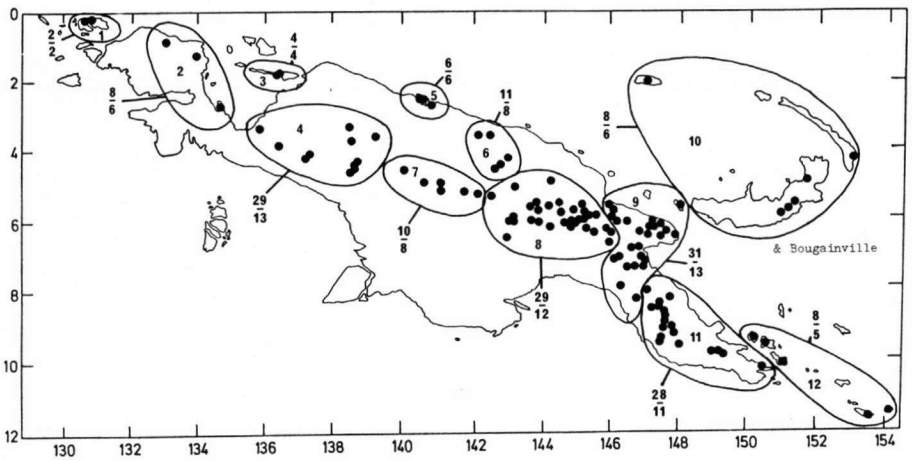
The sixth is that of New Guinea endemics and is shown by three species groups and 44 species.

The distribution of *Grammitis* in New Guinea may usefully be examined in more detail. The localities where the genus has been collected can be regarded, on the basis of *Grammitis* species distribution, as divisable into 12 phytogeographic regions (table 16). These are in most cases distinct from the districts or divisions used in the lists of specimens cited for each species which are also cited in table 16. The delimitation of the regions is shown in map 72 together with all the localities where *Grammitis* has been collected and the numbers of species and species groups in each region.

Within New Guinea there is a central core of distribution within the 12 phytogeographic regions with an attenuation towards the east and west for both species and species groups, with Irian Jaya Highlands, PNG Highlands, Mid-PNG and Southeast Pen. containing the most species and also the highest numbers of New Guinea-endemic species. Non-endemic species are in general more widely distributed in New Guinea than are the endemic species, but the majority of species are found in only one region.

Table 16. Phytogeographical regions of New Guinea and their district or division components.

	Phytogeographical region	District or division
1.	Waigeo I.	Waigeo I.
2.	Vogelkop Pen.	Vogelkop Pen.
3.	Japen I.	Japen I.
4.	Irian Jaya Highlands	Central Irian Jaya except Star Mts
5.	Cyclops Mts	Cyclops Mts and part of West Sepik
6.	Sepik	part of West Sepik and part of East Sepik
7.	Star Mts	part of Central Irian Jaya and part of West Sepik
8.	PNG Highlands	Western, Southern and Eastern Highlands, Enga, Chimbu, Western part of East Sepik and part of Madang
9.	Mid-PNG	Morobe, Gulf and part of Madang
10.	Northeast Is.	Manus, East and West New Britain, New Ireland and Bougainville
11.	Southeast Pen.	Central, Northern and part of Milne Bay
12.	Southeast Is.	part of Milne Bay



Map 72. Phytogeographical regions of New Guinea.

4. ECOLOGY

The ecology of each species of *Grammitis* in New Guinea is outlined in the preceding taxonomic account (when known), and the information is summarised and discussed below.

The genus in New Guinea occurs in the four major vegetation zones, which are lowland, montane, subalpine and alpine, but is absent from lowland swamp forest and mangrove forest and is rare in lowland forest. Most species occur as epiphytes in lower montane and midmontane forests; the rupestral habitat is important, however, in subalpine grasslands and in the alpine zone.

Various factors may affect the distribution of *Grammitis* within these vegetation zones, but the available data are extremely sparse and much work remains to be done on the habitat preferences of all species.

Topography is important in small scale distribution, especially in steeply dissected country. Three main zones are recognisable: ridge crests, ridge slopes and valleys. The first, particularly on steepsided ridges, may support a rather stunted dry open forest, while the trees of the ridge slopes are taller, forming a more dense cover, and the valleys provide a much more moist environment, with at least some very dense shade. Ridge slopes contain more species of *Grammitis* than the other two zones. Two species of *Grammitis* have only been recorded from ridge crests, four only from ridge slopes and three only from valleys.

Host preference may also be important for epiphytic species, but the available data may be misleading as the most commonly recorded host genus, *Cyathea*, is also one of the most easily recognised and it is very likely that only the most distinctive hosts are noted by collectors. Factors such as bark texture, chemical composition

and frequency of bark shedding are doubtless important in the choice of host species. Epiphytes are absent or extremely sparse on trees which regularly shed their bark. The presence of epiphytes on a given host species may vary with the host's age (i.e. diameter), topography and altitude, smaller trees and those on ridge crests or at lower altitudes being more likely to have fewer epiphytes than larger trees, those on ridge slopes and in valleys, or those at higher altitudes. Drying out of the bark may be the most critical factor in determining the presence and abundance of epiphytes, especially at lower altitudes where the forest is less heavily mossed than at higher altitudes. It would be useful to know if the prothallus of *Grammitis* establishes directly on the tree bark or whether it is epiphytic upon bryophytes, as this would be relevant in considering the effects of the host (e.g. through bark texture and chemistry) upon the epiphyte and its establishment. The effects of the host upon the prothallus may be direct, if it establishes directly on the host, or indirect if it establishes itself on bryophytes, by affecting the selection of suitable epiphytic bryophytes to act as hosts. In heavily mossed forest it is noticeable that many plants of *Grammitis* appear to have little or no contact with the host tree and seem to be rooted entirely in mosses. This may not reflect the conditions of establishment, however, but be a product of more or less balanced growth between ferns and bryophytes which had settled directly upon the host at a similar time.

Vertical position on the host is doubtless important in the small-scale distribution of *Grammitis* in New Guinea. Two species have only been recorded growing on logs or rotten wood lying on the ground; 10 species have only been noted as growing on the trunks of trees and 5 of these have only been recorded at heights of less than 2 metres above the ground, while 3 species have only been noted as growing on the branches of trees, 2 of them being restricted to high or minor branches. Position on diagonal trunks and branches, and on horizontal branches (whether on the undersurface, upper side or laterally) may be important for some species.

Distribution on a small scale may also be influenced by the availability of hosts of a certain diameter; 6 species of *Grammitis* have only been recorded on tree trunks or branches less than 5 cm diameter, 1 has only been noted on trunks and branches of between 5 and 10 cm diameter and 3 have not been recorded on trunks less than 10 cm diameter.

Many rupestral species are also epiphytic and few are restricted to rocks. In lowland rainforest and montane forest rupestral species are restricted to rocks in or by streams or in ravines. Plants on rocks in or by streams are only on rocks 1 m or more in diameter and always on their downstream side. Such large rocks would not be rolled downstream in floods and the downstream side is more protected from waterborne debris which might scrape off the plants. In the subalpine and alpine zones rupestral species are not restricted to streams or ravines.

Substrate preferences may be important for rupestral species of *Grammitis*, but very little information is available as to whether any species is restricted to only one type of rock. Five species are known to occur on both andesitic (volcanic) and granitic (metamorphic) rock types.

For the reasons discussed under host preferences of epiphytes, it would be interesting to know if the prothalli of New Guinea species of *Grammitis* establish directly on the rock substrate or whether they are epiphytic upon bryophytes (as are the prothalli of *G. congener* in Borneo).

Relative vertical position on rocks appears to be relatively constant in the few species for which it has been noted; where these are also epiphytic the same relative vertical position is seen on tree trunks and branches.

The non-endemic species of *Grammitis* in New Guinea tend to have a wider ecological distribution than the endemic species; most are found in more than one vegetation type, occupy two or more topographic types, grow in more than one habitat, occur in the greatest number of vertical positions on host trees and are found on host trees of several diameter classes. In addition, some non-endemic species appear to be tolerant of a certain amount of environmental disturbance (e.g. *G. sumatrana, G. caespitosa, G. padangensis, G. knutsfordiana, G. dolichosora*) while *G. reinwardtii* may be favoured by low-level disturbance. Two non-endemic species, *G. sumatrana* and *G. reinwardtii*, are probably the earliest members of the genus in New Guinea to recolonise regenerating forests.

In contrast, the endemic species are usually found in only one vegetation type, occupy fewer topographic types, grow in one habitat, occur in fewer different vertical positions on trees and are found on fewer different size classes of host. In general, the endemic species seem to be less tolerant of environmental disturbance than the non-endemic species, which is probably related to their narrower ecological distribution.

Many of the endemic species of *Grammitis* in New Guinea must be regarded at least as vulnerable in conservation terms because of their ability to utilise a limited number of microhabitats and because of their limited geographical distribution; some of these may be threatened, if not endangered, by large-scale habitat disturbance such as logging and a few may even be extinct. The status of endemic species known from only one or two localities which have not been seen recently certainly needs investigation.

5. RELATIONSHIPS, DISTRIBUTION AND SPECIATION IN GRAMMITIS IN NEW GUINEA

Grammitis is one of the larger fern genera in New Guinea, with a high proportion of endemic species, many of which have an extremely limited distribution and it is clear that considerable local speciation must have taken place. On the basis of our present knowledge of the taxonomy, distribution and ecology of *Grammitis* in New Guinea we can briefly assess the role that geography and ecology may have played in influencing the patterns of distribution and of speciation.

If we consider first geographical distribution and its relationship to taxonomy we can identify four basic types of relationship.

1. Wide-ranging species without close relatives which, with the exception of *G. parva*, are not endemic.

2. Wide-ranging species with close relatives of more limited distribution from which they are usually geographically or altitudinally isolated. The wide-ranging species are, with the exception of *G. ceratocarpa*, not endemic.
3. Species with a more limited distribution which are closely related to and probably derived from wide-ranging species from which they are usually geographically or altitudinally isolated. These are endemic with the exception of *G. subfasciata*.
4. Species of limited distribution which are not obviously related to wide-ranging species but which may have vicariant (as defined by Davis & Heywood, 1973) or sibling (as defined by Mayr, 1963) species. Only one of these species, *G. curtipila*, is not endemic.

Table 17 shows that the numbers 3 and 4 are the commonest type of relationship within species groups and that there are approximately equal numbers of species in each of these two types. It also indicates that 75% of the New Guinea species have close relatives within the country.

A fundamental influence on the geographical distribution of species must be the availability, extent and diversity of habitat. Of the twelve phytogeographic regions, five contain eight or more vegetation types and four of these regions contain 28 or more species, there being few collections from the Star Mountains, which only have ten species (table 18). Seven regions have three or fewer vegetation types and none has more than eleven species of *Grammitis*. This relative impoverishment of the *Grammitis* flora is probably due to the absence of the upper montane forest and the subalpine and alpine zones and, in some regions, the midmontane forest also, which provide suitable habitats for species otherwise widespread in New Guinea (e.g. *G. frigida, G. graminifolia, G. debilifolia*) or further afield (e.g. *G. scabristipes, G. clemensiae, G. locellata*).

While this may explain some of the large scale differences in distribution, to examine smaller scale differences we need to identify the mechanisms by which related species (i.e. within a species group) may be isolated from one another. If sympatric they may be segregated altitudinally or by other ecological means such as microhabitat preferences, or there may be no evidence of any isolating mechanism. This information is set out in tables 19 to 27 and summarised in table 28. Geographical separation is the most important species isolating mechanism for *Grammitis* in New Guinea in all species groups except those of *G. sumatrana, G. caespitosa, G. setosa* and *G. locellata*, where altitudinal segregation is more important. The altitudinal ranges of the species in these groups are summarised in fig. 32.

This analysis suggests that geographical isolation has been particularly important in the speciation of *Grammitis* in New Guinea. In addition to the establishment of new populations by medium or long-distance dispersal, fragmentation of existing populations may have been promoted by the lowering of the vegetation zones on mountains during the Pleistocene in connection with climatic cooling and lowering of the sea-level during glaciation and by subsequent re-elevation of the vegetation zones with warming of the climate. Other factors such as mountain uplift and asso-

ciated vulcanism in the Pleistocene were doubtless important in the evolution of the genus in New Guinea.

There are a number of clear-cut cases of altitudinal segregation and these may have arisen following contact of two closely related but hitherto geographically isolated species which had acquired reproductive isolation. If these species had very similar ecological requirements the resulting competition might have acted either to eliminate one altogether or to promote effective local allopatry, i.e. altitudinal segregation.

If, however, the species showed some differences in ecological requirements then the resulting differences in microhabitat selection might be sufficient for both species to co-exist over similar altitude ranges in broadly similar habitats (e.g. *G. reinwardtii, G. hirtiformis, G. knutsfordiana*).

For some co-occurring species the data are inadequate to determine the nature of any isolating mechanisms. In particular for the sibling species pairs *G. pleurogrammoides* and *G. interrupta*, and *G. mesocarpa* and *G. inconstans* we do not know whether they co-occur and, if so, whether they have different ecological requirements. *G. archboldii* and *G. scabristipes* seem to have more or less identical ecological requirements and occur together apparently without hybridising.

There is no evidence that hybridisation has played a major part in speciation and only *G. sumatrana* and *G. crenulata* are possibly of hybrid origin. They may have owed their development to contact between closely related species which had failed to acquire reproductive isolation and in which selection subsequently favoured the hybrid rather than the parent stock.

As no chromosome counts have been made on *Grammitis* in New Guinea the role of polyploidy in the evolution of the genus there remains unknown.

APPENDIX 1

Place names used on collectors' labels and their equivalents in current gazetteers: Gazetteer (no. 2) of New Guinea and Nearby Islands, U.S. Navy Dept., 1943; Gazetteer of Indonesia and Portuguese Timor, 2nd edition, United States Board of Place Names, 1968; Gazetteer of Papua New Guinea, the Papua New Guinea Place Names Committee, 1974.

Angi Lakes	Anggi Gita	Mt Carstensz	Punjak Sukarno
Carstensz Mts	Peg. Sukarno	Mt Doorman	Ngga Simanggela
Central Ra.	Peg. Maoke	Mt Wilhelmina	Punjak Trikora
Cyclops Mts	Peg. Cycloop	Nassau Mts	Peg. Sudirman
Doorman R.	Su. Angolah	Rook I.	Rooke Umboi I.
Idenberg R.	Su. Taritatu	Sudest I.	Tagula I.
L. Habbema	Danau Habbema	Swart Valley	Ilim Valley
Mt Buffelhoorn	G. Nok	Wissel Lakes	Danau-danau Wissel

Table 17. Types of relationship in the New Guinea species of *Grammitis*.

species group	wide-ranging species without close relatives	wide-ranging species with close relatives of more limited distribution	close relatives probably derived from wide-ranging species	species of limited distribution not obviously related to wide-ranging species
G. adspersa	G. viridula	G. adspersa	G. glossophylla	G. demissa [1]
G. sumatrana	G. sumatrana G. torricelliana			
G. caespitosa		G. caespitosa	G. frigida G. loculosa G. taeniophylla	G. dictymioides G. pleurogrammoides* G. interrupta*
G. fasciata	G. padangensis	G. fasciata	G. graminifolia G. crenulata G. subfasciata	
G. ceratocarpa		G. ceratocarpa	G. salticola	
G. setosa	G. impressa	G. scabristipes	G. archboldii* G. tuberculata*	
G. reinwardtii		G. reinwardtii G. knutsfordiana	G. hirtiformis G. hispida	G. curtipila [2]
G. mesocarpa				G. mesocarpa* G. papuensis G. inconstans*

Table 17 continued.

G. hirtella		G. oblanceolata	G. meijer-dreesii	G. imberbis }
			G. clavipila	G. tenuis }
				G. reducta }
				G. coredrosora }
				G. silvicola }
				G. ahenobarba }
G. intromissa	G. parva	G. intromissa	G. debilifolia	G. subreticulata
	G. ornatissima		G. reptans } }	G. habbemensis
	G. merrillii		G. nigropaleata } }	G. montana
			G. murrayana } }	G. excelsa
			G. tomaculosa } }	G. rupestris
			G. trogophylla } }	G. collina
			G. trichopoda } }	
G. mollipila				G. mollipila }
				G. crinifera }
G. clemensiae	G. clemensiae			
G. locellata		G. locellata	G. pseudolocellata	
G. dolichosora	G. dolichosora			

[1] vicariant is *G. pseudaustralis* of New Caledonia.

[2] vicariant is *G. brassii* of the Solomon Islands.

} indicates vicariant species; * indicates sibling species.

Table 18. Vegetation types in phytogeographic regions of New Guinea where *Grammitis* has been collected.

	Waigeo I.	Vogelkop Pen.	Japen I.	Irian Jaya Highlands	Cyclops Mts	Sepik	Star Mts	PNG Highlands	Mid-PNG	Northeast I.	Southeast Pen.	Southeast I.
Vegetation type	1	2	3	4	5	6	7	8	9	10	11	12
lowland rainforest	?	×	?	×	–	?	–	–	?	–	×	–
lower montane forest	?	×	?	×	?	×	×	×	×	×	×	×
midmontane forest	–	–	–	×	?	?	×	×	×	×	×	–
upper montane forest	–	–	–	×	–	–	×	×	×	–	×	–
montane grassland	–	–	–	–	–	–	–	×	–	–	×	–
subalpine forest	–	–	–	×	–	–	×	×	×	–	×	–
subalpine shrubland	–	–	–	×	–	–	×	×	×	–	×	–
subalpine grassland	–	–	–	×	–	–	×	×	×	–	×	–
alpine shrubland	–	–	–	×	–	–	×	×	×	–	×	–
alpine grassland	–	–	–	×	–	–	×	×	×	–	×	–
total of vegetation types	2?	2	2?	9	2	3	8	9	9	2	10	1
number of species	2	8	4	29	6	11	10	29	31	8	28	8

Key to Tables 19 to 28:

A	indicates altitudinal segregation.
?A	indicates that the limits of altitude given in the taxonomic treatment are suspect and the species are probably altitudinally segregated.
±A	indicates little overlap (less than 100 m) between the species.
G	indicates geographical segregation.
?G	indicates possible geographical segregation between a widely distributed species and one known from a single locality.
?	indicates that the manner of species segregation is not known, but that it is apparently neither altitudinal nor geographical.
*-****	indicates ecological segregation.
†	indicates possible reproductive isolation.

Table 19. Species segregation in the *G. sumatrana, G. ceratocarpa, G. mollipila* and *G. locellata* species groups in New Guinea.

G. sumatrana and G. torricelliana:	±A
G. ceratocarpa and G. salticola:	?G
G. mollipila and G. crinifera:	G
G. locellata and G. pseudolocellata:	A

Table 20. Species segregation in the *G. adspersa* species group in New Guinea.

		1			
1.	G. demissa				
2.	G. adspersa	?G	2		
3.	G. viridula	G	?A	3	
4.	G. glossophylla	G	?G	G	

Table 21. Species segregation in the *G. caespitosa* species group in New Guinea.

		1					
1.	G. frigida						
2.	G. caespitosa	A	2				
3.	G. loculosa	A	±A	3			
4.	G. taeniophylla	A	A	G	4		
5.	G. dictymioides	?G	A	A	G	5	
6.	G. pleurogrammoides	A	?	?	?	A	6
7.	G. interrupta	A	?	A	A	A	?

Table 22. Species segregation in the *G. fasciata* species group in New Guinea.

		1			
1.	G. fasciata				
2.	G. graminifolia	?	2		
3.	G. crenulata	G	G	3	
4.	G. subfasciata	A	?	G	4
5.	G. padangensis	?	?	G	?

Table 23. Species segregation in the *G. setosa* species group in New Guinea.

		1		
1.	G. archboldii			
2.	G. impressa	A	2	
3.	G. tuberculata	?	A	3
4.	G. scabristipes	†	A	?

†: *G. archboldii* and *G. scabristipes* sometimes grow together but apparently do not hybridise.

Table 24. Species segregation in the *G. reinwardtii* species group in New Guinea.

		1			
1.	G. reinwardtii				
2.	G. hirtiformis	*	2		
3.	G. curtipila	?	G	3	
4.	G. knutsfordiana	**	***	?	4
5.	G. hispida	?G	G	?G	G

* Where both species have been recorded in the same locality *G. hirtiformis* was growing on the trunk of the tree-fern *Dicksonia sciurus* in valleys in deep shade and *G. reinwardtii* was growing on slender saplings and small trees on ridge crests and ridge slopes.

(Table 24 continued)

** When these species occur in the same localities *G. reinwardtii* grows higher above the ground and on more slender host trunks than *G. knutsfordiana*; in steep terrain *G. reinwardtii* occurs on ridge slopes and *G. knutsfordiana* on ridge crests.

*** In localities where both species occur, *G. hirtiformis* grows in valleys and *G. knutsfordiana* on ridge crests and ridge slopes.

Table 25. Species segregation in the *G. mesocarpa* species group in New Guinea.

		1	
1.	G. mesocarpa		
2.	G. papuensis	G	2
3.	G. inconstans	?	G

Table 26. Species segregation in the *G. hirtella* species group in New Guinea.

		1							
1.	G. imberbis								
2.	G. tenuis	G	2						
3.	G. reducta	G	G	3					
4.	G. oblanceolata	A	A	?G	4				
5.	G. meijer-dreesii	G	G	G	A	5			
6.	G. clavipila	G	G	G	A	G	6		
7.	G. coredrosora	G	G	?	?	G	G	7	
8.	G. silvicola	G	G	G	A	G	A	G	8
9.	G. ahenobarba	G	G	G	?G	G	G	G	G

Table 27. Species segregation in the *G. intromissa* species group in New Guinea.

1.	G. debilifolia	1														
2.	G. nigropaleata	?A	2													
3.	G. tomaculosa	?	G	3												
4.	G. intromissa	?	?	*	4											
5.	G. reptans	?	G	**	?G	5										
6.	G. trogophylla	?	?A	G	?	G	6									
7.	G. murrayana	A	G	G	?	G	G	7								
8.	G. trichopoda	?	G	G	?	G	G	A	8							
9.	G. subreticulata	G	G	G	A	G	G	G	A	9						
10.	G. merrillii	G	G	G	A	G	G	G	G	G	10					
11.	G. parva	A	A	A	A	G	A	A	A	G	G	11				
12.	G. habbemensis	G	G	G	?G	G	G	G	G	G	G	G	12			
13.	G. montana	?	A	G	?	G	±A	G	G	G	G	A	G	13		
14.	G. excelsa	G	G	G	?G	G	G	G	G	G	G	G	G	G	14	
15.	G. rupestris	G	G	G	A	G	G	G	G	G	G	G	G	G	G	15
16.	G. collina	A	G	A	***	G	G	G	G	G	G	G	G	G	G	G
17.	G. ornatissima	A	?	A	****	A	A	A	A	A	A	?	A	A	A	A

* *G. intromissa & G. tomaculosa* are found in different vegetation types and may be altitudinally segregated where both occur.

** *G. reptans & G. tomaculosa* are found in different vegetation types when they occur in the same locality.

*** *G. collina & G. intromissa* are topographically separated, the former occurring on ridge crests and the latter on ridge slopes and in valleys.

**** When *G. intromissa & G. ornatissima* occur in the same locality *G. intromissa* occurs at a higher altitude.

Table 28. Summary of the nature of isolation between pairs of species in species groups of *Grammitis* in New Guinea.

species group	A	?A	±A	G	?G	?	*-****	†
G. adspersa	–	1	–	3	2	–	–	–
G. sumatrana	–	–	1	–	–	–	–	–
G. caespitosa	12	–	1	2	1	5	–	–
G. fasciata	1	–	–	4	–	5	–	–
G. ceratocarpa	–	–	–	–	1	–	–	–
G. setosa	3	–	–	–	–	2	–	1
G. reinwardtii	–	–	–	3	2	2	3	–
G. mesocarpa	–	–	–	2	–	1	–	–
G. hirtella	6	–	–	26	2	2	–	–
G. intromissa	29	2	1	83	3	14	4	–
G. mollipila	–	–	–	1	–	–	–	–
G. locellata	1	–	–	–	–	–	–	–

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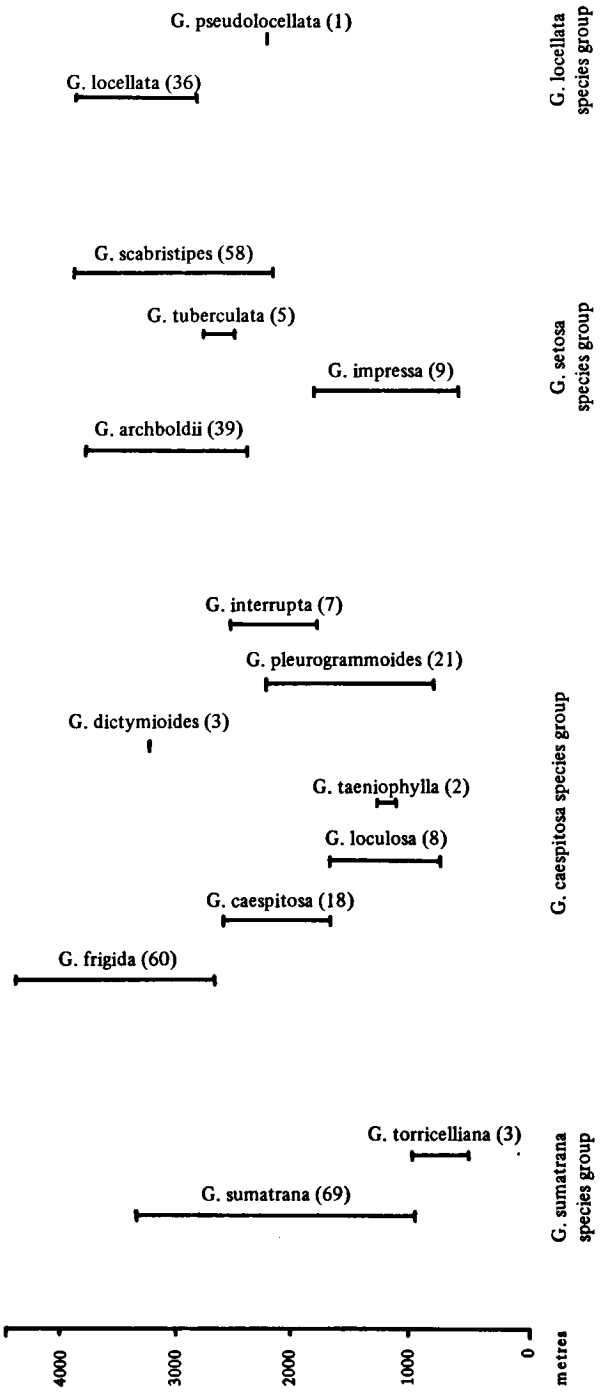

Fig. 32. Altitudinal separation in four species groups of *Grammitis* in New Guinea. (Sample size in parenthesis).

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