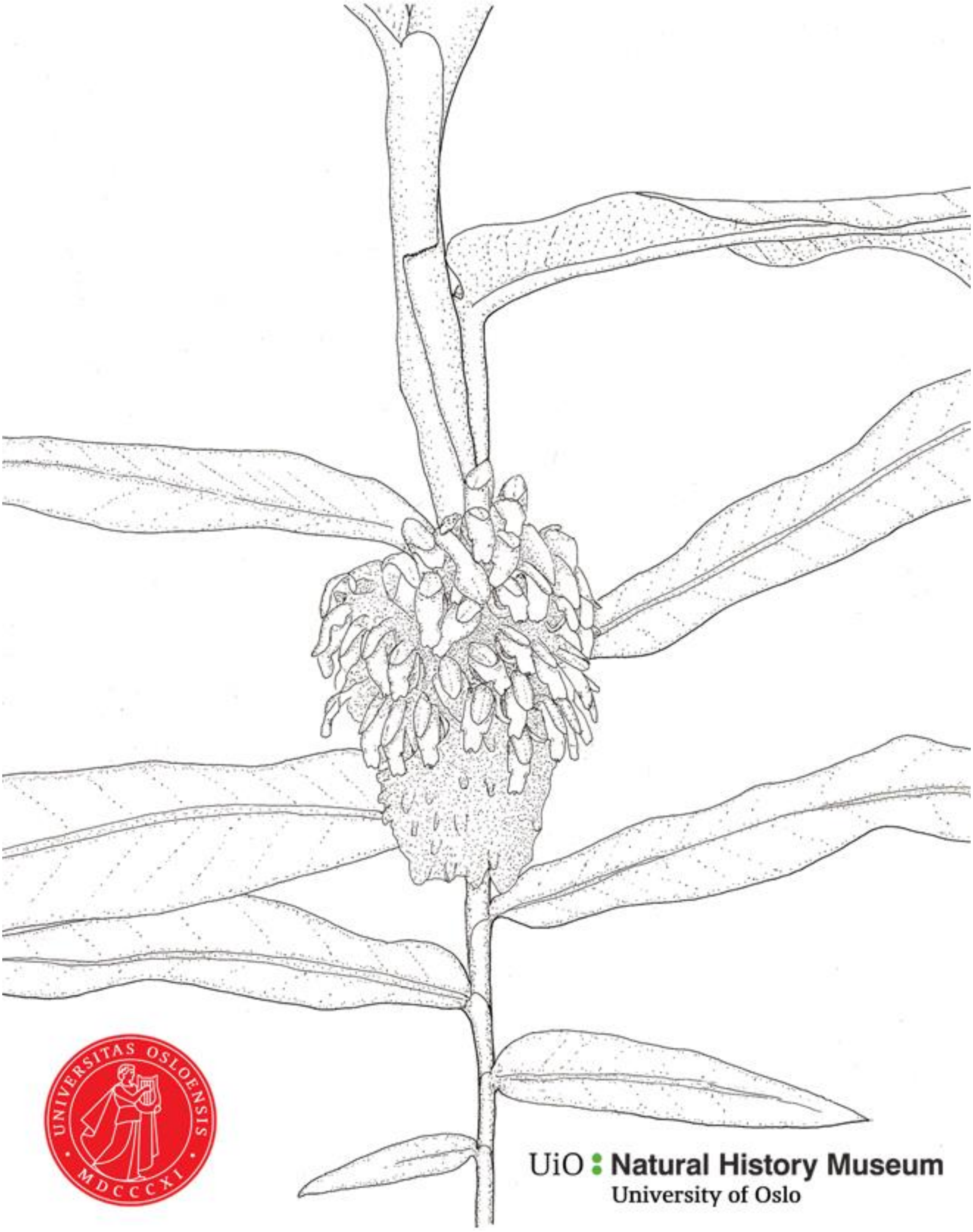
The genus *Pleuranthodium* (K.Schum.) R.M.Sm. (Zingiberaceae): taxonomy and phylogeny

Master of Science Thesis, Øystein Lofthus 2014



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Øystein Lofthus

The ginger genus *Pleuranthodium* (Zingiberaceae), taxonomy and phylogeny

Cover and all other ink drawings: Øystein Lofthus

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Abstract

The present study elucidates the phylogenetic relationship within the tribe Riedelieae in family Zingiberaceae, with a main focus on the genus *Pleuranthodium* and its intrageneric relationship. Previous phylogenetic studies have only included up to five species of *Pleuranthodium* and its neighbouring genus *Riedelia*. The present study utilises more regions of DNA than previously used, and a total of 73 collections from the tribe, including 53 samples of *Pleuranthodium* and 14 *Riedelia*. The morphological division of the genus *Pleuranthodium* by Schumann (1904) and Smith (1991) is tested with phylogenetic methods. The phylogenies were constructed using separate chloroplast and nuclear dataset and finally a combined dataset, all analysed with Bayesian Inference and maximum likelihood. Dating phylogenies were performed using the nuclear internal transcribed spacer (ITS) and calibration with fossil data and *Siphonochilus* as outgroup. The biogeographical distribution was explored using herbarium metadata from GBIF. The monophyly of *Pleuranthodium* is well supported, and the *Riedelia* grade is the sister group. The two sections within the genus, *Pleuranthodium* and *Psychanthus*, are also monophyletic with lower support. Morphologically, the two sections are easily distinguished, and good diagnostic characters are found for both. The genus separated from its Bornean origin approximately 13 Ma, with subsequent radiation, mainly in New Guinea. Species on smaller islands to the east of New Guinea are younger.

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1. Introduction

1.1 What is Zingiberaceae

1.1.1 Distribution

The ginger family (Zingiberaceae) in the order Zingiberales is one of the largest monocot families, with close to 1600 currently accepted species (The Plant List 2013). The family is widespread, across five continents (Figure 1), but most species are found in to the tropics and subtropics. The main centre of diversity is tropical South East Asia.

Figure 1. Distribution of Zingiberaceae (red), and the genus Pleuranthodium (blue).
Map modified after Stevens 2012.

1.1.2 Zingiberaceae morphology

Zingiberaceae displays high variation in morphological diversity in the inflorescence, infructescence and vegetative parts.

The gingers have rhizomes which can be short-creeping and forming a clump like the common gingerroot *Zingiber officinale* Roscoe, or long-creeping with more separate leaf bases. As a rhizome is in fact a stem, scale-like leaves or remains of them are always present on the rhizome. The sheaths of the leaves form a pseudostem, ending in a ligule which is only found elsewhere in the sister family Costaceae. The families, however, are otherwise easy to delimit, as Zingiberaceae has a distichous leaf arrangement, while Costaceae has monostichous arrangement and spiralling leaves.

The flower is usually showy, and like most monocots trimerous, but with some modifications. The inflorescence can be radical, sub terminal or terminal. The flowers are epigynous, with calyx and corolla usually forming tubes near the base. The calyx and corolla can also have variously shaped lobes. The most striking feature of the ginger flower is the petaloid lip formed by two fused staminodes, which is the prominent part of the flower. In addition, some genera have two lateral staminodes present. One stamen has been lost, which leaves only one functional stamen. The stamen has two thecae, which separates the group of Zingiberaceae and Costaceae from the related Cannaceae and Marantaceae which only have one theca. There is only one style which sometimes is adnate to the stamen, and emerging through the gap between the thecae. Another special feature of the flower is the nectar producing epigynous glands for which the morphological origin is still debated (Sharawy 2013).

1.1.3 Molecular phylogeny

The major phylogenetic patterns of Zingiberaceae were uncovered with the ITS, MatK, trnL-F and rps16 regions (Rangisiruji A. 2000, Kress et al. 2002, Ngamriabsakul C. 2004, Pedersen 2004, Kress et al. 2005, Kress et al. 2007). This showed the relations within the tribe Riedelieae consisting of *Siliquamomum* Baill., *Siamanthus* K.Larsen & Mood, *Burbidgea* Hook.f., *Riedelia* Oliv. and *Pleuranthodium* (K.Schum) R.M.Sm is. *Riedelia* was (with one sample) identified as the sister genus to *Pleuranthodium* (two samples), and *Siamanthus* and *Siliquamomum* are the basal in the tribe. However, in one of the trees, *Pleuranthodium* turned out to be polyphyletic with respect to *Riedelia*. The selection of genera to form an outgroup in the phylogenetic analysis was based on known relations within the tribe, as *Siliquamomum* was problematic to place in the phylogeny (Kress et al. 2002), therefore *Siamanthus*, *Siliquamomum* and an *Alpinia* Roxb. were selected as outgroup in this study.

1.2 The genus *Pleuranthodium*

The genus *Pleuranthodium*, has currently 23 accepted species, mainly from New Guinea and the Bismarck Archipelago (Appendix 1). It is separated into the two sections *Pleuranthodium* sect *Pleuranthodium* (K.Schum.) R.M.Sm and *Pleuranthodium* sect *Psychanthus* (K.Schum.) R.M.Sm based on morphological characters (Schumann 1904, Smith 1991).

Character/Section	sect. *Pleuranthodium*	sect. *Psychanthus*
Calyx shape	Sheath-like	Bell-shaped
Filament	Narrow/linear	Cymbiform
Subapically toothed	No	Yes
Labellum & filament	Labellum connate to filament	Labellum curving behind filament
Anther apex	Often rounded	Often pointy

Table 1. Morphological differences of the two sections of Pleuranthodium *after Smith 1991.*

1.2.1 The vegetative part

The rhizome is creeping with a distance of 2 to 20 cm between the leafbases. The surface is smooth and with short lived scales.

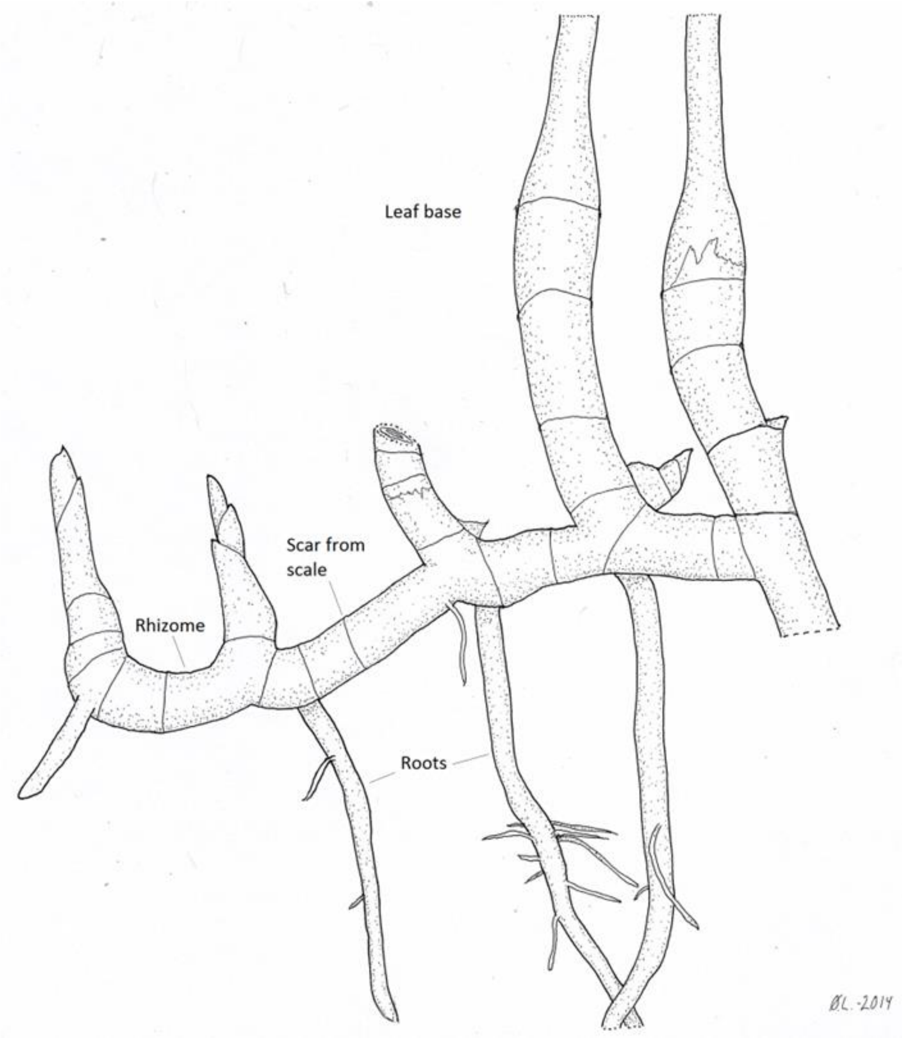

Figure 2. The rhizome of Pleuranthodium *is creeping, and not all species have distinct swollen leaf bases either.*

The base is bulbose or cylindrical as shown in Figure 2, and its size is dependent on the general size of the plant, and can reach a diameter of about 12 cm, but is usually around 2–5 cm. Most of the species are 1,5–3 m long, but more extreme species can reach 5–6 metres. The sheath and ligule are glabrous or reticulate, with floccose to scabrid indumentum (Figure 3). The ligule may be truncate, emarginate or bilobed, and 2–30 mm long. The lamina is often plicate, and usually mid-green, with a pale green underside, and an even paler midrib.

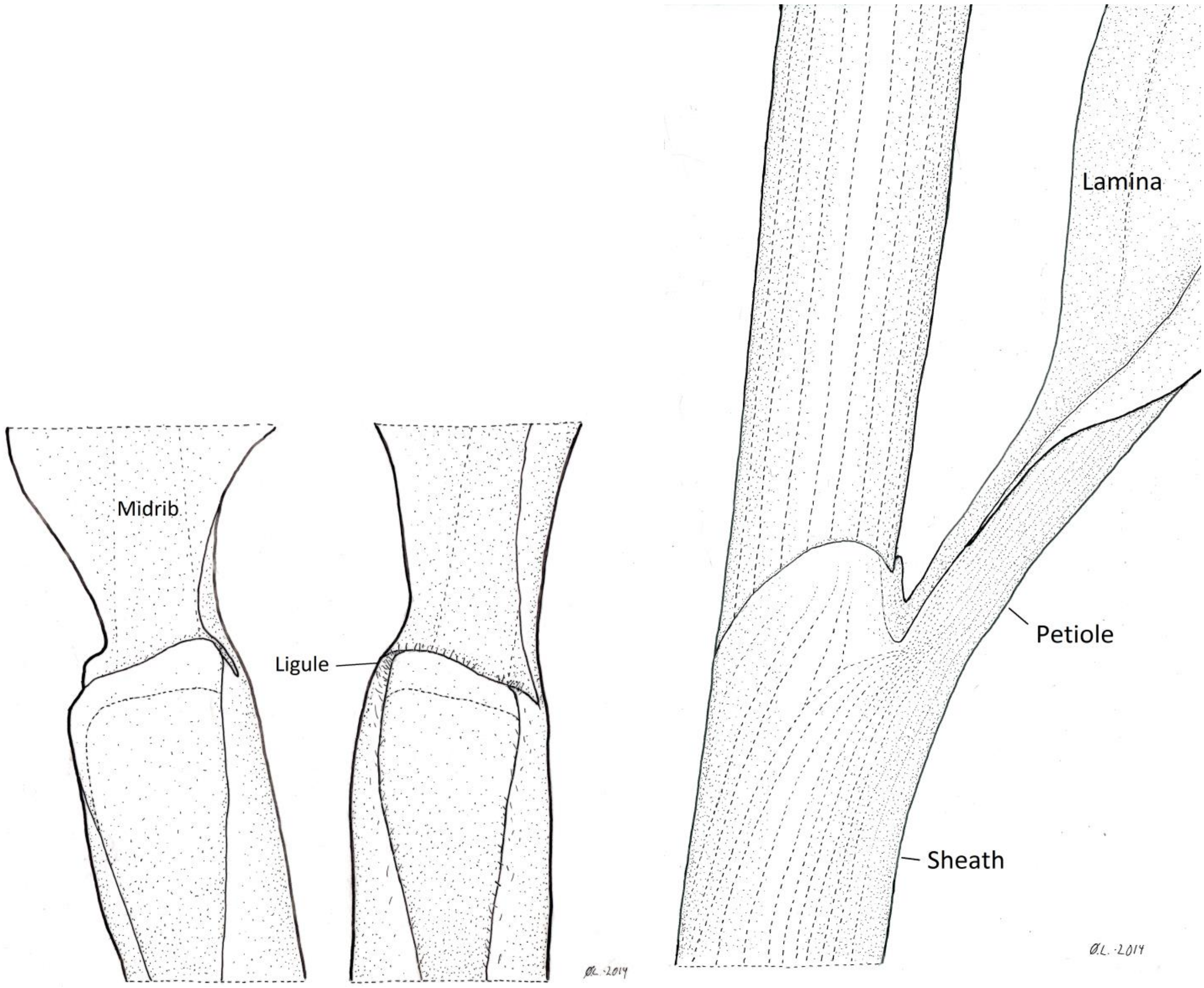

Figure 3. The sheath and ligule among species: oblique ligule and pubescent sheath (left), and emarginate ligule with striate sheath (right).

1.2.2 The inflorescence

The inflorescence of *Pleuranthodium* is a raceme with the exception of *P. pelecystylum* (K.Schum.) R.M.Sm which has a panicle (Schumann 1899, Valeton 1915). It is and terminal or subterminal, emerging from the leaf sheaths of the upper leaves, the peduncle is sometimes exserted from the sheaths as well. Except for *P. comptum* (K. Schum.) R.M.Sm.), the inflorescence is pendant resulting in flowers hanging up-side down. The size and shape varies from five cm and capitate, to 50 cm and cylindrical. The inflorescence sometimes have one or more sheath-like bracts when young, which are lost before flowering, leaving linear scars on the peduncle. The calyx is either bell-shaped or sheath-like, and can sometimes be circumscissile (Smith 1990). The labellum is cup-shaped and adnate to the stamen, or a tube overlapping around the filament. The filament is often involute and is either subapically toothed or narrow and lacking teeth. The anther is basifixed adnate to the filament and is either rounded or pointed in both ends. The style is narrow with a small tip which is bent outwards at the end, sometimes locked in place behind the brim of the two thecae. The epigynous glands are horseshoe-shaped and have an irregular surface pattern.

The flower parts are in the white-cream-yellow-red colour range, however the colours are rarely mentioned in the original descriptions, and usually lost in dried specimen.

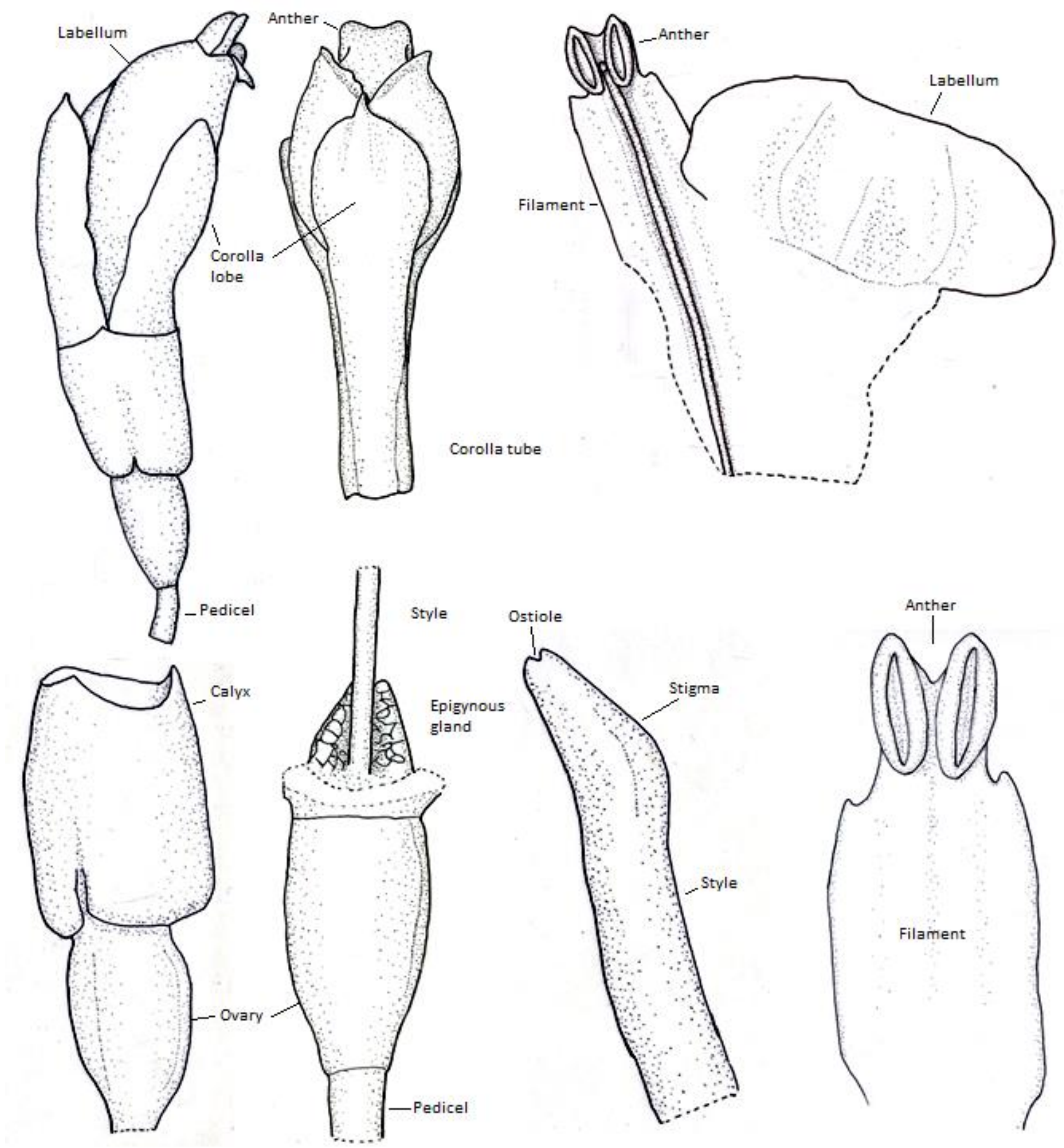

Figure 4. Flower parts of Pleuranthodium peekelii. *The labellum has been flattened to show the shape of its margin.*

1.2.3 The Infructescence

The ovary is green when flowering and shift to orange or red when mature. The fruit is an ellipsoid trilocular capsule that dehisces into three parts. It contains many greenish-black seeds with a red or orange aril that does not completely cover the seeds. The fruit is up to 15 x 30 mm and the seeds are 2–3 mm in diameter. The remains of the calyx are present on the ovary even after the flowering is over (Figure 5).

Figure 5. Ripe capsules of Pleuranthodium *(left), and* Riedelia *(right). Showing the swollen aril covering the seeds and the typical dehiscence into two parts in* Riedelia. Photographs: Lofthus.

1.3 Taxonomic history of *Pleuranthodium*

Most of the species in the genus were described by Theodor Valeton and Karl Moritz Schumann around year 1900 (Schumann and Hollrung 1889, Schumann 1899, Schumann 1904, Valeton 1909, Valeton 1915). *Pleuranthodium* was at the time included in the genus *Alpinia*, which consisted of several sections, in which they were divided between two of the sections, *Alpinia* sect. *Pleuranthodium* K.Schum. and *Alpinia* sect. *Psychanthus* K.Schum., based on morphological characters. In 1916 Ridley proposed generic status for *Psychanthus*, but his circumscription of the genus was only based on the presence of subapical teeth on the filament, and the species he himself placed in the genus was incorrect. Two species were added in more recent times (Royen 1979, Gilli 1980) no taxonomic revisions were made until 1990 when the two sections of *Alpinia* combined into the genus *Psychanthus* with section *Pleuranthodium* and section *Psychanthus* by Rosemary M. Smith. This turned out to be an illigitimate name as *Psychanthus* is an older synonym to *Polygala*, and the genus was then renamed *Pleuranthodium* (Smith 1991).

1.4 Aims of this study

The objectives of this study are to:

- Test the monophyly of the genus *Pleuranthodium* and elucidate sister relationships.
- Test whether the two sections of *Pleuranthodium, P.* sect *Pleuranthodium* (K.Schum.) RM.Sm and *P.* sect. *Psychanthus* (K.Schum.) R.M.Sm., are monophyletic. Simultaneously, the diagnostic value of morphological characters will be assessed.
- To elucidate the biogeography of the genus, and its neighbouring genera.

1.5 Background

1.5.1 Geological history

The plate tectonics of the archipelago north of Australia is very complex, and could harbour some interesting biogeographical patterns (Figure 6.). Especially noteworthy is how the islands of the Bismarck Archipelago has a roundtrip starting and ending close to mainland New Guinea. New Guinea and Australia are located on the Sahul shelf, which has had a shift towards north for the past 40 million years, pushing New Guinea close to the equator. The plate tectonics is also forming the mountains of New Guinea with the collision of the Australian plate and several smaller plates.

1.5.2 Biogeographical lines

There are several biogeographical lines to the west of New Guinea (Figure 7), the closest one, Lydekker's line goes along the Sahul shelf. The line passing through the Makassar strait between Sulawesi and Borneo is Wallace's line, and the area between Lydekker's line and Wallace's line is Wallacea (van Welzen 2005). To the west of the Wallace's line is the Sunda shelf, which is a part of continental Asia. There is a strong biogeographical pattern that few genera of Zingiberaceae are distributed on both sides of the lines, which results in a high level of endemism in New Guinea and Australia.

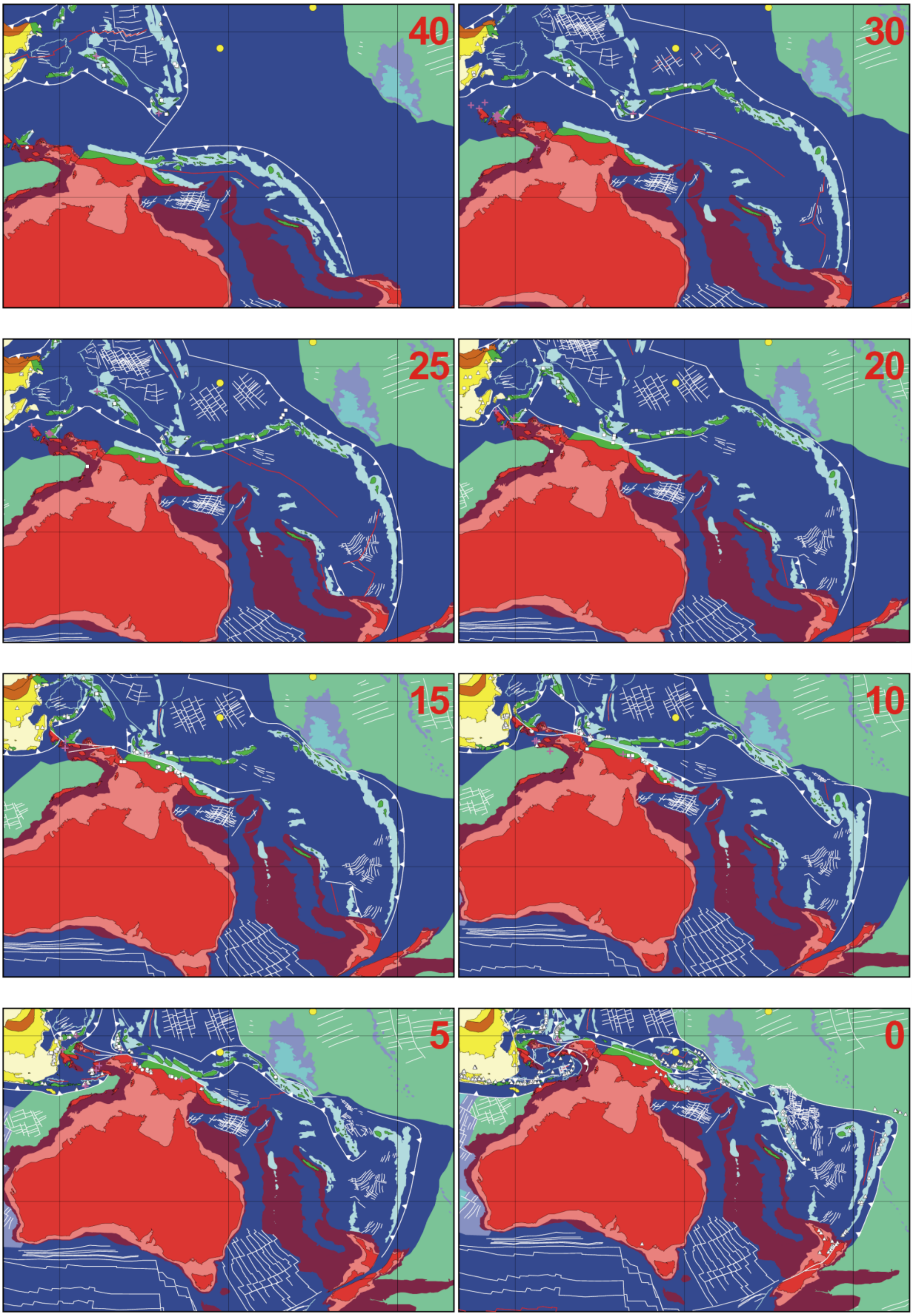

Figure 6. The plate tectonics of the South West Pacific, Australia and parts of Melanesia. From Hall (2002)

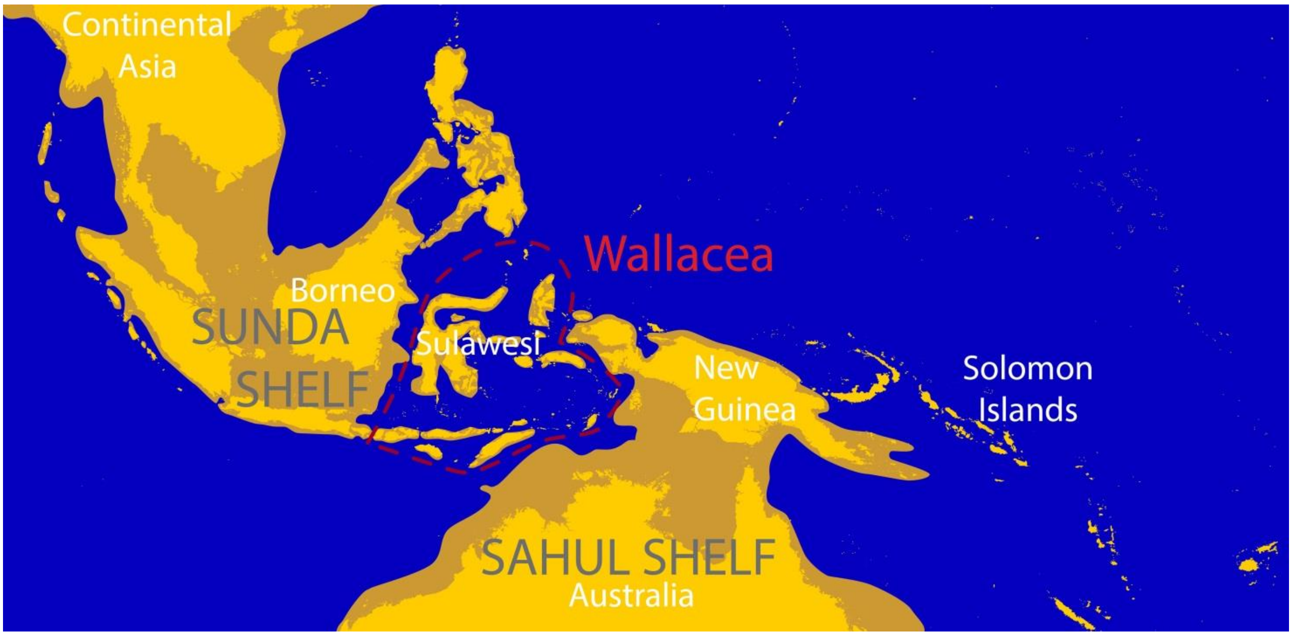

Figure 7. Map of South East Asia and Western Pacific showing the two tectonic plates (Sahul and Sunda) and the intermediate archipelago (Wallacea). After Poulsen (2007).

1.5.3 Rainfall pattern and distribution

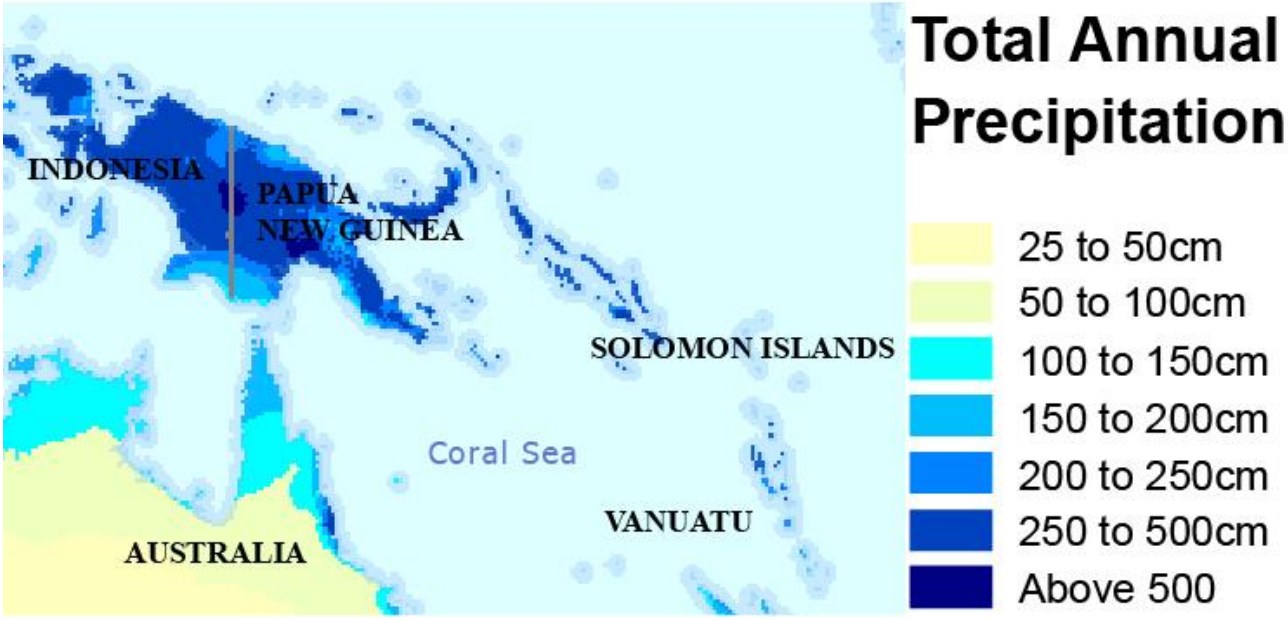

Figure 8. Weather data showing annual precipitation in the distribution area. Map from United Nations OCHA.

As the genus is distributed within New Guinea, an area known for having pristine rainforests, it is reasonable to suggest that water is one of the limiting factors in the niche.

The trade winds are coming in from the west, and the rain pattern forming is a result of the orographic lift, forming precipitation. The southern part of Papua New Guinea is also shown to by drier as it is in the rain shadow of the mountains to the east (Figure 8.). This is known as the Trans-Fly savannah and grasslands, and is certainly not a likely place to find gingers (Bowe et al. 2007).

The Torres Strait, between New Guinea and Australia, has been above the sea in about every ice age, and therefore could be a route of dispersal. However, there is a large gap between the northern tip of Australia and the distribution of *Pleuranthodium* (Figure 9.) in Australia. This could probably be explained by the need of an actual rainforest for the species to thrive, and the northernmost part of Queensland does not have proper rainforests.

Pleuranthodium racemigerum (F.Muell.) R.M.Sm has a limited distribution correlated to a zone in Australia, with an average annual rainfall of more than 2000 mm. This pattern is like in New Guinea a result of the trade winds coming from the east. Moist air meets the Great Diving Range at the east coast resulting in orographic precipitation in an area around Cairns (Bonell and Gilrnour 1980).

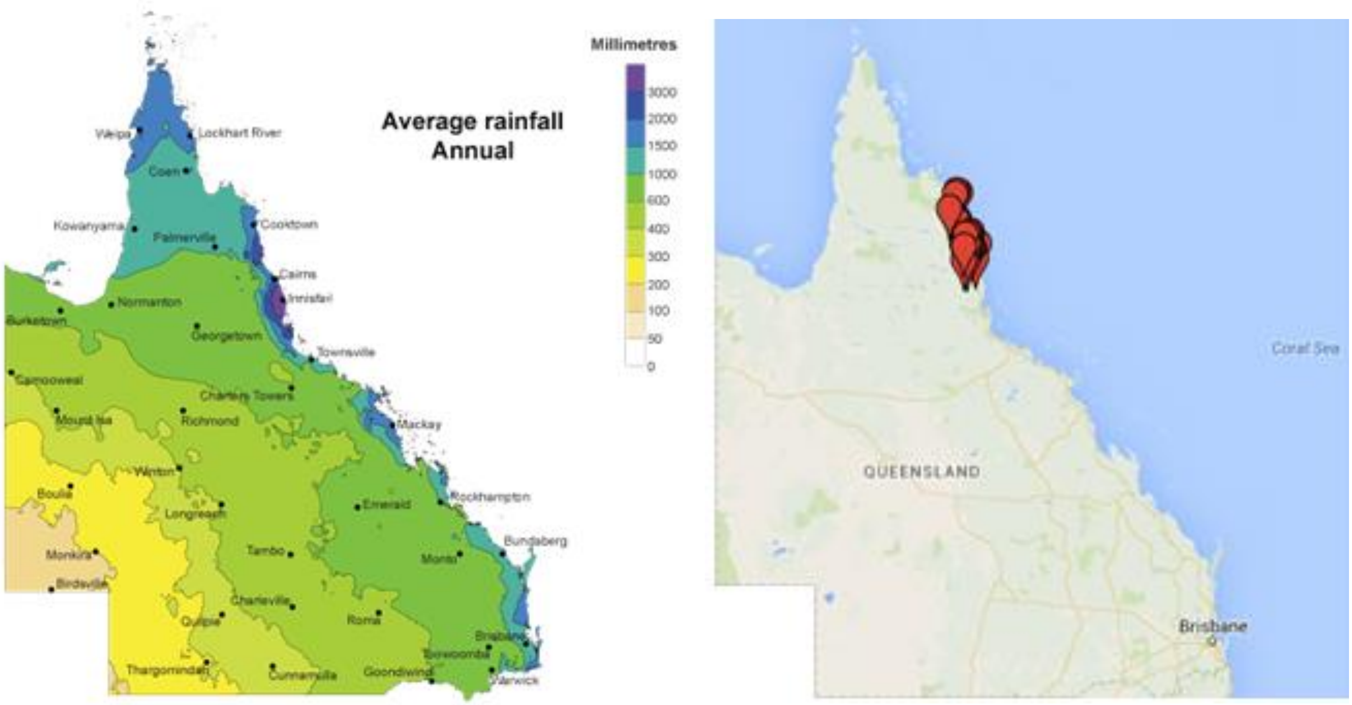

Figure 9. Average annual rainfall (left), distribution of Pleuranthodium racemigerum (right). Map from the Australian Bureau of Meterology and Google Maps.

2. Materials and Methods

2.1 Sampling

I sampled and studied the living collections in Waimea Arboretum and Botanical Garden and the Harold L. Lyon Arboretum, located in Hawaii U.S.A in February 2013.

I further conducted field work in Papua New Guinea in April and May 2013 accompanied by my supervisor Axel Dalberg Poulsen (Figure 10). Research permits were granted by the National Research Insitute of Papua New Guinea and was issued by the Papua New Guinea High Commission, London U.K.

Leaf material that had been sampled during previous expiditions, for the purpose of DNA extraction, was received from Axel Dalberg Poulsen, John Mood and Yessi Santika. In April 2014, I sampled additional living accessions in The Royal Botanic Garden Edinburgh. Two species were only found as herbarium accessions, from which a small leaf sample was removed with permission from the curator of the herbarium.

Herbarium material was studied at the Australian Tropical Herbarium (CNS), The Royal Botanic Garden Edinburgh (E), Papua New Guinea National Herbarium (LAE), Singapore Botanic Gardens (SING) and the Waimea Valley Herbarium (WAI). Digitized type material at Harvard University (A), Nationaal Herbarium Nederland, Leiden University branch (L), Muséum National d'Histoire Naturelle (P) and Naturhistorisches Museum Wien (W) was studied as picture files.

I was unable to obtain samples of *Pleuranthodium* from the Indonesian region of Papua (Figure 16). Although a few herbarium accessions exist, among them some type specimens, the locality of which is difficult to place. This is partly because it is easier to obtain permission to collect in Papua New Guinea, but as also seen on the map, the number of samples decrease before the border between the two countries. Which is probably due to both the general accessibility when reaching further inland due to the logistics and that it is more expensive.

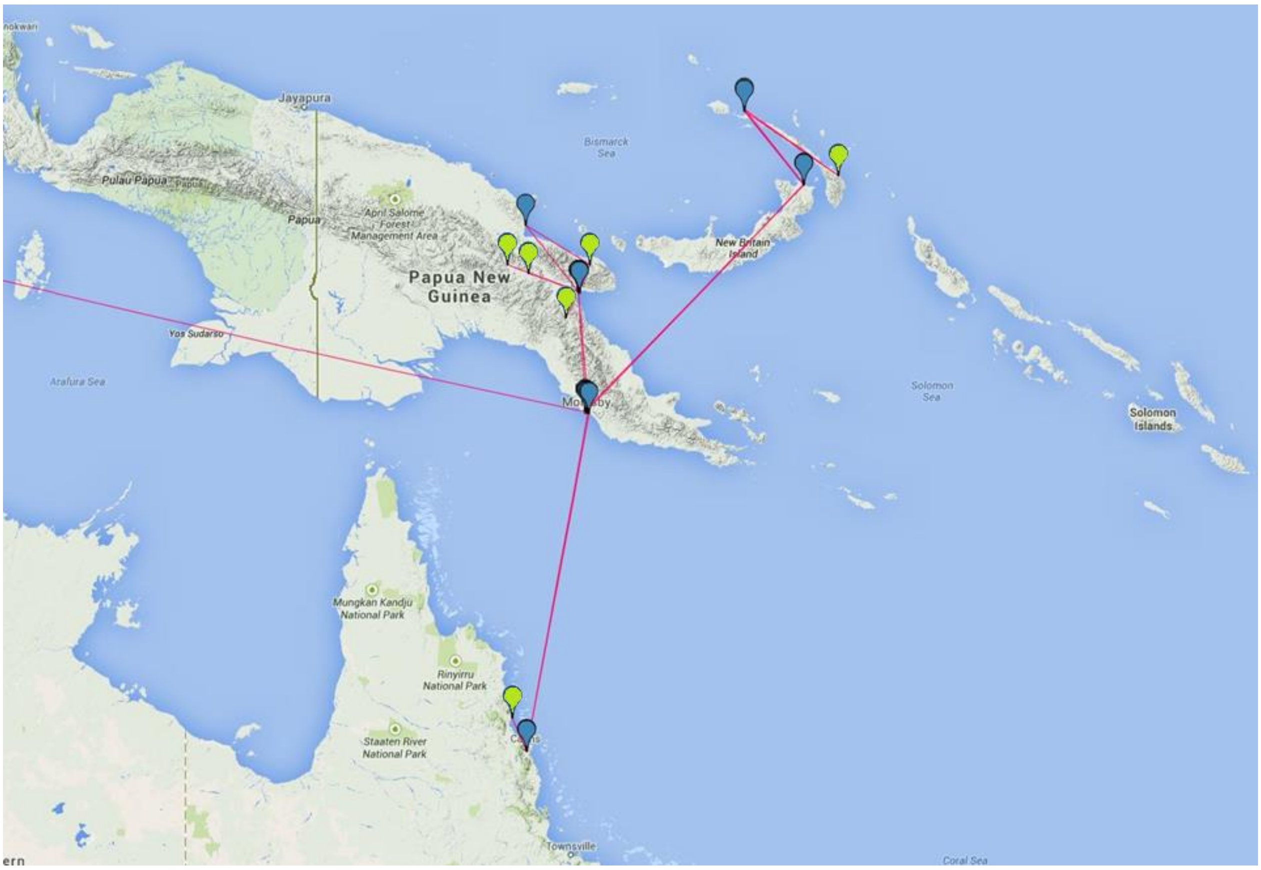

Figure 10. Map of sampling sites (green) and travelling route (blue) during fieldwork in April-May 2013.

2.2 Field methods

2.2.1 Description and measurements

The species of *Pleuranthodium* are difficult to determine in the vegetative state, and having flowers or fruits is therefore an essetial criteria when deciding whether to collect the plant or not.

To conserve as much information as possible about the plant, notes were taken on characters like- colours, shapes and habits that are often not visible when it is dried and fixed on a herbarium sheet. The life form was always described, along with the height of the plant and shoot length of the rhizome. For the leafy shoot, the number of leaves and diameter of base was measured, for sheath, ligule and lamina, the size, shape and structure were described.

The total length of the inflorescence, peduncle and spike were measured, and the orientation noted. The number of flowers and open flowers at a time of collection were counted. The number and shape of both sterile and fertile bracts was counted, and the presence or absence of bracteoles was noted. Basic measurements like length, width and shape of the infructescence and individual fruits were noted in the field. The number of parts in dehiscing fruits was counted. Seed colour and surface structure, and the colour of the aril were noted.

Coordinates and altitude measurements was registered using a Garmin eTrex 10 GPS unit (Garmin).

2.2.2 Preserving the specimen

To prevent deterioration due to slow drying in humid conditions, specimens have to be preserved in the field. The specimens were packed in layers of newspaper, preserved using 70 % ethanol, and sealed in a sturdy plastic bag. The material was later pressed and dried using a heated device back at the herbarium. The plants were always collected with two bases connected with a rhizome. The collection included at least one typical leaf from the middle of the shoot, including the sheath, and an intact ligule as these are important morphological characters. As the inflorescence is terminal or subterminal, the peduncle is collected along with the top of the leafy shoot to display the point where the inflorescence emerges.

A few individual flowers and fruits were stored separately in 70 % ethanol in old 35 mm film canisters or 50 mL centrifuge tubes according to size. Even if whole inflorescence are pickled, separate flowers were collected in this way as they might be damaged in a large container. Whole inflorescences and infructescences, which are more bulky, was conserved in zip lock bags with ethanol when preserving the samples at the end of the day, and later transferred to suitable plastic containers. As infructescences are fleshy and hold quite an amount of water, it is important to change the ethanol when transferring to new containers, as it might have been diluted by the fruit. The tubes, canisters and containers was then stored and transported in wide-neck plastic kegs with rubber sealed lids as these are more suitable to withstand the journey.

Leaf samples were collected from the living plants, and dried on silica using the Tea Bag method (Wilkie et al. 2013). In this way, all the DNA samples collected from a six week field trip could be stored in a small container.

2.3 Laboratory methods

All lab work was done at the DNA-lab at NHM by the author.

2.3.1 Extraction

Total genomic DNA was extracted from herbarium specimens or silica dried leaf tissue samples using the DNeasy Plant Mini Kit (Qiagen, Hilden, Germany) following the manufacturer's instructions, except that 50 µL was eluted twice instead of the recommended 100 µL twice. This was done to get higher concentrations of DNA in the extract. For the more deteriorated samples like the herbarium specimens, the incubation times was increased from 5 to 10 minutes and the elution was done in two separate Safe-Lock Tubes™ (Eppendorf) instead of into the same tube, as the first elution of 30 µL would get higher concentration of DNA, and the second elution of 50 µL serving as a backup to ensure the same yield of DNA.

The leaf material (¼ cm^2) was added to a 2 mL collection tube with 2 Tungsten Carbide Beads 3 mm (Applied Biosystems®), and crushed to a powder at 25-30 Hz for 1-10 minutes in a mixer mill (Retsch MM301).

2.3.2 Amplification using Polymerase Chain Reaction (PCR)

The selection of regions to amplify was chosen based on what had been successful earlier, and therefor present on Genbank. I also tested regions not amplified in Zingiberaceae earlier like At103, Agt1, AroB and Eif3E (Li et al. 2008). To optimize the amplification conditions I ran a primer test using a gradient of temperatures, and also tried different concentrations of $MgCl_2$. The chemicals used were GeneAmp® dNTP Blend, 10 mM (Applied Biosystems®), Bovine Serum Albumine (Invitrogen) and AmpliTaq® DNA Polymerase with Buffer II (Life Technologies®), including $MgCl_2$. Primers were syntesized by Eurofins MWG Operon, and were purified to be salt free and then lyophilized. PCR programs are found in Appendix 2.

The thermocyclers used were GeneAmp® PCR System 9700 (Applied Biosystems®) and T100™ Thermal Cycler (Bio-Rad Laboratories, Inc.). All amplification was done as 12,5 µL reactions according to (Appendix X).

2.3.3 Gel imaging

Gels were cast from 1,5 % LE agarose, SeaKem® (Lonza) mixed with 0.5X Tris-borate-EDTA-buffer and stained with 40 µL/L GelRed™ (Biotium, Hayward, CA, USA) nucleic acid dye. 4 µL of each PCR-product were mixed with 2µL of loading dye (50 mM EDTA, 30 % glycerol, 0,25 % bromphenol blue and 0,25 % xylene cyanol), and loaded onto the gel. One gel well per row was loaded with 1,5 µL FastRuler™ Low Range DNA Ladder (Fermentas®) for sequence length reference. Images was taken with Gel Logic 200 Imaging System (Kodak) using Kodak MI Application (Molecular Imaging Systems Eastman Kodak)

2.3.4 PCR-product cleaning

For PCR product cleanup the ExoSAP-IT® (Affymetrix®), (USB Products®) was diluted 10 times with deionized water, and 3 µL of diluted ExoSAP was added to each PCR tube. The PCR-strips was then incubated for 15 minutes at 37 °C followed by 45 minutes denaturation at 80 °C. This breaks down residual primer sequences and nucleotides.

2.3.5 Cycle sequencing

Cycle sequencing was done in GeneAmp® PCR System 9700 thermal cycler (Applied Biosystems®) and T100™ Thermal Cycler (Bio-Rad Laboratories, Inc.). Most of the regions were sequenced using BigDye® Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems). For PCR products shorter than 400 base pairs the BigDye® Terminator v1.1 Cycle Sequencing Kit (Applied Biosystems®) was preferred as it give better sequences for short regions. All sequences were run for 1 minute at 96 °C for initial denaturation, followed by 30 cycles of, 10 seconds at 96 °C, five seconds at 50 °C and 4 minutes at 60 °C. Reactions were terminated by lowering the temperature to 4 °C.

2.3.6 Ethanol precipitation

Was done following a quite general protocol for 10 µL cycle sequencing product using only 0.125M EDTA, 3M sodium acetate and ethanol. 1 µL of both 0.125M:

1) EDTA and sodium acetate was added to each sample, followed by 25 µL of 96 % ethanol to achieve a concentration of approximately 65 % ethanol. The samples was then vortexed and left to incubate in room temperature for 15 minutes before they were centrifuged for 25 minutes at 5500 RPM at 4°C using a 9 inch rotor in a plate centrifuge (Rotanta 46 RS (Andreas Hettich GmbH & Co. KG)).
2) The samples were drained directly after precipitating to a pellet in the centrifuge by spinning them upside down on lint free paper at 400 RPM for 20 seconds.

3) 35 µL of 70 % ethanol was added to the drained samples, which were vortexed to resuspend the cycle sequencing product. The samples were then centrifuged at 4 °C for 20 minutes at 5500 RPM to precipitate and pelletize.

4) Repeat step 2). This step now removes any salts left from step 1) and prepares the samples drying.

5) Dry the samples for 3 minutes in a vacuum centrifuge to remove any ethanol left in the pellet. The samples are now ready to be suspended in formamide.

2.3.7 Sequencing

10.2 µL of Hi-Di™ Formamide (Applied Biosystems®) was added to each sample in the PCR-strip, incubated at room temperature for 15 minutes and vortexed to suspend the DNA in the formamide. 10 µL of the solution was then added to plates and sequenced in the ABI prism 3130*xl* Genetic Analyzer (Hitachi, Applied Biosystems®) sequencing machine. The 36 cm capillaries (Applied Biosystems®) was used in combination with the POP-7 polymer (Applied Biosystems®), the resulting sequences were analyzed with Foundation Data Collection v3.0 (Applied Biosystems®).

2.4 Analytical methods

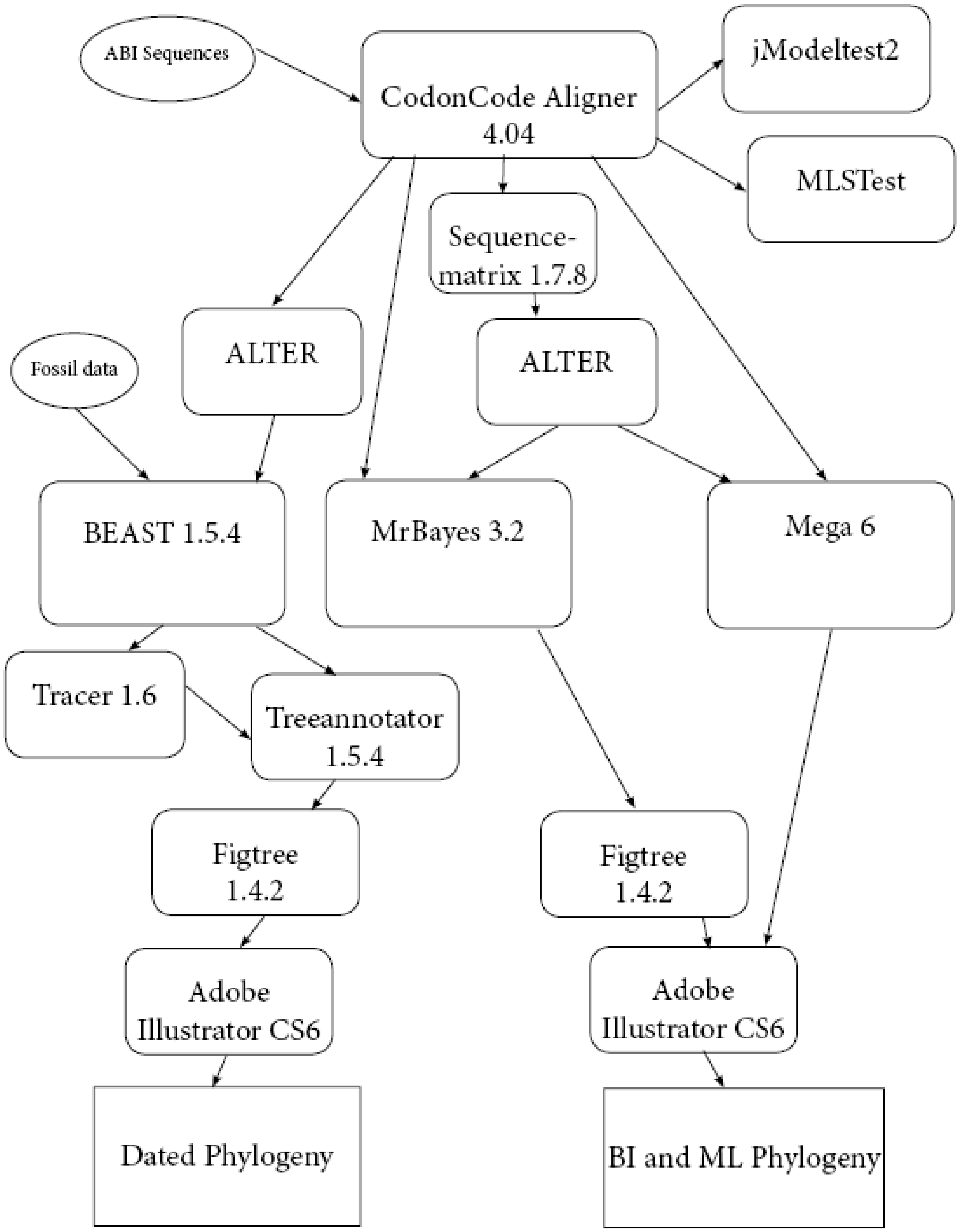

Figure 11. Flowchart giving an overview of the analysis procedures.

The analytical methods followed the flowchart shown in Figure 11.

2.4.1 Sequence editing

Sequences were edited in CodonCode Aligner version 4.04 (CodonCode Corporation), and aligned with the built in ClustalX algorithm (Thompson et al. 1997), and finally edited manually. As the trnL-F region was sequenced in two parts it was aligned to a reference sequence of *Pleuranthodium schlechteri* (K.Schum) R.M.Sm retrieved from Genbank.

2.4.2 Model selection

Alignments in nexus format created in Codoncode Aligner were fitted to the nexus standard required by jModeltest2 (Guindon and Gascuel 2003, Darriba et al. 2012) using ALTER (Glez-Pena et al. 2010). The alignments was analysed using jModeltest2 using 11 substitution schemes. The analysis was set to include four discrete gamma categories, Gamma distributed rate variation (+G), Invariable sites (+I), unequal base Frequencies (+F) and was searched for with a Subtree Pruning and Regrafting (SPR) algorithm. The model was selected on the basis of the BIC and the AIC. The models available are restricted to those that can be used in MrBayes. It was also considered that the same model should be used for all regions as they hopefully could be concatenated later to yield a phylogeny with better resolution and support. The General Time Reversible (GTR) model with Gamma distribution (G), was the highest or among the highest scoring models in all regions.

2.4.3 Phylogenetic analyses

2.4.3.1 Maximum Likelihood

Maximum Likelihood analyses were performed using Mega 6 (Tamura et al. 2013) as the program now includes the SPR algorithm. The GTR+G model was used for all regions according to the model test. Again, 4 discrete gamma categories were used. Substitution type was set to «Nucleotide». The alignments revealed some plausible phylogenetic informative gaps, so the alignments were cut to the same length with internal gaps, which means that they were treated as actual characters by checking the «Use all sites» option. The heuristic method used was the SPR level 5, and the branch swap filter was set to «Weak» to ensure that the best possible tree was found. The remaining options were set to default.

2.4.3.2 Bayesian Inference

Running the analysis

For the Bayesian phylogenetic analyses, MrBayes 3.2 (Ronquist et al. 2012) was run for all regions. Commands in (Appendix 1).

The analysis used the GTR+G parameter model and was set to run for 2 million generations sampling every 1000nd generation and giving diagnostics every 10000nd generation. If the diagnostic of the standard deviation of split frequencies was stabilised at less than 0,01 after finishing, the analysis was be terminated, if not, I continued until it did.

Tracing and removing burn-in

The program Tracer (Rambaut et al. 2014) was used identify and eliminate the burn-in from MrBayes. It is easily recognisable in the graphical user interface if the chains have converged, and this ensures that the final tree will be valid. The number of burn-in generations was divided by 1000 as this was the sample frequency.

The parameter summary and plot were evaluate to determine if the run was successfull. Then I produce a clade credibility tree containing credibility values for all clades, and a phylogram with branch lenghts.

2.4.3.3 Concatenating the regions

Before concatenating, the regions were compared using a Templeton test (Templeton 1983) incorporated in the MLSTest software (Tomasini et al. 2013).

Sequencematrix (Vaidya et al. 2011) was used to concatenate single fasta alignments of regions to a joined alignment and exported as nexus files for phylogenetic analyses inn MrBayes. To use the same data in Mega6 as in MrBayes to produce maximum likelihood phylogenies they have to be converted. The nexus files produced in Sequencematrix was edited and converted with ALTER (Glez-Pena et al. 2010) to be compatible with Mega6.

2.4.3.4 Displaying the phylogenetic trees

The concatenated tree was made into a cladogram to be able to include all collections and regions, otherwise branch lengh would have been a result of the number of regions per taxa.

The bayesian inference trees produced in MrBayes were displayed in Figtree 1.4.2 (Rambaut 2014). The the bootstrap values from the maximum likelihood tree was added to the baysian inference tree using Adobe Illustrator CS6 (Adobe Systems 2012).

2.4.4 Dating phylogenies

The phylogenies were dated using BEAST 1.5.4, with input files made in BEAUti, both in the BEAST v1.5.4 package (Drummond and Rambaut 2007). The priors were set to Yule tree prior, GTR+G model parameters and a relaxed clock with lognormal distribution (Drummond et al. 2006). The runs were performed with 10 million generations, of which the burn in was removed using Tracer. The crown divergence time was calibrated after the dating of *Zingiberopsis magnifolia* (Knowlton) Hickey, which is from the Campanian-Maastritchtian boundary approximately 72.1 Ma (Peppe et al. 2007). The time of divergence was allowed to have a confidence interval reaching from the dating at 72.1 Ma to about 80 Ma. Two sequences from genbank of *Siphonochilus* were used as outgroup.

The resulting 8 million trees left after removing the burn-in were combined using TreeAnnotator 1.5.4 (Drummond and Rambaut 2007).

2.4.5 Biogeography

2.4.5.1 Displaying locations on the map

The distribution of the genera is displayed by plotting the known collections in Google Earth. The web application Earth Point (Clark 2014) was used to convert data from excel files to KNM files for Google Earth

2.4.5.2 Histogram of the elevational distribution

The histograms were made using data retrieved from GBIF, which is gathered from several herbaria that have indexed their material. I also added the data from our own collections which have not been indexed by any herbarium yet. The data management was done manually as there are often duplicates from the same selection which have to be sieved out.

3. Results

3.1 Molecular Phylogeny

3.1.1 Nuclear data set

The combined nuclear data set consist of the regions ITS, At103 and ndhf, and has an aligned length of 1781 bp, of which 133 are parsimoniously informative characters (Figure 12). The topology of this tree is very similar to the one made with all the regions combined, and parts that are identical to the combined tree will therefore be commented in part **3.1.3 Concatenated data set**. One exceptions is that *Riedelia* aff *lanata* Oliv. resolves in a clade with other *Riedelia* species (0.27/98) instead of being sister to the *Pleuranthodium* and *Riedelia* aff. *umbellata* Valeton clade.

3.1.2 Chloroplast data set

The aligned length of the chloroplast data set was 1601 bp, of which 43 were parsimoniously informative. The regions sequences were trnL-F and rps16. The cladogram for the chloroplast regions had in general lower resolution and support than the cladogram based on the nuclear regions (Figure 12 and 13).

The tree has in general poor support in the basal nodes, but several terminal clades are supported. The supported terminal clades, in concordance with the nuclear tree, and they will therefore be described in **3.1.3 Concatenated data set**.

The incongruence between the chloroplast topology and the nuclear topology had very low support in either of the topologies, so there were actually no hard incongruence, and the datasets could therefore be concatenated.

3.1.3 Concatenated data set

The concatenated cladogram (Figure 14) includes all the regions sequenced, the total aligned lenght was 3384 bp, with 176 parsimoniously informative sites.

Pleuranthodium resolves as monophyletic with a support of (0.88/37). *Riedelia*, however, comes out as paraphyletic in four clades with *Pleuranthodium* nested within. The *Pleuranthodium/Riedelia* clade is very well supported (1.00/-). The two most species rich clades of *Riedelia* are highly supported, (1.00/34) and (1.00/98).

Pleuranthodium sect. *Psychanthus* is monophyletic, however not very well supported (0.74/-). *Pleuranthodium peekelii* (Valeton) R.M.Sm is in a clade with good support, and the clade includes two undetermined samples from Vanuatu and the Solomon Islands (1.00/93). The *P. peekelii* clade has a well-supported sister clade (1.00/98).The adjacent clade, containing species from Eastern Highlands has high internal support(1.00/99), but low support as sister to the rest of the clade (0.50/-). *Pleuranthodium floribundum* (K.Schum.) R.M.Sm. comes out in a separate clade with three other cultivated collections (1.00/-), it has *P. papillionaceum* (K.Schum) R.M.Sm. as sister group (0.93/58). The two last collection in the section from the *P. papillionaceum/P. floribundum* clade, with fair support (0.94/36).

Pleuranthodium sect. *Pleuranthodium* resolves as monophyletic, however, without formal support. The collection *Poulsen et al. 2895*, comes out as a poorly supported basal clade in the section. Two species from the Eastern Highlands (*Poulsen et al. 2921* and *Lofthus 1013*) forms a highly supported sister to the remaining clade (0.91/-). The remaining well supported clade (1.00/65) bifurcates into the “trichocalyx/macropychnanthum clade” (0.82/41) and the “racemigerum/platynema clade” (1.00/83).

The clade containing *P. trichocalyx* and *P. piundaundensis* is well supported (1.00/87), and is divided into two subclades .*Pleuranthodium trichocalyx* (Valeton) R.M.Sm. is shown as a separate clade from *P.* aff. *trichocalyx* and has a support of (0.99/-) . *P.* aff. *trichocalyx* is together with *P. piundaundensis* (Royen) R.M.Sm. shown as monophyletic group with rather low support (0.86/45). *Pleuranthodium sp. 1* is well supported as a clade (1.00/87) with *P. macropychnanthum* (Valeton) R.M.Sm (0.88/45).

P. racemigerum and *P.* aff. *racemigerum* are placed in two neighbouring clades, constituting a clade with one additional collection (*Poulsen et al. 2485*) with support value (0.98/67) . The “racemigerum clade” contains one undetermined specimen from the Makira Island. Both *P. racemigerum* has high support (0.66/99), while *P.* aff. *racemigerum* is unresolved. *Pleuranthodium platynema* (K.Schum.) R.M.Sm. is to the *P. racemigerum* and *P.* aff *racemigerum* clade with fair support (0.82/56). Collection (*Lofthus 1009* and *Poulsen et al. 2899, 2831*) is a well supported group (1.00/62), which is sister to *P. platynema* and the rest of the *P. racemigerum* clade (1.00/83).

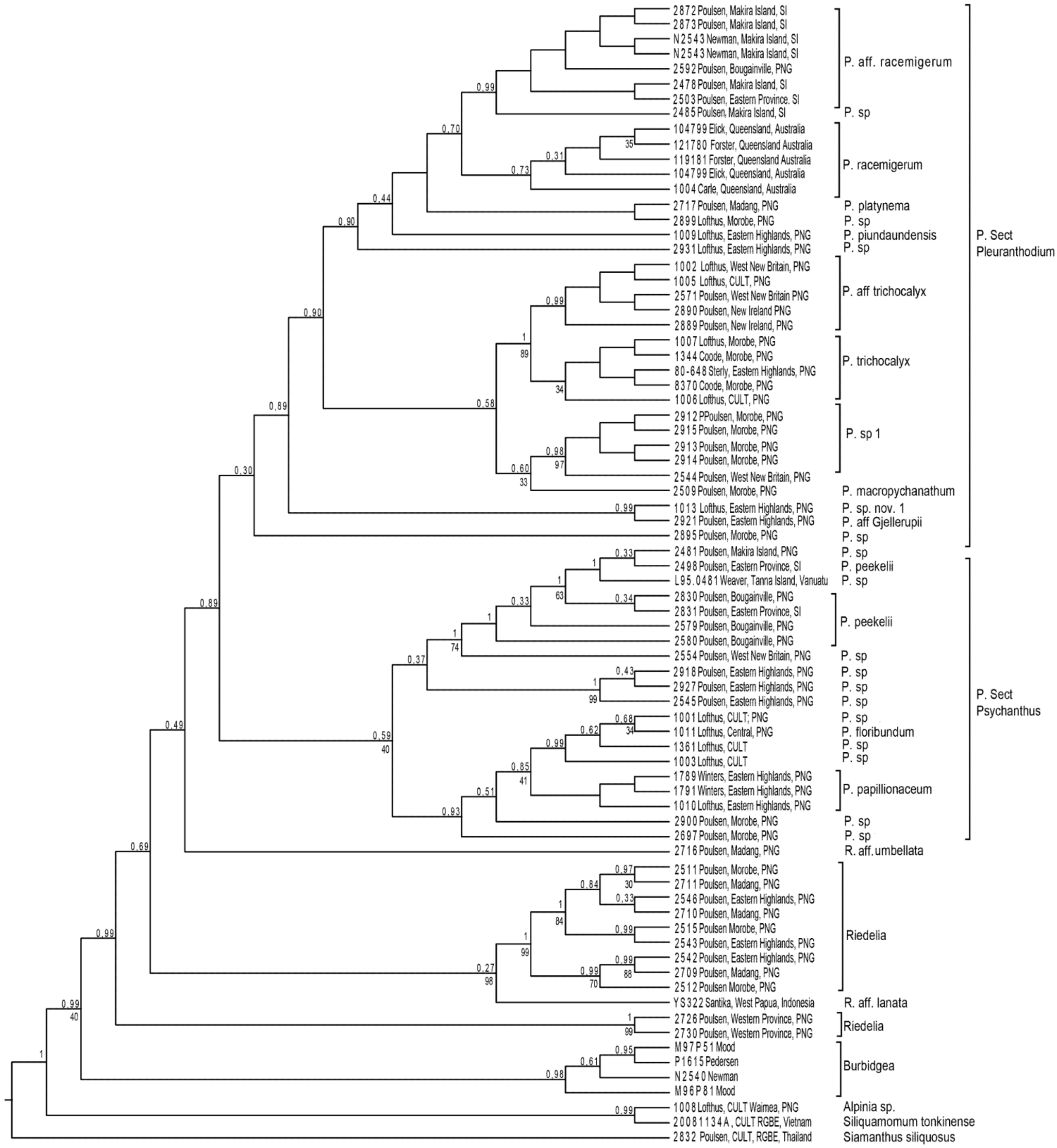

Figure 12. Phylogeny made with Bayesian Inference showing posterior probability values greater than 0.30, with bootstrap values >30 from Maximum Likelihood added below the branches. The nuclear regions used ITS, ndhf and At103, which were all concatenated.

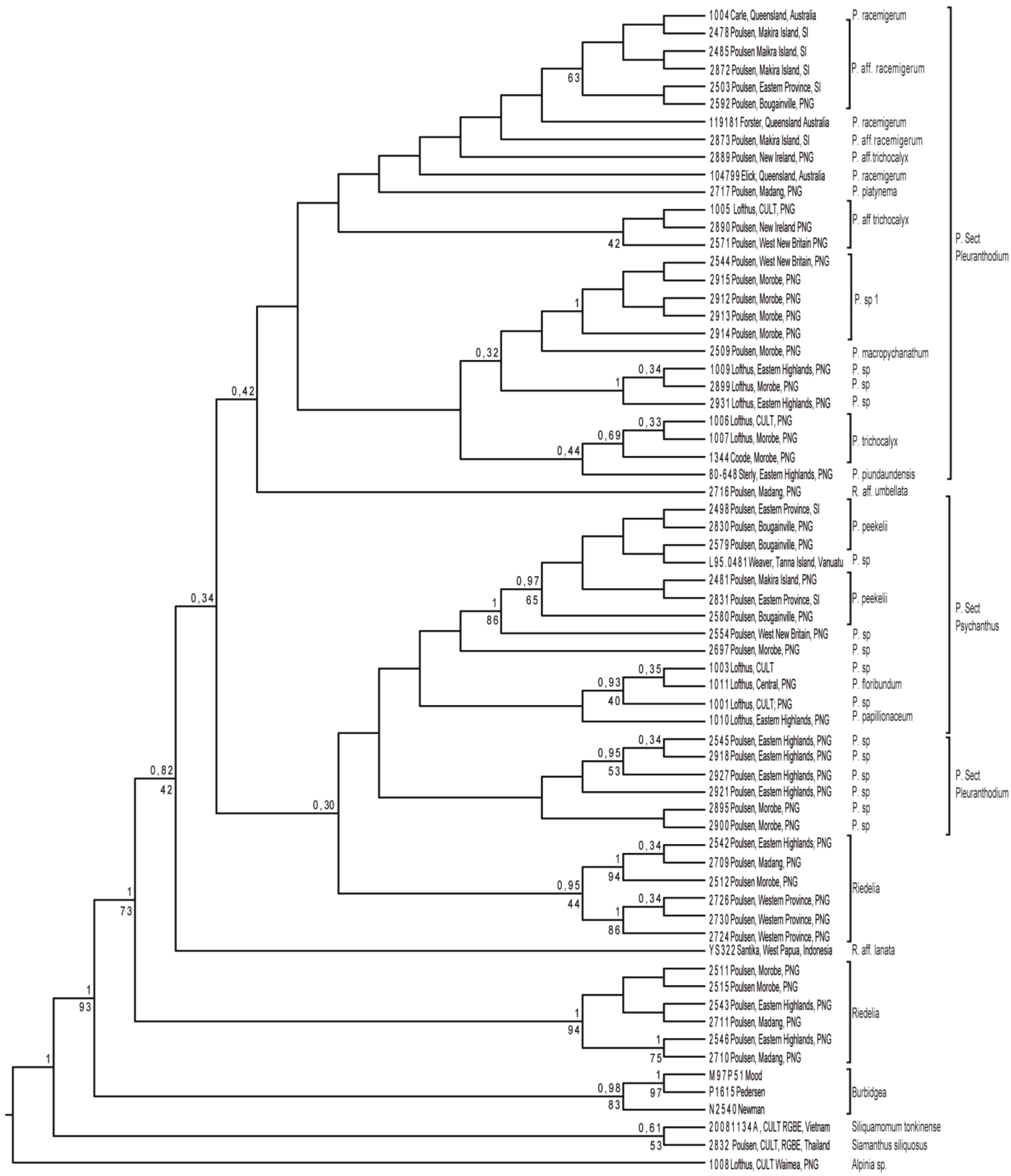

Figure 13. Phylogeny made with Bayesian Inference showing posterior probability > 0.30, with bootstrap values >30 from Maximum Likelihood added below the branches. The chloroplast regions used were trnL-F and rps16, which were all concatenated.

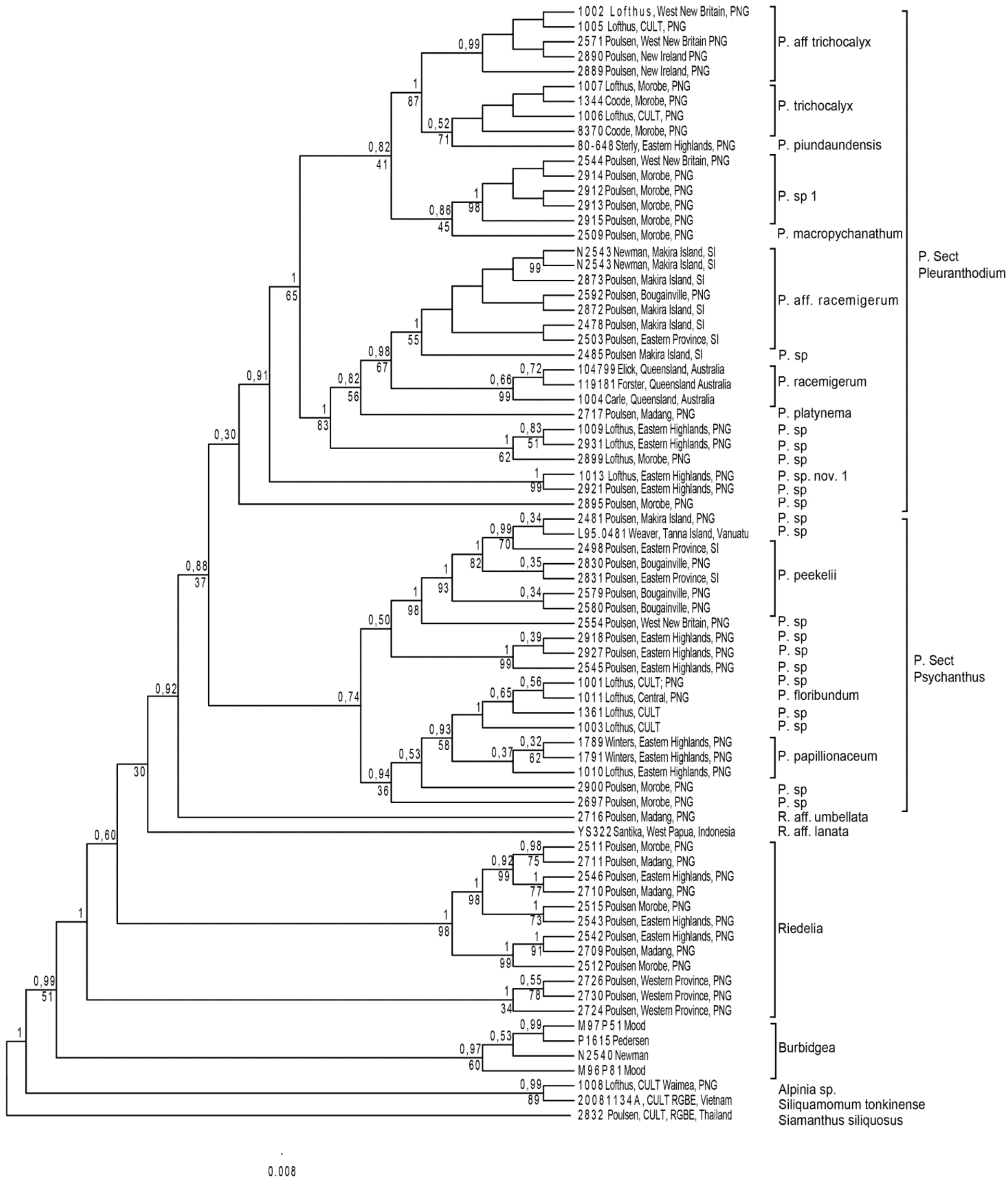

Figure 14. Cladogram made with the regions ITS, At103, ndhf, TrnLF and rps16. The posterior probability from the Bayesian inference analysis is shown above the branches, and the bootstrap values from the maximum likelihood analysis are shown beneath. Values lower than 30 for bootstrap and 0.30 for posterior probability are not shown.

3.2 Dating phylogenies

The dated phylogeny made from the ITS region show mainly that the likely time of divergence from Burbidgea was about 13,1±7 Ma (Figure 15). *Pleuranthodium* splits off from its closest related *Riedelia* clade 7,9±3,7 Ma, and then the two sections diverge 1 million years later.

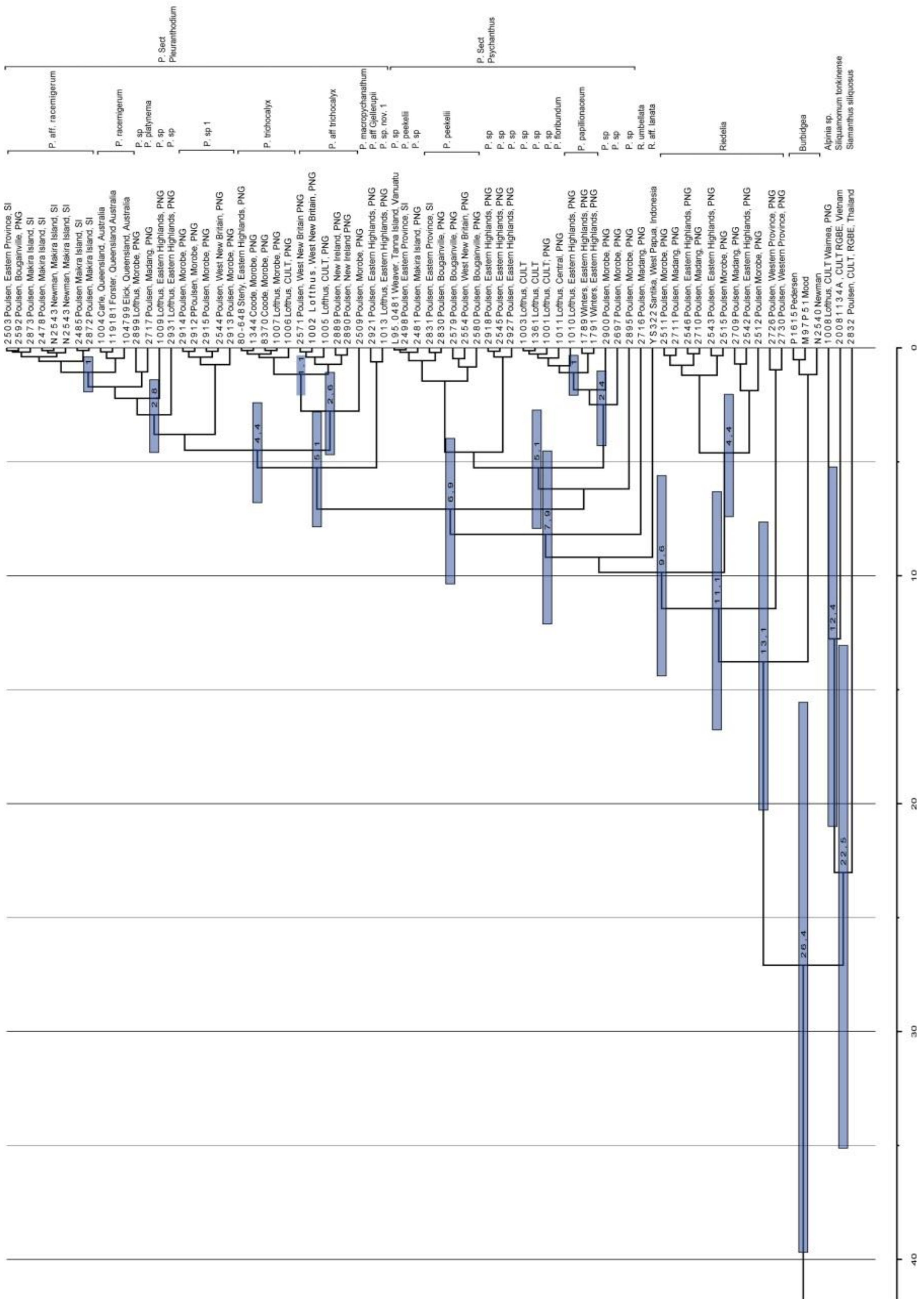

Figure 15. Dated phylogeny of the ITS region, calibrated with Siphonochilus and fossil.

3.3 Biogeography

3.3.1 The distribution of the genera

Only a small number of the herbarium collections have both the required pickled flower for determination and the DNA-samples needed to be useful in the phylogenetic analyses. Other collections, however, still serve the purpose of showing the distribution of the genera (Figure 16.).

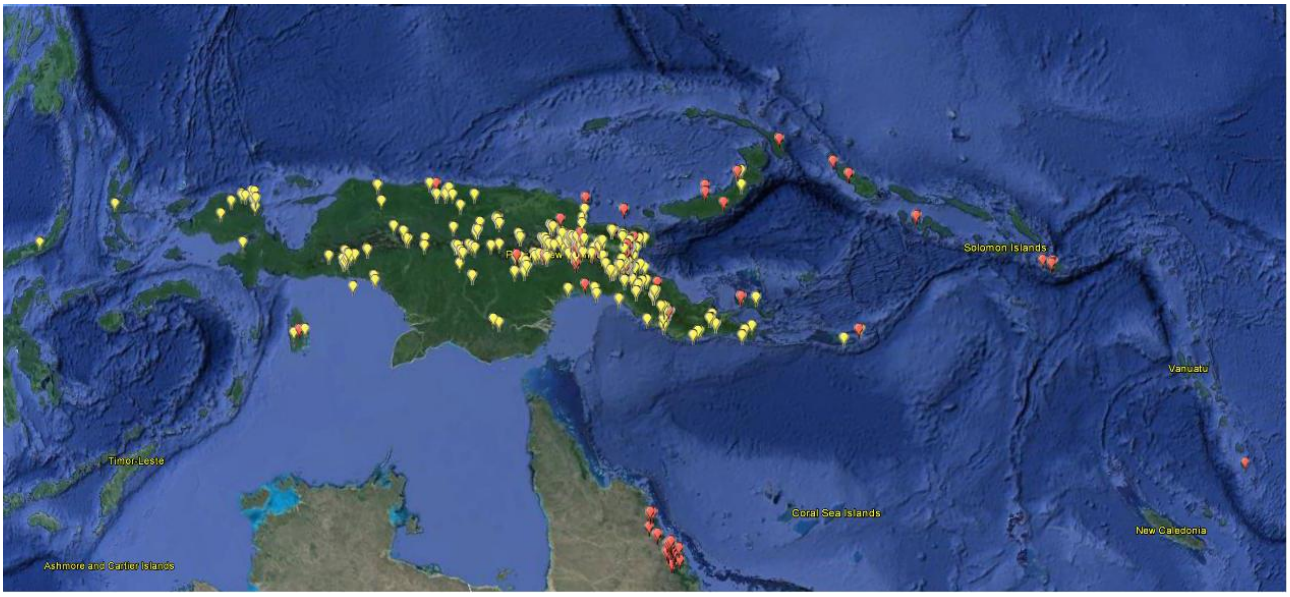

Figure 16. The distribution of the genera, Pleuranthodium (red) and Riedelia (yellow). Produced using Earth Point and Google Earth.

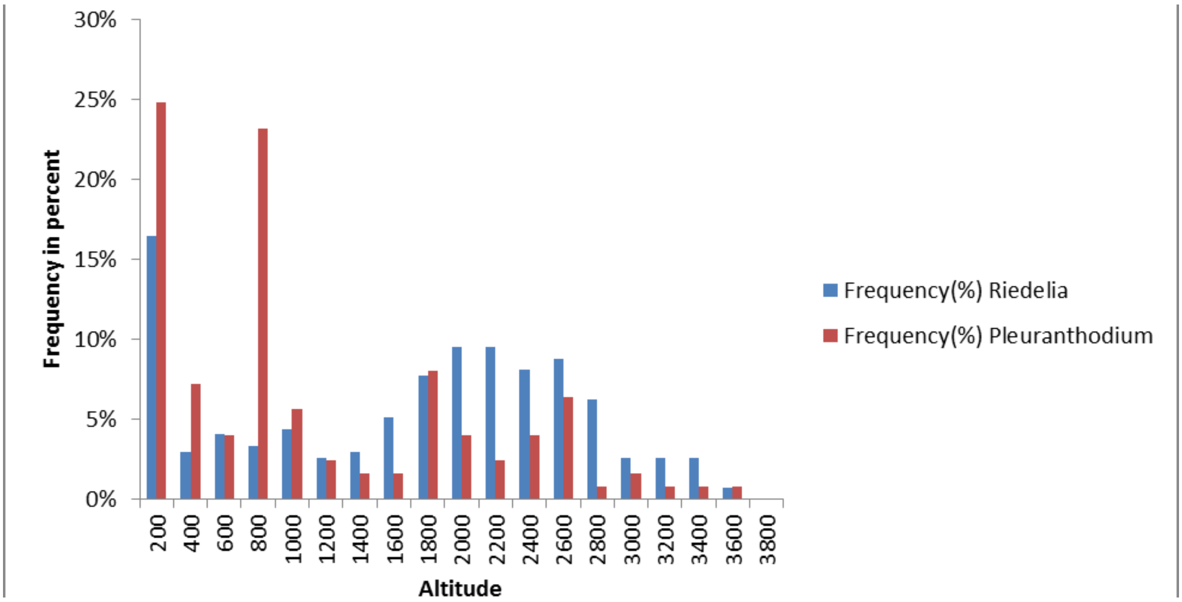

Figure 17. Histogram of the frequency percentage of collection of the genera Pleuranthodium *(red) and* Riedelia *(blue) with respect to altitude.*

The histogram of elevational distribution shows that both genera have the highest peak below 200m. There is a clear trend for *Riedelia* which has a mid elevational hump with a peak around 2000-2200 metres (Figure 17). Data for Figure 16 and 17 are found in Appendix 3.

4. Discussion

4.1 Phylogeny

4.1.1 The monophyly of *Pleuranthodium*

The only previous study including these genera was by Kress *et al.* (2002) but included so few species that the monophyly or relationship between *Riedelia* and *Pleuranthodium* could not be evaluated properly. The phylogenetic results of this study generally support Smith's perception of the genus *Pleuranthodium* with *Riedelia* as sister group. In the chloroplast tree, the support value for the insertion of *R.* aff. *Umbellata* as sister to the sect. *Pleuranthodium* is low and not to be trusted.

Riedelia resolves as paraphyletic but form a monophyletic group together with *Pleuranthodium.* Paraphyletic groups like the zoological example of amphibians, reptiles and dinosaurs are famous. The option of merging *Pleuranthodium* and *Reidelia* into one huge genus to obtain strict monophyly is not recommended, as there are good morphological characters that delimit the genera.

They two genera can to some degree be distinguished by the general impression of the plants, *Pleuranthodium* is often larger than two metres in length, while *Riedelia* usually is below 1.5 metres. Riedelia is more diverse in leaf morphology, and can have more attenuate lamina bases, while *Pleuranthodium* always has a more cuneate lamina base, and are often subpetiolate.

Morphologically the genera *Pleuranthodium* and *Riedelia* are easy to recognise if they are fertile. The large labellum in section *Psychanthus* is very different from the narrow more trumpet shaped *Riedelia* flowers. The type species for *Riedelia*, *R. lanata* R.Sheffer, however, has more open flowers somehow resembling *P.* sect *Pleuranthodium*.

Most commonly, *Riedelia* has 2-valved fruits and *Pleuranthodium* 3-valved; (Figure 5). *Riedelia lanata* and *R. umbellata*, however, have capsules that dehisce in three parts. These two species are placed as sister grades to the *Pleuranthodium* clade. We also observed that the surface structure of most *Riedelia* species are irregularly warty and straw yellow, in contrast to the greenish-black and smooth seeds in *Pleuranthodium* and *R.* aff. *umbellata*. Typical for the same group of *Riedelia* is that the aril is swollen and covering the seeds, which is never seen in *Pleuranthodium* or *R. umbellata*. The two synapomorphic characters are thus not unique to the genus *Pleuranthodium*. A unique character found in many *Pleuranthodium* is the persistent calyx on the fruit. This does not occur elsewhere in the tribe.

Seen in the light of the phylogeny, which shows that *Burbidgea* is sister to *Riedelia* and *Pleuranthodium*, there might be a trend in the colours of the flowers. The species in *Burbidgea* all have bright yellow-orange flowers. *Riedelia* generally have yellow flowers where the colour shift towards orange-red at the apex of the lip and corolla lobes. While the *Pleuranthodium* flower is mostly white or cream coloured, sometimes red or partly red. The only exception is *P. piundaundensis* which has pale yellow flowers.

4.1.2 The monophyly of the two sections

Both the nuclear and chloroplast based phylogenies support the section *Psychanthus* as a monophyletic clade, and therefore the final phylogeny also supports it. The support for section *Pleuranthodium* is lower, and it resolves as polyphyletic in the chloroplast phylogeny. The supports for the polyphyletic clades are, however, very low, and could be presented as a polytomy. There is more support for the section in the nuclear tree, and if compared with the final tree, the support is increasing, which means that there are some data in the chloroplast alignment supporting this as well.

The sections have clearly defined characters (Tab. 1.) that separates them, however not all characters are present in all the species. Section *Pleuranthodium* is a well-supported clade if the most basal branch (Poulsen et al. 2895) is left out which also differs morphologically from the rest of the clade. Section *Psychanthus* is defined in all topologies, and has fair support. My results thus support the existing section division.

4.2 What is a good character

The genus of *Pleuranthodium* and most species in *Riedelia* have terminal inflorescences, although it is sometimes sub-terminal, the difference between a terminal and a radical inflorescence is very distinct. And to my knowledge, the only place it appears within the tribe is in *R. umbellata* and possibly in closely related species if they exist. As a diagnostic character this is about as strong as it can get.

The sections are delimited with a few presence/absence characters. Neither of them are crossing the boundaries between the sections, but some are more affected by abnormal growth than others. As seen in (appendix 4), the tooth character of section *Psychanthus* can sometimes be lacking on one side. The description of the species *P. floribunda* in the section also mention that it is lacking the character, while the other defining characters remain. The cymbiform filament is probably a more sturdy character for section *Psychanthus*, but some species in section *Pleuranthodium* have filament folding upon themselves, which is broad and resembles the cymbiform anther of *P.* sect. *Psychanthus* if unfolded. The species in *P.* sect *Pleuranthodium* with the broader filaments apparently have a shoulder on the filament, which can to some degree resemble the tooth found in *P*. sect. *Psychanthus*.

The presence, absence, grade or type of hair is a large set of characters combined. It is however not very reliable as they tend to change in both extent and appearance as the plant ages. The sheath and lamina of the same plant are variable; one of the shoot generations was younger than the other, and was pubescent, while the other was glabrous (Figure 3, page 9).

The colour of the floral parts can be a good character if there are a narrow colour range not overlapping the one of related species. As the species descriptions in *Pleuranthodium* rarely mention colours, it would be a secondary character which needs to be linked more closely to the species determined by other characters. Colours could however act as guidance when determining whether two collections are the same species or not.

In the vegetative part, the ligule is often a good character for many genera in Zingiberaceae, and a variation was observed within *Pleuranthodium*.

The characters emphasised above will be important to include when determining species in the genus *Pleuranthodium*.

4.5 Biogeograpical patterns

4.5.1 Geological factors

The genus *Burbidgea* is endemic to Borneo and is estimated to diverge from the group of *Riedelia* and *Pleuranthodium* occurring East of Wallace’s Line at about 13 Ma. This is within the time window 15–10 Ma, where the islands between Borneo and New Guinea were aligned (Hall 2002), perhaps creating a more efficient route of dispersal. Dispersal in this time period has also been seen in other genera and families in the flora of Sahul (Morley 2003). The islands in this chain subsequently retracted to the west and combined to form Sulawesi. The further divergence between *Riedelia* and *Pleuranthodium* (including its sections) occurred in New Guinea or nearby islands and it is not possible to relate that to specific geological events.

4.5.2 Elevation

The histogram of elevational distribution of the two genera, confirms the general impression that *Riedelia* occurs at higher elevation than *Pleuranthodium*. The lack of collections from altitudes higher than 3600 m is because this is approaching the alpine zone. Plants do not react per se to altitude but more so to the climatic factors correlated with it, like rain patterns or moisture from the clouds (Grytnes and Beaman 2006).

4.5.3 An updated distribution of *Pleuranthodium*

As seen in (Figure 1.), the previously known distribution of *Pleuranthodium* is constricted to New Guinea and Australia. From the data we and others have collected, which is shown in Figure 16, the genus also occurs in the Solomon Islands and Vanuatu. It is not surprising that purposeful collection expands the known distribution range.

5. Conclusion

The genus *Pleuranthodium* is monophyletic with high support. *Riedelia* is a paraphyletic sister group, and is divided into at least two well supported subclades. A good character circumscribing Pleuranthodium is corolla which is only tubular to less than half the length of the flower, in contrast to *Ridelia*, where the corolla tube reaches almost the full length. In addition, the 3-valved fruit with persistent calyx, and containing greenish-black shiny seeds not completely covered by the aril are useful. The two sections within the genus *Pleuranthodium* are also monophyletic but with lower support. They are easy to recognise morphologically. The subapical pair of teeth diagnostic for the section *Psychanthus* was found in all sampled species, though sometimes single or somewhat obscure. The genus separated from its Bornean origin approximately 13 Ma, with subsequent radiation, mainly in New Guinea. Species on smaller islands to the east of New Guinea are younger.

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Appendix 1: Checklist of known species

The following checklist was retrieved from Newman et al. 2004. Notes on *Pleuranthodium racemigerum* was added by the author.

Pleuranthodium (K.Schum.) R.M.Sm.
Pleuranthodium (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 63. — Basionym: *Alpinia* Sect. *Pleuranthodium* K.Schum., Pflanzenr. IV, 46 (1904) 322. — Type species: *Pleuranthodium tephrochlamys* (Lauterb. & K.Schum.) R.M.Sm.
Distribution — West Papua, Papua New Guinea, Bismarck Archipelago.

1. *Pleuranthodium biligulatum* (Valeton) R.M.Sm.
Pleuranthodium biligulatum (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 64. — Basionym: *Alpinia biligulata* Valeton, Nova Guinea 8 (1913) 939. — *Psychanthus biligulatus* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 81. — Type: *L.S.A.M.vonRömer 643* (syn BO), *G.M.Versteeg 1411* (syn BO, L!).
Distribution — West Papua.

2. *Pleuranthodium branderhorstii* (Valeton) R.M.Sm.
Pleuranthodium branderhorstii (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 64. — Basionym: *Alpinia branderhorstii* Valeton, Nova Guinea 8 (1913) 941. — *Psychanthus branderhorstii* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 81. — Type: *B.Branderhorst 412* (holo BO, iso L!).
Distribution — West Papua.

3. *Pleuranthodium comptum* (K.Schum.) R.M.Sm.
Pleuranthodium comptum (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 66. — Basionym: *Alpinia compta* K.Schum., Bot. Jahrb. Syst. 27 (1899) 277. — *Psychanthus comptus* (K.Schum.) R.M.Sm., Edinburgh J. Bot. 47 (1990) 79. — Type: *U.M.Hollrung 195a*.
Distribution — Papua New Guinea.

4. *Pleuranthodium floccosum* (Valeton) R.M.Sm.
Pleuranthodium floccosum (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 64. — Basionym: *Alpinia floccosa* Valeton, Nova Guinea 8 (1913) 940. — *Psychanthus floccosus* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 81. — Type: *L.S.A.M.vonRömer 690* (syn BO), *F.R.R. Schlechter 17326* (syn BO).
Distribution — West Papua, Papua New Guinea.

5. *Pleuranthodium floribundum* (K.Schum.) R.M.Sm.
Pleuranthodium floribundum (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 66. — Basionym: *Alpinia floribunda* K.Schum., Pflanzenr. IV, 46 (1904) 439. — *Psychanthus floribundus* (K.Schum.) R.M.Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *F.R.R.Schlechter 14291*.
Distribution — Papua New Guinea.

6. *Pleuranthodium gjellerupii* (Valeton) R.M.Sm.
Pleuranthodium gjellerupii (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 66. — Basionym: *Alpinia gjellerupii* Valeton, Nova Guinea 8 (1913) 938. — *Psychanthus gjellerupii* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *K.Gjellerup 115* (iso L!).
Distribution — West Papua.

7. *Pleuranthodium hellwigii* (K.Schum.) R.M.Sm.
Pleuranthodium hellwigii (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 66. — Basionym: *Alpinia hellwigii* K. Schum., Pflanzenr. IV, 46 (1904) 320. — *Psychanthus hellwigii* (K.Schum.) R.M.Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *F.C.Hellwig 416*.
Distribution — Papua New Guinea.

8. *Pleuranthodium iboense* (Valeton) R.M.Sm.
Pleuranthodium iboense (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 66. — Basionym: *Alpinia iboensis* Valeton, Bot. Jahrb. Syst. 52 (1914) 60. — *Psychanthus iboense* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *F.R.R.Schlechter 17081* (iso P!), Madang, Mt. Ibo.
Distribution — Papua New Guinea.

9. *Pleuranthodium macropycnanthum* (Valeton) R.M.Sm.
Pleuranthodium macropycnanthum (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 64. — Basionym: *Alpinia macropycnantha* Valeton, Nova Guinea 8 (1913) 940. — *Psychanthus macropycnanthus* (Valeton) R.M. Sm., Edinburgh J. Bot. 47 (1990) 81. — Type: *L.S.A.M.vonRömer 705* (syn BO), *F.R.R.Schlechter 17839* (syn BO).
Distribution — West Papua, Papua New Guinea.

10. *Pleuranthodium neragaimae* (Gilli) R.M.Sm.
Pleuranthodium neragaimae (Gilli) R.M.Sm., Edinburgh J. Bot. 48 (1991) 64. — Basionym: *Alpinia neragaimae* Gilli, Ann. Naturhist. Mus. Wien, B 84 (“1980”) (1983) 43. — *Psychanthus neragaimae* (Gilli) R.M.Sm., Edinburgh J. Bot. 47 (1990) 81. — Type: *A.Gilli 285* (holo W!), Chimbu, Nera Gaima.
Distribution — Papua New Guinea.

11. *Pleuranthodium papilionaceum* (K.Schum.) R.M.Sm.
Pleuranthodium papilionaceum (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 68. — Basionym: *Alpinia papilionacea* K.Schum., Fl. Kais. Wilh. Land (1889) 29. — *Psychanthus papilionaceus* (K Schum.) R.M.Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *U.M.Hollrung 195*.
Distribution — Papua New Guinea.

12. *Pleuranthodium pedicellatum* (Valeton) R.M.Sm.
Pleuranthodium pedicellatum (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 68. — Basionym: *Alpinia pedicellata* Valeton, Bot. Jahrb. Syst. 52 (1914) 60. — *Psychanthus pedicellatus* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *F.R.R.Schlechter 16057* (BO), Madang, Bulu.
Distribution — Papua New Guinea.

13. *Pleuranthodium peekelii* (Valeton) R.M.Sm.
Pleuranthodium peekelii (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 68. — Basionym: *Alpinia peekelii* Valeton, Bot. Jahrb. Syst. 52 (1914) 62. — *Psychanthus peekelii* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *G.Peekel 765* (BO).
Distribution — Bismarck Archipelago.

14. *Pleuranthodium pelecystylum* (K.Schum.) R.M.Sm.
Pleuranthodium pelecystylum (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 65. — Basionym: *Alpinia pelecystyla* K.Schum., Bot. Jahrb. Syst. 27 (1899) 277. — *Psychanthus pelecystyla* (K.Schum.) R.M. Sm., Edinburgh J. Bot. 47 (1990) 81. — Type: *O.Beccari 784* (holo FI), Andai.
Distribution — West Papua.
Notes. This is the only species with a branched inflorescence, and one should assess the possibility that it might be a *Riedelia*.

15. *Pleuranthodium piundaundensis* (P.Royen) R.M.Sm.
Pleuranthodium piundaundensis (P.Royen) R.M.Sm., Edinburgh J. Bot. 48 (1991) 65. — Basionym: *Riedelia piundaundensis* P.Royen, The Alpine Flora of New Guinea 2 (1979) 875. — *Psychanthus piundaundensis* (P.Royen) R.M.Sm., Edinburgh J. Bot. 47 (1990) 81. — Type: *M.vanBalgooy 584* (holo L!), Piundaunde.
Distribution — Papua New Guinea.

16. *Pleuranthodium platynema* (K.Schum.) R.M.Sm.
Pleuranthodium platynema (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 65. — Basionym: *Alpinia platynema* K.Schum., Pflanzenr. IV, 46 (1904) 438. — *Psychanthus platynemus* (K.Schum.) R.M.Sm., Edinburgh J. Bot. 47 (1990) 82. — Type: *F.R.R.Schlechter 14327* (iso BO), West Sepik, Torricelli Mts.
Distribution — Papua New Guinea.

17. *Pleuranthodium pterocarpum* (K.Schum.) R.M.Sm.
Pleuranthodium pterocarpum (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 65. — Basionym: *Alpinia pterocarpa* K.Schum., Pflanzenr. IV, 46 (1904) 322. — *Psychanthus pterocarpus* (K.Schum.) R.M. Sm., Edinburgh J. Bot. 47 (1990) 82. — Type: *A.Zippelius s.n.*, West Papua.
Distribution — West Papua, Papua New Guinea.
Notes. The prologue did not include a description of the flower. Ridley described the flower of this species in 1916 having teeth on the non-membranous calyx with a short tooth of 8–9 mm and an almost 3-lobed labellum. I find this odd for a *Pleuranthodium*. It could be more similar to the teeth in *Riedelia*. Also, his description of the style being longer than the stamen is more typical for *Riedelia*. I also think that Ridley meant that the thecae are linear by "Anther cells linear". This might be true for what I've seen from sect. *Psychanthus*, but not for sect. *Pleuranthodium* which has more rounded thecae. Silky corolla lobes also sound a bit off, I've seen short hair on *Riedelia* lobes, but never on a *Pleruranthodium*.

18. *Pleuranthodium racemigerum* (F.Muell) R.M.Sm.
Pleuranthodium racemigerum (F Muell) R.M.Sm., Edinburgh J. Bot. 48 (1991) 65. — Basionym: *Alpinia racemigera* F.Muell., Fragm. 8 (1873) 27. — Type: *J. Dallachy s.n*. (lecto MEL!), Queensland, Rockingham Bay
Distribution — NE Queensland, Australia.

19. *Pleuranthodium roemeri* (Valeton) R.M.Sm.
Pleuranthodium roemeri (Valeton) R.M.Sm., Edinburgh J. Bot. 48 (1991) 65. — Basionym: *Alpinia roemeri* Valeton, Nova Guinea 8 (1913) 941. — *Psychanthus roemeri* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 82. — Type: *L.S.A.M.vonRömer 696* (holo BO), Sg. Lorentz.
Distribution — West Papua.

20. *Pleuranthodium schlechteri* (K.Schum.) R.M.Sm.
Pleuranthodium schlechteri (K.Schum.) R.M. Sm., Edinburgh J. Bot. 48 (1991) 68. — Basionym: *Alpinia schlechteri* K. Schum., Pflanzenr. IV, 46 (1904) 438. — *Psychanthus schlechteri* (K.Schum.) R.M. Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *F.R.R.Schlechter 14519*, West Sepik, Torricelli Mts..
Distribution — Papua New Guinea.

21. *Pleuranthodium scyphonema* (K.Schum.) R.M.Sm.
Pleuranthodium scyphonema (K.Schum.) R.M.Sm., Edinburgh J. Bot. 48 (1991) 68. — Basionym: *Alpinia scyphonema* K.Schum., Pflanzenr. IV, 46 (1904) 438. — *Psychanthus scyphonemus* (K.Schum.) R.M. Sm., Edinburgh J. Bot. 47 (1990) 80. — Type: *F.R.R.Schlechter 14352*, West

Sepik, Torricelli Mts.
Distribution — Papua New Guinea.

22. ***Pleuranthodium tephrochlamys*** (Lauterb. & K.Schum.) R.M.Sm.
Pleuranthodium tephrochlamys (Lauterb. & K.Schum.) R.M. Sm., Edinburgh J. Bot. 48 (1991) 65. — Basionym: *Alpinia tephrochlamys* Lauterb. & K.Schum., Fl. Schutzgeb. Südsee (1900) 226. — *Psychanthus tephrochlamys* (Lauterb. & K.Schum.) R.M.Sm., Edinburgh J. Bot. 47 (1990) 82. — Type: *C.A.G.Lauterbach 1211* (syn B), Madang, Melanua Harbour, *2550* (syn K), Madang, Ramu River.
Alpinia tephrochlamys var. *aspericaulis* Lauterb. & K.Schum., Fl. Schutzgeb. Südsee (1900) 226. — Type: *C.A.G.Lauterbach 589* (holo B), Morobe, Sattelburg.
Distribution — Papua New Guinea.
Notes. The syntype at Kew has not been seen since 1999.

23. ***Pleuranthodium trichocalyx*** (Valeton) R.M.Sm.
Pleuranthodium trichocalyx (Valeton) R.M. Sm., Edinburgh J. Bot. 48 (1991) 66. — Basionym: *Alpinia trichocalyx* Valeton, Bot. Jahrb. Syst. 52 (1914) 63. — *Psychanthus trichocalyx* (Valeton) R.M.Sm., Edinburgh J. Bot. 47 (1990) 82. — Type: *F.R.R.Schlechter 16084* (syn BO), Madang, near Bulu, *16218* (syn P!), Madang, Male.
Distribution — Papua New Guinea.

Appendix 2: PCR cycling conditions

Region/Step	Initial denaturing		PCR cycle						
			Denaturing		Annealing		Elongation		Cycles
Temperature/Time	Temp. (°C)	Time (mm:ss)	Temp. (°C)	Time (mm:ss)	Temp. (°C)	Time (mm:ss)	Temp. (°C)	Time (mm:ss)	Times
ITS	94	04:00	94	00:30	55	01:00	72	01:00	35
trnLFc-trnLfd	94	04:00	94	00:30	58	01:00	72	01:00	35
trnLFe-trnLFf	94	04:00	94	00:30	56	01:00	72	01:00	35
At103	94	04:00	94	00:30	56	00:30	72	01:00	35
RPS16	94	04:00	94	00:30	58	01:00	72	01:00	35
ndhf	94	04:00	94	00:30	58	01:00	72	01:00	35

Region/Step	Final elongation		Termination	
Temperature/Time	Temp. (°C)	Time (mm:ss)	Temp. (°C)	Time (mm:ss)
ITS	72	10:00	5	∞
trnLFc-trnLfd	72	10:00	5	∞
trnLFe-trnLFf	72	10:00	5	∞
At103	72	10:00	5	∞
RPS16	72	10:00	5	∞
ndhf	72	10:00	5	∞

Appendix 3: MrBayes commands
Commands for MrBayes 3.2.0:

execute (Name of file.nex)

Lset nst=6 rates=gamma

Mcmc ngen=2000000 samplefreq=1000 printfreq=1000 diagnfreq=10000

In if in need of more generations, enter **y** and then number of generations

sump burnin=(burn-in/1000) **relburnin=no**

sumt burnin=(burn in/1000) **relburnin=no contype=allcompat**

Appendix 3: Herbarium specimens

Species	Coll#	Wild Collector	Herbarium	CULT in	CULT#	CULT collector	Coll#2	Area	Province	Latitude	Longitude	Elevation	DNA	Flower
P. pedicellata	80-307	Sterly, J.	E					New Guinea	Chimbu			2475.0		
P. racemigerum	5562	Webb, L.J.	BRI, CANB					Australia	Queensland	-17.0	145.5667	700.0		
P. tephrochlamys	LAE87000	Kuria, T. K.; Paul, O. K.	NSW					New Guinea	Morobe	-6.3583	147.183	80.0		
P. sp.	306	Armstrong, Kate E.	E					New Guinea	West Papua	-2.645	140.86917	27.0		
P. sp.	324	Armstrong, Kate E.	E					New Guinea	West Papua	-3.01917	140.79694	112.0		
P. sp.	LAE67921	Benjamin, M.A.	E					New Guinea	Milne Bay	-9.26667	150.3	920.0		
P. sp.	LAE67951	Benjamin, M.A.	E					New Guinea	Milne Bay	-9.26667	150.3	1500.0		
P. sp.	5377	Conn, B. J.	NSW					New Guinea	Madang	-5.9378	146.553	2569.0		
P. sp.	C8370	Coode M.J.	E	E	19691344	Lofthus, Ø	C8370	New Guinea	Morobe				y	y
P. sp.	s.n.	Coode M.J.	BRI					New Guinea	Morobe	-6.75833	147.00833	30.0		
P. sp.	s.n.	Coode M.J.	BRI					New Guinea	Madang	-5.09167	144.85833	60.0		
P. sp.	LAE 61620	Croft, J.R.	E					New Guinea	Central	-8.08333	147.58333	2700.0		

P. sp.	NGF34 567	Croft, J.R. & Lelean, Y.	E	New Gui-nea	Central	-9.15	147.71 667	1800. 0	
P. sp.	LAE 61986	Croft, James, R.	E	New Gui-nea	Northern	- 9.1666 7	147.75	2000. 0	
P. sp.	LAE611 21	Croft, James, R.	E	New Gui-nea	Gulf	- 7.5166 7	145.11 667	5.0	
P. sp.	13489	Daly, D.C.; G	E	New Gui-nea	Milne Bay	- 11.325 28	154.10 25	10.0	
P. sp.	72462	Henty, Edward E.	E	New Gui-nea	Morobe	- 6.6666 7	146.91 667	30.0	
P. sp.	2358	Hunt, P.F.	E	Polynesia	Makira	- 10.378 907	161.49 5161	0.0	
P. sp.	NGF32 295	Isles, S. & Vinas, A.N.	E	New Gui-nea	West New Britain	-5.0	151.25	140.0	
P. sp.	3821	J.A.Mcdonald & Ismail	E	New Gui-nea	Papua	- 2.0666 7	138.76 667	15.0	
P. sp.	s.n.	M. Lovave	AAU	New Gui-nea	Morobe	-6.85	146.8	700.0	
P. sp.	NGF40 636	Millar, A. N.	NSW	New Gui-nea	Eastern Highlands	-6.08	145.25	2438. 0	
P. sp.	NGF.40 952	Millar, Andrée N.	E	New Gui-nea	Morobe	- 7.3333 3	146.75	1219. 0	
P. sp.	104	Nooteboom	E	New Gui-nea	North Mo-luccas	-6.2	134.53	25.0	
P. sp.	2481	Poulsen, Axel Dalberg	BSIP, E	Polynesia	Makira	- 10.483 33	161.9	250.0	y
P. sp.	2485	Poulsen, Axel Dalberg	BSIP, E	Polynesia	Makira	- 10.566 67	161.81 667	800.0	y

P. sp.	2503	Poulsen, Axel Dalberg	AAU, E					Polynesia	Western	-7.91667	157.1	700.0	y	
P. sp.	2544	Poulsen, Axel Dalberg	AAU, E, LAE					New Guinea	Eastern Highlands	-6.01667	145.41667	2300.0	y	
P. sp.	2545	Poulsen, Axel Dalberg	AAU, E, LAE, SING					New Guinea	Eastern Highlands	-6.01667	145.41667	2300.0	y	
P. sp.	2554	Poulsen, Axel Dalberg	E, LAE					New Guinea	West New Britain	-5.95	150.51667	720.0	y	
P. sp.	2571	Poulsen, Axel Dalberg	E, LAE	E	20070120	Newman, M.F	2550	New Guinea	West New Britain	-5.45	149.98333	50.0	y	y
P. sp.	2579	Poulsen, Axel Dalberg	E, LAE					New Guinea	Bougainville	-5.4	154.63333	40.0	y	
P. sp.	2592	Poulsen, Axel Dalberg	E, LAE					New Guinea	Bougainville	-5.96667	155.08333	770.0	y	
P. sp.	2697	Poulsen, Axel Dalberg	AAU, E, LAE					New Guinea	Morobe	-6.55389	146.8675	100.0	y	
P. sp.	2706	Poulsen, Axel Dalberg	E, LAE					New Guinea	Madang	-4.58806	145.88861	120.0		
P. sp.	2717	Poulsen, Axel Dalberg	E, LAE					New Guinea	Madang	-5.28083	144.53333	1850.0	y	
P. sp.	2917	Poulsen, Axel Dalberg	E, LAE, O, SING	E	20141066			New Guinea	Eastern Highlands	-6.01431	145.41103	2350.0	y	
P. sp.	ALPHA	Poulsen, Axel Dalberg	E	E	2007004	Newman, M.F	2543	Polynesia	Makira	-10.53333	161.85	400.0	y	y
P. sp.	BETA	Poulsen, Axel Dalberg	E	E	2007005A	Poulsen, A.D	2872	Solomon Islands	Makira	-10.53334	161.86	400.1	y	y

P. sp.	2895	Poulsen, Axel Dalberg	CNS, E, LAE, O, SING	New Guinea	Morobe	-06.855	146.794	1340	y	y
P. sp.	2899	Poulsen, Axel Dalberg	LAE	New Guinea	Morobe	-06.859	146.797	1425	y	
P. sp.	2900	Poulsen, Axel Dalberg	E, LAE, O, SING	New Guinea	Morobe	-06.859	146.798	1375	y	y
P. sp.	2912	Poulsen, Axel Dalberg	E, LAE	New Guinea	Morobe	-05.947	146.546	2300	y	y
P. sp.	2913	Poulsen, Axel Dalberg	E, LAE, O	New Guinea	Morobe	-05.951	146.547	2450	y	y
P. sp.	2914	Poulsen, Axel Dalberg	E, LAE, O	New Guinea	Morobe	-05.955	146.574	2250	y	
P. sp.	2915	Poulsen, Axel Dalberg	E, LAE	New Guinea	Morobe	-05.940	146.552	2430	y	
P. sp.	2917	Poulsen, Axel Dalberg	E, LAE, O, SING	New Guinea	Eastern Highlands	-06.014	145.411	2350	y	y
P. sp.	2918	Poulsen, Axel Dalberg	E, LAE	New Guinea	Eastern Highlands	-06.014	145.411	2350	y	
P. sp.	2921	Poulsen, Axel Dalberg	E, LAE	New Guinea	Eastern Highlands	-06.351	145.281	2100	y	y
P. sp.	2927	Poulsen, Axel Dalberg	CNS, E, LAE, O, SING	New Guinea	Eastern Highlands	-06.360	145.297	2350	y	y
P. sp.	2931	Poulsen, Axel Dalberg	E, LAE	New Guinea	Eastern Highlands	-06.373	145.912	1850	y	y
P. sp.	1705	Sterly, Joachim	E	New Guinea	Chimbu			2500.0		
P. sp.	75-437	Sterly, Joachim	E	New Guinea	Chimbu			2100.0		
P. sp.	LAE54949	Stevens, Peter F.	E	New Guinea	Western Highlands	-5.58333	144.08333	2560.0		
P. sp.	4570	Takeuchi, W.	E, LAE	New Guinea	Morobe			975.0		
P. sp.	4612	Takeuchi, Wayne N.	E	New Guinea	Morobe			20.0		
P. sp.	12621	Takeuchi, Wayne N.	E	New Guinea	Eastern Highlands	-6.7166	145.0	1402.0		

										7				
P. sp.	LAE 66704	W.E.Barker & A.Vinas	E					New Guinea	West New Britain	-5.21667	150.03333	200.0		
P. sp.	s.n.	Wiakabu J.	BRI					New Guinea	West sepik	-3.14167	141.10833	700.0		
P. sp.	LAE 73452	Wiakabu, J.	E					New Guinea	Western Highlands	-5.58333	144.16667	1760.0		
P. sp.	203	Winters, Harold Franklin		WAI	75p166	Lofthus, Ø	1009	New Guinea	Eastern Highlands				y	y
P. sp.	75P334	Winters, Harold Franklin	E	E	19751789/19751791	Lofthus, Ø	1789/1791	New Guinea	West New Britain				y	y
P. sp.	2156	Woods, P.J.B.	E					New Guinea	Morobe			1300.0		
P. sp.	3047	Woods, Patrick	E					New Guinea	Central			2835.0		
P. aff. Tricho-calyx	2889	Poulsen, Axel Dalberg	E, LAE, O					New Guinea	New Ireland	-04.202	152.976	750	y	
P. aff. Tricho-calyx	2890	Poulsen, Axel Dalberg	E, LAE					New Guinea	New Ireland	-04.207	152.969	1050	y	y
P. biligulatum	86/212	G.Argent & J.Sandham	E					New Guinea	Chimbu	-6.2	145.16667	2500.0		
P. floribundum	NGF 49234	Henty, Edward E.	E					New Guinea	Madang	-5.73333	145.41667	198.0		
P. floribundum	LAE88013	Sennart,	NSW					New Guinea	Morobe	-7.30367	146.626	1818.0		
P. floribundum	80-705	Sterly, Joachim	E					New Guinea	Chimbu	-5.9	143.05	2100.0		
P. floribundum	4573	Takeuchi, W.	E					New Guinea	Morobe			1190.0		
P. floribundum	s.n.	Woolliams, K		WAI	75s1701	Lofthus, Ø	1011	New Guinea	Central					
P. hellwigii	16162	Takeuchi, W.;	E					New Gui-	Morobe	-	146.93	70.0		

		Ama, D.						nea		6.66667	333			
P. hellwigii	16330	Takeuchi, W.; Ama, D.	E					New Guinea	Morobe	-6.66667	146.93333	70.0		
P. macropycnanthum	2509	Poulsen, Axel Dalberg	AAU, E, LAE, SING					New Guinea	Morobe	-7.18333	146.46667	2150.0	y	y
P. macropycnanthum	12307	Takeuchi, Wayne N.	E					New Guinea	Eastern Highlands	-6.71667	145.0	1783.0		
P. macropycnanthum	12540	Takeuchi, Wayne N.	E					New Guinea	Eastern Highlands	-6.71667	145.0	1706.5		
P. neragaimae	s.n.	Gilli,A. 285	W					New Guinea	Chimbu			2300.0		
P. peekelii	LAE 61063	Croft, J.R.	E					New Guinea	Southern Highlands	-6.16667	143.98333	2340.0		
P. peekelii	NGF 48561	Millar, A.N.	E					New Guinea	Madang	-5.33333	147.08333	0.0		
P. peekelii	2498	Poulsen, Axel Dalberg	BSIP, E					Polynesia	Eastern Province	-7.88333	157.13333	200.0	y	
P. peekelii	2580	Poulsen, Axel Dalberg	E, LAE	E	20070123	Poulsen, A.D	2830	New Guinea	Bougainville	-5.95	155.06667	750.0	y	y
P. peekelii	LAE 50124	Stevens, P.F.	E					New Guinea	Madang	-5.33333	147.08333	129.5		
P. peekelii	4488	Takeuchi, W.	E					New Guinea	Morobe	-0.23333	146.6	1005.0		
P. pterocarpum	12339	Takeuchi, W.	E					New Guinea	Eastern Highlands	-6.71667	145.0	1920.5		
P. pterocarpum	12901	Takeuchi, W.	E					New Gui-	Eastern	-6.5	145.05	1770.		

					nea	Highlands			0
P. racemigerum	214	Cooper, W.	CNS		Australia	Queensland	-17.4167	145.7	680.0
P. racemigerum	514	Cooper, W.;	CNS		Australia	Queensland	-17.4167	145.7	680.0
P. racemigerum	697	Dockrill, A.W.	CNS		Australia	Queensland	-15.8333	145.25	350.0
P. racemigerum	616	Douglas, A.W.	MEL		Australia	Queensland	-17.3833	145.7611	650.0
P. racemigerum	1156	Dowe, J.L.	CNS		Australia	Queensland	-16.9414	145.7139	313.0
P. racemigerum	130	Elick, R.	CNS		Australia	Queensland	-17.3667	145.7	800.0
P. racemigerum	23979	Forster, P.I.	CNS		Australia	Queensland	-17.0	145.6667	480.0
P. racemigerum	24007	Forster, P.I.	BRI, CNS		Australia	Queensland	-16.5667	145.3167	440.0
P. racemigerum	PIF15492	Forster, P.I.	BRI		Australia	Queensland	-17.25680	145.9261	80.0
P. racemigerum	PIF17119	Forster, P.I.	BRI		Australia	Queensland	-17.2170	145.6992	640.0
P. racemigerum	PIF24050	Forster, P.I.	BRI		Australia	Queensland	-17.2162	145.6972	740.0
P. racemigerum	967	Gray, B.	CNS		Australia	Queensland	-17.2667	145.4667	807.0
P. racemigerum	1581	Gray, B.	BRI, CNS, E		Australia	Queensland	-	145.51	920.0

						17.73333	667	
P. racemigerum	5520	Gray, B.	CNS	Australia	Queensland	-17.1	145.6833	120.0
P. racemigerum	5737	Gray, B.	CNS	Australia	Queensland	-17.3833	145.7667	660.0
P. racemigerum	5900	Gray, B.	CNS	Australia	Queensland	-17.3667	145.5	820.0
P. racemigerum	7107	Gray, B.	CNS	Australia	Queensland	-17.3167	145.5	760.0
P. racemigerum	127	Hind, P. D.	NSW	Australia	Queensland	-16.58	145.27	609.0
P. racemigerum	7233	Hyland, B.	CNS	Australia	Queensland	-17.75	145.5833	280.0
P. racemigerum	7730	Hyland, B.	CNS, E	Australia	Queensland	-17.3333	145.75	0.0
P. racemigerum	7959	Hyland, B.	BRI CNS, E	Australia	Queensland	-17.09013	145.6761	100.0
P. racemigerum	8508	Hyland, B.	CNS	Australia	Queensland	-16.25	145.0833	960.0
P. racemigerum	8624	Hyland, B.	BRI, CNS	Australia	Queensland	-17.34013	145.5094	760.0
P. racemigerum	9506	Hyland, B.	BRI, CNS, E	Australia	Queensland	-17.67346	145.8428	250.0
P. racemigerum	11707	Hyland, B.	CNS	Australia	Queensland	-17.4667	145.65	700.0
P. racemigerum	12153	Hyland, B.	CNS	Australia	Queensland	-15.75	145.2667	300.0
P. racemigerum	14314	Hyland, B.	CNS	Australia	Queensland	-17.383	145.75	640.0

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P. racemigerum	14631	Hyland, B.	CNS					Australia	Queensland	-17.3833	145.75	700.0		
P. racemigerum	SFR 191	Hyland, B.	E					Australia	Queensland	-17.33333	145.5	760.0		
P. racemigerum	2605	Moriarty, V.K.	BRI, CNS					Australia	Queensland	-16.60680	145.2928	1000.0		
P. racemigerum	CAIRNS 06052	Morris, F.R.	CNS					Australia	Queensland	-17.25	145.6333	760.0		
P. racemigerum	2478	Poulsen, Axel Dalberg	AAU, BSIP, E	E	20070007	Poulsen, A.D	2873	Polynesia	Makira	-10.5	161.9	470.0	y	y
P. racemigerum	7325	Pullen, R.	E					New Guinea	Western			15.0		
P. racemigerum	AFO 03243	Rudder, E.J.	CNS					Australia	Queensland	-17.3333	145.5	760.0		
P. racemigerum	1396	Wannan, B.S.	BRI					Australia	Queensland	-16.97347	145.64281	520.0		
P. racemigerum	13769	Webb, L.J.	BRI, CNS					Australia	Queensland	-15.79014	145.35941	20.0		
P. tephrochlamys	NGF 49163	Henty, Edward E.	E					New Guinea	Eastern Highlands	-6.58333	145.66667	1768.0		
P. trichocalyx	86/193	G.Argent & J.Sandham	E					New Guinea	Chimbu	-6.2	145.16667	2600.0		
P. trichocalyx	s.n.	Richardson, J		WAI	76p794	Lofthus, Ø	1002	New Guinea	West New Britain				y	
P. piundaundensis	LAE 68131	Croft, J.R. & Akakavara, O.	E					New Guinea	Eastern Highlands	-6.71667	145.96667	3000.0		
P. piundaundensis	80-648	Sterly, Joachim	E					New Guinea	Chimbu	-5.9	143.05	3150.0		

P. piundaun-densis	LAE 50250	Stevens, P.F.	E					New Gui-nea	Western Highlands	-5.58333	144.08333	2591.0		
P. piundaun-densis	LAE 54646	Stevens, P.F.	E					New Gui-nea	Eastern Highlands	-5.83333	145.25	3500.0		
P. piundaun-densis	s.n.	Balgooy, MMJ van	L					New Gui-nea	Eastern Highlands	-5.75	145.08333	3350.0		
					75P334	Lofthus, Ø	1010							
			E, HLA			Nagata, K.M	3670							y
Cultivated material of unknown origin														
P. sp.				HLA		Lofthus, Ø	1001	New Gui-nea					y	
P. sp.				WAI	83p686	Lofthus, Ø	1003	New Gui-nea					y	
P. racemige-rum	s.n.	Carle, A		WAI	87p300	Lofthus, Ø	1004	New Gui-nea					y	
P. sp.				WAI	90p263	Lofthus, Ø	1005	New Gui-nea					y	
P. sp.					93p265	Lofthus, Ø	1006	New Gui-nea					y	
P. sp.				WAI	75p1791	Lofthus, Ø	1007	New Gui-nea					y	y
Alpinia sp.				WAI		Lofthus, Ø	1008	New Gui-nea					y	
P. sp.				WAI		Lofthus, Ø	1009	New Gui-nea						

Species	Coll#	Wild Collector	Herbarium	Area	Province	Latitu-de	Longi-tude	Elevation	DNA
R. aff. Lanata	322	Santika, Y	BO, E		Indonesia			50	y
R. affinis	LAE 50349	Stevens, P.F.	E	New Guinea	Central	-9,5	147,46667	732	

R. arfakensis	s.n.	Gjellerup, K	L					1200
R. arfakensis	1021	Gjellerup, K.	K	Indonesia				1200
R aurantiaca	126	Willis, F.R.	K	Indonesia		-4,4	136,87	10
R. bicuspis	286	Willis, F.R.	K	Indonesia		-4,23	137,03	1600
R. bidentata	633	Atkins, S.	K	Indonesia		-4,23	137,03	1670
R. bidentata	s.n.	Foreman	BRI		Central	-8,34167	147,475	2760
R. bidentata	s.n.	Stevens P.F.	BRI		Eastern highlands	-5,84167	145,25833	3300
R. bidentata	s.n.	Streimann H.	BRI		Morobe	-7,34167	146,175	1675
R. bidentata	1307	Woods, P.J.B.	E	New Guinea	Eastern Highlands			1676,5
R. bidentata	2244	Woods, P.J.B.	E	New Guinea	Milne Bay			1200
R. bidentata	2073	Woods, Patrick	E	New Guinea	Morobe			1341
R. bidentata	1249	Woods, Patrick J.B.	E	New Guinea	Eastern Highlands			1676,5
R. capillidens	s.n.	Gilli,A. 494	W					2800
R. charontis	93	Utteridge, T.M.A.	K	Indonesia		-4,28	137,02	522
R. corallina	329	Armstrong, Kate E.	E	New Guinea	West Papua	-3,02417	140,79667	151
R. corallina	329	Armstrong, Kate E.	E	New Guinea	Papua Province	-3,02417	140,79667	151
R. corallina	LAE66483	Conn, B. J.	NSW			-6,3486	143,251	800
R. corallina	s.n.	Floyd A.G.	BRI		Eastern Highlands	-6,08333	145,41667	2190
R. corallina	s.n.	Forster P.I.	BRI		Madang	-5,4416	145,54167	420

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R. corallina	s.n.	Gideon, O.G.	L		New Guinea	-10,06817	148,6	
R. corallina	NGF18408	H. Streimann & Y. Lelean	E	New Guinea	Western	-6,16667	141,33333	33
R. corallina	s.n.	Henty, E.E.; Isgar, R.; Galore, M.	L		New Guinea	-5,33333	142,25	
R. corallina	s.n.	Hoogland R.D.	BRI		East sepik	-4,5	142,66667	135
R. corallina	s.n.	Kerenga, K.; Katik, P.	L		New Guinea	-7,25	146,66667	
R. corallina	NGF 46354	Lelean, Yakas	E, BRI	New Guinea	Central	-8,30833	146,14167	914
R. corallina	3822	McDonald, J.A. & Ismail, R.	E	New Guinea	Papua Province	-2,06667	138,76667	15
R. corallina	s.n.	McDonald, J.A.; Isma	L		New Guinea	-2,66667	138,76667	
R. corallina	s.n.	Millar A.N.	L, BRI		Morobe	-6,83333	146,83333	1290
R. corallina	s.n.	Okada H.	BRI, BPBM		Morobe	-6,66667	147	200
R. corallina	2084	P.J.B. Woods & Lelean	E	New Guinea	Morobe			1341
R. corallina	s.n.	Royen, P. van	L		New Guinea	-6,33333	144,83333	
R. corallina	s.n.	Sands, M.J.S.	L		New Guinea	-0,83333	133,63333	
R. corallina	s.n.	Schodde R.	BRI		Gulf	-7,9166	145,41667	12

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R. corallina	s.n.	Streimann H.	BRI		Morobe	-7,175	146,675	1200
R. corallina	s.n.	Streimann, H.	L		New Guinea	-7,16667	146,66667	
R. corallina	NGF24452	Streimann, H. & Foreman, D.B.	E	New Guinea	Morobe	-7,33333	147,16667	200
R. corallina	s.n.	Streimann, H.; Kairo, A.	L		New Guinea	-2,93333	141,28333	
R. corallina	4544	Takeuchi, Wayne N.	E	New Guinea	Morobe			100
R. corallina	12781	Takeuchi, Wayne N.	E	New Guinea	Eastern Highlands	-6,71667	145	1170
R. corallina	s.n.		E	New Guinea				1280
R. corallina	s.n.		E	New Guinea				1280
R. corallina	s.n.		NSW		Southern Highlands	-6,2	143,3	
R. curcumoidea	s.n.	Erik Emanuelsson	S		Papua-Irian Jaya			2700
R. curviflora	5622	Nooteboom	E	Malay Islands	Maluku			25
R. curviflora	s.n.	Turner, H.	L		Moluccas	-6,25	134,75	
R. sp.	V25	A. Hay	E	New Guinea	West Sepik (Sandaun)			15
R. sp.	s.n.	A.S. Barfod	AAU		West sepik	-3,416	142,116	975
R. sp.	s.n.	Al Gentry	MO		Central			750
R. sp.	s.n.	Al Gentry	MO		Central			750
R. sp.	s.n.	Al Gentry	MO		Chimbu	-5,83	145	2800
R. sp.	36	Argent, George	E	New Guinea	West Papua [Irian Jaya]	-1,105	133,91778	1398
R. sp.	70	Argent, George	E	New Guinea	Papua (Irian Jaya)	-3,98639	136,35583	1899

R. sp.	20/16	Argent, George C.G.	E	New Guinea	Southern Highlands			2300
R. sp.	322	Armstrong, Kate E.	E	New Guinea	Papua Province	-2,56639	140,64667	212
R. sp.	323	Armstrong, Kate E.	E	New Guinea	Papua Province	-3,01917	140,79694	112
R. sp.	821	Baker, W.J.	K	Indonesia		-4,33	136,97	435
R. sp.	s.n.	Baker, W.J.; et al.	L		New Guinea	-4,33333	136,96667	
R. sp.	LAE 66916	Barker, W.R.	E	New Guinea	West Sepik (Sandaun)	-5	141,08333	3050
R. sp.	LAE 67521	Barker, W.R.	E	New Guinea	West Sepik (Sandaun)	-5	141,08333	2100
R. sp.	LAE 67522	Barker, W.R.	E	New Guinea	West Sepik (Sandaun)	-5	141,08333	2100
R. sp.	s.n.	Barker, W.R.	L		New Guinea	-5	141,08333	
R. sp.	LAE 67914	Benjamin, M.A.	E	New Guinea	Milne Bay	-9,26667	150,3	
R. sp.	s.n.	Burley, J.S.; et al.	L		Sulawesi	0,68333	123,66667	
R. sp.	s.n.	Conn B.J.	NSW			-6,4	143,33333	800
R. sp.	s.n.	Conn B.J.	NSW			-6,16667	146,83333	2200
R. sp.	s.n.	Conn B.J.	NSW			-5,83333	144,16667	
R. sp.	5336	Conn, B. J.	NSW			-5,9336	146,503	2808
R. sp.	5337	Conn, B. J.	NSW			-5,9336	146,503	2808
R. sp.	LAE69292	Conn, B. J.	NSW			-5,33	143,33	2250

R. sp.	LAE69294	Conn, B. J.	NSW			-5,33	143,33	2250
R. sp.	LAE69426	Conn, B. J.	NSW			-6,17	146,83	2200
R. sp.	NGF 40317	Coode	E	New Guinea	Southern High-lands	-6,16667	144,08333	2042
R. sp.	NGF 40321	Coode	E	New Guinea	Southern High-lands	-6,16667	144,08333	2042
R. sp.	NGF.29933	Coode, Mark	E, L	New Guinea	Eastern High-lands	-6,53333	145,61667	6100
R. sp.	s.n.	Croft J.R.	BRI		Milne bay	-9,425	150,80833	1700
R. sp.	NGF 34564	Croft, J. & Lelean, Y.	A, BRI, CANB, E, K, L	New Guinea	Central	-9,15	147,71667	1800
R. sp.	LAE 61984	Croft, J. et al	E	New Guinea	Northern	-9,16667	147,75	2000
R. sp.	LAE 61086	Croft, J.R.	E	New Guinea	Gulf	-7,51667	145,11667	5
R. sp.	LAE 61620	Croft, J.R.	CNS			-8,9167	147,5833	2700
R. sp.	s.n.	Croft, J.R.	L		New Guinea	-8,91667	147,58333	
R. sp.	LAE 68123	Croft, J.R.	E	New Guinea	Eastern High-lands	-6,71667	145,96667	3000
R. sp.	NGF 34637	Croft, J.R. & Lelean, Y.	E	New Guinea	Central	-9,15	147,71667	1800
R. sp.	s.n.	Croft, J.R.; et al.	L		New Guinea	-9,41667	150,8	
R. sp.	LAE 65764	Croft, J.R.; Lelean, Y.	CNS, E			-5	141,0833	2000
R. sp.	LAE	Croft,J.R.	BRI, E	New	West Sepik	-5	141,08	3200

	65971			Guinea	(Sandaun)		333	
R. sp.	LAE 74514	Damas, K.	BRI, CNS, E, L			- 11,508 33	153,50 833	600
R. sp.	s.n.	Davis, A.P.	L		New Guinea	- 0,7166 7	133,5	
R. sp.	LAE 74040	Essig, F.B. & Young, B.E.	E	New Guinea	West Sepik (Sandaun)	- 4,6666 7	139,91 667	60
R. sp.	LAE 74055	Essig, F.B. & Young, B.E.	E	New Guinea	West Sepik (Sandaun)	- 4,6666 7	141,91 667	50
R. sp.	LAE 74088	Essig, F.B. & Young, B.E.	E	New Guinea	Milne Bay	- 10,333 33	150,41 667	200
R. sp.	LAE 74107	Essig, F.B. & Young, B.E.	E	New Guinea	Morobe	- 7,1666 7	146,41 667	1800
R. sp.	s.n.	Essig, F.B.; Young, B.E.	CANB		West Sepik	- 4,6667	141,91 67	60
R. sp.	s.n.	Essig, F.B.; Young, B.E.	CANB			-4,66	141,91	60
R. sp.	s.n.	Fallen-Endress, M.E.	L		New Guinea	-7	146	
R. sp.	s.n.	Floyd A.	BRI		Gulf	- 7,5083 3	144,50 833	
R. sp.	LAE 60107	Foreman, D. & Vinas, A.	E	New Guinea	Central	- 9,0833 3	147,63 333	1370
R. sp.	s.n.	Foreman, D.B.	L		New Guinea	- 83,333 33	147,46 667	
R. sp.	s.n.	Foreman, D.B.; Kumul, M.	L		New Guinea	-3,2	141,35	
R. sp.	NGF 48125	Foreman, Donald B.	E	New Guinea	Morobe	- 6,4666 7	147,35	1676
R. sp.	s.n.	Forster P.I.	BRI		Madang	-4,975	145,75 833	300

R. sp.	s.n.	Forster P.I.	BRI		Eastern high-lands	-6,025	145,40833	1800
R. sp.	s.n.	Frodin D.	BRI		Southern high-lands	-6,00833	143,175	2040
R. sp.	s.n.	Frodin, D.G.	L		New Guinea	-6	143,16667	
R. sp.	9940	Gardner, Rhys O.	E	New Guinea	Madang	-5,21667	144,48333	400
R. sp.	9949	Gardner, Rhys O.	E	New Guinea	Madang	-5,21667	144,48333	2200
R. sp.	9973	Gardner, Rhys O.	E	New Guinea	Madang	-5,21667	144,48333	2600
R. sp.	LAE 57376	Gideon, O.	E	New Guinea	Southern High-lands	-6,46667	142,83333	1500
R. sp.	s.n.	Gideon, O.G.	L		New Guinea	-3,65	141,53333	
R. sp.	s.n.	Grubb, P.J.; Edwards, P.J.	L		New Guinea	-6	145,18333	
R. sp.	s.n.	H	L		New Guinea	-7,33333	146,25	
R. sp.	s.n.	Hartley, T.G.	L		New Guinea	-9,36667	147,46667	
R. sp.	s.n.	Hartley, T.G.	L		New Guinea	-6,4	146	
R. sp.	s.n.	Hartley, T.G.	L		New Guinea	-6,36667	145,93333	
R. sp.	s.n.	Heatubun, C.D.; et al.	L		New Guinea	-4	137	
R. sp.	s.n.	Henty E.E.	BRI		Eastern high-lands	-6,20833	146,04167	1200
R. sp.	s.n.	Henty, E.E.	L		New Guinea	-11,333	154,16667	

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R. sp.	s.n.	Henty, E.E.	L		New Guinea	-6,2	146,08889	
R. sp.	s.n.	Henty, E.E.	L		New Guinea	-5,08333	141,5	
R. sp.	s.n.	Henty, E.E.; Katik, P.	L		New Guinea	-7,71667	145,41667	
R. sp.	s.n.	Henty, E.E.; Lelean, J.R.	L		New Guinea	-10,16667	148,33333	
R. sp.	1179	Hiepko, P. & Schultze-Motel, W.	E	New Guinea		-4,41667	140,01667	1950
R. sp.	449	Hoover, Scott	E	New Guinea	West Sepik			500
R. sp.	665	Hoover, Scott	E	New Guinea	West Sepik			550
R. sp.	865	Hoover, Scott	E	New Guinea	West Sepik			815
R. sp.	514	Hoover, W.S.	E	New Guinea	West Sepik			850
R. sp.	883	Hoover, W.S.	E	New Guinea	West Sepik			815
R. sp.	s.n.	Hopkins, H.C.	L		New Guinea	-6,36667	143,28333	
R. sp.	NGF 32463	Isles & Vinas	E	New Guinea	Central	-9,08333	147,56667	500
R. sp.	NGF 32320	Isles, S. & Vinas, A.N.	E	New Guinea	West New Britain	-5	151,25	30
R. sp.	4581	J.S. Burley & Ismail	E, L	New Guinea	Watdangu	-3,66667	139	
R. sp.	s.n.	Jacobs, M.	L		New Guinea	-6,51667	143,16667	

R. sp.	s.n.	Jacobs, M.	L		New Guinea	-6,4	147,01667	
R. sp.	s.n.	Jensen R.	BRI		Gulf	-6,575	145,00833	1600
R. sp.	8727	Johns, R.J.	K	Indonesia		-4,25	136,83	400
R. sp.	8806	Johns, R.J.	K	Indonesia		-4,4	136,83	75
R. sp.	s.n.	Johns, R.J.; et al.	L		New Guinea	-5,31667	136,96667	
R. sp.	s.n.	Johns, R.J.; et al.	L		New Guinea	-1,36667	133,93333	
R. sp.	s.n.	Kalkman, C.	L		New Guinea	-6	143	
R. sp.	s.n.	Kalkman, C.	L		New Guinea	-5,25	141,66667	
R. sp.	LAE 56380	Katik, P.	E	New Guinea	Morobe	-7,33333	146,66667	2000
R. sp.	s.n.	Katik, P.	L		New Guinea	-9,61667	149,16667	
R. sp.	LAE 62028	Katik, P. & Larivita, G.	E	New Guinea	Morobe	-7	146,58333	914
R. sp.	NGF 37910	Katik, P. & Taho, K.	E	New Guinea	Morobe	-6,75	147,16667	1830
R. sp.	NGF 37913	Katik, P. & Taho, K.	E	New Guinea	Morobe	-6,75	147,16667	1830
R. sp.	5440	Leach, G.	E	New Guinea	Enga			2720
R. sp.	s.n.	Lister Turner R.	BRI		Milne bay	-10,58333	150	
R. sp.	s.n.	Lucas, E.J.; et al.	L		New Guinea	-5,33333	137,83333	
R. sp.	92892	Lugrayasa, Nyoman	E	New Guinea				2620
R. sp.	LAE 57004	M. Andrew	E	New Guinea	Southern Highlands	-6,1666	144	2535

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R. sp.	69	Mary Rogers Toner	E	New Guinea	Madang			1524
R. sp.	92627	Mendum, M.	E	New Guinea				2200
R. sp.	s.n.	Millar A.N.	BRI		Eastern high-lands	-6,00833	145,00833	2580
R. sp.	NGF.40954	Millar, A.N.	E	New Guinea	Morobe	-7,75	146,75	2438
R. sp.	NGF38337	Millar, A.N.	A, BISH, BO	New Guinea	Western High-lands	-5,83333	144,66667	2286
R. sp.	NGF38363	Millar, A.N.	E, L	New Guinea	Chimbu	-6	145	2591
R. sp.	NGF38467	Millar, A.N.	E	New Guinea	Morobe	-7,33333	146,75	2134
R. sp.	NGF40959	Millar, A.N.	E	New Guinea	Morobe	-7,75	146,75	2286
R. sp.	s.n.	Millar, A.N.	L		New Guinea	-8	141,83333	
R. sp.	s.n.	Millar, A.N.	L		New Guinea	-7,83333	141,66667	
R. sp.	s.n.	Millar, A.N.	L		New Guinea	-5,83333	144,66667	
R. sp.	s.n.	Milliken, W.	L		New Guinea	-4,23333	139,33333	
R. sp.	34134	New Guinea Forestry	E	New Guinea	Western	-6,16667	141,33333	25
R. sp.	12400	New Guinea Forestry Department	E		Southern Highlands			1981
R. sp.	LAE 54682	P.F. Stevens, P.J. Grubb	E, L	New Guinea	Eastern High-lands	-5,83333	145,25	3300
R. sp.	s.n.	Polak, A.M.	L		New Guinea	-1,15	132,48	

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R. sp.	2511	Poulsen, Axel Dalberg	LAE, E, AAU, SING, BO	New Guinea		-7,18333	146,46667	2150	y
R. sp.	2542	Poulsen, Axel Dalberg	AAU, E, LAE	New Guinea	Eastern Highlands	-6,01667	145,41667	2300	y
R. sp.	2709	Poulsen, Axel Dalberg	AAU, E, LAE	New Guinea	Madang	-5,28139	144,51889	2200	y
R. sp.	2716	Poulsen, Axel Dalberg	E, LAE	New Guinea	Madang	-5,28083	144,53333	1850	y
R. sp.	2724	Poulsen, Axel Dalberg	E, LAE	New Guinea	Western	-5,2	141,15	1475	y
R. sp.	2726	Poulsen, Axel Dalberg	AAU, E, LAE, SING	New Guinea	Western	-5,3	141,2	700	y
R. sp.	2730	Poulsen, Axel Dalberg	E, LAE	New Guinea	Western	-5,31667	141,2	800	y
R. sp.	s.n.	Pullen, R.	L		New Guinea	-10,06667	148,53333		
R. sp.	1C	R.A.W. Lowe	E	New Guinea				2743	
R. sp.	s.n.	R.A.W. Lowe	E	New Guinea				2438	
R. sp.	246	R.A.W. Lowe, Lady Maclehose, Diana Rendell	E	New Guinea				2	
R. sp.	s.n.	Ridsdale, C.E.	L		New Guinea	-7,33333	146,41667		
R. sp.	s.n.	Ridsdale, C.E.	L		New Guinea	-5,63333	141		
R. sp.	s.n.	Royen, P. van	L		New Guinea	-6,45	147		
R. sp.	7193	Sands, M.J.S.	K	Indonesia		-4,15	137,1	2280	
R. sp.	s.n.	Sauveur, E.G.; Sinke, G.	L		New Guinea	-4,26667	139,4		

R. sp.	s.n.	Sauveur, E.G.; Sinke, G.	L		New Guinea	-3,95	139,3	
R. sp.	543	Soegeng Reksodihardjo	E	New Guinea		-5	141	1400
R. sp.	LAE 75194	Sohmer & Katik	E	New Guinea	Madang	-5,25	145,61667	70
R. sp.	77-6	Sterly, J.	E	New Guinea	Chimbu			2600
R. sp.	80-641	Sterly, J.	E	New Guinea	Chimbu	-5,9	145,05	2800
R. sp.	80-70	Sterly, J.	E	New Guinea	Chimbu	-5,83333	145,11667	2600
R. sp.	80-93	Sterly, J.	E	New Guinea	Chimbu			2715
R. sp.	80-123	Sterly, Joachim	E	New Guinea	Chimbu			2300
R. sp.	s.n.	Stevens P.F.	BRI		Eastern highlands	-6,09167	145,25833	2550
R. sp.	LAE 50251	Stevens, P.F.	E	New Guinea	Western Highlands	-5,58333	144,08333	2530
R. sp.	LAE 50377	Stevens, P.F.	E	New Guinea	Central	-9,5	147,46667	968
R. sp.	LAE 55647	Stevens, P.F.	E	New Guinea	Milne Bay	-9,75	149,08333	2030
R. sp.	LAE 55851	Stevens, P.F.	E	New Guinea	Southern Highlands	-6,25	144,06667	3340
R. sp.	LAE 58141	Stevens, P.F.	E	New Guinea	Milne Bay	-9,96667	149,2	1470
R. sp.	s.n.	Stevens, P.F.	L		New Guinea	-5,58333	144,08333	
R. sp.	LAE 53373	Stone & Galore	E	New Guinea	Gulf	-7,91667	145,43333	7,5
R. sp.	LAE 54859	Streimann & Stevens	E	New Guinea	Morobe	-7,33333	146,16667	1750

R. sp.	8573	Streimann, H.	E	New Guinea	Southern Highlands	-6,15	143,98333	2250
R. sp.	LAE 53876	Streimann, H.	E	New Guinea	Morobe	-7,33333	146,16667	1675
R. sp.	LAE 54832	Streimann, H.	E	New Guinea	Morobe	-7,33333	146,16667	1600
R. sp.	s.n.	Streimann, H.	L		New Guinea	-7,31667	146,8	
R. sp.	NGF44026	Streimann, H. & Kairo, A.	E	New Guinea	Morobe	-7,08333	146,61667	671
R. sp.	s.n.	Streimann, H.; Stevens, P.	L		New Guinea	-7,33333	146,16667	
R. sp.	s.n.	Takeuchi W.	BPBM			-6,63333	147	200
R. sp.	4771	Takeuchi, W.	E	New Guinea	East Sepik	-4,43333	142,73333	
R. sp.	5712	Takeuchi, W.	BPBM, E	New Guinea	Eastern Highlands	-5,81667	145,08333	2600
R. sp.	6042	Takeuchi, W.	BPBM, E	New Guinea	East Sepik	-4,43333	142,06667	125
R. sp.	6242	Takeuchi, W.	E	New Guinea	East Sepik	-4,48333	142,68333	475
R. sp.	6710	Takeuchi, W.	E	New Guinea	East Sepik	-4,65	142,73333	100
R. sp.	9087	Takeuchi, W.	E	New Guinea	Morobe			300
R. sp.	s.n.	Takeuchi, W.N.	L		New Guinea	-2,47333	133,1345	

R. sp.	s.n.	Thomas B. Croat	MO		Morobe	-6,75	147	100
R. sp.	s.n.	Van Royen P.	BRI		Morobe	-7,34167	146,75833	1200
R. sp.	s.n.	Vandenberg, J.	L		New Guinea	-6,08333	143,83333	
R. sp.	s.n.	Vandenberg, J.	L		New Guinea	-5,75	145,08333	
R. sp.	s.n.	Vandenberg, J.	L		New Guinea	-5,36667	142,55	
R. sp.	s.n.	Versteegh C.	BRI, L		Irian Jaya	-0,83333	133,01667	1650
R. sp.	LAE 59505	Vinas, A. & Wiakabu, J.	E	New Guinea	West Sepik	-5	141,08333	2200
R. sp.	LAE 59730	Vinas, N. Artis	E	New Guinea	West New Britain	-5,48333	151,26667	1610
R. sp.	LAE 59331	Vinas, N.A.	E	New Guinea	West Sepik	-5	141,08333	1500
R. sp.	s.n.	Wayne Takeuchi	Conservation International			-7,735	146,496	
R. sp.	s.n.	Weiblen, G.D.; et al.	L		New Guinea	-5,21667	144,46667	
R. sp.	s.n.	White C.T.	BRI		Central	-9,58333	147,41667	
R. sp.	s.n.	White C.T.	BRI		Central	-9,23333	146,91667	
R. sp.	LAE 50, 545	Wiakabu, J.	E	New Guinea		-3,11667	141,11667	500
R. sp.	LAE 50584	Wiakabu, J.; et al.	CNS			-3,1333	141,1	700
R. sp.	s.n.	Wiakabu, J.; et al.	L		New Guinea	-	144,16	

						5,58333	667	
R. sp.	s.n.	Wiakabu, J.; et al.	L		New Guinea	-4,33333	141,1	
R. sp.	s.n.	Winters & Higgins	E					835
R. sp.	s.n.	Womersley J.S.	BRI		West sepik	-5,16667	141,58333	1600
R. sp.	NGF 48710	Womersley, J.S.	E	New Guinea	West Sepik			1600
R. sp.	s.n.	Womersley, J.S.	L		New Guinea	-6,08333	145,16667	
R. sp.	s.n.	Womersley, J.S.; Millar, A.N.	L		New Guinea	-5,66667	144,83333	
R. sp.	s.n.	Womersley, J.S.; Tomlinson, B.	L		New Guinea	-6,58333	147	
R. sp.	1681	Woods, P.J.B.	E	New Guinea	Morobe			1950
R. sp.	2241	Woods, P.J.B.	E	New Guinea	Milne Bay			1200
R. sp.	2554	Woods, P.J.B.	E	New Guinea	Milne Bay			1097
R. sp.	s.n.		NSW		Western Highlands	-5,7	144,2	
R. sp.	s.n.		NSW		Western Highlands	-5,2	143,3	
R. decurva	s.n.	Sands, M.J.S.	L		New Guinea	-0,91667	133,96667	
R. geluensis	s.n.	H	L		New Guinea	-7,41667	146,6	
R. geluensis	s.n.	H	L		New Guinea	-7,35	146,66667	
R. geluensis	s.n.	Kerenga, K.; Dao, C.N.	L		New Guinea	-7,4	146,73	

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R. geluensis	s.n.	Stevens P.F.	BRI		Central	- 9,5083 3	147,47 5	
R. geluensis	s.n.	Takeuchi, W.N.	L		New Guinea	- 5,5918 8	144,78 753	
R. geluensis	LAE 59780	Vinas, N.A.	E, L	New Guinea	Western Highlands			3470
R. geluensis	LAE 50631	Wiakabu, J. & Gideon, O.	E	New Guinea	Morobe	- 7,3333 3	146,08 333	2100
R. geluensis	s.n.	Wiakabu, J.; Gideon, O.G.	L		New Guinea	- 7,3333 3	146,83 333	
R. geluensis	233	Willis, F.R.	K	Indonesia		-4,13	137,08	1850
R. geluensis	272	Willis, F.R.	K	Indonesia		-4,13	137,08	2000
R. geluensis	s.n.	Womersley J.S.	BRI		Southern high-lands	- 6,0083 3	143,67 5	2300
R. geluensis	s.n.	Womersley, J.S.	L		New Guinea	-6	143,66 667	
R. geluensis	1309	Woods, P.J.B.	E	New Guinea	Eastern Highlands			915,5
R. geluensis var. microflora	s.n.	Gilli,A. 173	W			- 5,9666 7	144,88 333	2200
R. geluensis var. microflora	s.n.	Gilli,A. 497	W					2900
R. geluensis var. microflora	s.n.	Gilli,A. 497	W					2900
R. graminea	LAE 74058	Essig, F.B. & Young, B.E.	E	New Guinea	West Sepik (Sandaun)	- 4,6666 7	141,91 667	50
R. graminea	LAE 74080	Essig, F M	E	New Guinea	West Sepik (Sandaun)	-4,75	141,83 333	900
R. hollandiae	s.n.	Floyd A.G.	BRI		Morobe	- 7,9166 7	147,08 333	420

R. hollandiae	NGF14594	Millar, A.N.	E	New Guinea	Morobe	-6,66667	146,75	610
R. hollandiae	s.n.	Takeuchi W.	BPBM			-6,61667	147	
R. hollandiae	5594	Takeuchi, W.	E	New Guinea	Morobe	-6,61667	147	200
R. hollandiae	s.n.	Wiakabu J.	BRI		West sepik	-3,025	141,175	160
R. hollandiae	s.n.	Wiakabu, J.; et al.	L		New Guinea	-3,01667	141,16667	
R. klossii	s.n.	Davis, A.P.	L		New Guinea	-0,76667	133,5	
R. lanata	s.n.	Balgooy, M.M.J. van	L		Moluccas	-6,25	134,28333	
R. lanata	s.n.	Dransfield, J.; Zona, S.	L		New Guinea	-0,75	133,93333	
R. lanata	231	Edwards, Ian D.	E	New Guinea	Banten-Serang			400
R. lanata	s.n.	Sands, M.J.S.	L		New Guinea	-1,05	134,03333	
R. lanata	s.n.	Sands, M.J.S.	L		New Guinea	-0,8	134,03333	
R. lanata	16327	Takeuchi, W.; Ama, D.	E	New Guinea	Morobe	-6,66667	146,93333	70
R. lanata	4618	Van Balgooy, Max, M.J.	E	New Guinea				170
R. lanata	4860	Van Balgooy, Max, M.J.	E	Malay Islands				150
R. lanata	s.n.	Vogel, E.F. de	L		Moluccas	0,81667	127,86667	
R. ligulata	17539	Touw, A.	MEL		West Sepik	-5	141,08333	2300
R. longifolia	NGF 49207	Henty, E.E.	E, L	New Guinea	Morobe	-6,66667	146,91667	61

R. longifolia	6095	Takeuchi, W.	E	New Guinea	East Sepik	-4,46667	142,71667	150	
R. longifolia	15540	Takeuchi, W.; Ama, D.	E, L	New Guinea	Morobe	-6,66667	146,93333	100	
R. longifolia	s.n.	Wada K.	BRI		Morobe	-7,33333	146,66667	1500	
R. longirostra	s.n.	R. Schlechter	BGBM					0,1	
R. macrantha	s.n.	Gideon, O.	L		New Guinea	-10,41667	150,15		
R. macrantha	1134	Sands, M.	E	New Guinea	West Sepik			280	
R. macrantha	s.n.	Sands, M.J.S.	L		New Guinea	-1,08333	134,01667		
R. macrantha	7378	Takeuchi, W.	E	New Guinea	Southern Highlands			149	
R. macrantha	12950	Takeuchi, W.	E	New Guinea	Eastern Highlands			1768	
R. macrantha	s.n.	Willis, F.R.; et al.	L		New Guinea	-4,26667	137,16667		
R. macranthoides	6623	Takeuchi, W.	E	New Guinea	East Sepik			100	
R. macranthoides	6705	Takeuchi, W.	E	New Guinea	East Sepik	-4,65	142,73333	75	
R. maculata	NGF 47628	Streimann, H.	E	New Guinea	Morobe	-7,13333	146,76667	1219	
R. marafungensis	s.n.	Conn, B.J.	L		New Guinea	-6,08333	143,75		
R. maxima	11433	Takeuchi, W.; Kulang, J.	E	New Guinea	Gulf	-7,73333	146,48472	107	
R. maxima	11475	Takeuchi, W.; Kulang, J.	E	New	Gulf	-	146,5	137	

				Guinea		7,73333		
R. microbotrya	19/16	Argent, George C.G.	E	New Guinea	Southern Highlands	-6,16667	143,95	2300
R. microbotrya	LAE 68229	Croft, J.R. & Akakavara, O.	E	New Guinea	Eastern Highlands	-6,71667	145,96667	2400
R. microbotrya	54920	Lisowski, S.	E	New Guinea	Western Highlands			2000
R. microbotrya	49	Lovave, M.	AAU, E	New Guinea	Morobe	-6,85	146,8	950
R. microbotrya	s.n.	Lovave, M.J.	L		New Guinea	-6,25	146,8	
R. microbotrya	80-94	Sterly, J.	E	New Guinea	Chimbu			2700
R. microbotrya	80-94	Sterly, J.	E	New Guinea				2700
R. microbotrya	s.n.	Veldkamp, J.F.	L		New Guinea	-8,96667	147,63833	
R. microbotrya	s.n.	Womersley J.S.	BRI		Eastern Highlands	-6,06667	145,2	2400
R. microbotrya	s.n.	Womersley, J.S.	L		New Guinea	-6,41667	145,33333	
R. microbotrya	NGF 43610	Womersley, John S.	E	New Guinea	Western Highlands	-5,83333	144,25	2667
R. microbotrya	s.n.		E		Sepik, W			1524
R. montana	92386	Argent, G. & Tanjung, R.	E	New Guinea	Western			2700
R. montana	LAE 58586	Stevens, P.F. & Lelean, Y.	E, L	New Guinea	West New Britain	-5	151,38333	210
R. montana	12939	Takeuchi, W.	E	New Guinea	Eastern Highlands	-6,5	145,05	1770
R. montana	8525	Veldkamp, J.F	E	New Guinea	Central	-8,21028	146,78333	3270

R. montana	s.n.	Veldkamp, J.F.	L		New Guinea	-8,20617	146,78333	
R. montana var. arfakensis	s.n.	Gjellerup, K	L					1900
R. montana var. goliathensis	s.n.	Kock, AC de	L					3200
R. monticola	NGF 34562	Croft, J. & Lelean, Y.	E	New Guinea	Central	-9,15	147,71667	1800
R. monticola	LAE 61966	Croft, J.R.	E	New Guinea	Northern	-9,16667	147,75	2000
R. monticola	NGF 34785	Croft, J.R. & Lelean, Y.	E	New Guinea	Central	-9,15	147,71667	1920
R. monticola	LAE 58844	Damas, K.	E	New Guinea	Southern Highlands	-6,43333	142,83333	2000
R. monticola	NGF 45588	Foreman, Donald B.	E	New Guinea	Central	-8,33333	147,41667	2438
R. monticola	NGF 48040	Foreman, Donald B.	E, L	New Guinea	Eastern Highlands	-5,91667	144,41667	2835
R. monticola	s.n.	H	L		New Guinea	-7,25	146,83333	
R. monticola	s.n.	Henty, E.E.	L		New Guinea	-7,41667	146,95	
R. monticola	s.n.	Henty, E.E.	L		New Guinea	-6,25	145,91667	
R. monticola	s.n.	Johns	L		New Guinea	-4,2	137,83333	
R. monticola	8904	Johns, R.J.	K	Indonesia		-4,25	137,02	1900
R. monticola	NGF 40169	Kanis & Coode	E	New Guinea	Morobe	-7,33333	146,66667	2286
R. monticola	LAE 56660	Kerenga, K. & Cruttwell, N.	E	New Guinea	Eastern Highlands	-6,05833	145,4	2175
R. monticola	183	Marsden, J.	K	Indonesia		-4,17	137,08	2600

R. monticola	NGF40957	Millar, Andre N.	E	New Guinea	Morobe	-7,75	146,75	2286
R. monticola	3270	Philipson, W.R.	E, L	New Guinea	Central	-6,36667	145,75	1676
R. monticola	s.n.	Ridsdale C.	BRI		Central	-8,50833	147,34167	2550
R. monticola	NGF. 36888	Ridsdale, C.E.	E	New Guinea	Central	-8,5	147,33333	2438
R. monticola	NGF 36878	Ridsdale, Colin Ernest	E	New Guinea	Central	-8,5	147,33333	2591
R. monticola	LAE 75488	S.H.Sohmer	E	New Guinea	Chimbu	-5,78333	145,025	3000
R. monticola	7016	Sands, M.J.S.	K	Indonesia		-4,12	137,08	2324
R. monticola	s.n.	Sands, M.J.S.	L		New Guinea	-5,16667	137,83333	
R. monticola	LAE88018	Sennart	NSW			-7,42117	146,642	2017
R. monticola	LAE88008	Sennart, S. B.	NSW			-7,37	146,63	2530
R. monticola	s.n.	Stevens P.	BRI		Milne bay	-9,975	149,20833	1570
R. monticola	LAE58140	Stevens, P.F.	E	New Guinea	Milne Bay	-9,96667	149,2	1570
R. monticola	LAE 54002	Stevens, Peter F	E	New Guinea	Milne Bay	-9,73333	149,03333	1860
R. monticola	LAE 53907	Streimann, H.	E	New Guinea	Morobe	-7,33333	146,16667	1675
R. monticola	s.n.	Takeuchi W.	BPBM			-4,48333	142,68333	
R. monticola	5885	Takeuchi, W.	E	New	Eastern Highlands			2850

				Guinea				
R. monticola	6187	Takeuchi, W.	E	New Guinea	East Sepik	-4,48333	142,68333	440
R. monticola	LAE 74844	Umba, T.	E	New Guinea	Chimbu	-5,78333	145,01667	3600
R. monticola	s.n.	Van Royen P.	BRI		Central	-8,91667	147,5	2660
R. monticola	s.n.	Witono, J.	L		New Guinea	-4,18333	137,83333	
R. nymanii	NGF 48141	Foreman, Donald B.	E	New Guinea	Morobe	-6,46667	147,35	1585
R. paniculata	19/19	Argent, George C.G.	E	New Guinea	Southern High-lands	-6,16667	143,95	2500
R. paniculata	s.n.	Baker, W.J.; et al.	L		New Guinea	-4,23333	137,33333	
R. paniculata	NG29	Jenson, R.	E	New Guinea	Eastern High-lands	-6,56667	145	1600
R. paniculata	4335	W.Takeuchi	E	New Guinea	Morobe	-7,26667	146,11667	2348
R. paniculata	4137	Widjaja, Elizabeth A.	E	New Guinea	West Papua			1910
R. robusta	s.n.	Sands, M.J.S.	L		New Guinea	-1,11667	134	
R. rosacea	LAE88017	Sennart, S.	NSW			-7,3061	146,718	1818
R. rosacea	80-75	Sterly, Joachim	E	New Guinea	Chimbu			2600
R. rosacea	s.n.	Takeuchi, W.N.	L		New Guinea	-5,5333	144,78333	

						3		
R. rosacea	1250	Woods, Patrick J.B.	E	New Guinea	Eastern Highlands			1676,5
R. sessilanthera	s.n.	Stevens P.F.	BRI		Western highlands	-5,59167	144,09167	2625
R. sessilanthera	s.n.	Vinas, A.	L		New Guinea	-6,48333	147,53333	
R. sessilanthera var. euodon	NGF32952	Coode, M.; Katik, P.;	E	New Guinea	Southern Highlands	-6,1	143,66667	2743
R. sessilanthera var. euodon	NGF 42841	Henty, Foreman & Galore	E	New Guinea	Western	-5,2	141,13333	1829
R. sessilanthera var. euodon	80-37	Sterly, Joachim	E	New Guinea	Chimbu			2500
R. sessilanthera var. euodon	LAE51455	Stevens, P. & Coode, M.	E	New Guinea	Central	-8	146,91667	2438
R. stricta	s.n.	Takeuchi, W.N.	L		New Guinea	-7,73333	146,49167	
R. subalpina	80/93 (969)	Sterly, Joachim	E	New Guinea				2715
R. subalpina	s.n.	Veldkamp, J.F.; Obedi, S.	L		New Guinea	-5,97283	145,48833	
R. subalpina	s.n.	Vink, W	L					3270
R. subalpina	16015	Vink, W.	A, CANB		Western Highlands	-6,0167	144,6833	3270
R. subalpina	s.n.	Vink, W.	CANB			-6,01	144,68	3270
R. suborbicularis	s.n.	Brass, LJ	L					3040
R. suborbicularis	s.n.	Buderus J.	BRI, L		Central	-7	147	1950
R. suborbicularis	s.n.	Millar, A.N.; Gebo, A.	L		New Guinea	-8,41667	147,41667	
R. suborbicularis	80-67	Sterly, Joachim	E	New Guinea	Chimbu			2550
R. suborbicularis	s.n.	Stevens, P.F.	L		New Guinea	-6,0833	145,25	

						3		
R. subulocalyx	NGF 40168	Kanis, A.; Coode, M. J.E.	E	New Guinea	Morobe	-7,33333	146,66667	2286
R. subulocalyx	75-419	Sterly, Joachim	E	New Guinea	Chimbu			2600
R. subulocalyx	80-100	Sterly, Joachim	E	New Guinea	Chimbu			2450
R. subulocalyx	LAE 50268	Stevens, P.F.	E	New Guinea	Western Highlands	-5,58333	144,08333	2667
R. subulocalyx	s.n.	Takeuchi, W.N.	L		New Guinea	-5,5456	144,79687	
R. tenuifolia	LAE 52527	Lelean & Streiman	E	New Guinea	Milne Bay			40
R. tenuifolia	NGF45009	Streimann, H. & Students, F.C.	E	New Guinea	Morobe	-7,91667	147,23333	701
R. tenuifolia	16174	Takeuchi, W.; Ama, D.; Siga, B.; Kavua, M.	E	New Guinea	Morobe	-7,48333	147,28333	50
R. urceolata	9831	Gardner, Rhys O.	E	New Guinea	Madang	-5,21667	144,48333	2200
R. urceolata var. sessilifolia	NGF 40297	Coode, Mark	E	New Guinea	Southern Highlands	-6,16667	144,08333	2042
R. urceolata var. sessilifolia	NGF40325	Coode, Mark	E	New Guinea	Southern Highlands	-6,16667	144,08333	2042

Species	**Coll#**	**Wild Collector**	**Herbarium**	**Country**	**Province**	**DNA**	**Genbank ID**
Pleuranthodium schlechterii	00-6725	Kress, J.W	US	Papua New Guinea		y	AY424776
Siamanthus siliquosus K. Larsen & Mood	2832	Poulsen, A.D	E	Thailand		y	
Siliquamomum tonkinense Baill.	20081134A	RBGE	E	Viet Nam		y	

Siphonochilus decorus (Druten) Lock	125	GH	US	East Africa	y	AF47879 3
Siphonochilus aethiopicus (Schweinf.) B.L.Burtt	134	GH	US	East Africa	y	AF47879 2

Appendix 4: Morphological presentation

All pictures are taken by the author or Axel Dalberg Poulsen unless otherwise is stated.

All line drawings are made by the author, on which all scale bars are 5mm.

The accessions are ordered in the same way as the genera in the phylogeny, starting with *Pleuranthodium*.

The Accessions included are:

Coode 8370 *Pleuranthodium trichocalyx*

Hyland 11746 *Pleuranthodium racemigerum*

Newman 2543 *Pleuranthodium* aff. *racemigerum*

Newman 2550 *Pleuranthodium* aff. *trichocalyx*

Poulsen 2509 *Pleuranthodium macropychnanthum*

Poulsen 2872 *Pleuranthodium* aff. *racemigerum*

Poulsen 2873 *Pleuranthodium* aff. *racemigerum*

Poulsen 2890 *Pleuranthodium* aff. *trichocalyx*

Poulsen 2895 *Pleuranthodium* sp.

Poulsen 2913 *Pleuranthodium* sp. 1

Poulsen 2914 *Pleuranthodium* sp. 1

Poulsen 2917 *Pleuranthodium* sp. nov 1

Poulsen 2931 *Pleuranthodium* sp.

Poulsen 2697 *Pleuranthodium* sp.

Winters 75P334 *Pleuranthodium papillionaceum*

Winters 1791 *Pleuranthodium papillionaceum*

Woolliams s.n. *Pleuranthodium floribundum*

Ingit 449 *Riedelia* aff. *lanata*

Poulsen 2511 *Riedelia* sp.

Poulsen 2512 *Riedelia* sp.

Poulsen 2709 *Riedelia* sp.

Poulsen 2710 *Riedelia* sp.

Poulsen 2711 *Riedelia* sp.

Poulsen 2716 *Riedelia* sp.

Poulsen 2724 *Riedelia* sp.

Poulsen 2726 *Riedelia* sp.

Poulsen 2730 *Riedelia* sp.

Newman 2540 *Burbidgea* sp.

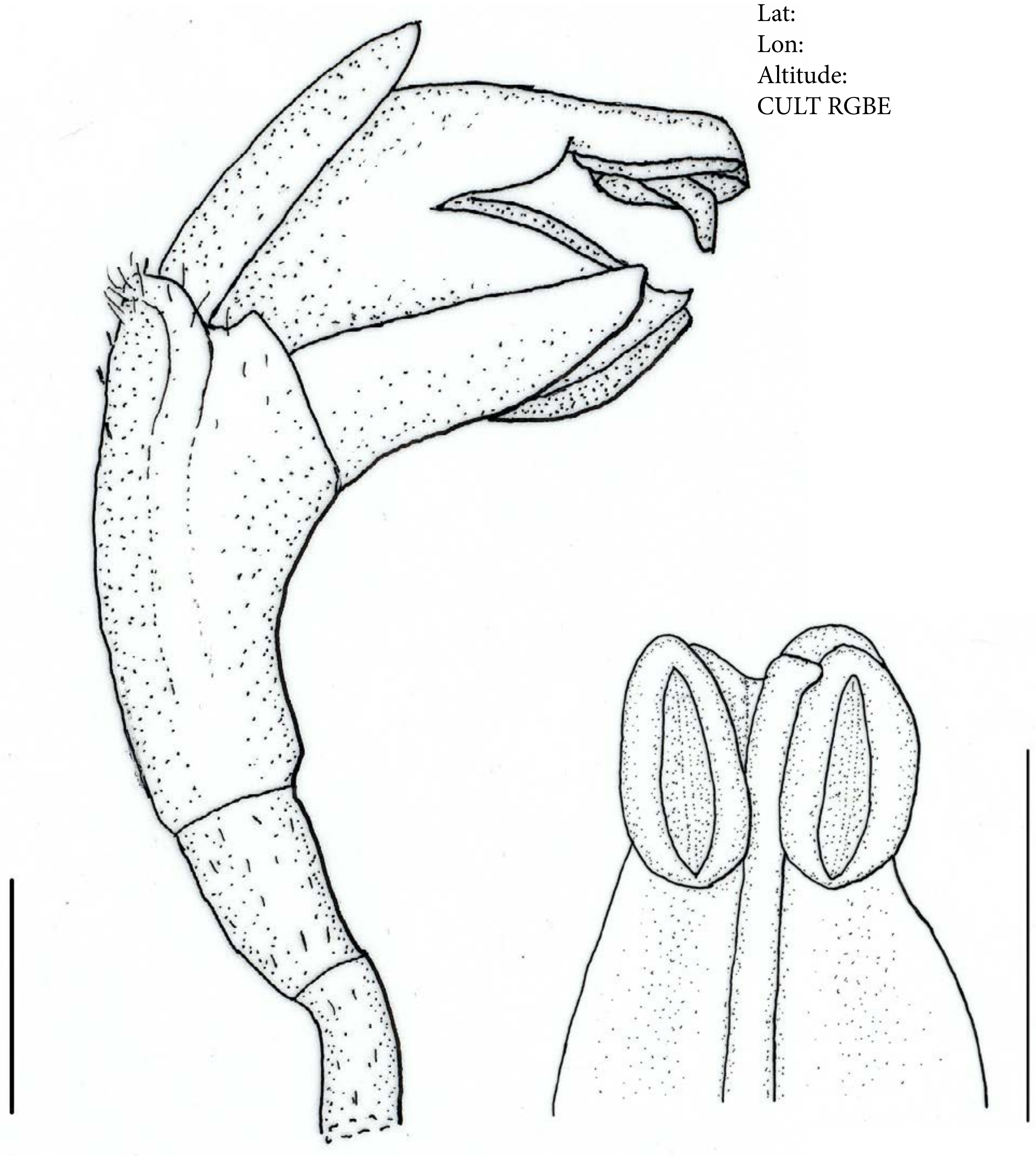
Poulsen 2832 *Siamanthus siliquosus*

RBGE 20081134A *Siliquamomum tonkinense*

Lofthus 1008 *Alpinia* sp.

Collection: Coode 8370
P. trichocalyx (Valeton) R.M.Sm.
Det: R.M.Sm.
Section *Pleuranthodium*

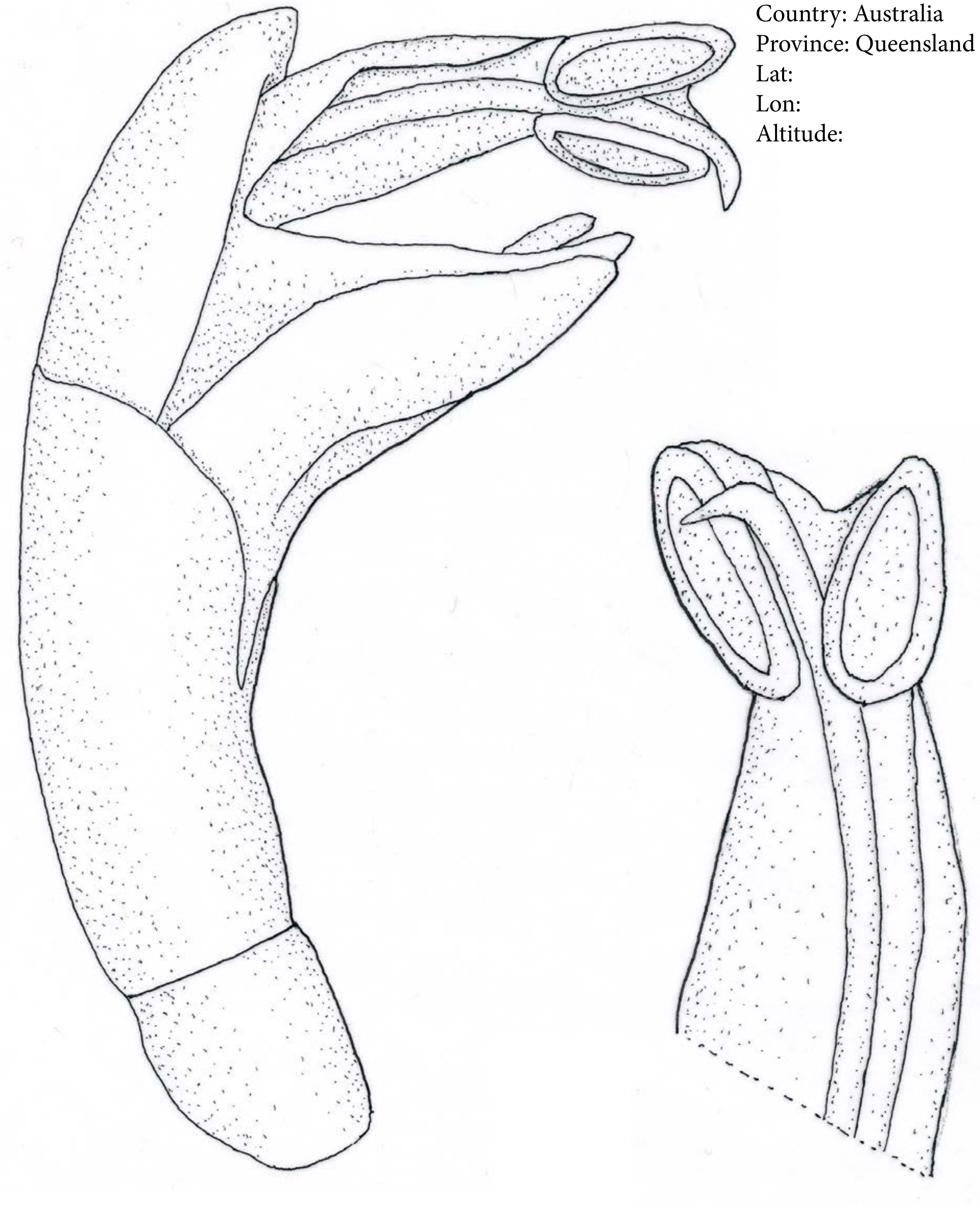
Country: Papua New Guinea
Province: Morobe
Lat:
Lon:
Altitude:
CULT RGBE



Special notes:
From Markham river.

Collection: Hyland 11746
P. racemigerum (F.Muell.) R.M.Sm.
Det: Hyland, B.
Section *Pleuranthodium*

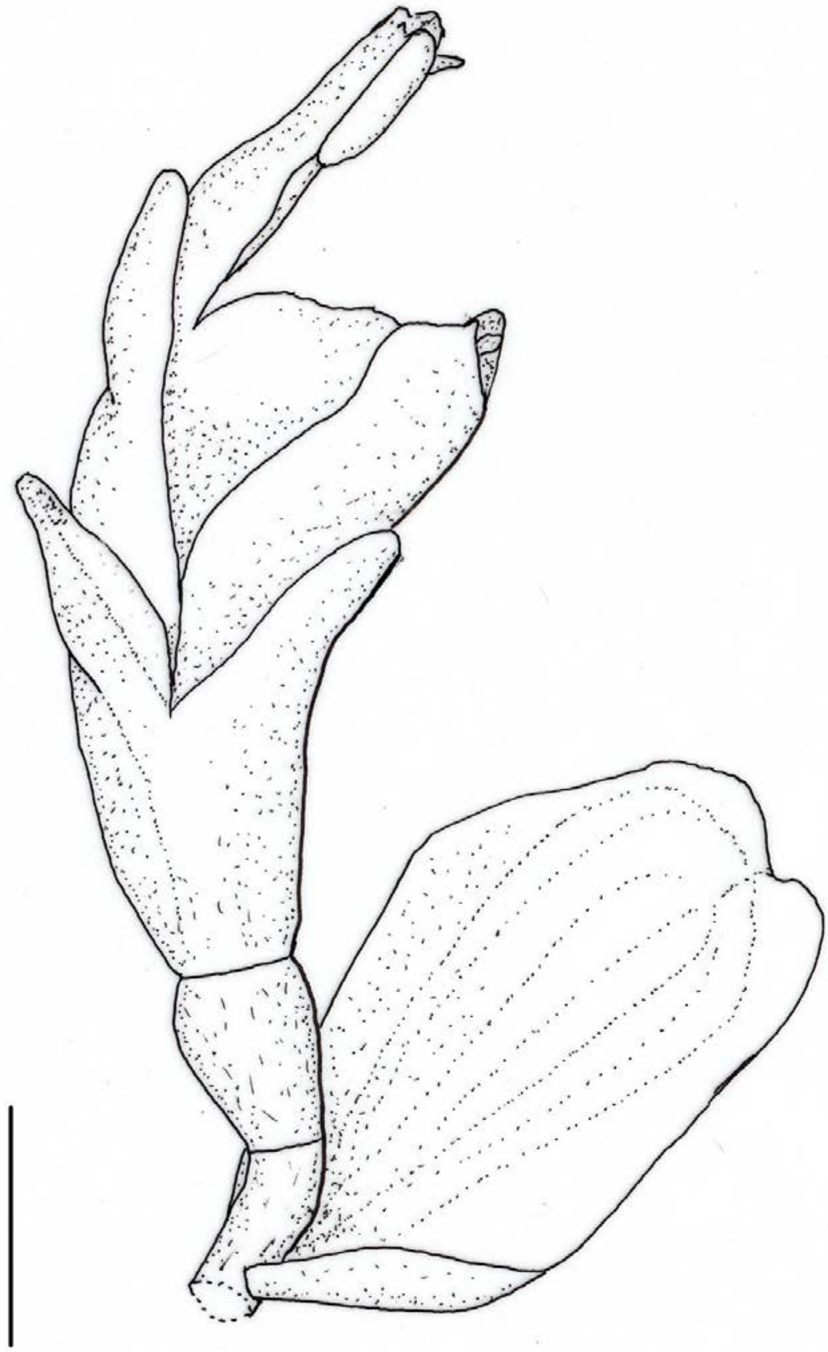
Country: Australia
Province: Queensland
Lat:
Lon:
Altitude:

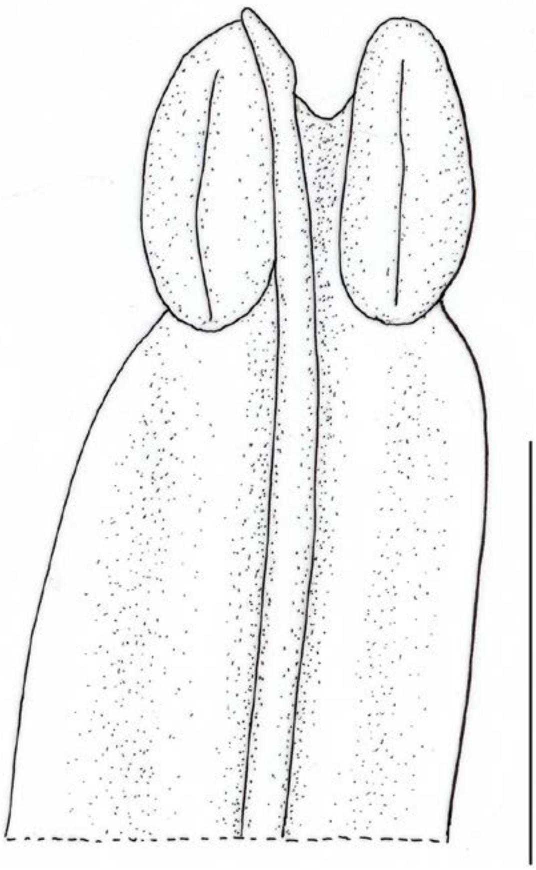


Special notes:
Has bracetole like P. aff. racemigerum. Not to scale.

Collection: Newman 2543
Pleuranthodium aff. *racemigerum*
Det: Lofthus, Ø.
Section *Pleuranthodium*

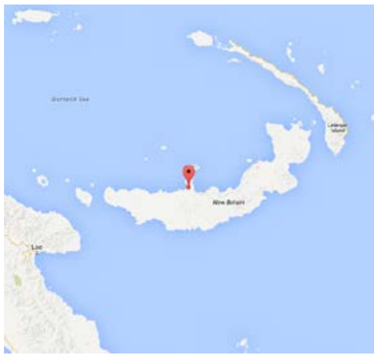
Country: Solomon Islands
Province: Makira
Lat: -10.53333
Lon: 161.85
Altitude: 400 m
CULT RBGE





Special notes:
Cultivated from Poulsen 2478
Differs from *P. racemigerum* in leaf morphology and general size.

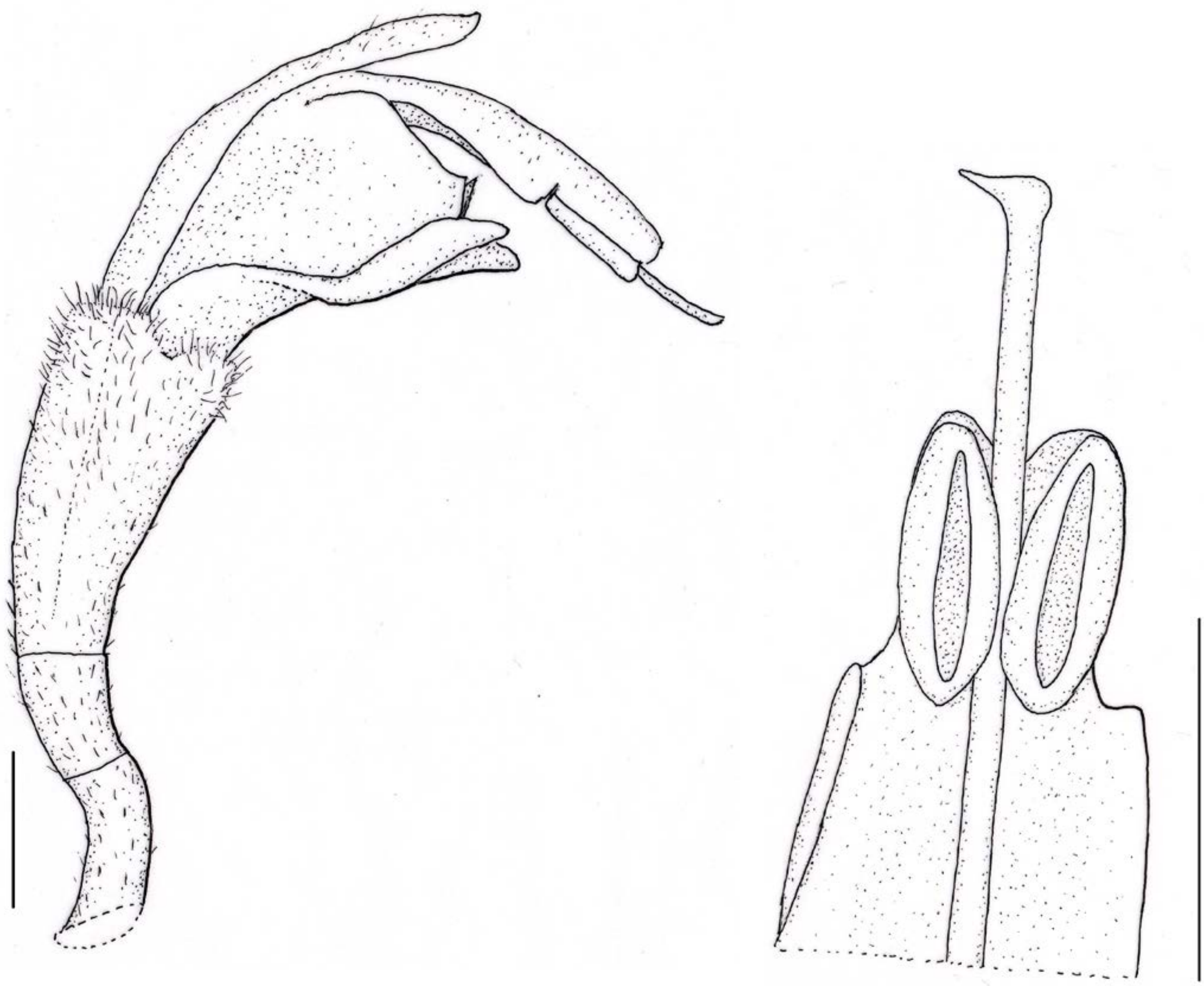
Collection: Newman 2550
P. aff. *trichocalyx* (Valeton) R.M.Sm
Det: Newman, M.F. & Lofthus, Ø.
Section *Pleuranthodium* sp.



Field description:
Terrestrial herb in clump (5-10 cm between neighbouring shoots). Leafy shoot to 2.7 m tall. Base to 4.5 cm diam., brown. Sheath pale green. Lamina to 69 x 16 cm, plicate.

Flower description:
Infructescence terminal, pendulous. Fruits orange-red.

Country: Papua New Guinea
Province: West New Britain
Lat: -5.45
Lon: 149.983
Altitude: 50 m
CULT RBGE



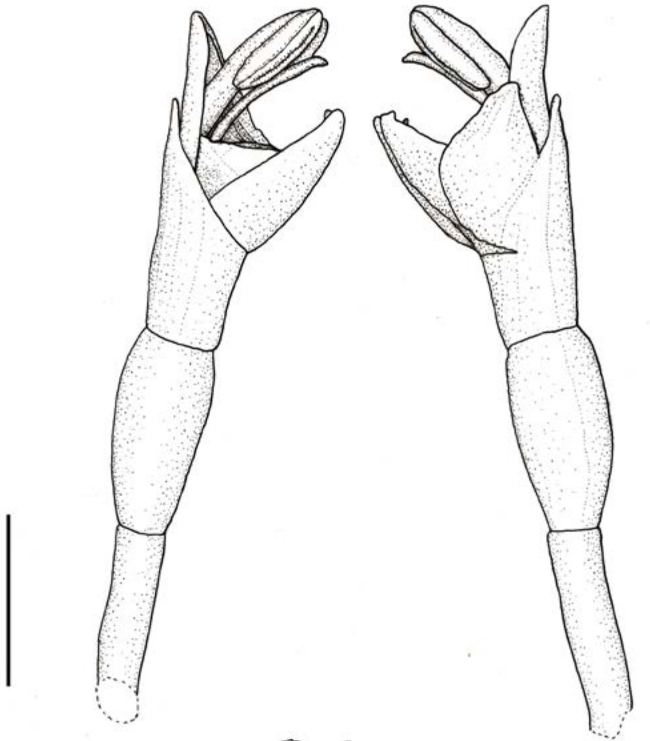
Special notes:
Cultivated from Poulsen 2571

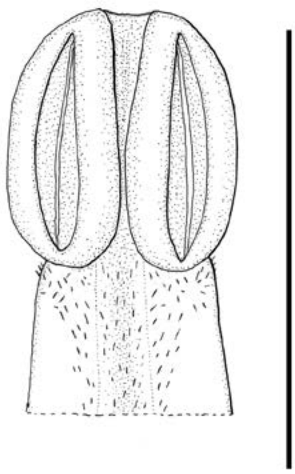
Collection: Poulsen et al. 2509
P. macropycnanthum (Valeton) R.M. Sm.
Det. Newman, M.F.
Section *Pleuranthodium* sp.

Country: Papua New Guinea
Province: Morobe
Lat: -7.183
Lon: 146.466
Altitude: 2150 m

Flower description:
Inflorescence terminal appearing to 30 cm below apex, enclosed by 3 bracts: to 40 cm long, yellow with pointed green tips to 18 cm. Inflorescence below plane of distichy of leaves, eventually becoming pendulous, with at least 400 flowers, many open at the same time, before bracts are shed, starting from base. Peduncle reddish. Ovary orange-yellow with reddish tinge. Calyx brownish purple. Corolla lobes dark purple. Labellum pale purple, central lobe darker, bidentate. Stamen purple. Stigma pale orange-red. Fruits orange-red, smooth, shiny, splitting in 3, pyriform, calyx and corolla ± persistent, brown. Seeds brown.

Field description:
Terrestrial herb in dense clump (5-20 cm between neighbouring shoots). Leafy shoots 2-3.5 m long. Base 5-8 cm, pale pink to pale brown. Sheath green. Ligule truncate to slightly emarginate, brown. Petiole to 15 mm long. Lamina to 66 x 19 cm, narrowly ovate, slightly plicate, plastic-like texture, base rounded, apex acute, margin yellowish orange.

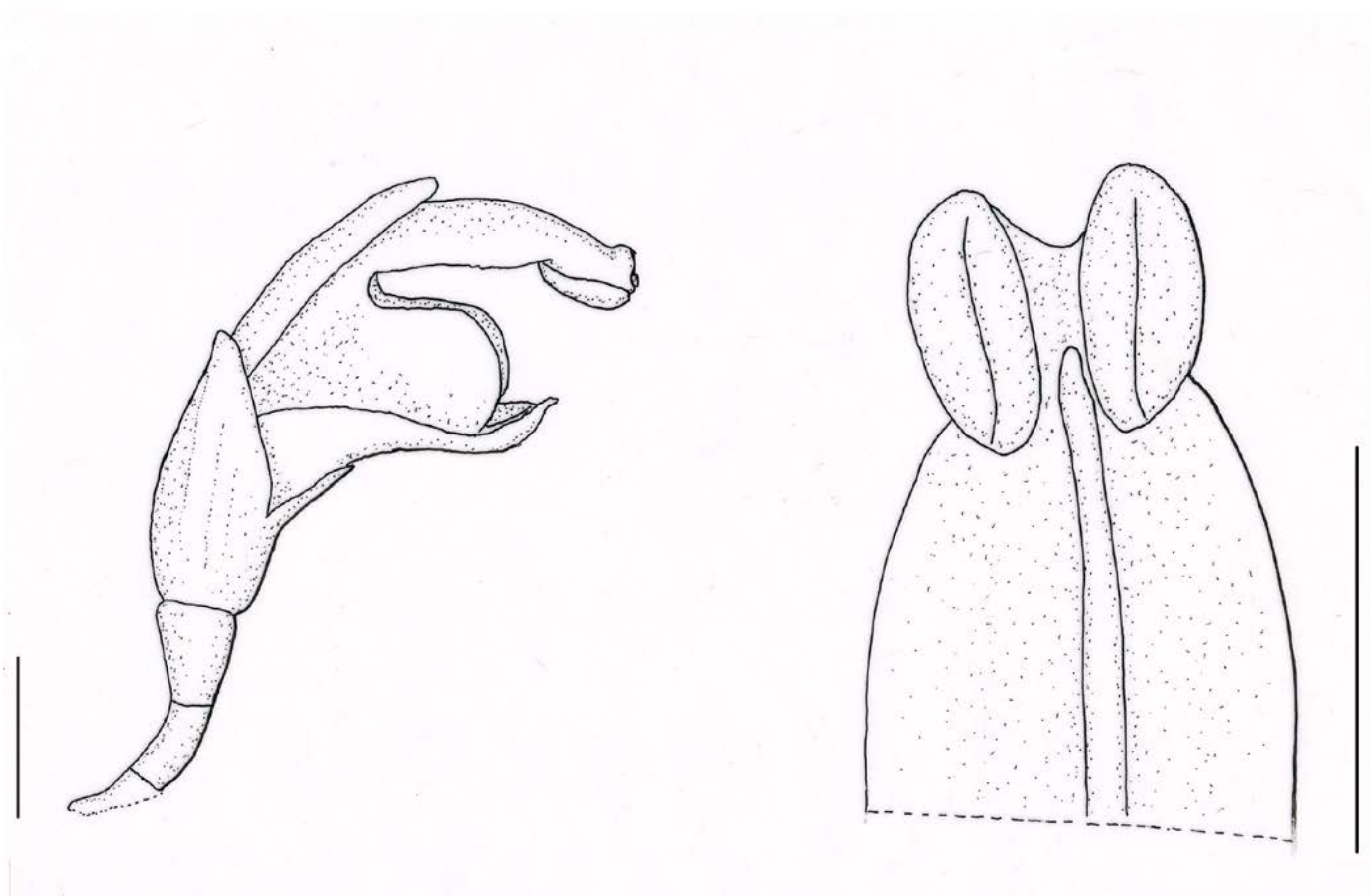




Collection: Poulsen et al. 2872
Pleuranthodium aff. *racemigerum*
Det: Lofthus, Ø.
Section *Pleuranthodium*

Flower description:
Pedicel curved;, ovary obconical, calyx sheath-like. Corolla lobes bent, longr than labellum. Labellum cup-shaped and adnate to filament. Filament narrowing towards anthers, anthers rounded. Style round, with bent stigma.

Country: Solomon Islands
Province: Makira
Lat: -10.53334
Lon: 161.86
Altitude: 400 m
Cultivated in RBGE



Special notes:
Cultivated. from (Poulsen BETA).

Collection: Poulsen et al. 2873

Pleuranthodium aff. *racemigerum*

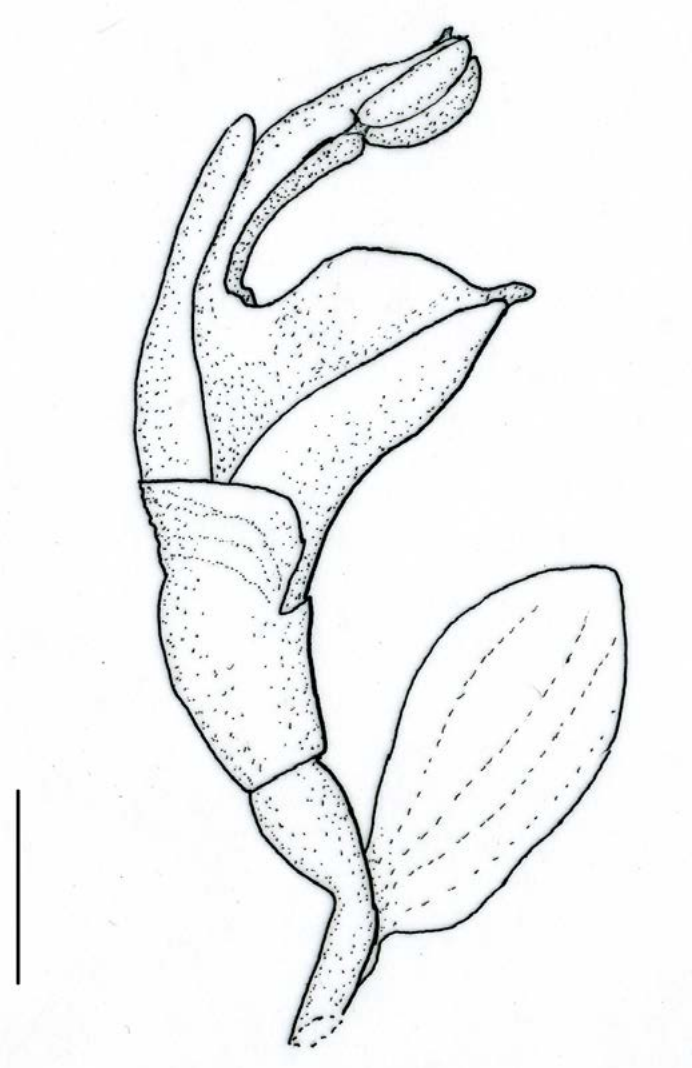
Det: Lofthus, Ø.

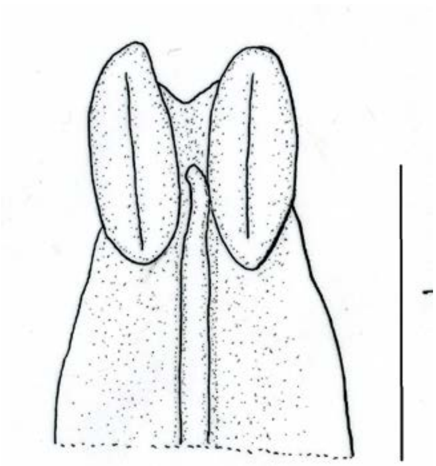
Section *Pleuranthodium*

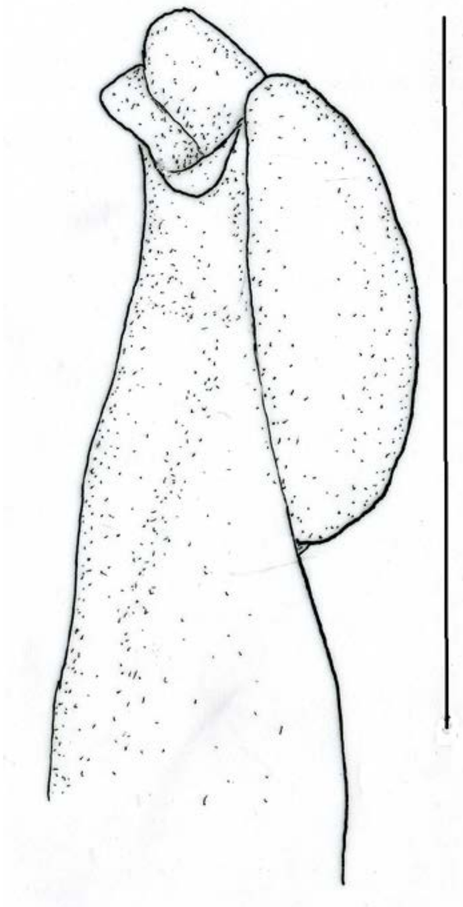
Field description:
Terrestrial herb to c. 3 m tall, in loose clump (< 10 cm between neighbouring shoots). Base to 6 cm diam., green. Sheath green. Ligule 8 mm long, green. Lamina sessile, 55 x 16 cm. Vernacular name: bubumera (Bauro language; mera means red).

Country: Solomon Islands
Province: Makira
Lat: 10.5
Lon: 161.9
Altitude: 470 m
Cult in RBGE

Flower description:
Bracteole attached to pedicel, ovary obconic, calyx sheath like, breaking ventrally, ridges dorasally and covering corolla tube. Corolla lobes cymbiform and equally long as labellum. Labellum cup-shaped and adnate to filament. Filament bent, with elevated edges ending in a shoulder. Thecae rounded.







Special notes:
Cultivated. from (Poulsen 2478).

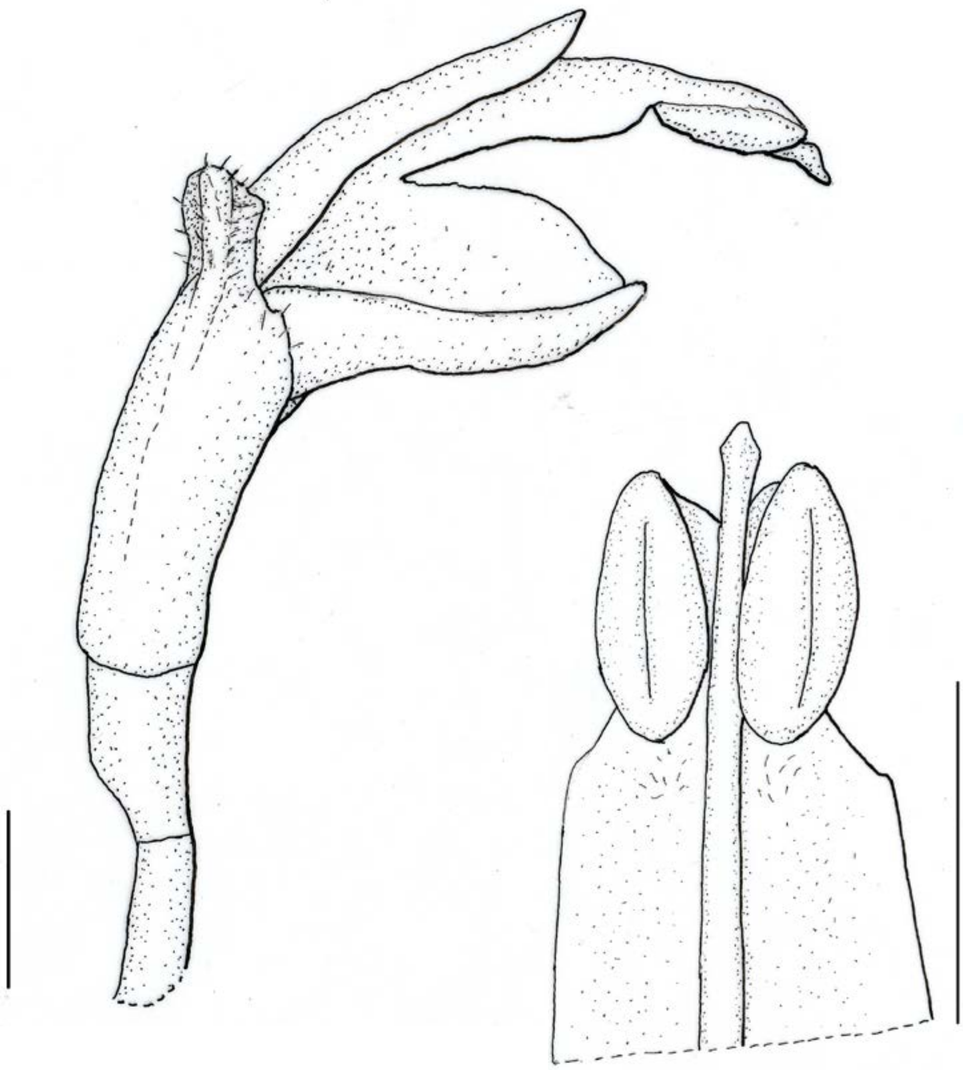
Collection: Poulsen et al. 2890
Pleuranthodium aff. *trichocalyx*
Det: Newman, M.F. & Lofthus, Ø.
Section *Pleuranthodium*

Country: Papua New Guinea
Province: New Ireland
Lat: -04.207
Lon: 152.969
Altitude: 1050 m

Field description:
Terrestrial herb. Leafy shoots to 2.5 m long with up to 20 leaves; base cylindrical , 3 cm diam., 6 cm apart; sheath pubescent, olivegreen; ligule 2–3 mm long, oblique to emarginate, greenish brown; lamina to 45 x 11 cm, plicate, plain green, beneath pale green and pubescent.

Flower description:

Inflorescence head pendant, 10 x 6 cm. Pedicel and ovary pale yellowish; calyx pale rose at base – dark burgundy at apex, very hairy; corolla lobes pale burgundy; labellum, stamen, style and stigma white, filament without obvious teeth but reduced to bumps; thecae pale brown laterally.



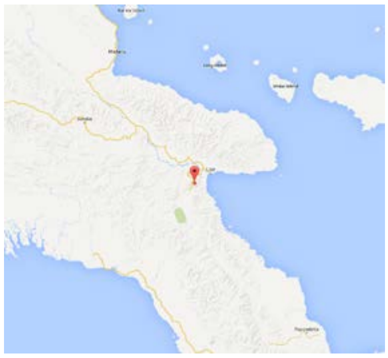
Special notes:
Probably same species as 2889, which was only found in fruit

Collection: Poulsen et al. 2895

Pleuranthodium sp.

Det: Poulsen, A.D. & Lofthus, Ø.

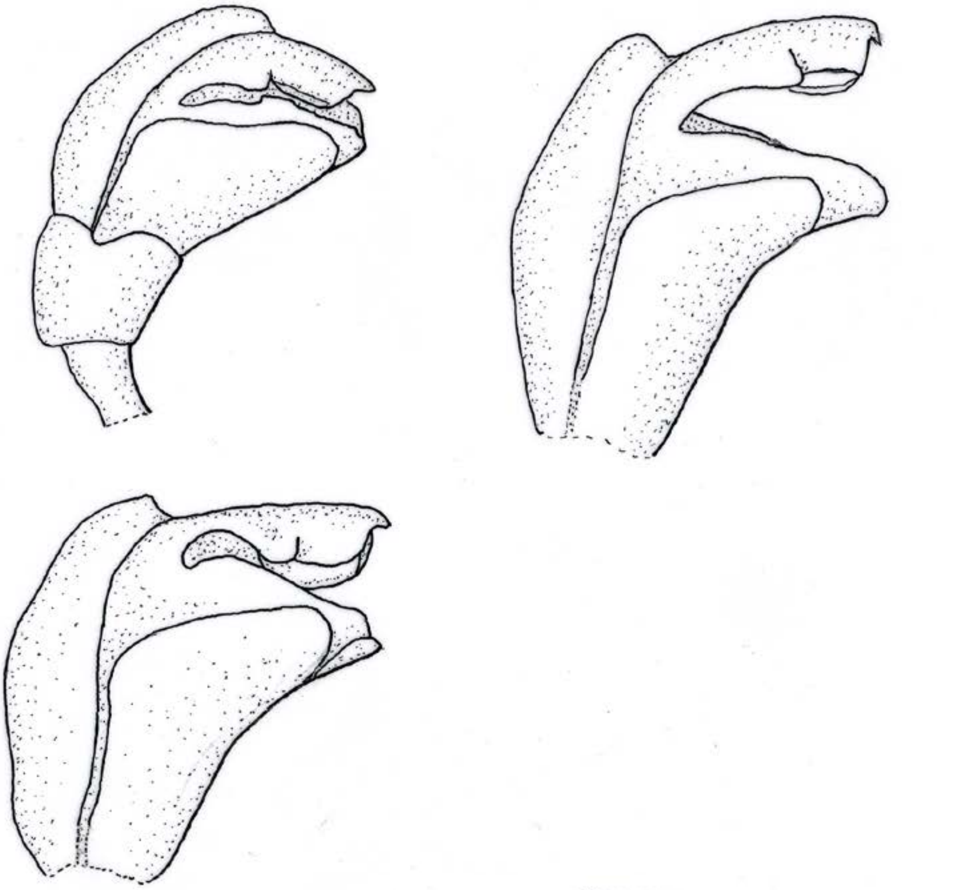
Section *Pleuranthodium*

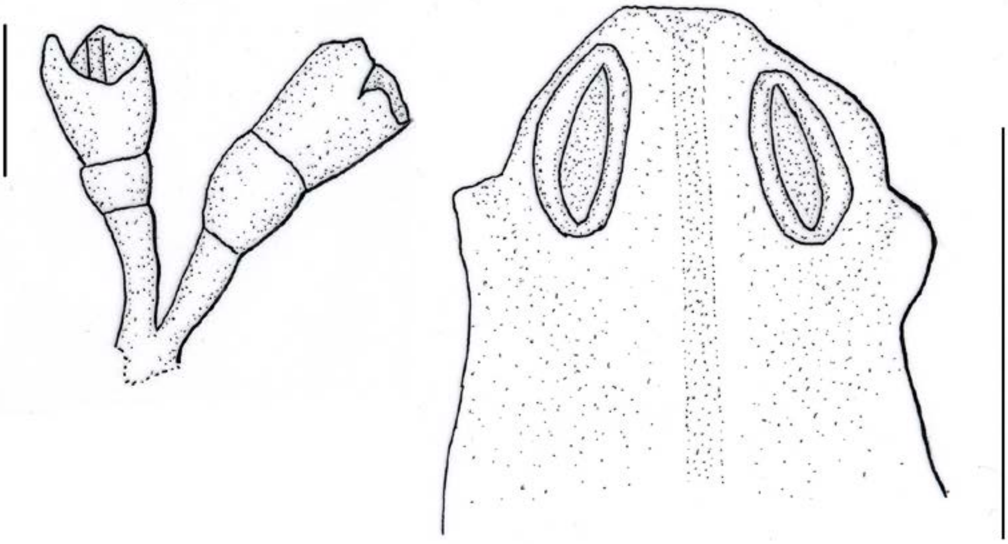


Country: Papua New Guinea
Province: Morobe
Lat: 06.855
Lon: 146.794
Altitude: 1340 m

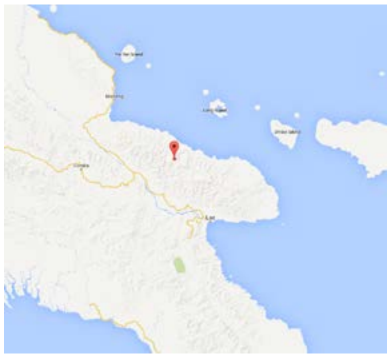
Field description:
Terrestrial herb. Leafy shoots to 1.8 m long, 8–9 cm apart, with 14–20 leaves per shoot when flowering; base 2.5 cm diam.; sheath dark olive-green; ligule 2–3 mm long, emarginate, ±uneven, greenish; lamina to 30 x 8 cm, slightly wavy.

Flower description:
Inflorescence subterminal by 7.5–9.5 cm, between third and fourth leaf from top of leafy shoot,
pendant, 16–25 cm long, peduncle 2–4 cm long, flowers spiralling at
base – in rings above; rachis pale olive-green; pedicel and ovary pale
green, calyx creamish brown.
Fruits elongate and pale green.





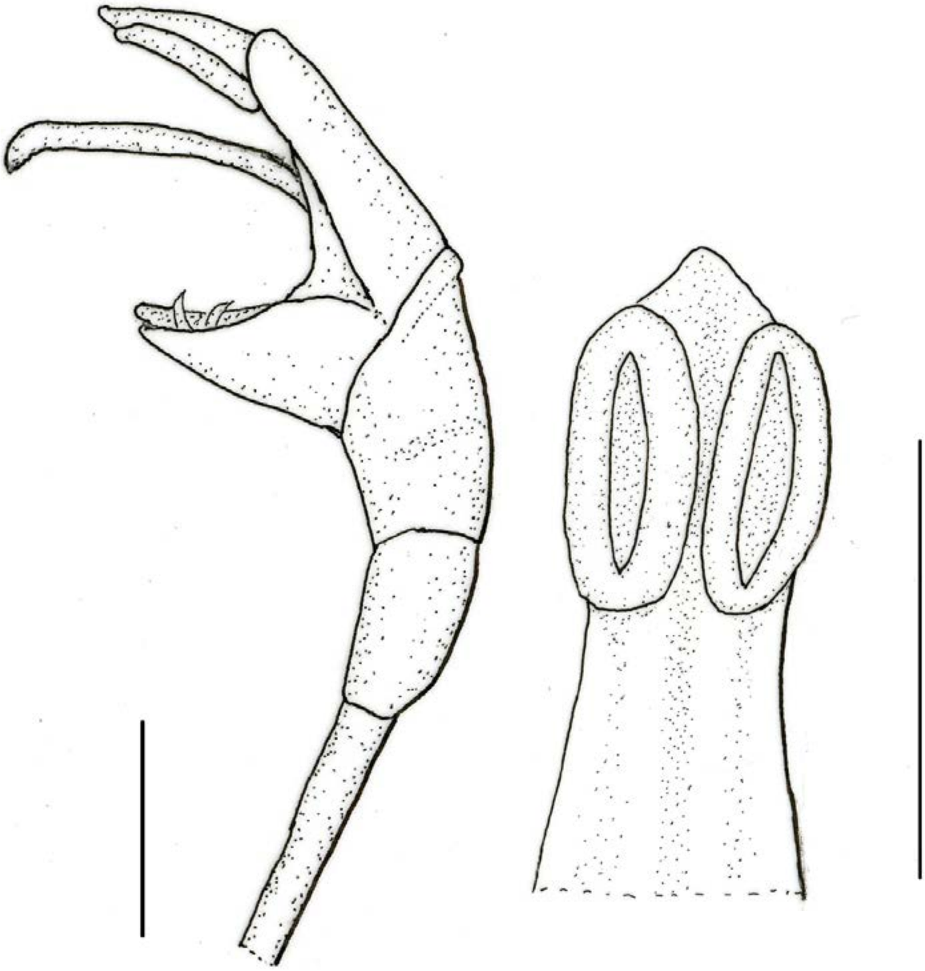
Collection: Poulsen et al. 2913
Pleuranthodium sp. 1
Det: Poulsen, A.D. & Lofthus, Ø.
Section *Pleuranthodium*



Country: Papua New Guinea
Province:
Lat: -05.951
Lon: 146.547
Altitude: 2450 m

Field description:
Terrestrial herb. Leafy shoots to 3.1 m long, to 13 cm apart; base to 4 cm diam., greenish to red; sheath yellowish green; ligule to 2.5 cm long, papery, caducous, splitting at apex; lamina to 44 x 7.5 cm. Vernacular name: jodal (generic name for all gingers in Yopno language).

Flower description:
Inflorescence subterminal by 17 cm, spathe cream, pendent, 12 x 3.5 cm; rachis, pedicel and ovary pale yellow-green; calyx and buds yellowish cream.



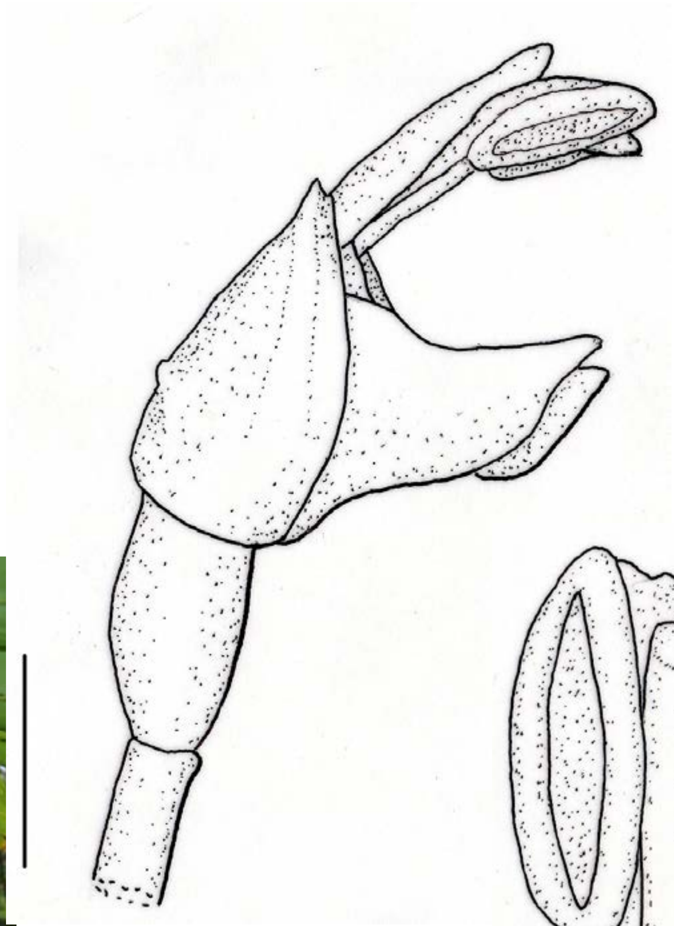
Special notes:
The flower have two teeth-like structures on the margin of the labellum

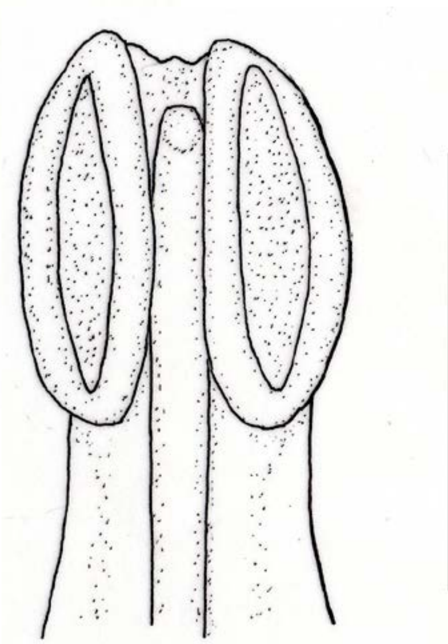
Collection: Poulsen et al. 2914
Pleuranthodium sp. 1
Det: Poulsen, A.D. & Lofthus, Ø.
Section *Pleuranthodium*

Country: Papua New Guinea
Province: Morobe
Lat: -05.955
Lon: 146.574
Altitude: 2250 m

Field description:
Terrestrial herb. Leafy shoots to 4 m long, to 15 cm apart, with up to 26 leaves per shoot; base to 3.5 cm diam., reddish; sheath dull green; ligule to 3 cm long, drying, splitting from apex; lamina to 40 x 9.5 cm, dark green, beneath pale green.

Flower description:
Inflorescence subterminal by
15–20 cm, 16–19 x 4 cm. Fruits green to yellowish orange. Flower white.





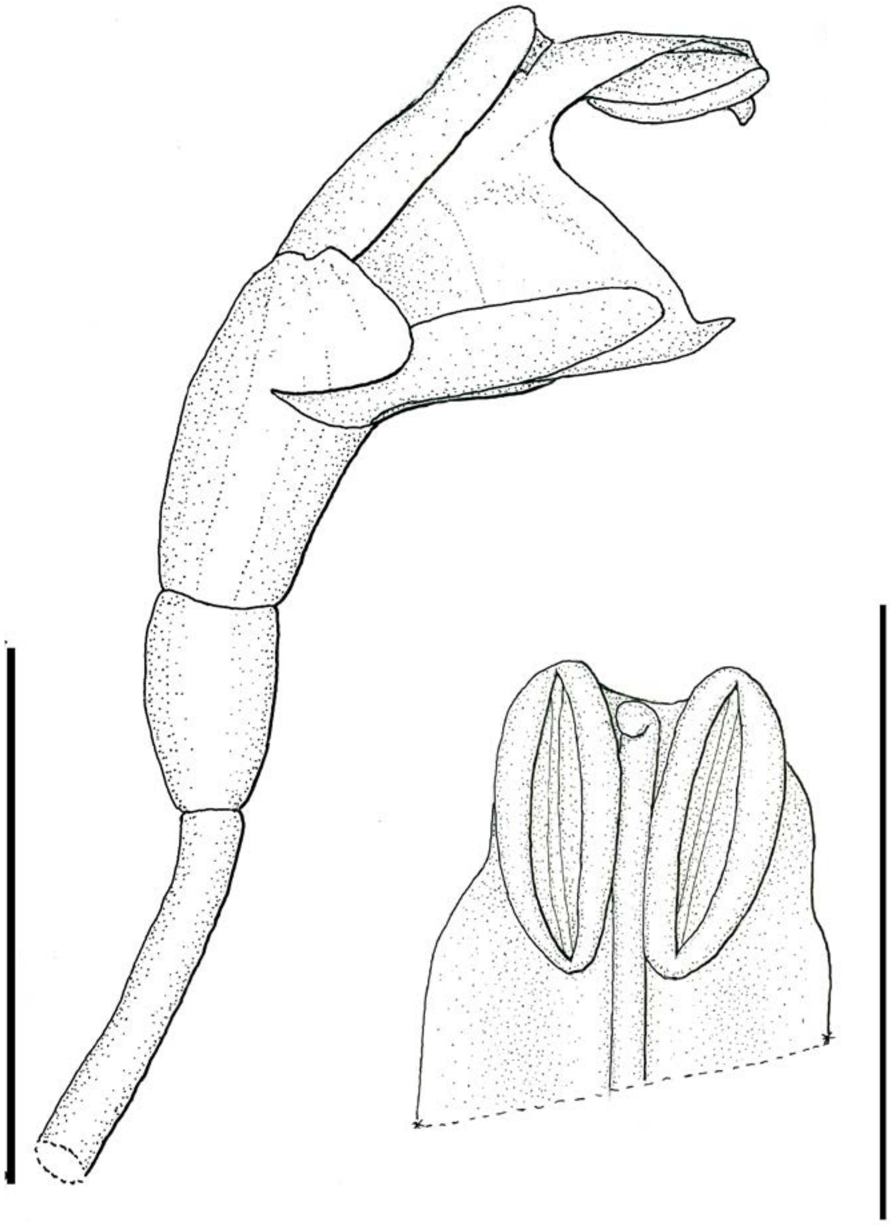
Special notes:
Has the same hump on the calyx as *Poulsen 2913* and is probably the same species

Collection: Poulsen et al. 2917
Pleuranthodium sp. nov. 1
Det: Newman, M.F. & Lofthus, Ø.
Section *Pleuranthodium*

Country: Papua New Guinea
Province: Eastern Highlands
Lat: -06.014
Lon: 145.411
Altitude: 2350 m

Field description
Terrestrial. Leafy shoots to 1.6 m long, 7–12 cm apart, with 8–9 leaves; bases creamish green, reddish when young; sheath compressed, yellow-green, margin ± reddish; ligule to 15 mm long, truncate, reddish; lamina to 58 x 14 cm, subsessile, slightly plicate, dark green, reddish beneath, especially when young. Vernacular name: ugupa (Arekano language).

Flower description:
Inflorescence terminal, pendent, to 39 cm long, peduncel to 9 cm long; rachis and pedicels pale yellow green; ovary pale green; calyx cream, lobes pale yellow-green; corolla cream tinged pale green; stamen white; stigma pale yellow. Infructescence to 43 x 8 cm; rachis elongating, ascending, greenish; pedicels green. Fruit 16 x 10 mm, ellipsoid, orange when mature.



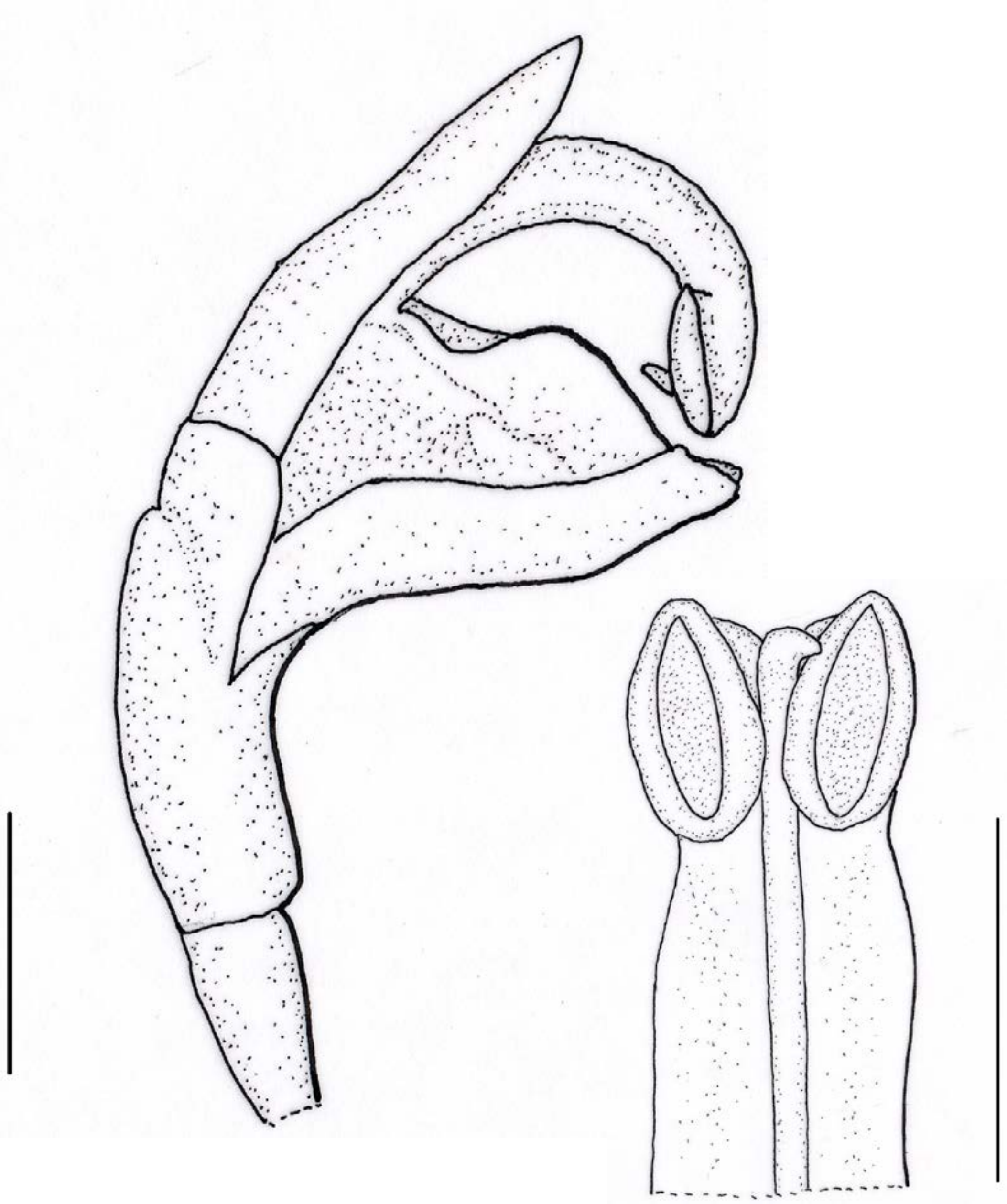
Special notes:
Comes out as P. tephrochlamys in the key by Valeton, but leaves are red underneath. Highly likely to be a new to science.

Collection: Poulsen et al. 2931
Pleuranthodium sp.
Det: Poulsen, A.D. & Lofthus, Ø.
Section *Pleuranthodium*

Country: Papua New Guinea
Province: Eastern Highlands
Lat: -06.373
Lon: 145.912
Altitude: 1850 m

Field description:
Terrestrial herb. Leafy shoots 2–3 m long; bases 6 cm apart, to 2.5 cm diam., cylindrical, pale brown to greenish; sheath green; ligule to 5 mm long, entire; petiole 1–1.5 cm long; lamina to 36 x 6.5 cm, dark green, pale beneath, apex caudate by 3 cm.
Vernacular name:
takorokai (Tayrora language).

Flower description:
Inflorescence subterminal by 16 cm, pendent, c. 12 cm long, peduncle c. 2 cm; rachis and pedicel pale yellow-green; ovary and calyx pale yellowgreen; corolla cream, lobes tinged yellow-green.



Collection: Poulsen et al. 2697

P. sp.

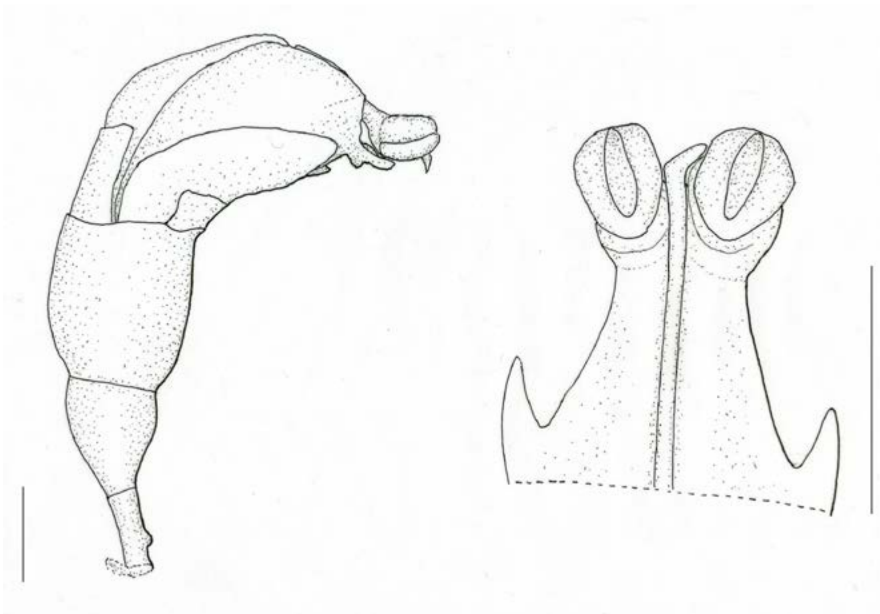
Det: Poulsen

Section *Psychanthus*

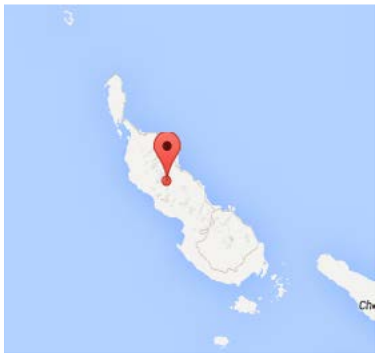
Country: Papua New Guinea
Province: Morobe
Lat: -6.55389
Lon: 146.8675
Altitude: 100 m

Field description:
Terrestrial herb in loose clump (>20 cm between shoots). Leafy shoot to 4.2 m long. Sheath yellow-green. Ligule to 10 mm long. Lamina sessile, to 45 x 15 cm, ovate, slightly plicate.

Flower description:
Inflorescence terminal, pendent, to 22 cm long. Rachis pale green. Ovary and calyx red. Corolla pale red. Labellum cream. Stamen cream, margin of thecae red. Vernacular name: asi (Yalu language).



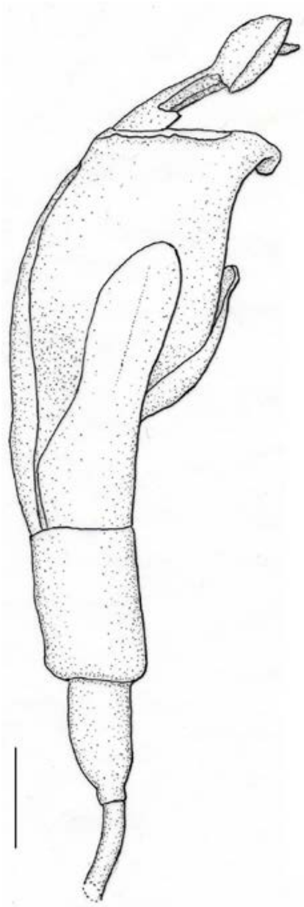
Collection: Poulsen & Newman 2830
P. pekeelii (Valeton) R.M. Smith
Det. : M.F. Newman
Section *Psychanthus*

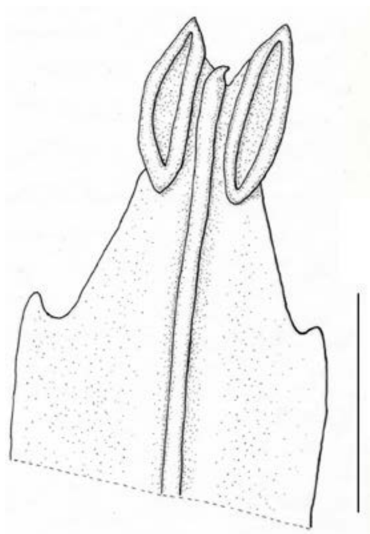


Country: Papua New Guinea
Province: Bougainville
Lat: -5.95
Lon: 155.06
Altitude: 750 m
CULT in RBGE

Field description:
Leafy shoots 5-13 cm apart, to 2.25 cm long. Base to 3.5 cm diameter, pale yellow-green. Sheath yellow-green, with a reddish margin at least below ligule. Ligule to 5 mm long, ± emarginate, reddish. Lamina to 51 x 13 cm, dark green above, slightly plicate, sessile to subsessile, base attenuate.

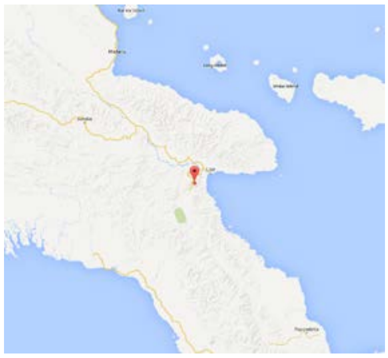
Flower description:
Inflorescence subterminal, appearing 12-16 cm from apex of pseudostem, pendent, to 22 cm long, with c. 50 flowers, covered by 2 pale yellow-green, dehiscent, fragile bracts. Axis, pedicel and ovary pale yellow-green. Calyx pale yellowish white. Corolla, labellum, filament style and stigma cream white. Corolla lobes tinged pale reddish. Epigynous gland yellow. Flowering in Edinburgh DEC 2009.





Special notes
CULT origin Poulsen 2580 from Bougainville
Living collection info.: Garden Collector: Poulsen, Axel Dalberg & Newman, Mark F. No. 2830 Accession number & Qualifier: 20070123*A Collected: 18 DEC 2009 Garden Location: G65 - RBGE Research Collection Garden
Grown from original wild seed collection: Poulsen et al. 2580, Bougainville Island, trail from Togarau village to Mt. Balbi Disturbed roadside vegetation, 750 m, 20 Jan 2007, 5o57' S 155o4'E. Field notes: Terrestrial herb in clump (5-10 cm between neighbouring shoots). Leafy shoot to 3 m tall. Base to 5 cm diam., tinged slightly red. Sheath yellowish green, margin reddish brown. Ligule 7 mm long, bilobed, brownish green. Pseudopetiole to 5 mm long (winged). Lamina to 60 x 17 cm, narrowly ovate, plicate. Infructescence sub-terminal, pendulous, to 30 x 9 cm. Fruit to 4 x 1.2 cm, orange-red, opens in 3 parts. Vernacular name: opatè (Rotokas language; young inflorescence edible).

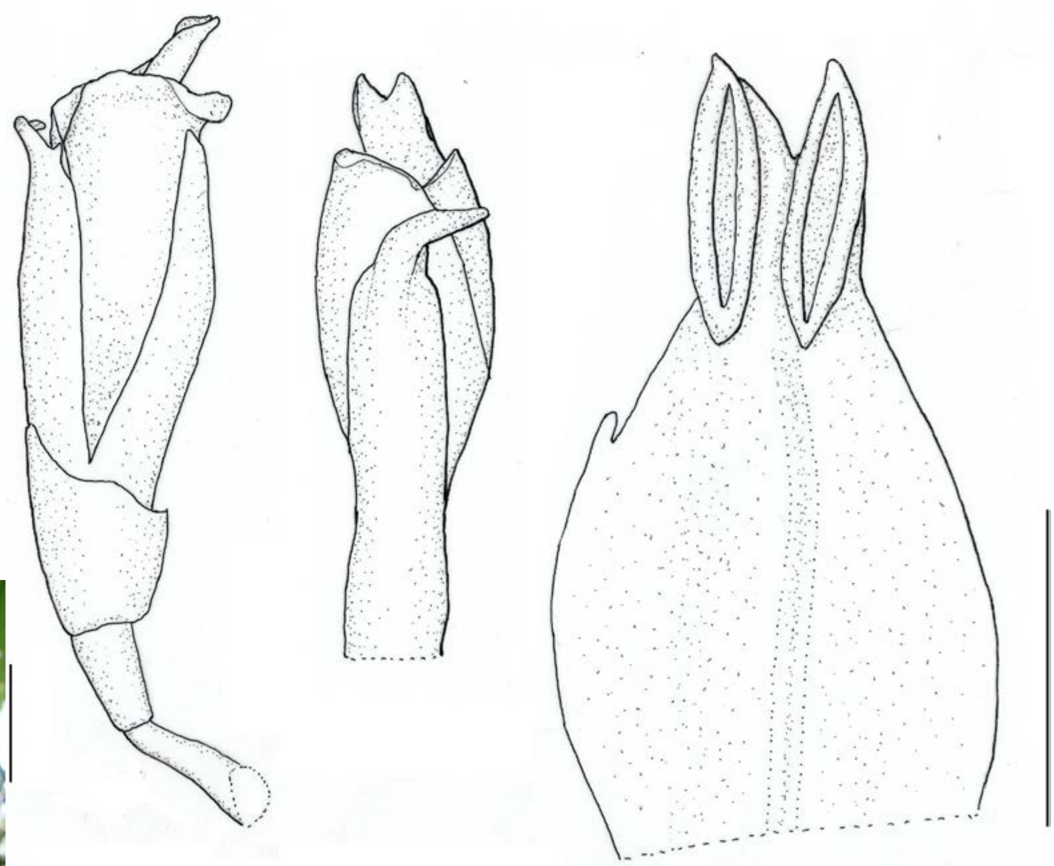
Collection: Poulsen et al. 2900
Pleuranthodium sp.
Det.: Poulsen & Lofthus
Section *Psychanthus*



Country: Papua New Guinea
Province: Morobe
Lat: 06.852
Lon: 146.804
Altitude: 1200 m

Field description:
Terrestrial herb. Leafy shoots to 3 m long with 14–15 leaves when flowering; bases 13–39 cm apart, base 3.5–4 cm diam., maroon; sheath pale green with longitudinal lines, margin maroon on younger shoots; ligule 15–25 mm long, maroon; lamina to 66 x 14.5 cm, slightly plicate, mid-green.

Flower description:
Inflorescence terminal, pendent, 29 cm long, peduncle 3 cm long, rachis yellow-green; pedicel palebrown; ovary burgundy; corolla pale yellow: fruits reddish brown



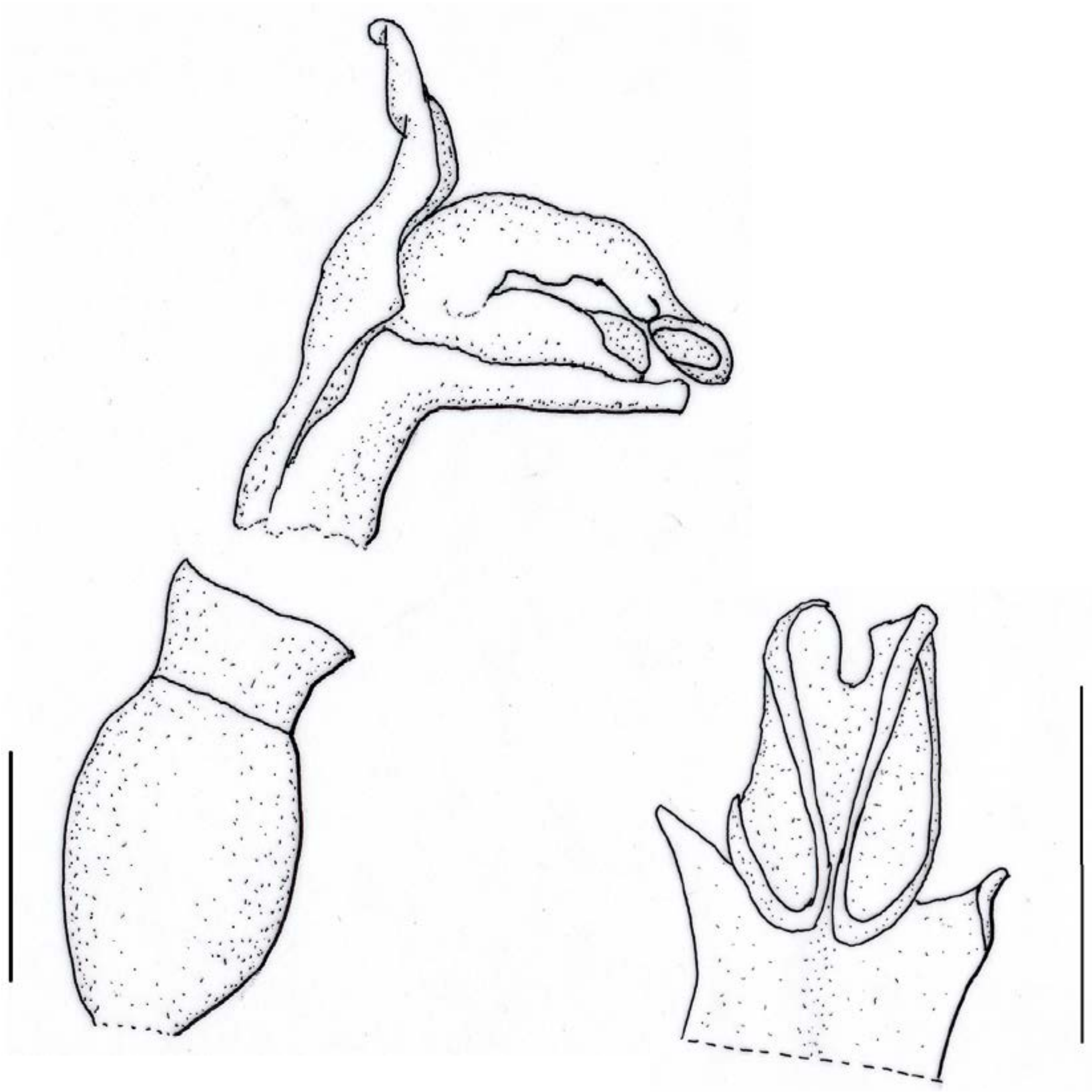
Special notes:
Both collected flowers had the bent apex on the corolla lobe. Pictures from the field verify that the apex often is bent, but not always. The filament can have two teeth.

Collection: Poulsen et al. 2927
Pleuranthodium sp.
Det. Poulsen, A.D. & Lofthus, Ø.
Section *Psychanthus*

Country: Papua New Guinea
Province:
Lat: -06.360
Lon: 145.297
Altitude: 2350 m

Field description:
Terrestrial herb. Leafy shoots to 1.4 m long, with 17 leaves per shoot when flowering; bases 4–10 cm apart, to 3 cm diam., green, pinkish when young; sheath green, tinged red at base, pruinose; ligule to 3 mm long, entire, truncate; petiole to 1 cm long; lamina to 39 x 10 cm, plicate, base rounded oblique, margin wavy.

Flower description:
Inflorescence subterminal by 5 cm, 27 cm long, peduncle 3 cm long, rachis yellow-green, pedicel yellow-green; ovary developing when still in flower, reddish brown with 3 green lines; calyx persistent; corolla cream. Fruits orange, split in 3 parts, seed dark green, aril /seed attachment red.

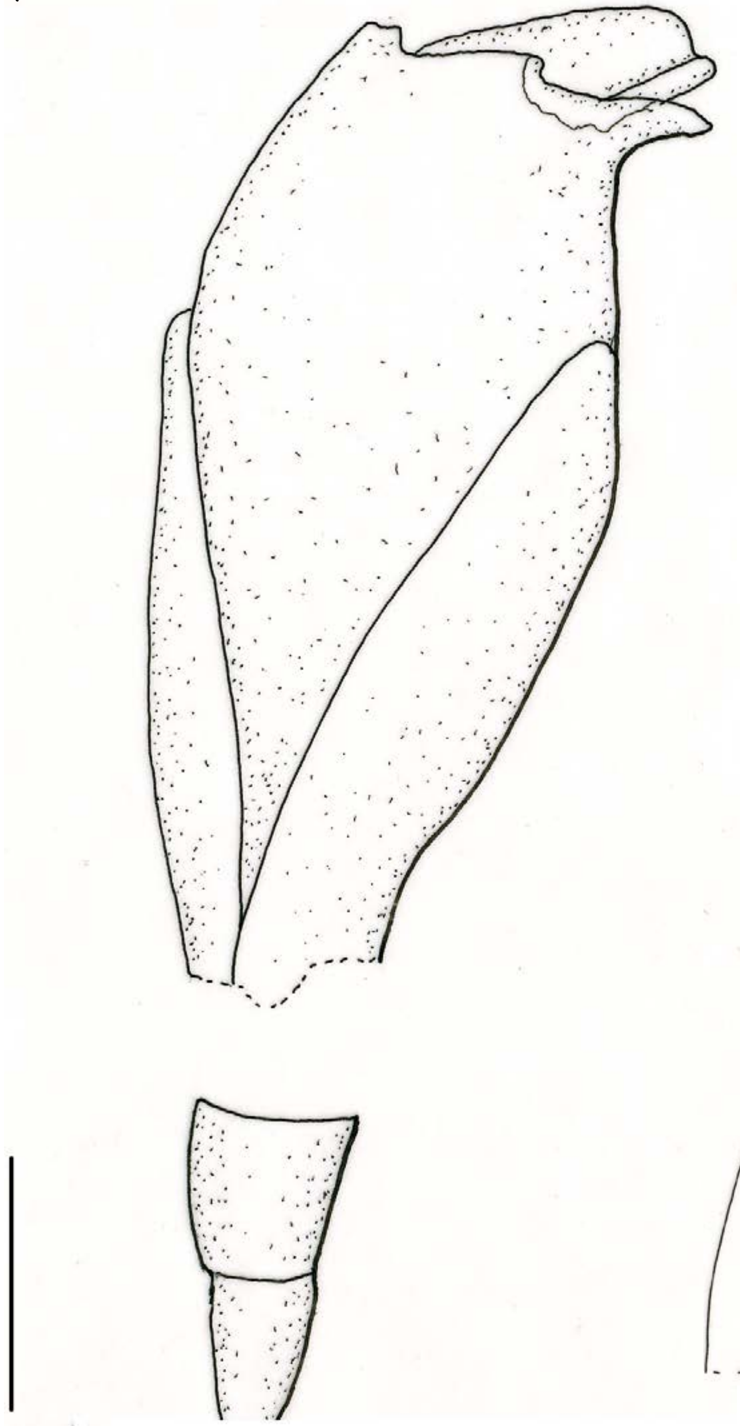


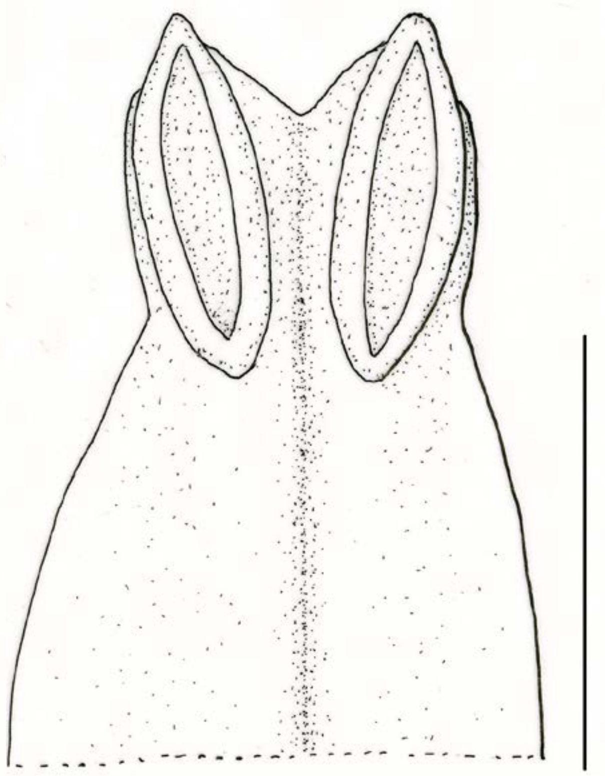
Special notes:
Collected late in the flowering.

Collection: Winters 75P334/Lofthus 1789
P. papillionaceum (K.Schum.) R.M.Sm.
Det: R.M.Sm
Section *Psychanthus*

Flower description:
Ovary, narrow, small and obconic. Calyx short and bell-shaped. Corolla lobes cymbiform. Labellum with truncate base and folded apex. Anther almost totally contained by labellum. Thecae pointy.

Country: Papua New Guinea
Province: West New Britain
Lat:
Lon:
Altitude:
Cult RGBE



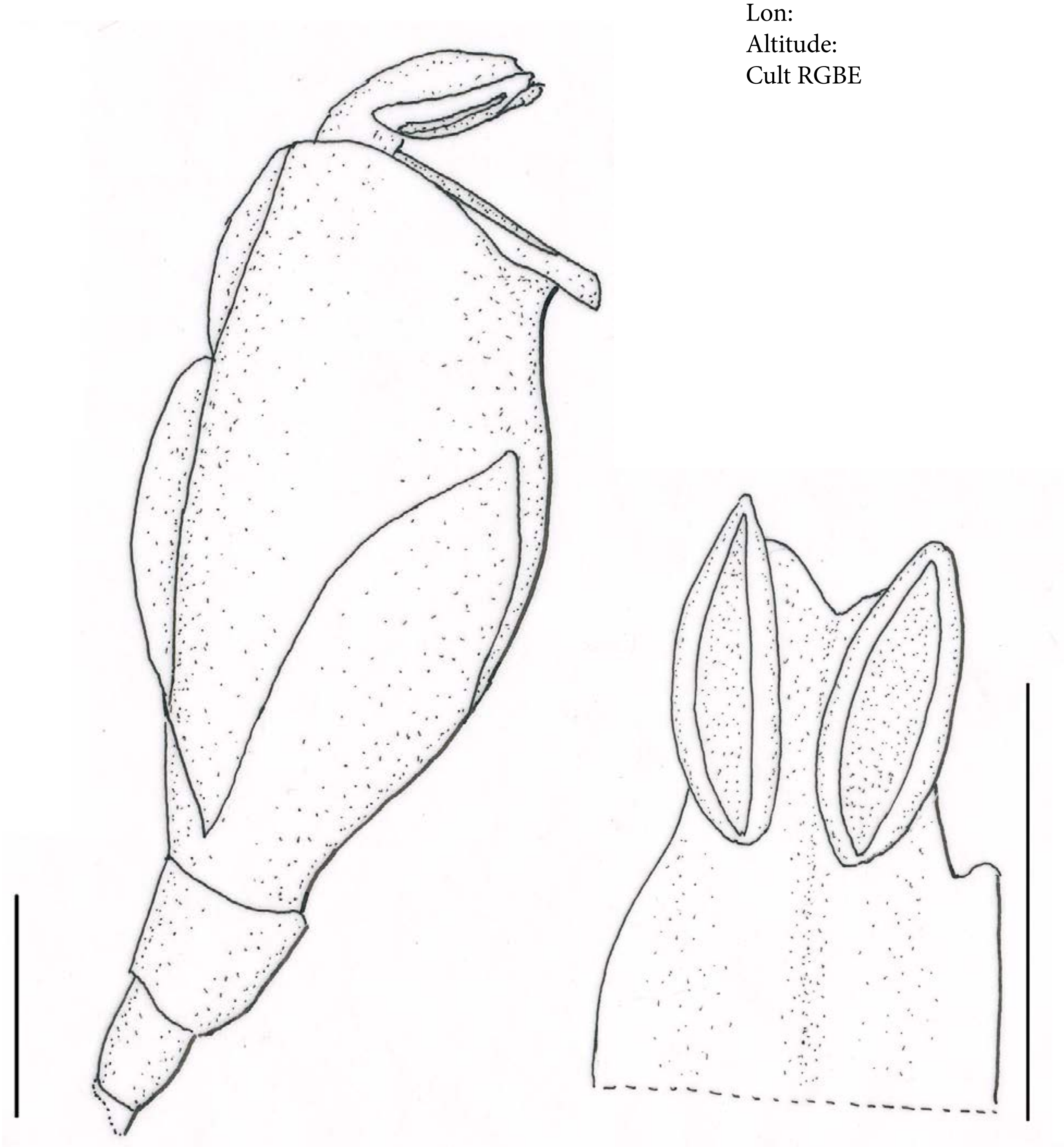


Special notes:
Cultivated in RBGE as 19751789 and 19751791. Also cultivated in Waimea as 75P334, of which DNA was sampled as Lofthus 1010.

Collection: Winters 19751791
P. papillionaceum (K.Schum) R.M.Sm
Det: R.M.Sm
Section *Psychanthus*

Ovary, narrow, small and obconic. Calyx short and bell-shaped. Corolla lobes cymbiform. Labellum with truncate base and folded apex. Anther almost totally contained by labellum. Thecae pointy.

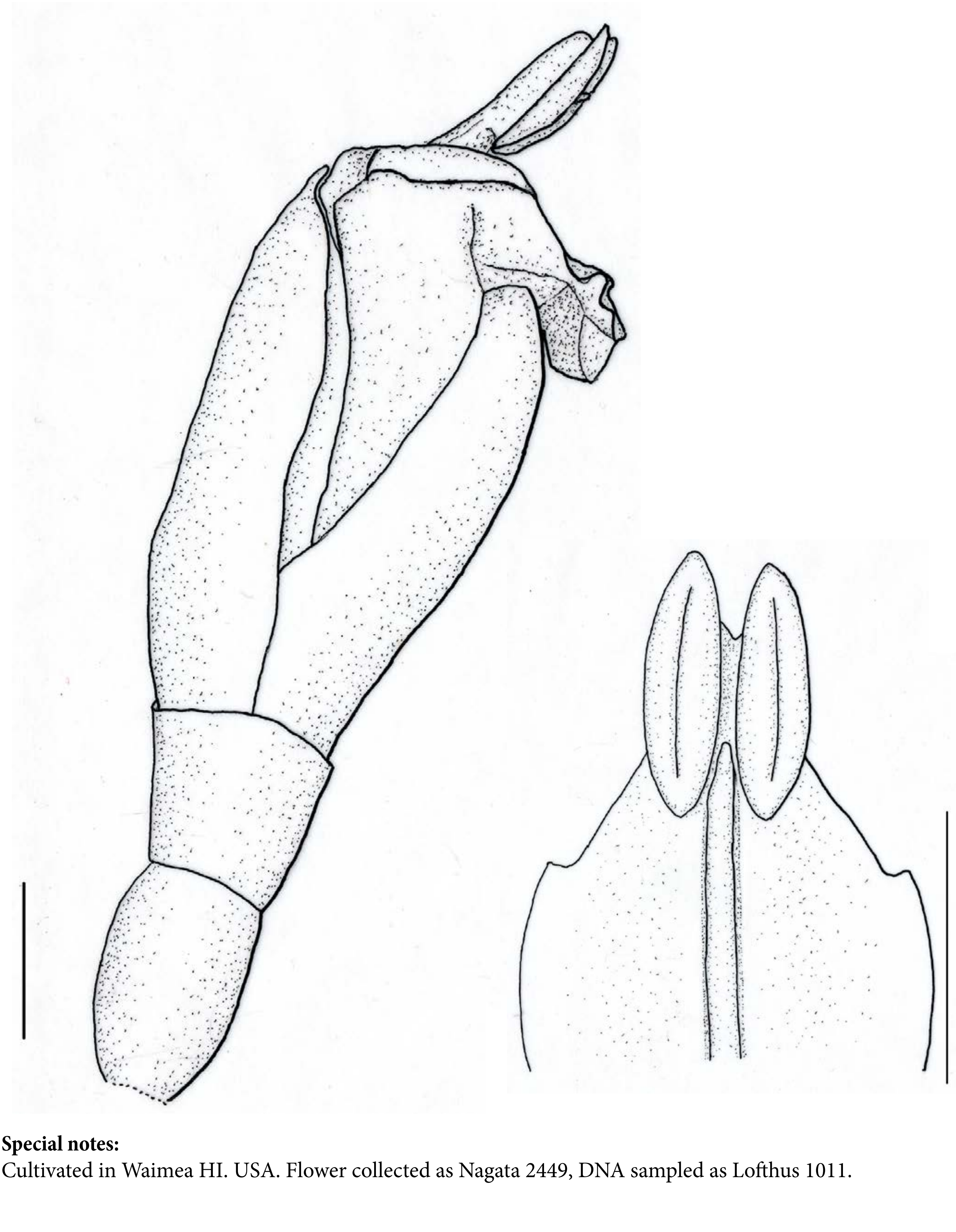
Country: Papua New Guinea
Province: West New Britain
Lat:
Lon:
Altitude:
Cult RGBE



Special notes
Cultivated in RBGE as 19751789 and 19751791. Also cultivated in Waimea as 75P334, of which DNA was sampled as Lofthus 1010.

Collection: Woolliams s.n.
P. floribundum (K.Schum) R.M.Sm.
Det: R.M.Sm
Section *Psychanthus*

Country: Papua New Guinea
Province: Central
Lat:
Lon:
Altitude:
CULT Waimea



Special notes:
Cultivated in Waimea HI. USA. Flower collected as Nagata 2449, DNA sampled as Lofthus 1011.

Collection: Ingit 449
Riedelia aff. *lanata* K.Schum ex. Valeton
Det: Newman, M.F.
Recollected: Santika 322

Country: Indonesia
Province: Sulawesi
Lat:
Lon:
Altitude: 50 m

Field description:
Terrestrial herb, 1,5 m tall, in loose clump (c. 6 cm between neighbouring shoots). Base c. 3 cm. diam., greenish swollen. Leafy shoot c. 1,7m long, with 10-22 leaves. Sheath green, lamina 34 x 7,2 cm, glabrous: petiole, short to 0,5 cm long, base cuneate, apex acute. Ligula to 2 cm long.

Flower description:
Infloresence terminal, pendulous. Rachis to 17 cm, yellowish green. Infloresence 25 cm long with 33 flowers. Primary bract turning brown, shed, 2. Calyx yellow, otherwise pale yellow-green, translucent, margin in-rolled, apex pointed, 4,2 cm. Corolla cream, translucent. Labellum white, deep lobes, apex pointed, pubescent. Filament cream; anther cream. Stigma cream. Ovary inferus, green. Peduncle 0,6 cm.

Special notes:
There is a strong suspicion that the correct origin of this collection is in the West Papuan province of Indonesia, and that it got mixed up with another collection. The description, however, is correct.
Photographies: Yessi Santika

Collection: Poulsen et al. 2511
Riedelia sp.
Det: Poulsen, A.D.

Country: Papua New Guinea
Province: Morobe
Lat: -07.183
Lon: 146.467
Altitude: 2150 m

Field description:
Terrestrial herb in clump. Base wine-red. Sheath tinged purple. Petiole to 15 mm. Lamina tinged purple beneath.

Flower description:
Inflorescence terminal. Ovary green. Calyx pale orange. Corolla cream. Fruit yellowish, splitting in 2 halves.

Collection: Poulsen et al. 2512
Riedelia sp.
Det: Poulsen, A.D.

Country: Papua New Guinea
Province: Morobe
Lat: -07.183
Lon: 146.467
Altitude: 2150 m

Field description:
Terrestrial herb in clump. Base wine-red. Sheath tinged purple. Petiole to 15 mm. Lamina tinged purple beneath. Inflorescence terminal. Ovary green. Calyx pale orange. Corolla cream. Fruit yellowish, splitting in 2 halves.

Flower description:
Inflorescence terminal. Ovary green. Calyx pale orange. Corolla cream. Fruit yellowish, splitting in 2 halves.

Collection: Poulsen et al. 2709
Riedelia sp.
Det: Poulsen, A.D.

Country: Papua New Guinea
Province: Madang
Lat: -05.281
Lon: 144.519
Altitude: 2200 m

Field description:
Terrestrial herb in loose clump. Leafy shoot arching, to 1.2 m long. Sheath brownish red to green. Ligule to c. 3 mm long, reddish. Petiole to 6 mm long. Lamina to 20 x 6 cm, dark green, velvety.
(Kalam language; no use informed.

Flower description:
Inflorescence terminal ascending. Rachis and ovary bright green. Calyx orange. Corolla tube yellow, lobes cream tinged pink at apex. Stamen and stigma cream. Fruit 20 x 8 mm, greenish when young; orange-yellow when mature. Aril red. Vernacular name: galgal

Collection: Poulsen et al. 2710
Riedelia sp.
Det: Poulsen, A.D.

Field description:
Terrestrial or epiphytic herb, in clump. Leafy shoot to 85 cm long. Lamina to 65 x 5 cm.

Flower description:
Inflorescence terminal, erect, with 2–3 branches. Rachis reddish brown. Pedicel, ovary and calyx dark red. Corolla pale orange, red at apex. Fruit 6 x 6 mm, globose, dark red. Vernacular name: gaigai (Kalam language); leaves used for making mumu.

Country: Papua New Guinea
Province: Madang
Lat: -05.281
Lon: 144.519
Altitude: 2200 m

Collection: Poulsen et al. 2711
Riedelia sp.
Det: Poulsen, A.D.

Field description:
Terrestrial herb in clump. Leafy shoot to 45 cm long. Sheath speckled winde-red. Ligule inconspicuous. Petiole to 10 mm long. Lamina to 22 x 7 cm, mid-green.
Vernacular name: walam (Kalam language), no use.

Flower description:
Inflorescence terminal, to 10 cm long, with one branch at base. Rachis reddish green. Ovary and calys reddish. Corolla yellow, apex of lobes red. Fruit red. Aril yellow.

Country: Papua New Guinea
Province: Madang
Lat: -05.281
Lon: 144.519
Altitude: 2200 m

Collection: Poulsen et al. 2716
Riedelia aff. *umbellata* Valeton
Det: Newman, M.F.

Country: Papua New Guinea
Province: Madang
Lat: -05.280
Lon: 144.533
Altitude: 1850 m

Field description:
Terrestrial herb in dense clump. Leafy shoot to 1.4 m long. Base to 2 cm diam., red when yong. Sheath yellow-green. Ligule to 7 mm long, reddish. Petiole to 11 mm long. Lamina to 19.5 x 8 cm, plicate, drip tip to 3 cm long.

Flower description:

Infructescence radical, 25 cm long, erect, with 2 fruits, orange-red, pale orange inside, opening by 3 valves. Seeds dark green — almost black, 2–6 per locule; aril pale orange.

Collection: Poulsen et al. 2724
Riedelia sp.
Det: Poulsen, A.D.

Country: Papua New Guinea
Province: Western Province
Lat: -05.200
Lon: 141.150
Altitude: 1475 m

Field description:
Terrestrial herb. Rhizome creeping (6–9 cm between neighbouring shoots). Leafy shoot to 1.6 m long. Base of leafy shoot to 3 cm diam., pale red when young. Sheath yellow-green. Ligule to 4 mm long. Lamina to 30 x 6 cm.

Flower description:
Inflorescence terminal. Rachis red. Pedicel and ovary dark red. Calyx red with yellow apex. Corolla pale pink, lobes white. Anther yellow-green.

Collection: Poulsen et al. 2726
Riedelia sp.
Det: Poulsen, A.D.

Country: Papua New Guinea
Province: Western Province
Lat: -05.300
Lon: 141.200
Altitude: 700 m

Field description:
Terrestrial herb in dense clump of c. 10 shoots. Leafy shoot to 3 m long. Base of leafy shoot to 7 cm diam., pale green. Sheath yellow to green. Ligule to 10 mm long, transparent, green, hidden by leaf base. Lamina to 110 x 14 cm, base with 2 cm auricle, attenuate, clasping the pseudostem.

Flower description:
Inflorescence subterminal with 3(–4) branches. Bract pale yellow-green, dehiscent. Rachis reddish brown. Pedicel and ovary red. Calyx orange. Corolla and labellum pale orange with with green apices. Anther pale orange, apex green. Stigma green.

Collection: Poulsen et al. 2730
Riedelia sp.
Det: Poulsen, A.D.

Country: Papua New Guinea
Province: Western Province
Lat: -05.316
Lon: 141.200
Altitude: 800 m

Field description:
Terrestrial herb in clump. Leafy shoot to 2 m long. Possibly = Poulsen 2726.

Flower description:
Inflorescence terminal, erect, with 4 branches. Rachis reddish brown. Pedicel and ovary red. Calyx orange. Corolla yellow with green apex. Labellum orange-yellow with green apex. Fruit obovoid, orange.

Collection: Newman 2540
Burbidgea sp.
Cultivated RBGE 860923

Country:
Province:
Lat:
Lon:
Altitude:
CULT RBGE

Collection: Poulsen 2832
Siamanthus siliquosus K. Larsen & Mood
Cultivated RBGE 20001319

Country: Thailand
Province:
Lat:
Lon:
Altitude:
CULT RBGE

Collection: RBGE 20081134A
Siliquamomum tonkinense Baill.
Cultivated

Country: Viet Nam
Province:
Lat:
Lon:
Altitude:
CULT RBGE

Collection: Lofthus 1008
Alpinia sp.
Cultivated Waimea 93p166
Det: Lofthus, Ø

Country: New Guinea
Province:
Lat:
Lon:
Altitude:
CULT WAI