

## Molecular phylogeny of *Planchonella* (Sapotaceae) and eight new species from New Caledonia

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We present a hypothesis of phylogenetic relationships in *Planchonella* (Sapotaceae, Chrysophylloideae) using nrDNA (ITS) data analysed with parsimony jackknifing and Bayesian inference. Results from these two approaches yield similar majority-rule consensus trees. *Planchonella* (formerly included in *Pouteria*) is a monophyletic genus of trees and shrubs with 60 species currently recognised. They are distributed in Australia (13 spp.), New Caledonia (32 spp.), the Pacific islands (10 spp.), and New Guinea (5 spp.), but more molecular research is needed in order to identify all members in New Guinea and Malesia. Three strongly supported clades and several subclades were recovered by our analysis. Two clades are restricted to New Caledonia. Within these are eight recently discovered species that are described here (*P. crenata*, *P. glauca*, *P. latihila*, *P. luteocostata*, *P. mandjeliiana*, *P. povilana*, *P. roseoloba*, *P. rufocostata*), each with a conservation assessment. Our molecular phylogeny shows that some of these taxa, initially believed to be conspecific or closely related, represent separate lineages that deserve species rank. Two of these species are restricted to areas with near-future mining activities, which is why urgent conservation assessments are needed. Several subspecies or varieties of *P. myrsinifolia* and *P. cotinifolia* are recognised in Australia. Neither of these two species is monophyletic in its present circumscription, and for this reason *P. cotinifolia* var. *pubescens* is given species rank here as *P. pubescens*. We also amend the generic description of *Planchonella*, a genus best distinguished on a character combination of stamens positioned just below (rarely in) the tube orifice, a multi-seeded fruit, and foliaceous cotyledons embedded in endosperm.

**KEYWORDS:** Australasia, Chrysophylloideae, ITS, IUCN status, *Niemeyera*, phylogeny, *Planchonella*, *Pouteria*, Sapotaceae

### INTRODUCTION

*Planchonella* Pierre is a genus of shrubs and medium to large sized trees in Sapotaceae (Ericales) with a distribution centred in Southeast Asia and Australasia. Its taxonomic history is rather complicated from being described (Pierre, 1890), extended (Dubard, 1912), lumped into *Pouteria* (Baehni, 1942), resurrected (van Royen, 1957), lumped again with *Pouteria* (Baehni, 1965), resurrected (Aubréville, 1964, 1967), and again reduced to a synonym of *Pouteria* (Pennington, 1991). The main reason for this turbulent history is controversy surrounding the taxonomic value of seed characters and the importance of geographic distribution on the circumscription of taxonomic units.

Pierre (1890) described *Planchonella* and assigned *P. obovata*, a widespread species from the Seychelles to the West Pacific, as the generic type. Pierre's contribution was to remove *Planchonella* from *Sideroxylon* and recognise the seed characters as diagnostic: a linear seed scar and foliaceous cotyledons embedded in a copious endosperm. In contrast, *Pouteria* is most often associated with plano-

convex cotyledons and the absence of an endosperm (Pennington, 1991). Baehni (1965) took issue with these characters and regarded the presence or absence of endosperm to be of no systematic value, which led him to reduce *Planchonella* and many other genera into *Pouteria*. In his generic review of Sapotaceae, Pennington (1991) identified several intermediate conditions. Although he postulated that the absence of an endosperm could have evolved many times, he found it untenable to separate *Planchonella* from *Pouteria*, a view followed by Govaerts & al. (2001) and Vink (2002). Distribution has also been an argument to accept or reject *Planchonella* on the generic level. For instance, van Royen (1957) and Aubréville (1961, 1963, 1967) clearly supported the view that *Planchonella* has its main centre of development in Australasia, whereas *Pouteria* has its centre in Tropical America.

Several recent phylogenetic studies in Sapotaceae have accumulated molecular and morphological evidence that indicate that *Pouteria* is polyphyletic and can be split in a way that is congruent with geographic distribution (Anderberg & Swenson, 2003; Bartish & al., 2005; Swenson & Anderberg, 2005; Swenson & al., in press; Bartish

& al., unpub. data). From these studies it is also clear that members of *Pouteria* form several well-supported clades, which more or less correspond to former recognised segregates, but their relationships are still unclear. Based on an extensive taxon sampling of Australasian representatives of the subfamily Chrysophylloideae, Swenson & al. (in press) performed parsimony jackknifing and focused on intergeneric relationships. While their study was not able to resolve these relationships, they showed that the segregates *Beccariella*, *Planchonella*, *Sersalisia*, and *Van-royena* must be resurrected in order for taxonomy to reflect the evolutionary lineages in this part of the world. *Planchonella* itself consists of three strongly supported subclades, which fall back to a polytomy. Other earlier recognised segregates (*Albertisiella*, *Bureavella*, *Iteiluma*, *Pyriluma*) do not correspond to any of these subclades and need to be embedded in *Planchonella*. Swenson & al. (in press) therefore made necessary combinations of *Planchonella* (and *Beccariella*), but a few included taxa still lack formal names. It is therefore desirable to resolve relationships within the base of the genus and to give names to the informally used taxa.

Sapotaceae taxonomy of subfamilial, tribal and generic limits is known to be notoriously difficult (Aubréville, 1964; Swenson & Anderberg, 2005), and species limits are not an exception. Aubréville (1967) published the very first volume of the Flora of New Caledonia, a volume treating Sapotaceae. He recognised *Planchonella* and at the time he accepted 19 species, most of them endemic. Some species were still poorly known, but yet he combined one in doubt (*P. amieuana*) and another was described (*P. thiensis*) based on leaf and bud material. Since his account and that of Swenson & al. (in press), more taxa with unknown relationships have been discovered in New Caledonia. Among them are what we below describe as *P. glauca*, *P. povilana*, and *P. latihila*. Fruiting specimens of these trees were discovered, determined to known species, but collected in areas with different abiotic factors from where they normally grow. For instance, from humid forests on schist in the northeast of Grand Terre, a similar taxon to *P. reticulata* was discovered. This locality was peculiar, because *P. reticulata* grows on ultramafic soil and in the south. In the south of the island (Forêt Nord), however, a fruiting tree was discovered in a valley threatened by mining operations (see below), similar to the specimens from the northeast, but with longer pedicels and a broader seed scar. It was thus not known if these collections represented subspecies, new species, or even *Planchonella*. As will be shown, these two are advanced taxa in *Planchonella*, not closely related to each other, genetically distinct from *P. reticulata*, and described herein as *P. glauca* and *P. latihila*, respectively.

Similarly there are systematic problems in the Australian species of *Planchonella*. One can be referred to

*P. cotinifolia* and another to *P. myrsinifolia*. *Planchonella cotinifolia* is a species of the rainforest of Queensland. From the same area, van Royen (1957) described a new variety (*P. cotinifolia* var. *pubescens*) distinguished by its yellowish pubescence on lower leaf surface, sepals, and ovary (glabrous in var. *cotinifolia*). The problem is that many specimens earlier identified as *P. myrsinoides* (see below) actually belong to *P. cotinifolia* var. *pubescens*, including the lectotype of the name selected by Green (1986), which affects the nomenclature of the taxa involved (Jessup, 2001). It is also unclear whether the two varieties are sisters.

*Planchonella myrsinifolia*, previously known as *Planchonella myrsinoides* or *Pouteria myrsinoides* (Govaerts & al., 2001; Jessup, 2001), originally involved three taxa from the Southwest Pacific: *P. myrsinoides* (Australia), *P. howeana* (Lord Howe Island), and *P. reticulata* (New Caledonia). Green (1990) studied these taxa and accepted only one species with two subspecies, *Pouteria myrsinoides* subsp. *myrsinoides* (plants from Australia) and subsp. *reticulata* (plants from Lord Howe Island and New Caledonia) based on the leaf venation pattern. Both taxa were included in the cladistic analysis using morphology and nrDNA by Swenson & al. (in press). In their analysis, *Pouteria myrsinoides* subsp. *myrsinoides* (plants from Australia) and subsp. *reticulata* (plants from Lord Howe Island and New Caledonia) belong to two separate clades, and differ in several morphological characters. For instance, plants from Australia have a greenish corolla with lobes and tube of similar length, whereas plants from New Caledonia have a cream-coloured corolla with lobes shorter than the tube. Hence, two species of *Planchonella* were recognised, *Planchonella myrsinifolia* and *P. reticulata*. However, no accession from Lord Howe Island was included and it remains an open question as to whether this taxon is more closely related to *P. reticulata* than to *P. myrsinifolia* as proposed by Green (1990).

New Caledonia is identified as a biodiversity hotspot with high priorities for conservation (Myers, 1988; Myers & al., 2000; Lowry & al., 2004), not least for its outstanding level of endemism and species richness (Morat, 1993; Lowry, 1998). The dry forest areas have been much reduced and are now subject to intensive conservation programmes, but the forest and shrubby maquis vegetation on ultramafic rocks is presently under high risk of destruction (Jaffré, 2005). These rocks are a rich source of metals such as cobalt and nickel, and New Caledonia is one of the largest producers of nickel in the world. In order to exploit the natural resources, hills or even mountains are stripped of vegetation and developed into large open-cast mines. An appeal to preserve the much threatened ultramafic vegetation was therefore appropriate (Jaffré, 2005). Many of the 25 described *Planchonella* species (Aubréville, 1967; Swenson & al., in press) and at least

two (*P. crenata*, *P. latihila*) of the eight new species are confined to ultramafic soils. Another, *P. luteocostata* is confined to threatened dry forest (Gillespie & Jaffré, 2003). All of these species are local endemics with narrow distributions. The situation for *P. latihila* is particularly serious, because it is only known from a single tree in a valley near Prony (southernmost Grand Terre), a valley threatened by ongoing mining activities. Although flowers have never been observed of this tree in the forest, it has sufficient vegetative characteristics that merit recognition as a new species.

The present study aims to investigate the phylogenetic relationships within Australasian and Pacific *Planchonella* using parsimony jackknifing and Bayesian inference based on nrDNA (ITS) data and an expanded taxon sampling (compared to Swenson & al., in press). We are especially interested in whether these analytic tools can provide further resolution at the base of the phylogeny. The relationships of the undescribed accessions are investigated. In addition we investigate whether *P. cotinifolia* and *P. myrsinifolia* are each monophyletic, and assess the taxonomic implications of these findings. A preliminary and amended generic description of *Planchonella* is proposed and eight new species are described, each with an IUCN status assessment (IUCN, 2001). Having formal names is particularly important for future conservation issues in New Caledonia.

## MATERIAL AND METHODS

**Nomenclature.** — We follow the subfamily classification by Swenson & Anderberg (2005). *Planchonella* is here recognised at generic level and names follow Swenson & al. (in press). A full list of published synonyms is found in the checklist of Sapotaceae (Govaerts & al., 2001), which follows the classification of Pennington (1991).

**Taxon sampling.** — A total of 60 terminal taxa were selected for this study: nine are represented by two accessions each, i.e., *Planchonella contermina*, *P. cotinifolia*, *P. koumaciensis*, *P. lauracea*, *P. linggensis*, *P. pohlmaniana*, *P. povilana*, *P. reticulata*, and *P. xylocarpa*, and six were designated as outgroup. Voucher information along with GenBank accession numbers is detailed in the Appendix. Multiple accessions for some species were necessary in order to address problems with species circumscription or because the taxon has a disjunct distribution. For instance, two accessions of *P. xylocarpa* are included, one from Australia and one from Papua New Guinea. Likewise, *P. contermina* is endemic to New Caledonia and is represented by one collection from the main island Grand Terre and one from the small island Yandé in the north. Our sampling was designed to

provide an almost complete representation of the genus in Australia, New Caledonia, and the Pacific Islands (except Fiji). Specific richness is high in New Guinea, but from this area only three accessions are available (*P. solida*, *P. sp.*, *P. xylocarpa*). Intensive research in this area is performed by another group of researchers (J. West, pers. comm.). The outgroups include four taxa of *Niemeyera* as well as the generic types of *Corbassona* and *Ochrothallus*. These taxa are rooted as a monophyletic sister group to the ingroup based on molecular evidence from Swenson & al. (in press) and Bartish & al. (unpubl. data).

**Molecular data.** — Bartish & al. (2005) and Swenson & al. (in press) have generated sequences from the nuclear ribosomal DNA, including parts of 18S and 26S, and the complete 5.8S nrDNA, ITS1, and ITS2, of which 47 sequences are used in the present study. Following the same protocol for DNA extraction, amplification, sequencing, and alignment, we here include an additional 21 accessions, plus one (*Planchonella costata*, AF396230) obtained from GenBank. Thus, our data matrix contains 69 accessions representing 60 species. The aligned data matrix can be obtained from the first author upon request.

Gaps were coded as additional binary characters following the method of Simmons & Ochoterena (2000). These authors argue that gaps should only be treated as homologous binary characters if they are of the same position, length, and sequence (insertions).

**Parsimony analysis.** — The molecular dataset was first analysed with an ordinary heuristic search to obtain a strict consensus tree using the following settings in PAUP 4.0b10 (Swofford, 2002): 100 random and stepwise additions, TBR branch swapping, collapse branches if minimum length was zero, save multiple trees, and steepest descent not in effect. A parsimony jackknifing analysis (Farris & al., 1996), as implemented in PAUP, was then performed, but with 1,000 replicates and saving a maximum of 1,000 trees. Both analyses used equally weighted characters. Jackknifing investigates the structure in a matrix without permutation, but excludes an assigned fraction of characters, here set to 35%. Groups with support frequencies (shown in parentheses) below 50% are not recognised; values of 50%–69% are recognised as weak, 70%–89% as moderate, and 90% or more as strong.

**Bayesian analysis.** — The dataset was also analysed with Bayesian inference (Ronquist & Huelsenbeck, 2003) using the program MrBayes version 3.1 (Ronquist & al., 2005). The matrix was partitioned by the data type, one for sequence data and one for gap data. Gaps were treated as discrete data (unordered). Sequence data was subjected to a general time reversible model (Rodríguez & al., 1990), including estimation of invariant sites and assuming a discrete gamma distribution with six rate categories (GTR+I+G). We examined the relative fit of

various models of nucleotide substitution for the nrITS region to identify the best performing model. Our selection was based on Akaike Information Criterion (AIC) as implemented in ModelTest 3.6 (Posada & Crandall, 1998). Estimated parameter values and log-likelihood scores for the different models were calculated based on a neighbour-joining tree and Jukes-Cantor-corrected distances.

The Markov Chain Monte Carlo (MCMC) sampling, starting from random trees and vague priors (default), was run for 1,500,000 generations and every 100th tree was sampled. We used four MCMC chains in our analyses. Three heated chains (temperature was 0.2) and a single cold chain were used providing 15,001 trees in each run. The log-likelihood scores of sample points were plotted against generation time, and stationary Markov chains were assumed when the log-likelihood values reached a stable equilibrium (Huelsenbeck & Ronquist, 2001). Majority-rule consensus trees and posterior probabilities for nodes were assembled from all post burn-in sampled trees (10,001). Phylogenetic reconstructions were estimated using three independent runs to confirm that they converged on similar stationary parameter estimates. Bayesian posterior probabilities (PP), often provide inflated measures of support when compared with nonparametric bootstrapping (Erixon & al., 2003), and this is especially true when priors assume long internal branch lengths (Yang & Rannala, 2005). The Jackknife is a slightly different method and it is unclear whether jackknife values can be compared to posterior probabilities (B. Oxelman, pers. comm.).

**Morphological examination.** — Specimens of the new species from New Caledonia are deposited in the Paris herbarium (P) with duplicates in MO, NOU, and S. Extensive fieldwork has generated several new specimens. For examination, flowers and fruits were boiled in Copenhagen mixture (70 ml ethanol, 29 ml distilled water, 1 ml glycerol) in a microwave oven and examined under a stereo-microscope. Flower and seed characters were also studied in the field, and when appropriate, fruits were dissected and seeds cleared from pulp. The terminology used follows Harris & Harris (1994).

**Conservation assessment.** — Conservation status of species is an important service for environmental protection. A recent call addressed that all taxonomic work ought to include preliminary IUCN Red List assessments (Callmander & al., 2005). We therefore applied the IUCN criteria (IUCN, 2001) to assess the threat to each new species. One of the criteria for vulnerable status is a distribution area smaller than 20,000 km<sup>2</sup>. However, this recommendation is difficult to apply considering the topography and total area of 19,200 km<sup>2</sup> of New Caledonia, where Grand Terre (main island) is about 16,595 km<sup>2</sup>. Also, increased human pressures on all natural habitats have caused the natural vegetation to decline (criteria B-b(iii)). Further, the flora of New Caledonia is still poorly

surveyed and many species are only known from less than 10 localities (criteria B-a(ii)). Considering the recommendation of the Red List Guidelines (IUCN & SSC, 2004), we adopted a precautionary and realistic approach. In some cases we proposed not to use the strict IUCN categories, but based the classification on our botanical knowledge and the real threat to the natural vegetation.

## RESULTS

The aligned nrDNA sequences resulted in a matrix of 915 characters with 892 characters of aligned sequence data and 23 coded gaps. Of the total number of molecular characters, 568 were constant, 150 autapomorphic, and 197 potentially informative.

The ordinary heuristic search yielded 243 most parsimonious (MP) trees 910 steps long (CI: 0.770; RI: 0.812). Both the jackknife and the Bayesian analyses recovered majority-rule consensus trees similar to the strict consensus tree, where jackknife values and posterior probabilities are mapped along the branches on the strict consensus (Fig. 1). In general, the results are congruent, but the Bayesian analysis also found support for additional clades or collapsed groups recovered in the MP analysis. This alternative topology is only pertinent for a part of Clade D3 and reported in Fig. 2. Support values for individual clades from the two methods are similar throughout the tree, that is, if a clade is recovered with > 95% jackknife, the posterior probabilities (PP) are often 1.00. Also, many jackknife values in a range of 60%–90% have similar or slightly increased PP.

*Planchonella* forms a strongly supported group (100%/1.00). Overall topology corresponds to the three Clades D1–D3 identified by Swenson & al. (in press; similarly numbered here for consistency). One difference between these studies is that we recover moderate to weak support (72%/0.68) for a sister relationship between clade D1 and D3, whereas no hypothesis of subclade relationship was suggested by the former study. Swenson & al. (in press) combined morphological and molecular data and found support for two subclades within D3 (their Fig. 1, D3a–D3b). One subclade (D3b) was also recovered here (90%/1.00), but excludes the Australian species *P. eerwah*. Their second subclade (D3a), a clade not found by the present analyses, included most species from Australia and the Pacific Islands. These taxa are here grouped in two small clades (D3b2 and *P. obovata*–*P. myrsinifolia*), but only supported by the MP and Bayesian analyses.

Two poorly known species assigned to *Planchonella* by Aubréville (1967) are both nested within *Planchonella*. *Planchonella amieuana* is sister to all species in Clade D1, a position recovered with strong support (99%/1.00). *Planchonella thiensis* is placed in Clade D2 with strong

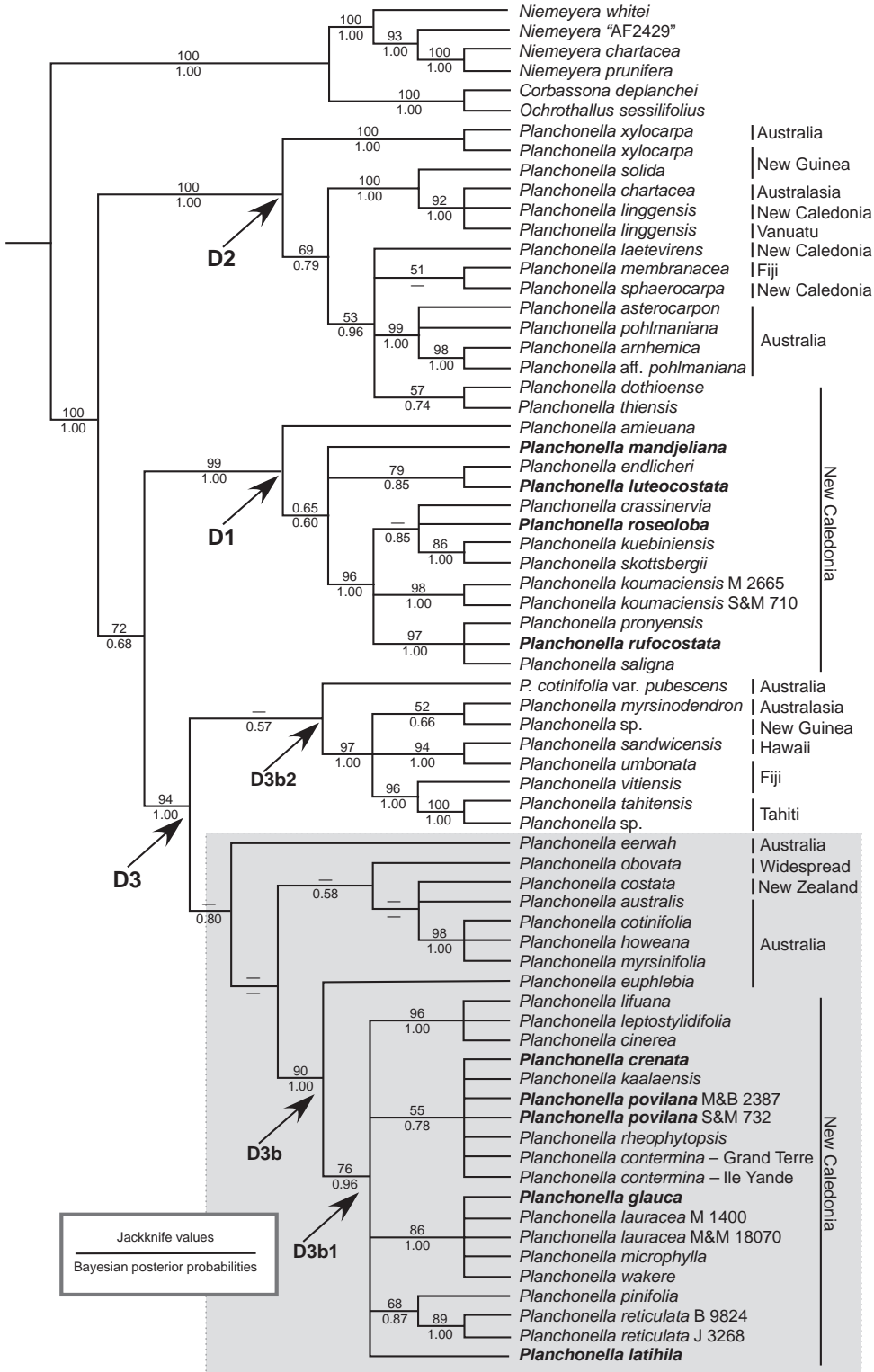


Fig. 1. Strict consensus of 243 trees from a parsimony analysis of *Planchonella* (Sapotaceae) using nrDNA sequence data and binary gap coding (910 steps, CI: 0.770, RI: 0.812). The jackknife and Bayesian analyses recovered similar majority-rule trees. Clade support is given as jackknife values (above) and posterior probabilities (below) on the branches. Branches without support are indicated with a dash (—). Species in bold are the new taxa described in this paper. The shaded box is where Bayesian analysis suggests a slightly different/more resolved topology (see Fig. 2). Subclades (D1–D3b) correspond to the subclades recovered by Swenson & al. (in press).

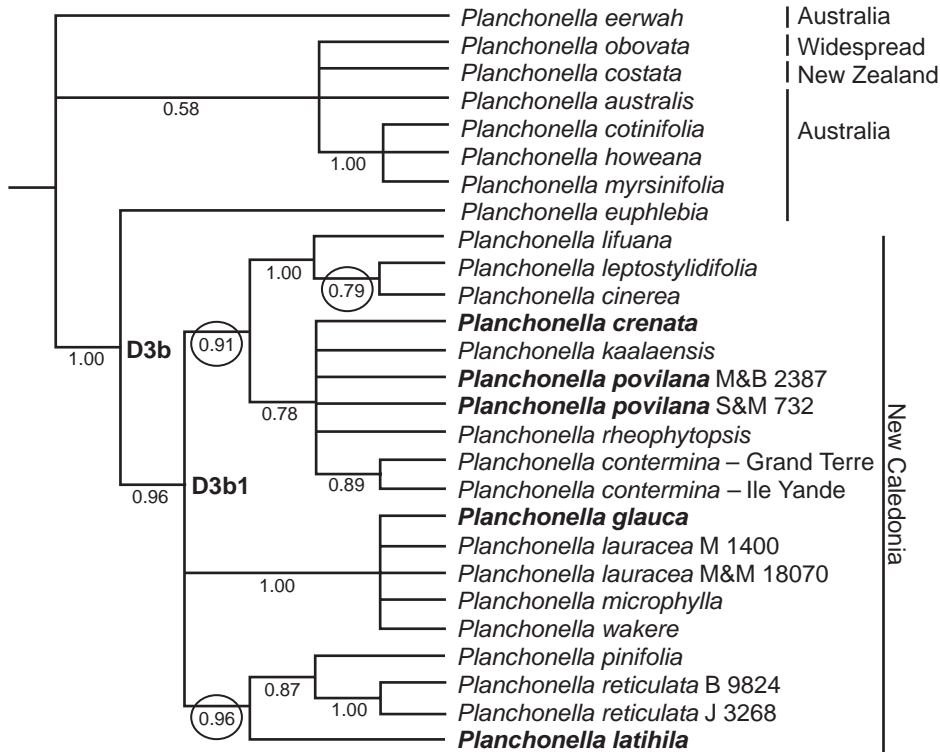


Fig. 2. Topology of the boxed clade in Fig. 1, where Bayesian analysis suggests some different relationships (PP encircled) compared to the parsimony analyses. Posterior probabilities are shown below the branches.

support (100% / 1.00), but its relationship to other species in this clade is not well resolved.

Interestingly, the two new taxa exemplified in the introduction are not sisters nor are they closely related to their putative sister species *Planchonella reticulata*. These two, herein formally described as *P. glauca* and *P. latihila*, are positioned in different clades (Fig. 2). All new species of *Planchonella* are recovered in two clades entirely confined to New Caledonia (D1 and D3b1). In D1 we find *P. mandjeliana*, *P. luteocostata*, *P. roseoloba*, and *P. rufocostata*, all medium sized trees with fairly restricted distribution. In clade D3b1, we find the even more restricted (local) endemics *P. crenata*, *P. latihila*, and *P. povilana*. *Planchonella glauca* is confined to schist (non-ultramafic soil) in the Mount Panié massif in northeast New Caledonia. Most taxa represented by two accessions each (*P. linggensis*, *P. koumaciensis*, *P. contermina*, *P. reticulata*, *P. xylocarpa*) group together.

Both accessions of the Australian species *Planchonella cotinifolia* are found in clade D3, but the two taxa are not one another's closest relatives. The subspecies *Pouteria myrsinoides* subsp. *reticulata* sensu Green (1990) with accessions from Lord Howe Island and New Caledonia also appear in two separate clades. The accession from Lord Howe Island, recognised as *Planchonella howeana* (Jessup, 2001), however, forms a strongly supported group

(98% / 1.00) with the Australian species *P. cotinifolia* and *P. myrsinifolia*. Also, there is no molecular evidence that the two accessions of *P. pohlmaniana* are one another's closest relatives, but they do group with strong support (99% / 1.00) with *P. asterocarpon* and *P. arnhemica*.

## DISCUSSION

The main difference between the MP search versus the jackknife and Bayesian analyses, is that the former resolved some relationships in Clade D3, which found no support in the latter two analyses. For example, at the top in the shaded box, *Planchonella eerwha* from Australia is placed as the sister to a large clade, but this position has no support from the jackknife nor Bayesian analyses. Similarly, the Bayesian provides more hypotheses of relationships than the jackknife analysis (cf. Figs. 1–2). An example is the position of *P. latihila*, which was believed (based on gross morphology) to be closely related to *P. glauca*, but jackknife provides no support for this hypothesis. Bayesian analysis, however, attaches *P. latihila* with strong support as sister to *P. pinifolia*–*P. reticulata* rather than to its expected relative. It is known that Bayesian posterior probabilities are often higher when compared to bootstrapping (Erixon & al., 2003), but this latter position

points to a very important result, that *P. glauca* and *P. latihila* are distinct species, different from each other and other already accepted taxa. We also conclude that the jackknife tree is the most conservative solution.

**Molecular phylogeny of *Planchonella*.** — Our results suggest that *Planchonella* forms a well-supported clade that is distinct from the outgroup. *Planchonella* itself is made up of three main lineages (D1–D3), with a weakly supported sister relationship between clades D1 and D3. Thus, our result is fully congruent with previous reports (Bartish & al., 2005; Swenson & al., in press). Also, the evidence shows that Sapotaceae colonized New Caledonia by several dispersal events. *Planchonella* most probably dispersed into this area at least three times and from these events, the ancestors gave rise to two species radiations (to be discussed later). Thus, most New Caledonian species (including the eight new species) belong to two clades (D1 and D3b1).

Formal and informal attempts to subdivide *Planchonella* have been suggested by Dubard (1912), van Royen (1957), and Aubréville (1963, 1964, 1967). Dubard's classification was untenable (van Royen, 1957), because he had mixed taxa of *Planchonella* and *Xantolis*. Although belonging to the same subfamily, *Xantolis* has been shown to be the sister to other Chrysophylloideae (Anderberg & Swenson, 2003). Van Royen (1957) refrained from recognizing formal sections, but envisioned seven informal groups. His taxonomy is not supported by the clades found here. His "Groups 3, 4, and 7" belong to *Beccariella* sensu Swenson & al. (in press). Then, species of his "Group 1" are distributed in the three main lineages of *Planchonella* (Clades D1–D3) and in the same group he placed with doubts *P. baillonii*. *Planchonella baillonii* belongs to the genus, but its position within it is uncertain and it may be of hybrid origin (Swenson & al., in press). It was therefore excluded from this study. Thus, van Royen's informal groups are also untenable because he did not see the groups corresponding to D1–D3 nor did he distinguish between *Planchonella* and *Beccariella*.

Aubréville recognised several segregate genera including *Bureavella*, *Iteiluma*, and *Pyriluma*. Analyses of combined molecular and morphological data have shown that all these taxa are polyphyletic or embedded in *Planchonella* (Swenson & al., in press). The latter authors also examined the diagnostic characters for each of these segregates and found them unusable and rejected them. Yet, there is strong molecular support for at least three lineages in *Planchonella*. Despite this, we have not identified any clear morphological character combination that is diagnostic for any of these groups.

Although morphology was not included here, fruit morphology may distinguish Clades D1–D3. Observations on living trees in New Caledonia reveal that some characters are partly correlated with these clades. In general,

the fruits are a few centimetres long, vary from ovoid to obovoid, have very little pulp and a persistent style, and the fruit apices are round, acuminate, or acute. Also, the fruits are either round where the number of seeds cannot be counted from the outside of the fruit, or ridged where each ridge corresponds to a seed (cf. Figs. 7 and 10). A tentative fruit character combination may facilitate identification or serve as a future hypothesis. All but one species in Clade D1 (confined to New Caledonia) have ridged fruits, almost no pulp, acuminate apices, and short styles. Exception are *Planchonella amieuana*, where the mature fruit is still unknown, and *P. endlicheri*, where the fruit may better fit in Clade D3, but the seeds are ridged. Clade D2 has fleshy, apple-like, slightly polygonous fruits with much more pulp and apices that are retuse with a short style. Species in Clade D3 have more variable fruits, but are generally small, round (or slightly ridged), with less pulp, and apices that are round or acute (not acuminate). Future studies of the genus in Australia and New Guinea, where all members are still not identified, should pay attention to fruit characters.

**Taxa with double accessions.** — Several taxa were represented in our analyses with double accessions. The purpose of this was to investigate taxonomic problems, to determine if taxa with a disjunct distribution are monophyletic, or to clarify the identity of some odd specimens. We discuss these with reference to the phylogenetic tree in Figure 1 and begin with widespread taxa followed with possible taxonomic problems.

At top of the tree (Clade D2), double accessions were included of *Planchonella xylocarpa* and *P. linggensis*. *Planchonella xylocarpa* is found in Queensland, New Guinea, and Solomon Islands, of which accessions from the first two areas were available. These two form a strong monophyletic group (100%/1.00), sister to the rest of Clade D2, and we regard this as an unproblematic widespread species. In contrast *Planchonella linggensis* is widely distributed, from Malesia in the west to many islands in the West Pacific. Earlier analysis found this taxon paraphyletic and possibly conspecific with *P. chartacea* (Swenson & al., in press). Our analyses group these accessions in a polytomy, sister to the New Guinean species *P. solida*. The affinity of *P. solida* is thought to be with taxa from Australia, Micronesia, and New Guinea, i.e., *P. micronesica* and *P. peekelii* (van Royen, 1957). A cursory inspection of *P. solida* indicates morphological similarities with *P. linggensis*. We believe this complex of taxa require a closer morphological examination to reveal species limits.

*Planchonella koumaciensis* (Clade D1) was described by Aubréville (1967) based on a few flowering specimens from Mount Tiébaghi, not far from Koumac, in northwest New Caledonia. This is a small, isolated mountain rich in nickel, and mining operations have already cleared much

of the natural vegetation. Due to these facts, *P. koumaciensis* is listed as endangered (Jaffré & al., 1998). Fruiting material is now available, but a single individual was recently found in an as yet undisturbed area near the western base of Koniambo massif (Coco River Valley). This specimen differs in having larger leaves, but our analyses group the two accessions with strong support (98% / 1.00). This new locality extends the range of *P. koumaciensis* to the more southern Koniambo massif. However, this area of unspoiled maquis is not protected, and is threatened by urbanisation in conjunction with mining activities in the next few years. The new locality indicates that the *P. koumaciensis* may also occur on other ultramafic areas, such as Mt. Kaala and Mt. Ouazangou-Taom.

The following examples are all found in subclade D3b1 (Figs. 1–2). *Planchonella povilana* is a new species described below and is restricted to a small area around Poindimié in northeast New Caledonia. It has not been recognised until now, because it has been confused with *P. lifuana*, a species confined to the Loyalty Islands. Both accessions of *P. povilana* belong to a small clade (*P. crenata*–*P. contermina*), whose members have near identical DNA sequences. Yet, its morphology is distinct from its closest relatives (see below). Two accessions of *P. contermina* were included. This species is known from a fairly small area in northwest New Caledonia and classified as endangered (Jaffré & al., 1998). Previously only imperfect flowers and fruits were known, but well developed flowers and fruits have been collected recently. A population bearing fruits was recently found on the little offshore island Yandé. This opened the possibility that it may represent a new taxon or simply the first record from the island. In fact, *P. contermina* belongs to a clade (D3b1) with weak to moderate support, low molecular variability, but large morphological variation. The two accessions group together in the Bayesian analysis and considering the morphology, we believe it represents the first record of *P. contermina* from Yandé.

Specimens of *Planchonella lauracea* are frequently difficult to distinguish from *P. wakere*. The former often grow into a shrub or small tree up to 4 m tall, whereas the latter becomes a large tree. Fruit and seed morphology is probably the best feature to separate them. Fruits are small and brownish pubescent in *P. lauracea*, versus larger and glabrous in *P. wakere*, and seeds are twice as long in the latter. However, there is a considerable overlap in these as well as other characters. These two species are closely related and group with a few more species in a clade with virtually identical sequences. Thus, we suggest that an examination of morphology and distribution is necessary to reveal species limits between *P. lauracea* and *P. wakere*.

**Taxonomic implications in Australia.** — In Australia, *Planchonella cotinifolia* is represented by two

varieties, var. *cotinifolia* and var. *pubescens*. Both grow in the semi-evergreen forests of Queensland (sympatric), but seem to differ in microhabitat (allopatric). *Planchonella cotinifolia* var. *pubescens* tolerates a drier type of vegetation and is distinguished by its yellowish pubescence on lower leaf surface, sepals, and ovary. In contrast, var. *cotinifolia* is more common in southeast Queensland where the dry season is shorter and its various parts are glabrous (van Royen, 1957; L. Jessup, pers. comm.). Our results unambiguously show that *P. cotinifolia* is not monophyletic. In spite of the low support for the position of var. *pubescens* in clade D3b2, it is not closely related to var. *cotinifolia*, which instead forms a trichotomy with *P. howeana* and *P. myrsinifolia*. Due to the lack of fieldwork, it is possible that van Royen (1957) had a conservative view and avoided the species rank when in doubt. For instance, his varieties of *Planchonella costata* var. *smithii* and var. *umbonata* from Fiji were later given species rank (Smith, 1981), and var. *umbonata* is evidently not closely related with *P. costata* (Swenson & al., in press). Thus, the two varieties of *P. cotinifolia* cannot be treated under the same specific name, and we suggest that *Planchonella cotinifolia* var. *pubescens* is given species rank (see below).

*Planchonella myrsinifolia* is a species complex of three taxa in the Southwest Pacific with a convoluted nomenclature and taxonomy (Green, 1986, 1990; Govaerts & al., 2001; Jessup, 2001). These taxa have been named, among others, *P. myrsinoides* (Australia), *P. howeana* (Lord Howe Island), and *P. reticulata* (New Caledonia). Based on leaf venation, Green (1990) proposed to recognise two subspecies, subsp. *myrsinoides* from Australia and subsp. *reticulata* from Lord Howe Island and New Caledonia, but Swenson & al. (in press) demonstrated that these subspecies are not closely related. However, here we also included material from Lord Howe Island to investigate its relationship with plants from New Caledonia. Our analyses recovered a strongly supported trichotomy of *P. cotinifolia*, *P. howeana*, and *P. myrsinifolia*, with *P. reticulata* excluded from this clade. An inspection of these three accessions reveals identical nrDNA sequences. Lord Howe Island is a small offshore island situated much closer to the Australian coast than to New Caledonia. A biogeographic affinity to Australia rather than to New Caledonia may therefore seem more logical. However, we suggest that a close morphological analysis of the Australian taxa is necessary to understand the morphological variation, species limits, and to determine whether some are conspecific.

**Conservation in New Caledonia.** — The descriptions of eight new *Planchonella* species increase the number of species in New Caledonia by 25%. The first volume of the flora of New Caledonia treated Sapotaceae (Aubréville, 1967) and the new additions highlight some



aspects of the present conservation status in New Caledonia. Morat (1993) estimated that 5% to 10% of the flora remained to be discovered, a figure that we predict will turn out to be a conservative estimate. Several researchers have pointed out that many species will be described in the future, but that they were insufficiently known at the time. For example, the species here described as *P. luteocostata* was first collected in 1966 and identified as “Veillon 6585” in various publications (Bouchet & al., 1995; Jaffré & al., 1998, 2001; Morat & al., 2001). *Planchonella povilana* has also “been known” since 1966 but had been confused with *P. lifuana*, a species confined to the Loyalty Islands where it grows on limestone. We believe that specimens collected many years ago will be used to describe new species in the future. However, *P. crenata* and *P. latihila* were discovered only a few years ago in conjunction with botanical inventories in areas prospected for future mining and/or urbanisation activities. *Planchonella latihila* was fortunately found with fruits, collected for DNA study, and based on these results recognised as a new species. This illustrates the importance of exhaustive botanical inventories in areas earmarked for development so that adequate conservation measures can be proposed to protect rare habitats and species for future generations. Thus, we urge for taxonomists to study and revise the flora of New Caledonia to avoid or reduce loss of biodiversity in the future.

## TAXONOMY AND NEW SPECIES

The only treatment of *Planchonella* (van Royen, 1957) is now 50 years old and uses an outdated classification. Recent phylogenetic work has accumulated evidence that distinguishes monophyletic groups earlier reduced to *Pouteria* (Bartish & al., 2005; Swenson & Anderberg, 2005; Swenson & al., in press). This is a time consuming procedure when all members are not yet identified. Also, we predict that there might be many more undescribed species, especially in New Guinea. *Planchonella* is one such group and in order to ease future endeavour of understanding this genus, we give a preliminary generic circumscription here.

As currently known, *Planchonella* lacks a single, non-homoplasious, and diagnostic synapomorphy, which is why a combination of characters is necessary to diagnose the clade. The simplest combination includes stamens fixed just below (rarely in) the orifice of the tube, a style with round stigmatic areas, a multi-seeded fruit, and foliaceous cotyledons embedded in endosperm (Swenson & al., in press).

Common characters for the genus are normally given in the generic description and not reiterated under each species. When the word “or” has been used in the descrip-

tion, the appropriate character state is always given for each species. If words such as “sometimes” or “rarely” are used in the generic description, the appropriate character state is repeated only for the pertinent species. Types are not cited among the additional specimens.

- Planchonella*** Pierre, Not. Bot. Sapot. 1: 34. 1890, nom. cons. – Type: *Planchonella obovata* (R. Br.) Pierre.  
 = *Hormogyne* A. DC. in Prodr. 8: 176. 1844, nom. rejic. – Type: *Hormogyne cotinifolia* A. DC.  
 = *Bureavella* Pierre, Not. Bot. Sapot. 1: 16. 1890 – Type: *Bureavella maclayana* (F. Muell.) Pierre.  
 = *Iteiluma* Baill. in Bull. Mens. Soc. Linn. Paris 2: 892. 1890 – Type: *Iteiluma baillonii* (Zahlbr.) Baill. ≡ *Poissonella* Pierre, Not. Bot. Sapot. 1: 29. 1890.  
 = *Peuceluma* Baill. in Bull. Mens. Soc. Linn. Paris 2: 895. 1890 – Type: *Peuceluma pinifolia* Baill.  
 = *Albertisiella* Pierre ex Aubrév. in Adansonia, n.s., 4: 42. 1964 – Type: *Albertisiella novoguineensis* (Vink) Aubrév.  
 = *Pyriluma* Aubrév., Fl. N. Caléd. & Dépend. 1: 83. 1967 – Type: *Pyriluma sphaerocarpum* (Baill.) Aubrév.

Trees or shrubs. *Leaves* simple, spirally arranged, entire or very rarely crenate, glabrous or tomentulose below, often glabrescent; leaf hairs ferruginous, grey, or white; leaf base often cuneate, apex rounded or very rarely mucronate; stipules absent; secondary venation brochidodromous or eucamptodromous, very seldom craspedodromous; intersecondaries rarely present; tertiary veins reticulate, parallel, oblique, or sometimes horizontal, never areolate. *Inflorescence* axillary, rarely ramiflorous or cauliflorous, fasciculate, burls absent. *Flowers* (4–)5(–6)-merous in all parts, bisexual or female, pedicellate, rarely sessile. *Sepals* in a single whorl, free, quincuncial, broadly ovate, often tomentulose outside, glabrous inside, persistent in fruit. *Corolla* tubular, 2–10 mm, rarely up to 35 mm long, glabrous or rarely hairy, white, cream, greenish, yellowish, or red, sometimes bicoloured; corolla tube as long as or longer than the lobes; lobes erect; corolla margin eciliate or rarely ciliate. *Stamens* fixed just below (rarely in) the orifice of the tube, glabrous, included, shorter than the corolla or subsessile; anthers ovate, basifixed, shortly calcarate, flexible; anther appendage absent or minute. *Staminodes* inserted in the corolla sinus, entire or sometimes with a bifid apex, glabrous, oblong, lanceolate, subulate, or aristate. *Gynoeceium* subglobose or ovoid, ovary hairy; style slender or conical, included, as long as the corolla, rarely exerted, glabrous or basally hairy, often persistent in fruit; apex with round stigmatic areas. *Fruit* a berry, ovoid, ellipsoid, obovoid, or globose, rounded or ridged, glabrous or hairy, often glabrescent, pulp generally poorly developed, 1–5-seeded, often reduced (?) to 1–3 seeds;

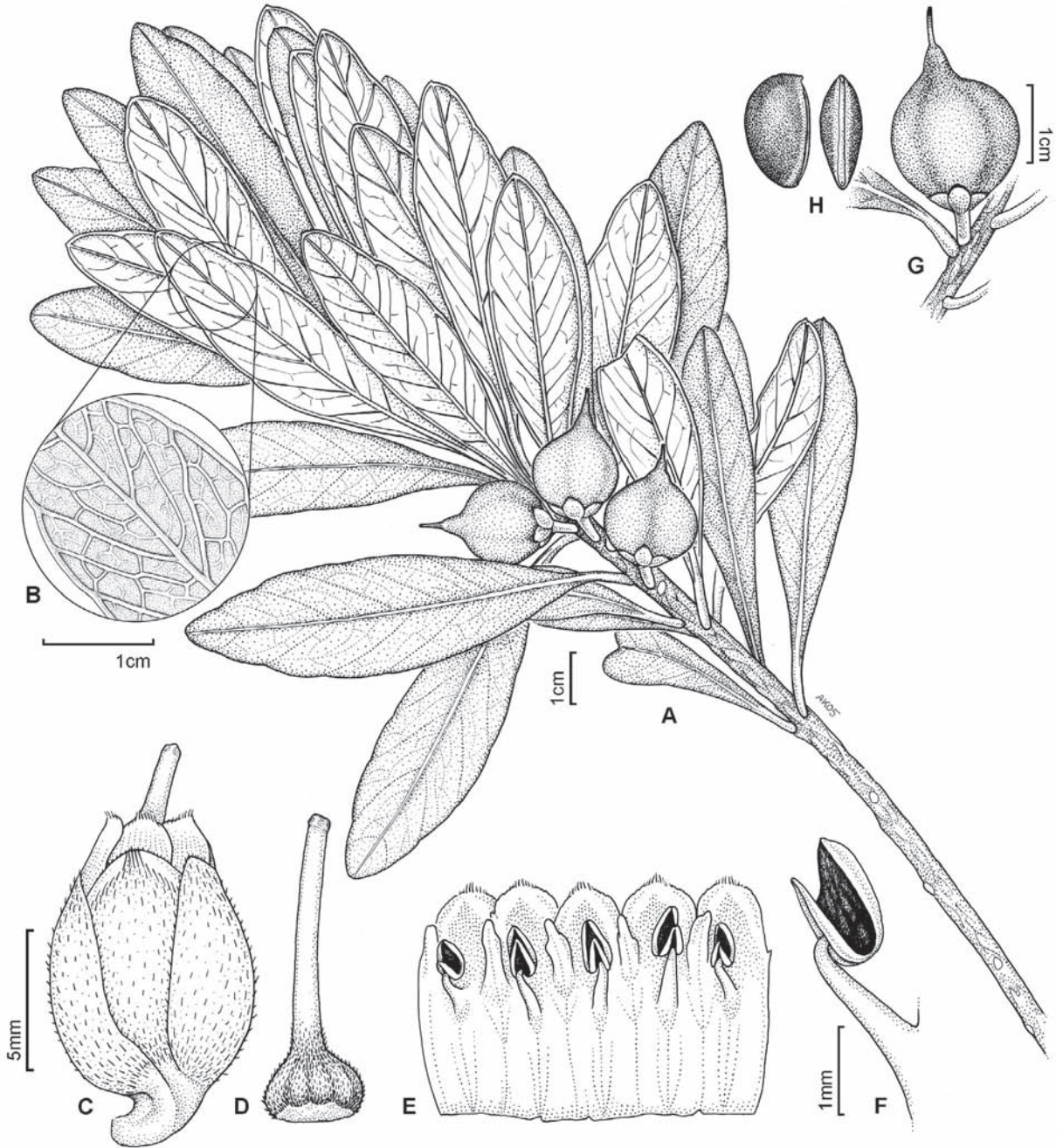


Fig. 3. *Planchonella crenata*. A, habit; B, leaf venation (lower surface); C, flower; D, ovary; E, open corolla with stamens and staminodes; F, stamen; G, fruit; H, seed, side view (left) and ventral view (right). Drawn from Swenson & Munzinger 709 (A–B, F–G), Jaffré 3505 (C–E).

seeds laterally compressed, shaped like the segment of an orange, sometimes keeled; seed scar linear-oblong, narrow, covering 90%–100% of the seed length, rarely shorter; testa nitidous or dull, brown in different shades, thin (0.2–0.5 mm), hard (0.5–1.0 mm), or woody (1.0–3.0 mm). *Embryo* vertical; radicle exerted below the cotyledons; cotyledons thin and foliaceous, rarely thick and flat, smooth, white; endosperm copious, rarely scarce.

*Planchonella crenata* Munzinger & Swenson, **sp. nov.**

– Holotype: New Caledonia, Province Nord, Koné, Koniambo, along Pandanus River Valley, Lat S 21°01'13", Long E 164°47'22", 50 m alt, 3 Oct 2005, Swenson & Munzinger 705 (P) – Isotypes: NOU, S.

Species haec *Planchonellae reticulatae* affinis, sed foliis craspedodromis et interdum crenatis, et fructibus distincte acuminatis differt.

Shrub up to 3 m tall, monocaulous or multi-stemmed; young twigs grey with fine, short, white hairs, old twigs grey, scaly. *Leaves* clustered at branch apex, oblong or obovate, 4–8(–9) × (1–)2–3 cm, coriaceous, shiny, glabrous or with a few adpressed white hairs below; craspedodromous venation, secondaries of 5–6 pairs, tertiaries reticulate; margin often crenate; apex mucronate or rounded; petiole 10–13 mm long; petiole, midvein, and margin sometimes tinged red. *Flowers* 5-merous, bisexual, 1–3 in each fascicle; pedicel ca. 4 mm long, sparsely tomentulose. *Sepals* 6.0–8.0 mm long. *Corolla* 7 mm long, pale yellow, corolla tube slightly longer than the lobes; lobes suborbicular, shortly hairy at the tip of the margin. *Stamens* shorter than the corolla; anthers 1.5 mm long, acute, divided laterally, without appendage. *Staminodes* oblong or lanceolate. *Gynoecium* subglobose; style slender, basally hairy. *Fruit* ovoid, not ridged, acute, 25–30 × 15–20 mm including a 5–10 mm long persistent style, tomentulose, (1–)3–5-seeded; seeds 15–16 × 8–9 mm; testa nitidous, dark brown, 1.0 mm thick (Fig. 3).

*Etymology:* This species is named after the crenate leaves, a very rare character in Sapotaceae and the only case from New Caledonia.

*Distribution and notes:* Restricted to the Koniambo massif (Fig. 4), where it grows in maquis on serpentine at low altitudes. Flowers have been observed in March and mature fruits in October. The species resembles *Planchonella reticulata* by its glabrous and coriaceous leaves, conspicuous venation on both leaf surfaces, but is distinguished by a craspedodromous venation, where the secondaries run to and anastomose with the marginal vein. This gives the margin a characteristic crenate appearance.

*Conservation status:* Based on its very restricted distribution, the current mining project on the Koniambo massif (Jaffré, 2005), and the involved urbanisation of the area, *Planchonella crenata* matches the IUCN criteria for being *Endangered* (EN, B1+2ab(iii)).

*Additional specimens examined:* New Caledonia, Province Nord, Koniambo, 1 Mar 2002, Jaffré (leg. D. Massard) 3505 (NOU); Koniambo, Lat S 21°01', Long E 164°47', 1 Jul 2004, Munzinger (leg. V. Dumontet) 2284 (NOU, P, S); Between Koné and Voh, Koniambo, along Coco River Valley, Lat S 20°59'38", Long E 164°44'22", 50 m alt, 3 Oct 2005, Swenson & Munzinger 709 (MO, NOU, P, S).



Fig. 4. Distribution of *Planchonella crenata* (●), *P. glauca* (■), *P. latihila* (□), and *P. luteocostata* (▲). The coloured areas are land/mountains dominated by ultramafic soil.

***Planchonella glauca* Swenson & Munzinger, sp. nov.**

– Holotype: New Caledonia, Province Nord, Roches de la Ouaième, ca. 750 m alt., humid forest, 28 Oct 2005, Munzinger, Lowry, Blaffart & Brown 3128 (P)  
 – Isotypes: A, BRI, MO, NOU, S.

Species haec *Planchonellae wakere*, *P. lauraceae*, et *P. reticulatae* similis sed a totis foliis glaucis differt; a priore inflorescentia laxa, foliis et fructibus minoribus differt; a *P. lauracea* floribus minoribus; a posteriore foliis tomentosis differt.

Tree up to 12 m tall. Leaves clustered at tips of branches, obovate, 4–8(–9) × 2–4 cm, glabrescent, min-

utely dotted above, tomentulose below, hairs first ferruginous, turning greyish, ultimately glaucous; brochidodromous venation, secondaries of 5–7 pairs, tertiaries reticulate; petiole 5–15 mm long. Flowers 5-merous, bisexual, 1–3 in each fascicle; pedicel 4–6 mm long, tomentulose. Sepals 3.0–3.5 mm long. Corolla 4.0–4.5 mm long, white, corolla tube slightly longer than the lobes, lobes ± rectangular. Stamens shorter than the corolla; anthers 0.5 mm long, without appendage. Stamínodes oblong. Gynoecium subglobose; style slender, glabrous. Fruit obovoid–ellipsoid, not ridged, acute, 25 × 20 mm, sparsely tomentulose, glabrescent, 1–3-seeded; seeds 20–

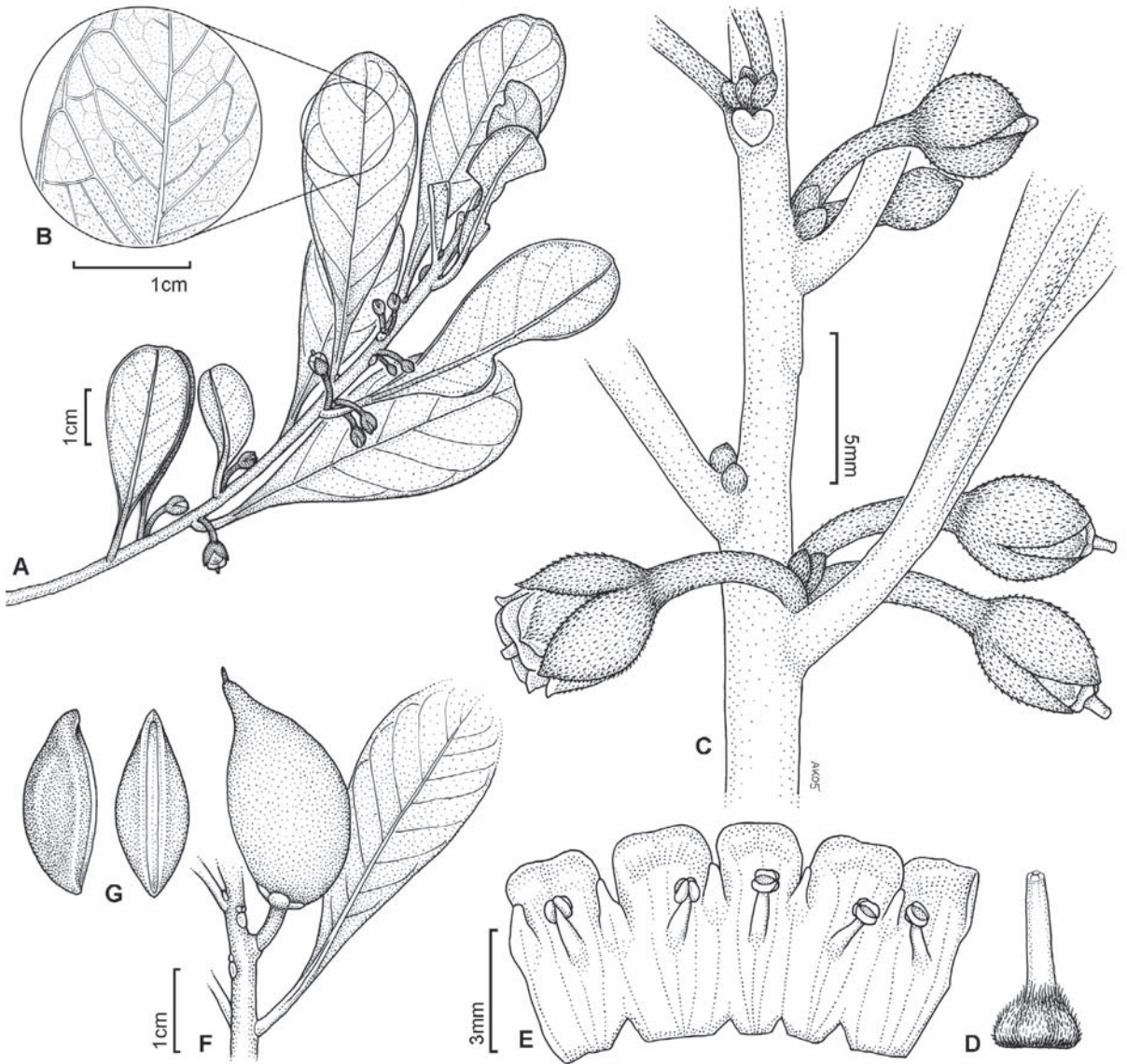


Fig. 5. *Planchonella glauca*. A, habit; B, leaf venation, hairs, and dots (upper surface); C, flowers; D, ovary; E, open corolla with stamens and staminodes; F, fruit; G, seed, side view (left) and ventral view (right). Drawn from Munzinger & al. 3128 (A–E), Swenson, McPherson & Mouly 629 (F–G).

23 × 5–8 mm; testa nitidous, 0.5–0.8 mm thick; peduncle 5–6 mm long (Fig. 5).

*Etymology:* The specific epithet *glauca* refers to the foliage of the tree. Apart from young leaves, which often are ferruginously hairy, the hairs soon lose their colour and the entire tree has a bluish nuance.

*Distribution and note:* Endemic to the Mount Panié massif and Roches de la Ouaième (south of River Ouaième) in northeast New Caledonia (Fig. 4). It grows on schist (non-ultramafic soil) in humid forest from 600–1,000 m. A rare species with a restricted distribution, but common on Mt. Colnett. Flowers in October to November and fruits have been observed during the same time. The glaucous foliage, small white flowers, and rectangular corolla lobes are diagnostic. Apart from not growing on ultramafic soils, it differs from *P. wakere* in its lax inflorescence, smaller leaves (not 8–20 × 3–8 cm) and fruits (not 40–60 × 25–40 mm), from *P. lauracea* in the smaller flowers (not 5–7 mm), and from *P. reticulata* in tomentulose leaves (not glabrous).

*Conservation status:* *Planchonella glauca* appears as isolated individuals or small populations in its range from Mt. Mandjéla in the north to Roches de la Ouaième in the south. Part of the distribution is located inside the Mt. Panié Reserve (presently monitored for biodiversity), where threats from deliberately set fires are reduced. Fires north and south of this area, however, occur frequently and possess a potential threat to the entire forest. Apart from former operations, current mining and logging activities are absent. The plant may match the IUCN criteria for being Endangered (EN, B1+2ab(iii)), but threats against the humid forest in this area is much lower than in others parts of New Caledonia. Thus, we believe the status *Near Threatened* (NT) is a better estimate accounting for the explicit threats and present knowledge of the flora in this part of the island.

*Additional specimens examined:* New Caledonia, Province Nord, Mt. Mandjéla, 12 Nov 1981, *McPherson 4263* (MO), also 19 Dec 1981, *McPherson 4523* (BRI, MO, NOU, P), and 12 Nov 1981, *Pennington & McPherson 10308* (MO, NOU); Pouébo, along trail between Mt. Mandjéla and Ignambi, Lat S 20°23'48", Long E 164°31'56", 715 m alt, 6 Oct 2005, *Swenson & Munzinger 718* (MO, NOU, P, S); Mt. Colnett, below the camp site (1,000 m), Lat S 20°30', Long E 164°42', 950 m alt, 1 Nov 2003, *Swenson, McPherson & Mouly 625* (MO, NOU, P, S), also *Swenson, McPherson & Mouly 629* (S); Mt. Panié, above Haut Coulna, Lat S 20°36'82", Long E 164°44'40", 820–970 m alt, 28 Oct 1999, *McPherson & van der Werff 17788* (MO, P); Roches Ouaième, 28 Oct 2005; *Munzinger & al. 3109* (NOU, P, S).

*Planchonella latihila* Munzinger & Swenson, **sp. nov.**

– Holotype: New Caledonia, Province Sud, Prony

Est, High Kwé West valley, zone S5, 21 Sep 2004, *Munzinger* (leg. *G. Dagostini*) 2394 (NOU) – Isotypes: P, S.

Species haec *Planchonellea lifuanea*, *P. cinerea* et *P. glauca* affinis sed a totis foliis glaucis et cinereis differt; a *Planchonella lifuanea* foliis subter tomentosis et fructibus minoribus, a *P. cinerea* fructibus majoribus, et a *P. glauca* hilis latis differt.

Tree up to 20 m tall, 35 cm in diameter; bark with longitudinal crevices; young twigs brownish tomentulose. *Leaves* clustered at tip of branches, obovate, 7–10 × 2.5–4 cm, coriaceous, glabrous above or sparsely hairy along midvein, tomentulose below, hairs first brown, turning light brown or greyish; brochidodromous venation, secondaries of 7–8 pairs, tertiaries reticulate, often parallel near midvein; petiole 5–7 mm long, glabrescent. *Flowers* 5-merous, bisexual or female; 1–3 in each fascicle; pedicel tomentulose. *Sepals* 4.0–5.0 mm long. *Corolla* 5–6 mm long, greenish, corolla tube longer than the lobes; lobes suborbicular, hairy along the margin. *Stamens* subsessile; anthers 0.5 mm long, without appendage. *Staminodes* oblong. *Fruit* obovoid, not ridged, 20–22 × 12–14 mm, tomentulose, 1-seeded; seeds ellipsoid, 17–18 × 5–6 mm; testa nitidous, dark brown; seed scar oblong or oblanceolate, 16–17 × 4–5 mm; style remains hairy at base; peduncle 8–10 mm long (Fig. 6).

*Etymology:* The specific epithet *latihila* is adopted after the, for the genus, unusually broad seed scar.

*Distribution and notes:* *Planchonella latihila* is only known from a single adult individual and a few saplings (in a ring of ten meters around the adult) in high Kwé West valley in a small remnant forest on ultramafic soil, approximately at 200 m elevation (Fig. 4). One sapling taken for propagation flowered recently and are the only flowers known. The foliage is similar to *P. cinerea*, *P. glauca*, and *P. lifuana*, but differ in fruit form, a broad seed scar, and abiotic factors. These species are restricted, respectively, to littoral forests in southwest, humid forests on schist in northeast, and forests on calcareous soils in the Loyalty Islands. Fruits of *P. cinerea* and *P. lifuana* are more or less spherical, two molecular closely related species. *Planchonella glauca* and *P. latihila* have both obovoid fruits, but the peduncle of the latter is almost twice as long. Also, Bayesian analysis places these in two separate subclades inside Clade D3b1.

*Conservation status:* The only individual of this species is directly threatened by an ongoing mining project. Intensive botanical inventories in neighbouring forests have not been able to locate any additional individuals. The species conservation status is therefore classified as *Critically Endangered* (CR, B1+2ab(iii)).

*Additional specimens examined:* New Caledonia, Province Sud, Prony Est, High Kwé West valley, 29 Oct 2005, *Munzinger & Swenson 3001* (NOU, P, S), and 12 Sep 2006, *Munzinger 3546* (NOU).

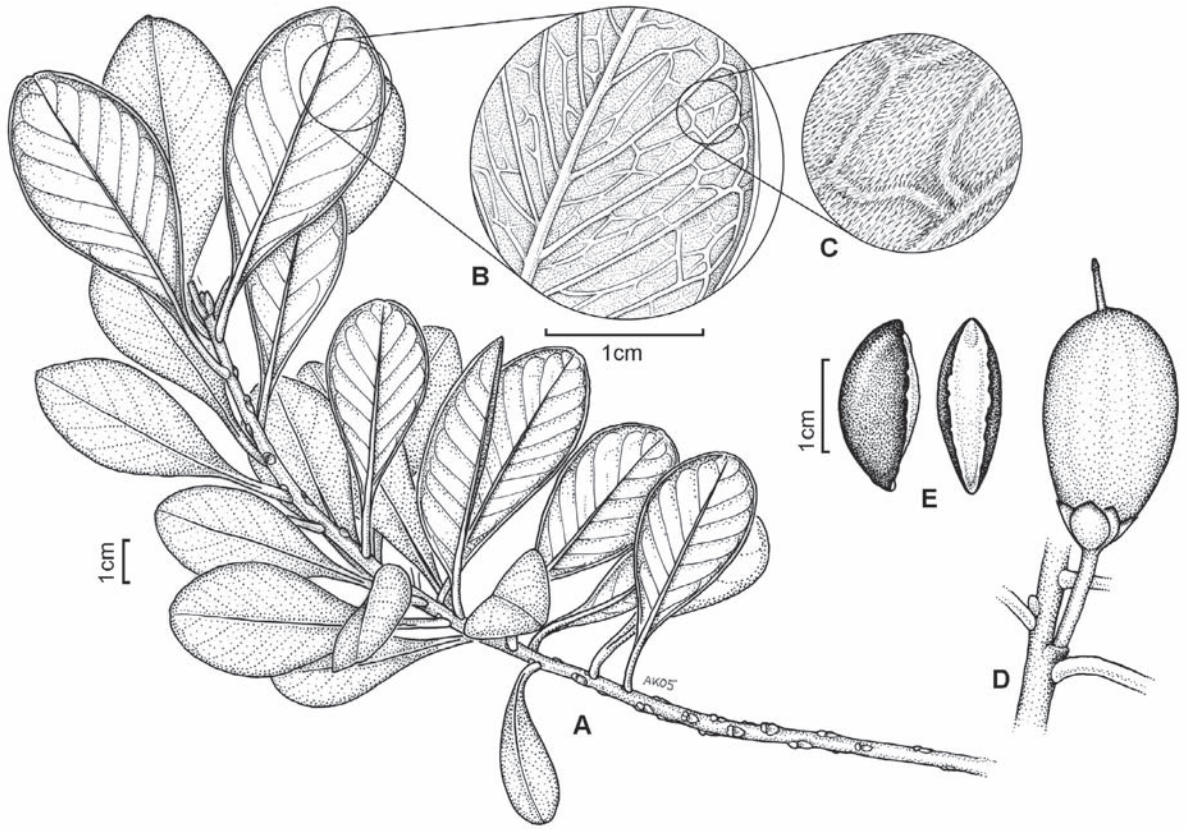


Fig. 6. *Planchonella latihila*. A, habit; B, leaf venation (lower surface); C, leaf pubescence (lower surface); D, fruit; E, seed, side view (left) and ventral view (right). Drawn from *Munzinger & Swenson 3001* (A–C), *Munzinger 2394* (D–E).

*Planchonella luteocostata* Munzinger & Swenson, **sp. nov.** – Holotype: New Caledonia, Province Nord, Tiéa, Propriété Nicoli, Conservatoire forêt sclérophyll, Lat S 21°08'19", Long E 164°56'18", 19 Nov 2004, *Munzinger, Labat & Butin 2601* (P) – Isotypes: A, BRI, MO, NOU, S.

Species haec *Planchonellae roseolobae* affinis sed corollis minusculis et viridulis, fructibus minoribus, foliis minoribus et ramis cum lenticellis differt.

Tree up to 8 m tall, 30 cm in diameter; bark grey with longitudinal crevices; young twigs light grey, tomentulose, old twigs dark with many bright, round or elliptic lenticels. *Leaves* clustered at tips of branches, obovate–elliptic–orbicular, 3–15 × 2.5–6.5 cm, glabrous above, sparsely whitish tomentulose below, soon glabrous; brochidodromous venation, secondaries of 4–10(–13) pairs, tertiaries reticulate, often parallel near midvein; midvein, secondaries, and sometimes the leaf margin yellow; petiole 7–25 mm long, whitish tomentulose, soon glabrous. *Inflorescence* axillary and/or ramiflorous. *Flowers* 5-merous, bisexual, 2–10(–15) in each fascicle, sessile. *Sepals* 2.5–4.0 mm long. *Corolla* 2.0–3.0 mm long, greenish, corolla tube slightly longer than the lobes, lobes suborbicular. *Stamens*

subsessile; anthers 0.5–1.0 mm long, appendage minute. *Staminodes* oblong. *Gynoecium* subglobose; style slender, glabrous. *Fruit* obovoid, ridged, acuminate, 25–33 × 15–22 mm (acumen ca. 10 mm), glabrous, (1–)5-seeded; seeds keeled, 18–21 × 6–9 mm; testa dull, pale brown, 0.2–0.3 mm thick. *Embryo* with thick and flat cotyledons, endosperm scarce (Fig. 7).

*Etymology*: The name refers to the yellow colour (*luteo-*) of the primary (*costa*) and secondary veins.

*Distribution and notes*: *Planchonella luteocostata* is restricted to the sclerophyll forests of the west coast of New Caledonia (Fig. 4). It grows on calcareous substrate, black clays, and alluvial deposits. Two records are from the same locality on serpentine soil (*MacKee 25071, 24513*), but this is doubtful since it also states “near the coast”, an area devoid of serpentine. Flowers in June to September and bears mature fruits from November to February. Leaves on immature individuals are sometimes peculiarly shaped, almost linear–oblanceolate, up to 25 cm long and only 1–3 cm wide, and sometimes with a mucronate apex. *Planchonella luteocostata* is easily distinguished from all others species by its glabrous leaves, yellow venation (especially the midvein), numerous lenticels, tiny greenish

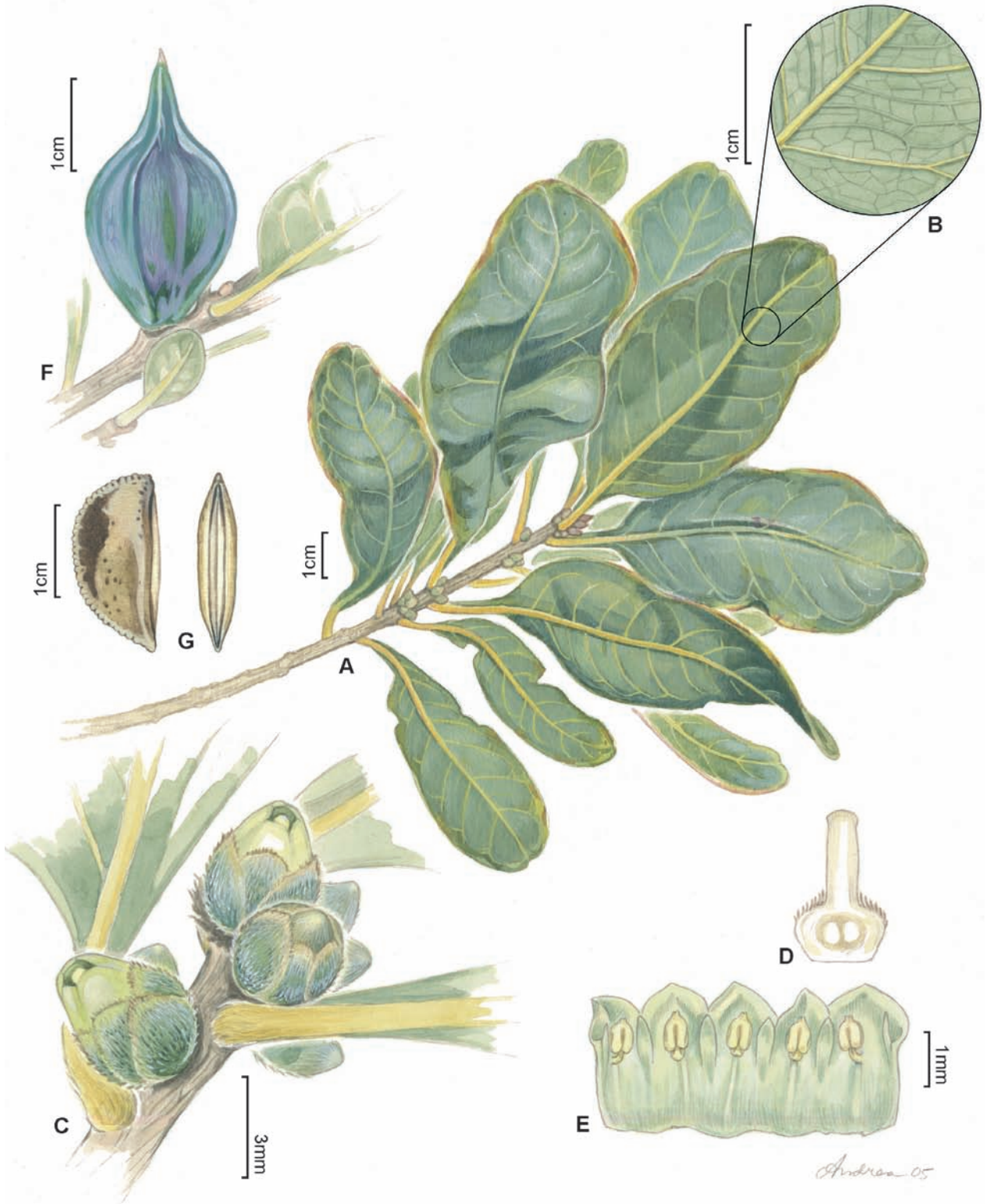


Fig. 7. *Planchonella luteocostata*. A, habit; B, leaf venation (lower surface); C, flowers; D, ovary; E, open corolla with stamens and staminodes; F, fruit; G, seed, side view (left) and ventral view (right). Drawn from Munzinger, Jaffré & Roumagnac 2375 (A–C, F), Munzinger, Labat & Butin 2601 (D–E), Veillon 7324 (G).

flowers, and its ecology (dry forest). Its habitat causes the latex to emerge slowly in dry weather.

**Conservation status:** This species was identified as new (*Planchonella* sp., Veillon 6585) and restricted to the sclerophyll forest already by Bouchet & al. (1995). Due to inadequate protection of this habitat, these authors suggested further steps to conserve the sclerophyll forest. Then, Jaffré & al. (1998) classified this undescribed species as *Vulnerable* (VU), and we propose to keep it in that IUCN category.

**Additional specimens examined:** New Caledonia, Province Nord, Koumac, Koum, 12 Dec 1982, *MacKee* 41089 (P); Koumac, Sud-Est de la Corne, 10 Jul 1972, *MacKee* 25658 (NOU, P, S); Koumac, Tchabel, 27 Dec 1966, *MacKee* 16199 (NOU, P), also 26 Nov 1967, *Veillon* 1532 (NOU); Koumac, Trou Poutier, 16 Oct 1982, *MacKee* 40897 (NOU); Nékoru, 8 Aug 2003, *Dagostini & Rigault* 695 (NOU), also 26 Nov 2003, *Dagostini* 724 (NOU, P, S); Népoui, 19 Jan 1972, *MacKee* 25071 (P), also 31 Oct 1971, *MacKee* 24513 (NOU, P, S), 19 Feb 1972, *MacKee* 25072 (P, S), 9 Jun 1981, *MacKee* 39171 (NOU, P, S), and 20 Dec 1981, *MacKee* 40120 (NOU); Pouembout, conservatoire botanique de Tiéa, 3 Aug 2000, *Dagostini, Rigault & Fambart* 182 (NOU); also ancienne propriété Berton, 11-10-1988, *Veillon* 6972 (NOU), and Tiéa, Propriété Nicoli, Conservatoire forêt sclérophylle, 10 Sep 2004, *Munzinger, Jaffré & Roumagnac* 2375 (NOU, P, S); Poum, 25 Nov 1982, *MacKee* (leg. Bourguine) 41025 (NOU, P, S), also 21 Dec 1982, *MacKee* 41089 (NOU, P, S); Poya, forêt de Nekoro, vers 5 m, 28 Sept 1988, *Veillon* 6902 (NOU); Poya Nord, entre le creek Hervouet et son affluent nord, au dessus de la RT1, 14 Oct 1998, *Veillon* 8132 (NOU); Presqu'île de Népoui, Pindaï, 18 Nov 1987, *Veillon* 6585 (NOU, P, S), and 17 Nov 1987, *Jaffré* 2895 (NOU). Province Sud, Boulouparis, Ilot Leprédour, 24 Dec 1977, *Jaffré* 2100 (NOU), 23 Nov 1982, *MacKee* 41013 (NOU, P, S), versant S. O., 21 Dec 1977, *Veillon* 3435 (NOU, P, S), forêt sud, 28 Jul 1988, *Veillon* 6851 (NOU); Presqu'île Montagnès, versant sud-ouest, 31 Jan 1991, *Veillon* 7324 (NOU, P, S).

***Planchonella mandjeliana* Munzinger & Swenson, sp.**

**nov.** – Holotype: New Caledonia, Province Nord, Ouégoa, Mandjélia, près de l'ancienne scierie, vers 700 m alt, 12 Dec 1991, *Veillon, Tirel & Jérémie* 7457 (NOU) – Isotypes: BRI, NOU, P, S.

Species haec *Planchonellae linggensis* affinis sed foliis constanter ellipticis, floribus albis, et fructibus majoribus et ellipsoideis differt.

Tree up to 8 m tall. *Leaves* clustered at tips of branches, elliptic, 5–7(–9) × 1.5–3.5 cm, glabrous and shiny above, glabrous and pale green below; brochidodromous venation, secondaries of 6–14 pairs, tertiaries reticulate, often parallel to secondaries, midvein yellowish, leaf margin slightly recurved; petiole 10–13(–15) mm long,

glabrous. *Flowers* 5-merous, bisexual or female, 1(–2) in each fascicle; pedicel 6–10 mm long, glabrous or sparsely tomentulose. *Sepals* 2.0–3.0 mm long, membranous, glabrous or slightly tomentulose. *Corolla* 2.0–3.5 mm long (female often short), white, corolla tube slightly longer than the lobes, lobes suborbicular. *Stamens* subsessile; anthers 0.7–1.0 mm long, without appendage. *Staminodes* oblong or ovate, apex shortly bifid at least in bisexual flowers. *Gynoeceium* subglobose; style slender or slightly conical, included, glabrous. One *fruit* known from a single specimen, ellipsoid, ridged, acuminate, 45 × 20 mm (acumen ca. 7 mm), 1–3-seeded(?); seeds circa 30 × 5 mm; peduncle 12 mm long (Fig. 8).

**Etymology:** The specific epithet refers to its only known locality, Mt. Mandjélia, northeast New Caledonia.

**Distribution and notes:** *Planchonella mandjeliana* is known only from a small area of Mt. Mandjélia, west of Pouébo, in the northern part of the Panié massif (Fig. 9). It has been collected in a narrow altitudinal range between 600 and 750 m, where it grows in humid forest on a micascist substrate. It seems to flowers all the year round, but only a single mature fruit (collected in December) is known. This species might be confused with *P. linggensis*, but is distinguished on a more rounded leaf apex (not acuminate or acute), white flowers (not greenish), and ellipsoid and apiculate fruits. Also, *P. linggensis* occurs in forests of low elevation, usually on islands and calcareous ground.

**Conservation status:** The humid forest of the 600–700 m altitudinal interval of Mt. Mandjélia was severely logged decades ago. Open areas from these activities are now slowly invaded by the introduced species *Pinus caribaea*. Deliberately set fires represent a further threat and are difficult to fight in this part of the territory. Fires often start at villages at low altitude, spread along the mountain slopes, and finally nibble the edges of the humid forest. Our own experience indicates that it is almost impossible to find more than two individuals of this species, and we believe further work is needed to confirm successful seedling recruitment. Therefore, we suggest that *Planchonella mandjeliana* is given the IUCN status as *Critically Endangered* (CR, B1+2ab(iii)).

**Additional specimens examined:** New Caledonia, Province Nord, Pouébo, entre Mandjélia et Salamandé, 26 Feb 1970, *MacKee* 21645 (NOU, P, S); Mandjélia, *MacKee* 32771 (NOU, P), also 17 Oct 1981, *McPherson* 4041 (MO, NOU, P, S), 14 Nov 1981, *Pennington & McPherson* 10313 (NOU, MO), 20 Feb 1984, *McPherson* 6318 (MO, NOU, S), 15 Apr 1984, *McPherson* 6471 (MO, NOU), 12 Jun 2005, *Munzinger & Pillon* 2861 (NOU, P, S), 6 Oct 2005, *Swenson & Munzinger* 720 (NOU) and Lat S 20°23', Long E 164°31', 600 m alt, 7 October 2005, *Swenson & Munzinger* 723 (NOU, S); Ouégoa, 31 Jul 1973, *Veillon* 2998 (NOU); Oumbarinien, 6 Feb 1980, *MacKee* 37795 (NOU, P, S).



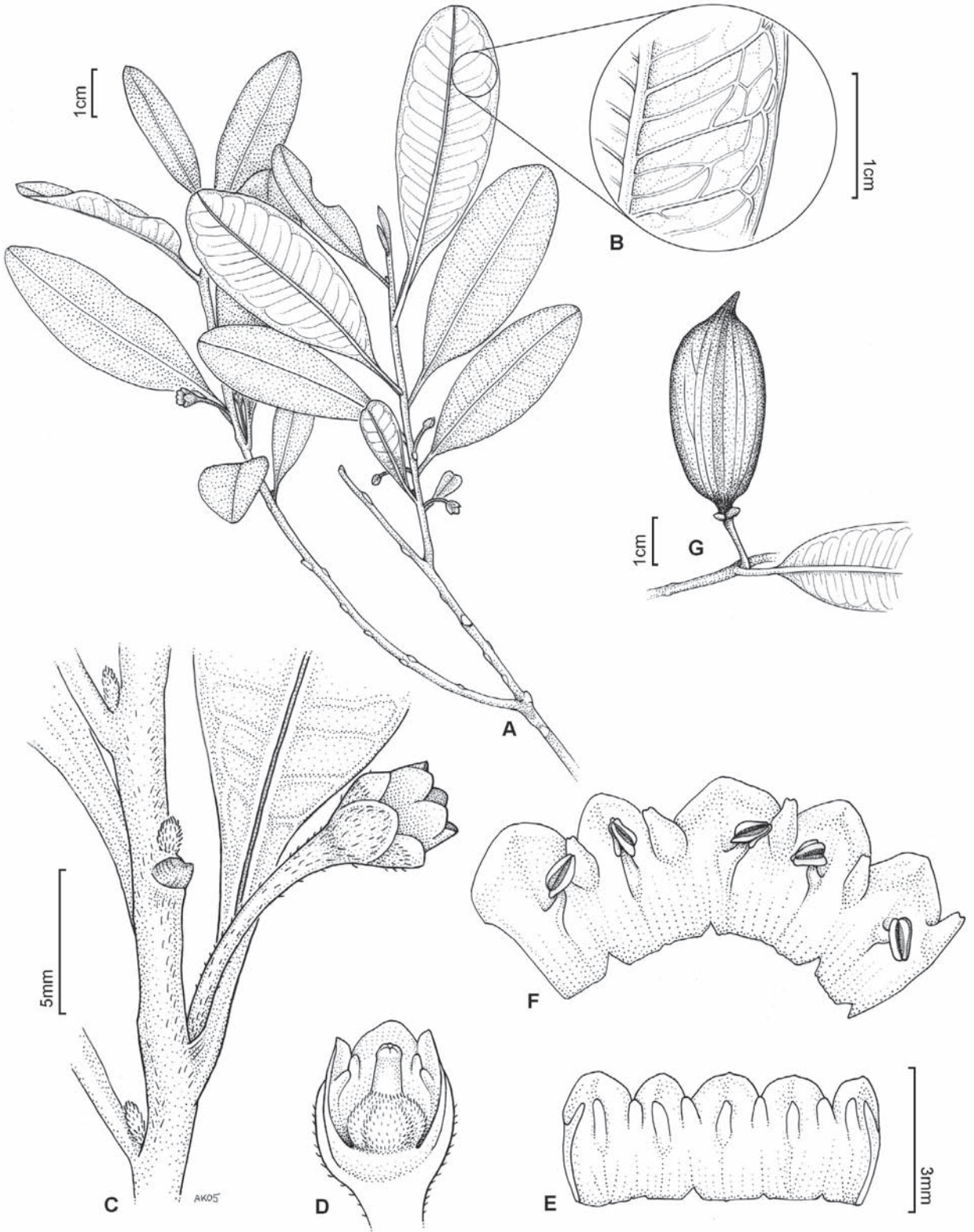


Fig. 8. *Planchonella mandjeliana*. A, habit; B, leaf venation (lower surface); C, flower; D, transection of a female flower; E, open female flower with staminodes and reduced stamens; F, open bisexual flower with stamens and staminodes; G, fruit. Drawn from McPherson 4041 (A–E), MacKee 21645 (F), Veillon 7457 (G).



Fig. 9. Distribution of *Planchonella mandjeliana* (●), *P. povilana* (■), *P. roseoloba* (□) and *P. rufocostata* (▲). The coloured areas are land/mountains dominated by ultramafic soil.

*Planchonella povilana* Swenson & Munzinger, **sp. nov.**

– Holotype: New Caledonia, Province Nord, along RPN3 just north of Monéo, west of the road, 100 m to the sea shore, in small forest remnant on serpentine, Lat S 21°09'00", Long E 165°20'03", 10 Oct 2005, Swenson & Munzinger 732 (P) – Isotypes: A, BRI, MO, NOU, S.

Species haec *Planchonellae lifuanae* et *P. latihilae* similis sed a priore fructibus fusiformibus, a posteriore seminum cicatrice angustata differt.

Tree up to 12 m tall. *Leaves* spaced along branches, spatulate–orbicular, (4–)5–9 × (2–)3–5 cm, glabrous above, ferruginous tomentulose below, partly glabrescent; brochidodromous venation, secondaries of 6–8 pairs, tertiaries reticulate, parallel near the midvein. *Flowers* 5-merous, bisexual, solitary; pedicel 5 mm long, tomentulose. *Sepals* 6–8 mm long. *Corolla* 7 mm long, greenish, corolla tube longer than the lobes, lobes suborbicular. *Stamens* shorter than the corolla; anther 1 mm long, without appendage. *Staminodes* oblong, apex often bifid. *Gynoecium* ovoid; style slender, basally hairy. *Fruit* fusiform, 30–35 × 7–13 mm, tomentulose,

1–3-seeded; seeds 15–20 × 5–6 mm; testa nitidous, 0.5–0.6 mm thick; peduncle 12–15 mm long (Fig. 10).

*Etymology*: The specific epithet *povilana* refers to the Povila catchment area just west of Poindimié, where this species has its main distribution.

*Distribution and note*: Known from a relative small area of northeast New Caledonia, between Ponandou River Valley in the north and Monéo in the south (Fig. 9). It occurs in maquis vegetation from sea level to 100 m altitude on ultramafic soil. Flowers in April and set fruits in August to November. The only known flowering specimen was collected near Monéo by MacKee, misidentified, and used for the line drawings of *Planchonella lifuana* (see Aubréville, 1967). This latter species is confined to the limestones of the Loyalty Islands. Hence, the flower of *P. lifuana* has never been studied. Although the two are similar in their foliage, *P. povilana* is distinguished by its spatulate or even orbicular leaves, fusiform (not globular) and smaller fruits.

*Conservation status*: The maquis vegetation is severely damaged in this part of New Caledonia, especially from deliberately set fires by humans. We suspect that

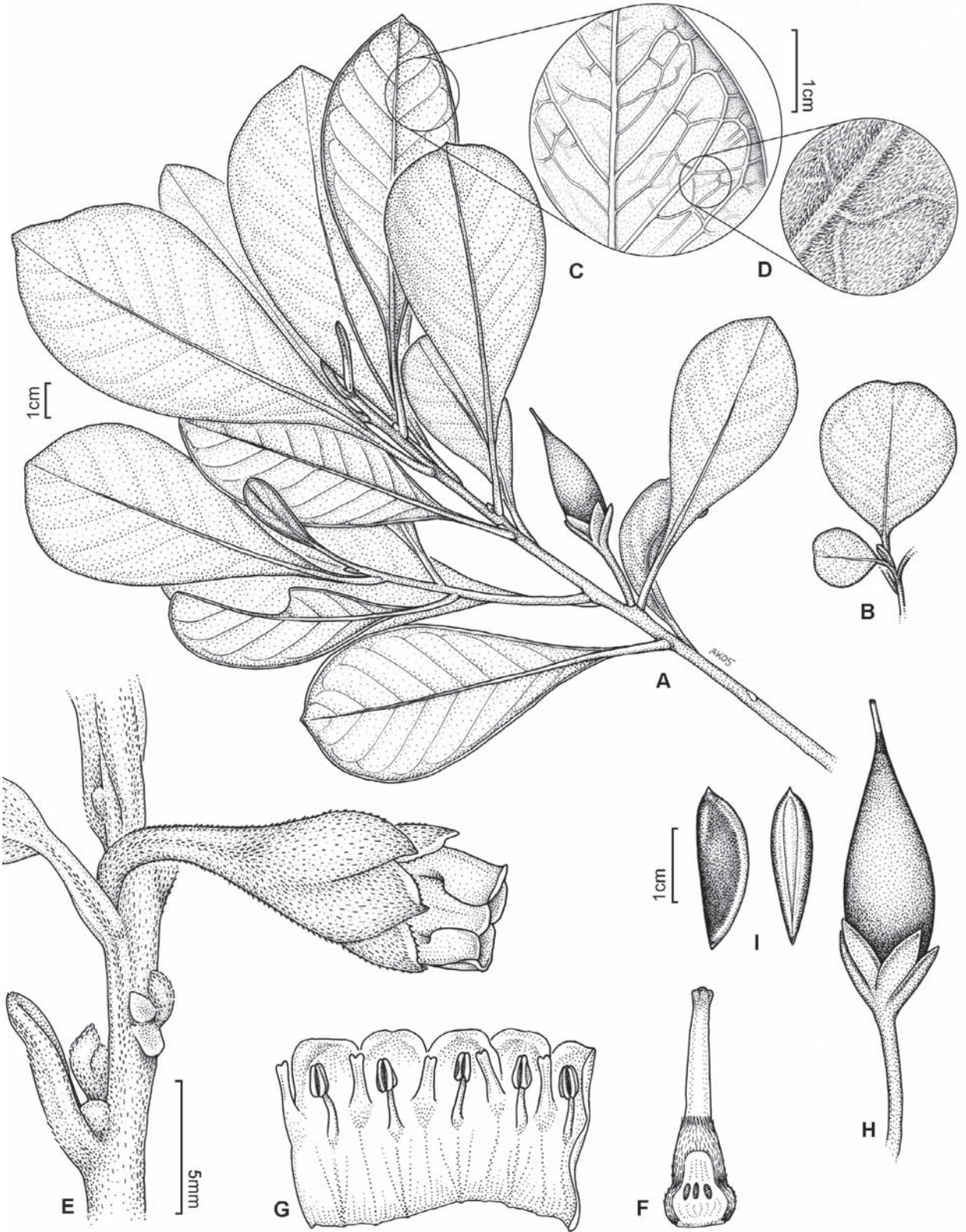


Fig. 10. *Planchonella povilana*. A, habit; B, rhombic leaf; C, leaf venation (lower surface); D, leaf pubescence (lower surface); E, flower; F, ovary; G, open corolla with stamens and staminodes; H, fruit; I, seed, side view (left) and ventral view (right). Drawn from Swenson & Munzinger 728 (A, C–D, H–I), MacKee 17233 (B), MacKee 14661 (E–G).

many localities have been destroyed, leading to a reduced and scattered distribution. The type was collected from the only tree in a very small grove near the sea, surrounded by more or less barren hills. The Povila locality appears to house a larger population, but risk of fires is high in this kind of vegetation. *Planchonella povilana* matches IUCN criteria and is classified as *Endangered* (EN, B1+2ab(iii)).

*Additional specimens examined:* New Caledonia, Province Nord, Houailou, Ho, 15 Jul 1976, *MacKee 31582* (P); Povila, *MacKee 40487* (P, S), also 29 Jul 2004, *Munzinger & Butin 2387* (NOU); Catchment area of Povila, 3 km SW of Poindimié, along the southern track, Lat S 20°55'39", Long E 165°17'58", 50 m alt, 9 Oct 2005, *Swenson & Munzinger 727* (NOU, S), also 3 km SW of town, along the northern track, 100 m alt, 9 Oct 2005, *Swenson & Munzinger 728* (BRI, MO, NOU, P, S); Monéo, 4 Apr 1966, *MacKee 14661* (NOU, P, S), also 10–50 m, 6 Aug 1967, *MacKee 17233* (P, S); Touho, Ponandou, 16 Apr 1980, *MacKee 38040* (P, S).

***Planchonella roseoloba* Munzinger & Swenson, sp. nov.**

– Holotype: New Caledonia, Province Nord, Tchamba valley, 15 Jul 2004, *Munzinger, D. & I. Létocart & Gateblé 2232* (P) – Isotypes: BRI, MO, NOU, S.

Species haec *Planchonellae rufocostatae* similis sed petiolis et foliis glabris et staminodiis bifidis differt.

Shrub or small tree up to 6 m tall; young twigs grey or brownish tomentulose, glabrescent, old twigs dark. *Leaves* clustered at tips of branches, elliptic–broadly elliptic or obovate, 10–20 × (3.5–)5–9 cm, glabrous above, sparsely tomentulose below, quickly glabrous; brochido- or eucamptodromous venation, secondaries of 7–12 pairs, tertiaries reticulate or oblique; petiole (7–)10–30(–35) mm long, glabrous. *Inflorescence* axillary and/or ramiflorous. *Flowers* 5-merous, bisexual, 1–3 in each fascicle, sessile. *Sepals* 4.5–5.0 mm long. *Corolla* 3–5 mm long, white with pink lobes, corolla tube longer than the lobes, lobes suborbicular. *Stamens* subsessile; anthers 0.6–0.7 mm long, without appendage. *Staminodes* oblong, caudate, bifid. *Gynoecium* subglobose or obovoid; style slender, as long as the corolla, glabrous. *Fruit* obovoid, ridged, acuminate, 43–50 × 22–32 mm (acumen ca. 6 mm), glabrous but often hairy behind the persistent sepals, (1–)5-seeded; seeds 27 × 8 mm; testa dull, light brown, 0.5 mm thick. *Embryo* with thick and flat cotyledons, endosperm scarce (Fig. 11).

*Etymology:* The name refers to the pink or reddish corolla lobes.

*Distribution and notes:* Restricted to the humid forest in the central area of New Caledonia, where it grows on micaschist soils between 450 and 700 m altitude (Fig. 9). Flowers from April to August and it seems to set fruits in more or less the same season (from May to July). *Plan-*

*chonella roseoloba* can occur in the same forests as *P. rufocostata*, two species with similar flowers and fruits, but the former is distinguished on the almost glabrous petiole, leaf venation, and leaf surface (not tomentose). Also, the bifid staminode is another useful character, which separates them.

*Conservation status:* *Planchonella roseoloba* is only known from isolated individuals scattered in central New Caledonia. As a member of the humid forest, it is a quite difficult tree to recognise without flowers or fruits and is probably under-collected. Since it seems to be confined to non-ultramafic soils its localities are not under an immediate threat from mining operations. The species would match criteria for being Vulnerable (B1+B2ab(iii)), but a *Low Concern* status appears to be more justified.

*Additional specimens examined:* New Caledonia, Province Nord, Aoupinié 460 m alt, 29 May 1997, *Litaudon 279* (NOU), also 20 Jul 1976, *Morat 5090* (NOU, P), and 21 Jul 1976, *Sévenet 1198* (NOU); Col des Roussettes, 15 Aug 2004, *Munzinger 2311* (NOU, P, S); Haute Tchamba, 11 May 1967, *MacKee 16755* (NOU, P, S), also 28 Apr 1968, *MacKee 18716* (NOU, P, S), 19 Jul 1979, *Sévenet 1736* (NOU), 15 Jul 2004, *Munzinger 2232* (NOU), 550 m, 3 Apr 2006, *Munzinger & al. 3379* (NOU, P, S), and May 1980, *Veillon 4438* (NOU); Ponérihouen, Haute vallée de Mou, 600 m alt, 25 Sep 1969, *MacKee 20882* (P, S).

***Planchonella rufocostata* Munzinger & Swenson, sp. nov.**

– Holotype: New Caledonia, Province Nord, Touho, Pondanou River Valley, in humid forest on schist south of river, Lat. S 20°49'06", Long E 165°13'11", 160 m alt, 8 Oct 2005, *Swenson & Munzinger 725* (P) – Isotypes: A, BRI, CANB, K, MO, NOU, NSW, S, WELTU.

Species haec *Planchonellae roseolobae* similis sed foliis basilater tomentosis et staminodiis triangularibus differt.

Tree up to 8 m tall, 25 cm in diameter. *Leaves* clustered at tips of branches, obovate or rarely elliptic, 5–17(–28) × 3–7(–10) cm, sparsely tomentose on both surfaces, glabrescent above; brochido- or eucamptodromous venation, secondaries of 6–10 pairs, tertiaries reticulate or oblique; petiole robust, 3–8(–15) mm long; young twigs, petiole, midvein, and secondary veins rufous tomentose, especially near the leaf base. *Inflorescence* axillary and/or ramiflorous. *Flowers* 5-merous, bisexual, 1–3 in each fascicle, sessile. *Sepals* 2.5–4.0 mm long, tomentose. *Corolla* 3.0–4.5 mm long, white or pale yellow with pink lobes, corolla tube longer than the lobes, lobes suborbicular. *Stamens* subsessile; anthers 0.7–0.8 mm long, without appendage. *Staminodes* triangular, acute. *Gynoecium* globose; style slender, as long as the corolla, glabrous. *Fruit* obovoid, ridged, acuminate, 43 × 22 mm (acumen ca. 10 mm), sparsely tomentose, (1–)5-seeded; seeds

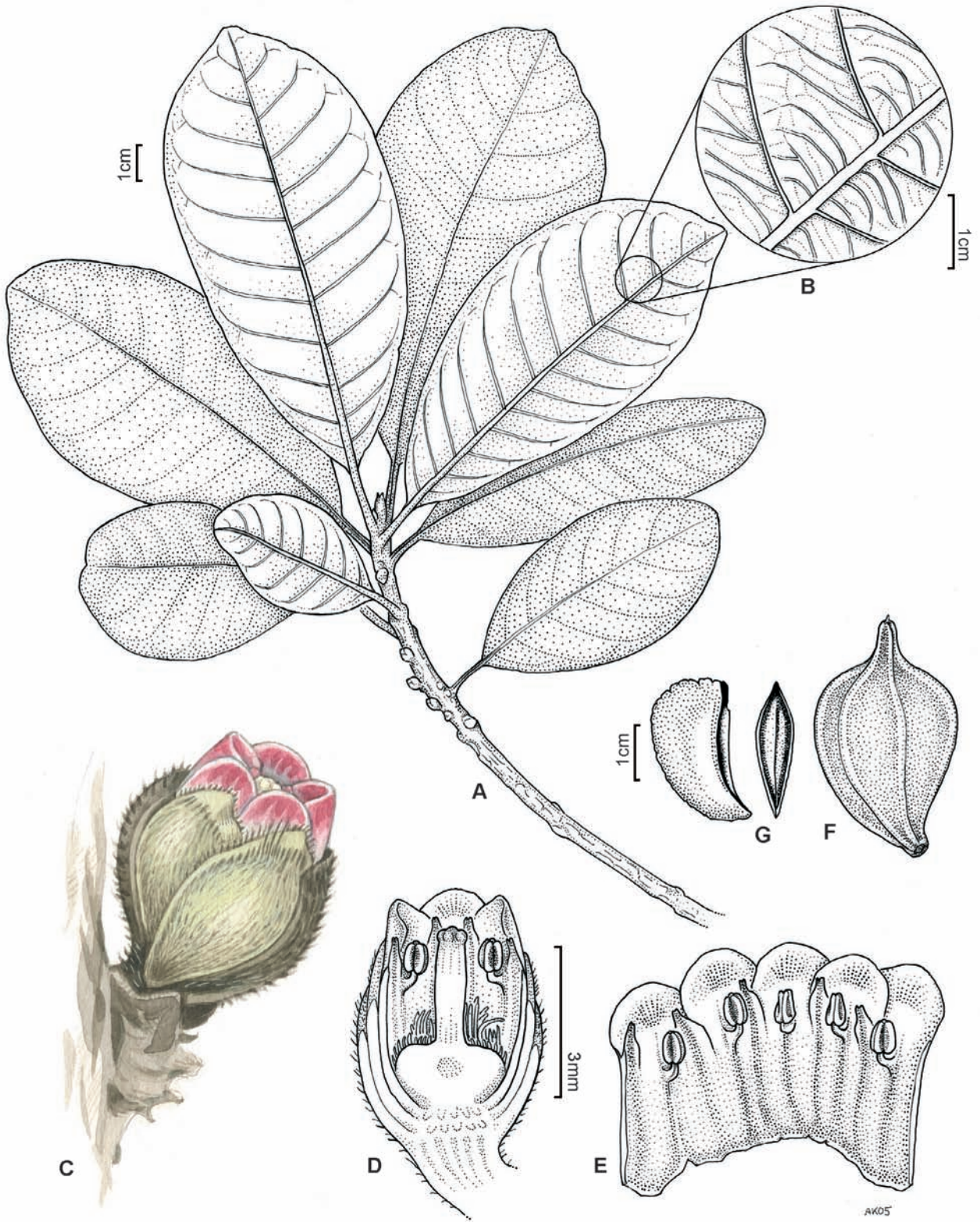


Fig. 11. *Planchonella roseoloba*. A, habit; B, leaf venation (lower surface); C, flower; D, transection of flower; E, open corolla with stamens and staminodes; F, fruit; G, seed, side view (left) and ventral view (right). Drawn from Munzinger, Létocart & Gateblé 2232 (A–E), Veillon 4438 (F–G).

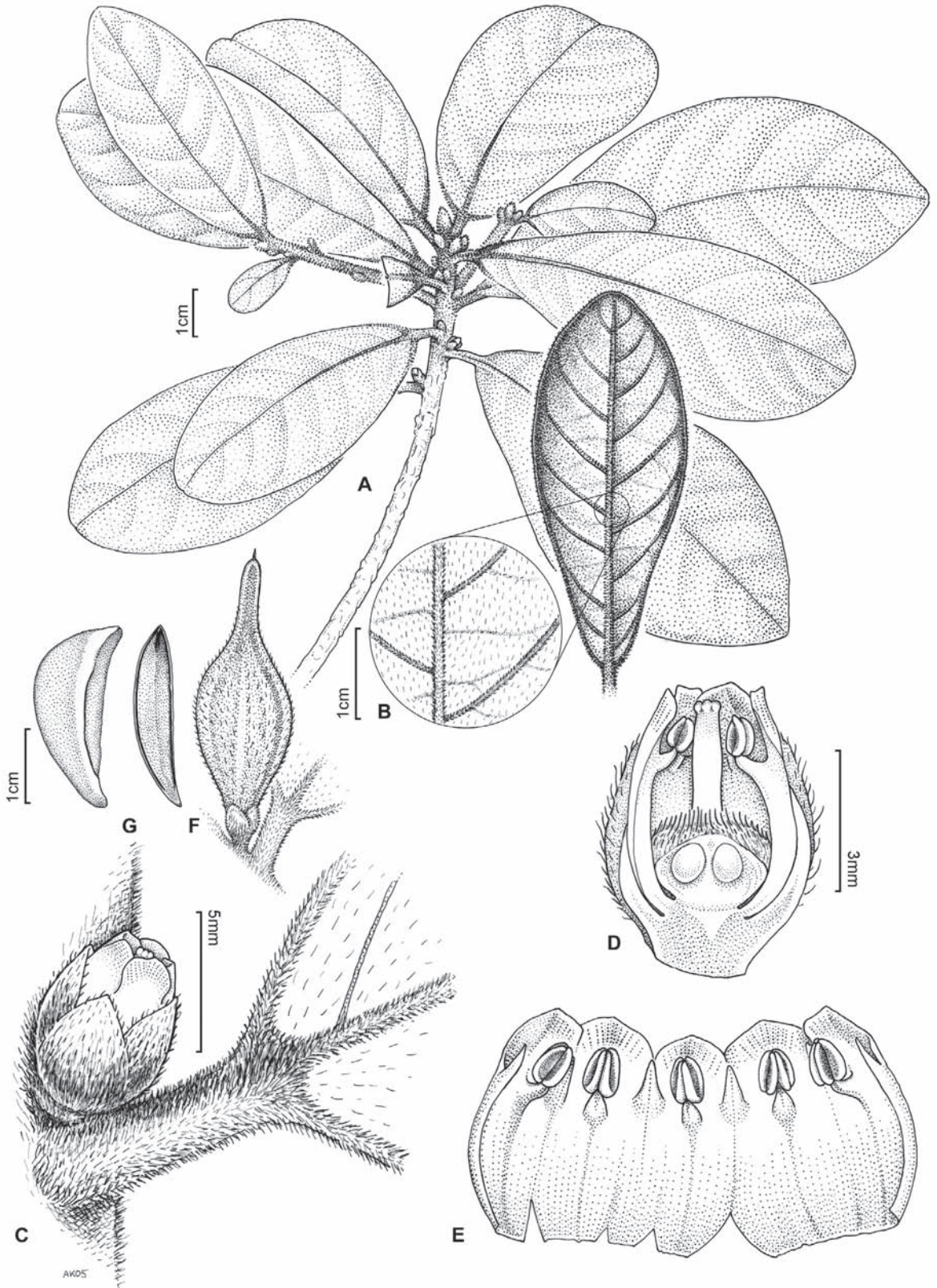


Fig. 12. *Planchonella rufocostata*. A, habit; B, venation (lower surface); C, flower; D, transection of flower; E, open corolla with stamens and staminodes; F, fruit; G, seed, side view (left) and ventral view (right). Drawn from Munzinger, Pignal & Létocart 1989 (A–C), Munzinger, Knox & Pillon 2721 (D–E), Munzinger, Labat & Butin 2583 (F), Swenson & Munzinger 725 (G).

14–24 × 3–5 mm; testa nitidous, pale brown, yellowish near seed scar. *Embryo* with thick and flat cotyledons, endosperm scarce (Fig. 12).

*Etymology*: The name refers to the midvein (*costa*), which is always covered below with brownish-reddish (*rufus*) hairs, at least near the leaf base.

*Distribution and notes*: *Planchonella rufocostata* is found in central-east New Caledonia, where it grows in humid forest on both micaschist (non-ultramafic) and ultramafic soils (Tchingou) (Fig. 9). It flowers regularly between May and June, but may flower as early as February. Mature fruits are known from November. This species is closely related and similar to *P. roseoloba* and *P. crassinervia*, but differs from both in having rufous tomentum on the petiole, midvein, and secondaries, and from the latter by having a flat (not revolute) leaf margin. The leaves are densely clustered at the tips of the branches, which gives the tree a special habit.

*Conservation status*: This species appears to be quite common in the Tiwaka valley, as well as in some locations of the east coast (Aoupinié, Houaïlou, Ponandou). Severe reduction of the forests in these regions is not foreseen for the next few years, even if some logging in Aoupinié Reserve is currently done. *Planchonella rufocostata* would match criteria for Vulnerable (B1+2ab(iii)), but a *Low Concern* status appears to be more justified.

*Additional specimens examined*: New Caledonia, Province Nord, Haute Ahoa, base du Mt Grandié, 3 Jun 1976, *MacKee* 31355 (NOU, P, S); Haute Tchamba, 24 Apr 2004, *Munzinger, Pignal & Létocart* 1989 (MO, NOU, P, S); Houaïlou, 8 Apr 1981, *MacKee* 38934 (NOU, P, S); Houaïlou, Ho, 19 Jun 1973, *MacKee* 26798 (NOU, P, S); Tchingou, 21 Nov 2002, *Dumontet, Blanchard & Maituku* 229 (NOU, S); also 17 Nov 2004, *Munzinger* 2583 (NOU, S); Tiwaka-Koné, 16/18 Feb 1993, *Cosson, Franck & Maituku* 997 (NOU), also Tiwaka-Koné, le Grand coude, 9 Oct 2005, *Munzinger & Swenson* 3056 (NOU); Touho, Ponandou, 15 May 1973, *MacKee* 26717 (NOU, P, S), also Rivière Ponandou, le captage, 16 Mar 2005, *Munzinger, Knox & Pillon* 2721 (NOU, S).

### New combination

*Planchonella pubescens* (P. Royen) Swenson, Munzinger & Bartish, **stat. nov.** ≡ *Planchonella cotinifolia* var. *pubescens* P. Royen in *Blumea* 8: 296, 428. 1957 ≡ *Pouteria cotinifolia* var. *pubescens* (P. Royen) Jessup in *Austrobaileya* 6: 162. 2001.

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**Appendix. List of taxa, voucher information, and GenBank accession of *Planchonella* (Sapotaceae) included in this study. Sequences published here have the prefix EF.**

Taxon	Origin and voucher	GenBank accession
<b>Outgroup:</b>		
<i>Corbassona deplanchei</i> (Baill.) Aubrév.	New Caledonia, <i>Munzinger 978</i> (P, S)	AY552120
<i>Niemeyera chartacea</i> (F.M. Bailey) C.T. White	Australia, <i>Bartish &amp; Jessup 5</i> (BRI, S)	DQ154057
<i>Niemeyera prunifera</i> (F. Muell.) F. Muell.	Australia, <i>Jessup 5238</i> (S)	DQ154058
<i>Niemeyera whitei</i> (Aubrév.) L.W. Jessup	Australia, <i>Floyd s.n.</i> (S)	AY552137
<i>Niemeyera</i> "AF2429"	Australia, <i>Ford 2429</i> (S)	EF025089
<i>Ochrothallus sessilifolius</i> (Panchar & Sebert) Pierre ex Guillaumin	New Caledonia, <i>McPherson &amp; Munzinger 18176</i> (MO, P)	AY552118
<b>Ingroup:</b>		
<i>Planchonella amieuana</i> (Guillaumin) Aubrév.	New Caledonia, <i>Dumontet, Zongo &amp; Maituku 510</i> (NOU, S)	EF025090
<i>P. arnhemica</i> (F. Muell. ex Benth.) P. Royen	Australia, <i>Harwood 1170</i> (S)	AY552107
<i>P. asterocarpon</i> (P. Royen) Swenson, Bartish & Munzinger	Australia, <i>Bartish &amp; Ford 25</i> (QRS, S)	DQ154078
<i>P. australis</i> (R. Br.) Pierre	Australia, <i>Floyd s.n.</i> (S)	AY552148
<i>P. chartacea</i> (F. Muell. ex Benth.) H.J. Lam	Australia, <i>Bartish &amp; Ford 16</i> (QRS, S)	DQ154064
<i>P. cinerea</i> (Panchar ex Baill.) P. Royen	New Caledonia, <i>Veillon 7878</i> (P)	AY552144
<i>P. contermina</i> Pierre ex Dubard	New Caledonia, Grande Terre, <i>Munzinger &amp; Dumontet 2285</i> (P, S)	DQ154065
<i>P. contermina</i> Pierre ex Dubard	New Caledonia, Ile Yandé, <i>Swenson &amp; Munzinger 715</i> (NOU, P, S)	EF025091
<i>P. costata</i> (Endl.) Pierre	New Zealand (cultivated in U.S.A.), <i>Fritsch 1770</i> (CAS)	AF396230
<i>P. cotinifolia</i> (A. DC.) Dubard	Australia, <i>Bartish &amp; Jessup 11</i> (BRI, S)	DQ154066
<i>P. cotinifolia</i> var. <i>pubescens</i> P. Royen	Australia, <i>McDonald 3365</i> (QRS, S)	EF025092
<i>P. crassinervia</i> Dubard	New Caledonia, <i>Munzinger 2275</i> (NOU, P, S)	DQ154067
<i>P. crenata</i> Munzinger & Swenson, sp. nov.	New Caledonia, <i>Swenson &amp; Munzinger 705</i> (NOU, P, S)	EF025093
<i>P. dothioense</i> (Aubrév.) Swenson, Bartish & Munzinger	New Caledonia, <i>Munzinger 995</i> (NOU, P, S)	AY552138
<i>P. eerwah</i> (F.M. Bailey) P. Royen	Australia, <i>Floyd s.n.</i> (S)	AY552147
<i>P. endlicheri</i> (Montrouz.) Guillaumin	New Caledonia, <i>Munzinger, Lowry &amp; Létocart 2038</i> (NOU, P, S)	DQ154068
<i>P. euphlebia</i> (F. Muell.) Francis	Australia, <i>Bartish &amp; Ford 18</i> (QRS, S)	DQ154069
<i>P. glauca</i> Swenson & Munzinger, sp. nov.	New Caledonia, <i>Swenson, McPherson &amp; Mouly 625</i> (MO, NOU, P, S)	AY552104
<i>P. howeana</i> (F. Muell.) Pierre	Australia, <i>Le Cussan 1210</i> (BRI)	EF025094
<i>P. kaalaensis</i> Aubrév.	New Caledonia, <i>Jaffré 3505</i> (NOU)	AY552105
<i>P. kouvaciensis</i> Aubrév.	New Caledonia, <i>Munzinger 2665</i> (NOU)	EF025095
<i>P. kouvaciensis</i> Aubrév.	New Caledonia, <i>Swenson &amp; Munzinger 710</i> (MO, NOU, P, S)	EF025096
<i>P. kuebiniensis</i> Aubrév.	New Caledonia, <i>Munzinger &amp; Létocart 2057</i> (NOU, P, S)	DQ154070
<i>P. laetevirens</i> (Baill.) Pierre ex Dubard	New Caledonia, <i>Munzinger, Pignal &amp; Lowry 2001</i> (MO, NOU, P, S)	DQ154071
<i>P. latihila</i> Munzinger & Swenson, sp. nov.	New Caledonia, <i>Munzinger &amp; Dagostini 2394</i> (NOU, S)	EF025097
<i>P. lauracea</i> (Baill.) Dubard	New Caledonia, <i>Munzinger 1400</i> (NOU, P, S)	AY552145
<i>P. lauracea</i> (Baill.) Dubard	New Caledonia, <i>McPherson &amp; Munzinger 18070</i> (MO, NOU, P, S)	AY552146
<i>P. leptostylidifolia</i> Guillaumin	New Caledonia, <i>Dagostini 850</i> (NOU, P, S)	DQ154072
<i>P. lifuana</i> (Baill.) Pierre ex Dubard	New Caledonia, <i>Munzinger (leg. C. Zongo) 3317</i> (NOU, S)	EF025098
<i>P. linggensis</i> (Burck) Pierre	New Caledonia, unknown collector (P)	AY552140
<i>P. linggensis</i> (Burck) Pierre	Vanuatu, <i>Wheatley 271</i> (K)	DQ154062
<i>P. luteocostata</i> Munzinger & Swenson, sp. nov.	New Caledonia, <i>Munzinger, Jaffré &amp; Roumagnac 2375</i> (NOU, P, S)	EF025099
<i>P. mandjeliana</i> Munzinger & Swenson, sp. nov.	New Caledonia, <i>Munzinger &amp; Pillon 2861</i> (NOU, P, S)	EF025100
<i>P. membranacea</i> H.J. Lam	Fiji, <i>Smith 4609</i> (S)	DQ154074
<i>P. microphylla</i> Pierre ex Dubard	New Caledonia, <i>Munzinger &amp; Dagostini 2163</i> (NOU, P, S)	DQ154075
<i>P. myrsinifolia</i> (F. Muell.) Swenson, Bartish & Munzinger	Australia, <i>Floyd s.n.</i> (S)	AY552143
<i>P. myrsinodendron</i> (F. Muell.) Swenson, Bartish & Munzinger	Australia, <i>Bartish &amp; Jessup 2</i> (BRI, S)	DQ154077
<i>P. obovata</i> (R. Br.) Pierre	Taiwan, <i>Chung &amp; Anderberg 1166</i> (S)	DQ154076
<i>P. pinifolia</i> (Baill.) Dubard	New Caledonia, <i>MacKee 13886</i> (P)	AY552111
<i>P. pohlmaniana</i> (F. Muell.) Burkill	Australia, <i>Bartish &amp; Ford 22</i> (QRS, S)	DQ154079
<i>P. aff. pohlmaniana</i> (F. Muell.) Burkill	Australia, <i>McDonald 3378</i> (QRS, S)	EF025101
<i>P. povilana</i> Swenson & Munzinger, sp. nov.	New Caledonia, <i>Swenson &amp; Munzinger 732</i> (MO, NOU, P, S)	EF025102
<i>P. povilana</i> Swenson & Munzinger, sp. nov.	New Caledonia, <i>Munzinger &amp; Butin 2387</i> (NOU)	EF025103
<i>P. pronyensis</i> Guillaumin	New Caledonia, <i>Munzinger 2051</i> (NOU)	DQ154080
<i>P. reticulata</i> (Baill.) Pierre ex Dubard	New Caledonia, <i>Bernardi 9824</i> (P, S)	DQ154081

## Appendix. Continued.

Taxon	Origin and voucher	GenBank accession
<i>P. reticulata</i> (Baill.) Pierre ex Dubard	New Caledonia, <i>Jaffré 3268</i> (NOU, P)	AY552142
<i>P. rheophytopsis</i> P. Royen	New Caledonia, <i>Dagostini 818</i> (NOU)	DQ154082
<i>P. roseoloba</i> Munzinger & Swenson, sp. nov.	New Caledonia, <i>Munzinger 2311</i> (MO, NOU, P, S)	DQ154090
<i>P. rufocostata</i> Munzinger & Swenson, sp. nov.	New Caledonia, <i>Munzinger, Labat &amp; Butin 2583</i> (NOU, S)	DQ154089
<i>P. saligna</i> S. Moore	New Caledonia, <i>Munzinger, Létocart &amp; Gateblé 2218</i> (NOU, P, S)	DQ154083
<i>P. sandwicensis</i> (A. Grey) Pierre	Hawaii, <i>Koolan 119d</i> (GB)	DQ154084
<i>P. skottsbergii</i> Guillaumin	New Caledonia, <i>Munzinger 2391</i> (NOU, S)	DQ154085
<i>P. solida</i> P. Royen	Papua New Guinea, <i>Takeuchi, Towati &amp; Ama 17286</i> (S)	EF025104
<i>P. sphaerocarpa</i> (Baill.) Dubard	New Caledonia, <i>Tronchet, Munzinger &amp; Oddi 389</i> (P)	AY552139
<i>P. sp.</i>	Tahiti, <i>Meyer 3013</i> (PAP)	EF025108
<i>P. sp.</i>	Papua New Guinea: <i>Takeuchi &amp; Ama 17902</i> (S)	EF025109
<i>P. tahitensis</i> (Nadéaud) Pierre ex Dubard	Tahiti, <i>Meyer 3051</i> (PAP)	EF025105
<i>P. thiensis</i> Aubrév.	New Caledonia, <i>Munzinger &amp; al. 2625</i> (NOU, P, S)	EF025106
<i>P. umbonata</i> (P. Royen) A.C. Sm.	Fiji, <i>Smith 8298</i> (K)	DQ154086
<i>P. vitiensis</i> Gillespie	Fiji, <i>Smith 7700</i> (S)	DQ154088
<i>P. wakere</i> (Pancher & Sebert) Pierre	New Caledonia, <i>Munzinger 1069</i> (NOU, P)	AY552149
<i>P. xylocarpa</i> (C.T. White) Swenson, Bartish & Munzinger	Australia, <i>Bartish &amp; Ford 31</i> (QRS, S)	DQ154049
<i>P. xylocarpa</i> (C.T. White) Swenson, Bartish & Munzinger	Papua New Guinea, <i>Takeuchi, Towati &amp; Ama 17284</i> (S)	EF025107