

Three new species of *Planchonella* Pierre (Sapotaceae) with a dichotomous and an online key to the genus in New Caledonia

Jérôme MUNZINGER

Institut de Recherche pour le Développement, UMR AMAP,
Laboratoire de Botanique et d'Écologie végétale appliquées,
Herbarium NOU, 98848 Nouméa (New Caledonia)
and Institut de Recherche pour le Développement, UMR AMAP,
F-34000 Montpellier (France)
jerome.munzinger@ird.fr

Ulf SWENSON

Swedish Museum of Natural History, Department of Phanerogamic Botany,
P.O. Box 50007, SE-104 05 Stockholm (Sweden)
ulf.swenson@nrm.se

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ABSTRACT

In spite of a recent publication of eight new species of *Planchonella* (Sapotaceae) from New Caledonia, three additional novelties are here described and illustrated (*P. cauliflora*, *P. ericiflora*, and *P. minutiflora*). *Planchonella cauliflora* was discovered in 2006 near La Foa and is the first and sole member in the archipelago with a cauliflorous inflorescence, a genus otherwise having axillary flowers (rarely ramiflorous). The other two were discovered among herbarium material but not earlier identified as new. A recent suggested hypothesis (Swenson *et al.* 2007b) that fruit morphology indicates phylogenetic relationships within *Planchonella* is supported. A ridged fruit with acuminate apices and a short style place *P. cauliflora* in their Clade D1, a clade confined to New Caledonia. Fruits of *P. minutiflora* are unknown, but based on ITS sequence data it belongs to the same clade as *P. cauliflora* and it is predicted that the fruit is similar. Molecular sequences of *P. ericiflora* are still missing, but based on a pear-shaped fruit, round apices and a fairly long style, we believe it is closely related to a different clade of *Planchonella* that is also restricted to New Caledonia. All three species have very narrow distributions and match the criteria of the IUCN red list as Critically Endangered. *Planchonella* contains henceforth 36 species in New Caledonia to which we here provide a diagnostic and an interactive online key under Xper², available at <ftp://ftp.ird.nc/pub/outgoing/biologie/herbier-nou/>.

KEY WORDS

Sapotaceae,
Planchonella,
Xper²,
IUCN status,
New Caledonia,
new species.

RÉSUMÉ

Trois nouvelles espèces de *Planchonella* (Sapotaceae) avec une clé dichotomique et une clé interactive pour le genre en Nouvelle-Calédonie.

Malgré la publication récente de huit nouvelles espèces de *Planchonella* (Sapotaceae) de Nouvelle-Calédonie, trois autres nouveautés sont décrites et illustrées (*P. cauliflora*, *P. ericiflora*, and *P. minutiflora*). *Planchonella cauliflora* a été découverte près de La Foa en 2006 et est le premier et unique représentant de l'archipel à avoir une inflorescence cauliflore, dans un genre ayant des fleurs axillaires (rarement ramiflores). Les deux autres ont été découvertes à partir de matériel d'herbier, où elles n'avaient pas été identifiées comme nouvelles auparavant. L'hypothèse récemment suggérée par Swenson *et al.* (2007b), selon laquelle la morphologie du fruit indique les relations phylogénétiques au sein du genre *Planchonella*, est soutenue. Un fruit anguleux avec un apex acuminé et un style court place *P. cauliflora* dans leur clade D1, un clade confiné à la Nouvelle-Calédonie. Les fruits de *P. minutiflora* sont inconnus, mais d'après les données des séquences ITS il appartiendrait au même clade que *P. cauliflora* et nous pensons que son fruit sera similaire. Les séquences moléculaires de *P. ericiflora* ne sont pas disponibles, mais en s'appuyant sur son fruit pyriforme, l'apex arrondi et un style relativement long, nous pensons qu'il sera proche d'un autre clade, également restreint à la Nouvelle-Calédonie. Ces trois espèces ont des très petites aires de distribution et répondent aux critères d'inscription de la liste rouge de l'UICN, en Danger critique d'extinction (CR). *Planchonella* comprend désormais 36 espèces en Nouvelle-Calédonie et nous proposons une clé diagnostique et interactive sous Xper², disponible à l'adresse <ftp://ftp.ird.nc/pub/outgoing/biologie/herbier-nou/>.

MOTS CLÉS

Sapotaceae,
Planchonella,
Xper²,
statut IUCN,
Nouvelle-Calédonie,
nouvelles espèces.

INTRODUCTION

New Caledonia is recognized worldwide as a “hot-spot” for its terrestrial (Myers 1988; Myers *et al.* 2000) and marine biodiversity (Roberts *et al.* 2002). Its very peculiar flora was noticed early by the French botanist Balansa (1873a, b), and some of his successors have attributed the flora a special status such as “New Caledonian Sub-Region” (Thorne 1963), “New Caledonian Region” (Good 1964) or “New Caledonian Sub-Kingdom” (Takhtajan 1969). Guillaumin (1921), for example, stated that the “Flora of New Caledonia is strongly characterized by the special development of Cunoniaceae, Araliaceae and Sapotaceae.” The latter family was first to be treated in the *Flore de Nouvelle-Calédonie et Dépendances* (Aubréville 1967). At that time, 80 species were recorded and several, such as *Pycnantra* (?) *paniensis*

Aubréville, were described on poor or even sterile material. As a consequence, our knowledge of species and generic limits of Sapotaceae in New Caledonia remained unsatisfactory.

Three decades later, Sapotaceae were considered as the seventh biggest family of dicotyledons in New Caledonia, including the 80 species listed by Aubréville and three undescribed species (Jaffré *et al.* 2001). Two were well known and given provisional numbers such as “*Planchonella* sp1 Veillon 6585” and “*Leptostylis* sp1 Veillon 6850” (Bouchet *et al.* 1995), and even given IUCN status in order to allow protection of these undescribed taxa (Jaffré *et al.* 1998). Ecological studies during the 1990s in rainforests of New Caledonia revealed many troubles with species identification of Sapotaceae, many collections remained undetermined or referred to as supposed new taxa (Jaffré & Veillon 1990, 1995). A revision of the family

in the region was strongly needed; this is why we seriously embarked on systematic and phylogenetic studies of Sapotaceae in 2002. One main problem of Sapotaceae classification in Australasia emerged when Pennington (1991) lumped *Planchonella* Pierre with *Pouteria* Aubl. Both van Royen (1957) and Aubréville (1967) recognized *Planchonella*, but Pennington's view was adopted in the checklist of the family (Govaerts *et al.* 2001). Nevertheless, subsequent phylogenetic studies based on both molecular and morphological data have shown that *Planchonella* is a monophyletic group, not at all related to *Pouteria* which is (as far as known) restricted to tropical America (Bartish *et al.* 2005; Swenson & Anderberg 2005; Triono *et al.* 2007; Swenson *et al.* 2007a).

Planchonella circumscribes 60 species of trees and shrubs with a distribution range from the Seychelles in the west to Tahiti in the east, and with a diversification centre in Australasia. The latest contribution to *Planchonella* systematics put forward a molecular phylogeny, an amended generic circumscription, and eight new species from New Caledonia (Swenson *et al.* 2007b). However, recent field and herbarium work in the archipelago has identified three additional taxa not recognized earlier. Also, Swenson *et al.* (2007b) showed that there are three main evolutionary lineages within the genus (clades D1-D3, their fig. 1) and suggested that fruit morphology may indicate phylogenetic relationships. They suggested that species with a ridged fruit, almost no pulp, acuminate apex, and short style most often distinguish Clade D1; a fleshier, apple-like fruit with retuse apex and short style is characteristic for Clade D2; and fruits that are generally smaller, round, poor in pulp, and an apex that is non-acuminate would fit Clade D3.

The purpose of this paper is to describe and illustrate these three species, each with a conservation assessment (IUCN 2001; IUCN & SSC 2005), and to discuss their phylogenetic relationships based on unpublished nrDNA data and/or fruit morphology. We finally provide botanists, ecologists, and conservationists with a new diagnostic key and an interactive online key, available at <ftp://ftp.ird.nc/pub/outgoing/biologie/herbier-nou/>, based on the software Xper2 (Chalubert *et al.* 2006), available at <http://lis.snv.jussieu.fr/apps/xper2/>.

SYSTEMATICS

Genus *Planchonella* Pierre

REMARKS

Swenson *et al.* (2007b) provided an updated nomenclature and a revised generic description of *Planchonella*. This description and common generic characters are not reiterated here for the new taxa, morphological terminology follows Harris & Harris (1994).

Planchonella cauliflora

Munzinger & Swenson, sp. nov.

(Fig. 1)

Species haec Planchonellae luteocostatae affinis sed inflorescentiis caulifloris, fructibus majoribus, foliis majoribus et corollis carneis differt.

TYPUS. — **New Caledonia.** Province Sud, La Foa, vallée de la Ouaménie, 21°46'29"S, 165°58'39"E, fl., 1.VII.2006, Munzinger, Létocart D. & I., Amice 3495 (holo-, P; iso-, K, MO, NOU, NSW, P, S).

ADDITIONAL MATERIAL EXAMINED. — **New Caledonia.** Province Sud, La Foa, vallée de la Ouaménie, 21°46'29"S, 165°58'39"E, 1.VII.2006, st., Munzinger, Létocart D. & I., Amice 3495bis (NOU 013908, P, S). — Loc. cit., 2.IX.2006, fl., fr., Munzinger, Létocart D. & I., Amice, Gateblé 3537 (K, MO, NOU 014292, P, S). — Loc. cit. 17.V.2007, fr, Mouly, Barrabé, Létocart D. & I., Létocart C., Létocart S. & B. 871 (P, NOU 022039).

DESCRIPTION

Small tree reaching 8-10 m high, 20 cm in diameter, bark grey, often with burls; young twigs grey, glabrous, old twigs dark with few lenticels. Leaves dark green above, light green below, clustered at tips of branches, obovate-oblongate, 15-17 × 4-6(-8) cm (juvenile up to 20 cm long), glabrous; brochidodromous venation, secondaries of 14-17 pairs (up to 20 in juvenile), tertiaries reticulate, somewhat parallel near midvein; petiole 15-25 mm long (up to 40 mm in juvenile), glabrous. Inflorescence cauli- and ramiflorous, often forming burls up to 15 × 3 mm. Flowers 5(-6)-merous, bisexual or female, 1-3 in each fascicle, sessile. Sepals broadly elliptic, 2.5-3.5 mm long, tomentulose outside, the inner with a glabrous margin, glabrous inside.



FIG. 1. — *Planchonella cauliflora* Munzinger & Swenson, sp. nov.: **A**, habit; **B**, leaf venation (lower surface); **C**, leaf of juvenile individual; **D**, cauliflorous flower; **E**, open corolla of a female flower with staminodes and reduced anthers; **F**, open corolla of bisexual flower with stamens and staminodes; **G**, ovary and pistil; **H**, fruit (nearly ripe, seeds aborted on the right); **I**, cotyledons. *Munzinger et al. 3495*. Scale bars: A-C, H, I, 1 cm; D-G, 1 mm.

Corolla 2.5–3.0 mm long, flesh-coloured, corolla tube slightly longer than the lobes; lobes suborbicular. Stamens shorter than the corolla; anthers 0.5–0.6 mm long, without appendage. Staminodes triangular or oblong, 0.5 mm long. Gynoecium broadly obovoid, 1 × 1.5 mm, hairy; style slender, glabrous, c. 1 mm long. Fruit obovoid, ridged, acuminate, 25–55 × 15–30 mm (acumen 4–12 mm), glabrous, (1–)5-seeded; seeds keeled, 20 × 9 × 5 mm; seed scar covering 100% of the seed length, 4 mm wide; testa nitidous, pale brown. Cotyledons thick and flat, smooth, white; radicle exserted; endosperm scarce.

REMARKS

Planchonella cauliflora is known only from the type locality at low elevation in mesophyll forest near La Foa (Fig. 2). The location is situated on grauwackes, which is a volcano-sedimentary soil. As far as known, it flowers between July and September, when young fruits have been observed. It is easily distinguished from all other congeners in being cauliflorous with large burls on the trunk, but also by the small flesh-coloured flowers.

Fruits of *Planchonella cauliflora* are ridged, acuminate, poor in pulp, and have short styles. The species should then, as per prediction, belong to Clade D1 (Swenson *et al.* 2007b). In fact, results of a jackknife analysis based on unpublished nrDNA (ITS) sequence data place *P. cauliflora* as sister to *P. luteocostata*, another member of Clade D1. Thus, the hypothesis that fruit morphology conveys on a phylogenetic signal is here supported. We therefore further predict that members of this clade have keeled seeds, an embryo with thick but flat cotyledons, and a scarce endosperm.

ETYMOLOGY

The species epithet refers to the flowers on the trunk (*caulis*), which is odd to the genus where flowers almost always are axillary or seldom along the branches.

CONSERVATION STATUS

Planchonella cauliflora is only known from one population in a small valley, estimated to 1.2 km², without any protection or present conservation plan. The adjacent valleys were prospected but we

failed finding other populations until now. Thus, the plant matches criteria D, “Very small or restricted population”. Then, introduced rusa deer is known to be a threat against the native flora of New Caledonia (de Garine-Wichatitsky *et al.* 2005), which seems to prevent seedlings to survive and develop into reproducing individuals in the site where only adult trees are present. Hence, *Planchonella cauliflora* matches the criteria B1ab (iii, v) + 2ab (iii, v) and is here assigned a preliminary status of Critically Endangered (IUCN 2001).

Planchonella ericiflora

Munzinger & Swenson, sp. nov.

(Fig. 3)

Species haec Planchonellae povilanae similis sed foliis glabris et pusillis, corollarum tubis longioribus, piliferis et roseis, fructibus glabris et pyriformibus differt.

TYPUS. — **New Caledonia.** Province Sud, vallée de la Tontouta, 11.III.2007, bt., fr., Munzinger, McPherson, Létocart D. & I., Amice & Chapelle 4197 (holo-, NOU 017125; iso-, MO, P, S).

ADDITIONAL MATERIAL EXAMINED. — **New Caledonia.** Province Sud, Tontouta rive gauche, 10.X.1986, fr., Jaffré 2740 (NOU 017126, S). — Loc. cit., alt. 50–300 m, steep rocky slope on north side of valley at junction of Kalouehola, 15.VII.1956, Mackee 4915 (P). — Loc. cit., 11.III.2007, bt., fr., Munzinger, McPherson, Létocart D. & I., Amice & Chapelle 4200 (MO, NOU 010724, NSW, P, S). — Loc. cit., vieille piste minière, 21°56'01.2"S, 166°17'37.7"E, 22.VII.2007, y.fr., Munzinger, Létocart D. & I., Chapelle 4395 (NOU).

DESCRIPTION

Small, much branched shrub, mostly prostrate, up to 1 m tall, branches hanging and layering; young twigs ferruginous hairy, soon glabrous, old twigs grey-whitish, scaly. Leaves shiny green on both sides, clustered at tips of branches, narrowly obovate, 1.5–3.5(–4.5) × 0.4–1(–1.3) cm, glabrous; brochidodromous venation, secondaries of 4–6 pairs, indistinct, tertiaries weak, reticulate; petiole 2–5 mm, glabrous or with a few greyish hairs. Flower 5-merous, bisexual, solitary, pendulous; pedicel 7–10 mm, glabrous. Sepals broadly elliptic, 4–7 mm, green, glabrous, the inner being larger and

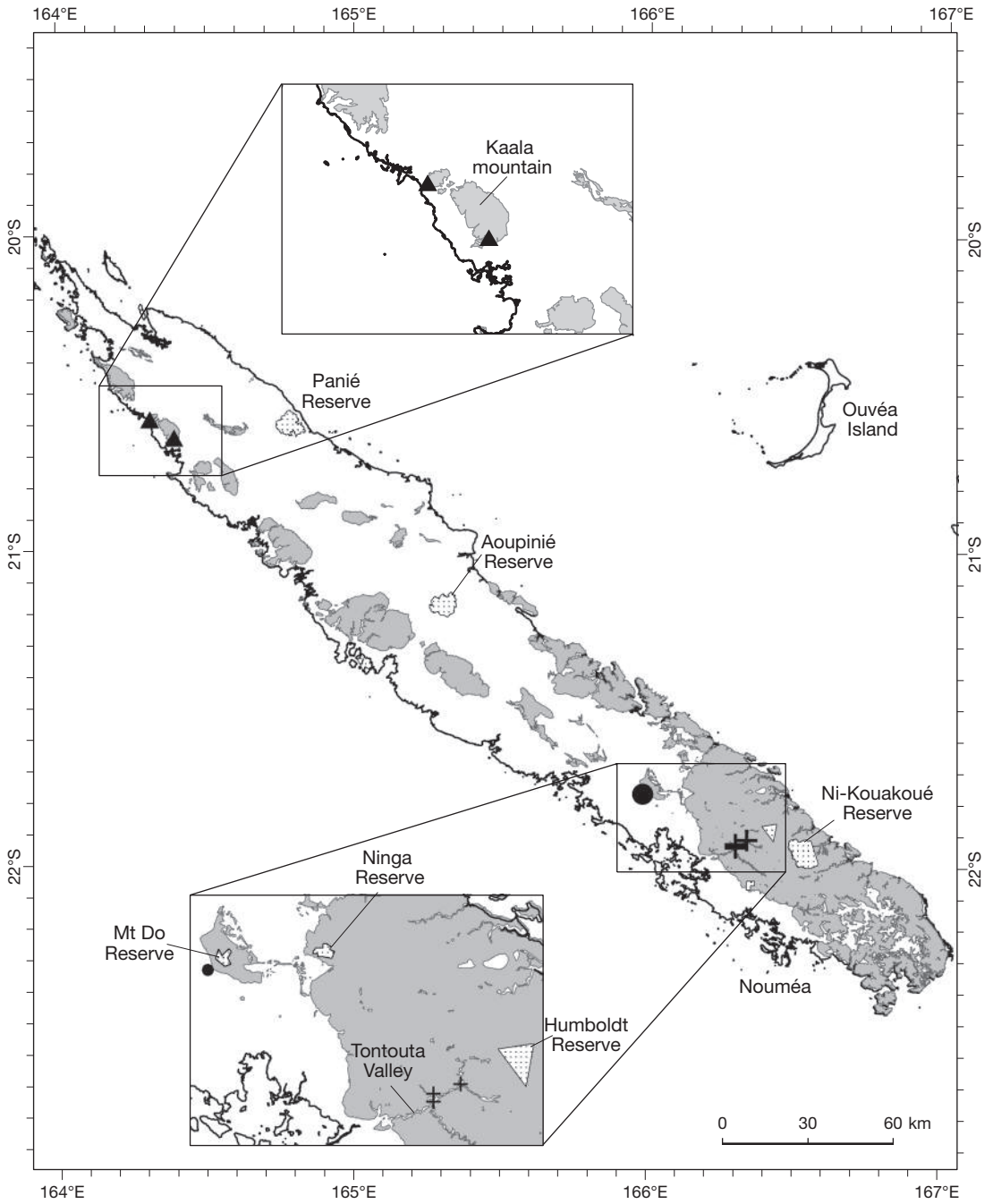


FIG. 2. — Map of New Caledonia with some protected areas (for conservation discussion) and the distribution of *Planchonella cauliflora* Munzinger & Swenson, sp. nov. (●), *P. ericiflora* Munzinger & Swenson, sp. nov. (+) and *P. minutiflora* Munzinger & Swenson, sp. nov. (▲). Ultramafic soils (including serpentinites) appear in grey.

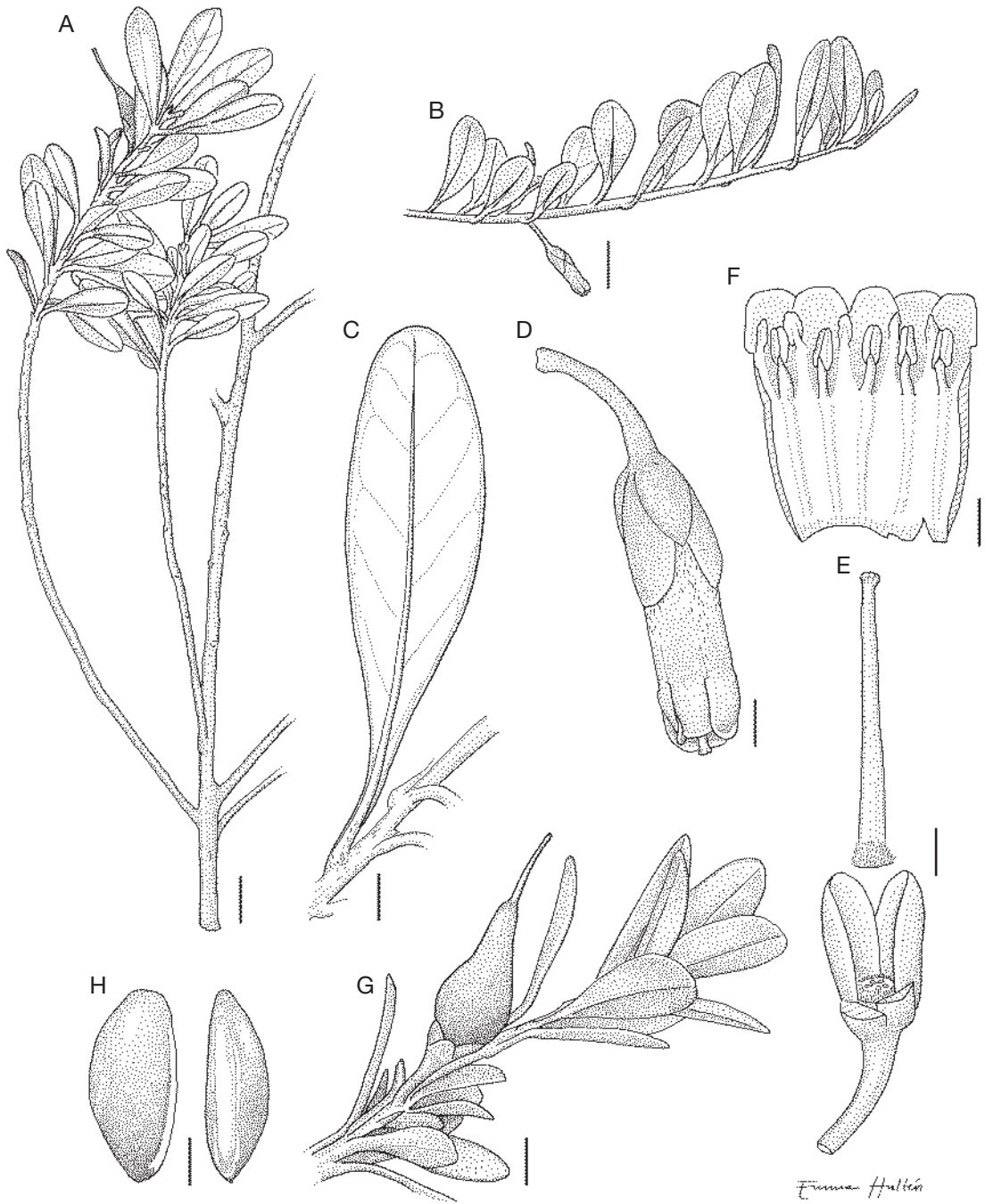


FIG. 3. — *Planchonella ericiflora* Munzinger & Swenson, sp. nov.: **A**, habit; **B**, leaf venation (lower surface); **C**, flowering branch; **D**, flower; **E**, calyx, transection of ovary, and pistil; **F**, open corolla of bisexual flower with stamens and staminodes; **G**, fruit (erected); **H**, seed, side view (left) and ventral view (right). *Munzinger et al.* 4197. Scale bars: A, C, 1 cm; B, 2.5 mm; D-F, H, 2 mm; G, 6 mm.

with a scarious margin. Corolla 9-11 mm long; tube longer than lobes, 6-8 mm long, pink, hairy outside; lobes greenish, 3-4 mm, \pm rectangular, clawed. Stamens shorter than corolla, pink; anthers 1.2-1.5 mm long, without appendage. Staminodes oblong, *c.* 1.5 mm long. Gynoecium ovoid, hairy, 1.2 \times 1.2 mm, slightly lobed; style slender, 9-10 mm long, slightly longer than the corolla. Fruit ovoid or pear-shaped, rounded, erect (while the flower is hanging), purple when mature, 30-32 \times 10 mm, including a 10 mm long persistent style, glabrous, 1-3 seeded; seeds 8-9 \times 3-4 mm; seed scar covering 60-85% of the seed length, 1-1.5 mm wide; testa nitidous, dark brown, 0.2 mm thick. Cotyledons thin and foliaceous, smooth, white; radicle exerted below the cotyledons; endosperm copious.

REMARKS

Planchonella ericiflora is restricted to a small area of Tontouta valley in the south of New Caledonia (Fig. 2). It occurs here in open to dense maquis vegetation and grows on serpentine soil at low altitudes. Flowers have been observed in July after intensive rains and fruits are recorded in March, July, and October. We therefore suspect that rain can be an important factor to induce blooming, which seems to take place all around the year. No congener is particularly similar to *P. ericiflora*, but sterile individuals might be confused with some *Rapanea* species (Myrsinaceae), though, the white sap is diagnostic.

Fruits of *Planchonella ericiflora* are pear-shaped, rounded, poor in pulp, and with a non-acuminate apex. In addition, it has a long (not short) style, an embryo with thin and foliaceous cotyledons, and copious endosperm. This character combination fits with Clade D3, which circumscribes many species in Australia, West Pacific, and a monophyletic group (Clade D3b1) that is restricted to New Caledonia (Swenson *et al.* 2007b). However, sequence data of *P. ericiflora* is still unavailable, but we believe it belongs here and could be closely related to *P. crenata* and/or *P. povilana*.

ETYMOLOGY

The name refers to the aspect of the flower, which with its pendulous habit and long corolla tube is superficially similar to an *Erica* (Ericaceae) flower.

CONSERVATION STATUS

Planchonella ericiflora is only known from small and scattered populations in Tontouta valley, a valley known for at least 17 local endemic species such as *Xanthostemon francii* Guillaumin, *X. longipes* Guillaumin, and *Syzygium laxeracemosum* (Guillaumin) J.W.Dawson (Myrtaceae; Dawson 1992, 1999; Jaffré *et al.* 2003). The tontouta valley was deeply investigated, what for example allowed rediscovering the *Ochrosia bodenheimerarum* Guillaumin (Apocynaceae), which was only known from the type collection from 1951 (Boiteau 1981). Field researches were also done in Dumbea valley, which is slightly in the south and also presents serpentinites and some floristic affinities with Tontouta, but failed finding the plant. Tontouta valley possesses still no legal protection. Soils of the lower parts of the valley are of peridotitic alluvial deposits and cover about 26 km². Within this area is the total distribution of *P. ericiflora*, estimated to only 0.7 km². Although mining companies do not exploit the alluviums here, the peridotites are mined in some places on the higher slopes. New mining projects will evidently have serious impact on the remaining natural vegetation if new roads are opened. Indeed, this leads to an influx of human activities and risk of fires, especially when the valley becomes more frequently used for recreation, hiking, and camping. For example, Dumbea valley was severely damaged in 2006 from fires caused by young campers. Thus, based on a very restricted distribution, present and future mining projects, and an area without conservation plan, we suggest that *P. ericiflora* is given the IUCN status as Critically Endangered (CR B1+2ab(iii)).

Planchonella minutiflora

Munzinger & Swenson, sp. nov.

(Fig. 4)

Species haec Planchonellae pinifoliae similis sed foliis glabris, floribus minutis et styli brevissimis differt.

TYPUS. — **New Caledonia.** Province Nord, pente du mont Kaala au dessus de Gomen, vers 300-500 m, maquis sur terrain rocheux serpentineux, 21.IV.1967, fl., MacKee 16639 (holo-, P; iso-, NOU 011147, S).

ADDITIONAL MATERIAL EXAMINED. — **New Caledonia.** Province Nord, Koumac, Siounda, 22.IV.1967, fl., MacKee 16666 (NOU 011144, P, S).

DESCRIPTION

Slender shrub to 2 m tall; twigs grey, smooth, scaly. Leaves shiny green on both sides, clustered at tips of branches, linear, 20-50 × 2-6 mm, coriaceous, glabrous; brochidodromous venation, secondaries of 4-6(-7) pairs, tertiaries weak, reticulate; margin thick, slightly recurved; petiole 1-3 mm long, sparsely tomentulose. Flowers 5-merous, bisexual, 1 or 2 in each fascicle; pedicel 0.5-1.5 mm long, tomentulose. Sepals 1.5-2.0 mm long, tomentulose outside, glabrous inside. Corolla 2.5 mm long, cream, corolla tube longer than lobes; lobes suborbicular. Stamens shorter than corolla; anthers 0.2 mm long, without appendage. Staminodes lanceolate, 0.5 mm long. Gynoecium ovoid, ovary hairy; style slender, glabrous, included, 1.0-1.5 mm long. Fruits unknown.

REMARKS

Planchonella minutiflora is only known from two collections in northwest New Caledonia, between Koumac and Kaala-Gomen, approximately 10 km apart (Fig. 2). It grows here in rocky maquis vegetation on serpentine soil at fairly low altitudes, most probably between 200 and 300 m. The two collections were made in April 1967 (within 24 hours) when it was in full flower. In the same region, north of Koumac, grows *P. pinifolia*, another local endemic that can be confused with *P. minutiflora*. The species have almost identical leaves in form and size, but the leaves of *P. minutiflora* are glabrous below (not tomentulose). However, the minute, 2-3 mm long flowers and short styles of *P. minutiflora* distinguish it from the larger, 30-40 mm long flowers and long styles of *P. pinifolia*.

The herbarium material of *Planchonella minutiflora* from 1967 is still in such a good condition for being used for nrDNA extraction. A jackknife analysis place *P. minutiflora* in a strongly supported sister relationship with *P. koumaciensis*, i.e. another member of Clade D1, just like *P. cauliflora*. This sister pair is united by minute flowers on short pedicels but distinguished by linear leaves in *P. minutiflora* versus obovate in *P. koumaciensis*. We therefore predict that fruits of *P. minutiflora* are ridged, acuminate, and have a short style.

ETYMOLOGY

The name refers to the very small flowers.

CONSERVATION STATUS

Planchonella minutiflora has not been collected since MacKee's two original collections in 1967. In his field book, it is specified for specimen 16639 that he saw only one individual, and for specimen 16666 he wrote, "seems to be rare in the locality". Recent important botanical inventories of the maquis on the main ultramafic mountains in northwest Grande Terre, from Boulinda in the south to Poum in the north, have not recorded the plant again. Without doubt, it is an uncommon species and its possible distributional range around the base of Mount Kaala is estimated to 13 km². This kind of vegetation is threatened by deliberately and accidental set fires. Altogether we therefore assign *P. minutiflora* a provisional IUCN (2001) status of Critically Endangered (CR B1ab(iii, v)+2ab(iii, v)).

IDENTIFICATION TOOLS

One important task for taxonomists is to provide users with identification keys. Standard dichotomous keys are often frustrating and impractical when usually both flowers and fruits are used. In many cases the user looks for distinctive characters such as a crenate leaf margin or a white dot on the seed, but search in vain for these characters in the key. Online interactive keys provide therefore new opportunities as they can quickly be updated, improved, and distributed around the world (Farr 2006). However, a dichotomous and online key combined is even a better plant identification tool. Together with a traditional diagnostic key we here introduce an online key, using Xper² (Chalubert *et al.* 2006), to all species of *Planchonella* in New Caledonia (see <ftp://ftp.ird.nc/pub/outgoing/biologie/herbier-nou/>).

The dichotomous key below uses to a large extent leaf, sepal, and fruit characters. Some mutually exclusive couplets have similar character states. In such cases, all diagnostic characters must fit. Leaf measurements refer only to the blade, excluding the petiole. The number of secondary veins (pairs) is

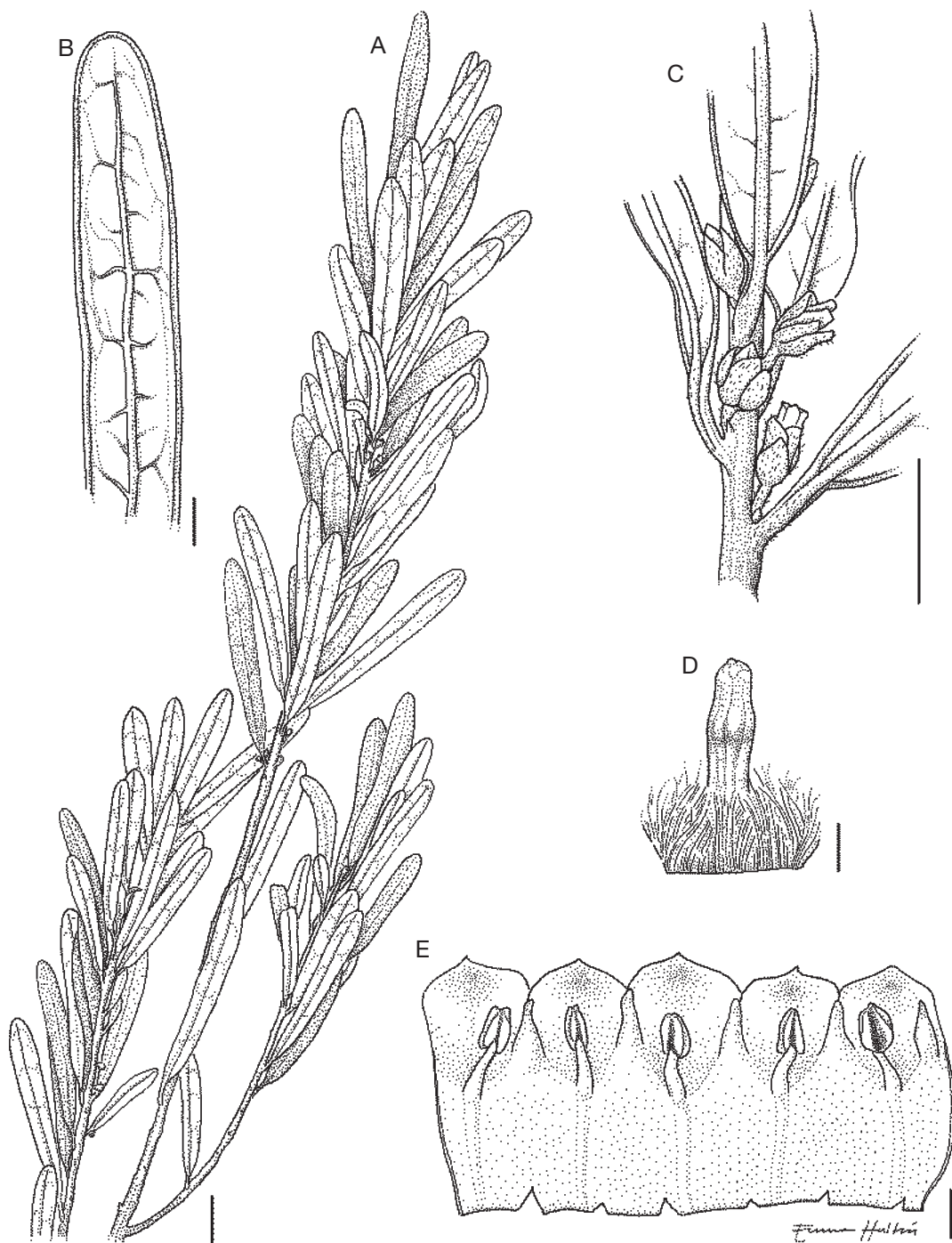


FIG. 4. — *Planchonella minutiflora* Munzinger & Swenson, sp. nov.: **A**, habit of a flowering branch; **B**, leaf venation (lower surface); **C**, axillary flowers; **D**, ovary and pistil; **E**, open corolla of bisexual flower with stamens and staminodes. MacKee 16639. Scale bars: A, 1 cm; B, 2.5 mm; C, 5 mm; D, E, 0.5 mm.

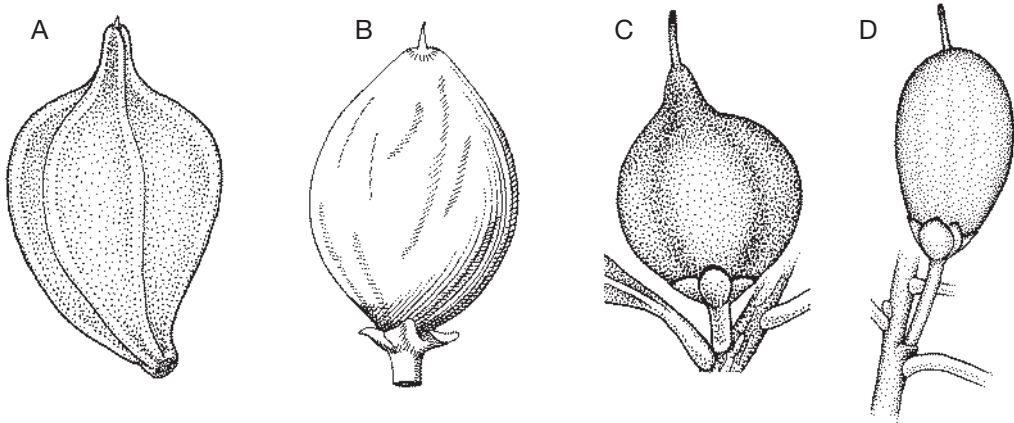


FIG. 5. — Fruit types in *Planchonella* as proposed by Swenson *et al.* (2007b): **A**, ridged, apiculate, a short style remnant, and almost no pulp (Clade D1); **B**, round, fleshy, apple-like, rich in pulp, obtuse apex, and a short style remnant (Clade D2); **C**, **D**, round, little pulp, contour of seeds may be seen but fruit not ridged, apices round or acute (not acuminate), and a fairly long style remnant (Clade D3).

sometimes helpful and used. Measurements (mm, cm) always refer to the length of a structure. If two measures are stated, the second is the width. Flowers of Sapotaceae vanish quickly and are used as little as possible.

Sapotaceae possess malpighian hairs that are unicellular with two arms and one stalk, which attach them to the organs. As long as the stalk is short, a *tomentulose* pubescence is formed, which is the most common type, but the length of both arms and stalks may vary. If the stalk and arms are of similar length, or one arm branch off near the stalk and is short while the second is long, a “Y-shaped” hair is formed that gives a longer pubescence, here termed *tomentose*. Both arms can also be reduced (?) to form a simple hair, a pubescence that is rather *villous* in appearance. Homology of these structures, however, is unclear because several species have different combinations of hair types. The last

type is the *adpressed* hair (not present among these species), formed of a very short or absent stalk. In principle, hairs are present on young leaves of nearly all *Planchonella* species, but indeed, some species are glabrous, others have glabrate leaves, and some have a persistent pubescence. Hairs are frequently ferruginous on young organs, but often turn greyish. It is therefore important to study the foliage carefully and decide if hairs are ferruginous, grey, or change with age.

Fruit morphology seems to convey a phylogenetic signal in *Planchonella*. Swenson *et al.* (2007b) identified three main clades (clades D1-D3) in the genus, each represented by a more or less consistent fruit type. One important character is whether the fruit, from base to apex, is ridged or round (Fig. 5). A ridged fruit has, as far as known, ridged seeds, whereas a round fruit has not. The fruit type is used in the diagnostic key.

KEY TO THE SPECIES OF *PLANCHONELLA* PIERRE IN NEW CALEDONIA

- 1. Leaves linear 2
- Leaves ovate, elliptic, obovate, oblanceolate, or spatulate (not linear) 6
- 2. Leaves glabrous on both surfaces 3
- Leaves pubescent below, old leaves sometimes glabrescent 4
- 3. Length of leaves 2-5 cm; midvein glabrous; apex rounded *P. minutiflora*
- Length of leaves 30-45 cm; midvein with some hairs; apex ± acuminate *P. pronyensis*

4. Upper surface of leaves glabrous, apex often retuse; sepals ≥ 12 mm *P. baillonii*
 — Upper surface of leaves tomentulose, apex rounded or apiculate; sepals ≤ 12 mm 5
5. Leaves (3-)6-12 \times 1.0-1.5 cm; sepals 7-10 mm, greyish villous *P. kaalaensis*
 — Leaves 3-5 \times 0.3-0.5 cm; sepals 9-11 mm, brownish tomentulose *P. pinifolia*
6. Leaves glabrous on both surfaces, even on young leaves (or with a few scattered hairs below) 7
 — Leaves evenly pubescent below, even on young leaves, persistent or glabrescent 19
7. Leaf margin crenate, apex often mucronate; craspedodromous venation *P. crenata*
 — Leaf margin entire; apex not mucronate; brochido- or eucamptodromous venation 8
8. Sepals, all five glabrous; corolla 9-11 mm, tube pink, lobes greenish *P. ericiflora*
 — Sepals, at least the inner \pm hairy 9
9. Outer three sepals glabrous, inner two \pm hairy 10
 — All five sepals hairy 12
10. Leaves oblanceolate; flowers subsessile *P. laetevirens*
 — Leaves obovate-elliptic (rarely oblanceolate); flower pedicel > 3 mm 11
11. Petiole (20-)25-45 mm; primary nerve distinctly prominent acute below, secondaries 10-15 pairs, arcuate; sepals 3-4 mm *P. dothioensis*
 — Petiole 20-30 mm; primary nerve prominent flat or rounded below, not acute, secondaries 20-30 pairs, straight; sepals 5-6 mm *P. endlicheri*
12. Leaves oblanceolate(-oblong); sepals tomentose; corolla orange; growing on schist, along water streams *P. saligna*
 — Leaves different; sepals tomentulose, often sparsely; corolla not orange 13
13. Flowers sessile, axillary or borne along branches and/or stems; fruit ridged 14
 — Flowers borne among leaves, pedicel ≥ 5 mm; fruit round 16
14. Secondaries ≥ 14 pairs; cauliflorous, burls present; corolla flesh-coloured ... *P. cauliflora*
 — Secondaries ≤ 12 pairs; ramiflorous, burls absent; corolla differently coloured 15
15. Petiole and midvein yellow; corolla greenish (on fresh material), dry forest *P. luteocostata*
 — Petiole and midvein grey to greenish; corolla white with pink lobes (on fresh material), humid forest *P. roseoloba*
16. Leaves elliptic; pedicel glabrous or with a few ferruginous hairs; fruit *c.* 45 mm; growing on schist *P. mandjeliana*
 — Leaves \pm obovate; pedicel with at least some scattered grey hairs; fruit ≤ 30 mm 17
17. Petiole ≤ 5 (-15) mm; pedicel ≥ 10 mm; corolla cream, 6-8 mm, ultramafic soils on Main Island and Isle of Pines *P. reticulata*
 — Petiole ≥ 5 mm; pedicel ≤ 10 mm; corolla greenish, 2-4 mm (unknown in *P. lifuana*), coastal tree on Main Island or Loyalty Islands tree 18
18. Leaves obovate; petiole 10-20 mm; sepals 3-6 mm; from calcareous soils *P. lifuana*
 — Leaves also oblanceolate; petiole 5-10 mm; sepals 2-3 mm; grows on various soil types *P. linggensis*
19. Sepals and leaves below and/or leaf margin and petiole tomentose or villous 20
 — Sepals and leaves below tomentulose 23
20. Leaves 17-20 \times 7-11 cm; fruit globose, not acuminate, velvety hairy *P. thiensis*

- Leaves smaller; fruit acuminate, sparsely tomentulose, ridged 21
- 21. Leaves with margin strongly revolute *P. crassinervia*
- Leaves with margin flattened, not revolute 22
- 22. Leaves obovate or elliptic, 4-12 × 3-5 cm; sepals tomentose; secondaries 6-10, volcano-sedimentary and serpentinites soils *P. rufocostata*
- Leaves ± orbicular, 6-13 × 5-9 cm; sepals ± villous; secondaries 8-12 pairs, only known from upper part of Montagne des Sources, on ultramafic soil *P. skottsbergii*
- 23. Leaves below cinereous pubescent; littoral forests on calcareous soils *P. cinerea*
- Leaves below ferruginous pubescent, often turning greyish and/or glabrescent 24
- 24. Leaves broadly obovate or elliptic, often ≥ 10 cm long 25
- Leaves spatulate-obovate-oblancheolate, often ≤ 10 cm long 29
- 25. Style hairy at base; fruit ridged, acuminate 26
- Style glabrous, fruit round, generally not acuminate (exceptions in *P. wakere*, *P. glauca*, *P. lauracea*) 27
- 26. Leaves glossy green above; secondaries 5-7 pairs; corolla greenish *P. amieuana*
- Leaves glaucous above; secondaries 8-11 pairs; corolla cream *P. kuebiniensis*
- 27. Leaves quickly glabrescent below; corolla red; fruit globose *P. sphaerocarpa*
- Leaf pubescence ± persistent below; corolla white or cream; fruit obovoid 28
- 28. Fruit 20-35 × 10-15 mm; leaves obovate-oblancheolate, 5-13 cm long; secondaries 8-10 pairs; corolla lobe margin ciliate *P. lauracea*
- Fruit 40-60 × 25-40 mm; leaves obovate-oblong, 8-20 cm; secondaries 9-12 pairs; corolla lobe margin eciliate *P. wakere*
- 29. Leaves spatulate-orbicular 30
- Leaves obovate-oblancheolate 31
- 30. Leaves pubescence below brown; corolla greenish; fruit fusiform *P. povilana*
- Leaves pubescence below dark brown; corolla white; fruit obovoid *P. lauracea*
- 31. Sepals 12-20 mm; corolla 17-35 mm, cream or white; style exerted out of corolla; from Koumac in the north to Tontouta Valley in the south, a difficult group where size of leaves, sepals and corolla varies *P. leptostylidifolia* and *P. rheophytopsis*
- Sepals and corolla, respectively, < 10 mm long; style included in corolla 32
- 32. Fruit ridged with a style remnant < 1 mm; petiole ≤ 5 mm *P. koumaciensis*
- Fruit round with a style remnant ≥ 2 mm; petiole ≥ 3 mm 33
- 33. Leaves oblanceolate, glossy green above, glabrescent below, hairs only persistent along midvein, finally glabrous *P. microphylla*
- Leaves obovate-oblancheolate, dark green or glaucous above, tomentulose below, turning grey 34
- 34. Leaves glaucous, pubescence below light brown, soon grey; sepals ≤ 5 mm 35
- Leaves green above, pubescence below dark brown, soon grey; sepals ≥ 5 mm 36
- 35. Corolla 4-4.5 mm, white; peduncle 4-6 mm in fruit; leaves 4-8 cm *P. glauca*
- Corolla 5-6 mm, greenish; peduncle 8-10 mm in fruit; leaves 7-10 cm *P. latihila*
- 36. Petiole 3-10 mm; secondaries 4-6 pairs; fruit 10-15 mm *P. contermina*
- Petiole 10-20 mm; secondaries 8-10 pairs; fruit 20-35 mm *P. lauracea*

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REFERENCES

- AUBRÉVILLE A. 1967. — Sapotacées, in AUBRÉVILLE A. (ed.), *Flore de la Nouvelle-Calédonie et Dépendances*. Muséum national d'Histoire naturelle, Paris: 1-168.
- BALANSA B. 1873a. — Nouvelle-Calédonie. *Bulletin de la Société de Géographie* (Paris), 6^e série 5: 113-132.
- BALANSA B. 1873b. — Sur la géographie botanique de l'Océanie et de la Nouvelle-Calédonie. *Bulletin de la Société d'Histoire naturelle de Toulouse* 7: 327-332.
- BARTISH I. V., SWENSON U., MUNZINGER J. & ANDERBERG A. A. 2005. — Phylogenetic relationships among New Caledonian Sapotaceae (Ericales): molecular evidence for generic polyphyly and repeated dispersal. *American Journal of Botany* 92: 667-673.
- BOITEAU P. 1981. — Apocynacées, in AUBRÉVILLE A. & LEROY J.-F. (eds), *Flore de la Nouvelle-Calédonie et Dépendances*. Muséum national d'Histoire naturelle, Paris, 302 p.
- BOUCHET P., JAFFRÉ T. & VEILLON J.-M. 1995. — Plant extinction in New Caledonia: protection of sclerophyll forests urgently needed. *Biodiversity and Conservation* 4: 415-428.
- CHALUBERT A., DUBUS G., GALLUT C., PAVIE B. & VIGNES-LEBBE R. 2006. — *Xper²*. Laboratoire d'Informatique et de Systématique, Université Pierre et Marie Curie, Paris.
- DAWSON J. W. 1992. — Myrtaceae-Leptospermoideae, in MORAT P. & MACKEE H. S. (eds), *Flore de la Nouvelle-Calédonie et Dépendances*. Muséum national d'Histoire naturelle, Paris: 1-251.
- DAWSON J. W. 1999. — Myrtaceae-Myrtoideae I: *Syzygium*, in MORAT P. (ed.), *Flore de la Nouvelle-Calédonie et Dépendances*. Muséum national d'Histoire naturelle, Paris: 1-144.
- DE GARINE-WICHATITSKY M., SOUBEYRAN Y., MAILLARD D. & DUNCAN P. 2005. — The diets of introduced rusa deer (*Cervus timorensis russa*) in a native sclerophyll forest and a native rainforest of New Caledonia. *New Zealand Journal of Botany* 32: 117-126.
- FARR D. F. 2006. — On-line keys: more than just paper on the web. *Taxon* 55: 589-596.
- GOOD R. 1964. — *The Geography of the Flowering Plants*. 3rd ed. Longmans, London, 518 p.
- GOVAERTS R., FRODIN D. G. & PENNINGTON T. D. 2001. — *World Checklist and Bibliography of Sapotaceae*. Royal Botanic Gardens, Kew, 361 p.
- GUILLAUMIN A. 1921. — Essai de géographie botanique de la Nouvelle-Calédonie, in SARASIN F. & ROUX J. (eds), *Nova Caledonia, Botanique*. Kreidel's Verlag, Berlin und Wiesbaden: 256-293.
- HARRIS G. H. & HARRIS M. W. 1994. — *Plant Identification Terminology: An Illustrated Glossary*. Spring Lake Publishing, Spring Lake, Utah, 198 p.
- IUCN 2001. — *IUCN Red List Categories and Criteria*. Version 3.1. IUCN Species Survival Commission, IUCN, Gland, Switzerland; Cambridge, UK, 32 p.
- IUCN & SSC 2005. — *Guidelines for Using the IUCN Red List Categories and Criteria*, Gland, Switzerland, 52 p.
- JAFFRÉ T. & VEILLON J.-M. 1990. — Étude floristique et structurale de deux forêts denses humides sur roches ultrabasiques en Nouvelle-Calédonie. *Bulletin du Muséum national d'Histoire naturelle*, 4^e sér., sect. B, *Adansonia* 12: 243-273.
- JAFFRÉ T. & VEILLON J. M. 1995. — Structural and floristic characteristics of a rain forest on schist in New Caledonia: a comparison with an ultramafic rain forest. *Bulletin du Muséum national d'Histoire naturelle*, 4^e sér., sect. B, *Adansonia* 17: 201-226.
- JAFFRÉ T., BOUCHET P. & VEILLON J.-M. 1998. — Threatened plants of New Caledonia: is the system of protected areas adequate? *Biodiversity and Conservation* 7: 107-135.
- JAFFRÉ T., MORAT P., RIGAUT F., VEILLON J.-M. & DAGOSTINI G. 2001. — *Composition et caractéristiques de la flore indigène de la Nouvelle-Calédonie*. IRD, Nouméa, 121 p.
- JAFFRÉ T., DAGOSTINI G. & RIGAUT F. 2003. — *Identification, typologie et cartographie des groupements végétaux de basse altitude du Grand Sud calédonien et de la vallée de la Tontouta*. IRD, Sciences de la vie. Botanique. Conventions n° 12, Nouméa, 84 p.
- MYERS N. 1988. — Threatened biotas: "Hot Spots" in tropical forests. *Environmentalist* 8: 1-20.
- MYERS N., MITTERMEIER R. A., MITTERMEIER C. G.,

- DA FONSECA G. A. B. & KENT J. 2000. — Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.
- PENNINGTON T. D. 1991. — *The Genera of Sapotaceae*. Royal Botanic Gardens, Kew, 296 p.
- ROBERTS C. M., MCCLEAN C. J., VERON J. E. N., HAWKINS J. P., ALLEN G. R., MCALLISTER D. E., MITTERMEIER C. G., SCHUELER F. W., SPALDING M., WELLS F., VYNNE C. & WERNER T. B. 2002. — Marine biodiversity hotspots and conservation priorities for tropical reefs. *Science* 295: 1280-1284.
- SWENSON U. & ANDERBERG A. A. 2005. — Phylogeny, character evolution, and classification of Sapotaceae (Ericales). *Cladistics* 21: 101-130.
- SWENSON U., BARTISH I. V. & MUNZINGER J. 2007a. — Phylogeny, diagnostic characters, and generic limitation of Australasian Chrysophylloideae (Sapotaceae, Ericales): evidence from ITS sequence data and morphology. *Cladistics* 23: 201-228.
- SWENSON U., MUNZINGER J. & BARTISH I. V. 2007b. — Molecular phylogeny of *Planchonella* (Sapotaceae) and eight new species from New Caledonia. *Taxon* 56: 329-354.
- TAKHTAJAN A. 1969. — *Flowering Plants, Origin and Dispersal*. Oliver and Boyd, Edinburgh, 310 p.
- THORNE R. F. 1963. — Biotic distribution patterns in the tropical pacific, in GESSITT J. L. (ed.), *Pacific Basin Biogeography*, Bishop Museum Press, Honolulu: 311-350.
- TRIONO T., BROWN A. H. D., WEST J. G. & CRISP M. D. 2007. — A phylogeny of *Pouteria* (Sapotaceae) from Malesia and Australasia. *Australian Systematic Botany* 20: 107-118.
- VAN ROYEN P. 1957. — Revision of the Sapotaceae of the Malaysian area in a wider sense. VII. *Planchonella* Pierre. *Blumea* 8: 235-445.

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