Two new genera of Sapindaceae (Cupanieae) from the southern Pacific: Lepidocupania and Neoarytera

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Two new genera of Sapindaceae (Cupanieae) from the southern Pacific: Lepidocupania and Neoarytera

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Abstract

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Phylogenetic analyses of the family *Sapindaceae* inferred from nuclear and plastid sequence data have revealed a high level of para- and polyphyly at the subfamilial, tribal, and generic levels. A phylogenetic study focusing on taxa in the southern Pacific belonging to tribe *Cupanieae* has shown that the two most species-rich genera, *Arytera* Blume and *Cupaniopsis* Radlk., are polyphyletic. This study aims to clarify generic limits among the taxa currently placed in these two genera by identifying morphological features that support monophyletic groups suitable for recognition at the generic level. Specimens deposited in major herbaria holding material of these taxa were examined to complement extensive field observations. Careful consideration of morphological features in light of previous taxonomic treatments and the results of phylogenetic analyses enabled us to propose a re-aligned generic framework for *Cupanieae* in which two new genera are described to accommodate species previously placed in *Arytera* and *Cupaniopsis*: viz., *Lepidocupania* Buerki, Callm., Munzinger & Lowry (21 species) and *Neoarytera* Callm., Buerki, Munzinger & Lowry (4 species). A total of 25 new combinations are made, lectotypes are designated for nine names (two first step and seven second-step), and one new synonym is established. A key to the newly circumscribed genera *Arytera* and *Cupaniopsis*, along with allied genera, is provided, accompanied by information on the distribution and ecology of each species.

Keywords

SAPINDACEAE – *Cupanieae* – *Arytera* – *Cupaniopsis* – *Lepiderema* – *Lepidocupania* – *Neoarytera* – *Synima* – Australia – New Caledonia – New genus – New combination – Typification

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Introduction

Phylogenetic analyses of the family *Sapindaceae* inferred from nuclear and plastid sequence data have revealed a high level of para- and polyphyly at the subfamilial, tribal, and generic levels (Harrington et al., 2005; Buerki et al., 2009, 2010). A new informal infra-familial classification was proposed by Buerki et al. (2009), mainly based on molecular data, to accommodate these findings and to provide a framework for developing improved generic circumscriptions that meet the criterion of monophyly. Within *Sapindaceae*, the Cupania group, which occurs in Australasia, Asia, South America, and Madagascar, but is absent in continental Africa, corresponds to the largest radiation in terms of the number of genera and species (Buerki et al., 2009). A forthcoming genus-level phylogeny of the family based on 353 nuclear genes will provide the basis for a new, formal tribal delimitation, in which the Cupania group corresponds to tribe *Cupanieae* Radlk. (Buerki et al., unpubl. data). To date, the only study that has used a phylogenetic framework to test the monophyly of genera in the Cupania group is that of Buerki et al. (2012), which focused on taxa in the islands of the southern Pacific. This study demonstrated that the two most species-rich genera, *Arytera* Radlk. and *Cupaniopsis* Radlk., were both polyphyletic. Within the Cupania group, they were placed in clade B (see Buerki et al., 2012 for more details on the composition of this clade) and their members were distributed among two subclades (B-III and B-VI), within which species of both genera were intermixed (see Fig. 1). *Lepiderema* Radlk. was shown to be sister to species of *Arytera* and *Cupaniopsis* in clade B-III, whereas within clade B-IV, *Synima* Radlk. was inferred to be sister to other taxa currently placed in *Arytera* and *Cupaniopsis*.

Arytera was described by Blume (1849), who recognized two species, *A. litoralis* Blume (designated as the lectotype of the genus by Reynolds, 1985a) (Fig. 2A) and *A. montana* Blume (later transferred to *Lepidopetalum* Radlk. by Radlkofer, 1879a). The first comprehensive account of the genus included 21 species (Radlkofer, 1931–1934), and more recently Turner (1995) published a monograph in which he recognized 25 species (Fig. 2A–B). The monophyly of *Arytera* was questioned by Turner (1995), who established the genus *Mischarytera* (Radlk.) H. Turner to accommodate the species previously placed by Radlkofer (1879b) in *Arytera* sect. *Mischarytera* Radlk. Turner (1995) also divided *Arytera* sect. *Azarytera* Radlk. into two subsections, *Arytera* subsect. *Pacifica* H. Turner and *Arytera* subsect. *Distylis* H. Turner.

Cupaniopsis was described by Radlkofer (1879b) to accommodate species originally placed in various other genera, including taxa such as *C. anacardioides* (A. Rich.) Radlk. (≡ *Cupania anacardioides* A. Rich), which was designated as lectotype of *Cupaniopsis* by Reynolds (1984). The first account of the genus included 44 species (Radlkofer, 1931–1934) (Fig. 2C–D), whereas Adema (1991) recognized 60 species in his monograph

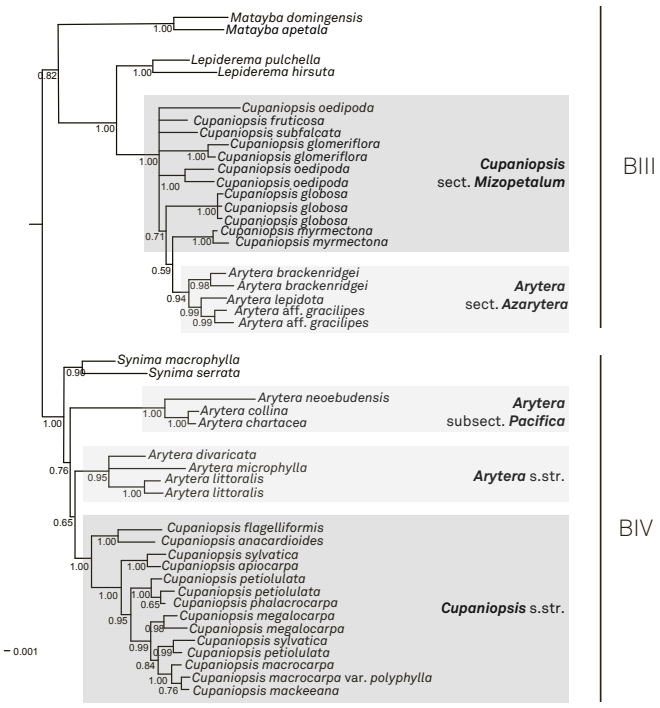

Fig. 1. – MrBayes Bayesian halfcompat consensus tree inferred from eight nuclear and plastid DNA regions adapted from Buerki et al. (2012) showing relationships within the Cupania group. Bayesian posterior probability (BPP) support values are indicated. Shades of grey highlight the polyphyly of *Arytera* Blume and *Cupaniopsis* Radlk.

of *Cupaniopsis*, ranging from East Malesia to Australia and several South Pacific islands (Fiji, New Caledonia, and Vanuatu), with centers of diversity in Australia, New Guinea, and New Caledonia. Radlkofer (1879b) described two sections within *Cupaniopsis*, in addition to the nominal section, *Cupaniopsis* sect. *Mizopetalum* Radlk. and *Cupaniopsis* sect. *Macropetalum* Radlk. Neither of these two sections were recognized by Adema (1991), even though the 18 species of *Cupaniopsis* sect. *Mizopetalum* formed a clade in the cladistic analysis he performed based on morphological characters (see Adema, 1991: 50–51, fig. 20).

Among the allied genera belonging to the Cupania group, *Lepiderema* Radlk. was established by Radlkofer (1879b), with its type being *L. papuana* Radlk. As currently circumscribed, this genus includes eight species, six endemic to Australia and two to New Guinea (Reynolds, 1982; Schot, 1991) (Fig 2F). A second member of the Cupania group, *Synima* Radlk., has four species, three in Australia and one in New Guinea (Reynolds, 1985b; Forster, 2006; Callmander et al., 2020) (Fig. 2E).

Several authors have questioned the monophyly of *Arytera*. Radlkofer (1931–1934) commented on the morphological similarities between species of *Arytera* sect. *Azarytera* and *Cupaniopsis* sect. *Mizopetalum* as follows: "Among the Asian and Oceanic *Cupanieae* possessing the calyx of *Matayba* and only small un-crested petals with 2 scales or nearly lacking scales, the genus [*Arytera*] is remarkable by its capsule [that is]

Fig. 2. – A. *Arytera litoralis* Blume (Halmahera, North Maluku, Indonesia); **B.** *Arytera divaricata* F. Muell. (Queensland, Australia); **C.** *Cupaniopsis macrocarpa* var. *polyphylla* Adema (New Caledonia); **D.** *Cupaniopsis flagelliformis* (F.M. Bailey) Radlk. (Queensland, Australia); **E.** *Synima serrata* (S.T. Reynolds) Callm. & Buerki (Queensland, Australia); **F.** *Lepiderema punctulata* (F. Muell.) Radlk. (Queensland, Australia). [**A:** *Bangun 440*; **B:** *Gray et al. 9741*; **C:** *Lowry et al. 7319*; **D:** *Gray et al. 9693*; **E:** *Gray et al. 9856*] [Photos: **A:** I.A. Haris; **B, D:** B. Gray; **C:** P. Lowry; **E:** S. & A. Pearson; **F:** G. Sankowsky]

more or less divaricately lobed with cocci not at all winged, or somewhat compressed-obovate [and] usually sessile […], its unappendaged aril usually completely enclosing the seed, the compact structure of its leaves and in the species of section IV [*Arytera* sect. *Azarytera*] by the lepidote leaflets, by which character this section agrees with the genus *Cupaniopsis* section III *Mizopetalum* […]." (Radlkofer, 1931–1934: 1270; translated from Latin by R. Gereau). Turner (1995: 28) mentioned that *Arytera*, as he circumscribed it, is only recognizable based "on a polythetic set of [six] character states", and excluded three species (*A. bullata* H. Turner, *A. lautereriana* (F.M. Bailey) Radlk., and *A. macrobotrys* (Merr. & L.M. Perry) R.W. Ham), which he transferred to his new genus *Mischarytera* (see above).

In light of the long-recognized issues regarding the delimitation of *Arytera* and *Cupaniopsis*, coupled with the recent molecular phylogenetic analyses that have clearly shown both of them to be polyphyletic, as currently circumscribed, a thorough review of both genera seems appropriate. In the present study, we aim to revise generic limits so that they correspond to monophyletic groups, and to place all of the taxa currently assigned to *Arytera* and *Cupaniopsis* within this new generic framework, supported by morphological features that characterize the clades defined by Buerki et al. (2012). Taxa belonging to the phylogenetically closely related genera *Lepiderema* and *Synima* have also been included in an effort to clarify their relationships and taxonomic identities. Our goal is to resolve generic delimitations within this challenging group and thereby further Radlkofer's quest, which started nearly 150 years ago.

Material & Methods

In order to identify potentially informative morphological characters that support monophyletic groups and to assess affinities among the taxa currently placed in *Arytera*, *Cupaniopsis*, *Lepiderema*, and *Synima*, we examined material from the following herbaria: BM, BRI, CNS, G, K, L, MO, MPU, NOU, P, SING, and SUVA. This was complemented by accessing digital images of type specimens at other herbaria through the Global Plants website [https://plants.jstor.org]. To encompass the full range of morphological variation within species across their distributional ranges, we also consulted the descriptions provided in regional floras (i.e. *Flora Malesiana*, Adema et al., 1994; *Flora of Australia*, Reynolds, 1985b) and generic monographs (i.e. *Cupaniopsis*, Adema, 1991; *Arytera*, Turner, 1995), as well as the seminal works of Radlkofer (1879a, 1879b, 1931–1934). Data were compiled on key morphological characters for each taxon. Finally, between 2009 and 2017, we also conducted fieldwork throughout much of the range of the study group, including in Australia, Borneo, the Fijian archipelago, the Moluccas, New Caledonia, Peninsular Malaysia, Singapore, and Vanuatu, in order to observe and collect material of indigenous species, and to gain insights into their morphology and ecology, as well as their relationships with other members of the family.

Phylogenetic results and morphological characters

A key step toward resolving generic delimitations within the closely related *Sapindaceae* that were the focus of this study involved aligning our morphological findings with previous taxonomies and discussing the results in light of the phylogenetic framework presented in Buerki et al. (2012). Biogeography was also taken into consideration as a criterion for delimiting genera. The presentation of our findings given below follows the sequence of clades presented in Buerki et al. (2012). We also have sought to corroborate our taxonomic findings by expanding phylogenetic analyses to include DNA sequences from several key species, although the results of this work are not formally included in the present paper and will instead be the subject of a forthcoming publication focusing on the evolution and biogeography of the *Cupania* clade in the Pacific islands and neighboring regions. Our goal here is to provide the new generic classification required as a basis for conducting evolutionary and biogeographical analyses.

Clade B-III identified by Buerki et al. (2012) (Fig. 1) contains all sampled taxa of *Lepiderema*, which form a subclade that is sister to another subclade comprising all sequenced species of *Cupaniopsis* sect. *Mizopetalum* (including 18 species, five of which were originally placed in this section by Radlkofer and the rest were subsequently added by Adema (1991) in his treatment of the genus). In this treatment, we are only recognizing 17 of these species (see taxonomic treatment below), together with all four sampled species of *Arytera* sect. *Azarytera*. Although the sampling from these groups used by Buerki et al. (2012) was limited, their phylogenetic results strongly suggested that species of *Arytera* sect. *Azarytera* were nested within *Cupaniopsis* sect. *Mizopetalum*, which precluded the possibility of recognizing either of these infrageneric taxa as a separate genus. The presence of lepidote scales on the vegetative and reproductive organs of these species represents a clear morphological synapomorphy for clade B-III. Two taxonomic interpretations are possible given this phylogenetic context: 1) recognize one large genus encompassing all the members of *Lepiderema*, *Arytera* sect. *Azarytera*, and *Cupaniopsis* sect. *Mizopetalum*; or 2) treat *Lepiderema* as one genus and place the remaining species in another genus. We prefer the second option because species of *Lepiderema* can easily be distinguished from the other members of clade B-III by their lack of petal and ovary scales (vs. petal and ovary scales present in the other taxa). Moreover, *Lepiderema* is restricted to Australia and New Guinea, whereas the other taxa occur in New Caledonia, Fiji and Samoa (with the exception of *A. brackenridgei* Radlk., which has a wide distribution in the

Solomon Islands, Vanuatu, Fiji, Wallis and Futuna (Horn Islands), Tonga and Samoa). In order to accommodate the group that is sister to *Lepiderema*, which comprises the species previously placed in *Arytera* sect. *Azarytera* and *Cupaniopsis* sect. *Mizopetalum*, a new genus is required, which we described below as *Lepidocupania* Buerki, Callm., Munzinger & Lowry.

The taxa belonging to clade B-IV of Buerki et al. (2012) (Fig. 1) can easily be distinguished from those in clade B-III by the absence of lepidote scales on their vegetative and reproductive organs. *Synima* is inferred to occupy a basal position in clade B-IV. This genus is restricted to Australia, with the exception of a single species in New Guinea, viz. *S. cordieri* (F. Muell.) Radlk. (Reynolds, 1985b). *Synima* is characterized by having crested scales on its petals and seeds, the latter fully covered with a sarcotesta (Reynolds, 1985a; Forster, 2006; Callmander et al., 2020). The remainder of clade B-IV comprises three subclades, which are fully aligned with previously recognized taxonomic entities. The species of *Arytera* subsect. *Pacifica* correspond to the first subclade, which is sister to the two other subclades, one containing the type of the genus (*A. litoralis*) and all species currently assigned to *Arytera* subsect. *Arytera* and *Arytera* subsect. *Distylis*, and a third subclade comprising the type of *Cupaniopsis* (*C. anacardioides*) and all species currently placed in this genus, with the exception of those belonging to *Cupaniopsis* sect. *Mizopetalum* (see above). Since each of these three subclades is consistent with a currently recognized taxonomic entity and is also morphologically coherent, we have opted to recognize them as a separate, well-defined genus. Two of the subclades correspond to *Arytera* and *Cupaniopsis* because they contain their respective types, whereas the third subclade represents a new genus, which we formally describe here as *Neoarytera* Callm., Buerki, Munzinger & Lowry.

Below we provide a key to the genera, which includes the two new genera, and we also include an appendix that presents a synopsis of currently accepted species of *Arytera*, *Cupaniopsis*, *Lepidocupania*, and *Neoarytera*, with their respective distributions. The taxonomy of the two new genera follows the comprehensive monographs by Adema (1991) and Turner (1995), with the exception of *Cupaniopsis rotundifolia* Adema, which is not accepted here. The synonymies proposed by Adema and Turner are not repeated here except for two names that require nomenclatural clarification: *Arytera pachyphylla* Radlk. and *Cupaniopsis ganophloea* Radlk.

A key to the newly circumscribed Arytera, Cupaniopsis and allied genera

The following key is adapted from Reynolds (1985b).

1. Calyx lobes free (sometimes sepals basally united), orbicular, elliptic or obovate, concave 2
1a. Calyx shortly cupular, the lobes toothed or partite, usually ovate 4
2. Scales absent from petals ..... ***Lepiderema***
2a. Scales present on petals 3
3. Scales present on vegetative and fertile organs ..... ***Lepidocupania***
3a. Scales absent from vegetative and fertile organs ..... ***Cupaniopsis***
4. Petal scales crested ..... ***Synima***
4a. Petal scales not crested 5
5. Petal scales adnate to the petal margin or free from the petals; central axis of fruit not thickened ..... ***Arytera***
5a. Petal scales comprising minute enations; central axis of fruit distinctly thickened ..... ***Neoarytera***

Taxonomy

Description and synopsis of Lepidocupania

Lepidocupania Buerki, Callm., Munzinger & Lowry, **gen. nov.** (Fig. 3A–C).

Type: *Lepidocupania lepidota* (Radlk.) Buerki, Callm., Munzinger & Lowry (≡ *Arytera lepidota* Radlk.).

= *Cupaniopsis* sect. *Mizopetalum* Radlk. in Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9: 588. 1879. **Type:** *Cupaniopsis fruticosa* Radlk. (≡ *Lepidocupania fruticosa* (Radlk.) Buerki, Callm., Munzinger & Lowry) (lectotype designated by Adema, 1991: 60).

= *Arytera* sect. *Azarytera* Radlk. in Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9: 554. 1879. **Type:** *Arytera arcuata* Radlk. (≡ *Lepidocupania arcuata* (Radlk.) Buerki, Callm., Munzinger & Lowry) (lectotype designated by Turner, 1995: 151).

Trees or *shrubs*. Indument of short, straight, patent or appressed trichomes; glandular scales present on vegetative parts, inflorescence axes, pedicels, abaxial surface of calyx, pistil, and fruits; buds "varnished". *Leaves* alternate, 1–12-jugate; leaflets opposite to alternate, subsessile to petiolulate, margin entire to coarsely dentate. Inflorescences axillary or pseudo-terminal. *Flowers* zygomorphic or actinomorphic (in *L. arcuata, L. brackenridgei, L. gracilipes,* and *L. lepidota*), functionally unisexual; sepals (4–)5(–6), free and imbricate or united (in *L. arcuata, L. brackenridgei, L. gracilipes,* and *L. lepidota*) to form a dentate calyx cup; petals 5 (4 in *L. glomeriflora*), with 2 distinct scales; disc lobed or not (in *L. arcuata, L. brackenridgei, L. gracilipes,* and *L. lepidota*), rim glabrous to pilose; stamens (6–)8–9, anthers basifixed; ovary 2–3-locular. *Fruit* a capsule, with 2–3 well developed lobes, rarely 1 (in *L. concolor*, *L. guillauminii*, and *L. samoensis*),

dehiscence loculicidal, glabrous to puberulous and rugose to verrucose outside, glabrous to pilose inside; seed ellipsoid or ovoid to globose, sarcotesta covering half to all of the seed, flesh-membranaceous.

Distribution. – *Lepidocupania* comprises 21 species occurring in the Caroline Islands, Fiji, New Caledonia, Samoa, the Solomon Islands, and Vanuatu (Fig. 4).

Notes. – *Lepidocupania* shares the presence of lepidote scales on its vegetative and reproductive organs with *Lepiderema*. However, *Lepidocupania* can easily be distinguished from *Lepiderema* by the presence (vs. absence) of petal and ovary scales, and it differs from *Cupaniopsis* by the presence (vs. absence) of glandular scales on its vegetative and fertile organs.

Lepidocupania arcuata (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Arytera arcuata* Radlk. in Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Munich 9: 554. 1879.

Lectotypus (designated by Turner, 1995: 158): **New Caledonia. Prov. Sud:** Nouméa, X.1868, *Balansa 150* (M [M0225363]!; isolecto-: FI [FI010518]!, NY [NY00038712, NY00038713]!, P [P00205443, P00205444]!).

Distribution and ecology. – According to Turner's (1995) concept, *Lepidocupania arcuata* is endemic to the New Caledonian archipelago, where it occurs from sea level to 200 m, predominantly on calcareous soils (Loyalty Islands, Ile des Pins), but also on sand, clay and schist. It is found in mesophyll and sclerophyll forest and scrub.

Notes. – Additional taxonomic analyses are required, especially with regard to material from the Loyalty Islands, which exhibits very peculiar indument compared to that from the main island of New Caledonia [Grande Terre]. Moreover, Turner (1995) tentatively identified a specimen from Tonga (*Parks 16317*: L 0468503) as *L. arcuata*, which, if confirmed, would significantly expand the geographic range of this species.

Lepidocupania brackenridgei (A. Gray) Buerki, Callm., Munzinger & Lowry, **comb. nov.** (Fig. 3B).

≡ *Cupania brackenridgei* A. Gray in Wilkes, U.S. Expl. Exped., Phan. 1: 255. 1854. ≡ *Arytera brackenridgei* (A. Gray) Radlk. in Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Munich 9: 555. 1879.

Holotypus: Fiji: Ovalau, 1838–1842, *Wilkes s.n.* (US [US 00095325] image seen; iso-: P [P00646032]!).

Distribution and ecology. – *Lepidocupania brackenridgei* is widespread in the Solomon Islands, Vanuatu, Fiji, Wallis and Futuna (Horn Islands), Tonga and Samoa, where it occurs from sea level to 1050 m (Adema, 1991). This common species occurs in primary and secondary rainforest, but is also found in savannah; it grows on limestone and lava fields.

Lepidocupania concolor (Gillespie) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Guioa concolor* Gillespie in Bull. Bernice P. Bishop Mus. 83: 17. 1931. ≡ *Arytera concolor* (Gillespie) A.C. Sm. in J. Arnold Arbor. 31: 298. 1950. ≡ *Cupaniopsis concolor* (Gillespie) R.W. Ham in Blumea 23: 287. 1977.

Holotypus: Fiji: Taveuni, vicinity of Waiyevo, 3.III.1928 *Gillespie 4794* (BISH [BISH1004953] image seen; iso-: BISH [BISH1004954, BISH1004955] images seen, K [K000701623]!, NY [NY00337873]!, GH [GH00050772] image seen, US [US00095352] image seen).

Distribution and ecology. – *Lepidocupania concolor* is endemic to Fiji, where it is known from the three main islands of Viti Levu, Vanua Levu, and Taveuni (Smith, 1985).

Lepidocupania fruticosa (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis fruticosa* Radlk. in Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Munich 9: 588. 1879.

Lectotypus (designated by Adema, 1991: 111): **New Caledonia:** *sine loco*, s.d., *Pancher 142* (M [M0225246] image seen; iso-: MEL [MEL1539980] image seen, P [P05310069, P05310082, P05310086, P05310089]!).

Distribution and ecology. – *Lepidocupania fruticosa* is endemic to the southwestern part of Grande Terre, where it grows in dense humid forest, usually on serpentinite, but sometimes also on schist or laterite, from 5 to 300(–900) m (Adema, 1991).

Notes. – Based on our current knowledge on this species, additional taxonomic studies appear to be needed to clarify its circumscription. This should also include material currently assigned to *L. subfalcata* and *L. tontoutensis* (see below for additional details).

Lepidocupania glabra (Adema) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis glabra* Adema in Leiden Bot. Ser. 15: 113. 1991.

Holotypus: New Caledonia. Prov. Sud: Basse Tontouta, rive gauche, terrain serpentineux, 50 m, 10.II.1962,

Fig. 3. – A. *Lepidocupania glomeriflora* (Radlk.) Buerki, Callm., Munzinger & Lowry (New Caledonia); **B.** *Lepidocupania brackenridgei* (A. Gray) Buerki, Callm., Munzinger & Lowry (Vanua Levu, Fiji); **C.** *Lepidocupania lepidota* (Radlk.) Buerki, Callm., Munzinger & Lowry (New Caledonia); **D.** *Neoarytera collina* (Pancher & Sebert) Callm., Buerki, Munzinger & Lowry (New Caledonia); **E.** *Neoarytera neoebudensis* (Guillaumin) Callm., Buerki, Munzinger & Lowry (New Caledonia); **F.** *Neoarytera chartacea* (Radlk.) Callm., Buerki, Munzinger & Lowry (New Caledonia).
[**A:** *Callmander et 788*; **B:** *Munzinger 379*; **C:** *Munzinger 7700*; **D:** *Munzinger 7395*; **E:** *Munzinger 7404*; **F:** *Hequet 3525*]
[Photos: **A–B, D–E:** P. Lowry; **C:** J. Munzinger; **F:** V. Hequet]

MacKee 40234 (L [L0013372]!; iso-: NOU [NOU006523]!, P [P05213382]!).

Distribution and ecology. – *Lepidocupania glabra* is endemic to the Tontouta River valley (Grande Terre). It is found in maquis and continuous tall maquis ("maquis paraforestier", see McCoy et al., 1999 for details) dominated by *Gymnostoma chamaecyparis* (J. Poiss.) L.A.S. Johnson (*Casuarinaceae*) on ultramafic substrate, primarily alluvium, between 20 and 400 m (Adema, 1991; D'Angelo, 2017).

Notes. – This species has been assigned an IUCN risk of extinction status of "Critically Endangered" [CR] based on its narrow distribution and reduction in population size (IUCN, 2020).

Lepidocupania globosa (Adema) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis globosa* Adema in Leiden Bot. Ser. 15: 114. 1991.

Holotypus: New Caledonia. Prov. Sud: Bourail, les Montagnes Blanches, 12.X.1982, *Suprin 2080* (P not found; iso-: L [L0013373]!, NOU [NOU006522]!).

Distribution and ecology. – *Lepidocupania globosa* is endemic to the west coast of Grande Terre, where it is restricted to sclerophyll forest (Bouchet et al., 1995).

Notes. – This species has been assigned an IUCN risk of extinction status of "Vulnerable" (IUCN, 2020). See note under *L. pennelii*.

Lepidocupania glomeriflora (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.** (Fig. 3A).

≡ *Cupaniopsis glomeriflora* Radlk. in Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Munich 9: 589. 1879.

Lectotypus (first step designated by Adema, 1991: 116; second step designated here): **New Caledonia. Prov. Sud:** Bourail, dans les bois, III.1869, *Balansa 1447* (P [P00639131]!; isolecto-: P [P00639133, P00639134]!).

Distribution and ecology. – *Lepidocupania glomeriflora* is endemic to New Caledonia, where it occurs on Grande Terre, the Ile des Pins, and the three larger Loyalty Islands (Adema, 1991; Butaud, 2014). It is found in maquis vegetation, dry to mesic forests, or forest remnants, along the coast, on hills or mountainsides, often along rivers, and occurs on calcareous substrates, serpentinite and schist, but appears not to favor peridotitic substrates and is completely absent from Grande Terre's large southern ultramafic massif. *Lepidocupania glomeriflora* has been recorded from 10 to 500 m.

Notes. – Nine syntype collections were cited in the protologue of *Cupaniopsis glomeriflora*: *Balansa 153* p.p., *1447*, *Baudouin 354* p.p., "*Culta in hort. Paris*", *Deplanche 83*, *Labillardière 169*, *Pancher 782*, *Vieillard 228*, and *233*. Adema (1991: 116) designated *Balansa 1447* as the lectotype. Original material at P is, however, mounted on three sheets, necessitating the second step lectotypification designated here, for which we have selected the most complete and best-preserved sheet [P00639131].

Lepidocupania gracilipes (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Arytera gracilipes* Radlk. in Repert. Spec. Nov. Regni Veg. 20: 38. 1924.

Lectotypus (designated by Turner, 1995: 181): **New Caledonia. Prov. Nord:** "montagnes de Panloïtch, près Gatop", s.d., *Vieillard 2403* (K [K000701494]!; isolecto-: FI [FI010518]!, NY [NY00038712, NY00038713]!, M [M0225444] image seen, P [P00639134, P00639135, P00639136, P00639137, P00639138, P05310259, P05310260]!).

Distribution and ecology. – *Lepidocupania gracilipes* is endemic to Grande Terre, where it grows in gallery forest, continuous tall maquis ("maquis paraforestier", see McCoy et al., 1999 for details), and thickets on (rocky) serpentine terrain, and sometimes along streams on alluvium (Turner, 1995). It seems to be restricted to serpentine, hyper-magnesium brown soils. The species has been recorded from sea level to 600 m.

Lepidocupania grandiflora (Adema) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis grandiflora* Adema in Bull. Mus. Natl. Hist. Nat., B, Adansonia, 10: 263. 1989.

Holotypus: New Caledonia. Prov. Sud: Mont Do, 950 m, s.d., *McPherson 3805* (MO [MO260722]!; iso-: NOU [NOU006521]!).

Distribution and ecology. – *Lepidocupania grandiflora* is endemic to Grande Terre, where is has a peculiar distribution and edaphic range; most collections are from the central region (Mont Do and around the Col d'Amieu), but others have been made in the Pouébo area, some 175 km to the northwest. *Lepidocupania grandiflora* grows in wet forest and maquis vegetation, on ultramafic and non-ultramafic substrates, from 400 to 1000 m.

Notes. – Adema (1991: 119) suggested a close affinity between this species and *L. oedipoda* based on vegetative

characters. Their morphological similarity points toward the need for further analyses, especially focusing on collections from the Pouébo area.

Lepidocupania guillauminii (Kaneh.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Mischocarpus guillauminii* Kaneh. in Bot. Mag. (Tokyo) 46: 672. 1932. ≡ *Cupaniopsis guillauminii* (Kaneh.) Adema in Leiden Bot. Ser. 15: 121. 1991.

Holotypus: Caroline islands: Truk [Chuuk] atoll, VI.1931, *Kanehira 1268* (FU; iso-: A [A00050841] image seen, BISH [BISH1004940] image seen, P [P05301428]!).

Distribution and ecology. – *Lepidocupania guillauminii* is endemic to Chuuk atoll in the Caroline Islands, where it grows in lowland evergreen forests on volcanic soil and humus (Adema, 1991).

Note. – While Adema (1991: 122) noted that the available material of this species is rather incomplete and that it resembles both *L. concolor* and *L. samoensis*, he recognized it as distinct based on several differences in the amount of indument and in features of the fruits.

Lepidocupania inoplea (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis inoplea* Radlk. in Sitzungsber. Math.-Phys. CI. Konigl. Bayer. Akad. Wiss. Munich 9: 589. 1879.

Lectotypus (designated here): **New Caledonia. Prov. Nord:** Mt. Poum, V.1871, *Balansa 3307* (P [P00639140]!; isolecto-: P [P00639141, P00639142]!).

Distribution and ecology. – *Lepidocupania inoplaea,* as circumscribed by Adema (1991), is endemic to the archipelago of New Caledonia, where it occurs in the northwestern part of Grande Terre and two of the Loyalty Islands (Lifou and Maré). It is found in maquis vegetation and gallery forest on serpentinite and schist, from sea level to 700 m.

Notes. – *Cupaniopsis inoplea* was described based on *Balansa 3307*. Original material at P is mounted on three sheets, two of which [P00639140, P00639141] bear the following note in Radlkofer's hand: "Cupaniopsis inoplaea m. Radlk." Here we designate the most complete and best-preserved of these two sheets [P00639140] as the lectotype.

It has come to our attention that the original spelling of the epithet, '*inoplea*', was changed to '*inoplaea*' by Guillaumin (1948) and Adema (1991), but the rules of nomenclature do not justify this change, and we therefore retain the original spelling, as proposed by Radlkofer (1879b).

Adema (1991) did not indicate that this species grows on calcareous substrate, although two collections cited in his monograph from the Loyalty Islands (*Schmid 677* and *MacKee (Leg. Suprin) 43447*) were gathered without doubt from calcareous sites. Further study will be needed to determine whether these collections belong to *Lepidocupania inoplea* or another species.

Lepidocupania lepidota (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.** (Fig. 3C).

≡ *Arytera lepidota* Radlk. in Sitzungsber. Math.-Phys. CI. Konigl. Bayer. Akad. Wiss. Munich 9: 555. 1879.

Lectotypus (first step designated by Turner, 1995: 182; second step designated here): **New Caledonia. Prov. Sud:** Mont Dore, s.d., *Pancher [Mus. Néocal.] 222* (P [P00639113]!; isolecto-: C [C10018554] image seen, K [K000701492]!, MEL [MEL1586135] image seen; NY [NY00038710] image seen, P [P05310135]!).

Distribution and ecology. – *Lepidocupania lepidota* is endemic to Grande Terre, where it is restricted to dense humid forest on ultramafic substrates, from 10 to 915 m. Most collections are from the main ultramafic massif of the south, although it is also recorded from a few isolated localities in the north, including Mont Do and Cap Bocage (Turner, 1995), and more recently from Kantalupaik (Munzinger et al., 2018).

Notes. – Seven syntype collections were cited in the protologue of *Arytera lepidota*: *Balansa 1445*, *2841*, *Baudouin 134A*, *Pancher [Mus. Néocal.] 222*, *Vieillard 205*, and *206*. Turner (1995: 182) designated *Pancher [Mus. Neocal.] 222* as the lectotype. The original material deposited at P is, however, mounted on two sheets, necessitating the second step lectotypification designated here, for which we have selected the most complete and best-preserved sheet [P00639113].

Lepidocupania mouana (Guillaumin) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis mouana* Guillaumin in Mém. Mus. Natl. Hist. Nat., Sér. B, Bot. 15: 109. 1967.

Holotypus: New Caledonia. Prov. Nord: Mt. Mou, 8.II.1950, *Baumann-Bodenheim [leg. Baas Becking] 6036* (P [P05256547]!; iso-: L [L0484153]!, Z [Z-000028070] image seen).

Distribution and ecology. – *Lepidocupania mouana* is endemic to Grande Terre, where it is restricted to Mont Mou in the southwest. Adema (1991) cited a single specimen, the holotype, collected in 1951, while an additional collection was made in 2009 (*Grignon & Munzinger 256*). This species grows in continuous tall maquis ("maquis paraforestier", see McCoy

et al., 1999 for details) dominated by species of *Gymnostoma* L.A.S. Johnson, on peridotitic substrate.

Note. – *Lepidocupania mouana* was assigned an IUCN risk of extinction status of "Endangered" [EN] by Jaffré et al. (1998).

Lepidocupania myrmoctona (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis myrmoctona* Radlk. in Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Munich 9: 588. 1879.

Lectotypus (designated by Adema, 1991: 140; second step designated here): **New Caledonia:** *sine loco,* s.d., *Labillardière s.n.* (G [G00019027]!; isolecto-: FI [FI006799 FI006840]!, G [G00341584, G00341590]!, K).

Distribution and ecology. – *Lepidocupania myrmoctona* is endemic to Grande Terre, where it is abundant along the east coast and grows in dense humid forest, mostly on non-ultramafic substrate (schist), but it has also been recorded in montane ecosystems in the main southern ultramafic massif (Adema, 1991).

Notes. – *Cupaniopsis myrmoctona* was described based on "Labillardière (Hb. Webb, Hook., Deless.)" (Radlkofer, 1879b: 588). Adema (1991: 140) designated material from G as the lectotype. A second step lectotypification is, however, required because the original material at G comprises three sheets originating from three different herbaria: Delessert [G00019027], Moricand [G00341590], and Ventenat [G00341584]. Ventenat's herbarium was originally part of the Delessert herbarium (Callmander et al., 2017) and both [G00019027] and [G00341584] are annotated in Radlkofer's hand: "Cupaniopsis myrmoctona m. Radlk.". Here we designate the most complete and best-preserved sheet [G00019027], originating from the Delessert herbarium, as the lectotype.

Lepidocupania oedipoda (Radlk.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis oedipoda* Radlk. in Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Munich 9: 590. 1879.

Lectotypus (first step designated by Adema, 1991: 146; second step designated here): **New Caledonia. Prov. Sud:** escarpements du Cougui [Koghi], 400 m, s.d., *Pancher s.n.* (P [P00639149]!; isolecto-: M [M0225258] image seen; P [P00639148, P00639150, P00639151]!).

= *Cupaniopsis ganophloea* Radlk. in Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. Munich 9: 590. 1879. **Lectotypus** (designated here): **New Caledonia. Prov. Nord:** "Balade", 1855–1860, *Veillard 230* (P [P00639147]!; probable isolecto-: P [P05309776]!).

Distribution and ecology. – *Lepidocupania oedipoda* is restricted to Grande Terre, extending to the northwest in the Belep archipelago (Art Island); it grows in maquis vegetation, humid forests, gallery forests, and forest remnants, often along streams, usually on hills or mountainsides, on serpentine, greywacke and schist, from sea level to 850 m (Adema, 1991).

Notes. – Five syntypes were cited in the protologue of *Cupaniopsis oedipoda*: *Balansa 153* p.p., *1441* and *2257*, *Baudouin 354* p.p. and *Pancher s.n.* Adema (1991: 146) designated *Pancher s.n.* as the lectotype. Original material of this collection at P is, however, mounted on four sheets, necessitating a second step lectotypification. Here we designate the fruiting material with a note in Radlkofer's hand: "Cupaniopsis oedipoda m. Radlk." as the lectotype.

Cupaniopsis ganophloea was described based on four syntypes: *Labillardière s.n.*, *Pancher 777*, *Vieillard 227*, *230* and *231*. The most complete and best-preserved material bearing, in Radlkofer's hand, "Cupaniopsis ganophloea m. Radlk." is [P05309776]. This collection has no label data and could represent material of either *Veillard 230* or *231*. *Veillard 230* in P [P00639147] only has a few fruits with the note "Cupaniopsis ganophloea m. Radlk." in Radlkofer's hand. We prefer to designate the later sheet as lectotype and consider [P05309776] as a probable isolectotype.

Lepidocupania pennelii (Guillaumin) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis pennelii* Guillaumin in Bull. Soc. Bot. Fr. 79: 338. 1932.

Holotypus: New Caledonia. Prov. Sud: env. de Bourail, 8.II.1950, *Pennel 403* (P [P00639152]!; isolecto-: P [P00639153, P00639154]!).

Distribution and ecology. – *Lepidocupania pennelii* is endemic to Grande Terre, where it is restricted to the west-central coastal area between Bourail and Moindou, and one site along the east coast at the same latitude, around Saint Pol. It grows in forests on limestone, from 20 to 100 m in elevation (Adema, 1991).

Notes. – *Cupaniopsis pennelii* was described based on *Pennel 403*. Material of the collection at P is mounted on three sheets, but only one of them [P00639152] bears the name of Guillaumin's new species in his own hand, and we therefore regard it as the holotype.

Lepidocupania pennelii is morphologically similar to *L. globosa* and *L. rosea* (the latter known only from the type specimen), whose ecological preferences and distributions are nearly the same. They likely form a species complex and will require further taxonomic work.

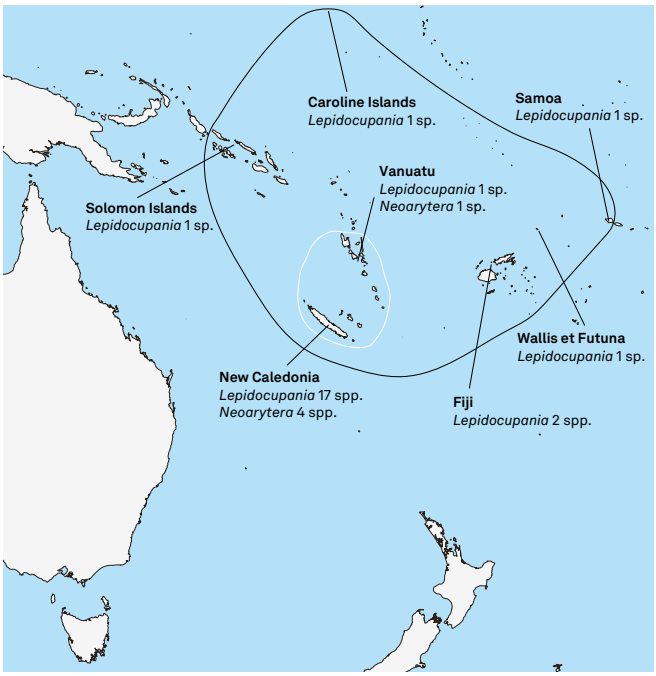

Fig. 4. – Distribution map of *Lepidocupania* Buerki, Callm., Munzinger & Lowry (black line) and *Neoarytera* Callm., Buerki, Munzinger & Lowry (white line) in the southern Pacific. [Oceania Region Map by Vemaps.com]

Lepidocupania rosea (Adema) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis rosea* Adema in Leiden Bot. Ser. 15: 159. 1991.

Holotypus: New Caledonia. Prov. Nord: 5 km E of Col de Crève-Coeur on road between Canala and Thio, c. 350 m, 27.IX.1979, *McPherson 1905* (L [L0013386]!; iso-: MO [MO260721]!, NOU [NOU006557]!, P [P05213006]!).

Distribution and ecology. – *Lepidocupania rosea* is only known from the type specimen, collected on Grande Terre, near Nakety, in a forest around 350 m.

Notes. – See note under *Lepidocupania pennelii.*

Lepidocupania samoensis (Christoph.) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis samoensis* Christoph. in Bernice P. Bishop Mus. Bull. 14: 154. 1938.

Holotypus: Samoa: Savai`i, above Matavanu, 14.VIII.1931, *Christophersen & Hume 2045* (BISH [BISH1004933] image seen; iso-: A [A00050711] image seen, BISH [BISH1004931, BISH1004932] images seen, K [K000701626]!, P [P00639282]!, UC [UC1352449] image seen, US [US00094201] image seen).

Distribution and ecology. – *Lepidocupania samoensis* is endemic to the two main islands of Samoa, Savai`i and Upolu, where it grows in primary evergreen forests between 650 to 1350 m (Adema, 1991).

Lepidocupania squamosa (Adema) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis squamosa* Adema in Bull. Mus. Natl. Hist. Nat., B, Adansonia, 10: 264. 1989.

Holotypus: New Caledonia. Prov. Nord: massif de la Tiébaghi, c. 550 m, 21.XII.1983, *McPherson 6176* (MO [MO 260720]!; iso-: L [L0013387]!, NOU [NOU006555]!, P [P00639157]!).

Distribution and ecology. – *Lepidocupania squamosa* is endemic to Grande Terre, where it grows in dense maquis-like scrub vegetation on serpentine, from 200 to 600 m (Adema, 1991, and recent collections) and on isolated ultramafic mountains of the northeast (Boulinda, Kopéto, Tiébaghi, and Poum).

Notes. – *Lepidocupania squamosa* was assigned an IUCN risk of extinction status of "Endangered" by Jaffré et al. (1998). Since this assessment was conducted, a large portion of the vegetation on the Tiébaghi massif has been cleared for mining, which has surely led to further population decline (especially concerning since this area contained the largest subpopulation of *L. squamosa*).

Lepidocupania subfalcata (Adema) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis subfalcata* Adema in Leiden Bot. Ser. 15: 172. 1991.

Holotypus: New Caledonia. Prov. Nord: summit plateau Mt. Koniambo, 800–900 m, 31.III.1956, *MacKee 4297* (L [L0013389]!; iso-: A [A00050713] image seen, K [K000701621]!, P [P05310065]!).

Distribution and ecology. – When Adema (1991) published his monograph of *Cupaniopsis*, this species was thought to be endemic to Grande Terre and was known only from the type collection from Mt. Koniambo, between 800–900 m. However, one year later, Adema identified a second specimen to this species (*Jaffré 2944*) in L [L.2296660] from the Mé Adéo road, about 100 km southeast of Koniambo.

Notes. – The holotype of this species was initially identified by Guillaumin as *C. sebertii* Guillaumin, a name considered a synonym of *C. fruticosa* (≡ *Lepidocupania fruticosa*) by Adema (1991). Our examination of the available herbarium material suggests that further taxonomic analysis is needed to clarify

species delimitations within this group, which probably represents a species complex.

Lepidocupania tontoutensis (Guillaumin) Buerki, Callm., Munzinger & Lowry, **comb. nov.**

≡ *Cupaniopsis tontoutensis* Guillaumin in Mém. Mus. Natl. Hist. Nat., Sér. B, Bot. 4: 19. 1953.

Holotypus: New Caledonia. Prov. Sud: cours moyen de la Tontouta, rive droite, c. 50 m, 14.I.1945, *Virot 1448* (P [P00639164]!; iso-: P [P00639165]!).

= *Cupaniopsis rotundifolia* Adema in Leiden Bot. Ser. 15: 160. 1991. **Holotypus: New Caledonia. Prov. Sud:** colline surplombant la Tontouta, 25.VIII.1984, *Jaffré 2531* (NOU [NOU006556]!; iso-: P [P00639156, P00639158]!), **syn. nov.**

Distribution and ecology. – *Lepidocupania tontoutensis* is endemic to Grande Terre, where it is restricted to the Tontouta River valley. It is found in maquis vegetation on serpentine substrate, mostly alluvium, between 20 and 100 m (Adema, 1991).

Notes. – *Cupaniopsis tontoutensis* was described based on *Virot 1448*. Original material at P is, however, mounted on two sheets, only one of which [P00639164] bears the name of Guillaumin's new species in his own hand, along with the word "type". We regard this specimen as the holotype.

Cupaniopsis rotundifolia Adema was only known from the type specimen from the Tontouta River valley, with ecological and edaphic preferences similar to those of *C. tontoutensis* (≡ *Lepidocupania tontoutensis*), as mentioned by Adema (1991: 161), who wrote: "Probably closely related to *C. fruticosa* and *C. tontoutensis*". *Cupaniopsis tontoutensis* was said to differ from *C. rotundifolia* by its fewer, wider leaflets with the secondary venation oriented at a wider angle to the midrib, and by the stiff trichomes on the endocarp of its fruits. However, several recent collections made in the lower Tontouta River valley as part of a study of rare species from this area (D'Angelo, 2017) show a perfect continuum in leaflet shape (as exemplified by *Lannuzel & D'Angelo 49* [MPU312290], *Lannuzel & D'Angelo 34* [MPU091683], and *Lannuzel & D'Angelo 39* [MPU312292]) and fruits (cf. *Lannuzel & D'Angelo 32* [MPU312293]), with leaves clearly corresponding to *L. tontoutensis* and the presence of stiff trichomes on the endocarp. We have therefore placed *C. rotundifolia* in synonymy under *L. tontoutensis*.

Description and synopsis of Neoarytera

Neoarytera Callm., Buerki, Munzinger & Lowry, **gen. nov.** (Fig. 3D–F).

Type: *Neoarytera chartacea* (Radlk.) Callm., Buerki, Munzinger & Lowry (≡ *Arytera chartacea* Radlk.).

= *Arytera* subsect. *Pacifica* H. Turner in Blumea, Suppl. 9: 151. 1995. **Type:** *Arytera collina* Pancher & Sebert (≡ *Neoarytera collina* (Pancher & Sebert) Callm., Buerki, Munzinger & Lowry).

Trees. Indument comprising short, straight, appressed trichomes; glandular scales absent; buds not "varnished". *Leaves* alternate, 1–4-jugate; leaflets opposite to subopposite, subsessile to petiolulate, margin entire. Inflorescences axillary or pseudo-terminal. *Flowers* actinomorphic, functionally unisexual; calyx 5-dentate, teeth equal; petals 5, with a distinct claw, scales minute, petal margin with minute enations; disc more or less distinctly five-lobed, rim subpilose; stamens (6–)8(–10), anthers basifixed; ovary (2–)3-locular. *Fruit* a capsule, with 1 or 2 well developed lobes, dehiscence loculicidal, central axis distinctly thickened, glabrous to puberulous and rugose to verrucose outside, pilose inside, calyx persistent; seed ellipsoid, sarcotesta covering all or sometimes only half of the seed (*N. neoebudensis*), fleshy-membranaceous, comprising a single layer. Radicle bearing trichomes, at least basally.

Distribution. – *Neoarytera* comprises four species, three endemic to New Caledonia and one occurring on both New Caledonia and Vanuatu (Fig. 4).

Notes. – *Neoarytera* is characterized by the distinctly thickened central axis of its fruit (vs. not thickened in *Arytera* and *Cupaniopsis*), petal scales comprising minute enations (vs. scales adnate to the margins of the petals or free from the petals in the other two genera), and its 3-, rarely 2-locular ovary and fruit (vs. ovary and fruit 2- or 3-locular in the two other genera). *Arytera*, as re-circumscribed here, can easily be distinguished by its 2-layered sarcotesta (vs. single-layer in *Cupaniopsis* and *Neoarytera*) (Turner, 1995: 72). Finally, *Cupaniopsis* differs from *Arytera* and *Neoarytera* by having free or nearly free calyx lobes, which are usually 2-seriate, orbicular, elliptic or obovate, and concave (vs. calyx shortly cupular, the lobes toothed or divided, and usually ovate in the other two genera) (Reynolds, 1985a).

Neoarytera chartacea (Radlk.) Callm., Buerki, Munzinger & Lowry, **comb. nov.** (Fig. 3F).

≡ *Arytera chartacea* Radlk. in Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9: 553. 1879.

Lectotypus (first step designated by Turner, 1995: 167; second step designated here): **Nouvelle-Calédonie. Prov. Sud:** Port des Français près de Nouméa, IX.1868, *Balansa 147* (P [P00639108]!; isolecto-: K [K000701499 K000701500]!, M [M0225350, M0225351] images seen, NY [NY00038711] image seen, P [P00639109, P00639110]!).

Distribution and ecology. – *Neoarytera chartacea* is endemic to the west coast of Grande Terre, where it grows in sclerophyll forest or various types of substrate, in particular limestone and serpentine (Turner, 1995).

Notes. – Three syntypes were cited in the protologue of *Arytera chartacea*: *Balansa 147*, *1442* and *Pancher 610*. Turner (1995: 167) designated *Balansa 147* as the lectotype. Original material at P is, however, mounted on three sheets, necessitating a second step lectotypification. Here we designate the most complete and best-preserved sheet [P00639108] as the lectotype.

Neoarytera collina (Pancher & Sebert) Callm., Buerki, Munzinger & Lowry, **comb. nov.** (Fig. 3D).

≡ *Cupania collina* Pancher & Sebert in Rev. Marit. Colon. 41: 205. 1874. ≡ *Arytera collina* (Pancher & Sebert) Radlk. in Not. Syst. (Paris) 2: 10. 1911.

Lectotypus (first step designated by Turner, 1995: 169; second step designated here): **New Caledonia:** *sine loco,* s.d., *Pancher [Bois] 79* (P [P00639111]!; isolecto-: P [P00639112, P05310137, P05310138]!).

= *Arytera pachyphylla* Radlk. in Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9: 554. 1879. **Lectotypus** (designated here): **New Caledonia. Prov. Sud:** "environs de Nouméa, Pont des Français", 1861–1867, *Deplanche 280 [Vieillard 2391]* (P [P06598871]!; isolecto-: K [K000701502]!, G [G00341933, G00341934]!, P [P05310258, P05310262, P06598866, P06598867, P06598869, P06598870, P06599102]!).

Distribution and ecology. – *Neoarytera collina* is endemic to New Caledonia, where it occurs on the southwestern coast of Grande Terre, Ile des Pins, and Maré Island in the Loyalties. It grows in sclerophyll forest on various types of substrate, in particular limestone and serpentine (Turner, 1995).

Notes. – Turner (1995: 169) designated *Pancher [Bois] 79* as the lectotype, since it was cited by Pancher & Sebert (1874: 270) as material associated to *Cupania collina* when they described it in their *Notice sur les bois de la Nouvelle Calédonie*. Original material at P is mounted on four sheets, necessitating a second step lectotypification, for which we have here chosen the most complete and best-preserved sheet [P00639111].

Six syntypes were cited in the protologue of *Arytera pachyphylla*: *Balansa 148*, *Baudouin 690*, *Deplanche 280*, *447*, *Pancher [Mus. Néocal.] 215, 778* and *Vieillard 247*. Turner (1995: 169) cited only two of these syntypes, *Baudouin 690* and *Deplanche 280*. Original material of these two collections at P is, however, mounted on three sheets, from among which we designate the most complete and best-preserved collection of *Deplanche 280* as the lectotype [P06598871].

Neoarytera nekorensis (H. Turner) Callm., Buerki, Munzinger & Lowry, **comb. nov.**

≡ *Arytera nekorensis* H. Turner in Blumea, Suppl. 9: 199. 1995.

Holotypus: New Caledonia. Prov. Nord: Poya, forêt de Nekoro, 16.VIII.1984, *MacKee 42137* (L [L0013337]!; iso-: P [P00078650, P00078651]!).

Distribution and ecology. – *Neoarytera nekorensis* is endemic to the Nekoro forest in the centre-west region of Grande Terre, where it grows in sclerophyll forest on black clay soil (Turner, 1995).

Notes. – This species has been assigned an IUCN risk of extinction status of "Vulnerable" (IUCN, 2020).

Neoarytera neoebudensis (Guillaumin) Callm., Buerki, Munzinger & Lowry, **comb. nov.** (Fig. 3E).

≡ *Cupaniopsis neoebudensis* Guillaumin in J. Arnold Arbor. 12: 241. 1931. ≡ *Arytera neoebudensis* (Guillaumin) H. Turner in Blumea 9: 200. 1995.

Holotypus: Vanuatu. Prov. Taféa: Erromango Isl., Dillon Bay, 8.VI.1928, *Kajewski 381* (A; iso-: BISH, BRI [BRI-AQ0031093]!, K [K000701498]!, NY, P [P00639281]!).

Distribution and ecology. – *Neoarytera neoebudensis*, as currently circumscribed, occurs in New Caledonia (Grande Terre and the Loyalty islands), Walpole Island, and Vanuatu. It grows on rocky slopes near lagoons and in lowland evergreen forests on volcanic soils (Turner, 1995).

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Bibliography

Adema, F. (1991). Cupaniopsis Radlk. (Sapindaceae): a monograph. *Leiden Bot. Ser*. 15.

Adema, F., P.W. Leenhouts & P.C. van Welzen (1994). Sapindaceae. *Fl. Malesiana* ser. 1, 11(3).

Blume, C.L. (1849). Arytera. *Rumphia* 3: 169–171.

Bouchet, P., T. Jaffré & J.M. Veillon (1995). Plant extinction in New Caledonia: protection of sclerophyll forests urgently needed. *Biodivers. Conserv.* 4: 415–428.

Buerki, S., F. Forest, P. Acevedo-Rodríguez, M.W. Callmander, J.A.A. Nylander, M. Harrington, I. Sanmartín, P. Küpfer & N. Alvarez (2009). Plastid and nuclear DNA markers reveal intricate relationships at subfamilial and tribal levels in the soapberry family (Sapindaceae). *Molec. Phylogenet. Evol.* 51: 238–258.

Buerki, S., P.P. Lowry II, N. Alvarez, S.G. Razafimandimbison, P. Küpfer & M.W. Callmander (2010). Phylogeny and circumscription of Sapindaceae revisited: molecular sequence data, morphology and biogeography support recognition of a new family, Xanthoceraceae. *Pl. Ecol. Evol.* 143: 148–161.

Buerki, S., F. Forest, M.W. Callmander, P.P. Lowry II, D.S. Devey & J. Munzinger (2012). Phylogenetic inference of New Caledonian lineages of Sapindaceae: molecular evidence requires a reassessment of generic circumscriptions. *Taxon* 61: 109–119.

Butaud, J.-F. (2014). *Flore des îles Loyauté (Nouvelle-Calédonie): plantes patrimoniales, plantes envahissantes et espaces naturels remarquables*. Rapport Conservation International, Nouméa & Province des Iles Loyauté, Lifou.

Callmander, M.W., O.D. Durbin, H.W. Lack, P. Bungener, P. Martin & L. Gautier (2017). Etienne-Pierre Ventenat (1757–1808) and the gardens of Cels and Empress Joséphine. *Candollea* 72: 87–132.

Callmander, M.W., A.J. Ford & S. Buerki (2020). New combinations for two species in the genus Synima (Sapindaceae, Cupanieae) from Queensland (Australia). *Candollea* 75: 241–244.

D'Angelo, S. (2017). *Ecologie et conservation de trois espèces rares et menacées de Nouvelle-Calédonie*. Mémoire de Master. Université de Lorraine-UMR ECOFOG, Kourou & IAC, Païta.

Forster, P.I. (2006). Synima reynoldsiae P.I. Forst. (Sapindaceae), a new species from the 'Wet Tropics' of north-east Queensland. *Austrobaileya* 7: 285–291.

Guillaumin, A. (1948). Sapindacées. *Flore analytique et synoptique de la Nouvelle-Calédonie, phanérogames*: 197–202. Office de la Recherche Scientifique Coloniale, Paris.

Harrington, M.G., K.J. Edwards, S.A. Johnson, M.W. Chase & P.A. Gadek (2005). Phylogenetic inference in Sapindaceae sensu lato using plastid matK and rbcL DNA sequences. *Syst. Bot.* 30: 366–382.

IUCN (2020). *The IUCN Red List of threatened species*. [https://www.iucnredlist.org]

Jaffré, T., P. Bouchet & J.M. Veillon (1998). Threatened plants of New Caledonia: is the system of protected areas adequate? *Biodivers. Conserv.* 7: 109–135.

McCoy, S.G., T. Jaffré, F. Rigault & J.E. Ash (1999). Fire and succession in the ultramafic maquis of New Caledonia. *J. Biogeog.* 26: 579–594.

Munzinger, J., M. Pignal & D. Bruy (2018). Flore & végétation du Katalupaik. *In:* Pascal, O. (ed.), *La Planète Revisitée, Nouvelle-Calédonie 2016–18, Volet «Forêt» 2017 en province Nord. Rapport d'étape* 1: 6–16. ProNatura, MNHN, Paris.

Pancher, J.A.I. & H. Sebert (1874). *Notice sur les bois de la Nouvelle Calédonie.* Paris.

Radlkofer, L. (1879a). Ueber die Sapindaceen Holländisch-Indiens. *Actes du congrès international de botanistes, d'horticulteurs, de négociants et de fabricants de produits du règne végétal tenu à Amsterdam 1877*: 70–133, 216–254. A. W. Sijthoff, Leide.

Radlkofer, L. (1879b). Ueber Cupania und damit verwandte Pflanzen. *Sitzungsber. Math.-Phys. Cl. Konigl. Bayer. Akad. Wiss. München* 9: 457–678.

Radlkofer, L. (1931–1934). Sapindaceae. *In:* Engler, A. (ed.), *Das Pflanzenreich* 98a-h. W. Engelmann, Leipzig.

Reynolds, S.T. (1982). Notes on Sapindaceae II. *Austrobaileya* 1: 472–496.

Reynolds, S.T. (1984). Notes on Sapindaceae III. *Austrobaileya* 2: 29–64.

Reynolds, S.T. (1985a). Notes on Sapindaceae IV. *Austrobaileya* 2: 153–189.

Reynolds, S.T. (1985b). Sapindaceae. *In:* George, A.S. (ed.), *Fl. Australia* 25: 4–215.

Schot, A. (1991). The two New Guinea species of Lepiderema Radlk. (Sapindaceae). *Blumea* 36: 235–238.

Smith, A.C. (1985). *Flora vitiensis nova* 3. Pacific Tropical Garden, Kauai.

Turner, H. (1995). Cladistic and biogeographic analyses of Arytera Blume and Mischarytera gen. nov. (Sapindaceae) with notes on methodology and a full taxonomic revision. *Blumea, Suppl.* 9.

Appendix – Synopsis of accepted species of *Arytera* Blume, *Cupaniopsis* Radlk., *Lepidocupania* Buerki, Callm., Munzinger & Lowry, and *Neoarytera* Callm., Buerki, Munzinger & Lowry, with their respective distributions.

Genus	Species	Distribution
Arytera Blume		
	A. bifoliolata S.T. Reynolds	Indonesia (Western New Guinea), Australia
	A. brachyphylla Radlk.	Papua New Guinea
	A. densiflora Radlk.	Papua New Guinea
	A. dictyoneura S.T. Reynolds	Australia
	A. distylis (Benth.) Radlk.	Australia
	A. divaricata F. Muell.	Australia
	A. foveoleata F. Muell.	Australia
	A. lineosquamulata H.Turner	Papua New Guinea, Australia
	A. litoralis Blume	From India across SE Asia throughout Malesia up to the Solomon Islands
	A. microphylla (Benth.) Radlk.	Australia
	A. miniata H.Turner	Papua New Guinea
	A. morobeana H.Turner	Papua New Guinea
	A. multijuga H.Turner	Papua New Guinea
	A. musca H.Turner	Papua New Guinea
	A. novaebrittanniae H.Turner	Papua New Guinea, Solomon Islands
	A. pauciflora S.T. Reynolds	Australia
	A. pseudofoveolata H.Turner	Papua New Guinea, Australia
Cupaniopsis Radlk.		
	C. acuticarpa Adema	Papua New Guinea
	C. amoena A.C. Sm.	Fiji
	C. anacardioides (A.Rich.) Radlk.	Indonesia (Western New Guinea), Papua New Guinea, Australia
	C. apiocarpa Radlk.	New Caledonia
	C. azantha Radlk.	New Caledonia
	C. baileyana Radlk.	Australia
	C. bilocularis Adema	Papua New Guinea
	C. bullata Adema	Papua New Guinea
	C. celebica Adema	Indonesia (Sulawesi)
	C. chytradenya Radlk.	New Caledonia
	C. cooperorum P.I. Forst.	Australia
	C. crassivalvis Radlk.	New Caledonia
	C. curvidens Radlk.	Indonesia (Western New Guinea), Papua New Guinea
	C. dallachyi S.T. Reynolds	Australia
	C. diploglottoides Adema	Australia
	C. euneura Adema	Papua New Guinea
	C. flagelliformis Radlk.	Australia
	C. fleckeri S.T. Reynolds	Australia
	C. foveolata Radlk.	Australia
	C. grisea Adema	New Caledonia
	C. hypodermatica Radlk.	New Caledonia
	C. kajewskii Merr. & L.M. Perry	Papua New Guinea, Solomon Islands
	C. leptobotrys Radlk.	Vanuatu, Fiji
	C. mackeeana Adema	New Caledonia
	C. macrocarpa Radlk.	New Caledonia

Genus	Species	Distribution
	C. macropetala Radlk.	Indonesia (Western New Guinea), Papua New Guinea
	C. megalocarpa Adema	New Caledonia
	C. napaensis Adema	Papua New Guinea
	C. newmanii S.T. Reynolds	Australia
	C. petiolulata Radlk.	New Caledonia
	C. phalacrocarpa Adema	New Caledonia
	C. phanerophlebia Merr. & L.M. Perry	Papua New Guinea
	C. platycarpa Radlk.	Indonesia (Western New Guinea), Papua New Guinea
	C. rhytodocarpa Adema	Papua New Guinea
	C. serrata Radlk.	Australia
	C. shirleyana Radlk.	Australia
	C. stenopetala Radlk.	Indonesia (Moluccas), Papua New Guinea
	C. strigosa Adema	Indonesia (Sulawesi)
	C. sylvatica Guillaumin	New Caledonia
	C. tomentella (F.Muell. ex Benth.) S.T. Reynolds	Australia
	C. trigonocarpa Radlk.	New Caledonia
	C. vitiensis Radlk.	Fiji
	C. wadsworthii Radlk.	Australia
Lepidocupania Buerki et al.		
	L. arcuata (Radlk.) Buerki et al.	New Caledonia
	L. brackenridgei (A. Gray) Buerki et al.	Vanuatu, Fiji, Wallis et Futuna, Samoa, Solomon Islands
	L. concolor (Gillespie) Buerki et al.	Fiji
	L. fruticosa (Radlk.) Buerki et al.	New Caledonia
	L. glabra (Adema) Buerki et al.	New Caledonia
	L. globosa (Adema) Buerki et al.	New Caledonia
	L. glomeriflora (Radlk.) Buerki et al.	New Caledonia
	L. gracilipes (Radlk.) Buerki et al.	New Caledonia
	L. grandiflora (Adema) Buerki et al.	New Caledonia
	L. guillauminii (Kaneh.) Buerki et al.	Caroline Islands
	L. inoplea (Radlk.) Buerki et al.	New Caledonia
	L. lepidota (Radlk.) Buerki et al.	New Caledonia
	L. mouana (Guillaumin) Buerki et al.	New Caledonia
	L. myrmoctona (Radlk.) Buerki et al.	New Caledonia
	L. oedipoda (Radlk.) Buerki et al.	New Caledonia
	L. pennelii (Guillaumin) Buerki et al.	New Caledonia
	L. rosea (Adema) Buerki et al.	New Caledonia
	L. samoensis (Christoph.) Buerki et al.	Samoa
	L. squamosa (Adema) Buerki et al.	New Caledonia
	L. subfalcata (Adema) Buerki et al.	New Caledonia
	L. tontoutensis (Guillaumin) Buerki et al.	New Caledonia
Neoarytera Callm. et al.		
	N. chartacea (Radlk.) Callm. et al.	New Caledonia
	N. collina (Pancher & Sebert) Callm. et al.	New Caledonia
	N. nekorensis (H. Turner) Callm. et al.	New Caledonia
	N. neoebudensis (Guillaumin) Callm. et al	New Caledonia, Vanuatu