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Novitates neocaledonicae. XIII. Taxonomy and nomenclature of the genus *Xyris* (Xyridaceae, Poales) in New Caledonia, with description of a new species

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Abstract

Three endemic species of *Xyris* (Xyridaceae, Poales) are currently recognized in New Caledonia. A recent multivariate analysis of 18 morphological characters based on 129 specimens of *Xyris* from New Caledonia, supported by 10 anatomical and micromorphological observations, suggested that three species should be recognized in the New Caledonian archipelago. However, the three published names did not correspond to the three entities identified via the multivariate analyses. The results showed that *Xyris neocaledonia* Rendle was morphologically distinct but requires lectotypification, *Xyris guillauminii* Conert was indistinct from *X. pancheri* Rendle, and that a new morphologically distinct species required description. We therefore propose to clarify the taxonomy of the genus for New Caledonia, by designating a lectotype, making this synonymy and describing the new species. The new species, *Xyris desquamatus* J.R.Morel & Munzinger, *sp. nov.*, has the remarkable feature of leaves that are shed as the plant senesces, and is reflected in the specific epithet for this new species. Line drawings are provided for the new species, along with colour photos for the three New Caledonian *Xyris* species and a distribution map. Three identification keys are provided, the first based on vegetative characters, the second on reproductive characters and the third on anatomical features of the leaf. *Xyris desquamatus* is preliminarily assigned an IUCN risk of extinction assessment of vulnerable.

Keywords: Taxonomy, anatomy, Flora of New Caledonia, lectotype, conservation

Introduction

The flora of New Caledonia remains incompletely known, and since 2000, one new species is described per month (Gâteblé *et al.* 2018). Six years ago, the second author started the *Novitates neocaledonicae* series (Munzinger 2015), which aims to describe new species from the territory in a standardised way, including an illustration, a distribution map and a preliminary assessment according to IUCN criteria.

The family Xyridaceae (Poales), the yellow-eyed grasses, comprises 420 species of which 95% are represented by the genus *Xyris* L., which is mainly distributed in subtropical regions (Campbell 2005; Remizowa *et al.* 2012; Wanderley and Campbell 2018). New species of *Xyris* continue to be described, as recently in Brazil (Wanderley and Mota 2015; Lozano *et al.* 2016; Wanderley and Campbell 2018). In New Caledonia, the genus is only known from the ultramafic massif of southern Grande-Terre, and three species of *Xyris* have been described, *X. neocaledonica* Rendle (1899: 507), *X. pancheri* Rendle (1899: 507), and more recently *X. guillauminii* Conert (1965: 185), all of which are considered endemic to the territory (Morat *et al.* 2012; Munzinger *et al.* 2020). All New Caledonian species of *Xyris* have a trilocular ovary with axile placentation, thus they belong to the sect. *Pomatoxyris* (Morel *et al.* 2021), which until now was considered endemic to Australia (Conn and Doust 1997; Doust and Conn 1994).

From a conservation point of view, *X. guillauminii* was suggested to be considered as Vulnerable, according to IUCN criteria, by Jaffré *et al.* (1998), a status not currently retained by the IUCN Red List, while *Xyris pancheri* is currently considered endangered (Quiton Tuijelaars 2013) and is protected in the South Province of New Caledonia (Anonymous 2020). However, no specimens of *X. guillauminii* have been reported from P or L, although some type material was present in both herbaria. In addition, most material was unidentified at the species-level in international

herbaria (up to 45% for the NOU herbarium, 37% in P herbarium), as the family has not yet been studied within the framework of the Flore de la Nouvelle-Calédonie. A revision of this genus was necessary, and could have important consequences in terms of conservation.

We published previously a taxonomic study about Xyridaceae from New Caledonia (Morel *et al.* 2021), realized on 129 specimens from five different herbaria (BM, L, NOU, MPU, P; Acronyms following Thiers (2021)) including all types. The multivariate morphometric analysis was conducted on 19 morphological characters and was supported by 10 independent anatomical and micromorphological characters. In particular, this study showed 1) that *Xyris neocaledonia* was morphologically distinct but requires lectotypification, 2) demonstrated that *X. guillauminii* and *X. pancheri* were not morphologically distinct and should be placed in synonymy, and 3) revealed a yet undescribed species. As a consequence of this previous article, we present here the description, illustration and preliminary conservation status of the new species, the geographical distribution of the three species, we formally synonymize *X. guillauminii* with *X. pancheri*, and we select a lectotype for *X. neocaledonica*. Finally, three identification keys are provided, the first based on vegetative characters, the second on reproductive characters and the third on anatomical features of the leaf.

Material and methods

All material of *Xyris* collected in New Caledonia from NOU, MPU, and P was studied. Scans of specimens at BM, K, L, and Z have been observed via their websites, respectively <https://data.nhm.ac.uk/dataset/collection-specimens>, <https://apps.kew.org/herbcat/navigator.do>, <https://bioportal.naturalis.nl> and <https://www.herbarien.uzh.ch/en.html>. Online herbarium databases are fundamental to research in systematics (James *et al.* 2017; Kovtonyuk *et al.* 2019) and have a key role in many taxonomic revisions (e.g. Bongcheewin *et al.* 2019; Goncalves *et al.* 2019). Scans of the HO, CANB and NSW specimens were received directly by email upon request. Morphological descriptions were prepared using standard terminology from Harris and Harris (2001). Measurements of leaves, stipes and spikes are taken from the data of the previous morphometric study (see Morel *et al.* 2021), either by direct measurement on herbarium specimens from MPU, NOU and P or using the software ImageJ (1.0) (Schneider *et al.* 2012) for specimens used by Conert at L and the type of *Xyris pancheri* at BM. Measurements on floral elements and seeds were made on rehydrated specimens. The measurements from Morel *et al.* (2021) are given as follows: (Minimum–) First Quartile–Third Quartile (–Maximum). The drawings of flowers of *Xyris desquamatus* are based on photographs of rehydrated herbarium specimens and *in vivo* specimens (photos taken by Gildas Gâteblé and Guillaume Lannuzel). Herbarium samples were rehydrated in a container filled with water and placed in an oven at 60°C for 24 hours, then placed into 70% ethanol.

When geo-coordinates were not indicated on original labels of herbarium specimens, they were calculated post-facto using MacKee's gazetteer (available at <http://phanero.novcal.free.fr>, last consulted on 17th November, 2020) and are provided in square brackets. The year of the Raoul s.n. collection was also interpreted, using Morat's (2010) review of collectors in New Caledonia.

We applied the IUCN Red List Categories and Criteria (IUCN 2012; IUCN Standards and Petitions Subcommittee 2019) to assess the risk of extinction of each species. We calculated EOO and AOO (with a 2 × 2 km grid) using the online “geocat” software (<http://geocat.kew.org>; Bachman *et al.* 2011).

Taxonomy

Xyris desquamatus J.R. Morel & Munzinger, *sp. nov.* (Figs. 1, 2)

Type:—NEW CALEDONIA. Southern end of plaine des lacs, road le Carénage, elev. 150 m, 20 August 1956, *H.S. MacKee 5056* (holotype: P! [P01760130], isotypes: L [L1430190] (image seen), K [K000481266] (image seen)).

Diagnosis—Differs from *X. pancheri* in having junciform and terete leaves (13–50 x 0.1–0.3 cm) (versus linear and elliptic in cross-section), which peel away and become ribbed at senescence (versus remain entire), staminodes reduced to filaments (versus staminodes developed and densely feathery), presence of palisade parenchyma and collenchyma (versus absence) and a thickening of the medullary parenchyma (versus no thickening) before its disintegration to form a thatch.

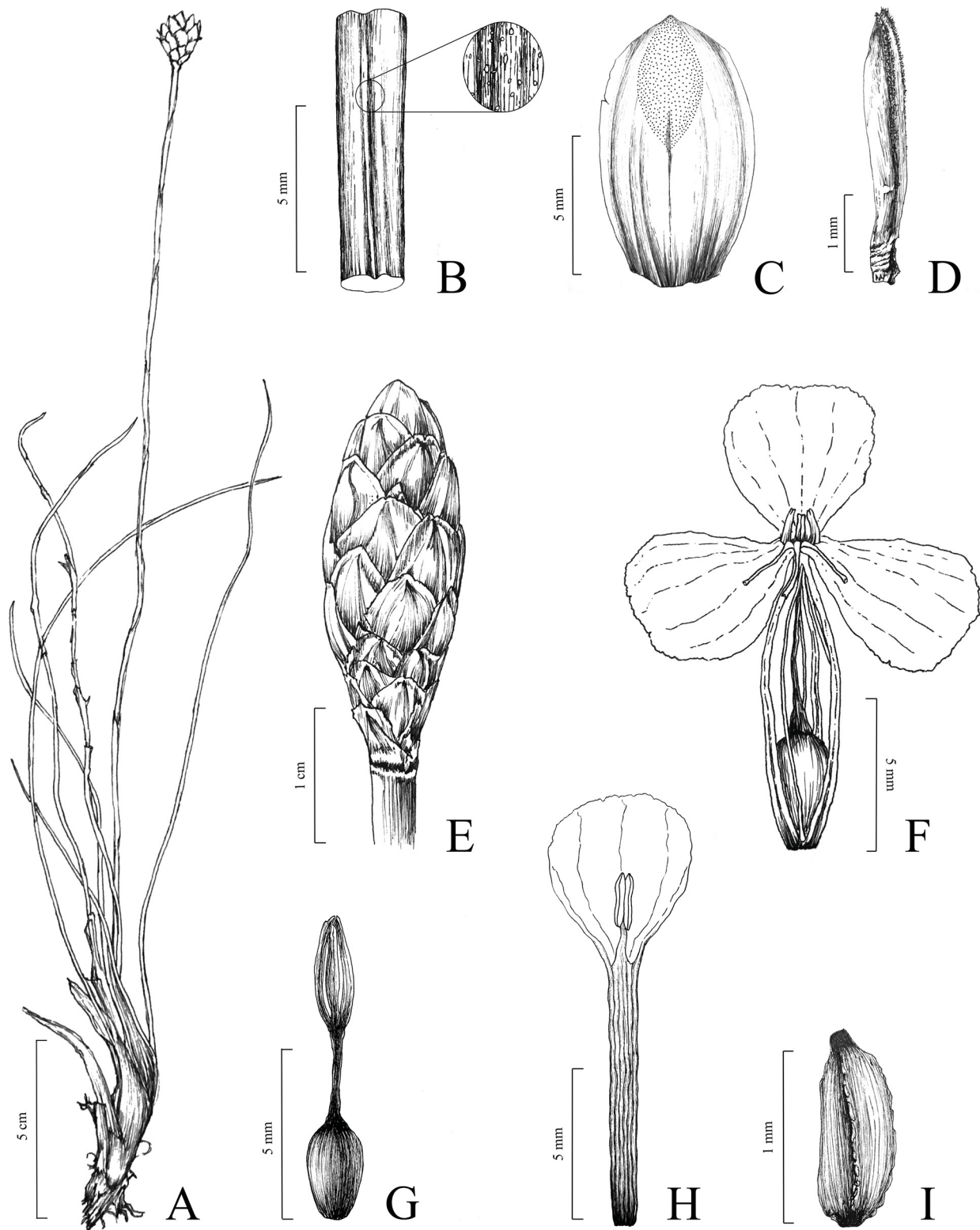


FIGURE 1.—*Xyris desquamatus* J.R.Morel & Munzinger, **A** Habit (*MacKee 5056*, holotype [P01760130]) **B** Leaf tip with details of the surface (*Balansa 665*) **C** Fertile bract, dorsal view (*Dagostini & Rigault 544*) **D** Sepal (*MacKee 42273*) **E** Spike (Based on a picture in the field of the collection *Gâteblé et al. 1070*) **F** Flower (*Dagostini & Rigault 544*) **G** Gynoecium (*Dagostini & Rigault 544*) **H** Petal and stamen (*Dagostini & Rigault 544*) **I** Seed (*Dagostini & Rigault 544*). Drawings by Jérémie Morel.

Perennial herbs, scapose and cespitose, clumps to 30 cm square. Leaves (12.7–)23.6–36.5(–50.4) cm long, spiral, erect, twisted, green, glabrous, sheaths 5.4–10 × 0.7–1 cm, widely dilated towards the base, dark and glossy brown,

smooth, margin brown-hyaline to golden, glabrous, blade junciform, terete, highly variable in length, from 0.3 to 41 cm long \times (1–)1.8–2.1(–2.9) mm in diameter. Ligule absent. Peduncle erect, twisted, elliptic in cross-section, smooth, green, glabrous, (26.4–)30.6–53.6(–83.4) cm long, (1.5–)1.7–2.1(–3.5) mm in diameter. Leaves and peduncles brownish at senescence, then peel away (corresponding to epiderm, palissade parenchyma and collenchyma) and become ribbed (corresponding to prominence of vascular bundles). Spikes (8.3–)14.2–18.1(–41) \times (5.6–)10.7–13.6(–18) mm, with few flowers, ellipsoid to ovoid. Basal sterile bracts 2–3 \times 2 mm, ovate, ecarinate, forming a continuum with fertile bracts 10–13 \times 5.6–6.7 mm, yellowish, oblong, slightly curved, bordered by a translucent membranous margin, carinate apically, apex rounded (difficult to see on isolated and dehydrated bracts), glabrous, distinct reddish triangular dorsal region *in vivo* (absent on herbarium specimens) with some ornaments, each ornament white and circular, (0.3–)0.4–0.45(–0.5) mm in diameter. Flowers with lateral sepals 6.3–8.2 \times 0.9–1.1 mm, brown adaxially, included, bordered with translucent yellowish margins, two dark brown dorsal longitudinal lines topped with gradually attenuating brownish trichomes, free, equal and linear. Petals yellow, glabrous, clawed, 14–16 mm long, lobes 4.7–6.2 \times 3.8–4 mm, obovate, margins crenate. Androecium yellow, glabrous, anthers linear, 2.3–2.7 mm long, pressed against the blades of the petals and barely protrude, filaments adnate along the entire length of the claw, free for 1.4–1.7 mm long, staminodes reduced to filaments. Gynoecium yellow, glabrous, style 5–5.5 mm long, branches ca. 2.5 mm long, stigma dilated at the apex. Ovary obovoid, glabrous, 2–4 mm long, ca. 1 mm in diameter, glabrous, brownish, trilobular, axile placentation. Capsule globose, 4.5 \times 2–3 mm, brown. Seeds ellipsoid, sometimes prismatic, 1–1.3 \times 0.4–0.6 mm, brownish with irregular protuberances.

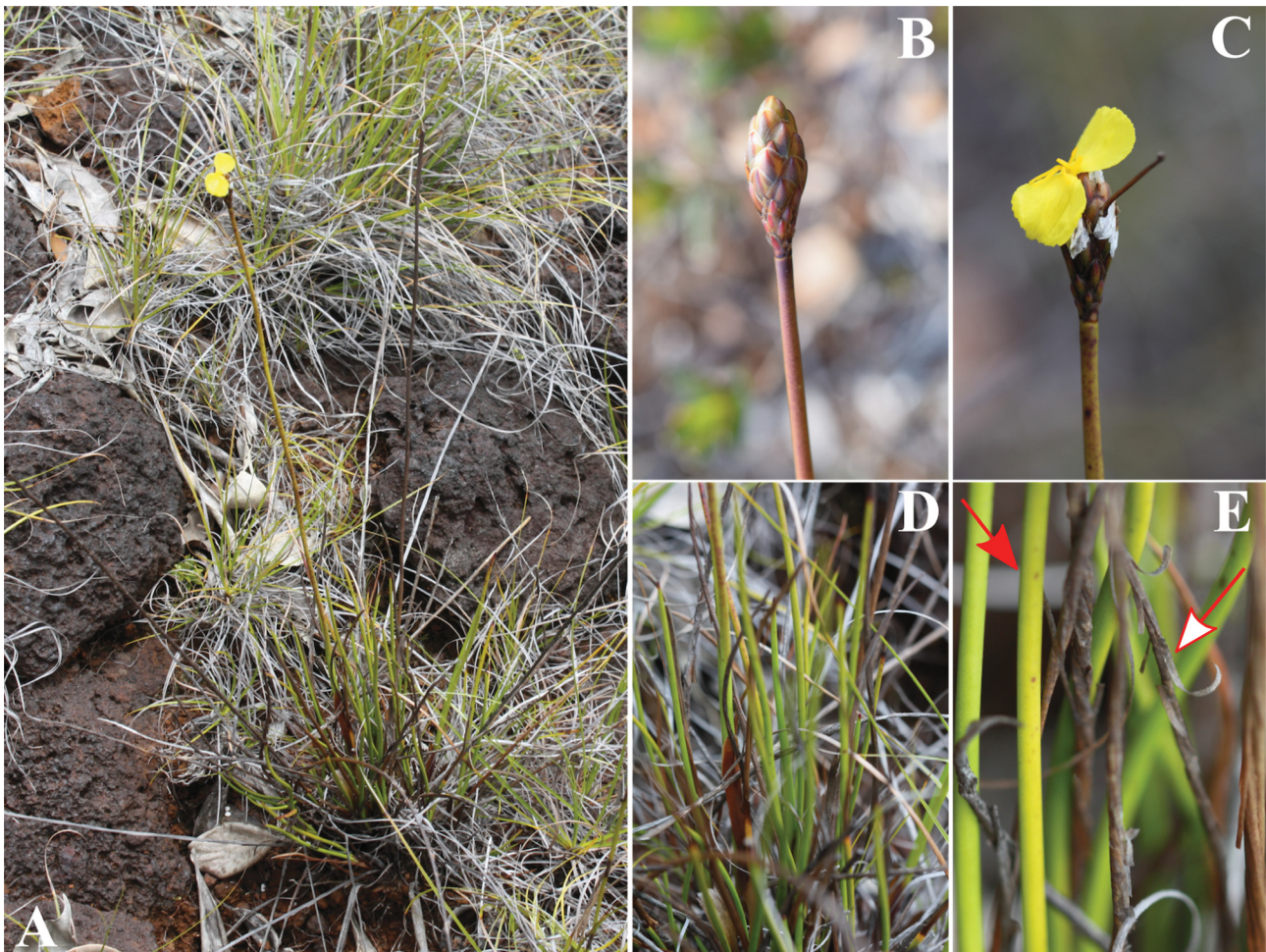


FIGURE 2.—*Xyris desquamatus* A Habit *in situ* B Spike C Spike with a flower in lateral view D Junciform leaves E Focus on junciform (red arrow) and desquamating leaves (red and white arrow). (Same population as Gâteblé *et al.* 1070 & 1071). Photos by Gildas Gâteblé (A–E).

Anatomy:—Anatomically (Fig. 3), the leaves differ from the other two species present in New Caledonia by a strong cutinization inward the epidermal cells, presence of a palissade parenchyma, collenchyma and a progressive thickening of the medullary parenchyma (pith) prior to its disintegration, what create a thatch.

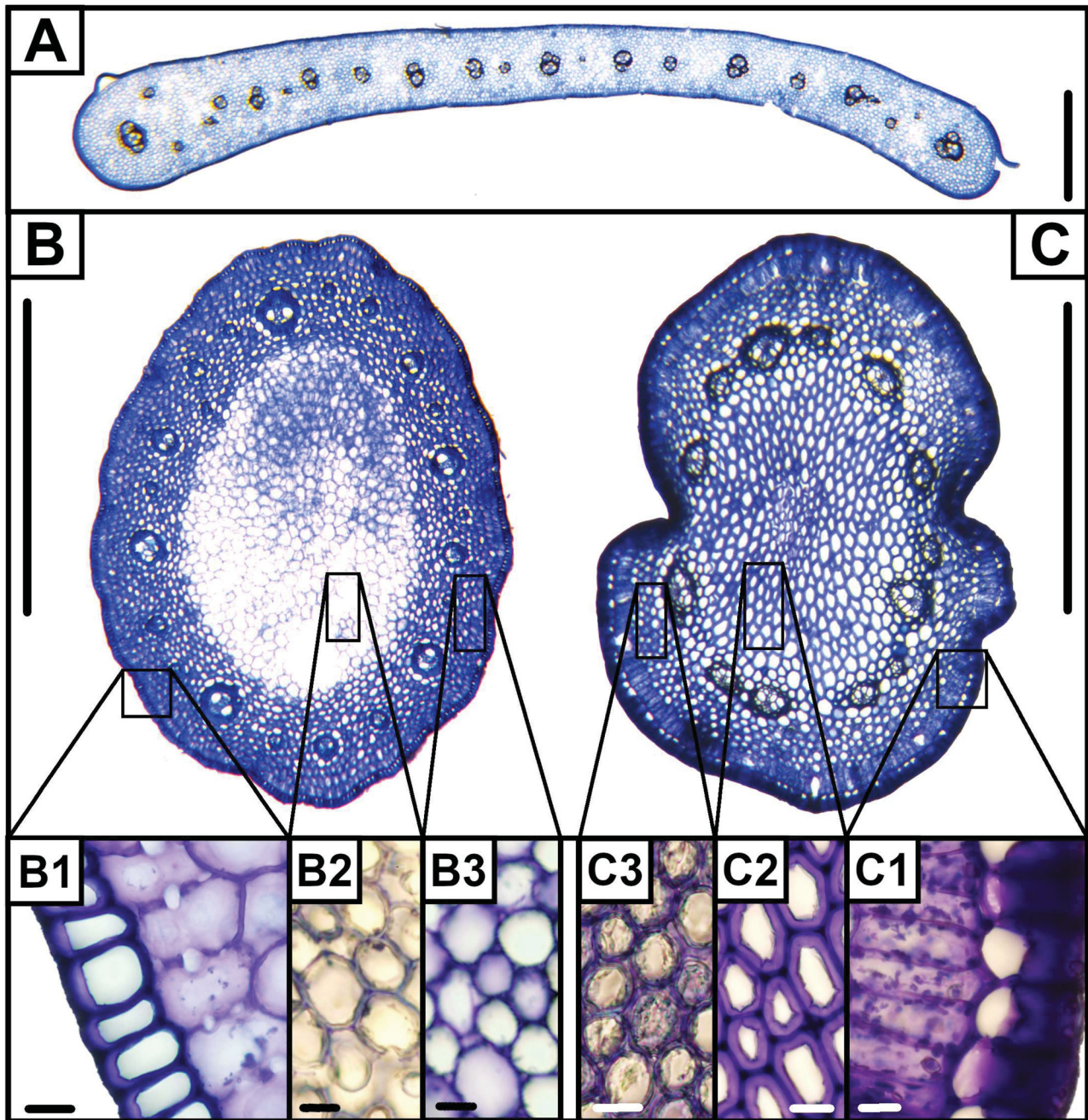


FIGURE 3.—Comparison of anatomical characters of the three species of *Xyris* of New Caledonia. Transversal cross sections of leaves (A–C, scale bars = 1000 μ m), epidermis with cortical parenchyma (B1) and epidermis with palisade parenchyma (C1), medullary parenchyma (B2 & C2), cortical parenchyma (B3) and cortical collenchyma (C3), scale bars = 20 μ m. **A** *Xyris neocaledonica* [NOU046858] **B** *Xyris pancheri* [P01766981] **C** *Xyris desquamatus* [P01766983] **B1** *X. pancheri* [NOU04838] **B2** *X. pancheri* [P01767050] **B3** *X. pancheri* [NOU021191] **C1** *X. desquamatus* [NOU046832] **C2** *X. desquamatus* [P01760139] **C3** *X. desquamatus* [P01766983].

Distribution and Ecology:—*Xyris desquamatus* is restricted to the southern province of New Caledonia, on ultramafic substrates (ironcrust, peridotites, lateritic alluviums or colluviums), over an altitude ranging from 150 to 550 m (Fig. 4). It is present in tufts scattered in open swampy vegetation with Cyperaceae and Juncaceae (*MacKee 5056*, *Brown 92/231*), very open dry maquis (*MacKee 43247*), hydromorphic maquis (*Dagostini 1343*), riparian maquis (*Dagostini & Rigault 544*) or river bank, amongst gymnosperms and stunted maquis vegetation with epacrids and *Acacia* (*Brown 92/210*). The population found at the highest altitude (540–550 m, *Gâteblé et al. 1070 & 1071*) was found in a scrubland resembling high altitude maquis (Gâteblé pers. comm.).

Photos of the plant in the field seem to show that the stigmas are mature while the stamens are not yet at anthesis, suggesting that the species may be protogynous.

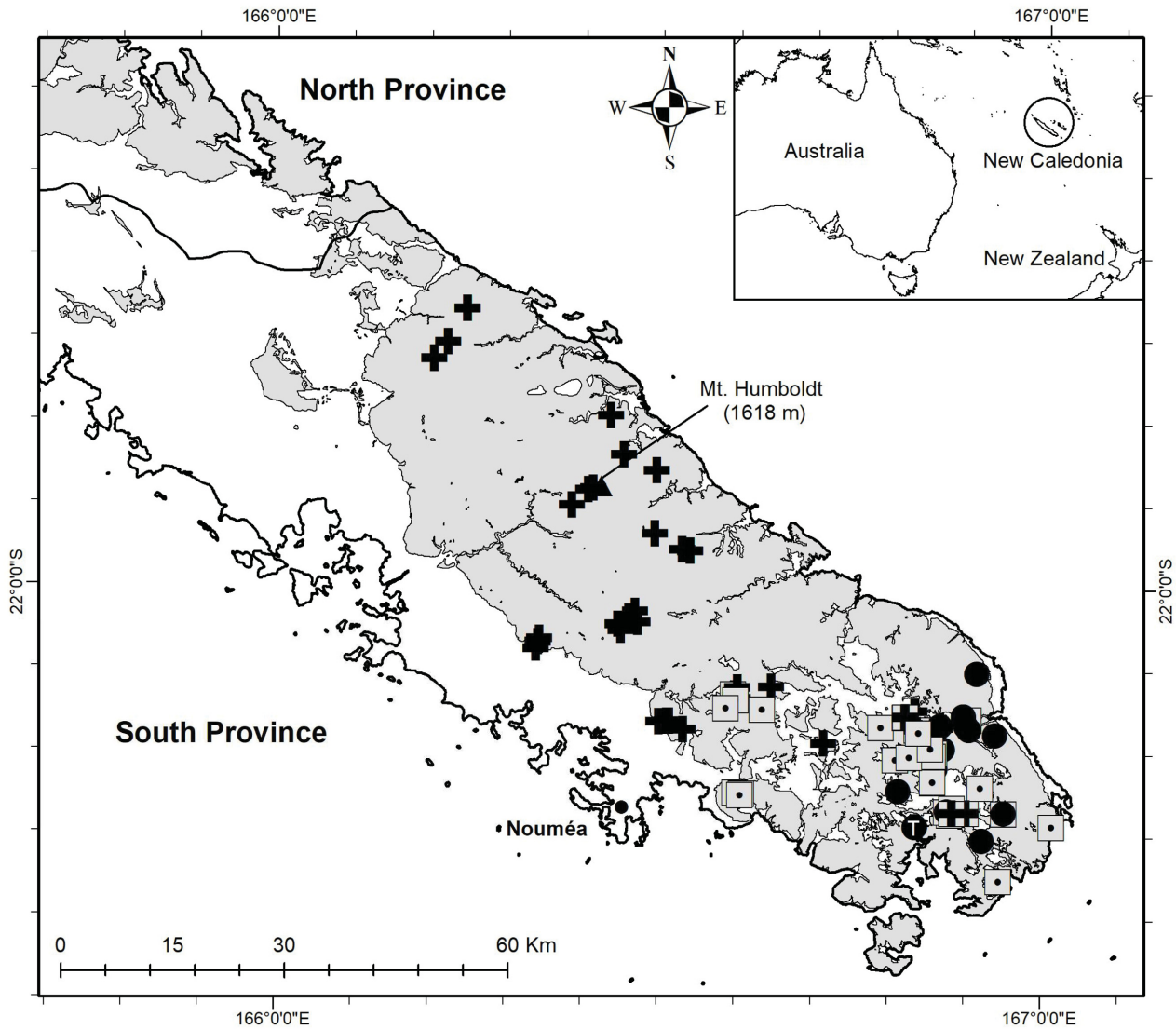


FIGURE 4.—Distribution of *Xyris* on Grande Terre, New Caledonia based on herbarium specimens. *X. desquamatus* (black dots, type specimen indicated with a “T”), *X. neocaledonica* (black crosses), *X. pancheri* (dark grey squares with a black dot).



FIGURE 5.—Comparison between flowers of the three species of *Xyris* of New Caledonia. **A** *X. desquamatus* (same population as Gâteblé *et al.* 1070 & 1071) **B** *X. pancheri* (Gâteblé 999) **C** *X. neocaledonica* (Munzinger *et al.* 7689). Photos by Gildas Gâteblé (A–B) and Jérôme Munzinger (C).

Etymology:—The epithet *desquamatus* refers to the peeling of leaves and stipes at senescence.

Discussion:—Conert (1965) confused *Xyris desquamatus* with *X. pancheri*. These two species coexist in open vegetation environments. Of the 129 specimens studied during the revision of the genus (Morel *et al.* 2021), only 18 belong to the species *X. desquamatus*. This species has a terete stipe which distinguishes them from *X. neocaledonica*. Nevertheless we can differentiate them by distinct leaf forms: jonciform (terete) in the case in *X. desquamatus* and linear (elliptic in cross-section) in *X. pancheri*. In addition, only the leaves and stipes of *X. desquamatus* can peel and become ribbed. Furthermore, the bracts of the spike of *X. desquamatus* are more rigid with a finer membranous margin and a constant and prominent carina than in *X. pancheri*. Finally, the flower of *X. desquamatus* has only staminodes reduced to filaments while the staminodes of *X. pancheri* are feathery (Fig. 5).

It is relevant to note that Guillaumin (1956: 133) rightly identified *MacKee 2609* as *X. pancheri* and indicated *MacKee 2365* as a new species (indeed this specimen is *X. desquamatus*). Conert probably wanted to dedicate this species to Guillaumin but he inverted his identifications and described *X. guillauminii* for the taxa already described as *X. pancheri*, and leaving the new species, *X. desquamatus*, undescribed (Morel *et al.* 2021).

Conservation status:—The plant is known from eleven subpopulations, only one of which is in a protected area: “La réserve naturelle du Pic du Pin”, while five of them are included in mining concessions. The calculated EOO is 189 km² and the AOO is 48 km². According to *MacKee 5056* [P01760130] and *MacKee 43247* [P01766991] 30 years apart (1956 and 1986), *X. desquamatus* is generally infrequent, sometimes common but in small areas. Some subpopulations may be threatened by bushfires and/or introduced browsers, in addition to mining activity. We assign *Xyris desquamatus* a preliminary status of Vulnerable (VU B1ab(iii,v)+2ab(iii,v)).

Additional specimens examined (Paratypes):—NEW CALEDONIA. Province Sud: Baie de Prony, Sep 1868, *B. Balansa 665* (P01760139, P01760140, P01760141); Chutes de la Madeleine, 22°13'10"S, 166°51'39"E, 7 Nov 1992, *Brown 92/210* (NSW262218); Road between Nouméa and Yaté, 8.3 km E of turnoff to Chutes de la Madeleine, 22°10'03"S, 166°54'00"E, 10 Nov 1992, *Brown 92/231* (NSW262220); Goro-nickel, Kwé Est [-22,3064; 166,9221333], 17 Oct 2002, *G. Dagostini & F. Rigault 544* (NOU046841); Rivière des Lacs (La Madeleine) en amont des chutes [-22,1928016; 166,8732611], 20 Sep 2007, *G. Dagostini, F. Rigault, L. Barrabé & W. Nigote 1343* (NOU023766); Plaine des lacs: Grand Lac [-22,268464; 166,914619], 15 Sep 1981, *P. Endress 6235* (Z-000175352); Yaté, Sommet du Mont Gouemba, 540 m alt., 22°10'42.40"S, 166°56'21.69"E, 29 Nov 2018, *G. Gâteblé, Y. Isagi & Y. Suyama 1070* (MO, MPU, NOU107278, NOU107279, NSW, P); Yaté, Sommet du Mont Gouemba, 540 m alt., 22°10'42.40"S, 166°56'21.69"E, 29 Nov 2018, *G. Gâteblé, Y. Isagi & Y. Suyama 1071* (MO, MPU, NOU107280); Pic du Pin [22°14'49"S; 166°48'48"E], 1 Apr 1951, *A. Guillaumin & M. Baumann-Bodenheim 11947* (P01679382); Open seepage slope bordering the Anna-Madeleine River. Nouméa - Yaté road about 42 km. ENE of Noumea [-22,1675, 166,8666667], 23 Nov. 1979, *Hartley 15055* (CANB289172.1, NOU046840); Col de Yaté, 300 m alt. [22°10'19"S; 166°54'15"E], 1 Mar 1992, *H. Koyama & H. Setoguchi 8204* (P01760146); Plaine des lacs, on road to Le Carenage, 150 m [22°17'25"S; 166°50'5"E], 8 Apr 1955, *H.S. MacKee 2365* (L1430188); Grand Lac, 250 m [-22,2727778, 166,9008333], 30 Sept 1984, *MacKee 42273* (NOU046832, NSW, P01767010); Yaté, 350 m alt. [22°9'21"S; 166°53'48"E], 31 Aug 1986, *H. S. MacKee 43247* (NOU046835, NSW, P01766991); Lac en 8 [22°16'17"S; 166°52'35"E], 13 Oct 1976, *P. Morat & B. Suprin 5141* (NOU046836, P01766979); Plaine des lacs, [1889], *M. Raoul* s.n. (P01760152); Bords du lac Arnaud [22°6'40"S; 166°48'51"E], 1855/1860, *E. Vieillard 1410* (P01766983).

Lectotypification

Xyris neocaledonica Rendle, Journ. Bot. 1899, 507.

Type:—NEW CALEDONIA. Mt. Mon [=Mou], *E. Vieillard 1408*, (lectotype, **designated here:** BM [BM000990765] (image seen); isolectotype: P [P01766970]!).

Nomenclatural remarks:—The protologue of Rendle (1899: 507) indicates “Hab. New Caledonia. Dry ferruginous soil, 400 metres; Pancher no. 411. Mt. Mon [=Mou]; Vieillard 1408 in herb. Hance no. 17,369”, thus implicitly designing a syntype (Turland *et al.* 2018; Article 40, Note 1). The two collections cited were mounted on the same sheet at BM, where Rendle was working, but clearly identified as distinct, and each having a barcode [BM000990764, BM000990765]. Hance has never made a collection in New Caledonia (Morat 2010), so he received collection 1408 from Vieillard, and gave it his own number 17,369. This Vieillard collection [BM000990765] is in good condition,

with flowers and bears the locality of the protologue, and this is selected as the lectotype. Then, it is usual for Pancher and Vieillard to encounter the same label numbers assigned to different gatherings (MacKee and MacKee 1981; Hopkins and Bradford 2009). Six duplicates of *Vieillard 1408* were found at P, five collected from “M’bée mountains” in 1855-1860 [P01766975, P01760201, P01760200, P01760183, P0176697] and one from “Mont Mou”, 1861-1867 [P01766970]. Therefore, only this latest specimen, whose locality conforms to the protologue, can be considered as an iso-lectotype.

Synonymy

Xyris pancheri Rendle, J. Bot. 37: 507. 1899

Type:—NEW CALEDONIA. sin loc., sin date, *Pancher 412* (holotype: BM [BM000990766] (image seen)).

= *Xyris guillauminii* Conert, Senckenberg. Biol. 46(2): 185 (-188; figs.). 1965. *syn. nov.*

Type:—NEW CALEDONIA. Marais Kiki, plaine des lacs. 18 June 1955, *H.S. MacKee 2609* (holotype: L [L1430189] (image seen), isotype: P! [P01760129]).

Nomenclatural remarks:—Rendle (1899) pointed out that he is working on BM collections, and there was a single collection of *Pancher 412* in BM (BM000990766). The protologue indicates “Damp hollows on dry ferruginous mountains at a height of 150 m”, what is the exact translation of the information on the label “trous humides sur les montagnes ferrugineuses arides, alt. 150 m” seen on BM000990766. Thus this latest is considered as the single specimen studied by Rendle, and by consequence as the holotype (see McNeill 2014). Outside the British Museum, five collections are annotated as *Pancher 412*, four in P [P01760143, P01760147, P01760149, P02209231] and one in S [S12-17386]. None of them bears the same information as the protologue and cannot be considered as isotypes. Finally, a specimen in K [K000457998] is signalled as type on <https://plants.jstor.org>, but the collection is a *Pancher s.n.* and cannot be considered as type.

Conert (1965: 186) designated the L specimen of *MacKee 2609* as holotype of *X. guillauminii*, with a picture of the specimen in the publication. Surprisingly, this collection [L1430189] was not annotated by Conert, and remained with Guillaumin’s identification, made in 1955, under *X. pancheri*. An isotype in P was also with Guillaumin’s identification of *X. pancheri*. As no other specimen was identified as *X. guillauminii* in L or P, this name was not existing in both databases of these herbaria, while few collections were identified under that name in NOU. Furthermore, based on a previous study (Morel *et al.* 2021) no morphological nor anatomical characters support the separation between *X. guillauminii* and *X. pancheri*. Therefore, we propose the synonymy of *X. guillauminii* under *X. pancheri*.

Two specimens were identified by P. Phonsena in L as *X. operculata* Labill. in 2010 (L.1426037 & L.1426035), while this species was never reported before in New Caledonia and was considered as endemic to Australia (Conn and Doust 1997). The duplicates in P of these two collections were included in the analysis of Morel *et al.* (2021) and were identified as *X. pancheri*. Thus reporting the presence of *X. operculata* in New Caledonia is considered as a mistake.

Key to the species of New Caledonian *Xyris* based on vegetative characters

- 1 Leaves ensiform, linear in cross section, more than 3 mm wide.....*X. neocaledonica*
- Leaves junciform, terete or linear and elliptic in cross section, less than 2 mm wide2
- 2 Leaves junciform, terete, outer layers shed and inner core ribbed at senescence *X. desquamatus*
- Leaves linear, elliptic in cross section, outer layers not shed at senescence*X. pancheri*

Key to the species of New Caledonian *Xyris* based on reproductive characters

- 1 Staminodes included, reduced to filaments; stigmas not alternate with petals (Fig. 5, A)..... *X. desquamatus*
- Staminodes excluded, apex densely feathery; stigmas alternate with petals (Fig. 5, B, C)2
- 2 Filaments protrude from the claws of the corolla about twice the size of the anthers; apex of staminodes trilobed (Fig. 5, C).....*X. neocaledonica*
- Filaments barely protrude from the claws of the corolla; apex of staminodes dilated to a large truncated disc (Fig. 5, B).....*X. pancheri*

Anatomical key to the species of New Caledonian *Xyris* based on cross sections of leaves

- 1 Leaves linear in cross section; vascular bundles arranged in 1 or 2 linear series (Fig. 3, A).....*X. neocaledonica*
- Leaves terete or elliptic in cross section; vascular bundles arranged in a circular or elliptical series (Fig. 5, B–C).....2
2 Presence of collenchyma; palisade parenchyma and thickened medullary parenchyma (Fig. 3, C1–C3).....*X. desquamatus*
- Absence of collenchyma; palisade parenchyma and thickened medullary parenchyma (Fig. 3, B1–B3)*X. pancheri*

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