

## *Phebalium cicatricatum* (Rutaceae), a newly described and Critically Endangered species from north-eastern Queensland, Australia.

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### Abstract

*Phebalium cicatricatum* A.J.Ford & Duretto is formally described and illustrated. Notes on habitat, distribution and conservation status are provided, as are detailed information how to distinguish it from *P. longifolium*, the only other species of the genus in the Wet Tropics area of north-eastern Queensland, and the pink-flowered *P. nottii*. A key to the species of *Phebalium* found in Queensland is provided.

### Introduction

The genus *Phebalium* Vent. (Rutaceae) is an endemic Australian genus with more than 30 species being recognised (Wilson 2013; Telford *et al.* 2019). *Phebalium* occurs throughout much of eastern and southern Australia (including Tasmania though absent from the Northern Territory) with centres of species diversity in south-western Australia and south-eastern Australia (New South Wales and Victoria).

Recently, a number of species have been segregated from the *Phebalium squamulosum* Vent. complex which exhibits considerable morphological variation. These newly recognised species include: *P. longifolium* S.T.Blake being reinstated as a species (Forster 2003), *P. verrucosum* (Paul G.Wilson) I.Telford & J.J.Bruhl being raised to the status of species (Telford and Bruhl 2014) and the newly described species *P. distans* P.I.Forst. (Forster 2003), *P. graniticola* I.Telford & J.J.Bruhl, *P. stellatum* I.Telford & J.J.Bruhl and *P. sylvaticum* I.Telford & J.J.Bruhl (Telford *et al.* 2019).

Currently there are three species of *Phebalium* known from north Queensland, *P. nottii* (F.Muell.) Maiden & Betche and *P. glandulosum* Hook. from elevated near-coastal and inland areas, and *P. longifolium* from the mountainous north-east. A morphologically distinct population of a *Phebalium* species, that superficially resembles both *P. longifolium* and *P. nottii*, from a rhyolite outcrop in north-east Queensland has been known since the early 2000's (Ford, pers. observation). Adequate material has not been obtained until very recently to understand this species' identity and possible close relatives. Collection of both flowering and fruiting material has enabled confirmation that the population represents an undescribed species and we name this new species below as *P. cicatricatum* A.J.Ford & Duretto.

## Material and Methods

This study of *Phebalium* was exclusively based on the examination of herbarium specimens held at NSW and CNS including spirit (alcohol) collections at CNS. In addition, fieldwork by the first author enabled the collection of fresh material for morphological assessment as well as pertinent ecological and conservation information.

## Taxonomy

### *Phebalium cicatricatum* A.J.Ford & Duretto, *sp. nov.*

Type: QUEENSLAND: North Kennedy District: Ravenshoe State Forest, off Wooroora road south of Ravenshoe, 21 Apr 2020, A. Ford 6778 and W. Cooper (holotype: BRI; isotypes: AD, CANB, CNS, HO, K, MEL, MO, NE, NSW, PERTH).

Diagnosis: Differs from *Phebalium longifolium* in its leaf margins (strongly recurved versus ±flat), longer calyx lobes (0.9–1.1 mm versus 0.3–0.5 mm), petal habit (geniculate versus straight), longer petals (5.6–6.1 mm versus 3–3.5 mm), petal colour (white to pale pink versus yellow), longer anthers (2–2.1 mm versus 0.7–1.2 mm) and longer seeds (2.8–3 mm versus 1.8–2.2 mm); and from *P. nottii* in its adaxial leaf surface (glabrous versus sparsely hairy), and shorter calyx lobes (0.9–1.1 mm versus 1.2–4.5 mm).

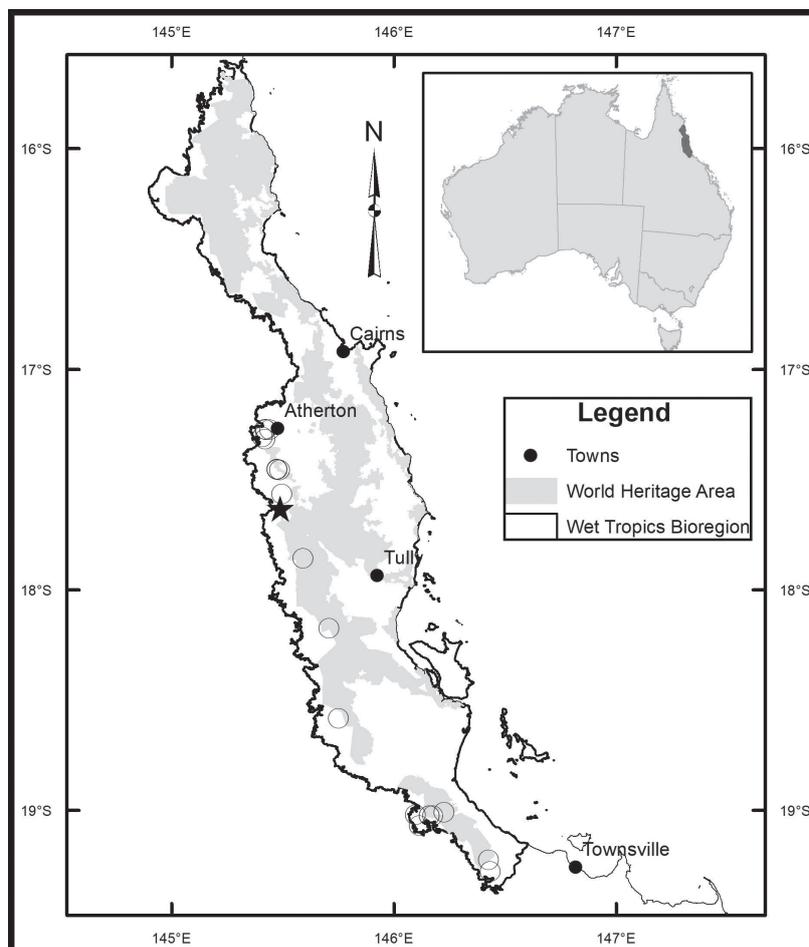
Divaricately branched shrub to 2.1 m high, bark rough and lacking any other distinguishing features, stems to 35 mm diameter; plant killed by fire. Indumentum (unless stated otherwise) on foliage, twigs and reproductive organs consist of overlapping, peltate, rusty-brown to silver-brown fimbriate, lepidote trichomes that are shiny (with age trichomes become dull and turn grey-brown). Branchlets not glandular-tuberculate, terete when mature (flattened when young) and densely lepidote; trichomes rusty-brown, becoming grey with age. *Leaves* alternate, crowded distally, aromatic when crushed; petiole 1.1–2.6 mm long, strongly grooved adaxially, densely clothed in persistent trichomes; lamina narrow-elliptic to oblong 9.4–34 mm long, 2.2–6.5 mm wide, length to width ratio 4.3–5.4: 1, coriaceous, “m”-shaped in transverse section (i.e. not flat); abaxial surface densely lepidote, trichomes white with scattered red-brown trichomes; adaxial surface dull to shiny and glabrous, oil glands large, scarcely raised adaxially; apex bluntly pointed (acute) to retuse, with a short reflexed acumen; base attenuate; margin entire, strongly recurved; midvein impressed adaxially and raised abaxially, secondary venation inconspicuous. *Inflorescence* terminal, umbel-like or flowers in fascicles, very shortly pedunculate or appearing sessile, 2–4-flowered; peduncles densely clothed in persistent trichomes, to 1 mm long; pedicels densely clothed in trichomes, terete, 2.5–5 mm long, c. 1 mm diameter. *Flowers* 8–11 mm diameter, 5(6)-merous, actinomorphic. *Calyx* urceolate, densely clothed in red-brown to dark brown lepidote trichomes abaxially, glabrous adaxially; tube 1.9–2.1 mm long, 2.9–3.1 mm diameter, weakly glandular-tuberculate; lobes 0.9–1.1 mm long, 1.2–1.5 mm wide, triangular, margin entire. *Corolla* white to palest pink, densely lepidote abaxially, trichomes rusty-brown; petals free, geniculate, 5.6–6.1 mm long, 1.8–2.2 mm wide, elliptic-obovate, apex thickened-papillose, glabrous adaxially. *Stamens* 10–12; filaments unequal, 4–6 mm long, filiform, glabrous, white to pale pink; anthers 2–2.1 mm long including a conspicuous papillose terminal elongated glandular appendage, c. 0.7 mm wide, elliptic, basifixed but appearing dorsifixed due to elongated bases which have a short appendage, dehiscing laterally through longitudinal slits. *Ovary* globose, densely lepidote, c. 1.8 mm high, 5–6-locular; stigma capitate, echinate, c. 0.2 mm long, c. 0.4 mm wide; style 4.5–5.4 mm long, with dense multifid stellate trichomes in lower half. *Fruit* capsular, consisting of (4–through abortion) 5–6 cocci, calyx persistent; cocci c. 3.8 mm high, c. 2.5 mm wide, apex truncate, densely lepidote. *Seed* ellipsoidal-reniform, 2.8–3 mm long, c. 1.3 mm wide, c. 1.2 mm thick, testa with numerous curved and parallel more or less continuous ridges running longitudinally, grey-black, endosperm oily. *Embryo* c. 1.9 mm long, cotyledons narrower and shorter than radicle; cotyledons pointed, c. 0.8 mm long; radicle c. 1.1 mm long, thickest proximally. Specific wood density 749 kg/m<sup>3</sup>. Fig. 1.

**Distribution:** *Phebalium cicatricatum* is endemic to the western edge of the Wet Tropics bioregion (Department of Environment 2012) in north-eastern Queensland, Australia, where it is currently only known from a very restricted area near Ravenshoe (south-west of Cairns) (Fig. 2).

**Habitat and Ecology:** This species is currently only known from a mosaic of sclerophyll shrub woodland and associated heath community on rhyolite outcrops. Tree species at this site are poorly formed and often of mallee habit or resemble tall shrubs include: *Corymbia abergiana*, *Eucalyptus lockyeri* and *Syncarpia glomulifera*. Low, and dense common shrub species include: *Acacia leptostachya*, *Homoranthus porteri*, *Hovea densivellosa*, *Persoonia tropica*, *Pimelea linifolia*, *Platysace valida*, *Pseudanthus ligulatus* and *Zieria whitei*. The ground layer consists of: *Aristida benthamii*, *Arthrostylis aphylla*, *Borya septentrionalis*, *Cheilanthes* sp., *Cladia* sp., *Cleistochloa subjuncea*, *Gonocarpus* sp., *Lepidosperma laterale*, *Mitrasacme oasena*, *Pomax umbellata*, *Tripogonella loliiformis* and ephemeral sedges and herbs. Altitudinal range unknown with the only collections recorded at 940 m.



**Fig. 1.** *Phebalium cicatricatum*. **a** (top left), habit of flowering branch (Ford 6778). **b** (top right), close-up of flower. **c** (bottom left), close-up of flowering branchlet showing inflorescence structure (leaf removed from flower at front on right hand side). **d** (bottom right), habitat showing rhyolite substrate. Copyright: CSIRO Andrew Ford (1a, c, d); Tim Hawkes (1b).



**Fig. 2.** Distribution of *Phebalium cicatricatum* (★) and *Phebalium longifolium* (○) in north-east Queensland. Shaded areas represent the Wet Tropics World Heritage Area within the Wet Tropics Bioregion.

**Phenology:** Flowering is recorded for April–July and mature fruit is known from July–September.

**Conservation Status:** *Phebalium cicatricatum* is currently only known from Ravenshoe State Forest, near Ravenshoe, where it is known from one rocky outcrop. Extensive surveys of the area in April 2020 by the first author found 12 plants over an area of c. 0.2 hectares. Despite considerable collecting effort in geographically and geologically similar adjacent heathy habitats by many collectors, including the first author, in recent years, no additional collections or observations of this species have been made. This species would not be overlooked due to the typical showy *Phebalium* flowers and the densely ‘salt and pepper’ lepidote indumentum on leaf abaxial surfaces, which would attract collector attention. Although not occupying the same niche or vegetation community, *Melaleuca lophocoracorum* is also a very narrow and localised endemic species being restricted to Ravenshoe State Forest, strengthening the biodiversity and conservation value of the Estate.

We strongly recommend a status of *Critically Endangered* (IUCN 2019) with a minimum coding of CR: B1+2ab(iii, v) and CR: D. Recurrent fire in a fire sensitive habitat is a serious threat, with seed production requiring 3–4 years post fire. Individual plants do not occur in the core area of the heathy vegetation but are closely adjacent to the forest/rock outcrop margin, being more susceptible to any increase in fire frequency. The invasive weed *Praxelis clematidea* (*Praxelis*) occupies a range of microhabitats amongst *P. cicatricatum* plants from rock cracks and skeletal soil pockets to areas densely covered in *Cladia* sp., and should be classed as a threatening species. *Praxelis* establishes quickly with or without the assistance of disturbance, giving it a competitive edge in these marginal sites where competition for root space is strongly contested.

**Affinities:** Morphologically *Phebalium cicatricatum* would appear to be most closely related to the geographically closest species, *P. longifolium*, and the pink flowered *P. nottii*. Although beyond the scope intended, it is possible that taxa currently (and previously) included in *Phebalium squamulosum* Vent. or *P. nottii* may be close relatives. For example, the testa ornamentation shown for *P. squamulosum* (Telford *et al.* 2019, p.7 Figure 1B) is nearly identical to that of *P. cicatricatum*. This ornamentation is also similar to that seen in the *P. nottii* group (Telford 2020, pers. comm.). A comparison of diagnostic differences between *P. cicatricatum*, *P. nottii* and *P. longifolium* is provided in Table 1.

**Table 1. Morphological comparison between *Phebalium cicatricatum*, *P. nottii* and *P. longifolium*.**

Character	<i>P. cicatricatum</i>	<i>P. nottii</i>	<i>P. longifolium</i>
Leaf transverse section	‘m’-shaped	flat	flat
Leaf appearance (adaxial surface)	dull to shiny	dull/matt	shiny/reflective
Adaxial leaf surface (new leaves)	glabrous	sparsely hairy	glabrous
Leaf margin	strongly recurved	flat to slightly recurved	±flat
Calyx lobe length (mm)	0.9–1.1	1.2–4.5	0.3–0.5
Adaxial calyx surface	lepidote	lepidote	glabrous
Petal colour	white to pale pink	pink	yellow
Petal habit	geniculate	straight	straight
Petal length (mm)	5.6–6.1	5.5–8.6	3–3.5
Anther length (mm)	2–2.1	1.5–2.2	0.7–1.2
Seed length (mm)	2.8–3	1.6–3.0	1.8–2.2
Habitat	heath	forest	forest

**Etymology:** The epithet *cicatricatum*, from the Latin *cicatrix* (scar), in reference to the high probability of injury that explorers face as a consequence of walking amongst the thick heathy vegetation and jagged angular rocks (rhyolite) in the Ravenshoe area including where this species is found.

**Notes:** *Phebalium cicatricatum* is an obligate seeder and is killed by fire. The most recent fire affecting the population was in late 2012, with about 90% of the total adjacent heath mosaic being burnt to varying degrees of intensity. Despite these figures less than 50% of the total area of occupation for *P. cicatricatum* was impacted.

Although the distribution of *Phebalium cicatricatum* and *P. longifolium* overlap (Fig. 2), they occupy different habitats. The former occurring in rocky heath communities with skeletal soil and the latter restricted to wet sclerophyll forest and rainforest margins.

The presence of another localised sclerophyllous rhyolite inhabiting endemic adds additional weight to the earlier comments of Craven and Ford (2004) when discussing the biological richness of the western edge of the Atherton Tableland. They suggest that there is a complex interaction involving “altitude, climate and geology....which may foster evolutionary activity leading to speciation” (Craven and Ford 2004, p. 6). Other local endemic species

restricted to rhyolite areas in the Atherton-Ravenshoe area include: *Comesperma anemosmaragdinum*, *Hibbertia concinna*, *Melaleuca lophocoracorum*, *Melaleuca sylvana*, *Melaleuca uxorum*, *Micromyrtus delicata*, *Persoonia tropica*, *Prostanthera clotteniana*, *Zieria fordii* and *Zieria whitei*. Similar examples of localised endemism on acid volcanic substrates is discussed by Telford (2013). The McPherson Range and adjacent areas of south-east Queensland have long been recognised as an ecological zone which boasts not only regional endemics but also site-specific and evolutionarily lead local endemism. For example, *Acacia acrionastes* and *Pultenaea whiteana* may be considered as regional endemics whereas *Bertya ernestiana* (site-specific) and *Phebalium speciosum* (two-location endemic) are very narrow regional endemics (Telford 2013).

**Additional specimens seen:** QUEENSLAND: North Kennedy District: Ravenshoe Forest Reserve 2 (former State Forest 488); off Wooroora Road, S of Ravenshoe, 15 Apr 2013, *P. Forster PIF39739* (BRI, NSW); Ravenshoe State Forest, off Wooroora road south of Ravenshoe, 20 Jul 2018, *A. Ford and J. Mackenzie AF6704* (BRI, CNS, NSW); *loc. cit.*, 28 Sep 2018, *A. Ford and W. Cooper AF6712* (BRI, CNS, NSW).

### Key to the species of *Phebalium* in Queensland and their distribution within Queensland

Modified from Forster (2003) and including newly recognised species; petal colour refers to the adaxial surface.

- 1a. Petals > 4.5 mm long..... 2
- 1b. Petals < 4.5 mm long..... 5
- 2a. Petals yellow..... **P. whitei** (SQ)
- 2b. Petals white or pink..... 3
- 3a. Leaves sparsely hairy on adaxial surface..... **P. nottii** (SQ, CQ, NQ)
- 3b. Leaves glabrous on adaxial surface ..... 4
- 4a. Leaves flat ..... **P. woombye** (SQ, CQ)
- 4b. Leaves strongly “m”-shaped in cross section, recurved ..... **P. cicatricatum** (NQ)
- 5a. Leaf margin undulate, markedly glandular ..... **P. glandulosum** (SQ, CQ, NQ)
- 5b. Leaf margin entire or sinuate to crenate near the apex, not markedly glandular..... 6
- 6a. Leaf adaxial surface glabrescent, scabridulous..... **P. graniticola** (SQ)
- 6b. Leaf adaxial surface glabrous..... 7
- 7a. Longest leaves to 25 mm long; calyx more or less truncate..... **P. squamulosum** (SQ)
- 7b. Longest leaves > 40mm long; calyx lobed..... 8
- 8a. Petals yellow; style 4–4.5 mm long ..... **P. sylvaticum** (SQ)
- 8b. Petals cream to white; style 2.8–3.5 mm long..... 9
- 9a. Leaf margin recurved, leaf length: width ratio 7.7–15.5: 1 ..... **P. distans** (SQ)
- 9b. Leaf margin flat, leaf length: width ratio 5–7.2: 1 ..... **P. longifolium** (NQ)

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