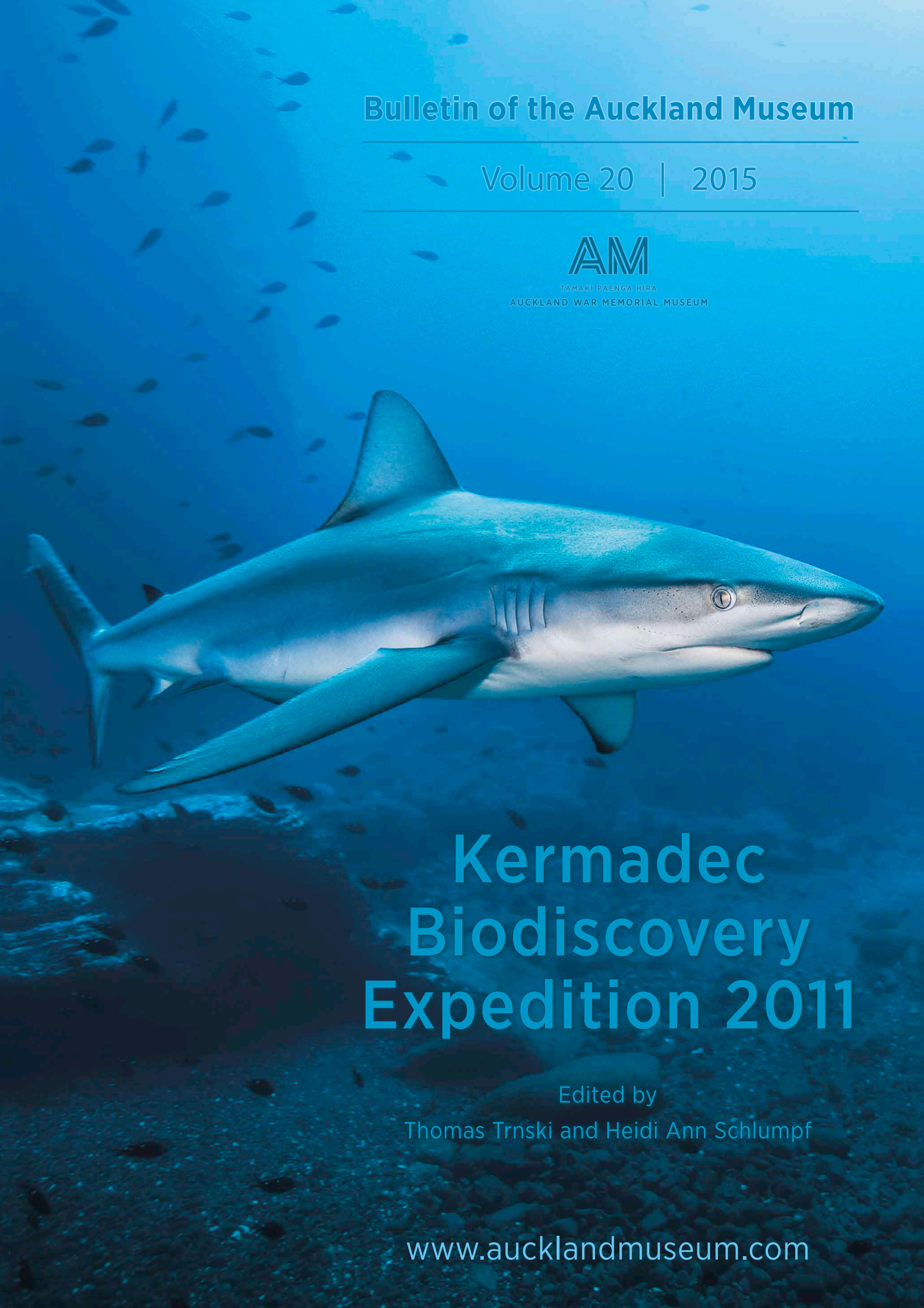




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Lichen notes from the Kermadec Islands.

I. Lobariaceae

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Abstract

The Lobariaceae of the Kermadec Islands group, South Pacific are treated. Four genera of the family are present: *Crocodia*, *Podostictina*, *Pseudocyphellaria* and *Sticta*. Two species of *Crocodia* (*Crocodia aurata*, *C. poculifera*), two species of *Podostictina* (*P. nermula*, *P. pickeringii*) nineteen species of *Pseudocyphellaria* (*P. argyracea*, *P. bartlettii*, *P. carpoloma*, *P. chloroleuca*, *P. crocata*, *P. dissimilis*, *P. episticta*, *P. glabra*, *P. godeffroyi*, *P. haywardiorum*, *P. homalosticta*, *P. insculpta*, *P. intricata*, *P. multifida*, *P. prolificans*, *P. punctillaris*, *P. reineckeana*, *P. semilanata* and *P. sulphurea*) and nine species of *Sticta* (*S. babingtonii*, *S. brevipes*, *S. caperata*, *S. cyphellulata*, *S. fuliginosa*, *S. limbata*, *S. pedunculata*, *S. squamata* and *S. wiegelii*) are accepted for the Kermadec Islands group, all of which are known only from Raoul Island, the other islands apparently not supporting any members of the family. *Pseudocyphellaria godeffroyi*, *P. homalosticta*, *P. prolificans*, *P. punctillaris*, *P. reineckeana*, *P. semilanata*, *P. sulphurea*, *Sticta brevipes*, *S. caperata*, *S. cyphellulata*, *S. pedunculata* and *S. wiegelii* are all additions to New Zealand's lichen mycobiota. Although two species of *Podostictina* are present on the Kermadec Islands only one of these, *P. pickeringii*, currently has a valid name in that genus the other remains in *Pseudocyphellaria* as *P. nermula*. Therefore, we provide here a new combination in *Podostictina*, *P. nermula* (D.J.Galloway) de Lange et D.J.Galloway for this second species. Also to complete the full transfer of the remaining five New Zealand and South American *Pseudocyphellaria* belonging to *Podostictina* the necessary combinations are made. A key to species is presented and the family Lobariaceae in the Kermadec Islands group is discussed in relation to its known distribution in the wider Pacific, Australia and New Zealand. We conclude that the unusual diversity of the Lobariaceae in relation to other nearby island groups relates to the dense forest cover that Raoul Island has maintained throughout its human history, dispersal of these lichens propagules from New Zealand, and the northeastern Pacific, and also, by the dispersal of propagules of western Pacific tropical species of *Pseudocyphellaria* and *Sticta* by cyclones generated between the northern coast of Australia and the Solomon Islands.

Keywords

Kermadec Islands group; Raoul Island; Lobariaceae; *Crocodia*; *Podostictina*; *Pseudocyphellaria*; *Sticta*; new combinations, new records; biogeography; tropical cyclones; New Zealand botanical region

INTRODUCTION

The Kermadec Islands group (Fig. 1), a remote and widely scattered oceanic archipelago of 19 islands, islets and rock stacks, are the most northerly part of the New Zealand Botanical Region (*sensu* Allan 1961, but see also de Lange & Rolfe 2010). The islands lie between latitude 29°S and 31.5°S and longitudes 177°W and 179°W (Sykes 1977). Geologically they are mostly andesitic volcanic islands resulting from ongoing subduction between the overriding Indo-Australian Plate

and the subducted Pacific Plate (Lloyd & Nathan 1981). The largest of the islands is Raoul Island (2943 ha, ca.520 m a.s.l., Fig. 2), a volcanically active, cliff-girt, heavily forested island. The climate of Raoul Island is described as humid, subtropical <http://en.wikipedia.org/wiki/Raoul_Island, viewed 17 August 2011> and mostly warm and wet throughout the year. Climate data for the island (gathered since the 1940s) ranges from an average high of 22.1°C to an average low of 16.7°C, with a mean yearly precipitation of 1558 mm. In the summer months temperatures reach an average recorded

* David Galloway, deceased 6 December 2014.

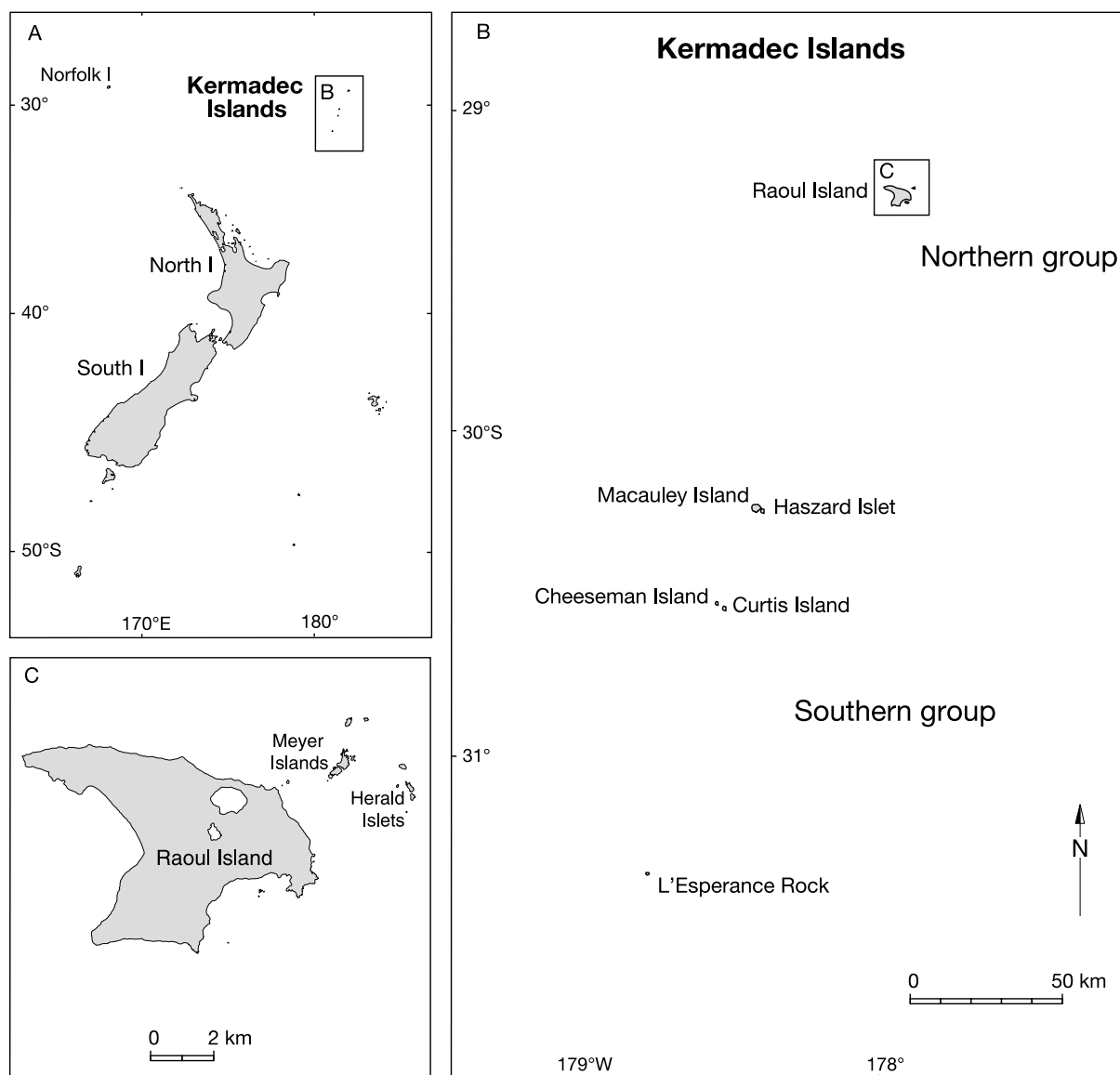


Figure 1. Location of the Kermadec Islands. **A.** Showing location of the Kermadec Islands in relation to New Zealand and Norfolk Island. **B.** The Kermadec Islands. **C.** The Northern Kermadec Islands comprising Raoul Island (study area), the Meyer Islands and the Herald Islets. Map by Jeremy R. Rolfe

maximum of 25.7°C and an average minimum of 20.5°C, and in winter temperatures may drop to 13.3°C. Rainfall is more or less evenly distributed throughout the year, although the winter months are slightly wetter. More significant to the island's vegetation cover is the fact that the Kermadec Islands group are periodically assailed by tropical cyclones (Morton 1957; Sykes 1977).

While the vascular plant flora has received considerable attention (Sykes 1977; Sykes & West 1996; de Lange *et al.* 2004; de Lange *et al.* 2005; Barkla *et al.* 2008) until recently, little was known about the bryophytes, fungi and lichens of the islands. While the mosses of the archipelago are now reasonably well-documented (de Lange & Beever 2015), there has yet to be a comprehensive account of the island group's hornworts and liverworts (Renner & de Lange 2011; Braggins *et al.* 2014), while the listing available for the island group's fungi is rudimentary (McKenzie 1992).

A SHORT HISTORY OF KERMADEC ISLANDS GROUP LICHEN COLLECTING

The first lichen collections from the Kermadec Islands group were those collected from Raoul by the Scottish botanist/gardener, W.G. Milne, who visited in 1854 on HMS *Herald*. Two lichens from this visit are recorded by J.D. Hooker in his "Handbook of the New Zealand Flora": *Cladonia furcata* (Huds.). Schrad. (Hooker 1867: 561) and *Lecidea intermixta* Nyl. (Hooker 1867: 582).

In August 1887, T.F. Cheeseman, Director of the Auckland Museum, visited Curtis, Macauley and Raoul Islands as part of a team of government officials who undertook the islands' formal annexation to New Zealand. During this time he collected at least one lichen *Crocodia aurata* (Ach.) Link (Galloway 1994a). However, other than this collection we were unsuccessful in determining whether Cheeseman made any further lichen collections.



Figure 2. View from Moumoukai (518 m a.s.l.), the highest point on Raoul Island, looking northwest across the crater area to the Terraces (delineated in this image by the Norfolk Island pines (*Araucaria heterophylla*)).

Photo: Peter J. de Lange.

In 1908, when W.R.B. Oliver visited the Kermadec Islands group for ten months he made a small collection of lichens. These were later identified at Kew (K)¹ by A.D. Cotton who recognised 13 taxa in eight genera (Oliver 1912). We have located ten of these in the Museum of New Zealand Te Papa Tongarewa Herbarium (WELT) with duplicates in AK. A set is also held at K (R.D. Seppelt pers. comm.). Although we have not examined those specimens, we have seen Oliver's collections at AK and WELT. These are now mostly in poor condition but within them, and excluding those belonging to the Lobariaceae, we recognise *Cladia aggregata* (Sw.) Nyl., *Cladonia macilenta* Hoffm., *C. nudicaulis* S.Hammer, *Heterodermia casarettiana* (A.Massal.) Trevis., *H. speciosa* (Wulfen) Trevis., *Leptogium cyanescens* (Rabenh.) Körb., *Ramalina pacifica* Asahina and *Usnea rubicunda* Stirt.

Following Oliver's visit to the Kermadec Islands group, R.C. Cooper visited Raoul Island in 1956 as part of a University of Auckland expedition. During this visit, Cooper collected a few lichens (Sykes 1977). While most of these lichens are now located at AK, some, such as the "*Sticta limbata*" specimens mentioned by Sykes (1977), appear to have since been lost or destroyed. Of the 40 lichen specimens of Cooper's that we have now seen, there are a few taxa among them that were then new records for the islands, such as *Cladonia floerkeana* (Fr.) Flörke, *C. enantia* Nyl., *Leptogium denticulatum* Nyl., *Pannaria fulvescens* (Mont.) Nyl. and *Parmotrema*

reticulatum (Taylor) M.Choisy, along with others in the Lobariaceae that are treated more fully in this paper.

In 1977, Sykes published what is still the authoritative account of the Flora of the Kermadec Islands group, in which he provided a small listing of the lichens of the Kermadec Islands. For that listing, Sykes (1977) examined both Oliver's and Cooper's Kermadec lichen collections, and these, together with his own collections (whose identity was determined by T.W. Rawson of the then DSIR Botany Division), resulted in his documentation of 22 taxa for the islands. Otherwise, Sykes (1977: 43) noted that there did not "seem to be...other references to Kermadec lichens". Subsequently, Sykes made further trips to the Kermadec Islands group during the 1980s and early 1990s, during which time he continued to collect lichens lodging his material in the Allan Herbarium (CHR). However, aside from those specimens in the Lobariaceae, none of these collections were specifically examined for this account, although some of them were recorded by Galloway (1985; 2007), the most recent of which notes 36 lichens from the Kermadec Islands group.

Despite the apparent dearth of published information on the Kermadec Islands lichen mycobiota, there were, prior to 2011 at least, two concerted efforts to collect lichens from the northern Kermadec Islands group. In 1993, C.J. West visited the northern group for ten weeks, during which time she was mostly based on Raoul Island, though she did visit the Meyer Islands. During that time, West collected in excess of 200 lichen packets, and this collection was augmented with specimens collected, again mostly from Raoul Island, during trips to the Kermadec Islands group in 1994, 1999, 2002 and 2008. Some of these lichens were examined for the revised Lichen Flora (Galloway 2007) and several were lodged in AK and WELT, however, at the time of writing (November 2014), the majority of her collections, though gifted to AK and UNITEC in September 2011, have yet to be formally incorporated into these herbaria.

Also in 1994, B.W. Hayward and A.E. Wright spent seven days (five full days) on Raoul Island, during which time they collected 187 packets of lichens, all of which were lodged in AK. However, as yet very few of these collections have been studied in any detail, and as with West's collections, few of Hayward and Wright's lichens were included in the revised New Zealand Lichen Flora (Galloway 2007).

During May 2009 and May 2011 the senior author visited the Kermadec Islands group. Landfalls were made on all of the islands, islets and rock stacks within the archipelago except for South and West Chanter, Hazard, "Hazardette" and Curtis Islands, and the Dougal and Milne Rocks. Lichens were sampled from all the other islands and rock stacks, though out of time and necessity mostly those larger taxa, particularly within the family Lobariaceae were collected. At the time of writing (June 2015) 175 taxa have been identified from these collections, and these, together with the collections of Hayward, and Wright form the nucleus of a checklist of the lichenized fungi of the Kermadecs now under preparation by P.J. de Lange, D.J. Blanchon and C.J. West.

¹ Herbarium Acronyms follow Thiers (2012)

THE LOBARIACEAE

The family Lobariaceae comprises the genera *Anomalobaria* B.Moncada et Lücking, *Crocodia* Link, *Dendroscosticta* B.Moncada et Lücking, *Lobaria* (Schreb.) Hoffm., *Lobariella* Yoshim., *Lobarina* Nyl. ex Croub., *Parmostictina* Nyl., *Podostictina* Clem., *Pseudocyphellaria* Vain., *Ricasolia* De Not., *Sticta* (Schreb.) Ach., *Yarrumia* D.J.Galloway, *Yoshimuriella* B.Moncada et Lücking, and at least two still unresolved additional genera (Lumbsch & Huhndorf 2010; Galloway & Elix 2013; Moncada *et al.* 2013; Moncada *et al.* 2014). The family is represented on the Kermadec Islands by *Crocodia*, *Podostictina*, *Pseudocyphellaria* and *Sticta*, all of which are confined to the largest, and the only heavily forested, island of the group, Raoul. The other islands and vegetated islets and rock stacks evidently lack the necessary conditions suitable to support these lichen genera.

In his treatment of *Pseudocyphellaria* in the palaeotropics, Galloway (1994a) noted a Milne Kermadec Islands collection of *P. prolificans* (Nyl.) Vain. that probably came from Raoul Island. This appears to be the first collection of the family Lobariaceae made from the archipelago. Subsequently, as noted above, T. F. Cheeseman, in August 1887, collected a specimen of *Crocodia aurata* (Galloway 1994a).

This slight tally of Lobariaceae was supplemented first by those taxa collected by Oliver (1912). His collections included what he listed as *Sticta variabilis* Ach. (noted by Oliver as “abundant on tree-stems”, of which the sole specimen that we have seen is actually *S. squamata* D.J.Galloway) and *S. aurata* Ach. (= *Crocodia aurata*, though Oliver’s specimens are *C. poculifera* (Müll.Arg.) D.J.Galloway et Elix.). Later, Sykes (1977), using his own collections and those of Oliver and Cooper, recorded six Lobariaceae [as Stictaceae]: *Sticta aurata* Sm. var. *aurata* [= *Crocodia aurata*], *Sticta aurata* var. *pallens* Nyl. [= *C. aurata*., the name *S. aurata* var. *pallens* Nyl. is a synonym of *C. rubella* (Hook.f. et Taylor) Trevis., a species not found on Raoul Island], *Sticta intricata* f. *subargyrea* (Nyl.) Hue [= *P. argyrea* (Delise) Vain., however, at least one of the collections on which that record was based, one of Oliver’s collections, is here referred to *Pseudocyphellaria punctillaris* (Müll.Arg.) D.J.Galloway], *Sticta variabilis* Ach. [= *S. squamata* – see above] and *S. weigeli* (Ach.) Vain. The basis of Sykes’s 1977 (Pp. 47) record of *Sticta limbata* Ach. is more problematic for, although that species is definitely recorded in this paper from a May 2011 collection from Raoul Island, the basis for Sykes’s listing was “1956 ones of Cooper’s from Raoul” lodged at “AK (held at AKU)” (Sykes 1977: 47). As noted above, we could not locate these in either AK or AKU, nor indeed in any New Zealand herbaria. Therefore, in the absence of these specimens, we tentatively refer the *S. limbata* Sykes listing to *S. weigeli*, a species which was in the 1970s much misunderstood and widely confused with *S. limbata* and *S. caliginosa* D.J.Galloway and whose real identity was only unraveled decades later (see Galloway

1994b; 2006). We have made this decision because *S. weigeli* is well-represented in *Sticta* collections from the Kermadec Islands, while the only genuine *S. limbata* specimen that we have seen from the Kermadec Islands was collected from there in May 2011. In addition to those taxa listed by Sykes (1977), Cooper’s Lobariaceae collections include specimens of *Pseudocyphellaria punctillaris* and *Crocodia poculifera*.

In Carol West’s 1993 lichen collections, we found 20 Lobariaceae, including numerous collections of *Crocodia aurata* and *Pseudocyphellaria argyrea*, and one each of *P. semilanata* (Müll.Arg.) D.J.Galloway and *Sticta weigeli*. Of these, *Pseudocyphellaria semilanata* is a new record not only for the mycobiota of the Kermadec Islands group but also for the New Zealand Botanical Region. In the 1994 lichen collections of Hayward and Wright, aside from numerous collections of *Crocodia aurata*, *Pseudocyphellaria argyrea*, and a few specimens of *P. punctillaris*, *P. semilanata* and *Sticta weigeli*, we found two new records for the lichen mycobiota of the islands and the New Zealand Botanical Region, *Pseudocyphellaria reineckeana* (Müll.Arg.) D.J.Galloway and *Sticta brevipes* (Müll.Arg.) Zahlbr.

In May 2009, the senior author visited Raoul Island for four days (two full days in the field) (Renner & de Lange 2011). Although time was limited he collected a number of large, conspicuous lobariaceous lichens. Later in May 2011, the author participated in the three-week Auckland Museum Kermadec Biodiscovery Expedition, when he made further collections of *Crocodia*, *Podostictina*, *Pseudocyphellaria* and *Sticta*. From these collections we recognise 23 taxa, which, it appears, were neither previously collected nor recorded from the islands and of these, seven (*Pseudocyphellaria godeffroyi* (Kremp.) D.J.Galloway, *P. homalosticta* Vain., *P. insculpta* (Stizenb.) D.J.Galloway, *P. sulphurea* (Schaer.) D.J.Galloway, *Sticta caperata* (Nyl.) Nyl., *S. cyphellulata* (Müll.Arg.) Hue. and *S. pedunculata* Kremp.) are new to the mycobiota of the New Zealand Botanical Region. Here, we provide a full account of the Kermadec Islands Lobariaceae (excluding typifications and synonymy as these may be found in Galloway (1988; 1994; 1997; 2001; 2006).

NEW COMBINATIONS

Based on morphological, chemical and molecular data (Galloway 1986, 1988, 1989, 1992; Moncada *et al.* 2013, 2014) the following combinations are necessary to effect the full transfer of those species of *Pseudocyphellaria* belonging to the segregate genus *Podostictina* but currently lacking names in that genus.

Podostictina encoensis (R.Sant.) D.J.Galloway et de Lange, comb. nov.

Basionym: *Pseudocyphellaria encoensis* R.Sant., in D.J. Galloway *Lichenologist* 21: 88 (1989). Type: Chile, IX Region (Valdivia), Lago Riñihue, Enco, on *Nothofagus dombeyi* in open rainforest, 29 September 1940, R. Santesson 3676, S! – holotype.

Podostictina endochrysa (Delise) D.J.Galloway et de Lange, comb. nov.

Basionym: *Sticta endochrysa* Delise, *Mém. Soc. Linn. Calvados* 2: 43 (1825), Pl. 19, Fig. 1. Type: [Falkland Islands]. Isles Malouines, *M. Gaudichaud*, PC LENORMAND! – holotype; PC-HUE! – isotype. For additional synonymy see Galloway (1992: 108–109).

Podostictina jamesii (D.J.Galloway) de Lange et D.J.Galloway, comb. nov.

Basionym: *Pseudocyphellaria jamesii* D.J.Galloway, *Bull. Br. Mus. (Nat. Hist.) Bot.* 17: 174 (1988). Type: New Zealand. South Island, Canterbury, Boyle River near Lewis Pass, on twigs of *Leptospermum scoparium* on terraces behind Boyle Hut, September 1981, *P.W. James*, BM! – holotype.

Podostictina nermula (D.J.Galloway) de Lange et D.J.Galloway, comb. nov.

Basionym: *Pseudocyphellaria nermula* D.J.Galloway, *Bull. Br. Mus. nat. Hist. (Bot.)* 17: 210 (1988). Type:

New Zealand, South Island, Canterbury, Boyle river, on bark of *Fuscospora (Nothofagus) cliffortioides*, 29.iii.1980, *D.J. Galloway s.n.* (CHR 379996 – holotype; BM – isotype).

Podostictina scabrosa (R.Sant.) D.J.Galloway et de Lange, comb. nov.

Basionym: *Pseudocyphellaria scabrosa* R.Sant. in D.J.Galloway, *Lichenologist* 18: 155 (1986). Type: Chile, Prov. Valdivia, Lago Riñihue, Enco, corticicola in silva mixta humida, 12.x.1940, *R. Satnesson* 3877 (*Lichenes austroamerici ex Herbario Regliano* Fasc. 18: 440 (1945), S! – holotype; B, BM, C, FH, G, H, L, LD, LIL, MSC,), R, S, UPS, US, W – isotypes.

Podostictina vaccina (Mont.) D.J.Galloway et de Lange, comb. nov.

Basionym: *Sticta vaccina* Mont., *Annls Sci. Nat. Bot. sér. 3*, 18: 307 (1852). Type: Chile, sine loco, *C. Gay*, PC-MONTAGNE! – lectotype (*fide*, Galloway 1986: 161). For additional synonymy see Galloway (1989: 161).

ARTIFICIAL KEY TO KERMADEC LOBARIACEAE

1. Pseudocyphellae present on lower (and sometimes also on upper) surface; cyphellae absent 2.
Pseudocyphellae absent; cyphellae present on lower surface 24.
2. Photobiont green 3.
Photobiont cyanobacterial 14.
3. Pseudocyphellae white 4.
Pseudocyphellae yellow *Pseudocyphellaria carpoloma*
4. Pseudocyphellae present on upper surface 5.
Pseudocyphellae not present on upper surface 7.
5. Thallus isidiate and/or phyllidiate 6.
Thallus without isidia or phyllidia *Pseudocyphellaria reineckeana*
6. Thallus phyllidiate, never isidiate; phyllidia often densely coralloid; pseudocyphellae on the upper surface up to 0.05 mm diam. *Pseudocyphellaria episticta*
Thallus mostly isidiate, pseudocyphellae on the upper surface up to 0.1 mm diam. *Pseudocyphellaria homalosticta*
7. Thallus margins lacking isidia and/or phyllidia *Pseudocyphellaria sulphurea*
Thallus isidiate, and/or phyllidiate 8.
8. Thallus isidiate, never phyllidiate and/or isidiate 9.
Thallus phyllidiate 10.
9. Pseudocyphellae 0.1–1.0 mm diam., prominent; lower surface irregularly wrinkled without a distinct marginal ridge; usually with a distinct whitish to pale buff broad margin, this grading through dark chocolate to black centrally *Pseudocyphellaria glabra*
Pseudocyphellae ≤ 0.1 mm diam., not apparent; lower surface wrinkled-plicate, ± bullate with distinctly ridged margins; coloured white or pale buff-pink *Pseudocyphellaria chloroleuca*
10. Medulla white 11.
Medulla yellow 12.
11. Thallus upper surface plane or undulate, not punctate-impressed; lower surface margins unthickened, ± naked; phyllidia copious, squamiform not lobule like and proliferating *Pseudocyphellaria multifida*
Thallus upper surface punctuate-impressed; lower surface margins distinctly thickened; phyllidia sparse to abundant, not squamiform, lobuliferous, proliferating *Pseudocyphellaria prolificans*
12. Thallus without phyllidia, apothecia when present stalked 13.
Thallus phyllidiate, apothecia when present sessile *Podostictina pickeringii*
13. Isidiate, isidia granular-erose *Crocodia poculifera*
Sorediate *Crocodia aurata*

14. Medulla white	15.
Medulla yellow	<i>Podostictina nermula</i>
15. Thallus without isidia, phyllidia or soredia	16.
Thallus with isidia and/or phyllidia, or sorediate	17.
16. Upper surface areolate-scabrid	<i>Pseudocyphellaria godeffroyi</i>
Upper surface smooth, not areolate-scabrid	<i>Pseudocyphellaria semilanata</i>
17. Thallus sorediate, without isidiate or phyllidia	18.
Thallus esorediate, isidiate and/or phyllidiate sometimes lobulate	21.
18. Soredia yellow	<i>Pseudocyphellaria crocata</i>
Soredia white	19.
19. Upper surface plane or undulate, emaculate; pseudocyphellae of lower surface scarce or absent.....	<i>Pseudocyphellaria intricata</i>
Upper surface ± faveolate-reticulate or punctuate-impressed, white-maculate; pseudocyphellae ± prominent below	20.
20. Upper surface reticulate-faveolate; pseudocyphellae below pale cream, minute, punctiform.....	<i>Pseudocyphellaria bartlettii</i>
Upper surface punctuate-impressed; pseudocyphellae below white, conspicuous, large ± plane.....	<i>Pseudocyphellaria haywardiorum</i>
21. Isidiate, isidia associated with pseudocyphellae	<i>Pseudocyphellaria argyracea</i>
Isidiate, phyllidiate or lobulate, if isidiate and/or phyllidiate then these structures not associated with pseudocyphellae	22.
22. Thallus malachite-green or glaucous blue when wet, never dark red-black; upper surface scabrid-areolate; thallus margins often lobulate, not phyllidiate or isidiate	<i>Pseudocyphellaria punctillaris</i>
Thallus dark red-black or blue black when wet, never malachite green or glaucous blue; upper surface smooth, dimpled or punctate impressed; thallus margins phyllidiate or isidiate, rarely lobulate-phyllidiate	23.
23. Thallus margins isidiate (very rarely phyllidiate), isidia initially simple, often becoming coralloid; upper surface smooth	<i>Pseudocyphellaria dissimilis</i>
Thallus margins phyllidiate, phyllidia mostly simple, projecting, digitiform; upper surface dimpled or punctate impressed	<i>Pseudocyphellaria insculpta</i>
24. Photobiont green	25.
Photobiont cyanobacterial	28.
25. Thallus attached by a basal holdfast	<i>Sticta pedunculata</i>
Thallus without a basal holdfast	26.
26. Thallus without isidia or phyllidia	<i>Sticta caperata</i>
Thallus isidiate or phyllidiate	27.
27. Thallus isidiate, isidia dense, marginal and laminal, squamiform imbricate; cyphellae white	<i>Sticta squamata</i>
Thallus phyllidiate, phyllidia mainly marginal, sometimes laminal, simple to coralloid; cyphellae orange to orange-yellow	<i>Sticta babingtonii</i>
28. Thallus attached by a basal holdfast, from which lobes are attached by short or long stalks	29.
Thallus without a basal holdfast, attached over the entire (or sometimes central) surface	30.
29. Lobes narrow, 1–2(–6) mm wide, ± canaliculate; margins not thickened below	<i>Sticta cyphellulata</i>
Lobes rounded-flabellate 5–10(–15) mm wide; margins thickened below, noticeably down-turned	<i>Sticta brevipes</i>
30. Thallus sorediate, without isidia	<i>Sticta limbata</i>
Thallus esorediate, with isidia	31.
31. Lower surface pale; cyphellae large; lobes broadly rounded, ± monophyllous	<i>Sticta fuliginosa</i>
Lower surface dark brown to black; cyphellae small; lobes not monophyllous	<i>Sticta weigelii</i>

THE SPECIES

Crocodia Link

Crocodia aurata (Ach.) Link

Description Thallus 50–150 mm diam., in neat rosettes to irregularly spreading, loosely attached, ± subscendent, undulate at margins, more tightly adnate centrally, on Raoul Island corticolous, occasionally saxicolous. Lobes 3–20 × 24–40 mm, irregularly lacinate, ± discrete at margins, becoming imbricate-confluent centrally to ± discrete from margins to centre. Margins

sinuous, undulate, ± subscendent, ± entire to slightly notched, scalloped or crenate, slightly thickened below, with punctiform to linear, yellow pseudocyphellae, or more often becoming sorediate, occasionally minutely lobulate with small, regenerating thalline leaflets. Upper surface bright lettuce-green to ± dark green when wet, pale glaucous-grey, olive-brown or buff when dry; undulate, occasionally shallowly to obscurely ridged or pitted in parts, though never truly faveolate, internal cephalodia visible as ± hemispherical swellings; matt, minutely scabrid-areolate in parts, especially near margins which may also be occasionally very finely

short-tomentose, to distinctly or delicately pruinose, pruina patchy, thin, white. Soredia yellow, coarse, granular often blackened and appearing pseudoisidiate, in primarily marginal, sinuous, labriform soralia which erode conspicuously on the lower surface, also widely scattered at times laminally, in rounded, erose soralia. Isidia, maculae, phyllidia and pseudocyphellae absent. Medulla yellow. Photobiont green, *Dictyochloropsis*. Lower surface yellow when wet, rufous, brownish red when dry, dark-brown centrally; tomentum rather thin and variable, silky, pinkish buff or whitish at margins, thicker and darker to $\pm$ chocolate-brown centrally to rather poorly developed and often lacking centrally; shallowly wrinkled-puckered at margins, $\pm$ smooth elsewhere. Pseudocyphellae 0.5–2.0 mm diam., yellow, numerous, conspicuous, round to irregular, minute, punctiform especially at margins, often confluent centrally, margins very slightly raised, decorticate area flat to shallowly concave, rarely somewhat concave, occasionally with central corticated areas. Pycnidia to 0.1 mm diam., scattered, occasional, minute, punctiform to $\pm$ raised papillate, red-brown when wet, black when dry. Apothecia not seen in Raoul Island specimens.

Kermadec Islands group: Raoul Island: Representative specimens (from 21 collections seen): *T.F. Cheeseman*, BM; *G.B. Rawlings s.n.*, Mar 1940, CHR 374531; Pukekohu Area, *W.R. Sykes* 402/K, 12 Dec 1966, CHR 16123; Accommodation Grounds, *C.J. West* RAO1, 20 Jun 1993, AK 328811; Hutchison's Hut Track, *C.J. West* RAO36, 5 Jul 1993, AK 328819; Denham Bay, *B.W. Hayward* 982983, 22 Nov 1994, AK 227520; Boat Cove Road (near Boat Cove Hut), *P.J. de Lange* K912, 14 May 2011, AK 326673; Sunshine Valley Head, *P.J. de Lange* K935, 16 May 2011, AK 326758.

Comments Although described as abundant by Oliver (1912), his comments may not apply as the only Oliver vouchers we have seen labelled as *C. aurata* are in fact examples of the superficially similar *C. poculifera*. Irrespective, *C. aurata* (and perhaps the allied *C. poculifera*) was evidently not common by the time Sykes recorded it (Sykes 1977). Indeed, comments made by Sykes (1977) suggest that he did not knowingly see *C. aurata* and he regarded it as scarce, though as it transpires he did collect it several times and, further, his cited collection of *Sticta aurata* var. *pallens* is actually *Crocodia aurata* as well. Although none of the nine collections made by West or Hayward discuss this species' abundance either, the sole 1994 collection made by Wright notes that this species was "uncommon". Based on the 2009 and 2011 observations by the author, it now seems that *C. aurata*, whatever its past status, is largely confined to the lower "dry" forest type of Raoul Island, where it is most often found on the taller and/or more exposed Kermadec pōhutukawa trees, and on their exposed roots (especially where the trees abut cliff faces and roadsides), especially in the northern part of the island. Though it can be locally common in these habitats, overall the species has a very patchy distribution on the island, and, if Oliver's published 1912 observations on "*C. aurata*" are correct, then it must have undergone a significant decline over the last 100 or so years. This

decline could reflect changes in the forest structure and density following the progressive eradication of goats from Raoul Island, which was initiated in the 1960s and completed in 1983, since which time the vegetation cover has thickened up considerably, with a corresponding reduction in the extent of habitat for photophilous lichens. There is at least some support for this, in the decline observed in the abundance of another photophilous lichen genus on the island *Ramalina*, and in particular *R. pacifica* Asahina, which Sykes (1977: 48) described as common on the trunks of nīkau (*Rhopalostylis baueri* (Seem.) H. Wendl. et Drude). This is not the situation on Raoul Island now, where representatives of this genus are scarce but notably more common on the smaller, less densely vegetated islands off the north-eastern coastline of Raoul Island (The Meyer and Herald Islets) (de Lange & Blanchon 2015). If these observations are correct, then presumably, populations of *Crocodia aurata* (and *Ramalina*) are also likely to fluctuate following tropical cyclone episodes, which can and do temporarily open up the forest canopy of Raoul Island. In this case, one would expect that this species will temporarily increase its abundance on Raoul Island, following the widespread destruction to the island's forest, caused by the passage of Tropical Cyclone Bune during the last week of March 2011.

With respect to Lobariaceae collections from Raoul Island, *C. aurata* has been frequently confused by collectors with *C. poculifera*. *Crocodia poculifera* is seemingly even scarcer on Raoul Island, being known only from three collections made by Oliver in 1908 and Cooper in 1956. From *Crocodia poculifera*, *C. aurata* is distinguished by its thicker thallus ((200–)250–350(–450) μ m cf. 140–165(–200) μ m in *C. poculifera*), usually broader, less incised, mostly entire thallus lobes, and by the distinctive labriform-linear soralia without isidia.

Crocodia poculifera (Müll.Arg.) D.J. Galloway et Elix

Description Thallus 30–120 mm diam., variable, rosette-forming to irregularly spreading, loosely attached centrally, $\pm$ subscendent and free at margins, corticolous, rarely saxicolous. Lobes somewhat dissected lacinate, 40–100 $\times$ 10–40 mm, discrete and incised-pectinate at margins, contiguous lobes $\pm$ consistently discrete, rarely imbricate, branching very irregular, shallowly to deeply lacerate. Margins slightly thickened below, sinuous, subscendent, uneven, crenate, to irregularly notched, often torn or ragged, $\pm$ eroding to lower surface, furnished with fine, delicate, $\pm$ coralloid pseudoisidia, often distinctly white-tomentose in absence of isidia, tomentum thin, sericeous. Upper surface bright-green, emerald-green to dark-green when moist, pale glaucous-buff when dry becoming brick-red or red-brown on storage in the herbarium, undulate, obscurely wrinkled or pitted in parts, not faveolate, internal cephalodia visible as hemispherical swellings; matt, often somewhat coriaceous, minutely scabrid-areolate in parts, especially toward apices, also sometimes conspicuously minutely pubescent at margins and on large areas of upper surface, tomentum fine, sericeous, white, best seen at lobe margins. Isidia greenish yellow, mainly marginal (rarely on upper surface regenerating from cracks or holes), densely clustered, minutely coralloid,

± corticated but soon eroding and appearing sorediate. Maculae and pseudocyphellae absent. Medulla yellow. Photobiont green, ?*Dictyo chloropsis*. Lower surface pale buff, brownish or pinkish centrally, yellowish at margins becoming distinctly reddish on storage in the herbarium, irregularly tomentose, tomentum white, sericeous, ± dense in parts at margins, elsewhere entirely glabrous from margins to centre, coarsely to finely wrinkled, often minutely faveolate at margins. Pseudocyphellae 0.1–1.0 mm diam., yellow, conspicuous, scattered, frequent, round to irregular, to ± effigurate-sigmoid, often ± erose, decorticate area flat or shallowly concave, sometimes developing granular pseudoisidia. Apothecia not seen not seen in Raoul Island specimens.

Kermadec Islands group: Raoul Island: Representative Specimens (from 3 collections seen): *W.R.B. Oliver s.n.*, 1908, AK 132617 (Duplicate: WELT L04266).

Comments *Crocodia poculifera*, a characteristic species of the palaeotropics and abundant on Norfolk Island (Galloway 1988; 1994; Galloway *et al.* 2001; Galloway & Elix 2012; McCarthy 2013), is evidently rather scarce on Raoul Island (see comments under *C. aurata* above). Most often confused with *Crocodia aurata*, *C. poculifera* is distinguished from that species by its thinner thallus (140–165(–200) µm cf. (200–)250–350(–450) µm in *C. aurata*), which is characteristically more deeply divided, with the lobe margins distinctly incised, while the soredia are derived from densely clustered, mainly marginal isidia.

Podostictina Clem.

Podostictina nermula (D.J.Galloway) de Lange et D.J.Galloway

Description (Fig. 3) Thallus 20–100 mm diam., rosette-forming, loosely attached over whole of surface, margins ± ascendant, muscicolous on Raoul Island. Lobes 5–12 mm wide, complex-imbricate, convex to plane, not easily distinguished, ± coalescing centrally, margins crenate-dentate and complexly sinuous at lobe apices, becoming densely phyllidiate centrally, not sorediate or pseudocyphellate, strongly thickened and slightly inflexed below. Upper surface dark navy-blue when wet, pale-tan when dry, margins of lobes and phyllidia suffused brown, red-brown to ± blackened, shallowly and minutely wrinkled-uneven, ± pitted in places, often minutely areolate-scabrid, sparsely tomentose near lobe apices, tomentum short, velutinous, matt, coriaceous, shining in parts, without isidia, soredia or pseudocyphellae. Phyllidia developing from crenulate margins, primarily marginal, occasionally also on laminal ridges, 0.1–0.4 × 0.4 mm, clustered, simple, tear-shaped at first, soon becoming nodular-glomerulate to ± coralloid-branched; flattened, dorsiventral, lower surface pale yellow, corticated, without pseudocyphellae, upper surface concolorous with thallus or somewhat darkened brownish to blackened. Medulla yellow. Photobiont *Nostoc*. Lower surface pale-yellow or buff, ± uniformly tomentose from margins to centre, tomentum thin, velutinous at margins, thicker and woollier centrally, very evenly and rather



Figure 3. *Podostictina nermula* (P.J. de Lange K682, AK 325472). Note dorsal thallus surface showing phyllidia. Scale bar = 10 mm. Photo: Peter J. de Lange.

densely and tightly developed, whitish to yellowish-buff at margins, red-brown centrally. Pseudocyphellae 0.2–0.5 mm diam., yellow, pulverulent, convex, conspicuously projecting above tomentum, sparse, scattered, rarely present near margins, more common and prominent centrally. Apothecia not seen in Raoul Island specimen.

Kermadec Islands group: Raoul Island: Specimen seen: Smiths Bluff Track: P.J. de Lange K682, 15 May 2011, AK 325472.

Comments Judging from the single fragmentary collection of this distinctive species and its absence from any earlier collections, *Podostictina nermula* is one of the more uncommon taxa on Raoul Island. The sole collection came from the fallen upper canopy branches of cyclone-damaged Kermadec pōhutukawa trees. This collection represents a significant range extension of an otherwise poorly-known, montane, Australasian species known from continental New Zealand from only a few collections: from the Boyle River, near Lewis Pass, South Island; the Kaweka Ranges, North Island; and from the Blue Mountains, Australia (Galloway 1988; 2007; Galloway *et al.* 2001; P.J. de Lange unpubl. data). On Raoul Island, *Podostictina nermula* is most likely to be confused with *Podostictina pickeringii*. *Podostictina nermula*, being a cyanobacterial species, is distinguished from *Podostictina pickeringii* by the dark navy-blue rather than bright-green thallus.

Podostictina pickeringii (Tuck.) Moncada et Lücking

Description Thallus orbicular, rosette-forming to irregularly spreading 50–120 mm diam., Raoul Island collections corticolous, loosely to tightly attached centrally, margins ± free. Lobes usually ± rounded and ragged-incised, 5–20 × 5–20 mm. Margins notched and incised, sinuous, phyllidiate, sinuses not apparent,

± semicircular to imbricate. Upper surface bright-green or glaucous-green when moist, greyish yellow when dry, ± convex-undulate, shallowly wrinkled or pitted, occasionally irregularly faveolate, chartaceous to somewhat coriaceous when wet, thin and brittle when dry, dull or glossy, smooth, soredia, maculae, and pseudocyphellae absent. Isidia mainly marginal, then occasionally spreading to lamina, minute, terete at first (≤ 0.1 mm tall), simple, soon bifurcating, becoming flattened-coralloid, phyllidiate or palmate-squamiform or ± pectinate, ± constricted at base, often forming a dense marginal crust spreading on to lamina and occasionally obscuring thallus. Phyllidia 0.1–3.0 mm tall, flattened, dorsiventral, upper surface convex, lower surface pale yellow, margins ridged, apices inflated, occasionally with minute, punctiform pseudocyphellae at margins and on lower margins. Medulla yellow. Photobiont green. Lower surface pale yellowish to yellow-white at margins, darker yellow to yellow-brown centrally, glabrescent with a glabrous (or nearly so) broad margin, tomentum sparse, rather short and even, velutinous white to red-brown. Pseudocyphellae 0.05–0.5 mm diam., yellow, scattered, fleck-like, round to irregular, sunk in tomentum, often not apparent, flat to ± papillate-verruciform, decorticate area flat to convex. Pycnidia ≤ 0.1 mm diam., scarce in Raoul Island specimens, those seen scattered, laminal, minute, mostly punctate-impressed, a few ± papillate, ostiole red-brown. Apothecia not seen in Raoul Island specimens.

Kermadec Islands group: Raoul Island:
Representative Specimens (from 4 collections seen):
 Fishing Rock, Boat Landing: *P.J. de Lange K499*, 10 May 2009, AK 306115; Smiths Bluff Track, *P.J. de Lange K986*, 15 May 2011, AK 327320.

Comments Although collected from four widely separated sites, *Podostictina pickeringii* is not common

on Raoul Island. There it appears to be exclusively corticolous on Kermadec pōhutukawa, where it was collected in association with *Crocodia aurata*, *Podostictina nermula*, *Pseudocyphellaria argyracea*, *Parmotrema* spp., *Sticta squamata* and the fern *Pyrrosia eleagnifolia* (Bory) Hovenkamp. *Podostictina pickeringii* could only be confused with *Podostictina nermula* which differs by its blue-green photobiont, presence of only marginal phyllidia and absence of isidia.

Pseudocyphellaria Vain.

Pseudocyphellaria argyracea (Delise) Vain.

Description (Fig. 4) Thallus 10–100 mm diam., ± rosette-forming, orbicular, corticolous, muscicolous or saxicolous, closely attached to bark or rocks, loosely attached and ± free when on twigs or amongst mosses. Lobes 3–20 × 10–30 mm, irregularly lacinate to broadly rounded, ± discrete to imbricate. Margins sinuous, often slightly revolute and very slightly ridged on the lower surface, entire or minutely crenulate-incised, usually delicately isidiate. Upper surface grey-blue or grey-black, very minutely mottled when moist, pale olivaceous-grey to red-brown when dry, plane, undulate or minutely and irregularly wrinkled, smooth or minutely roughened, fragile, sorediate and isidiate, without maculae or phyllidia. Pseudocyphellae to 3 mm diam., laminal, scattered, punctiform, becoming sorediate, ulcerose, round to irregular, flat to convex, soredia white, coarsely granular. Pseudoisidia minute, styliform, terete, simple to coralloid, at first clustered at margins of pseudocyphellae and at apices and margins of lobes, in some specimens spreading more widely to form a diffract-coralloid crust, dark brown, mainly corticate, rarely sorediate below or occasionally forming expanded and flattened regenerating lobules. Medulla white. Photobiont *Nostoc*. Lower surface pale fawnish



Figure 4. *Pseudocyphellaria argyracea* (*P.J. de Lange K915*, AK 326676). **A.** Whole specimen showing the dorsal thallus surface with circles indicating location of apothecia. **B.** Close-up apothecia. **C.** Dorsal view of thallus showing isidiate pseudocyphellae. **D.** Ventral view of thallus showing pseudocyphellae. Scale bars = 10 mm. Photos: Jeremy R. Rolfe.

or pinkish white, shallowly wrinkled or pitted, $\pm$ densely tomentose from centre to margins, tomentum whitish, sericeous, entangled, rather shaggy. Pseudocyphellae scarce or absent, minute, white, punctiform. Apothecia rare or absent (only seen once), when present laminal, scattered, sessile, constricted at base, rounded 0.1–2.5 mm diam., exciple minutely to coarsely verrucose-areolate, obscuring disc when young, pale-buff to brown when dry, $\pm$ translucent when moist; disc pale yellow-brown when moist, pale to dark red-brown when dry, consistently darker than, and contrasting with, margin, shallowly concave at first, plane to subconvex at maturity, matt, smooth, epruinose. Epithecium dilute yellow-brown, unchanged in K, 8.5–12.0 μ m thick. Hymenium colourless, 80–95 μ m tall. Ascospores colourless to pale-brown, dark red-brown when over-mature, ellipsoidal with pointed apices, 20–32 $\times$ 5.0–8.5 μ m.

Kermadec Islands group: Raoul Island: Representative specimens (from 35 collections seen): 1956, R.C. Cooper 44242, AK 328791; M.A. Nolan s.n., Jul 1959, CHR 112487; Accommodation grounds, C.J. West RAO2, 20 Jun 1993, AK 328812; Denham Bay (northern end), C.J. West RAO71, 5 Aug 1993, AK 328832; track to Tui Lake, B. W. Hayward s.n., 21 Nov 1994, AK 223969; near bottom of Sunshine Valley, on true left, B. W. Hayward s.n., 24. Nov 1994, AK 227549; Fishing Rock Road, crater wall near Ammunition Store Cliff, P.J. de Lange K504, 10 May 2009, CHR 604773; Boat Cove Road (near Boat Cove Hut), P.J. de Lange K915, 14 May 2011, AK 326675; Moumoukai Summit, P.J. de Lange K912, 14 May 2011, AK 326680.

Comments *Pseudocyphellaria argyracea* is a characteristic, laminally pseudocyphellate, pseudoisidiate white-medulla species that is widespread in the palaeotropics (Galloway 1991; 1994a; Galloway & James 1986). *Pseudocyphellaria argyracea* was not previously recorded as fertile (see comments by Galloway 1994a) and so the description provided here of the apothecia is

the first for the species. *Pseudocyphellaria argyracea* is well-represented in collections from Raoul Island and is the most common species of the genus there. It is also this species which seems at least in part (see *P. punctillaris*) to have been confused, in earlier literature on the island's lichens, with *P. intricata* (as *Sticta intractata* f. *subargyracea*) (*sensu* Sykes 1977 but not it seems *sensu* Oliver 1912) and by field collectors with *P. episticta*, *P. knightii* D.J.Galloway and *P. lividofusca* (Kremp.) D.J.Galloway et P.James. *Pseudocyphellaria argyracea* is a rather variable and somewhat “weedy” tropical species that is scarce in continental New Zealand (Galloway 1988; 1994a; 2007). On Raoul Island, although common and widespread, it is perhaps most common in the “dry” forest (as defined by Oliver (1910) and Sykes (1977)). Here it associates with *Crocodya aurata*, and is a conspicuous component of the trunks and branches of Kermadec pōhutukawa (*Metrosideros kermadecensis* W.R.B.Oliv.), especially where these trees abut road and track sides, ridgelines and cliff tops.

Pseudocyphellaria bartlettii D.J.Galloway

Description (Fig. 5) Thallus 30–120 mm diam., orbicular, loosely attached centrally, margins free, on Raoul Island exclusively corticolous. Lobes 10–30 mm diam., broadly rounded, discrete to subimbricate. Margins entire to minutely crenate, notched or incised, sorediate and eroding back onto lower surface, sometimes $\pm$ inrolled. Upper surface dark leaden-grey when wet, with white maculae in well-defined reticulate patterns giving a marbled, pale olivaceous-grey, grey-buff or brownish red when dry (maculae less obvious when dry), weakly to strongly reticulate-faveolate or wrinkled-plicate towards margins, $\pm$ undulate to shallowly pitted or wrinkled centrally, matt, rather fragile and chartaceous when dry, sorediate, pseudocyphellate, without isidia or phylidia. Soredia 0.2–2.0 mm diam., in scattered, laminal erose soralia, becoming confluent and $\pm$ linear at margins and along reticulate ridges, brownish or grayish, gnarled-glomerulate, minutely style-formed, pseudoisidiate, $\pm$

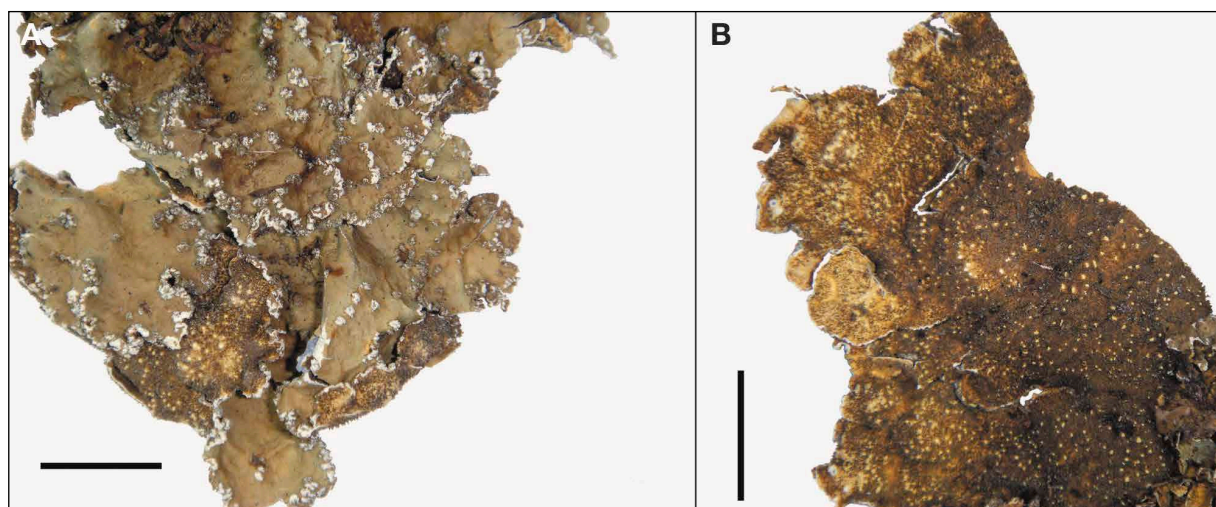


Figure 5. *Pseudocyphellaria bartlettii* (P.J. de Lange K921, AK 326682). A. Dorsal thallus surface showing soredia. B. Ventral thallus surface showing pseudocyphellae and dense tomentose surface covering. Scale bars = 10 mm. Photos: Peter J. de Lange

coarsely granular, becoming eroded-white at maturity, often densely clustered near margins and obscuring lamina. Pseudocyphellae occasional, scattered, inconstant, minute, pinprick-like, white, fading to cream with age, on ridges near margins of lobes. Medulla white. Photobiont *Nostoc*. Lower surface distinctly bullate, minutely wrinkled or pitted below tomentum, pale yellowish buff and $\pm$ glabrous in narrow zone at margins, or $\pm$ uniformly buff or dark red-brown to black. Pseudocyphellae ≤ 0.1 mm diam., scattered, sparse to moderately numerous, eroded-papillate appearing verruciform, decorticate area flat, white or very pale cream, level with or slightly embedded in tomentum. Apothecia not seen.

Kermadec Islands: Raoul Island: Specimen seen: Prospect Hill: *P.J. de Lange K921*, 15 May 2011, AK 326682.

Comments This is apparently the first collection of this widely distributed, palaeotropical species (Galloway 1988; Galloway & Arvidsson 1990; Galloway *et al.* 2001) from the Kermadec Islands. The sole collection of *P. bartlettii* came from the upper branches of a cyclone-toppled Kermadec pōhutukawa, a habitat which is normally inaccessible to the field collector on Raoul Island. This apparent habitat preference may explain its absence from past collections. In the field on Raoul Island, *P. bartlettii* is most likely to be confused with *P. intricata* and *P. haywardiorum*. From *P. intricata*, *P. bartlettii* is distinguished by its broader, entire lobes, and faveolate surface bearing pseudoisidiate, punctiform laminal or reticulate laminal and marginal soralia. For distinctions between *P. bartlettii* and *P. haywardiorum* see under that species.

Pseudocyphellaria carpoloma (Delise) Vain.

Description Thallus 50–500 mm diam., irregularly spreading, loosely entangled in often extensive festoons, on Raoul Island exclusively corticolous. Lobes 30–80 $\times$ 10–70 mm, lacinate-elongate, plane to subconcave-subcanaliculate, discrete to entangled, $\pm$ dichotomously branching, tapering from centre to periphery, apices blunt or pointed, often furcate, or $\pm$ shallowly notched or crenate. Margins entire, thickened below, with sparse to frequent, verruciform, conical, yellow pseudocyphellae projecting, decorticate area strongly to weakly pigmented. Upper surface bright lettuce-green to olive-green when wet, suffused brownish in parts, especially towards the apices of lobes, pale greyish green when dry; strongly faveolate, ridges rather smooth, faveolate deep to shallow, matt, smooth, isidia, phylidia, maculae, pseudocyphellae, and soredia absent. Medulla white. Photobiont green. Lower surface pale yellowish at margins, buff, brownish to dark red-brown centrally, margins with a conspicuously and $\pm$ raised continuously raised rim, wrinkled, bullate, $\pm$ glabrous slightly tomentose centrally, tomentum pale becoming darker centrally, sericeous. Pseudocyphellae ≤ 0.1 mm diam., scattered, minute, on ridges, $\pm$ verruciform, decorticate area flat, yellow. Pycnidia sparse to frequent, on upper surface, occurring as small (≤ 0.5 mm diam.),

hemispherical swellings, apical pore minute, red-brown or black, surrounded by a pale marginal zone. Apothecia marginal or somewhat compressed, disc matt, pale to dark red-brown when wet, black when dry, imperforate, epruinose, exciple pale flesh pink or whitish, pubescent at first, then roughened-sparse verrucose to $\pm$ scabrid, margins conspicuously dentate-striate often obscuring disc. Exciple without photobiont, of colourless, $\pm$ isodiametric, thick-walled cells arranged in parallel, radiating rows from centre to periphery, in basal parts cell rows elongating to form short tomental hairs, cells round to irregular 4.5–9.0 μ m diam., walls to 2.5 μ m thick, tissue 45–65 μ m thick. Hymenium 80–90(–100) μ m tall, colourless; epithecium pale red-brown or yellow-brown, 6.5–11.5 μ m paler in K. Asci cylindrical to clavate, 70–78(–85) $\times$ 12–16 μ m. Ascospores grey-brown, oval-ellipsoid, thickened 1-septate, septum 4.5–7.0 μ m thick, at maturity 3-septate (20–)22–25(–27) $\times$ 7–11 μ m.

Kermadec Islands: Raoul Island: Specimen seen: Moumoukai Track: *P.J. de Lange K219*, 8 May 2009, AK 305104.

Comments In northern New Zealand and Norfolk Island this is an especially common species of coastal and lowland forest (Galloway 1985; 1988; 1994a; 2007; Galloway & James 1986; Galloway & Hayward 1987; McCarthy 2013) and so its presence on the Kermadec Islands would be expected. Although *Pseudocyphellaria carpoloma* is present on Raoul Island, it is evidently rather scarce as it is absent from past collections made by others and it was seen only once during the May 2009 visit by the author. In May 2011, despite dedicated searching, no further specimens were found. From those other species of *Pseudocyphellaria* recorded here from Raoul Island, *P. carpoloma* is easily distinguished by the bright-green upper thallus surface, and distinctive, raised, yellow pseudocyphellae on the lower thallus surface and along the lobe margins.

Pseudocyphellaria chloroleuca (Hook.f. et Taylor) Du Rietz

Description Thallus 50–300 mm diam., orbicular to irregular spreading, on Raoul Island exclusively corticolous, loosely attached centrally. Margins and apices free. Lobes 2–12 $\times$ 10–150 mm, linear-elongate, very variable, apices discrete, complex-imbricate centrally, slightly convex to strongly canaliculated. Margins entire to ragged, lobulate-incised, sparsely to densely isidiate, slightly to strongly revolute, ascending. Upper surface bright lettuce-green when moist, pale greenish grey suffused red-brown towards apices when dry becoming yellow-brown on storage, irregularly wrinkled to shallowly faveolate, matt, minutely granular-papillate, isidiate, without soredia, maculae, phylidia or pseudocyphellae. Isidia 0.5–2.0 $\times$ 0.2 mm, slender, rather fragile, initially simple, terete and fingerlike, somewhat flattened, at first often in groups of 3–5, then branching and becoming coralloid, mainly marginal and there often densely developed, in small clumps laminally or originating from breaks and fissures,

some times densely covering thallus in a thick crust, eventually eroding and then leaving small pits. Medulla white. Photobiont green. Lower surface white or pale buff-pink, glabrous, wrinkled-plicate to $\pm$ bullate, rarely thinly and patchily white-tomentose centrally, margins distinctly ridged. Pseudocyphellae ≤ 0.1 mm diam., white, minute, numerous, not apparent, punctiform, fleck-like, flat or slightly punctuate. Pycnidia scarce, marginal and on thallus ridges, minute, not apparent, punctiform red-brown, not papillate. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Representative specimens (from 3 collections seen): Moumoukai, eastern side of Summit: *P.J. de Lange K518*, 8 May 2009, AK 326859.

Comments *Pseudocyphellaria chloroleuca* seems to be uncommon on Raoul Island despite the seeming abundance of suitable habit there, and the fact that this species is often found in similar habitats in coastal areas of northern New Zealand, Norfolk and Lord Howe Islands (Galloway 1986; 1988; 2007; Galloway & Hayward 1987; Elix & McCarthy 1998; McCarthy 2013). On Raoul Island, *P. chloroleuca* is most likely to be confused with *P. homalosticta* and *P. multifida*. From *P. homalosticta*, *P. chloroleuca* is easily distinguished by the absence of pseudocyphellae from the upper thallus surface and lack of phyllidia, and from *P. multifida* by the isidiate thallus.

Pseudocyphellaria crocata (L.) Vain.

Description Thallus 200 mm diam., rosette-forming. On Raoul Island exclusively corticolous, loosely attached centrally, margins free. Lobes 2–35 $\times$ 10–45 mm, broad, $\pm$ deeply lacinate and canaliculate. Margins sinuous, $\pm$ subascending and indented, ragged, incised, slightly thickened below, sparingly sorediate, soralia punctiform, eroding lower surface, soredia yellow, farinose. Upper surface dark chocolate-brown when moist, pale glaucous-grey suffused red-brown when dry, plane to $\pm$ undulate, shallowly and irregularly wrinkled to $\pm$ faveolate, ridges smoothly rounded, smooth, coriaceous, matt to $\pm$ glossy in parts, $\pm$ glabrous, without isidia, phyllidia or pseudocyphellae; maculate and sorediate. Maculae occasional, delicate, white, reticulate, following ridges. Soredia sparse, more common toward centre of thallus, variable, randomly distributed, occurring as erose soralia up to 2.2 mm diam., farinose, yellow, central parts eroding yellow-granular erupting from pseudoisidiate warts on laminal ridges. Medulla white. Photobiont *Nostoc*. Lower surface pale-cream to yellowish at margins, red-black centrally, wrinkled-undulate, $\pm$ weakly bullate. Pseudocyphellae 0.1–1.2 mm diam., sparse, $\pm$ convex, sunk in tomentum or slightly projecting above. Apothecia not seen in Raoul Island specimen.

Kermadec Islands: Raoul Island: Specimen seen: Denham Bay, overlooking crater: *P.J. de Lange K946*, 18 May 2011, AK 326781.

Comments Only collected once from a fallen nīkau *Rhopalostylis baueri*. *Pseudocyphellaria crocata* is a widespread, highly variable species (Galloway 1988; 1994a) of the palaeo- and neotropics which is widespread in the Pacific Basin. The sole Raoul Island collection is of a form which is only sparingly sorediate (see comments on variation by Galloway 1994a), which is markedly different to the typical condition seen in New Zealand collections of this species (though similar forms have been collected from Tuhua (Mayor Island) (de Lange *et al.* 2012) and from East Cape (P.J. de Lange unpubl. data, see CHR 625110). From those other species of *Pseudocyphellaria* recorded from Raoul Island, *P. crocata* is easily distinguished by the dark chocolate-brown thallus, and sparse, widely scattered, yellow, punctiform soralia.

Pseudocyphellaria dissimilis (Nyl.) D.J.Galloway et P.James

Description Thallus 50–250 mm diam., irregularly spreading to $\pm$ orbicular, loosely attached centrally, margins free, ascending, Raoul Island collection saxicolous. Lobes 1–12 $\times$ 10–100 mm, variable, $\pm$ linear-elongate to shallowly rounded, branching $\pm$ subdichotomous to irregular, apices $\pm$ discrete to centrally complex-imbricate, canaliculate, basally divided into numerous, $\pm$ strap-like phyllidia. Margins entire, sinuous, upper surface smoothly rounded, $\pm$ thickened below, sinuses rounded to acute, mostly prominent, becoming isidiate/phyllidiate, without soredia or pseudocyphellae. Upper surface dark red-black, distinctly paler centrally, with minute, white, marbled maculae when moist, drying grey-blue, smooth or shallowly wrinkled, $\pm$ glossy. Isidia initially marginal then laminal, 0.5–3.5 $\times$ 0.1 mm diam., simple, terete, becoming densely crowded, coralloid-branched and eventually flattened and $\pm$ phyllidiate. Phyllidia mostly marginal, with constricted bases, simple, strap-like to palmate-squamiform. Maculae laminal, minute, marbled, sparse, irregular, pale buff or brown Photobiont-free zones often present as extensive blotches or patches. Medulla white. Photobiont *Nostoc*. Lower surface with pale buff to white, glabrous, glossy margins, centrally pale brown to dark brown, costate and tomentose, tomentum short, white, velutinous, somewhat sparse, glistening. Pseudocyphellae 0.01–0.1(–0.3) mm diam., white, randomly sparsely scattered, flat, fleck-like, margins indistinct, round, oval to $\pm$ sigmoid, decorticate area convex or plane, level with, or slightly projecting above tomentum. Apothecia 0.1–2.5 mm diam., shallowly concave to plane, disc dark red-brown, smooth, epruinose, exciple whitish-buff to flesh-coloured, $\pm$ scabrid-areolate, with $\pm$ crenulate margins. Exciple cellular, cells thick-walled, colourless to pale straw-yellow, 8–27 μ m diam. Hypothecium 55–62 μ m thick, pale yellow-brown to pale straw-yellow, not changing in K. Thecium colourless 90–102 μ m tall; epithecium yellow-brown to pale red-brown, unchanged in K, to 12 μ m thick. Asci 77–95 $\times$ 11–15 μ m. Ascospores pale yellow-brown, fusiform-ellipsoid, 1–3-septate, straight or slightly curved, apices rounded or pointed, 20.5–29.5 $\times$ 7.0–9.0 μ m.

Kermadec Islands: Raoul Island: Specimen seen: Ravine 8, “Hebe Site”: *P.J. de Lange K497*, 9 May 2009, AK 306114.

Comments *Pseudocyphellaria dissimilis* is so far known from only the one collection. From the other species of *Pseudocyphellaria* recorded here from Raoul Island, *P. dissimilis* is easily distinguished from all except *P. insculpta*, by the isidiate/phyllidiate condition and the upper surface which is red-black in colour, and lacks pseudocyphellae. From the superficially similar *P. insculpta*, *P. dissimilis* is distinguished by the lack of phyllidia (though in some specimens the isidia may become isidiate/phyllidiate), and especially by the smooth or shallowly wrinkled rather than distinctly dimpled, punctate-impressed upper thallus surface.

Pseudocyphellaria episticta (Nyl.) Vain.

Description Thallus rosette-forming to irregularly spreading, 50–200 mm diam., closely attached centrally and to margins, apices slightly free and subscendent, corticolous. Lobes linear-elongate, deeply indented, rather ragged, 5–15 × 25 mm, apices and central parts complex-imbricate, folded. Margins lacerate-indented, ragged, rarely ± entire and shallowly rounded, usually sinuous and ± ascending, crisped, crenate to ± densely coralloid-phyllidiate, very slightly thickened below. Upper surface bright lettuce-green when moist, pale grey-green to fawn when dry, undulate, ± convex to subcanaliculate or plane, minutely wrinkled and/or pitted, not faveolate, matt or shining, rather coriaceous, without soredia, isidia or maculae, pseudocyphellate. Pseudocyphellae laminal, scattered, white punctiform, fleck-like up to 0.05 mm diam., rarely in older parts. Phyllidia mainly marginal, simple at first and ± constricted at base, flattened, becoming coralloid-branched, 0.05–0.5 mm tall, often clustered, imbricate or forming extensive crusts, very occasionally on lamina and then rather scattered and irregular in appearance, not, or rarely, associated with pseudocyphellae. Medulla white. Photobiont green. Lower surface whitish to pale buff, darker centrally, tomentose from margins to centre or occasionally with a narrow, glabrous, slightly wrinkled, shining marginal zone, tomentum short, ± even, velutinous or ± arachnoid-woolly, pale whitish-buff, glistening, to brownish or grey-brown. Pseudocyphellae white, sparse, occasional to rare, sunk in tomentum or scattered, fleck-like at or near margins, decorticate area flat 0.05–0.2 mm diam. Apothecia not seen in Raoul Island collection.

Kermadec Islands: Raoul Island: Specimen seen: Boat Cove Track (near Boat Cove Hut): *P.J. de Lange K949*, 14 May 2011, AK 326809.

Comments On Raoul Island, *Pseudocyphellaria episticta* is known only from the one small collection. Because this is a widespread, common New Zealand species (albeit it one hitherto considered endemic to that archipelago (Galloway 1988)) which is very common in northern New Zealand and such offshore island groups

as the Three Kings (Galloway & Hayward 1987), it is a species that one would expect should be on the Kermadec Islands, though it is notable, it has not yet been recorded from either Lord Howe or Norfolk Island groups (Elix *et al.* 1992; Elix & McCarthy 1998; Galloway 1988; 1994a; 2007; Galloway *et al.* 2001; McCarthy 2013). The green, distinctly pseudocyphellate upper surface, and densely coralloid-phyllidiate lobe margins serve to distinguish this species from the other superficially similar species of *Pseudocyphellaria* (*P. chloroleuca*, *P. multifida* and *P. reineckeana*) on Raoul Island except from *P. homalosticta*. From *P. homalosticta*, *P. episticta* differs by its closely attached, spreading thallus rather than loosely attached thallus with subdichotomously divided ascending lobes, and by the often well-developed and densely coralloid-phyllidiate lobe margins.

Pseudocyphellaria glabra (Hook.f. et Taylor) C.W.Dodge

Description Thallus rosette-forming to irregularly spreading, 50–250(or more) mm diam., loosely attached centrally, margins closely attaching to ± ascending, corticolous. Lobes variable, narrowly lacinate, strap-like and discrete from margins to centre 2–17 × 4–15 mm, and ± imbricate-complex from near margins to centre. Margins entire, ± sinuous to crenulate or shallowly or deeply notched or incised and becoming isidiate with age to somewhat erose-glomerulate. Upper surface lettuce-green when moist, yellowish-fawn to whitish often suffused brown-black to blackish at margins when dry, undulate, shallowly wrinkled or obscurely ridged in parts, not faveolate, matt to ± glossy, finely dimpled, without soredia, maculae, phyllidia or pseudocyphellae. Isidia sparse to copiously developed, mainly marginal or form surface cracks, terete, finger-like, mainly simple, occasionally furcate, 0.5–1.0 mm tall, often crowded-congested, Medulla white. Photobiont green. Lower surface smooth to irregularly wrinkled-shining, glabrous, whitish to pale buff in a wide marginal zone, grading through dark chocolate-brown to black centrally. Pseudocyphellae common, prominent, white, round to irregular, 0.1–1.0 mm diam., raised, verruciform-papillate, margins of papillae free from tomentum, decorticate area flat or shallowly excavate. Pycnidia scattered, mainly marginal, some submarginal, punctate-impressed, inconspicuous, ≤ 0.1 mm, central ostiole pale red-brown, minute, surrounded by a slightly raised margin concolorous with thallus, often eroding and leaving small pits. Apothecia not seen in Raoul Island collection.

Kermadec Islands: Raoul Island: Specimen seen: Boat Cove Road, ca. 800 m northwest of Moumoukai Track start: *P.J. de Lange K507* & *D.C. Havell*, 8 May 2009, AK 306166.

Comments *Pseudocyphellaria glabra*, a widespread austral species (Galloway 1988; 1992; 2007; 2008), is currently known from Raoul Island from just the one collection. Although it should be more widespread on the island, it was not seen there again; despite dedicated searching for it during the May 2011 field survey. Primarily a cool temperate species, *P. glabra* is

not known from the Three Kings Islands (Galloway & Hayward 1987) and is not very common in Northland, New Zealand (Galloway 1988). In this regard, its occurrence on the Kermadec Islands, though surprising, has its parallels with the Raoul Island occurrence of *Podostictina nermula*, another cool temperate species (Galloway 1988; 2007; Galloway *et al.* 2001). From the other species of *Pseudocyphellaria* recognised here from Raoul Island, *P. glabra* is easily distinguished by the combination of having, when fresh, a green, non-pseudocyphellate, distinctly isidiate upper surface, characteristically ragged, isidiate lobe margins, and by the dark chocolate-brown to black lower surface with prominent, white pseudocyphellae.

Pseudocyphellaria godeffroyi (Kremp.) D.J.Galloway

Description (Fig. 6) Thallus rosette-forming, wide-spreading, 50–250 mm diam., closely attached to substrate, margins $\pm$ free. Lobes 8–20 mm diam., broadly rounded, contiguous to over-lapping at margins, imbricate centrally. Margins entire, sinuous, shallowly to deeply notched, slightly thickened. Upper surface dark malachite green-blue, suffused brownish at apices when wet, pale buff-brown when dry, undulate, irregularly pitted or shallowly wrinkled in places, minutely roughened to verrucose-scabrid (especially at apices), apices minutely white-tomentose, coriaceous, tough when dry, pliable and flabby when wet, pseudocyphellate, without isidia, phyllidia or soredia. Pseudocyphellae 0.2–1.5 mm diam., white, large and prominent, rounded to irregular, scattered, occasional to frequent, margins $\pm$ ulcerose with a raised margin, decorticate area flat to concave. Medulla white. Photobiont cyanobacterial. Lower surface pale yellowish buff or brownish at margins, darkening centrally, tomentum uniformly shortly velutinous, very even, pale-buff to dark red-brown. Pseudocyphellae 0.1–2.0 mm diam., white, prominent, scattered or more often crowded, minute, at margins smaller (0.1–0.3 mm), centrally larger (1–2 mm), margins very shallowly raised, concolorous with lower cortex, decorticate area flat to concave, distinctly granular-roughened. Pycnidia to 0.5 mm diam., prominent, solitary or crowded, marginal and laminal, raised, hemispherical, ostiole 0.1–2.0 mm diam., red-brown. Apothecia not seen in Raoul Island collection.



Figure 6. *Pseudocyphellaria godeffroyi* (P.J. de Lange K503 & D.C. Havell, CHR 604777), ventral surface. Scale bar = 10 mm. Photo: Peter B. Heenan

Kermadec Islands: Raoul Island: Specimen seen: Moumoukai, eastern side of summit: P.J. de Lange K503 & D.C. Havell, 8 May 2009, CHR 604777.

Comments Prior to this collection, *Pseudocyphellaria godeffroyi* was considered endemic to the Fijian archipelago (Galloway 1994a). From the other blue-green *Pseudocyphellaria* with a white medulla recorded here from Raoul Island, *P. godeffroyi* is easily recognised by the large, evenly circular, mostly firmly appressed, dark malachite glaucescent, areolate-scabrid thallus, which is neither sorediate nor isidiate nor phyllidiate. On Raoul Island, it is so far known only from a single May 2009 collection made in the "wet" forest surrounding the upper slopes of Moumoukai. That collection came from the lower trunk of a massive Kermadec pōhutukawa, festooned in epiphytic ferns and thick cushions of bryophyte and lichens – especially *Pseudocyphellaria argyracea*. During the May 2011 expedition to the Kermadec Islands, this tree was relocated, unfortunately it was severely cyclone-damaged and much of the luxuriant bryophyte, fern and lichen growth that had covered it in 2009 had gone. Despite careful searching of this tree, and indeed numerous other trees in the general vicinity, no further specimens of *P. godeffroyi* were found.

Pseudocyphellaria haywardiorum D.J.Galloway

Description Thallus $\pm$ orbicular, 30–80 mm diam., corticolous, $\pm$ loosely attached from margins to centre, margins $\pm$ weakly ascending, Lobes $\pm$ rounded, 2–20 $\times$ 4–25 mm, discrete, contiguous, $\pm$ complex-imbricate and clustered. Margins sinuous, $\pm$ ascending, irregular, delicately to coarsely crenate-lacerate, slightly thickened below; lower surface sometimes bearing clustered soredia and $\pm$ grey-white, erose. Upper surface dark grey-blue to blue-black or brown-black, notably darker at lobe apices (often tinged brownish) when wet, dark olivaceous-brownish to glaucescent-yellow or isabelline centrally and with margins dark greyish when dry, plane to shallowly undulate, $\pm$ wrinkled-faveolate at apices, elsewhere conspicuously punctuate-impressed, sparsely bearing minute, pale-buff papillae, matt, smooth or minutely arachnoid in parts, coriaceous to brittle-coriaceous when dry, soft and flabby when wet, sorediate, maculate, without phyllidia or pseudocyphellae. Maculae minute, scattered, irregular, whitish-buff, forming distinct reticulate patterns toward lobe apices, occasionally developed centrally as larger, photobiont-free patches. Soredia dark brownish blue, to glaucescent-grey, often eroding white, coarsely granular to crowded-pseudoisidiate, present in scattered efflorescent clusters to 0.5 mm diam., often dense and spreading, delimited in round to irregular, laminal soralia, or in $\pm$ sinuous, linear, marginal soralia, or $\pm$ coalescent, forming broad areas of sorediate to pseudoisidiate crust. Medulla white. Photobiont *Nostoc*. Lower surface $\pm$ bullate or irregularly undulate-wrinkled, pale buff or brownish and $\pm$ glabrous in a narrow, marginal zone, elsewhere evenly, densely tomentose, tomentum red-brown to black-brown, short and velutinous near margins, longer and woolly centrally. Pseudocyphellae well-delimited from tomentum,

common centrally, marginally sparse, 0.1–2.0 mm diam., white, conspicuous, with a distinctive raised, pale-buff, glabrous margin, decorticate area concave to convex, granular. Apothecia not seen in Raoul Island collections.

Kermadec Islands: Raoul Island: Specimens seen: Boat Cove Road (near Boat Cove Hut): *P.J. de Lange K913*, 14 May 2011, AK 326674; Denham Bay Track, *P.J. de Lange K943*, 18 May 2011, AK 326775.

Comments *Pseudocyphellaria haywardiorum*, a palaeotropical species (Galloway 1994a; Galloway *et al.* 2001; McCarthy 2013), is so far known from Raoul Island from two fragmentary collections collected from amongst the debris of cyclone-toppled Kermadec pōhutukawa. These collections suggest that *P. haywardiorum* is a high forest canopy inhabitant. Of those species of *Pseudocyphellaria* recorded here from Raoul Island, *P. haywardiorum* is most likely to be confused with *P. bartlettii* and *P. intricata*. From *P. intricata*, *P. haywardiorum* is distinguished by the punctuate-impressed upper surface, and by the more or less bullate lower surface, conspicuously covered in prominent, large, raised pseudocyphellae (these are characters which also distinguish it from the superficially similar, and on Raoul Island, very common *P. argyracea*). From *P. bartlettii*, *P. haywardiorum* is distinguished by the punctuate-impressed rather than reticulate-faveolate upper surface, and by the conspicuous, large, raised rather than minute, punctiform pseudocyphellae. *Pseudocyphellaria bartlettii* also has distinctly broader, rounded lobes and a less ragged, neater rosette-forming growth habit.

Pseudocyphellaria homalosticta Vain.

Description (Fig. 7) Thallus 30–140 mm diam., irregularly spreading, loosely attached centrally, margins and apices ascending. Lobes 1–8 mm diam., subdichotomously to intricately branched. Margins entire at apices, soon becoming isidiate-phyllidiate or proliferating into long,

narrow lobules, slightly thickened, ridged below, scattered white pseudocyphellae present, sometimes appearing ± sorediate. Upper surface lettuce-green when wet, pale olive-green or brownish when dry, fragile, very brittle and easily damaged when dry, pliable when wet, maculae and soredia absent. Isidia 0.1–5 mm diam., common, variable, terete, simple at first becoming 1–3-branched to coralloid, becoming dorsiventral and phyllidiate, primarily marginal, rarely developing from margins of laminal pseudocyphellae. Phyllidia to 5 mm long, developing from terete isidia or intermixed and independent of them, dorsiventral, with minute pseudocyphellae below, elongate. Pseudocyphellae ≤ 0.1 mm diam., white, scattered, punctiform, ± flat, occasionally with isidia developing from margins. Medulla white. Photobiont green. Lower surface pale whitish buff at margins, darkening centrally, occasionally ± blackened centrally, glabrous, matt or glossy from margins to centre or with scattered, thin tomentum centrally. Pseudocyphellae 0.1–0.3 mm diam., white, prominent, widely scattered, conically verruciform, rounded, margins not prominent. Pycnidia ≤ 0.1 mm diam., hemispherical, solitary, ± marginal, ostiole red-brown, punctuate. Apothecia not seen in Raoul Island collections.

Kermadec Islands: Raoul Island: Specimens seen: Prospect Hill: *P.J. de Lange K927*, 15 May 2011, AK 326688; Mahoe, *P.J. de Lange K930*, 15 May 2011, AK 326746.

Comments Of those *Pseudocyphellaria* recorded from Raoul Island, *P. homalosticta* is only likely to be confused with *P. chloroleuca*, *P. episticta* and perhaps *P. multifida*. From *P. chloroleuca* and *P. multifida* it is easily distinguished by the pseudocyphellate upper thallus surface and phyllidiate condition. From *P. episticta*, *P. homalosticta* differs by its loosely attached thallus with subdichotomously divided ascending lobes, and by the phyllidia which never form the dense coralloid aggregations typical of *P. episticta*.

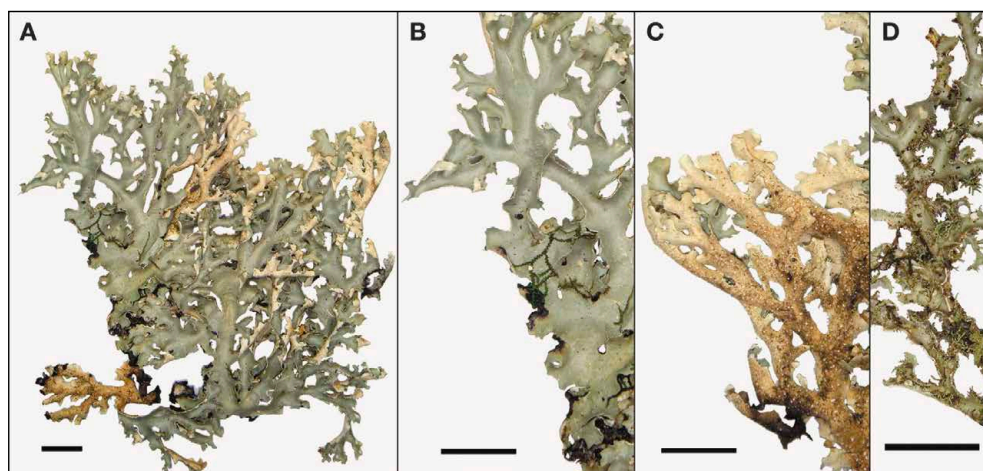


Figure 7. *Pseudocyphellaria homalosticta* (*P.J. de Lange K927*, AK 326688 (A–C), K930, AK 326746 (D)). A. Entire specimen showing dorsal view of thallus. B. Close-up of dorsal thallus surface. C. Ventral thallus surface showing minute pseudocyphellae. D. Dorsal view of thallus showing phyllidia. Scale bars = 10 mm. Photos: Peter J. de Lange



Figure 8. *Pseudocyphellaria insculpta* (P.J. de Lange K915, AK 326683). A. Dorsal thallus surface showing marginal phyllidia. Scale bar = 10 mm. B. Ventral surface of thallus showing tomentum and pseudocyphellae. Scale bar = 5 mm. C. Dorsal surface of thallus showing apothecia. Scale bar = 5 mm. Photos: Jeremy R. Rolfe

Pseudocyphellaria insculpta (Stizenb.) D.J.Galloway

Description (Fig. 8) Thallus orbicular to irregularly spreading in entangled clones, 50–120(–200) mm diam., loosely attached centrally, margins and apices free $\pm$ ascending. Lobes very variable, irregularly divided, subdichotomously, branching at apices to complex-imbricate centrally, 10–40(–80) $\times$ 5–10(–40) mm long. Margins irregularly notched or incised, densely phyllidiate to lobulate-phyllidiate. Upper surface dark blue-black to almost black when wet, pale olivaceous grey when dry, irregularly undulate, conspicuously dimpled, punctate-impressed, here and there minutely papillate, rather fragile when dry, flabby when wet, phyllidiate to isidiate-phyllidiate, maculate, without pseudocyphellae or soredia. Maculae frequent, minute, white, effigurate to $\pm$ reticulate imparting a delicate marbling to the upper surface. Phyllidia mainly marginal, occasionally also laminal, simple, digitiform to coralloid, terete to flattened-dorsiventral, constricted at base 0.2–0.5(–1.0) $\times$ 1.0–2.0 mm. Isidia scarce, terete, subgranular at first, becoming flattened-phyllidiate. Medulla white. Photobiont cyanobacterial. Lower surface pale yellow-brown or whitish to buff-brown at apices, darkening centrally, glabrous in a narrow to broad marginal zone and tomentose centrally, or uniformly tomentose from margins to centre, tomentum long, silky, white to brown-black, densely entangled to $\pm$ felted-woolly. Pseudocyphellae 0.1–1.1 mm diameter, prominent, white, round to irregular, margins raised, concolorous with lower surface, decorticate area flat to convex, sunk in tomentum. Apothecia common, 1.0–2.0(–2.5) mm diameter, rounded, sessile, constricted at base to $\pm$ subpedicellate, exciple pale pinkish brown, translucent when wet, wrinkled-striate, with occasional to dense white, sericeous tomentum below, disc plant to subconcave, red-brown, matt, smooth epruinose. Epithecium pale yellow-brown, 8–12 μ m thick. Hymenium colourless, 70–85 μ m tall. Ascospores 28.0–33.5 $\times$ 6.5–8.5 μ m, yellow-brown to red-brown, 1–3-septate, ellipsoid-fusiform, apices rounded or pointed.

Kermadec Islands: Raoul Island: Specimen seen: Prospect Hill: P.J. de Lange K922, 15 May 2011, AK 326683.

Comments *Pseudocyphellaria insculpta* is a palaeotropical species known from Sri Lanka to the southwest Pacific and northern Australia (Galloway 1994a; McCarthy 2013). Within the New Zealand Botanical Region it was previously collected once from continental New Zealand, from Mt Misery in western Northland, North Island (B.W. Hayward s.n., Jan 1984, AK 228752), though that specimen was inadvertently overlooked by the recent Flora treatment (Galloway 2007). The absence of further collections of this distinctive species suggests that, in continental New Zealand, it is a scarce species. The sole Raoul Island collection is copious and came from the upper branches of a cyclone-toppled Kermadec pōhutukawa. Its absence from other *Pseudocyphellaria* collections from Raoul Island could suggest that it is scarce, that it has been overlooked as part of the natural variation of *P. argyracea* (a species which it superficially resembles) or that it is a component of the rarely seen canopy branch vegetation of large forest trees. Of those species recorded here from Raoul Island, *P. insculpta* can be confused with *P. argyracea*. From that species it is easily distinguished by the non-pseudocyphellate upper thallus surface, and phyllidiate condition. Otherwise, the species has a passing resemblance to *P. dissimilis* from which it is chiefly distinguished by the non-isidiate, phyllidiate condition, and strikingly dimpled, punctate-impressed upper thallus surface.

Pseudocyphellaria intricata (Delise) Vain.

Description Thallus 20–200 mm diam., rather variable, lobes narrow, lacinate $\pm$ rosette-forming, closely attached centrally, margins free and $\pm$ ascendant, Raoul Island specimens corticolous and terricolous. Lobes 3–25 $\times$ 10–50 mm, strap-like, irregularly linear-lacinate, ragged, discrete or separate in parts from margins to

centre, some sections $\pm$ complexly folded centrally, apices discrete, contiguous or imbricate. Margins delicately crenulate to ragged-lacerate, $\pm$ ascending, sinuous, in places coarsely sorediate and eroding both upper and lower surfaces. Upper surface dark blue-black to reddish chocolate-brown when wet, mustard-yellow to red-brown when dry, plane, undulate, minutely wrinkled to weakly punctuate-impressed toward lobe apices, smooth to $\pm$ minutely scabrid in places, dull, coriaceous, in places minutely tomentose especially near lobe apices, sorediate, without isidia, phyllidia or pseudocyphellae. Soralia laminal and marginal, soredia farinose to coarsely granular, often appearing pseudoisidiate or with round to irregular 0.1–3.0 mm diam., $\pm$ flat to distinctly raised, pulverulent, widely scattered, crowded or in lines on shallow ridges near margins, marginal soralia linear, sinuous, eroding lower surface, often $\pm$ labriform, soredia white to grey-white. Maculae minute, scattered, irregular, whitish or buff patches, not in any reticulate pattern, only seen when moist. Medulla white. Lower surface plane, undulate, dark chocolate-brown to yellowish fawn, tomentose from the margins to centre, tomentum stiff, silky, velvety to woolly-entangled. Pseudocyphellae scarce, mostly present near lobe margins, white, 0.2–0.9 mm diam., round to irregular, margins thin, raised, concolorous with lower cortex, decorticate area plane to deeply concave, granular. Apothecia not seen in Raoul Island collections.

Kermadec Islands: Raoul Island: Specimens seen: Alongside road from landing, 800 m from Accommodation House: *B.W. Hayward s.n.*, 21 Nov 1994, AK 227474; Boat Cove Road, near Boat Cove, *P.J. de Lange K1034*, 14 May 2011, AK 327534.

Comments *Pseudocyphellaria intricata*, a widespread species of the tropics and cool temperate regions (Galloway 1988; 1992; 1994a), is apparently scarce on Raoul Island. From the other *Pseudocyphellaria* recorded from Raoul Island, it is most similar to *P. argyracea*, *P. bartlettii* and *P. haywardiorum*. From *P. argyracea*, Raoul Island specimens of *P. intricata* are distinguished by their lack of isidia, and by their dark chocolate-brown to yellowish fawn, evenly and thickly tomentose lower surface. For distinctions from *P. bartlettii* and *P. haywardiorum* see the accounts of these species above.

Pseudocyphellaria multifida (Nyl.) D.J.Galloway et P.James

Description Thallus 20–80 mm diam., rather delicate, irregularly spreading, loosely attached, extremely phyllidiate, margins free, ascending, papery when wet very brittle when dry, corticolous. Lobes 1–5 mm wide, complexly branched, entangled-imbricate, $\pm$ discrete at margins, densely imbricate centrally. Margins sinuous, to $\pm$ ragged, dentate-incised, extremely phyllidiate, smoothly rounded, slightly thickened below, without pseudocyphellae, sinuses semi-circular. Upper surface bright-green when moist, pale-grey to greenish grey when dry, undulate, $\pm$ pitted and minutely white-papillate, smooth, dull to somewhat glossy, cephalodia

visible as small (0.2 mm diam.) hemispherical swellings, without soredia, isidia or pseudocyphellae. Maculae sparse, at lobe apices and margins, white, scattered, effigurate. Phyllidia copious, obscuring thallus, mostly marginal but also regenerating from cracks in upper thallus surface, flattened, $\pm$ dorsiventral, constricted at base, lower surface bearing minute, scattered, white pseudocyphellae, sparsely tomentose, simple to richly divided, squamiform to strap-like, or palmately coralloid, apices often brown, glabrous. Medulla white. Photobiont green. Lower surface whitish to pale pinkish white at margins, becoming yellowish on storage, glabrous, darker centrally, $\pm$ smooth, internal cephalodia visible as minute swellings, concolorous with lower surface, tomentum scattered and somewhat diffuse, often interspersed with sometimes extensive glabrous patches, becoming denser centrally, and thin, soft, whitish, short $\pm$ velutinous. Pseudocyphellae $\leq$ 0.1 mm diam., white, fleck-like, round to irregular, flat or very shallowly papillate, decorticate area flat or subconcave. Apothecia not seen in Raoul Island collections.

Kermadec Islands: Raoul Island: Specimen seen: Boat Cove Road, ca. 800 m northwest of Moumoukai Track start: *P.J. de Lange K506 & D.C. Havell*, 8 May 2009, AK 306165.

Comments *Pseudocyphellaria multifida* is a palaetropical species (Galloway 1994a) known only from the one Raoul Island collection. That collection is of a very finely divided and extremely phyllidiate form. Of those species of *Pseudocyphellaria* on Raoul Island, *P. multifida* is most similar to *P. chloroleuca* and *P. homalosticta*. From the isidiate/phyllidiate *P. homalosticta*, *P. multifida* is readily distinguished by the non-pseudocyphellate upper thallus surface and lack of isidia; from *P. chloroleuca* it differs by the lack of isidia.

Pseudocyphellaria prolificans (Nyl.) Vain.

Description Thallus 50–180 mm diam., variable, orbicular to irregularly spreading. Forming densely to entangled clones, loosely to closely attached centrally, margins and apices free, $\pm$ ascending. Lobes very variable, most commonly rather narrow, 1–8 $\times$ 10–80 mm long, linear-laciniate, ragged, subdichotomously branching at or near apices, complex-imbricate, entangled centrally, apices truncate, rounded or $\pm$ furcate, divergent. Margins entire towards apices becoming densely phyllidiate towards centre, upper and lower surfaces notably thickened, pseudocyphellae prominent on lower surface margin. Upper surface bright-green when wet, undulate, irregularly to markedly dimpled, punctate-impressed, often with dense to widely scattered papillae, chartaceous to firmly coriaceous, without isidia, maculae, pseudocyphellae or soredia. Phyllidia in Raoul material sparse, mainly marginal but also laminal, occasionally terete at first, soon becoming flattened-dorsiventral, constricted at base, 0.1–0.5 $\times$ 1–10 mm, simple, branched to $\pm$ coralloid, single or densely clustered and proliferating. Medulla white.

Photobiont green. Lower surface whitish to pale yellow-brown, glossy and smooth, centrally darker red-brown, tomentose only in older parts, tomentum variable, somewhat sparse and ragged distally, and scattered in patches but tending to be thicker toward at proximal lobe ends, red-brown, sericeous. Pseudocyphellae white, 0.1–1.5 mm diam., white, round and irregular, margins raised, projecting from tomentum decorticate area flat, common and conspicuous. Pycnidia common on upper surface, scattered, 0.1 mm hemispherical, ostiole raised, red-brown. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Specimens seen: *Sine loco*, Milne NY; Boat Cove Road, near Boat Cove Hut: P.J. de Lange K1036, 14 May 2011, CHR 616780.

Comments This species was first recorded for the Kermadec Islands by Galloway (1994a) based on a Milne collection. During the May 2011 visit to the island, this species was recognised from the shattered remains of a specimen retrieved from within the upper canopy branches of a cyclone-toppled Kermadec pōhutukawa. On the basis of this find, it seems likely that *P. prolifans* is not only scarce but probably also an inhabitant of the upper forest canopy. On Raoul Island, *P. prolifans* is only likely to be confused with *P. sulphurea* which has a dimpled-impressed upper surface but without phyllidia (see below). *Pseudocyphellaria prolifans* is distinguished from it by the generally narrower lobes and the distinctive proliferating phyllidia.

Pseudocyphellaria punctillaris (Müll.Arg.) D.J.Galloway

Description (Fig. 9) Thallus 50–150 mm diam., rosette-forming, closely attached from margins to centre. Lobes 5–12 mm wide, broadly rounded, contiguous or imbricate at margins, crowded-imbricate centrally. Margins entire, sinuous, broadly rounded at apices, becoming markedly lobulate-phyllidiate centrally, thickened and sometimes

with the lower surface inrolled. The upper surface of Raoul Island specimens mostly malachite-green some times glaucous-blue when wet, pale yellowish fawn to brownish (often with darker apices) when dry, undulate, conspicuously verrucose-scabrid, thick, coriaceous, without isidia, maculae or soredia. Phyllidia 0.2–1.5 mm diam., marginal, rarely regenerating from cracks on upper surface, lobulate, joined at base, simple to subcoralloid. Pseudocyphellae 0.1–1.5 mm diam., white, round to elongate, conical-verruciform, margins raise, decorticate area flat; numerous often crowded, conspicuous. Medulla white. Photobiont cyanobacterial. Lower surface pale yellowish white to buff at margins, cinnamon-brown to red-brown centrally, uniformly tomentose from margins to centre, tomentum thick, woolly, pale at margins, brownish or greyish centrally, often obscuring pseudocyphellae. Pseudocyphellae 0.1–1.0 mm diam., white, round to irregular, margins not raised, decorticate area flat or concave, granular; scattered, most noticeable at margins. Pycnidia 0.2–1.0 mm diam., common, prominent, swollen, marginal and laminal, solitary or crowded, ostiole red-brown, punctate. Apothecia 1–3 mm diam., sparse to frequent, submarginal and laminal, central rarely at lobe apices, sessile, constricted at base, round or deformed, shallowly concave to plane, exciple prominent, coarsely verrucose-scabrid, obscuring disc when young, persisting as a coarse, dentate-verrucose margin to disc at maturity, pale brownish, disc shining, slightly roughened, pale to dark red-brown, epruinose. Epithecium red-brown, 8–14 µm thick. Hymenium colourless 110–115 µm tall. Ascospores 1-septate, contents vacuolate, pale red-brown or yellow-brown, broad-ellipsoid, apices pointed or rounded, 25.0–28.0 × 8.5–11.0 µm.

Kermadec Islands: Raoul Island: Specimens seen: W.R.B. Oliver s.n., 1908, WELT L04267; R.C. Cooper 44178, 1956, AK 328792; Smiths Bluff track: P.J. de Lange K932, 15 May 2011, AK 326750.

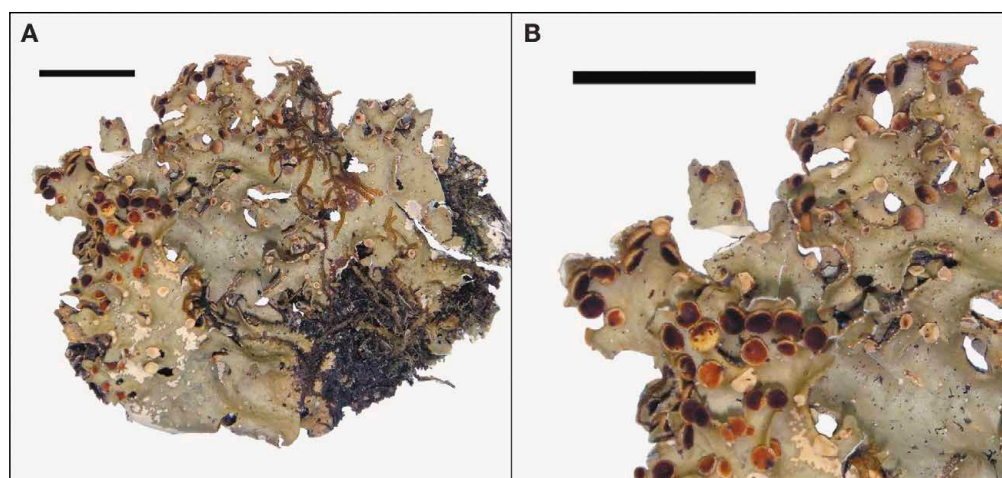


Figure 9. *Pseudocyphellaria punctillaris* (P.J. de Lange K932, AK 326750). A. Dorsal thallus surface. B. Close-up of apothecia. Scale bars = 10 mm. Photos: Peter J. de Lange

Comments *Pseudocyphellaria punctillaris* is a palaeotropical species known from Indonesia, the Philippines, New Guinea, Australia, Samoa and Hawaii (Galloway & Kemp 1993; Galloway 1994a; McCarthy 2013). It was first collected from Raoul Island in 1908 by W.R.B. Oliver, whose specimen (WELT L04267) was identified by the then DSIR Botany Division Herbarium Keeper, T.W. Rawson as *Sticta intricata* f. *subargyracea* (= *Pseudocyphellaria argyracea*). The species has an admittedly superficial resemblance to *P. argyracea* which differs from *P. punctillaris* by its isidiate condition. In the field, *P. punctillaris* is recognised by the rather shortly, more or less subdichotomously branching lobes, white medulla, and the scabrid-areolate upper surface, blue-green photobiont and white pseudocyphellae present on both surfaces of the thallus. Of those species of *Pseudocyphellaria* on Raoul Island, it is most likely to be confused with *P. godeffroyi* from which it is distinguished by the marginal lobulate phyllidia, and from *P. semilanata* which lacks the scabrid-areolate upper surface and marginal lobulate phyllidia. *Pseudocyphellaria punctillaris* has also been collected from continental New Zealand on Tuhua (Mayor Island) (de Lange *et al.* 2012).

Pseudocyphellaria reineckeana (Müll.Arg.) D.J.Galloway

Description (Fig. 10) Thallus 20–80 mm diam., irregularly spreading, loosely attached centrally, margins $\pm$ free. Lobes 1–8 $\times$ 5–25 mm, dichotomously to irregularly branching, divergent, discrete at apices, complex-imbricate centrally, apices pointed or smoothly rounded. Margins entire, only very slightly thickened below. Upper surface bright-green, suffused brownish when wet, pale glaucous-green to pale-buff when dry, undulate, smooth, to irregularly wrinkled, not faveolate or punctate-impressed, dull or glossy, rather brittle, friable when dry, without isidia, maculae, phyllidia or soredia. Pseudocyphellae 0.1 mm diam., white, fleck-like, punctiform, minute, margins not

noticeably raised, white, scattered, rather sparse. Medulla white. Photobiont green. Lower surface pale whitish buff to brownish, darkening centrally, smooth or shallowly wrinkled, glossy at margins, thinly to thickly tomentose centrally, tomentum ragged, whitish to pale buff, often not apparent, to thick, black or brown-black, woolly entangled and obscuring lower surface and pseudocyphellae. Pseudocyphellae 0.1 mm diam., white, margins not noticeably raised, minute, fleck-like, widely scattered. Pycnidia clustered into groups or in lines, $\leq$ 0.1 mm diam., minute, punctiform, ostiole brown-black. Apothecia 0.2–2.0 mm diam., marginal or submarginal, sessile, constricted at base, rounded, exciple prominent, coarsely verrucose-scabrid, obscuring disc when young, persisting as verrucose-areolate margin at maturity, pinkish-brown, translucent when wet, disc orange to red-brown, shining, epruinose. Epithecium pale yellow-brown, 5.5–9.0 μ m thick. Hymenium colourless to pale-straw 85–100 μ m tall. Ascospores 1-septate, yellow-brown to red-brown, contents vacuolate, ellipsoid, apices rounded or pointed 25.0–31.0 $\times$ 8.5–11.5 μ m.

Kermadec Islands: Raoul Island: Specimens seen:

On ridge track to lakes: *B.W. Hayward s.n.*, 21 Nov 1994, AK 223971; Moumoukai, just below summit: *A.E. Wright 12470*, 24 Nov 1994, AK 223968.

Comments *Pseudocyphellaria reineckeana* is a distinctive Pacific species known from Borneo to Samoa (Galloway 1994a). On Raoul Island, it is only likely to be confused with *P. episticta*, another scarce species on Raoul, which is distinguished from *P. reineckeana* by its prominent coralloid-phyllidiate thallus margins. Despite careful searching during the May 2009 and 2011 surveys, no further specimens of *Pseudocyphellaria reineckeana* were located and this species remains known only from the two collections made in 1994.

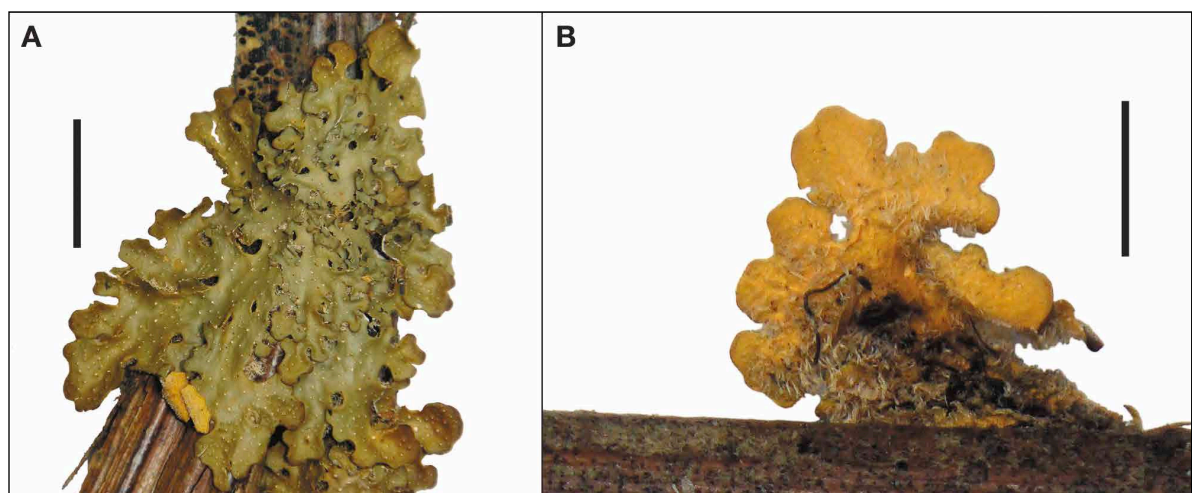


Figure 10. *Pseudocyphellaria reineckeana* (*A.E. Wright 12470*, AK 223968). **A.** Dorsal thallus surface showing pseudocyphellate surface. Scale bar = 10 mm. **B.** Ventral thallus surface showing sparse, minute, pseudocyphellae and dense tomentose surface covering. Scale bar = 5 mm. Photos: Peter J. de Lange

Pseudocyphellaria semilanata (Müll.Arg.) D.J.Galloway

Description (Fig. 11) Thallus 80–150 mm diam., irregularly spreading, loosely attached centrally, apices $\pm$ ascending. Lobes 10–60 $\times$ 4–10 mm, dichotomously branching, very variable, apices divergent, furcate, pointed or rounded, discrete from margins to centre or complex-imbriate, flat to $\pm$ canaliculate. Margins entire, distinctly ridged above and below with often prominent tomentum from lower surface projecting at right angles. Upper surface dark-blue to glaucous-green when moist, often suffused red-brown in parts, especially at margins and apices, pale olivaceous to brownish when dry, undulate, shallowly ridged to distinctly punctate-impressed, rigid, pliable when wet, rather coriaceous when dry, without isidia, phyllidia or soredia. Maculae minute, white, imparting a delicate marbling to the upper surface, prominent, larger and $\pm$ reticulate at lobe apices. Pseudocyphellae 0.1–0.2 mm diam., white, minute, punctiform, scattered. Medulla white. Photobiont cyanobacterial. Lower surface yellowish white or pale-buff at margins, darkening to red-brown centrally, tomentose from margins to centre, tomentum very thick, entangled, woolly, whitish to red-brown or $\pm$ blackened. Pseudocyphellae 0.2–2.0 mm diam., white, prominent, scattered, round to irregular, margins swollen, prominent, concolorous, with lower cortex, often immersed in tomentum. Pycnidia 0.1 mm diam., hemispherical, solitary or in groups, ostiole dark red-brown or blackened. Apothecia uncommon in Raoul Island specimens, 0.5–2.0 mm diam., marginal or submarginal, rarely laminal, sessile, constricted at base, rounded, subconcave to plane, exciple prominent in immature examples, persistent to occluded at maturity, slightly roughened to coarsely scabrid-verrucose, pale brownish, translucent when wet, disc pale to dark red-brown, smooth, epruinose, some times with a small central thalline lobule of sterile tissue. Epithecium pale red-brown, 8.5–14.0 μ m thick. Hymenium colourless, 70–85 μ m tall. Ascospores pale yellow-brown to red-brown, 13-septate, fusiform-ellipsoid, (25.0–)30.5–33.0(–36.0) $\times$ 5.5–8.0 μ m.

Kermadec Islands: Raoul Island: Representative specimens (from 5 collections seen): Western end of Denham Bay: *C.J. West* RAO13, 20 Jun 1993, AK 328813; Track over to lakes, Moumoukai, eastern side of summit: *P.J. de Lange* K502 & *D.C. Havell*, 8 May 2009, CHR 604776; Smiths Bluff track: *P.J. de Lange* K318, 15 May 2011, AK 326748.

Comments *Pseudocyphellaria semilanata* is a palaeo-tropical species extending from the Bonin Islands to Samoa and the Cook Islands (Galloway 1994a; P.J. de Lange unpubl. data). Of those species of *Pseudocyphellaria* recorded from Raoul Island, *P. semilanata* may be confused with *P. argyracea* and *P. punctillaris*. From *P. argyracea* it is readily distinguished by the lack of isidia, and from *P. punctillaris*, by the shallowly ridged to distinctly punctate-impressed rather than scabrid-areolate upper surface and by the absence of marginal lobulate phyllidia.

Pseudocyphellaria sulphurea (Schaer.) D.J.Galloway

Description (Fig. 12) Thallus 100–350 mm diam., forming large entangled clones, irregularly spreading, loosely attached centrally, apices free, $\pm$ ascending. Lobes 1–12 $\times$ 10–120 mm long, linear-elongate, $\pm$ dichotomously branching, contiguous or discrete, apices usually free, $\pm$ divergent, rounded, pointed, truncate or furcated, complex-entangled-imbriate centrally. Margins entire, smoothly rounded, conspicuously thickened-ridged on both upper and lower surfaces, bearing infrequent, scattered white fleck-like pseudocyphellae. Upper surface bright-green when wet, occasionally suffused red-brown at apices and margins, pale yellow-brown to fawn when dry, glossy, conspicuously dimpled, in parts smooth, mostly though punctate-impressed, to $\pm$ shallowly faveolate, coriaceous, without isidia, maculae, phyllidia, pseudocyphellae or soredia. Medulla white. Photobiont green. Lower surface pale whitish to pale yellow-brown, margins wrinkled and finely tomentose from margins to centre (becoming thicker

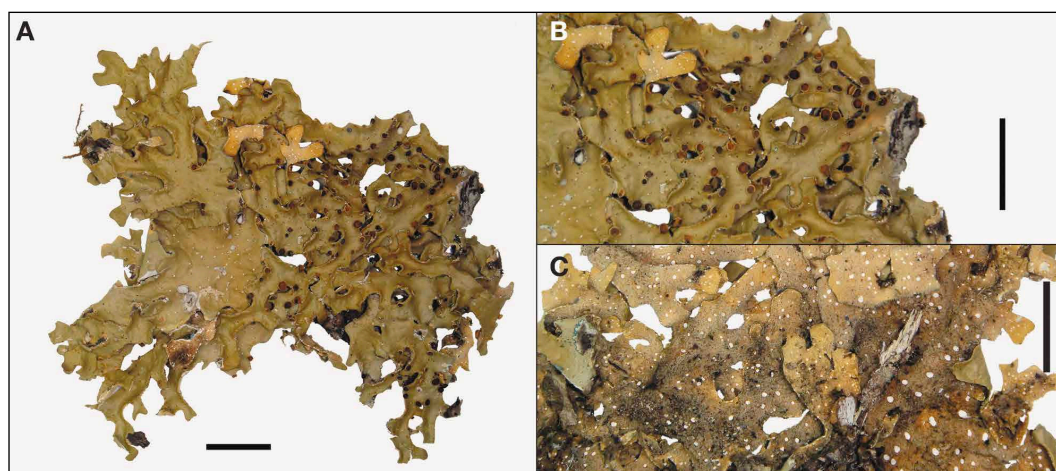


Figure 11. *Pseudocyphellaria semilanata* (P.J. de Lange K318, AK 326748). **A.** Whole specimen (dorsal thallus surface). **B.** Close-up of dorsal thallus note the ridged to distinctly punctate-impressed smooth surface and absence of marginal phyllidia. **C.** Ventral thallus surface showing the prominent, scattered, round to irregular pseudocyphellae and tomentum which is distinctly pale toward the margins and darker centrally. Scale bars = 10 mm. Photos: Peter J. de Lange

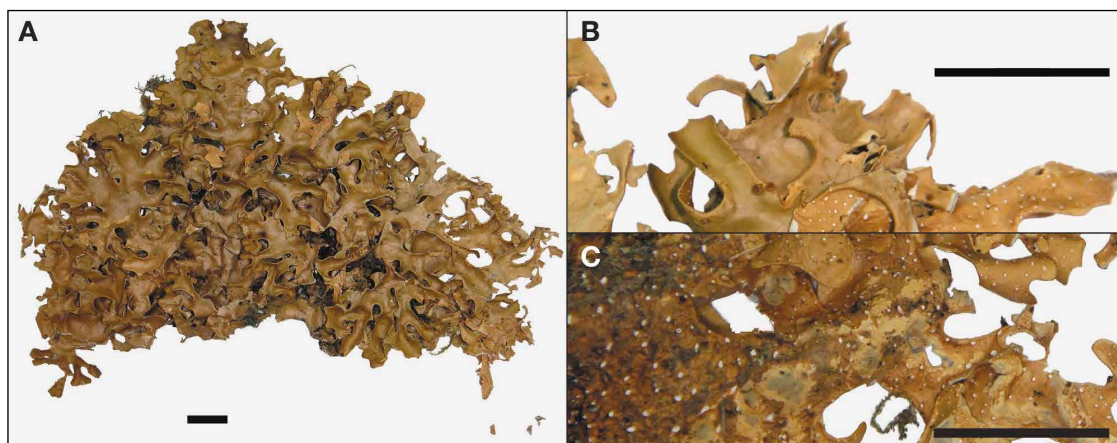


Figure 12. *Pseudocyphellaria sulphurea* (P.J. de Lange K661, AK 325270). A. Whole specimen (dorsal thallus surface). B. Close-up of dorsal thallus note the smooth, mostly though punctate-impressed, to weakly shallowly faveolate surface. C. Ventral thallus surface showing the fleck-like, scattered, pseudocyphellae and sparsely pale tomentose margins thickening and darkening only slightly centrally. Scale bars = 10 mm. Photos: Peter J. de Lange

centrally), tomentum short, velutinous, pale honey-brown. Pseudocyphellae common, 0.2–0.5 mm diam., white, fleck-like, round to irregular centrally, margins slightly raised, concolorous with lower surface, decorticate area flat. Pycnidia scarce, marginal, in diffuse clusters, 0.1 mm diam., punctate, ostiole red-brown to black. Apothecia scarce, marginal and submarginal, sessile, constricted at base, rounded 0.5–2.3 mm diam., exciple pale initially pinkish fawn maturing yellow-brown, translucent when wet, persistent, coarsely scabrid-areolate, disc subconcave to plane, smooth, dull, pale to dark red-brown, epruinose. Epithecium pale yellow-brown, 9–15 µm thick. Hymenium colourless 70–95 µm tall. Ascospores 1-septate, yellow-brown to red-brown, fusiform-ellipsoid, (22.0–)25.0–28.0(–30.5) × 6.5–8.0(–11.0) µm.

Kermadec Islands: Raoul Island: Specimens seen: Moumoukai Track, summit ridge: P.J. de Lange K500 & D.C. Havell, 8 May 2009, CHR 604778; Smiths Bluff track: P.J. de Lange K661, 15 May 2011, AK 325270.

Comments *Pseudocyphellaria sulphurea* is one of the most common and widespread of palaeotropical lichens recorded from Madagascar to Samoa and the Cook Islands (Galloway 1994a; P.J. de Lange unpubl. data). It is one of the largest species on Raoul Island. Of those species of *Pseudocyphellaria* recorded from Raoul Island, *P. sulphurea* is only likely to be confused with *P. prolificans*, which is amply distinguished by its phyllidiate (often phyllidiate-proliferate) condition.

Sticta (Schreb.) Ach.

Sticta babingtonii D.J.Galloway

Description Thallus loosely to ± firmly attached throughout, 50–150 mm diam., thick, coriaceous, brittle when dry. Lobes 2–5 × 15 mm, ± discrete at periphery, overlapping and becoming complicate-convolute centrally, margins raised, crenate-incised, pectinate, sinuous, phyllidiate. Upper surface matt,

smooth, bright-green to olive-greenish when wet, tinged red-brown to dark-brown at margins, pale greenish buff when dry, ± papillate in places due to internal cephalodia. Phyllidia mainly marginal and there often dense, less often laminal, simple to coralloid-branched, 0.1–0.3 × 0.2–1.2 mm, terete or flattened at apices. Photobiont green. Lower surface mainly smooth, minutely wrinkled or pitted near margins, ± uniformly tomentose to margins, tomentum thin at margins, thick centrally, brownish to brown-black centrally, buff or pale-brown at margins. Cyphellae 0.1–1.5 mm diam., sparse to numerous, immersed in tomentum, round to irregular, pit membrane roughened, orange to yellowish orange. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Specimen seen: Boat Cove Track (near Boat Cove Hut): P.J. de Lange K981, 14 May 2011, AK 327126.

Comments *Sticta babingtonii*, hitherto a New Zealand endemic (Galloway 1983; 1985; 1997; 2007), is, along with the superficially similar *S. squamata*, evidently uncommon on Raoul Island. Of those *Sticta* recorded here from Raoul Island, *S. babingtonii* is only likely to be confused with *S. squamata* from which it differs by its phyllidiate condition and orange to yellow-orange cyphellae.

Sticta brevipes (Müll.Arg.) Zahlbr.

Description (Fig. 13) Thallus firmly attached by a basal, root-like holdfast, lobes irregularly palmate 10–30 mm wide at apices; lobes connected to holdfast by a blackened terete stalk 2–10 mm tall, 2–5 mm diam. Lobes irregularly polyphyllous, occasionally ± monophyllous, 5–15 mm wide, apices, ± rounded to lacerate-laciniate, inrolled; secondary ± reniform stalked lobules often developing from margins; margins rounded, entire, notched or incised, conspicuously thickened-ridged at broad apices, distinctly down-rolled. Upper surface dark blue-black when moist, pale grey-brown to

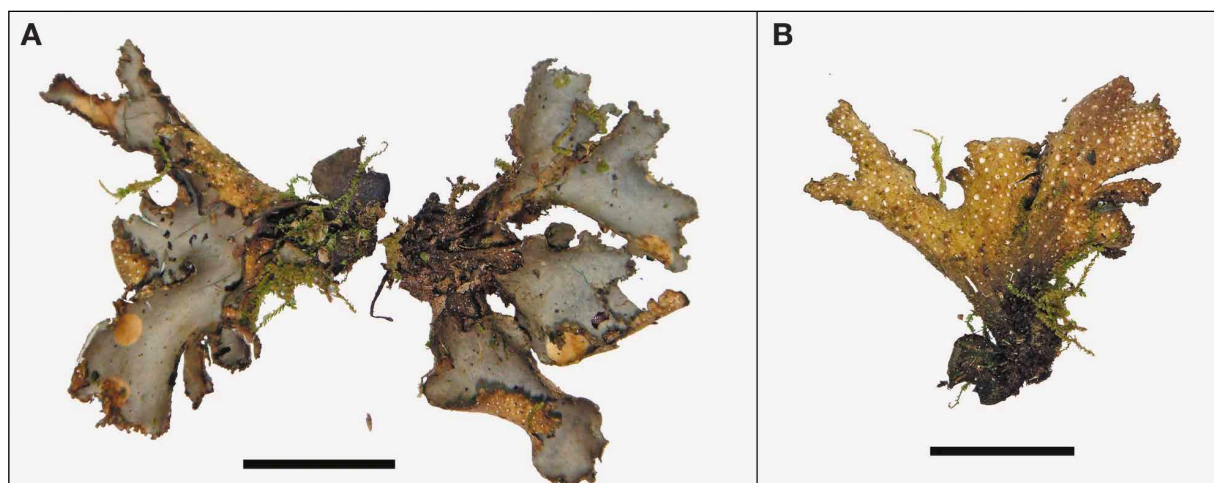


Figure 13. *Sticta brevipes* (P.J. de Lange K944, AK 326777). **A.** Two specimens (dorsal thallus surface) showing stalked growth habit, and minutely lobulate and isidiate thallus margins. **B.** Ventral thallus surface showing sparse, prominent, cyphellae and dense tomentose surface covering. Scale bars = 10 mm. Photos: Peter J. de Lange

glaucous-grey when dry, smooth, dull, undulate, wrinkled, ridged close to holdfast, punctate-impressed, isidiate, maculate, without phyllidia or soredia. Isidia dark blue-black, minute, granular, coralloid, densely crowded in thick lines at apices and margins or in discrete patches on upper surface. Maculae minute, white. Photobiont *Nostoc*. Lower surface irregularly wrinkled-ridged, costate above holdfast, whitish, glabrous, margins glossy, pale- to dark-brown, centrally tomentose, tomentum velutinous. Cyphellae prominent, scattered, pin-prick-like, 0.1–0.3 mm diam.; margins pale, swollen, wider than central pore; pit membrane white. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Representative specimens (from 5 collections seen): Moumoukai Ridge track: *B.W. Hayward s.n.*, 24 Nov 1994, AK 227537; Prospect Hill, *P.J. de Lange K925*, 15 May 2011, AK 326687; Denham Bay track – overlooking Tui lake: *P.J. de Lange K944*, 18 May 2011, AK 326777.

Comments *Sticta brevipes* was previously known only from eastern Australia and Norfolk Island (Galloway 1998; McCarthy 2013). *Sticta brevipes* has a superficial resemblance to the New Zealand endemic *S. caliginosa* D.J.Galloway, which is what the initial Raoul Island collections of this species were referred to, or the cosmopolitan *S. limbata*. *Sticta caliginosa* is not present on the Kermadec Islands (Galloway 1983; 1985; 1997; 2007). *Sticta brevipes* differs from *S. caliginosa* by its smaller, more rounded, flabellate lobes which are markedly thickened and down-rolled at their apices, presence of marginal lobules (absent in *S. caliginosa*) and smaller cyphellae size range (0.1–0.3 mm cf. 0.1–1.8 mm in *S. caliginosa*). From *Sticta limbata*, which is known from Raoul Island, *S. brevipes* differs by the presence of a distinct root-like basal holdfast, and mostly polyphyllous lacerate-laciniate thallus, and isidiate condition. Based on the collections made and the

habitats occupied, it seems likely that this diminutive *Sticta* is probably a reasonably common species on Raoul Island. However, its absence from pre-1990 collections also suggests that it may be a recent arrival to the Kermadec Islands.

Sticta caperata (Nyl.) Nyl.

Description (Fig. 14) Thallus 50–180 mm wide, rosette-forming to irregularly, loosely attached centrally. Lobes 10–30 mm wide, broadly rounded, irregularly and sparingly branched, discrete, contiguous to overlapping at margins, complex-imbricate to $\pm$ continuous centrally; sinuses rounded; margins entire, sinuous, thickened below, with or without short dark tomentum. Upper surface olive-green to green when wet, pale grey-green or olivaceous when dry, plane to convex, shallowly undulate, minutely pitted or wrinkled in parts, matt or glossy. Photobiont green. Lower surface pale-tan at margins, darkening centrally, uniformly dark tomentose. Cyphellae 0.1–0.8 mm diam., common, crowded; margins conspicuous, swollen; pit membrane white. Apothecia occasional to rare or absent, marginal and submarginal, sessile, constricted at base, 1.0–2.0(–2.5) mm diam., disc concave to plane, pale to dark red-brown, matt to glossy, exciple persistent, coarsely scabrid-areolate, pale-buff, translucent when moist. Epithecium red-brown, 11–14 μ m thick, unchanged in K. Hymenium colourless, 80–95 μ m tall. Hypothecium orange-brown, unchanged in K. Ascospores colourless, fusiform-ellipsoidal with pointed apices, 1–3-septate, contents vacuolate and appearing spuriously 5–7-septate, 36.0–44.5(–47.0) $\times$ 8.0–9.0 μ m.

Kermadec Islands: Raoul Island: Specimens seen: Moumoukai Track, summit ridge: *P.J. de Lange K501* & *D.C. Havell*, 8 May 2009, CHR 604775; Prospect Hill: *P.J. de Lange K924*, 15 May 2011, AK 326685; Denham Bay Track, overlooking Denham Bay: *P.J. de Lange K695*, 18 May 2011, AK 325485.

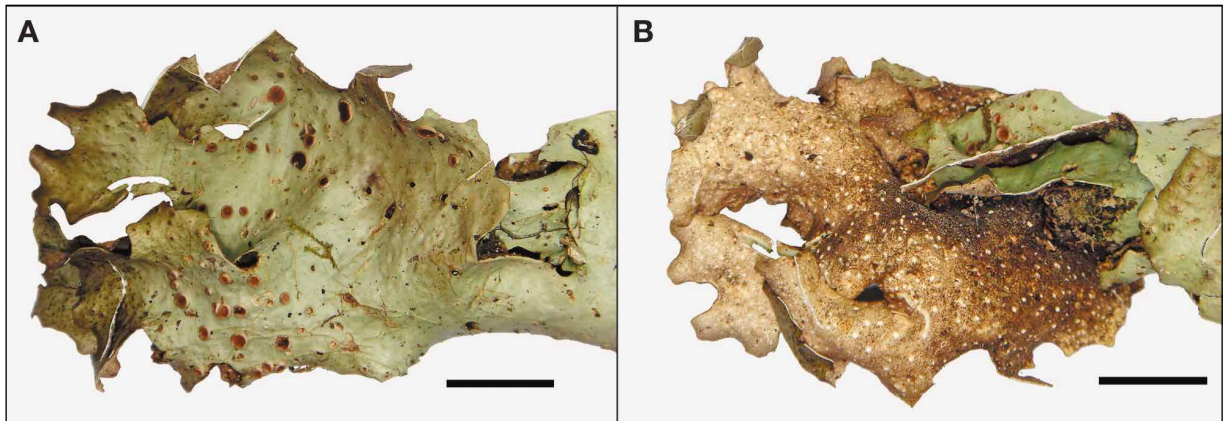


Figure 14. *Sticta caperata* (P.J. de Lange K695, AK 325485). **A.** Dorsal thallus surface showing smooth thallus margins and apothecia. **B.** Ventral thallus surface showing abundant, crowded cyphellae and tomentum which is sparser and so appears paler toward the margins and denser, and so darker centrally. Scale bars = 10 mm. Photos: Peter J. de Lange

Comments *Sticta caperata* is a widespread species of Oceania as well as islands and land masses bordering the Indian Ocean and north-eastern Australia (Galloway 1998; Galloway *et al.* 2001; McCarthy 2013). Its occurrence on Raoul Island is therefore not unexpected, though the species is not yet recorded from Lord Howe or Norfolk Islands (Elix & McCarthy 1998; Galloway *et al.* 2001; McCarthy 2013). In New Zealand proper it is ecologically replaced by the morphologically similar *Sticta subcaperata* (Galloway 2007). Of those species of *Sticta* recorded from Raoul Island, *S. caperata* is readily distinguished by the combination of a green photobiont, large, loosely attached thallus lacking a basal holdfast, isidia, phylidia and soredia.

Sticta cyphellulata (Müll.Arg.) Hue

Description (Fig. 15) Thallus 20–50 mm tall, ± palmate, growing from a central root-like holdfast; lobes proliferating from a short terete stalk 1–3 mm tall and 2–3 mm diam. Lobes linear-laciniate, rather narrow, 10–60

× 10–60 mm, irregularly to dichotomously branched, often having a conspicuous subcanaliculate main branch from which lateral, commonly canaliculate branches develop; margins entire, ± thickened above, sinuous to irregularly notched, occasionally with projecting black cilia, commonly crowded-isidiate, often somewhat raised. Upper surface dark blue-black when wet, greyish glaucous or grey-brown when dry, smooth, undulate, matt or glossy, minutely papillate in parts, maculate, isidiate. Isidia 0.1–0.2 mm tall, granular, styliform, mainly marginal, not on lower or upper surfaces, densely clustered to coralloid-branched, occasionally developing into small lobules or leaflets at lobe margins. Maculae minute, white. Photobiont *Nostoc*. Lower surface pale or whitish and wrinkled-striate at margins, dark brown-black and costate centrally, uniformly velvety buff-tomentose. Cyphellae 0.1–0.2 mm diam., pin-prick-like, scattered, often crowded, margins prominent, swollen, white, pit membrane white. Apothecia not seen in Raoul Island specimens.



Figure 15. *Sticta cyphellulata* (P.J. de Lange K527 & D.C. Havell, CHR 616718) showing from left to right ventral thallus and dorsal thallus surfaces. Note dark tomentum (brown-black in this species) and cyphellae, as well as prominent stalked holdfast, and canaliculate branches. Scale bar = 10 mm. Photo: Sue Gibb

Kermadec Islands: Raoul Island: Specimens seen: Moumoukai Track, summit ridge: *P.J. de Lange K527* & *D.C. Havell*, 8 May 2009, CHR 616718.

Comments *Sticta cyphellulata* is a palaeotropical species known from East Africa to eastern Australia, New Caledonia, Fiji and the Cook Islands (Galloway 1998; McCarthy 2013; P.J. de Lange unpubl. data). Known from only the one Raoul Island May 2009 collection, *Sticta cyphellulata* is seemingly another very uncommon species of *Sticta* on that island. Of those species of *Sticta* recorded from Raoul Island, *S. cyphellulata* is most similar to *S. pedunculata* which differs from it by its green photobiont, non-caliculate thallus lobes and by the lack of isidia. Of those blue-green species of *Sticta*, *S. cyphellulata* is perhaps most similar to the diminutive *S. brevipes* which differs by the smaller, rounded, flabellate lobes which have markedly thickened, down-rolled apices (see Fig. 13, 15).

Sticta fuliginosa (Hoffm.) Ach.

Description Thallus 20–120 mm diam., monophyllous, deeply indented and so appearing polyphyllous, rather loosely attached centrally. Lobes 5–40 mm wide, broadly rounded to $\pm$ ragged-lacinate, undulate, folded to $\pm$ imbricate centrally, free otherwise; margins broadly rounded, entire or shallowly indented, thinly ridged below and rolled under. Upper surface $\pm$ shallowly faveolate-wrinkled, scabrid-areolate, chartaceous, dark bluish-brown and $\pm$ blackened when wet and then pungent (smelling strongly of fish), pale bluish-grey when dry, isidiate, maculate. Isidia minute, delicate and friable, scattered or in clusters, brown-black, glossy, terete, simple or coralloid, some delicately and minutely stalked, in clusters at margins and on thalline ridges, eroding to form a sooty diffract crust. Maculae minute, white, Photobiont *Nostoc*. Lower surface $\pm$ uniformly tomentose, pale mushroom-grey to cream when wet, drying buff at margins, slightly darker centrally. Cyphellae 0.5–2.0 mm diam., abundant, white, plane to crateriform, large and prominent centrally, minute at margins; pit membrane white. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Specimens seen: Matatirohia, Water Tanks track: *P.J. de Lange K517*, 9 May 2009, AK 315062.

Comments *Sticta fuliginosa* is known only from a single May 2009 collection, and it was not seen again in the same general area or elsewhere on the island during the May 2011 survey. It is a very widespread, cosmopolitan species that is abundant in Australasia but not apparently known from Lord Howe or Norfolk Islands (see comments on distribution by Galloway 1997; 2001; McCarthy 2013). On Raoul Island this species is readily distinguished from all other species of *Sticta* by its broadly lobed (not deeply divided), monophyllous, loosely, though centrally, attached thallus, lacking a distinct, stalked basal holdfast; by the isidiate condition, and, when fresh, by the extremely strong fishy smell.

Sticta limbata (Sm.) Ach.

Description Thallus 5–40 mm wide, $\pm$ monophyllous, reniform to irregular, loosely attached at one point. Lobes broadly rounded to subirregular, $\pm$ cochleate; margins sinuous, rarely notched or incised, thickened, $\pm$ revolute with a definite ridge below. Upper surface reddish grey-brown when wet, grey-brown when dry, undulate, punctuate-impressed or $\pm$ smooth to subfaveolate in parts, subglossy to $\pm$ matt, maculate, sorediate, without isidia or phyllidia. Maculae minute, white. Soredia mostly in erose marginal soralia as well as occasional scattered, rounded pustular laminal soralia (these usually close to lobe margins), coarsely granular, grey-blue, sometimes also developing in cyphellae. Photobiont *Nostoc*. Lower surface pale yellowish buff to grey-brown, red-brown or dark-brown, delicately wrinkled-ridged or striate near margins, scabrid-roughed close to margins, elsewhere densely felted-tomentose. Cyphellae 0.5–1.0 mm diam., white, sparse, rounded, sunk in tomentum, margins very thin; pit membrane white. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Specimens seen: Upper Sunshine Valley Track: *P.J. de Lange K985*, 16 May 2011, AK 327131.

Comments *Sticta limbata* is a widespread cosmopolitan lichen (Galloway 1994b; 1997; 1998). Although *Sticta limbata* has been recorded from the Kermadec Islands before (Oliver 1912; Sykes 1977), as we have not been able to locate the specimens on which those records were based, there remains doubt as to what these authors actually saw. Irrespective, we here confirm *S. limbata* as present on Raoul Island. *Sticta limbata* is easily distinguished from *S. brevipes* by the absence of a distinct, root-like, basal holdfast (being loosely attached at one or more points along the thallus); mostly monophyllous, cochleate, sinuous-margined thallus and sorediate condition.

Sticta pedunculata Kremp.

Description (Fig. 16) Thallus 20–50 mm tall, irregularly monophyllous, attached by a rooted holdfast; lobes proliferating directly from the holdfast or from a short stalk. Lobes 5–15 mm wide, broadly rounded, reniform to sublinear or lanceolate; margins entire, thickened below, often inrolled at apices, not secondarily lobulate. Upper surface bright-green to deep olive-green when wet, pale grey-green or olivaceous buff when dry, bearing small, unevenly scattered, irregular coralloid projecting tufts of “*Dendriscocaulon*”, without isidia, maculae, phyllidia or soredia. Photobiont green. Lower surface whitish to pale tan, $\pm$ glabrous, glossy or occasionally thinly and minutely tomentose centrally, bearing occasional tufts of projecting “*Dendriscocaulon*” growths. Cyphellae to 2 mm diam., white, occasional, widely scattered centrally; margins plane, narrow; pit membrane white. Apothecia occasional to rare or absent, marginal, sessile, constricted at base, shallowly invaginate on lower surface, round, 0.2–1.5(–2.0) mm diam., margins blackened, corrugate-scabrid, prominent, amphithecium, smooth, pale

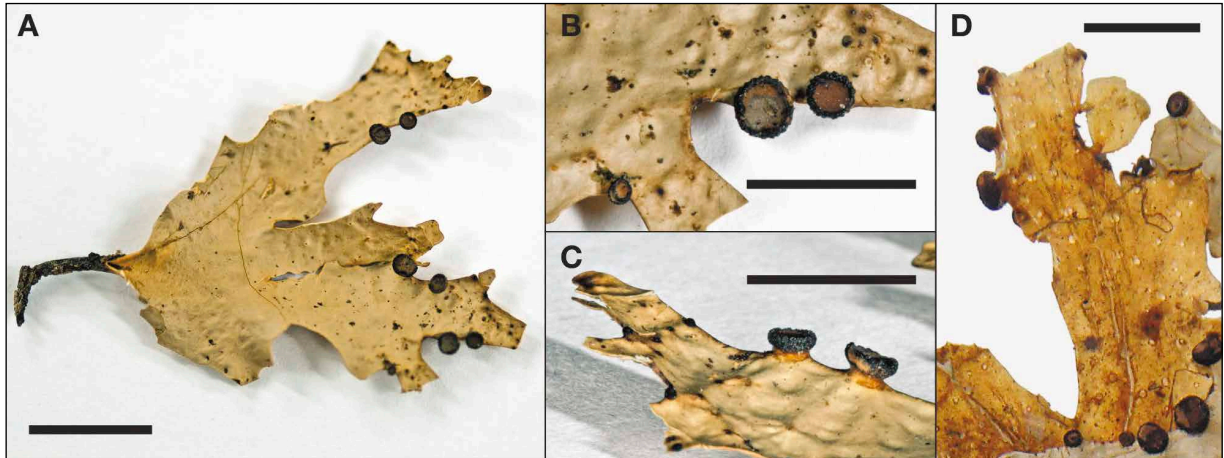


Figure 16. *Sticta pedunculata* (P.J. de Lange K945, AK 326779 (A–C), K666, AK 325540 (D)). A. Dorsal thallus surface showing entire margins and apothecia. B. Dorsal view of apothecia. C. Oblique view of thallus. D. Ventral thallus surface showing minute cyphellae. Scale bars = 5 mm. Photos: A–C, Jeremy Rolfe. D, Peter J. de Lange

brownish, disc plane to shallowly concave, matt to slightly glossy, red-brown, epruinose. Epithecium pale yellowish brown to orange-brown, not dissolving in K, not granular, 6.5–10.0 μm thick. Hymenium colourless (80–)85–100(–110) μm tall; paraphyses slender, 2–3 μm thick, apices slightly expanded to 4 μm diam. Hypothecium opaque, orange-brown, unchanged in K. Asci cylindrical, 80–85 $\times$ 15–20 μm , 8-spored, Ascospores, twisted in ascus, colourless, 1–3-septate, broadly fusiform with pointed apices, 30.0–35.0(–40.0) $\times$ 8.5–10.0 μm . Pycnidia widely scattered, laminal, punctate, brownish, visible as brownish, swellings on lower surface, to 0.2 mm diam.

Kermadec Islands: Raoul Island: Specimens seen: Smiths Bluff track: P.J. de Lange K666, 15 May 2011, AK 325540; Denham Bay track – overlooking Tui lake: P.J. de Lange K945, 18 May 2011, AK 326779.

Comments *Sticta pedunculata* is known from northern Queensland, Australia, New Guinea, the Solomon Islands, Fiji and Samoa (Galloway 1998; McCarthy 2013). Of those species of *Sticta* recorded from Raoul Island, *S. pedunculata* is easily recognised by the bright-green colour of the thallus when moist, a basal, root-like hold fast, and by the narrow, non-canaliculate, lanceolate lobes. These characters set it well apart from any other species of *Sticta* on the island, except perhaps *S. cyphellulata*, which differs in its dark blue-black colour when moist, and by its distinctly canaliculate lobes. Both collections of *Sticta pedunculata* came from cyclone-toppled Kermadec pōhutukawa trees growing in the “wet” forest vegetation type. This observation, together with its absence from other lichen collections from the island, suggests that not only is it uncommon but that it has a very specific high canopy branch habitat on Raoul Island, and so it may also have been overlooked by past collectors as well. Alternatively, *Sticta pedunculata* may be a recent arrival to the island.

Sticta squamata D.J.Galloway

Description Thallus 50–220 mm diam., foliose, lobate, spreading, broadly attached, thin and fragile, chartaceous. Lobes 3–12 mm wide, loosely subdichotomously branching near periphery, more complex-imbricate centrally, margins $\pm$ subascendent, rarely entire, crisped, somewhat thickened, often tinged brownish, $\pm$ densely isidiate. Upper surface bright-green when wet, superficially browned at margins, pale greenish buff when dry, smooth, matt, $\pm$ coriaceous, $\pm$ wrinkled-plicate in parts, isidiate. Isidia 0.1–1.2 $\times$ 0.1 mm, squamiform-imbricate, $\pm$ flattened to erect, marginal at first in well-defined lines, often dense, spreading to lamina and sometimes forming a dense diffract, fragile crust centrally. Photobiont green. Lower surface pale-buff, whitish to whitish-pink grading to dark-brown centrally, tomentose, tomentum regular, to margins, or only $\pm$ central with patches of shining, irregularly, pitted or wrinkled lower cortex at margins. Cyphellae 0.1–1.2 mm diam., rounded to subirregular, white, margins plane; pit membrane white. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Specimens seen: W.R.B. Oliver s.n., 1908, WELT L04268; Denham Bay Track: A.E. Wright 12417, 22 Nov 1994, AK 227570; Prospect Hill: P.J. de Lange K926, 15 May 2011, AK 326686.

Comments As a bright-green species which tends to grow on the lower trunks and exposed roots of Kermadec pōhutukawa, it is unlikely that *Sticta squamata* was overlooked by past collectors and it seems more likely that this species is genuinely scarce on Raoul Island. This is at odds with Oliver’s herbarium notes “abundant on tree stems” on his specimen (WELT L04268), which he collected as *S. variabilis*. Possibly, as inferred from Oliver’s comment, *Sticta squamata* was once more common on Raoul Island, perhaps favouring the open forested habitats created by goats which were then

rampant on that island. Certainly in New Zealand, where this species had hitherto been regarded as endemic (see Galloway 1985; 2007), *Sticta squamata* is common in northern coastal areas, especially in remnant, under-grazed pōhutukawa (*Metrosideros excelsa* Sol. ex Gaertn.) forest within farmland, or in urban areas and parkland, and it is often found on isolated pōhutukawa trees within paddocks, growing together with such photophilous lichens as *Crocodia aurata*, *C. poculifera*, *Parmotrema reticulatum* (Taylor) M.Choisy and *Pannaria elixii* P.M.Jørg et D.J.Galloway (Galloway 1983; 1997; 2007). So, as is suggested for *Crocodia aurata* on Raoul Island, it is possible that after the eradication of goats with the subsequent thickening of the island's forest vegetation, that *Sticta squamata* has declined in abundance. Less likely, but also possible, is that Oliver confused the bright-green *Sticta squamata* with the superficially similar isidiate but distinctly grey-black to red-brown *S. weigeli*. This is a species which is well-represented in the collections of Sykes's, made during the 1960s when goats were as yet uncontrolled, and which was a lichen still reasonably common when other visiting lichenologists such as C.J. West, A.E. Wright and B.W. Hayward made collections of it from Raoul Island in the early 1990s, though it was not seen by the senior author during his surveys of the island's Lobariaceae in May 2009 and 2011. Irrespective, *Sticta squamata* is clearly now a very uncommon species on Raoul Island. From those other species of *Sticta* recorded here from Raoul Island, *Sticta squamata* is easily recognised by its bright-green colour when moist, isidiate condition and white cyphellae. As noted above, it could, especially when dry, be confused with the grey-black to red-brown *S. weigeli* and, perhaps, also with *S. babingtonii* which differs from *S. squamata* by its phyllidiate condition and orange to yellowish-orange cyphellae.

Sticta weigeli (Ach.) Vain.

Description Thallus 20–120 mm, orbicular to irregular, closely to loosely attached centrally. Lobes variable, broadly rounded to lacinate, often deeply dissected or folded, complex-imbricate centrally; margins sinuous, irregularly notched or torn, rather ragged, densely isidiate. Upper surface grey-black suffused red-brown when wet, pale-grey to chesnut-brown when dry, wrinkled, pitted, punctate-impressed, to ± faveolate in parts, isidiate, maculate, without soredia. Isidia minute, styliiform, granular to coralloid-branched, dark-brown to grey-brown, glossy, densely crowded in a thick marginal crust, occasionally in small laminal clumps or forming a more diffract laminal crust. Photobiont *Nostoc*. Lower surface dark-brown to black, pale at margins, thickly tomentose, sometimes with tufts of long black anchoring hyphae projecting near margins and scattered over lower surface. Cyphellae 0.1–3.0 mm, white, deeply sunk in tomentum; pit membrane white to fawn. Apothecia not seen in Raoul Island specimens.

Kermadec Islands: Raoul Island: Representative specimens (from 9 collections seen): Moumoukai Ridge: *W.R. Sykes* 640/K, 20 Jan 1967, CHR 161106; Blue Lake: *W.R. Sykes* 669/K, 26 Sep 1969, CHR 161121;

Hutchison's Hut track above Denham Bay: *C.J. West* RAO38, 5 Aug 1993, AK 328822; track to Tui Lake: 21 Nov 1994, *B.W. Hayward s.n.*, AK 227502.

Comments *Sticta weigeli*, a widespread, pantropical species (McDonald *et al.* 2003; Galloway 2006), was accepted for New Zealand by Galloway (1985) on the basis of what was then understood to be that species. Subsequent research has shown that New Zealand material then attributed to *S. weigeli* was better referred to *S. caliginosa* (Galloway 1997) and on that basis *S. weigeli* was excluded from the revised second edition of the New Zealand lichen Flora (Galloway 2007). Now that the correct identity of *Sticta weigeli* has been determined (Galloway 2006), it is clear that the name, at least in past New Zealand literature, was misapplied, and on that basis, the records of *S. weigeli* accepted here for Raoul Island are in fact the first genuine records of this species for the New Zealand Botanical Region.

Sticta weigeli, as judged by numbers of collections, is the most common *Sticta* on Raoul Island. Nevertheless, it was not seen by the author during his survey of the islands in May 2009 and 2011 (see comments under *S. squamata*). It is possible that, like *Sticta squamata*, it has declined in abundance since the 1960s, possibly as a consequence of the general thickening up of the forest cover on Raoul Island following the reduction in goats during the 1970s, culminating in their successful eradication in 1983.

Of those species of *Sticta* present on Raoul Island, *S. weigeli* is perhaps most likely to be confused with the superficially similar isidiate but green, rather than blue-green, *S. squamata* (for distinctions see *S. squamata*).

DISCUSSION

This paper accepts 32 lobariaceous taxa in the genera *Crocodia* (2 species), *Podostictina* (2 species), *Pseudocyphellaria* (21 species) and *Sticta* (9 species). Based on Galloway 2007, these taxa are divided into six biogeographical elements (Table 1). It is notable that the largest contributing element to the Lobariaceae flora of the Kermadec Islands are those palaeotropical species (19 taxa).

Of the 32 species recorded here: *Pseudocyphellaria godeffroyi*, *P. homalosticta*, *P. insculpta*, *P. punctillaris*, *P. reineckeana*, *P. sulphurea*, *Sticta brevipes*, *S. caperata*, *S. cyphellulata*, *S. pedunculata* and *S. weigeli* are new to the mycobiota of the New Zealand Botanical Region. Aside from *P. insculpta* and *P. punctillaris*, the other species are known from that region only from Raoul Island. Several species recorded here from Raoul Island, represent considerable range extensions from their previous recorded stations in Australasia, e.g. *Podostictina nermula* (cf. Galloway 2007; Galloway *et al.* 2001), while the discovery on Raoul of three endemic elements of the New Zealand mycobiota (see Table 1): *Pseudocyphellaria episticta*, *Sticta babingtonii* and *S. squamata*, means that these species should now be excluded from the endemic mycobiota of New Zealand (Zealandia) subcontinent. Indeed their presence on Raoul Island suggests that lichenologists should now look further afield in the South Pacific to see where else they may reside.

Table 1. Biogeographic Elements in the Kermadec Islands Lobariaceae.

Endemic (New Zealand)
<i>Pseudocyphellaria episticta</i>
<i>Sticta babingtonii</i>
<i>S. squamata</i>
Australasian
<i>Podostictina nermula</i>
<i>Pseudocyphellaria chloroleuca</i>
<i>Sticta brevipes</i>
Austral
<i>Pseudocyphellaria glabra</i>
Palaeotropical
<i>Crocodia poculifera</i>
<i>Podostictina pickeringii</i>
<i>Pseudocyphellaria argyracea</i>
<i>P. bartlettii</i>
<i>P. carpoloma</i>
<i>P. dissimilis</i>
<i>P. godeffroyi</i>
<i>P. haywardiorum</i>
<i>P. homalosticta</i>
<i>P. insculpta</i>
<i>P. multifida</i>
<i>P. prolificans</i>
<i>P. punctillaris</i>
<i>P. reineckeana</i>
<i>P. semilanata</i>
<i>P. sulphurea</i>
<i>Sticta caperata</i>
<i>S. cyphellulata</i>
<i>S. pedunculata</i>
Pantropical
<i>Sticta wiegelii</i>
Cosmopolitan
<i>Crocodia aurata</i>
<i>Pseudocyphellaria crocata</i>
<i>P. intricata</i>
<i>Sticta fuliginosa</i>
<i>S. limbata</i>

What is especially noteworthy is that for such an isolated island group as the Kermadec Islands, Raoul Island is surprisingly rich in Lobariaceae. Indeed, the next nearest island groups, lying to the west of the Kermadec Islands, are the Norfolk Island and Lord Howe Island groups. From the Norfolk Island group, ten species of *Pseudocyphellaria* and three species of *Sticta* have so far been recorded (Elix *et al.* 1992; Elix & McCarthy 1998; Galloway 1994a; 2001; McCarthy 2013). Of these, *Crocodia clathrata* (de Not.) Trevis. and *Sticta caliginosa* D.J.Galloway are not known from Raoul Island. However, we regard the Norfolk Island

Table 2. *Pseudocyphellaria* and *Sticta* taxa found on Raoul Island with distributions centred on the land masses within the key cyclone-generating seas of the South Pacific.

<i>Pseudocyphellaria</i>
<i>Pseudocyphellaria insculpta</i>
<i>P. godeffroyi</i>
<i>P. homalosticta</i>
<i>P. prolificans</i>
<i>P. punctillaris</i>
<i>P. reineckeana</i>
<i>P. semilanata</i>
<i>P. sulphurea</i>
<i>Sticta</i>
<i>Sticta brevipes</i>
<i>S. caperata</i>
<i>S. cyphellulata</i>
<i>S. pedunculata</i>

record of the New Zealand endemic *Sticta caliginosa* D.J.Galloway, accepted by McCarthy (2012), as rather unlikely. Lord Howe Island has eight species of *Pseudocyphellaria*, three *Crocodia*, and three species of *Sticta* (Elix & McCarthy 1998; McCarthy 2012; Galloway 2001; Galloway & Elix 2013), of which *P. glaucescens* (Kremp.) Imshaug, *P. mooreana* (Zahlbr.) Imshaug, *P. rubrina* (Stirt.) D.J.Galloway, *Sticta flavocyphellata* D.J.Galloway, *S. howei* D.J.Galloway and *S. latifrons* A.Rich., are not known from Raoul Island. Further south, nearer to New Zealand, but potentially still contributing to the Kermadec Islands lichen flora, are the Three Kings Islands. The lichens of these islands were investigated in some detail by Galloway & Hayward (1987). From there they recorded one species of *Crocodia*, seven species of *Pseudocyphellaria*, and two of *Sticta*. All but two of these: *Pseudocyphellaria montagnei* (C.Bab.) D.J.Galloway et P.James and *Sticta latifrons* A.Rich., are shared with Raoul Island.

Although only 14 Lobariaceae have so far been recorded from the Lord Howe Island (McCarthy 2013), two of them (*Sticta flavocyphellata* and *S. howei*) are endemic, which is in marked contrast to the absence of endemic lobariaceous taxa from the Norfolk and Kermadec islands. Though for the Kermadec Islands at least this pattern is consistent with that observed for cryptogamic plants (no endemic mosses, one supposedly endemic liverwort (de Lange & Beever 2015; Braggins *et al.* 2013). Nevertheless, it seems remarkable that Lord Howe Island, which is heavily forested and mountainous, has less diversity in Lobariaceae than that recorded here from Raoul Island. The same cannot be said for the Lobariaceae recorded from Norfolk and Three Kings islands. This is expected considering that these islands have had a long history of human modification prior to their being properly botanically investigated. Most species of *Crocodia*, *Podostictina*, *Pseudocyphellaria* and *Sticta* require forested habitats and especially ones which are moist or seasonally so.

Approximately two thirds of the indigenous forest cover of Norfolk Island is now missing (Green 1994; Streiman 2002), whilst all of the largest forested islands of the Three Kings were once covered in low grass and fern (Cheeseman 1888; Baylis 1948; Turbott 1948; de Lange 1997). By comparison, the forest cover of Raoul Island has fared much better. Though it is true that the forest of Raoul Island was affected by periodic attempts to settle the islands by humans and associated animal pests, which included at various times goats, pigs, sheep, cats and rats, and that the island continues to be naturally disrupted by cyclonic, seismic and volcanic activity (Moreton 1957; Sykes 1977; de Lange 2011), Raoul has still retained a mostly dense forest cover. Following the eradication of feral animals, cats and rats the forest cover of Raoul Island has by and large thickened, the only substantial changes being those wrought by volcanism, earthquakes and tropical cyclones. In this paper we note how some species of *Crocodia*, *Sticta* and also *Ramalina*, previously common on Raoul Island, are now scarce, whilst others in these genera and the allied *Pseudocyphellaria*, not recorded and/or collected by W.R.B. Oliver, R. Cooper, and W.R. Sykes are now found on Raoul. These observations suggest that the diversity of these genera on Raoul Island is increasing, perhaps as a consequence of the general improvement of the forest cover and the associated creation of a greater variety of microhabitats.

We also think it likely that this mycobiota is being added to by wind-borne propagules emanating from New Zealand via the south-westerly air stream during winter and from the northeast of the Pacific in the summer (see Bannister & Blanchon 2003; Blanchon *et al.* 2012). Further, the mycobiota of the island is probably being augmented by propagules uplifted by passing tropical cyclones. Those which strike the Kermadec Islands are typically generated in the seas between northern Australia, New Guinea and the Solomon Islands, and between the Solomons, New Caledonia and Fiji (Revell 1981; Terry 2007). These are landmasses where most of the new additions to the New Zealand mycobiota recorded here are commonly found (Galloway 1991; 1994a; 1994b; 2007; Galloway *et al.* 2001) (Table 2). There is even the possibility that some lichens may have reached the Kermadec Islands via avian vectors. For example, de Lange *et al.* (2004) recorded *Achryanthes velutina* (as *A. aspera*) as a new indigenous plant for Macauley Island, which they felt most probably arrived via sea birds traveling between Norfolk and Macauley Islands. More recently, Fife and de Lange (2009) suggested that the occurrence of the widespread tropical moss *Calymperes tenerum* on the Kermadec Islands and Chatham Island, arose from the dispersal of the gemmae of that species to these islands by seabirds. Therefore we think it likely that at least some lichens may also have been dispersed by birds moving between Pacific island groups.

While it seems probable that tropical cyclones are a critical agent for dispersing lichens from the north-western Pacific to the Kermadec Islands, this paper also makes frequent mention of the severe damage these storms

cause to the vegetation of the islands. Indeed, the impact of such cyclones as Tropical Cyclone Bune on the forest cover of Raoul Island was tremendous (see de Lange 2011), and so if our speculations are correct, we would predict that future visiting lichenologists will find that a range of such photophilous lichens as *Crocodia aurata*, *C. poculifera*, and *Sticta squamata*, species described in this paper as scarce, will again (at least until the forest recovers) become temporarily abundant. It also remains to be seen whether Tropical Cyclone Bune brought any further species of Lobariaceae to Raoul Island.

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