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Rust fungi in the subantarctic islands of New Zealand

Received: February 13, 2007 / Accepted: August 20, 2007

Abstract Twenty-four species of rust fungi known from Auckland Islands and Campbell Island are listed, together with details of their host plants. Several species are recorded for the first time in these subantarctic islands. Four species are newly described and illustrated, viz., *Milesia polystichi-vestiti* on *Polystichum vestitum* (Dryopteridaceae), *Petersonia dracophylli* on *Dracophyllum longifolium* (Epacridaceae), *Puccinia austrina* on *Isolepis habra* (Cyperaceae), and *Puccinia chathamica* on *Carex trifida* (Cyperaceae). *Uredo inflatus* is transferred to *Uromyces* (as *Uromyces inflatus* comb. nov.) following recognition of the spores on *Anisotome latifolia* (Apiaceae) as teliospores.

Key words Auckland Islands · Campbell Island · New species · Taxonomy

Introduction

The New Zealand subantarctic islands consist of five island groups lying between approximately 47°–52° S and 166°–178° E. They range in size from 135 ha to more than 61 000 ha. Rust fungi are known from only two of the island groups (Auckland and Campbell) and not from the other three (Antipodes, Bounty, and Snares). Campbell Island, 700 km south of Bluff (the southernmost point of the South Island) is the most southerly, with an area of about 11 000 ha. The flora consists of 213 species including 128 native (Anonymous 1999). The Auckland Islands, the largest group, is about 465 km south of Bluff. Approximately 233 taxa of plants are recorded on the Auckland Islands, of which 196 are native (Anonymous 1999).

The first rust fungus known from the New Zealand subantarctic islands was *Uredo antarctica* Berk., collected by

J.D. Hooker during Ross's Antarctic Expedition. This rust, collected on Campbell Island in December 1840, was described from leaves of *Luzula crinita* by Berkeley (1845). It is now known to be the uredinial state of *Puccinia tenuispora* McAlpine, described from Australia (McAlpine 1906). It is probable that *P. compacta* Berk. (now *P. novozelandica* Bubák), described by Berkeley (1855), was also collected by Hooker in either the Auckland Islands or Campbell Island. Thomas Kirk, who visited all the New Zealand subantarctic islands in 1890, collected two new rust species that were described by Cooke (1890) – *Uredo inflata* Cooke (now *Uromyces inflatus* comb. nov.) and *Uredo oleariae* Cooke on leaves of *Anisotome latifolia* (Campbell Island) and *Olearia lyallii* (Auckland Islands), respectively. Gjørnum (1998) reported *Puccinia brachypodii* var. *poaenemoralis* (G.H. Otth) Cummins & H.C. Greene on leaves of *Poa pratensis* from Auckland Islands. This rust, picked out from phanerogams in Kew Herbarium, was also collected by T. Kirk. In the 20th century, a further three rusts were recorded from Auckland Islands (*Puccinia coronata* Corda, *P. pulverulenta* Grev., *P. tararua* G. Cunn.) and four from Campbell Island (*Aecidium monocystis* Berk., *P. oreoboli* Cummins, *P. pulverulenta*, *P. tararua*) (Cunningham 1923, 1931; Baker 1956; Dingley 1977; McKenzie and Foggo 1989).

Until the year 2000 there had never been an expedition specifically to collect fungi from the New Zealand subantarctic islands. In that year, the author was part of a group that focused on fungi, slime molds, and beetles during a 10-day expedition to Campbell Island, followed by a brief visit to the Auckland Islands. During this trip rust fungi were collected, including several species newly recorded from either Auckland Islands or Campbell Island. Among the specimens were four new species of rust fungi. *Milesia polystichi-vestiti* sp. nov. was found on the fern *Polystichum vestitum*, and *Petersonia dracophylli* sp. nov. was found on *Dracophyllum longifolium*. In addition, teliospores were found for *Uredo scirpi-nodosi* McAlpine and *U. chathamica* McKenzie, enabling the description of the species *Puccinia austrina* sp. nov. and *P. chathamica* sp. nov., respectively. “Urediniospores” of *Uredo inflata* were recognized as telio-

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spores when true urediniospores were found for the first time, requiring a new combination in *Uromyces*.

Materials and methods

In the following account 24 species of rust fungi are reported, which include species collected by the author as well as those collected and/or reported by earlier workers. The author collected rust fungi during a 10-day visit to Campbell Island and a 2-day visit to Auckland Islands in March 2000. Specimens were pressed and dried as soon as possible. Following determination, they were deposited in the New Zealand Fungal Herbarium (Herb. PDD) in Auckland.

The type specimens of *Uredo antarctica* and *Puccinia compacta*, held in Kew Herbarium, were examined. All specimens were mounted in lactophenol before examination. The presence of aecia is indicated by a I, uredinia by a II, and telia by a III.

Results and discussion

1. *Aecidium hebe* G. Cunn., Transactions and Proceedings of the New Zealand Institute 59: 496 (1928).

Specimen examined: Campbell Island, Mt. Honey, on *Hebe benthamii* (Hook. f.) Cockayne & Allan [Scrophulariaceae], March 12, 2000, E.H.C. McKenzie (PDD 85501 – I).

This endemic rust is known on several *Hebe* spp. in the South Island and Stewart Island. This is the first record on *H. benthamii*.

2. *Aecidium monocystis* Berk., in Hooker, The Botany of the Antarctic Voyage II. Flora Novae-Zelandiae. Part II. Flowerless Plants: 196 (1855).

Specimen examined: Campbell Island (McKenzie and Foggo 1989), Mt. Honey, on *Abrotanella rosulata* (Hook. f.) Hook. f. [Asteraceae], January 1981, M.N. Foggo (PDD 43969 – I).

This rust was described from Tasmania (see McKenzie and Foggo 1989). In New Zealand it is known from only two localities: Campbell Island, and from a specimen collected in January 1953 on *Abrotanella pusilla* (Hook. f.) Hook. f. in the Tararua Ranges, North Island.

3. *Milesia polystichi-vestiti* McKenzie, sp. nov. Fig. 1

Uredinia hypophylla, ellipsoidea, usque ad 0.5 mm longa, saepe aggregata, maculis decoloratis insidentibus, erumpentia. Urediniosporae (22–)26–36(–49) × (13–)16–24(–27) μm, late ellipsoideae, ellipsoideae, obovoideae vel subgloboseae, interne hyalinae, membrana 1–1.5 μm crassa hyalina echinulata, poris germinationis ignotis.

Uredinia hypophyllous, inconspicuous, ellipsoidal, usually ca. 0.25 mm long, but sometimes up to 0.5 mm, often aggregated on discolored tissue, erumpent, long covered by the epidermis which eventually splits open, surrounded by a rudimentary peridium. Urediniospores (22–)26–36(–49) ×

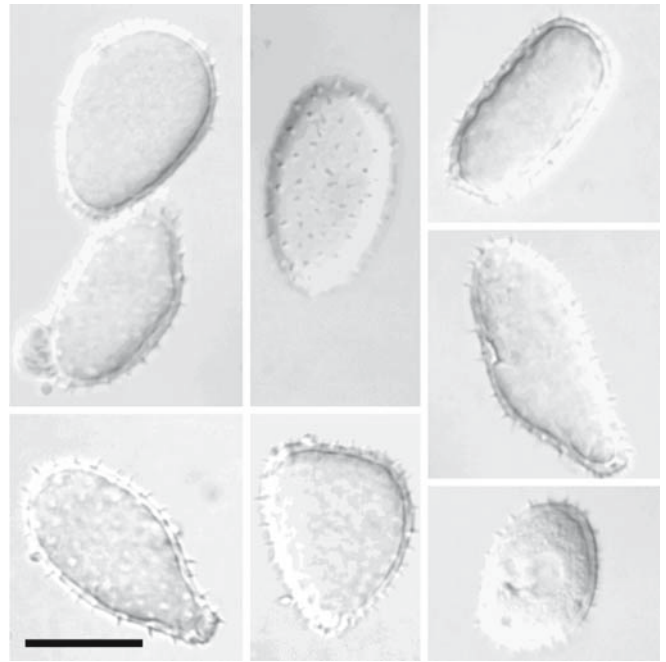


Fig. 1. Urediniospores of *Milesia polystichi-vestiti* McKenzie on *Polystichum vestitum* (G. Forst.) C. Presl (holotype). Bar 20 μm

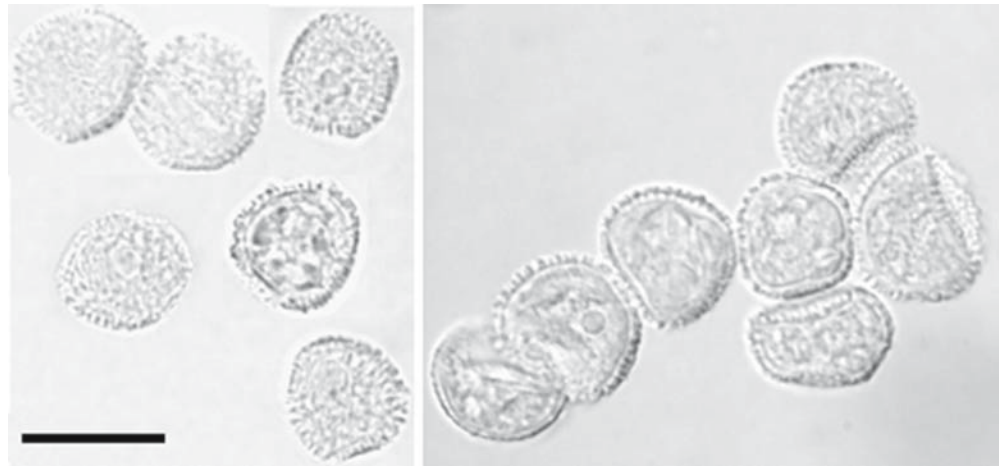
(13–)16–24(–27) μm (mean of 65 spores, 32.5 × 20.2 μm), broadly ellipsoid, ellipsoid, obovoid or subglobose, contents hyaline, wall 1–1.5 μm thick, hyaline, echinulate, germ pores not seen.

Specimens examined: Campbell Island, Camp Cove, on *Polystichum vestitum* (G. Forst.) C. Presl [Dryopteridaceae], March 11, 2000, P.R. Johnston (PDD 87904 – II – HOLOTYPE); boardwalk to Mt. Azimuth, on *P. vestitum*, March 14, 2000, E.H.C. McKenzie & P.R. Johnston (PDD 87903 – II); Beeman Cove, on *P. vestitum*, March 15, 2000, E.H.C. McKenzie (PDD 87902 – II).

Although lacking telia, this rust appears similar to *Milesia whitei* (Faull) Hirats. f. known on *Polystichum* species in Europe and Russia. The urediniospores of *M. whitei* are slightly smaller (Wilson and Henderson 1966; 22–40 × 17–22 μm, av. 30 × 19 μm). The uredinia of *M. whitei* are circular, ca. 0.15–0.3 mm diameter, and rupture through a central pore. *Milesia exigua* Faull occurs widely on *Polystichum* spp., but it has smaller urediniospores (17.5–32.5 × 19–20 μm) and a thinner wall (0.5–1 μm) (Hiratsuka et al. 1992).

Milesia polystichi-vestiti is the third rust to be recorded on a fern in New Zealand. *Milesia histiopteridis* (G. Cunn.) Faull (originally described as *Milesina histiopteridis* G. Cunn.) was described from New Zealand on *Histiopteris incisae* (Thunb.) J. Sm. (Cunningham 1924), and *Hyalospora polypodii* (Dietel) Magnus was recorded on *Deparia peterseanii* ssp. *congrua* (Brack.) M. Kato (McKenzie 1990). In all cases, only uredinia are known from New Zealand. The urediniospores of *Milesia polystichi-vestiti* are larger than those of either *M. histiopteridis* (18–26 × 14–20 μm) or *H. polypodii* [(20–)23–30(–32) × (11–)14–15(–16 μm)].

Fig. 2. Aeciospores of *Petersonia dracophylli* McKenzie on *Dracophyllum longifolium* (J.R. Forst. & G. Forst.) R. Br. (holotype). Bar 20µm



Polystichum vestitum is endemic and widespread throughout the New Zealand botanical region. It is morphologically highly variable, but molecular data does not support classification at the varietal level (Perrie et al. 2003).

4. *Petersonia dracophylli* McKenzie, sp. nov. Fig. 2

Pycnia ignota. Aecia plerumque abaxialia, pallida, usque ad 1(–1.5) × ca. 0.25 mm, maculis brunneis vel subrufus insidentibus diu epidermidibus obtectis. Peridia nulla. Aeciosporae catenata, 17.5–27(–34) × (13–)15.5–21.5 µm, obovoideae, ellipsoideae vel subgloboseae, saepe angulatae, interne hyalinae, membrana ca. 0.5 µm crassa hyalina verrucosa, poris germinationis ignotis.

Pycnia not seen. Aecia mainly on abaxial surface, pale, linear, lying between the parallel leaf veins, usually up to 1(–1.5) mm long, ca. 0.25 mm wide, usually only 2–4 per leaf and lying end to end, on brown or reddish leaf discoloration that usually extends through to opposite surface of leaf, long covered by the epidermis which ruptures irregularly often along one edge and end of pustule but rarely becomes detached, spores seen when liberated onto leaf surface. Peridium absent. Aeciospores catenate, no separating cells, 17.5–27(–34) × (13–)15.5–21.5 µm (mean of 75 spores, 22.6 × 18.2 µm), obovoid, ellipsoidal or subglobose, often somewhat angular, contents hyaline, wall ca. 0.5 µm thick, hyaline, verrucose, germ pores not seen.

Specimens examined: Campbell Island, east of Beeman Hill, on *Dracophyllum longifolium* (J.R. Forst. & G. Forst.) R. Br. [Epacridaceae], March 6, 2000, P.R. Johnston & E.H.C. McKenzie (PDD 87909 – I – HOLOTYPE); Mt. Honey, on *D. longifolium*, March 7, 2000, E.H.C. McKenzie (PDD 87905 – I); fence line from Tucker Cove, on *D. longifolium*, March 9, 2000, P.R. Johnston (PDD 87907 – I); North West Bay hut, on *D. longifolium*, March 13, 2000, P.R. Johnston (PDD 87906 – I).

The genus *Petersonia* was erected by Cummins and Hiratsuka (2003) to accommodate those rusts producing aecia that lack a distinct peridium and have catenate aeciospores without separating cells; this is *Caeoma* type IV and V of Sato and Sato (1985), and would include the aecial states of *Mikronegeria* and *Blastospora*. To date the genus

is monotypic with only the original species, *P. sanctaecrucis* (Espinosa) Cummins & Y. Hirats., the aecial state of *Mikronegeria fagi* Dietel & Neger, which occurs in the Andes in Chile and Argentina and produces telia on *Nothofagus* and aecia on *Araucaria*. Some other species with a similar aecial morphology have been described in the genus *Caeoma*; these include *C. peltatum* C.G. Shaw III & C.G. Shaw described from New Zealand on cladodes of *Phyllocladus trichomanoides* D. Don (Shaw 1976). The aeciospores of *C. peltatum* are somewhat larger (23.8–46.3 × 17.5–30 µm, mean 32.7 × 25.3 µm) with a thicker wall (1–2.1 µm) than those of *Petersonia dracophylli*.

The host genus, *Dracophyllum* (or “grass tree”), is placed within the mainly Southern Hemisphere, predominantly Australian family Epacridaceae. Almost 40 species of *Dracophyllum* occur in New Zealand with a few species in New Caledonia, and 1 or 2 in Australia. This is the first record of a rust fungus on the genus.

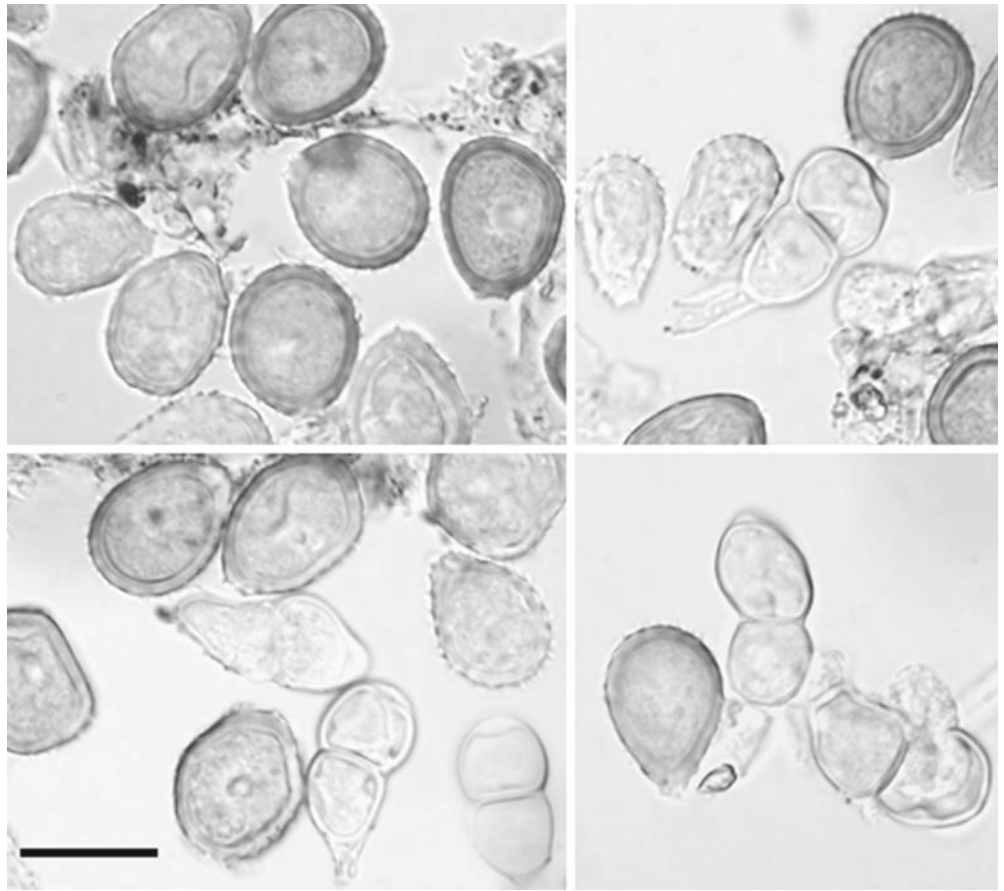
5. *Phragmidium* sp.

Uredinia hypophyllous, orange, pulvinate, pulverulent, mainly circular, sometimes oval, up to 0.75 mm long, with peripheral paraphyses; paraphyses up to 90 µm long, hyaline, curved, sometimes capitate (up to 16 µm wide) or only slightly swollen at apex, wall 1.5–2.5 µm thick. Urediniospores 19.5–22(–28.5) × 18–21 µm, subglobose, ellipsoidal, obovoid or pyriform, contents orange, becoming white when old and dried, wall 0.5–2 µm thick, hyaline, verruculose, germ pores 6–8, scattered.

Specimens examined: Campbell Island, east of Beeman Hill, on *Acaena* sp. [Rosaceae], March 6, 2000, E.H.C. McKenzie (PDD 83399 – II, PDD 83462 – II).

Four species of *Phragmidium* have been described from New Zealand on species of *Acaena*. They are distinguished from each other primarily on characters of the teliospores, especially average length and number of cells. There is little if any difference between their urediniospores. Unfortunately, neither of the collections from Campbell Island possess teliospores, and it is thus impossible to determine the species.

Fig. 3. Urediniospores and teliospores of *Puccinia austrina* McKenzie on *Isolepis habra* (Edgar) Soják (holotype). Bar 20µm



6. *Puccinia austrina* McKenzie, sp. nov.

Fig. 3

Anamorph = *Uredo scirpi-nodosi* McAlpine, The Rusts of Australia: 202 (1906).

Uredinia amphigena, cinnamomeo-brunnea, bulliformia, pulverulentia, elliptica, usque ad 2 cm longa. Urediniosporae 23–29 × (16–)18–21(–23) µm, obovoideae vel subgloboseae, valde pallide aureo-brunnea, membrana 1.5–3 µm crassa pallide aureo-brunnea echinulata, poris germinationis 2 aequatorialibus. Telia uredinii similia, ex ipsis soris orientia. Teliosporae 27–41 × 10–17 µm, ellipsoidae vel subclavatae, ad septum constrictae, valde pallide luteae, membrana ad latera ca. 1 µm ad apicem 1–4 µm crassa levi pallide lutea, pedicello usque ad 15 × 5–9 µm pallide flavido.

Uredinia amphigenous, cinnamon brown, bullate, pulverulent, elliptical, up to 2 cm long. Urediniospores 23–29 × (16–)18–21(–23) µm (mean of 44 spores, 25.7 × 19.6 µm), obovoid to subglobose, contents very pale golden brown; wall 1.5–3 µm thick, pale golden brown, echinulate, germ pores 2, equatorial. Telia arising from same sori as the uredinia. Teliospores 27–41 × 10–17 µm (mean of 20 spores, 32.4 × 14 µm), ellipsoid or subclavate, straight or slightly curved, apex rounded or sometimes acuminate, constricted at the septum, contents very pale luteus, wall ca. 1 µm thick at sides, 1–4 µm at apex, smooth, pale luteus; pedicels up to 15 µm long, but usually broken shorter, 5–9 µm wide, hyaline.

Specimens examined: Campbell Island, Mt. Honey, on *Isolepis habra* (Edgar) Soják [Cyperaceae], March 7, 2000, E.H.C. McKenzie (PDD 87917 – II, III – HOLOTYPE). South Island, Otago Lakes, Cardrona Ski Field, on *I. subtilissima* Boeck., February 5, 1998, E.H.C. McKenzie (PDD 87918 – II, III).

This is the first record of a rust fungus on either *Isolepis habra* or *I. subtilissima*.

McAlpine (1906) described *Uredo scirpi-nodosi* on *Scirpus nodosus* (= *Ficinia nodosa* (Rottb.) Goetgh., Muasya & D.A. Simpson; syn. *Isolepis nodosa* (Rottb.) R. Br.) from Victoria, Australia. He described the urediniospores as “brown, subglobose, ellipsoid to oblong, variable in size, 25–32 µ diam., or 27–36 × 19–25 µ; episporae echinulate, often 3 µ thick.” The species was subsequently reported from New Zealand (Cunningham 1924) and the urediniospores are described by Cunningham (1931) as “elliptical, obovate or subglobose, 24–35 × 16–24 µ, average 27 × 20 µ; episporae tinted cinnamon brown, coarsely and sparsely echinulate, 1.5 µ thick.” Cunningham (1924) stated that the episporae was 2–2.5 µ thick.

Further specimens of *Uredo scirpi-nodosi* in Herb. PDD were examined: PDD 61891 on *Isolepis distigmata* (C.B. Clarke) Edgar, PDD 34174 and 45171 on *I. inundata* R. Br., PDD 44048 on *Ficinia nodosa*, PDD 31479 and 41097 on *I. prolifera* (Rottb.) R. Br. These specimens had uredinio-

spores measuring (23–)25–31(–35) × (16.5–)19–26(–28) μm (mean 120 spores, 27.8 × 22.6 μm). *U. scirpi-nodosi* has been also recorded on *Bolboschoenus medianus* (V.J. Cook) Soják and *Schoenoplectus tabernaemontani* (C.C. Gmel.) Palla (= *S. validus* (Vahl) Á. Löve & D. Löve) in New Zealand (McKenzie 1998).

Gjærum (1990) described *Puccinia isolepidis* on *Isolepis fluitans* from Ethiopia. This rust has urediniospores that measure 21–27 × 13–21 μm, which is smaller than those described for *Uredo scirpi-nodosi* (McAlpine 1906). In addition, the urediniospore wall is only 1(–1.5) μm thick in *P. isolepidis*, compared to up to 3 μm in *U. scirpi-nodosi*. The teliospores of *P. isolepidis* are considerably larger than those of *P. austrina* (38–65 × 16–24 μm vs. 27–41 × 10–17 μm).

7. *Puccinia brachypodii* var. *poae-nemoralis* (G.H. Otth) Cummins & H.C. Greene, *Mycologia* 58: 705 (1966).

Specimens examined: Auckland Islands, on *Agrostis capillaris* L. [Poaceae], March 21, 2000, E.H.C. McKenzie (PDD 83448 – II); on *Poa pratensis* L. [Poaceae], T. Kirk, 1890 (K – II, Gjærum 1998); Enderby Island, Sandy Bay, on *Poa* sp. (*P. astonii* Petrie or *P. litorosa* Cheeseman), March 21, 2000, E.H.C. McKenzie (PDD 83446 – II, III). Campbell Island, Mt. Honey, on *Agrostis capillaris*, March 7, 2000, E.H.C. McKenzie (PDD 83452 – II); on *A. magellanica* Lam., March 7, 2000, E.H.C. McKenzie (PDD 83456 – II); Mt. Honey, on *A. magellanica*, March 12, 2000, E.H.C. McKenzie (PDD 83450 – II); Beeman Camp, on *Anthoxanthum odoratum* L. [Poaceae], March 8, 2000, E.H.C. McKenzie (PDD 73903 – II); on *Poa antipoda* Petrie [Poaceae], March 9, 2000, E.H.C. McKenzie (PDD 83447 – II); hills above head of North-East Stream, on *P. foliosa* (Hook. f.) Hook. f., March 14, 2000, E.H.C. McKenzie (PDD 83449 – II); Tucker Cove, on *Poa* sp., March 16, 2000, E.H.C. McKenzie (PDD 83451 – II).

A widespread rust, especially in temperate areas of the world. Occurs throughout New Zealand on a range of both introduced and endemic grasses. This is the first New Zealand record of this rust on the genus *Agrostis*, and on *Poa antipoda* and *P. foliosa*.

8. *Puccinia caricina* DC., *Flore Française, Troisième Edition* 6: 60 (1815).

Specimens examined: Campbell Island, east of Beeman Hill, on *Carex appressa* R. Br. [Cyperaceae], March 6, 2000, E.H.C. McKenzie (PDD 72449 – II, III); Camp Cove, on *C. appressa*, March 11, 2000, E.H.C. McKenzie (PDD 72450 – II).

A widespread rust, especially in temperate areas of the world. Presumably indigenous to New Zealand, it occurs throughout the country on various species of *Carex*.

9. *Puccinia chathamica* McKenzie, sp. nov. Fig. 4

Anamorph = *Uredo chathamica* McKenzie, *Mycotaxon* 41: 309 (1991).

Uredinia plerumque hypophylla (abaxialia), cinnamomeo-brunnea, pulverulentia, usque ad 2 mm longa. Urediniosporae 33–49 × 27–33 μm, subgloboseae, ellipsoideae vel

obovoideae, membrana 2–3.5 μm crassa pallide brunnea echinulata, poris germinationis 3 aequatorialibus. Telia hypophylla (abaxialia), atro-brunnea vel nigra, compacta, usque ad 1 mm longa. Teliosporae 43–56 × 18.5–21 μm, ellipsoideae vel subclavatae, ad septum constrictae, membrana ad latera 1–2.5 μm ad apicem 9–10.5 μm crassa levi pallide brunnea, pedicello usque ad 30 × 4–5 μm pallide luteo.

Uredinia amphigenous, mainly on lower (abaxial) surface, cinnamon-brown, pulverulent, linear, up to 2 mm long or longer when confluent, surrounded by the ruptured epidermis. Urediniospores 33–49 × 27–33 μm (av. of 39 spores, 41.4 × 30.0 μm), subglobose, ellipsoidal or obovoid, wall 2–3.5 μm thick, light brown, echinulate, germ pores 3, equatorial. Telia on lower (abaxial) surface, dark brown to black, compact, up to 1 mm long, surrounded by the ruptured epidermis. Teliospores 43–56 × 18.5–21 μm, ellipsoid or subclavate, apex rounded, constricted at septum, wall 1–2.5 μm thick at sides, 9–10.5 μm at apex, smooth, light brown; pedicels up to 30 × 4–5 μm, but usually broken shorter, pale luteus.

Specimens examined: Auckland Islands, Enderby Island, Sandy Bay, on *Carex trifida* Cav. [Cyperaceae], March 21, 2000, E.H.C. McKenzie (PDD 83426 – II). Campbell Island, Beeman wharf, on *C. trifida*, March 8, 2000, E.H.C. McKenzie (PDD 83420 – II, III – HOLOTYPE). Chatham Islands, Rekohu, Owenga, March 11, 1983, E.H.C. McKenzie (PDD 44228 – II – holotype of *Uredo chathamica*).

The description of the urediniospores matches that given by McKenzie (1991) for *Uredo chathamica* [(28–)33–39(–46) × (24–)26–31(–35) μm], and a comparison of specimens also indicates that they are conspecific. McKenzie (1991) described *U. chathamica* based on four collections of a rust fungus on *Carex chathamica* Petrie and two on *C. trifida* from the Chatham Islands, New Zealand. None of the six specimens had teliospores. The collection of rust on *C. trifida* from Campbell Island is the only one to have both urediniospores and teliospores.

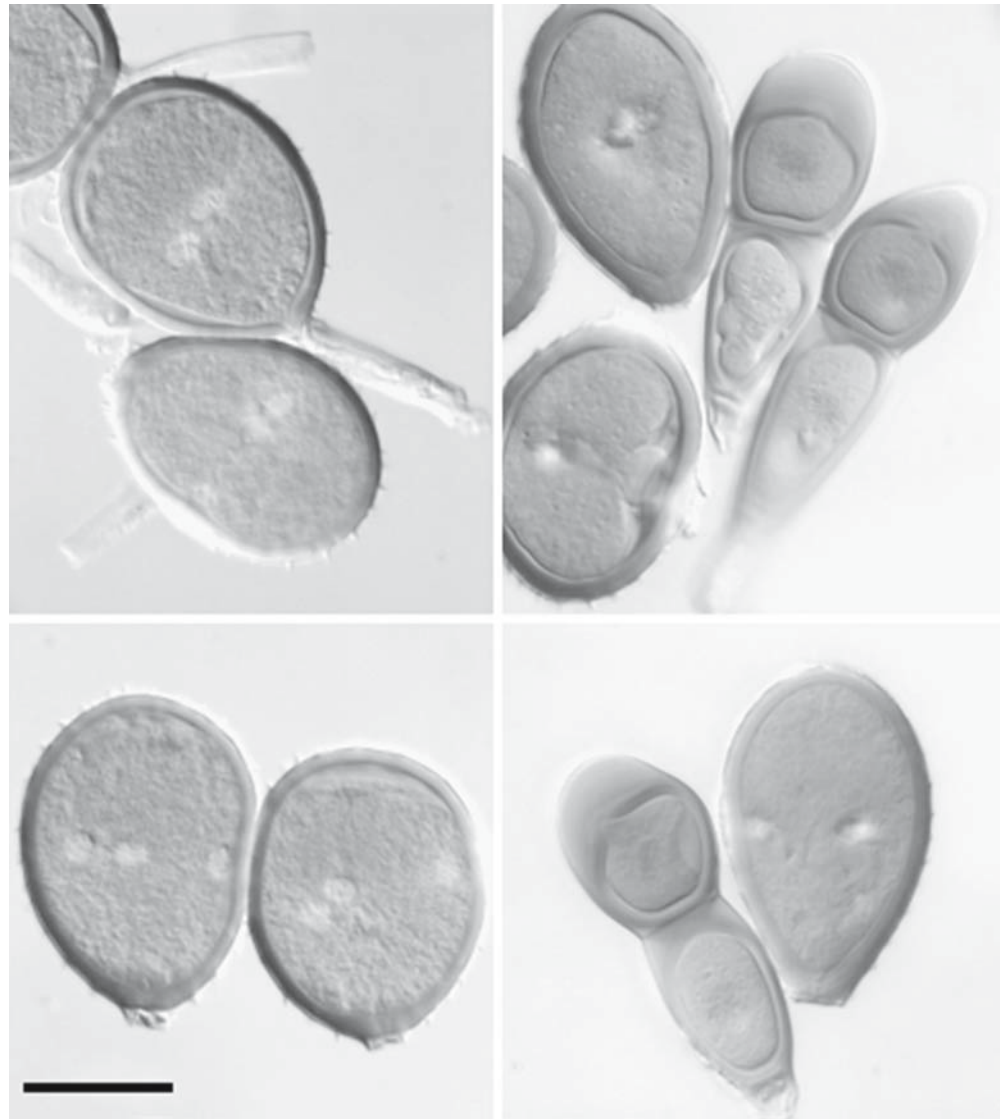
Unusually, it is the urediniospores of *P. chathamica* that are quite distinctive from those of four other species of *Puccinia* known on *Carex* spp. in New Zealand. The urediniospores are larger than those of the other four species (*P. caricina*, *P. mania* G. Cunn., *P. maurea* G. Cunn., *P. rautahi* G. Cunn.) and they generally have three equatorial germ pores. The teliospores are less distinctive. In size they are most similar to those of *P. maurea* and *P. rautahi*, but are slightly larger. The teliospores of *P. rautahi* have an acuminate apex whereas those of *P. chathamica* and *P. maurea* are mainly rounded.

Key to rust fungi on *Carex* spp. in New Zealand

A. Teliospores

1. Teliospores with apex mainly acuminate, 36–48 × 18–22 μm (av. 42 × 20 μm) *P. rautahi*
1. Teliospores with apex mainly rounded 2
2. Teliospores average less than 55 μm in length 3
2. Teliospores average more than 55 μm in length 4
3. Teliospores 32–44 × 16–22 μm (av. 41 × 19 μm) *P. maurea*

Fig. 4. Urediniospores and teliospores of *Puccinia chathamica* McKenzie on *Carex trifida* Cav. (holotype). Bar 20µm



- | | |
|--|---|
| 3. Teliospores 43–56 × 18.5–21 µm (av. 49 × 20 µm) | 4. Urediniospores with 4 germ pores, 24–36 × 18–25 µm (av. 29 × 24 µm), wall 1 µm thick |
| <i>P. chathamica</i> | <i>P. caricina</i> |
| 4. Teliospores 35–70 × 16–22 µm (av. 60 × 20 µm). | 4. Urediniospores with 3–4 germ pores, 24–30 × 20–24 µm |
| <i>P. caricina</i> | (av. 27 × 21 µm), wall 3–3.5 µm thick |
| 4. Teliospores 52–84 × 14–20 µm (av. 66 × 17 µm). | <i>P. rautahi</i> |
| <i>P. mania</i> | |

B. Urediniospores

- | | |
|---|---|
| 1. Urediniospores with 2(–3) superequatorial germ pores, 24–32 × 20–28 µm (av. 29 × 22 µm), wall 1.5–2 µm thick | 10. <i>Puccinia coronata</i> Corda, Icones Fungorum Hucusque Cognitorum 1: 6 (1837). |
| <i>P. maurea</i> | Specimens examined: Auckland Islands (McKenzie and Foggo 1989), Enderby Island, Sandy Bay, on <i>Holcus lanatus</i> L. [Poaceae], March 21, 2000, E.H.C. McKenzie (PDD 83427 – II); on <i>Poa foliosa</i> (Hook. f.) Hook. f.) [Poaceae], August 1985, M.N. Foggo (PDD 47673 – II). |
| 1. Urediniospores with 2–4 equatorial germ pores 2 | Campbell Island, Camp Cove, on <i>Arrhenatherum elatius</i> (L.) J. Presl & C. Presl subsp. <i>elatius</i> [Poaceae], March 11, 2000, E.H.C. McKenzie (PDD 72291 – II, III, PDD 72296 – II, III). |
| 2. Urediniospores with 3(–4) germ pores, 28–49 × 24–35 µm (av. 41 × 30 µm), wall 2–3 µm thick. | The cosmopolitan “crown rust” is widespread throughout New Zealand, on a broad range of mainly introduced grasses. |
| <i>P. chathamica</i> | |
| 2. Urediniospores smaller 3 | |
| 3. Urediniospores with 2 germ pores, 28–36 × 22–28 µm (av. 31 × 24 µm), wall 2.5–3 µm thick. | |
| <i>P. mania</i> | |
| 3. Urediniospores with 3–4 germ pores. 4 | |

11. *Puccinia hordei* G.H. Otth, Mittheilungen der Naturforschenden Gesellschaft in Bern 1870: 114 (1871).

Specimens examined: Campbell Island, Mt. Honey, on *Holcus lanatus* [Poaceae], March 7, 2000, E.H.C. McKenzie (PDD 83395 – II); Beeman Camp, on *H. lanatus*, March 8, 2000, E.H.C. McKenzie (PDD 83431 – II); Tucker Cove, on *H. lanatus*, March 16, 2000, E.H.C. McKenzie (PDD 83397 – II). North Island, Bay of Plenty, Rotorua, Tikitere, on *H. lanatus*, A. Gianotti, December 15, 1998 (PDD 69785 – II). South Island, Mid Canterbury, Christchurch, Addington, on *H. lanatus*, A.J. Healy, December 5, 1998 (PDD 70648 – II, III). Stewart Island, Halfmoon Bay, on *H. lanatus*, E.H.C. McKenzie, C. & K. Vánky, February 9, 1998 (PDD 85516 – II, III).

In New Zealand, *Puccinia coronata* has been commonly found on *Holcus lanatus* wherever the host plant grows. However, in 1998 *P. hordei* was collected for the first time on *H. lanatus* in New Zealand (PDD 69785, 70648, 85516). Rust was common on *H. lanatus* on Campbell Island in 2000, and it was also determined as *P. hordei*, although no teliospores were found. Overseas, *H. mollis* is well known as a host of *P. hordei*. *P. hordei* is common and widespread on barley (*Hordeum vulgare* L.) and barley grasses (*Criticism* spp.) in New Zealand.

12. *Puccinia junciphila* Cooke & Masee, in Cooke, Grevillea 22: 37 (1893).

Specimen examined: Campbell Island, Mt. Honey, on *Juncus antarcticus* Hook. f. [Juncaceae], March 7, 2000, E.H.C. McKenzie (PDD 73900 – II).

This indigenous rust, described from Australia, is widespread on *Juncus* spp. in New Zealand. This is the first record on *J. antarcticus*.

13. *Puccinia kirkii* G. Cunn., Transactions and Proceedings of the New Zealand Institute 54: 653 (1923). Fig. 5

Uredinia amphigenous, but mainly epiphyllous on *R. neglectus*, pulverulent, pulverulent, orbicular, ca. 0.5 mm diam., but up to 2 mm or more and irregular in shape when coalescent, surrounded by epidermis, amber colored. Urediniospores (20.5–)24–30(–33) × 16–25 μm (mean of 99 spores, 27.2 × 20.2 μm), obovoid, ellipsoidal to broadly ellipsoid, contents bright golden yellow; wall 0.6–2 μm thick, hyaline to pale yellow, echinulate, germ pores 3–4, equatorial. Teliospores mixed in with urediniospores, 24.5–36 × 16–23.5 μm (mean of 71 spores, 28.8 × 20.4 μm), ellipsoidal, each cell subglobose, slightly constricted at septum, contents yellow-brown or bright yellow gold; wall 0.7–1.3 μm thick at sides, 1–2.3 μm at apex, yellow-brown, smooth; germ pore at apex in upper cell, slightly papillate, and near pedicel in lower cell; pedicels up to 10 μm, hyaline.

Specimens examined: Auckland Islands, Auckland Island, near Dea's Point, on *Rumex neglectus* Kirk [Polygonaceae], March 22, 2000, E.H.C. McKenzie (PDD 83435 – II, III); Auckland Island, Chambres Inlet, on *R. neglectus*, March 27, 2006, P.R. Johnston (PDD 87919 – II, III); Enderby Island, East Bay, on *R. neglectus*, February 7, 1999, C.J. West (PDD 70278 – II, III); Enderby Island, Sandy Bay, on *R. neglectus*, March 21, 2000, E.H.C. McKenzie

(PDD 83433 – II, III). Chatham Islands, Rekohu, Ohira Bay, on *R. neglectus*, January 7, 2007, R.E. Beever (PDD 92012 – II, III).

This endemic rust is known from the western and southern parts of the South Island, Stewart Island, and Chatham Islands. It has been recorded on two native species of dock, *Rumex flexuosus* Spreng. and *R. neglectus*. The plants seen in the Auckland Islands in March 2000 were heavily infected.

14. *Puccinia novozelandica* Bubák, Sitzungsberichte der Königlichen Böhmisches Gesellschaft der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse 1901(2): 5 (1902).

≡ *Puccinia compacta* Berk., in Hooker, The Botany of the Antarctic Voyage II. Flora Novae-Zelandiae. Part II. Flowerless Plants: 195 (1855) (non *P. compacta* Kunze 1827).

Aecia, pycnia, and uredinia not known. Telia hypophyllous, circular, single, 1–1.25 mm diameter, sometimes surrounded by a ring of smaller pustules, pale amber, pulvinate, compact. Teliospores fusiform or ovoid, straight or slightly curved, apical cell oval or ellipsoidal, basal cell oval, ellip-

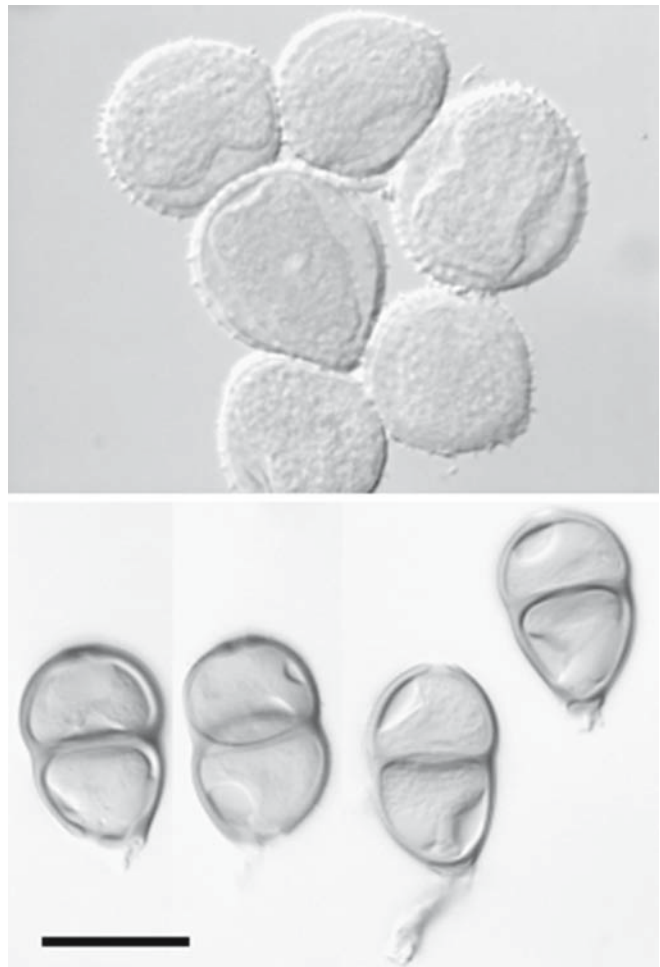


Fig. 5. Urediniospores and teliospores of *Puccinia kirkii* G. Cunn. on *Rumex neglectus* Kirk (PDD 83435). Bar 20 μm

soidal or obovoid, apex subacute, rounded, base attenuated, slightly constricted at septum, 45–68 × 16.5–23 µm (mean of 32 spores, 56.1 × 19.5 µm); wall smooth, yellowish, 2.25–3.5 µm thick at side, 4.5–10 µm thick at apex; pedicel persistent, up to 190 µm long, 8–14 µm wide, wall 2.25–3.25 µm thick, hyaline.

Specimen examined: Auckland Islands (Cunningham 1931; McKenzie and Foggo 1989), on *Myosotis capitata* Hook. f. [Boraginaceae], J.D. Hooker (Kew (M) 52415 – III).

The teliospore measurements obtained from an examination of the type specimen held at Kew are comparable to those given by Sydow (1922), who also examined the type specimen, and cited measurements of 42–62 × 15–20 µm.

This rust was initially described as *Puccinia compacta* Berk. (Berkeley 1855), which is a later homonym of *P. compacta* Kunze. It was said to have been collected by Lyall in the “Southern Island” (= Stewart Island). However, the host is restricted to the Auckland and Campbell island groups. Cunningham (1931) cites the specimen as being collected by J.D. Hooker on the Auckland Islands, but it is equally likely that it was collected on Campbell Island, as there is nothing on the Kew specimen to indicate either Campbell Island or Auckland Islands as the locality.

15. *Puccinia oreoboli* Cummins, Mycologia 33: 65 (1941).

Uredinia amphigenous, bullate, up to 0.75 × 0.25 mm, long-covered by a shield-like flap of epidermis, cinnamon colored. Urediniospores (23–)26–32(–35) × (18–)20.5–25.5(–28) µm (mean of 63 spores, 29.2 × 23.3 µm), subglobose, ellipsoid, obovoid, sometimes angular; wall 2–3 µm thick, cinnamon brown, echinulate, germ pores 2, equatorial.

Specimens examined: Auckland Islands, Enderby Island, near Sandy Bay, on *Oreobolus pectinatus* Hook. f. [Cyperaceae], March 21, 2000, E.H.C. McKenzie (PDD 83421 – II). Campbell Island (Dingley 1977; McKenzie and Foggo 1989), Homestead Flat, on *O. pectinatus*, November 21, 1975, B.M. May (PDD 34185 – II, III, 34186 – II, III).

This rust was described from Samazing, Papua New Guinea on *Oreobolus* sp. (Cummins 1941). Dingley (1977) found a few teliospores intermixed with urediniospores in the two Campbell Island specimens, but no teliospores were seen in the more recent Auckland Islands specimen, and they could not be located on the Campbell Island specimens. The rust is not known on *Oreobolus* in mainland New Zealand. The current distribution of Papua New Guinea and the subantarctic islands of New Zealand is unusual for a rust fungus. However, Samazing is about 2000 m above sea level, and a similar distributional pattern encompassing New Zealand, New Guinea, New Caledonia, and Solomon Islands exists for several genera of agaricales (Horak 1983). *Oreobolus* is a mainly Southern Hemisphere genus, but it also occurs in Hawaii, Malaysia, and Central America.

16. *Puccinia pulverulenta* Grev., Flora Edinensis: 432 (1824).

Specimens examined: Auckland Islands (Cunningham 1923, 1931; McKenzie and Foggo 1989), Enderby Island, on

Epilobium confertifolium Hook. f. [Onagraceae], May 25, 1911, L. Cockayne (PDD 1440 – I). Campbell Island (McKenzie and Foggo 1989), on *E. confertifolium*, January 1981, M.N. Foggo (PDD 43968 – I); on *E. confertifolium*, February 3, 1984, C.D. Meurk (PDD 45093 – I); Dent Island, on *E. confertifolium*, February 14, 1984, T.K. Crosby (PDD 45050 – I).

This indigenous rust, which is widespread around the world, is common throughout New Zealand on many species of *Epilobium*. Only the aecial stage was found in the subantarctic islands. The aecia are amphigenous and can be very crowded on the leaf surface.

17. *Puccinia recondita* Desm., Bulletin de la Société Botanique de France 4: 798 (1857).

Specimen examined: Campbell Island, Camp Cove, on *Festuca rubra* ssp. *commutata* Gaudin [Poaceae], March 11, 2000, E.H.C. McKenzie (PDD 87916 – II).

A widespread rust, especially in temperate areas of the world. Occurs throughout New Zealand on a range of mainly introduced grasses. *Puccinia recondita* is a “species complex.”

18. *Puccinia tararua* G. Cunn., Transactions and Proceedings of the New Zealand Institute 54: 671 (1923).

Specimens examined: Auckland Islands (Cunningham 1931; McKenzie and Foggo 1989), on *Gentianella cerina* (Hook. f.) T.N. Ho & S.W. Liu [Gentianaceae], January 1890, T. Kirk (PDD 10069 – II); Auckland Island, Port Ross, top of ridge to north of harbor, on *Gentianella* sp., March 29, 2006, P.R. Johnston (PDD 88475 – II). Campbell Island (Baker 1956; McKenzie and Foggo 1989), on *G. antarctica* (Kirk) T.N. Ho & S.W. Liu, November 1951 (PDD 13247 – II); on *G. antarctica*, February 1984, T.K. Crosby (PDD 45051 – II); on *G. antarctica*, January 1981, M.N. Foggo (PDD 43967 – II); fence line from Tucker Cove, on *G. antarctica*, March 9, 2000, E.H.C. McKenzie (PDD 83439 – II).

Two species of rust fungi have been recorded on *Gentianella* in New Zealand, but the second species, *Puccinia cockaynei* G. Cunn., is not known from the subantarctic. Although the two species can be readily distinguished by the size and shape of their teliospores, only urediniospores have been found on the subantarctic specimens. The urediniospore wall of *P. tararua* averages about 3 µm (range, 2–4.3 µm), which is noticeably thicker than the wall of *P. cockaynei* (average less than 2 µm; range, 1.3–3 µm). The wall is pale yellow in *P. tararua* and cinnamon brown in *P. cockaynei* (Cunningham 1931).

19. *Puccinia tenuispora* McAlpine, The Rusts of Australia: 137 (1906).

Anamorph = *Uredo antarctica* Berk., in Hooker, The Botany of the Antarctic Voyage I. Flora Antarctica. Part I. Botany of Lord Auckland's Group and Campbell's Island: 170 (1845).

Specimens examined: Auckland Islands (Cunningham 1931; McKenzie and Foggo 1989), on *Luzula crinita* Hook. f. [Juncaceae]. Campbell Island (Cunningham 1931;

McKenzie and Foggo 1989), on *L. crinita*, J.D. Hooker (Kew (M) 52413; Berkeley 1845 – holotype of *Uredo antarctica*); fence line from Tucker Cove, on *Luzula* sp., March 9, 2000, E.H.C. McKenzie (PDD 72448 – II).

Puccinia tenuispora was described from Victoria, Australia, on *Luzula campestris* (L.) DC. In New Zealand, it is known on several species of *Luzula* from the Tararua Ranges southward, including the Chatham Islands. The anamorph, *Uredo antarctica* was described from a Campbell Island specimen. The subglobose to ellipsoidal urediniospores of this specimen measure $22.5\text{--}29.5 \times 18\text{--}24\ \mu\text{m}$ (mean of 20 spores, $25.4 \times 21.2\ \mu\text{m}$); this is very similar to the measurements of $22\text{--}27 \times 16\text{--}24\ \mu\text{m}$, mean $25 \times 21\ \mu\text{m}$ given by Cunningham (1931) for urediniospores of *P. tenuispora*. There is no specimen in Herb. PDD to substantiate Cunningham's (1931) record of this fungus from Auckland Islands.

20. *Puccinia uncinarum* Dietel & Neger, Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 22(2): 351 (1896).

Specimens examined: Campbell Island, Mt. Honey, on *Uncinia hookeri* Boott [Cyperaceae], March 7, 2000, E.H.C. McKenzie (PDD 72451 – II); boardwalk to Mt. Azimuth, on *Uncinia* sp., March 14, 2000, E.H.C. McKenzie (PDD 87908 – II).

This indigenous rust was originally described from Chile. It occurs throughout New Zealand, including the Chatham Islands, on several species of *Uncinia*.

21. *Uredo oleariae* Cooke, Grevillea 19: 48 (1890).

Specimens examined: Auckland Islands (Cooke 1890; Cunningham 1924, 1931; Sydow and Sydow 1924; McKenzie and Foggo 1989), Port Ross, coast, on *Olearia lyallii* Hook. f. [Asteraceae], 1890, T. Kirk (PDD 42 – II – isotype); on *O. lyallii*, November 1907, B.C. Aston (PDD 10076 – II); Ewing Island, on *O. lyallii*, December 27, 1962, F.J. Fisher (PDD 40284 – II ex CHR 134024); on *O. lyallii*, February 13, 1987, W.R. Sykes (PDD 52963 – II); Port Ross, near Hardwicke site, on *O. lyallii*, March 22, 2000, E.H.C. McKenzie (PDD 87910 – II); Enderby Island, on *O. lyallii*, March 21, 2000, E.H.C. McKenzie (PDD 87911 – II).

This endemic rust is known only from the Auckland Islands and Stewart Island. Wilson (1982) stated that *Olearia lyallii* was introduced from Snares Islands to Auckland Islands, and that it is very similar to the coastal leatherwood (*O. colensoi* Hook. f.) of Stewart Island.

22. *Uromyces inflatus* (Cooke) McKenzie, comb. nov. Fig. 6

≡ *Uredo inflata* Cooke, Grevillea 19: 48 (1890).

Pycnia and aecia not known. Uredinia amphigenous, scattered, yellowish, bullate, ellipsoidal, up to $3 \times 1\ \text{mm}$, long covered by epidermis. Urediniospores $28\text{--}38\text{--}(48) \times (15\text{--})17.5\text{--}21.5\text{--}(23)\ \mu\text{m}$ (av. of 50 = $34.0 \times 19.7\ \mu\text{m}$), obovoid, ellipsoidal or pyriform, contents yellow, wall $1.25\text{--}2.5\ \mu\text{m}$ thick, colorless, coarsely echinulate, germ pores obscure. Telia amphigenous, scattered or crowded, yellowish, bullate, ellipsoidal, up to $3 \times 1\ \text{mm}$, long covered by epidermis.

Teliospores $19.5\text{--}25 \times 16\text{--}20\text{--}(21.5)\ \mu\text{m}$, (mean of 60 spores, $21.9 \times 18.5\ \mu\text{m}$), subglobose, contents pale luteus, wall $2.5\text{--}4\ \mu\text{m}$ thick, sometimes slightly thickened at apex, smooth or slightly verruculose especially near apex, luteus, germ pore obscure, pedicels up to $15 \times 3\ \mu\text{m}$, but usually broken shorter, hyaline.

Specimens examined: Auckland Islands, Adams Island, Fairchild's Garden, on *Anisotome* sp. [Apiaceae], March 22, 2006, P.R. Johnston (PDD 87920–II). Campbell Island (Cooke 1890; Cunningham 1924, 1931; McKenzie and Foggo 1989), on *Anisotome antipoda* Hook. f., February 1984, T. K. Crosby (PDD 53798 – II); on *A. latifolia* Hook. f., 1890, T. Kirk (PDD 41 – III – holotype of *Uredo inflata*); on *A. latifolia*, January 1981, M.N. Foggo (PDD 53586 – III); on *A. latifolia*, January 29, 1984, T.K. Crosby (PDD 45179 – II, III); South Col, by track to Asimuth, on *A. latifolia*, February 6, 1984, T.K. Crosby (PDD 83459 – III); North West Bay, on *A. latifolia*, March 13, 2000, P.R. Johnston (PDD 72455 – III); hills above head of North East Stream, on *A. latifolia*, March 14, 2000, E.H.C. McKenzie (PDD 73902 – III); fence line from Tucker Cove, on *A. latifolia*, March 2000, E. Edwards (PDD 72457 – III).

This endemic rust is known only from Auckland Islands and Campbell Island. Although originally described in the genus *Uredo*, Cunningham (1931) suggested that the spores resembled teliospores of a *Uromyces*. The sole specimen from Auckland Islands and two specimens from Campbell



Fig. 6. Urediniospores and thick-walled teliospores of *Uromyces inflatus* (Cooke) McKenzie on *Anisotome latifolia* Hook. f. (PDD 45179). Bar $20\ \mu\text{m}$

Island have a second spore type present; these spores are obviously urediniospores. The spores originally described by Cooke (1890) and redescribed by Cunningham (1931) are teliospores. The new combination, *Uromyces inflatus* (Cooke) McKenzie, is made following Article 59 of the Botanical Code

23. *Uromyces macnabbii* Cummins, The Rust Fungi of Cereals, Grasses and Bamboos: 483 (1971).

Specimen examined: Campbell Island, boardwalk to Mt. Azimuth, on *Chionochloa antarctica* (Hook. f.) Zotov [Poaceae], March 14, 2000, E.H.C. McKenzie (PDD 73025 – II).

Uromyces macnabbii is known only from New Zealand on several species of *Chionochloa*. This is the first record on *C. antarctica*.

24. *Uromyces otakou* G. Cunn., Transactions and Proceedings of the New Zealand Institute 54: 627 (1923).

Specimen examined: Campbell Island, east of Beeman Hill, on *Poa* sp. [Poaceae], March 6, 2000, E.H.C. McKenzie (PDD 83453 – II).

This rust is endemic to New Zealand, occurring on both native and introduced species of *Poa*. Microscopically, the uredinia of *U. otakou* differ from those of *Puccinia brachypodii* var. *poae-nemoralis*, the other common rust on *Poa* spp., by the absence of paraphyses. The germ pores on urediniospores of *U. otakou* are more obvious than those of *P. brachypodii* var. *poae-nemoralis*, and they have a slight, but noticeable, cap.

Acknowledgments Funds for this research were provided by the New Zealand Foundation for Research, Science and Technology, and the United States National Science Foundation (Grant DEB-9971695 to S.L. Stephenson, G.A. Laursen, and R.A.B. Leschen). R.O. Gardner and E. Cameron, Auckland Museum, kindly determined the identification of many of the host plants.

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