



A new species of rust fungus on the New Zealand endemic plant, *Myosotidium*, from the isolated Chatham Islands

MAHAJABEEN PADAMSEE & ERIC H.C. MCKENZIE

Landcare Research, Private Bag 92170, Auckland, New Zealand

email: padamseem@landcareresearch.co.nz; mckenziee@landcareresearch.co.nz

Abstract

Pucciniastrum myosotidii sp. nov. is described from plants of the Chatham Island forget-me-not (*Myosotidium hortensium*), a host plant that has a conservation status of “nationally endangered”. The rust has been found only on cultivated plants and not on wild plants. Although no teliospores were found, LSU and SSU sequence analysis showed that the new rust is closely related to some species of *Pucciniastrum* and *Thekopsora* forming a weakly supported clade together with *P. boehmeriae*, *P. epilobii*, *P. circaeae*, *P. goeppertianum*, *P. guttatum*, *P. pustulatum*, *T. minima* and *Melampsorella symphyti*. If this rust is endemic to Chatham Islands, then it must be accepted as a species of conservation value since the host plant is under threat from grazing animals and habitat loss.

Key words: Boraginaceae, endemic, megaherb, ornamental, phylogenetic analyses, *Pucciniastrum symphyti* comb. nov.

Introduction

Plants of the Chatham Island forget-me-not or giant forget-me-not (*Myosotidium hortensium* (Decne.) Baill.; Boraginaceae), growing in the Chatham Islands, were found to be infected by a rust fungus in January 2007 (Fig. 1 A–B). The rust was common in a garden on established plants and in a nearby nursery (Beever 2007). The rust has been since seen on cultivated plants, but never on wild plants. Although 63 species of rust fungi were recorded during earlier surveys of fungi in the Chatham Islands (McKenzie 1991, McKenzie & Johnston 1999), no rust was observed on *Myosotidium*. The host, which is a perennial and robust megaherb, is cultivated as an ornamental in both the North and South Islands of New Zealand although, in general, it struggles to survive outside of the Chathams. The Chatham Islands lie approximately 860 km east of Christchurch, New Zealand and have a total land area of less than 100,000 ha.

The genus *Myosotidium* is monotypic and endemic to the Chatham Islands where it grows naturally in coastal habitats on cliffs, rock outcrops and sandy and rocky beaches just above the strand zone (Heenan & Schönberger 2009). Although formerly abundant it has been significantly reduced to scattered remnants by farming, competition from marram grass, and trampling and browsing by animals. Consequently, it has been given a conservation status of “nationally endangered” (Hitchmough 2002).

Myosotidium has no obvious generic relatives in the Boraginaceae, but DNA analysis suggests that *Omphalodes nitida* Hoffmanns. & Link (1811) from Portugal and Spain is the closest relative of *Myosotidium*, which appears to represent a Chatham Island–Mediterranean disjunction (Heenan *et al.* 2010). It is also related to *Lappula squarrosa* and *Trichodesma scottii* (Heenan *et al.* 2010).

Based primarily on a phylogenetic analysis the rust on Chatham Island forget-me-not is herein described as a new species of *Pucciniastrum*. The question of whether or not this species is native or introduced to the Chatham Islands is also raised.

- ≡ *Thekopsora symphyti* (Bubák) Berndt, Untersuchungen zur Ultrastruktur und Anatomie der Melampsoraceen (Uredinales, Basidiomycetes): 198. 1993.
- ≡ *Thekopsora symphyti* (Bubák) J. Müll., Czech Mycol. 62: 97; 2010.

Acknowledgements

This research was supported through the Landcare Research Systematics Portfolio, with funding from the Science and Innovation Group of the New Zealand Ministry of Business, Innovation and Employment. We thank Dr H.D. Shin and Dr W. Cho (Korea University Herbarium) for providing specimens of *Pucciniastrum* (*Thekopsora*) *brachybotrydis*, and Dr D.J. McLaughlin (University of Minnesota Fungal Herbarium) for the specimen of *Naohidemyces vaccinii*.

References

- Aime, M.C. (2006) Toward resolving family-level relationships in rust fungi (Uredinales). *Mycoscience* 47: 112–122.
<http://dx.doi.org/10.1007/S10267-006-0281-0>
- Arthur, J.C. (1906) Eine auf die Struktur und Entwicklungsgeschichte begründete Klassifikation der Uredineen. *Résultats Scientifiques du Congrès International de Botanique Vienne 1905*: 331–348.
- Arthur, J.C. (1921) New species of Uredineae. XIII. *Bulletin of the Torrey Botanical Club* 48: 31–42.
<http://dx.doi.org/10.2307/2480021>
- Bary, A. de (1879) *Aecidium abietum*. *Botanische Zeitung* 37: 801–811.
- Beever, R.E. (2007) Notes on Chatham Island fungi and some plant pests. *Journal of the Auckland Botanical Society* 62: 28–31.
- Braun, U. (1999) An annotated list of Mongolian phytoparasitic micromycetes. *Schlechtendalia* 3: 1–32.
- Bubák, F. (1901) Über die Puccinien vom Typus der *Puccinia Anemones virginianae* Schwein. *Sitzungsberichte der Königlichen Böhmisches Gesellschaft der Wissenschaften* 1901: 1–11.
- Bubák, F. (1903) *Uredo symphyti* DC, und die zugehörige Teleutosporen- und Aecidienform. *Berichte der Deutschen Botanischen Gesellschaft* 21: 356.
- Cho, W.D. & Shin, H.D. (2004) *List of plant diseases in Korea*, 4th edn. The Korean Society of Plant Pathology. 779 pp.
- Corda, A.C.J. (1837) *Icones fungorum hucusque cognitorum*, volume 1. J.G. Calve. 32 pp.
- Cummins, G.B. & Hiratsuka, Y. (2003) *Illustrated genera of rust fungi*, 3rd edn. American Phytopathological Society, St Paul, MN.
- Cunningham, G.H. (1931) *The rust fungi of New Zealand*. John McIndoe, Dunedin. 261 pp.
- Desmazières, M.J.B.H.J. (1857) Coniomycetes. Vingt-quatrième notice sur les plantes cryptogames récemment découvertes en France – 1. *Bulletin de la Société Botanique de France* 4: 797–803.
- Dietel, P. (1897) Uredinales. *Die Natürlichen Pflanzenfamilien*, volume 1. Wilhelm Engelmann, Leipzig. pp. 24–48.
- Fitzpatrick, H.M. (1918) The life history and parasitism of *Eocronartium muscicola*. *Phytopathology* 8: 197–218.
- Gjaerum, H.B. (1986) Rust fungi (Uredinales) from Iran and Afghanistan. *Sydowia* 39: 68–100.
- Guindon, S. & Gascuel, O. (2003) A simple, fast, and accurate algorithm to estimate large phylogenies by maximum likelihood. *Systematic Biology* 52: 696–704.
<http://dx.doi.org/10.1080/10635150390235520>
- Heenan, P.B. & Schönberger, I. (2009) Typification of *Myosotis hortensia* Decne., the basionym of *Myosotidium hortensium* (Decne.) Baill., and its synonym *Cynoglossum nobile* Hook.f. (Boraginaceae). *New Zealand Journal of Botany* 47: 121–125.
<http://dx.doi.org/10.1080/00288250909509798>
- Heenan, P.B., Mitchell, A.D., de Lange, P.J., Keeling, J. & Paterson, A.M. (2010) Late-Cenozoic origin and diversification of Chatham Islands endemic plant species revealed by analyses of DNA sequence data. *New Zealand Journal of Botany* 48: 83–136.
<http://dx.doi.org/10.1080/0028825X.2010.494337>
- Hiratsuka, N., Sato, S., Katsuya, K., Kakishima, M., Hiratsuka, Y., Kaneko, S., Ono, Y., Sato, T., Harada, Y., Hiratsuka, T. & Nakayama, K. (1992) *The rust flora of Japan*. Tsukuba Shuppankai, Ibariki, Japan. 1205 pp. + 159 pp.
- Hitchmough, R. (comp.) (2002) New Zealand Threat Classification System lists—2002. *Threatened Species Occasional Publication* 23: 210 pp.
- Hylander, N., Jørstad, I. & Nannfeldt, J.A. (1953) Enumeratio Uredinearum Scandinavicarum. *Opera Botanica* 1: 1–102.
- Jørstad, I. (1958) Nomenclatural notes, chiefly on Uredinales. *Nytt Magazin for Botanik* 6: 135–140.
- Klebahn, H. (1904) *Die Wirtswechselnden Rostpilze*. Gebrüder Borntraeger, Berlin. 447 pp.

<http://dx.doi.org/10.5962/bhl.title.29948>

- Magnus, P.W. (1875) Ueber die Familie der Melampsoreae und ihre Gattungen. *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin* 1875: 57–60.
- Maier, W., Begerow, D., Weiß, M. & Oberwinkler, F. (2003) Phylogeny of the rust fungi: an approach using nuclear large subunit ribosomal DNA sequences. *Canadian Journal of Botany* 81: 12–23.
<http://dx.doi.org/10.1139/b02-113>
- McKenzie, E.H.C. (1991) Fungi of the Chatham Islands. *Mycotaxon* 41: 195–217.
- McKenzie, E.H.C. & Johnston, P.R. (1999) New records of phytopathogenic fungi in the Chatham Islands, New Zealand. *Australasian Plant Pathology* 28: 131–138.
<http://dx.doi.org/10.1071/AP99023>
- McKenzie, E.H.C. & Johnston, P.R. (2004) *Puccinia embergeriae* sp. nov. on Chatham Islands sow thistle (*Embergeria grandifolia*) and a note on *Miyagia pseudosphaeria* on sow thistles (*Sonchus* spp.) in New Zealand. *New Zealand Journal of Botany* 42: 657–661.
<http://dx.doi.org/10.1080/0028825X.2004.9512917>
- McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme van Reine, W.F., Smith, G.F., Wiersema, J.H. & Turland, N.J. (Eds.) (2012) *International code of nomenclature for algae, fungi, and plants (Melbourne code) adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011*. Available from: <http://www.iapt-taxon.org/nomen/main.php> (accessed 9 April 2014).
- Moncalvo, J.-M., Wang, H.H. & Hseu, R.S. (1995) Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers and 25S ribosomal DNA sequences. *Mycologia* 87: 223–238.
<http://dx.doi.org/10.2307/3760908>
- Oth, G.H. (1862) [1861] Über die Brand- und Rostpilze. *Mitteilungen der Naturforschenden Gesellschaft Bern*. 1861:57–88.
- Persoon, C.H. (1801) *Synopsis methodica Fungorum*. Henricus Dieterich, Göttingen. 706 pp.
- Rabenhorst, L. (1872) *Hedwigia. Ein Notizblatt für kryptogamische Studien nebst Repertorium für kryptogamische Literatur.*, volume 11. Druck und Verlag von C. Heinrich, Dresden. 192 pp.
- Saccardo, P.A. (1880) Conspectus generum fungorum Italiae inferiorum nempe ad Sphaeropsideas, Melanconieas et Hyphomyceteas pertinentium systemate sporologico dispositurum. *Michelia* 2: 1–38.
- Schröter, J. (1874) *Melampsorella*, eine neue Uredineen-Gattung. *Hedwigia* 13: 81–85.
- Spegazzini, C.L. (1879) *Decades Mycologicae Italicae*, volume 3. Conegliano. Nos 1–120.
- Sydow, H., & Sydow, P. (1903) Diagnosen neuer Uredineen und Ustilagineen nebst Bemerkungen zu einigen bereits bekannten Arten. *Annales Mycologici* 1: 15–23.
- Sydow, P. & Sydow, H. (1815) Pucciniaceae (excl. *Puccinia* et *Uromyces*) - Melampsoraceae – Zaghouaniaceae – Coleosporiaceae. 3 ed. *Monographia Uredinearum*. Fratres Borntraeger, Leipzig. 726 pp.
- Teppner, H., Gjaerum, H.B. & Brandenburger, W. (1977) Ein für Europa neuer Rostpilz, *Pucciniastrum brachybotrydis* (Uredinales), in Österreich gefunden. *Sydowia* 29: 281–284.
- Tranzschel, W. von (1907) Diagnosen einiger Uredineen. *Annales Mycologici* 5: 547–551.
- Vilgalys, R. & Hester, M. (1990) Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology* 172: 4238–4246.
- White, T.J., Bruns, T., Lee, S. & Taylor, J. (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis, M.A., Gelfand, D.H., Sninsky, J.J. & White, T.J. (Eds) *PCR protocols: a guide to methods and applications*. Academic Press, San Diego, 315–322.