

Phragmidium mexicanum (Uredinales: Phragmidiaceae) a neophyte rust established in Britain, with notes on its European distribution

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Abstract

We report recent records of the introduced rust *Phragmidium mexicanum* infecting *Potentilla indica* in Britain and, through published sources since its initial discovery in Europe in 1952, summarise its global distribution and review the spread of records of it in Europe.

Introduction

A dozen species of *Phragmidium* Link (including *Frommeëlla* Cummins & Y. Hirats.; see McCain & Hennen 1990; Yun *et al.*, 2011) are currently known from Britain, all infecting members of the Rose family (Rosaceae) (Henderson 2004, Legon & Henrici 2005, Woods *et al.*, 2024). They are characterised by multi-celled, pigmented teliospores, which (at least to those of a certain age!) resemble a spaceship from old Flash Gordon films. They include the most commonly recorded fungus on mycological forays, *P. violaceum*, infecting brambles *Rubus* spp. Three of them occur on species of *Potentilla*: *P. fragariae* on *Potentilla sterilis* (also reported on *Fragaria vesca*), *P. potentillae* on *Potentilla anglica*, *P. argentea*, *P. tabernaemontani*, and *P. spp. cult.*, and *P. tormentillae* on *P. erecta* and *P. reptans*. Recently, a rust on leaves of *Potentilla indica*, a neophyte not previously known as a host in Britain, has been collected from at least two sites in Wales (Woods *et al.*, 2024), and in England from the Royal Botanic Gardens, Kew in Surrey. This rust is referable to *Phragmidium mexicanum* (Mains) H.Y. Yun, Minnis & Aime, described from Mexico and not yet formally reported from Britain. A description of British material is given, and the wider distribution of the rust and its spread in Europe considered. Parasites reported from the sori are noted, and other taxa described or reported from *P. indica* are also briefly noted.

Phragmidium mexicanum

As well as the set of British species which may infect both native and introduced hosts, a neophyte species has followed its host *Potentilla indica* (Yellow Strawberry, formerly *Duchesnea indica*) to Europe, where it was first detected in August 1952 (Viennot-Bourgin 1954). McCain & Hennen (1990) and Poelt & Zwetko (1991) describe the complicated taxonomic history of rusts on *P. indica*.

Phragmidium mexicanum is named after *Fragaria mexicana*, to which the type host was first ascribed, only later being reidentified as *Po. indica* (McCain & Hennen, 1990). It has been through several generic placements (*Kuehneola*, *Frommea* (*nomen inval.*), *Frommeëlla*) but, following the work of Yun *et al.* (2011), now seems to be settled in *Phragmidium*. Its correct name is therefore *Phragmidium mexicanum* (Mains) H.Y. Yun, Minnis & Aime.

McCain & Hennen (1990) resolved part of the taxonomic confusion by describing two varieties, the type var. *mexicanum* with slightly shorter and wider teliospores than var. *indicae*, and with one fewer cell (2–4 rather than 3–5), and uredinia without paraphyses. However, subsequent records seem consistently to be of var. *indicae*, so the importance of the differences remained to be demonstrated, or supported by an investigation of DNA. Yun *et al.* (2011) argued that the differences between the varieties represent variable characters and were not of taxonomic importance, so that there is only a single species-level taxon. We follow this approach here.

Poelt & Zwetko (1991) also highlight the conundrum of the origin of the rust. *Po. indica* has a wide native distribution covering much of eastern Asia, but has also been widely introduced around the world, and is now found in both anthropic and seminatural habitats. *Ph. mexicanum* s.l. was, however, described from Mexico, so it is not known whether the rust originated in the New World or the Old World.

Phragmidium mexicanum in Britain

Ph. mexicanum was first detected in Britain by AOC in 2018 in Penglais Dingle, Aberystwyth, below the University Botany Garden, vc46, and subsequently also by Ray Woods in Insole Court Gardens, Llandaff, Cardiff, vc41, and these appear in the compilation of parasitic microfungus records in Woods *et al.* (2024).

During a field meeting of the British Plant Gall Society to Kew Gardens on 31 August 2024 (Spooner 2024), a rust on *Po. indica* was noted (Figs. 1 & 2). Though mostly uredinial, a few telia were present and it can clearly be ascribed to *Ph. mexicanum*. This appears to be

a new record for England, and a first for the Royal Botanic Gardens, Kew. As several other authors note, it is likely that *Ph. mexicanum* is overlooked, and has actually been present in Britain for some time. Hopefully, this article will draw attention to it and encourage further

reports. The rust may prove to be fairly frequent and widespread in Britain, though a recent inspection of four sites in Cardiganshire where the host is also known found the rust to be absent.



Fig. 1. *Phragmidium mexicanum* infecting *Potentilla indica*, Kew Gardens, 31 August 2024. Photo © P. A. Smith.



Fig. 2. *Phragmidium mexicanum* infecting *Potentilla indica*, Kew Gardens, 31 August 2024. Photo © P. A. Smith.

Phragmidium mexicanum (Mains) H.Y. Yun, Minnis & Aime, *Mycologia* 103(6): 1452 (2011)

Frommea mexicana Mains, *Bull. Torrey Bot. Club* 66: 618 (1939)

Frommeëlla mexicana (Mains) McCain & Hennen, *Mycotaxon* 39: 250 (1990)

Phragmidium duchesneae (Arthur) P. Syd. & Syd. *Monogr. Uredin.* (Lipsiae) 3(1): 93 (1912) [1915]

Kuehneola duchesneae Arthur, *N. Amer. Fl.* (New York) 7(3): 185 (1912)

Frommea duchesneae (Arthur) Arthur, *Bull. Torrey Bot. Club* 44: 504 (1917)

Frommeëlla duchesneae (Arthur) Yohem, Cummins & Gilb., *Mycotaxon* 22(2): 452 (1985)

Uredo duchesneae (Arthur) McCain & Hennen, *Mycotaxon* 39: 252 (1990)

Frommeëlla mexicana var. *indicae* McCain & Hennen, *Mycotaxon* 39: 251 (1990)

Frommea obtusa f. *duchesneae* (Arthur) Arthur, *Manual of the Rusts in United States & Canada*: 93 (1934).

Type: on *Potentilla indica*, from Veracruz, Mexico

The following description is based on the three Kew collections cited:

Aecia lacking. Uredinia hypophyllous, densely scattered, minute, orange to orange-yellow; urediniospores subglobose, finely echinulate, 17–19 x 15–17 µm. Telia brown, scattered amongst uredinia, minute, sparse in material examined; teliospores (33–) 50–110 x (19–) 22–25 µm, yellow-brown, smooth, 1–6-septate, wall somewhat thickened, 3–4 µm, at the apex, obtuse to bluntly conical, broadest at centre; pedicel short, non-hygroscopic. Basidia present, sparsely septate, thin-walled, slightly curved, c. 70 x 7–9 µm, sterigmata c. 10 µm long. Basidiospores few, ellipsoid, c. 9 x 4 µm. Paraphyses not seen.

Specimens examined: vc17 Surrey, Kew, Royal Botanic Gardens, Quercetum, on leaves of *Potentilla indica* under *Quercus rugosa*, 31

Aug. 2024, B.M. Spooner & P.A. Smith, K-M 1444352; same locality, 12 Sept. 2024, B.M. Spooner, K-M 1444392; same locality, 31 Oct. 2024, B.M. Spooner, K-M 1444391.

Other specimens reported: Wales, vc41 Glamorgan, Cardiff, Llandaff, Insole Court Gardens, ST15011766, 15 Jul. and 14 Dec. 2024, R. Woods; vc46 Cardiganshire, Aberystwyth, Penglais Dingle, below University Botany Garden, by muddy footpath in wooded ravine, SN59308200, 50m, 23 Oct. 2018, A.O. Chater, det. R.N. Stringer.

This is an autoecious rust, completing its life cycle on a single host species. Telia (Fig. 3) develop later than the uredinia, being largely absent from leaves collected in late September, but present on those collected later in October and in early November.



Fig. 3: Teliospores of *Ph. mexicanum*. Photo © A.O. Chater.

Wider distribution of *Ph. mexicanum*

Now known to be virtually cosmopolitan and probably present wherever the host occurs, whether native or naturalised. Much of the recorded distribution is given by Fraiture & Vanderweyen (2007) and by Yun *et al.* (2011). It is known from Africa (Yun *et al.*, 2011); Asia, including China (Tai, 1979; Zhao *et al.*, 2021), Korea (Yun *et al.*, 2011), and Pakistan (Fahad *et al.*, 2018); Australia (Fahad *et al.*, 2018) and New Zealand (McKenzie, 1998); Europe (see below); Mexico (Mains, 1939) and N. America (Arthur, 1912; Cummins & Stevenson, 1956); and S. America, including Argentina, Brazil, and Colombia (Hennen *et al.*, 2005). The account by Solano-Báez *et al.* (2021), claiming a first record of this rust from Mexico, evidently overlooked the re-identification of the type host as *P. indica* and is hence superfluous.

European distribution

It would be interesting to assess the spread of *Phragmidium mexicanum* in Europe. It has probably been present for some considerable time, though not been widely known or reported. Published records are, nevertheless, interesting, but may represent the spread of knowledge about this taxon more than they represent the spread of the fungus itself.

Ph. mexicanum was first reported in Europe from Denguin, near Pau in the Pyrénées-Atlantiques department (at low altitude) by Viennot-Bourgin (1954), but then seems to have escaped the attention of mycologists until

it was discovered in several localities around Graz, Austria in 1988-1990 (Poelt & Zwetko, 1991), with a further Austrian locality in Poelt & Zwetko (1997). It is also known from the Azores (Gjaerum & Dennis, 1976; Dennis *et al.*, 1977, as *Frommea obtusa*; Spooner & Butterfill, 1999) and Madeira (Gjaerum, 1970, 2001 (as *Frommeëlla duchesneae*); Fraiture & Vanderweyen, 2007). In mainland Europe it was next detected in Switzerland in 2000 (Berndt & Brodtbeck, 2022, without details) and then Czechia in 2002, at the botanic garden of Masaryk University, Brno (Müller, 2003), and as with the Austrian find, once alerted to its presence it proved to be widespread, but not ubiquitous – Müller (2006) found it in 7 out of 13 localities searched where the host was present.

A further extension was to Poland, originally at Kraków in August 2004, and then elsewhere in 2006 and 2008 (Wolczańska & Piątek, 2010). Fraiture & Vanderweyen (2007) reported *Ph. mexicanum* from the national botanical garden of Belgium on 8 June 2007, and then (again) in several more localities in Belgium quickly thereafter. They also report a previously unpublished record from the garden of the Natural History Museum in Karlsruhe, southern Germany, by Markus Scholler.

The next records are from near the Slovenian Forestry Institute, Ljubljana, Slovenia in 2008 (Piškur & Jurc, 2017) and from Ukraine, in the Botanical Garden of Odessa National University in September 2009 (Tykhonenko & Korytnyanska, 2012). Both the reporting

articles include electron micrographs of the uredinia, and the latter also has light microscope pictures of the urediniospores and teliospores. There are, however, many more occurrences in GBIF (2024), including from (with the year of the earliest record in brackets) Germany (2003), Hungary (2024), Netherlands (2012), Portugal (other than Macronesia) (2014), Russia (2022) and Spain (2001). In particular there are very many records from the Netherlands, where it is clearly widespread when systematically recorded.

Parasites

Fraiture & Vanderweyen (2007) reported uredinia of *Ph. mexicanum* to be infected by two hyperparasitic fungi, *Eudarlucacaris* (Fr.) O.E. Erikss. and *Lecanicillium muscarium* (Petch) Zare & Gams. The former is a widespread parasite of rust fungi, with a very broad host range, so its occurrence is not particularly surprising. The latter, on the other hand, is a more curious record, this being an entomopathogenic species, not otherwise recorded from rust sori. The identification was, however, tentative. *L. muscarium* was described from Norfolk, as *Cephalosporium muscarium* Petch, the anamorph of *Akanthomyces muscarium* and used now as a biocontrol agent for whitefly. Larvae, probably of a *Mycodiplosis* sp. (Diptera: Cecidomyiidae), such as are commonly present on sori of many rusts as well as of powdery mildews (Erysiphales), were also noted feeding on the urediniospores of *Ph. mexicanum*. None of these have so far been recorded on British collections of *Ph. mexicanum*.

Phragmidium mexicanum differs from other rusts on *Potentilla* in its host species and, especially, in characters of the urediniospores, telia and teliospores (Henderson, 2004).

Although the common host of *P. mexicanum* is *Po. indica*, it has also been recorded from *Potentilla hebiichigo* in Korea (Yun *et al.*, 2011).

One other taxon has been described from *Po. indica*:

Phragmidium duchesneae-indicae P. Zhao & L. Cai, *Fungal Diversity* 110: 1007 (2021).

Uredinia lacking paraphyses. Urediniospores echinulate, globose to broadly ellipsoid or obovoid, 13–19 x 11–17 µm. Telia brown to black, paraphyses absent; teliospores brown to black, 2–4-septate, 66–91 x 17–27 µm, pedicels hygroscopic.

Described from China.

Discussion

Ph. mexicanum has been recorded in a wide scatter of countries and localities across

Europe, but mostly rather sporadically. In the Netherlands, however, it is clearly widespread, and we suspect that this will be true in other places if there is systematic recording of the rust. The UK can now be added to the list of countries where *Ph. mexicanum* is known. It is interesting that so many of the published finds have been made in and near botanical gardens and similar institutions. We suspect that this results from a combination of *Po. indica*, as an introduced species, being relatively likely to be found in gardens, and people with the skills to recognise the rust visiting such places more frequently.

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