
AN ANNOTATED CHECKLIST OF *PERONOSPORA* SPECIES IN VICTORIA

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Abstract

All Victorian *Peronospora* specimens in herbarium VPRI were re-examined. Twenty-two species are listed here, and another four undetermined taxa are noted. Most species infect members of the Caryophyllaceae, Chenopodiaceae and Fabaceae. Only one specimen was encountered on a native Australian plant (*Mentha laxiflora*), but it could not be identified. The names applied to two groups of *Peronospora* species are of particular note. Firstly, as the only species of *Trifolium* to be infected by *Peronospora* in Victoria is *T. repens*, this species is treated as *P. trifolii-repentis*. Secondly, the *Peronospora farinosa* formae speciales classification for several taxa on the Chenopodiaceae has not been used. These taxa are treated as *P. farinosa* on *Atriplex*, *P. effusa* on *Spinacia oleracea*, *P. chenopodii* on *Chenopodium album*, and *P. schachtii* on *Beta vulgaris*.

J. H. Cunnington (2008). An annotated checklist of *Peronospora* species in Australia. *Australasian Mycologist* 27 (1): 1-6.

Introduction

Peronospora Corda (Peronosporales, Oomycota) is a large genus of obligately plant pathogenic fungi. It comprises over 550 validly published names (Constantinescu 1991). The use of many of these names has varied from country to country as different species concepts were applied. This has made it difficult to compare floras (Walker 1983). However, it is clear that the Southern Hemisphere is relatively deficient in *Peronospora* species, when compared to temperate parts of the Northern Hemisphere (Gustavsson 1959, Walker 1983). Very few *Peronospora* species occur on plants native to Africa, South America and Australia. Almost all species in these areas have been introduced from the Northern Hemisphere. The occurrence of *Peronospora* species in Australia has not been well documented. Walker (1983) counted, but did not list, 24 species in Australia based on plant disease checklists published by the various Australian State agriculture departments. These checklists are

often unreliable, as they are not always based on preserved specimens.

Here I present a checklist of *Peronospora* species in Victoria based on a re-examination of herbarium specimens.

Materials and Methods

Herbaria acronyms/abbreviations follow Holmgren & Holmgren (2006). All 135 Victorian *Peronospora* specimens in herbarium VPRI were re-examined. Few Victorian *Peronospora* specimens found in BRIP and DAR, which collectively with VPRI constitute the Australian National Collection of Fungi, were not re-examined as these specimens were on hosts already represented by VPRI specimens. Material was mounted in 60% or 100% lactic acid and warmed near the boiling point and examined with a compound microscope using interference contrast. Taxa were generally identified using Gäumann (1923) and Gustavsson (1959), in conjunction with recent phylogenetic data (Voglmayr 2003).

Taxonomy

Species are listed in alphabetical order. Collection details are given for 52 of the specimens examined. These cover all the *Peronospora*-host combinations found in the 135 VPRI specimens.

Peronospora aestivalis Syd.

On leaves of *Medicago sativa* L. [Fabaceae]

Representative specimens: Alvie, R. Clarke, 9 Dec. 1980, **VPRI** 11231; Harcourt, E.M. Straw, Nov. 1934, **VPRI** 177.

This species has been included in *Peronospora trifoliorum* de Bary in the Australian literature. However, the conidia of *P. aestivalis* have a length to breadth ratio of 1.2-1.4, whereas members of the *P. trifoliorum* group have a 1.0-1.2 ratio (Gustavsson 1959). The molecular phylogenetic study by Voglmayr (2003) showed that *P. aestivalis* lies outside the *P. trifoliorum* group.

Peronospora alsinearum Casp.

On leaves of *Stellaria media* (L.) Vill. [Caryophyllaceae]

Representative specimen: Merrigum, I.G. Pascoe, 22 Aug. 1991, **VPRI** 17562.

Peronospora arborescens (Berk.) Casp.

On leaves of *Papaver nudicaule* L. and *P. hybridum* L. [Papaveraceae]

Representative specimens: *P. nudicale*, Burnley, A.T. Pugsley, May 1935, **VPRI** 115; *P. hybridum*, Timmering, I.G. Pascoe, 22 Aug. 1991, **VPRI** 17556.

DNA sequence data were recently used to demonstrate that the *Peronospora* species on *Papaver somniferum* L. in Tasmania is *Peronospora cristata* Tranzschel (Scott *et al.* 2004). This contradicts the earlier report that the fungus was *P. arborescens* (Cotterill & Pascoe 1998). It was suggested that this mistake was made because morphological characters alone cannot be used to differentiate these two species (Scott *et al.* 2004). But, they can be distinguished by the size and shape of the conidia, and the length of the terminal conidiophore branchlets

(Francis 1981, Reid 1969), as well as by the ornamentation on the resting organs.

Peronospora chenopodii Schlecht.

On leaves of *Chenopodium album* L. [Chenopodiaceae]

Representative specimens: Torquay, S.E. Morley, 19 Nov 2002, **VPRI** 30505; Black Flat, G.H. Robinson, 11 Apr. 1905, **VPRI** 150; Orbst, A.T. Pugsley, 20 Mar. 1935, **VPRI** 148.

Common *Peronospora* species infecting the Chenopodiaceae are often treated as host specialised forms of *P. farinosa* (Fr. : Fr.) Fr., as proposed by Byford (1967). These are *P. farinosa* f. sp. *chenopodii* on *Chenopodium album*, *P. farinosa* f. sp. *betae* on *Beta* species, and *P. farinosa* f. sp. *spinaciae* on *Spinacia oleracea*. Choi *et al.* (2002) found morphological and molecular difference between the forms on *C. album* and *S. oleracea*. They recommended that these be treated as separate species. Here, we treat all three forms as separate taxa, and use *P. farinosa* only for the species on *Atriplex*. *Peronospora farinosa* was described from *Atriplex*, but the type specimen appears to be lost (Constantinescu 1991).

Peronospora chlorae de Bary

On leaves of *Eustoma grandiflorum* (Raf.) Shinn. [Gentianaceae]

Representative specimen: Fiveways, 28 Nov. 1991, **VPRI** 17735.

Peronospora conferta (Unger) Unger

On leaves of *Cerastium* spp. [Caryophyllaceae]

Representative specimens: *C. diffusum* Pers., Undera, B. Williams & I.G. Pascoe, 22 Aug. 1991, **VPRI** 17557; *C. sp.*, Timmering, I.G. Pascoe, 22 Aug. 1991, **VPRI** 17560.

Peronospora destructor (Berk.) Casp. ex Berk.

On leaves of *Allium cepa* L., *A. ascalonicum* L. and *A. porrum* L. [Alliaceae]

Representative specimens: *A. cepa*, Clyde, E. Minchinton, 7 Aug. 2001, **VPRI** 22915; *A.*

ascalonicum, Ivanhoe, H.-Y. Yip, 9 Sep. 1985, **VPRI** 12936; *A. porrum*, Leopold, F. Barkla, 3 Sep. 1981, **VPRI** 11520.

Peronospora effusa (Grev.) Rabenh.

On leaves of *Spinacia oleracea* L. [Chenopodiaceae]

Representative specimens: Pearcedale, E. Minchinton, 6 Mar. 2003, **VPRI** 30651; Bacchus Marsh, J. Sutherland, 13 Jul. 1984, **VPRI** 12374.

See discussion under *P. chenopodii*.

Peronospora farinosa (Fr. : Fr.) Fr.

On leaves of *Atriplex* sp. [Chenopodiaceae]

Representative specimen: Kerang, K. Vose, 26 Jul. 1990, **VPRI** 16841.

See discussion under *P. chenopodii*.

Peronospora grisea (Unger) Unger

On leaves of *Hebe diosmifolia* Andersen, *H. salicifolia* (G. Forst.) Pennell and *Veronica arvensis* L. [Scrophulariaceae]

Representative specimens: *H. diosmifolia*, Silvan, S. Branson, 28 Feb. 1992, **VPRI** 17808; *H. salicifolia*, Monbulk, C. Bate, 9 Mar. 1990, **VPRI** 16638; *V. arvensis*, Orbost, J. Black, 17 Oct. 1912, **VPRI** 152.

Peronospora hyoscyami de Bary

On leaves of *Nicotiana tabacum* L., *N. suaveolens* Lehm., *Solanum melongena* L. and *Lycopersicon esculentum* Miller [Solanaceae]

Representative specimens: *N. tabacum*, Burnley, A.T. Pugsley, Nov. 1934, **VPRI** 117; *N. suaveolens*, Myrniong Creek, C.C. Brittlebank, 24 Apr. 1924, **VPRI** 120; *S. melongena*, Mildura, T. Brown, 20 Jul. 1995, **VPRI** 20629; *L. esculentum*, Keysborough, J. Hough, 15 Jul. 2003, **VPRI** 31521.

Uncommon on hosts other than *N. tabacum* in Victoria.

Peronospora jaapiana Magnus

On leaves of *Rheum rhabarbarum* L. [Polygonaceae]

Representative specimens: A.T. Pugsley, Nov. 1934, **VPRI** 123; Diggers Rest, K. Lacey, 31 Jul. 1987, **VPRI** 15544.

Peronospora knautiae Fuckel ex J. Schröt.

On leaves of *Scabiosa columbaria* L. [Dipsacaceae]

Representative specimen: Kew, A.T. Pugsley, Jun. 1935, **VPRI** 125.

A second specimen (VPRI 127) collected at the same time lacks visible signs of the fungus.

Peronospora lamii A. Braun

On leaves of *Salvia muirii* L. Bolus [Lamiaceae]

Representative specimen: Fiveways, J. Johnson, 23 Oct. 2001, **VPRI** 22992.

Peronospora obovata Bonord.

On leaves of *Spergula arvensis* L. [Caryophyllaceae]

Representative specimens: Nyora, G.H. Robinson, Jul. 1900, **VPRI** 130; Doncaster, G.H. Robinson, 1 Oct. 1902, **VPRI** 131.

Peronospora pisi Syd

On leaves of *Pisum sativum* L. [Fabaceae]

Representative specimens: Myrniong, D. McAlpine, 12 Dec. 1901, **VPRI** 186; Werribee, A.T. Pugsley, Dec. 1955, **VPRI** 188; Telangutuk, S.E. Morley, 10 Oct. 2002, **VPRI** 30323.

Often noted as a host specific form of *P. viciae* in the Australian literature.

Peronospora polygoni Thüm. ex A. Fisch.

On leaves of *Polygonum aviculare* L. [Polygonaceae]

Representative specimens: Ardmona, 16 Sep. 1898, **VPRI** 191; Netherby, G.H. Robinson, 30 Sep. 1903, **VPRI** 175; P. Merrigum, B. Williams & I.G. Pascoe, 22 Aug. 1991, **VPRI**

17561; Walpeup, *R. Clarke*, 10 Sep. 1986, **VPRI** 14405.

Peronospora schachtii Fuckel

On leaves of *Beta vulgaris* L. [Chenopodiaceae]

Representative specimen: Fiveways, *F. Mileto*, 7 Nov. 2005, **VPRI** 32415.

See discussion under *P. chenopodii*.

Peronospora sparsa Berk.

On leaves of *Rosa* cultivars and *Rubus fruticosus* L. [Rosaceae]

Representative specimens: *Rosa* sp., Templestowe, *M. Reid*, 21 Sep. 2000, **VPRI** 22539; *Rosa* sp. Baxter, *T. Allen*, 19 Nov. 1992, **VPRI** 18497; *Rubus fruticosus* cv. Lochness, Toolangi, *C. Copes*, 16 Oct. 1996, **VPRI** 21204.

Peronospora trifolii-repentis Syd.

On leaves of *Trifolium repens* L. [Fabaceae]

Representative specimens: Timboon, *G. Ward*, 15 Oct. 1991, **VPRI** 17633b; Timboon, *G. Ward*, 15 Oct. 1991, **VPRI** 17638.

This species has been included in *P. trifoliorum* in the Australian literature. Recent molecular work (Voglmayr 2003) demonstrated that ribosomal DNA internal transcribed spacer sequences could differentiate several host specific taxa that were described on *Trifolium* by Gäumann (1923). Of these, only *P. trifolii-repentis* occurred on *T. repens*. As *T. repens* is the only species of *Trifolium* recorded to be affected by a *Peronospora* in Victoria, *P. trifolii-repentis* is the most appropriate name for the Victorian material.

Peronospora viciae (Berk.) Casp.

On leaves of *Vicia sativa* L. [Fabaceae]

Representative specimens: Swan Hill, *R. Clarke*, 23 Sep. 1992, **VPRI** 18271; Drysdale, *D. McAlpine*, 30 Oct. 1895, **VPRI** 187.

Peronospora violae de Bary

On leaves of *Viola tricolor* L. and related cultivars. [Violaceae]

Representative specimens: Keysborough, *P. Pierce*, 12 Sep. 1994, **VPRI** 20343; Clayton, *I. Smith*, 2 May 1990, **VPRI** 16692.

Unidentified taxa

On leaves of *Dianthus caryophyllus* L. [Caryophyllaceae]

Representative specimens: Keysborough, *I. Smith*, 11 Sep. 1989, **VPRI** 16493; Keysborough, *R. Slobodiuk*, 6 Nov. 1995, **VPRI** 20744.

This fungus is commonly named *P. dianthicola* Barthelet, but this is an invalid binomial (Francis 1983, Constantinescu 1991).

On leaves of *Mentha laxiflora* Benth. [Lamiaceae]

Representative specimen: Mount Macedon, *J. Edwards*, 10 Jan. 1998, **VPRI** 21617.

This is definitely not *P. stigmaticola* Raunk. that infects flowers of *Mentha* in Eurasia and North America. By its small conidia (17-19 × 14-16 µm) it mostly resembles *P. stachydis* Syd., an Eurasian fungus.

On leaves of *Geum chiloense* Balb. [Rosaceae]

Representative specimen: Glen Iris, *T. Crawford*, 6 Aug. 1999, **VPRI** 22110.

In their checklist of plant diseases in South Australia, Cook & Dubé (1989) listed this fungus as *Peronospora gei* Syd. Constantinescu & Negrean (1983) considered *P. gei* to be synonymous with *P. sparsa*, while others have kept it separate (Gustavsson 1959, Francis & Waterhouse 1988). The conidia on this specimen are more globose than those of *P. sparsa* found on *Rosa* in Victoria.

On leaves of *Vaccaria hispanica* (Mill.) Rauschert [Caryophyllaceae]

Representative specimen: Rosebud, *P. Mitchell*, 3 Dec. 1985, **VPRI** 13114.

Gustavsson (1991) listed *P. dianthi* de Bary on *V. hispanica* in Spain, although he did not examine the material.

Discussion

This re-examination of Victorian *Peronospora* species yielded few surprises. Most species in Victoria are common in the Northern Hemisphere, and most occur on the Carophyllaceae, Chenopodiaceae and Fabaceae, which are the major plant families infected by *Peronospora* species around the world (Constantinescu 1991). The discovery of a specimen of *Basidiophora entospora* Roze & Cornu., noted in Cunnington & Constantinescu (2006) was the most interesting. Only one reported species could not be substantiated by a voucher specimen. *Peronospora antirrhini* Schroet was recorded on *Antirrhinum majus* L. (Scrophulariaceae) in Carnegie, in September 1940 (Chambers 1982). Given that this species occurs in NSW (specimens in herbarium DAR), it is possible that record is correct.

The realisation the only species of *Trifolium* affected by downy mildew in Victoria is *T. repens* is also worthy of note. Aggregating all *Peronospora* species on *Trifolium* under '*Peronospora trifolorum*', gives the impression that a wide range of *Trifolium* species are affected in Victoria. But by applying Gäumann's (1923) species concept for the group, only *P. trifolii-repentis* occurs in Victoria, while *P. trifoliorum*, *P. trifolii-pratensis* A. Gustavsson, *P. trifolii-arvensis* (Thüm.) Syd., *P. trifolii-hybrid* Gäum. and *P. trifolii-minoris* Gäum. are now recognised as exotic organisms. This may have quarantine implications.

Acknowledgments

Ovidiu Constantinescu (UPS, Uppsala, Sweden) is thanked for identifying several of the specimens listed here.

References

- Byford, W.J. (1967). Host specialisation of *Peronospora farinosa* on *Beta*, *Spinacia* and *Chenopodium*. *Transactions of the British Mycological Society* **50**, 603–607.
- Chambers, S.C. (1982). List of diseases recorded on ornamentals, native plants and weeds in Victoria, before 30 June, 1980. Technical Report Series No. 61. Department of Agriculture, Government of Victoria.
- Choi, Y.J., Hong, S.B. & Shin, H.D. (2002). A comparison of *Peronospora farinosa* isolates from *Chenopodium album* and *Spinacia oleracea* using morphological and molecular characteristics, p. 195, in IMC7 Book of Abstracts. IMC7 Organizing Committee, Oslo.
- Constantinescu, O. (1991). An annotated list of *Peronospora* names. *Thunbergia* **15**, 1–110.
- Constantinescu, O. & Negrean, G. (1983). Check-list of Romanian Peronosporales. *Mycotaxon* **16**, 537–556.
- Cook, R.P. & Dubé, A.J. (1989). Host-pathogen index of plant diseases in South Australia. South Australian Department of Agriculture.
- Cotterill, P.J. & Pascoe, I.G. (1998). Downy mildew of *Papaver somniferum* in Tasmania. *Australasian Plant Pathology* **27**, 263–264.
- Cunnington, J.H. & Constantinescu, O. (2006). *Basidiophora entospora* in Australia. *Australasian Mycologist* **25**, 58–60.
- Francis, S.M. (1981). *Peronospora arborescens*. CMI Descriptions of Pathogenic Fungi and Bacteria **686**, 1–2.
- Francis, S.M. (1983). *Peronospora dianthicola*. CMI Descriptions of Pathogenic Fungi and Bacteria **764**, 1–2.
- Francis, S.M. & Waterhouse, G.M. (1988). List of Peronosporaceae reported from the British Isles. *Transactions of the British Mycological Society* **91**, 1–62.
- Gäumann, E. (1923). Beiträge zu einer Monographie der Gattung *Peronospora* Corda. *Beiträge zur Kryptogamenflora der Schweiz* **5**, 1–360.
- Gustavsson, A. (1959). Studies on Nordic Peronosporas. I. Taxonomic revision. *Opera Botanica* **3**, 1–271.
- Gustavsson, A. (1991). The genus *Peronospora* in the Iberian Peninsula, especially in northern Spain and Andorra. *Anales del Jardín Botánico de Madrid* **49**, 3–38.
- Holmgren, P.K. & N.H. Holmgren (2006). Index Herbariorum. New York Botanical Garden. Available online at: <http://sciweb.nybg.org/science2/IndexHerbariorum.asp> (Verified on 24 November 2006).
- Reid, D.A. (1969). New or interesting British plant diseases. *Transactions of the British Mycological Society* **52**, 19–38.
- Scott, J.B., Hay, F.S. & Wilson, C. (2004). Phylogenetic analysis of the downy mildew pathogen of oilseed poppy in Tasmania, and

- its detection by PCR. *Mycological Research* **108**, 198–205.
- Voglmayr, H. (2003). Phylogenetic relationships of *Peronospora* and related genera based on nuclear ribosomal ITS sequences. *Mycological Research* **107**, 1132–1142.
- Walker, J. (1983). Pacific mycogeography: Deficiencies and irregularities in the distribution of plant parasitic fungi. *Australian Journal of Botany Supplemental Series* **10**, 89–136.