

Distribution and ecology of Oomycetes in polar regions

Motoaki Tojo¹

¹Graduate School of Life and Environmental Sciences
Osaka Prefecture University

Oomycetes, synonyms Oomycota and Peronosporomycetes, are fungus-like microorganisms belonging eukaryotic kingdom Chromista. Oomycetes comprise more than 900 species. They are saprobic or parasitic on both plant and animal matters in water and soil over the world. Only a limited number of Oomycetes species, *Peronospora alsinearum*, *Peronospora parasitica*, *Pythium* sp., *Pythium polare*, *Pythium ultimum* var. *ultimum* and *Saprolegnia* sp., have been recorded from polar regions. This is in contrast with the true fungi which show an excessive diversity in the regions. Reason of this difference is unknown, but probably related to requirements of free water or high humidity on reproductions for many of Oomycetes species.

In polar regions, *Pythium* spp. can cause snow rot on mosses. *Pythium* is the most cosmopolitan genus among Oomycetes and holds more than 200 species through the world. Among of them, several *Pythium* species occur in polar regions. The first record of isolation of *Pythium* in the polar region was from a moribund *Sanionia* moss in Spitsbergen Island, Norway (Hoshino et al. 1999). This isolate was originally described as *P. ultimum* var. *ultimum*, but was re-identified as an unknown *Pythium* sp. afterwards with further taxonomic analysis (M.T. unpublished). Since then, several species of *Pythium* have been recorded from polar regions (e.g. Tojo and Newsham 2012, Tojo et al. 2012). Most of *Pythium* spp. in polar regions were still unnamed, and *P. polare* is the only named *Pythium* across the regions.

Pythium polare is the most common Oomycetes in polar regions which have a bipolar distribution (Tojo et al. 2012). This species is a heterothallic which requires antheridial and oogonial isolates to produce oospores even in between the Arctic antheridial isolate and the Antarctic oogonial isolate. *P. polare* is characterized by globose sporangia with discharge tubes of various lengths that release zoospores. The species taxonomically closely related with snow rot *Pythium* such as *P. iwiyamai*. *P. polare* is distinguished from the snow rot *Pythium* by longer discharge tubes to release zoospores and aplerotic oospores, usually with one to five antheridia. *P. polare* is, therefore, one of the snow rot *Pythium* showing a wide distribution throughout the polar regions. *P. polare* is also closely related with the moss parasitic *P. barbulae* (Ueta and Tojo 2016). *P. polare* and *P. barbulae* are the only *Pythium* which have been reported as moss parasites in natural environmental conditions.

Pythium polare infects broad range of plants including mosses and monocotyledons. The main host *Sanionia* moss has a bipolar distribution and grow predominantly in locations with a steady supply of snow melt water. *P. polare* requires snow melt water to produce zoospores for dissemination. *P. polare* is also highly dependent on *Sanionia* moss to survive in the polar regions, although this Oomycete has a greater frost resistance than the other snow rot *Pythium* (Murakami et al. 2015). It is recently reported that *P. polare* is infected by a toti and toti-like viruses which is named *Pythium polare* RNA virus 1 (PpRV1) (Sasai et al. 2018). Advantages and/or disadvantages of PpRV1 infection on *P. polare* host is unclear, and remains as a further study.

References

- Hoshino, T., M. Tojo, G. Okada, H. Kanda, S. Ohgiya and K. Ishizaki. 1999. A filamentous fungus, *Pythium ultimum* Trow var. *ultimum*, isolated from moribund moss colonies from Svalbard, northern islands of Norway. *Polar Biol Sci* 12: 68-75.
- Murakami, R., Y. Yajima, K. Kida, K. Tokura, M. Tojo and T. Hoshino. 2015. Surviving freezing in plant tissues by oomycetous snow molds. *Cryobiology* 70: 208-210.
- Sasai, S., K. Tamura, M. Tojo, M.L. Herrero, T. Hoshino, S.T. Ohki and T. Mochizuki. 2018. A novel non-segmented double stranded virus from an Arctic isolate of *Pythium polare*. *Virology* 522: 234-243.
- Tojo, M. and K.K. Newsham. 2012. Snow mould in polar environments. *Fungal Ecol* 5: 395 -402.
- Tojo, M., P. Van West, T. Hoshino, K. Kida, H. Fujii, H. Hakoda, Y. Kawaguchi, H.A. Mühlhauser, A.H. Van den Berg, F.C. Küpper, M.L. Herrero, S.S. Klemsdal, A.M. Tronsmo and H. Kanda. 2012. *Pythium polare*, a new heterothallic Oomycete causing brown discoloration of *Sanionia uncinata* in the Arctic and Antarctic. *Fungal Biol* 116: 756-768.
- Ueta, S. and M. Tojo. 2016. *Pythium barbulae* sp. nov. isolated from the moss, *Barbula unguiculata*; morphology, molecular phylogeny and pathogenicity. *Mycoscience* 57: 11-19.