

Puccinia punctiformis (F. Strauss.) Rohl.)

INVASIVE SPECIES ATTACKED: Canada thistle (*Cirsium arvense* (L.) Scop.)

TYPE OF AGENT: Leaf and stem rust (fungus)

COLLECTABILITY: Not permitted

ORIGIN: Unknown

DESCRIPTION AND LIFE CYCLE

General Development:

Puccinia punctiformis is a systemic rust that is specific to Canada thistle^{2, 5}. The rust spores redistribute by wind⁶.

Detailed Development:

P. punctiformis has several stages of spore development and ideal conditions are necessary for the successful advancement of the stages. The overwintering mycelium infects new shoot growth that develops from Canada thistle roots⁵. The dormant, thick walled spores (teliospores) store themselves in dead plant tissue in preferred environments and in ideal conditions will germinate in the spring to produce spores that require cross pollination (basidiospores). Up to four basidiospores develop in the basidium and germinate and attack other parts of the host plant including adventitious root buds^{5, 6}. Next, the orange coloured asexual spores (spermagonia) develop, followed by the reproductive body (aecia). The aecium of *P. punctiformis* produces spores (aeciumspores) that are capable of infecting adjacent host plant leaves. The leaves that become infected with the aeciumspores then develop self-producing spores (urediniospores)⁵. The urediniospores are then redistributed to other plants and nearby patches by wind⁶. An early symptom of *P. punctiformis* development is visible when the orange spermagonia are accompanied with a strong sweet smell⁵.

Overwintering stage:

The mycelium overwinters on the plants' rhizomes⁶. Urediniospores may overwinter in dead leaves and teliospores may overwinter in the soil⁵.

EFFECTIVENESS ON HOST PLANT

P. punctiformis infested shoots block the plant's ability to absorb light and produce chlorophyll referred to as etiolation. This process eventually causes necrosis to other plant parts, including the leaves and stems⁵. Significant damage can be caused from the systematic rust and infected roots generally do not survive³. Most likely, *P. punctiformis* is unable to provide complete control of Canada thistle, however, studies have shown that in some populations it is capable of causing 95% host plant decline when it occurs on a site with the approved biocontrol agent *Hadroplontus litura*⁶. In a growth chamber study, the flowers and vegetative reproduction capabilities of Canada thistle plants infected with *P. punctiformis* were reduced⁵. In southern Ontario, where *P. punctiformis* appears to be common, Canada thistle plants can be killed from the rust¹. Also in Ontario, the decline of Canada thistle plants at one infestation was partially attributed to the presence of the three adventives species, *P. punctiformis*, *Cassida rubiginosa* and *Cleonus piger*⁴.



Fig. 1. *P. punctiformis* on Canada thistle



Fig. 2. *P. punctiformis* on Canada thistle

HABITAT AND DISTRIBUTION

Native:

P. punctiformis is believed to be established throughout most of the world, however, its specific native range is unknown⁷. It is widespread in the eastern hemisphere, occurring in Asia, Australia, New Zealand and Europe. In Asia it is found in Afghanistan, Armenia, Azerbaijan, Republic of Georgia, Iran, Japan, Kazakhstan, Kirgizia, Tadjikistan, and east and south Russia. It is found throughout all of Australia and New Zealand. In Europe, it is established in Austria, Belarus, Belgium, Denmark, Estonia, Finland, France, Germany, Great Britain, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, western Russia, Spain, Sweden, Switzerland and Ukraine⁶.

North America:

Although *P. punctiformis* is found widespread throughout Canada and the U.S. it is considered to be adventive to North America⁷. In Canada it is more common in B.C., N.S., and Que, but, is rarer in the prairies. In the U.S.A., it is recorded to be more widespread through varying habitat types in Calif., Maine, Mass., Mich., Mont., N. J., N.Y., Ohio, Penn., R.I., S. Dak., Vt., Wash., and Wis.. In Canada, *P. punctiformis* appears to be more frequently found in eastern Canada and in moist sites³.

British Columbia:

P. punctiformis has been recorded established in the Bunchgrass, Coastal Douglas-fir, Coastal western hemlock, Interior Douglas-fir and Sub-boreal spruce biogeoclimatic (BEC) zones. It is believed *P. punctiformis* is much more widespread in B.C. and established in more BEC zones than what is currently recorded.

BRITISH COLUMBIA RECORD

Origin:

P. punctiformis is relatively widespread in Canada, however, the original source of the adventive rust found in B.C. is unknown⁷.

History:

It is not known when *P. punctiformis* was first found in B.C. There has been interest in using *P. punctiformis* for biological control of Canada thistle in North America and New Zealand since 1923⁶. There is renewed interest in the potential of this rust as a biocontrol agent in North America, particularly in the U.S.A.

Field results:

In any infestation a number of plants may have varying levels of *P. punctiformis*, from those showing no sign of attack, to others with light, moderate and heavy attack. In B.C., in the Salmon Arm area, some plants have been found to be completely collapsed when found heavily infested with the rust. Plants observed in July at Smithers appeared to be unaffected by the rust. A plant can be heavily laden with rust and show signs of total collapse while standing adjacent to healthy plants appearing resistant to attack. The rust appears to be quite widespread, but, it occurs sporadically and to varying degrees.



Fig. 3. *P. punctiformis* on Canada thistle at Smithers (Sub-boreal spruce zone)

NOTES

- Studies in Switzerland have shown that the weevil *Apion onopordi*, an established feeder of European thistles, readily transfers *P. punctiformis* spores on Canada thistle. Research also shows female *A. onopordi* appear to prefer to oviposit on rust-infested plants and their offspring are larger and lay more eggs than those reared on plants free of *P. punctiformis*².
- In a laboratory study carried out on Canada thistle plants, the best disease symptoms occurred when host plant roots were stored at 5, 10, or 15°C after being inoculated with *P. punctiformis*. All the clones tested, including both male and female plants, became infected. However, there was a varying range of receptiveness to the rust⁵.
- Studies have shown that *Hadroplontus litura* does not assist with the dispersal of *P. punctiformis*³. However, it is unknown whether research has been carried out on other biocontrol agents such as *Rhinocyllus conicus* and *Larinus planus* to determine their effectiveness as a vector of the rust.

REFERENCES

1. Forsythe, S.F. and D. Peschken. 1986. Biological control of Canada thistle (*Cirsium arvense* (L.) Scop.) Canadex Weed Control 64 Ag. Canada, Ottawa.
2. Gassmann, A., B. Kiefer and H. Schneider. 2002. Weed biological control, Quarterly Report. CAB International, CABI Bioscience Switzerland Centre.
3. McClay, A.S., R.S. Bouchier, R.A. Butts and D.P. Peschken. 2002. Chap. 65, *Cirsium arvense* (L.) Scopoli, Canada thistle (Asteraceae). In: Biological control programmes in Canada, 1981-2000. P.G. Mason and J.T. Huber (editors). CAB International, UK.
4. Peschken, D.P. 1984. Sect. II, Chap. 32, *Cirsium arvense* (L.) Scop., Canada thistle (Compositae). In: Biological Control Programmes Against Insects and Weeds in Canada, 1969-1980. J.S. Kelleher and M.A. Hulme (editors). Commonwealth Agricultural Bureaux, England.
5. Thomas, R.F., T.J. Tworowski, R.C. French, and G.R. Leather. 1994. *Puccinia punctiformis* affects the growth and reproduction of Canada thistle (*Cirsium arvense*). Weed Sci. Soc. of America, 8(3) (Jul.-Sep): 488-493.
6. Tykhonenko, Y.Y. and D.W. Minter. Undated. *Puccinia punctiformis*. IMI descriptions of fungi and bacteria. CAB Abstracts, CAB International. <http://www.cabdirect.org/publishing-products/online-information-resources/cab-abstracts> (Accessed Nov. 9, 2012).
7. Winston, R., C. Bell Randall, R. De Clerck-Floate, A. McClay, J. Andreas and M. Schwarzlander. 2014. Biological control of weeds in the northwest. Forest Health Technology Enterprise Team.