

Occurrence of European Tar Spot (*Rhytisma acerinum*) on Norway Maple (*Acer platanoides*) causing severe infections in Minnesota.

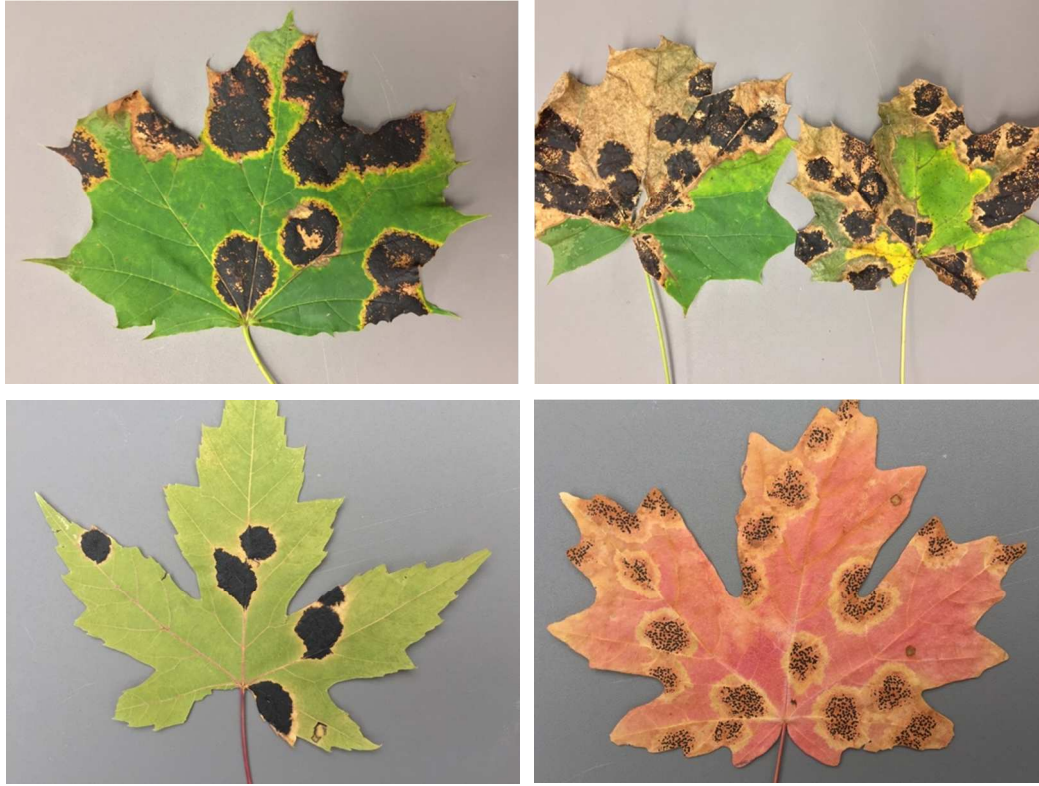
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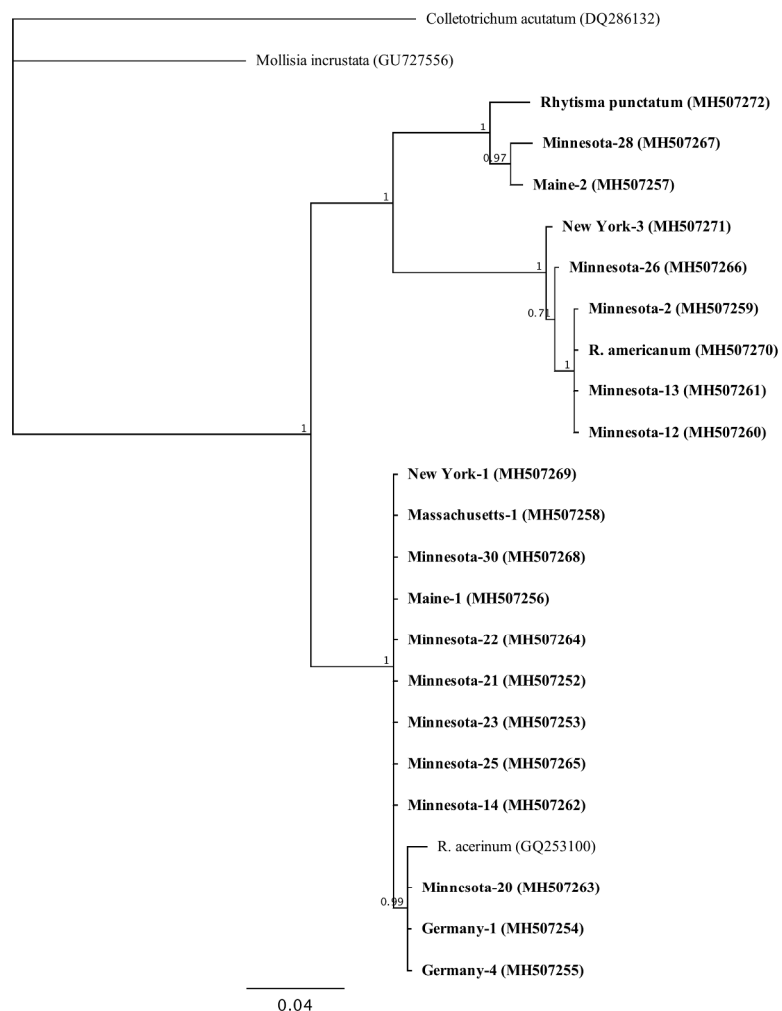
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Rhytisma species causing tar spot of maple (*Acer* spp.) have a worldwide distribution wherever maples are found. In North America, three *Rhytisma* species are found affecting *Acer*; *R. americanum* (Hudler & Banik), *R. punctatum* (Pers.) Fr. and *R. acerinum* (Pers.) Fr. For a number of years, *R. americanum* was erroneously called *R. acerinum*, despite early reports that there may be two distinct species (Bracher 1924). Hudler et al. 1998 described *R. americanum* as a separate species that occurs on red (*A. rubrum*) and silver (*A. saccharinum*) maples while *R. acerinum* is only found on Norway maple (*Acer platanoides*) in North America. Norway maple was introduced to the United States in about 1856 from England (Nowak & Rowntree 1990) and since then it has been planted widely as an urban ornamental tree. It is currently considered one of the most common invasive exotic tree species in the United States. *Rhytisma acerinum* appears native to Europe and was introduced into the United States with the first outbreaks of severe defoliation noted in New York (Hudler et al. 1987). *Rhytisma acerinum* infects Norway maple causing lesions on leaves and black masses of stomatal tissue. During severe infections, multiple lesions coalesce and remaining leaf tissue becomes necrotic leading to defoliation. However, there are conspicuous morphological differences between the three *Rhytisma* species in North America (suppl. data 1). In the late summer of 2017, we observed extensive infections on Norway maple in the Minneapolis/St. Paul, Minnesota area including the maple collection at the University of Minnesota Landscape Arboretum which includes several *A. platanoides* cultivars, most of which showed severe infection. Several cultivars ('Olmstead', 'Emerald Queen' and 'Crimson King') appeared to have more leaf necrosis that affected large portions of the crown compared to others ('Columnare') indicating there may be differences in susceptibility. In addition, two sugar maple (*A. saccharum*) cultivars ('Sweet Shadow' and 'Bailsta') showed limited infection as well as a hybrid (*A. truncatum* x *A. platanoides* 'Keithsform') which to our knowledge has not yet been reported as a host. Further observations and testing are needed to identify possible resistance in Norway maple cultivars. *Rhytisma acerinum* DNA was extracted directly from infected leaves by carefully excising small portions of tar spots and briefly surface sterilizing with a 5% bleach solution, rinsed with 95% EtOH and air dried followed by a CTAB extraction protocol which provided the template for the amplification of the ITS region of rDNA (Blanchette et al. 2016). A Bayesian phylogenetic analysis using ITS data showed that *R. acerinum* samples separated from other *Rhytisma* species that formed two clades (suppl. data 2). One Minnesota sample shared a clade with the type specimen (Genbank #GQ253100) originating from Germany along with tar spot samples obtained from Germany for this study with a posterior probability of 100%. The other Minnesota samples grouped in a closely related clade with samples from Massachusetts, Maine and New York. *Rhytisma americanum* grouped with strong support with the type species described by Hudler et al. 1998. *Rhytisma acerinum* has just started to cause severe infection in Minnesota and it is important to recognize the impact and damage from this pathogen across the regions where Norway maple is planted in order that specific control measures may be implemented.

- Blanchette, R.A. et al., 2016. Arctic driftwood reveals unexpectedly rich fungal diversity. *Fungal Ecology*, 23. pp 58-65
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- Hudler, G.W. et al., 1987. Unusual epidemic of tar spot on Norway maple in upstate New York. *Plant disease*, 71(1), pp.65–68.
- Hudler, G.W. et al., 1998. *Rhytisma americanum* Sp. Nov.: A Previously Undescribed Species of *Rhytisma* on Maples (*Acer* spp.). *Mycotaxon*, 68, pp.405–416.
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Supplemental 1. Photographs showing examples of *Rytisma acerinum*, *R. americanum* and *R. punctatum* on *Acer* spp. **Upper left**; large black spots of stomatal fungal tissue of *R. acerinum* on Norway maple and **Upper right**; severe infection of Norway maple by *R. acerinum* causing leaf necrosis beyond infection spots. **Lower left**; more compact leaf spots with slight ridges on the stroma of *R. americanum* on silver maple. **Lower right**; stippled leaf spots of *R. punctatum* on mountain maple.



Bayesian gene tree of *R. acerinum*, *R. americanum* and *R. punctatum* from the United States based on ITS sequences. The GenBank isolate (GQ253100) originated from Germany, which shares a clade with samples we obtained from Germany and one sample from MN (MN-20). The remaining *R. acerinum* samples group together which includes samples from MA, ME, MN and NY. Names of isolates from this study are in bold. Posterior probabilities are shown at branch nodes.

