

# Taxonomy of the genus *Gremmeniella*, causal agent of scleroderris canker

Gaston Laflamme

Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, 1055 du P.E.P.S., P.O. Box 3800, Sainte-Foy, Quebec, Canada G1V 4C7.  
E-mail: glaflamme@cfl.forestry.ca

## Abstract

The conifer disease known as Scleroderris canker is caused by ascomycetes of the genus *Gremmeniella*. The taxonomy of these pathogens has undergone many changes from the rank of order down to the rank of species, since the first description of the teleomorph in Sweden under the name *Crumenula abietina* Lagerberg, in 1913. A second species found in Switzerland on larch, *C. laricina* Ettlinger, was described in 1945. In 1975, three serovars or races were recognized for the species *G. abietina*. In 1989, a reassessment of the genus was made based on results of morphological, cultural and biochemical studies. Thus, in addition to the var. *abietina*, representing the three serovars, the var. *balsamea* was proposed for the pathogen infecting spruce and balsam fir in Canada. New information on the epidemiology of these fungi infecting different hosts, in combination with results of sequencing the isolates representative of the host range of the disease, provides a better understanding of this disease on its respective hosts. A review of the genus *Gremmeniella* is presented, including a proposal for several new species.

**Keywords:** Scleroderris canker, *Gremmeniella*, taxonomy

## Introduction

Pathogen fungi belonging to the genus *Gremmeniella* cause serious diseases of conifers in Asia, Europe and North America (Donaubauer 1972, Karlman et al. 1994, Laflamme and Lachance 1987, Ohman 1966, Setliff et al. 1975, Yokota 1984). In the genus *Gremmeniella*, morphological characteristics are not very helpful for microscopic identification and overlaps are common between measurements of specimens from different hosts (Petrini et al. 1989). The diagnostic of the disease on pine was limited to the identification at the genus level which was believed for quite a long time to be monospecific with *G. abietina*. This is why the pathogen identification at the species level was not considered to be a problem even if fungal taxonomy is a key element in the understanding of a pathosystem. For example damage caused by the so called European race, which can kill large trees, is very different from that caused by all other *Gremmeniella* types.

Symptoms of the disease are quite well known, starting in early spring with brown coloration at the base of the previous year's needles, followed by a shoot

blight in the summer (Laflamme 1991). Cankers can be produced a few years later on twigs and on the main stem. The English name of the disease comes from the fungus's scientific denomination *Scleroderris lagerbergii*, used in the late 1960s when the disease became an epidemic in western Europe, in eastern North America and in Japan. This disease has been found on several conifer species of the northern hemisphere but the most severe damage has been recorded on pine.

### Classification from the order to the genus

These *Ascomycetes* were classified in the order *Helotiales* and in the family *Helotiaceae* by Dennis (1968); these fungi are now ranked in the order and family *Leotiales* and *Leotiaceae* by Hawksworth et al. (1995). *Gremmeniella*, the genus denomination, is now widely accepted, but this was not always the case; the denomination went through several changes over the last century. When discovered in 1913 by Lagerberg in Sweden, this pathogen was first included in the genus *Crumenula*. Forty years later, Gremmen decided to integrate this fungus into the genus *Scleroderris*. Several fungal taxonomists did not agree with this last change and from 1969 to 1971 three different genera were proposed by three different authors. Schläpfer Bernhard (1969) proposed integrating this fungus into the genus *Ascocalyx*. At the same time, Morelet (1969) and Reid (in Dennis 1971) created two different new genera, respectively *Gremmeniella* and *Lagerbergia*. *Gremmeniella* was the valid name because it was published first. But it took some time before everyone agreed on that name because *Ascocalyx* was proposed again (Müller and Dorworth 1983). Based on a study using chemical, biochemical, cultural and morphological information on these fungi, Petrini et al. (1989) supported the name *Gremmeniella*.

**Table 1.** List of genera used for the teleomorph denomination during the last century for the causal fungi of *Scleroderris* canker.

---

|                           |      |
|---------------------------|------|
| <i>Crumenula abietina</i> | 1913 |
| <i>Scleroderris</i>       | 1953 |
| <i>Ascocalyx</i>          | 1969 |
| <i>Gremmeniella</i>       | 1969 |
| ( <i>Lagerbergia</i> )    | 1971 |
| <i>Ascocalyx</i>          | 1983 |
| <i>Gremmeniella</i>       | 1989 |

---

### Species in the genus *Gremmeniella*

Morelet (1969) created the new genus *Gremmeniella* with *G. abietina* as the type species and the only species of the genus. *Crumenula laricina* was then moved to the genus *Encoeliopsis*. A few years later, Dorworth and Krywienczyk (1975) recognized three pathological races based on serology: the North American race, the Eu-

ropean race and the Asian race. These races or serovars do not have any taxonomic value.

Petrini et al. (1989) studied isolates and their corresponding herbarium specimens of *Gremmeniella* spp. from pine, spruce and balsam fir as well as specimens of *Ascocalyx laricina* from larch and of *Ascocalyx abietis* from balsam fir. For that study, morphological, cultural and chemical characteristics were used. All the specimens from larch were very distinct from the specimens of all other hosts but had the characteristics of the genus *Gremmeniella*. Therefore, a new combination was created, *G. laricina* (Ettlinger) Petrini et al. The species *Ascocalyx abietis* Naumov, a saprophyte on fir, was retained as it is distinct from *G. abietina*. All the specimens on the other hosts had overlaps in their morphological measurements and the authors could not create new species. Then two varieties were recognized: the variety *abietina* for the type species including the three serovars, and the variety *balsamea* for the specimens from spruce and balsam fir from Canada.

New information on the disease and on the fungi give a better understanding of the genus *Gremmeniella*. It was believed that the European race was more virulent than the other two races on all pine species, but that was not true. In fact *P. banksiana* and *P. contorta* are strongly resistant to the European race (Laflamme and Blais 2000, Laflamme et al. 2000, Simard et al. 2000) and probably other pine species are too. The isolates from pine, balsam fir and spruce in North America show host specificity reactions (Laflamme et al. 1996). Phylogenies based on sequencing show that the three races of the type species are not closely related (Hamelin and Rail 1997). The Asian race is closely related to the variety *balsamea*. The divergence between *G. abietina* and *G. laricina* is as great as between the varieties *balsamea* and *abietina*. Finally, in the variety *balsamea*, it is possible to differentiate isolates from fir and spruce by their colour in culture on PDA. In Europe, the so-called European race of *G. abietina* has been divided into three entities. The Fennoscandian amplotype (Hamelin et al. 1996) is the equivalent of the small tree type in Sweden (Hellgren 1995) or type B in Finland (Uotila 1983). The second one, the Alpine amplotype, is restricted to the Alps and damage caused by the pathogens is similar to the previous one and to the North American race in North America. The third one, the European amplotype, is the equivalent of the large tree type in Sweden (Hellgren 1995), type A in Finland (Uotila 1983) and the European race in North America. The species *G. juniperina* L. Holm & K. Holm has not been studied.

## Discussion

From this review, it is becoming more and more evident that the genus *Gremmeniella* is a complex of several species. When Morelet (1980) studied the type species *Crumenula abietina*, he did not have access to the type specimen collected by Lagerberg on *Picea abies*. As the type specimen was lost, he had to propose a neotype, which was another specimen that Lagerberg collected on *Pinus sylvestris*. But the first specimen on spruce could have been the European amplotype and the one on Scots pine could have been the Fennoscandian amplotype. If the first Lagerberg specimen could be found, further observations could clarify this point.

For the past several years, we have studied *Gremmeniella* on fir and spruce in Canada (Laflamme 1988a, 1988b). We are now confident that we are dealing with two different species and a paper is in preparation to describe them.

We did not have enough material from Japan on *Abies sachalinensis* but it seems possible that the Asian race could prove to be a new species after further studies. Finally, more observations should be done on isolates from *G. juniperus*.

## Conclusion

In short, the complex of suggested species is as follows:

1. *G. abietina* (or a new species?) found mainly on *Pinus* spp.
  - = NA race
  - = small tree type
  - = type B
  - = Finoscandian amplotype
  - = Alpine amplotype, which is very similar to the Fennoscandian one
2. *G. abietina* (or a new species?) found mainly on *Pinus* spp.
  - = European race
  - = large tree type
  - = type A
  - = European amplotype
3. *G. n.sp. 1* on *Abies balsamea* in Canada
  - = *G. abietina* var. *balsamea*
4. *G. n.sp. 2* on *Picea* spp. in Canada
  - was included in *G. abietina* var. *balsamea*
5. *G. (new species?)* on *Abies sachalinensis* in Japan
  - = Asian race
6. *G. laricina* on *Larix* spp.
  - Is the species in Europe different from the one in North America?
7. *G. juniperina* on *Juniperus*: to be further studied.

## References

- Dennis, R.W.G. 1968. British Ascomycetes. Verlag von J. Carmer, Stuttgart, Germany.
- Dennis, R.W.G. 1971. New or interesting British microfungi. Kew Bulletin 25: 335-374.
- Donaubauer, E. 1972. Distribution and hosts of *Scleroderris lagerbergii* in Europe and North America. Eur. J. For. Pathol. 2: 6-11.
- Dorworth, C.E. and Krywienczyk, J. 1975. Comparisons among isolates of *Gremmeniella abietina* by means of growth rate, conidia measurement, and immunogenic reaction. Can. J. Bot. 53: 2506-2525.
- Hamelin, R.C. and Rail, J. 1997. Phylogeny of *Gremmeniella* spp. based on sequences of the 5.8S rDNA and internal transcribed spacer region. Can. J. Bot. 75: 693-698.
- Hamelin, R.C., Lecours, N., Hansson, P., Hellgren, M. and Laflamme, G. 1996. Genetic differentiation within the European race of *Gremmeniella abietina*. Mycol. Res. 100: 49-56.
- Hawksworth, D.L., Kirk, P.M., Sutton, B.C., and Pegler, D.N. 1995. Ainsworth & Bisby's Dictionary of Fungi. 8<sup>th</sup> ed. CAB International.

- Hellgren, M. 1995. Comparison of *Gremmeniella abietina* isolates from *Pinus sylvestris* and *Pinus contorta* in terms of conidial morphology and host colonization. *Eur. J. For. Pathol.* 25: 159-168.
- Karlman, M., Hansson, P. and Witzell, J. 1994. Scleroderris canker on lodgepole pine introduced in northern Sweden. *Can. J. For. Res.* 24: 1948-1959.
- Laflamme, G. 1988a. Scleroderris canker on balsam fir. *Can. J. Plant Pathol.* 10: 367.
- Laflamme, G. 1988b. Description et distribution du chancre scléroderrien sur *Picea mariana* (Mill.)B.S.P. *Eur. J. For. Pathol.* 18: 230-239.
- Laflamme, G. 1991. Scleroderris canker on pine. *For. Can - Quebec Region. Information Leaflet LFC 3* (revised 1991).
- Laflamme, G. and Blais, R. 2000. Resistance of *Pinus banksiana* to the European race of *Gremmeniella abietina*. *Phytoprotection* 81: 49-55.
- Laflamme, G., Blais, R., Bussi res, G. and Mallett, K. 2000. Resistance to *Gremmeniella abietina*, European race, in *Pinus contorta*. *Can. J. Plant Pathol.* 22: 187.
- Laflamme, G. and Lachance, D. 1987. Large infection center of Scleroderris canker (European race), in Quebec province. *Plant Dis.* 71: 1041-1043.
- Laflamme, G., Ylimartimo, A. and Blais, R. 1996. Host preference of two *Gremmeniella abietina* varieties on balsam fir, jack pine, and black spruce in eastern Canada. *Can. J. Plant Pathol.* 18: 330-334.
- Morelet, M. 1969. Un discomyc te inopercul  nouveau. *Bull. Soc. Sci. Nat. Arch ol. Toulon.* 183, 9.
- Morelet, M. 1980. La maladie   Brunchorstia. I. Position syst matique et nomenclature du pathog ne. *Eur. J. For. Pathol.* 10: 268-277.
- M ller, E. & Dorworth, C.E. 1983. On the discomycetous genera *Ascocalyx* Naumov and *Gremmeniella* Morelet. *Sydowia* 36: 193-203.
- Ohman, J.H. 1966. *Scleroderris lagerbergii* Gremmen: the cause of dieback and mortality of red and jack pines in upper Michigan plantations. *Plant Dis. Rep.* 50: 402-405.
- Petrini, O., Petrini, L.E., Laflamme, G. and Ouellette, G.B. 1989. Taxonomic position of *Gremmeniella abietina* and related species: a reappraisal. *Can. J. Bot.* 67: 2805-2814.
- Schl pfer-Bernhard, E. 1969. Beitrag zur Kenntnis der Discomycetengattungen *Godronia*, *Ascocalyx*, *Neogodronia* und *Encoeliopsis*. *Sydowia* 22: 1-56.
- Setliff, E.C., Sullivan, J.A. and Thompson, J.H. 1975. *Scleroderris lagerbergii* in large red and Scots pine trees in New York. *Plant Dis. Rep.* 59: 380-381.
- Simard, M., Rioux, D. and Laflamme, G. 2000. Formation of ligno-suberized tissues in *Pinus banksiana*: response to infection by the European race of *Gremmeniella abietina*. *Can. J. Plant. Pathol.* 22: 192.
- Uotila, A. 1983. Physiological and morphological variation among Finnish *Gremmeniella abietina* isolates. *Comm. Inst. Forestalis Fenniae* 119 12p.
- Yokota, S.T. 1984. Pathogenicity and host range of races of *Gremmeniella abietina* in Hokkaido. In Manion, P.D. (Ed.) *Proc. Int. Symp. on Scleroderris canker of conifers*, Syracuse, N.Y., June 21-24, 1983. pp. 47-53.

# Proceedings of the IUFRO Working Party 7.02.02 Shoot and Foliage Diseases, Meeting at Hyytiälä, Finland, 17-22 June, 2001



Edited by  
Antti Uotila  
Vellamo Ahola

VANTAA RESEARCH CENTRE

**METLA**

Uotila, A. and Ahola, V. (eds.) 2002. Proceedings of the IUFRO Working Party 7.02.02 Shoot and Foliage Diseases, Meeting at Hyytiälä, Finland, 17-22 June, 2001. Finnish Forest Research Institute, Research Papers 829. 201 p. ISBN 951-40-1809-5, ISSN 951-40-1809-5.

Keywords: forest trees, pathogens, endophytes, rDNA-ITS sequences, *Gremmeniella*, *Sphaeropsis*, *Sirococcus*, *Botrytis*, *Raffaelea*, *Phytophthora*, *Tubercularia*, *Flammulina*, *Septoria*, *Neofabraea*, *Phomopsis*, *Phacidium*, *Guignardia*, *Cryptocline*

Publisher: The Finnish Forest Research Institute, Vantaa Research Centre.

Cover photos: Leaf discoloration observed on *Picea jezoensis* inoculated with *Ceratocystis polonica* (photo up on the left, Keiko Kuroda). Needle disease on *Taxus baccata* caused by *Cryptocline taxicola*: The conidia of the fungus on the ripe acervuli which rupture the epidermis (photos on the right, Alfred Wulf). Spherical fruit bodies develop beneath the epidermis (photo down on the left, A.W.).

Hakapaino Oy  
Helsinki 2002

Orders:

1. Hyytiälä Forestry Field Station, Fin-35500 Korkeakoski  
Tel. +358 3 3355 111  
Fax. +358 3 3355 555  
E-mail: antti.uotila@helsinki.fi
2. The Finnish Forest Research Institute, Library, P.O. Box 18, Fin-01301 Vantaa  
Tel. +358 9 857 051  
Fax. +358 9 8570 5582  
E-mail: kirjasto@metla.fi

Editors' address: Hyytiälä Forestry Field Station, as above.

© Authors and Finnish Forest Research Institute