

Note

## First Report of *Gymnosporangium globosum* Causing American Hawthorn Rust in Korea

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(Received on November 11, 2007; Accepted on January 28, 2008)

Field surveys and specimen collections of the rust fungal pathogen *Gymnosporangium* were carried out for 15 years from 1985 through 1999 in various locations of Korea. Macroscopic and microscopic examinations of morphological characteristics of aecia from the collected specimens revealed that *Gymnosporangium globosum* is the causal agent of American hawthorn rust disease on *Crataegus pinnatifida* and *C. pinnatifida* var. *major*. The host plants are new for this rust fungus. *G. globosum* was found only in Gyeonggi and Chungbuk provinces, indicating that its distribution in Korea is limited. This is a first full description on morphological characters of aecia of *G. globosum* in Korea.

**Keywords :** aecial host, geographical distribution, *Gymnosporangium globosum*, morphological characteristics

*Gymnosporangium* is the genus of heteroecious fungi that infects primarily telial hosts, junipers, and alternate aecial hosts, the members of the family Rosaceae. A common species in this genus is *G. globosum* whose aecial hosts are reported on four genera, *Crataegus*, *Malus*, *Pyrus*, and *Sorbus*, all of which belong to the rose family. The disease caused by this fungus is called American hawthorn rust as the fungus forms aecia commonly on leaf surface of *Crataegus* whose common name is hawthorn (Kern, 1973).

With approximately 280 species (Foster, 1993), *Crataegus* is distributed mostly in the temperate regions of the Northern hemisphere, including North America, Europe, and Northern Asia. In Korea, this plant genus is distributed widely in mountain and urban areas for landscaping (Lee, 1999). However, the American hawthorn rust caused by *G. globosum* has not been reported in Korea until now.

Field surveys and specimen collections of *Gymnosporangium* had been carried out for 15 years from 1985 through 1999 in various locations of Korea. The specimens

collected were deposited at the Herbarium of Korea Forest Research Institute (HKFRI) and examined using light microscopy (LM) and scanning electron microscopy (SEM). Two foreign specimens, which had been kept at the National Mycological Herbarium of Biosystematics Research Institute (DAOM), Ottawa, Canada, were also examined for comparison with Korean specimens used in this study. For light microscopy, specimens of peridia and peridial cells, and aeciospores were observed under a compound light microscope (Axiophot, Zeiss, Germany) to examine their shapes, sizes and colors, and the thickness of their cell walls. For scanning electron microscopy, aeciospores and peridial cells obtained from natural host plants were dusted on double-sided adhesive tapes placed on specimen holders and then coated with gold using a Hitachi E-1010 Ion Sputter. The gold-coated specimens were observed under an S-3000N scanning electron microscope (Hitachi, Japan) at 15 kV to examine fine surface structures of aeciospores and peridial cells. The types of surface structures were classified according to the criterion used by Lee and Kakishima (1999a, 1999b).

American hawthorn rust fungus *G. globosum* has been known to occur commonly in the northeastern United States and eastern Canada (Kern, 1973). Examination of the *Gymnosporangium* specimens in Korea revealed that *G. globosum* occurred on two hawthorn host plants, *Crataegus pinnatifida* and *C. pinnatifida* var. *major* only at Pocheon and Osan in Gyeonggi province and at Boeun in Chungbuk province, respectively, indicating that the distribution of this fungus is confined to these two provinces in Korea.

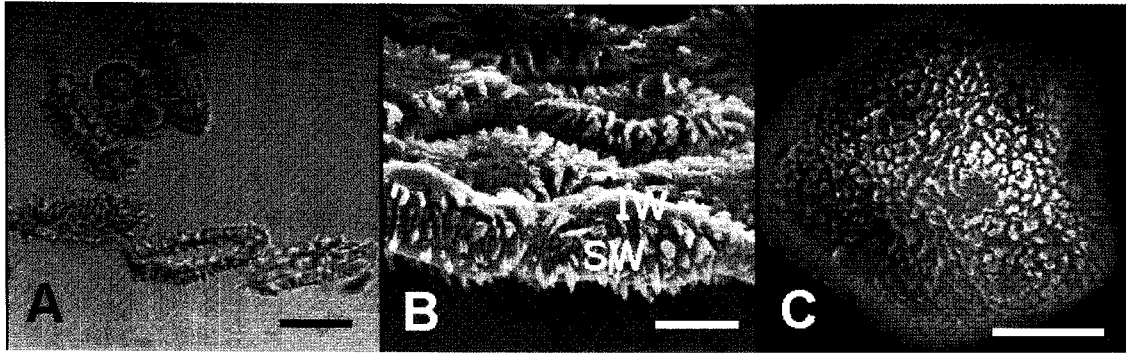
Initial symptoms of the American hawthorn rust on the two *Crataegus* plants were orange to brown spots containing small black fruiting structures (spermogonia) in the center of upper surfaces of leaves in late spring or early summer. Several weeks later, whitish yellow-fringed cup-shaped structures (aecia) were abundantly formed on the lower leaf surfaces opposite to the upper leaf spots, which later enlarged and darkened in color.

The specimens sampled from the hawthorn plants were

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**Fig. 1.** Light (A) and scanning electron micrographs (B, C) of *Gymnosporangium globosum*, showing peridial cells and aeciospores from *Crataegus pinnatifida* (A), surface structures of peridial cells (B) and aeciospore (C). IW, inner wall; SW, side wall. Scale bars, A = 50  $\mu\text{m}$ ; B = 30  $\mu\text{m}$ ; C = 15  $\mu\text{m}$ .

**Table 1.** Morphological characteristics of aeciospores and peridial cells of *Gymnosporangium globosum*

Structure	Present study	Kern (1973)	Lee and Kakishima (1999)
<b>Aeciospores</b>			
Type of surface structure <sup>a</sup>	SC	–	SC
Wall thickness ( $\mu\text{m}$ )	1.8 - 2.0	1.5 - 2.0	1.5 - 2.0
Size ( $\mu\text{m}$ )	16-20 $\times$ 19-27	15-19 $\times$ 18-25	15-19 $\times$ 18-25
<b>Peridial cell</b>			
Type of surface structure <sup>b</sup>			
OW	S	– <sup>c</sup>	S
SW	R	–	R
IW	SP	–	SP
Length ( $\mu\text{m}$ )	60-90	60-90	–

<sup>a</sup>SC, type SC (small coronate) (Lee and Kakishima, 1999a).

<sup>b</sup>OW, outer wall; SW, side wall; IW, inner wall; S, type S (smooth); R, type R (rugose); SP, type SP (small papillae) (Lee and Kakishima, 1999b).

<sup>c</sup>–, Not described.

examined macroscopically and microscopically, and their characteristic features are as follows (Table 1, Fig. 1). Aecia foliicolous, roestelioid, 2-4 mm high; peridium cylindrical-acuminate, becoming lacerate; peridial cells linear rhomboidal, 60-90  $\mu\text{m}$  long, inner and side walls 3-4  $\mu\text{m}$  thick, outer walls smooth (type S), inner walls small papillae (type SP) and side walls rugose (type R); aeciospores globoid or broadly ellipsoid, small coronate (type SC), 16-20  $\times$  19-27  $\mu\text{m}$  in size, wall 1.8-2  $\mu\text{m}$  thick, pale cinnamon brown.

In Korea, *Crataegus pinnatifida* has not been reported as an aecial host for species of *Gymnosporangium* except for *G. asiaticum* listed by Chung et al. (1977) without morphological descriptions. The artificial inoculation test using

various forms of telia confirmed experimentally that only one type among four telial types of *G. asiaticum* could infect *C. pinnatifida* (Yun et al., 2005). The rust fungus found of *Crataegus* in Korea has morphological characters of aecia that were identical to those of *G. globosum* described by Kern (1973) and Lee and Kakishima (1999a, 1999b). Considering host plants, symptoms, and aecia and peridial cell characters also confirmed that the fungus should be identified as *G. globosum*. Therefore, this is the first report on the occurrence of American hawthorn rust on *C. pinnatifida* and *C. pinnatifida* var. *major* in Korea.

Brief notes of observations are as follows:

**Hosts in Korea:** O (Spermatogonial state), I (Aecial state): *Crataegus pinnatifida* Bunge; *Crataegus pinnatifida* var. *major* N. E. Br..

**Specimens examined:** O, I on *Crataegus brunetiana* Sarg., Canada, Ontario, 10 September 1975; (DAOM 151699); O, I on *Crataegus pedicellata* Sarg., Canada, Ottawa, 8 September 1952, (DAOM 34124); O, I on *Crataegus pinnatifida* Bunge, Korea, Pocheon, Gyeonggi, 8 July 1999, S. K. Lee (HKFRI 304); Korea, Osan, Gyeonggi, 19 June 1986; S. K. Lee (HKFRI 1074). O, I on *Crataegus pinnatifida* var. *major* N. E. Br., Korea, Boeun, Chungbuk, 24 June 1985, S. K. Lee (HKFRI 310).

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