The Status of a White Pine Blister Rust in Korea*1

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韓國의 잣나무 털녹病 現況*1

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Korean white pine (*Pinus koraiensis* Sieb. & Zucc.), native to Korea and currently the most important timber species in Korea is being threatened by a blister rust disease caused by a *Cronartium* species. The fungus has been tentatively identified as *Cronartium ribicola* Fischer. The fungus alternates between *P. koraiensis* and *Pedicularis resupinata* L.(a herbaceous perennial) under natural conditions in Korea although experimentally it has been shown to infect several *Ribes* species. The taxonomic diagnosis of the causal fungus is not fully resolved. A review of the status of this rust disease on *P. koraiensis* and other possible hosts in Korea and its potential international significance along with present work underway in Korea is discussed.

우리나라의 在來樹種이며 重要한 造林樹種 가운데 하나인 잣나무에 털녹병이 發生하여 잣나무 造林에 위협이 되고 있다. 잣나무 털녹병의 病原菌은 잠정적으로 *Cronartium ribicola* Fischer로 同定되었지만 이 病原菌의 正確한 分類學的 同定을 위해서는 좀 더 檢討가 必要하다. 잣나무 털녹병균은 우리나라의 自然條件下에서 잣나무와 송이풀(宿根性 草本植物)에 輪延寄生하는데 實驗的으로는 數種의 까치밥나무類에도 寄生한다는 것이 立證되었다. 이 論文에서는 우리나라의 잣나무 털녹병 發生狀況과 이 病의 國際的 重要性 및 이에 對한 講究策이 論議되고 있다.

INTRODUCTION

A blister rust of Korean white pine *Pinus koraiensis*, Sieb. et Zucc. caused by a *Cronartium* species has been progressively spreading over Korea on *P. koraiensis* stands since about 1963. The disease is now well established in several major areas in the country where the Korean white pine is grown. It has killed a vast number of young Korean white pines during the last ten years and is a major threat to this valuable timber species. The disease is, without any question, one of the most important forest diseases in Korea.

This blister rust disease was first found in Korea in 1937(5), and reported as caused by *Cronartium ribicola* Fischer(2).

Since 1939, however, further work on this important disease has not been carried out. In 1965, when severe outbreaks of the disease were reported from several locations in Korea, studies of the disease were again initiated. Much concern both on the part of Government and growers of Korean white pines has been focused on this serious disease during the last several years. But little progress has been made on the successful control of the disease. It is the objective of this paper to present briefly the status of the disease

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and some of the progress made as well as work now underway on the Korean white pine blister rust disease.

THE HOST-FUNGUS SITUATION

Four species of 5-needled white pine grow in Korea. They are *P. koraiensis*, *P. parviflora* Sieb. & Zucc., *P. pumila* Regel and *P. strobus* L. The first three species are native to Korea while *P. strobus* is being introduced. Of these four species of white pines, *P. koraiensis* is by far the most widely distributed. (Fig. 1).

Blister rust symptoms have been observed so far only on *P. koraiensis* and not from the other white pine species. *P. strobus* which is one of the principal hosts of *C. ribicola* elsewhere in the world has not been reported to be infected in Korea. The disease is most prevalent and severe on young *P. koraiensis* stands of 4-15 years old.

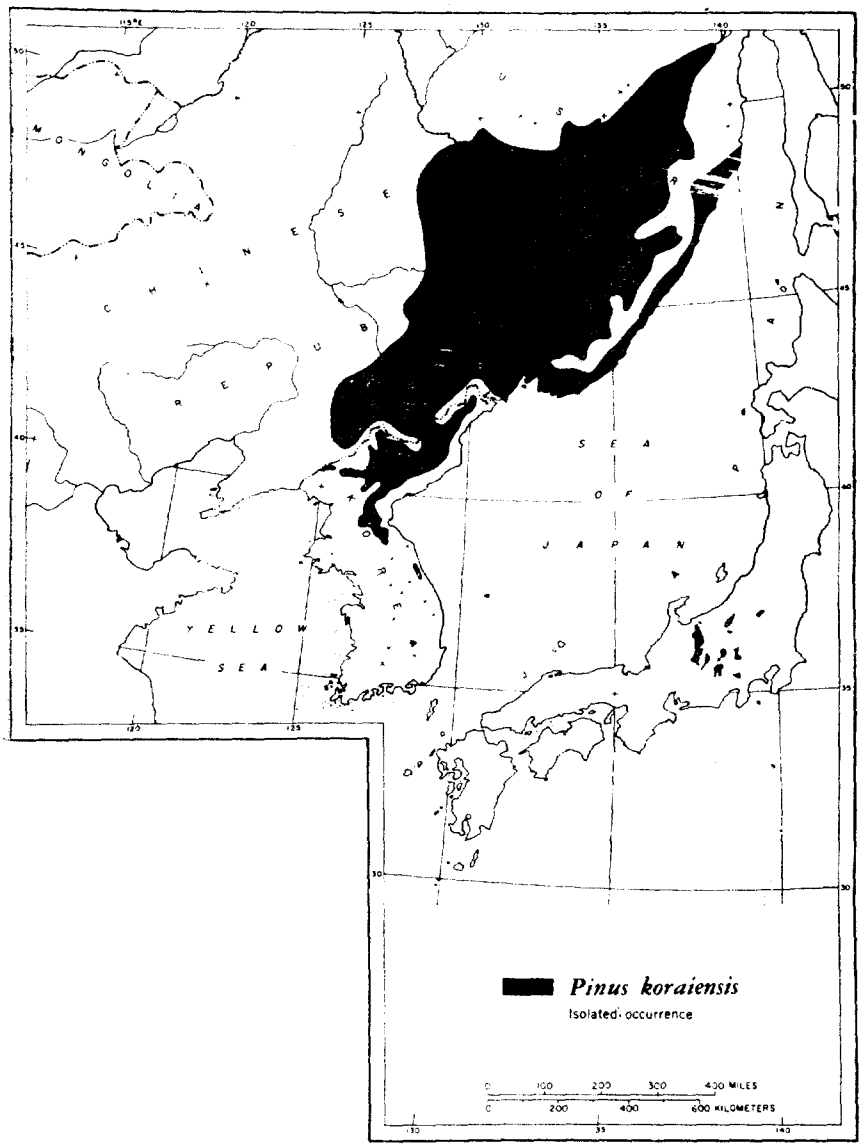

Fig. 1. Geographic distribution of Korean white pine (*Pinus koraiensis* Sieb. et Zucc.) (After Critchfield & Little, 1966)

Twelve species of *Ribes* are reported to grow in Korea (3). They are: *Ribes burejense* Fr. Schmidt, *R. horridum* Rupr., *R. diacantha* Pallas, *R. grossularis* L., *R. fasciculatum* Sieb. et Zucc. var. *chinense* Max., *R. triste* Pallas, *R. ussuriense* Janczewski, *R nigrum* L., *R. mandshuricum* var. *villosum* Komar., *R. maximowiczianum* Komar., *R. komarovi* A. Pojarkova and *R. latiolium* Janczewski. Among these *Ribes* species, *R. fasciculatum* var. *chinense* and *R. mandshuricum* var. *villosum* are the most frequently found in Korean white pine stands.

Since *Ribes* plants are known to be the primary alternate hosts of *C. ribicola*, intensive search for *Ribes* plants within and around the blister rust infected Korean white pine stands were made. Close examination of these *Ribes* for the presence of uredia or telial horns were carried out through April to November, 1970 but without success. In the middle of Octorber, 1970, *Pedicularis resupinata* L. plants were found to bear abundant telial horns on the undersurface of the leaves. *P. resupinata* is a perennial herbaceous plant that is particularly abundant throughout areas of infected pine stands.

To confirm whether the telia observed on *P. resupinata* were produced by the same blister rust fungus found on *P. koraiensis*, inoculation of *P. resupinata* with aeciospores collected from blister rust infected Korean white pines were made under controlled conditions. Inoculations resulted in all instances in the production of abundant uredia followed by telia. Therefore the blister rust fungus must alternate between *P. koraiensis* and *P. resupinata* under natural condit ions in Korea (6).

In an attempt to clarify the relationship of the Korean white pine blister rust fungus with *Ribes* species, the native species in Korea (*R. fasciculatum* var. *chinense*) and two species obtained from the U.S. A. (*R. hudsonianum* var. *petiola*, and *R. nigrum*) were inoculated in the green house with aeciospores from infected Korean white pines. The inoculations were successful and all three *Ribes* spp. produced uredia followed by telia. (6).

The relationship between the Korean white pine rust complex and host plants as it now appears in Korea, may be summarized as follows:

1. The blister rust fungus of *P. koraiensis* alternates between *P. koraiensis* and *P. resupinata* under natural conditions in Korea.
2. Although *Ribes* spp. infected with the blister rust fungus have not been observed under natural conditions, nevertheless, abundant uredia and telia were produced on *R. fasciculatum* var. *chinense*, *R. hudsonianum* var. *petiola* and *R. nigrum* when they were artificially inoculated with aeciospores of *P. koraiensis*.
3. Blister rust has not been observed in any of the *P. strobus* stands in Korea. But it should be noted that such stands are not extensive and any conclusions drawn from this would be at best very tenuous.
4. Dr. Y. Hiratsuka from the Canadian Forestry Service examined germinating aeciospores and the germ tubes during his Korean visit in June, 1973. Based on his observations, he confirmed that the rust affecting *P. koraiensis* is typical of the heteroecious, or full-cycle *Cronartium* rust, and not the autoecious, pine to pine rust.

CONTROL

Currently the following measures are being attempted to keep the Korean white pine blister rust disease under control.

1. Eradication of infected Korean white pines. This is done only when the trunk is affected.
2. Prunning of diseased branches when only branches show signs of the disease.
3. Eradication of *P. resupinata* and *Ribes* spp. growing in Korean white pine stands and in adjacent protective zones. This is being carried out by digging. It is, however, often difficult and in many cases economically not feasible to remove all the alternate hosts, particularly the widely distributed *P. resupinata* from the steep pine forest lands by this method. The use of herbicides such as 2,4-D and 2,4,5-T is being considered.
4. To prevent seedling infection, the establishment of Korean white pine seedling nurseries in the vicinity of blister rust infected pine stands is forbidden.

5. To prevent the introduction of the disease into new areas, the movement of Korean white pines from blister rust affected areas to other areas is forbidden.
6. A long-term project of selecting pine clones resistant to blister rust is under way.

DISCUSSION

Based on inoculation experiments and observations in Korean white pine stands, the possibility that this rust fungus on *P. koraiensis* may be a strain of *C. ribicola* is considered likely. But the possibility that the fungus is a strain of *C. kamtschaticum* Jørstad is under examination.

Observations of *P. koraiensis* reported in several foreign countries indicate that the Korean white pine is either highly resistant or not affected by *C. ribicola* (1,4). Sφegaard's report (4) is quoted here: "Schenk states that *P. koraiensis* is not attacked by *C. ribicola* in the U.S.A., and that *P. koraiensis* in Germany situated near a highly infected stand of *P. strobus* was not attacked. *P. koraiensis* in Denmark grown in the Forest Botanical Garden since 1890 has not been attacked by *C. ribicola*, and the same is the case with several offspring from these trees." The fact that *P. koraiensis* remains unattacked by *C. ribicola* in U.S.A. and some of the European countries where the rust incidence is high, but is severely attacked by the rust in Korea raises the critical question as to the identity of the fungus.

Is the rust fungus on *P. koraiensis* really *C. ribicola*? It is premature at this stage to state that such a phenomenon is due to the presence of different races of *C. ribicola*. Further experimentaion toward answering this question is in progress. Regardless of the mycological and experimental aspects of the Korean white pine rust complex, the disease is already a very serious problem on *P. koraiensis* in Korea. The potential virulence of this fungus on the world's white pines is not known. But a possible threat to the world's white pines in general does exist. It is apparent that an immediate, if only temporary, quarantine is justified now by countries where white pines are grown. International cooperation in unveiling the rust complex in white pines and specifically on white pines of Korea is critical and must be initiated on an international basis.

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