Scientific Name of *Cylindrocarpon* sp. Causing Root Rot of Ginseng

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松尾卓見*・宮沢洋一**：ヤクヨウニンジン根腐病を起因する *Cylindrocarpon* 属菌の学名

Key Words : root rot, ginseng, *Cylindrocarpon destructans* f. sp. *panacis*.

We¹⁾ reported first that root rot of ginseng is caused by *Cylindrocarpon* sp., and named the causal fungus as *Cylindrocarpon panacis* Matuo et Miyazawa. This disease is the most destructive to the ginseng root, and is perceived the decisive obstacle on the continuous cropping (replantation) of this crop.

This fungus produces its microconidia and chlamydospores on ordinary media, but usually do not produce many-septate macroconidia. We barely found them on the propylene oxide sterilized pieces of ginseng root as we described before¹⁾. On the other morphological points, this fungus resembles *Cylindrocarpon destructans* (Zins.) Scholten described by Booth²⁾.

C. destructans (*C. radicicola*) has frequently been reported causing decay of woody seedlings, especially conifers, and many other hosts were reported as well²⁾. Generally this fungus is not severe in its pathogenicity and has been regarded in many cases as the wound infectious fungus or the secondary invader. In Japan, dry rot of arrowhead and lotus³⁾ in storage, *Cylindrocarpon* rot of conifers⁴⁾, root disease of tea⁵⁾, and black root rot of tree peony and Chinese peony⁶⁾ have been reported as the diseases caused by *C. destructans* (or *C. radicicola*). Chung⁷⁾ reported *C. destructans* causing root rot of ginseng in Korea and regarded *C. panacis* Matuo et Miyazawa as a synonym of *C. destructans*.

We agree with the opinion of Chung that *C. panacis* is a synonym of *C. destructans* as *C. panacis* resembles *C. destructans* in many morphological points, provided that the forma

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specialis, which indicates the special pathogenicity to ginseng, is added to the species *C. destructans*. In this paper we described the results of pathogenicity tests of several isolates of *C. destructans* from the roots of tea, the root of *Cryptomeria* seedling and the roots of ginseng to ginseng and proposed *C. destructans* f. sp. *panacis* for the isolates from ginseng.

Inoculation test Inoculation tests of several isolates of *C. destructans* from the roots of tea and the root of *Cryptomeria* seedling and the roots of ginseng to ginseng seedling were conducted. H-1, 3, 6, 16, 18, 21 in Table 1 are isolates from roots of tea

Table 1. Measurements of conidia and chlamydospores of *C. destructans* isolates from tea, *Cryptomeria* and ginseng

Isolate ^{a)}	Size range of spores (μm)			
	0-sept. conidium	1-sept. conidium	3-sept. conidium	Chlamydospore
H-1	5-10 $\times$ 2.5-3.0	12-24 $\times$ 3.5-6.0	24-34 $\times$ 4.0-6.0	8-12 $\times$ 8-10
H-3	5-12 $\times$ 2.5-4.0	8-22 $\times$ 3.0-5.0	24-26 $\times$ 4.0-5.0	8 $\times$ 8
H-6	5-12 $\times$ 2.5-4.0	14-22 $\times$ 2.5-4.5	28-36 $\times$ 4.0-6.5	10-20 $\times$ 10-20
H-16	6- 8 $\times$ 3.0-3.5	10-24 $\times$ 3.0-5.0	28-38 $\times$ 4.5-6.0	8 $\times$ 6- 8
H-18	5-10 $\times$ 2.5-3.5	10-24 $\times$ 3.0-6.0	26-32 $\times$ 4.0-6.0	8-10 $\times$ 8
H-21	6- 8 $\times$ 2.5-4.0	10-18 $\times$ 3.0-5.0	22-38 $\times$ 4.5-7.0	10-12 $\times$ 10
K-1	7-10 $\times$ 3.0-3.5	10-20 $\times$ 3.5-4.5	28-38 $\times$ 4.5-6.0	8-12 $\times$ 8-10
SUF 811	8-14 $\times$ 2.5-4.0	18-26 $\times$ 3.5-5.0	42-44 $\times$ 5.5-6.0 ^{b)}	12-16 $\times$ 10-18
SUF 840	6-14 $\times$ 2.5-4.0	14-30 $\times$ 3.5-6.0 ^{b)}	34-48 $\times$ 4.0-6.0 ^{b)}	12-18 $\times$ 12-16
SUF 859	6-16 $\times$ 2.5-4.0	14-24 $\times$ 3.0-4.0	—	12-16 $\times$ 10-16
SUF 860	6-18 $\times$ 2.0-4.0	16-28 $\times$ 3.5-6.0	38-46 $\times$ 6.0-7.0 ^{b)}	12-18 $\times$ 10-16

a) H-1,3,6,16,18,21 are isolates from the roots of tea. K-1 is a isolate from the root of *Cryptomeria* seedling. SUF 811,840,859,860 are the isolates from the ginseng roots.

b) [mark shows that these conidia were discovered only on the propylene oxide sterilized pieces of ginseng root.

in Shizuoka, Aichi and Tottori Prefectures by S. Hirokawa from 1965 to 1969. K-1 is a isolate from the root of *Cryptomeria* seedling in Ibaraki Prefecture by H. Kondo in 1969. SUF 811, 840, 859 and 860 are isolates from ginseng roots in Saku-district of Nagano Prefecture from 1962 to 1967. The inocula were prepared by growing the isolate in flasks on sterile wheat-bran medium, consisting of five parts of wheat-bran and three parts of water. The upper part of steamed soil in 30 cm clay pots were infested with 15-20 g of inoculum, and there the seed of ginseng was sown (30 seeds per clay pot). The inoculation tests were begun on the latter part of March, 1975 and the results of the tests were observed finally in October of the same year. The results were shown in Table 2 and Fig. 1.

As shown in Table 2 and Fig. 1, the pathogenicity of ginseng isolates was very severe to the seedling of ginseng and killed all seedlings, and also influenced remarkably to the germinability of ginseng seeds. On the other hand, many other isolates did not show pathogenicity to ginseng though some isolates showed weak pathogenicity (less than 30 % in diseased seedlings), indicating the remarkable contrast of pathogenicity to ginseng among them.

Table 2. Result of inoculation tests of *C. destructans* isolates from tea, *Cryptomeria* and ginseng to the seedling of ginseng

Isolate ^{a)}	Seed No. sown	Seed No. germinated	Diseased seedling No.		Diseased % (Diseased seed- ling No. / Seedling No.)
			Killed No.	Small lesion seedling No.	
H - 1	120	106	20	0	18.8
H - 3	120	104	0	0	0
H - 6	120	118	0	0	0
H -16	120	101	16	0	15.8
H -18	120	112	0	4	3.5
H -21	120	108	0	0	0
K - 1	120	102	25	4	28.4
SUF 811	120	36	36	0	100
SUF 840	120	38	38	0	100
Cont.	120	116	0	0	0

a) Origins of isolates are explained in Table 1 and in the text.

Fig. 1. Result of inoculation test of *C. destructans* isolates from tea, *Cryptomeria* and ginseng to the seedling of ginseng. Origins of isolates are explained in Table 1 and in the text.

Taxonomic consideration The results of measurements of conidia and chlamydospores of isolates from tea, *Cryptomeria* and ginseng were shown in Table 1. The sizes of these spores are similar among isolates, but the 3 septate conidia of ginseng isolates were discovered only on propylene oxide sterilized pieces of ginseng root. This character may be not important in species delimitation and we identify all isolates of Table 1 with *Cylindrocarpon destructans*. However, we regard the difficult formation of macroconidia (3 septate conidia) of isolates from ginseng one of the characteristics of the ginseng isolates. Miyazawa⁸⁾, one of the authors, reported that the growth rate of ginseng isolates on ordinary media is slow and they grow during 3-26°C (optimum temperature 22°C) and do not grow at 28°C showing that they like comparatively cool temperature. This character seems to explain the reason why the isolation of this fungus from the diseased ginseng was very difficult for us in summer, and narrowly succeeded it in April or November from the early lesion of ginseng root.

8) Miyazawa, Y. (1970). Nogyo oyobi Engei 45: 1279-1280.

The *C. destructans* isolate which Chung⁷⁾ illustrated as the pathogen of root rot of ginseng in Korea appears to produce macroconidia (3 septate conidia) without difficulty on ordinary media. In addition, the growth response to temperature is different from the Japanese ginseng isolates. That is, according to him, the maximum growth of his isolate occurred at 22-25 C, and differences were statistically non-significant at 30 C. His pathogenicity test was carried out not using soil but in polyethylene sacks or test tubes in which a moistened paper or cotton was placed. Accordingly, it is not certain that Chung's isolate shows the same severe pathogenicity to ginseng planted in soil as the Japanese ginseng isolates do.

As we described before¹⁾ and above, the pathogenicity of the Japanese ginseng isolates to ginseng was very clear. In their inoculation tests, the seed, the 1st year root and the 3rd year root often did not sprout. In the 5th year root, the dwarf sprout with the dark green leaves appeared, but soon died. All roots were found to be diseased. This fungus attacks not only *Panax ginseng*, but also *Panax quinquefolium* L. (most susceptible) and *Panax japonicum* C. A. Meyer (more resistant than *P. ginseng*), but does not attack potato, pea, kidneybean, squash, cucumber, radish, carrot, burdock etc. On the other hand, as we described above, many isolates from tea roots and *Cryptomeria* seedling root did not show pathogenicity to ginseng though some isolates showed weak pathogenicity. On the above facts, we propose *Cylindrocarpon destructans* (Zins.) Scholten f. sp. *panacis* Matuo et Miyazawa f. sp. nov. for the Japanese ginseng isolates.

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