

## RESEARCH NOTE

Mycobiology 40(3) : 205-207 (2012)  
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<http://dx.doi.org/10.5941/MYCO.2012.40.3.205>  
pISSN 1229-8093  
eISSN 2092-9323

# Seed-borne *Brachycladium penicillatum* Intercepted under Plant Quarantine Inspection in Korea

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(Received August 13, 2012. Revised August 24, 2012. Accepted August 29, 2012)

A fungus detected from the importing seeds of *Papaver rhoeas* under plant quarantine inspection in Korea was identified as *Brachycladium penicillatum* Corda. It differed in morphological characteristics from a similar species, *B. papaveris*, which was known to form no macroconidiophores and no microsclerotia. Since the first interception in 2006, this fungus has frequently been found from importing seeds of *Papaver* spp. It was detected from 31 out of 282 seed consignments imported from 2006 to 2011. To prevent its introduction to Korea, the seed consignments infested by *B. penicillatum* were destroyed or reshipped.

**KEYWORDS :** *Brachycladium penicillatum*, *Dendryphion*, *Papaver*, Plant quarantine, Seed-borne

Various kinds of seeds are imported into Korea from abroad. The amount of imported seeds has shown a continuous increase. *Papaver* spp. are species of flowering plants in the poppy family, *Papaveraceae*. Among them, growth and import of *Papaver somniferum* L. is prohibited in Korea, because it can be synthetically converted to the illicit drug heroin. However, some other *Papaver* spp. seeds have recently been imported from various countries for use as flowering plants.

Under the plant quarantine inspection, a fungus considered as *Dendryphion* species was initially detected from seeds of *Papaver rhoeas* in 2006. Sporulation of the fungus can be induced by use of the blotter method [1]. Three blotters were soaked in tap water and placed in Petri dishes. Fifty seeds were placed on wetted blotters in Petri dishes. After placement of the seeds, they were incubated at 22°C with alternating 12-hr cycles of fluorescent light and darkness. Sporulation was observed from the third day of incubation and was well recognized at the fifth day. A compound microscope was used for observation of detailed structures of the fungus. Pieces of fungal tissues were transferred from seeds to a microscopic slide and then mounted in lactic acid.

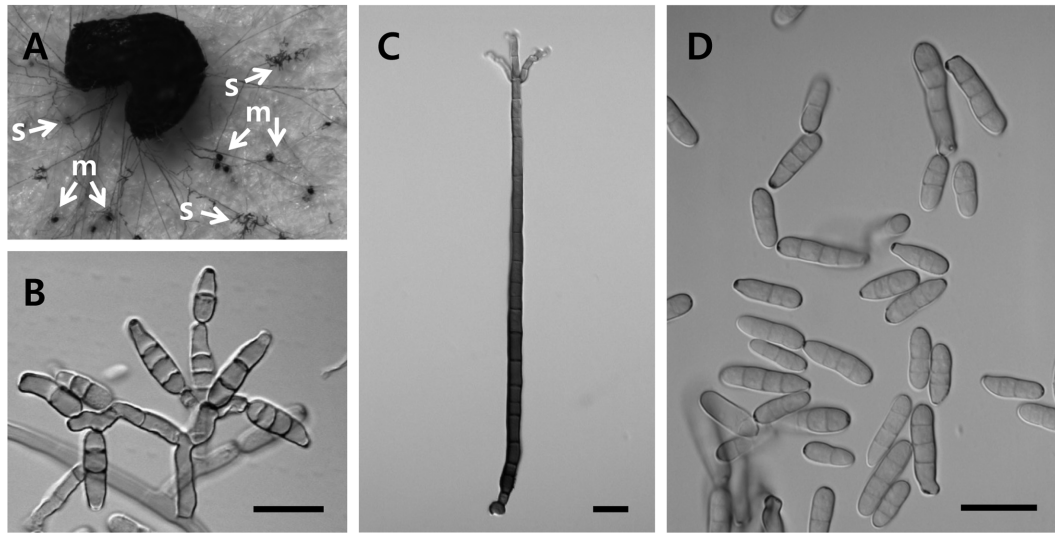
It formed macroconidiophores and microconidiophores

(Fig. 1B and 1C). Macroconidiophores were erect, cylindrical, straight, and simple, and then branched 2~3 times near the apex, and were dark reddish brown, measuring 320~430 × 10~16 μm in size. Microconidiophores were cylindrical, straight or curved, pale to light reddish brown, measuring 20~70 × 4~5 μm in size. Conidia were solitary or in chains, cylindrical, straight, hyaline to light reddish brown, unstricted, smooth, and measured 13~34 × 4~7 μm in size, with 3~4 (5) septa (Fig. 1D). Microsclerotia were additionally observed on the seeds and blotter at around the fifth day after incubation (Fig. 1A). They were rounded, elongate or of irregular shape, dark brown to black, and measured 30~70 × 20~65 μm in size. Based on these morphological characteristics, this fungus was identified as *Brachycladium penicillatum* Corda.

These features were similar to those described previously by Inderbitzin *et al.* [2] (Table 1). *B. penicillatum* was formerly known as *Dendryphion penicillatum* (Corda) Fr., the conidial state of *Pleospora papaveracea* [3, 4]. Shoemaker [5] suggested that *Pleospora papaveracea* contained one sexual species with the asexual state *Dendryphion penicillatum* (Corda) Fr. On the other hand, Farr *et al.* [6] found two species among the isolates of *P. papaveracea*; one of these formed a sexual state, and the other did not.

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**Fig. 1.** Morphological features of *Brachycladium penicillatum* from seeds of *Papaver* spp. A, Microsclerotia (m) and sporulation (s) produced from seeds on blotter; B, Microconidiophores forming solitary or in chains of conidia; C, Macroconidiophore; D, Conidia (scale bars = 20  $\mu$ m).

**Table 1.** Morphological characteristics of *Brachycladium penicillatum* detected from seeds of *Papaver rhoeas*

		Present study	<i>B. penicillatum</i> [2]
Macroconidiophores	Shape	Cylindric, straight	Cylindric, straight
	Color	Dark reddish brown	Dark reddish brown
	Size ( $\mu$ m)	320~430 $\times$ 10~16	400~600 $\times$ 10~20
Microconidiophores	Shape	Cylindric, straight or curved	Cylindric, straight or curved
	Color	Pale to light reddish brown	-
	Size ( $\mu$ m)	20~70 $\times$ 4~5	30~60 $\times$ 4~6
Conidia	Shape	Cylindric, straight, uncostricted	Cylindric, straight, uncostricted
	Color	Hyaline to light reddish brown	Hyaline to light reddish brown
	Size ( $\mu$ m)	13~34 $\times$ 4~7	17~30 (35) $\times$ (4) 5~7 (8)
	No of septum	3~4 (5)	3~4 (6)
Microsclerotia	Shape	Rounded, elongate or irregular	Rounded, elongate or irregular
	Color	Dark brown to black	Dark brown to black
	Size ( $\mu$ m)	30~70 $\times$ 20~65	20~100 $\times$ 25~75

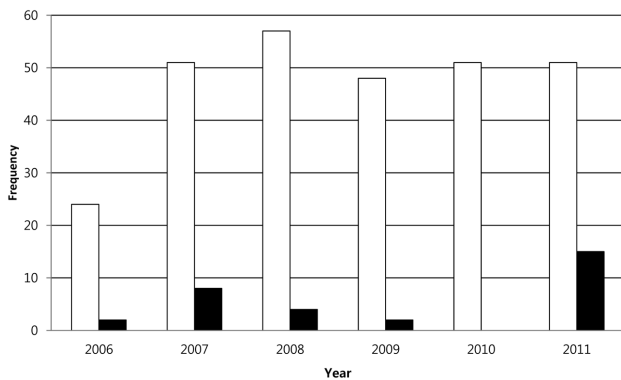
They concluded that the correct asexual state of *P. papaveracea* was *Dendryphiella* sp., and that *D. penicillatum* was a distinct asexual species without known sexual state. However, as a revision, Inderbitzin *et al.* [2] reported that *B. penicillatum* corresponds to *D. penicillatum*, and *Brachycladium papaveris*, a new combination, corresponds to *Dendryphiella* sp. based on the molecular and morphological analysis.

The fungus intercepted in this study was easily differentiated from *B. papaveris*. Morphological features of *B. penicillatum* resemble those of *B. papaveris*. However, presentation of microsclerotia is observed in *B. penicillatum* but not in *B. papaveris*. *B. penicillatum* forms macroconidiophores but *B. papaveris* does not [2].

After the first interception in 2006, *B. penicillatum* was frequently found from importing seeds. This fungus exhibits host specific characteristics. It was detected only from seeds of *Papaver* spp., including *P. nudicaule*, *P. rhoeas*,

and *P. orientale*. On the other hand, as the import is increasing, the frequency of interception has also increased (Fig. 2). It was intercepted from 31 out of 282 seed consignments imported from 2006 to 2011. Distribution of *B. penicillatum* has been reported in Afghanistan, Australia, Austria, Azerbaijan, Colombia, Germany, Hungary, India, Iran, Japan, Nepal, Pakistan, Poland, Romania, South Africa, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, USA, Venezuela, and Zambia [4, 7]. During the last six years, *B. penicillatum* has been detected during plant quarantine inspection from seeds imported from Canada, China, Germany, Netherlands, New Zealand, Sweden, United Kingdom, and USA. Therefore, the fungus is also considered to be distributed in Canada, China, Netherlands, and New Zealand.

*B. penicillatum* is a quarantine pest of Korea, which causes leaf blight disease of *Papaver* spp. It has even been studied for its potential as a mycoherbicide against



**Fig. 2.** Frequency of interception of *Brachycladium penicillatum* from seeds of *Papaver* spp. under quarantine inspection from 2006 to 2011. White and black bars indicate frequency of importation of *Papaver* spp. seeds and frequency of interception, respectively.

*Papaver somniferum* [8, 9]. Existence of the fungus in Korea has not been reported [10]. Seeds infested by exotic seed-borne fungi may cause progressive development of disease in the field, which can result in reduction of yield and quality. The seed consignments infested by *B. penicillatum* were destroyed or reshipped in order to prevent its introduction to Korea. Intensive plant quarantine is necessary in order to prevent introduction of the invasive fungal pathogen into Korea.

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