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Short Communication

Bulb canker of garlic caused by *Embellisia allii*, newly found in Japan

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Bulb canker of garlic caused by *Embellisia allii* was newly detected in Japan. Symptoms of the disease are described and the morphological characteristics of the causal fungus are illustrated and described.

Key Words——bulb canker; *Embellisia allii*; garlic bulb; polyfilm wrapping; post-harvest disease.

In the couse of our studies on post-harvest deterioration of fruits and vegetables in the market, a disease on bulbs of garlic (*Allium sativum* L.), which had not previously been recorded in Japan, was detected at markets in the Kyoto and Kusatsu area, located in the central part of the Japanese archipelago. The disease was identified as bulb canker of garlic, previously recorded in Europe and America. Here we report the disease as a new post-harvest disease in Japan. The morphological characteristics of the causal fungus, *Embellisia allii* (Campanile) Simmons, are also described.

This disease was mainly observed at the market early in the production period, from June to July. It was observed on newly harvested garlic bulbs that had been wrapped in polyfilm. The common feature of the disease was the occurrence of black powder scattered on the surface of the enveloping scale of the bulbs. This was due to a thin mycelial felt and conidia of the fungus on the surface of the scale. Sometimes the surface of cloves and the inner part of the scape was also darkened by the fungal infestation, discoloration of fleshy inner part of cloves was seldom observed (Fig. 1).

The causal fungus was easily isolated and assignable as *E. allii*, originally recorded in Italy (Camapnile, 1924a, 1924b) and the United States (Walker, 1924). The disease was described as bulb canker of garlic (Moore, 1942) and the fungus was considered to be a cosmopolitan inhabitant (Ellis, 1976). This disease of garlic is new to Japan, and we propose the Japanese name "rinkei sumi-yogore sho".

The relation between the presence of the disease and the place of production is shown in the Table 1. Consignments from most garlic-growing districts in Japan were infested with the fungus. When normal bulbs purchased at the market were incubated in moist chambers, some bulbs became blackened. The fungus appears to be commonly distributed in Japan. The temperature dependency of mycelial growth and conidial production is indicated in Table 2. The optimum temperature for mycelial growth was around 25°C and conidia were more abundantly produced with increasing temperature up to 30°C. In an inoculation test (Table 3), surface discoloration by mycelial growth clearly developed only at 25°C and above.

When the inoculated bulbs were kept at room temperature of 20–25°C in conventional packaging, namely, polynet, perforated polyfilm wrap, and sealed polyfilm wrap, the symptoms were observed in the latter two cases. This accorded with our observations in the market and with previous reports (Campanile, 1924a, 1924b; Walker, 1924; Moore, 1942), and indicated that the pathogen is a weak parasite which can cause disease only when bulbs were kept in moist conditions. It is recommended, therefore, the bulbs be kept as dry as possible by avoiding tightly sealed packaging.

The fungus lacks the ability to invade *Allium* species other than garlic. No symptoms developed after inoculation of the fungus on onion (*A. cepa* L., 4 bulbs) and scallion (*A. bakeri* Regal, 14 bulbs).

The morphological characteristics of the fungus on bulbs of garlic and cultural media (Fig. 2) concurred with those of *Embellisia* species. The characteristics of the genus *Embellisia* Simmons are as follows,

Mycelial mat: Smooth margin, grey to black, velvety to powdery, sclerotia (−)
Mycelium: Brown, intrahyphal chlamydospore (+), hyphopodia (−)
Conidiophores: Simple (rarely branched), straight or flexuous, often geniculate at the upper parts

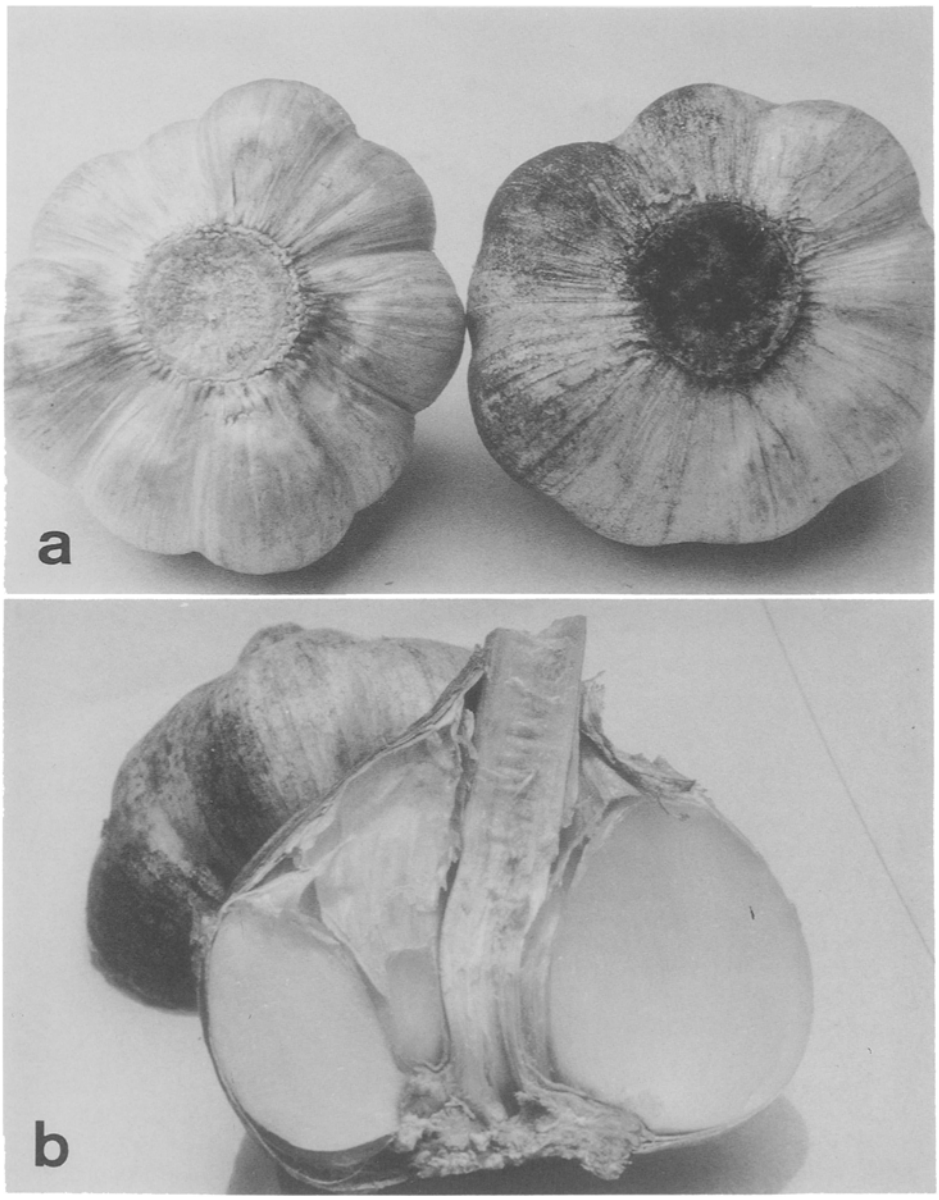

Fig. 1. Symptoms of bulb canker of garlic. a. Black powdery mycelia and conidia scattered on the surface of enveloping scale (left, normal bulb; right, infected bulb). b. Infected scape with normal fleshy inner part of cloves.

Table 1. Infestation of garlic bulds by *Embellisia allii*.

Place of production	Place of purchase	Disease
Aomori	Kusatsu	+
	Kyoto 1	−
Shizuoka	Kusatsu	+
Kagawa	Kyoto 2	+
	Kusatsu	+
	Kusatsu	+
Saga	Uji	−
?1*	Kyoto 2	+
?2*	Kyoto 1	+
China		−

* Place of production was not determined.

Table 2. Temperature dependence of mycelial growth of *E. allii* isolate Emb-1.

Temp (°C)	Mycelial growth (A)	Extent of conidiation (B)	B/A
10	17.5 mm	4.3 mm	24.5%
15	32.8	14.7	44.8
20	46.3	38.3	82.7
25	49.7	45.8	92.2
30	39.8	39.0	97.9

On V-8 juice agar, 7 days' incubation.

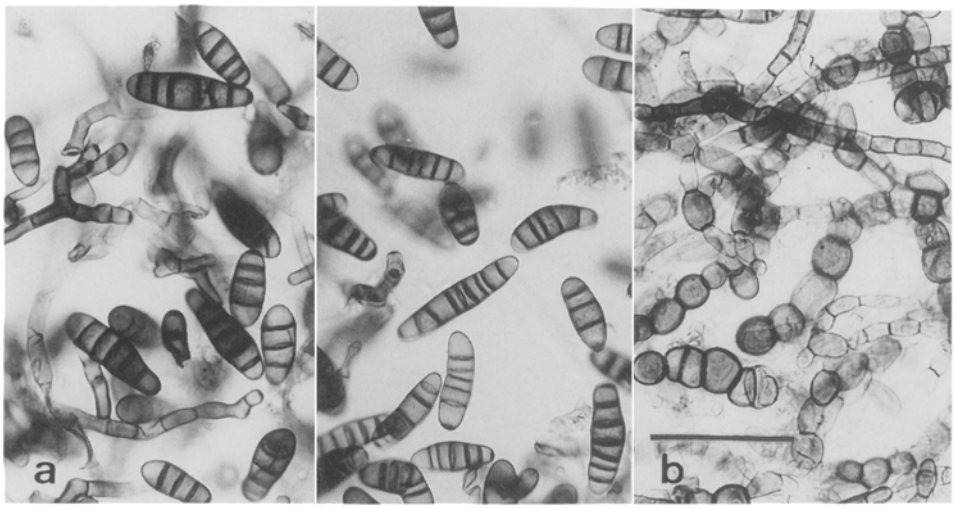

Fig. 2. *Embellisia allii* produced on the surface of enveloping scales of specimen collected at Kyoto (bar=50 μm). a. Conidia and conidiophores b. Chlamydospores

Table 3. Temperature dependence of disease development of garlic bulbs inoculated with *E. allii*.

Temp (°C)	Disease Index*					Number of diseased cloves**				
10	−	−	−	−	−	0	0	0	0	0
15	−	−	−	−	−	0	0	0	0	0
20	−	−	+	+	2+	0	0	2/8	2/8	2/8
25	2+	2+	2+	3+	3+	6/10	6/6	7/7	7/7	7/10
30	2+	2+	2+	3+	3+	3/8	4/8	6/9	6/9	6/9

* 3+: >80%, 2+: 30~80%, +: <30%, −: none.
** Diseased cloves / total cloves.

Conidiogeneous cells: Polytretic, integrated, sympodial, scar crater-like
Conidia: Solitary, dry, almost straight, ellipsoidal to ovoid, brown, multiseptate, with thick, very dark transverse and oblique septa
Type species: *Embellisia allii* (Campanile) Simmons =*Helminthosporium allii* Campanile

There are three species in the genus (Ellis, 1976), namely, *E. allii, E. chlamydospora* (Hoes et al.) Simmons, and *E. hyacinthi* de Hoog et Muller. *E. hyacinthi* differs somewhat from the other two species in its conidial morphology. It produces conidia with roughly triangular apical cells (e.g., Ellis, 1976, Fig. 342). Its host plants are *Free-*

Table 4. Morphological characteristics of conidia of *Embellisia* species and *E. allii* from garlic bulbs in Japan.

Species (Condition)	Range (mean value±S.D.) (μm)	No. of septa
Present fungus		
on garlic bulb		
from Kagawa	23-40×7.5-12.5 (30.5±5.2×9.4±1.1)	3-6(-8)
Place of production undetermined		
	26-56×8.7-12.5 (40.5±6.7×10.7±1.1)	(-3)4-7(-8)
on cultural condition (isolate Emb-1)		
PDA	25-72×10.7-13.7 (33.2±10.9×10.5±1.1)	3-5(-10)
Soil	25-43× 9.5-12.5 (28.7± 4.1×10.3±1.5)	3-6
Embellisia allii		
Moore, 1942	30-41 × 9-11 (35×9.5)	4-8(4-5)
Simmons, 1971	30-40(-56)×10-12(-14)	4-6(-10)
Ellis, 1976	24-45 ×10-15	3-6(-10)
E. chlamydospora		
Hoes et al., 1965	11-36 ×5.6-9.8 (20.6-28.1×7.6-7.9)	3-5
Simmons, 1971	20-30 ×7.5-9	
Ellis, 1976	20-35 × 7-9	3-5

sia, *Hyacinthus* and *Scilla*. Its occurrence in Japan was recently confirmed by Morikawa and Nomura (1994).

The conidial measurements of Japanese garlic isolates (Table 4) closely matched the descriptions of *E. allii*. The reported conidial sizes of *E. chlamydospora* were smaller than those of *E. allii* and our fungus. Therefore, we assigned the fungus as *E. allii* (Fig. 2). This is the first record of the fungus in Japan. However, precise examination is required to settle the distinction between *E. allii* and *E. chlamydospora*, as the differences between the two species are considered to be few.

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