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FULL PAPER

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# *Exobasidium dubium* and *E. miyabei* sp. nov. causing Exobasidium leaf blisters on *Rhododendron* spp. in Japan

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**Abstract** Two *Exobasidium* species causing Exobasidium leaf blister on *Rhododendron* spp. are described. An Exobasidium leaf blister on *Rhododendron yedoense* var. *yedoense* f. *yedoense* has been recognized in Hokkaido Prefecture, Japan, since the first report was issued in 1950. The causal fungus is identified with *Exobasidium dubium* from the morphology of its hymenial structure and mode of germination of the basidiospores. Another Exobasidium leaf blister on *Rhododendron dauricum* has been observed in Hokkaido Prefecture, Japan. In comparison with morphology based on hymenial structure and mode of germination of the basidiospores of the 100 validly described taxa, this fungus differs from those known taxa in the size of basidia and basidiospores, the numbers of sterigmata and septa of basidiospores, and the mode of germination of basidiospores. Thus, a new species, *Exobasidium miyabei*, is established and illustrated.

**Key words** Basidiomycetes · Culture · *Exobasidium* · Japan · Taxonomy

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## Introduction

In Japan, three Exobasidium leaf blisters causing small leaf spots (Ezuka 1991a) have been recorded on ericaceous plants: viz., on six species with a variety of *Rhododendron* L. belonging to subgenus *Sciadorhodion* section *Brachycalyx* (Yamazaki 1989) caused by *Exobasidium yoshinagae* Henn, on *Pieris japonica* D. Don ex G. Don by *E. asebi* Hara et Ezuka, and on *Lyonia ovalifolia* (Wall.) Drude var. *elliptica* (Siebold et Zucc.) Hand.-Mazz. by *E. pieridis-ovalifoliae* Sawada. Another Exobasidium leaf blister on *R. yedoense* Maxim. var. *yedoense* f. *yedoense* was reported by Sawada (1950) in Iwate Prefecture, assigning the causal agent to *E. magnusii* Woron. Ito (1955) and Ezuka (1992) excluded this fungus from their monograph or list of *Exobasidium* in Japan and placed it among the doubtful species. However, Nannfeldt (1981) examined Sawada's specimens in Iwate University and treated *E. magnusii* as a synonym of *E. dubium* Racib. Taxonomic reassessment of *E. magnusii* using different herbarium materials was preceded by Nannfeldt, and no additional collection in Japan has been reported since Sawada's publication. In June 2001, Akimoto, one of the authors here, found an Exobasidium leaf blister on *R. yedoense* var. *yedoense* f. *yedoense* at Hakodate-shi, Hokkaido Prefecture. Identification of this *Exobasidium* species leads to revealing whether the causal agent is *E. dubium*.

Since 1996, an Exobasidium leaf blister on *Rhododendron dauricum* L. has been reported at Bibai (Akimoto 1999) and at Hidaka (Nagao et al. 2000) in Hokkaido Prefecture. *Rhododendron dauricum* belongs to subgenus *Rhodorastrum* (Yamazaki 1989). No species has been reported to cause *Exobasidium* diseases on *R. dauricum* in Japan, whereas two species, *E. caucasicum* Woron. and *E. rhododendri* (Fuckel) C.E. Cramer apud Geyler, were described in the USSR to infect leaves and branches (Murashkinsky and Sieling 1928; cited in Farr et al. 1996). In the herbarium of University of Hokkaido (SAPA), similar spotted leaves of *R. dauricum* are deposited as a specimen infected by *Exobasidium* sp., but the taxonomic examina-

tion has not appeared in the literature. There is no comment and no annotation slip in and on the specimen envelopes. In 2001, we could obtain several specimens of diseased leaves in new localities at Hakodate and Teshikaga, Hokkaido Prefecture. These fresh materials gave us an opportunity to identify the causal agent on *R. dauricum* and to determine how the fungus differed from that on *R. yedoense* var. *yedoense* f. *yedoense*, which also causes an Exobasidium leaf blister in the same season.

Therefore, we examined the morphology of these specimens collected in Hokkaido Prefecture compared with the described *Exobasidium* spp. We propose the fungus that caused an Exobasidium leaf blister on *R. dauricum* is a new *Exobasidium* species.

## Materials and methods

### Morphological observations

Fresh specimens on *R. dauricum* and *R. yedoense* var. *yedoense* f. *yedoense* (simplified as *R. yedoense* hereafter) collected in the field were used for morphological observations. Specimens examined are listed in the description of the species. Morphological observations were conducted by light (LM) and scanning electron microscopy (SEM). The basidia, basidiospores, and conidia were scratched from hymenia, mounted in Shear's mounting fluid on glass slides, and were occasionally stained with 1% (w/v) Phloxine B dye solution or 0.01% (w/v) lacto-phenol Cotton blue solution for LM observations. Germination of basidiospores was also examined according to Graafland (1960) and Sundström (1964). The germination method was followed as described next. Germinated basidiospores on Difco potato dextrose agar (PDA) were fixed with formalin-acetic acid solution (10 ml formalin, 5 ml acetic acid, 85 ml distilled water). After microscopic examination through the bottom of the Petri dish, the areas of fallen basidiospores and germinated basidiospores were marked with a marker pencil on the bottom surface of the Petri dish. The agar was cut with a small knife along the marking on the bottom of the dish and transferred to the glass slide. Shear's mounting fluid was poured first to prevent overstaining of agar. Then, the lacto-phenol Cotton blue solution was added. Excess staining solution was absorbed with filter paper. Finally, the agar surface was again covered with Shear's mounting fluid and then covered with a coverslip. Samples for SEM were prepared as described previously (Nagao et al. 2001). All specimens were deposited in the Mycological Herbarium of Laboratory of Plant Parasitic Mycology, Institute of Agriculture and Forestry, University of Tsukuba (TSH).

### Culture of basidiospore isolate

Fresh materials were kept in a plastic bag for vegetables until newly sporulating lesions were observed. Leaves with lesions were cut into small pieces about 5 mm square and fixed with a water agar block about 10 mm square to the inside of the lid of a sterile Petri dish, poured with PDA acidified with 10% (v/v) lactic acid. The dish was kept at 22°C in the dark. Basidiospores then fell down from the hymenium onto the agar surface. After microscopic examination through the bottom of the Petri dish, a single basidiospore was isolated from the dish, and 18 isolates were transferred to a new PDA dish to grow. Then, three to five colonies that were growing well were selected among these colonies and stored on PDA slants as the representative strains. Cultures were kept in the Laboratory of Plant Parasitic Mycology, Institute of Agriculture and Forestry, University of Tsukuba and also deposited in National Institute of Agrobiological Resources (MAFF).

## Taxonomy

***Exobasidium dubium*** Racib. Figs. 1,2

≡*Exobasidium* sp. Magnus, Acta Hortic. Petropol. 16:540, 1900

=*Exobasidium vaccinii* (Fuckel) Woron. f. *rhododendrifavi* Bubák, Ann. Naturh. Hofmus. Wien 23:101, 1909

=*E. magnusii* Woron., Monit. Jard. Bot. Tiflis 28:18, 1913

Specimens examined: TSH-B0076, TSH-B0077 (Nagaoh 13119, 13120, Donan Branch, Hokkaido Forestry Research Institute, Hakodate, Hokkaido Prefecture, June 14, 2001).

The hymenium was composed of basidia with 3–5 sterigmata and conidia (Fig. 3A). Hyphae did not develop directly on the surface of the epidermis. Basidia were clavate to cylindrical, 20–30 × 6.5–10 μm. Apices of basidia were obtuse. Basidia emerged directly from the host surface or through stomata. Basidia were not fasciculate. Sterigmata were 1.5–2 μm in diameter at the base and 3–7 μm in height, emerging outwardly and tapering toward the tip (Fig. 3B). Basidiospores were ellipsoid to ovoid, 15–25 × 3.8–5 μm, hyaline, smooth, one-celled when formed, becoming septate with 1–4 (6) septa (see Fig. 1A,B). Septate basidiospores germinated after 6 h when dropped on the agar surface (Fig. 2). Germ tubes of the basidiospores emerged from the cells of both ends at first, then from other cells, and produced conidia at the tip of germ tubes or laterally 22 h after dropping (Fig. 2). Hyphae grew into pseudohyphae and branched. Conidia were bacilliform, lacrimiform, subfusiform, and clavulate (Fig. 1C), 6–14 × 1–2 μm, and budded polarly. Conidia budded to produce daughter cells polarly and also developed hyphae. Colonies on PDA grew gradually, to a maximum 11 mm diameter in 21-day incubations, and were wrinkled irregularly around the periphery. The surface of the colonies was pale yellow to pale pink and corrugate. Colonies were gelatinous and fixed on the agar surface. Conidial formation did not produce a powdery appearance. Colonies were composed of branching, intricate hyphae and pseudohyphae and conidia. The reverse of colonies was also pale yellow to pale pink. Dark pigmentation was not observed on PDA (see Fig. 6A). Colonies from conidia showed the same morphological features as those from basidiospores.

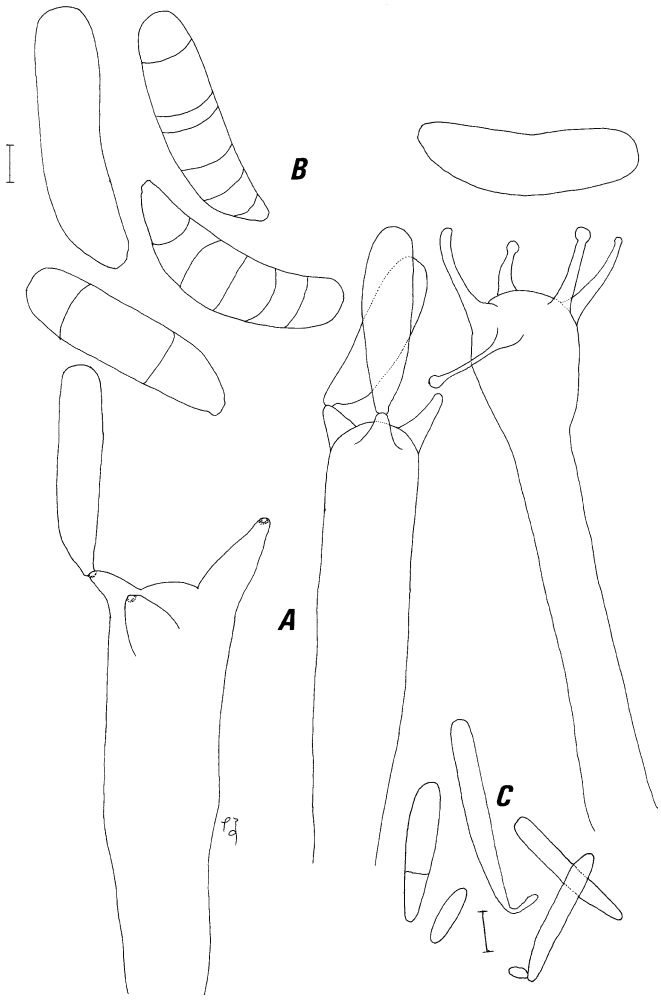



**Fig. 1.** Basidia and basidiospores of *Exobasidium dubium* formed on the infected leaf on *Rhododendron yedoense*. Basidia (**A**) and basidiospores (**B**) collected in Hokkaido Prefecture (TSH-B 0076). Conidia (**C**) produced on potato dextroseagar (PDA) in 21-day incubations at 22°C. *Bars* **A**, **B** 3 μm; **C** 2 μm

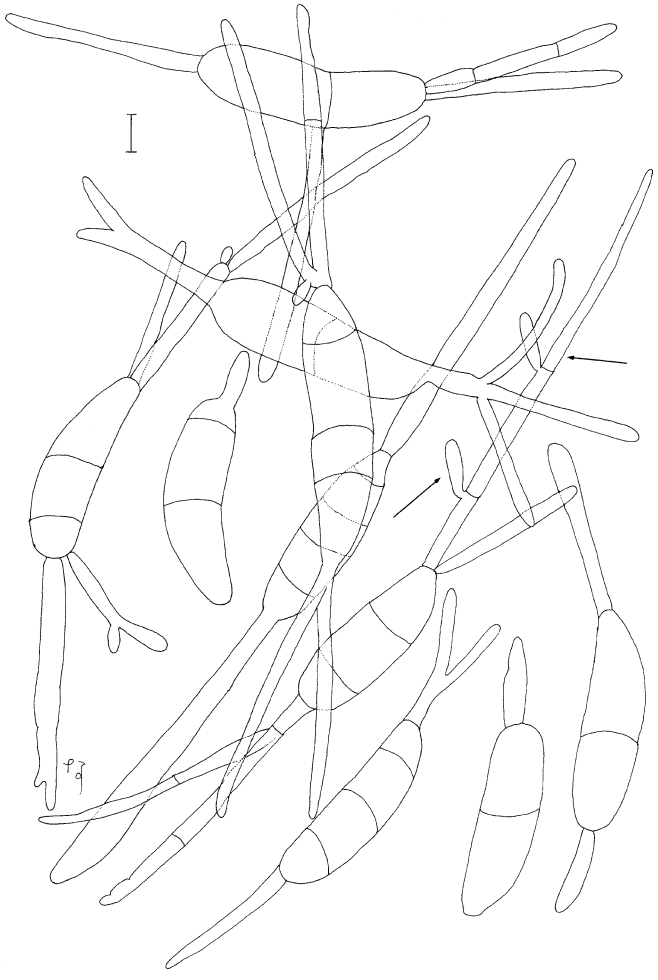


**Fig. 2.** Germination of the basidiospore of *E. dubium* on PDA after 8-h incubation. Some of the basidiospores produced conidia on the germ tube (*arrows*). *Bar* 3 μm

Sawada (1950) identified the causal agent of the *Exobasidium* leaf blister of *R. yedoense* with *E. magnusii*. As his note simply described the sizes of basidiospores and did not show an illustration, his description was not enough to identify his material with *E. magnusii*. Unfortunately, we could not obtain Sawada's specimens in Iwate University. In the original description, Woronichin (1913) described the morphology of basidia, basidiospores, and sterigmata. These numerical data matched very well with those of the Hakodate specimens. His illustrations pointed out a germinated basidiospore. After Sundström (1964), the modern criterion for germination of basidiospores in *Exobasidium* is determined as the conidial form, in which the conidia bud directly from basidiospores without a germ tube or hyphae, and the mycelial form, in which basidiospores germinate with a hyphal tube. Thus, the mode of germination of *E. magnusii* was interpreted as the mycelial form from Woronichin's illustration. This mode of germination of basidiospores also agrees with the specimens obtained from Hokkaido (Fig. 2).

Woronichin (1913) established *E. magnusii* based on the Caucasian specimens. He commented that he noticed a very similar *Exobasidium* spp. mentioned in Bubák (1909) and Raciborski (1909a) and wondered if these fungi were the same. Although he borrowed and checked Raciborski's specimens, he could not find basidiospores and basidia (Woronichin 1913). However, Raciborski (1909b) described *E. dubium* with a type mentioned in a previous paper (Raciborski 1909a). Nannfeldt (1981) proposed to synonymize *E. magnusii* into *E. dubium*. *Exobasidium dubium* has basidia 6–11 μm wide with (2) 4 (5) sterigmata, basidiospores (15) 18–24 × 4–5 μm with 0–1 (–3) septation, and conidia 5–9 (12) × 0.7–1.5 μm, and forms small spots (0.5 mm diameter) on *R. luteum* Sweet (= *A. pontica* L. = *R. flonum* G. Don).

Among 100 taxa of *Exobasidium* hitherto validly described, 3 taxa show similarities in some morphological measurements. *Exobasidium dubium* is distinguishable from *E. burtii* Zeller by the number of its sterigmata and by having a vertical septum in basidiospores, from *E. asebi*

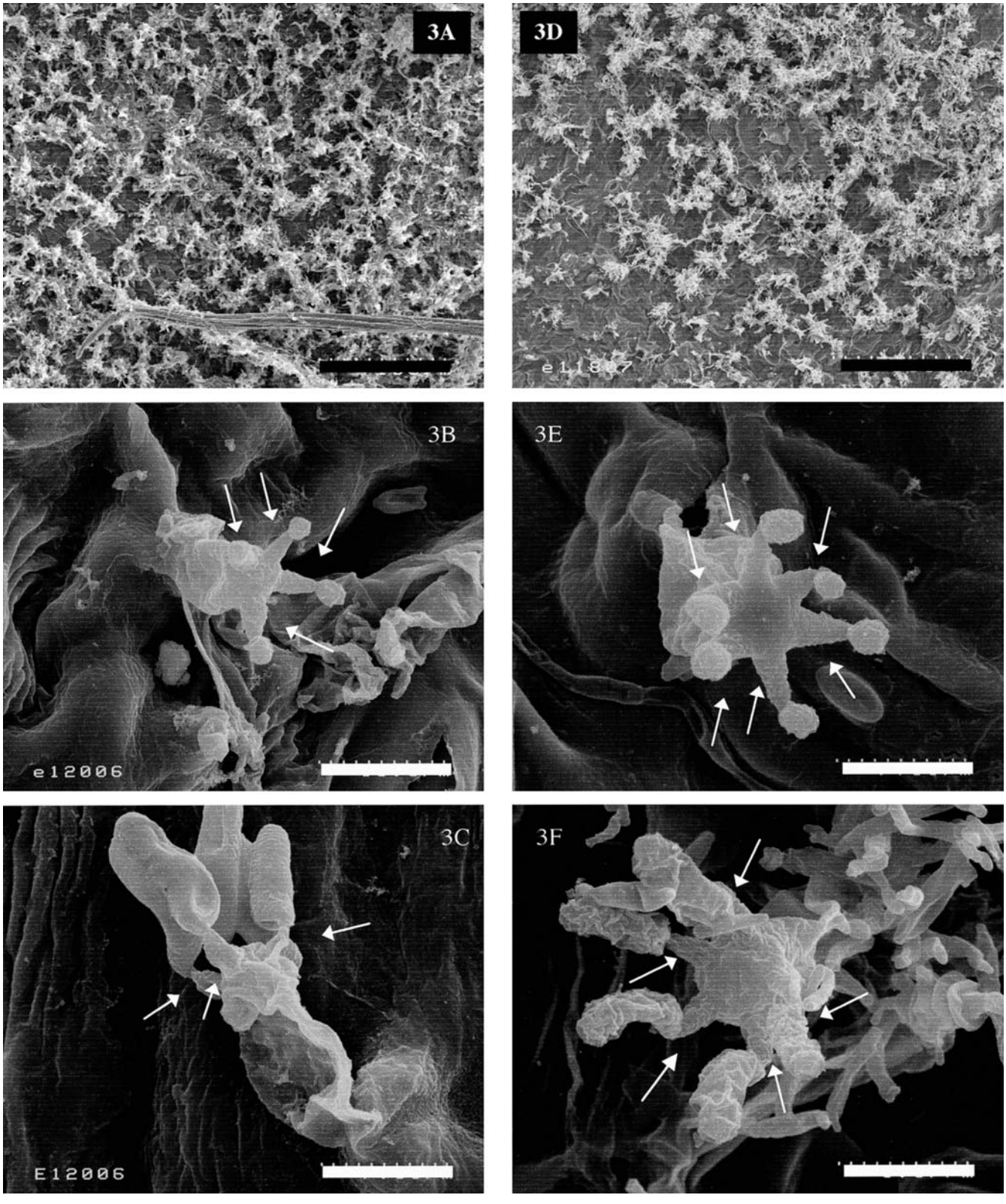



**Fig. 3.** Hymenium and basidia of *E. dubium* and *E. miyabei* observed by scanning election microscopy (SEM). **A** Hymenium of *E. dubium* on *R. yedoense*. **B**, **C** Basidium with immature basidiospores. *Arrows* indicate sterigmata. **D** Hymenium of *E. miyabei* on *R. dauricum*. **E**, **F** Basidium with immature basidiospores. *Arrows* indicate sterigmata. *Bars* **A**, **D** 150 μm; **B** 10 μm; **C** 7.5 μm; **E** 6.7 μm

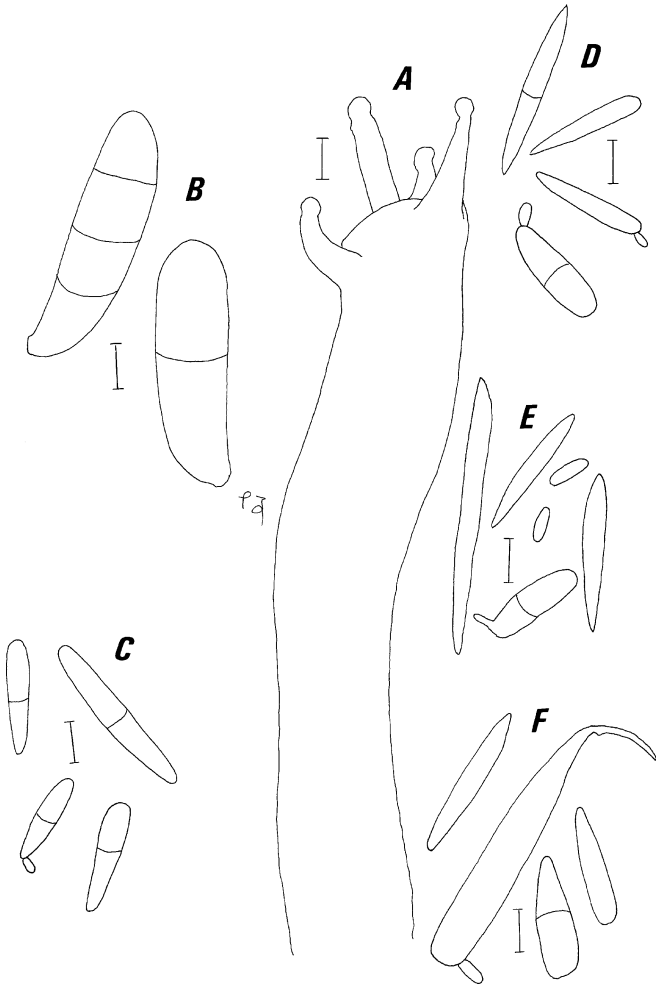



**Fig. 4.** Basidia and basidiospores of *E. miyabei* formed on the infected leaf of *R. dauricum*. Basidia (**A**) and basidiospores (**B**) collected in Hokkaido Prefecture (TSH-B 0073). Conidia produced on PDA in 21-day incubations at 22°C in nagaoh-13116 (**C**), nagaoh-13130 (**D**), nagaoh-99796 (**E**), or nagaoh-13118 (**F**). *Bars* **A**, **C–F** 2μm; **B** 3μm

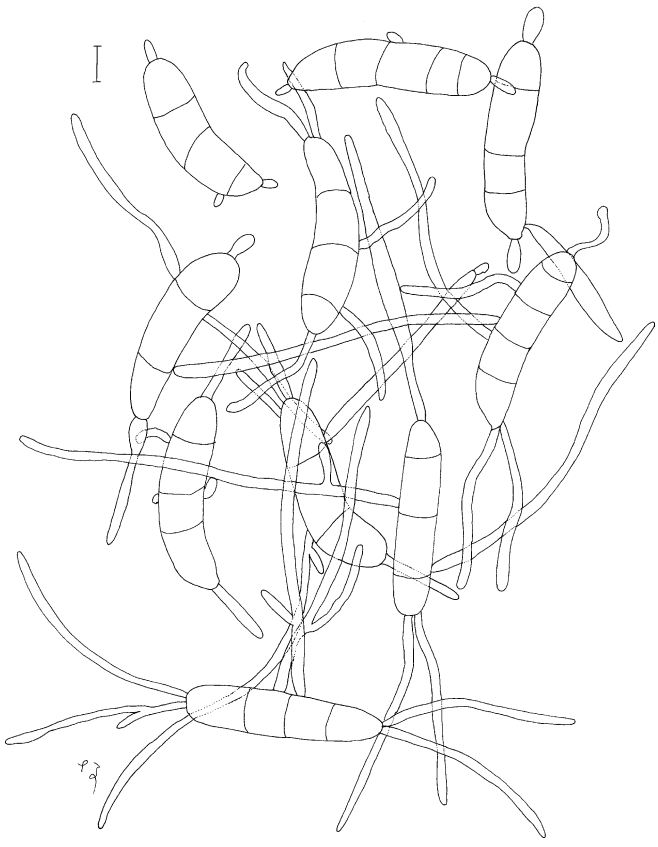


**Fig. 5.** Germination of the basidiospore of *E. miyabei* on PDA after 8-h incubation. *Bar* 3μm

Hara et Ezuka by the size of its basidia and number of sterigmata, and from *E. fraserii* McNabb by the size of its basidia, size and number of sterigmata, and number of septa of basidiospores. Therefore, *E. dubium* is a unique species that is completely identical in the morphological characters. The mode of germination of the Japanese specimens was the same mycelial form as that of *E. dubium*. Hokkaido was thus recorded as a new locality for the distribution of this fungus.

Leaf lesions are a chlorotic spot circumscribed with a dark-colored rind (Fig. 7A), whereas the chlorotic spot sometimes lacks the dark rind when infected trees grow in the shade (Fig. 7B). Irrespective of the dark rind, the diameter of lesions ranges from 3 to 12mm. Lesions are sometimes confluent to develop larger and ambiguous ones, 5–24 × 3–10mm, when several infections occur coincidentally in timing and location. A hymenium is formed on the underside of leaves (Fig. 7C). Chlorotic spots are uniquely observed, as reported by Woronichin (1913) and Nannfeldt (1981).

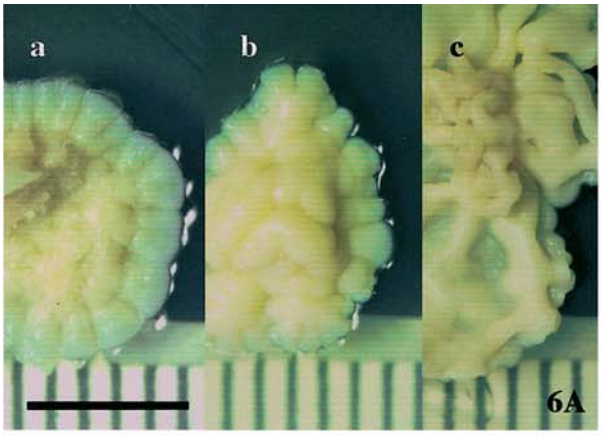
***Exobasidium miyabei*** Nagao, Akimoto et Kishi, sp. nov. Figs. 4,5

Maculae in foliis rotundae, 3–9mm diameter, planae et haud incrassatae, supra flavae vel viridiflavae et infra albofarinosae. Hymenium hypophyllum, determinatum infra maculas. Basidia hyalina, clavato-cylindracea, 25–41 × 7–9μm, ad apicem obtusata vel deplanata, terminaliter cum 3–5 sterigmatibus longiconicis 3–5 × 1–2μm praedita. Basidiosporae hyalinae, laeves, cylindricae vel falcatae, apice rotundatae, ad basim curvatae et angustatae, 14–23 × 4–5μm, primo continuae dein 1–6-septatae, per hyphas germinantes. Conidia hyalina, continua, laevia, linearia, 3–12 × 1–1.5μm. Coloniae in PDA restricte crescentes, ad ambitum irregulariter rugosae, ex hyphis circa 1μm latis et conidiis constantes, cremeae vel pallide aurantiacae, in agaro non pigmentiferae; reversum coloniis concolor.

Holotypus in foliis *Rhododendri daurici* Makino, Kikyo, Hakodate, Hokkaido Prefecture in Japonia, 14 VI 2001, H. Nagao et M. Akimoto leg., in Herbario Instituti Agriculturae et Silviculturae, University of Tsukuba, Tsukuba, Japonia conservatus (TSH-B 0075).

Etymology: Referring to a Japanese mycologist, Prof. K. Miyabe, who collected materials of this species for the first time.

Specimens examined: TSH-B0017 (Nagaoh 99796, Miyamae, Kawasaki, Kanagawa Prefecture, June 8, 1999); TSH-B0073, TSH-B0075 (Nagaoh 13116, 13118, Donan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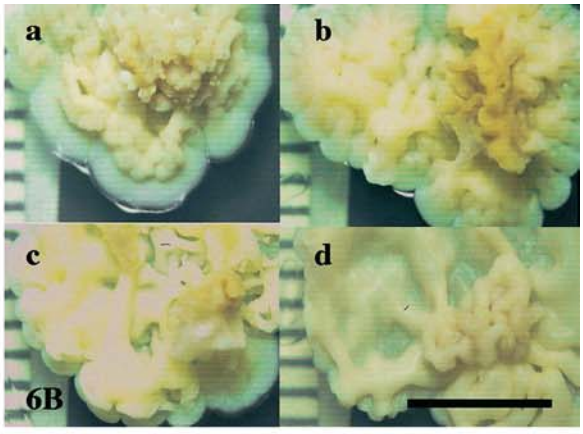
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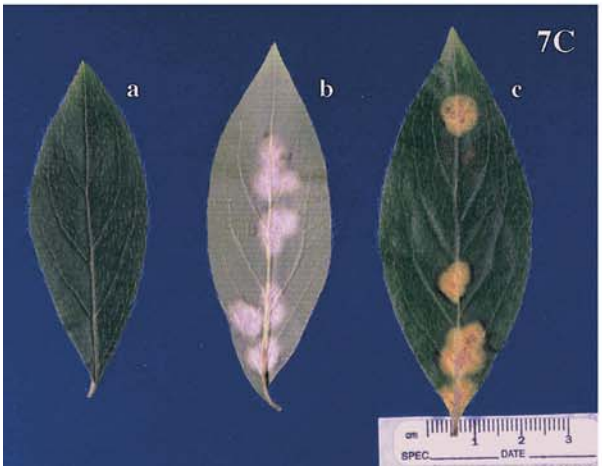
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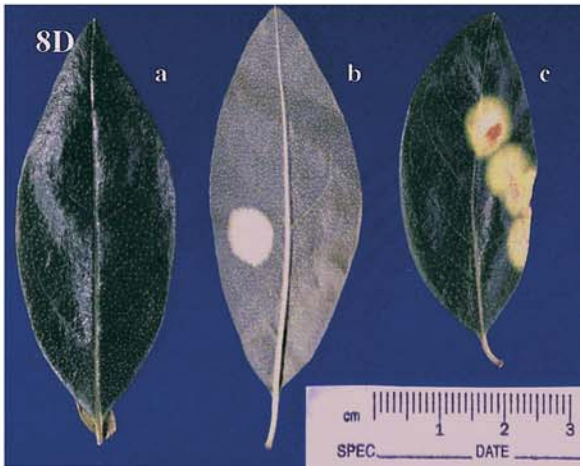
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Branch, Hokkaido Forestry Research Institute, Hakodate, Hokkaido Prefecture, June 14, 2001); TSH-B0087 (Nagaoh 13130, on the roadside, Teshikaga, Hokkaido Prefecture, June 21, 2001).

The hymenium was composed of basidia with 3–5 sterigmata and conidia (Fig. 3C). Hyphae did not develop directly on the surface of the epidermis. Basidia were clavate to cylindrical, 25–41 × 7–9 μm (Fig. 4A). The apex of basidia was blunt or flattened (Fig. 3E,F). Basidia emerged directly from the host surface or through stomata. Basidia were not fasciculate. Sterigmata were 1–2 μm in diameter at the base and 3–5 μm in height, emerging outwardly and tapering toward the tip (Fig. 3D). Basidiospores were ellipsoid to ovoid, 14–23 × 4–5 μm, hyaline, smooth, one-celled when formed, becoming septate with 1–6 septa (Fig. 4B). Septate basidiospores germinated after 6 h when dropped on the agar surface. Germ tubes of the basidiospores emerged from each cell and produced conidia at the tip 12 h after dropping (Fig. 5). Hyphae grew into pseudohyphae and branched. Conidia were bacilliform, lacrimiform, subfusiform, or clavulate, 3–12 × 1–1.5 μm, and budded polarly (Fig. 4C–F) to produce daughter cells polarly and also developed a germ tube or hyphae. Colonies on PDA grew gradually, to a maximum 15 mm diameter in 21-day incubations, and were wrinkled irregularly around the periphery. The surface of the colonies was pale yellow to pale orange and corrugate. Colonies were thin and fixed on the agar surface. Formed conidia did not produce a powdery appearance. Colonies were composed of branching, intricate hyphae and pseudohyphae, and conidia. The reverse of colonies was also pale yellow to pale orange. Dark pigment was not produced on PDA (Fig. 6B). Colonies from conidia showed the same morphological features as those from basidiospores.

The first report of an Exobasidium leaf blister on *R. dauricum* was in 1999 by Akimoto, whereas earlier samplings of an Exobasidium leaf blister on *R. dauricum* were in 1909 and 1919; these were deposited in the herbarium of University of Hokkaido (SAPA). The first recognition of this disease was at Sapporo, Hokkaido Prefecture, in August 1909 by Prof. K. Miyabe. The second collection was made at Sapporo, Hokkaido Prefecture on August 1, 1919, by Prof. S. Ito. These two specimens showed circular lesioms on the leaves of 5–8 mm and 3–6 mm in diameter, respectively. Two *Exobasidium* species, *E. caucasicum* and *E. rhododendri*, were recorded as infecting leaves and branches of *R. dauricum* in Russia (Murashkinsky and Sieling 1928; cited in Farr et al. 1996). Woronichin (1920) described *E. caucasicum* on *R. caucasicum* Pall. and indicated that its hymenia were formed all over the lower leaves. *Exobasidium caucasicum* showed systemic infection (Nannfeldt 1981). The symptom caused by these two species is clearly different from this Exobasidium leaf blister on *R. dauricum* in Japan. However, these Japanese specimens were just treated as *Exobasidium* sp. and did not appear in the later literature (Ito 1955). We examined these materials, and sufficient basidia and basidiospores to identify the taxon were not obtained because of the secondary infection on these lesions or because it was not the correct season for the collection of these materials. It is supposed that taxonomic investigations have not treated the causal fungus of this Exobasidium leaf blister.

The taxonomy of *Exobasidium* has been debated because of the simple morphology of taxonomic characters and the highly variable symptoms and wide host range (Burt 1915; Ezuka 1991b; Nannfeldt 1981; McNabb 1962; Savile 1959; Sundström 1964). We compared the morphology of basidia, basidiospores, and sterigmata and the mode of germination of basidiospores. One hundred taxa of *Exobasidium* have been validly described to date. Among these, 19 taxa show similarities in some morphological measurements (Table 1). The new species is distinguishable from *E. dracophylli* McNabb and *E. vaccinii-uliginosi* Boud. apud Boud. et E. Flesch. by width of basidia, length and number of sterigmata, and width and numbers of septa of basidiospores. It is also distinguishable from *E. otanianum* Ezuka var. *otanianum* and *E. yoshinagae* by length of basidia, size of sterigmata, and number of septa of basidiospores; from *E. cylindricum* Ezuka by size of basidia, length of sterigmata, and number of septa of basidiospores; from *E. bisporum* Sawada ex Ezuka in width of basidia and basidiospores, number of sterigmata, and mode of germination of basidiospores (conidial form); from *E. pieridis* Henn. by length of basidia, size and number of sterigmata, number of septa of basidiospores, and mode of germination of basidiospores (conidial form); from *E. burtii* Zeller and *E. uvae-ursi* (Maire) Juel by number of sterigmata and septa of basidiospores; from *E. aequale* Sacc. by number of sterigmata, width of basidiospores, and number of septa of basidiospores; from *E. dimorphosporum* Savile and *E. empetri* S. Ito et Y. Otani by size of basidiospores and number of septa of basidiospores; from *E. asebi* by size of basidia and number of septa of basidiospores; and from 6 other taxa, *E. canadense* Savile, *E. caucasicum*, *E.*

**Fig. 6.** Morphology and coloration of colonies formed by *E. dubium* and *E. miyabei* on PDA. **A** Surface of colonies of *E. dubium* MAFF 238581 (nagaoh-13119) collected in Hakodate (*a*), *E. dubium* MAFF 238582 (nagaoh-13120) collected in Hakodate (*b*), and *E. yoshinagae* MAFF 238607 (nagaoh-99807) (*c*). **B** Surface of colonies of *E. miyabei* MAFF 238583 (nagaoh-99796) collected in Kawasaki (*a*), *E. miyabei* MAFF 238593 (nagaoh-13116) collected in Hakodate (*b*), *E. miyabei* MAFF 238594 (nagaoh-13118) collected in Hakodate (*c*), and *E. miyabei* MAFF 238595 (nagaoh-13130) collected in Teshikaga (*d*). Submerged hyphae in colonies of *E. dubium* and *E. miyabei* were not pigmented

**Fig. 7.** Symptoms of Exobasidium leaf blister on *R. yedoense* by *E. dubium*. **A** Chlorotic spots observed on June 2001 in Hokkaido Prefecture. **B** Chlorotic spots without black rinds. **C** *a*, Healthy leaf; *b*, white hymenia occurred on the lower surface of leaf; *c*, symptom on the upper surface

**Fig. 8.** Symptoms on Exobasidium leaf blister on *R. dauricum* by *E. miyabei*. **A** Chlorotic spots observed on June 2001 in Hokkaido Prefecture. **B** Red pigmentation on the chlorotic spot. **C** Small chlorotic spots collected in Teshikaga. White hymenia occurred on the lower surface of leaf (*arrow*). **D** *a*, Healthy leaf; *b*, white hymenia occurred on the lower surface of leaf; *c*, symptom on the upper surface

**Table 1.** Morphological measurements of *Exobasidium* spp.

| Species | Size of basidia (μm) | Size of sterigmata (μm) | Number of sterigmata | Size of basidiospores (μm) | Number of septa basidiospores | References |
|---|---|---|---|---|---|---|
| *miyabei* | 25–41 × 7–9 | 3–5 × 1–2 | 3–5 | 14–23 × 4–5 | 1–6 | In this article |
| *aequale* | 6–8 wide | 4–6 long | 2 | (14) 15–22 × (6) 7–9 (10) | 0 | Symb. Bot. Ups. 28 (1981):1–72 |
| *asebi* | 60–80 × 4–7 | 4–6 × 1.5–2.5 | 3–4 | 16–23 × 3–5.5 | 1–3 | Nougyo Oyobi Engei 34 (1959):1353–1354 |
| *bisporum* | 40 × 6–7 | 4–6 long | 2 | 15–24 × 5–7 | 0–7 | Tohoku Biol. Res. 1 (1950):97–98 |
| *burtii* | 36–50 × 8–10 | 5–6.5 × 1.5–1.7 | 4 (5) | (14) 16–24 × 3.2–5.5 | 0–1 (3) | Mycologia 26 (1934):291–304 |
| *camadense* | 24–40 × 5.5–8 | 2.5–4.5 × 1.5–2 | 2–4 (5) | 14–20 × 3–4.7 | 1–3 | Can. J. Bot. 37 (1959):641–656 |
| *caucasicum* | 7–9 wide | nd | (2) 4 | 13–18 × 5–5.5 | 1 | Symb. Bot. Ups. 28 (1981):1–72 |
| *cylindricum* | 50–60 × 5–7 | 5–6 × 2 | (4) 5 (6) | 12–22 × 2.8–4.4 | (1) 3 | Trans. Mycol. Soc. Jap. 31 (1990):439–455 |
| *decolorans* | 18–35 × 6.5–8.5 (10) | 3.5–5 (8) × 1.8–2.5 | (2) 3–5 (6) | 14.5–22 × 4.2–6.5 | 1–3 | Can. J. Bot. 37 (1959):641–656 |
| *dimorphosporum* | 26–40 × 5–9.5 | 5–7 × 1.5–2.5 | 2–3 | 13–18.5 × 6.5–8.5; 18.5–28.5 (32) × 5–7 (8) | 0 (1) | Can. J. Bot. 37 (1959):641–656 |
| *dracophylii* | 25–45 × 5–6.5 | 6–8.5 long | 2 (3) | 20–27 × 5–8 | 0 (1) | Trans. N-Z. Bot.1 (1962):259–268 |
| *dubium* | 6–11 wide | nd | (2) 4 (5) | (15) 18–24 × 4–5 | 0–1 (3) | Symb. Bot. Ups. 28 (1981):1–72 |
| | 20–30 × 6.5–10 | 3–7 × 1.5–2 | 3–5 | 15–25 × 3.8–5 | 1–4 (6) | In this article |
| *empetri* | 20–28 × 8.5 | nd | 2–4 | 8.5–14 × 5.5–9.5 | 0–1 | Trans. Mycol. Soc. Jpn. 1 (1958):3 |
| *nobeyamense* | 35–40 × 7–10 | 3.5–5.5 × 2–2.5 | 3–6 | 12–21 × 2–5.5 | 2–4 | Mycoscience 42 (2001):549–554 |
| *otanianum var. otanianum* | 50–70 × 6–8 | 4.5–5.5 × 2 | (2) 4–5 (8) | 13–21 (23) × 3.5–6 | 0–1 (3) | Trans. Mycol. Soc. Jpn. 32 (1991):71–86 |
| *pieridis* | 50–60 × 7–9 | 5–9 × 2.5–3 | 2–3 (4) | 15–22 × 4–5.5 | 1–3 | Trans. Mycol. Soc. Jap. 32 (1991):71–86 |
| *unedonis* | 35–45 × 7 | nd | 4 | 13–21 × 4–6 | 1 | Symb. Bot. Ups. 28 (1981):1–72 |
| *uvae-ursi* | nd | nd | 2–3 (4) | 15–22 × 5–6 | 1–3 | Symb. Bot. Ups. 28 (1981):1–72 |
| *vaccinii-uliginosi* | 9–10 wide | 7 long | 2 | 16–23 (28) × 6.5–9 (12) | 0 | Symb. Bot. Ups. 28 (1981):1–72 |
| *yoshinagae* | 50–70 × 7.5–10 (12) | 5–6 × 2–2.5 | (3) 4–5 (6) | 13–23 × 3.5–6 | 0–1 (3) | Trans. Mycol. Soc. Jpn. 32 (1991):71–86 |

nd, Datum was not indicated in its original description

*decolorans* Harkn. *E. dubium, E. nobeyamense* Nagao et Ezuka, and *E. unedonis* Maire, in numbers of septa of basidiospores. In addition, *E. caucasicum* germinates by conidia (conidial form), whereas the new species germinates by hypha (mycelial form). There are several morphological differences in *E. dubium* and *E. yoshinagae*, which cause Exobasidium leaf blisters on *Rhododendron* spp. in Japan. This new species is distinguished from *E. dubium* by number of septa of basidiospores and from *E. yoshinagae* by length of basidia, shape of the apex of basidia (see Fig. 3B) (Ezuka 1991a), size of sterigmata, and number of septa of basidiospores. The new species on *R. dauricum* morphologically differs from the known species in size of basidia and basidiospores, number of sterigmata and septa of basidiospores, and mode of germination of basidiospores.

Compared with the conidia of *E. yoshinagae* MAFF 238607 (nagaoh-99807), isolated from an Exobasidium leaf blister of *R. wadanum* Makino, 2–7 × 1 μm, those of *E. dubium* MAFF 238581 (nagaoh-13119), isolated from an Exobasidium leaf blister of *R. dauricum*, were 6–14 × 1–2 μm and those of *E. miyabei* 3–12 × 1–1.5 μm. The conidial size of *E. miyabei* overlaps that of the former two species. The shapes of the conidia of these three species are bacilliform, lacrimiform, subfusiform, and clavulate. From the anamorphic examination, there is not any common morphological character to distinguish among these three leaf blister species. Colonies of *E. miyabei* on PDA do not show dark pigmentation (Fig. 6B).

The typical symptom of an *Exobasidium* leaf blister on *R. dauricum* is a chlorotic spot on the upper side of the leaves (Fig. 8A,C), corresponding to the hymenium that appears on the lower side (Fig. 8C,D). At the beginning of the infection, a minute yellow spot occurs on the leaves. This spot then gradually develops up to 3–9 mm in diameter. One of the symptoms is a red pigmentation on the upper side of leaves (Fig. 8B); these lesions actually match with hymenial parts. On the specimens collected in Misato, Teshikaga, Hokkaido Prefectue, chlorotic spots were limited as lesions at the beginning, but hymenial areas developed up to 2 mm in diameter (Fig. 8C). This observation suggests that hymenial development does not necessarily correspond with symptom development. As the occurrence of disease and the day of our samplings in Hakodate and Teshikaga, Hokkaido Prefecture, were within 8 days, environmental conditions, i.e., sunshine, temperature, and humidity, may have affected symptom development. The host range of *E. dubium* and *E. miyabei* will be studied with inoculation tests to determine their pathogenicity.

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