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Soil fungal floras in the Bonin (Ogasawara) Islands, Japan

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Soil fungi in the Bonin (Ogasawara) Islands, Japan are surveyed, and among a total of 370 isolates studied, more than 81 fungus species belonging to 47 genera are identified. The significance of the flora is discussed.

Key Words——bait method; cucumber seed; direct inoculation; fungus flora; toothpick.

The Bonin (Ogasawara) Islands (20°25′–24°27′N, 136°05′–153°59′E) are ocean islands located in the subtropics nearly 1000 km south-south-east of Central Japan. With Chichijima (2395 ha) and Hahajima (2080 ha) as the two main islands, the Bonin Islands are isolated from the main islands of Japan and have no easy access, and they are known for the biodiversity of the indigenous organisms and their evolutionary development (Ito, 1994; Ono, 1994). However, only a few works have been done on the soil fungi of the Islands, although there are several mycological works (Harada, 1979; Hattori and Ryvarden, 1996; Ito and Imai, 1937a, b; 1939; 1940a, b; Katumoto and Harada, 1979; Kobayashi, 1937a, b; Sato, 1987).

During studies on lignocellulose and dioxin-decomposing fungi, a total of 370 soil isolates from the islands were examined and identified, and here are listed, including new species.

Materials and Methods

The soil samples were collected from several locations on Chichijima and Hahajima islands, including Chyuouzan, Mikazukiyama, Miyanohama, Oogamiyama and Yoakeyama on the former and Chibusayama, Sekimonzan, Kuwanokiyama, Kitakou, Minamizaki and Miyukigahama on the latter, on January 12 to 17, 2000 and January 11 to 16, 2001. Samples collected from the top 15 cm of surface soil at a total of 61 sites were assayed. Fungi were isolated by a modification of Waksman's direct inoculation method with water agar as an isolation medium (Watanabe, 1989), and the bait method with cucumber seeds (Watanabe, 1981; 1994) or commercial toothpicks (*Betula* sp.) (Watanabe et al., 2001).

Living cultures were deposited at the Bioconsortia Program Laboratory, National Institute of Advanced Industrial Science and Technology, Ministry of Economy, Trade and Industry, and the Gene Bank, National Institute of Agrobiological Sciences, Ministry of Agriculture, Forestry and Fisheries (with the MAFF code number) in Tsukuba, Japan.

Results and Discussion

Representative isolates of the species obtained in this study were always stocked, and the data are qualitative, not quantitative. The total of 370 isolates studied included 151 strains isolated by the direct inoculation method, 96 by the bait method with cucumber seeds, and 123 by the bait method with toothpicks. These fungi were identified as belonging to more than 73 species in 43 genera, namely, 3 genera of Zygomycotina, 1 genus each of Mastigomycotina, Ascomycotina, and Basidiomycotina, and 41 genera of Mitosporic fungi (Deuteromycotina) following Watanabe (1993, 1994). These fungi are listed alphabetically in Table 1 with the record of isolation or non-isolation from Chichijima and Hahajima and the isolation method.

Although sample size, number of isolates examined, isolation methods and conditions, and study purposes were different, and the data are not strictly comparable, soil fungi in the Bonin Island appear to be richer in diversity than those of Hachijyo-jima, with more than 57 species belonging to 37 genera recovered (Watanabe, 1989).

Oceanic islands are known for the richness of the indigenous species of organisms, as exemplified by the Galapagos Island. The Bonin Islands are another example (Ito, 1994; Ono, 1994). The soil fungus flora of the Bonin Islands characterized by comparison with that of Hachijo-jima island (Watanabe, 1989), a terrestrial island, close to the Bonin Islands although the experimental purposes and methods of identifying the floras are different. For example, a soil-plate method and a bait method with potato cubes were used at Hachijo-jima, and bait methods with cucumber seeds and the toothpicks at the Bonin Islands, but the direct inoculation

Table 1. List of soil fungi and representative stock cultures (TW (abbreviated), and MAFF code numbers) isolated from Chichijima and Hahajima of the Bonin (Ogasawara) Islands by the direct inoculation (DI), and bait method with cucumber seeds (C) or toothpicks (T).

Fungus	Isolates[a]: Chichijima	Hahajima	Methods
Mastigomycotina			
Pythium acanthophoron Sideris (00–30)	−	+	C
P. deliense Meurs (01–101; –102)	−	+	C
P. irregulare Buisman (00–42; 01–112; –209)	+	+	DI, C
P. paroecandrum Drechsler (01–110)	−	+	C
P. rosratum Butler (01–155)	+	−	C
P. salpingophorum Drechsler (01–106)	−	+	C
P. splendens Braun (01–149; –211; –435)	+	+	C, DI, T
P. sylvaticum Campbell et Hendrix (01–153; –180)	+	+	DI
P. ultimum Trow (00–26)	−	+	C
P. vexans de Bary (00–31; 01–128)	−	+	C
Pythium spp. (00–41; –45; 01–142)	+	+	C
Zygomycotina			
Cunninghamella echinulata (Thaxter) Thaxter (01–147)	+	−	C
Gongronella butleri (Lendn.) Peyronel & Dal Vesco (01–227)	+	−	DI
Gongronella sp. (01–174)	−	+	DI
Mortierella exigua (01–200)	−	+	DI
M. gemmifera Ellis (01–199)	−	+	DI
Mortierella sp. 1 (01–125)	−	+	C
Mortierella sp. 2 (00–21 (MAFF 238166))	−	+	C
Mortierella sp. 3 (00–33 (MAFF238167))	−	+	C
Mortierella spp. (01–125; –148)	+	+	C
Ascomycotina			
Chaetomium virescens (von Arx) Udagawa (01–217)	+	−	DI
Chaetomium sp. (01–461)	+	−	DI
Basidiomycotina			
Basidiomycetous fungus (01–213)	+	−	DI
Mitosporic Fungi			
Acremonium sp. (00–50 (MAFF 238162))	−	+	DI
Acremonium spp. (01–163; –183; –254)	+	+	DI
Aspergillus spp. (01–230; –454)	+	−	DI, T
Botyotrichum piluliferum Downing (01–66; –220)	+	+	DI
Candida spp. (00–55; –285)	−	+	DI, T
Chrysosporium sp. (01–233)	+	−	DI
Cladorrhinum bulbillosum Gams & Mouchacca (01–176)	−	+	DI
Colletotrichum sp. (00–61, 01–135; –161)	+	+	DI, C
Curvularia lunata (Wakker) Boedijn (00–78)	+	−	DI
Cylindrocarpon obtusisporum (Cooke & Harkness) Wollenw. (00–53)	−	+	DI
Cylindrocarpon sp. (00–62 (MAFF238163); –299 (MAFF238169))	−	+	C, T
Cylindrocarpon spp. (00–62; 01–141)	+	+	C
Cylindrocladium camelliae Venkataramani & Venkata Ram (00–49 (MAFF 238170); 01–204)	−	+	DI
C. tenue (Bugnicourt) T. Watanabe (01–162; –479)	+	+	DI, T
Cylindrocladium sp. (00–52 (MAFF 238171))	−	+	DI
Dactylella sp. (00–315 (MAFF 238165))	+	−	T
Diplodia frumenti Ellis & Everh. (00–74; –291)	+	+	DI, T
Epicoccum purpurascens Ehrenb. ex Schlecht. (01–468)	+	−	T
Fumago sp. (00–76)	+	−	DI
Fusarium ciliatum Link (00–54 (MAFF 238164), 01–185)	−	+	DI
F. oxysporum Schlecht. emend. Snyder & Hansen (00–17; –18)	+	+	DI

Table 1. (Continued)

F. roseum Link (01–245)	+	−	DI
F. solani (Mart.) App. & Wr. emend. Snyder & Hansen (00–47, 01–139)	+	+	DI, C
Geotrichum spp. (00–293)	−	+	T
Gliocladium penicilloides Corda (00–71)	+	−	DI
Gliocladium spp. (00–49 (MAFF 238170); –57, 01–469)	+	+	DI, C
Helicomyces sp. (01–433)	−	+	T
Humicola grisea Traaen (00–48; –308)	−	+	DI, T
Humicola spp. (00–67; 01–242)	+	+	DI
Monacrosporium bembicodes (Drechsler) Subram. (00–295, 01–175)	+	+	T, DI
M. sclerohypha (Drechsler) Xing-Z Liu & K.-Q. Zhang (01–483)	−	+	T
Monilia pruinosa Cooke & Masse (00–277; 01–108)	+	+	T, C
Monilia sp. (00–269)	−	+	T
Myrothecium sp. 1 (01–250)	+	−	DI
Myrothecium sp. 2 (01–249)	+	−	DI
Neta quadriguttuta (Mats.) de Hoog (01–481)	−	+	T
Paecilomyces puntonii (Vuil.) Nannizzi (00–51)	−	+	DI
Paecilomyces sp. (01–164)	−	+	DI
Papulaspora sp. (01–427)	−	+	T
Penicillium spp. (01–182; –198; –465)	+	+	DI
Pestalotia sp. (01–464)	+	−	T
Pestalotia spp.(00–270; 01–219)	+	+	T, DI
Phoma spp. (01–195; –214)	+	+	DI
Pyrenochaeta sp. (00–309; 01–197; –228)	+	+	T, DI
Rhinocladiella sp. (01–216)	+	−	DI
Rhizoctonia fragariae Husain (00–304; 01–221)	+	+	T
R. solani Kühen (00–4; –311)	+	+	T
Rhizoctonia spp. (00–296; –314)	+	+	T
Sclerotium sp. (00–75)	+	−	C
Scolecobasidium constrictum Abbott (00–278)	−	+	T
Sphaeropsidales (01–178; –248)	+	+	DI
Sporoschisma saccardoi Mason & Br. (01–480)	−	+	T
Staphylococcus cocosporum Meyer & Nicot (01–181; –208)	+	+	DI
Torula sp. (00–68)	−	+	DI
Trichoderma spp. (00–80; –83, 01–429)	+	+	DI, T
Verticillium sp. (00–65 (MAFF238172))	−	+	DI
Wiesneriomyces javanicus Koorders (00–273 (MAFF238168); –286)	+	+	T
Xylohypha sp. (00–271; 01–463; –472)	+	−	T
UNIDENTIFIED (00–59; –63)	+	+	DI, C

[a] "+" and "−" indicate isolation and non-isolation, respectively.

method was commonly used in both islands. Therefore, the preliminary comparisons were conducted on the basis of the data reported (Watanabe, 1989) and presented in this report by calculating a coefficient of similarity using the formula $2w/(a+b)$, where "a" is the total number of species (or genera) in one population, "b" is the total number of species (or genera) in the other population, and "w" is the number of species (or genera) common to both populations (Christensen et al. 1962).

The similarity coefficients (%) of Hachijo-jima and the Bonin Islands are 42.9 at the genus level and 34.8 at the species level, based on the data (numbers of genera and species are 37 and 57 for the former, and 47 and 81 for the latter, and the number of common genera and species, 18 and 24). However, two or more unknown species belonging to the same genus are considered to be single identical species for the above calculation, but UNIDENTIFIED fungi are not included for the calculation.

In addition, the similarity coefficients of Chichijima and Hahajima in the Bonin Islands are 63.8 at the genus level, and 51.9 at the species level, based on the data in Table I (number of genera and species are 35 and 47 for the former, and 34 and 61 for the latter, and the number of common genera and species, 22 and 28). As Christensen et al. (1962) found similarity coefficients of 18.9–40.7 among the floras of five locations of Wisconsin forest soils in the U. S., the values of 42.9 for the genus level and 34.8 for the species level between Hachijo-

jima and the Bonin islands are similar to their data, but lower than those between Chichijima and Hahajima, indicating that Hachijo-jima and the Bonin Islands have rather different floras, but Chichijima and Hahajima may be closer.

Fusarium ciliatum Link, *Mortierella gemmifera* Ellis, *Pythium salpingophorum* Drechsler, *Wiesneriomyces javanicus* Koorders, *Xylohypha* sp. and a few others may be new or are rarely reported in Japan. All of them are to be published elsewhere in a series of papers.

These findings indicate the rich fungal diversity of the Bonin Islands.

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