effective compound (Xb) was over 10 times more potent than codeine phosphate (13.1 mg/kg) used as the standard compound. The further pharmacological studies are in progress and will be published in detail elsewhere.

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Odorous Metabolites of a Fungus, *Chaetomium globosum* KINZE ex FR. Identification of Geosmin, a Musty-smelling Compound[1)]

Geosmin, an earthy-musty smelling compound, and 2-phenylethanol were detected by gas chromatography and mass spectrometry combined with gas chromatography from the volatile metabolites of *Chaetomium globosum* KINZE ex FR., a fungus isolated from the soil at Sugadaira, Nagano Prefecture. It was suggested that fungi are partly responsible for the unpleasant earthy-musty odor and taste in public water supplies.

Keywords——geosmin; 2-phenylethanol; fungi; *Chaetomium globosum*; earthy-musty odor; odorous metabolite; public water supplies; water pollution

Unpleasant earthy-musty odor and taste occurred in public water supplies in recent years have been attributed mainly to geosmin (I)[2)] and 2-methylisoborneol[3)] which are produced by several actinomycetes and blue-green algae.[4)] In connection with the study on the causal agents of odors and tastes in water supplies, we previously reported the isolation and identification of 6-pentyl-α-pyrone from two strains of fungi, *Trichoderma* and *Aspergillus* species,[5)] and also the identification of 2-phenylethanol and phenylacetaldehyde from several fungi, such as *Chaetomium*, *Penicillium*, and *Robillarda* species, obtained from the bottom deposits of Sengari reservoir, Kobe City Water Supply Bureau.[4d)] However, these compounds have

only a waxy or aromatic flavor and we could not isolate any musty-smelling substance from these fungi, although the intact fungi had a weak smelling. Recently we have isolated a strongly smelling fungus, identified as *Chaetomium globosum* Kinze ex Fr., from the soil at Suga-daira, Nagano Prefecture, and examined its volatile metabolites.

The fungi were grown on a stationary liquid medium (yeast extract 4 g, malt extract 4 g, peptone 1 g, and glucose 4 g in water 1000 ml) at 26° for 25—30 days and the whole culture (10 l) was submitted repeatedly to steam distillation. Extraction of the final distillate with methylene chloride and careful concentration of the extract gave a small amount of oily substance having an earthy-musty odor.

Examination of this substance by gas chromatography (GC)[6] using a 5% Thermon-1000 column indicated the presence of a compound which showed the same retention time as that of *dl*-geosmin (I) (Fig. 1, peak A).

The above substance was further purified by chromatography on silica gel (Mallinckrodt, 0.8×4.5 cm column) eluting with ether–pentane (3: 97) to give a colorless oil (*ca.* 20 mg). We then examined it by the combined mass spectrometry–gas chromatography (GC–MS).[7]

The mass spectrum arising from peak A was reproduced in Fig. 2, which was fully identical

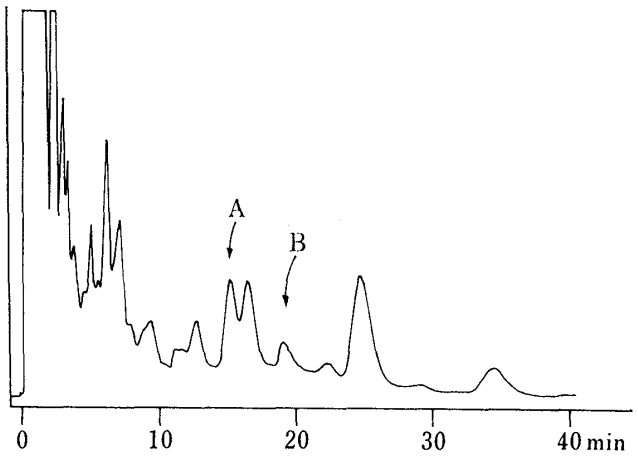

Fig. 1. Gas Chromatogram of the Volatile Metabolites of *Chaetomium globosum*

(peak A: geosmin, peak B: 2-phenylethanol).

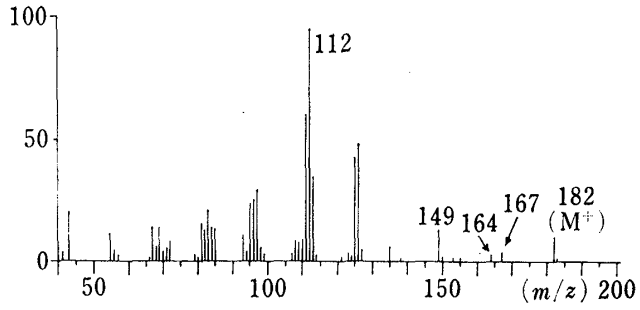

Fig. 2. Mass Spectrum of the Odorous Metabolite (Peak A) of *Chaetomium globosum*

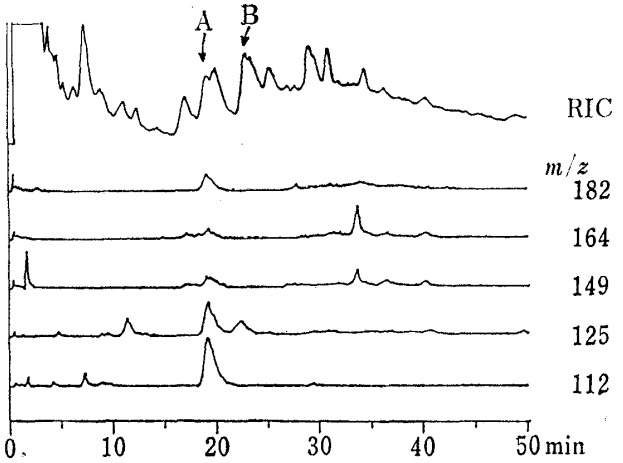

Fig. 3. Mass Chromatogram of the Volatile Metabolites of *Chaetomium globosum*

(peak A: geosmin, peak B: 2-phenylethanol).

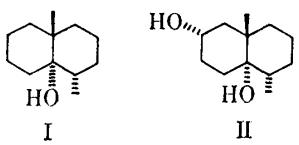

Chart 1

with that of authentic *dl*-geosmin (I) measured under the same condition. Also the mass chromatography based on the characteristic ions at *m/z* 182 (M^+), 164, 149, 125, and 112 supported evidently that peak A corresponds to geosmin (Fig. 3).

Furthermore, peak B in Fig. 1 was ascribed to 2-phenylethanol by mass chromatography and by comparison of its GC–mass spectrum with that of an authentic sample.

Our present result provided the first example of detection of geosmin (I) from the fungal metabolites and suggested that, besides actinomycetes and blue-green algae, fungi may also be responsible for the unpleasant odor and taste in public water supplies.

It is worth to note here that a compound named cybullol (II),[8] which is closely related to geosmin, have been isolated from a fungus obtained from bird's nest.

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7) GC–MS was carried out on a JEOL D-300 mass spectrometer using a glass column packed with 5% Thermon-1000 on Chromosorb W (AW DMCS) (2 m × 2 mm i.d.) at 100→160° (3°/min). Carrier gas, helium (1 kg/cm²); ionization energy 22 eV, accelerating voltage 3 kV.
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