Critical Revision on the Genera *Rhizosphaera* MANGIN et HARIOT and *Rhizophoma* PETRAK et SYDOW, a Little-known Fungal Group Associated with Needle Disease of Conifers

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Introduction

During the spring through the summer of 1965, an unusual outbreak of a needle blight of Japanese pines, especially of Japanese red pine, *Pinus densiflora* Sieb. et Zucc., was recorded from the low-altitude areas throughout the central and eastern parts of Japan. Such occurrence of this needle blight has not been recorded previously in Japan, although locally restricted development of the disease has been observed several times. On these blighted needles a particular fungus was usually recognized and it was tentatively called a species of the genus *Rhizosphaera* or *Rhizophoma*. This epidemic occurrence of the needle blight extending over vast areas provided a good opportunity for the author to determine systematic position of the fungus. Accordingly, many fresh materials of pine and other conifers showing similar signs as those on pine were collected from various localities to examine in detail the morphology of the fungus found on them.

In the course of examination on these materials, it was found that at least three species of fungi belonging to the same genus being separable only by their spore size, were distributed in Japan. Moreover, a question whether the genera *Rhizosphaera* and *Rhizophoma* precisely differ from each other or not, came to the author's mind. To answer this question, morphology of Japanese species was comparatively studied with that of the authentic specimens of the genus *Rhizosphaera*. This paper describes the results of critical study on the genera *Rhizosphaera* and *Rhizophoma*, and gives additional information on the species belonging to these genera.

The author expresses his special appreciation to Dr. Kazuo ITO, Director of Forest Protection Division, to Dr. Osamu CHIBA, Chief of Forest Disease Section, and to Dr. Rokuya IMASEKI, Laboratory of Forest Mycology, of the Government Forest Experiment Station, for their helpful advice during the study and constructive criticism in the preparation of this paper.

He is greatly indebted to Dr. Roger HAIM and Patrick JOLY, Museum National d'Histoire Naturelle, Paris, France, for their courtesy to provide for the author a chance to study authentic specimens of *Rhizosphaera abietis* MANGIN et HARIOT deposited in the Museum, and, to Dr. E. DONAUBAUER, Forstliche Bundesversuchsanstalt, Wien, Austria, and to Dr. B. C. SUTTON, Forest Insect and Disease Survey, Department of Forestry, Canada, for their kindness in photocopying literature which hitherto has not been available in Japan.

Thanks are also due to Mr. Tadashi Uozumi, Laboratory of Forest Pathology of the

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Criticism and revision on the genera Rhizosphaera and Rhizophoma

In examining many materials collected newly or deposited in the laboratory herbarium, it was found that the fungi associated with the needle blight of pines and other conifers were divided into three groups which belonged to the same genus but were apparently distinguishable by their spore size. Concerning the determination of systematic position of these fungi, some confusion in literature has been found.

In 1907, MANGIN and HARIOT who investigated a needle blight of Abies pectinata in Jura province of France, described a genus Rhizosphaera as a new member of Sphaeropsidales based on the fungus inhabiting blighted needles. The basic ground, by which they differentiated it from the hitherto known genera, was the structure of pycnidium. According to them, a stalk like bundle of brown hyphae grows up from the hyphal mass aggregated beneath the stoma, and penetrates through the stoma, then finally forms a pycnidium on the stoma. Therefore, mature pycnidia have apparent stalk and hyphal mass at their base.

MANGIN and HARIOT likened the fruit-body of Rhizosphaera abietis MANGIN et HARIOT, the type species of the genus, to a balloon; i.e., hyphal mass was equivalent to a hanging basket, stalk to sash-chain, and pycnidium to ball.

At the same time, they recorded that there were two different ways in conidial formation. Pycnidial wall which is formed from outer hyphal layer of the stalk changes into the spore producing cells having short conidiophore. Branched brown hypha which grows upward from inner hyphal strand of the stalk, is the source of another way in its conidial formation. Conidia are produced on these hyphae at the inner part of pycnidium as if they are produced on the long slender conidiophore (Figure 5 in MANGIN & HARIOT). They, however, mentioned only the former type of conidial formation in their description, that is "sporophora brevia, simplicia, monospora".

Shortly after the time when MANGIN and HARIOT erected the genus Rhizosphaera, MAU-BLANC found that two older species would belong to this genus. One of them, Coniothyrium pini CORDA, was considered by him to be the same species as Rhizosphaera abietis MANG, et HAR, and he recombined it newly as R. pini (CDA.) MAUBL. having a synonym of R. abietis. For another species, Sacidium abietis OUDEMANS, he gave a new combination of Rhizosphaera oudemansii MAUBL. to avoid confusion with R. abietis MANG et HAR. According to the description of this fungus, it has filiform conidiophore.

In 1914, BUBAK added one species to this genus based on his re-study of an older species, Sphaeronema pini DESMAZIERE described in 1848. He named it newly as Rhizosphaera kalkhoffii Bub., because the species name pini could not be used for it owing to the CORDA's older species, R. pini (CDA.) MAUBL. described in 1840. With regard to the way of conidial formation in this fungus, BUBAK noted that the conidia were directly born on the inside cell of pycnidial wall; in other words, conidiophore was absent.

Shortly after, HöHNEL established Sclerophomaceae as a new family of Sphaeropsidales, in which he aggregated many pycnidial fungi having no conidiophore. Rhizosphaera kalkhoffii Bub. was transferred by him to the genus Sclerophoma and revived its species name pini as S. pini (DESM.) HöHNEL. Van LUYK who studied several species of the genus Sclerophoma
inhabiting coniferous plants, however, rejected HÖNNEL’s treatment and supported BUBÁK’s name for the fungus in question. He thought the genus Sclerophoma Hönnel consisted of heterogeneous fungi that needed re-examination. In 1924, PETRAK discussed relative connection in the fungi belonging to the family Sclerophomaceae. It was emphasized in his conclusion that the family was composed from quite heterogeneous genera in relation to their structure and life-history, and, at least five distinguishable ways of conidial formation were observed among them.

WILSON and WALDIE reported two Rhizosphaera species, i.e. R. pini (CDA.) MAUBL. and R. kalkhoffii BUR., from Britain. They stated that British materials of Rhizosphaera pini always produced its conidia directly on the inside wall of pycnidium, and such long conidiophore as that noted by MANGIN and HARIOT was not observed in these materials. As to Rhizosphaera kalkhoffii, they noted that chief points to differentiate this species from R. pini were the smaller conidia and entire lack of conidiophore.

In 1927, PETRAK and SYDOW, who published a result of re-examination on various pycnidial fungi having unicellular conidia, established a new genus Rhizophoma with a new combined species Rhizophoma pini (DESM.) PETR. et SYD., segregating it from the genus Rhizosphaera. Exactly the same reason by which WILSON and WALDIE distinguished two species of the genus Rhizosphaera, R. pini (CDA.) MAUBL. and R. kalkhoffii BUR. (=Rhizophoma pini (DESM.) PETR. et SYD.), prompted them to separate two genera, Rhizosphaera and Rhizophoma. Namely, they estimated the different ways in conidial formation between them as an important characteristic to distinguish these genera each from the other.

In 1947, WATERMAN reported Rhizosphaera kalkhoffii BUR. from the United States and noted its conidial formation by the budding way.

Now, if the systematic position of Japanese fungi which are summarily shown in Table 2 is judged from the description of genera Rhizosphaera and Rhizophoma, there is no doubt that they belong to the genus Rhizophoma PETR. et SYDOW. However, in view of literature cited above, a question arises as to whether or not the genus Rhizophoma would be distinctly differentiated from the genus Rhizosphaera. The first reason is that the existence of conidiophore in the genus Rhizosphaera MANGIN et HARIOT seems to be doubtful. On the type species of the genus Rhizosphaera, R. pini (CDA.) MAUBL., the workers other than MANGIN and HARIOT, did not observe the existence of conidiophores. In addition to this fact, that the rest of dissolving contents in pycnidium are often misjudged to be a real conidiophore among the pycnidial fungi having no conidiophore has been well known. Secondly, PETRAK and SYDOW, by whom the genus Rhizophoma was segregated from the genus Rhizosphaera, did not ascertain directly the way of conidial formation in Rhizosphaera pini (CDA.) MAUBLANIC. They accepted the existence of conidiophore in the genus Rhizosphaera from the description and figure made by MANGIN and HARIOT.

In order to dispose of this uncertainty, two authentic specimens of Rhizosphaera pini (CDA.) MAUBL. identified by MANGIN were investigated in detail. From this investigation it was revealed that the general features of this species were quite identical with those of Rhizophoma PETR. et SYDOW. No conidiophores were recognized and conidia were born directly on the inside wall of pycnidium or on the wall of inner hyphae. Then, it may be said that the conidiophores of Rhizosphaera observed by MANGIN and HARIOT are no more than the rest of dissolving hyphal wall.
Judging from the foregoing facts, it can be concluded that there is no reason to separate both genera, *Rhizosphaera* MANGIN et HARIOT and *Rhizophoma* PETRAK et SYDOW, from each other. Description for the genus *Rhizosphaera* given by MANGIN and HARIOT, therefore, will be amended as follows, and the genus *Rhizophoma* PETRAK et SYDOW treated as a synonym of the genus *Rhizosphaera*.

But by conceding that the genus *Rhizophoma* was contained in the synonym of genus *Rhizosphaera*, a further problem arises. Type species of both genera have the same species name *pini*, respectively. However, it will be clear, as pointed out previously by BURAK, that *Coniothyrium pini* CORDA described in 1840, the oldest synonym *Rhizosphaera pini* (CDA.) MAUBL., possesses its nomenclature. Species name *pini* in *Rhizophoma pini* (DESM.) PETR. et SYD. which was first described by DESMAZIERE in 1848, therefore, could not be used under the genus *Rhizosphaera*. Then, *Rhizosphaera kalkhoffii* BURAK is revived again for it instead of the old species name *pini* originated from *Sphaeronema pini* DESMAZIERE.

In "Genera of Fungi" published in 1931, CLEMENTS and SHEAR treated the genus *Ectosticta* SPEG. and *Sclerochaeta* HÖHN. (=*Chaetopyrena* PASS.) as synonyms of the genus *Rhizosphaera*. The author has not seen any specimens of these two genera. Judging from the description, the genus *Ectosticta* differs distinctly from the genus *Rhizosphaera* by its entirely superficial pycnidia having no hypostroma—stalk and hyphal mass—and the genus *Sclerochaeta* also differs in its superficial and setous pycnidia. Then, the author retains here the treatment by CLEMENTS and SHEAR as a problem to be cleared up in future.

Concerning the life history of the genus *Rhizosphaera* and/or *Rhizophoma*, PETRAK presumed that the perfect stage of these fungous groups was probably species of the genus *Phaeocryptopus* NAOUOFF. On the other hand, ROHDE gave a practical disproof against PETRAK's assumption, based on his isolation experiment from the conidium of *Rhizosphaera* and ascospore of *Phaeocryptopus*. According to him, cultural characters of *Rhizosphaera* species were different from those of *Phaeocryptopus*. PETRAK, however, once more rejected ROHDE's opinion and presented life historical schema of these fungi; i.e., *Rhizosphaera pini* (CDA.) MAUBL. was equivalent to macroconidial stage of *Phaeocryptopus nudus* (PECK) PETR., and *Rhizophoma pini* (DESM.) PETR. et SYD. to microconidial stage of it, though he did not give any practical evidence. PETRAK's supposition was accepted exactly in AINSWORTH and BISBY's "Dictionary of Fungi".

It is quite doubtful, however, whether *Rhizophoma pini* (DESM.) PETR. et SYD. is the microconidial stage of *Phaeocryptopus nudus* (PECK) PETR. No similarity between these two fungi has been recognized in the isolation experiments, as noted in the latter part. To clear up the genetic relation between the species of the genera *Rhizosphaera* and *Phaeocryptopus* is an important problem to be solved in future.


Mycelium grows within the blighted needles which are grayish brown to reddish brown in colour, aggregates beneath the stoma and forms a ball-like hyphal mass, brown to greenish brown in colour. From such hyphal mass slender hyphal strand grows up, penetrates the stoma and forms a stalk-like bundle in the stomatal cavity. Outer hypha of the bundle
continuously grows up and specializes to pycnidial wall. Inner hypha branches sparsely and fills finally within the pycnidium. At this stage many small black dots are macroscopically recognized on blighted needles in several regular rows equivalent to those of stomata. Under a hand lens, pycnidium is found to be a small black globule with white resinous mass on it, but becomes pale to yellowish brown in colour under moist condition. Pycnidium is globular to subglobular, somewhat flattened at the lower part, and has a stalk- and ball-like hypostroma at its base. Hypostroma is more clearly visible on the host plant, having thick epiderm and wide stomatal cavity. Pycnidial wall is constituted from a layer of brown-coloured hypha. Inner part of pycnidium is also constituted from prosenchymatous brown hyphae at immature stage. With its maturity, conidia are born directly from the wall of hyphae and inside wall of pycnidium, and, these inner hyphae are dissolved gradually. Consequently, mature pycnidium is filled entirely with pycnospores instead of brown hyphae. Ostiole is lacking, but pycnidium breaks out irregularly at its upper part. Conidiophore is absent, although in some cases rest of dissolving hyphal wall is incorrectly judged to be conidiophore. Pycnospore is hyaline, unicellular, ovoid, elliptic or cylindric, often somewhat irregular shaped.

Species of the genus *Rhizosphaera* MANGIN et HARIOT

Since 1907 when the genus *Rhizosphaera* was established by MANGIN and HARIOT as a monotypic member of Sphaeropsidales, three species were added to this genus, and four species are known in this genus at the present time. Morphology of these fungi reported by many workers is summarily presented in Table 1. In addition to this table, morphology and host of Japanese materials collected on various conifers are given in Table 2, and average size of conidia in each material is dotted in Figure 1 together with those of hitherto known species. Histograms of length, width and length/width ratio of conidia of Japanese materials, being separable into three groups chiefly by their spore size, are shown in Figures 2 to 4.

It is apparent from these tables and figures that morphology of the fungus included in group I of Table 2 quite agrees with that of *Rhizosphaera kalkhoffii* Bub. reported by many workers. *Pinus* is the common host between them, although the latter has been reported more often on the needle of *Picea*. From these viewpoints Japanese materials including group I are identified as *Rhizosphaera kalkhoffii* Bubak. Moreover, no essential differences are recognized between *Rhizosphaera kalkhoffii* Bubak. and *R. radicata* NAOUM, as pointed out previously by LUYK and PETRAK and SYDOW, so the latter is included in the synonyms of the former in this paper.

Group II consists of three materials, and their spore size completely overlaps those of *Rhizosphaera pini* (CDA) MAUBLANC. It is presumed from the fact discussed above that MANGIN and HARIOT incorrectly recognized the existance of conidiophore in this species. This being so, the fungus collected on *Abies* and *Tsuga* in Japan is identified as *Phizosphaera pini* (CDA) MAUBL., and morphological characteristics of this species will be emended in the latter part.

No identical species with the materials of group III which have largest conidia was found among the hitherto known species as shown in Table 1 and Figure 1. Their conidia are far longer than those of *Rhizosphaera pini*. In the case of *Rhizosphaera pini*, length of conidia ranges from 15 to 21.5μ (18μ in average), whereas that of group III range from 20 to 37.5μ with the average 25.1μ. On the other hand, width range of conidia in these two
Table 1. Comparison in morphology and host range of the hitherto known species of the genus *Rhizosphaera*.

<table>
<thead>
<tr>
<th>Species</th>
<th>Host</th>
<th>Author</th>
<th>Pycnidium</th>
<th>Conidiophore</th>
<th>Conidium</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Size</td>
<td>Pore</td>
<td>+</td>
<td>Size</td>
</tr>
<tr>
<td><em>Rhizosphaera pini</em> (CDA.) MAUBL.</td>
<td><em>Abies pectinata</em></td>
<td>MANGIN &amp; HARIOT</td>
<td>90X120</td>
<td>+</td>
<td>16~20X8</td>
<td>ovoid</td>
</tr>
<tr>
<td></td>
<td>A. fraseri</td>
<td>Vuillemin</td>
<td>64~75</td>
<td>-</td>
<td>17~18X7,5</td>
<td>oblong elliptic</td>
</tr>
<tr>
<td></td>
<td>A. grandis</td>
<td>Saccardo</td>
<td>90~120</td>
<td>-</td>
<td>16~18</td>
<td>oblong ovoid</td>
</tr>
<tr>
<td></td>
<td><em>Pinus sp.</em></td>
<td>Wilson &amp; Waldie</td>
<td>90~120</td>
<td>-</td>
<td>16~20X8</td>
<td>oblong ovoid</td>
</tr>
<tr>
<td></td>
<td>Grove</td>
<td>Kobayashi</td>
<td>50X122</td>
<td>-</td>
<td>15<del>20X7</del>9,5</td>
<td>elliptic to ovoid</td>
</tr>
<tr>
<td><em>R. oudemansii</em> MAUBL.</td>
<td><em>Abies grandis</em></td>
<td>Maublanc</td>
<td>60~100</td>
<td>+</td>
<td>9<del>13X7</del>9,5</td>
<td>elliptic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saccardo</td>
<td>70~100</td>
<td>-</td>
<td>5.5~8.25X4</td>
<td>ovoid to oblong</td>
</tr>
<tr>
<td><em>R. radicata</em> NAOU.</td>
<td><em>Abies sibirica</em></td>
<td>Naoumoff</td>
<td>70~100</td>
<td>-</td>
<td>7<del>10X3</del>4</td>
<td>ovoid</td>
</tr>
<tr>
<td></td>
<td>A. pectinata</td>
<td>Saccardo</td>
<td>80~150</td>
<td>-</td>
<td>7<del>10X3</del>4</td>
<td>ovoid</td>
</tr>
<tr>
<td><em>R. kalkhoffii</em> Bubak (= <em>Rhizophoma pini</em> (DESM.) Petr. et Syd.)</td>
<td><em>Picea excelsa</em>, <em>P. pungens</em>, <em>P. pungens var. argentea</em>, <em>P. nigra</em>, <em>P. sitchensis</em>, <em>P. glauca</em>, <em>P. orientalis</em>, <em>P. schrenkiana</em>, <em>P. abies</em>, <em>Abies pectinata</em>, <em>A. nobilis</em>, <em>Pseudotsuga douglasii</em> <em>Pinus austriaca</em>, <em>P. montana</em>, <em>P. strobus</em>, <em>P. mugo</em>, <em>P. nigra</em></td>
<td>Bubak</td>
<td>80~150</td>
<td>-</td>
<td>7<del>10X3</del>4</td>
<td>ovoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wilson &amp; Waldie</td>
<td>70~160</td>
<td>-</td>
<td>7<del>10X3</del>4</td>
<td>ovoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Petrak &amp; Sydow</td>
<td>50</td>
<td>-</td>
<td>5<del>10X2.7</del>4</td>
<td>ovoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saccardo</td>
<td>80~150</td>
<td>-</td>
<td>7<del>10X3</del>4</td>
<td>ovoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grove</td>
<td>10</td>
<td>-</td>
<td>7<del>10X3</del>4</td>
<td>ovoid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waterman</td>
<td>10</td>
<td>-</td>
<td>7<del>10X3</del>5</td>
<td>ovoid</td>
</tr>
</tbody>
</table>
Table 2. Data of the genus *Rhizosphaera* collected in Japan.

<table>
<thead>
<tr>
<th>Host</th>
<th>Locality</th>
<th>Altitude</th>
<th>Conidia Size</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pinus densiflora</em></td>
<td>Meguro, Tokyo</td>
<td>&lt;600m</td>
<td>5.5~ 7.5× 2.8~ 3.5μ</td>
<td>elliptic to ovoid</td>
</tr>
<tr>
<td></td>
<td>Chiba-city, Chiba Pref.</td>
<td></td>
<td>6.0~ 9.0× 3.0~ 4.5μ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fujiyoshida, Yamanashi</td>
<td></td>
<td>5.0~ 7.5× 3.0~ 3.5μ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minori, Ibaraki Pref.</td>
<td></td>
<td>7.5<del>10.0× 3.8</del> 5.0μ</td>
<td></td>
</tr>
<tr>
<td><em>Pinus thunbergii</em></td>
<td>Meguro, Tokyo</td>
<td></td>
<td>6.5~ 9.0× 3.0~ 4.0μ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mie Pref.</td>
<td></td>
<td>6.0~ 8.0× 3.0~ 4.0μ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chiba-city, Chiba Pref.</td>
<td></td>
<td>7.0<del>10.0× 3.0</del> 4.5μ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uchihara, Ibaraki Pref.</td>
<td></td>
<td>6.3~ 8.8× 3.0~ 4.5μ</td>
<td></td>
</tr>
<tr>
<td><em>Pinus excelsa</em></td>
<td>Mito, Ibaraki Pref.</td>
<td></td>
<td>7.0<del>10.0× 3.8</del> 5.0μ</td>
<td></td>
</tr>
<tr>
<td><em>Abies veitchii</em></td>
<td>Narusawa, Yamanashi Pref.</td>
<td>&gt;1,000m</td>
<td>16.3<del>21.3× 7.5</del>10.0μ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gotenba, Shizuoka Pref.</td>
<td></td>
<td>15.0<del>21.3× 7.5</del>11.3μ</td>
<td></td>
</tr>
<tr>
<td><em>Tsuga diversifolia</em></td>
<td>Narusawa, Yamanashi Pref.</td>
<td></td>
<td>16.3<del>20.0× 8.0</del>12.5μ</td>
<td></td>
</tr>
<tr>
<td><em>Abies mariesii</em></td>
<td>Miyata, Nagano Pref.</td>
<td></td>
<td>20.0<del>26.3× 7.5</del>10.0μ</td>
<td>elliptic to cylindric</td>
</tr>
<tr>
<td><em>Pinus pumila</em></td>
<td>Miyata, Nagano Pref.</td>
<td></td>
<td>21.3<del>37.5× 8.8</del>12.5μ</td>
<td></td>
</tr>
<tr>
<td>(on culture)</td>
<td></td>
<td></td>
<td>22.5<del>30.0×10.0</del>12.5μ</td>
<td></td>
</tr>
</tbody>
</table>

*Hitherto known species*  
1 *R. pini*  
2 *R. oudemansii*  
3 *R. kaikhoji*  
4 *R. radicata*  

Japanese materials

Figure 1. Average size of conidia in hitherto known species of the genus *Rhizosphaera* and in each material collected in Japan.
Rhizosphaera entirely overlap each other, and no difference is recognized in their average size as shown in Table 2 and Figure 3; namely 7~12.5μ (9.3μ in average) is the case of Rhizosphaera pini and in the case of group III width of conidia ranges from 7.5~12.5μ (9.8μ in average). Then, group III presented in Table 2 seems to be separable fairly well from Rhizosphaera pini (Cda.) MAuBl. by its length and length/width ratio of conidia as shown in Figures 2 and 4.

However, determination of the species on group II is retained here until comparative

Figure 2. Histogram of length of conidia in three Japanese species of the genus Rhizosphaera (Total numbers of measured conidia)

Figure 3. Histogram of width of conidia in three Japanese species of the genus Rhizosphaera (Total numbers of measured conidia)
cultural and life historical studies between *Rhizosphaera pini* (Corda) Maubl. and the fungus of group III have been conducted. Monosporous culture from the fungus collected on *Pinus pumila*, one of the materials of group III, distinctly differs from that of *Rhizosphaera kalkhoffii* Büb. (Plate 4, H), but it is still uncertain whether it also differs from that of *R. pini* or not, owing to the failure to obtain monosporous culture of the latter. As noted above, genetic connection between *Phaeocryptopus nudus* (Peck) Petr. and *Rhizosphaera kalkhoffii* Büb. was denied by the comparative cultural studies (Plate 4, H). The relationship between *Phaeocryptopus nudus* and *Rhizosphaera* species other than *R. kalkhoffii* has not yet been critically investigated fully, so it seems to be necessary to supplement present knowledge by further morphological and life-historical studies based on many fresh materials and culture from them. Therefore, materials of group III presented in Table 2 are treated here as an undetermined species of genus *Rhizosphaera*.


Synonym: *Coniothyrium pini* Corda, Icon. Fung. IV, p. 38, t. VIII, f. 105, 1840
*Leptothyrium pini* (Corda) Saccardo, Syll. Fung. 3: 627, 1884

Mycelium grows within the blighted needles which are grayish brown to reddish brown in colour, aggregates beneath stoma and forms a ball-like hyphal mass which is brown to greenish brown in colour and, 20~45×33~45μ in size. From such hyphal mass a few slender hyphal strand grow upward, penetrate the stoma and form a stalk-like bundle, 45~63×10~13μ in size, in the stomatal cavity. Outer hypha of the bundle continuously grows up and specializes to the pycnidial wall. Inner hypha branches sparsely and finally fills within the pycnidium. At this stage, many small black dots are macroscopically recognized on the
blighted needles in a few regular rows equivalent to those of stomata. Under a hand lens, pycnidium is found to be a small black globule with white resinous mass on it, but becomes pale to yellowish brown in its colour under moist condition. Pycnidium is globular to subglobular, somewhat flattened at the lower part, 50~65×55~125μ in size, and has stalk-and ball-like hypostroma at its base. Hypostroma is more distinctly visible on the host plant having thick epiderm and wide stomatal cavity. Pycnidial wall is constituted from a layer of brown hypha. Inner part of pycnidium is at first constituted from prosenchymatous brown hyphae. With its maturity, conidia are born directly on the inside wall of pycnidium and wall of inner hyphae, and, these hyphae are gradually dissolved. Consequently, the whole pycnidium is filled with many hyaline conidia instead of brown hyphae. Ostiole is lacking, but pycnidium breaks out irregularly at its upper part. Conidiophore is also lacking, although in some cases the rest of dissolving inner hyphae remains and is incorrectly taken to be conidiophore. Pycnospor is hyaline, rarely become brownish with age, unicellular, elliptic to ovoid, rounded at both ends, often somewhat irregular in shape, 15.0~21.5×7.0~12.5μ, usually 16~20×7~10μ in size.


**Distribution:** Europe (France, Britain, Germany, Austria, Czechoslovakia, Italy), North America (United States), and Asia (Japan).

**Material:** *Abies pectinata*—Ambert, France, II-30, 1905, by M. Brevier (Para-type); Vorgu, France, IV-, 1908, by M. Mangin. *Abies veitchii*—Narusawa, Yamanashi Pref., VI-22.

![Figure 5. Rhizosphaera pini (CDA.) MAUER.](image)

a: Pycnidium having hypostroma which constitutes of stalk-like and ball-like hyphal tissue (on *Abies veitchii* Lind.) (50μ)
b: Conidia produced on *Abies veitchii* Lind. (10μ)
c: Conidia produced on *Tsuga diversifolia* Maxim.
d: Conidia produced on *Abies pectinata* DC.
Note: In Japan this species was found in the high mountain region and not on pines grown in lowland areas as shown in Table 2. No instance of serious damage caused by the present Rhizosphaera in Japan has been recorded, though at first this fungus attracted the attention of French mycologists in causing serious needle blight of Abies pectinata. Several attempts to isolate this fungus were unsuccessful, so to verify PETRAK’s presumption that this species is the conidial stage of Phaeocryptopus nudus (PECK) PETRAK remains the object of future study.


Phoma pini Saccardo, Syll. Fung. 3 : 101, 1884

general features of this species closely resemble those of Rhizosphaera pini (CDA.) MAUBL., the type species of this genus, so it is very difficult to distinguish them macroscopically or under a hand lens one from the other. Pycnidium is 50~95×50~115μ, and has stalk- and ball-like hypostroma which is 45~58×18~23μ and 40~58×30~50μ in size, respectively, at its base. Ostiole is lacking, but appears irregularly at the upper part of pycnidium. Conidiophore is absent. Conidia are produced directly on the inside wall of pycnidium and wall of inner hyphae. Inner hyphae dissolve with the maturity of pycnidium. Finally, pycnidium is filled with many pycnospores. Conidium is hyaline, elliptic to ovoid, unicellular, 5.0~10.0×3.0~5.0μ, usually 6~8×3~4μ in size.

Host: On blighted needles of Picea excelsa Link\(^{3234}\), (Oshu-tohi), P. pungens Engelm.\(^1\)

Abies pectinata DC.\(^{3234}\), A. nobilis Lind.\(^{4134}\), A. sibirica Leder.\(^{1928}\), Pseudotsuga douglasii Carr.\(^{24}\), Pinus austricaa Hoess.\(^{4134}\), P. montana Mill.\(^{234}\), P. strobus L.\(^6\), P. mugo Poir.\(^{1928}\), P. nigra Arn.\(^{23}\), P. densiflora Sieb. et Zucc.\(^{4123}\)(Aka-matsu), P. thunbergii Parl.\(^{1923}\)(Kuro-matsu), and P. excelsa Wall. (Himaraya-goyo).

Distribution: Europe (Russia\(^{1928}\), Austria\(^9\), France\(^9\), Germany\(^9\), Czechoslovakia\(^9\), Norway\(^{1924}\), Britain\(^{6200}\)(Ireland\(^{638}\)), Ireland\(^{638}\), Netherland\(^{2007}\), North America(United States\(^{122}\), Canada\(^{19}\)), and Asia (Japan\(^{19}\)).

Figure 6. *Rhizosphaera kalkhojfii* BuBAK

a: Immature pycnidium on *Pinus densiflora* S. et Z. showing young conidia produced directly on the wall of inner hyphae

b: Mature pycnidium on *Pinus thunbergii* PARL.

c: Conidia produced on *Pinus densiflora* S. et Z.

(— 10 µ)

Note: The present fungus has commonly been reported to be a causal agent of the needle blight of spruce, especially of *Picea pungens*, in Europe and North America, though it has wide-host range on various conifers including pines. However, biology of this fungus has not yet been critically investigated fully. Rohde [11] and Waterman [21] obtained successfully its culture and some cultural characters on agar media were noted by them. Waterman [21] and Peace [20] pointed out the importance in determining pathogenicity of the present species as applying to coniferous plants, although they obtained only negative results. In Japan, the present fungus was first recorded by Suder [30] who examined successive occurrence of the needle blight of pines caused by it in a limited area of the San-in District. In a case of epidemic outbreak of the pine needle blight during the year of 1965, Chiba [4] and Kondo [12] discussed the predisposing factors in pines to the present *Rhizosphaera* based on their analytical examination of the diseased stands. Kondo [13] also noted different susceptibility among many Japanese pine clones pertaining to the needle blight. Chiba [4] and Peace [20] suggested conclusively that infection of fungus and/or development of the disease may be stimulated by abnormal water relation onto pine or spruce brought by drought.

The present fungus was easily isolated. Two ways of germination were generally
observed. In the first, its conidium multiplicates in a budding way and the fungus gradually increases the number of secondary conidia by repeated multiplication. Hyphae grow from the mass of secondary conidia. The other case is the normal type of germination, i.e. germ-tube is born on conidium directly. In either case colony finally shows similar macroscopic appearance. Growth of colony is fairly fast and mucous conidial drops are scatteredly produced on blackish mycelial colony. Conidia are luxuriantly produced on the cultural hyphae without conidiophore as illustrated by Waterman.

Culture of the present fungus differs much from that of Phaeocryptopus nudus (Peck) Petr. as pointed out previously by Rohr.

3: *Rhizosphaera* sp.—(Plate 3, E, F; 4, A~E; Figure 7)

General features of this undetermined species of genus *Rhizosphaera* bear close resemblance to those of two *Rhizosphaera* described above. It is very difficult to distinguish these three *Rhizosphaera* macroscopically, as they differentiate only by microscopic examination one from another. Pycnidium is 65~85×70~100μ, and has stalk- and ball-like hypostroma, 55~70μ in length and 20~38×20~50μ in size, respectively. Ostiole is lacking. Conidiophore is absent. Pycnospore is produced directly on the inside wall of pycnidium and mass of inner hyphae. These inner hyphae dissolve as the pycnidium age and pycnidium is finally filled with many conidia.

**Figure 7. *Rhizosphaera* sp.**

a: Pycnidium on *Abies mariesii* Mast.
b: Conidia on *Abies mariesii*
c: Pycnidium on *Pinus pumila* Regel.
d: Conidia on *Pinus pumila*
e: Conidia on culture isolated from a material on *Pinus pumila* 

(LLLL=50μ, ----=10μ)
conidia. Conidium is hyaline, elliptic to cylindric, unicellular, 20–37.5×7.5–12.5\(\mu\), mostly 22–28×8–12\(\mu\).

**Host and material:** On blighted needles of *Abies mariesii* MAST. (Aomori-todomatsu)—Narusawa, Yamanashi Pref., IX–, 1960, by Y. ZINNO, and *Pinus pumila* REGEL (Hai-matsu), Miyata, Nagano Pref., IX–, 1966, by T. KURO.

**Note:** As mentioned earlier, this undetermined group is separable from the hitherto known species of the genus *Rhizosphaera* by its longer conidia. Monosporous culture from the fungus on *Pinus pumila* was obtained successfully. Dark brown-coloured colony developed on potato-sucrose agar. Its growth is comparatively slow, and small black pycnidia are scatteredly produced on the colony, then mucous conidial masses ooze out from them. Conidia produced on culture are quite identical with those on the host plant (Table 2, Figure 7 and Plate 4, F, G). It is worthy of note that the culture of *Phaeocryptopus nudus* (Peck) PETR. is quite similar to that of this isolate from *Pinus pumila* not only in its macroscopic appearance but also in the size of conidia produced on it. Verification of life-historical relationship between these two fungi remains as an important problem for future study and solution.


**Synonym:** *Sacidium abietis* OUDEMS, Contrib. Fl. Myc. Pays-Bas XVII, P. 333, 1900; SACCARDO, Syll. Fung. 16 : 992, 1902

**Note:** Among the hitherto known species of genus *Rhizosphaera*, *R. oudemansii* MAUBL. has been recorded only once from the Netherlands\(^{50}\). The author has not seen either its specimen or its original description and figure. According to MAUBLANC\(^{57}\), however, general features and figure given by OUDEMS as *Sacidium abietis* Oud. are quite identical with those of *Rhizosphaera pini* (CDA.) MAUBL. except for its conidia being smaller than the latter, as shown in Table 1. So, he transferred it to the genus *Rhizosphaera* from *Sacidium*, and newly named it as *R. oudemansii* MAUBL. to avoid confusion with *R. abietis* MANG. et HAR., a synonym of *R. pini* (CDA.) MAUBLANC. Judging from his treatment and from the description by SACCARDO\(^{58}\), it seems highly probable that this fungus is maintained in the genus *Rhizosphaera*.

**Summary**

1. Justification of the genera *Rhizosphaera* MANGIN et HARIOT and *Rhizophoma* PETRAK et SYDOW was critically reexamined. The genus *Rhizophoma* lost its independency followed by the revision of misdescription of the old genus *Rhizosphaera* made by MANGIN and HARIOT.

2. Nomenclature of the species name *pini* in the type species of both genera is of *Rhizosphaera pini* (CDA.) MAUBL. described in 1840. The species name of *Rhizosphaera kalkhofii* BUB. is, therefore, revived for *Rhizophoma pini* (DESM.) PETR. et SYD., first described in 1848, under the genus *Rhizosphaera*.

3. In the course of identification on Japanese materials, it was found that three species belonging to the genus *Rhizosphaera* were distributed in our country, two of which were the hitherto known species, namely *R. pini* (CDA.) MAUBL. and *R. kalkhofii* BUBAK. At the same time, *Rhizosphaera radicata* NOUM. was treated as a synonym of *R. kalkhofii* BUBAK.

4. On the other species identification was retained here and its morphological and cultural characters were briefly noted. It was pointed out that the culture of *Phaeocryptopus nudus* (Peck) PETR. was quite similar to that of this undetermined *Rhizosphaera*, and further
study to verify the genetic relation between them is required.

5. Judging from the critical notes made by MAUBLANC and SACCARDO, *Rhizosphaera oude-mansii* MAUBL. may remain to be the fourth species in this genus.

**Literature**


12) KONDO, H.: Needle blight disease of pines caused by a species of the genus *Rhizopoma*:


21) ——— & MURRAY, J. S.: Forest pathology, in Rept. For. Res. for 1956, p. 64, (1957), and


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Explanation of plates

Plate 1

*Rhizosphaera pini* (CORDA) MAUBLANC

A: Blighted needles showing minute black pycnidia on the under leaf surface

(A piece of PARATYPE specimen on *Abies pectinata* DC. deposited in France). ×1.2

B: Do. On *Abies veitchii* LIND. ×1.3

C: Enlarged needles showing a number of pycnidia arranged into two streaks. On *Tsuga diversifolia* MAX. ×2.5

D: Do. On *A. veitchii*. ×2.5

E: Closed masses of pycnidia having white resinous substance on them. On *A. pectinata*. ×15
F: Pycnidium having apparent stalk- and ball-like hypostroma on *A. pectinata*. Stained by KOH. ×370

**Plate 2**

*Rhizosphaera pini* (Corda) Maublanc

- A: Pycnidium on *Abies veitchii* Lind. ×370
- B: Conidia on *A. pectinata* DC. ×500
- C: Conidia on *A. veitchii*. ×500

*Rhizosphaera kalkhoffii* Bubák

- D: Diseased seedlings of pines in Asakawa nursery. (Photograph by Mr. T. Uozumi)
  - Front row: Heavily blighted seedlings of *Pinus densiflora* Sieb. et Zucc.
  - Back row: Seedlings of *P. thunbergii* Parl. infected very slightly
- E: Mature pycnidia broken out irregularly on their upper wall. On *P. thunbergii*. ×210
- F: Do. On *P. densiflora*. ×210

**Plate 3**

*Rhizosphaera kalkhoffii* Bubák

- A: Heavily blighted needles of *Pinus densiflora* Sieb. et Zucc. (Photograph by Mr. Uozumi). ×1/2
- B: Closed mass of pycnidia forming regular row. On *P. densiflora* (Photograph by Mr. T. Uozumi). ×25
- C: Conidia on *P. densiflora*. ×500
- D: Conidia on *P. thunbergii*. ×500

*Rhizosphaera* sp.

- E: Blighted needles of *Abies mariesii* Mast. showing minute black pycnidia on the under leaf surface. ×2
- F: Blighted needles of *Pinus pumila* Regel. ×1.5

**Plate 4**

*Rhizosphaera* sp.

- A: Closed mass of pycnidia forming regular row of black globules. On *Abies mariesii* Mast. ×20
- B: Do. On *Pinus pumila* Regel. ×15
- C: Pycnidium on *Abies mariesii*. ×370
- D: Pycnidium on *Pinus pumila*. ×370
- E: Conidia on *Abies mariesii*. ×500
- F: Conidia on *Pinus pumila*. ×500
- G: Conidia produced on culture isolated from the conidium on *Pinus pumila*. ×500

Test-tube cultures of *Rhizosphaera* and *Phaeocryptopus* (After a month on potato-sucrose agar). ×2/3

H: Left: *Rhizosphaera kalkhoffii* Bubák isolated from *Pinus densiflora* S. et Z.
  - Middle: *Rhizosphaera* sp. isolated from *Pinus pumila* Regel.
針葉樹すす葉枯病菌の属および
種の再検討

小 林 享 夫

(要 旨)

1965年の春から夏にかけて、東北南部から甲信、東海地方の広範囲にわたって、天然生あるいは人工植栽マツ林に一種の葉枯性病害が大発生した。従来この葉枯性病害は関東あるいは山陰地方において局部的な発生が知られており、今回のような広域大発生の記録はまったくなかった。したがって本病および病原菌に関する知見はほとんどなく、病原と考えられる菌の同定もなされず、たとえ Rhizophoma 属あるいは Rhizosphaera 属の一種であろうとされていたにすぎない。そこでこの広域大発生を機に、本病および病原菌の調査研究がとりあげられ、筆者は病原菌の所属の同定を担当して、内外の標本および文献によって調査を開始した。

調査にあたってはまず日本各地産のマツ類標本を収集するとともに、マツと似た病状をしめす他の針葉樹の標本をも採集につけた。これらの新鮮な標本および保存標本によってその形態調査をおこなった結果、わが国では、同一属に属し、たがいに相似した病状を呈する菌が少なくとも3種類あることがわかった（Table 2, Figure 1-4）。これらの菌は外観的にはまったく区別することが難しく、おもに分生胞子の大きさによって類別される。

この3種の菌は、文献によって記載のみから判断すると、Petrak と Sydow が1927年に Rhizosphaera 属から分離独立させた、Rhizosphaera 属とその特徴がまったく一致する。元来、Rhizosphaera 属は1907年 Mangin と Hariot によって Abies pectinata DC. 上の菌をもとににして創設された不完全菌類球菌科の一属である。Rhizosphaera 属は柄子胞下部に気孔を貫通する柄と気孔直下の菌糸塊（近代分類用語では両者をあわせて hypostroma 柄子胞下層という）を有するという特徴によって新設された。Mangin はこの形態を気球に近く、菌糸塊を剥取、柄を剥取、柄子胞を浮球上にたえたが、同時に分生胞子形成方法についてもふれ、ひとつは柄子胞内層の短い分生胞子梗上に生じ、いまひとつは柄子胞下部からのびる長束菌糸状の分生胞子梗に頂生する。かれらは、その捕糸（第5図）にはこの両種の分生胞子梗を描いたが、正式の属の記載文書には前者の短い分生胞子梗しかのべていない。そのご本属には3種が加えられ、現在4種が知られている。Wilson と Waldie はイギリス産の本属菌2種についてのべ、本属のタイプ種 Rhizosphaera pini (C.Da.) Maub. の英国産標本には Mangin らのいう細長い分生胞子梗はみられず、分生胞子は柄子胞壁から直接芽生すること、いまひとつは R. kalkhoffii BuB. はまったく分生胞子梗を欠き、この点と分生胞子の大きさのちがいが両者の類別点であることを指摘した。Petrak らは、Wilson らが種の類別点とした分生胞子形成方法のちがいを重視し、属を分ける価値を認めて Rhizosphaera kalkhoffii BuB. をもとにして Phizosphaera 属を分離独立させたのである。

ところが Wilson らがのべたように、Rhizosphaera 属のタイプ種において、分生胞子梗の存在をみて
の際は、MANGINの記載と異なり、またPETRAKが指摘したように、分生子梗はしばしば直立した細胞を形成し、これらが分生子と見なすことができる。また、R. kalkhojjiiの存在を認め、分生子梗を欠くR. piniをBubと同定した。なお、本研究の両属の菌果が個体によってその分生子胞形成方法に本質的な差異があるかどうかは未だ確認がなされた。

この疑問を解消するために新ら、バーリの国立自然科学博物館保存のRhizosphaera pini (CoA.) MAUBL.のparatypeをふくむ標本3点の調査は、分生子胞が胞内菌系細胞膜および胞子胞内層から直接芽生し、分生子梗をもたないことを示し、また溶失過程の胞内菌系の膜のみがMANGINの記載にある点が異なることであることが示された。したがって、Rhizosphaera属の特徴は一部修正され、同時に、これによってPETRAKらがRhizophoma属を独立させた主たる理由は消失するので、Rhizophoma属はふたたびRhizosphaera属に統合し、その異名となる。

この両属はタイプ種がそれぞれ同じ種名piniを有するので、同一属に統合する場合いずれかの種名はそのまま用いない。Rhizosphaera pini (CoA.) MAUBL.は1840年に記載されたConidioryum pini Cordaにとついており、一方Rhizosphaera pini (Desm.) PETR. et SYD.は1848年に記載されたPhaeomeronema pini Desmazièreをもとにしている。したがって先例権はRhizosphaera piniにあり、Rhizophoma piniはRhizosphaera属の下でpiniの種名を用いることができる。そこで、この種の異名のなかで2番目に古い種名であるRhizosphaera kalkhojjiiBubakがふたたび復活する。

一方ClementsとShearはEctosticta Speg.属とSclerochaeta Höhn.(=Chaetopyrema Pass.)属をRhizosphaera属の異名として処理している。筆者はこの両属菌の標本をみていないが、いずれも農業樹にのみ生ずること、記載からすると両者ともまったく発生の様子を生じ、後者はさらに柄子胞に剛毛があること、などから本報においてはこの両属をRhizosphaera属の異名とすることを保留した。

ときにベータ日本産の本属菌3種のうち2種は既知の種に該当し(Table 1, 2, Figure 1)，それぞれRhizosphaera pini (CoA.) MAUBL.およびR. kalkhojjii Bub.と同定された。あと1種は分生子胞が大きく既知種に該当するものがいない。しかしながら資源が少ないこと、ハマツ上の標本からの単胞子培養がPhaeocryptopus nudus (Peck) PETR.の培養に似ており、後者が培養上に生ずる分生子の大きさが前者のそれに一致し、両者の同種関係についての検討が必要であることに、ここではこのRhizosphaera属菌の種名の決定は保留し、たんにRhizosphaera属の一種としておく。

NAOUMOFFがロシアから報告したRhizosphaera radicataNAOUM.は、LUYK47やPETRAKら44が指摘し、またTable 1, Figure 1にみられるように、その形態がRhizosphaera kalkhojjii Bub.によく一致するので、その異名として処理した。

オランダからODEMANSが報告したRhizosphaeraoud.mansiiMAUBL.は、はじめSacidium abiesisOud.として記載されたが、MAUBLANC77の再検査によりRhizosphaera属に移され、同時にR. pini (Coi.) MAUBL.の異名であるR. abietis MANG. et HAK.との種名の重複混乱をさけるため新たに命名されたものである。わが国には本種に該当するものがなく、またその原標本もみることがなかったが、MAUBLANCやSACCARDO40の報告から判断してRhizosphaera属の種としてよいものと思われる。
以上述べてきた諸点を整理し、日本産の針葉樹類の葉枯病菌の属、種名を次に示し、終わりに本属菌の検索表を付す。


異名: Coniothyrium pini Corda, Icon. Fung. IV, t. III, f. 105, 1840
Sacidium pini (Corda) Fries, Sum. Veget. Scand., p. 420, 1849
Leptothyrium pini (Corda) Saccardo, Syll. Fung. 3 : 627, 1884

寄主: Abies pectinata DC. (631, 341), A. grandis Lind. (538, 353), A. fraseri Lind. 11, Pinus sp. (89), シラベおよびメタツの針葉に生ずる。

分布: 欧州（フランス651, イギリス820, ドイツ89, オーストリア631, チェコスロバキア331, イタリア831), 北米（アメリカ831）およびアジア（日本）。

資料: Abies pectinata DC. 2 点 (MANGIN の同定による、Paratype 1 点を含む)、シラベ 2 点およびメタツ 1 点。

記事: Table 2 にみられるように、わが国では黒髪山地帯に分布し、低地のマツ類にはみとめられなかった。欧州ではおもに北緯と関連してモミ類の葉枯（落葉）病菌として記録されている。数回試みた本菌の分離実験はいずれも不成功（不発芽）に終わり、培養の比較によって Petruk の仮説を誇示することはできなかった。

* この点については、Phaeocryptopus 属菌の培養的性質を詳述しなければならないので、ここでは深く論議しない。
針葉樹すす葉枯病菌の属および種の再検討（小林） 111


*Phoma pini* SACCARDO, Syll. Fung. 3：101, 1884


寄主：オウシュウトウヒ町26)34', シトカトウヒ町に Picea pungens var. 4γgentea8)6)18)24)8 l85) , P. nigra 27 )34), P. glauca 6 )18)27)34 l, P. orientalis CARR. 28 )84), P. abies I8 )28)88), Abies pectinata DC.印刷ペ A. nobilis LIND.的18)8的, A. sibirica LEDEB.19)26), ダグラスファイナの34), Pinus austriaca HOUSE(518534), P. mugo POIR, P. nigra AEN48, モンタナマツ644, ストレープマツ町, アカマツ町, クロマツ町, 栗山12日町, ヒマラヤゴヨウの針葉に生ずる。

分布：欧州の (ロシア10)26), オーストリア3), フランス3), ドイツ6), チェコスロバキア5), ノルウェー10)24), イギリス6)20)21)27)34), アイルランド6)34), オランダ20)27)34), 北米（アメリカ13)22, カナダ15）およびアジア（日本4)11)23)39)20)300）。

資料：アカマツ4点, クロマツ4点およびヒマラヤゴヨウ1点。

記事：本菌は Table 2 にみられるように, 他の2種と異なり, 標高1,000m以下の低地帯でマツ類にのみ産する。欧米では一般にトウヒ類の葉枯〔落葉〕病菌として知られている。本属既知種のなかでは最も分布, 寄主範囲が広く, 報知も比較的多いが, 生態等の詳細な調査研究はほとんどなされておらず, ROHDE25）と WATERMAN32）が分離別養をおこなって若干の培養的特徴をのべているほかは, PEACE20）, WATERMAN82）がトウヒ類に接種実験をしたが陰性に終わったことを記述しているにすぎない。

わが国では周藤29)80)が山陰地方における本菌によるマツの葉枯性病害の発生状況をのべたのが最初の報告である。1965年の大発生に際して千葉6), 近藤12)らは発生環境, 発病誘因等について調査観察結果を解析して報告し, 千葉によって本菌によるマツの病害がすす葉枯病と正式に命名された。周藤12)13)はさらにアカマツ, クロマツの多くのクローンを調べ, すす葉枯性病害程度がクローン間で著しく差のあることを報じた。さらに千葉6), PEACE ら10)によって, マツ, トウヒなどの本菌による感染あるいは発病は, 乾燥等による樹体内水分の消粛, 供給のアンバランスによって誘発促進されるらしいという。

本菌分生胞子は容易に発芽管を生じ, あるいは芽生增殖をおこなう。両発芽型のいずれからも, のちに同一の胞子を発達する。発育は良好で, WATERMAN82）が図示したように, 胞子より直接分生胞子を芽生し, 黒色胞子表面に液滴状の分生胞子粘塊を散生あるいは一団に生ずる。Phaeocryptopus nudus （PECK）PETRAK の胞子はこれとまったく異なり, ROHDE25）が指摘したように, 両者の間の同根関係は否定される。
3. *Rhizosphaera* sp.—(Plate 3: E, F, Plate 4: A~G, Figure 7)

寄主および資料：アオモリトドマツおよびハイマツ各1点の針葉に生ずる。

記事：ここにあげた資料の菌は *Rhizosphaera pini* (CDA.) MAUBL. とは分生胞子長あるいは分生胞子の長さと幅の比によって類別される(Table 2, Figure 1~4)。2つの資料のうち、ハイマツ上の分生胞子から分離した培養は、*Rhizosphaera kalkhoffii* Bub. のそれとはまったく異なるが、*R. pini* (CDA.) MAUBL. の分離に失敗したため、この両者の培養比較ができなかった。一方 *Phaeocryptopus nudus* (Peck) Petr. の培養の一般的特徴および培地上に形成された分生胞子の大きさが、ハイマツから分離された *Rhizosphaera* 菌株のそれとよく似ている。このことから、この群の菌と *Phaeocryptopus* 属菌との関係をさらに多くの資料とその分離培養によって検討する必要があり、ここでは種名の決定を留保した。

*Rhizosphaera* 菌の検索表（括弧内の種は本邦未記録種）

A1: 分生胞子は小さく（10μ以下）、卵形ないし椭円形、低地に産しマツ類に生ずる

A2: 分生胞子は大き（10μ以上）、椭円形ないし長椭円形

B1: 分生胞子は9~3×7~9.5μ、椭円形

B2: 分生胞子は15μ以上、高地に産し、亜高山性樹種に生ずる。

C1: 分生胞子は16~20×8~10μ

C2: 分生胞子は22~28×8~12μ