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Incidence of the Conidiophores of *Fomes annosus* (Fr.) Cooke on the Logging Waste of Spruce (*Picea abies* (L.) Karst.)

Fomes annosuksen kuromankannattimien esiintyminen kuusen hakkuutähteissä

Tauno Kallio

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INCIDENCE OF THE CONIDIOPHORES OF *FOMES ANNOSUS* (FR.) COOKE ON THE LOGGING WASTE OF SPRUCE (*PICEA ABIES* (L.) KARST.)

FOMES ANNOSUKSEN KUROMANKANNATTIMIEN ESIINTYMINEN KUUSEN HAKKUUTÄHTEISSÄ

TAUNO KALLIO

HELSINKI 1971

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INTRODUCTION

The mycelium of *Fomes annosus* is identified by the conidiophores (Brefeld 1889). Under laboratory conditions, the fungus usually produces conidiophores on any and every substrate (Hiley 1919), whereas they are relatively infrequently seen in nature. This is presumably due to the drying effect of air (Hiley 1919, Neger 1919), and light (Nechleba 1927). Conidiophores in a natural environment have usually been found in places that are shielded from light and dryness (Hubert 1950, Rishbeth 1951). Such places are e.g. under the scales of the bark on dug-up pine roots (Jørgensen and Petersen 1951) and on the surface of a Douglas fir stump with an early stage of heart rot, the stump having been covered by branches after felling (Rishbeth 1957), and also in the tunnels of beetles (Bakshi 1950, 1952, Francke-Grosmann 1962). In the USA, conidiophores have been reported from the cut surfaces of *Pinus taeda* (L.) stumps (Morris and Knox 1962), while in Finland they have been found on the cut surfaces of the stumps of both *Picea abies* (Kallio 1967) and *Pinus silvestris* (L.) (Nuorteva and Laine 1968).

A large number of studies have been carried out both in laboratories, greenhouses and in nature, using fungal conidia as the infection material. The conidia withstand exposure to heat better than basidiospores (Ross 1969). In the soil, they have been found to retain their power of infection for several months (Kuhlman 1969 a). Conidia have been successfully used to infect healthy spruce and pine seedlings under sterile conditions (Hyppel 1970, Kuhlman 1970). They have also been used successfully under natural conditions for root infection of pines (Kuhlman 1969 b).

It has been considered unlikely that conidia play an important role in the dispersal of the fungus (Rishbeth 1951, 1957). However, insects, for example, have been shown to distribute conidia (Nuorteva and Laine 1968). On the other hand, hardly any study results based on long-term observations concerning the occurrence of conidiophores in nature are available. The purpose of the present study was to investigate, over the course of several years, the incidence of conidiophores on the stump surfaces of spruce decayed by *Fomes annosus*. The underside of small pieces of decayed wood lying in the forest was also investigated.

MATERIAL AND METHOD

The investigations were carried out in the forest of the Helsinki University Experimental Farm, Viikki, about 10 km northeast of the centre of Helsinki, in a spruce forest, about 100 years old, growing on Oxalis-Myrtillus site type.

A preliminary study of the occurrence of conidiophores on the cut surfaces of stumps decayed by *Fomes annosus* was made in 1967—68. The study material consisted of the cut surfaces of the stumps of spruce timber, decayed by *F. annosus*, and decayed pieces of wood, with a cross section surface of 100—150 sq.cm and a thickness of 3—5 cm, which had remained in the forest as logging waste. Investigations after winter fellings were continued in an expanded form in 1969—70. In 1971, in addition to fellings in the winter, spruce trees decayed by *F. annosus* were also felled at 6-week intervals during the summer. After felling, a number of the stumps were covered by spruce branches, while others were left bare.

The presence of conidiphores on the cut surfaces was determined by a stereomicroscope (Wild M5) in situ. Some stumps were covered with spruce branches immediately after the trees had been felled. The purpose

was to make the conditions on the cut surfaces as far as possible identical to those prevailing on most stump surfaces after the ordinary commercial fellings. Efforts were made to keep the amount of logging waste covering the stumps constant throughout the period of study. The needles shed by branches onto the cut surfaces were removed while the search for conidiophores was being made. After the search was over, the same needles were replaced on the surfaces. The pieces of wood included in the study were lying on the ground and were only lifted long enough for the conidiophore search to be made.

The weather observations for the year 1969 were taken at the Finnish Meteorological Institute's station on an open site, about 1 km north of the investigation forest. Air temperatures and humidities were recorded in 1970 and 1971 by a thermohydrograph (Lambrecht No. 252, weekly graph) in a Stevenson screen in the forest at 2 metres above the ground. In addition, in the summer of 1970 the temperatures of 3 stumps were measured by a thermocouple (Wallace GS 3) inserted about 5 cm into the side of the stump, at 5, 10 and 20 cm below the sawn surface.

RESULTS

The 1967 investigation revealed conidiophores on the undersurface of a piece of decayed wood lying on the ground from April 28 onwards (KALLIO 1967). From May 2 onwards conidiophores were seen on the cut surface of a decayed spruce stump. The cut surfaces of stumps covered by logging waste showed conidiophores during the entire month of May, but none thereafter.

The cut stump surfaces of the 5 timber-

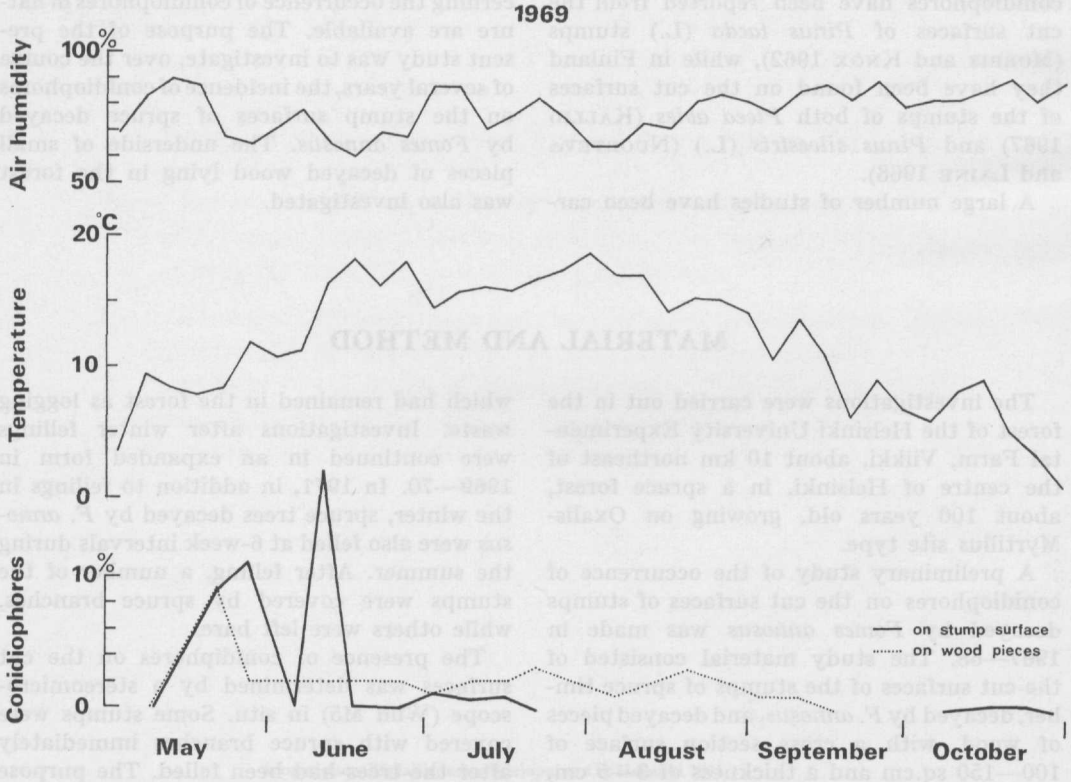

Fig. 1. Incidence of conidiophores on the logging waste of spruce in 1969.

sized spruce trees decayed by *F. annosus* and felled in January 1968, were inspected once weekly throughout the snowless season and at the same time the undersurfaces of 5 pieces of decayed wood lying on the ground were also inspected. Conidiophores were first noted on these surfaces on April 20. On the cut surface of a stump coated by plastic film, conidiophores were present from the end of April to mid-June, whereas no conidiophores occurred on the cut surfaces of 3 stumps which had been left uncovered (cf. KALLIO 1964). The incidence of conidiophores on the undersurfaces of pieces of decayed wood lying on the ground was the same as in the preceding year. After mid-June no conidiophores were found either on the cut surfaces or on the pieces of wood on the ground.

The 1969 investigation comprised 7 spruce stumps decayed by *F. annosus*. One of these stumps was covered by spruce branches. The cut surfaces were inspected once weekly from May 9 to October 23. The first conidiophores were seen on the cut surface of the branch-covered stump on May 22. Fig. 1 shows conidiophore growth areas on the cut surface of this stump as a percentage of the decayed area. The same figure also shows the conidiophore growth areas on the wood pieces as a percentage of the total area facing the ground. Conidiophores were found on the cut surface of the stump uninterruptedly up to the middle of July, excepting June 6 when none were found. However, conidiophores, though only a few, were again found on October 15 and 23. From July 22 onwards the stump surface grew conidiophores and conidia of *Trichoderma viride* Pers. They were abundant on the cut surface until the latter half of August. About the middle of October, conidiophores of the *Fusarium* and *Cephalosporium* types, with conidia, were noted on the cut surfaces. They covered a large proportion of the cut surface of the stump. Only one of the cut surfaces not covered by spruce branches showed *F. annosus* conidiophores on June 6 and August 20, and on both occasions they were very few.

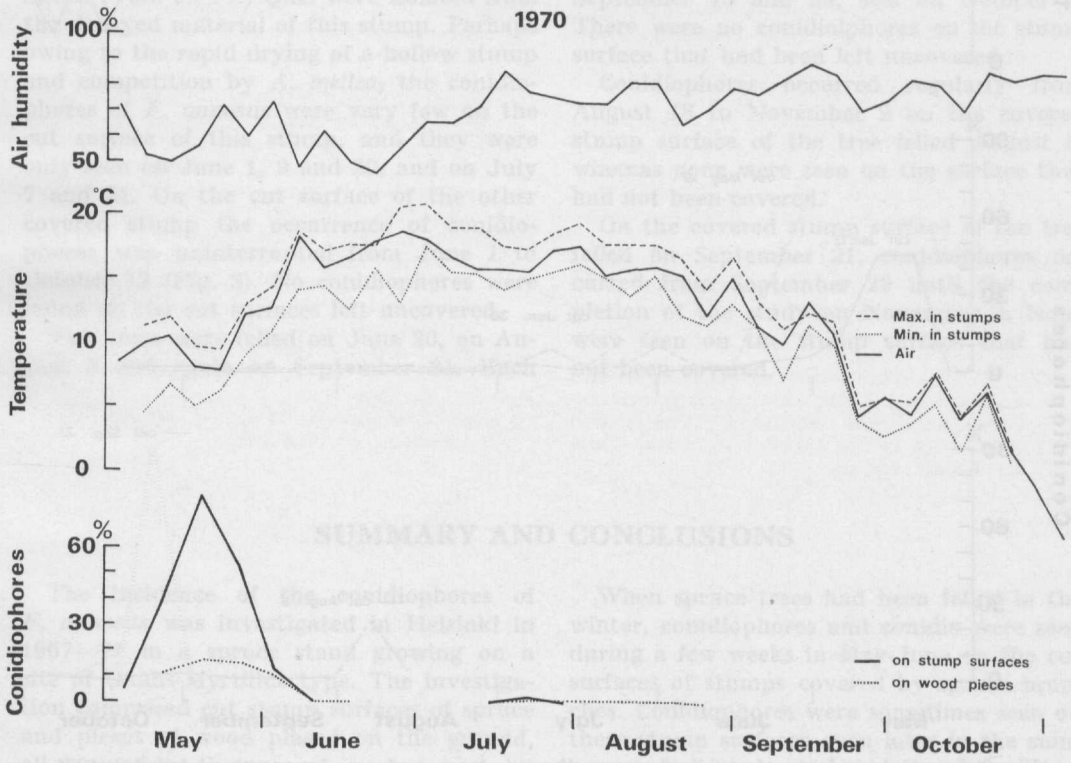

Fig. 2. Incidence of conidiophores on the logging waste of spruce in 1970.

In 1970, 4 cut surfaces of the stumps of spruce trees felled on January 12, decayed by *F. annosus* and covered by spruce branches, and pieces of decayed wood placed on the ground adjacent to the stumps, were studied once weekly from May 5 to October 20. Fig. 2 shows the growth areas of conidiophores on the cut surfaces and on the underside of the wood lying on the ground, calculated as a percentage in the sam way as for Fig. 1. Air temperature and humidity, and also the minimum and maximum temperatures inside the stumps are indicated in the figure. Conidiophores were found on the cut surfaces in the spring, at about the same time as in 1969, i.e. from the beginning of May to mid-June. In the latter half of July conidiophores were again noted on the cut surfaces of stumps. The occurrence of conidiophores on the pieces of wood on the ground began at approxima-

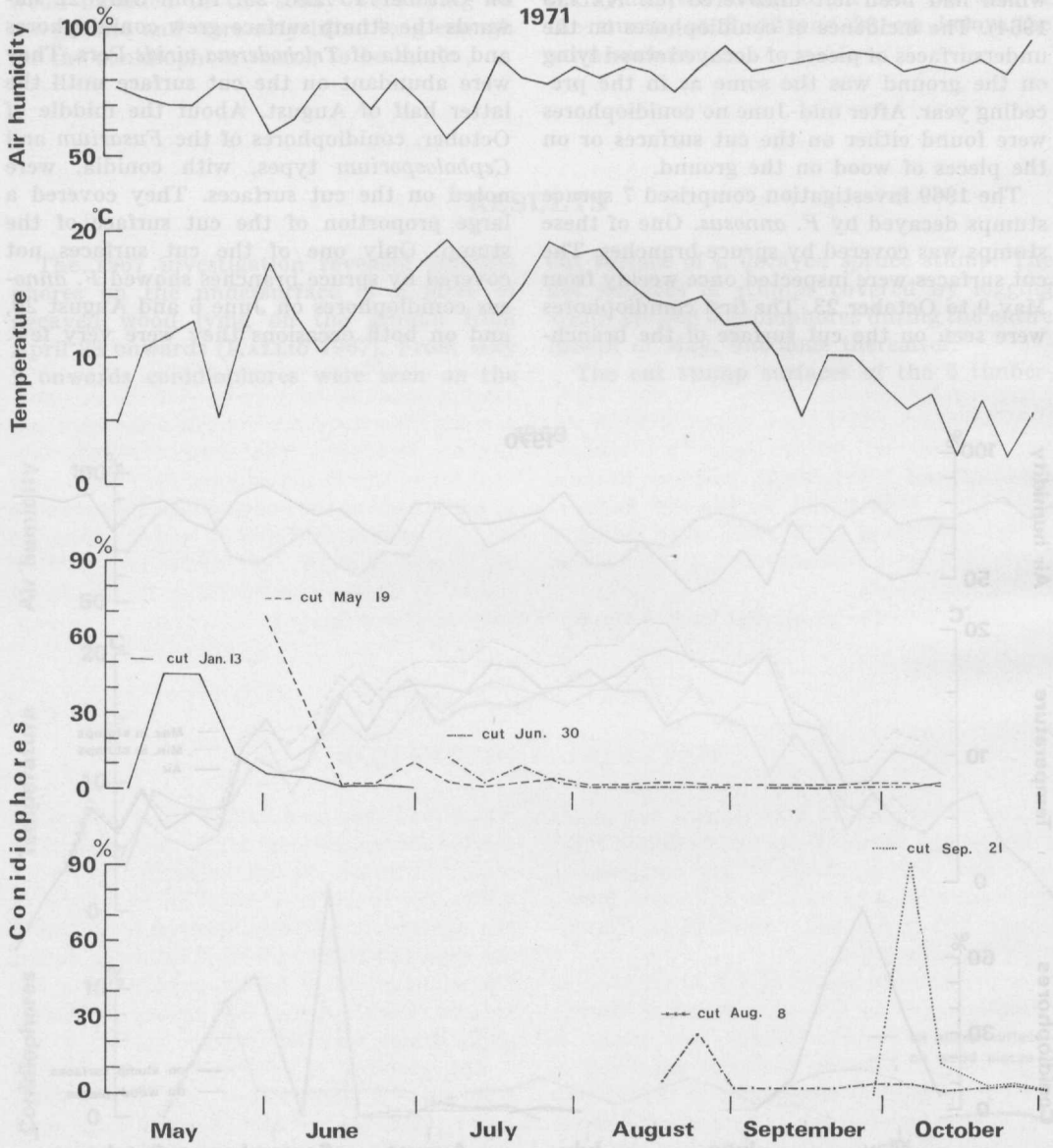

Fig. 3. Seasonal incidence of conidiophores on the cut stump surfaces of spruce trees felled in 1971.

tely the same time as in 1969, but continued until the latter half of August, except for a intermission in late June and early July. The relative air humidity towards the endof July was unusually high and air temperature unusually low for the time of year.

The effect of the time of felling on the occurrence of the conidiophores was studied in 1971. The stumps of 4 spruce trees felled on January 13 and decayed by *F. annosus* were included in this study. The cut surfaces were inspected weekly from April 14 to November 2 for identification of the growth areas of conidiophores. Fig. 3. shows the results of the 1971 study. On the covered surfaces of trees felled in the winter, conidiophores were present from May 12 to June 23, and there were again a very few on October 12. No conidiophores were found on the cut surfaces that had not been covered. On May 19, 4 spruce trees were felled. The stump surfaces of 2 were covered with branches and the other 2 were left uncovered. One of the covered stumps was hollow in the middle as the result of decay (Fig. 4). Subsequently, not only *Fomes annosus*, but also *Armillaria mellea* (Vahl ex Fr.) Quél were isolated from the decayed material of this stump. Perhaps owing to the rapid drying of a hollow stump and competition by *A. mellea*, the conidiophores of *F. annosus* were very few on the cut surface of this stump, and they were only seen on June 1, 9 and 30, and on July 7 and 21. On the cut surface of the other covered stump the occurrence of conidiophores was uninterrupted from June 1 to October 12 (Fig. 3). No conidiophores were found on the cut surfaces left uncovered.

Two trees were felled on June 30, on August 8 and again on September 21. Each time one stump surface was covered with branches and the other was left uncovered.

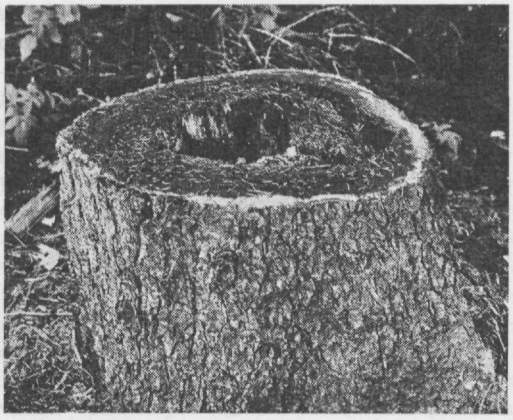

Fig. 4. Hollow spruce stump decayed by *F. annosus* and *A. mellea*. Reduced to about 0.1x natural size.

Conidiophores were seen one week after felling on the covered stump surface of the tree felled on June 30, and the occurrence continued without interruption until August 25. A few conidiophores were again seen on September 15 and 29, and on October 6. There were no conidiolphores on the stump surface that had been left uncovered.

Conidiophores occurred regularly from August 18 to November 2 on the covered stump surface of the tree felled August 8, whereas none were seen on the surface that had not been covered.

On the covered stump surface of the tree felled on September 21, conidiophores occurred from September 29 until the completion of the study on November 2. None were seen on the stump surface that had not been covered.

SUMMARY AND CONCLUSIONS

The incidence of the conidiophores of *F. annosus* was investigated in Helsinki in 1967—71 in a spruce stand growing on a site of Oxalis-Myrtillus type. The investigation comprised cut stump surfaces of spruce and pieces of wood placed on the ground, all decayed by *F. annosus*.

When spruce trees had been felled in the winter, conidiophores and conidia were seen during a few weeks in May-June on the cut surfaces of stumps covered by spruce branches. Conidiophores were sometimes seen on these stump surfaces even later in the summer and autumn, but by that time they

were only very few. Their occurrence on the cut surfaces of stumps that had not been covered was extremely rare, and the conidiophores were always very few in number. Cut surfaces of trees felled the year before showed no conidiophores. Conidiophores were also found on the undersurfaces of the pieces of decayed wood lying on the ground.

When spruce trees decayed by *F. annosus* were felled in the summer and autumn, the cut surfaces of stumps covered with spruce branches showed the first conidiophores one week after the felling. The occurrence continued almost uninterruptedly until the winter.

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FOMES ANNOSUKSEN KUROMANKANNATTIMIEN ESIINTYMINEN KUUSEN HAKKUUTÄHTEISSÄ

SELOSTE

Kuromankannattimien esiintymistä tutkittiin vuosina 1967—1971 Helsingissä n. 100-vuotiaassa maannousemalahoisessa OMT-kuusikossa. Kuromankannattimia etsittiin lumettomana aikana kerran viikossa stereomikroskoopilla kuusen kantojen kaatopinnoilta ja maahan laskettujen lahojen puupalojen maata vasten olleilta pinnoilta. Osa kantojen kaatopinnoista peitettiin kaatamisen jälkeen havuilla, osa jätettiin peittämättä. Oksista kaatopinnoille varisseet neulaset poistettiin tutkimisen ajaksi ja samat neulaset palautettiin tutkimisen jälkeen kaatopinnoille.

Talvella kaadettujen tukkipuun kokoisten maannousemasienen lahottamien kuusien peitetyillä kaatopinnoilla esiintyi kuromankannattimia muutaman viikon aikana keväällä ja kevätkesällä. Keskikesällä sattuneen tauon jälkeen kuromankannattimia havaittiin usein uudelleen syksyllä, joskin esiintyminen oli tällöin vähäisempää kuin keväällä. Peittämättömillä kaatopinnoilla kuromankannattimia tavattiin vain harvoin ja niukasti. Maahan laskettujen puupalojen maata vasten olleilla pinnoilla kuromankannattimia esiintyi talvikaadon jälkeen pääasiassa keväällä ja kevätkesällä.

Vuonna 1971 kaadettiin lahoja kuusia kuuden viikon välein myös kesällä. Kuromankannattimia alkoi esiintyä peitetyillä kaatopinnoilla viikon kuluttua kaatamisesta ja esiintymistä jatkui usein talven tuloon saakka. Peittämättömillä kaatopinnoilla kuromankannattimia ei tavattu.

Kuromankannattimia ei tavattu ylivuotisilla kaatopinnoilla.

KALLIO, TAUNO O.D.C. 172.8

1971. Incidence of the conidiophores of *Fomes annosus* (Fr.) Cooke on the logging waste of spruce (*Picea abies* (L.) Karst.). – ACTA FORESTALIA FENNICA 9. p. 124.

When decayed spruce timber had been felled in the winter, conidiophores were present for some weeks in the spring and early summer on the cut stump surfaces covered by branches. In the middle of the summer there were no conidiophores, but often they re-appeared in the autumn, although in very small numbers. On uncovered stump surfaces conidiophores were seldom seen, and were always very few. They also grew on the undersurfaces of decayed wood pieces lying on the ground in the forest.

After felling in the summer, conidiophores were usually present until the beginning of the winter. None were found on stump surfaces of spruce trees felled one year earlier.

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