

Some aquatic Hyphomycetes on grasses in Finland

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Abstract. — This paper is part of a larger study of the fungi causing leaf-spot diseases on the grasses in leys in Finland. The material examined consisted of grasses growing on cultivated grassland or in the borders of fields. The fresh material (c. 3770 samples) was collected throughout the country, but chiefly from the Viikki Experiment Farm of Helsinki University, from 1966 to 1970. Conidia produced in natural infestations were examined microscopically. The fungi have not been grown in pure culture.

Conidia of the fungi were found on the growing leaves of grasses during the period between early spring (March) and late autumn (November). They occurred rather commonly but in small numbers; mostly only single spores of fungi were found. The aquatic *Hyphomycetes* live as saprophytic fungi on grasses, and are of negligible importance.

Four species of the aquatic *Hyphomycetes* were identified on 14 grass species. The most common species was *Volucrispora graminea* (Haskins) Ingold, McDougall & Dann. *Tricel-lula aquatica* Webster occurred rather commonly, but in small numbers. *Varicosporium elodeae* Kegel was found on two samples of *Phleum pratense* L. and *Tetracladium maxilliformis* (Rostrup) Ingold on one of *Dactylis glomerata* L.

Introduction

Mycologists have investigated the aquatic *Hyphomycetes* during the last three decades. Material for study has been collected mostly from decaying leaves of trees and shrubs (e.g. *Alnus*, *Quercus*, *Castanea*, *Salix*, *Populus*, *Betula*, *Cornus*, *Rubus*) and other plant debris or from scum and foam from streams, lakes and other waters (INGOLD 1942, 1943, 1944, INGOLD & ELLIS 1952, FENTON 1950, WEBSTER 1959, BAXTER 1960, PETERSON 1962a, NILSSON 1964). Material from terrestrial plants growing in fields (ROSTRUP 1894, INGOLD et al. 1968) and from soil (BESSEY 1939, WAID 1954, NILSSON 1964, DOMSCH & GAMS 1970) has been collected rarely. The demarcation line between the aquatic members and the terrestrial members of *Hyphomycetes* is not distinct (cf. TUBAKI 1957, NILSSON 1964). Many fresh water *Hyphomycetes* e.g. *Tetracladium maxilliformis* and *Varicosporium elodeae* occur in different types of habitats

from terrestrial to semiaquatic in addition to streams and lakes (NILSSON 1964).

The climatic conditions may be of major importance for the survival of some aquatic *Hyphomycetes*, but for the majority of the common species they are not (NILSSON 1964). However, a relatively low temperature optimum is a frequent feature of aquatic *Hyphomycetes* from Britain (INGOLD 1944, THORNTON 1963).

The purpose of the present paper is to report the occurrence of some aquatic *Hyphomycetes* on leaves of grasses. The material examined consisted of grasses growing on cultivated leys or in borders of fields. This paper is part of a larger study of fungi causing leaf spot diseases (cf. MÄKELÄ 1972).

Materials and Methods

Grass samples were collected between spring thaw and the first heavy snow fall in

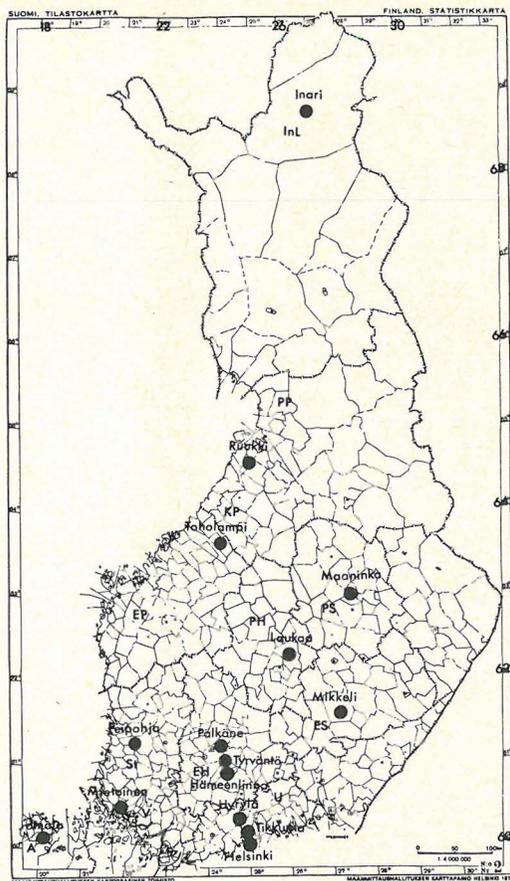


Fig. 1. Origin of the material.

autumn during the years 1966—1970. Approximately 3770 samples in all were collected from leys and field borders at Viikki, the Muddusniemi Experiment Farm of Helsinki University, Experiment Stations of the Agricultural Research Centre, The Plant Breeding Institute of Hankkija in Hyrylä, at Hämeenlinna, and from fields in the vicinity of Helsinki (Fig. 1).

Conidia produced in natural infestations were examined. The slides of the fungus material were prepared from fresh grass leaves and placed on slides in lactic-acid and lactophenol solutions with trypanblue where the conidia were measured and photographed. The fungi were not grown in pure culture.

Results and Discussion

Volucrispora Haskins, *Canad. J. Microbiol.* 4: 278, 1958.

Volucrispora graminea (Haskins) Ingold, McDougall & Dann, *Trans. Brit. Mycol. Soc.* 5: 325—328, 1968. Similar spores were described by de WILDEMAN (1893), INGOLD (1942), WEBSTER (1954) and NILSSON (1962, 1964). WEBSTER's (1954) isolates were from *Dactylis glomerata* and apparently also from *Poa*. As a rule, spores this type have been isolated from fresh water.

In the present study the fungus was found on 360 grass samples involving 12 grass species and from different localities ranging from Helsinki to Lapland (at Inari). Spores of the fungus were found during the period between early spring (28. III. 1968), often immediately after the spring thaw, and late autumn (24. XI. 1967). Conidia were most abundant in the spring months, i.e. from April to May, and also in autumn, whereas midsummer occurrence was infrequent. According to INGOLD et al. (1968) the temperature optimum for growth of this fungus in 2 % malt solution was in the 15—20°C range with no growth at 25°C. Also in INGOLD's studies (1942, 1944) most species of aquatic *Hyphomycetes* reached their best development in autumn and winter.

In the present study conidia of *Volucrispora graminea* were observed in less than 10 % of the 3770 samples examined. The fungus was found most at Viikki (Helsinki).

The hyaline conidia (about 570 examined) consist of a slightly curved main axis averaging (18) 32 (60) μ long, (1.5) 2.7 (4.4) μ wide, (2) 2 (7) -septa, and a smaller single lateral branch 0—1-septa. Sometimes the branch fails to form (Fig. 2 A, C, G, L, Q) (cf. INGOLD et al. 1968). The distance between the tips of the two branches in the conidium was (12) 20 (39) μ . In the present study the spores were larger than those described by INGOLD et al. (1968) in which the main axis was 1—3-septate, 25—40 μ long, and 1.5—2 μ broad, and lateral branches 10—20 μ long and 1.5 μ broad, 0—1-septate. On the other hand the form of conidia was similar in both studies (Figs. 2, 3) (cf. also HASKINS 1958).

The form and size of the conidia from different localities, grasses and times of collection showed little variation (Figs. 2, 3).

Material examined

On *Agropyron repens* (L.) PB.:

U: Helsinki, Viikki (2 specimens); ES: Mikkeli (1 specimen).



Fig. 2. Conidia of *Volucrispora graminea* A-Q, *Tricellula aquatica* R-X, *Varicosporium elodeae* Y and *Tetracladium maxilliformis* Z. A: on *Agropyron repens*; B: on *Agrostis tenuis*; C, D, W: on *Alopecurus pratensis*; E-I, R-U: on *Festuca pratensis*; J, X: on *Lolium perenne*; K-O, Y: on *Phleum pratense*; P, Q: on *Poa pratensis*; Z: on *Dactylis glomerata*. A: 24. XI. 1967; B: 3. XI. 1967, Hämeenlinna; C: 7. V. 1969; D: 23. XI. 1966; E: 28. III. 1968; F: 13. VI. 1968, Mikkeli; G: 17. VII. 1967; H: 23. X. 1967; I, J: 24. XI. 1967; K: 28. III. 1968; L: 12. VI. 1969, Tikkurila; M: 10. VII. 1967; N: 24. XI. 1967; O: 24. IX. 1966; P: 17. VII. 1967; Q: 24. XI. 1967; R: 30. IX. 1966; S: 23. X. 1967; T: 14. X. 1968, Mikkeli; U: 5. VI. 1969, Mietoinen; V: 12. VI. 1969, Tikkurila; W: 29. V. 1970; X: 15. X. 1968; Y: 30. IX. 1966; Z: 27. IX. 1966; nothing but the date = Helsinki, Viikki.

On *Agrostis stolonifera* L.:

U: Helsinki, Viikki (5 specimens); InL: Inari (1 specimen).

On *Agrostis tenuis* Sibth.:

U: Helsinki, Viikki (12 specimens); EH: Hämeenlinna (5 specimens); InL: Inari (1 specimen).

On *Alopecurus pratensis* L.:

U: Helsinki, Viikki (24 specimens); ES: Mikkeli (1 specimen).

On *Bromus inermis* Leyss.:

U: Helsinki (3 specimens); Hyrylä (2 specimens); KP: Toholampi (1 specimen).

On *Dactylis glomerata* L.:

A: Jomala (2 specimens); U: Helsinki, Viikki (38 specimens), Hyrylä (1 specimen); EH: Hämeenlinna (6 specimens); ES: Mikkeli (6 specimens); KP: Toholampi (1 specimen).

On *Deschampsia caespitosa* (L.) PB:

InL: Inari (2 specimens).

On *Festuca pratensis* Huds.:

A: Jomala (2 specimens); U: Helsinki, Viikki (84 specimens), Tikkurila (2 specimens), Hyrylä (1 specimen); V: Mietoinen (3 specimens); EH: Hämeenlinna (2 specimens), Pälkäne (1 specimen); St: Peipohja (8 specimens); ES: Mikkeli (8 specimens); PH: Laukaa (1 specimen); KP: Toholampi (1 specimen); PP: Ruukki (1 specimen); InL: Inari (2 specimens).

On *Festuca rubra* L.:

U: Helsinki, Viikki (16 specimens), Hyrylä (2 specimens); EH: Hämeenlinna (1 specimen).

On *Lolium perenne* L.:

U: Helsinki, Viikki (19 specimens), Hyrylä (1 specimen); St: Peipohja (2 specimens); ES: Mikkeli (1 specimen); InL: Inari (3 specimens).

On *Phleum pratense* L.:

U: Helsinki, Viikki (45 specimens), Tikkurila (1 specimen), EH: Hämeenlinna (3 specimens); St: Peipohja (1 specimen); ES: Mikkeli (1 specimen); KP: Toholampi (2 specimens); PP: Ruukki (2 specimens); InL: Inari (5 specimens).

On *Poa pratensis* L.:

U: Helsinki, Viikki (19 specimens), Hyrylä (1 specimen); EH: Hämeenlinna (2 specimens); InL: Inari (2 specimens); in 1966—70; (HPP).

Tricellula aquatica Webster, Trans. Brit. Mycol. Soc. 42: 416—420, 1959.

This fungus has been found on decaying leaves of *Alnus glutinosa* Geartn., *Castanea sativa* Mill. and *Hedera helix* L., and in water in Britain (WEBSTER 1959). Also a few have been found in scum and foam samples from a few well-investigated waters in Småland and Upland in Sweden (NILSSON 1964) as well as in soil in Kiel (Germany) and in the Netherlands (DOMSCH & GAMS 1970).

In the present study the fungus was found on grass samples from localities ranging from Helsinki to Lapland (at Inari). As with *Volucrispora graminea* mentioned above spores of the fungus were found during the snow free season. Conidia of *Tricellula aquatica* were found on 13 grass species and in a total of 90 samples. Spores of the fungus were found in abundance in 2 % of the 3770 samples examined and also in small numbers.

The hyaline, three-celled conidia consists of a basal cell which bears at its tip two other cells (Fig. 3 E). The size of the total conidia (about 180 examined) averaged (9) 12.6 (15) μ long and (5) 7.5 (12) μ wide. The basal cell was (1.8) 2.3 (3.0) μ wide. The size of conidia was the same as in WEBSTER's (1959) material. The size and form of conidia showed little variation between samples collected from different localities, grasses and at different times (Fig. 2 R—X). The form of spores was similar to that described by WEBSTER (1959), PETERSEN (1962b) and DOMSCH and GAMS (1970).

Material examined

On *Agropyron repens* (L.) PB:

U: Helsinki, Viikki (1 specimen); EH: Hämeenlinna (1 specimen).

On *Agrostis stolonifera* L.:

U: Helsinki, Viikki (1 specimen).

On *Agrostis tenuis* Sibth.:

U: Hyrylä (2 specimens).

On *Arrhenatherum elatius* (L.) M. & K.:

U: Hyrylä (1 specimen).

On *Alopecurus pratensis* L.:

U: Hyrylä (2 specimens).

On *Bromus inermis* Leyss.:

U: Hyrylä (1 specimen).

On *Dactylis glomerata* L.:

U: Helsinki, Viikki (8 specimens), Tikkurila (1 specimen); ES: Mikkeli (2 specimens); PS: Maaninka (1 specimen); KP: Toholampi (2 specimens).

On *Festuca pratensis* Huds.:

U: Helsinki, Viikki (26 specimens), Tikkurila (3 specimens), Hyrylä (1 specimen); V: Mietoinen (1 specimen); EH: Pälkäne (1 specimen); St: Peipohja (2 specimens); ES: Mikkeli (7 specimens); KP: Toholampi (2 specimens).

On *Festuca rubra* L.:

U: Helsinki, Viikki (1 specimen); InL: Inari (1 specimen).

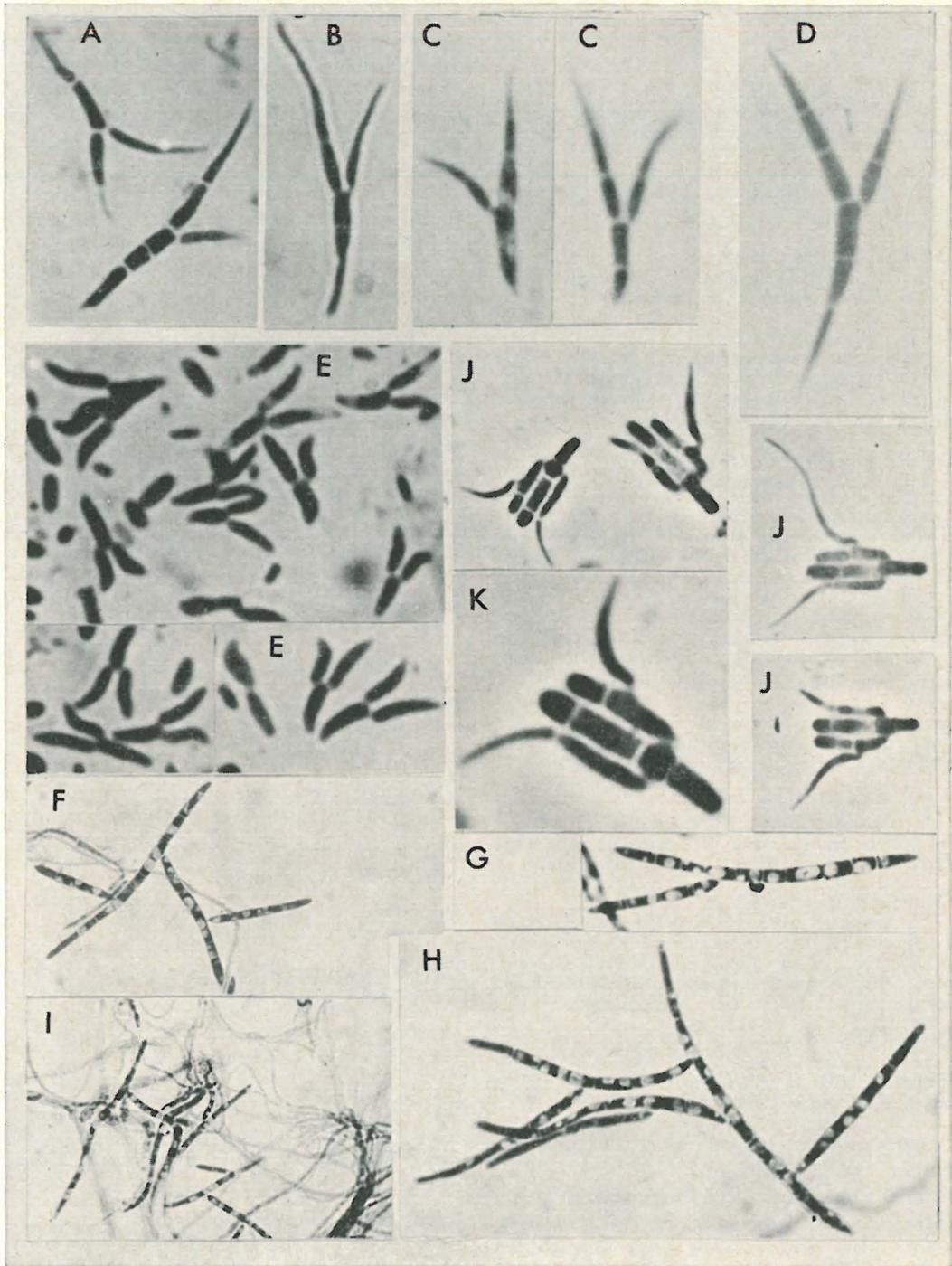


Fig. 3 Conidia of *Volucrispora graminea*, A-D; *Tricellula aquatica*, E; *Varicosporium elodeae*, F-I; and *Tetracladium maxilliformis* J, K. A, E: on *Festuca pratensis*, Mikkeli; A: 21. V. 1968, E: 14. X. 1968; B, C, J, K: on *Dactylis glomerata*; B: Hyrylä 29. V. 1970, C: Hämeenlinna 15. IV. 1968; D: on *Lolium perenne*, Helsinki 28. III. 1968; F-I: on *Phleum pratense*, Helsinki 30. IX. 1966; J, K: Helsinki 27. IX. 1966. A-E, J: x 1000, F: x 500, G, H: x 600, I: x 300, K: x 2000.

On *Lolium perenne* L.:

U: Helsinki, Viikki (5 specimens); St: Peipohja (2 specimens).

On *Phleum pratense* L.:

U: Helsinki, Viikki (6 specimens), Tikkurila (1 specimen), Hyrylä (1 specimen); St: Peipohja (2 specimens).

On *Poa annua* L.:

EH: Jaala (1 specimen); InL: Inari (1 specimen).

On *Poa pratensis* L.:

U: Helsinki, Viikki (4 specimens); in 1966—70; (HPP).

Varicosporium elodeae Kegel, Ber. deutsch Bot. Ges. 24: 213—216, 1906; Ingold (1942: 394—398).

The fungus has been recorded as occurring on dead *Elodea canadensis* Rich. et Michx. in Germany (KEGEL 1906), on decaying older leaves in Britain (INGOLD 1942), on decaying leaves of *Alnus glutinosa* and *Quercus* sp. in Ireland (FENTON 1950), on submerged tissue of *Drosera rotundifolia* L. and on leaves of *Nuphar ozeensis* and on *Alnus* sp. in Japan (TUBAKI 1957), as well as in scum and foam samples and on submerged leaves in streams in many localities from Skåne to Lapland in Sweden (NILSSON 1964). BESSEY (1939) isolated the fungus from soil in Canada, and WAID (1954) found it on roots of beech. According to TUBAKI (1957) *Varicosporium elodeae* is a species intermediate between aquatic and semi-aquatic. NILSSON (1964) is also of this opinion.

In the present study the fungus was found only at Viikki (Helsinki) on leaves of *Phleum pratense* L. and only in 2 samples. Conidia of the fungus (Figs. 2 Y, 3 F—I), were typically branched (cf. LINDAU 1910: 760, INGOLD 1942, TUBAKI 1957). The hyaline conidia (about 60 examined) consist of a main axis (36) 60 (114) μ long, (2) 3 (4) μ wide and one to four (average 1.7) laterals (11) 40 (66) μ long, (2) 2.8 (4) μ wide. The size is close to those described by INGOLD (1942). The fungus also had hyaline mycelia (Fig. 3 I).

Material examined

On *Phleum pratense* L.:

U: Helsinki, Viikki 30. IX. 1966, 17. V. 1968.

Tetracladium maxilliformis (Rostrup) Ingold, Trans. Brit. Mycol. Soc. 25: 371—372, 1942; Syn. *Titea maxilliformis* Rostrup Bot. Tidsskr. 19: 46—47, 1894.

The fungus has been recorded as occurring on stalks of *Trifolium pratense* L. already attacked by *Typhula trifolii* Rostrup in Denmark (ROSTRUP 1894), on decaying older leaves (INGOLD 1942), in the scum on the surface of a fresh-water ditch in England (INGOLD & ELLIS 1952), and in scum and foam samples from streams in Sweden, where it is a very rare species (NILSSON 1964).

In the present study the fungus was found at Viikki (Helsinki) on one sample of leaves of *Dactylis glomerata*. The leaves were gathered from the ley on Sept. 27. 1966, kept in petri dishes on water-soluble agar in the refrigerator at +5° — +10°C to Jan. 12. 1967, then prepared on slides and examined microscopically. A fairly large number of spores were observed. According to THORNTON (1965) the optimal temperature for growth of this fungus is +10°C. Conidia had the typical form (Figs 2 Z, 3 J, K) which resembled closely those described by ROSTRUP (1894: 47) and INGOLD and ELLIS (1952: 160).

The size of the conidia (about 30 examined) (cf. Fig. 2 ZZ) a: (12) 15.6 (18) μ long, (2) 2.1 (3) μ wide, b: (6) 10.1 (14) μ long, (1) 2.0 (2) μ wide, c: (10) 13.0 (20) μ long, (1) 1.4 (2) μ wide, d: (4) 8.0 (18) μ long, 1 μ wide. These dimensions are close to those found by ROSTRUP (1894: 47, LINDAU 1907: 545).

Material examined

On *Dactylis glomerata* L.:

U: Helsinki, Viikki 27. IX. 1966.

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