Some graminicolous species of Helminthosporium in Finland

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Abstract. — This paper is part of a larger study of the fungi causing leaf-spot diseases which affect the grasses on leys in Finland. The material examined consisted of grasses growing on cultivated grassland or the borders of fields. The fresh material (c. 3770 samples) was collected at Viik and the Muddusniemi Experiment Farm of Helsinki University, at Experiment Stations of the Agricultural Research Centre, the Plant Breeding Institute of Hankkija and in other localities in sounthern Finland. In addition seeds of grasses (c. 160 lots) chiefly from the State Seed Testing Station (SSTS) and from the material (c. 40 lots) of the late Prof. Otto Valle's experiments were investigated. The last mentioned lots of the Finnish seeds (Tammisto) were produced in the USA. This study is moreover based on artificial culture and inoculation tests.

The genus *Helminthosporium* Link has been found to be well-represented in Finland on various grasses. Descriptions of disease symptoms, morphological chracters and general significance are given for the following species. *Helminthosporium dictyoides* Drechs. f. sp. *dictyoides* Braverman & Graham, *H. dictyoides* Drechs. f. sp. *perenne* Braverman & Graham, *H. phlei* (Graham) Scharif, *H. siccans* Drechs., *H. vagans* Drechs., *H. tritici-repentis* (Died.) Diedicke, *H. sativum* Pammel, King & Bakke, *H. biforme* Mason & Hughes, *H. triseptatum* Drechs., as well as *Drechslera dactylidis* Shoemaker.

The most important and widespread species are *H. phlei* on *Phleum pratense* L., *H. dictyoides* f. sp. *dictyoides on Festuca pratensis* Huds., *H. dictyoides* f. sp. *perenne* and *H. siccans* on *Lolium multiflorum* Lam. and *L. perenne* L. as well as *H. vapans* on *Poa* pratensis L. *H. tritici-repentis* is at least locally common on *Agropyron repens* (L.) PB., whereas *H. sativum, H. biforme* and *H. triseptatum* were found only accidentally.

Introduction

Helminthosporium Link is a genus of *Moniliales* (AINSWORTH 1961). More than 100 species live on graminaceous hosts, particularly the parasitic forms (DRECHSLER 1923, LUTTRELL 1954, 1964). According to HUGHES (1959) the graminicolous species of *Helminthosporium* form conidia only at the conidiophore apex and produce a new apex by subterminal growth. NISIKADO (1928) divided these *Helminthosporium* species into two subgenera: *Eu-Helminthosporium,* with fusiform conidia, germinating from the polar cells, and *Cylindro-Helminthosporium,* with cylindrical conidia, germinating from the polar cells as well as the intermediate cells. ITO (1930) classified these subgenera as separate genera, the former as *Helminthosporium,* the latter as *Drechslera.* SHOEMAKER (1959) gave the former a new name: *Bipolaris.*

In the present study the older, more common form of undivided genus *Helminthosporium* is used, because the new nomenclature is still not established (cf. LUTTRELL 1964).

The study was based on collections of fresh material, seed tests and inoculation tests on seedlings of different grass species. The

characteristics of the species in artificial culture were also incorporated into the work.

About 44 per cent of the total arable land in Finland is covered by grass (1210 500 hectares). This area consists mostly of temporary leys (Maataloustilastollinen Kuukausikatsaus 1969). In addition, wild grass is common throughout the country (HULTÉN 1950, PAATELA 1953). The red clover-timothy leys are the most common type of leys cultivated in Finland. In 1951, when an extensive study of leys was made, the percentage of clover leys was 30, that of timothy, 46, and that of all other grasses, 13 (PAATELA 1953). According to the survey of leys in 1966—67, the proportion of cultivated grasses had increased, being about 65 % (MUKULA et al. 1967). *Phleum pratense* L. is the most abundant sown grass in Finland, even though the importance of *Festuca pratensis* Huds., *Dactylis glomerata* L., *Lolium-*, *Poa-* and *Agrostis* -species is growing.

In Finland there is little knowledge of the fungi causing leaf-spot diseases on the grasses and on these seeds (cf. BRUMMER 1937, RITVANEN 1958, MÄKELÄ 1970). There is information about the damage, to *Hordeum vulgare* L. caused by *Helminthosporium gramineum* Rabh. (ROUVALA 1967), and to *Avena sativa* L. caused by *H. avenae* Eidam (REKOLA et al. 1970) Information on the *Helminthosporium*-species on grasses is scanty. According to KARSTEN (1884: 39) *H. flexuosum* Corda, syn. *Brachysporium flexuosum* (Corda) Sacc. was found to occur on the leaves of *Aira alpina* L., *Glyceria angustata* Fries, *Poa stricta* Lindeb. and *Luzula hyperborea* R. Br. p.p. In Finnish-produced *Phleum pratense* L. seeds, RITVANEN (1958) observed a *Helminthosporium* which was not precisely identified. The same observation was made in Denmark with a lot of seeds sent from Finland (NEERGAARD 1956). In BRUMMER's (1937) study of timothy diseases, however, *Helminthosporium* did not appear at all.

Materials and methods

Studies on the genus *Helminthosporium* were carried out in 1966—70 at the Plant Pathology Department of Helsinki University, located at Viik, Helsinki. The material examined covered the diseases that attack grasses growing on leys and the borders of fields. Observation and the collection of fungus samples was done during the period between spring thaw and the first real snowfall in autumn. In addition, samples were collected (3770 sampels) at the Muddusniemi Experiment Farm of Helsinki University in Inari, at the Experiment Stations of the Agricultural Research Centre, the Plant Breeding Institute of Hankkija, in Hyrylä, in Hämeenlinna, Iitti, and the neighbouring localities of Helsinki (Fig. 1). Microscopic slides for measuring were prepared from all samples bearing spores of *Helminthosporium*. In this material, 18 samples came from *Agropyron repens*, 1 from *Agrostis stolonifera*, 28 from *Alopecurus pratensis*, 211 from *Dactylis glomerata*, 879 from *Festuca pratensis*, 36 from *F. rubra*, 7 from *Lolium multiflorum*, 93 from *L. perenne*, 572 from *Phleum pratense*, 1 from *Poa annua* and 66 from *Poa pratensis*, the total number of samples being 1911.

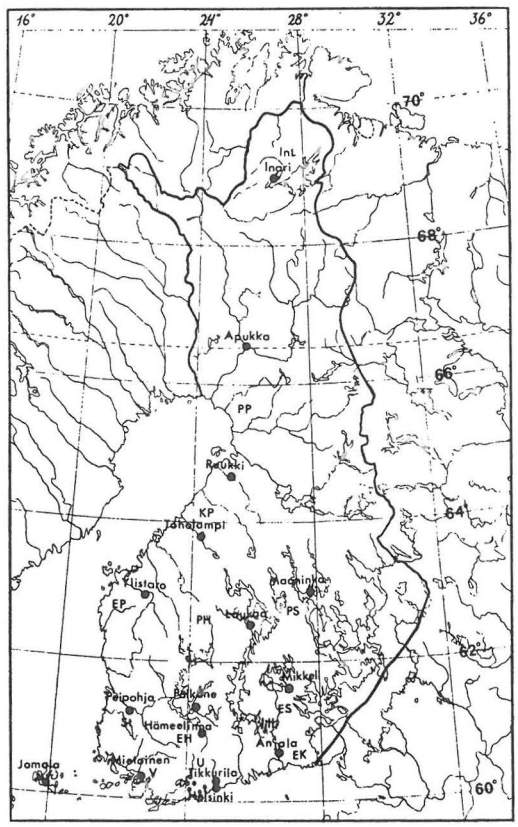

Fig. 1. Origin of the material.

For the present study leys with the following grass species and varieties were established at Viik and at Muddusniemi in 1966—70.

Agrostis tenuis Sibth.	Foreign
Alopecurus pratensis L.	Finnish
Bromus inermis Leyss.	Jokioinen, Jo 266
Dactylis glomerata L.	Tammisto, Esko, Hera
Festuca pratensis Huds.	Tammisto, Paavo, Leto
F. rubra L.	Dasas, Echo, Highlite
Lolium multiflorum Lam.	Leda
L. perenne L.	Valinge, Mito
Phleum pratense L.	Tammisto, Tarmo
Poa pratensis L.	Øtofte, Nike, Dasas

The size of the field plots varied from 5 to 50 m² in different years. The grasses were sown in rows 15 cm apart. Specimens were also collected from Professor Otto Valle's seed production experiments in which the grass species were *Dactylis glomerata, Festuca pratensis,* and *Phleum pratense,* all of them Tammisto varieties.

In addition seeds of grasses (c. 160 lots) chiefly from the State Seed Testing Station (SSTS) and from the material (43 lots) of Professor Otto Valle's experiments were investigated. The last mentioned seed lots, 21 lots came from *Dactylis glomerata,* 13 from *Festuca pratensis* and 9 from *Phleum pratense,* were the Finnish seeds (Tammisto) which were produced in the USA. The seeds were put into lots of 100—400 seeds in the laboratory, and the fungi of seeds were studied by means of both germinating and sprouting experiments. The germinating experiments were carried out in incubator at a temperature of +20—22°C; the seeds were kept on a moist blotting paper and the development of the fungi was observed through a stereomicroscope for periods of 7, 14, 21 and 28 days. The sprouting samples were grown in small plastic pots containing sterilized sand under laboratory conditions (temperature +15 — +25°C, relative humidity c. 60—70 %).

After the completion of the experiment (21—28 days) the pots were kept in a moisture chamber for approximately one week, after which the fungi were examined through a microscope.

Inoculation studies on grasses were carried out under laboratory conditions. The species of grasses examined were the same as in the field trials. In addition to these the following cereals and varieties were used for certain studies.

Avena sativa L.	Sisu
Hordeum vulgare L.	Otra
Secale cereale L.	Ensi
Triticum aestivum L.	Svenno Spring wheat
»	Elo Autumn wheat

The grasses were grown in a greenhouse to a height of about 5—10 cm. The plants were inoculated with a spore suspension prepared in distilled water with conidia produced on potato dextrose-agar (Difco). After inoculation the plants were kept in the phytothron at +22°C and under illumination by day, as well as at +15°C and in the dark by night from 7 to 10 days. Varying and representative materials were used for the size readings and colour descriptions of the disease symptoms. The colour descriptions were based on the classification of KORNERUP and WANSCHER (1967). Conidia produced in natural infectations were chiefly examined. The slide of the fungus material was preserved in lactic-acid, and lactophenol solution (H_2O 20 g, phenol 20 g, lactic-acid 40 g, glycerin 20 g, trypanblau 0.05 g) where the conidia and conidiophores were also metsured and photographed. For each sample from between (5) 10 and 100 conidia were measured. The minimum, average, and maximum measurements were recorded.

Climate and weather

An important factor contributing to the frequent occurrence of fungi in Finland is evidently the Finnish climate with its long, humid spring and autumn as well as its short and cool summer. The length of the thermal spring (0°—10°C) varies from 45 to 65 days, that of the thermal autumn (10°—0°C) from 45 to 85 days. The length of the growing season is from 100 to 180 days. The monthly precipitation during the growing season varies from 35 to 80 mm, and is lower early in the season than in the autumn (KOLKKI 1966).

Year 1966. Precipitation during the growing season in most parts of the country was higher than the average. Temperatures were below the normal.

Year 1967. The weather during the growing season was, as a rule, rainier than normal. Temperatures in May and September were above, in other months of the growing season below, the average. November was exceptionally warm.

Year 1968. During the entire growing season, the weather in central and eastern Finland was rainier than normal, elsewhere it was the same as, or lower, than normal. Temperatures throughout the country were below the mean, only June in southern Finland was warm.

Year 1969. Precipitation during the growing season, particularly in June, July, August and October was considerably lower than the average, especially in southwestern Finland and upper Pohjanmaa. The spring was cool while the whole summer was extraordinarily warm.

Year 1970. Precipitation throughout the country varied considerably in May, was lower than normal in June and August, and higher than normal in July. Temperatures in May were normal, in June much higher than normal throughout the country. In Lapland July and August were also warmer than the average. In Southern and Central Finland temperatures were normal in July, below the normal in August.

Results

Helminthosporium dictyoides Drechsler J. Agric. Res. 24: 679, 1923. Syn. *Drechslera dictyoides* Shoemaker Canad. J. Bot 37: 881, 1959. Braverman and Graham (1960) divided this species into two *formae speciales: H. dictyoides* Drechs. f. sp. *dictyoides.* Sclerotial bodies produced in culture; causing a net-blotch and blotch on leaves of *Festuca elatior* and *F. arundinacea; H. dictyoides* Drechs. f. sp. *perenne.* No sclerotial bodies were produced in culture; blotching was produced on leaves of *Lolium perenne* and *L. multiflorum.*

Helminthosporium dictyoides Drechs. f. sp. *dictyoides* Braverman & Graham.

On *Festuca pratensis*

The fungus frequently attacks *Festuca pratensis* in the USA (Drechsler 1923, Sprague 1950, Graham 1955, Braverman & Graham 1960), in Canada (Shoemaker 1962) in Britain (Dennis & Wakefield 1946), in Germany (Mühle 1953, Frauenstein 1968), in Switzerland and in Denmark (Ammon 1963). In an inoculation test, in which the fungus was isolated from *F. pratensis,* only this grass species was infected according to Graham (1955) and to Ibrahim and Threlfall (1966), while according to Ammon (1963), the disease symptoms appeared on *Bromus inermis, Dactylis glomerata, Festuca pratensis* and *Lolium multiflorum.* In the studies of Fauenstein (1968) 32 *Festuca*-species were inoculated; of these 30 *Festuca*-species were infected; the species affected were *F. pratensis, F. rubra* and *F. ovina,* as well as 6 *Lolium*-species among *L. perenne* and *L. multiflorum.*

In the present study *H. dictyoides* f. sp. *dictyoides* was found on *Festuca pratensis* from different localities ranging from Helsinki to Inari (Fig. 1). 80 % of the material studied (c. 1100 samples) was infected by the fungus. Disease symptoms and viable spores of the fungus were found on the leaves during the period between early spring (28. III. 1968), often immediately after spring thaw, and late autumn (24. XI. 1967). Conidia were most abundant in mid and late summer. The fungus caused brown leaf spots surrounded by a chlorotic zone (Fig. 2 A, F), withering leaf tips and borders (Fig. 2 B, C) (cf. Dickson 1947, Frauenstein 1968), as well as indefinite net-blotch (Fig. 2 D, E) (cf. Drechsler 1923, Shoemaker 1962). The centres of the lesions were sepia — chocolate — coffee brown in colour. The margin was butter yellow to cream coloured; often the margin was lacking. The size of lesions collected from different localities (about 1100) was (0.5) 9.3 (80) mm long, (0.5) 1.8 (4) mm wide. Conidiophores grow singly or in groups, simple, erect and short; the are dark grey to brownish grey in colour (Fig. 4 A, D); in moist conditions conidiophores germinated very rapidly, forming long mycelia. Conidia are nearly colourless at first, later light yellowish grey — light yellowish brown to dark grey. Conidia are widest near the basal septum. The basal cell is short and

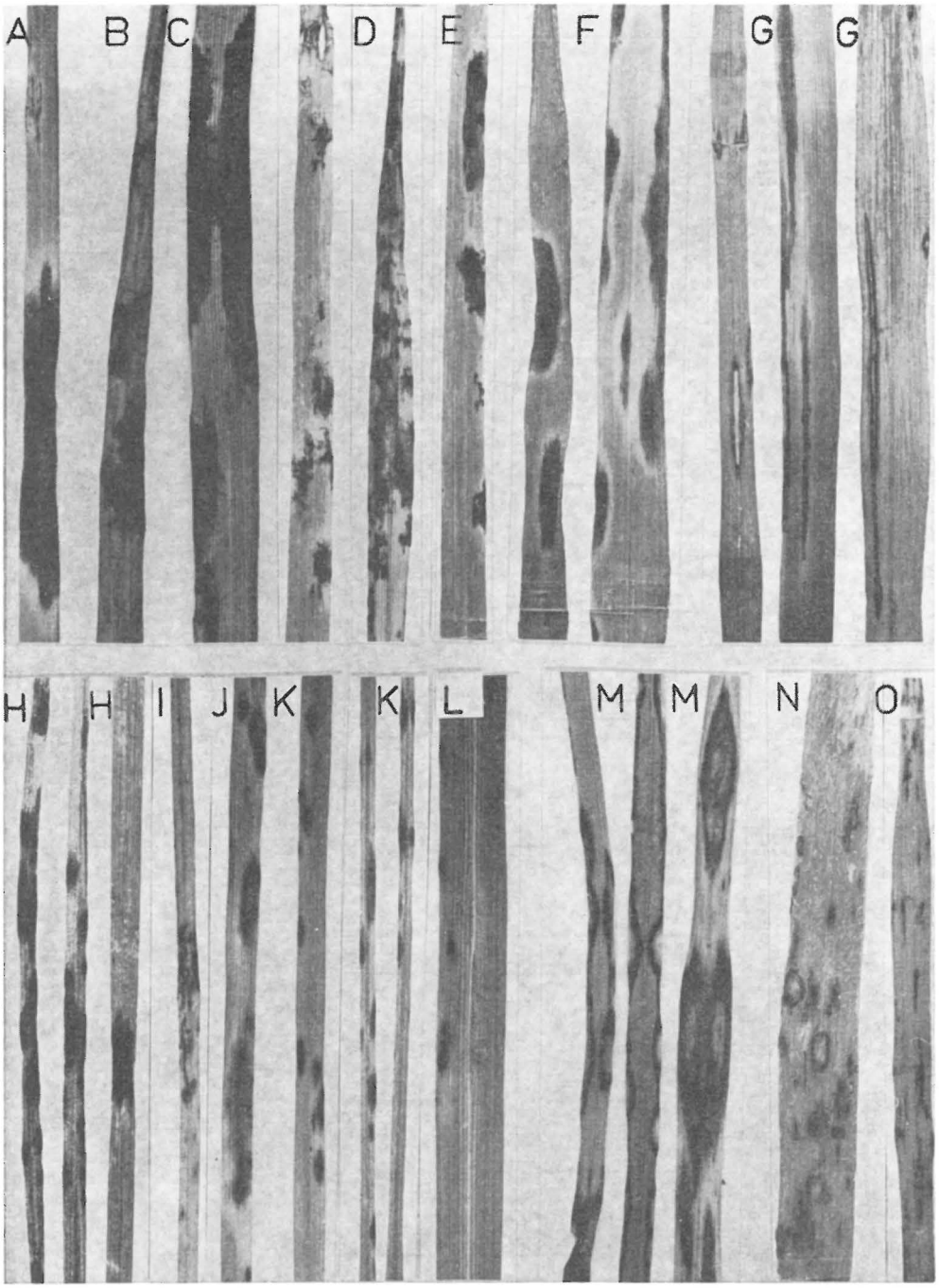

Fig. 2. Lesions on leaves caused by *Helminthosporius* species. A-F, H: *H. dictyoides* f. sp. *dictyoides*, A—F: on *Festuca pratensis*, H: on *F. rubra*; G: *H. phlei* on *Phleum pratense*; I—J: *H. dictyoides* f. sp. *perenne* on *Lolium perenne*; K—L: *H. siccans*, K: on *L. perenne*, L: on *L. multiflorum*; M: H. *vagans* on *Poa pratensis*; N—O: *H. tritici-repentis* on *Agropyron repens*. x 1.

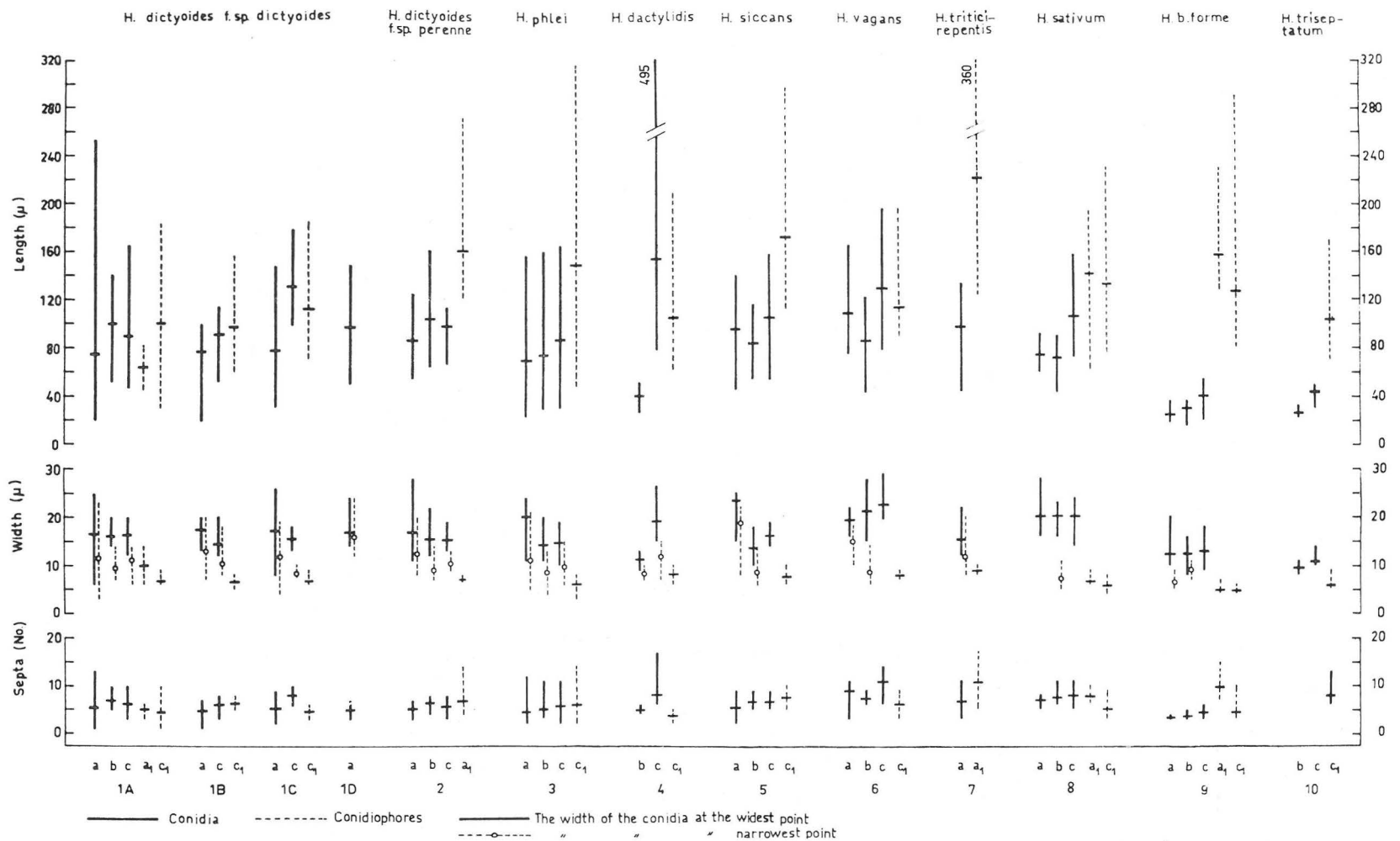

Fig. 3. Size of conidia and conidiophores of the *Helminthosporium* species. a, a1: on leaves from fields, b: on seed, c, c1: on inoculated seedlings. 1A: on *Festuca pratensis*, 1B: on *F. rubra*, 1C: on *Dactylis glomerata*, 1D: on *Alopecurus pratensis*. Vertical lines indicate the range of specimens, horizontal lines are average.

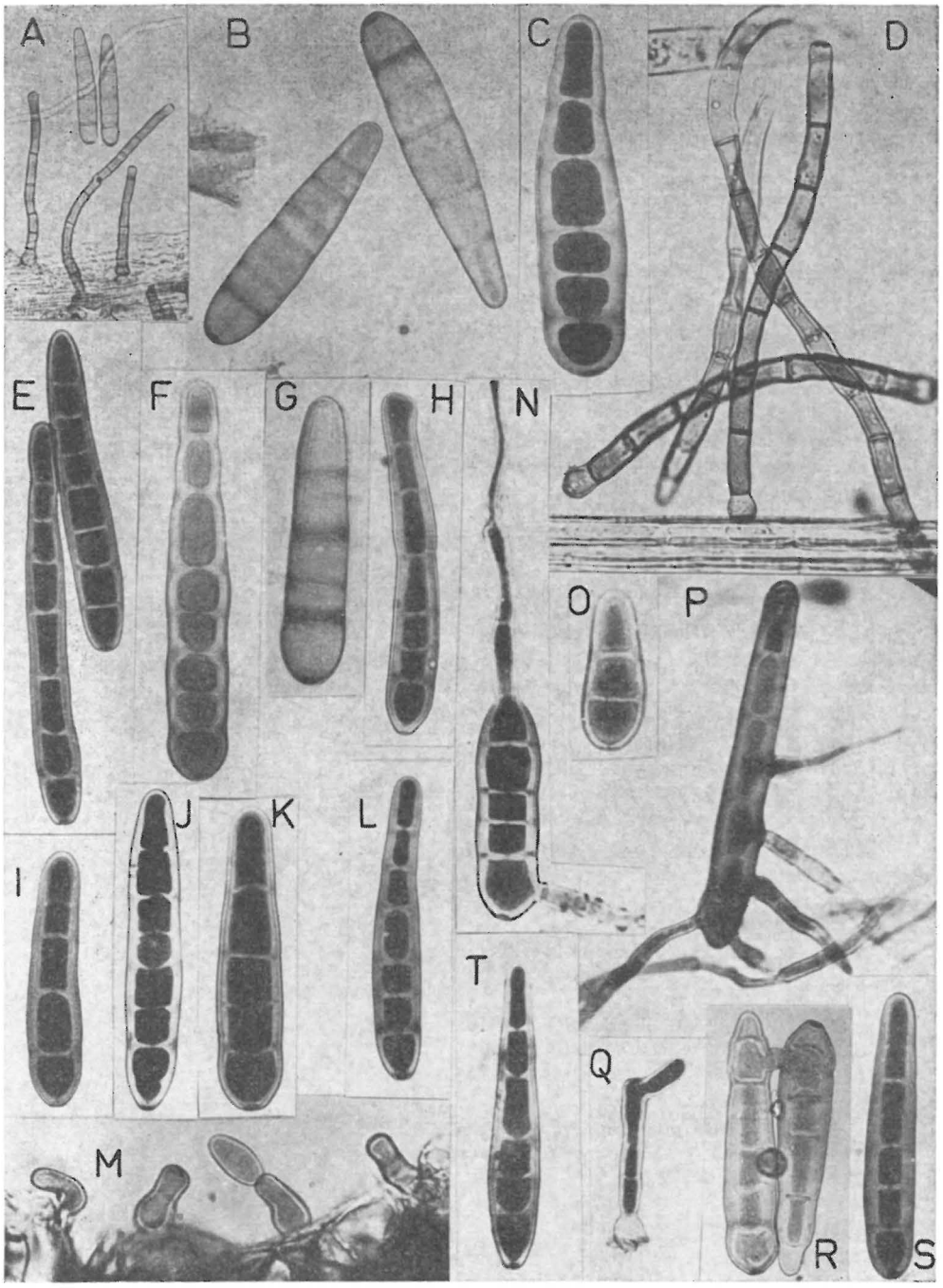

Fig. 4. Conidia and conidiophores of *Helminthosporium dictyoides* f. sp. *dictyoides*. A-P: on *Festuca pratensis*, Q-S: on *F. rubra*, T: on *Dactylis glomerata*. A-B, D-E: on seeds, C, D-T: on leaves from fields. A, D: 'Tammisto' 30625, 191968, Finnish, B: 'Leto' 1967, Commercial seed, C: Helsinki 27. IX. 1967, 'Paavo', E: 'Paavo', Jokioinen, 1967, F-G: Helsinki 27. IX. 1966 (F: 'Paavo', G: 'Leto'), H-I: Jomala 19. VIII. 1969, J: Tikkurila 11. VI. 1969, K: 8. IX. 1969, L: Mikkeli 28. VI. 1868, M: Helsinki 20. VIII. 1969, N: Toholampi 30. VII. 1969, O: Helsinki 20. VIII. 1969, P: 8. VII. 1970 'Tammisto', Q-S: Inari 14. VII. 1969, T: Mikkeli 22. VII. 1969. A × 150, B-T × 400.

Table 1. Results of the inoculation tests in the laboratory with *Helminthosporium*-species in 1970 (at Viik [1])

Host	Variety	*H. dictyoides* f. sp. *dictyoides* from: Seed of *Festuca pratensis* Tammisto 14590, 1969	Seed of *F. pratensis* Paavo 5789, 1969	Seed of *F. pratensis* Leto 22440, 1967	Seed of *F. pratensis* Tammisto [1]) 31. VII., 4. VIII.	Seed of *F. pratensis* Paavo [1]) 22. VII.	Fields of *F. pratensis* Leto [1]) 22. VII.	Fields of *F. rubra* Dasas [1]) 31. VIII.	*H.dict.* f. sp. *perenne* from: Fields of *Dactylis glomerata* Tammisto [1]) 31. VIII., 11. IX.	Fields of *Lolium perenne* Valinge [1]) 22. VII., 4. VIII.	Seed of *Phleum pratense* 6291, 1969, at Viik 1968	Seed of *Phl. pratense* at Viik 1966	*H. phlei* from: Fields of *Phl. pratense* 31. VII., 11. VIII.[1])	Fields of *Phl. pratense* at Viik 1968 [1]) 19. VIII.	Fields of *Phl. pratense* in Peipohja 10. VIII.	Seed of *Phl. nodosum* 31086, 1968
Agrostis tenuis	Foreign	0	0	0	+	0	0	0	0	0	0	0	0	0	+	0
Alopecurus pratensis	Finnish	0	0	0	+	0	0	+	(+)	0	0	0	+	0	+	0
Bromus inermis	Jo 266	+ + +	+	+ +	+	0	0	+	+	0	+ + +	+	+ +	(+)	+	0
Dactylis glomerata	Tammisto	0	0	0	+	0	0	+ +	+	0	0	+ +	+	0	0	0
»	Esko	0	0	+ +	+	0	(+)	+ +	+	0	0	+ +	+ +	+	+	0
»	Hera	0	0	(+)							0	+ +				0
Festuca pratensis	Paavo	+ + +	+ + +	+ + +							0	0				(+)
»	Leto	+ + +	+ + +	+ + +	+ +	+ +	+ +	+ +	+ +	+ + +	0	+	+ +	+	+	+ + +
F. rubra	Echo				+ + +	(+)	0	+ +	+	(+)			+	0	+	
»	Highlite	+	0	+ + +							0	+ +				0
Lolium multiflorum	Leda	+ + +	0	+ + +	+	+	0	+	+	0	+ + +	+ +	+	+	+	+ + +
L. perenne	Valinge	+ + +	0	+ + +	+	(+)	0	+ +	+	+ + +	+ +	+ +	+ +	+ +	+ +	+ + +
»	Mito				+	0	(+)	+	+	+ + +			+ +	+ +	+ +	
Phleum pratense	Tammisto	0	0	0	0	0	0	0	0	0	+ + +	0	+ + +	+ + +	+ +	+ + +
»	Tarmo	0	0	0							+ + +	+ + +				0
Poa pratensis	Dasas				0	0	0	0	0	0			+	+	0	
»	Nike	0	0	0							0	0				0

broad (Fig. 4 C, F, K) (cf. DRECHSLER 1923, SHOEMAKER 1962, FRAUENSTEIN 1968) or narrower and longer (Fig. 4 E, J) (cf. PAUL and BARBERY 1968). The spores tapered uniformly to an apical segment, germinating from all segments, mostly from the end segments (Fig. 4 N, P). The formation and size of the conidia (about 1170) averaged (20) 75.1 (255) µ long, (6) 16.5 (25) µ wide at the widest point, (3) 11.8 (23) µ wide at the narrowest point, (1) 5.3 (13)-septa (Fig. 3, 1 A) showing little variation between the different localities and times of collection. Exceptional types of spores were also found in samples collected during early spring and late autumn. Both on seeds and on leaves from fields broader types of conidia were found side by side with narrower ones (cf. KENNETH 1958). In the present study the size of spores was greater than DRECHSLER's (1923) and AMMON's (1963) material and smaller than reported by SHOEMAKER (1962) and FRAUENSTEIN (1962).

All (100 %) the seed lots of *Festuca pratensis* examined (24 lots, chiefly from the State Seed Testing Station) were infected by the fungus. This corresponds to 34 % (range 3—86 % of all the seeds examined. The fungus grew slowly and sparsely on the seedling and was short-lived; sclerotial bodies developed abundantly on these.

In inoculation tests on various grass species (Table 1) inoculated with conidia of *H. dictyoides* f. sp. *dictyoides* produced on potato dextrose agar (many isolates from seeds and leaves from fields of *Festuca pratensis*), abundant conidia appeared on *F. pratensis*, moderate conidia on *Bromus inermis, Lolium multiflorum* and *L. perenne,* infrequent conidia on *Festuca rubra* as well as accidental conidia on *Alopecurus pratensis* and *Dactylis glomerata.* The results are confirmed by AMMON's (1963) observations in her inoculation tests.

The colony (Fig. 10, A—D) grows rapidly, at first forming a fine black strand. After 2 to 3 weeks a low greyish green — olivaceous mycelium develops on the agar surface. The rate of growth of different isolates varies. The protothecia form abundantly. The fungus is long-lived in culture.

On *Festuca rubra*

This species is known to be a host plant for *H. dictyoides* f. sp. *dictyoides* in Germany (FRAUENSTEIN 1968), *F. rubra* var. *commutata* Gand. (SPRAGUE 1950), and on *F. rubra* (COUCH & GOLF 1957) in the USA.

In this study *H. dictyoides* f. sp. *dictyoides* was found on *Festuca pratensis* from some localities. About 15 % of the material studied (c. 240 samples) was infected by the fungus. At Viik viable spores of the fungus were found on the leaves from early spring (3. IV. 1967) to late autumn (24. XI. 1967). Spores were always found in small quantity. The fungus usually caused scarce mustard — tobacco brown to dark brown leaf spots surrounded by a greyish orange margin (Fig. 2 H). The size of lesions (about 50) was (1) 3.1 (10) mm long, (0.5) 1.0 (2) mm wide. Conidiophores and conidia were similar in shape and colour to those of *F. pratensis* (Fig. 4, Q—S). The size of spores was (40 spores) (19) 77.3 (99) µ long, (13) 17.4 (20) µ wide at the widest point, (7) 13.2 (20) µ wide at the narrowest point, (1) 4.8 (7)-septa (Fig. 3, 1 B).

Of all the seed lots of *Festuca rubra* (16 lots) from the State Seed Testing Station that were examined, about 20 % were infested by the *Helminthosporium (H. biforme* and *H. dictyoides* f. sp. *dictyoides.* This corresponds to only 0.4 % (range 0—4 %) of all the seeds examined. The fungus grew slowly and sparsely on the seedlings.

In inoculation tests (Table 1) in which different grass species were inoculated with conidia of *H. dictyoides* f. sp. *distyoides* produced on potato dextrose agar (an isolate from *Festuca rubra* 'Dasas', 1969 from Denmark), moderate conidia appeared on *Dactylis glomerata, Festuca pratensis, F. rubra* and *Lolium perenne,* as well as infrequent conidia on *Alopecurus pratensis, Bromus inermis* and *L. multiflorum.*

The colony (Fig. 10 E, F) resembled that of the isolates on *Festuca pratensis.*

H. dictyoides f. sp. *dictyoides* were, above all, the fungus of the species *Festuca* (cf. SPRAGUE 1950), especially *F. pratensis.* It was found in nearly all the samples throughout the growing season. *H. dictyoides* f. sp. *dictyoides* was a seed-borne fungus; all the seed lots examined were infected. This somewhat explains its prevalence in nature, although according to PAATELA (1953) its occurrence on leys was only 3 %. It is found uncultivated only in Central Finland and along the coast as far north as Tornio (HULTÉN 1950),

F. rubra commonly grows uncultivated throughout the country (HULTÉN 1950), although, according to PAATELA (1953), its occurrence on leys was under 2 %. The results from this study of the *H dictyoides* species were similar to ANDERSEN's (1955, 1959) results on the *H. catenarium*-species.

On *Dactylis glomerata*

The fungus, which resembles *H. dictyoides* f. sp. *dictyoides,* was found on *Dactylis glomerata* in various localities ranging from Helsinki to Toholampi (Fig. 1). About 20 % of the material studied (c. 1000 samples) was infected by the fungus. Viable conidia occurred on the leaves from the end of May to late autumn (November): in spring, they occurred later on this grass species than on the others. Spores were always found in small quantity. Sparse, irregular necrotic streaks and necrotic areas similar to those of *H. phlei* on *Phleum pratense* (Fig. 2 G) were found on the leaves. The size of lesions (about 60) was (5) 8.1 (17) mm long and (0.5) 1.3 (2) mm wide. *Rhynchosporium orthosporum* Caldwell often occurs abundantly on the leaves of *D. glomerata.* This has made it difficult to confirm the possible precence of other kinds of symptoms.

The formation and size of conidia was (about 130) (31) 77.8 (147) µ long, (8) 17.3 (26) µ wide at the widest point, (4) 11.6 (19) µ wide at the narrowest point, (2) 5.4 (9)-septa (Fig. 3, 1 C, Fig. 4 T) showing little variation between the different localities and times of collection. The size of conidia was on the average like that of *H. dictyoides* f. sp. *dictyoides* on *Festuca pratensis* (Fig. 3, 1 A).

Of all the seed lots of *D. glomerata* examined (about 30 lots), from the State Seed Testing Station), about 15 % were infected by the *Helminthosporium (H. biforme, H. catenarius, H. dactylidis, H. siccans;* but, certainly, no *H. dictyoides* f. sp. *dictyoides).* This corresponds to only 0.2 % (range 0—2 %) of all the seeds examined. Obviously other *Helminthosporium*-species grew on *D. glomerata* in nature.

The colony (Fig. 10, G) resembled that of the isolates on *Festuca rubra.*

This confirms the conception that *D. glomerata* is infected in nature by the *Helminthosporium*-species of other grass-species. The occurrence of *D. glomerata* on leys in Finland was under 2 % according to PAATELA (1953) It is almost nonexistent in the northern parts of they country (cf. HULTÉN 1950, PAATELA 1953).

On *Alopecurus pratensis*

This fungus, which resembles *H. dictyoides* f. sp. *dictyoides,* was found on *Alopecurus pratensis* from certain locality. About 14 % of the material studied (c. 200 samples) was infected by the fungus. Viable conidia occurred on the leaves from early in spring (3. IV. 1967) to late in autumn (24. XI. 1967). Spores were always found in small quantity. The symptoms of diseases on leaves were difficult to distinguish because of the simultaneously occurring spot of *Rhynchosporium* sp. The size of conidia (about 20) was (50) 96.5 (148) µ long, (14) 15.8—17.7 (24) µ wide, (3) 5.0 (7)-septa (Fig. 3, 1 D). The conidia were shaped like those of *H. dictyoides* f. sp. *dictyoides* on other grass species.

No *Helminthosporium*-species were found on the seeds of *A. pratensis.*

In the inoculation tests with sporesuspension of various *Helminthosporium*-species conidia of *H. dictyoides* f. sp. *dictyoides* (from *Festuca pratensis, F. rubra* and *Dactylis glomerata), H. phlei, H. siccans, H. vagans, H. sativum* and *H. triseptatum* on *Alopecurus pratensis* (Tables 1—2).

Alopecurus pratensis is not cultivated; it commonly grows uncultivated only in Southern and Central Finland (HULTÉN 1950). These facts confirm the opinion that in nature *A. pratensis* is infected by the *Helminthosporium*-species of other grass species The few references appearing in the literature (SPRAGUE 1950, SHOEMAKER 1962, FRAUENSTEIN 1968) also support this view.

Material examined
Plants

On *Festuca pratensis:*

A: Jomala (5 specimens); U: Kirkkonummi (2 specimens), Siuntio (1 specimen), Helsinki (643 specimens), Vihti (1 specimen), Tikkurila (58 specimens), Nummela (1 specimen); V: Mietoinen (20 specimens); EH: Hämeenlinna (6 specimens), Pälkäne (9 specimens); St: Peipohja (42 specimens); EK: Anjala (6 specimens); ES: Mikkeli (44 specimens); PS: Maaninka (2 specimens); PH: Laukaa (10 specimens); EP: Ylistaro (9

specimens); KP: Toholampi (13 specimens); PP: Ruukki (3 specimens); InL: Inari (4 specimens); in 1966—70; (HPP).

On *Festuca rubra:*

U: Helsinki (29 specimens), Hyrylä (3 specimens); EH: Hämeenlinna (1 specimen); St: Peipohja (1 specimen); InL: Inari (2 specimens); in 1966—70; (HPP).

On *Dactylis glomerata:*

A: Jomala (2 specimens); U: Espoo (1 specimen), Helsinki (149 specimens), Tikkurila (12 specimens), Hyrylä (1 specimen); V: Mietoinen (6 specimens); EH: Hämeenlinna (5 specimens), Pälkäne (1 specimen), Iitti (2 specimens); St: Peipohja (16 specimens); EK: Anjala (2 specimens); ES: Mikkeli (6 specimens); PS: Maaninka (1 specimen); PH: Laukaa (1 specimen); EP: Ylistaro (2 specimens); KP: Toholampi (4 specimens); in 1966—70; (HPP).

On *Alopecurus pratensis:*

U: Siuntio (1 specimen), Helsinki (23 specimens); EH: Hämeenlinna (1 specimen); St: Peipohja (1 specimen); InL: Inari (2 specimens); in 1966—70; (HPP).

Seeds (Number cited are SSTS)

On *Bromus inermis:*

Jo 266, EH: Jokioinen 1968.

On *Festuca pratensis:*

Tammisto: 1967 (Commercial seed); 21264, 1967; 21266, 1967; 14591, 1969; Paavo: 31340, 1967; EH: Jokioinen 1968; 3728, 1969; 5789, 1969; all seed lots are produced in Finland.

On *Lolium perenne:*

Valinge 14601, 1969, Finnish.

Helminthosporium dictyoides Drechs. f. sp. *perenne* Braverman & Graham

The species has been reported on *Lolium multiflorum* and *L. perenne* in the USA (Braverman & Graham 1960), in Canada (Shoemaker 1962), in New Zealand (Latch 1966), also in Britain the disease has been known to occur on *Lolium perenne* since 1921 (Sampson & Western 1940), and in Italy (Del Vescovo 1962). According to the descriptions of many authors (Sampson & Western 1940, Dennis & Wakefield 1946) this disease of *Lolium*-species is obviously caused by this fungus. In Denmark Andersen (1955) described *H. siccans* Drechs. Monosporous type on *Lolium*-species, later (Andersen 1959) regarded it to be *H. catenarium.* This fungus resembles *H. dictyoides* f. sp. *perenne.* Artificially infected hosts were, according to Del Vescovo (1962), *Lolium perenne* L., *L. italicum* A. Br., *Festuca elatior* var. *pratensis* Hud. and *Phleum pratense* as well as, according to Latch (1966), eg. *F. arundinacea* Schreb., *F. pratensis* Huds., and *F. rubra* L. subsp. *commutata* Gaud.

In this study *H. dictyoides* f. sp. *perenne* was found on leaves of *Lolium perenne.* Of all the material (c. 170 samples) collected from different localities (Helsinki, Hyrylä, Peipohja, Inari) (Fig. 1) about 55 % was infected by the fungus often together with *H. siccans* (cf. p. 18), the latter more commonly. The fungus overwinters with sclerotial bodies on which grow conidiophores and conidia (Fig. 5 H). Disease symptoms and viable conidia of the fungus were found on the leaves during the period between early spring (3. IV. 1967) and late autumn (24. XI. 1967). The fungus caused brown leaf spots surrounded by a chlorotic zone and often leaves withered from the tip downwards (Fig. 2 J). Indefinite net blotch (Fig. 2 I) (cf. Latch 1966) was also caused. The centres of the lesions were sepia — coffee — chocolate brown in colour. The margin was coffee brown. The symptoms of disease on *Lolium perenne* resemble those on *Festuca pratense* caused by *H. dictyoides* f. sp. *dictyoides* (cf. p. 4). Te size of lessions (about 180) was (0.5) 3.2 (22) mm long, (0.5) 1.4 (5) mm wide. Conidiophores grow generally singly, as simple or 1—2 geniculate, resembling a capital L (Fig. 5 A, I) (cf. Del Vescovo 1962); they are dark grey to brownish grey in colour. Conidia are nearly colourless at first, later light yellowish brown — to dark grey. Conidia are widest near the basal septum; they are in some measure more irregular in shape (Fig. 5 C, F, J) (cf. Braverman & Graham 1960) as well as more longlived than those of *H. dictyoides* f. sp. *dictyoides.* The size of conidia (about 100) was, (54) 85.6 (124) µ long, (11) 17.1 (28) µ wide at the widest point, (8) 12.3 (20) µ wide at the narrowest point, (3) 5.3 (7)-septa (Fig. 3, 2) (cf. Latch 1966).

Of all the seed lots of *L. perenne* examined (21 lots), 86 % were infected by *Helminthosporium*-species *(H. dictyoides* f. sp. *dictyoides, H. siccans, H. sativum, H. biforme).*

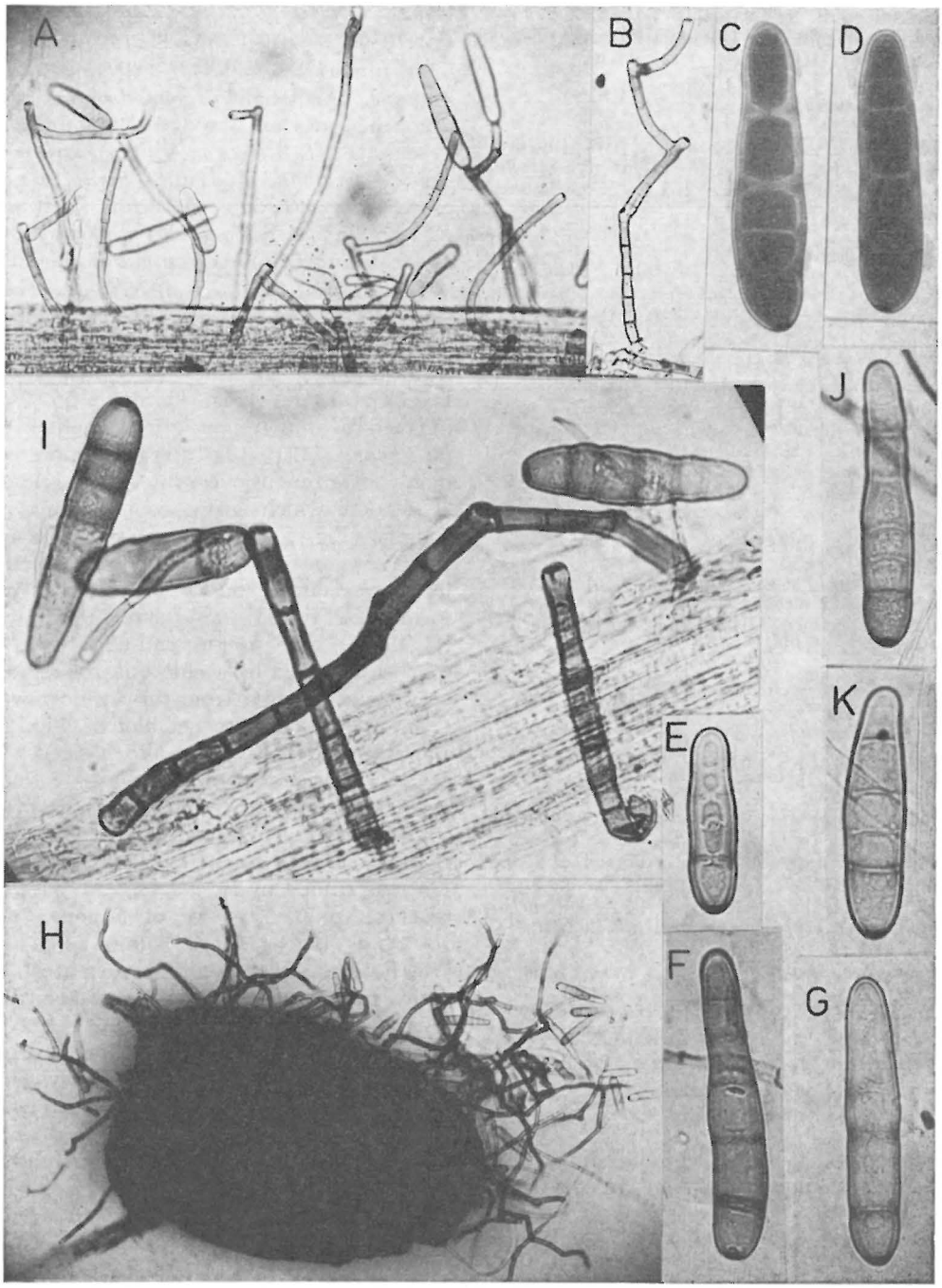

Fig. 5. Conidia and conidiophores of *Helminthosporium dictyoides* f. sp. *perenne* on *Lolium perenne*. A-G: on leaves from fields, I-K: on seeds. A-B: Helsinki 13. VII. 1970, C-D: 24. XI. 1967, E-G: Inari 24. VI. 1970, H: Helsinki 11. VI. 1970, sclerotium, I: 'Valinge', Viik, 1969, J-K: 'Verna' 31352, 1968 from Poland. A-B × 150, C-G, I-K × 400, H × 75.

This corresponds to 16 % (range 0—72 %) of all the seeds examined. The most common species was *H. dictyoides* f. sp. *perenne*.

In inoculation tests (Table 1) in which different grass species were inoculated with a fungus grown on potato-dextrose agar (two isolates from fields on *L. perenne*, Valinge at Viik), abundant conidia appeared on *L. perenne* and *Festuca pratensis* and infrequent conidia on *F. rubra*. This result is confirmed by BRAVERMAN's and GRAHAMS's (1960), IBRAHIM's and THRELFALL's (1966) and LATCH's (1966) studies. It differ from the research of Del VESCOVO (1962).

H. dictyoides f. sp. *perenne* were generally found as a seed-borne fungus on the seedlings of *Lolium perenne*. This partially explains the abundance of this fungus in natural samples, although the cultivation of the *Lolium*-species in Finland is insignificant (PAATELA 1953) and their native occurrence is only accidental (HULTÉN 1950).

The colony (Fig. 10, J—L) grows rapidly, forming fine, extremely long, sparsely branched, brown strands that run deep into the agar and resemble those of *H. dictyoides* f. sp. *perenne* described by SHOEMAKER (1962). Other colonies grow abundant lighter greyish green — olivaceous mycelium resembling those of *H. dictyoides f. sp. dictyoides* (cf. LATCH 1966). The fungus is long-lived in culture. The protothecia form moderately. This result differs from that of SHOEMAKER (1962).

Material examined
Plants

On *Lolium perenne:*

U: Helsinki (83 specimens; together *H. siccans);* Hyrylä (2 specimens); St: Peipohja (7 specimens, together *H. siccans*); InL: Inari (1 specimen).

Seeds (Numbers cited are SSTS)

On *Lolium multiflorum:*

Leda: 1967 (Commercial seed).

On *Lolium perenne:*

Valinge: U: Helsinki, Viik, 1968; 30766, 1968, Finnish; Mito: 31662, 1968; 32464, 1968; from Denmark; Verna: Pajbjerg 31352, 1968 from Poland; 5929, 1969 from Denmark.

Helminthosporium phlei (Graham) Scharif Trans. Brit. Mycol. Soc. 44: 217, 1961. Syn. *H. dictyoides* Drechsler var. *phlei* Graham Phytopathol. 45: 228, 1955; *Drechslera phlei* Shoemaker Canad. J. Bot. 37: 881, 1959. The species has been reported on *Phleum pratense* e.g. in the USA (GRAHAM 1955, BRAVERMAN & GRAHAM 1960, ELLIOTT 1962), in Canada (SHOEMAKER 1962), in England and in Scotland (SCHARIF 1961), in Switzerland (AMMON 1963), as well as on the seeds of timothy in Denmark and in Finland (SCHARIF 1961). Single collections were noted on *Agrostis alba* and *Dactylis glomerata* in Canada (SOEMAKER 1962). According to SCHAFTER (1961) *Festuca rubra* was slightly susceptible in the inoculation tests, as was *Phleum pratense*. Also *Festuca elatior* subsp. *arundinacea, Lolium multiflorum* and *L. perenne produced* a few fructifications in a moist chamber. AMMON (1963) found symptoms of disease on *Bromus inermis, Dactylis glomerata, Festuca pratensis, Lolium multiflorum* and *Poa pratensis.*

In the present study *H. phlei* was found on *Phleum pratense* from different localities ranging from Helsinki to Inari (Fig. 1). 73 % of the material studied (c. 780 samples) was infected by the fungus. The living spores of the fungus were found on the leaves during the period between early spring (3. IV. 1967) and late autumn (24. XI. 1967). Spores were most abundant in mid and late summer. The fungus produced on the leaves sparse, irregular, necrotic streaks and necrotic areas which may extend the length of the blade, or the tip of blade, up to 2/3 of blade dead (Fig. 2 G) (cf GRAHAM 1955, SCHARIF 1961). The centres of the streaks varied from light caramel brown — camel brown — flesh coloured, the margins from dark violet brown — chocolate brown to light maize yellow; often the margin was lacking. The streaks may be torn longitudinally. The size of the lesions (about 80) was (1.0) 16.2 (100) mm long, (1.0) 1.2 (8) mm wide. Small elongated purple eye spots described by SCHARIF (1961) were also found, but they were caused by *Mastigosporium rubricosum* (Dearn & Barth.) Nannf. (MÄKELÄ 1970).

Conidiophores usually grow as simple, single, cylindrical and unbranched or sparsely branched; they are long and slightly bent. They are light grey to light brownish grey, to dark grey in colour (Fig. 6 A). In the field conidiophores are shorter and wider than those produced in a moist chamber.

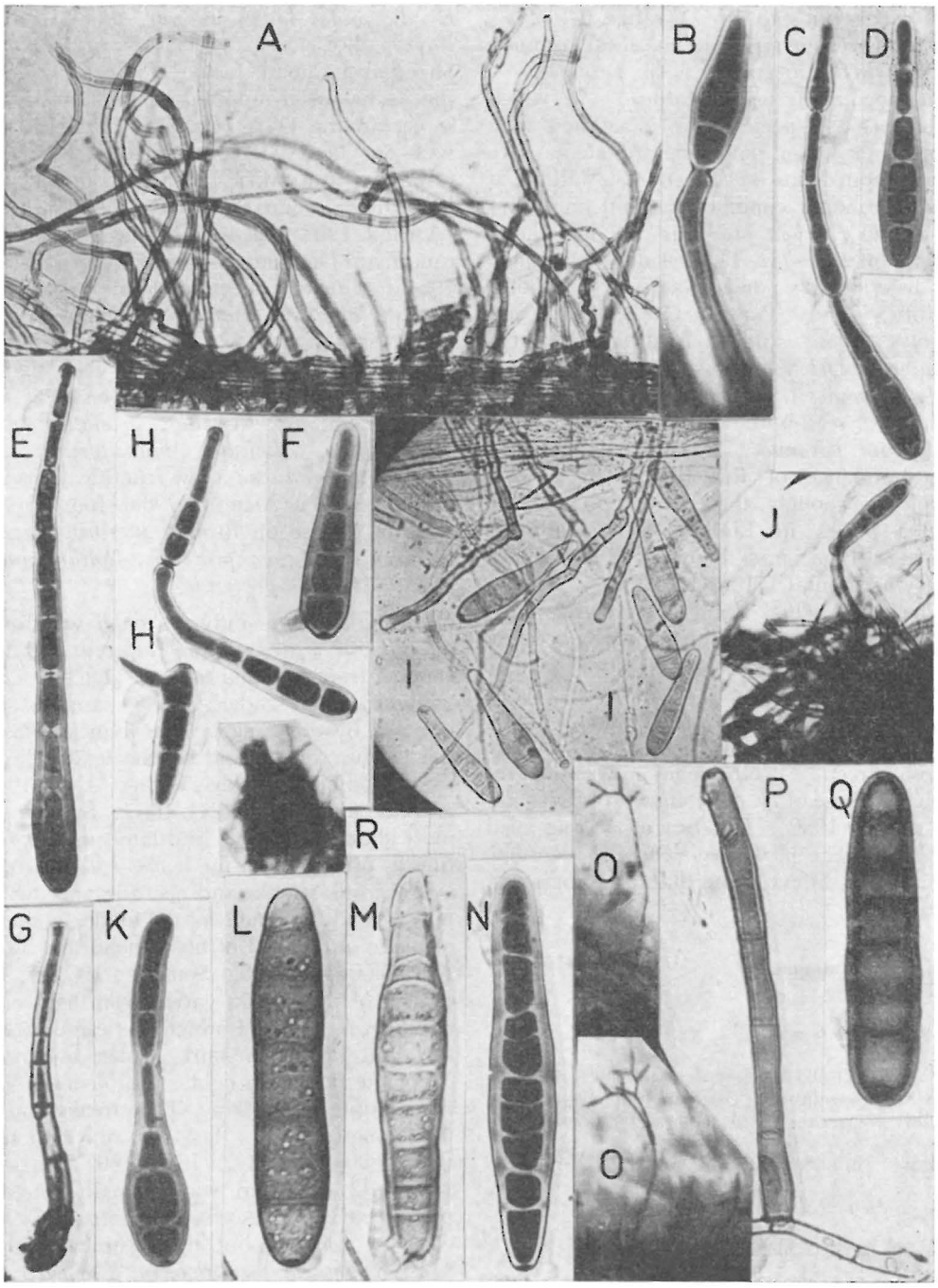

Fig. 6. Conidia and conidiophores of *Helminthosporium phlei*, A-K: on *Phleum pratense*, those of *H. vagans*, L-R: on *Poa pratensis*. A-G, L-N: on leaves from fields, H-K, P: on seeds, Q-R: on Potato dextrose agar. A, D: Hyrylä 29. V. 1970, B: Helsinki 10. VI. 1968, C: 2. VII. 1970, E: 8. VII. 1970, F: Hämeenlinna 11. V. 1968, G: Anjala 18. VII. 1968, H: 'Tammisto' 1969, Finnish, I: 27376, 1967, Pori, J: 31797, 1968, Finnish, sclerotium, K: 'Tammisto' 32076, 1968, Finnish, L-M: 'Nike', 1968, Commercial seed, N: Helsinki 17. V. 1968, O: 25. V. 1970, P: 'Golf', 31066, 1967, from Sweden, R: a protothecium. A × 150, B-H, K-Q × 400, I-J × 200, O, R × 20.

Conidia are subhyaline, light grey to light yellowish brown. The conidia are basically clublike in form. They are usually widest at the second cell and distinctly tapered to a narrow, hemielliptical apex (Fig. 6 B, D, E, K). Secondary conidia often form directly on the spore apex (Fig. 6 C, H). The size of conidia (about 650) is (22) 68.9 (156) µ long, (11) 15.2 (24) µ wide at the widest point, (5) 11.1 (21) µ wide at the narrowest point, (2) 4.7 (12)-septa (Fig. 3, 3) (cf. GRAHAM 1955). Conidia of *H. phlei* were shorter and thicker than those observed by SCHARIF (1961). Conidia of *H. phlei* were smaller than those of *H. dictyoides.* (Fig. 3, 1 and 3).

Of all the seed lots of *Phleum pratense* examined (26 lots, chifely from the State Seed Testing Station), about 73 % were infected by the fungus. This corresponds to 4 % (range 0—14 %) of all the seeds examined. The fungus grew rapidly on the seedling and abundant conidiophores and conidia as well as sclerotia (Fig. 6 J) developed on these.

In inoculation tests (Table 1) in which different grass species were inoculated with conidia of *H. phlei* produced on potato dextrose agar (many isolates from seeds and leaves from fields), abundant conidia appeared on *Phleum pratense,* moderate conidia on *Dactylis glomerata, Lolium multiflorum* and *L. perenne,* infrequent conidia on *Bromus inermis* and *Festuca pratensis,* as well as accidental conidia *Agrostis tenuis, Alopecurus pratensis* and *F. rubra.* This result differs from the studies of SCHARIF (1961) as well as IBRAHIM and THRELFALL (1966) but is close to that of AMMON (1963).

H. phlei occurred only on *Phleum pratense;* it was commonly found on leaves of this grass, though not always in abundance. The same may be said of the seeds of timothy (cf. RITVANEN 1958). In Finland timothy is the most important by grass; according to PAATELA (1953), its occurrence was 95 %.

H. dictyoides (cf. p. 9) spores were found to some extent on *Phl. pratense* leaves in nature. Also, in inoculation tests in which the isolate was from *F. pratensis, H. dictyoides* spores developed, though in small quantity, on *Phl. pratense* leaves and conversely. This is confirmed by AMMON (1963). However, according to GRAHAM (1955) and SCHARIF (1961) *H. phlei* derived from *Phl. pratense* did not infect *F. pratensis.*

H. phlei were generally found as a seed-borne fungus on the seedlings of *Phleum pratense.*

The colony (Fig. 11, A—D) grows rapidly, forming dark grey, low. dense mycelium. The margin is often light grey. The cultures are long-lived.

Material examined
Plants

On *Phleum pratense:*

U: Kirkkonummi (6 specimens), Espoo (3 specimens), Siuntio (3 specimens), Helsinki (477 specimens), Vihti (1 specimen), Lohja (1 specimen), Tikkurila (22 specimens), Nummela (1 specimen), Hyrylä (4 specimens), Mäntsälä (1 specimen); V: Mietoinen (2 specimens); EH: Hämeenlinna (14 specimens), Iitti (2 specimens); PH: Ruovesi (1 specimen), Parkano (1 specimen); St: Peipohja (15 specimens); ES: Mikkeli (6 specimens); KP: Toholampi (5 specimens); PP: Ruukki (6 specimens); KmL: Rovaniemi (1 specimen); InL: Inari (5 specimens); in 1966—70 (HPP).

Seeds (Numbers cited are SSTS)

On *Phleum pratense:*

Tammisto 1967, 1969 (Commercial seed); 31797, 32076, 1968; PK: Tohmajärvi 6291, 1969; EP: Seinäjoki 8525, 1969; U: Viik 1966, 1968; Tarmo, EH: Jokioinen 1967, 1968; 38081, 1967; St: Pori, native 27376, 1967; Solf 26885, 1967 from Sweden; Omnia 23353, 1968 from Sweden.

On *Phleum nodosum:*

31086, 1968 from Britain.

Helminthosporium siccans Drechsler
J. Agric. Res. 24: 682, 1923. Syn. *H. siccans* Drechsl. Polysporous type Andersen Friesia 5: 87, 1955; *Drechslera siccans* Shoemaker Canad. J. Bot. 37: 881, 1959. The species is common on *Lolium multiflorum* and *L. perenne* in the USA (DRECHSLER 1923, SPRAGUE 1950, BRAVERMAN & GRAHAM 1960) in Canada (SHOEMAKER 1962), in Wales and England (SAMPSON & WESTERN 1940), in Scotland in 1932 (DENNIS & FOISTER 1941—42, DOVASTON 1948), in Germany (MÜHLE 1953, FRAUENSTEIN 1968), in Switzerland (AMMON 1963), in Denmark (ANDERSEN 1955) and in New Zealand (LATCH 1966). The fungus reportedly infects *Festuca pratensis* (SAMPSON & WESTERN 1940, ANDERSEN 1955, BRAVERMAN & GRAHAM 1960). The species occurs also on seeds of *Dactylis glomerata, Fectuca pratensis, F. rubra, Lolium multiflorum, L. pe-*

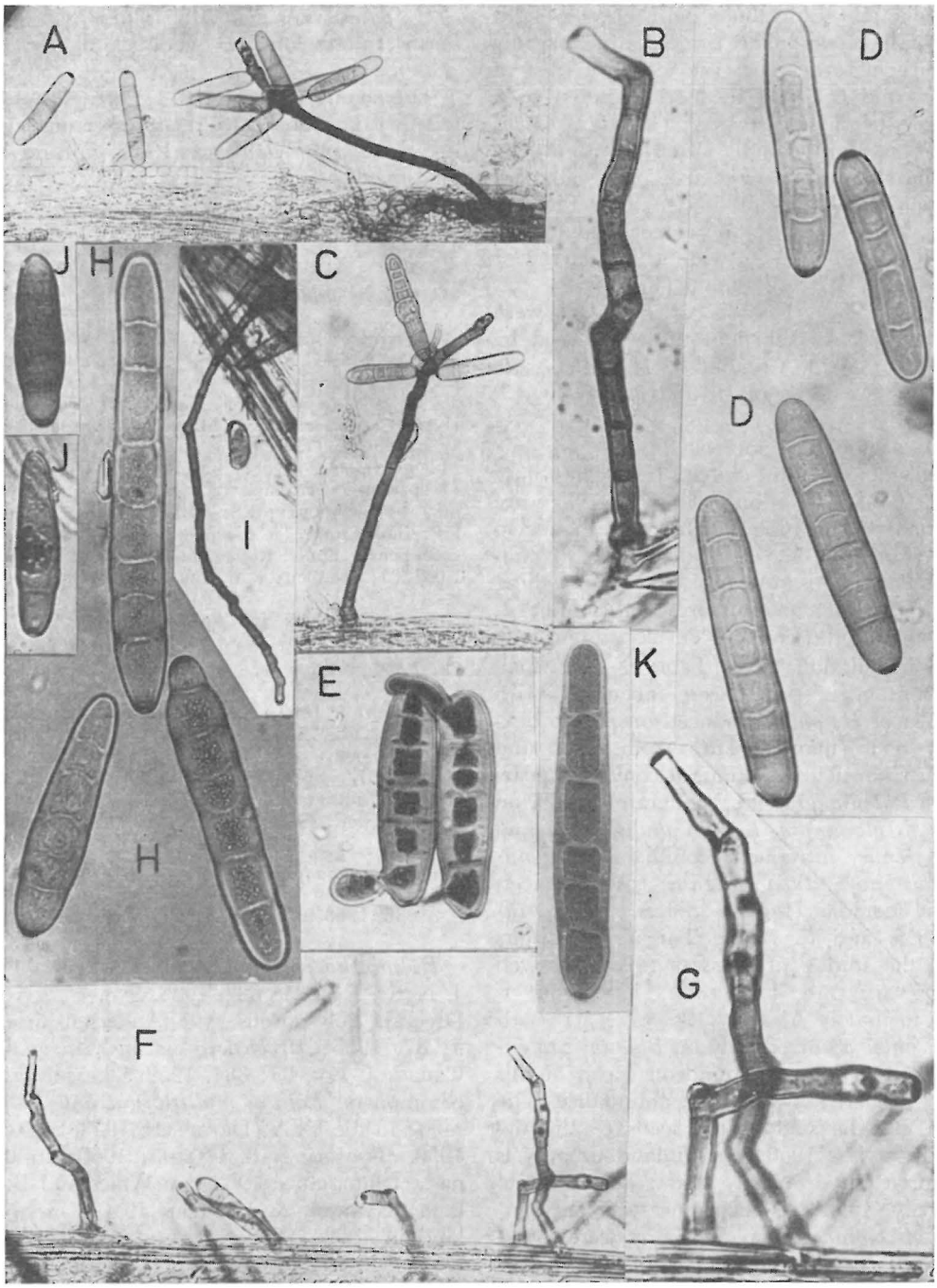

Fig. 7. Conidia and conidiophores of *Helminthosporium siccans,* A: on *Lolium perenne,* B-E: on *Festuca pratensis,* those of. *H. dactylidis* F-K: on *Dactylis glomerata.* A-D, F-J: on seeds, E, K: on leaves from fields. A: Terpas 26417, 1968 from Denmark, B: Paavo 5789, 1968, Finnish, C-D: Ötofte 22239, 1968, Foreign, E: Mietoinen 5. VI. 1969, F-H: TSTO 6075, 1969, Finnish, H-J: Fala 26870, 1968 from Poland, K: Helsinki 10. X. 1967. A, C, F, I × 150, B, D-E, G-H, J-K × 400.

Table 2. Results of the inoculation tests in the laboratory with *Helminthosporium*-species in 1970 (at Viik [1])

Host	Variety	*Drechslera dactylidis* from: Seed of *Dactylis glomerata* Tammisto 6075, 1969	*Drechslera dactylidis* from: Seed of *Lolium perenne* Valinge 12375, 1969	*H. siccans* from: Fields of *L. perenne* Valinge [1]) 4. VII., 11. VIII.	*H. siccans* from: Fields of *Festuca pratensis* Tammisto [1]) in Peipohja 19. VIII.	*H. vagans* from: Seed of *Poa pratensis* Nike 9138, 1969	*H. vagans* from: Fields of *P. pratensis* Ötofte 8. IX. [1])	*H. tritici-repentis* from: Fields of *Agropyron repens* in Inari, at Viik 11. VIII., 8. IX.	*H. sativum* from: Seed of *Festuca pratensis* Tammisto 7803, 1969	*H. biforme* from: Fields of *Agrostis tenuis* 25. VIII. [1])	*H. biforme* from: Seed of *Festuca ovina* 13412, 1969	*H. biforme* from: Fields of *Poa pratensis* Dasas 31. VIII. [1])	*H. triseptatum* from: Fields of *Phleum pratense* Tammisto 25. VIII. 1968 [1])
Agrostis tenuis	Foreign	0	0	0	0	0	0	0	+	+	0	0	+
Alopecurus pratensis	Finnish	0	0	0	+	0	(+)	0	0	+	0	0	+
Bromus inermis	Jo 266	+ + +	+ + +	+	+ + +	+ + +	(+)	0	+ (+)	+ + +	+ + +	0	+ + +
Dactylis glomerata	Tammisto	+ + +	+ + +	+	0	+	0	0	+	+ + +	+	0	+ +
»	Esko	+ + +	+	+	+	+ + +	0	0	+ + +	(+)	+	0	+ +
»	Hera	+	+ + +			+			+ +		+		
Festuca pratensis	Paavo	0	+ +	+ +		0			+		+		
»	Leto	+ + +	+ +	+	+	0	+	0	+ + +	+ + +	+ + +	(+)	+ +
F. rubra	Echo			+ +	+ +		0	0		+ +		0	+
»	Highlite	+ + +	+			0			(+)		+ +		
Lolium multiflorum	Leda	+ + +	+ +	0	+ +	+ + +	0	0	+ + +	+ + +	+ + +	0	+ + +
L. perenne	Valinge	+ + +	+ + +	+	+ (+)	+ + +	(+)	0	+ + +	+ + +	+ +	0	+ + +
»	Mito			+	+ +		0	0		+ + +		(+)	+ + +
Phleum pratense	Tammisto	0	+	+	+ (+)	0	0	0	+	+ +	+	+	(+)
»	Tarmo	+	+			+ + +			+ +		+		
Poa pratensis	Dasas			0	0		+	0		(+)		+ + +	+
»	Nike	+ +	+ +			+ +			+		+ +		
Avena sativa	Sisu			0				0		+			+ +
Hordeum vulgare	Otra			0				0		+ + +			+
Secale cereale	Ensi			0				0		+ + +			+
Triticum aestivum	Svenno			+				0		+ + +			+ + +
»	Ello			+				0		+ +			+ + +

renne and *Poa trivialis* in Denmark (ANDERSEN 1955).

According to AMMON (1963) in inoculation tests the typical disease symptoms appeared on *Lolium*-species and also on *Bromus mollis, Dactylis glomerata, Festuca arundinaceae, F. pratensis, F. rubra* subsp. *commutata,* whereas FRAUENSTEIN (1968) observed it on *F. pratensis* only.

In this study *H. siccans* was found on *Lolium perenne* from Helsinki and Peipohja (Fig. 1). The fungus occurred together with *H. dictyoides* sp. *perenne,* although the latter appeared more rarely. *H. siccans* also grows on *Festuca pratensis* in nature together with *H. dictyoides* f. sp. *dictyoides,* although the latter appears much more rarely. The fungus has been found in Helsinki, Mietoinen and Peipohja (Fig. 1). The conidiophores and conidia of both fungi were often found growing on the some leaf. The viable conidia of the fungus was found on the leaves during the period between early spring (3. IV. 1967) and late autumn (24. XI. 1967). Spores were most amundant in mid and late summer. The fungus produced sparse, small, oval, chocolate to sepia brown spots on the leaves (Fig. 2, K—L) (cf. DICKSON 1947, FRAUENSTEIN 1968). The size of the spots (about 50) was (0.5) 2.4 (22) mm long, (0.5) 1.2 (5.0) mm wide. On the leaves of *L. multiflorum* sparse spots occur only in late summer. *H. siccans* was found on this species in Helsinki and Inari. About 35 % of the limited material (c. 20 samples) was infected by the fungus. The conidiophores grow singly or in groups of 2 or 3, geniculate towards the tip and have many scars; they are medium reddish brown to black brown in colour (Fig. 7, A—C). The conidia are light yellowish brown, and cylindrical (Fig. 7, D, E). The size of conidia (about 100) is (45) 95.5 (140) µ long, (15) 18.6 (25) µ wide at the widest point, (8) 13.8 (22) µ at the narrowest point, (2) 5.6 (9) -septa (Fig. 3, 5) (cf. DREHSLER 1923, AMMON 1963, FRAUENSTEIN 1968).

Of all the seed lots of *L. multiflorum* examined (15 lots) 73 % were infected by *Helminthosporium*-species *(H. siccans, H. dictyoides* f. sp. *perenne, H. catenarium).* This corresponds to 9 % (range 0—34 %) of all the seeds examined. The most common species was *H. siccans.* The fungus was also common on seeds of *L. perenne* (cf. p 11).

In inoculation tests (Table 2) in which different grass species were inoculated on potato dextrose agar (a few field isolates from seeds and leaves of *L. perenne,* Valinge, as well as that of *Festuca pratensis* in Peipohja), abundant conidia appeared on *Bromus inermis, Dactylis glomerata* (Tammisto), *L. multiflorum* and *L. perenne,* moderate conidia on *Festuca pratensis,* as well as infrequent conidia on *F. rubra,* and *Phleum pratense.* This result is confirmed by AMMON's (1963) observations in her inoculation tests. It differs from the studies of SHOEMAKER (1962) as well as those of IBRAHIM and THRELFALL (1966).

H. siccans was the seed-borne fungus generally found on the seedlings of *Lolium multiflorum* and *L. perenne.* This partially explains the abundance of this fungus in samples gathered from nature, although the cultivation of *Lolium*-species in Finland is insignificant (PAATELA 1953) and their native occurrence is only accidental (HULTÉN 1950).

The colony (Fig. 10, H—I), grows rapidly, forming dark, brownish-grey to dark grey, low, dense mycelium. A light grey aerial mycelium later develops over the slant.

Material examined
Plants

On *Festuca pratensis:*

U: Helsinki 24. IX. 1966 (1 specimen); V: Mietoinen 5. VI. 1969 (1 specimen); St: Peipohja 31. VIII. 1970 (1 specimen); (HPP).

On *Lolium multiflorum:*

U: Helsinki (6 specimens); InL: Inari (1 specimen); 1966—70; (HPP).

On *Lolium perenne:* (cf. p.)

Seeds (Numbers cited are SSTS).

On *Lolium multiflorum:*

Leda 1967 (Commercial seed), 32471, 1968 from Denmark; E. F. 486 Dasas 28056, 1968 from Denmark; Barmultra 20708, 1968 from the Netherlands; Tur 27916, 1968 from Poland; Wloski 27130, 1969 from Poland.

On *Lolium perenne:*

Valinge U: Viik 1967; 6232, 1968, Finnish; Terpas 26417, 1968 from Denmark (SSTS); 12375, 1968 from Denmark; Pajbjerg Senta 20801, 1968 from Poland.

On *Dactylis glomerata:*

Tammisto 12369, 1969 from Denmark (SSTS).

Drechslera dactylidis Shoemaker
Canad. J. Bot. 40: 820, 1962.
Perfect stage: *Pryrenophora dactylidis* Ammon, Phytopath. Zeitsch. 47: 256, 1963. Syn. *Pleospora phaeocomes* Graham, Phytopathol. 45: 633, 1955. The fungus has been recorded on *Dactylis glomerata* in the USA (GRAHAM 1955, SHOEMAKER 1962) and in Switzerland (AMMON 1963). In AMMON's inoculation tests typical disease symptoms also appeared e.g. *Bromus inermis, Festuca pratensis* and *Lolium multiflorum.*

In this study *D. dactylidis* was found only on the seed. Of all the seed lots of *Dactylis glomerata* examined (c. 30 lots), about 10 % were (only two lots) infected by this fungus. Conidiophores grow singly, geniculate towards the tip and have occasional scars (Fig. 7 F, G, I); they are light yellowish brown to dark yellowish brown in colour and arise from ascocarps or from leaves. Conidia are light yellow — light yellowish brown to dark yellowish brown. The basal cell is often ligher and narrower than the others; the conidia is often widest at the second or third cells (Fig. 7 H, J). The size of conidia (on the seeds) (about 50) is (26) 40.4 (50.5) µ long, (9) 11.3 (12.6) µ wide at the widest point, (7) 8.3 (10) µ wide at the narrowest point, 5.0 (4—6)-septa (Fig. 3, 4). In the present study the size of the spores was smaller than in SHOEMAKER's (1962) and AMMON's (1963) material. The size of conidia (on the seedling of *Dactylis glomerata* in the inoculation tests, grown in the incubator) (about 50 conidia) was (84) 144.8 (351) µ long, (14) 18.1 (22) µ wide at the widest point, (8) 12.2 (15) µ wide at the narrowest point, (7) 8.4 (12)-septa (Fig. 3, 4).

In inoculation tests on various grass species (Table 2) inoculated with conidia of *D. dactylidis* produced on potato dextrose agar (an isolate from seeds of *Dactylis glomerata* TSTO 6075, 1969), abundant conidia appeared on *Bromus inermis, Dactylis glomerata, Festuca pratensis, Lolium multiflorum* and *L. perenne* as well as moderata conidia on *Poa pratensis.* This result is confirmed by AMMON's (1963) observations in her inoculation tests. It differs from the studies of IBRAHIM and THRELFALL (1966).

The colony (Fig. 11 E) grows rapidly, forming light grey — medium grey, moderately tall, aerial mycelium. Protothecia form rarely. The fungus is long-lived in culture.

Material examined
Seeds (Numbers cited are SSTS)

On *Dactylis glomerata:*

Fala 26870, 1968 from Poland: TSTO 6075, Finnish.

Helminthosporium vagans Drechsler
J. Agric. Res. 24: 688, 1923. Syn. *H. poae* Baudyš Lotos 64: 81, 1916; *Drechslera vagans* Shoemaker Canad. J. Bot. 37: 881, 11959; *D. poae* Shoemaker Canad. J. Bot. 40: 827, 1962. The fungus is a common parasite on many *Poa*-species, particularly on *Poa pratensis* e.g. in the USA (DRECHSLER 1923, 1930, SPRAGUE 1950, HALISKY & FUNK 1966), and in Canada (SHOEMAKER 1962). In Wales the fungus was recorded for the first time in 1938 (SAMPSON and WESTERN 1940) in Scotland in 1941 (DENNIS & FOISTER 1941—42), in Germany in 1941 (MÜHLE 1953, FRAUENSTEIN 1968), in Switzerland (SALZMANN 1960, AMMON 1963), and in Denmark (SMEDEGÅRD-PETERSEN 1970).

In inoculation tests on various grass seedlings inoculated with conidia of *H. vagans,* disease symptoms appeared on *Poa pratensis* as well as on the leaves of *Bromus inermis, Dactylis glomerata, Festuca pratensis* and *Lolium perenne* (AMMON 1963).

During the present study *H. vagans* was found on *Poa pratensis.* Of all the material (c. 230 samples) collected from different localities (Helsinki, Hyrylä, Hämeenlinna, Peipohja, Inari) (Fig. 1) about 30 % was infected by the fungus. Of all the seed lots of *P. pratensis* examined (11 lots, from the State Seed Testing Station), about 36 % were infected by the fungus. This corresponds to only 0.5 % of the seeds examined. Disease symptoms and spores of the fungus were found on the leaves from early spring (April) till late autumn (November). The fungus caused well-defined, oval leaf-spots with a chocolate brown to violet brown margin and white to sand-coloured centre (Fig. 2 M). The lesions were often framed with a circle, mostly sand-coloured to greyish orange in colour. The size of lesions (500) was (1.0) 3.8 (22) mm long. (0.5) 0.9 (4.0) mm

wide. Conidiophores emerged from the epidermal cells; on occasion from little black sclerotia on the leaves of the host, singly or in small groups, that are yellowish brown in colour (Fig. 6, O—P). Conidia are dark brown — dark olive brown, when young they are yellowish grey, subcylindrical, tapering toward the hemispherical ends (Fig. 6, L—N, Q). The size of conidia (about 100) is (30) 86—109 (166) µ long, (15) 19.5—21.4 (28) µ wide, (3) 7.5—9.1 (11)-septa (Fig. 3, 6) (cf. SHOEMAKER 1962, SMEDEGÅRD-PETERSEN 1970).

In inoculation tests (Table 2) in which different grass species were inoculated with conidia of *H. vagans* that were produced on potato-dextrose agar (an isolate from seeds of *Poa pratensis,* Nike 9138, 1969 from Denmark), abundant conidia appeared on *Bromus inermis, Dactylis glomerata* (Esko), *Lolium multiflorum, L. perenne, Phleum pratense* (Tarmo) and *Poa pratensis.* When an isolate from a field at Viik was used, scarce conidia appeared on *Alopecurus pratensis, Bromus inermis, Festuca pratensis, Lolium perenne* and *Poa pratensis* (cf. AMMON 1963).

H. vagans was the seed-borne fungus found on the seedlings of *Poa pratensis.*

The colony (Fig. 11, G) grows very slowly, forming dark, brown — black slants with irregular margins. The fungus penetrates into the surface of the agar.

Material examined
Plants

On *Poa pratensis:*

U: Helsinki (53 specimens), Hyrylä (6 specimens); EH: Hämeenlinna (3 specimens); St: Peipohja (1 specimen); InL: Inari (3 specimens); in 1966—70 (HPP).

On *Poa annua:*

EH: Iitti (1 specimen) (HPP).

Seeds (Number cited are SSTS)

On *Poa pratensis:*

Golf 31066, 1968 from Sweden; Soma Hundbolle 33586, 1968 from Denmark; Nike 9138, 2221, 1969, from Denmark.

Helminthosporium tritici-repentis Diedicke Centralbl. Bakt. Paras. Infekt. Krankh. Abt. 2, 11: 56, 1904. Syn. *Drechslera tritici-repentis* Shoemaker Canad. J. Bot. 37: 880, 1959. Perfect stage: *Pyrenophora tritici-repentis* (Died.) Drecshler J. Agric. Res. 24: 667, 1923. Syn. cf. Shoemaker 1962: 831. The species has been reported to be common on many grass species (SPRAGUE 1950, SHOEMAKER 1962) e.g. on *Agropyron repens* (L.) PB in the USA (DRECHSLER 1923, SPRAGUE 1950), in Canada (SHOEMAKER 1962), in Germany (DIEDICKE 1902, 1904, NOACK 1905), in Britain (DENNIS & WAKEFIELD 1946), in Denmark (ANDERSEN 1955) and to *Triticum durum* Desf. in Italy (Del VESCOVO 1962). In inoculation tests, with an isolate from *Triticum aestivum,* symptoms of diseases appeared on *Agropyron repens* and *Triticum vulgare* L.

In the present study *H. tritici-repentis* was found on *Agropyron repens* from certain localities ranging from Helsinki to Inari (Fig. 1). 50 % of the material studied (c. 35 samples) was infected by the fungus. According to the author's observations the disease is common in Finland. The fungus produced abundant delicate, necrotic black-brown spots and streaks (Fig. 2, N—O) or greater lighter (umbra — greyish brown) lesions on the leaves and dead tips of blades. The lesions (170) were (0.5) 2.2 (16) mm long, (0.5) 0.8 (2.5) mm wide.

Conidicphores usually assume a simple, individual, unbranched form, they are long and dark olivaceous in colour (Fig. 8 E, I). Conidia are subhyaline, straight — cylindrical basal spore segment tapering to a rounded cone shape (Fig. 8 D, F, G) (cf. DRECHSLER 1923, DENNIS & WAKEFIELD 1946, SHOEMAKER 1962, RAPILLY 1964). Conidia (about 100) are (44) 98 (168) µ long, (12) 15. 5 (22) µ wide at the widest point, (8) 11.7 (20) µ at the narrowest point, (3) 6.8 (11)-septa (Fig. 3, 10) (cf. DRECHLER 1923, AMMON 1963).

In inoculation tests on various cereals and grass species (Table 2) inoculated with conidia of *H. tritici-repentis* produced on potato-dextrose agar (many isolates from leaves of *Agropyron repens),* not a single species was infected.

The colony (Fig. 11 F) grows slovoly forming a dense, white to yellowish grey mycelium. Protothecia often form. The fungus is long-lived in culture (cf. SHOEMAKER 1962).

The mature ascocarps of *Pyrenophora tritici-repentis* were found in early spring (May —June), immature ascocarps were found in

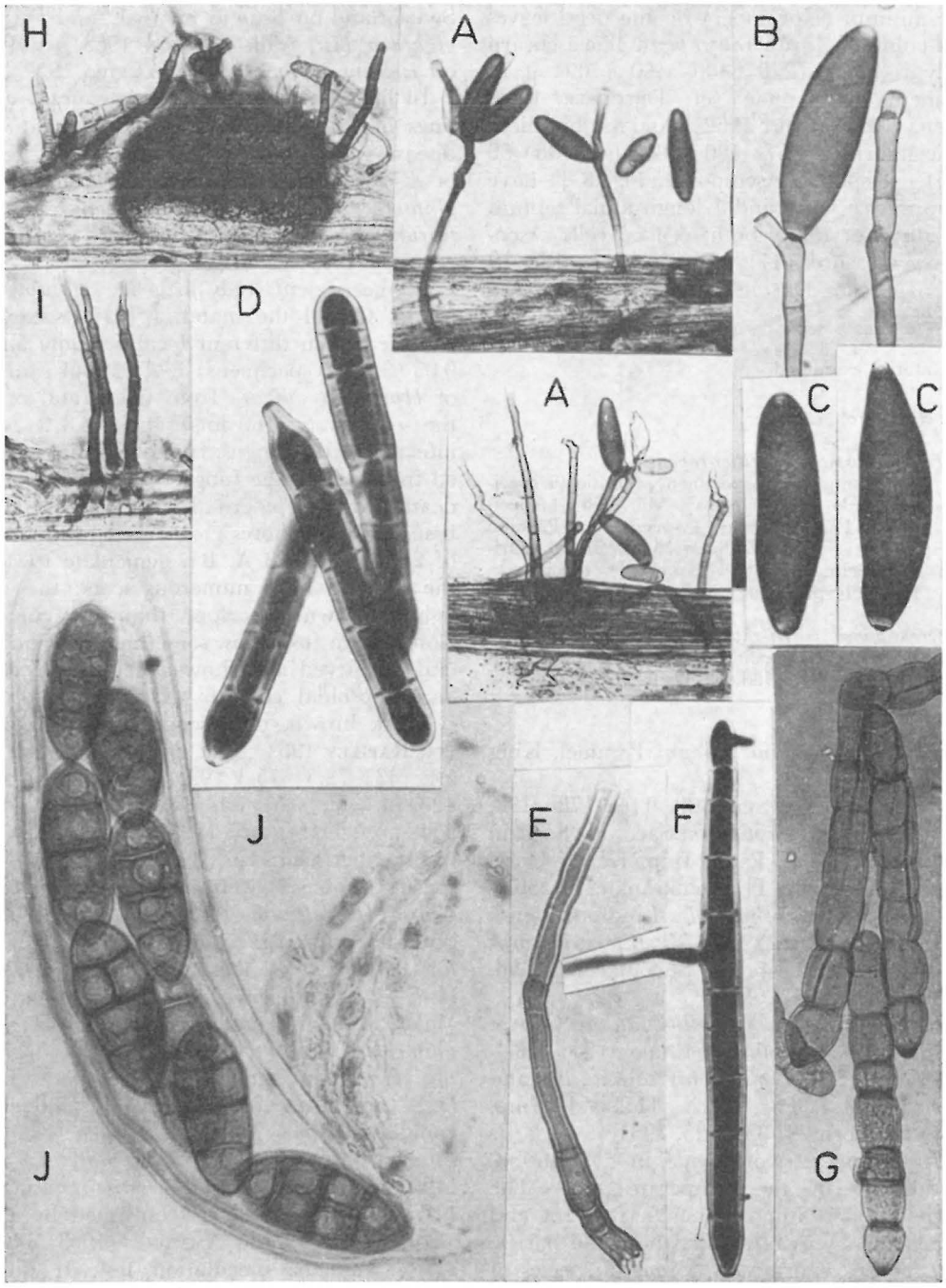

Fig. 8. Conidia and conidiophores of *Helminthosporium sativum,* A: on *Festuca pratensis,* B: on *Bromus inermis,* C: on *Phleum pratense,* those of *H. tritici-repentis,* D-I on *Agropyron repens.* Ascus and ascuspores of *Pyrenophora tritici-repentis,* J: on *A. repens.* A-B: on seeds, C-J: on leaves from fields. A: 'Tammisto' 37682, 1963, from the USA, B: 'Jo 266' Jokioinen, 1968, C: Helsinki 8. VI. 1970, D: Mikkeli 28. VI. 1968, E: Inari 13. VII. 1969, F: Ikaalinen 17. VIII. 1970, G-I: Pälkäne 17. VIII. 1970, J: Hämeenlinna 3. XI. 1967 (in laboratory +10°C to 16. II. 1968). A, H-I × 150, B-G × 400, J × 600.

late autumn (November) on the dead leaves and culms of *Agropyron repens*. The ascocarp body is black (270) 400—450 (700) µ in diameter with setae (cf. DRECHLER 1923, RAPILLY & PONCHET 1962). Asci are bitunicata, cylindrical (167) 180 (200) µ x (36) 50 (60) µ 8-spored. Ascospores (Fig. 8 J) have 3 transverse septa and 1 longitudinal septum in either, or rarely both, central cells. Ascospores measure (44) 50 (61) µ x (12) 19 (24) µ (cf. DRECHSLER 1923, SHOEMAKER 1962).

Material examined

On *Agropyron repens:*

Helminthosporium tritici-repentis
U: Kirkkonummi (1 specimen), Siuntio (1 specimen), Helsinki (6 specimens), Mäntsälä (1 specimen); EH: Hämeenlinna (4 specimens), Pälkäne (1 specimen); PH: Ikaalinen (1 specimen), Orivesi (1 specimen); ES: Mikkeli (1 specimen); InL: Inari (1 specimen); in 1967—70; (HPP).

Pyrenophora tritici-repentis
U: Helsinki (2 specimens); EH: Hämeenlinna (1 specimen); ES: Mikkeli (1 specimen); in 1967—68; (HPP).

Helminthosporium sativum Pammel, King and Bakke
Iowa Agric. Exp. Sta. Bull. 116: 178—190, 1910. Syn. *H. sorokinianum* Sacc. (in Sorokin in Trudy Obshch. Estest Imp. Kazan Univ. Abstr. in Zeitschr. Pflanzenkrankh. 1: 236—239, 1891; *H. acrothecioides* Lindfors Svensk Bot. Tidskr. 12: 227, 1918; *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoemaker Canad. J. Bot. 37: 884, 1959.

Perfect Stage: *Cochliobolus sativus* (Ito et Kurib.) Drechsler Phytopathology 24: 973—983, 1934. Syn. *Ophiobolus sativus* Ito and Kuribayashi J. Fac. Agric. Hokkaido Imp. Univ. Sapporo 29: 85—125, 1931.

H. sativum is world-wide in distribution, particularly in the temperate zone. The species is most important as a root rot and kernel smudge or blight of wheat and barley. It has been reported on dozens of species of grasses in the USA (SPRAGUE 1950, NELSON & KLINE 1962), causing e.g. severe seedling blight (ANDREWS 1953). The fungus occurs in Europe, e.g. in Denmark on plants of *Agropyron repens, Festuca pratensis, Lolium multiflorum* and *L. perenne,* and on seeds of *Dactylis glomerata, F. pratensis, F. rubra* and *L. multiflorum* (ANDERSEN 1953, 1955), in Switzerland on *Bromus mollis* L. and *Festuca gigantea* (L.) Vill. (AMMON 1963), in Italy on *Lolium perenne* (Del VESCOVO 1962).

In inoculation tests on various grass seedlings inoculated with conidia of *H. sativum* disease symptoms appeared e.g. on the leaves of *Agrostis alba* L., *Bromus inermis, Dactylis glomerata, Festuca pratensis, Lolium multiflorum, Phleum pratense* and *Poa pratensis* (AMMON 1963; cf. SPRAGUE 1950: 378).

In the present study little *H. sativum* was found. Of all the material (3770 samples) collected from different localities only about 0.05 % (two specimens) besides four samples of *Hordeum vulgare* from fields, and of all the seedlots (c. 160 lots) about 3.8 % were infected by the fungus. In the material collected from nature the fungus emerged from the death-brown epidermal cells of the host tissue. Conidiophores grow singly or in groups of 2 or 3 (Fig. 8 A, B), geniculate towards the tip and have numerous scars; they are lighter brown in colour than the conidia. Conidia are fusiforms, sometimes not equilateral or curved and show a hemispherical or hemiellipsoidal contour (Fig. 8 C); brown — dark brown, microscope black in colour (cf. RAPILLY 1964). The conidia (about 120) are (43) 72.5—75.3 (92) µ long, (16) 20.3 (28) µ wide, (5) 7.1—7.6 (11)-septa (Fig. 3, 8) (cf. DRECHSLER 1923, ANDERSEN 1955).

In experiments in which different grass species (Table 2) were inoculated with conidia of *H. sativum,* that were produced on potato-dextrose agar (an isolate from seeds of *Festuca pratensis,* Tammisto 7803, 1969, Finland and from leaves of *Agrostis tenuis* at Viik), abundant conidia appeared on *Dactylis glomerata, Lolium multiflorum, L. perenne, Hordeum vulgare* L., *Secale cereale* L. and *Triticum aestivum* L., moderate conidia on *Bromus inermis, Festuca pratensis, Phleum pratense* and *Poa pratensis* and infrequent conidia on *Agrestis tenuis* and *F. rubra.* This result is confirmed by PUTTERILL's (1954) and AMMON's (1963) observations in her inoculation test. It differs substantially from the studies of IBRAHIM and THREFALL (1966). According to them only *Hordeum vulgare* was infected.

H. sativum was the seed-borne fungus found on the seedlings of, at least, *Bromus inermis.*

The colony (Fig. 11, H—I) grows rapidly or slowly, forming a velvety layer of grey to

brown-black mycelium. Conidiophores and multiform conidia develop in masses. The fungus is longlived in culture (cf. DRECHSLER 1923, MALONE & MUSKETT 1964).

No perfect stage was found.

Material examined
Plants

On *Agrostis tenuis:*
U: Helsinki (Viik) 7. VIII. 1970; (HPP).

On *Bromus inermis:*
U: Helsinki (Viik) 20. X. 1970; (HPP).

On *Phleum pratense:*
U: Helsinki (Viik) 8. VI. 1970; (HPP).

On *Hordeum vulgare:*
U: Mäntsälä 9. IX. 1970; EH: Hollola 23. VIII. 1970; PH: Kangasala 17. VIII. 1970, Orivesi 17. VIII. 1970; (HPP).

Seeds (Numbers cited are SSTS)

On *Bromus inermis:*
Jo 266, EH: Jokioinen 1968; S—1389, 1968 from Canada.

On *Festuca pratensis:*
Paavo, EH: Jokioinen 1967; Tammisto 7803, 1969, Finnish; Tammisto 37682, from the USA, Shafter, 1963.

On *Lolium perenne:*
Terpas 26417, 1968, from Denmark.

On *Phleum pratense:*
Tarmo 9944, 1970, Finnish.

On *Secale cereale:*
Ensi, Viik, 1969.

On *Triticum aestivum:*
U: Helsinki, Viik, Elo, 1969.

Helminthosporium biforme Mason and Hughes

CHESTERS in an appendix Trans. Brit. Mycol. Soc. 30: 113—117, 1948. Syn. cf. CHESTERS (1948: 114); *H. biseptatum* Sacc. and Roum. (IBRAHIM and THRELFALL 1966: 369). The species was recorded during the testing of the Northern Irish seed *Avena sativa* L. for health (MALONE & MUSKETT 1964) and was also observed on *Apium graveolens* L. seed (IBRAHIM & THRELFALL 1966).

In the present study little *H. biforme* was found. Of all the material (3770 samples) collected from different localities, only about 0.05 % (two specimens) and of all the seed lots (c. 160 lots), about 5.6 % suffered infection by the fungus. In the material collected from nature the fungus emerged from the death-brown epidermal cells of the host tissue. The fungus produces two kinds of conidiophores. Macronematous conidiophores arise from sclerotinia-like bodies, are dark brown, and taper slighty towards the geniculate tip; they are up to 300 µ long, and (4.5) — 5.0—(7) µ wide (Fig. 9 G, I). Micronematous conidiophores are formed at the widening and darkening of the ends of the hyphae, which become geniculate (Fig. 9 E, G, J). The conidia are the same in both cases. They are generally obovate, sometimes elliptical, pale brown — yellowish brown exsept for the lighter — coloured basal cell, and the dark brown scar at the narrower end (Fig. 9, E—F, H). The size of conidia (about 50) (18) 26.9 (36) µ long, (8) 12.5 (20) µ wide at the widest point, (5) 6.4 (9) µ at the narrowest point, (3) 3.7 (5)-septa (Fig. 3, 9) (cf. CHESTER 1948, MALONE & MUSKETT 1964).

In experiments in which different grass species (Table 2) were inoculated with conidia of *H. biforme,* that were produced on potato dextrose agar (an isolate from seed of *Festuca ovina* 13412, 1969, foreign), abundant conidia appeared on *Bromus inermis, Festuca pratensis* (Leto), and *Lolium multiflorum,* moderate conidia on *Festuca rubra* and *Poa pratensis* and infrequent conidia on *Dactylis glomerata* and *Phleum pratense.* This result differs substantially from the studies of IBRAHIM and THRELFALL (1966), who found only *Festuca pratensis* infected.

The colony (Fig. 11, J—K) grows rapidly, forming uniform, dark grey — dark brownish grey — brownish black, low, dense mycelium. The margin is light grey. Conidiophores and conidia develop abundantly. The fungus is long-lived in culture.

Material examined
Plants

On *Agrostis stolonifera:*
U: Helsinki, Viik, 8. VI. 1970: (HPP).

On *Phleum pratense:*
U: Helsinki, Viik, 22. VI. 1970; (HPP).

Seeds (Numbers cited are SSTS).

On *Agrostis tenuis:*
Kito 27917, 1967 from Poland.

On *Dactylis glomerata:*
Tammisto, from the USA, Masshardy, 1963; (HPP).

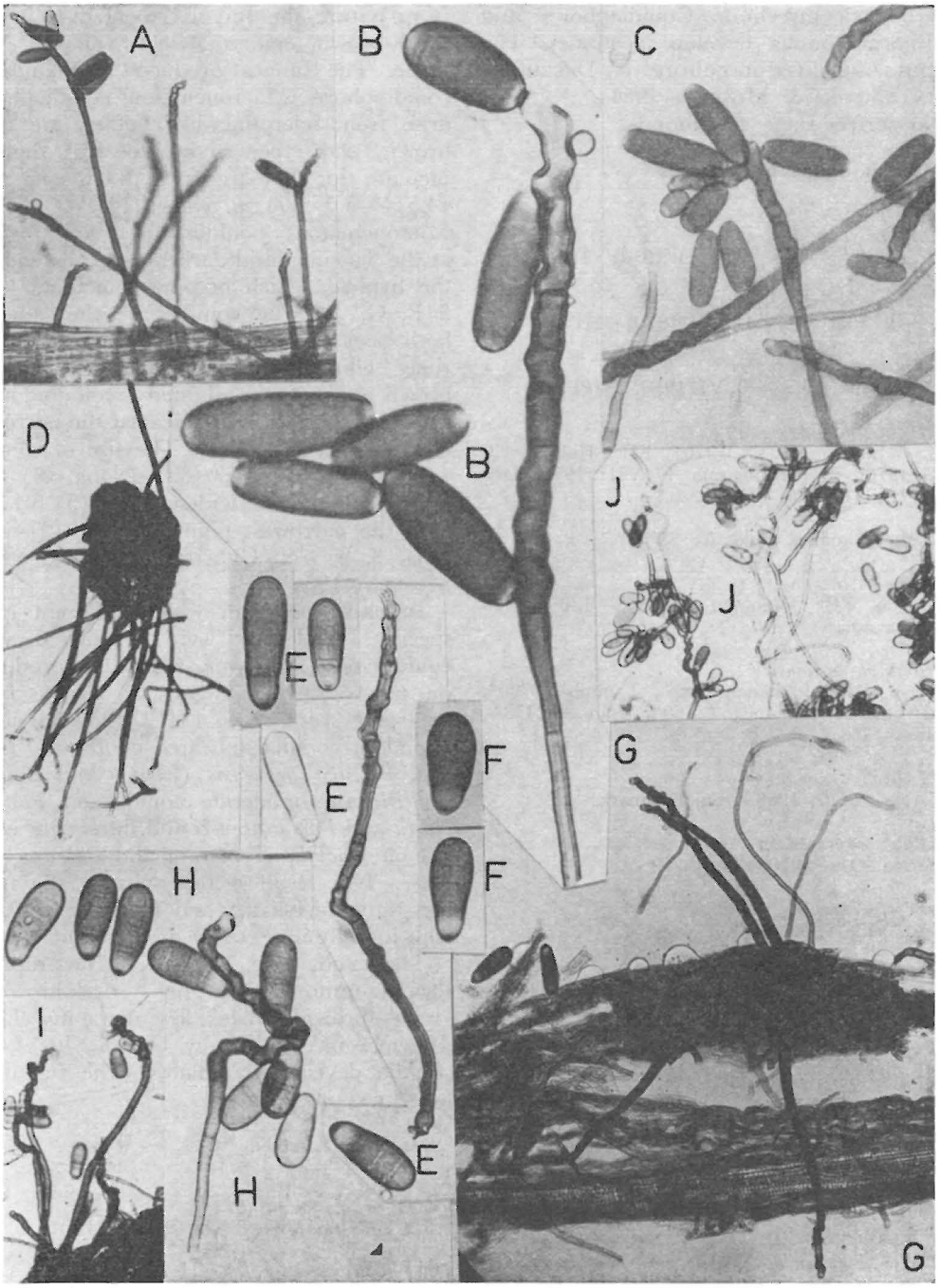

Fig. 9. Conidia and conidiophores of *Helminthosporium triseptatum,* A: on *Phleum pratense,* B-C: on Potato-dextrose agar, those of *H. biforme,* D-F: on *Fectuca ovina,* G: on *F. rubra* var. *fallax,* H-J: on *Dactylis glomerata,* A: on leaves from field, D-J: on seeds. A: Helsinki 12. VI. 1968, D-E: 13412, 1969, Foreign, F: 9157, 1969 from Germany, H: 14324, 1969, from the Netherlands, H-J: isolated from seed produced in the USA (Masshardy in 1963). A, G, I, J × 150, B × 1000, D × 75, C, E, F, H × 400.

On *Festuca ovina:*
9157, 1969, from Germany; 13412, 1969, Foreign.

On *Festuca rubra:*
Dasas 24897—98, 1968, from Denmark: Rubina Roskilde 21481, 1968, from Denmark; Highlite, GVE 627, from the Netherlands.

On *Festuca rubra* var. *fallax:*
14324, 1969, from the Netherlands.

On *Lolium multiflorum:*
Leda, commercial seed, 1968, from Denmark.
On *Phleum pratense:*
Solf 26885, 1968, from Sweden.

Helminthosporium triseptatum Drechsler J. Agric. Res. 24: 686, 1923. The species has been recorded to occur on *Holcus lanatus* L. in the USA (Drechsler 1923, Dickson 1947, Sprague 1950), in Canada (Shoemaker 1962) and in Britain (Dennis & Wakefield 1946, Ibrahim & Threlfall 1966). The fungus reportedly also infects *Agrostis*-species (Dickson 1947, Luttrell 1951, Salzmann 1959) e.g. *A. alba* L., *A. exarata* Trin. (Sprague 1950), *A. gigantea* Roth. (Dickson 1947) and *A. stolonifera* L. (Ibrahim & Threlfall 1966), *Dactylis glomerata* (Dickson 1947, Sprague 1950) and *Phleum pratense* (Dickson 1947, Ibrahim & Threlfall 1966), *Poa pratensis* (Bean 1964), as well as *Sorghum halopense* L. in Italy (Del Vescovo 1962).

In the present study little *H. triseptatum* was found. Of all the material (3770 samples) collected from different localities, only about 0.03 % (one specimen), and of all the seedlots (c. 160 lots) about 3.1 %, suffered infection by the fungus. The last mentioned seed lots were prof. Otto Valle's experiments, which were produced in the USA (cf. p. 3). Conidiophores grow on withering leaves, singly or in pairs, geniculate towards the tip and have numerous scars (Fig. 9, A—C); they are dark olivaceous to black brown in colour. On the upper part of conidiophores thickenings occur (Fig. 9 B) (cf. Drechsler 1923). Conidia are dark olivaceous to black brown; ellipsoidal or short cylindrical, regularly 2- to 3-septate (Fig. 9 B). The conidia (about 100) are (22) 26.8—34.0 (39) µ long, (8) 9.7—11.1 (14) µ wide, 3-septa (Fig. 3, 10). In this study conidia were smaller than those examined by Drechsler (1923).

In experiments in which different cereals and grass species (Table 2) were inoculated with conidia of *H. triseptatum* that were produced on potato dextrose agar (an isolate from leaves of *Phleum pratense* at Viik), abundant conidia appeared on *Bromus inermis, Lolium multiflorum, L. perenne* and *Triticum aestivum;* all the other species were also infected. This result is confirmed by Sprague's (1950) view that the fungus is saprophytic or weakly parasitic; however, the result differs essentially from the studies of Ibrahim and Threlfall (1966) who found only *Phleum pratense* infected.

The colonies (Fig. 11 L) grow rapidly, first forming a light olivaceous, then dark black-brown myselium. Conidiophores and conidia develop in masses. The fungus is long-lived (at least two years) in culture. Protothecia were not produced.

No perfect stage was found.

Material examined
Plants

On *Phleum pratense:*
U: Helsinki (Viik), 12. VI. 1968.

Seeds

On *Dactylis glomerata:*
Tammisto 38736, produced in the USA, Tehachapi 1965.

On *Festuca pratensis:*
Tammisto, Tikkurila 1960, 37672, produced in the USA, Tehachapi 1963; 39683, produced in the USA, Tehachapi 1967; 38718 produced in the USA, Shafter 1965.

Discussion

In the present study samples from localities throughout the country, from Ahvenanmaa to Lapland, were examined. The majority of the localities were Experiment Stations of the Agricultural Research Centre. Thus, the experiments were fairly uniform. The greater part of the samples was obtained from Viik (Helsinki). The leys studied were composed principally of one grass-species. In this respect they differed essentially from the typical Finnish ley. In Finland red clover-timothy leys are the most common type of cultivated leys (Raininko 1968). It is generally known that a growing unit composed of only one plant species is more susceptible to diseases than a heterogenous growing unit. On the other hand in Finland wild grass is common

throughout the country (HULTÉN 1950, PAATELA 1953). This makes the spread of grass diseases possible. Studies carried out by the author indicate that this notion is correct, at least as far as the species *Mastigosporium* (MÄKELÄ 1970) and *Helminthosporium* are concerned. Many species of *Helminthosporium* are known to be seed-borne fungi (MÜHLE 1953, ANDERSEN 1955, 1959, SCHARIF 1961). This exlains e.g. that *Helminthosporium* f. sp. *perenne* was found on *Lolium perenne* in Muddusniemi (Inari) although neither *L. perenne* nor other hosts of the fungus grow there in nature (HULTÉN 1950).

In most species of *Helminthosporium* viable conidia were found immediately after the snow had melted or shortly thereafter. Sclerotial bodies were also found in certain *Helminthosporium*-species (*H. dictyoides* f. sp. *perenne, H. vagans*); the perfect stage was found only in one species (*H. triticirepentis*). The long Finnish winter, the length of the thermal winter (0°—0°C) varying from 100 to 205 days (KOLKKI 1966), did not prevent most *Helminthosporium*-species from over-wintering at the conidia-stage (cf. MÜHLE 1953). In this contury the snow cover plays an important part in affecting the soil temperature as well as the dormant period of plants (YLIMÄKI 1962). The disease symptoms and spores of the fungus were found generally during the period between early spring (March) and late autumn (November). This is true in spite of the fact that the optimum temperature for many graminicolous species of *Helminthosporium* is from 10° to 22°C (LEACH 1967). The amount of conidia was most abundant in mid and late summer. However, great variation was observed between the species of grasses, times of collection and the different localities. It was most abundant during the moist periods (cf. DREGHSLER 1930, SAMPSON & WESTERN 1940, MÜHLE 1953, HALISKY & FUNK 1966, FRAUENSTEIN 1968).

In the present study a close affinity was confirmed in the occurrence of *Helminthosporium*-species between the researched plant samples and seed lots of the same grass-species. Thus *Helminthosporium*-species occurred commonly on *Phleum-pratense, Festuca pratensis, Lolium perenne* and *L. multiflorum* in both plant and seed samples. On the contrary *Helminthosporium* occurred scantily on *Dactylis glomerata* and *Alopecurus pratensis,* in both plant and seed samples.

The new foreign *Helminthosporium*-species which are carried by the seed are significant only when they are able to adapt to these new conditions. For example the seeds of Finnish-originated *Phleum pratense, Festuca pratensis* and *Dactylis glomerata* were produced in the USA. However, only one *Helminthosporium*-species has been confirmed to be transported with them; *H. triseptatum* was found only once, in nearly negligible quanity, at Viik (Helsinki).

Many *Helminthosporium*-species are cosmopolitan. This concept is also confirmed by the results of this study.

Summary

Helminthosporium phlei (Graham) Scharif was found frequently on *Phleum pratense* L. in leys throughout the country. The fungus was common also on the seed of timothy produced in Finland.

Helminthosporium dictyoides Drechs. f. sp. *dictyoides* Braverman & Graham was found very commonly and in adundance on *Festuca pratensis* Huds. in leys throughout the country. The fungus was very common also on the seed of medow fescues produced in Finland. The fungus was also found on *F. rubra* L., *Dactylis glomerata* L. and *Alopecurus pratensis* L. in leys, though less commonly and less significantly than on *F. pratensis.*

Helminthosporium dictyoides Drechs. f. sp. *perenne* Braverman & Graham was found common on *Lolium perenne* L. in some localities. The fungus was also found on the seed of perennial rye-grass produced both in Finland and in foreign countries.

Helminthosporium siccans Drechs. was found to be fairly common on *Lolium multiflorum* Lam. and *L. perenne* L. on leys in some localities. The fungus was also found to be very common on seed of *Lolium*-species produced in Finland and Denmark, as well as on seed of *Dactylis glomerata* produced in Denmark, *H. siccans* was also found on *Festuca pratensis* in leys in some localities.

Helminthosporium vagans Drechs. was found to be moderately common on *Poa pratensis* L. on leys in localities from Helsinki to Inari. One occurrence was recorded on *Poa annua* L. at Iitti. The fungus was also

found to be fairly common on seed of *P. pratensis* produced in foreign countries.

Helminthosporium sativum Pammel, King & Bakke was found to be uncommon and infrequent on *Phleum pratense* L., on *Agrostis tenuis Sibth.*, and on *Hordeum vulgare* L. in fields in certain localities in southern Finland. The fungus was found also on seed of *Bromus inermis* Leyss., *Festuca pratensis* Huds., *Lolium perenne* L., *Phleum pratense* L., *Secale cereale* L., and *Triticum aestivum* L. produced both in Finland and in foreign countries.

Helminthosporium biforme Mason & Hughes was found to be very uncommon and infrequent on *Agrostis stolonifera* L. and on *Phleum pratense* in one ley at Viik (Helsinki). The fungus was found more frequently on seed of *Agrostis tenuis, Dactylis glomerata, Festuca ovina* L., *F. rubra* L., *F. rubra* var. *fallax, Phleum pratense* and *Lolium perenne* produced in foreign countries.

Helminthosporium triseptatum Drechs. was found in very small quantities on *Phleum pratense* on only one ley at Viik (Helsinki). The fungus was also found to be very uncommon on seed of *Dactylis glomerata,* and *Festuca pratensis* produced in the USA.

Helminthosporium tritici-repentis Diedicke was found very common on *Agropyron repens* (L.) PB. on the borders of fields is many localities throughout the country. *Pyrenophora triticirepentis* (Died.) Drechs., the perfect stage of the fungus, was found in certain localities in southern Finland (Hämeenlinna, Mikkeli).

Small quantities of *Drechslera dactylidis* Shoemaker were found only on seed of *Dactylis glomerata* produced both in Finland and in Poland.

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