

Occurrence of *Helminthosporium* species on cereals in Finland in 1971—1973

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Abstract. This study was carried out on *Helminthosporium* species found on cereals (*Avena sativa* L., *Hordeum vulgare* L., *Triticum aestivum* L., *Secale cereale* L.) and couch grass (*Agropyron repens* (L.)PB.) The objective was to ascertain their distribution and general significance in Finland. The results were obtained from samples of cereals gathered in 2040 fields all over the country during the growing season 1971—1973. The samples of couch grass (approx. 170 samples) were collected in fields and the borders of fields.

The fungi in all the samples were examined by microscope, using the blotter method and with cultures.

Many *Helminthosporium* species were found to be very common and abundant on cereals, especially in 1972, throughout the country and as far as Lapland. The imperfect stages (conidia) of the fungi occurred dominantly and in abundance, whereas the perfect stages of the fungi were found only occasionally at all times. *Pyrenophora tritici-repentis* (Died.) Drechs. on *Agropyron repens* was exceptional in this respect.

The most widespread and common *Helminthosporium* fungi were the following species:

H. avenae Eidam was found to be very common and abundant in more than 60 per cent of the oat fields and in nearly 90 per cent of the localities that were studied throughout the country. These figures apply to seedlings as well.

H. gramineum Rabenh. ex Schlecht was found frequently in more than 30 per cent of the spring barley fields and in about 55 per cent of the localities that were studied. It was very common and abundant in Ostrobothnia and the northern parts of the country and was frequent on six-rowed barley, too.

H. teres Sacc. was found to be common and abundant in nearly 60 per cent of the spring barley fields and in nearly 90 per cent of the localities that were studied. These figures apply to the seedlings as well and are especially representative of observations made in the western and southern parts of the country. The fungus was more common on six-rowed than on two-rowed barley.

H. tritici-repentis Died. was found to be moderately common in southern and south-western Finland as follows: in nearly 30 per cent of the spring wheat fields and in 40 per cent of the localities studied; in 17 per cent of the winter wheat fields and in 23 the winter rye fields; for both the latter mentioned moderate abundance was observed in more than 50 per cent of the localities studied. On *Agropyron repens* the fungus was very common and abundant in 50 per cent of the samples and in nearly 60 per cent of the localities studied. In addition, the perfect stage of the fungi, *Pyrenophora tritici-repentis* (Died.) Drechs. with mature ascoma and ascospores was found in about 1/4 of the samples examined throughout the country.

H. sativum Pammel, King and Bakke was found to be moderately common and abundant in about 30 per cent of the spring barley fields and in 55 per cent of the localities studied throughout the country, being most common in southern and southwestern Finland. The fungus was more common on two-rowed than on six-rowed barley. The fungus was observed to be moderately common in 9 per cent of spring wheat fields and in nearly 20 per cent of the localities studied. In all fields *H. sativum* appeared sporadically also in seedlings on spring barley and spring wheat as well as on the roots of barley. The fungus was found to be moderately common also in oat fields, but only in 1972, whereas on winter wheat and winter rye its occurrence was only rare and sporadic.

An undetermined *Helminthosporium* species, like *H. gramineum* or *H. teres*, was found to be scarce but moderately common, in about 10 per cent of the spring wheat fields and in nearly 20 per cent of the localities studied. It occurred only occasionally on winter wheat and on winter rye fields.

It is not known how fungi damage affects crop yields. At least *H. gramineum*, *H. teres* and *H. sativum* on spring barley, as well as *H. avenae* on oats, caused severe damage to plants and occurred commonly throughout the country.

Introduction

Several *Helminthosporium* species are known to be serious causers of leaf spot diseases on cereals cultivated all over the world (SPRAGUE 1950). In Scandinavia these diseases have been known since the last century (RAVN 1901, JØRSTAD 1945), but due to the extensive use of mercurial fungicides they have continued to play only a minor role, except in the northern parts of the countries (FRITZ 1966, KOLK 1966, KOLK and KARLBERG 1973, ANDERSEN 1955, JØRGENSEN 1969, HANSEN and MAGNUS 1969, OVERAA 1972).

In recent years, however, there has been a marked increase in the prevalence of *Helminthosporium* species, especially on barley, e.g. in Norway (HANSEN and MAGNUS 1969), Denmark (SMEDEGÅRD—PETERSEN 1971, 1972 a, 1974) and Finland (BLOMQUIST 1970).

There may be several reasons for this: the increased acreage devoted to cultivation of barley, the influence of new barley varieties and climatic conditions (SMEDEGÅRD—PETERSEN 1972 b, 1974, MÄKELÄ 1972). Their abundance may also be due to the use of undressed seed (LIHNELL 1969, BLOMQUIST 1970, OVERAA 1972).

In Finland there are thus far only a few studies about the *Helminthosporium* species causing diseases on cereals. However, these fungi have been known for a long time and they have continually caused serious damage, especially on barley (LIRO 1917, HALKILAHTI 1971). In recent years there has been increased the interest in the *Helminthosporium* species of cereals (MÄKELÄ 1971, 1972, REKOLA et al. 1970, HALKILAHTI 1971, 1973 a, 1973 b).

Cereals are grown on about 46 per cent of Finland's total field area (2 665 000 hectares). More than 90 per cent of the cereals area is covered by spring cereals (oats, barley, wheat); less than 10 per cent by winter cereals (wheat, rye). Oats (area 19 %) and barley (area 17 %) are among the most important cultivated plants in Finland and they thrive even in the northern parts of the country. Spring wheat (area less than 5 %), winter wheat (area 2 %) and winter rye (area 2 %) are grown in the southern and central parts of the country. The proportion of barley is showing an increase in recent years,

whilst the acreage devoted to wheat and rye is decreasing (Official statistics of Finland 1973).

This study is part of a research project dealing with spot diseases on cereals, and specifically with the pathogens causing these diseases (cf. MÄKELÄ 1972, 1974). The purpose of the present study is to clarify the occurrence of *Helminthosporium* species on cereals. The study is based on samples of cereals which were gathered in farmers' fields throughout the country over a three year period (1971–1973).

Materials and Methods

The bulk of the cereal samples (Table 1) was gathered from southwestern and southern Finland; samples of barley and oats also came from northern Finland, particularly in 1973. Only rare samples were gathered from Uusimaa, South Savo and South Karelia in 1973, owing to exceptionally dry weather.

The samples of barley were gathered in 803 fields from 251 localities. About 80 per cent of these were six-rowed varieties and about 20 per cent were two-rowed varieties. The samples of oats came from 181 localities, the total samples numbering 415. The samples of spring wheat were collected in 222 fields from 111 localities, the corresponding figures for winter wheat being 259 fields and 72 localities. The samples of winter rye came from 112 localities, the total samples numbering 341.

The samples of *Agropyron repens* (c. 170 samples) were collected in fields and the borders of fields in about 80 localities throughout the country.

The bulk was gathered at a growth stage when the grain was milky ripe, chiefly from late July to early August (20 July – 14 Aug., 1971; 16 July – 8 Aug., 1972; 21 July – 14 Aug., 1973). The samples of winter wheat and rye as well as of *Agropyron repens* were gathered in May also. Furthermore, observations of appearance of diseases were made in fields during the entire growing season.

As a rule it was attempted to take the representative samples from large areas of the field. In general the samples were gathered in the same field only once. In most cases the variety remained unknown.

The following cultivated varieties of cereals have been commonest during this time in Finland (Official statistics of Finland 1973). Oats: Hannes, Pendek, Titus, Sisü, Kyrö, Nip; spring barley, two-rowed varieties: Karri, Ingrid; six-rowed varieties: Otra, Pirkka, Pomo, Paavo; spring wheat: Ruso, Apu, Norröna, Drott, Svenno, Touko, Diamant II; winter wheat: Vakka, Elo, Linna, Nisu; winter rye: Pekka, Toivo, Ensi, Voima.

The leaves were checked for diseases by ocular examination on the basis of symptoms. Fungi causing diseases were determined in the following way: 1. Diseases leaves were kept on moist blotter paper in Petri dishes for several days, after which the fungi that had grown were examined with a stereomicroscope. 2. Microscope slides were made from the leaves and, using these, the fungi were measured and photographed. 3. One-spore cultures of the fungi that had developed on the leaves were made on PDA (Difco). The stands were compared with each other. The results are grouped by biological provinces (HEIKINHEIMO and RAATIKAINEN 1971).

Table 1. Frequency of *Helminthosporium* species as a per cent of samples of cereals gathered in various localities and fields during the period 1971–1973.

Cereals	Year	The samples researched		<i>Helminthosporium</i> species, % of fields researched						
		No. of localities	No. of fields	<i>H. avenae</i>	<i>H. gramineum</i>	<i>H. teres</i>	<i>H. sativum</i>	<i>H. tritici-repentis</i>	<i>Helminthosporium</i> spp. perfect stage	
Oats	1971	50	73	61	—	—	1	—	—	
	1972	142	233	74	—	—	14	—	—	
	1973	48	109	46	—	—	2	—	—	
	1971–73	181	415	63	—	—	9	—	—	
Barley	1971	69	157	—	34	59	16	—	—	
		Two-rowed	25	39	—	18	46	21	—	—
		Six-rowed	58	117	—	39	64	15	—	—
Barley	1972	135	348	—	24	67	37	—	—	
		Two-rowed	47	59	—	29	68	59	—	—
		Six-rowed	113	289	—	23	66	33	—	—
Barley	1973	124	299	—	40	45	25	—	—	
		Two-rowed	23	52	—	19	37	33	—	—
		Six-rowed	112	247	—	44	47	24	—	—
Barley	1971–73	251	803	—	32	57	29	—	—	
		Two-rowed	83	150	—	23	51	40	—	—
		Six-rowed	234	653	—	34	59	26	—	—
Spring wheat	1972	88	140	—	—	—	10	26	—	
	1973	62	82	—	—	—	9	32	—	
	1972–73	111	222	—	—	—	9	27	—	
Winter wheat	1972	62	112	—	—	—	1	26	—	
	1973	56	147	—	—	—	4	10	—	
	1972–73	72	259	—	—	—	3	17	—	
Winter rye	1972	90	201	—	—	—	0	29	—	
	1973	62	140	—	—	—	0.7	13	—	
	1972–73	112	341	—	—	—	0.3	23	—	
Couch grass	1972	73	131	—	—	—	—	45	22	
	1973	21	38	—	—	—	—	68	32	
	1972–73	82	169	—	—	—	—	50	24	

Climate and Weather

Duration of the growing season (+5°–+5°C) in Finland is 120–180 days. Mean temperature varies from 10° to 13°C during this period (KOLKKI 1966). The average monthly precipitation varies from 35 to 80 mm and is lower early in the growing season than it is in the autumn (HELMÄKI 1967).

The weather in spring and summer in 1971 was characterised by the alternation of one or two week periods of exceptional cold or heat. There was very little precipitation during the growing season except for the early part of August, particularly in southern Finland.

The weather during the growing season of 1972 as well as from May to August of 1973 was exceptionally warm; in July it was even 2–4°C higher than normal. Precipitation conditions varied greatly in different parts of the country. In 1972 there was little rain in May and in June, whilst in August there was quite a lot of rain in southern and central Finland. During the entire growing season 1973 the amounts of precipitation were smaller than normal. Uusimaa and Kymenlaakso in particular suffered from drought.

The winter of 1970–1971 was long with abundant snowfall. The winters of 1971–1972 and 1972–1973 were much milder than normal (Meteorol. Yearb. Finland 1971, 1972, 1973).

Results

In the present study the old form of undivided genus *Helminthosporium* is used instead of genera *Drechslera* and *Bipolaris* (cf. SHOEMAKER 1959). The imperfect stages of *Helminthosporium* species are used instead of the perfect stages of *Pyrenophora* and *Cochliobolus* species because the former stage of the fungi appeared abundantly in Finland, whereas the latter named stages are found rarely or not at all (cf. MÄKELÄ 1971).

Helminthosporium avenae

Helminthosporium avenae Eidam, syn. *Drechslera avenae* (Eidam) Scharif, perfect stage: *Pyrenophora avenae* Ito & Kurib. Syn. cf. SHOEMAKER 1962: 815.

The fungus causes seedling blight and leaf stripe on young oat plants as well as leaf spot or leaf blotch on the oat plants at maturity. The earlier phase is considered important (TURNER and MILLARD 1931, DENNIS 1933, MÜLLER 1963).

The fungus is seed-borne and the most important source of infection is the resting mycelium on the grain (TURNER and MILLARD 1931, de TEMPE 1964).

H. avenae is widespread but only important in cool and moist climates, which in fact offer the conditions that suit the crop best (SPRAGUE 1950, de TEMPE 1964, CMI map no. 105).

In Europe the fungus is known to be common and destructive in the wetter, northern and western areas of British Isles (BUTLER and JONES 1949). It occurs also in Germany (MÜLLER 1963). In Scandinavia *H. avenae* has been known in Norway since 1891. There it has afflicted oat seedlings (JØRSTAD 1945). Today the fungus causes some damage to roots and culms of oats (OVERAA 1972). In Denmark *H. avenae* has been known on oat plants and on seed since 1896 (RAVN 1901). It is very common but the fact that it causes leaf blotch on oats has been overlooked (ANDERSEN 1955). Today the fungus is little known in Sweden (FRITZ 1965, KOLK 1966).

In Finland, too, *H. avenae* is apparently considered to be of negligible significance because up to now it has not attracted attention. According to HALKILAHTI (1973 a) *H. avenae* infection on samples of oat seed was common in the harvests of 1967 and 1972. The fungus was found on seed produced throughout the country as far as North Ostrobothnia. In field trials in 1968 and 1969 at Viikki, Helsinki, the crop losses caused by *H. avenae* on oats were 2–10 % (REKOLA et al. 1970).

H. avenae infects, besides oats (*Avena* spp.), also barley and other species of gramineae (SPRAGUE 1950, BRAVERMAN 1960, SHOEMAKER 1962, AMMON 1963).

In this study *H. avenae* was found to be common on oats throughout the country as far north as Lapland (Inari) (Fig. 1). The fungus was found in the following localities:

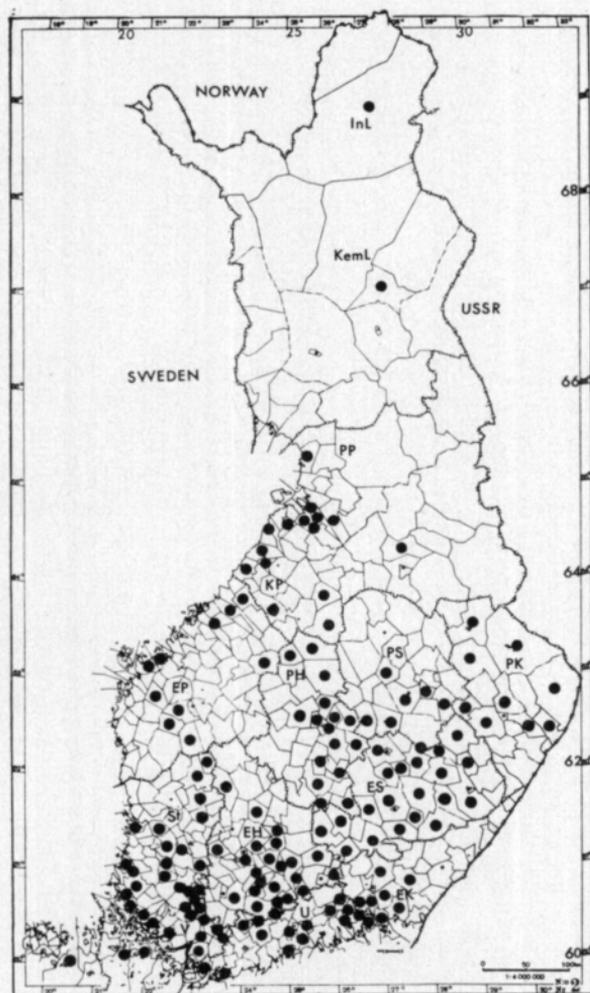


Fig. 1. The occurrence of *Helminthosporium avenae* on oats (*Avena sativa*) by localities in Finland during the period 1971–1973.

- A: Föglö;
V: Kalanti, Karainen, Karkkila, Kiikala, Kodisjoki, Korppoo, Koski Tl., Kuusjoki, Laitila, Lemu, Marttila, Nauvo, Perniö, Piikkiö, Pusula, Raisio, Salo, Suomusjärvi, Tenhola, Vehmaa, Vihti;
U: Anjala, Artjärvi, Elimäki, Espoo, Helsinki mlk., Hyvinkää, Lapinjärvi, Liljendal, Myrskylä, Pornainen, Pyhtää, Ruotsinpyhtää, Sipoo, Snappertuna, Tuusula;
EK: Karhula, Sippola, Vehkalahti;
St: Hämeenkyrö, Ikaalinen, Keikyä, Kihniö, Kokemäki, Kullaa, Köyliö, Loimaa, Loimaa mlk., Mellilä, Oripää, Parkano, Pori, Punkalaidun, Rauma, Säskylä;
EH: Asikkala, Hartola, Hattula, Hauho, Hausjärvi, Heinola mlk., Hämeenlinna, Janakkala, Korpilahti, Koski Hl., Kuhmalahti, Kuru, Kärkölä, Lammi, Loppi, Luhanka, Luopioinen, Nastola, Orivesi, Pälkäne, Renko, Riihimäki, Sysmä, Sääksmäki, Tammela, Tuulos, Vesilahti;
ES: Anttola, Enonkoski, Hirvensalmi, Joutsa, Juva, Luumäki, Mikkeli, Mäntyharju, Puumala, Ristiina, Sulkava, Sääminki;
EP: Ilmajoki, Jalasjärvi, Koivulahti, Kurikka, Laihia, Maksamaa;
PH: Hankasalmi, Jyväskylän mlk., Konginkangas, Konnevesi, Kinnula, Laukaa, Pihtipudas, Rautalampi, Saarijärvi, Sumiainen, Suolahti, Toivakka, Viitasaari, Äänekoski,
PS: Haukivuori, Heinävesi, Joroinen, Kangaslampi, Kuopio, Maaninka, Pieksämäki, Rautalampi, Riistavesi, Suonenjoki, Tuusniemi, Varkaus, Virtasalmi;
PK: Ilomantsi, Juuka, Kiihtelysvaara, Kontiolahti, Liperi, Nurmes, Outokumpu, Pielisjärvi, Tuupovaara;
KP: Kalajoki, Kannus, Krunupyy, Kälviä, Kärämäki, Merijärvi, Perho, Pyhäjoki, Pyhäjärvi, Raahe, Revonlahti, Sievi;
PP: Ii, Kempele, Liminka, Muhos, Temmes, Tyrnävä;
Kn: Paltamo;
KemL: Pelkosenniemi;
InL: Inari.
Prefect stage: U: Snappertuna 24. 5. 1972.

Table 2. Frequency of *Helminthosporium avenae* and *H. sativum* on oats (*Avena sativa*) in the fields researched in 1971–1973.

Biological provinces of Finland	The samples researched		<i>Helminthosporium</i> species, % of fields researched	
	No. of localities	No. of fields	<i>H. avenae</i> Fig. 1	<i>H. sativum</i> Fig. 13
A	1	1	(100)	(0)
V	24	44	64	5
U	18	49	53	22
EK	3	7	71	43
St	20	39	62	10
EH	27	81	54	7
ES	15	31	71	7
EP	6	20	65	10
PH	16	49	65	4
PS	13	26	73	0
PK	10	24	71	0
KP	18	30	67	7
Kn	3	5	20	20
PP	6	7	100	14
KemL	1	2	(50)	(0)
InL	(1)	(12)	(8)	(0)
Total	181	415		

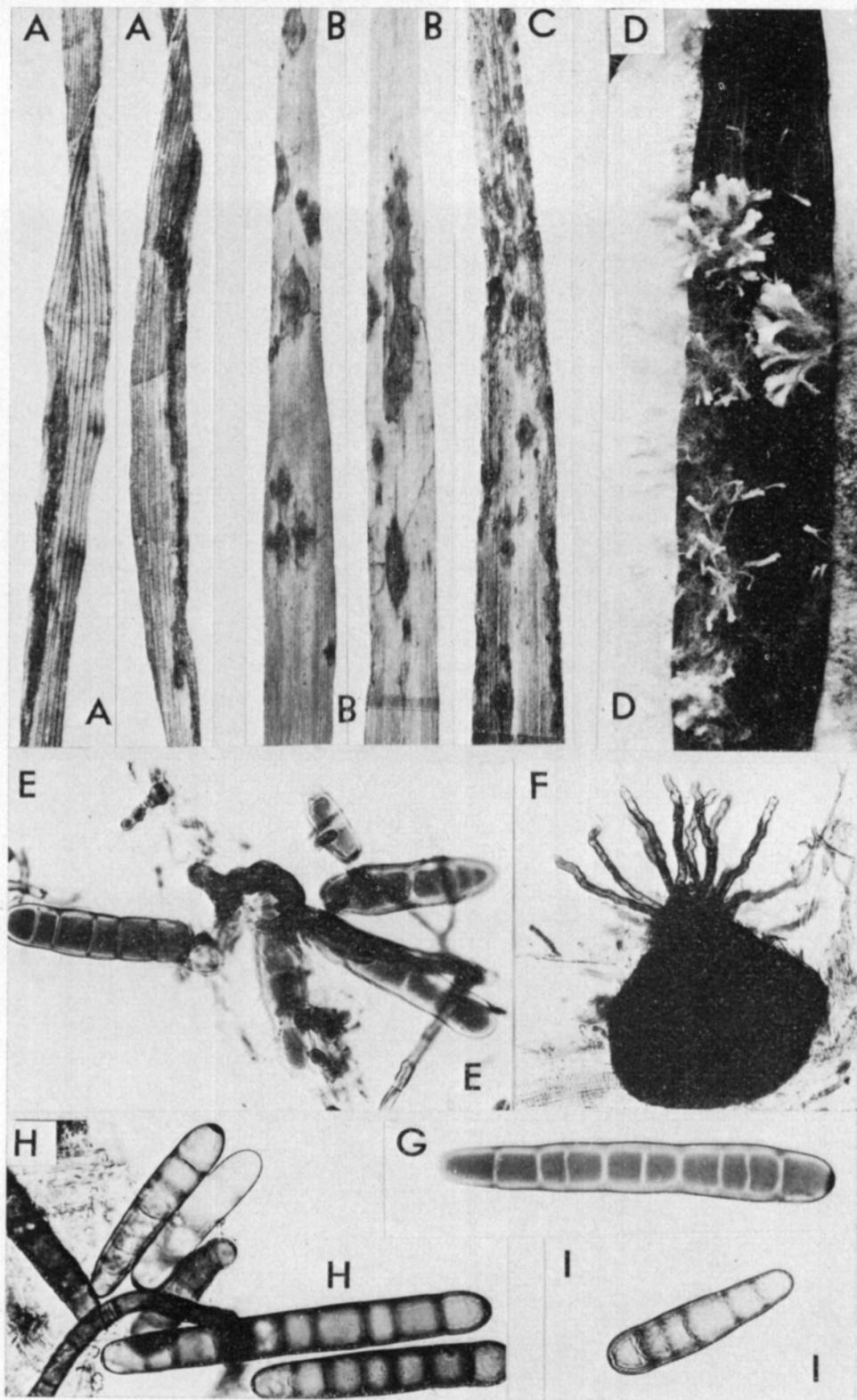


Fig. 2. *Helminthosporium avenae* on oats (*Avena sativa*). A: the primary leaf stripe on seedling in the middle of June, B—C: the secondary leaf spot on leaves in August, D: the mycelial tufts sprout up on the leaf on moist blotter, E: conidiophores and conidia on oat stubble in May, F: *Pyrenophora avenae*'s ascoma on oat stubble in May, G: the conidium on oat leaf in August. *Helminthosporium* spp. H: conidia on spring wheat (*Triticum aestivum*), I: the conidium on winter rye (*Secale cereale*). A—C: x 1, D: x 2, F: x 100, E, H, I: x 500, G: x 1 000.

H. avenae was encountered in different years in an average 63 % (range 46–74 %) of the oat fields (415 fields) and in 87 % of the localities (181 localities) examined (Table 1). The occurrence of the fungus was fairly uniform in different parts of the country (Table 2).

The fungus was found on seedlings, sometimes abundantly in, for instance peat soil in early summer. The first two or three leaves of an infected seedling show brown stripes with yellow-reddish margins (Fig. 2 A) (cf. REKOLA et al. 1970). Leaf damage was commoner, however, at maturity (cf. JØRSTAD 1945). Initially it took the form of spots with an reddish-orange margin surrounding a dead, brown area. The spots may join together (Fig. 2 C) (cf. MÜLLER 1963). In late summer the fungus was very common. The disease occurred equally throughout fields.

H. avenae formed a very characteristic tufty, white cotton growth or coremium on leaves of oats in humid conditions (Fig. 2 D) (cf. MÜLLER 1963, REKOLA et al. 1963). Conidia also formed abundantly, particularly on diseased mature leaves (Fig. 2 G). The perithecial stage and conidia were found only accidentally on stubble (Snappertuna, 24. 5. 1972) (Fig. 2 E, F).

Helminthosporium gramineum

Helminthosporium gramineum Rabenh. ex Schlecht., syn. *Drechslera graminea* (Rabenh. ex Schlecht.) Shoem., perfect stage: *Pyrenophora graminea* Ito & Kurib. Syn. cf. SHOEMAKER 1962: 825.

The fungus causes leaf stripe of barley and it occurs in most of the world's barley-growing areas (DREHCSLER 1923, SPRAGUE 1950). The fungus is seed-borne and usually is overwintered by mycelium in the pericarp (RAVN 1901, de TEMPE 1964).

This disease is generally of limited importance (de TEMPE 1964) but still causes crop losses in many countries, e.g. in the USSR (SHCHEKOKHIKHINA 1964, RASVLEV and KRAOTSOVA 1970) and in Czechoslovakia (ZEKOVIC 1970). In Scandinavia *H. gramineum* has been extremely scarce in Denmark for a long time (ANDERSEN 1955, JØRGENSEN 1969). The disease is found to some extent in Sweden (KOLK 1966) and in Norway (HANSEN and MAGNUS 1969), though its economic significance is small. However, the disease has again occurred in greater abundance, particularly on six-rowed barley, in recent years in the central and northern parts of these countries (LINHELL 1969, OVERAA 1972, KOLK and KARLBERG 1973).

In Finland *H. gramineum* has long been common (LIRO 1917) and continues to be so (HALKILAHTI 1971, MÄKELÄ 1972). According to field tests at the State Seed Testing Station, stripe disease has occurred in about 40–50 % of all the samples of barley examined during the last thirty years (HALKILAHTI 1971). In 1970 and 1971 *H. gramineum* was also found in about 30 % of the barley fields located in the southern and central parts of the country (MÄKELÄ 1972).

In this study *H. gramineum* was encountered on barley throughout the country as far as Lapland (Inari) (Fig. 3). The fungus was found in the following localities:

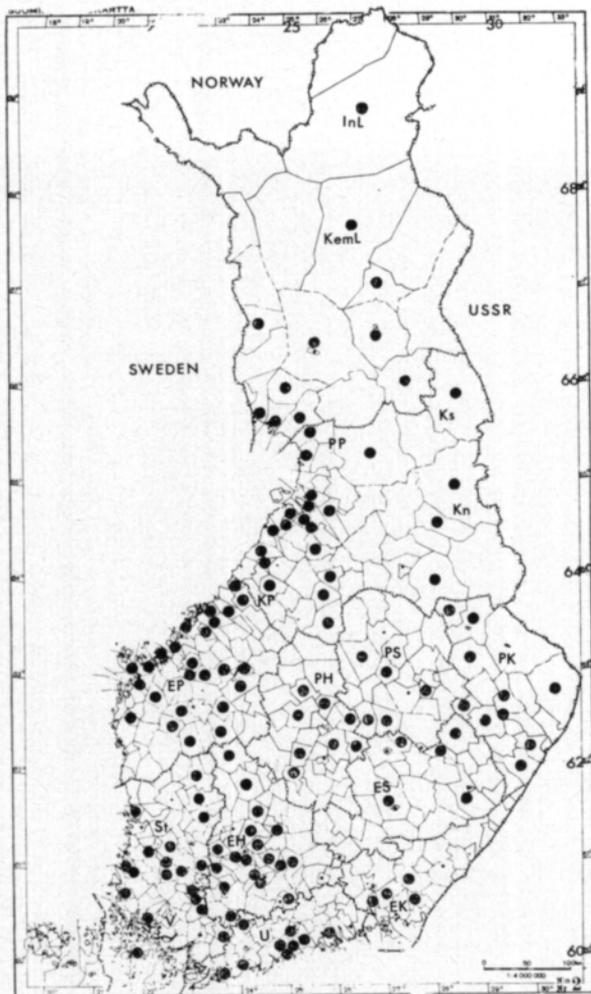


Fig. 3. The occurrence of *Helminthosporium gramineum* on spring barley (*Hordeum vulgare*) by localities in Finland during the period 1971–1973.

- V: Kalanti, Kodisjoki, Koski TL, Masku, Nauvo, Pusula, Suomensjärvi;
 U: Anjala, Helsinki, Inkoo, Porvoo mlk., Sipoo, Snappertuna, Vantaa, Tuusula;
 EK: Miehikkälä, Sippola;
 St: Ahlainen, Hämeenkyrö, Ikaalinen, Kiukainen, Kokemäki, Köyliö, Loimaa mlk., Mellilä, Parkano, Punkalaidun, Rauma, Säskylä, Vampula;
 EH: Forssa, Hattula, Hauho, Hausjärvi, Hämeenlinna, Jämsänkoski, Kangasala, Lammi, Orivesi, Pälkäne, Ruovesi, Sahalahti, Somerniemi, Sääksmäki, Toijala, Tuulos, Urjala, Vesilahti;
 ES: Kangaslampi, Luumäki, Mikkeli, Sääminki;
 EP: Alavus, Ilmajoki, Jalasjärvi, Kauhava, Koivulahti, Kuortane, Kurikka, Laihia, Maksamaa, Mustasaari, Vaasa, Ylihärmä, Ylimarkku;
 PH: Hankasalmi, Kannonkoski, Konginkangas, Konnevesi, Laukaa, Petäjälampi, Rautalampi, Saarijärvi, Virrat;
 PS: Heinävesi, Jäppilä, Maaninka, Pielavesi, Riistavesi, Suonenjoki;
 PK: Ilomantsi, Joensuu, Juuka, Kitee, Kontiolahti, Liperi, Nurmes, Outokumpu, Tohmajärvi, Valtimo;
 KP: Alahärmä, Alajärvi, Himanka, Kannus, Kruunupyy, Kokkola, Kälviä, Kärämäki, Lappajärvi, Merijärvi, Munsala, Pattijoki, Pietarsaari, Piippola, Pyhäjoki, Pyhäjärvi, Rantsila, Revonlahti, Vimpeli, Ylivieska, Ähtävä;

Kn: Hyrynsalmi, Sotkamo, Suomussalmi;
PP: Ii, Kemi, Kemijärvi, Kempele, Kuivaniemi, Liminka, Lumijoki, Muhos, Oulu, Pello,
Pudasjärvi, Rovaniemi, Simo, Temmes, Tervola, Tornio;
Ks: Kuusamo, Posio;
KemL: Pelkosenniemi, Sodankylä;
InL: Inari
Perfect stage: V: Tenhola, 24. 5. 1972,
U: Helsinki (Viikki), 6. 6. 1972.

H. gramineum was found in different years in an average 32 % (range 24–40 %) of the fields (803 fields) and in 54 % of the localities (251 localities) studied (Table 1). The fungus was much commoner in six-rowed varieties (23–44 %) than in two-rowed varieties (18–29 %), an observation which is widely confirmed (HANSEN and MAGNUS 1969, ZEKOVIC 1970, KOLK and KARLBERG 1973). Similar results were obtained during all the trial years. On the other hand the occurrence of *H. gramineum* varied greatly in different fields and in different provinces (Table 3). In the most important barley-cultivating areas, in the south-western and southern provinces, the fungus was observed to occur the least frequently. In Ostrobothnia (EP, KP, PP) leaf stripe of barley was found more frequently than in the neighboring provinces, not including the northern parts of the country. Fields may be found where more than 1/3 of the barley plants have been destroyed by leaf stripe in the late summer (Fig. 5). Results of the State Seed Testing Station substantiate these observations (HALKILAHTI 1971, 1973 b).

Ascocarps, morphologically similar to *Pyrenophora graminea* or *P. teres*, were found only a few times on overwintered stubble of barley.

Helminthosporium teres

Helminthosporium teres Sacc., syn. *Drechslera teres* (Sacc.) Shoem., perfect stage: *Pyrenophore teres* Drechs. Syn. cf. SHOEMAKER 1962: 826.

The fungus causes net-blotch disease of barley. It occurs occasionally also on oats, wheat, rye and other grasses (cf. SHIPTON et al. 1973).

The fungus can be seed-borne as conidia or mycelium. It may over-winter also as the perfect stage on culms straw and stubble and as sclerotia on the dead leaves and on crop debris (WEBSTER 1951, KENNETH 1962, SMEDEGÅRD—PETERSEN 1971, 1972 b). Seed infection is probably worse at low temperature (RAVN 1901).

H. teres occurs in most barley-growing countries (SPRAGUE 1950, CMI map no. 364, 1968) and has caused several kinds of damage to barley, particularly during the last years (KENNETH 1962, EVANS 1969, RINTELEN 1969, MELVILLE and LANHAM 1972).

In Scandinavia *H. teres* is commonly found in Sweden (FRIT 1966, KOLK 1966, KOLK and KARLBERG 1973) and in Norway (HANSEN and MAGNUS 1969, OVERAA 1972), though its economic significance is small. Also in Denmark the disease has so far played a minor role (ANDERSEN 1955). During the past five years, however, there has been a marked increase in the prevalence of *H. teres* (SMEDEGÅRD—PETERSEN 1971, 1972 a, 1974.)

Table 3. Frequency of *Helminthosporium gramineum*, *H. teres* and *H. sativum* on spring barley (*Hordeum vulgare*) in the fields researched in 1971—1973.

Biological provinces of Finland	The samples researched						<i>Helminthosporium</i> species, % of fields researched					
	Two-rowed		Six-rowed		Total		<i>H. gramineum</i>		<i>H. teres</i>		<i>H. sativum</i>	
	No. of localities	No. of fields	No. of localities	No. of fields	No. of localities	No. of fields	Two-rowed	Six-rowed	Total	Two-rowed	Six-rowed	Total
A	—	—	1	1	1	1	(0)	(0)	(0)	—	(0)	(0)
V	20	31	23	27	28	58	10	22	16	55	74	64
U	18	32	17	37	21	69	34	19	26	69	76	73
EK	1	1	7	11	7	12	(100)	9	17	(0)	91	83
St	13	24	26	72	27	96	17	21	20	46	64	59
EH	20	45	39	132	41	177	29	14	18	40	66	59
ES	3	4	14	48	15	52	0	15	14	75	65	65
EP	4	4	12	42	14	46	25	62	59	75	71	72
PH	1	2	19	77	19	79	(0)	25	24	(50)	52	52
PS	—	—	13	28	13	28	—	29	29	—	54	54
PK	—	—	13	49	13	49	—	35	35	—	53	53
KP	2	4	25	53	26	57	0	64	64	25	53	51
Kn	—	—	6	15	6	15	—	53	53	—	60	60
PP	1	3	14	40	15	43	33	88	84	0	28	26
Ks	—	—	3	10	3	10	—	90	90	—	10	10
KemL	—	—	2	11	2	11	—	100	100	—	18	18
InL	(1)	(7)	(1)	(8)	(1)	(15)	(0)	(13)	(7)	(0)	(0)	(0)
Total	83	150	234	653	251	803						

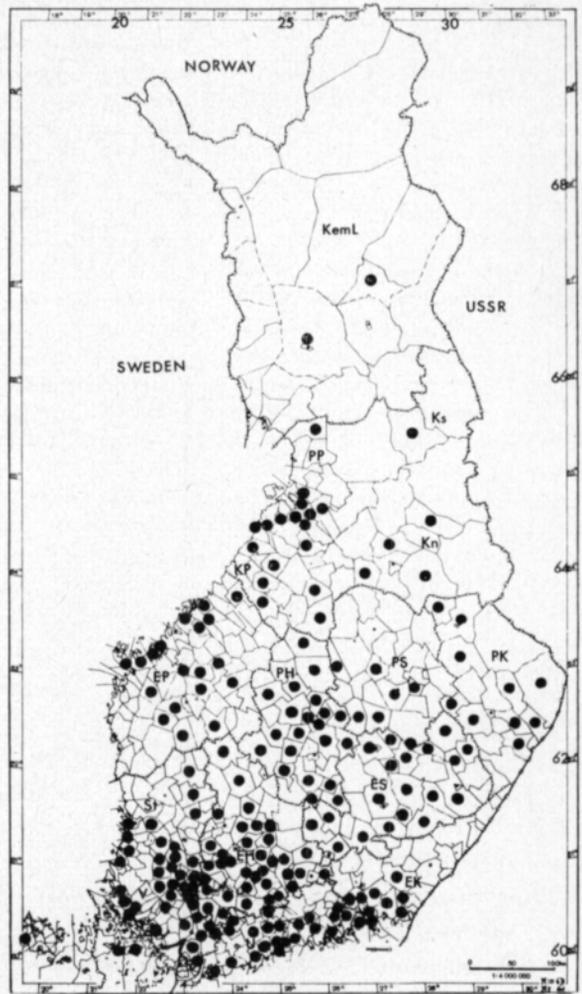


Fig. 4. The occurrence of *Helminthosporium teres* on spring barley (*Hordeum vulgare*) by localities in Finland during the period 1971–1973.

In Finland the same trend is seen. The fungus is apparently considered to be of negligible significance because up to now it has not attracted attention. In 1970 and 1971, however, *H. teres* was found in over 50 % of the barley fields examined (MÄKELÄ 1972).

In this study *H. teres* was encountered on barley throughout the country as far north as Kemi Lapland (Pelkosenniemi) (Fig. 4). The fungus was found in the following localities:

- A: Eckerö;
- V: Aura, Halikko, Kalanti, Karkkila, Kiikala, Korppoo, Koski Tl., Kuusjoki, Lemu, Mietoinen, Muurla, Nauvo, Nummi, Perniö, Piikkiö, Pusula, Pöytyä, Suomusjärvi, Tenhola, Vehmas, Vihti;
- U: Anjala, Askola, Elimäki, Espoo, Helsinki, Hyvinkää, Inkoo, Kirkkonummi, Lapinjärvi, Liljendal, Nurmijärvi, Pernaja, Pornainen, Porvoo mlk., Pyhtää, Ruotsinpyhtää, Sipoo, Snappertuna, Vantaa, Tuusula;
- EK: Karhula, Kymi, Luumäki, Miehikkälä, Sippola, Vehkalahti, Virolahti;
- St: Alastaro, Eurajoki, Huittinen, Hämeenkyrö, Ikaalinen, Keikyä, Kokemäki, Kullaa, Köyliö, Loimaa, Loimaa mlk., Luvia, Mellilä, Metsämaa, Oripää, Parkano, Pori, Punkalaidun, Rauma, Säkyliä, Vampula, Yläne;

- EH: Asikkala, Hartola, Hattula, Hauho, Hausjärvi, Heinola mlk., Hollola, Humpkala, Hämeenlinna, Janakkala, Jokioinen, Jämsänkoski, Kangasala, Korpilahti, Koski Hl., Kuhmalahti, Kylmäkoski, Kärkölä, Lammi, Loppi, Luhanka, Luopioinen, Nastola, Orivesi, Pälkäne, Renko, Riihimäki, Ruovesi, Sahalahti, Somerniemi, Somero, Sysmä, Tammela, Toijala, Tuulos, Urjala, Vesilahti, Viiala, Ylöjärvi;
- ES: Anttola, Enonkoski, Joutsa, Juva, Kangaslampi, Leivonmäki, Luumäki, Mikkeli, Mäntyharju, Puumala, Ristiina, Sulkava, Sääminki, Valkeala;
- EP: Alavus, Ilmajoki, Jalasjärvi, Kauhava, Koivulahti, Kurikka, Laihia, Lapua, Maksamaa, Mustasaari, Ylihärmä;
- PH: Hankasalmi, Kannonkoski, Karstula, Keitele, Keuruu, Konginkangas, Konnevesi, Laukaa, Multia, Petäjavesi, Pihtipudas, Rautalampi, Saarijärvi, Sumiainen, Suolahti, Uurainen, Viitasaari, Virrat, Äänekoski;
- PS: Joroinen, Jäppilä, Heinävesi, Kuopio, Maaninka, Pieksämäki mlk., Riistavesi, Savonranta, Suonenjoki, Varkaus, Virtasalmi;
- PK: Eno, Ilomantsi, Juuka, Kiihtelysvaara, Liperi, Nurmes, Outokumpu, Tohmajärvi, Tuupovaara, Valtimo;
- KP: Alajärvi, Kannus, Kruunupyö, Kärämäki, Lappajärvi, Munsala, Kokkola, Oulainen, Pattijoki, Pietarsaari, Pyhäjoki, Pyhäjärvi, Raahe, Rantsila, Revonlahti, Sievi, Ylivieska, Ähtävä;
- Kn: Hyrynsalmi, Paltamo, Sotkamo, Vuolijoki;
- PP: Kempele, Kuivaniemi, Liminka, Muhos, Oulu, Rovaniemi, Temmes, Tyrnävä;
- Ks: Taivalkoski;
- KemL: Pelkosenniemi.

H. teres was found indifferent years in an average 57 % (range 45–67 %) of the fields (803 fields) and in 87 % of the localities (251 localities) examined (Table 1). The fungus was rather commoner in six-rowed varieties (47–66 %) than in two-rowed varieties (37–68 %). Also e.g. two-rowed barley cv Herta is known to be resistant to *H. teres* (McDONALD and BUCHANNON 1964, HANSEN and MAGNUS 1969).

The occurrence of *H. teres* varied greatly in different fields and different provinces (Table 3). The disease was observed to occur most commonly in the southern and southwestern parts of the country, which are the most important areas where barley is grown, and to decrease gradually towards the north. The fungus was found to be particularly rare in North Ostrobothnia and Lapland. This runs counter to *H. gramineum*, which was found to be commonest in the northern parts of the country and rarest in the most important cultivating areas (Table 3, Fig. 3).

Results were similar during all the trial years. In 1973 *H. teres* was found to be comparatively rarer than in 1971 and 1972, especially in Uusimaa, South Karelia and South Savo, apparently owing to weather conditions. Also the occurrence of *H. teres* varied greatly in different fields. As a rule the disease was uniform in a given field.

The fungus tainted the leaves of barley with various kinds of spots, the commonest of which were net blotch and small leaf spot (Fig. 5). These often occurred together in the same sample (cf. MÄKELÄ 1972). This material does not furnish a basis for saying which type of symptom caused by *H. teres* is the commonest in Finland. Only in 1971 was the late summer sufficiently humid to study symptoms of the disease on barley leaves, whereas in 1972 and especially in 1973 barley ripened too rapidly. The spot type has been found to be somewhat

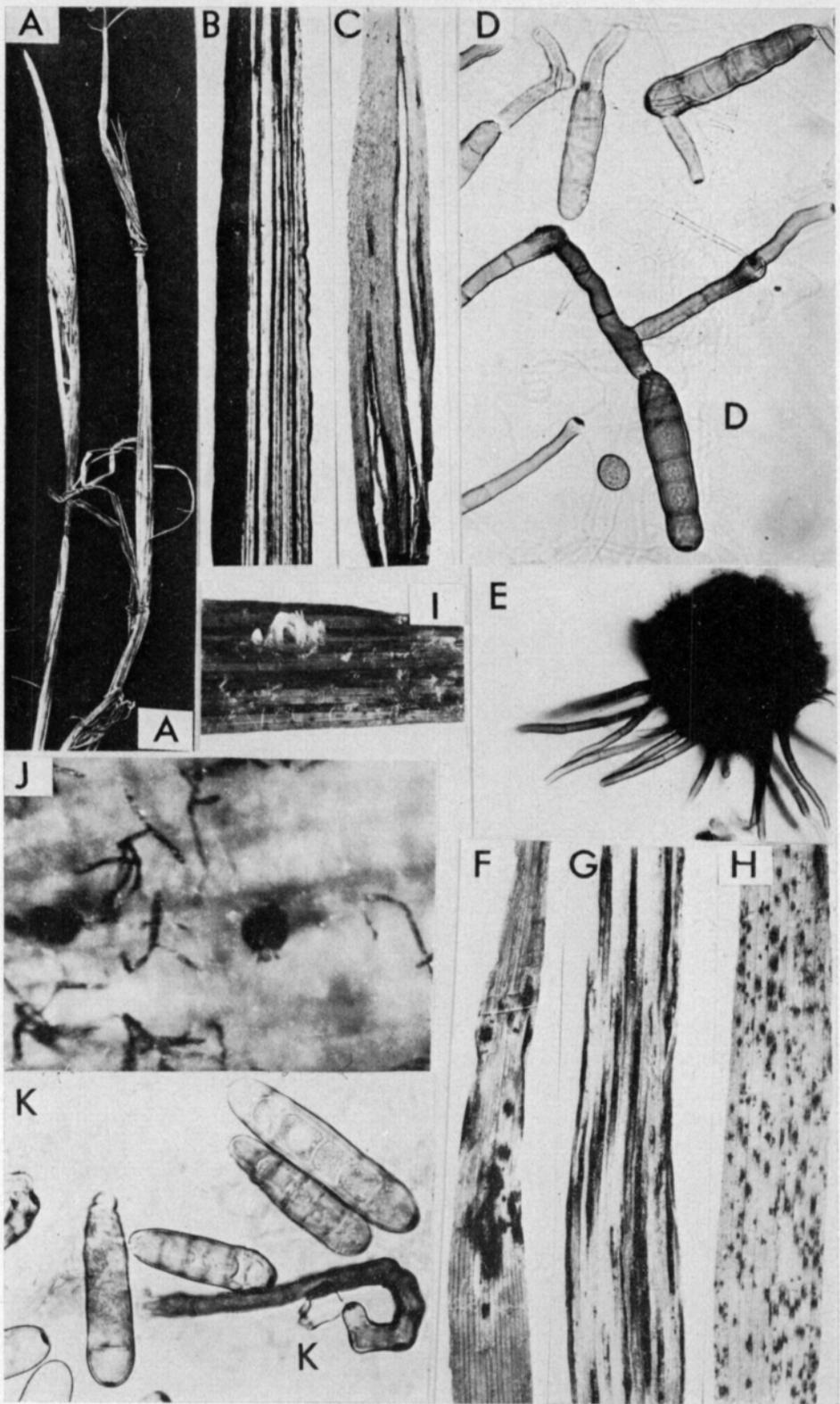


Fig. 5. *Helminthosporium gramineum* on spring barley (*Hordeum vulgare*). A: the ear is arrested in its development, B: the yellow stripes on the leaf of younger plants, C: the brown stripes, shredding of the leaf of mature plants, D: conidiophores and conidia, E: the protothecium with growing mycelia. *H. teres* on spring barley. F—H: types of lesion on barley leaves, F: the primary leaf lesions on seedling in the middle of June, G: net blotch, H: spot types in the end of July, I: the mycelial tufts sprout up on leaf on moist blotter, J: conidiophores, conidia and pycnidial stage on leaf, K: conidiophores and conidia. A: x 1/2, B, C: x 1, D: x 500, E: x 200, F—H: x 1 1/2, I: x 2, J: x 20, K: x 1 000.

commoner than the net blotch type both in Norway (HANSEN and MAGNUS 1969) and in Denmark (SMEDEGÅRD—PETERSEN 1971).

Pycnidia were observed in less than 5 % of the samples examined (MÄKELÄ 1972). The perfect stage *Pyrenophora teres* has not been found with certainty in Finland (cf. p. 191).

Helminthosporium spp.

Helminthosporium spp. on wheat and rye

In this study there was found on wheat and rye a fungus (or fungi) of the *Helminthosporium* species which is morphologically similar to *H. gramineum* and *H. teres*. The fungus was observed on rye only three times in 1972 (U: Tuusula 2. 8., St: Loimaa mlk. 22. 7., ES: Sääminki 24. 7.), and on winter wheat also three times (EH: Luopioinen 24. 7. 1972, St: Hämeenkyrö 1. 8. 1972, V: Muurla 25. 7. 1973). In addition *Helminthosporium* species were found on spring wheat in small quantities throughout the country up to North Savo (Table 4) in the following localities:

- V: Koski Tl., Marttila, Paimio, Pusula;
- U: Nurmijärvi, Ruotsinpyhtää, Tuusula, Vantaa;
- St: Säskylä;
- EH: Hauho, Kärkölä, Lammi, Sääksmäki, Tuulos;
- ES: Juva, Mäntyharju;
- EP: Laihia, Maksamaa;
- PS: Kangaslampi, Virtasalmi.

The fungus was encountered in about 11 per cent of the spring wheat fields (about 220 fields) and in 18 % of the localities (111 localities) studied (Table 1). Conidia of the fungus (or fungi) were found only on ripening and withering leaves of rye and wheat on brown, necrotic spots usually in the company of other fungi (Fig. 2 H, I). Only rare isolates have been made from leaves of spring wheat.

Besides barley, *H. gramineum* is known to occur in many localities, though with little importance (e.g. PETTINARI 1955, RASULEV and KAVTSOVA 1970) in inoculation tests also on rye (RASULEV and KAVTSOVA 1970, MÄKELÄ 1972).

Also *H. teres* has been found on wheat (cf. SHIPTOM et al. 1973), in inoculation tests both on wheat and rye (MÄKELÄ 1972). *H. avenae* has occurred sparsely on wheat and rye (KOLK 1966).

Helminthosporium tritici-repentis

Helminthosporium tritici-repentis Died., syn. *H. tritici-vulgaris* Nisikado (cf. SHOEMAKER 1962, HOSFORD 1971), *Drechslera tritici-repentis* (Died.) Shoem., perfect stage: *Pyrenophora tritici-repentis* (Died.) Drechs., syn. *P. trichostoma* (Fr.) Fckl. (cf. HOSFORD 1972). Syn. cf. SHOEMAKER 1962: 831.

The fungus causes leaf blight and root injury on wheat and *Agropyron repens* (L.) PB. but is frequently found on brown necrotic leaves of many grasses (SPRAGUE 1950, SHOEMAKER 1962). It appears to be a worldwide

Table 4. Frequency of *Helminthosporium tritici-repentis*, *H. sativum* and *Helminthosporium* spp. on spring wheat, winter wheat, winter wheat (*Triticum aestivum*), winter rye (*Secale cereale*) and couch grass (*Agropyron repens*) in the fields researched in 1972 and 1973.

Biological provinces of Finland	The samples researched										Helminthosporium species, % of fields researched					
	Spring wheat		Winter wheat		Winter rye		Couch grass		H. tritici-repentis		H. sativum		Helminthosporium spp.			
	No. of localities	No. of fields	No. of localities	No. of fields	No. of localities	No. of fields	No. of localities	No. of fields	Spring wheat	Winter wheat	Spring wheat	Winter wheat	Spring wheat	Winter wheat		
V	19	42	18	78	19	53	17	26	29	22	21	58	2	4	10	
U	20	56	18	67	19	86	12	49	34	15	15	45	4	5	7	
EK	2	2	1	1	3	2	—	—	(50)	(100)	(50)	—	(50)	(0)	(0)	
St	13	27	10	39	10	29	9	15	19	3	17	53	19	0	11	
EH	27	55	18	70	28	107	13	31	26	20	21	42	7	1	15	
ES	10	10	1	1	9	22	6	7	30	—	36	57	0	—	20	
LK	—	—	—	—	—	—	3	3	—	—	—	(100)	—	—	—	
EP	4	6	1	1	3	7	1	4	0	—	14	50	50	—	50	
PH	3	3	3	3	6	8	3	7	(0)	(100)	50	57	(33)	(0)	(0)	
PS	7	12	—	—	5	6	1	1	50	—	67	(0)	8	—	17	
PK	3	5	1	1	4	10	4	8	0	(0)	20	75	0	(0)	0	
KP	2	2	1	1	3	5	4	4	(50)	(0)	80	50	(50)	—	(0)	
Kn	1	2	—	—	1	1	3	4	(0)	—	(0)	25	(0)	—	(0)	
PP	—	—	—	—	2	5	3	5	—	—	40	20	—	—	—	
KemL	—	—	—	—	—	—	3	3	—	—	—	(67)	—	—	—	
EnL	—	—	—	—	—	—	1	2	—	—	—	(100)	—	—	—	
InL	(1)	(13)	—	—	—	—	—	—	(0)	—	—	—	(8)	—	(0)	
Total	111	222	72	259	112	341	82	169								

pathogen on wheat, especially on spring wheat (*Triticum aestivum* L.) (SPRAGUE 1950, HOSFORD 1971, 1972, VOÍTOVA 1971).

In Europe the fungus has played only a minor role on wheat. It was first observed in Germany in 1935 (RAABE 1937), Switzerland in 1959 (AMMON 1963) and Austria in 1965 (GLAESER 1966).

Only a little is known about *H. tritici-repentis* on rye (*Secale cereale* L.) in Poland (GARBOWSKI 1932), the USA (SPRAGUE 1950, EARHART 1952) and Canada (SHOEMAKER 1962).

On the other hand the species has been reported to be common on *Agropyron repens* (L.) PB. throughout the world (SPRAGUE 1950, SHOEMAKER 1960). In Europe the fungus has been known since the turn of the century in Germany (NOAK 1905), Britain (DENNIS and WAKEFIELD 1946), Denmark (ANDERSEN 1955), Poland (GARBOWSKI 1932) and Finland (MÄKELÄ 1971).

Wheat

Helminthosporium tritici-repentis occurred on wheat in the southern parts of the country (Fig. 6). The fungus was common on winter wheat in the south-

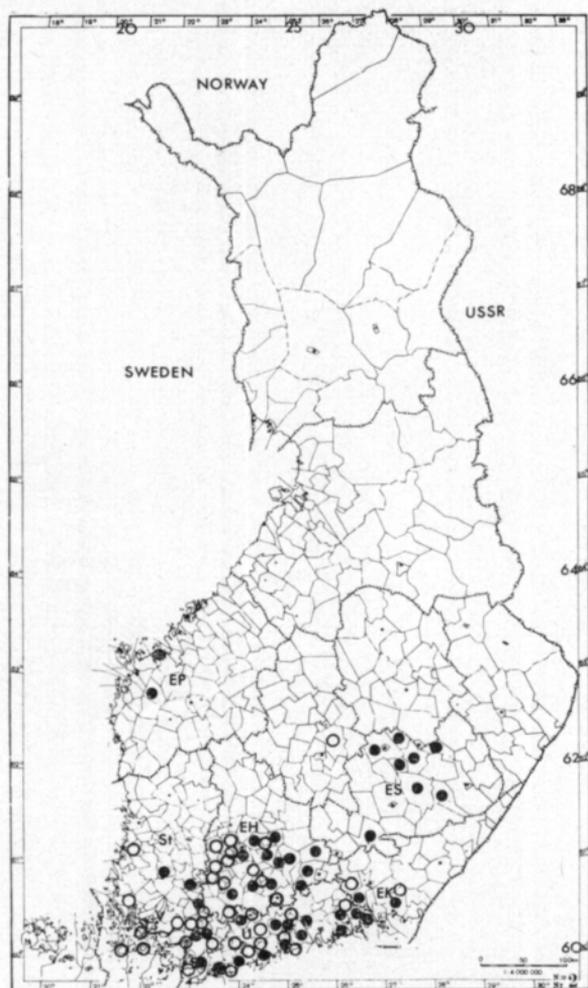


Fig. 6. The occurrence of *Helminthosporium tritici-repentis* on spring wheat (shaded circle) and winter wheat (open circle) (*Triticum aestivum*) by localities in Finland during the period 1971–1973.

western parts of the country and on spring wheat also in South Savo and in South Ostrobothnia. These are the main wheat-cultivating areas in Finland (Table 4). The fungus was encountered in 27 % of the fields of spring wheat (222 fields) and in 40 % of the localities (111 localities) studied as well as in 17 % of the fields of winter wheat (259 fields) and in 53 % of the localities (72 localities) examined (Table 1). *H. tritici-repentis* was found in the following localities:

Spring wheat

- V: Koski Tl., Muurla, Pusula, Salo, Tenhola;
U: Elimäki, Helsinki, Inkoo, Kirkkonummi, Liljendal, Nurmijärvi, Pernaja, Pornainen, Pyhäntää, Ruotsinpyhtää, Sipoo, Tammisaari mlk., Vantaa, Tuusula;
EK: Vehkalahti;
St: Loimaa mlk., Säskylä;
EH: Asikkala, Hauho, Hollola, Janakkala, Kärkölä, Lammi, Luopioinen, Pälkäne, Renko, Sääksmäki, Tammela, Tuulos;
ES: Juva, Mäntyharju, Sulkava;
EP: Laihia, Maksamaa;
PS: Haukivuori, Joroinen, Jäppilä, Kangaslampi, Pieksämäki, Virtasalmi;
Perfect stage: U: Helsinki (Viikki), 6. 6. 1972, Pornainen, 25. 5. 1972.
V: Lohja mlk., 24. 5. 1972.

Winter wheat

- V: Halikko, Kalanti, Karkkila, Kisko, Korppoo, Kuusjoki, Muurla, Nauvo, Paimio, Parainen, Perniö, Salo, Tenhola, Vehmas, Vihti;
U: Helsinki, Inkoo, Kirkkonummi, Lapinjärvi, Lohja mlk., Pornainen, Snappertuna, Tuusula, Vantaa;
EK: Vehkalahti;
EH: Forssa, Hattula, Humppila, Hämeenlinna, Iitti, Kylmäkoski, Lempäälä, Luopioinen, Riihimäki, Toijala, Urjala, Vesilahti;
PH: Laukaa.
Perfect stage: V: Perniö, 24. 5. 1972.

Spores of *H. tritici-repentis* were found in greatest abundance right often early spring (April) on winter wheat and after early summer (July) on spring wheat on ripening and withering leaves (Fig. 10 G); namely, on brown necrotic spot. The perithecial stage was found accidentally on stubble in spring (Fig. 8).

Winte rye

Helminthosporium tritici-repentis was encountered in the southern parts of the country up to Middle Ostrobothnia (Fig. 7). This is Finland's rye bowl. The fungus was found in about 1/4 of the rye fields studied (340 fields) and in about 1/2 of the localities (112 localities) (Table 1) as follows:

- V: Korppoo, Lohja mlk., Masku, Mietoinen, Nauvo, Paimio, Pöytyä, Raisio, Vehmas;
U: Helsinki, Hyvinkää, Inkoo, Tuusula;
EK: Sippola;
St: Huittinen, Ikaalinen, Köyliö, Luvia, Oripää;
EH: Asikkala, Hattula, Hauho, Heinola mlk., Hämeenlinna, Janakkala, Kylmäkoski, Kärkölä, Luopioinen, Pälkäne, Renko, Ruovesi, Sahalahti, Sysmä, Toijala, Tuulos, Urjala, Vesilahti;

ES: Juva, Kangaslampi, Mikkeli mlk., Mäntyharju, Puumala, Sulkava, Sääminki;
 EP: Jalasjärvi;
 PH: Laukaa, Pihtipudas, Sumiainen, Uurainen;
 PS: Haukivuori, Jäppilä, Pieksämäki;
 PK: Ilomantsi, Viinijärvi;
 KP: Munsala, Raahe, Sievi;
 PP: Ii, Liminka;
 Perfecta stage: U: Helsinki (Viikki), 18. 5. 1972.
 PS: Jäppilä, 25. 7. 1972.

Spores of *H. tritici-repentis* were found on rye since early June. In ripening season they were observed chiefly on brown necrotic spots, streaks or necrotic areas — these may extend the length of the blade — or the tip of the blade (Fig. 8 A). In addition to *H. tritici-repentis* several other parasitic species such as *Septoria nodorum* (Berk.) Berk. and other *Septoria* species, *Puccinia*, *Fusarium* species and *Erysiphe graminis* CD. were observed grow at the same time on the leaves of rye and wheat. Similar observations have been made elsewhere (SPRAGUE 1950, HOSFORD 1971, 1972).

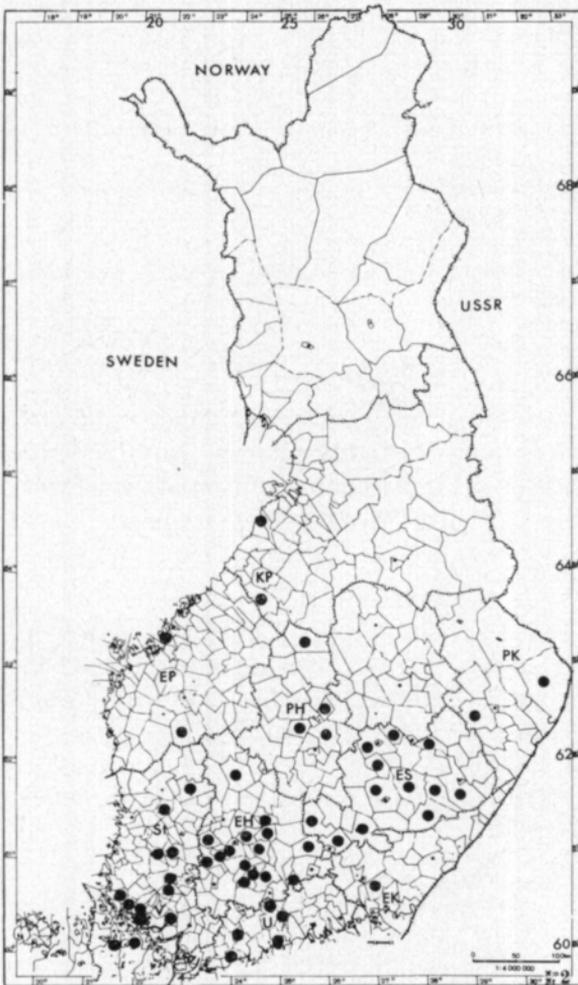


Fig. 7. The occurrence of *Helminthosporium tritici-repentis* on winter rye (*Secale cereale*) by localities in Finland during the period 1971—1973.

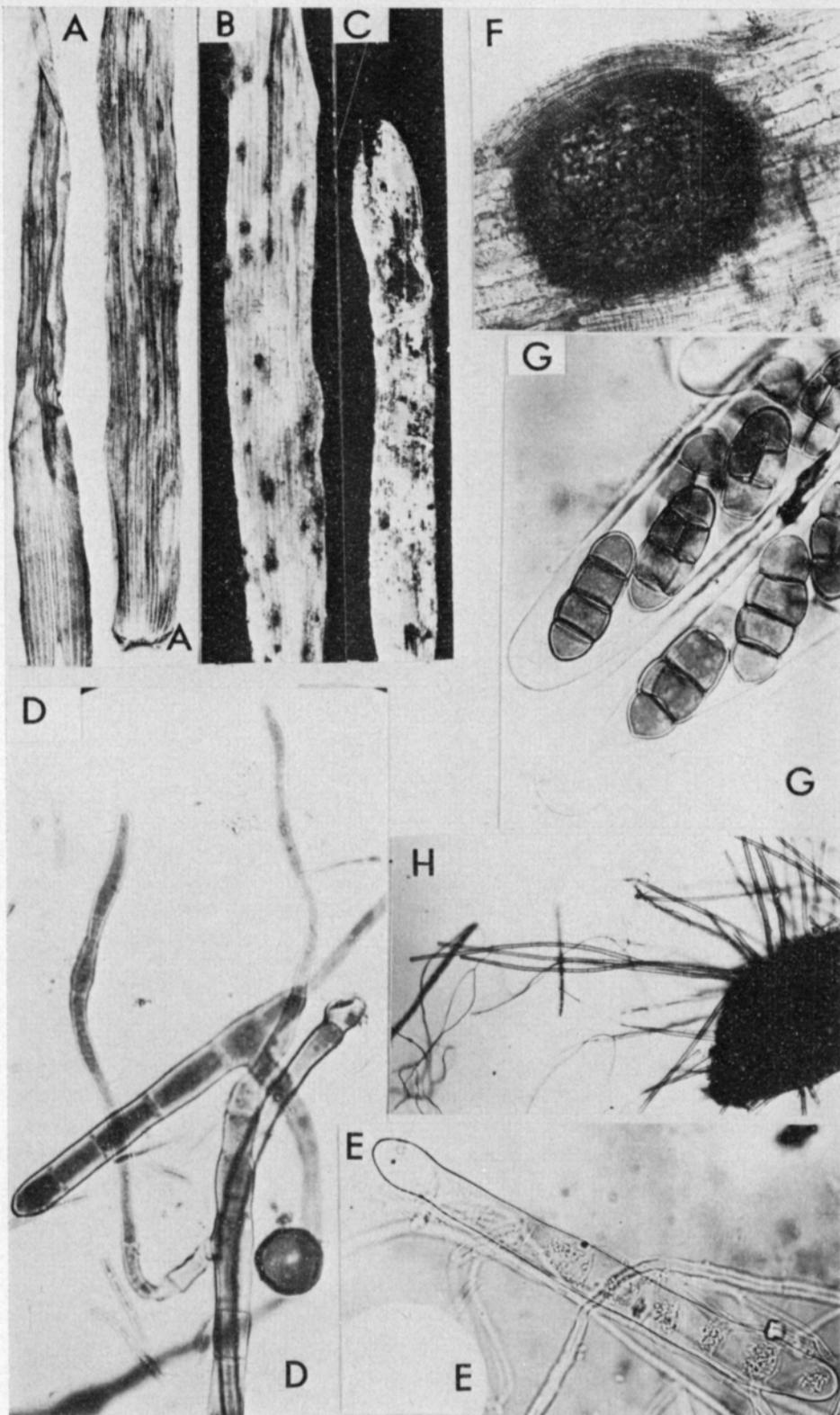


Fig. 8. *Helminthosporium (Pyrenophora) tritici-repentis* on winter rye (*Secale cereale*) (A–F) and winter wheat (*Triticum aestivum*) (G–H). A: the characteristic leaf lesions in the beginning of July, B: the immature pseudothecia on leaf and C: the white conidiophores and conidia of the fungi on leaf in moist blotter, D, E: conidiophores and conidia on leaves in July, F: the sclerotium in leaf, G: asci and ascospores on stubble in May, H: the sclerotium with growing conidiophores and conidia on stubble in May. A–C: x 1, D: x 500, E: x 1 000, F: x 200; G: x 500; H: x 150.

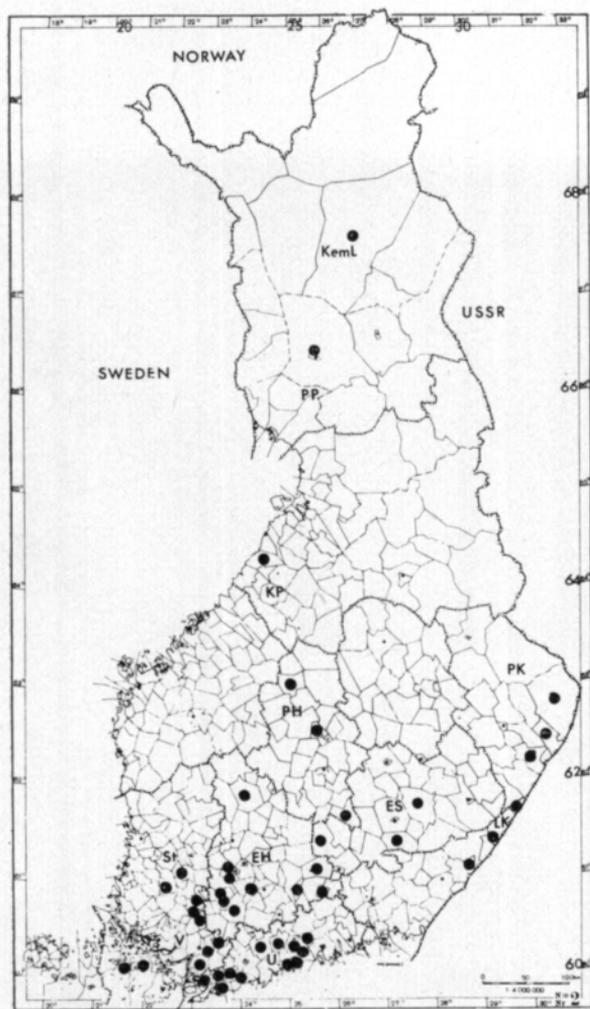


Fig. 9. The occurrence of *Helminthosporium tritici-repentis* on couch grass (*Agropyron repens*) by localities in Finland during the period 1971-1973.

Conidia of *H. tritici-repentis* were long, straight, cylindrical and light yellowish-brown in colour (Figs. 8 and 10) (cf. HOSFORD 1972). They were morphologically similar on wheat and rye.

The effect of this disease on the yield is not known. The fungus, however, is probably of small economic importance in spite of its commonness.

Couch grass

Helminthosporium tritici-repentis was found commonly throughout the country up to Lapland (Sodankylä) (Fig. 9). However, the most abundant samples were gathered in the southern parts of the country (Table 4). The fungus was found in about 1/2 of the couch grass samples examined (Table 1) as follows:

- V: Karjaa, Kiikala, Korppoo, Koski Tl., Muurla, Nauvo, Perniö, Pohja, Tenhola, Vihti;
- U: Helsinki, Inkoo, Kerava, Kirkkonummi, Nurmijärvi, Pornainen, Snappertuna, Vantaa;
- St: Huittinen, Loimaa, Mellilä, Säkylä;

- EH: Asikkala, Forssa, Hattula, Kojjärvi, Koski Hl., Kylmäkoski, Lahti, Sysmä, Tammela, Viiala;
 ES: Imatra, Joutsa, Juva, Ristiina;
 LK: Simpele, Uukuniemi;
 PH: Kivijärvi, Ruovesi, Äänekoski;
 PK: Ilomantsi, Tohmajärvi, Tuupovaara;
 KP: Pyhäjoki;
 PP: Rovaniemi;
 KemL: Sodankylä.
 Perfect stage: V: Kiikala, Koski Tl. 1. 6. 1972, Perniö 24. 8. 1972, Pohja 8. 5. 1973, Tenhola 24. 5. 1972, 5. 5. 1973, Vihti 1. 6. 1972;
 U: Helsinki 13. 5. 1968, 9. 4. 1972, 30. 5. 1972, 4. 6. 1972, Inkoo 24. 5. 1972, 8. 5. 1973, Kirkkonummi 24. 5. 1972, Snappertuna 24. 5. 1972, Vantaa 28. 5. 1972;
 St: Loimaa, Mellilä 1. 6. 1972;
 EH: Forssa 1. 6. 1972, Kojjärvi 4. 5. 1967, Koski Hl. 15. 6. 1972, Kylmäkoski 23. 6. 1973, Lahti 9. 7. 1972, Tammela 1. 6. 1972;
 ES: Imatra 29. 6. 1972, Juva 5. 7. 1972, Mikkeli 21. 5. 1968;
 LK: Simpele 29. 6. 1972, Uukuniemi 29. 6. 1972;
 EP: Vöyri 17. 8. 1972;
 PH: Kivijärvi 30. 6. 1973;
 PK: Ilomantsi 3. 6. 1972, 4. 6. 1972, Tohmajärvi, Tuupovaara 30. 6. 1972;
 KemL: Sodankylä 2. 8. 1973.

The fungus produced abundant delicate blackish-brown streaks, the margins of which sometimes can be yellow, and necrotic spots or greater lesions, which were lighter in colour on the leaves and dead tips of blades (Fig. 10 A) (cf. MÄKELÄ 1971). In moist conditions the leaves were rapidly overgrown with white tufts, conidia and perithecia.

Conidia of *H. tritici-repentis* was found to be most abundant on dead leaves in the early spring and the late summer; it was rather rare in the early summer. Conidia of the fungus observed on couch grass (Fig. 10 F) were similar to the conidia on wheat and rye (Figs. 8 and 10).

Perfect stage, *Pyrenophora tritici-repentis*' ascomas with mature ascospores were found to be very common (about 1/4) on overwintered dead culms and leaves in early spring, May—June (Fig. 10) (cf. MÄKELÄ 1971).

Helminthosporium sativum

Helminthosporium sativum Pammel, King and Bakke, syn. *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem., perfect stage: *Cochliobolus sativus* (Ito et Kurib.) Drechs. Syn. cf. SHOEMAKER 1959: 884.

The fungus causes root rot, seedling blight and leaf spot on cereals, above all on barley and wheat as well as on dozens of species of grasses (DRECHSLER 1923, SPRAGUE 1950). In the western hemisphere, where intensive cereal cultivation is practised and where temperatures are high, *H. sativum* is most important as a root rot or blight of wheat and barley (SPRAGUE 1950). The fungus caused root rots of wheat also in zones with sufficient moisture in western and eastern Siberia and in the Soviet Far East (KORSHUNOVA 1968). In Europe, however, *H. sativum* commonly causes a leaf spot and seedling blight on barley and also, though less frequently on wheat (MÜLLER 1956, LANGE de la CAMP 1958, de TEMPE 1964).

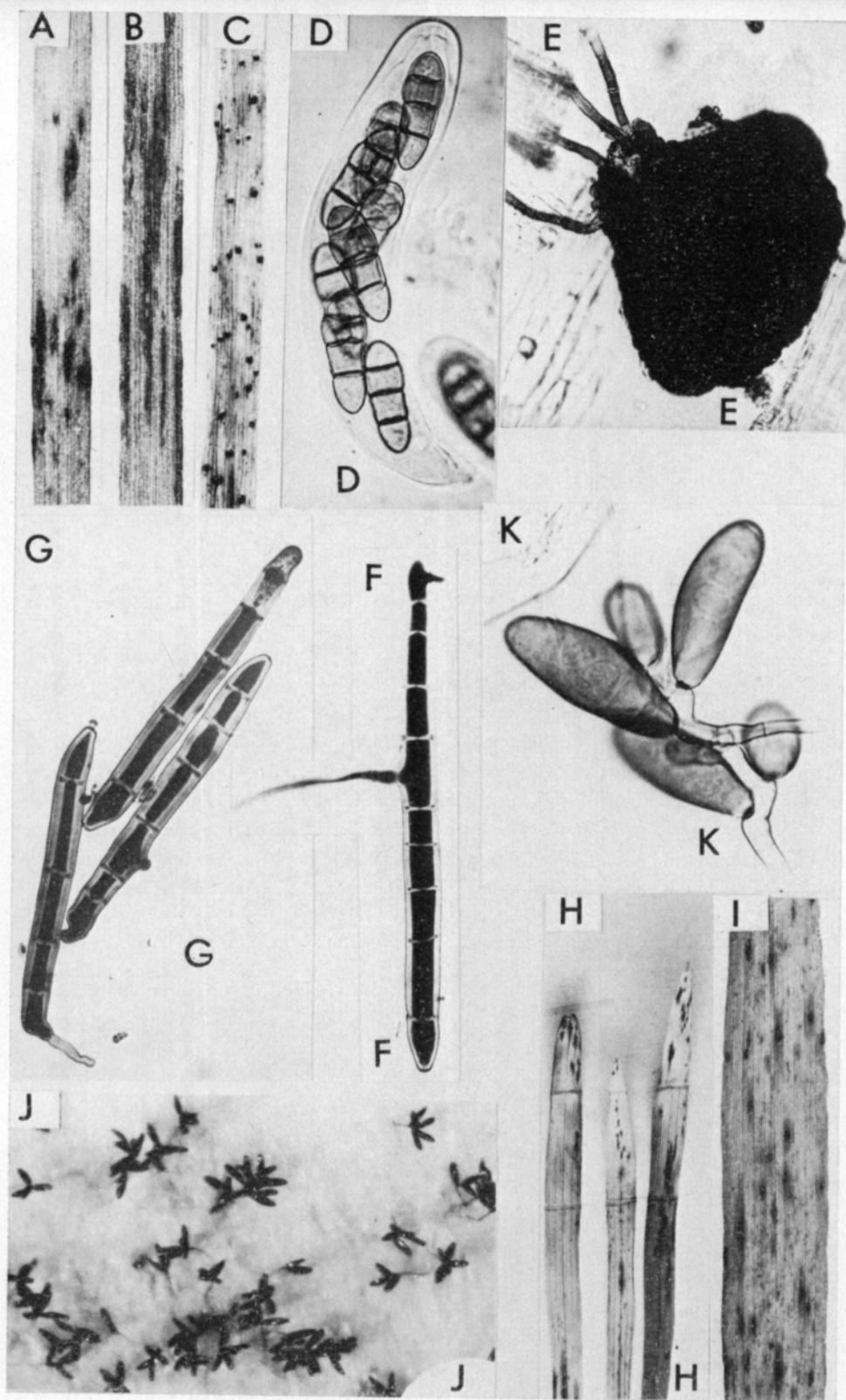


Fig. 10. *Helminthosporium* (*Pyrenophora*) *tritici-repentis* on couch grass (*Agropyron repens*) (A–F) and on spring wheat (*Triticum aestivum*) (G). A–B: the characteristic lesions on leaves in June–July, C: the mature ascomas in dead leaf in May, D: ascus and ascospores, E: the mature ascoma with growing conidiophores, F, G: conidia. H–J: *H. sativum* on spring barley (*Hordeum vulgare*). H: lesions on seedling, I: spots on leaf in July, J: the fungus growing on moist blotter, K: conidiophores and conidia on mature plant in August. A–C, H–I: x 1, D, F, G, K: x 500, E: x 200, I: x 20.

H. sativum survives in infected seed but can persist also in the soil (MÜLLER 1956, de TEMPE 1964, EVANS 1969, SHCHEKOKHIKHINA 1971, VOİTOVA 1971, JØRGENSEN 1974).

The fungus occurs all over the world (DRECHSLER 1923, SPRAGUE 1950, CMI map no. 322, 1967). In Europe, however, it is regarded as being of relatively little importance (BUTLER and JONES 1949, MÜLLER 1956, de TEMPE 1964). The fungus has been found on wheat and barley in Italy (PETTINARI 1955), Holland (VENDRIG 1956), Germany (MÜLLER 1956), also on rye (LANGE de la CAMP 1958) and in Britain also on oats (EVANS 1969).

In Scandinavia *H. sativum* has been found sporadically in Denmark on the roots and stems of barley plants since 1930 (SKOV 1966), whereas it was very common on seeds of barley, wheat and oats (ANDERSEN 1955). In recent years *H. sativum* has been recorded on barley seed (JØRGENSEN 1969, 1974). The fungus has also been found rather commonly on barley straw and stubble in fields (SMEDEGÅRD—PETERSEN 1972 a). The effect of such infections on the yield is not known.

In Norway *H. sativum* was found for the first time on barley in 1960. As a leaf spot fungus it seems to be insignificant (HANSEN and MAGNUS 1969), whereas it was found rather commonly on barley seeds as well as on oat seed, though somewhat rarely (OVERAA 1972).

In Sweden barley seeds were highly infected by *H. sativum*, while oats, wheat and rye to a lesser extent. The fungus had a distinct pattern of occurrence in different parts of the country (FRITZ 1965, 1966, KOLK 1966).

In Finland *H. sativum* was isolated from the leaves of barley from four localities for the first time in 1970. The fungus was also found on seeds of spring wheat and winter rye produced at Viikki (Helsinki) in 1969, as well as on many grasses (MÄKELÄ 1971). In the study carried out in 1970 and 1971 *H. sativum* was observed in about 15 per cent of the barley fields examined (180 fields). It was gathered in 90 localities in southern and central Finland. In the inoculation tests (*H. sativum* isolated from barley) all the cereals were attacked by the fungus (MÄKELÄ 1972).

Barley

H. sativum was found on barley throughout the country as far north as Kemi, Lapland (Pelkosenniemi) (Fig. 11). The fungus was found in the following localities:

- V: Aura, Halikko, Kalanti, Karinainen, Karkkila, Kiikala, Kodisjoki, Kuusjoki, Laitila, Lemu, Marttila, Mietoinen, Nummi, Parainen, Perniö, Piikkiö, Pöytyä, Raisio, Suomensjärvi, Tenhola, Vihti;
- U: Anjala, Askola, Espoo, Helsinki, Inkoo, Pernaja, Pornainen, Porvoo mlk., Pyhtää, Tuusula, Vantaa;
- EK: Miehikkälä, Sippola, Vehkalahti, Virolahti;
- St: Alastaro, Huittinen, Hämeenkyrö, Ikaalinen, Keikyä, Kokemäki, Loimaa mlk., Luvia, Mellilä, Metsämaa, Oripää, Parkano, Punkalaidun, Rauma, Säkylä, Vampula;
- EH: Asikkala, Hattula, Hauho, Hausjärvi, Heinola mlk., Hollola, Humppila, Hämeenlinna, Jokioinen, Jämsänkoski, Korpilahti, Koski Hl., Lammi, Loppi, Luhanka, Luopioinen, Orivesi, Pälkäne, Ruovesi, Sahalahti, Somero, Sysmä, Sääksmäki, Tammela, Tuulos, Urjala, Ylöjärvi;

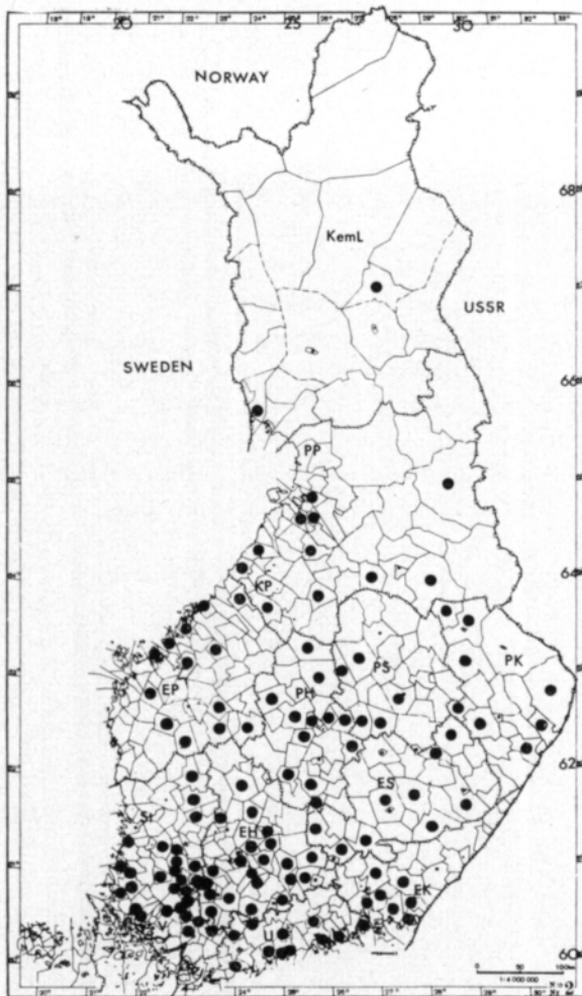


Fig. 11. The occurrence of *Helminthosporium sativum* on spring barley (*Hordeum vulgare*) by localities in Finland during the period 1971–1973.

- ES: Juva, Kangaslampi, Lumäki, Mikkeli, Mäntyharju, Puumala, Sääminki, Valkeala;
 EP: Alavus, Jalasjärvi, Kuortane, Kurikka, Laihia, Maksamaa;
 PH: Hankasalmi, Karstula, Keitele, Konginkangas, Konnevesi, Pihtipudas, Rautalampi, Saarijärvi, Sumiainen, Uurainen, Viitasaari, Äänekoski;
 PS: Heinävesi, Kuopio, Pielavesi, Suonenjoki, Tuusniemi;
 PK: Ilomantsi, Juuka, Liperi, Nurmes, Outokumpu, Tohmajärvi, Tuupovaara, Valtimo;
 KP: Alahärmä, Evijärvi, Kalajoki, Kannus, Kokkola, Kärämäki, Munsala, Pietarsaari, Pyhäjärvi, Rantsila, Sievi, Ähtävä;
 Kn: Sotkamo, Suomussalmi, Vuolijoki;
 PP: Liminka, Oulu, Tornio, Tyrnävä;
 KemL: Pelkosenniemi.

H. sativum was encountered in about 1/3 of the barley fields studied (about 800 fields) and in about 55 per cent of the localities (c. 250 localities) examined (Table 1). As a rule the fungus was commoner in tworowed than in six-rowed varieties (Table 3). The fungus was observed to be most common in the southern and southwestern parts of the country. *H. sativum* was rarest in northern Finland (Table 3).

As a rule conidia of *H. sativum* grew abundantly on the ripening leaves of barley without special lesions (cf. MÜLLER 1956, SKOV 1966). Sometimes the characteristic symptoms were found on the leaves having numerous dark-brown spots either with or without a light margin (Fig. 10) (cf. LANGE de la CAMP 1958, MÄKELÄ 1972).

Also in seedlings on spring barley brown stripes and spots were observed in early summer (Fig. 10 H).

Wheat

H. sativum was found on spring wheat (Fig. 12) in southern Finland up to Middle Ostrobothnia (Kärsämäki). It was also found in the experimental field in Lapland (Inari, Muddusniemi). The fungus was observed to be very rare on winter wheat, occurring only in Varsinais-Suomi and in Uusimaa (Table 4). The fungus was found in the following localities:

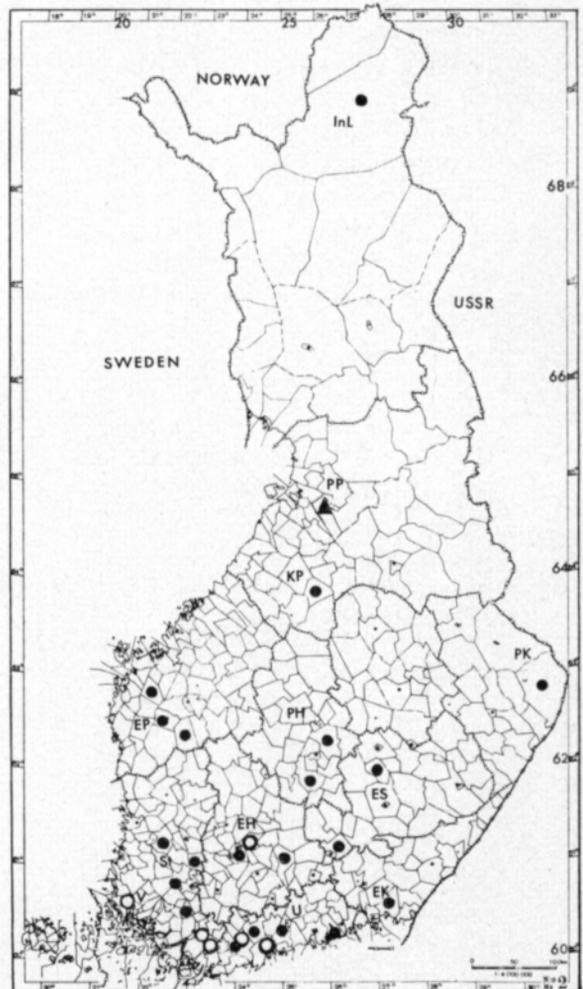


Fig. 12. The occurrence of *Helminthosporium sativum* on spring wheat (shaded circle), winter wheat (open circle) (*Triticum aestivum*) and winter rye (*Secale cereale*) by localities in Finland during the period 1971–1973.

Spring wheat

V:	Marttila, Vihti;
U:	Pernaja, Tuusula;
EK:	Vehkalahti;
St:	Oripää, Peipohja, Punkalaidun;
EH:	Heinola mlk., Korpilahti, Lammi, Sääksmäki;
EP:	Jalasjärvi, Kurikka, Laihia;
PH:	Laukaa;
PS:	Haukivuori;
PK:	Ilomantsi;
KP:	Kärsämäki;
InL:	Inari.

Winter wheat

V:	Kisko, Muurla, Vehmaa;
U:	Espoo, Lohja mlk., Tuusula;
EH:	Pälkäne.

H. sativum was encountered in 9 per cent of the spring wheat fields (222 fields) and in 18 per cent of the localities (111 localities) examined and only in about three per cent of the winter wheat fields studied (about 260 fields) (Table 1).

Also in seedlings of spring wheat brown tissues were observed in early summer, 1973 in one field in Peipohja (St).

Rye

On winter rye the fungus was observed only once in North Ostrobothnia (Muhos) (Fig. 12).

Oats

H. sativum was found on oats throughout the country up to North Ostrobothnia (Tyrnävä) (Fig. 13) in the following localities:

V:	Kiikala, Kuusjoki, Muurla;
U:	Anjala, Askola, Elimäki, Helsinki mlk., Hyvinkää, Lapinjärvi, Pyhtää, Tuusula;
EK:	Miehikkälä, Sippola;
St:	Eurajoki, Ikaalinen, Kokemäki, Loimaa mlk.;
EH:	Hausjärvi, Heinola mlk., Hämeenlinna, Korpilahti, Lammi;
ES:	Hirvensalmi, Joutsa, Kangaslampi;
EP:	Jalasjärvi, Laihia;
PH:	Pihtipudas;
KP:	Pyhäjärvi;
Kn:	Paltamo;
PP:	Tyrnävä.

H. sativum was found in per cent of the oat fields (415 fields) and in 17 per cent of the localities (181 localities) studied (Table 1). The fungus was found more frequently in Uusimaa than in the neighboring provinces (Table 2.)

In late summer *H. sativum* occurred on wheat and oats together with many other fungi e.g. *H. avenae*, *H. tritici-repentis* and *Septoria* species. The symptoms caused by *H. sativum* were rather unspecific (cf. MÜLLER 1956, MÄKELÄ 1972).

H. sativum was also found rather abundantly on grains of all cereals (barley, spring wheat, oats, rye) produced in fields in 1973 at Viikki (Helsinki) and at Maaninka (South Savo).

Discussion

This study was performed during the three year period 1971–1973. The meteorological conditions during the growing seasons were very similar. To be sure, there was great variation in the precipitation in different localities. The samples were gathered in different fields in different years and in part they came from different areas. The results are not given by year but are presented as a single unity. On the other hand they are grouped by biological provinces (HEIKINHEIMO and RAATIKAINEN 1971) which vary from each other in, for instance, climatic conditions, soil factors and, partially, in varieties (cv.).

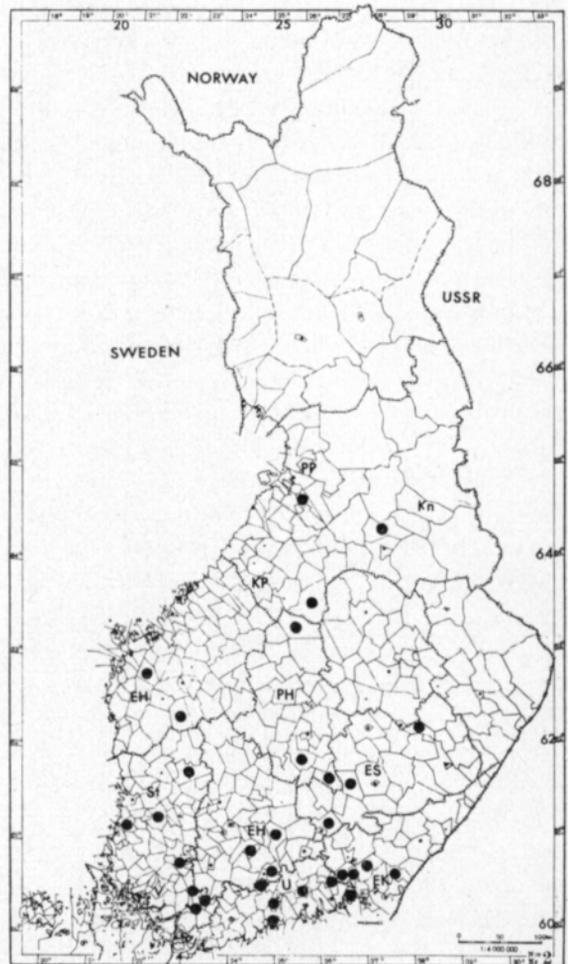


Fig. 13. The occurrence of *Helminthosporium sativum* on oats (*Avena sativa*) by localities in Finland during the period 1971–1973.

In comparing the results account should be taken not only of the above mentioned factors but also of errors that may possibly be due to the numbers of the samples. Nevertheless the possibility of error is reduced by the large number of sample localities as well as by the fact that for the most part the fungi determinations have been performed by the same individual, the researcher herself.

Helminthosporium species, above all *H. gramineum* Rabenh. ex Schlecht., *H. teres* Sacc. and *H. sativum* Pammel, King and Bakke on barley, *H. avenae* Eidam on oats and *H. tritici-repentis* Died. on wheat and rye were found to be particularly common on cereals. To date, studies along these lines have not been performed in Finland and therefore it is not known whether these diseases are on the increase in our country. This development has occurred in other Scandinavian countries in recent years, particularly in the case of barley (cf. p. 182).

H. gramineum was particularly widespread in Ostrobothnia and northern Finland. Among the many reasons for this are the cultivation of susceptible six-rowed varieties of barley. According to HALKILAHTI (1973 b), the main species of these, Otra, Pirkka and Pomo were more frequently and more thoroughly inoculated by *H. gramineum* than the other varieties. Neglect in the dressing of seed has been more common in the central and northern parts of the country than in the south (BLOMQUIST 1970). The same phenomena have also been observed in other Scandinavian countries (LIHNELL 1969, OVERAA 1972, KOLK and KARLBERG 1973). *H. gramineum* also occurred on a mass scale in the USSR; the Archangel district, in particular, deserves mention (SHCHEKOKHIKHINA 1964). Furthermore, climatic factors play a considerable role in the abundant occurrence of *H. gramineum* in northern regions. This observation is supported by the fact that in this study *H. teres* occurred more commonly in the southern than in the northern parts of the country, whereas for *H. gramineum* the reverse was true.

H. teres was the most common *Helminthosporium* species on barley. There are probably considerable crop damages, at least in those fields in which the fungus occurs abundantly already on the seedlings. The fungus caused premature destruction of the leaves and at the same time the ears remained underdeveloped (cf. McDONALD and BUCHANNON 1964, RINTELEN 1969, SMEDEGÅRD—PETERSEN 1974). In Norway (HANSEN and MAGNUS 1969) and Sweden (KOLK and KALBERG 1973), however, the disease is considered to be rather insignificant.

The perfect stage of *H. teres* has not been found with certainty in Finland nor is there any evidence that the fungus persists in fields in any other form. This fact is nevertheless indicated by the extreme frequency and abundance of the fungus also in areas in which the seed is in general dressed. The fungus is known to be preserved in the straw, stubble and debris of barley on the ground surface in Britain (EVANS 1969) and Denmark (SMEDEGÅRD—PETERSEN 1972 a). Mercurial treatment is satisfactory for controlling the seed-borne inoculum (de TEMPE 1964, SMEDEGÅRD—PETERSEN 1974).

H. avenae was extremely common on oats through the country. Disease-susceptible varieties were in part responsible for this. According to HALKI-

LAHTI'S (1973 a) study of seed, Hannes, Ryhti, Sisu and Blenda, as well as Nip, which is widely cultivated in the northern parts of the country, are more frequently inoculated by *H. avenae* than are Pendek, Tiitus, Kyrö and Sörbo. In field experiments, too, (REKOLA et al. 1970) Hannes and Sisu were much more susceptible than Pendek.

In this study the fungus was observed in certain cases to be particularly abundant on peat lands on both seedlings and on ripening leaves. In addition, it caused considerable crop losses (Hämeenlinna, cv. Hannes) (BUTLER and JONES 1949). In the other Scandinavian countries the fungus is considered to be of negligible importance (ANDERSEN 1955, FRITZ 1965, KOLK 1966, OVE-RAA 1972). This may be due to differences in varieties (HALKILAHTI 1973 b) and climatic factors (DENNIS 1933).

Dressing is an important method of warding off seed-borne fungus (de TEMPE 1964). In Finland, however, oats have never been dressed to the same extent as other cereals.

The commonness of *H. sativum* on cultivated fields in Finland is surprising; it occurs as far north as Lapland (Inari 69° N, 27° E) though it is regarded as being a fungus of the warm, southern regions (BUTLER and JONES 1949, MÜLLER 1956). In recent years *H. sativum* has been observed also on numerous grasses throughout the country (cf. MÄKELÄ 1971). The occurrence of the fungus on all cereals as well as its frequency and abundance point to the fact that it has long been present in Finland. The exceptionally warm summers in these years have probably also contributed to this (cf. MÜLLER 1956, JØRGENSEN 1974). The same conclusion is indicated by the fact that *H. sativum* occurred more frequently and more abundantly in the southernmost parts of the country and was considerably rarer in the northern parts.

Typical leaf blotch caused by *H. sativum* (LANGE de la CAMP 1958) was rare on the barley leaves in comparison with the frequency of the fungus. The reason for this may be that the temperature was too low. This may also be a reason why so little is known about the occurrence of *H. sativum* in Finland (cf. MÜLLER 1956). Virtually no true spores of the fungus turned up in the leaf samples. On the other hand, they developed rapidly and in abundance in the moist conditions that were employed in this study.

The significance of the fungus as a crop-reducing factor is considered to be small in the Scandinavian countries (FRITZ 1965, HANSEN and MAGNUS 1969, SMEDEGÅRD—PETERSEN 1972) and elsewhere in Europe (MÜLLER 1956, LANGE de la CAMP 1958, de TEMPE 1964).

In this study *H. sativum* apparently caused yield loss, at least in certain fields. In a number of cases the fungus was observed to damage the seedlings of barley, and spring wheat. According to JØRGENSEN (1974), however, the seed-borne inoculum of *H. sativum* had little or no influence on the emergence of barley in the field. In preliminary seed studies the fungus was common in the seeds of all species of cereals, in which case the abundance of the fungus would seem to determine the degree of damage to the seedling (cf. de TEMPE 1964).

H. tritici-repentis was rather common in Finland in all the regions where wheat and rye are cultivated. Similarly, it was the most important disease

affecting couch grass (*Agropyron repens*). Couch grass is a weed that grows everywhere (MUKULA et al. 1969, HULTÉN 1971). and, accordingly, it may easily spread the disease to both rye (cf. GARBOWSKI 1932) and wheat (MITRA 1934).

The fungus is considered to be seed-borne on cereals and on wheat in particular (de TEMPE 1964). In this study the fungus was not observed in seeds. On the other hand immature pseudothecia readily developed in abundance on the leaves of cereals in moist conditions. In nature they were observed rare with certainty. However, in the dead straws and leaves of couch grass in the spring there was also an abundance of ripe ascoma with matured ascospores. The fungus probably does not have much significance on cereals in spite of its commonness.

The observations set forth in the above indicate that there are several reasons for the abundant occurrence of *Helminthosporium* fungi in Finland.

First, the climatic conditions are favourable to the growth of these fungi because *Helminthosporium* species frequently occur as serious pathogens on plantations and on natural grasses throughout the country (MÄKELÄ 1971). The normal mean temperatures during the growing months (May—August) are rather low (approx. $+9^{\circ}$ — $+18^{\circ}$ C) even in the southernmost parts of Finland (KOLKKI 1966). The most important *Helminthosporium* species occurring on cereals do, in fact, thrive in comparatively cool and moist conditions, particularly in their early stages of development (RAVN 1901, DENNIS 1933, SHADS 1934, McDONALD and BUCHANNON 1964). In these conditions they are also most often preserved at the imperfect stage in seeds (RAVN 1901, MÜLLER 1956, de TEMPE 1964). In the present study, too, the *Helminthosporium* species occurred for the most part at the imperfect stage in the form of seed-borne fungi, as is the case in the other Scandinavian countries, (except for part of Denmark). (SMEDEGÅRD—PETERSEN 1971, 1972 b) and in Europe in general (BUTLER and JONES 1949, MÜLLER 1956, de TEMPE 1964). In very warm conditions the same fungi most often develop a perfect stage (cf. KENNETH 1962, SMEDEGÅRD—PETERSEN 1971, 1972 b). Warm weather is also favourable to secondary infection by windborne conidia (DENNIS 1933, SHADS 1934, ZEKOVIĆ 1970). During the period of this study the growing seasons were warmer than usual. In the summer of 1972, when the temperatures for June and July were $+2^{\circ}$ — $+4^{\circ}$ C higher than normal, with sufficient precipitation in July, *Helminthosporium* species occurred more abundantly than in other test years. The month of June was also very warm in 1973 but it was apparently too dry.

Second, the majority of cereals that are cultivated in Finland are domestic varieties, most of which are extremely susceptible to inoculation by *Helminthosporium*. This is above all true of the most commonly cultivated, six-rowed varieties of barley and oats (HALKILAHTI 1973 a, 1973 b).

Third, undressed seed is used for the most part in Finland. According to BLOMQUIST (1970), during the years 1953—1968, 77 % of the bread grain seed and 39 % of all the grain seed was treated with mercury disinfectants. Since 1969 only preparations of the alkoxyalkyl type have been available in Finland (BLOMQUIST 1970).

Fourth, during the last decades the proportion of planting seed purchased in stores has increased and at the same time there has been an increase in the number of new varieties available. Being seed-borne fungi, *Helminthosporium* species have thus been able to spread more rapidly over large areas (cf. de TEMPE 1964).

Fifth, the shift to the exclusive cultivation of cereals instead of the former rotation with hay, especially in the southern and south-western parts of the country, has contributed to the spread of *Helminthosporium* species. The same can be said about the considerable increase in the acreage devoted to the cultivation of barley in recent years.

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Helminthosporium-sienten esiintymisestä viljakasvustoissa vv. 1971—1973

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Tutkimuksessa selvitetään *Helminthosporium*-lajien levinneisyyttä ja merkitystä viljoilla. Tulokset perustuvat kasvukausina 1971—1973 kautta maan, etupäässä viljelijäin pelloilta kerättyihin kasvinäytteisiin (yht. 2 040 näytettä). Ohranäytteet kerättiin n. 800 pelloilta 250 paikkakunnalta, kauranäytteet 415 pelloilta n. 180 paikkakunnalta, kevätvehnänäytteet 220 pelloilta, n. 110 paikkakunnalta, syysvehnänäytteet n. 260 pelloilta n. 70 paikkakunnalta ja ruisnäytteet n. 340 pelloilta n. 110 paikkakunnalta. Lisäksi tutkittiin n. 170 juolavehänäytettä, jotka kerättiin viljapelloilta ja pientareilta n. 80 paikkakunnalta. Syynä tähän oli se, että juolavehnessä esiintyy osin samoja sieniä kuin viljoissa. Eräänä yleisimmistä viljapeltojen rikkaheinistä on sen osuus tautien levittäjänä meillä selvitettävä.

Kaikki näytteet tutkittiin silmävaraisesti ja mikroskooppisesti sekä kasvatettiin kosteissa oloissa. Lisäksi viljeltiin sieniä keinoalustalla.

Monien *Helminthosporium*-lajien todettiin esiintyvän viljojen kasvustoissa yleisenä ja runsaana kautta maan Lappia myöden. Koevuosina kesät olivat poikkeuksellisen lämpimiä, mutta samalla suuressa osassa maata vähäsateisia. Kesä 1972 oli *Helminthosporium*-sienten kannalta edullisin ja kesä 1973 epäedullisin, päätellen näiden sienten esiintymismääristä.

Yleisimmät *Helminthosporium*-lajit olivat seuraavat:

H. avenae Eidam esiintyi erittäin yleisenä kauralla kautta maan. Sientä todettiin lähes 90 % paikkakunnista ja yli 60 % tutkituista pelloista, joista valtaosa oli tuleentumisvaiheessa. Myös kauran oraissa todettiin sientä keväisin, varsinkin turvemailla. Sieni aiheuttaa kauran oraissa kaksi—kolmiletasteella ruskeita viirumaisia laikkuja ja oraiden kuolemista. Tuleentumisvaiheessa ilmaantuu lehtiin oranssinpunareunaisia ruskeita laikkuja ja suurempia kuolleita solukkoalueita. Tällöin tapahtuu myös jyvien saastunta. Sieni on siemenlevintäinen.

H. gramineum Rabenh. ex Schlecht., ohran viirutaudin aiheuttaja, esiintyi yleisenä kautta maan. Sientä todettiin yli 1/2 paikkakunnista ja yli 1/3 tutkituista pelloista. Yleisimpänä ja runsaimpana esiintyi sientä Pohjanmaalla sekä kautta Kainuun, Kuusamon ja Pohjois-Suomen. Näillä alueilla tapasi peltoja, joissa jopa 1/3 kasveista oli sienen tappamia ja kahutähkäisiä. Varsinaisilla viljanviljelyalueilla sientä esiintyi huomattavasti vähemmän. *H. gramineum* oli yleisempi monitahoisilla kuin kaksitahoisilla lajikkeilla.

H. teres Sacc., ohran verkkolaikun ja lehtilaikun aiheuttaja, todettiin ohralla kautta maan, lähes 90 % paikkakunnista ja n. 60 % tutkituista pelloista. Yleisimpänä ja runsaimpana sientä, esiintyi maan lounais- ja eteläosissa, parhailla viljanviljelyalueilla, vähiten maan pohjoisosissa päinvastoin kuin *H. gramineumia*. *H. teres* oli jossain määrin yleisempi monitahoisissa kuin kaksitahoisissa ohrissa. Sientä todettiin oraissa, joskus hyvinkin runsaana. Tuleentuvan ohran lehdissä tauti oli kuitenkin vasta runsaimmillaan. Pahimmin saastuneilla pelloilla saatoivat kaikki lehdet kuolla ennen aikojaan ja tähkät jäädä pieniksi, jopa kahuiksi.

H. tritici-repentis Died. esiintyi vehnässä ja rukiissa kautta niiden viljelyalueen. Sientä todettiin kevätvehnällä 27 %, syysvehnällä 17 % ja rukiilla 23 % tutkituista pelloista ja n. 1/2 tutkituista paikkakunnista. Koevuosia oli tosin vain kaksi (1972 ja 1973) ja niiden tulokset toisistaan poikkeavia. Sientä löytyi ruskeista viiruista ja laikuista useimmiten yhdessä muiden sienten, kuten *Septoria*-, *Puccinia*- ja *Fusarium*-lajien sekä *Erysiphe graminisen* kanssa. Juolavehnällä *H. tritici-repentis* todettiin vielä paljon yleisempänä kuin viljoissa, n. 1/2 tutkituista näytteistä. Myös sienen suvullista astetta *Pyrenophora tritici-repentis* (Died.) Drechs. esiintyi juolavehnällä n. 1/4 kerätyistä näytteistä. Onko syy sienen yleiseen esiintymiseen meillä viljoilla löydettävissä juuri tästä, vaatii lisätutkimuksia.

H. sativum Pammel, King ja Bakke todettiin viljapelloilla kautta maan. Sientä esiintyi yleisimpänä ohralla, yli 1/2 paikkakunnissa ja n. 1/3 tutkituista pelloista, varsinkin maan lounais- ja eteläosissa, parhailla viljanviljelyalueilla. Kaksitahoisissa lajikkeissa sieni oli yleisempi kuin monitahoisissa ohrissa. *H. sativumia* esiintyi muissa viljoissa huomattavasti

harvemmin kuin ohrassa. Kevätvehnällä ja kauralla todettiin sientä alle 20 % paikkakunnista ja vajaassa 10 % tutkituista pelloista, syysvehnällä n. 10 % paikkakunnista ja alle 3 % tutkituista pelloista. Sientä löytyi kautta kunkin viljan viljelyalueen, kuitenkin muita yleisempänä Uudeltamaalta kauralla ja Satakunnasta kevätvehnältä sekä Varsinais-Suomesta ja Uudelta- maalta syysvehnältä. Rukiilla todettiin *H. sativumia* vain kerran, (Muhos) *H. sativumin* todettiin vioittavan ennenmuuta ohran oraita.

Helminthosporium-lajien yleisyyteen Suomessa lienee useita syitä, mm. ilmasto-olot, taudinarat viljalajikkeet, peittauksen laiminlyönti, kaupasta ostetun kylvösiemenen osuuden jatkuva lisääntyminen, viljalajikkeitten vaihtuminen yhä nopeampaa tahtia, siirtyminen yhä enenevässä määrin yksipuoliseen viljanviljelyyn ja ohran viljelyalan nopea kasvu.

Helminthosporium-sienten aiheuttamien tautien vaikutukset satoon jäivät selvittämättä. Ainakin *H. gramineum*, *H. teres* ja *H. sativum* ohralla sekä *H. avenae* kauralla ovat siksi yleisiä tautien aiheuttajia kautta maan, että niiden merkitystä ja biologiaa olisi tutkittava edelleen.