

# OVERWINTERING OF GRAMINEAE-PLANTS AND PARASITIC FUNGI.

## I. *SCLEROTINIA BOREALIS* BUBÁK & VLEUGEL.

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The main causes of the poor overwintering of cereals and grasses in Finland are the fungi damaging the plants during their overwintering. This study, which is to be published in parts, will give an account of the role these fungi have in the cultivation of winter cereals and grasses in our country. The *Sclerotinia borealis* BUBÁK & VLEUGEL, which is met in the middle and northern parts of Sweden and Finland, is first taken under study.

### *Introduction.*

*Sclerotinia borealis* was noted in Luleå, Sweden, for the first time in *Dactylis glomerata* by ULANDER (17, p. 47) in 1906. Later it has been noted very commonly in the middle and northern parts of Sweden, especially in Norrbotten in winter rye and other *Gramineae*-plants (ULANDER and EKSTRAND in many papers, cf. references). In 1917 VLEUGEL (21, p. 308) described the fungus by the name *Sclerotinia borealis* BUBÁK & VLEUGEL.

During an excursion made with Mr. H. EKSTRAND, Fil. Lic., to the northern and middle Finland in spring 1946 the author noted that *S. borealis* was in many districts quite common in winter rye and timothy (14). In the next three years investigations were continued by the Department of Plant Pathology in order to find out the spreading of the fungus and the damages caused by it. In spring 1948 the author had an opportunity of making an excursion with EKSTRAND also to the north of Sweden where overwintering of cereals and grasses was examined.

In the Soviet Union, too, a fungus similar to *S. borealis* is met with, *Sclerotinia graminearum* ELENEV, which causes injury to overwintering *Gramineae*-plants chiefly in north-eastern parts of European Russia. Reports on *S. graminearum* in

Table 1. Measurements of the size relations of the sclerotia of *Sclerotinia borealis*.  
Taul. 1. Mittauksia *Sclerotinia borealis*en sklerotioiden suuruussuhteista.

10 sclerotia measured of each sample; average measures in mm, the variations in brackets.  
Kustakin näytteestä mitattu 10 sklerotiota; mitat keskimäärin mm:ssä, sulkeissa vaihtelut.

Host plant and its growing place Isäntäkasvi ja sen kasvupaikka	Length Pituus	Breadth Leveys	Thickness Paksuus
<i>Festuca rubra</i> , Tohmajärvi .....	3.59 (5.1—2.8)	2.24 (3.0—1.7)	1.56 (2.0—1.0)
<i>Poa serotina</i> , Apukka .....	2.21 (2.8—1.9)	1.62 (1.8—1.4)	0.94 (1.3—0.6)
<i>P. trivialis</i> , Apukka .....	2.38 (2.8—1.9)	1.48 (1.9—1.1)	0.91 (1.2—0.6)
<i>Phleum pratense</i> , Rovaniemi .....	2.92 (4.8—2.3)	1.91 (2.7—1.4)	1.31 (1.9—0.6)
» » Pielisensuu .....	3.28 (4.6—2.0)	1.82 (2.3—1.1)	1.34 (1.7—1.0)
» » Tärändö, Sweden .....	3.34 (5.0—1.8)	1.84 (2.7—1.0)	1.29 (1.9—0.9)
» » Karunki .....	3.43 (4.8—2.4)	1.82 (2.3—1.0)	1.19 (1.8—0.8)
» » Kemijärvi .....	3.60 (5.9—2.4)	2.01 (2.4—1.3)	1.39 (1.9—0.8)
» » Ranua .....	3.39 (4.2—3.0)	2.06 (2.8—1.7)	1.32 (1.8—1.0)
<i>Secale cereale</i> , Tohmajärvi .....	3.44 (4.6—2.1)	1.92 (2.3—1.4)	1.31 (2.0—1.0)
» » Apukka .....	4.29 (5.9—3.0)	2.30 (3.8—1.4)	1.51 (3.0—1.0)
» » Apukka .....	3.93 (6.0—3.1)	2.12 (2.7—1.4)	0.90 (1.2—0.6)
The same as above, sclerotia in water for 2 days Sama kuin edellä, sklerotiot 2 vrk. vedessä ..	4.53 (6.5—3.5)	2.24 (2.9—1.5)	1.20 (1.7—0.9)
<i>Triticum sativum</i> , Apukka .....	3.69 (4.7—2.8)	1.94 (2.4—1.6)	1.30 (1.8—0.9)
Dry sclerotia on the average — Kuivat sklerotiot keskimäärin .....	3.35 (6.0—1.8)	1.93 (3.8—1.0)	1.25 (3.0—0.6)

Russia are known since 1901 when it, according to ELENEV (cf. SOLKINA, 16, p. 100) caused damage to winter rye in the government of Vjatka (present Kirov Region). In 1919 ELENEV named the fungus *Sclerotinia graminearum* not describing it more exactly. In 1939 SOLKINA defines more closely *S. borealis* ELENEV with Latin descriptions (16). She arrives at the result that *S. graminearum* ELENEV described by her resembles most to *S. borealis* BUBÁK & VLEUGEL. SOLKINA (16, p. 105) regards, however, *S. graminearum* as a separate species, at the same time pointing out that because of insufficient knowledge of the biology of the fungus the question cannot be held as finally settled, and continued investigations may lead to including of *S. graminearum* among the closely related species.

*The morphology and biology of the fungus and the influence of growing conditions on its appearance.*

The sclerotia of the *Sclerotinia borealis* are, according to VLEUGEL's description (21, p. 308), 5—8 mm long, 2—4 mm wide, often curved or flat, first dirty-coloured, later black. Out of the sclerotium grow 1—3 apothecia which are cup-shaped and lightbrown. The asci are cylinder-shaped, consisting of 8 spores, 190—

210  $\mu$  long and 9—13  $\mu$  thick. The ascospore are straight, one-celled, elliptic or longish — the elliptic ones 19—28  $\mu$  long and 7—11  $\mu$  wide.

The above description by VLEUGEL on *S. borealis* corresponds to the idea formed by the author.

In the appended table 1 some figures of the size relations of the sclerotia of *S. borealis* are given. The measurements have been made with dry herbarium material collected by the author. The sclerotia of one sample has, besides, been kept in water for two days and measured after that. As the measurements show, the sclerotia had swollen in water. Accordingly, the sclerotia collected in the growing places are larger in size than they are later when dry. The figures given in the table show further that the sclerotia in rye and wheat are somewhat larger than in timothy and *Poa*-species. The size of the sclerotia is thus influenced by the size of the foliage of the host plant and apparently also by the conditions in which the host plants have grown.

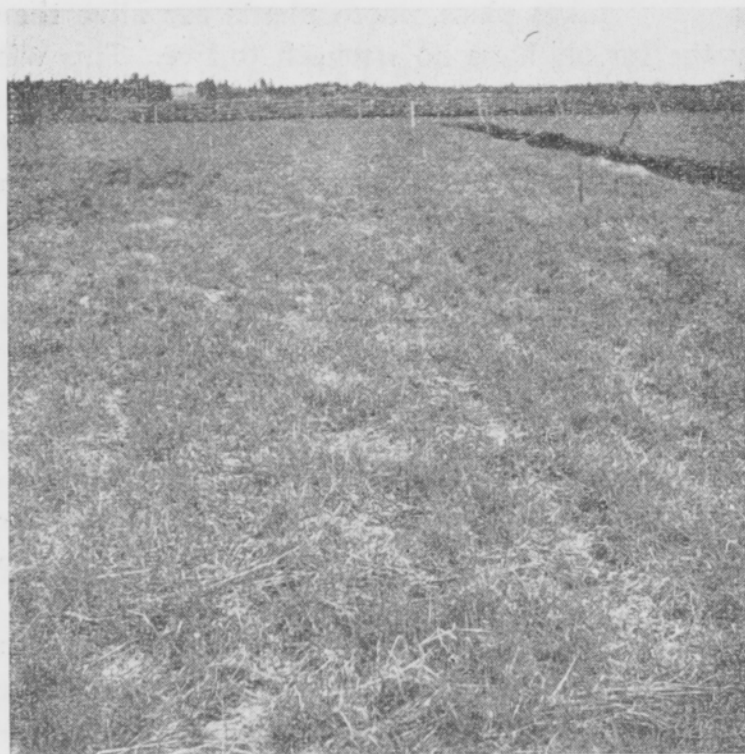


Fig. 2. Timothy thinned by *Sclerotinia borealis*.  
— Photo by E. A. Jamalainen

Kuva 2. *Sclerotinia borealisen* harventamaa timoteita.



Fig. 1. Sclerotia of *Sclerotinia borealis* with apothecia.  $\times 3$ . — Photo by H. Roivainen & E. A. Jamalainen.

Kuva 1. *Sclerotinia borealisen* sieni rihmapahkoja itiöemineen.  $\times 3$ .

The width of the cup of the apothecia was in the measurements by the author the following: young apothecia 0.5—2.1 mm., older apothecia 2—4 mm; the length of the stalk of the apothecia varied between 3.3—9.6 mm (Fig. 1). The size of the asci was the following: the average length 210  $\mu$  (ranging from 180 to 250) and thickness 10  $\mu$  (8—14). The ascospore, eight in each ascus, were elliptic in shape; their size was 9—22  $\mu$  on the average.

The best time to discover *S. borealis* is spring, directly after the snow has melted. The young crops of winter cereals and other Gramineae-plants having come forth from under the snow, larger or smaller areas of





Fig. 3. *Sclerotinia borealis* in winter rye.  $\times 2$ . — Photo by E. A. Jamalainen.

Kuva 3. *Sclerotinia borealis* syysrukiissa.  $\times 2$ .

vegetation in a field infected by the fungus have been destroyed (Fig. 2). Under wet conditions, grey mycelium can then be seen on the surface of the leaves in the infected plants (cf. 17, p. 47). According to the writer's observations, it is typical of the disease that the leaves killed by the fungus are, when dry, more or less thready, grey or greyish-brown in colour (Fig. 3). In this respect, the damages caused by *S. borealis* and by snow mould due to *Fusarium nivale* (FR.) CES. are easily distinguishable from each other. The leaves of the plants injured by *F. nivale* are, even when dry, spread out and often a little reddish. In spring, apparently immediately after the snow has melted, *S. borealis* begins to form sclerotia.

The damages caused by *S. borealis* may increase in the course of spring so that at the time the melting of snow takes place, more plants are alive than

later on. The plants damaged by the fungus have no strength to live. This was discovered by EKSTRAND (6, p. 47) in Sweden. He mentions that this happens in spring when the temperature is low and there is plenty of moisture. On the other hand, the plants that are weak because of the fungus may become stronger later on, as was discovered in Finland, at the Perä-Pohjola Agricultural Experiment Station in 1948 (cf. p. 131).

According to the experiments performed by the author, apothecia began to appear in the sclerotia of *S. borealis* gathered in spring only in autumn when the weather had become colder, in September-October. The sclerotia were kept outside during the summer. In laboratory conditions, the appearance of apothecia is not normal. Often the stalk only is formed. The apothecia are positively phototropic. It is obvious that the sclerotia of *S. borealis* require a ripening time — which is as long as the growing time — in sunlight so as to be able to produce normally developed apothecia with ascospore.

Information about the spreading of *S. borealis* show that it favours northern regions. The climatic conditions prevailing in these regions must have a decisive influence on its occurrence. A long, moist and warm autumn, when the snow falls on frostless ground, is obviously advantageous to the spreading of the fungus. Further, we may conclude that freezing of soil, on the one hand, and the thickness of the snow layer, on the other, and its quicker or slower melting affect the damages caused by the fungus in spring. If the freezing of soil is low and the



snow layer thick, and the snow melts slowly in spring, the fungus has great possibilities to cause damage.

During the four years information on *S. borealis* has been available by the author in Finland, its damages were greatest and the area of its appearance most extensive in 1946, as shown in pp. 131—132. In the following three springs the occurrence of the fungus was considerably slighter. In 1948—49 it caused direct damages only in the vicinity of the Perä-Pohjola Experiment Station near Rovaniemi. What this is due to, is difficult to conclude on the basis of the information on the climatic conditions, snow, and freezing of soil available then. So, e.g., the overwintering period 1947—48 was everywhere in Finland favourable to the damages of snow mould. *S. borealis* was then, however, not met with to a great extent. The question of the influence of climatic conditions on the greater or lesser appearance of *S. borealis* requires detailed studies, when, among other things, measurements of temperature and moisture in the areas of the occurrence of the fungus should be made in autumn as well as under the snow in spring.

#### *Occurrence of the fungus in different countries.*

Reports on the occurrence of *Sclerotinia borealis* have been received by the author from Sweden and Finland only. They will be elaborated in the following.

#### Sweden.

Information of the occurrence of *S. borealis* in Sweden were based earlier on the studies of ULANDER (17, 18, 19) and lately on those of EKSTRAND. The latter has annually reported on the significance of the fungus in Sweden in the periodical *Växtskyddsnotiser*. The area of occurrence of the fungus extends in Norrland in Sweden, according to EKSTRAND (10, p. 23), up to Dalarna and Gästrikland (in latitude abt. 61° N).

The damages caused by *S. borealis* in Sweden have been every year greatest in the country Norrbotten. Most abundant was the occurrence according to EKSTRAND in the springs 1942 (4) and 1946 (6). In 1946 the fungus caused injury in the whole Norrland. In many instances timothy had either entirely or for the most part disappeared especially from the first-year fields north of the arctic circle. EKSTRAND ascribes this to the fact that the soil had only slightly if at all frozen in the preceding autumn, and in the spring snow stayed long on the ground. In other years, too, except those mentioned, EKSTRAND noted occurrence of the disease in Sweden but not in so injurious a degree as in 1942 and 1946; e.g., in 1948 the damages were slight (12).

#### Finland.

VALLE, (20, p. 159—160) discovered at Tammisto (Plant Breeding Station of Hankkija at Malmi near Helsinki) in the spring of 1930 a fungus in timothy which

he modified to *S. borealis*. In the timothy strains that had had the poorest overwintering, 10 specimens out of 25 had been destroyed. The plants killed by the disease either died entirely or else only a few green leaves appeared on the injured plants. Besides timothy in 1930, damages by the fungus appeared during the overwintering at Tammisto also in cocksfoot in 1927.

Reports on *S. borealis* in Finland, which have been collected by the author, date from 1946. Material so far accumulated at Agricultural Research Institute, Department of Plant Pathology, on the fungus and its areas of occurrence is given in the following<sup>1</sup>.

*Agrostis canina* L.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 31. 5. 48: E. A. J.<sup>2</sup>; 27. 5. 49: E. A. J.

*A. stolonifera* L.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 27. 5. 49: E. A. J.

*Alopecurus pratensis* L.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 27. 5. 49: E. A. J.

*Anthoxanthum odoratum* L.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 27. 5. 49: E. A. J.

*Bromus inermis* LEYSS.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 31. 5. 48: E. A. J.<sup>2</sup>.

*Dactylis glomerata* L.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 31. 5. 48: E. A. J.<sup>2</sup>; 26. 5. 49: E. A. J.

*Festuca pratensis* HUDS.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 27. 5. 49: E. A. J.

*F. rubra* L.

*Kb.* Tohmajärvi, Exp. Sta., 7. 6. 46: E. A. J.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 31. 5. 48: E. A. J.<sup>2</sup>; 27. 5. 49: E. A. J.

*Lolium perenne* L.

*Sb.* Maaninka, Exp. Sta., 15. 5. 48: E. A. J.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 27. 5. 49: E. A. J.

*Phleum pratense* L.

*Sa.* Mikkeli, rural community, 4. 5. 48: A. YLIMÄKI. — Sääminki, Nojamaa, 5. 5. 48: A. YLIMÄKI.

*Sb.* Iisalmi, 17. 8. 46: J. PALTEMAA. — Maaninka, Exp. Sta., 8. 6. 48, from different parts of peat and mineral soil: H. EKSTRAND; 4. 7. 47, from peat and mineral soil: E. A. J.; 3. 5. 49, from peat soil: E. A. J.

*Kb.* Kontiolahti, Lehmo 2. 6. 47: E. A. J. — Pielisensuu, Mustola, 2. 6. 47: E. A. J. — Tohmajärvi, Exp. Sta., 7. 6. 46 and 2—3. 6. 47, from peat and mineral soil: E. A. J.; 13. 5. 48, from mineral soil: E. A. J. — Tohmajärvi, church village, 7. 6. 46 and 3. 4. 47, from different parts of timothy fields: E. A. J.

*Ob.* Karunki, Ojanperä, Korpikylä and Palovaara, 27. 4. 48: A. ALAKARHU. — Kemijärvi, Joutsijärvi and Puikkala, 1. 6. 48: E. A. J. — Ranua, Ylisimo, 10. 5. 48: A. WITIKAINEN. — Rovaniemi, Apukka, Exp. Sta., 2. 6. 46, 8. 6. 47, 31. 5. 48 and 27. 5. 49, from several places: E. A. J. — Rovaniemi, Saarenkylä, 31. 5. 48: E. A. J. — Tervola, 1. 6. 46, from several places: E. A. J. — Ylitornio, 25. 5. 48: L. MASSA.

<sup>1</sup> Abbreviations of the plant geographical countries in the list are the following: *Sa* = Savonia australis, *Oa* = Ostrobottnia australis, *Sb* = Savonia borealis, *Kb* = Karelia borealis, *Om* = Ostrobottnia media, *Ob* = Ostrobottnia borealis, *Lk* = Lapponia kemensis.

<sup>2</sup> Observed in the experiment of POHJAKALLIO (cf. p. 131).

*Lk.* Kolari, Venejärvi, 7. 6. 46: J. JUPPILA; Kolari, Nuottajoki, 10. 6. 48: E. AJANTI; Kolari Vaattajärvi, 25. 4. 48: V. KORTELAINE. — Pelkosenniemi, 25. 5. 48: M. UNKURI.

*Poa pratensis* L.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 26. 5. 49: E. A. J.

*P. seyoitina* EHRH.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 31. 5. 48<sup>1</sup> and 27. 5. 49: E. A. J.

*P. trivialis* L.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 27. 5. 49: E. A. J.

*Secale cereale* L., winter rye.

*Sa.* Mikkeli, Karila, Exp. Sta., 10. 6. 46: H. EKSTRAND; 29. 4. 48: Y. K. KOSKINEN.

*Oa.* Ylistaro, Exp. Sta., 5. 6. 46: E. A. J.

*Om.* Revonlahti, Ruukki, Exp. Sta., 4. 6. 46: E. A. J.

*Sb.* Maaninka, Exp. Sta., 8. 6. 46: H. EKSTRAND; 4. 6. 47: E. A. J.

*Kb.* Pielisensuu, Mustola, 2. 6. 47: E. A. J. — Tohmajärvi, Exp. Sta., 7. 6. 46 and 3. 6. 47, from peat soil and mineral soil; Tohmajärvi, church village, 7. 6. 46 and 3. 6. 47: E. A. J.

*Ob.* Town Kemi, 13. 5. 46, Kemi, Pattola, 1. 6. 46: E. A. J. — Kemijärvi, Joutsijärvi, 1. 6. 48, from different places: E. A. J. — Kuivaniemi, Kauppi, 30. 4. 48: A. HALTTU. — Rovaniemi, Apukka, Exp. Sta., 2. 6. 46, 8. 6. 47, 31. 5. 48 and 26. 5. 49: E. A. J. — Simo, Simonkylä, 2. 5. 48: O. SALMELA. — Ylitornio, 25. 5. 48: L. MASSA. — Tervola, 1. 6. 46, from different places: E. A. J.

*Lk.* Kolari, Sieppijärvi in Midsummer rye, 7. 6. 46: J. JUPPALA, Kolari, Vaattajärvi, 25. 4. 48: V. KORTELAINE.

*Triticum sativum* LAM., winter wheat.

*Ob.* Rovaniemi, Apukka, Exp. Sta., 7. 6. 47 ja 31. 5. 48: E. A. J.

Detailed observations on the occurrence of *S. borealis* in Finland were made by the author on visits to agricultural experiment stations in springs 1946—49. These are recorded in the following.

At the Perä-Pohjola Agricultural Experiment Station in Apukka (located near Rovaniemi in the arctic circle) some varieties of winter cereals were badly thinned by *S. borealis* in spring 1946 (cf. p. 134). Also in the timothy fields of 2nd and 3rd year damages were considerable; 20—30 % of the vegetation had disappeared because of the fungus. On the farm tillages of the Station, fungus was also met in Greus rye which in the variety experiments had remained uninfected. In 1947 the losses were smaller than in the preceding year. Winter wheat (Olympia) was entirely destroyed by snow mould and *S. borealis*, the share of the latter amounting to 20—30 %. In 1948 losses caused by *S. borealis* were only insignificant in the variety experiment of winter rye and slight in the Olympia winter wheat. An experiment arranged by POHJAKALLIO with different grass species in order to elucidate the significance of photoperiodism was damaged by *S. borealis* especially in regard to timothy. In the spring immediately after melting of snow it seemed as if the growth of timothy were completely checked. Later, in the beginning of June timothy had, however, grown stronger, though remained thin. In 1949 the amount of *S. borealis* met with in winter rye and grass tillages was next to nothing. On the other hand, a great deal of the fungus appeared in the grass experiment arranged at the Station (cf. p. 135).

<sup>1</sup> Observed in the experiment of POHJAKALLIO (cf. above).



At the Pohjois-Pohjanmaa Agricultural Experiment Station in Ruukki (abt. 45 km. south-west of the town Oulu) and at the Etelä-Pohjanmaa Agricultural Experiment Station in Ylistaro (abt. 50 km. east of the town Vaasa) the fungus was met in a small degree only in 1946. In 1947 and 1949 no detailed reports on the fungus were received from these stations and in 1948 it did not occur at all.

In the Pohjois-Savo Agricultural Experiment Station at Maaninka (abt. 45 km. north-west of the town Kuopio) *S. borealis* had according to the reports of EKSTRAND (cf. 7, 9, 10, 11) caused considerable damage on peat soil in the first-year timothy fields (abt. 50 % of the vegetation had suffered) and in winter rye, also in the Vjatka-variety, on the average 20 % of the plants were destroyed. In the fields on mineral soil the damages, again, were slight. The fungus caused plenty of damage in the neighbourhood of the Station in spring 1946. On account of it the hay yield was commonly poor from the 1st year fields on peat soil (according to Mr. M. SALMINEN in the annual report of the Station). In 1947 *S. borealis* occurred abundantly in the 1st year timothy fields on mineral soils destroying the lower leaves of timothy. Growth was luxuriant and no actual losses were caused by the fungus. The field was in good growing condition. In one field of winter rye on peat soil near the Station the fungus had completely ruined an area of about 3—4 ares. The field was on virgin soil, only slightly fertilized. In 1948 the fungus was met on the Station in the English rye-grass only. In the neighbourhood of the field where *S. borealis* had entirely killed the plants in the preceding year, no fungus was met in the rye. In 1949 slight damages by the fungus were discovered exclusively in 1st year timothy fields on peat soil.

At the Experiment Station of the Peat Culture Society, at Tohmajärvi (abt. 60 km. south-east of the town Joensuu) *S. borealis* was abundantly met in winter rye on peat soils in 1946. In the fertilization experiment about 60—70 % of the crops from plots given the basal fertilization were destroyed by *S. borealis*, snow mould (*Fusarium nivale*) and *Typhula* spp. In the plots fertilized with potassium and phosphates 10—20 % of the plants were damaged by fungi. On the mineral-soils of the Station *S. borealis* was rare. In spring 1947 *S. borealis* had not caused any marked losses at the Tohmajärvi Experiment Station. In spring 1948 *S. borealis* was met at the Station only in one single place in a timothy field on humus sand soil, and in 1949 it did not occur at all.

At the Etelä-Savo Agricultural Experiment Station in Karila near the town Mikkeli, EKSTRAND noted (7, p. 50) in spring 1946 considerable injury caused by the fungus in Ensi-rye on peat soil. In the fields on mineral soil the fungus was insignificant. In 1948 a sample of the plants of winter rye was received from the Station showing contamination by *S. borealis*.

Information about the appearance of *S. borealis* has been obtained, besides from experiment stations, also from other places on the basis of the author's observations and of the samples sent to the Department of Plant Pathology. The information obtained is presented on pp. 130—131.

The above reports on *S. borealis* from four years show that the fungus is in Finland as well as in Sweden a species occurring in the middle and northern parts

of the country. On the basis of the information so far obtained it can be concluded that the fungus is more or less common in years favourable to its occurrence in the provinces of Lapland, Oulu, Kuopio and Mikkel. What the significance of the fungus in other parts of the country is, cannot be decided for certain by the information available. In the author's opinion it may not be a cause of any greater damage in the south and south-western Finland.

In estimating the losses caused by the fungus it must be taken into account that they vary greatly in different years and even in the same year in different places. When occurring slightly, the fungus destroys a few percentages of the plants. There are either small bare places in the fields or the individual plants or their lower leaves are injured, as for instance at Maaninka in 1947 (see p. 132).

In such cases the damages are of no greater bearing, because as the growth advances the gaps will be filled in and not even noticed later in summer. When fungus makes larger areas bare (fig. 2) and these are met frequently, or when the borders of the field plots are damaged by the fungus, the losses occurred may rise high, 10—30 % of the crop may be lost. In the worst case the fungus may destroy large areas, several ares. The disappearance of timothy and other valuable grass species from many-year grass fields in the northern parts in Finland as well as in Sweden may often result from *S. borealis* (cf. Fig. 4).

#### *On the resistance of Gramineae-plants to Sclerotinia borealis.*

Occurrence of *S. borealis* has been noted, besides in the winter rye, wheat, and timothy reported in the preceding chapters, also in the following Gramineae-plants<sup>1</sup>: *Agrostis canina* L., *A. stolonifera* L., *A. tenuis* SIBTH. (2. p. 12), *Alo-*

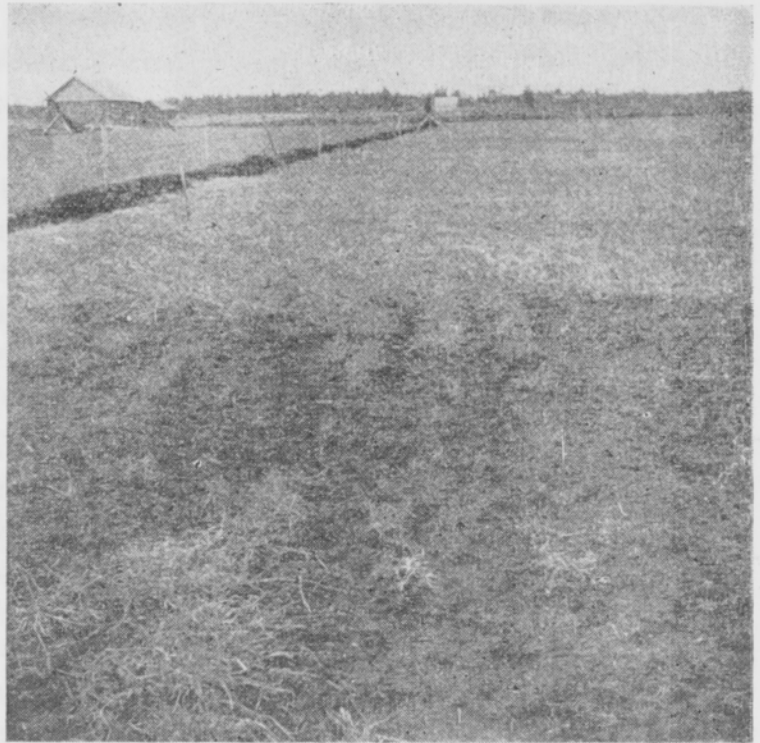


Fig. 4. Timothy damaged by *Sclerotinia borealis* in former years. Photograph in spring 1948 from an unfertilized plot in a fertilizing experiment. Place of experiment Sahavaara, Kaunisvaara, Sweden. — Photo by E. A. Jamalainen.

Kuva 4. *Sclerotinia borealisen* aikaisempina vuosina hävittämää timoteinurmea. Valokuvattu keväällä 1948 lannoituskokeen lannoittamattomasta ruudusta. Koepaikka Sahavaara, Kaunisvaara, Ruotsi.

<sup>1</sup> When no reference to literature is made of a species, the fungus has been observed in Finland, cf. p. 130—131.

*pecurus pratensis* L., *Anthoxanthum odoratum* L., *Bromus inermis* LEYSS., *Dactylis glomerata* L. (2, p. 12), *Festuca pratensis* HUDS. (8, p. 72), *F. rubra* L. (2, p. 12), *Lolium perenne* L. (2, p. 11), *Poa annua* L. (2, p. 11), *P. pratensis* L. (2, p. 12), *P. serotina* EHRH. (2, p. 12) and *P. trivialis* L.<sup>1</sup>.

ULANDER (17, 18, 19) and later NILSSON and NAESMAN (15) and EKSTRAND (2, 8, 9, 11 etc.) in Sweden emphasize that the resistance of winter rye varieties and field grasses to parasitic winter fungi is largely dependent on the fact where the plant has been grown. The varieties and strains grown in the north are more resistant to these fungi than those grown in the south. This holds true, according to EKSTRAND, also of *S. borealis*.

Different varieties of winter cereals are, according to the findings of EKSTRAND (11) during several years, approximately as resistant to *S. borealis* as to *Fusarium* and *Typhula* spp. Consequently, the varieties of winter cereals can be divided into two groups. Those resistant to parasitic winter fungi are the Finnish varieties Ensi, Oiva, and Toivo and of the other varieties Sangaste, Björn, and a number of country varieties, first of all the ryes of Norrland and the Midsummer ryes. Varieties susceptible to winter fungi are *inter alia* Improved Vaasa II, Stål, Kungs, Malm, Petkus, and some improved varieties of Svalöv.

The Finnish reports on the resistance of rye varieties to *S. borealis* date from 1946 when the fungus occurred abundantly at the Perä-Pohjola Experiment Station in Apukka (cf. p. 131). The density of the plants of different winter rye varieties was in the variety experiment in spring the following: Onni abt. 20 %, Oiva 20—25 %, Toivo 40—50 %, Ensi 75 %, and Greus (country variety) 95—100 %. The damages were mainly caused by *S. borealis*. According to the observations made by the author Ensi-rye is almost entirely free from *S. borealis* or only slightly damaged when grown as Midsummer rye.

The winter wheat is according to EKSTRAND (10, p. 24) more susceptible to *S. borealis* than rye. Differences are noted between different varieties, though not great.

The observations in Sweden show that the resistance to *S. borealis* of different strains of timothy is very variable. Such strains of timothy which have been developed in South Sweden are more susceptible to the fungus than the northern strains (8, p. 72). The Bottnia timothy has proved to be well resistant to *S. borealis* (15, p. 33). The resistance of other field grass strains is according to EKSTRAND (8, p. 72; 10, p. 24—32) also very variable in regard to *S. borealis*, for example the northern strains of *Festuca pratensis* and *F. rubra* are more resistant than the southern strains. Of the other field grasses in Sweden, except timothy, the

<sup>1</sup> ULANDER (17, p. 47—48) found sclerotia-forming fungi in North Sweder in the following field grasses: *Alopecurus nigricans*, *A. pratensis*, *Avena elatior*, *Dactylis glomerata*, *Festuca ovina*, *F. pratensis*, *F. rubra*, *Phleum pratense*, *Poa alpina*, *P. Chaixii*, *P. pratensis*, *P. serotina*, *P. sudetica* and *P. trivialis*. He assumed that one or two species of fungi were concerned and states later (19, p. 241—242) that they were *S. borealis* and *Typhula*.



following are susceptible to *S. borealis*: *Dactylis glomerata* (19, p. 239—241), *Lolium perenne* (cf. Fig. 5) and *Poa pratensis* (10, p. 26).

Department of Plant Pathology arranged an experiment in 1948 at the Perä-Pohjola Experiment Station in Apukka (cf. p. 131), in which the susceptibility of several grass species and strains to *S. borealis* was examined. The seeds were sown in mid-July, the plots were small, every plot contained 40—60 plants, the number of parallel plots was four. Results of the experiment are presented in Table 2. In spring, May 26—27, the experiments were analyzed, i.e. the healthy plants and those damaged by the fungi were counted.

The plants started their overwintering being fragile in growth, since the seeds had been sown only in the middle of the summer. For this reason, apparently, great amounts of *S. borealis* appeared in the test plants. As was mentioned before (p. 131), the amount of fungus observed in spring 1949 in other grass tillages of the Experiment Station was next to nothing.

In the experiment, *S. borealis* appeared most strongly in *Poa serotina*, *P. trivialis*, *Dactylis glomerata*, *Phleum pratense*, *Festuca rubra* and *Lolium perenne*. Great differences were observed between the different strains. Bottnia-timothy was almost entirely free from the disease. The timothy strain Lappi and Tarmo were also fairly well resistant to *S. borealis*. The appearance of fungus was strong in those samples, where the seed was of North American origin. The Finnish *Festuca rubra* strain was only slightly infected whereas in the Swedish strain the disease was comparatively plentiful. As was mentioned above, *Dactylis glomerata* is known to be susceptible to *S. borealis*. In our experiment, the Gullåker and Danish *Trifolium* strain showed *S. borealis* to a greater extent. In the experiments, *Lolium perenne* strains were very much infected.

More resistant to *S. borealis* than the above-mentioned grass species were *Alopecurus pratensis*, *Anthoxanthum odoratum*, *Agrostis canina* and *A. stolonifera*, in which there were 5—6 % diseased plants. The *Agrostis tenuis*, *Poa pratensis* and *Festuca pratensis* strains were either totally free from the disease or only slightly infected. As is seen in Table 2, the *Agrostis* species germinated badly, so the observation material on their part remains small.

*S. borealis* had in most cases entirely damaged the plants it had infected. The



Fig. 5. English rye-grass damaged by *Sclerotinia borealis*. Photographed in spring 1948 at Porsögården, Branch Station of the Swedish Seed Association near Boden. —

Photo by E. A. Jamalainen.

Kuva 5. *Sclerotinia borealisen* turmelema englantilainen raiheinä. Valokuvattu keväällä 1948 Ruotsin kylvösiemenyhdistyksen haaraosastossa Porsögårdenissa lähellä Bodenä.

Table 2. Grass experiment at Perä-Pohjola

Taul. 2. Nurmiheinäkoe Perä-Pohjolan

In brackets separately the percentage of injured

Sulkeissa erikseen se osa saastuneista yksi-

Grass species and strains	Density of growth in autumn 1948 0—10	Total number of plants in spring	Plants injured by <i>S. borealis</i> %
Heinälajit ja kannat	Kasvuston tiheys syksyllä 0—10	Yksilöitä keväällä yhteensä	<i>S. borealisen</i> turmelemia yksilöitä %
<i>Agrostis canina</i> , koiranrölli .....	0.5	20	5
<i>A. stolonifera</i> , rönsyrölli .....	4.6	68	6
<i>A. tenuis</i> , nurmirölli .....	3.6	49	0
<i>Alopecurus pratensis</i> , nurmipuntarpää			
Weihenstephan, Germany .....	8.3	220	4 (1.5)
A 660, Tammisto, Finland .....	7.1	168	6
<i>Anthoxanthum odoratum</i> , tuoksusimake ..	6.8	108	6.5
<i>Dactylis glomerata</i> , koiranruoho			
Gullåker, Sweden .....	9.1	166	20 (5)
Jo D 70, Jokioinen, Finland .....	6.8	87	9
Tammisto II, Finland .....	8.3	141	6
Trifolium, Denmark .....	9.8	148	21 (12)
<i>Festuca pratensis</i> , nurminata			
Bottnia, Sweden .....	9.6	231	1.5
Paavo, Jokioinen, Finland .....	9.6	237	0
Svalöf, late (myöh.), Sweden .....	9.9	215	2.5
Tammisto II, Finland .....	9.4	215	1
Øtofte I, Denmark .....	9.9	224	0
<i>F. rubra</i> , aronata			
Reptans, Sweden .....	9.3	229	20 (20)
Tammisto II, Finland .....	8.8	248	2
<i>Lolium perenne</i> , engl. raiheinä			
Valinge, Sweden .....	9.5	239	11.5
Viktoria, Sweden .....	9.3	199	20.5 (4)
Øtofte I, late (myöh.), Denmark .....	8.4	205	18 (5)

cases in which part of the plants were saved from the disease are mentioned separately in the table.

In the experiment, besides *S. borealis*, also damages by *Typhula* spp. fungi took place but they were not defined according to species. Mostly they occurred in *Trifolium timothy*, *Poa serotina*, in Weihenstephan *Alopecurus pratensis* strain and in *Agrostis* species. — In some grass species the green parts of the plants were either totally destroyed or part of the leaves were destroyed, although no fungi were to be observed in them at the moment the observations were made. In these instances, it was obviously a case of snow mould; the leaves of the plants

Experiment Station in Apukka in 1948—49.

koeasemalla Apukassa vv. 1948—49.

plantshat were only partly damaged by fungus.

löistä, jotka vain osittain sienen turmelemia.

Grass species and strains	Density of growth in autumn 1948 0—10	Total number of plants in spring	Plants injured by <i>S. borealis</i> %
Heinälajit ja kannat	Kasvuston tiheys syksyllä 0—10	Yksilöitä keväällä yhteensä	<i>S. borealisen</i> turmelemia yksilöitä %
<i>Phleum pratense</i> , timotei			
Bottnia, Sweden . . . . .	9.3	161	1
Gloria, Sweden . . . . .	8.4	173	11
Lappi Tl., Finland . . . . .	8.1	168	2.5
Omnia, Sweden . . . . .	9.3	187	16.5
Tammiston timotei (Tammisto timothy), Finland . . . . .	7.3	162	16.5
Ta 01, Tammisto, Finland . . . . .	5.6	153	8
Tarmo, Jokioinen, Finland . . . . .	7.1	173	6
Trifolium, Denmark . . . . .	6.8	132	10
Vanadis, Sweden . . . . .	8.6	148	38.5
Øtofte, Denmark . . . . .	9.0	181	8.5
Exp. series (koe-erä)			
No. 5, of Canadian origin (Kanadasta)	2.6	80	16.5
No. 2650, ————	6.4	99	54.5
No. 4, ————	5.0	107	31
No. 554, ————	6.3	130	23
<i>Poa pratensis</i> , niittynurmikka			
Adila, Esthonia . . . . .	9.9	280	2
Gullåker, Sweden . . . . .	9.9	253	0
Exp. series (koe-erä) No. 62, of foreign origin (ulkol. alkuperä) . . . . .	9.6	224	2
<i>Poa serotina</i> , rantanurmikka			
Hammenhög, Sweden . . . . .	9.4	179	40
Primus, Sweden . . . . .	9.9	172	29
<i>P. trivialis</i> , aronurmikka . . . . .	9.5	254	20 (6)

were destroyed in a manner typical of snow mould (cf. p. 128). This was observed in *Agrostis tenuis*, *Festuca pratensis*, *F. rubra* and in some strains of *Dactylis glomerata*.

It was shown in the above that some winter rye varieties developed in the north, in particular the Finnish ones, seem to be fairly resistant to the disease. As regards timothy and other field grasses, the information so far available likewise reveals that the varieties most resistant to *S. borealis* are to be found in the districts where the fungus occurs. It is not worth while to grow grass species and their



strains susceptible to the fungus in regions where *S. borealis* occurs. In the breeding work it is essential to use material derived from the northern parts of the country and resistant both to *S. borealis* and other parasitic winter fungi. Also testing of the varieties must be performed in conditions where these fungi are abundant.

#### *On the control of Sclerotinia borealis.*

In the control of the fungus chief attention must be paid to the growing of resistant varieties of winter cereals and grass strains, as pointed out in the foregoing. In addition, even some other measures must be considered in order to prevent losses by *S. borealis*.

Reports on *S. borealis* show that the plant nutrients of the soil have an effect on its more or less abundant occurrence. EKSTRAND (7, 9, 10, 13), draws attention to this question on the basis of his observations on the fertilizing experiments. In 1942 he found (10, p. 38) in Swedish experiment that in the unlimed plots the timothy was more infected by *S. borealis* than in the limed ones. Both lime and phosphate were used in the experiment. Lime was then no direct cause for the less abundant occurrence of the fungus, it had evidently set free mobilized phosphoric acid which was necessary for increasing the resistance of timothy. In Finland, at the Tohmajärvi Experiment Station, EKSTRAND and the author noted in 1946 that in the experiment with winter rye more plants were destroyed by *S. borealis* and snow mould in unlimed plots than in plots given both lime and phosphate. Under these circumstances for the control of *S. borealis* the fields must be in good growing condition and the plants must be given in particular phosphate fertilizers that seem to increase their resistance both to *S. borealis* and other parasitic winter fungi.

The other measures for the control of the disease are the same as those for the control of snow mould. An early harrowing is made in the spring and the dead leaves are gathered and burnt. Melting of snow drifts is forced by sprinkling ash or mould on them. To strengthen their growth the plants must be given nitrate. If it seems that the vegetation is entirely damaged, it is best to plough the field up. This should, however, be carefully considered, because as was mentioned above (p. 131) the plants impaired by the fungus do not always die altogether, but will revive in the spring when a satisfactory crop can be expected.

#### *Summary.*

In the middle and northern parts of Sweden and Finland *Gramineae*-plants are infected by a fungus of *Sclerotinia*-genus which causes injury during the overwintering of the plants. VLEUGEL in Sweden described the fungus with the name *Sclerotinia borealis* BUBÁK and VLEUGEL in 1917.

In Sweden *S. borealis* has been met in several years causing injury to winter rye, timothy, cocksfoot and other field grasses. It occurs commonly in Norrland, especially in the country Norrbotten. The southern limit of its spreading area in Sweden is in latitude about 61° N.

In Finland *S. borealis* is met in the middle and northern parts of the country. On the basis of the information hitherto the fungus is more or less general in the years favourable to its occurrence in the provinces of Lapland, Oulu, Kuopio and Mikkeli. When occurring more abundantly as happened during the overwintering 1945—46, *S. borealis* is in these regions one cause for the poor overwintering of winter rye, timothy and other grasses.

The climatical conditions prevailing during autumn, winter and spring are of decisive bearing for the spreading of *S. borealis* as well as for its abundant occurrence in certain years. The development of the apothecia of the fungus and the spreading of the ascospores is evidently favoured by long, rainy autumn, the damages are promoted by low freezing of the soil and thick cover of snow in the winter as well as by slow melting of snow in the spring.

Of the occurrence of *S. borealis* in different *Gramineae*-plants, see p. 133—134.

Different varieties of winter cereals and species and strains of grasses vary greatly in resistance to *S. borealis*. It has been observed that, of the varieties of winter rye, especially the Finnish ones resist the disease caused by the fungus very well. Of field grasses, *Phleum pratense*, *Dactylis glomerata*, *Lolium perenne*, *Poa serotina*, and *P. trivialis* are susceptible to *S. borealis*. Some strains of these species, however, are extremely well resistant to the fungus.

The strains of the grasses and varieties of winter rye grown in the north are generally more resistant to the damages by the fungus. In developing new varieties of winter cereals and strains of field grasses for the northern conditions these facts must be duly considered and for the breeding work such material should be selected which has grown in the district where the fungus occurs.

Obviously the damages caused by the fungus are less when the plants receive plenty of nutrients, especially phosphates whereby they become stronger to resist infections.

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## SELOSTUS.

## GRAMINEAE-KASVIEN TALVEHTIMINEN JA TUHOSIENET.

I. *SCLEROTINIA BOREALIS* BUBÁK & VLEUGEL.

E. A. JAMALAINEN.

*Maatalouskoelaitoksen kasvitautiosasto, Tikkurila.*

Tärkeimpiä syitä *Gramineae*-kasvien huonoon talvehtimiseen Suomessa ovat kasveja talvehtimisen aikana turmelevat tuhosienet, ns. talvehtimissienet. Tässä eri osina julkaistavassa tutkimuksessa tullaan tekemään selkoa, mikä merkitys talvehtimissienillä on maassamme syysviljojen ja niittyheinien viljelyssä. Ensimmäiseksi otetaan selostettavaksi *Sclerotinia borealis* BUBÁK & VLEUGEL, joka esiintyy vahinkojen aiheuttajana keski- ja pohjoisosissa Ruotsia ja Suomea.

Sienen totesi Ruotsissa ensimmäisen kerran ULANDER v. 1906 Luulajan seudulla (17). Myöhemmin osoitettiin, että *S. borealis* on yleinen Norrlannissa, varsinkin Norrbottenin maakunnassa, jossa se useina vuosina aiheuttaa huomattavia vahinkoja syysrukiissa, timoteissa ym. nurmiheinissä (ULANDER ja EKSTRAND useissa tutkimuksissaan, ks. kirjallisuusluetteloa). *S. borealis* esiintymisalue ulottuu Ruotsissa etelässä Taalainmaan ja Gästriklandin maakuntiin (10).

Suomessa on kirjoittaja yhdessä fil.lis. H. EKSTRANDIN kanssa keväällä 1946 suorittamallaan matkalla pohjois- ja keskiosissa maata todennut *S. borealis* esiintyvän useilla seuduilla yleisenä syysrukiissa ja timoteissa. Kolmena seuraavana vuonna on Maatalouskoelaitoksen kasvitautiosaston taholta jatkettu tutkimuksia sienien levinneisyyden ja sen aiheuttamien vahinkojen selvittämiseksi. Keväällä 1948 teki kirjoittaja yhdessä fil.lis. EKSTRANDIN kanssa matkan myös Pohjois-Ruotsiin, jossa suoritettiin tutkimuksia talvehtimissienistä.

*Sclerotinia borealis* BUBÁK & VLEUGEL-sienen kuvasi VLEUGEL Ruotsissa v. 1917 (21). Hänen selostuksensa vastaa kirjoittajan saamaa kuvaa sienestä. Apotekioiden muoto ja suuruus (kuva 1), samoin kuin itiökoteloiden ja itiöiden koko ovat samaa suuruusluokkaa. Taulukossa I on esitetty lukuja sienien sklerotioiden suuruussuhteista, josta käy selville, että sienirihmapahkojen koko vaihtelee riippuen siitä, mistä isäntäkasvista ne ovat peräisin sekä siitä tehdäänkö mittaukset kuivista vai kosteudessa olleista sklerotioista.

Paras aika *S. borealis* toteamiselle on kevät, kohta lumen sulamisen jälkeen. Syysrukiin oraiden ja heinäkavien paljastuttua lumen alta on sienien saastuttamissa pelloissa suurempia tai pienempiä aloja kasvustosta tuhoutunut (kuva 2). Kirjoittajan havaintojen mukaan on taudille tyypillistä, että sienien tappamat lehdet ovat kuivettuaan enemmän tai vähemmän rihmamaisia, väriltään harmaita tai harmaaruskeita (kuva 3). Tässä suhteessa ovat *S. borealis* ja lumihomeen aiheuttajan *Fusarium nivale* (FR.) CES:n vahingot helposti eroitettavissa toisistaan. *F. nivale* turmelemien oraiden lehdet ovat kuivettuaankin levällään ja usein hieman punertavia.

*S. borealis* aiheuttamat vahingot voivat kevään kuluessa lisääntyä siten, että juuri lumen sulaessa kasveja on runsaammin elossa kuin myöhemmin. Sienen heikentämät yksilöt eivät jaksaa elpyä, vaan kuolevat lopuksi. Toiselta puolen voivat sienien vuoksi heikossa kunnossa olevat kasvit vielä myöhemmin vahvistua, kuten todettiin Perä-Pohjolan kasvinviljelyskoeasemalla timoteissa v. 1948.

Kirjoittajan kokeiden mukaan alkoi keväällä kerättyihin *S. borealis* sklerotioihin muodostua apotekioita vasta syksyllä ilmojen muututtua kylmemmiksi, syys—lokakuussa. Laboratorio-olosuhteissa ei itiöemien muodostuminen ollut normaalia. Usein niihin kehittyi vain varsi. Apotekiot olivat selvästi valohakuisia.

Tiedot *S. borealis* levinneisyydestä osoittavat, että se suosii pohjoisia seutuja. Tästä syystä täytyy näillä seuduilla vallitsevilla ilmastosuhteilla olla ratkaiseva merkitys sen esiintymiselle. Pitkä, kostea ja lämmin syksy, jolloin lumi tulee routaantumattomaan maahan, on ilmeisesti edullisin sienien leviämiseksi. Edelleen voidaan päätellä, että toiselta puolen maan routaantuminen ja toiselta puolen lumikerroksen paksuus sekä sen nopeampi tai hitaampi sulaminen vaikuttavat sienien tuhojen suuruuteen keväällä. Jos maa on matalaan routaantunut ja lumikerros on paksu, samalla kun lumi sulaa keväällä hitaasti, on sienellä suuret mahdollisuudet tehdä vahinkoja.

Niiden neljän vuoden aikana, jolloin kirjoittaja on kerännyt tietoja *S. borealis*esta, olivat sen vahingot suurimmat ja esiintymisalue laajin keväällä 1946. Kolmena seuraavana keväänä tavattiin sientä huomattavasti vähemmän; vv. 1948 ja 1949 sitä esiintyi suoranaisten vahinkojen aiheuttajana vain Perä-Pohjolan koeasemalla lähellä Rovaniemeä. Mistä tämä johtuu on vaikeata varmemmin päätellä saatavissa olleiden sää-, lumisuus- ja maan routaantumistietojen perusteella. Kysymyksen selvittely edellyttää lämpötila-, lumisuus- ym. tutkimuksia sienien esiintymispaikoissa.

Sivuilla 130—131 luetellaan Maatalouskoelaitoksen kasvitautiosastolle kerääntynyt aineisto sienestä ja sen esiintymispaikoista. Yksityiskohtaisia tutkimuksia *S. borealis* esiintymisestä on kirjoittaja tehnyt koeasemille keväisin vv 1946—49 suorittamallaan matkoilla.

Neljän vuoden aikana saadut tiedot *S. borealis*esta osoittavat, että sieni on Suomessa kuten Ruotsissakin maan keski- ja pohjoisosissa esiintyvä laji. VALLE (20) totesi Tammistossa (Hankkijan kasvinjalostuslaitos Malmilla) timoteissa keväällä 1930 tuhoja, joita hän pitää *S. borealis* aiheuttamina. Sienen vahinkoja esiintyi Tammistossa paitsi timoteissa myös koiranruohossa v. 1927. Eteläisin paikka, Etelä-Savon koeasema, josta kirjoittaja on saanut näytteen sienestä, sijaitsee lähellä Mikkeliä. Tähän-



astisten tietojen mukaan tavataan sientä enemmän tai vähemmän yleisenä sen esiintymiselle edullisina vuosina Lapin, Oulun, Kuopion ja Mikkelin lääneissä. Mikä merkitys sienellä on muissa osissa maata, ei nykyisten tietojen mukaan voida lähemmin päätellä.

Jos tauti esiintyy lievänä, turmeltu sen vuoksi vain muutamia prosentteja kasvustosta, joko siten, että pellossa on pieniä aukkokohtia, joissa kasvit ovat tuhoutuneet, tai ovat yksityiset kasvit taikka niiden alemmat lehdet turmeltuneet. Tällaisissa tapauksissa ei vahingoilla ole suurta merkitystä, sillä kasvun edistyessä aukkokohdat täyttyvät, eikä niitä myöhemmin kesällä edes enää huomata. Sellaisissa tapauksissa, jolloin sieni synnyttää suurempia aukkokohtia ja niitä tavataan runsaasti (kuva 2) tai peltosarkojen reunat ovat sienen turmelemia, voi taudista johtuva vahinko olla huomattava, 10—30 % sadosta voi mennä hukkaan. Pahimmissa tapauksissa tuhoaa sieni suuria, yhtenäisiä useampien aarien suuruisia aloja. Timotein ja muiden arvokkaiden heinälajien häviäminen useampivuotisista nurmista pohjoisissa osissa maattamme samoin kuin Ruotsissa, voi täten olla monissa tapauksissa *S. borealisen* aiheuttamaa (vrt. kuva 4). — Tähänastisten tietojen mukaan on *S. borealis*, sen esiintymiselle edullisina vuosina yhtenä syynä syysrukiin ja nurmiheinien huonoon talvehtimiseen pohjois- ja keski-itäosissa maattamme.

*S. borealis* esiintyy paitsi syysviljoissa myös useissa heinäkasveissa, jotka on lueteltu siv. 133—134. Eri syysviljalajikkeiden ja nurmiheinälajien sekä niiden kantojen kestävyudessa *S. borealista* vastaan on huomattavia eroavaisuuksia. On todettu, että syysruislajikkeista varsinkin suomalaiset ovat kestäviä sienin aiheuttamaa tautia vastaan (vrt. EKSTRAND, 11). Sellaisia ovat tähänastisten tietojen mukaan lajikkeet Ensi, Toivo Greus (maatiaislajike) ja maassamme kokeiltavana ollut venäläinen lajike Vjatka. Muista rukiista on Ruotsissa todettu kestäviksi lumihometta, *S. borealista* ja *Typhula* spp.-sieniä vastaan Björn- ja Sangaste-rukiit, eräät ruotsalaiset maatiaislajikkeet sekä juhannusruis. Nurmiheinistä ovat timotei, koiranruoho, engl. raiheinä, rantanurmikka ja aronurmikka alttiita *S. borealiselle*. Eräät näiden lajien kannat ovat kuitenkin sienin suhteen hyvin kestäviä, kuten Ruotsissa tehdyt havainnot ja Suomessa Perä-Pohjolan koeasemalla suoritettut kokeet osoittavat (taul. 2).

Sienen esiintymispaikoilla kehittyneet syysviljalajikkeet ja heinäkantat, ovat kestävämpiä *S. borealista* vastaan kuin muualta saadut (ULANDER, 17, 18, 19; NILSSON & NAESSMAN, 15; EKSTRAND, 2, 8, 9, 11). Kehitettäessä uusia syysviljalajikkeita ja nurmiheinäkantoja pohjoisia olosuhteita varten on tämä otettava huomioon ja käytettävä jalostuksessa sienin esiintymisalueella kasvanutta aineistoa, samoin kuin jalostusmateriaali on kokeiltava seuduilla, joissa sientä esiintyy.

Sienen torjunnassa on kiinnitettävä ensisijainen huomio kestävien syysviljalajikkeiden ja heinäkantojen viljelemiseen. Tämän lisäksi ovat eräät muutkin keinot varteenotettavia *S. borealisen* aiheuttamien vahinkojen ehkäisemiseksi. Peltojen on oltava hyvässä kasvukunnossa ja kasveille on varattava varsinkin fosforilannoitteita, jotka näyttävät lisäävän kasvien kestävyttä sekä *S. borealista* että muita talvehtimissieniä vastaan niiden toteamuksien mukaan, joita Ruotsissa ja Suomessa on tehty lannoitus-kokeista (vrt. EKSTRAND, 7, 9, 10, 13).

Taudin muista ehkäisykeinoista tulevat kysymykseen samat menetelmät kuin lumihomeen torjunnassa. Keväällä suoritetaan varhainen äestys, jolloin kuolleet lehdet kerätään ja poltetaan. Hankien sulamista joudutetaan kylvämällä niille tuhkaa tai multaa. Kasvun vahvistamiseksi annetaan oraille salpietaria. Jos näyttää siltä, että kasvusto on kokonaan turmeltunutta, on syytä suorittaa pellon nurinkyntö. Tätä on kuitenkin tarkoin harkittava, sillä sienin heikentämät kasvit eivät aina kuole kokonaan, vaan saattavat elpyä myöhemmin keväällä.