The sawfly fauna on Norway spruce in a Danish plantation, with a comparison to some other NW-European countries.

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Introduction.

The collection of sawflies described below was carried out in connection with studies on the biology and the control of the noxious species *Pristiphora (Lygaeonematus) abietina* Christ. The locality was Bommerlund Plantation situated about 10 km north of Denmark's southern frontier at Padborg. The plantation consists almost completely of Norway spruce (*Picea abies*), mainly 50 to 80 years old. Some Sitka spruce (*P. sitchensis*) and white spruce (*P. glauca*) are intermingled but other tree species are only represented on very small areas of the total 660 ha.

Method.

Two roads in the south-western part of the forest were used for sweeping. The stand was Norway spruce at an age of 50 years with some Sitka spruce along the roadside (fig. 1). The roads were about 350 m long and 6-12 m broad. Their direction was north-south, thus protecting the sawflies against the prevalent west-winds. Along the roads the trees were green to the ground and therefore attractive to sawfly egg-laying.

Sweepings with a sweep-net without stick, diameter 35 cm, to catch the adult sawflies were carried out while walking along the roads, usually a half to a whole hour on each, mainly between 11 to 12 and 13 to 14 o'clock. As many sawflies as possible were caught. The collection period is seen from fig. 2.

The influence of weather on the spruce Nematini in the oviposition period—the period concerning us here—has been discussed earlier (Beier Petersen 1960).

Species and numbers caught.

Table 1 shows the results of the sweeping. Besides on Norway spruce most of the species are able to live also on Sitka spruce and white spruce, where larvae of many species were found. The nomenclature of Benson (1958) has been followed.

The species-list is mainly in agreement with the one published earlier (Beier Petersen 1956) but one species, *Cephalcia erythrogastra Hartig,* is new and apparently rare. Also *Gilpinia hercyniae* Hartig was found, distinguishable by the characters given by Reeks (1941). As a new species is further mentioned *Pristiphora amphibola* Förster, which has been segregated from *P. ambigua* Fallén (Benson 1948). In *P. compressa* is included var. *decipiens* Enslin which by Ranin (1961) is considered a separate species.

Table 1.

Spruce sawflies caught in the sweepings in 1955 and 1956. Bommerlund Plantation.

No.	Species		Catch 1955 ♂	♀	total	Catch 1956 ♂	♀	total
1	*Pristiphora abietina*	B	81	240	321	192	266	458
2	— *compressa**)	B	13	12	25	11	18	29
3	— *saxesenii*	B	5	5	10	3	4	7
4	— *pallida*		—	1	1	0	3	3
5	— *ambigua*	B	—	4	4	0	8	8
6	— *amphibola*	B?	—	5	5	0	5	5
7	*Pachynematus scutellatus*	B	34	23	57	63	0	63
8	— *montanus*	B?	68	28	96	71	29	100
9	— *pallescens*	B	51	4	55	69	20	89
10	— *leucopodia*	B?	2	13	15	14	10	24
11	— *nigriceps*		—	2	2	0	2	2
12	*Gilpinia polytoma*		11	8	19	71	29	100
13	— *hercyniae*	B	0	1	1	0	16	16
14	*Cephalcia arvensis*	B	66	1	67	100	6	106
15	— *abietis*	B	9	2	11	25	1	26
16	— *erythrogastra*		1	1	2	2	1	3

B = species known and B? = species probably known already from the Danish collections of Borries.

*) including *Pristiphora decipiens* Enslin.

The proportion of males and females.

It is seen from fig. 2 that the males usually begin flying before the females and reach their maximum number earlier. The proportion of males to females caught in the sweepings will therefore depend on how much of the flight period the sweeping period covers. It depends however also on to which extent the two sexes actually fly. It is known that in the "heavy" *Cephalcia* and *Gilpinia* the females fly only little and instead reach their egglaying positions walking. Thalenhorst (1966) mentions the same to apply to the Nematini, especially *Pachynematus,* and he rejects the sex ratio found in sweepings as expression for the ratio in the whole population.

In hatching from cocoons Thalenhorst (ibid.) for *P. montanus* found 21—28 % females and in sweepings about 6 %. I got in both years 29 % females in the sweepings which might indicate a very high ratio of females.

Fig. 1. Road in Bommerlund Plantation. South Jutland. Locality of sweeping for sawflies. (Phot. P. Haenschke, May 1955.)

P. scutellatus seems to hold a special position. Thalenhorst hatched 52—54 % females and mentions data from Gäbler (1952) and from Czechoslovakia with percentages of females of 67—76. It is well known that in this species many more males than females are seen flying. But interesting from the Danish sweepings is the very great change in sex ratio in the sweepings from 1955 to 1956. In the latter year even outside the sweeping locality no females were found. This indicates a large real change in sex ratio probably as a result of the well known arrhenotoke parthenogenesis (Thalenhorst 1966) and protandria. Such a lability might well be of importance for the understanding of the occasional, scattered and short *scutellatus* outbreaks.

Comparisons with the sawfly fauna on spruce in the Nordic Countries, Germany and Great Britain.

A. Qualitatively.

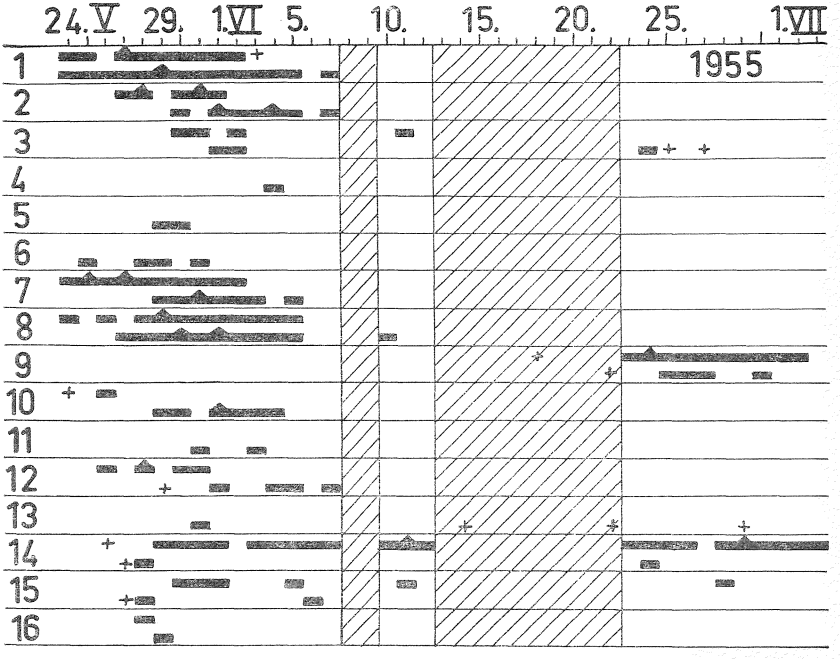
In Denmark and Great Britain all spruce are introduced conifers but Norway spruce is indigeneous to Finland, Norway, Sweden and Germany. It is of interest therefore to see to which extent the spruce sawflies have reached the new localities, Great Britain and Denmark.

The comparison for spruce is given in table 2. The list for Norway must be regarded as very incomplete (Bakke in litt.) and based on old investigations. For Sweden it is probably incomplete in respect to newly distinguished species. It should also be kept in mind, that the Danish list really refers to one locality only.

The countries have the following number of species: Finland 25, Germany 20, Denmark 17, Sweden 14, Great Britain 10, and Norway 8.

Fig. 2. Appearance of adult spruce sawflies in the period of sweeping in 1955 and 1956, Bommerlund Plantation.

Abscissa: date. Ordinate: species—1: *Pristiphora abietina,* 2: *compressa* including *decipiens,* 3: *saxesenii,* 4: *pallida,* 5: *ambigua,* 6: *amphibola,* 7: *Pachynematus scutellatus,* 8: *montanus,* 9: *pallescens,* 10: *leucopodia,* 11: *nigriceps,* 12: *Gilpinia polytoma,* 13: *G. hercyniae,* 14: *Cephalcia arvensis,* 15: *C. abietis,* 16: *C. erythrogastra.* Black triangles show maxima of appearance, crosses signify other observations than sweepings. For each species the males are given in the upper line, the females in the lower. The periods in which no sweeping took place are hatched.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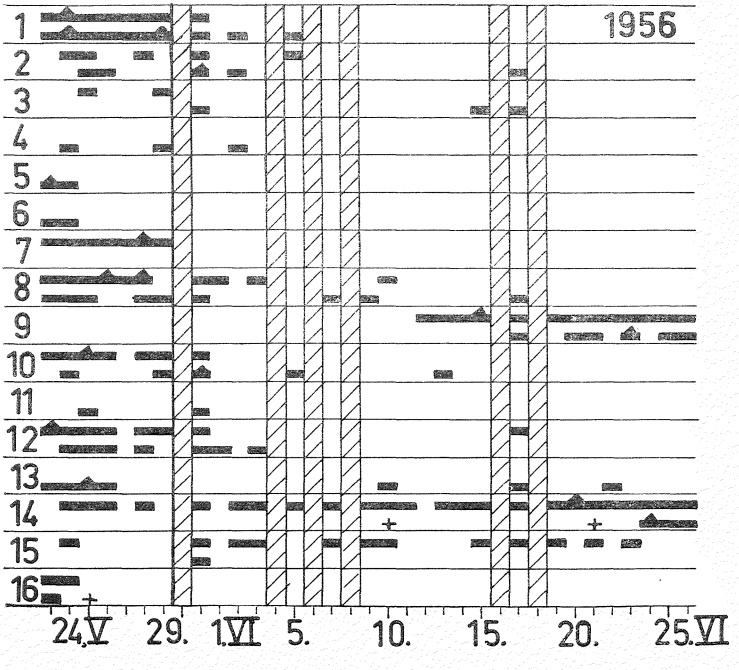
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Table 2.

A list of the spruce sawflies known from Germany, Great Britain and the Nordic countries.

Species	SF	S	N	DK	D	GB
Pristiphora abietina Christ	rr	+	+	+	+	+
— *decipiens* Enslin	rr			+	+	+
— *compressa* Hartig	rc	+	+	+	+	+
— *saxesenii* Hartig	rc	+		+	+	+
— *subarctica* Forssl.	r	+	+			+
— *pallida* Konow	vr			+	+	
— *ambigua* Fallén	c	+	+	+	+	+
— *amphibola* Förster	vr			+	+	+
— *robusta* Konow	vr					
Pachynematus scutellatus Hartig	c	+		+	+	+
— *montanus* Zaddach	r			+	+	+
— *pallescens* Hartig	vr			+	+	
— *insignis* Hartig	vr	+			+	
— *styx* Benson	r				+	
— *leucopodia* Hartig	rr			+	+	
— *nigriceps* Hartig	vr	+		+	+	
Diprion fennicus Forsius	r					
— *fuscipennis* Forsius	r					
Gilpinia polytoma Hartig	c	+	+	+	+	
— *hercyniae* Hartig	vr	+	+	+	+	+
— *abieticola* Dalla Torre	r				+	
Cephalcia arvensis Panzer	rr	+	+	+	+	
— *abietis* L.	rc	+	+	+	+	
— *fallenii* Dalm. (*annulata* Hart.)	rc	+				
— *saxicola* Hartig	vr					
— *erythrogastra* Hartig	r	+		+	+	
Total	25	14	8	17	20	10

+ = present, c = common, rc = rather common, rr = rather rare, r = rare, vr = very rare.

SF = Finland, S = Sweden, N = Norway, DK = Denmark, D = Germany, GB = Great Britain.

It is seen, that Denmark has reached a number of sawflies very near that of Germany. All Danish species are in common with Germany. As it was to be expected Great Britain has a good deal fewer species especially among the heavier ones (*Diprion, Cephalcia*). One British species (*P. subarctica*) is a northern one.

A safe comparison with the list of spruce-sawflies given for Denmark by Borries (1889) is not possible as his collection is lost. But in table 1 is with a B marked those species I think undoubtedly were found by Borries and with a B? those which might be included. The result is 9 and 12 species respectively. In the old list of Danish sawflies (Nielsen and Henriksen 1915) the spruce sawflies are represented with 10 species including *P. nigriceps*. It can now be said, that nearly all species found on spruce in the neighbouring countries Germany and Sweden are represented also in Denmark, and in one locality there. Our "artificial" Norway spruce forest thus seems to have acquired its "natural" sawfly fauna.

B. Quantitatively.

A quantitative comparison is only possible for the spruce Nematini and only between Bommerlund and the German localities studied by Thalenhorst (1958).

Thalenhorst has grouped his material after the dominance system of Tischler (1949) and besides adults his collections include larvae and cocoons. It is therefore better founded than the following one of the Danish adults.

In grouping the Danish species it was a difficulty that *P. abietina* in the years in question had an outbreak and therefore an abnormally high dominance, which diminishes the percentage of the other species. It was found reasonable to exclude *abietina* from the calculation of the percentages and simply place it as a dominant. The two very early flying species *P. ambigua* and *amphibola* had to be excluded because no sweeping had taken place in the major part of their flight-period.

The result is seen from table 3.

The groups from Bommerlund are identical in 1955 and 1956 and the similarity with the German localities is obvious. Only two species are a little lower grouped in Denmark (*saxesenii* and *nigriceps*) and one (*leucopodia*) a little higher.

From this it seems that not only qualitatively but also quantitatively is the spruce Nematini fauna very similar in the localities

Table 3.

Dominance of sawflies on spruce in Harz, Germany and Bommerlund, Denmark.

Dominance-group	Harz	Bommerlund 1955	Bommerlund 1956
Subrecedent (< 1 %)	*Nematus insignis*	*P. pallida*	*P. pallida*
	P. pallida	*P. nigriceps*	*P. nigriceps*
Recedent (1-2 %)	None	None	None
Subdominant (2-5 %)	*P. nigriceps*		
	P. leucopodia		
		P. saxesenii	*P. saxesenii*
Dominant (> 5 %)		*P. leucopodia* (6 %)	*P. leucopodia* (8 %)
	P. saxesenii		
	P. compressa	*P. compressa*	*P. compressa*
	P. ambigua-amphibola		
		P. abietina	*P. abietina*
	P. scutellatus	*P. scutellatus*	*P. scutellatus*
	P. montanus	*P. montanus*	*P. montanus*
	P. pallescens	*P. pallescens*	*P. pallescens*

P. abietina was not grouped by Thalenhorst.

investigated. Only *Pristiphora abietina* differs radically, of course more so during the outbreak. In a later paper Ohnesorge and Thalenhorst (1966) found that the abundance of *abietina* relatively to the other spruce Nematini was negatively correlated with the altitude above sea level.

The periods of appearance of the adult sawflies.

A. Males and females.

Fig. 2 shows the periods of appearance of the single species. As mentioned before the males appear before the females in all Nematini of which sufficient numbers have been caught, and the number of males culminate before that of the females. This is also true for *Gilpinia polytoma*. Nothing definite can be said for *Cephalcia*; it is known though (Escherich 1942), that at least

C. abietis follows the same line. This sequence in the appearance of males and females probably leads to a greater percentage of parthenogenesis in the late flying females.

B. The spruce Nematini.

The Danish observations on appearance are in the main in agreement with a grouping put up by Thalenhorst (1954). The same has earlier been found for the larvae (Beier Petersen 1956). The grouping of Thalenhorst, beginning with the earliest flying species, is as follows.

a) *ambigua* flies as the earliest and disappears before or at the same time as the next group appears. (The larvae live in opening buds.).
b) *scutellatus* group: *scutellatus, leucopodia, nigriceps, saxesenii,* and *compressa.*
c) *montanus.* Almost at the same time as b, but females fly earlier.
d) *pallescens.* Flies after the disappearance of almost all others.
e) *Nematus insignis.* Later than d.

The Danish observations (fig. 2) lead to a few comments on this grouping. *P. amphibola* belongs to group a; of both species in this group only females have been caught, and only in the beginning of the observation period. *P. abietina* belongs between a and b but is undoubtedly nearest to group b. *P. montanus* (group c) follows group b, but there are maybe not enough early observations to permit the conclusion, that no difference exists. *P. pallida* probably belongs to group b.

Nematus insignis is missing in the Danish sweepings. It has possibly appeared after the end of the observation period.

C. The other spruce sawflies.

The *Gilpinia* species begin flying almost synchronously with group b of the Nematini. Both *Cephalcia arvensis* and *C. abietis* were caught during the whole observation period, without very pronounced maxima. The long period of adult appearance for *C. abietis* is well known. Escherich (1942) thus mentions flying to have taken place from the middle of April into August (although not in the same year and on the same place). For a cooler climate he mentions the middle of June as the main flight period. Heqvist (1956) found, that in Skåne (Sweden) flight was usually

from the last of May until the middle of June, but adverse climatic conditions might make it endure for two months.

For *C. arvensis* Escherich mentions the period of appearance to be still more extended than for *C. abietis,* namely (in one place) "till the end of July". The investigations of Boas (1931) show, that the flight period in Kelstrup Skove (Denmark) lasted from the end of May till the beginning of July in 1930.

In these two *Cephalcia* species almost only the males fly, which is confirmed also by these sweepings. The heavier and more clumsy females usually climb the trees to deposit their eggs (Heqvist 1956 and others).

In contrast to this the few *C. erythrogastra* were caught very early, at the same time or maybe even before group a of the Nematini. Males and females were taken in about equal numbers. As flight period for *C. erythrogastra* Escherich mentions April-July, which seems in clear disagreement with the few Danish observations. Rather does *erythrogastra* in respect to flight period agree with the related species living on larch, *C. alpina* Klug. In Bommerlund this latter species was caught at the same time as *erythrogastra,* but mainly females were represented. For *C. alpina* Escherich mentions the period of appearance as April—beginning of May.

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Summary.

The sawfly fauna on Norway spruce has been investigated in a plantation in South Jutland, Denmark. The species list has been compared with that of Finland, Sweden, Norway, Germany and Great Britain. Spruce is introduced in Denmark as well as in Great Britain. While the Danish list contains 85 % of the German species (spruce is indigenous to Germany) the British has only 50 %.

A quantitative comparison between the Danish locality and the Harz (Germany) shows great similarity.

The period of appearance of the adult spruce sawflies as seen from fig. 2 is discussed.

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