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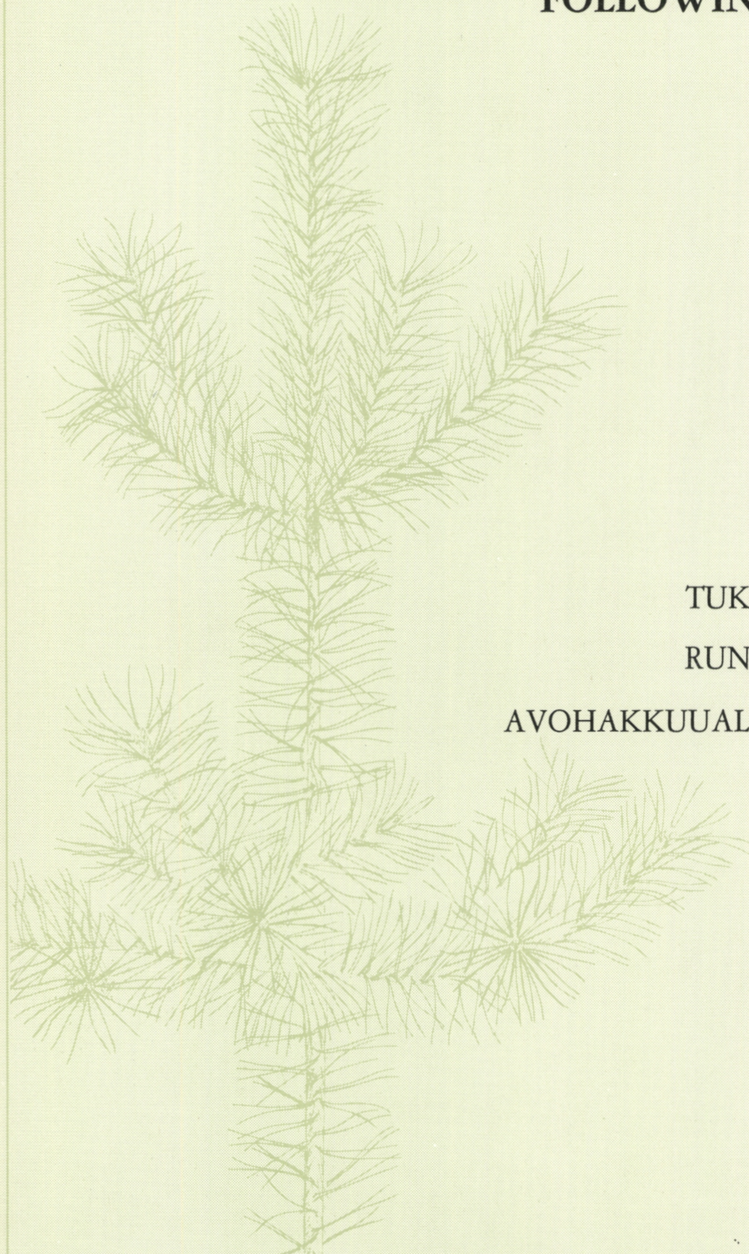
ABUNDANCE AND SEASONAL ACTIVITY OF ADULT HYLOBIUS-WEEVILS IN REFORESTATION AREAS DURING FIRST YEARS FOLLOWING FINAL FELLING

BO LÅNGSTRÖM



SELOSTE

TUKKIKÄRSÄKÄSAIKUISTEN
RUNSAUS JA ESIINTYMINEN
AVOHAKKUUALOILLA PÄÄTEHAKKUUN
JÄLKEISINÄ VUOSINA

HELSINKI 1982

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Cover (front & back): Scots pine (*Pinus sylvestris* L.) is the most important tree species in Finland. Pine dominated forest covers about 60 per cent of forest land and its total volume is nearly 700 mill. cu.m. The front cover shows a young Scots pine and the back cover a 30-metre-high, 140-year-old tree.

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Adult pine weevil populations were sampled in clear felled areas of different ages and forest site types in Finland using trap billets of Scots pine and Norway spruce. Relative abundance, host preference, seasonal activity and population structure of *Hylobius abietis, H. pinastri* and *H. piceus* was studied, as well as the seasonal course of attack on pine and spruce seedlings.

In general, the weevil abundance decreased from south to north. Fewer weevils were captured on spruce than on pine billets, and a similar difference was observed between moist spruce-dominated site types and dry pine-dominated ones. *H. abietis* dominated in most areas, but was much more frequent in pine-dominated areas, and clearly preferred pine before spruce billets. *H. pinastri* was regularly encountered in moist areas, and preferred spruce billets whereas *H. piceus* was rare, and indifferent regarding host preference. Weevil abundance (i.e. *H. abietis*) was high during at least three seasons following clear felling in the south, whereas it in northerly areas reached one peak in the first and another in 4—5 season depending on the generation time of *H. abietis*. Weevil activity was observed throughout the season with a peak in May—June. The occurrence of juvenile and senile *H. abietis* indicated a variable generation period and an adult longevity of more than one year, respectively. The seasonal activity and population structure of *H. pinastri* and *H. piceus* resembled that of *H. abietis*.

Tutkimus käsittelee tukkikärsäkäsaikuisten runsautta ja esiintymistä eri ikäisillä ja metsätyypiltään erilaisilla avohakkuualoilla. Kärsäkäsnäytteitä kerättiin männystä ja kuusesta tehdyillä pyyntipölkyillä. Näytteistä selvitettiin tukkimiehentäin (*Hylobius abietis*), pienen tukkikärsäkkään (*H. pinastri*) ja ison tukkikärsäkkään (*H. piceus*) suhteellista runsautta, puulajin valintaa, esiintymisaikaa sekä populaatioiden rakennetta koealueilla. Lisäksi seurattiin tuhojen esiintymistä männyn ja kuusen taimissa kasvukauden aikana.

Kärsäkkäiden runsaus väheni yleensä etelästä pohjoiseen siirryttäessä. Kuusipölkyillä pyydystettiin vähemmän kärsäkkäitä kuin mäntypölkyillä ja vastaava ero havaittiin kuusi- ja mäntyvaltaisten hakkuualojen välillä. Tukkimiehentäi oli valtalaji useimmilla koealoilla, mutta lajia tavattiin runsaimmin mäntyä kasvaneilla hakkuualoilla ja sen todettiin selvästi suosivan mäntyä. Pientä tukkikärsäkästä tavattiin säännöllisesti tuoreilla metsätyypeillä ja lajin todettiin suosivan kuusta. Iso tukkikärsäkäs oli harvinainen eikä erityisesti suosinut kumpaakaan puulajia.

Etelä-Suomessa tukkimiehentäi oli yleinen ainakin kolmena kasvukautena hakkuun jälkeen, mutta pohjoisempana havaittiin esiintymisessä huippu ensimmäisenä sekä neljäntenä tai viidentenä kasvukautena kehitysajan pituudesta riippuen. Kärsäkkäitä esiintyi koko kasvukauden ajan, mutta eniten niitä oli liikkeellä touko—kesäkuussa. Naaraiden sukukypsyyden perusteella pääteltiin, että kehitysajan pituus vaihtelee huomattavasti sekä että osa kärsäkkäistä elää yli vuoden. Pienen ja ison tukkikärsäkkään esiintyminen ja populaatiorakenne oli samantapainen kuin tukkimiehentäillä.

ODC 453:145.7 x 19.91 *Hylobius*
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CONTENTS

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1. INTRODUCTION

Weevils of the genus *Hylobius* Germar, 1817 (Coleoptera, Curculionidae) are amongst the most destructive insect pests of reforestation areas. The genus has a holarctic distribution, and conifer plantations are endangered by these weevils wherever forestry practice involves clear felling and subsequent planting measures (see, e.g. Browne 1968, Eidmann 1974). In general, these weevils breed in fresh conifer stumps, and the adults feed on the thin bark of conifers. Thus, the changes in forestry practice which have taken place during this century have created optimal breeding conditions for these weevils by providing them with an abundance of breeding material (stumps) and food (seedlings). It is therefore not surprising that this problem was first recognized in Central Europe where rational reforestation techniques have been used since the beginning of the 19th century (Ratzeburg 1839). Some decades later, pine weevil damage was also reported from Sweden (Holmgren 1867) and Finland (Blomqvist 1883).

Since then, many papers have been published on different aspects regarding the biology, economic significance and control of *Hylobius*-weevils (for references, see Escherich 1923, Christiansen 1971a, Eidmann 1971, 1974). Most of these deal with the large pine weevil, *Hylobius abietis* L., which is the most common species in Europe and widely distributed in Asia, as well. *Hylobius pinastri* Gyll. and *Hylobius piceus* De G. are less well known, and of minor economic importance. All three species occur in Fennoscandia (Lindroth 1960, Silfverberg 1979). *H. piceus* is the only holarctic species, and should, according to Smith (1956), belong to the genus *Hypolomyx* LeConte 1876.

From the late 1950s and throughout the 1960s, pine weevil damage was kept at a tolerable level by means of a preventive treatment of seedlings before planting, using DDT, lindane or other persistent insecticides (for references, see Skogsstyrelsen 1978). However, in the 1970s the use of insecticides was drastically restricted in Sweden and Finland owing to a fear of environmental pollution. Although lindane is still permitted for this purpose in Finland, and the new pyrethroids give good protection against pine weevil damage (cf. Eidmann 1979a), increasing research interest has been devoted to integrated measures of control and pest management schemes (cf. Eidmann 1979b, Selander 1979).

Successful pest management implies a thorough knowledge of the biology, population dynamics and behaviour of the species to be controlled. Although much research has been made on the pine weevils, there is still surprisingly little known e.g. about the seasonal activity and population structure of the weevils under varying environmental conditions. Some information on the occurrence of the three weevil species has been given by Sylvén (1927) and Ozols (1967), and additional information regarding *H. abietis* has been given by several authors (see e.g. Fischer 1932, Swaine 1951, Schwenke 1956, Eidmann 1968, 1974, Christiansen 1971b, Solbreck and Gyldberg 1979).

The present paper describes: firstly, the relative abundance of adults of *H. abietis, H. pinastri* and *H. piceus* in reforestation areas in relation to the latitude, forest site type and age of the areas, and secondly, the seasonal activity and population structure of the adult weevils in different geographical regions in Finland.

This study was carried out at the Finnish Forest Research Institute, and was partly supported by a grant from the Foundation for Research of Natural Resources in Finland. The study would never have come true without the co-operation of people within the practical forestry. Their skillful assistance is therefore gratefully acknowledged.

Professor Paavo Juutinen followed my work with keen interest, and I am greatly indebted to him for criticism of the manuscript as well as for assistance during the procedure of final editing and publication. I am also indepted to Dr. Erkki Annila for the use of part of his field data as well as for comments on the manuscript. My thanks are also due to Professor Hubertus H. Eidmann and Dr. Christer Solbreck for valuable comments on the manuscript. I am grateful to Mrs. Christina Sjöberg for typing, and to Mrs. Thérése Gustafson for making improvements to the English.

2. MATERIAL AND METHODS

21. Study areas

In 1970, field studies were carried out in three clear felled forest sites in Tuusula and in one locality at Somerniemi (Fig. 1). The following year, the field studies were extended to cover several reforestation areas of different geographical regions in Finland as well as different forest site types and age classes of clear fellings. Three main study areas were selected for detailed studies regarding the seasonal activity and population structure of the pine weevils. These areas were Tuusula (as in 1970), Juupajoki and Kivalo, and they were selected within the regions of 2-year-, 2—3-year-, and 3-year-generation periods of *H. abietis*, respectively (cf. Bejer-Petersen et al. 1962). Within these study areas, a range of clear felled sites was selected covering the first three, five or six vegetation periods (after the final felling) at Tuusula, Juupajoki and Kivalo, respectively. In addition, some study areas of different forest site types were included.

Besides these main study areas, weevils were collected in reforestation areas of different forest site types in different parts of Finland (see Fig. 1). Nearly all of them were 0—2-year-old clear fellings, except the northern ones (Laanila) which were recently thinned stands. Basic data on the study areas are given in Table 1 (for legends to forest site types, see e.g Lehto 1964).

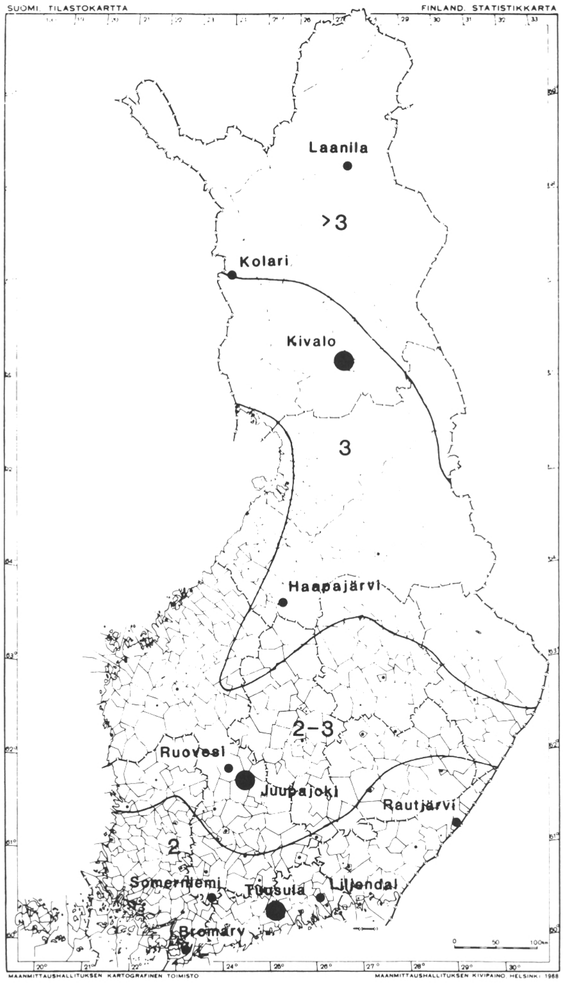

Fig. 1. Study areas of the present investigation. Large circles indicate main study areas with plots covering reforestation areas of different ages and small circles show plots of different site type classes. Regions with different generation times of *H. abietis* are separated by lines.

Kuva 1. Tutkimusalueet. Isot ympyrät osoittavat eri ikäisiä hakkuualoja käsittäviä pääkoealueita, pienet ympyrät eri metsätyyppejä käsittäviä alueita. Tukkimiehentäin kehitysaikavyöhykkeet merkitty viivoilla.

Table 1. Description of study areas.
Taulukko 1. Tutkimusalueiden kuvaus.

Year/locality/ study area *Vuosi/paikkakunta/ koealue*		Period of felling *Hakkuukausi*	Forest site type* *Metsätyyppi*	Mixture of tree species (estimated from stumps) *Puulajikoostumus (kantojen perusteella)* pine *mänty*	 spruce *kuusi*	 decid. *lehtip.*	Clear felled area, ha *Hakkuualan koko, ha*
1970 Tuusula	A	1969—70	VT	10			2,5
	B	1968—69	VT	10			1,0
	C	1968—69	VT-CT	10			1,0
1971 Tuusula (A, B, C as above)	D	1970—71 (1968—69)	VT-CT	10			2,0
	E	1970—71	MT	2	8		2,0
1971 Bromarv	A	1970—71	MT	4	6		1,5
	B	1968—69	MT	5	5		1,5
1971 Somerniemi	A	1970—71	MT-VT	2	8		0,5
	B	1970—71	MT	3	7		0,5
	C	1969—70	VT	10			2,0
	D	1969—70	MT-VT	1	9		1,5
1971 Liljendal		1968—69	VT	10			2,0
1971 Rautjärvi	A	1970—71	VT	10			5,0
	B	1970—71	MT	1	7	2	2,0
	C	1969—70	MT-VT	5	5		50,0
	D	1969—70	MT		10		50,0
1971 Juupajoki	A	1970—71	MT-VT	10			4,5
	B	1970—71	MT		10		4,5
	C	1969—70	MT		10		6,5
	D	1968—69	OMT-MT		10		2,5
	E	1968—69	VT-CT	10			1,5
	F	1967—68	MT +		10		12,5
	G	1966—67	MT		10		3,3
	H	1969—70	MT-VT		10		5,7
1971 Ruovesi	A	1970—71	MT	2	8		20,0
	B	1970—71	OMT	3	7		?
1971 Haapajärvi	A	1970—71	MT	2	4	4	?
	B	1970—71	VT	8	2		?
1971 Kivalo	A	1970—71	HMT	5	3	2	17,0
	B	1969—70	HMT		9	1	120,0
	C	1968—69	EMT	10			22,0
	D	1967—68	HMT		8	2	125,0
	E	1966—67	HMT		7	3	100,0
	F	1965—66	HMT		8	2	80,0
1971 Kolari		1970—71	EMT	10			1,0
1971 Laanila	A	1970—71	EMT	8	2		thinning
	B	1968—69	EMT	7	3		,,

* CT, VT, MT, OMT, EMT, HMT *are Calluna-, Vaccinium-, Myrtillus-, Oxalis-Myrtillus-, Empetrum-Myrtillus-* and *Hylocomium-Myrtillus*-types, respectively.

22. Field methods

221. Trap billets

Freshly cut billets of Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.) were used as trap billets to attract pine weevils. The use of trap billets is an old control method and large catches can be obtained providing that billets are fresh. Many modifications of this method have been designed (Escherich 1923, Sylvén 1927. Trägårdh 1939, Saalas 1940, Butovitsch 1955, Novak 1965a, Eidmann 1974), but today the method has little support as a control method (cf. Eidmann 1979a). However, the method has been employed to sample adult weevil populations (Swaine 1951, Eidmann 1968, Christiansen 1971a, Löyttyniemi and Hiltunen 1976).

In 1970, two different techniques were used. In early May, four groups of trap billets, each comprising of four fresh pine billets, were placed on the ground at 20 m spacing in scarified patches and covered with fresh pine twigs. All billets were 50 cm in length, and the diameter ranged from 5 to 10 cm. Only billets with thin bark were used. These billets and the covering twigs were changed in early July and late August. The billets were inspected twice a week throughout the summer, all weevils being collected from the bark surface, and from the ground below the billets. Similar billets were also dipped in a water emulsion of lindane (0,3 % a.i.), and these billets were placed out at a distance of 20 m from the untreated billets. These billets were not changed, but otherwise the procedure was similar to that of the untreated ones.

In 1971, the same procedure was carried out in the main study areas (Tuusula, Juupajoki and Kivalo). This time the untreated pine billets (two billets per group) were changed more frequently (every third week). In the remaining study plots, lindane-treated pine and spruce billets were laid out according to the above procedure (four groups comprising of two billets of each species at every locality). These billets were not changed, and inspection took place 1—2 times a month throughout the summer.

222. *Seedlings*

In some study areas seedlings of Scots pine and Norway spruce were planted in spring, and inspected for pine weevil damage throughout the first vegetation period.

In 1970, 50 transplants of pine (1 + 1 bare-root) were planted at Tuusula, site A (see Table 1), between the groups of trap billets, and 50 plants at the one-year-old clear felling (B). The seedlings were planted without soil scarification on the first of June, and thereafter inspected twice a week for pine weevil damage using a four-grade classification: 0 = no damage, 1 = slight damage (less than 5 feeding patches, altogether not exceeding 20 mm^2), 2 = moderate damage (5—10 feeding patches, ranging form 20—100 mm^2), 3 = heavy damage (more than 10 feeding patches, altogether exceeding 100 mm^2).

At Somerniemi (D, Table 1), 320 pine plants (1 + 1 bare-root) and a similar number of spruce plants (2 + 1 bare-root) were planted in a screening experiment for testing of the efficiency of insecticide treatments against pine weevil damage. The seedlings were planted in scarified patches on the 19 May and the experiments were inspected once a month including August. A total of 86 dead weevils were found and collected close to the lindane-treated plants. Grading of weevil damage was done according to the procedure described above.

In 1971, a total of 200 pine and spruce seedlings were planted in four study areas at Somerniemi (cf. Table 1), 25 of each species in every locality. These seedlings (1 + 1 bare-root pine, 2 + 1 bare-root spruce) were dipped in 0,6 % lindane (a.i.), and were planted in scarified patches on 19 May 1971. They were inspected according to the standard routine, and the scarification patches were carefully searched for dead weevils, of which a total of 88 were found.

At Juupajoki, 40 pine and 40 spruce plants (2 + 1 bare-root pine; 2 + 2 bare-root spruce) were planted in 5 study areas (B, C, D, F, G, see Table 1) close to the trap billets. By accident, only the pines were treated with 0,6 % lindane (a.i.). The planting was made in scarified patches during the last days of May, and the plants were inspected in accordance to the standard procedure throughout the summer.

223. *Other techniques*

In 1970, four plywood boxes (measuring 60 × 30 cm) were placed over pine roots to catch emerging pine weevils. Altogether 11 specimens of pine weevils were collected from May 1971 to September 1971. Simultaneously with these studies, Annila (1975) trapped hibernating specimens of *Pissodes validirostris* Gyll. in a nearby stand of *Pinus contorta.* He used 7 emergence frames (1 × 1 m in size) and captured 63 *Hylobius*-weevils during May and June 1971. These weevils have been included in the present study.

Flying pine weevils were trapped in window traps. This method has been widely used to trap bark beetles (see e.g. Annila et al. 1972), and the underlying assumptions have been discussed in Southwood (1978). In 1971, 18 window traps were put over six fresh pine stumps at Tuusula (study area A and E, cf. Table 1). The traps were of standard design (50 × 60 cm acrylic sheets placed over a trough containing water and liquid soap as wetting agent), and were emptied at least once a week from early May to early September.

23. Laboratory procedure

All weevils were transferred to the laboratory and frozen on the same day as the sample was taken.

The pine weevils were identified and sexed according to external characters (cf. Schwenke 1956, Eidmann 1974). The same sex characters of *H. abietis* (i.e. the median depressions on the first and last visible abdominal sternites in the male) were also valid for *H. pinastri* and *H. piceus.* All females deriving from the experiments with untreated trap billets were dissected, and the state of sexual maturity was investigated using a classification corresponding to that of Christiansen (1971b). The following groups were separated: 1a = juvenile (short ovarioles, no oocytes), 1b = developing juvenile (extended ovarioles, developing oocytes), 2 = fertile (large ovarioles, oocytes in oviducts, *corpora lutea* present), 3 = senile (extended ovarioles, no oocytes, *corpora lutea* present), 4 = redeveloping (as class 2, but *corpora lutea* present). In 1971, the males were also dissected but no reliable basis for classification could be obtained (cf. Novak 1965b). Before being dissected the beetles were also classified as ''young'', ''intermediate'' and ''old'' according to how much of the yellow scales on the elytra had worn off (cf. Schwechten 1933). Many weevils were observed to contain nematodes and some larvae of hymenopterous parasitoids were also seen. The latter ones were collected for later identification.

3. HOST PREFERENCE

The total catch of pine weevils obtained with the trap billet-technique was 6 483 specimens, and of these 89,2 % were *H. abietis,* 10,3 % *H. pinastri* and 0,5 % *H. piceus.*

The three *Hylobius*-species were not equally distributed over the pine and spruce trap billets (Fig. 2A). Although *H. abietis* was the dominating species on pine and spruce billets, the percentage of this species was considerably lower on spruce, where nearly 30 % of the weevils were *H. pinastri.* Chi-square analyses of the weevil frequencies on pine and spruce billets confirmed that the species were not equally distributed on the billets (2 x 2 contingency table, excluding *H. piceus:* χ^2 = 287,5***, d.f. = 1). Further Chi-square analyses showed that many more *H. abietis* were attracted to pine (n = 1999) than to spruce billets (n = 798; χ^2 = 615,7***, d.f. = 1) whereas an opposite pattern was found for *H. pinastri* (n_{pine} = 126, n_{spruce} = 273; χ^2 = 54,2***, d.f. = 1). Thus, it can be concluded that *H. abietis* preferred pine billets, whereas *H. pinastri* preferred spruce.

A very similar distribution was found amongst the weevils found around the lindane-treated seedlings at Somerniemi in 1970—71 (Fig. 2B). However, the catches of *H. pinastri* on pine (n = 10) and spruce plants (n = 11) did not differ significantly, whereas χ^2-analysis again confirmed that *H. abietis* was significantly more attracted to pine (n = 130) than to spruce (n = 20) (χ^2 = 80,7***, d.f. = 1).

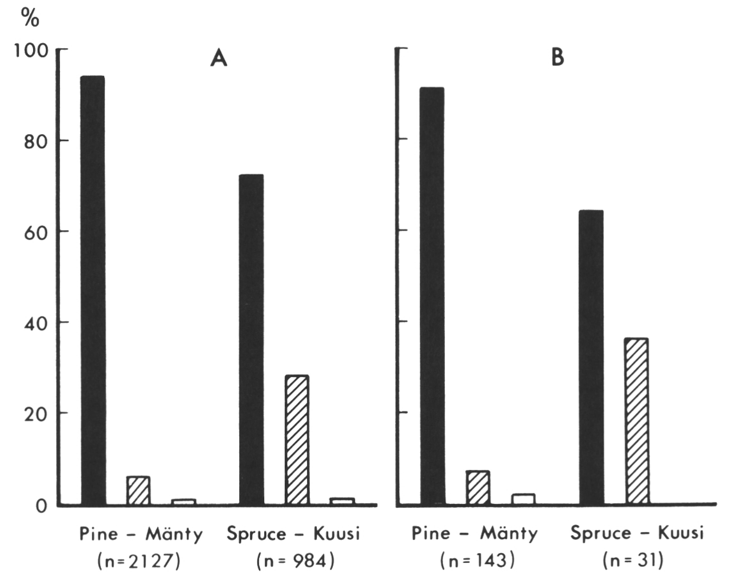

Fig. 2. Per cent distribution of *H. abietis* (black), *H. pinastri* (shaded) and *H. piceus* (white) captured at trap billets (A), and found around lindane treated seedlings (B) of pine and spruce, respectively. Totals are given in brackets.

Kuva 2. Tukkimiehentäin (musta), pienen tukkikärsäkkään (vinoviivoitus) sekä ison tukkikärsäkkään (valkoinen) pyyntipölkyiltä saatujen (A) ja lindaanilla käsiteltyjen taimien ympäriltä kerättyjen (B) aikuisten prosenttinen jakautuminen männyn ja kuusen kesken. Yksilöiden kokonaismäärät suluissa.

4. WEEVIL ABUNDANCE

41. Abundance in relation to geographical region

The relative abundance of pine weevils in the study areas is expressed as the average number of weevils per group of lindane-treated trap billets of pine or spruce during the trapping period. Only the study areas with comparable numbers of pine and spruce billets are included. Figures 3A and 3B show that the weevil abundance decreases from south to north. Furthermore, the catches were always larger on pine than on spruce billets. The ratios between the species varied considerably, although *H. abietis* dominated in most study areas, especially on pine billets. In some study areas, however, *H. pinastri* was

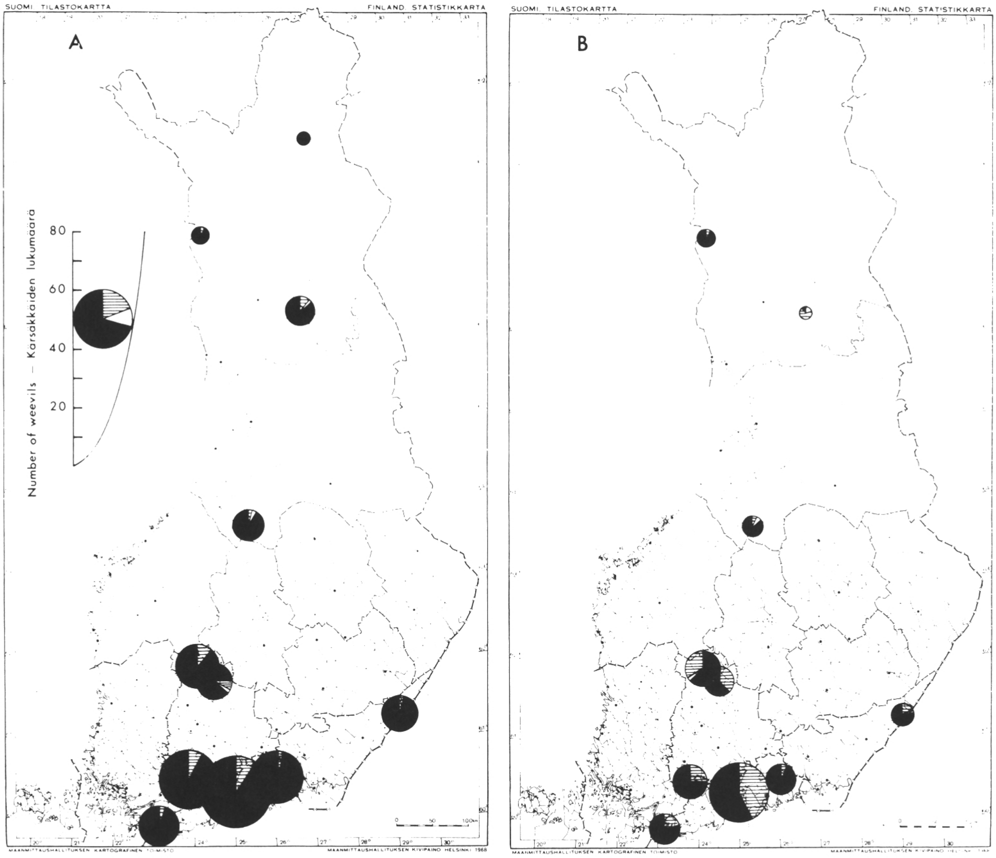

Fig. 3. Abundance of pine weevils in the study areas. The circles show the average number of weevils per group of trap billets of pine (A) and spruce (B) during June—July 1971. Percentages of *H. abietis, H. pinastri* and *H. piceus* are indicated as black, shaded and white circle sectors, respectively. Data derive from plots with equal numbers of pine and spruce billets.

Kuva 3. Tukkikärsäkkäiden runsaus koealueilla. Ympyrät osoittavat kärsäkkäiden lukumäärää männyn (A) ja kuusen (B) pyyntipölkkyryhmää kohti kesä—heinäkuussa 1971. Tukkimiehentäin. pienen ja ison tukkikärsäkkään prosenttijakautuma esitetty mustan, vinoviivoitetun tai valkoisen ympyrän sektorina. Aineisto käsittää vain ne koealueet, joilla oli sama määrä mänty- ja kuusipölkkyjä.

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nearly as frequent as *H. abietis* on spruce billets, and at Kivalo the former outnumbered the latter species. *H. piceus* was absent in the most southerly study areas and was accounted for in very low numbers in most localities, except at Kivalo where the largest capture of this species was made.

42. Abundance in relation to forest site type

The average catches of *Hylobius*-weevils were, in general, higher on the drier and pine-dominated forest sites than on the more damp and spruce-dominated ones (Fig. 4). Since these results were derived from pine billet-data, they primarily reflect the abundance of *H. abietis,* although there was a clear tendency towards an increase of *H. pinastri* with increasing site quality (1,5, 5,5, 13,6 and 22,5 % in CT-VT, MT-, MT + and MT-OMT, respectively).

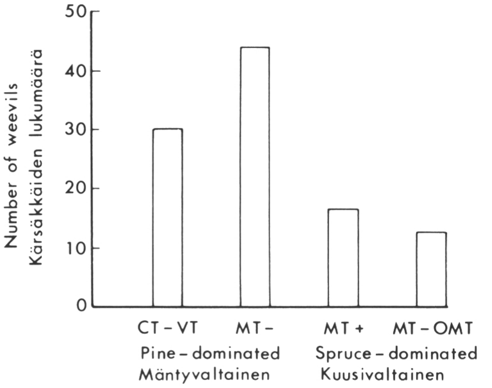

Fig. 4. Abundance of pine weevils (per group of trap billets) in relation to the forest site type and dominant tree species.

Kuva 4. Tukkikärsäkkäiden runsaus (pyyntipölkkyryhmää kohti) metsätyypin ja valtapuulajin mukaan.

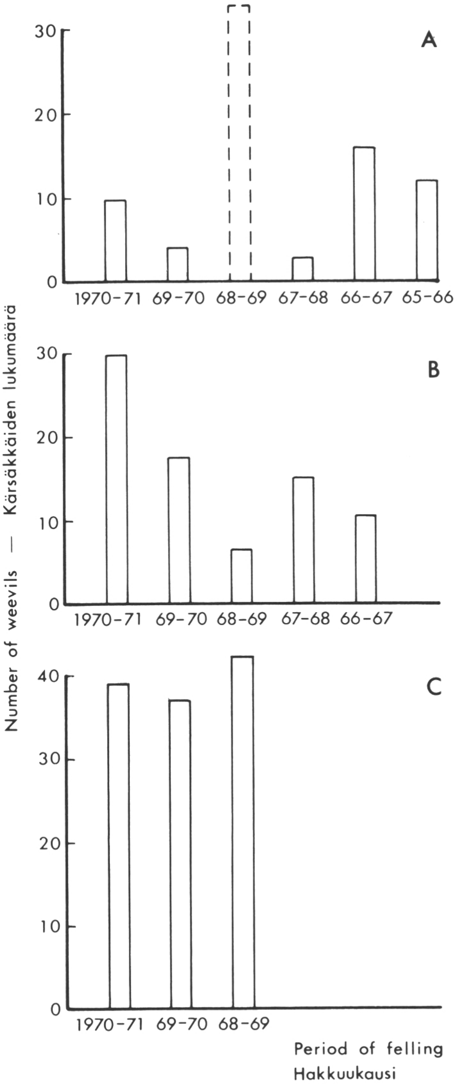

Fig. 5. Abundance of pine weevils (per group of trap billets) in relation to geographical region (A = N. Finland, 3-year-development period, B = S. Finland, 2—3-year-development period and C = S. Finland, 2-year-development period; cf. Fig. 1) and age of clear felling. Broken-line-column indicates deviating forest site type.

Kuva 5. Tukkikärsäkkäiden runsaus (pyyntipölkkyryhmää kohti) eri ikäisillä hakkuualoilla eri kehitysaikavyöhykkeissä (A = Pohjois-Suomi, 3-vuotinen kehitysaika, B = Etelä-Suomi, 2—3-vuotinen kehitysaika ja C = Etelä-Suomi, 2-vuotinen kehitysaika; vrt. kuva 1). Katkoviivoitus osoittaa poikkeavaa metsätyyppiä.

43. Abundance in relation to age of clear felling

In southern Finland, the relative abundance of pine weevils remained at the same level throughout the first three growth periods (Fig. 5). In central and northern Finland, the average catches decreased in the second year and then increased in year 3 and 4, respectively. This increase took place in the year when the majority of the new generation was expected to emerge (cf. Bejer-Petersen et al. 1962). It is also noteworthy that the average catch for comparable study areas was higher in the south than in the more northerly areas, although high population levels may occur in the north, as well, if the forest site type is suitable (Kivalo 1968—69).

5. SEASONAL ACTIVITY

51. Emergence and flight period

A total of 63 specimens of *H. abietis* were captured in the emergence frames (cf. Annila 1975) from 12 May to 22 June 1971 (Fig. 6). Of these, 54 % were females and none of the females were in a juvenile stage of sexual development. Evidently the weevils were leaving their hibernation site. In the trap cages only 11 specimens of *H. abietis* were captured. In 1970, one fertile female was found on 1 June, one male on the 3 June and another fertile female on 5 June. All of these were probably hibernating parent beetles. In September, one juvenile female, and three males (probably juvenile as well) emerged. In June 1971, another juvenile female and one male was captured, and in September two more males were encountered (all probably of the new generation).

In 1971, the majority of the flying weevils were captured at the end of May, and after the beginning of June only single individuals were seen in the traps (Fig. 6). When dissected, many of the females were found to be fertile, but some juvenile and senile ones were also observed. One fertile female of *H. pinastri* was captured at Tuusula on 28 June. The majority of the swarming weevils were caught during a hot period at the end of May with daily maximum air temperatures exceeding 20°C (cf. Fig. 7).

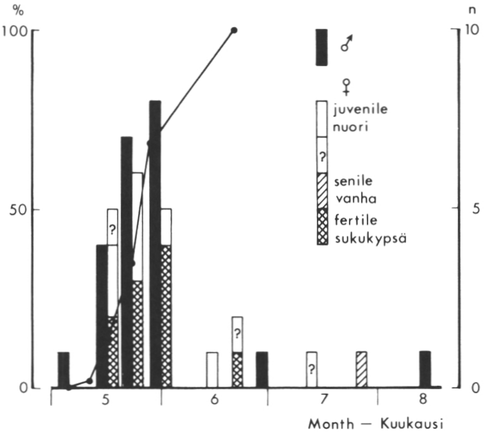

Fig. 6. Emergence and flight period of *H. abietis* at Tuusula in 1971. The curve shows the cumulative percentage (n = 63) of weevils emerging from the trap frames. Columns show the number of weevils (n = 43) captured in window traps, their sex as well as the sexual maturity of the females.

Kuva 6. Tukkimiehentäin esiintulo ja parveilu Tuusulassa 1971. Käyrä osoittaa maapyydyksistä saatujen kärsäkkäiden kumulatiivista prosenttimäärää (n = 63). Pylväät ilmaisevat ikkunapyydyksillä pyydystettyjen kärsäkkäiden lukumäärää ja sukupuolta sekä naaraiden sukukypsyyttä.

52. Occurrence on trap billets

The weekly catches of pine weevils at Tuusula, Juupajoki and Kivalo are shown in Figure 7. Meteorological data (daily maximum and minimum air temperature) were obtained from the weather stations of the Finnish Meteorological Institute at Tuusula and Juupajoki, whereas the station at Kivalo was run by the Department of Silviculture of the Finnish Forest Research Institute.

In all study areas specimens of *H. abietis* were found on the trap billets at the first inspection. Therefore, little can be said about the commencing of weevil activity and its relation to the temperature. The course of weevil occurrence at the trap billets was biased by the reduced attractivity of the billets owing to drying-out. The catches always increased after the billets had been exchanged. The highest catches of *H. abietis* were obtained in late May and early June at Tuusula and Juupajoki, and in late June at Kivalo. Regarding *H. pinastri*, there was a slight tendency towards a later culmination of the peak catches in all study areas. The few specimens of *H. piceus* were scattered over the whole season.

At Tuusula and Kivalo a few weevils were still captured in September after the first night frosts. No inspections were made at Juupajoki after 23 August.

Judging from the above results it may be concluded that all three species of pine weevils are active throughout the summer

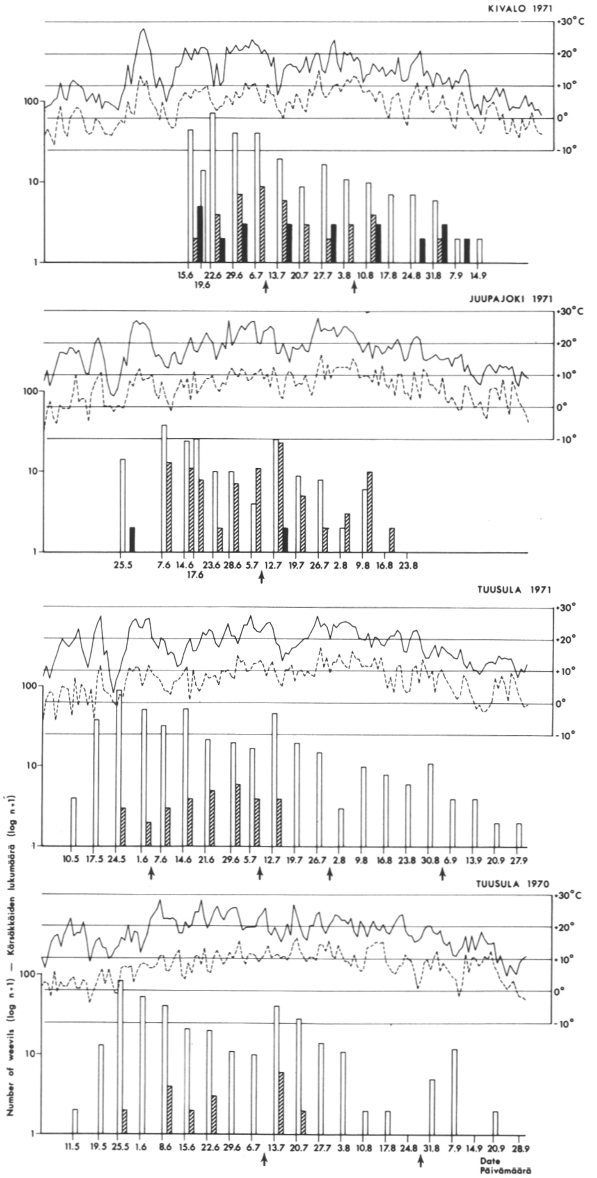

Fig. 7. Seasonal occurrence of *H. abietis* (white), *H. pinastri* (shaded) and *H. piceus* (black) on trap billets in the main study areas. Solid lines refer to daily maximum temperatures of air, and broken lines to daily minima, according to weather stations situated within 10 km from the study areas. Arrows indicate replacements of trap billets.

Kuva 7. Tukkimiehentäin (valkoinen), pienen (vinoviivoitus) ja ison tukkikärsäkkään (musta) esiintyminen pyyntipölkyillä pääkoealueilla kasvukauden aikana. Yhtenäinen viiva osoittaa vuorokauden korkeinta ja katkoviiva alinta lämpötilaa 10 km säteellä koealueista sijainneilla sääasemilla. Nuolet ilmaisevat, milloin pyyntipölkyt vaihdettiin.

season, but many more weevils occurred on the trap billets in early than in late season.

The sex ratios of the pine weevils which were captured at the trap billets are shown in Figure 8. Altogether significantly fewer females were encountered with the trap billet technique. In general, the female percentage was relatively seen lower in the summer than in spring or autumn, but no consistent patterns were seen neither when comparing the species nor the localities. The observed seasonal changes, of which a

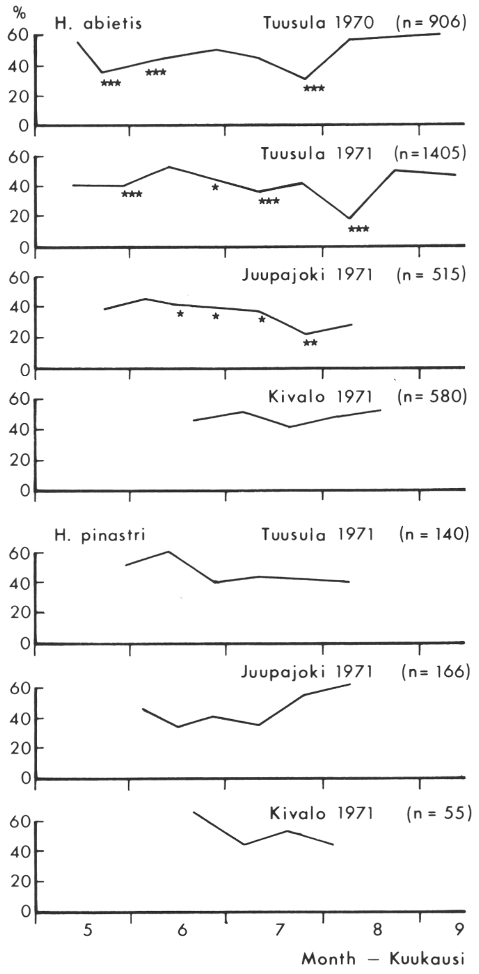

Fig. 8. Seasonal changes in female percentage of *H. abietis* and *H. pinastri* in the main study areas. Significant deviations from a 1:1 ratio are indicated by 1—3 asterisks corresponding to the level of significance ($P < 0{,}05$, $P < 0{,}01$ and $P < 0{,}001$, respectively).

Kuva 8. Tukkimiehentäin ja pienen tukkikärsäkkään sukupuoli-indeksin (naaras-%) muuttuminen kasvukauden aikana pääkoealueilla. Merkitsevät poikkeamat 1:1 suhteesta merkitty 1—3 tähdellä merkitsevyystasosta riippuen ($P < 0{,}05$, $P < 0{,}01$ ja $P < 0{,}001$).

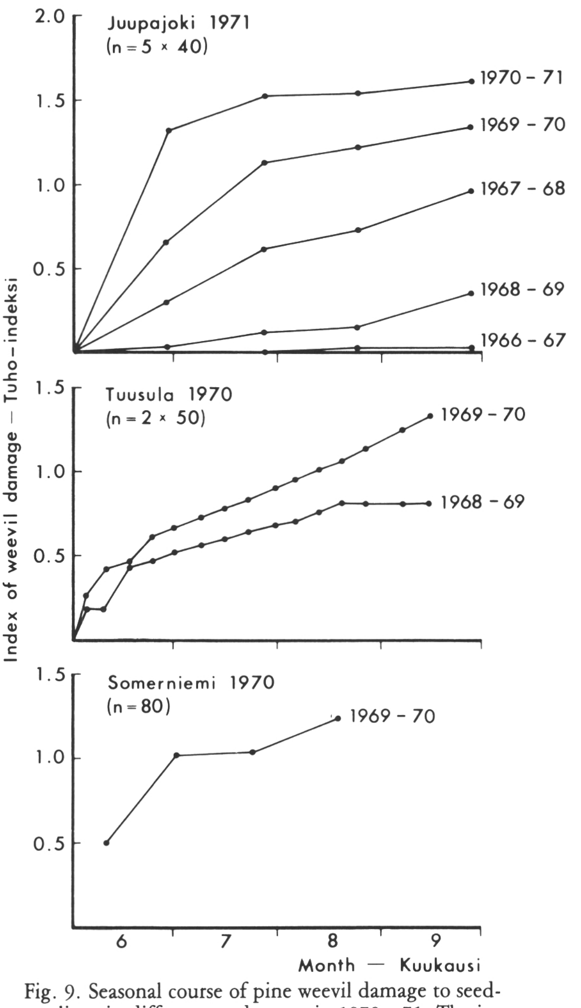

Fig. 9. Seasonal course of pine weevil damage to seedlings in different study areas in 1970—71. The index of damage was calculated as: % damaged seedlings x average degree of damage x 100^{-1}. Further information obtainable in the text.

Kuva 9. Tukkikärsäkästuhojen esiintyminen taimissa kasvukauden kuluessa eri koealueilla vuosina 1970—71. Tuhoindeksi laskettu seuraavasti: % vioittuneita taimia x keskimääräinen tuholuokka x 100^{-1}.

few were statistically significant, probably reflect behavioural differences between the sexes (e.g. ovipositional activity of the females).

53. The course of attack on seedlings

Figure 9 shows the gradual increase of attacks on planted seedlings at Somerniemi, Tuusula and Juupajoki. In most study areas the index of damage (i.e. per cent damaged plants x average degree of damage x 100^{-1}) increased throughout the season although the major feeding activity was observed in early summer. It is noteworthy that the level of attack at Juupajoki followed a pattern corresponding to the estimated population size (cf. Fig. 5), i.e. that more feeding took place in year 4 than in year 3. At Tuusula the difference between the curves was less prominent which also fits into the pattern seen in Figure 5.

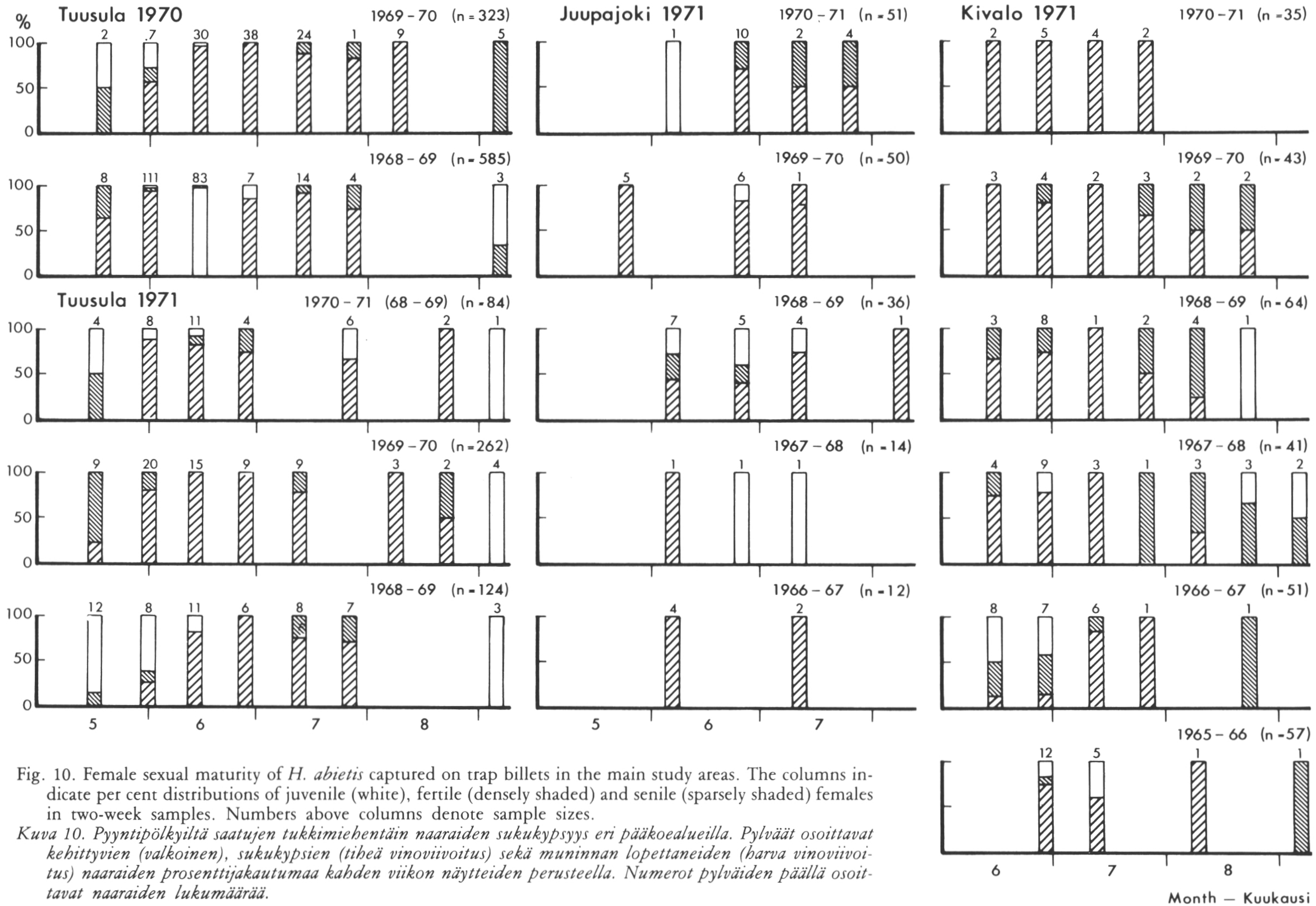

Fig. 10. Female sexual maturity of *H. abietis* captured on trap billets in the main study areas. The columns indicate per cent distributions of juvenile (white), fertile (densely shaded) and senile (sparsely shaded) females in two-week samples. Numbers above columns denote sample sizes.

Kuva 10. Pyyntipölkyiltä saatujen tukkimiehentäin naaraiden sukukypsyys eri pääkoealueilla. Pylväät osoittavat kehittyvien (valkoinen), sukukypsien (tiheä vinoviivoitus) sekä muninnan lopettaneiden (harva vinoviivoitus) naaraiden prosenttijakautumaa kahden viikon näytteiden perusteella. Numerot pylväiden päällä osoittavat naaraiden lukumäärää.

6. POPULATION STRUCTURE IN RELATION TO THE AGE OF THE STUDY AREA

61. Hylobius abietis

The sexual maturity of the females followed a pattern which could be expected from the corresponding development periods of *H. abietis*. Juvenile females were seen in early season at the fresh study areas as well as in late/early season of the second/third, third/fourth and fourth/fifth vegetation period after felling at Tuusula, Juupajoki and Kivalo, respectively (Fig. 10). However, the emergence of the new generation was extended over a long

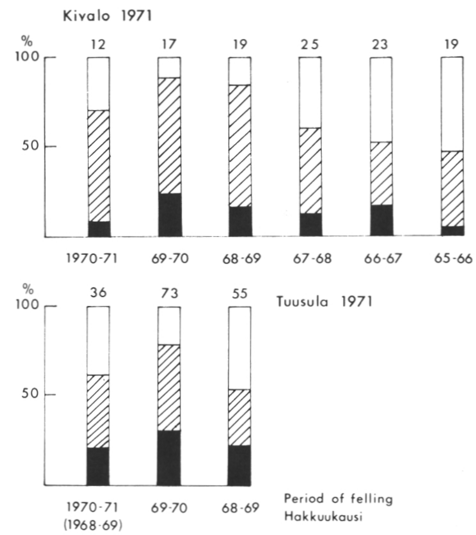

Fig. 11. Relative age classification of *H. abietis* females from study areas of different ages at Tuusula and Kivalo in 1971 according to the external character used (white = yellow scales abundant, ''young'', shaded = intermediate, black = scales worn off, ''old''; cf. Table 2). Sample sizes are given above the columns. Further information obtainable in the text.

Kuva 11. Tukkimiehentäin naaraiden suhteellinen jakautuminen ikäluokkiin peitinsiipien suomupeitteen kulumisen perusteella Tuusulassa ja Kivalossa 1971 (valkoinen = suomuja runsaasti, ''nuori'', vinoviivoitus = välimuoto, musta = suomupeite kulunut, ''vanha''; vrt. taulukko 2). Naaraiden lukumäärät ilmoitettu pylväiden yläpuolella.

period of time. At Tuusula, a few juvenile females were seen in 1971 at the fresh study area in the first year. This was due to the fact that the stand was felled in two steps 1968—69 and 1970—71. More surprising were the findings of juvenile weevils in mid-summer at Juupajoki, especially the one at the one-year-old study area. By definition, the weevils were classified as developing until the first mature oocytes were present in the oviducts. Consequently these weevils, here classified as juvenile, may have been in an advanced state of sexual maturity. At Kivalo, the first juvenile female was found after 2 ½ years indicating a three-year-generation period.

Since most weevils were classified as fertile, little can be said about the age structure of the local populations. However, senile females were seen in most study areas in the early season, indicating a second hibernation at the adult stage. One attempt was made to estimate the proportions of ''young'' and ''old'' weevils in the local populations of *H. abietis*. As can be seen in Table 2, most juvenile females were characterized by the presence of yellow scales on the elytra, whereas the senile weevils were seen in all three groups. Thus the value of this external age classification is questionable, at least on an individual level. However, when applied to samples of weevils some indication on the age structure in the local population can be obtained (Fig. 11).

62. Hylobius pinastri

The few observations regarding the population structure of *H. pinastri* are summarized in Figure 12. Judging from this, there is no evidence supporting an assumption that the seasonal activity, longevity and development period of *H. pinastri* is different from that of *H. abietis*. Since only occasional juvenile and senile females were encountered, a further evaluation of these results is not possible.

63. Hylobius piceus

Even less can be said about the population structure of *H. piceus*. Twelve of the 25 specimens captured at Kivalo were females, and amongst these, two juvenile ones were observed in June in the three-year-old study area.

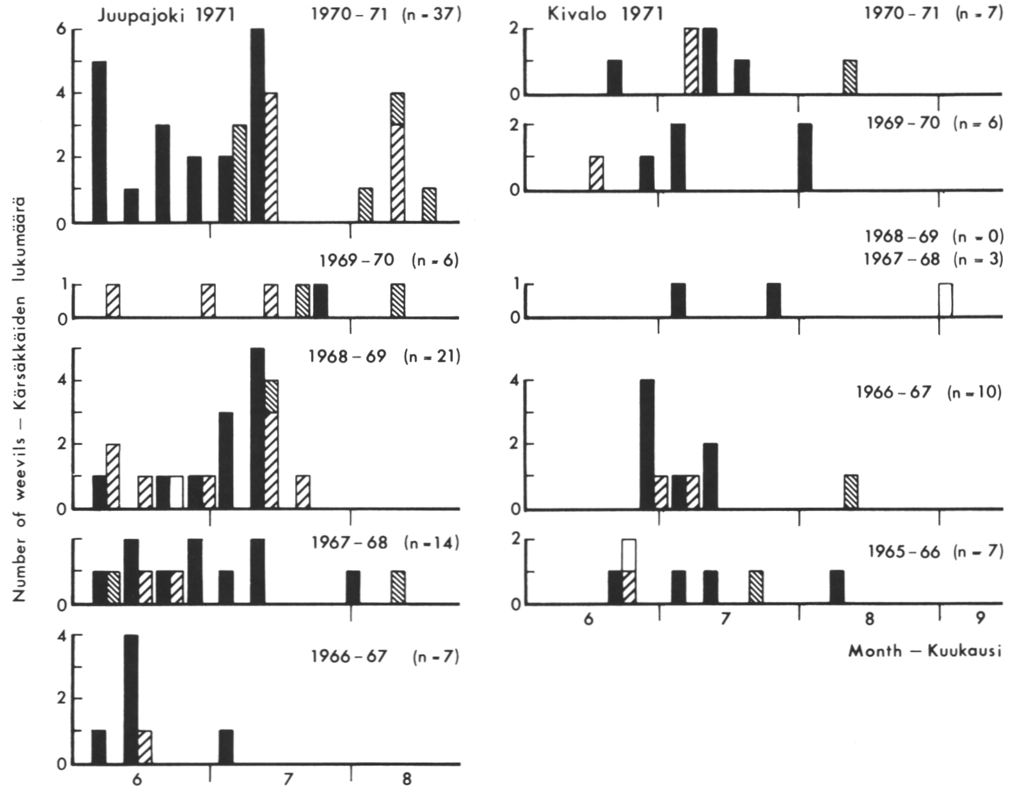

Fig. 12. Seasonal occurrence, and female sexual maturity of *H. pinastri* on trap billets at Juupajoki and Kivalo in 1971. Totals of males and females are given in brackets. For legend to female classification, see Fig. 10.

Kuva 12. Pienen tukkikärsäkkään esiintyminen sekä naaraiden sukukypsyys Juupajoella ja Kivalossa 1971 pyyntipölkyistä saadun aineiston perusteella. Yksilöiden kokonaismäärät suluissa. Naaraiden sukukypsyysluokat selitetty kuvassa 10.

Table 2. Females of *H. abietis* classified according to the presence or absence of yellow scales on the elytra, and the state of sexual maturity. Tuusula, Juupajoki and Kivalo 1971.

Taulukko 2. Tukkimiehentäin naaraiden luokittelu peitinsiipien suomupeitteen kulumisen sekä sukukypsyyden perusteella. Tuusula, Juupajoki ja Hyytiälä 1971.

"Age class" *"Ikäluokka"*	State of ovary development — *Ovaarioiden kehitysaste* juvenile *nuori* (1a + 1b)	fertile *kypsä* (2)	senile *vanha* (3 + 4)	total *yhteensä*
Scales abundant *Suomuja runsaasti*	50	61	17	128
Intermediate *Välimuoto*	6	114	31	151
Scales worn off *Suomut kuluneet*	—	45	17	62
Total *Yhteensä*	56	220	65	341

7. DISCUSSION

71. Host preference

Many more specimens of *H. abietis* were captured on trap billets of pine than on those of spruce, whereas the opposite pattern occurred in *H. pinastri.* The same tendency was to be observed regarding the pine and spruce seedlings, as well. Although both weevil species occurred on pine and spruce, the results indicate a clear preference for pine in *H. abietis* and spruce in *H. pinastri.* According to Ohnesorge (1953) extract of pine phloem attracted *H. abietis* four times more than did spruce extract. Using similar trap billets, Christiansen (1971b) also captured many more specimens of *H. abietis* on pine than on spruce billets. According to Saalas (1923) *H. pinastri* should prefer pine whereas Kangas (1959) assumed spruce to be the main host.

It has, for a long time, been assumed that *H. abietis* prefers pine before spruce seedlings (cf. Sylvén 1927), but on the other hand pine seedlings are often smaller and consequently become more severely attacked than the bigger spruce seedlings (cf. Eidmann 1969). However, it has been shown that the development of *H. abietis* is slower in spruce stumps or breeding billets than in those of pine (Bejer-Petersen et al. 1962). Moreover, Guslits (1970) has shown in laboratory studies that the development is not only slower on spruce, but also that the weevils emerging from spruce logs were smaller, laid fewer eggs and lived shorter as compared with those emerging from pine. Thus, pine phloem seems to be of a higher nutritive value to *H. abietis* as compared with spruce. Selander (1979) demonstrated that pine phloem contains several volatile constituents which attract the pine weevils, but he made no comparisons with spruce.

In the present study *H. piceus* was encountered in low numbers on pine and spruce. According to Saalas (1923) the species is also breeding in larch (*Larix* sp.). In Poland, larch is considered to be the main host of this species (Dominik 1966) whereas in North America it seems to prefer white spruce (*Picea glauca* (Moench)Voss) before pine and larch (Warren 1956).

72. Abundance of the species

The design of the present study does not permit any truly quantitative conclusions regarding the abundance of the different weevil species in the study areas. However, the results do give some indications on the relative abundance of the weevils in relation to some environmental factors.

In the total weevil catch, consisting of more than 6 000 specimens, 89,2 % were *H. abietis,* 10,3 % *H. pinastri* and 0,5 % *H. piceus.* These figures are similar to those obtained by Sylvén (1927) in central Sweden (94,5, 5,1 and 0,4 % respectively), and by Ozols (1967) in Latvia (84,6, 15,1 and 0,4 % respectively).

In Fennoscandia all three weevil species have been reported from most provinces up to the timber line in the north (Saalas 1923, Lindroth 1960). According to Heqvist (1957) *H. piceus* has a northerly distribution, and the present results support this observation. In a sample of 35 weevils from Messaure, north Sweden, Lundberg (1974) found 17, 34 and 49 % *H. piceus, H. pinastri* and *H. abietis,* respectively. Since *H. piceus* is not confined to stumps, and often breeds at the base of old conifers (cf. Dominik 1966) it may find suitable trees more easily in the extensively managed northern forests. According to Warren (1956) damage caused by this species was in Canada, more frequent at wet sites than at dry ones (cf. Ozols 1967).

The frequencies of *H. abietis* and *H. pinastri* varied considerably according to forest site type. The highest numbers of the former species (in absolute as well as in relative numbers) were seen at the dry pine-dominated forest sites, whereas the numbers decreased considerably in the more moist and spruce-dominated areas. Here the highest number (22,5 %) of *H. pinastri* was encountered. In Latvia, Ozols (1967) found that *H. abietis* was overwhelmingly dominant at the driest pine-growing sites (98,8 %), whereas *H. pinastri* accounted for 40 % of the population at the best (moist and spruce-dominated) forest sites. He also estimated the total number of weevils to be of the magnitude of 40 000 per hectare in the former and 10 000 in the latter areas. In Sweden, Nordanstig (see Lindelöw 1977) estimated the larval population in the stumps to be about 180 000 weevil larvae per hectare at a sandy pine-dominated clear felling in central Sweden. Charitonova's (1965, see Lindelöw 1977) corresponding figures from the Soviet Union are in the range of 20 000—70 000 weevil larvae per hectare.

Other studies confirm the present observation regarding higher weevil frequencies at pine-dominated sites as compared with moist spruce-sites (Sylvén 1927, Schwenke 1956, Ozols 1967). Juutinen (1962) observed twice as many damaged seedlings (31 %) in study areas with little herbaceous vegetation as compared with sites of abundant vegetation. More evidence supporting this observation has recently been provided by Stadnitskij (1978). He found that the weevil damage was inversely related to the density of the herbaceous vegetation surrounding the conifer plants. Controlled burning has also been observed to greatly increase weevil damages during the first year(s) after burning when vegetation is absent or scarce (Sylvén 1927, Juutinen 1962).

The average catches of pine weevils indicate that the population level, in general, is much lower in the northern part of Finland than in the southern one. This is in full agreement with the unpublished results of a joint Nordic survey on the frequency of pine weevil damage in different parts of Fennoscandia (Skogsstyrelsen 1978).

The relation between the relative weevil abundance and the age of the study area (Fig. 5) corresponds quite well to what could be expected in the regions of different development periods for *H. abietis*. The relatively small changes from year to year may be understood if we assume: firstly, that the adult beetles live longer than one season, and secondly, that emergence of the young generation occurs over a long period of time. These assumptions will be discussed later.

It is noteworthy, that the weevil population remained at the same level at Tuusula (development period of 2 years) throughout the three vegetation periods, whereas it clearly decreased at Juupajoki and Kivalo (2—3 and 3 years' development period) after the first summer, and then increased again in the year of main brood emergence.

According to the Nordic survey (unpubl.) and Swedish studies (Skogsstyrelsen 1978) high levels of attack have been encountered in southern Fennoscandia during the 3—4 years after clear felling, whereas in northerly areas the level of damage decreased with increasing age of the study areas.

In southern Norway, Christiansen (1971c) observed a higher level of weevil damage in the first growth period after clear felling as compared with 1—3 years' old study areas. Similar results were obtained by Juutinen (1962) in Finland, and Cankov (1970) in Bulgaria. There are, however, several observations contradicting the above mentioned ones regarding weevil damage in relation to the age of reforestation area (cf. Christiansen 1971a).

73. Seasonal activity

The present results show that weevils are active throughout the vegetation period. No clear differences between the species were seen. Similar results have been obtained for *H. abietis* (cf. Sylvén 1927, Christiansen 1971a, Lekander unpubl.). In Scandinavia, the flight period of *H. abietis* normally occurs during 1—3 weeks in late May and early June (Eidmann 1968, Eidmann and Novak 1970, Christiansen

1971b, Gyldberg and Thorell 1977, Löytyniemi and Uusvaara 1977, Solbreck and Gyldberg 1979). However, weevil activity has repeatedly been demonstrated prior to flight (cf. Eidmann 1968, Christiansen 1971b). *H. abietis* has been observed to leave hibernation sites early in spring at temperatures exceeding 8—9°C (Fischer 1932, Eidmann 1974). Flight has been shown mainly to occur at temperatures exceeding 18—19°C and at wind velocities below 3—4 m/s (Solbreck and Gyldberg 1979). After the cessation of flight the number of the weevils collected at trap billets decreases although weevils can be found throughout the season (Sylvén 1927, Eidmann 1968, Christiansen 1971b, Lekander unpubl.).

The results indicate changes in the sex ratios of *H. abietis* (Fig. 8). Similar changes have been observed by e.g. Eidmann and Novak (1970) and Christiansen (1971b) using trap billets, whereas Schwenke (1956) observed the opposite pattern (increasing female percentage) in trap ditches. These observations reflect the ovipositional activity which is known to extend over several months (Lekander unpubl.). According to Guslits (1969) the oviposition period of *H. abietis* follows a bimodal pattern with one peak in June followed by a feeding period and another peak in late summer.

Regarding *H. pinastri* and *H. piceus* little is known about the seasonal activity of these species. The flight period of the former species seems to coincide with that of *H. abietis* (cf. Sylvén 1927, Eidmann and Novak 1970). The present results do not indicate any differences between the three species regarding seasonal activity.

74. Population structure

In section 72 it was assumed that part of the population lives longer than for one oviposition period, and that the emergence of the new generation takes place over several years. The present results contain some evidence supporting these assumptions: 1) senile females of *H. abietis* were observed in many study areas in early season, 2) the age classification (according to the degree of wearing of yellow scales on elytra) indicated that at least 5—25 % of the weevils may have hibernated more than once as adults. These figures are greater than those (<10 %) reported by other authors (Schwechten 1933, Schwenke 1956, Novak 1965a). According to Cankov (1970), however, 50 % and 17 % of *H. abietis* survived a second and third hibernation, respectively, in outdoor cages. A longevity extending over at least two years under favourable conditions has also been observed by Eidmann (1974). Guslits (1969) has demonstrated that the females lay fewer eggs after a second hibernation than during the first oviposition period.

The regional generation periods of *H. abietis* which were demonstrated by Bejer-Petersen et al. (1962) have later been found to vary considerably within each region (Bakke and Lekander 1965, Bejer-Petersen 1975).

Little is known about the longevity and life cycle of *H. pinastri* and *H. piceus*. According to Eidmann (1974) their development periods correspond to that found in *H. abietis*.

Altogether, it is evident that the local pine weevil population may contain different age classes of weevils deriving from the actual site during the years following a clear felling. The situation becomes even more complex if we consider that weevils may also invade from adjoining areas (cf. Solbreck 1980). These two factors are the likely explanations of the high population levels and feeding damage observed in southern Fennoscandia during the 3—4 years following the clear felling. In northern Fennoscandia, weevil damage may occur during a longer period than indicated in this study, since breeding has been observed in the same spruce stumps during two years (cf. Bejer-Petersen et al. 1962), thus delaying the emergence with another year.

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SELOSTE

Tukkikärsäkäsaikuisten runsaus ja esiintyminen avohakkuualoilla päätehakkuun jälkeisinä vuosina

Tutkimus käsittelee tukkimiehentäin (*Hylobius abietis* L.), pienen tukkikärsäkkään (*H. pinastri* Gyll.) ja ison tukkikärsäkkään (*H. piceus* DeG.) aikuisten esiintymistä ja populaatioiden rakennetta sekä kärsäkkäiden nuorille taimille aiheuttamien tuhojen ajoittumista eri ikäisillä ja metsätyypiltään erilaisilla avohakkuualoilla.

Tutkimuksia tehtiin vuonna 1970 Tuusulassa ja Somerniemellä ja vuonna 1971 usealla paikkakunnalla Etelä- ja Pohjois-Suomessa (kuva 1). Koealueiksi valittiin Tuusulassa, Juupajoella ja Kivalossa (Rovaniemen mlk.) eri ikäisiä hakkuualoja, muualla tuoreita tai vuoden vanhoja eri metsätyyppejä edustavia avohakkuualoja (taulukko 1).

Pääosa aineistosta kerättiin käyttämällä ohuista männyn ja kuusen rungoista sahattuja tuoreita, 0,5 m:n pituisia pyyntipölkkyjä, jotka peitettiin havuilla. Tuusulassa, Juupajoella ja Kivalossa käytettiin sekä myrkyttämättömiä mäntypölkkyjä, jotka uusittiin määrävälein, että lindaanilla käsiteltyjä mänty- ja kuusipölkkyjä, joita ei vaihdettu. Myrkyttämättömät pölkyt tarkastettiin 2—3 kertaa viikossa toukokuun alusta syyskuun loppuun, lindaanilla käsitellyiltä pyyntipölkyiltä kerättiin kuolleet kärsäkkäät kahden viikon välein.

Tuusulassa seurattiin lisäksi kärsäkkäiden esiin tuloa maasta ja niiden parveilua maa- ja ikkunapyydysten avulla. Tuusulassa, Somerniemellä ja Juupajoella tarkastettiin koealueille istutettuja männyn ja/tai kuusen taimia kärsäkästuhojen esiintymisen ajankohdan selvittämiseksi.

Vaikka kaikki kolme kärsäkäslajia esiintyivät sekä männyllä että kuusella, vaihteli lajikoostumus sekä puulajin ja metsätyypin että hakkuualan maantieteellisen sijainnin mukaan (kuva 2). Tukkimiehentäi oli vallitseva laji lähes kaikilla koealoilla, mutta lajin suhteellinen runsaus oli kuitenkin selvästi suurempi mäntypölkyillä, kun sen sijaan pientä tukkikärsäkästä tavattiin runsaimmin kuusipölkyillä. Sama tulos kuvastuu lajien esiintymisessä männyn ja kuusen taimilla. Iso tukkikärsäkäs oli kaikkialla vähälukuinen ja puuttui täysin etelärannikon hakkuualoilta.

Suurimmat suhteelliset populaatiotiheydet todettiin Etelä-Suomen kuivilla mäntyvaltaisilla hakkuualoilla, missä tukkimiehentäi oli täysin vallitseva laji (yli 90 %) (kuva 3). Metsätyypin parantuessa kokonaissaalis väheni, ja samalla pienen tukkikärsäkkään osuus kasvoi jopa puoleen yksilömäärästä (kuva 4).

Eteläisimmässä Suomessa kärsäkäspopulaatio pysyi saman suuruisena kolmena avohakkuuta seuranneena kasvukautena (kuva 5). Sisämaassa populaatiotiheys laski ensimmäisen kesän jälkeen ja nousi uudelleen neljäntenä kesänä, jolloin suurin osa uudesta sukupolvesta oli (ainakin teoriassa) kuoriutunut. Pohjois-Suomessa populaatiotiheys oli selvästi alhaisempi kuin Etelä-Suomessa (lukuun ottamatta hakkuukauden 1968—69 metsätyypiltään poikkeavaa koealuetta); viidentenä kesänä havaittiin populaation nousua, mikä hyvin sopii teoreettiseen kehitysaikaan.

Talvehtimispaikoistaan tukkimiehentäit läksivät Tuusulassa touko—kesäkuussa (kuva 6). Parveilu tapahtui pääasiassa toukokuun lopussa, mutta yksittäisiä lentäviä yksilöitä tavattiin vielä elokuussakin. Pyyntipölkyillä kärsäkkäitä esiintyi toukokuun alusta syyskuun loppuun, mutta suurimmat määrät tavattiin Etelä-Suomessa kesäkuun alussa ja Pohjois-Suomessa kesäkuun lopussa (kuva 7). Esiintymisajoissa ei eri kärsäkäslajien välillä todettu eroja. Pyyntipölkyiltä tavattiin enemmän koiraita kuin naaraita (kuva 8). Kesän kuluessa sukupuolten välinen runsaussuhde kuitenkin vaihteli, mikä kuvastaa käyttäytymiseroja sukupuolten välillä.

Kärsäkkäitten aiheuttamien tuhojen todettiin lisääntyvän kasvukauden kuluessa hakkuualan iästä riippumatta (kuva 9). Tuhoindeksi (% vioittuneita taimia x keskimääräinen tuholuokka x 100^{-1}) vaihteli kuitenkin hakkuualan iän mukaan ollen tuoreilla aloilla vanhempia korkeampi.

Tukkimiehentäin aikuisten esiintyminen kasvukauden eri aikoina oli samanlaista kaiken ikäisillä hakkuualoilla. Suurin osa naaraista oli sukukypsiä, mutta nuorten, uuden sukupolven naaraiden esiintymisestä päätellen kehitysaika vaihteli melkoisesti kussakin kehitysaikavyöhykkeessä (kuva 10). Tämä osoittaa paikallisten olosuhteiden suurta vaikutusta kehitysajan pituuteen. Naaraiden sukukypsyyteen ja peitinsiipien suomujen kulumiseen perustuva ikäluokitus osoittautui melko epätarkaksi (taulukko 2), mutta tulokset viittaavat siihen, että osa tukkimiehentäin aikuisista todennäköisesti voi talvehtia toisen kerran (kuva 11). Varovaisen arvion mukaan vanhat aikuiset saattavat muodostaa keskimäärin 5—30 % populaatiosta hakkuualan iästä riippuen.

Pienen tukkikärsäkkään esiintymisessä ja populaation rakenteessa ei havaittu mitään tukkimiehentäistä ratkaisevasti poikkeavaa (kuva 12). Hakkuualoilla lajia tavattiin niiden iästä riippumatta kasvukauden alusta loppuun. Pääosa naaraista oli sukukypsiä. Yksittäisiä nuoria aikuisia tavattiin Juupajoella ja Kivalossa kolmantena kesänä, mikä viittaisi tukkimiehentäin tapaan 2—3-vuotiseen kehitysaikaan kyseisillä alueilla. Myös ison tukkikärsäkkään kohdalla havainnot, jotka tosin jäivät niukoiksi, viittaavat tukkimiehentäitä vastaavaan esiintymiseen.

LÅNGSTRÖM, B. 1982. Abundance and seasonal activity of adult *Hylobius*-weevils in reforestation areas during first years following final felling. Seloste: Tukkikärsäkäsaikuisten runsaus ja esiintyminen avohakkuualoilla päätehakkuun jälkeisinä vuosina. Commun. Inst. For. Fenn. 106:1—23.

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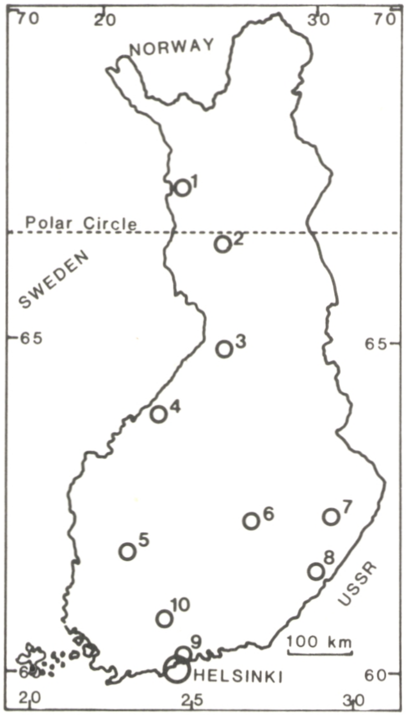

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FACTS ABOUT FINLAND

Total land area: 304 642 km^2 of which 60–70 per cent is forest land.

Mean temperature,°C:	Helsinki	Joensuu	Rovaniemi
January	-6,8	-10,2	-11,0
July	17,1	17,1	15,3
annual	4,4	2,9	0,8
Thermal winter (*mean temp.* < 0°C):	20.11.–4.4.	5.11.–10.4.	18.10.–21.4.

Most common tree species: Pinus sylvestris, Picea abies, Betula pendula, Betula pubescens

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