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WINDTHROWN SCOTS PINES AS BROOD MATERIAL FOR *TOMICUS PINIPERDA* AND *T. MINOR*

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Seloste

TUULEN KAATAMAT MÄNNYT PYSTY- JA VAAKANÄVERTÄJÄN LISÄÄNTYMISMATERIAALINA

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In 1980 and 1981, windthrown and felled Scots pines (*Pinus sylvestris* L.) were examined at 8 localities in Sweden. The number and length of egg galleries as well as the number of exit holes of *Tomicus piniperda* (L.) and *T. minor* (Hart.) were recorded on sample sections (30 cm in length) distributed at 3 m intervals on the 37 fallen or felled pine stems, which were successfully colonized by the beetles. In addition, 78 uprooted pines were surveyed in 6 localities. Most trees were attacked by *T. piniperda,* but only a few by *T. minor*. Successful colonization often resulted in the production of several thousand beetles per tree, the maximum being approximately 18 00. The attack density of *T. piniperda* seldom exceeded 200 egg galleries/m^2 bark area, and brood production usually remained below 1.000 beetles/m^2. Much higher figures were obtained for *T. minor*. In *T. piniperda,* the rate of reproduction (i.e. the number of exit holes/egg gallery) decreased rapidly with increasing attack density, whereas *T. minor* seemed to be less sensitive to intraspecific competition.

1. INTRODUCTION

The pine shoot beetles, *Tomicus piniperda* (L.) and *Tomicus minor* (Hart) (Col., Scolytidae), breed in fresh pine wood such as pulp wood, logging waste and windthrown pine trees.

The attack pattern and brood production of these beetles in waste wood after early thinnings (=cleanings), and pulp wood stacks has been studied in Sweden during the last decade (for references, see e.g. Dehlén et al. 1982). Although windthrown pines are known to be important brood material for the pine shoot beetles, few detailed studies exist on the propagation of the beetles in windthrown pines. Iacobaeus and Lindahl (1973) examined one windthrown pine tree, and found that about 40 000 beetles, mostly *T. minor* had emerged from that tree. Much lower figures were obtained by Annila and Petäistö (1978) when studying windthrown pines in western Finland. They reported a maximum of around 500 exit holes per square metre bark surface for *T. piniperda*. Several authors have reported that the proportion of fallen trees successfully attacked varies, and the attacks often covered a minor proportion of the available bark area (Trägårdh & Butovitsch 1935, Lekander 1955, Butovitsch & Ringselle 1968, Lekander 1971, Luitjes 1976, Annila & Petäistö 1978, Führer & Kerck 1978).

The purpose of this paper is to present findings regarding the attack pattern and propagation of *T. piniperda* and *T. minor* in windthrown and cut pines in different regions of Sweden during 1980 and 1981.

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2. MATERIAL AND METHODS

In autumn 1980, windthrown pines were examined at 3 localities in Sweden (Hörle, Vallnäs, Åsele; see Figure 1). The trees had fallen during the autumn 1979, but the specific dates for each locality are not known. Additional trees were cut at Oxberg and Åsele on 29 April and 5 May, respectively. Only trees with successful attacks (i.e. exit holes) of pine shoot beetles were examined, and in each locality a few trees were selected for examination (cf. Table 2). For each tree, sample sections (30 cm in length) from the middle of each 3 metre log section were studied, i.e. at 1.5, 4.5, 7.5 etc. metres from the stem base. Sampling intensity was thus approximately 10 %. The number of sections per tree varied from 5 to 7 depending on tree height. All exit holes were counted on the upper- and undersides of the sample sections before bark was removed, and the number and lengths of egg galleries were counted for *T. piniperda* and *T. minor*. The occurrence of other bark insects was assessed using the percentage of gallery coverage in samples containing the species in question. Data on bark type and thickness as well as the diameter and position of each section were also recorded.

On 21 April 1981, a strong storm uprooted many trees in Central Sweden. In June, 10–20 windthrown pines at each of 6 additional localities were surveyed for beetle attack. The localities were Hofors, Stjärnsund, Åmot, Svartnäs, Dalstuga and Evertsberg (see Figure 1 and Table 1). The number of egg galleries of *T. piniperda* and *T. minor* was counted on half-metre-long sections under the thick and thin bark, respectively. In autumn 1981, more detailed studies were made according to the procedure described above at Dalstuga, Evertsberg and Åmot as well as at Vallnäs and Gnosjö in southern Sweden.

Over a two year period a total of 37 trees was examined in detail. All these were successfully attacked by *T. piniperda*, and 14 of them also by *T. minor*.

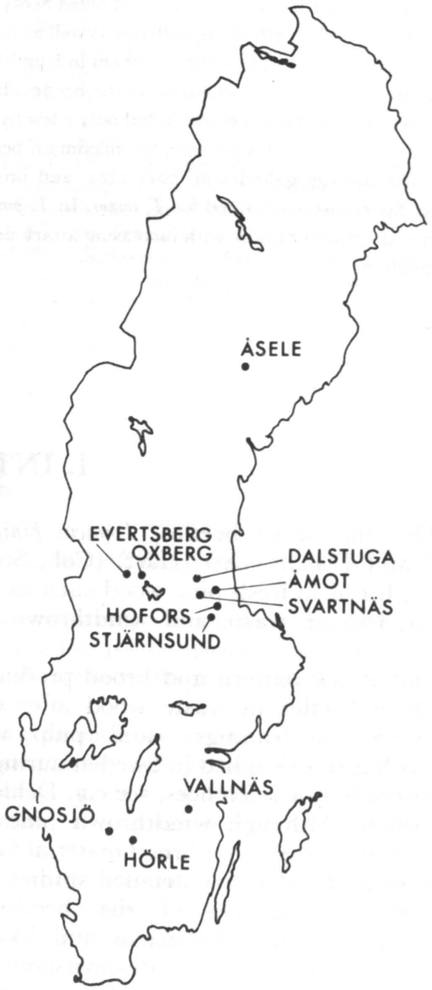

Figure 1. Situation of study areas.

Table 1. Occurrence of successful and/or unsuccessful attacks of *Tomicus piniperda* and *T. minor* on windthrown pine trees after the blowdown on 21 April. Inspections of randomly selected trees were made in June 1981.

Locality	Number of trees	DBH, mm x̄±s	Length, m x̄±s	Length of stem with rough bark, m x̄±s	Trees attacked by *T. piniperda* success	unsucc.	both	no att.	*T. minor* success	unsucc.	both	no att.
Eversberg	18	229±30	16.8±2.0	3.0±0.7	4	10	3	1	1			17
Åmot	10	261±55	19.8±1.4	3.2±0.8	2	8				2	2	6
Svartnäs	10	227±43	17.3±2.1	2.9±0.7		10						10
Dalstuga	20	299±68	19.3±1,9	4.6±1.4	5	8	6	1				20
Hofors	10	324±41	21.9±2.3	4.9±0.5	2	1	4	3	1	1	2	6
Stjärnsund	10	297±53	20.0±1.5	–	1	6	3		1	1	2	6
Total	78				14	43	16	5	3	4	6	65
Percent					18	55	21	6	4	5	8	83

3. RESULTS

3.1. Survey of beetle attacks

In 1980, no attempt was made to find out the proportion of windthrown trees that were attacked by the beetles. In 1981, a survey was done in six localities, and 78 trees were sampled (Table 1). All the trees were uprooted by a storm on 21 April 1981, i.e. just before or during the flight period of the pine shoot beetles. By the end of June, 94 percent of the trees were attacked. *T. piniperda* was present in all areas. Successful attacks (i.e. galleries with developing progeny) were found in 18 percent, unsuccessful attack (i.e. parent beetles repelled by the resin flow, and no living larvae) in 55 percent of the trees. In 21 percent of the trees both successful and unsuccessful attacks were found in the sample section. The success of attacks varied between localities, and the attack density varied from a few to 156 egg galleries per half-metre section. The latter figure corresponds to 404 egg galleries per square metre (measured under bark). Despite this high attack density, the beetles failed to establish a brood in that tree.

Most trees were not attacked by *T. minor* (83 %), but the beetle was present in four areas successfully attacking a few trees (4 %). Attack failures were seen in five percent and both successful and unsuccessful attacks in eight percent of the trees.

Attempts were made to classify the trees by vigour classes using the root area still attached to the ground, and the length of the current leader shoot as parameters. Although no consistent pattern could be found, many successfully attacked trees had shorter leader shoots than trees not attacked from the same area.

3.2 Beetle production in successfully attacked trees

Great variations in beetle production were observed between years, localities and individual trees even in those trees successfully attacked by the beetles (Table 2). In most trees the number of exit holes for both species was a few thousand or less despite high numbers of egg galleries in some trees. One tree differed drastically from the others in having a total of approximately 18 000 exit holes. This tree was exceptionally large, and was in an area where beetles had attacked other trees in the previous year.

Apart from the pine shoot beetles several species of bark-living insects were present in the pine trees (Table 2). *Pityogenes quadridens* (Hart.) was regularly seen under the thin bark of the top-most sample sections.

Table 2. List of trees studied with estimated numbers of pine shoot beetles per tree (i.e. sample totals x 10), and relative abundances of other bark-living beetles. 1 = species present, but galleries cover less than 10 % of the area of samples with records of the species; 2 = 10–19 % etc., and 9 = > 80 %.

Locality and year	Tree nr.	DBH 0.b. mm	Length m	Estimated numbers per tree of: *T. piniperda* Egg galleries	*T. piniperda* Exit holes	*T. minor* Egg galleries	*T. minor* Exit holes	Relative abundance of** quadr.	prox.	acum.	Piss.	Ceramb.
Åsele 1980	1	231	16.2	250	1400			1	2	3	1	5
	2	231	17.3	320	1850			5		5		5
(Trees 1–4 cut	3	204	17.4	200	940			2			1	6
5 May 1980)	4	267	18.5	220	1170						2	3
	5	235	19.1	40	0*						1	
	6	159	12.1								1	
	7	249	18.1	10	210			1	1		1	
Oxberg 1980	8	227	16.5	180	70	20				8	4	1
	9	187	13.2	120	50				9	8	4	1
(All trees cut	10	236	15.4	90	630			5	4	7	3	5
29 April 1980)	11	282	16.5	110	240			9	7	7	2	7
	12	218	15.1	200	580			2	4	4	2	2
	13	201	15.5	170	310			3		6	3	3
	14	219	15.2	70	80			6		6	1	4
	15	212	16.5	180	860	10		3	1	5	1	3
Hörle	16	271	20.5	460	1560	150	1030	6	2		2	3
	17	305	21.4	420	2820	20		1	2		2	1
	18	260	19.9	250	1400	660	4720	3	2		1	6
Vallnäs 1980	19	301	21.4	900	2060	10	1620	1	2		1	8
	20	344	20.9	210	200	20	20	7			1	
	21	319	19.3	400	1220	150	3270				2	2
	22	316	23.2	720	3520	110	2320	4				5
Evertsberg 1981	23	255	17.5	340	1940				2	8	3	2
	24	184	19.0	120	490				2	7	3	2
	25	256	14.5	170	860			3		6	1	2
	26	256	17.0	230	160			1	2	1	2	1
	27	240	20.0	70	80			1	4	8		1
	28	214	17.0	190	490			3	3	7		1
Dalstuga 1981	29	342	22.0	190	3830	30		1	6		3	1
	30	364	21.0	150	200						2	
	31	262	19.5	110	40						1	
	32	305	19.5	110	240						1	
Åmot 1981	33	239	18.0	170	320	10		1			2	1
	34	332	20.0	230	2230	260	80	3			2	1
Gnosjö 1981	35	335	20.3	360	2880			1	2		1	1
	36	212	20.3	200	1730	200	1670	1	2		1	1
Vallnäs 1981	37	470	23.8	420	3780	400	14910	6	3		2	2

*) Larvae, pupae and callow adults under bark at inspection 27 August 1980.

**) quadr. = *Pityogenes quadridens*, prox. = *Orthotomicus proximus*, acum. = *Ips acuminatus*, Piss. = *Pissodus* sp., Ceramb. = Cerambycidae.

Another bark beetle commonly seen in most areas, was *Orthotomicus proximus* (Eich.). *Ips acuminatus* (Gyll.) was abundant at Oxberg and Evertsberg, occupying a high percentage of the surface of infested trees. Larval mines of *Pissodes* sp., probably *P. pini* (L.), were found in most trees but generally at a low density. Larvae of *Acanthocinus aedilis* (L.), *Rhaqium inquisitor* (L.) and *Monochamus sutor* (L.) were locally frequent on the trees, but the cerambycid species were not noted separately. In addition to these records, *Orthotomicus suturalis* (Gyll.) was observed at Åsele, *Hylurgops palliatus* (Gyll.) at Hörle, and *Polygraphus poligraphus* (L.) surprisingly occurred on pine at Åmot.

3.3 Spatial attack patterns

Most attacks of *T. piniperda* occurred on the lower part of the stems (Figure 2). Beetle infestation was of the same magnitude on upper- and undersides, only occasionally surpassing 200 egg galleries per square metre bark area. In *T. minor*, the pattern was entirely different. Infestation mainly occurred on the undersides and on higher stem sections. The range in attack density was also far greater than in *T. piniperda*. Egg galleries of *T. piniperda* were found over a wide range of bark thickness classes whereas *T. minor* only occasionally occurred under bark thicker than a few millimetres (Figure 3).

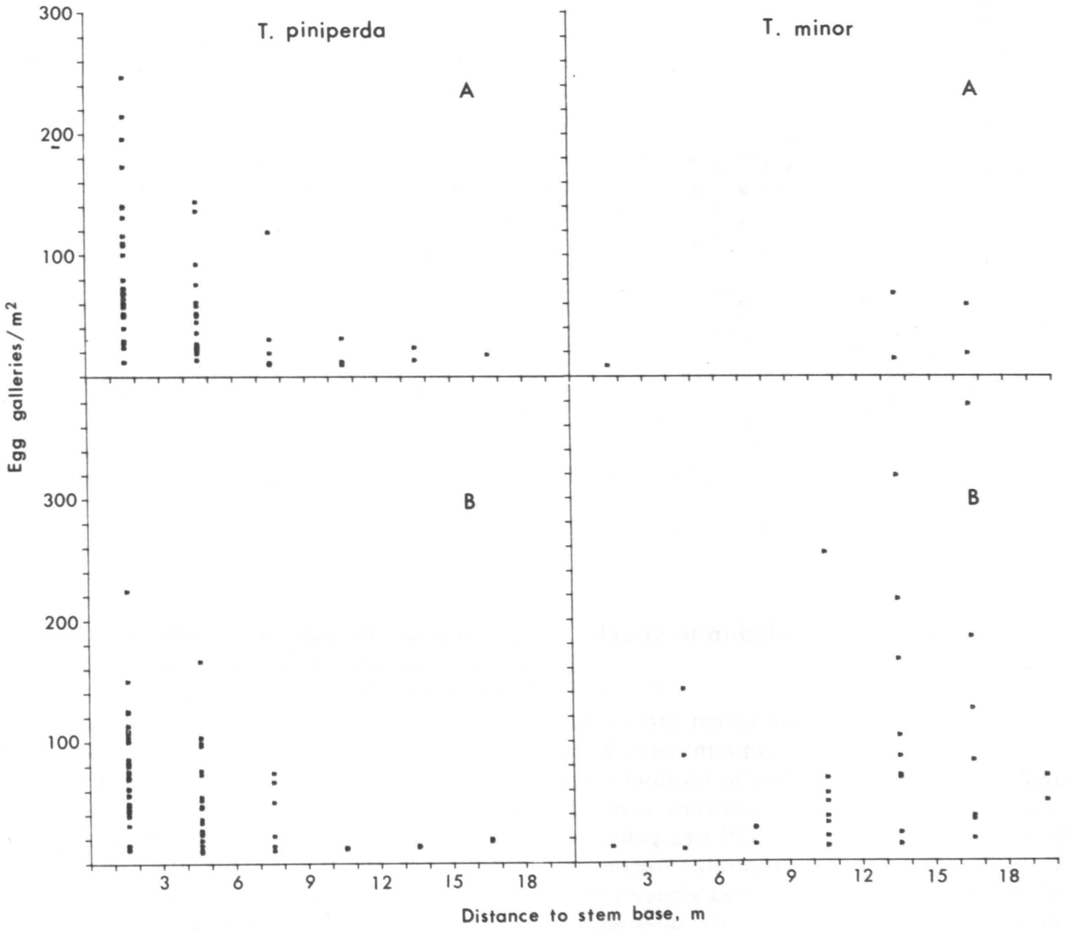

Figure 2. Attack density (i.e. number of egg galleries per m[2] bark area) of *Tomicus piniperda* and *T. minor* on upper- (A) and underside (B) of fallen pines at different distances from stem base. Samples without beetle attacks excluded.

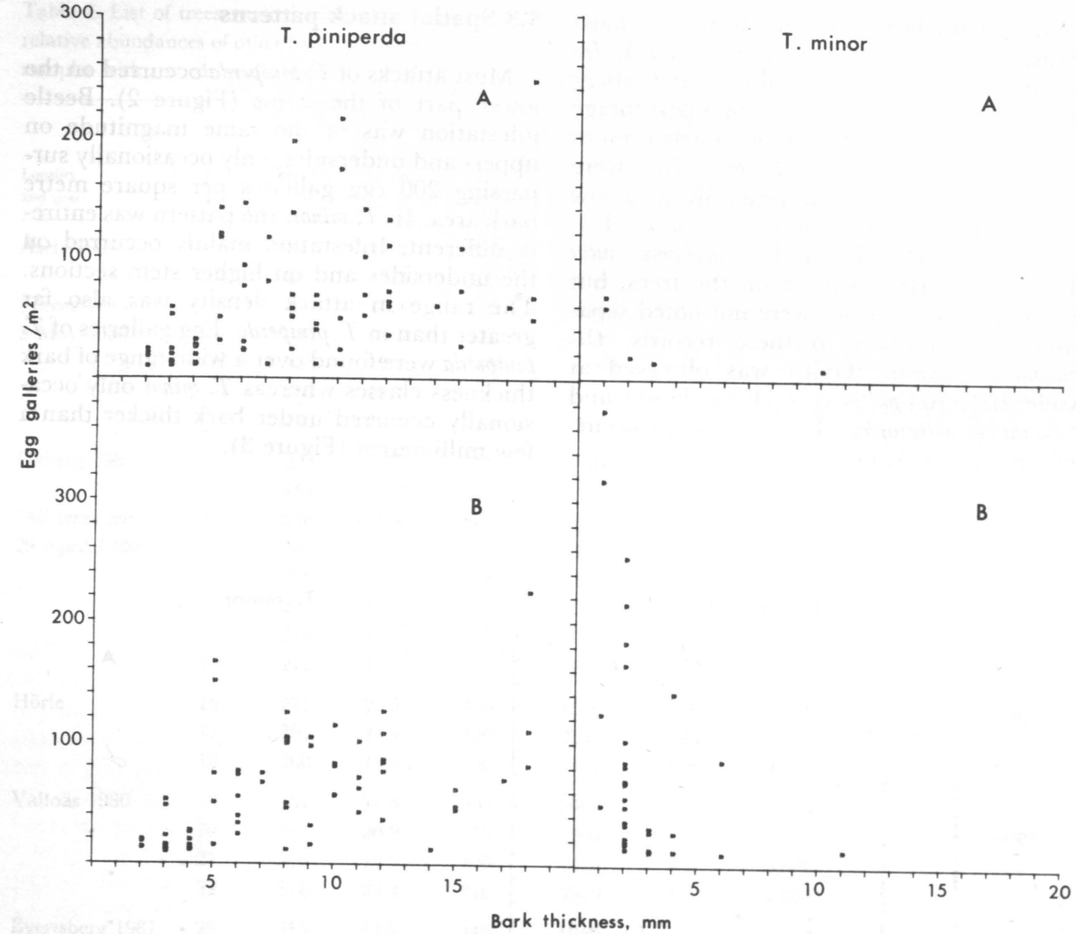

Figure 3. Attack density of *T. piniperda* and *T. minor* on upper- (A) and underside (B) of successfully attacked pines in relation to bark thickness.

3.4 Brood success in relation to attack density

Figure 4 shows that the brood production in *T. piniperda* was of the same magnitude on upper- and undersides. Beetle production of more than 500 beetles/m^2 occurred at attack densities ranging from 50–150 egg galleries/m^2. In *T. minor* virtually no production occurred on the upperside. There was a huge variation in brood production on undersides with a maximum observation of 7 800 beetles/m^2 at an attack density of 210 egg galleries/m^2. In *T. piniperda,* the rate of reproduction (i.e. the number of exit holes per egg gallery) decreased rapidly with increasing attack density (Figure 5). The pattern was similar on both the upper- and undersides. The maximun tally was 44 beetles/egg gallery at an attack density of 10 egg galleries/m^2. At 200 egg galleries/m^2 there was virtually no population increase at all. It is noteworthy that the reproduction rate often was very low even at low attack densities. In *T. minor* high reproduction rates occurred at much higher attack densities than in *T. piniperda* (Figure 5). Thus

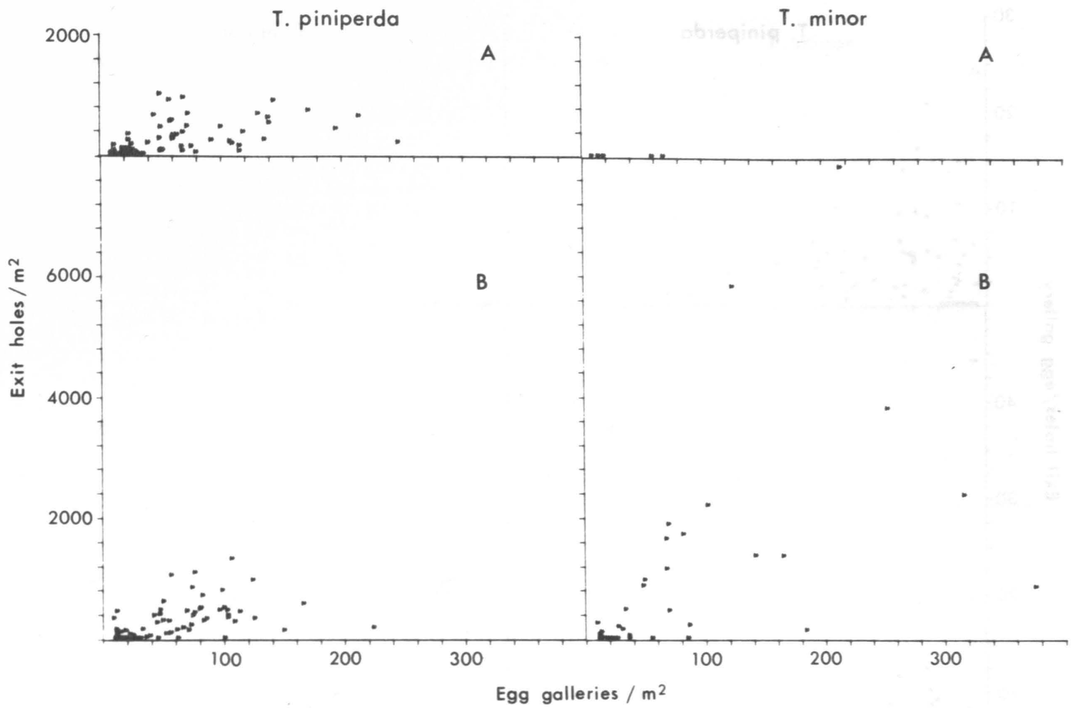

Figure 4. Brood production (i.e. number of exit holes of the new generation per m^2 bark area) of *T. piniperda* and *T. minor* on upper- (A) and underside (B) of successfully attacked pines in relation to attack density.

reproduction rate in *T. minor* seems to be less affected by the intraspecific competion as compared with *T. piniperda*.

There was, however, a tendency towards a decreasing average gallery length with increasing attack density in *T. piniperda* ($r = -0.16$ $p < 0.10$) but not in *T. minor* ($r = -0.01$ $p > 0.10$) (Figure 6). The total egg gallery length per square metre increased linearly with the attack density to ca 120 egg galleries/m^2 in both species. In *T. piniperda* only a few observations exceeded 15 m/m^2, whereas maximum records for *T. minor* were around 26 m/m^2 (Figure 7).

4. DISCUSSION

The present study showed large variations in attack density and brood production of *T. piniperda* and *T. minor* between individual windthrown pines. No attempts were therefore made to calculate average figures for each study locality. This large variation greatly reduces the possibility for risk-rating of beetle production with a reasonable accuracy.

A high beetle production per tree requires: firstly that there is a high enough population of parent beetles to colonize the breeding material, and secondly that the tree vigour is low enough for successful reproduction.

It has repeatedly been shown that the infestation of bark beetles often is low in the first summer following a large windthrow with many uprooted trees (Trägårdh &

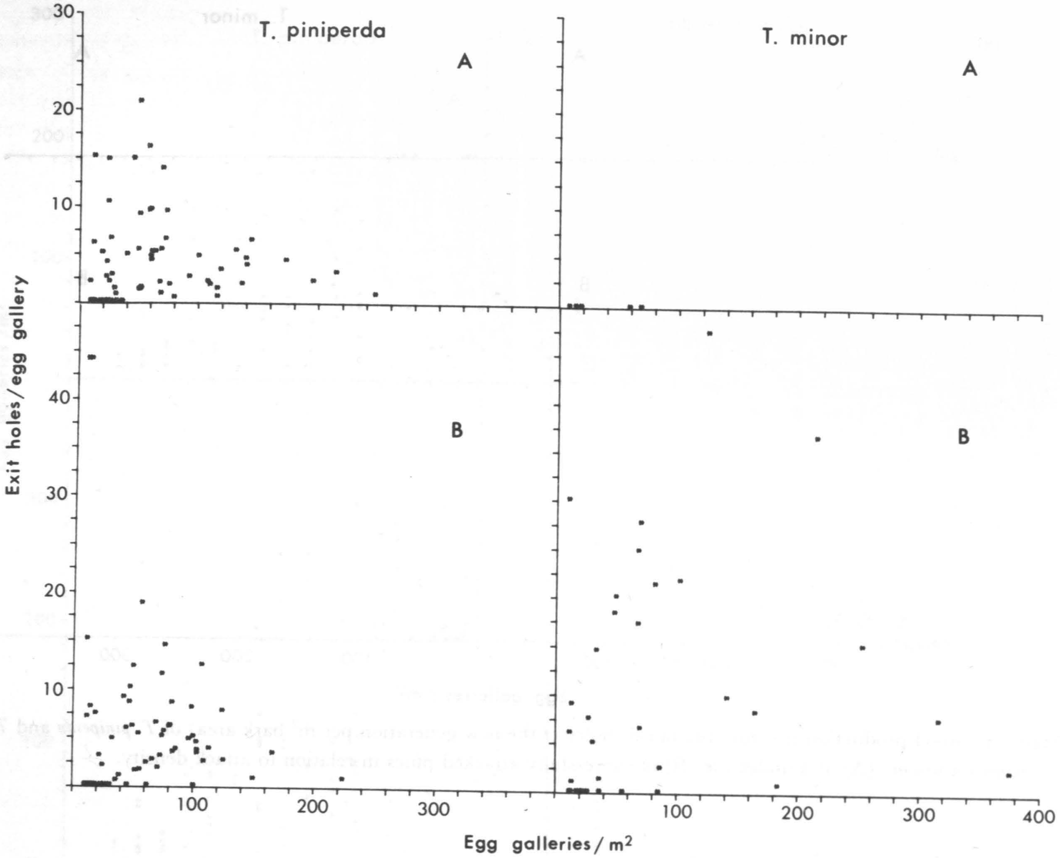

Figure 5. Rate of reproduction (i.e. number of exit holes per egg gallery) of *T. piniperda* and *T. minor* on upper- (A) and underside (B) of successfully attacked pines in relation to attack density.

Butovitsch 1935, Lekander 1955, 1971, Butovitsch & Ringselle 1968, Annila & Petäistö 1978 and Niemeyer 1979). In such a situation, there is simply not enough beetles in relation to the large amount of breeding material. This was not the case in the present study where only small groups of windthrown trees were available to the attacking beetles. Consequently, high attack densities of *T. piniperda* were seen in many successfully attacked trees. In these trees, the lower stem which was covered with thick or intermediate bark was heavily exploited by *T. piniperda*. Attack densities up to approximately 200 egg galleries per m² bark area have been encountered in earlier studies, but the figures mostly stay below 100 (for references, see Långström et al. 1984). Exceptionally high attack densities (up to 700 egg galleries per m²) have been observed by Doom & Luitjes (1971). Brood production seldom exceeds 1 000 new beetles per m² (cf. Långström et al. 1984), and this was also true for this study. Cage studies have, however, shown that much higher figures (up to 5 000 beetles/m²) are possible for *T. piniperda* (Eidmann & Nuorteva 1968).

Successful attacks of *T. minor* occurred on 14 trees in the present study. Since the species has a limited geographical distribution in Sweden (cf. Lekander et al. 1977), it was not expected to occur in the northern study area at Åsele. Attacks were recorded at three localities in Central Sweden (61° N. Lat.), but only a few exit holes were seen in September 1981. The species is known to require

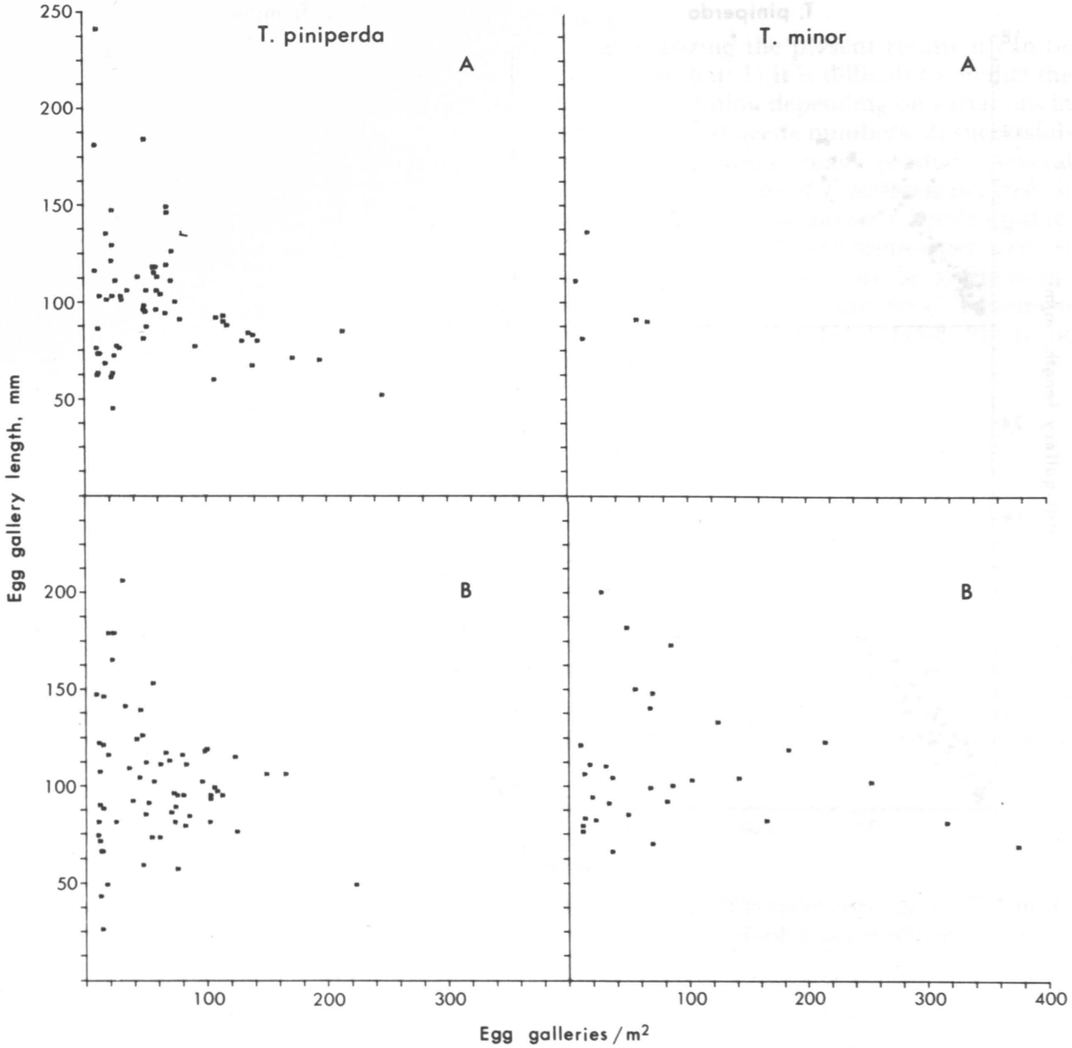

Figure 6. Mean egg gallery length of *T. piniperda* and *T. minor* on upper- (A) and underside (B) of successfully attacked pines in relation to attack density.

a longer period of time for its development than does *T. piniperda* (Bakke 1968, Eidmann 1974, Långström 1983a). Since immature stages do not survive the winter (Bakke 1968), *T. minor* failed to maintain its population level at these localities. In southern Sweden high attack densities and production figures were recorded. Most attacks occurred under thin bark and on the undersides of the uprooted pine stems. According to a detailed pilot study using samples from this material, eggs laid on uppersides totally failed to develop, whereas 2–55 % of the eggs on the undersides developed into emerging adults (Långström 1983b).

Intraspecific competition is known to play an important role in the population dynamics of bark beetles. This has been shown to be the case for *T. piniperda* as well (Nuorteva 1954, Eidmann & Nuorteva 1968, Beaver 1974, Annila & Petäistö 1979). The present results indicate that competition is less important in

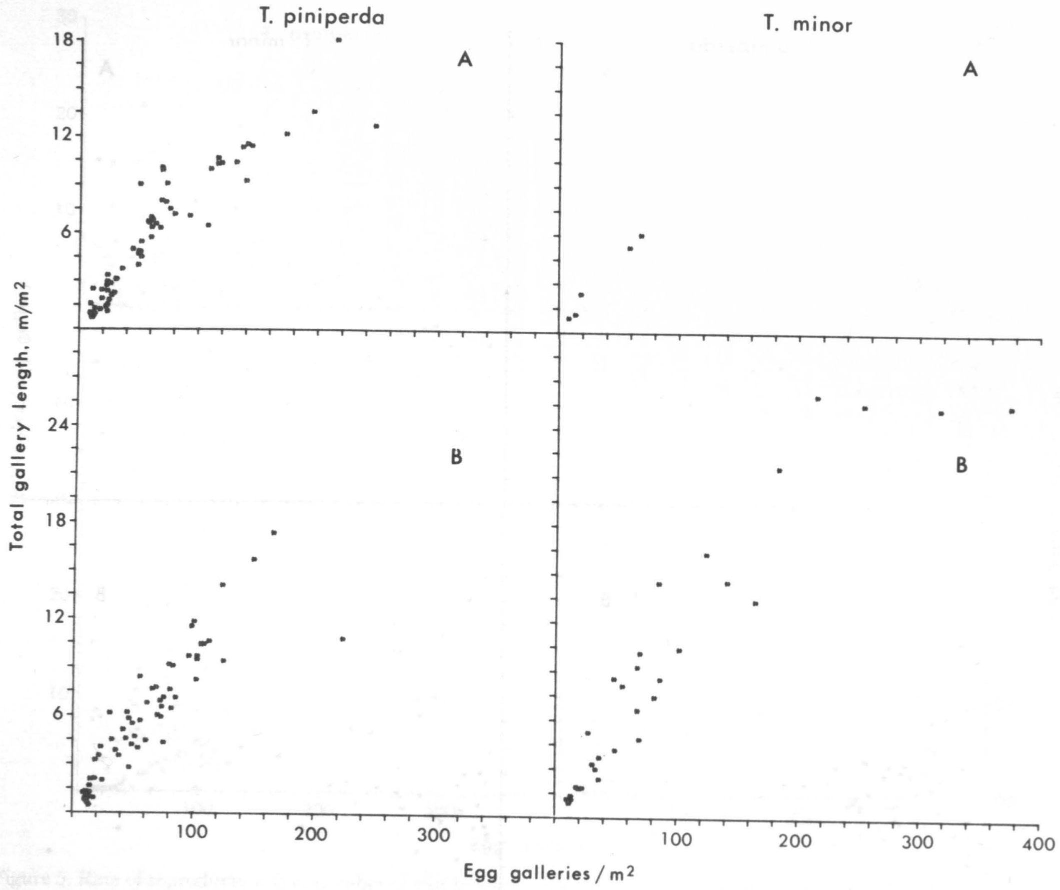

Figure 7. Total egg gallery length of *T. piniperda* and *T. minor* on upper- (A) and underside (B) of successfully attacked pines in relation to attack density.

the population dynamics of *T. minor*, probably due to the more sessile feeding behaviour of the larvae as compared with *T. piniperda*. Långström (1983b) observed that the developmental success was not affected by an egg density up to ca 12 000 eggs per m² bark area. In both species, the egg number is linearly related to the gallery length (Långström 1983b, Saarenmaa & Räisänen unpubl.). Thus, total gallery lengths per m² reflect egg densities, and the average gallery length indicates the mean egg number per ovipositing female. Although there was a large variation in mean gallery length, especially at low attack densities, the present results indicate that the number of eggs laid by each female is negatively affected by the attack density in *T. piniperda* but not in *T. minor*. Thus, intraspecific competion seems to regulate gallery excavation and oviposition in the former but not in the latter species.

As was seen in Figure 5, a low attack density did not always result in a high reproduction rate. In many samples the brood success was low despite the lack of intraspecific competition. This may be due to e.g. interspecific competition, predation or unsuitable host material. Since these factors were not estimated, little can be said about if, and how, they have influenced the brood development of the pine shoot beetles. It is, however, well known that *T. piniperda* propagates more successfully in host material felled during the autumn or winter preceding

flight than in trees from the previous summer (for references, see Långström 1979). Trees uprooted immediately before beetle flight may be vigorous enough to repel the beetles, at least at low attack densities. This is especially the case with windthrown pines with part of the root system intact. Not even at an attack density of ca 400 egg galleries per m² did *T. piniperda* manage to colonize a windthrown pine. This unsuccessful attack shows how little aggressive this species is (cf. Kangas 1981). *T. minor* is considered more aggressive than *T. piniperda* (cf. Jordal 1979), but did not at all prove that in the present study.

Summarizing the present results it can be concluded that: 1) it is difficult to predict the level of infestation depending on variations in tree vigour and beetle numbers, 2) successfully attacked trees may produce several thousand specimens of *T. piniperda* per tree, 3) in areas with *T. minor* present, beetle production may exceed 10 000 beetles per tree, 4) high priority must therefore be given to the logging of windthrown pine trees if increment losses in surrounding pine stands are to be avoided.

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SELOSTE

TUULEN KAATAMAT MÄNNYT PYSTY- JA VAAKANÄVERTÄJÄN LISÄÄNTYMISMATERIAALINA

Vuosina 1980 ja 1981 tutkittiin yhteensä 37 tuulen kaatamaa tai kaadettua mäntyä 8 paikkakunnalla Ruotsissa. Tietoja kerättiin pysty- ja vaakanävertäjän emokäytävien lukumäärästä, käytävän pituudesta ja lentoreikien lukumäärästä 30 cm pituisilta näytealoilta, jotka sijaitsivat männyn rungoilla kolmen metrin välein. Vuonna 1981 selvitettiin lisäksi ytimennävertäjien iskeytymistä yhteensä 78 tuulen, samana keväänä kaatamaan mäntyyn 6 paikkakunnalla.

Pystynävertäjiä tavattiin useimmissa puissa kaikilla paikkakunnilla, vaakanävertäjiä vain muutamassa puussa neljällä paikkakunnalla. Molempien lajien kohdalla iskeytyminen epäonnistui osittain tai täydellisesti monessa, vähän ennen parveilua kaatuneessa männyssä. Syksyllä kaatuneisiin mäntyihin varsinkin pystynävertäjä onnistui iskeytymään hyvin. Pystynävertäjä valloitti yleensä rungon paksukuorisen osan vaakanävertäjän esiintyessä rungon alapuolella ohuen kaarnan alla. Onnistuneen iskeytymisen seurauksena kehittyi tuhansia ytimennävertäjiä puuta kohti, poikkeustapauksessa jopa yli 18 000 ulostuloreikää, joista suurin osa vaakanävertäjän aiheuttamia.

Pystynävertäjän iskeytymistiheys ylitti harvoin 200 emokäytävää/m^2, uusien yksilöiden lukumäärän yleensä jäädessä alle 1000/m^2. Vaakanävertäjän kohdalla luvut olivat korkeampia mutta vielä vaihtelevampia kuin pystynävertäjällä. Molemmilla lajeilla lisääntyminen (uusien yksilöiden lukumäärä emokäytävää kohti) vähentyi iskeytymistiheyden kasvaessa riippuvuuden ollessa pystynävertäjällä selvempi kuin vaakanävertäjällä.

ODC 181.63+535+174.7 *Pinus sylvestris* ISSN 0037–5330

KELLOMÄKI S. 1984. Havaintoja puuston kasvatustiheyden vaikutuksesta mäntyjen oksikkuuteen. Summary: Observations on the influence of stand density on branchiness of young Scots pines. Silva Fenn. 18(2): 101–114.

The study based on young Scots pine stands (*Pinus sylvestris* L.) of varying density showed that branch number per whorl and total number of living branches per tree were negatively correlated with stand density. On the contrary, the number of dead branches increased with increasing stand density. The diameter of living and dead branches decreased with increasing stand density. Consequently, the branchiness i.e. the share of the branch cross-sectional area from the stem surface area, decreased in dense stands compared with undense stands. The 3/2th power model described relatively well the relationship between stand density and mean squared branch diameter of living branches.

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ODC 815.2:812.31:174.7 *Picea abies* ISSN 0037–5330

KÄRKKÄINEN, M. 1984. Effect of tree social status on basic density of Norway spruce. Seloste: Kuusen aseman vaikutus puuaineen tiheyteen. Silva Fenn. 18 (2): 115–120.

In planted even-aged spruce stands the effect of growth rate on basic density was studied on the basis of a material consisting of 53 stands and 30 trees in each stand. It was found that the prediction of basic density with the help of growth rate and some other tree characteristics could be improved if the social status of the tree was taken into account. The small trees of a stand had a lower and taller trees a higher density than they should have on the basis of growth rate alone.

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ODC 182.5 ISSN 0037–5330

KUUSIPALO, J. 1984. Diversity pattern of the forest understorey vegetation in relation to some site characteristics. Seloste: Metsän pintakasvillisuuden lajirunsauden suhde eräisiin kasvupaikkatekijöihin. Silva Fenn. 18(1): 121–131.

A field data set representing boreal forest-floor vegetation in southern Finland was analyzed using a simultaneous equation model. Some physical and chemical characteristics of the soil and some structural characteristics of the tree stand were treated as predictors in such a way that the tree stand factor was specified to be dependent on the soil variables. Alpha diversity, measured as the total number of species per plot, was treated as a criterion variable.

The model explains 60 per cent of variance in the alpha diversity indicating markedly strong relationships with the site characteristics. Alpha diversity appears to increase with increases in site fertility characteristics. On the other hand, measured characteristics of the tree stand indicate no significant independent effects on the alpha diversity.

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ODC 161.32+176.1 *Salix* sp. cv. *aquatica* ISSN 0037–5330

SMOLANDER, H. & LAPPI, J. 1984. The interactive effect of water stress and temperature on the CO_2 response of photosynthesis in *Salix*. Seloste: Vedenvajauksen ja lämpötilan yhteisvaikutus vesipajun fotosynteesin CO_2-vasteeseen. Silva Fenn. 18 (2): 133–139.

The interactive effect of water stress and temperature on the CO_2 response of photosynthesis was studied in *Salix* sp. cv. *Aquatica* using the closed IRGA system. A semi-empirical model was used to describe the CO_2 response of photosynthesis. The interactive effect of water stress and temperature was divided into two components: the change in CO_2 conductance and the change in the photosynthetic capacity. The CO_2 conductance was not dependent on temperature when the willow plant was well watered, but during water stress it decreased as the temperature increased. The photosynthetic capacity of the willow plant increased along with an increase in temperature when well watered, but during water stress temperature had quite the opposite effect.

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ODC 283.1+892.71+172.8 *Gyromitra esculenta* +*237.1* ISSN 0037-5330

JALKANEN, R., JALKANEN, E., JALKANEN, J. & JALKANEN, M. 1984. Maanpinnan rikkomisen 10-vuotisvaikutus korvasienisatoon. Summary: Ten-year effects of breaking the soil surface on the yield of *Gyromitra esculenta*. Silva Fenn. 18 (2): 141–149.

It is possible to improve the natural yield of *Gyromitra esculenta* by breaking the soil surface. With 286 m^2 of broken area in the whole research area of 1.6 ha the natural yield (1.54 kg/yr) could be improved to 3.94 kg/yr. Natural yield per hectare was 0.98 kg/yr. In treated plots the yield was 52.4 kg/yr (in the best year 191 kg/ha/yr). Fruit bodies of *G. esculenta* were found in treated plots every year after the soil treatment. The yield was at its best in the two first years declining later to the level of 10–20 per cent of the first year's yield. The best natural yield was reached in the last year. The previous year's precipitation was an important factor influencing to the yield of *G. esculenta*.

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ODC 116.1+114.444 ISSN 0037–5330

KURIMO, H. 1984. Simultaneous groundwater table fluctuation in different parts of virgin pine mires. Seloste: Pohjavesipinnan samanaikainen korkeusvaihtelu luonnontilaisten rämeiden eri osissa. Silva Fenn. 18 (2): 151–186.

The assumption generally used in hydrological computations that the simultaneous vertical fluctuation in the groundwater table in different parts of mires are equal does not hold good in detail. Numerous cases were detected where the fluctuation at one place did not correspond to that at another site to a statistically significant degree. The main reasons for the unequal fluctuation at the different sites seem to be the difference in the microtopography, and in the hydraulic conductivity between the sites.

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ODC 453+145.7×19.92 *Tomicus* +174.7 *Pinus sylvestris* ISSN 0037-5330

LÅNGSTRÖM, B. 1984. Windthrown Scots pines as brood material for *Tomicus piniperda* and *T. minor*. Seloste: Tuulen kaatamat männyt pysty- ja vaakanävertäjän lisääntymismateriaalina. Silva Fenn. 18(2): 187–198.

In 1980 and 1981, windthrown and felled Scots pines (*Pinus sylvestris* L.) were examined at 8 localities in Sweden. The number and length of egg galleries as well as the number of exit holes of *Tomicus piniperda* (L.) and *T. minor* (Hart.) were recorded on 37 fallen or felled pine stems, successfully colonized by the beetles. In addition, 78 uprooted pines were surveyed in 6 localities. Most trees were attacked by *T. piniperda,* but only a few by *T. minor*. Successful colonization often resulted in the production of several thousand beetles per tree, the maximum being approximately 18 000. The attack density of *T. piniperda* seldom exceeded 200 egg galleries/m^2 bark area, and brood production usually remained below 1 000 beetles/m^2. Much higher figures were obtained for *T. minor*.

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KIRJOITUSTEN LAATIMISOHJEET

Silva Fennica-sarjassa julkaistaan lyhyitä metsätieteellisiä tutkimuksia ja kirjoituksia kotimaisilla kielillä tai jollakin suurella tieteellisellä kielellä. Julkaistavaksi tarkoitettu käsikirjoitus toimitetaan kahtena kappaleena seuran sihteerille painatuskelpoisessa asussa. Seuran hallitus ratkaisee asiantuntijoita kuultuaan, hyväksytäänkö kirjoitus painettavaksi.

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Taulukot laaditaan mahdollisimman paljon lopullista painatusasuaan muistuttaviksi. Taulukoiden viivoituksen on oltava yhdenmukainen ja harkittu, yleensä pari johtoviivaa riittää. Vain pienet, yhdelle palstalle sopivat asetelmat ovat sallittuja, suuremmista tulee tehdä taulukko. Taulukot ja kuvat numeroidaan juoksevasti ja sijoitetaan tekstiosasta erilleen kukin omalle liuskalleen. Kuvien ja taulukoiden toivotut paikat merkitään käsikirjoituksen marginaaleihin. Jos vieraskielisessä summaryssä viitataan kuviin ja taulukoihin, tulee viitatuissa kuvissa ja taulukoissa olla vieraskieliset otsikot ja selitykset. Muut kuvat ja taulukot saavat olla yksikieliset.

Matemaattiset kaavat, ylä- ja alaindeksit sekä erikoismerkit on kirjoitettava selkeästi, niin että jokainen merkki on yksiselitteinen. Matemaattiset kaavat on muokattava sellaisiksi, että ne mahtuvat palstan leveydelle (n. 6,5 cm). Leveämmät kaavat on katkaistava soveltuvasta kohdasta ja jatkettava seuraavalle riville.

Tekstin lähdeviittaukset kirjoitetaan aikaisemmasta poiketen pienin kirjaimin. Milloin tekijöitä on kolme tai useampia, mainitaan tekstissä vain ensimmäinen (esim. Heikurainen ym. 1961). Jos julkaisulla on kaksi tekijää, pannaan nimien väliin ja-sana painatuskielellä. Sulkeiden sisässä olevat viittaukset erotetaan toisistaan pilkulla (esim. Aho 1976, Elo ja Virtanen 1979, Suk ym. 1980).

Kirjallisuusluettelossa julkaisujen tekijät kirjoitetaan isoin kirjaimin, milloin tekijänä on henkilö. Jos tekijöitä on useita, nimet erotetaan pilkulla, paitsi kaksi viimeistä, jotka erotetaan &-merkillä. Tekijäin etunimistä käytetään vain alkukirjaimia. Mikäli sama ensimmäinen tekijä on kirjoittanut useampia julkaisuja, nimeä ei toisteta vaan se korvataan yhtäläisyysmerkillä. Toisen tekijän suhteen ei näin kuitenkaan tehdä. Tutkimusten nimet kirjoitetaan lyhentämättä. Tavallisista julkaisusarjoista käytetään lyhenteitä, jotka on painettu Silva Fennica 5(2):ssa (1971). Harvinaisia tai poikkeuksellisia sarjoja ei lyhennetä. Julkaisun numeron yhteydessä ei mainita vol.- tai n:o -sanoja. Sivunumerot erotetaan kaksoispisteellä volyymistä tai julkaisun numerosta. Esimerkkejä:

GUSTAVSEN, H. G. 1976. Miten puut reagoivat lannoitukseen varttuneissa metsiköissä? Metsä ja Puu 4: 15–18.
— & LIPAS, E. 1975. Lannoituksella saatavan kasvunlisäyksen riippuvuus annetusta typpimäärästä. Summary: Effect of nitrogen dosage on fertilizer response. Folia For. 246: 1–20.
SMOLANDER, H., RÄSÄNEN, P. K. & KOSTAMO, J. 1981. Maan tiiviyden vaikutus männyntaimien haihduntaan ja pituuskasvuun istutuksen jälkeen. Summary: Effect of soil compaction on transpiration and height increment on planted Scots pine seedlings. Silva Fenn. 15(3): 256–266.
Sääsähkeohjeet 1982. Ilmatieteen laitos. Helsinki.

Englanninkielisten tekstien kääntämisestä ja pätevän kieliasiantuntijan tekemästä tarkastamisesta huolehtii kirjoittaja. Seura voi maksaa tarkastamiskustannukset valtionvarainministeriön antamien ohjeiden mukaisesti.

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