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RELATIONSHIP BETWEEN THE STEM DIAMETER OF TREES AT TIME OF DRAINING AND THEIR POST-DRAINAGE INCREMENT

PUUN OJITUSHETKEN LÄPIMITAN VAIKUTUS SEN OJITUKSENJÄLKEISEEN KASVUUN

INTRODUCTION

The terms revival and capacity for revival have been used in Finnish literature dealing wiht the subsequent development of trees growing on drained peatlands. The former term refers to the difference between the post-drainage and pre-drainage increment, and the latter, to the capacity of trees to accelerate their growth after drainage has been carried out. Both of these concepts have been used when estimating which of the individual trees are likely to develope further after drainage.

Generally speaking, the concept revival describes quite well the tree vigour. Nevertheless, when the effect of various factors on the magnitude of post-drainage tree increment is studied, an examination based on revival alone will not be without some drawbacks. The usability of the revival as such is hampered by the fact that both of its components — pre-drainage and post-drainage increment — are at least partly dependent on the same factors, for example, the site quality as well as the age and size of the trees.

This is probably one of the reasons why opinions concerning the importance of the age and size of a tree for its subsequent revival vary quite much in the Finnish literature (e.g. Multamäki 1923; Lukkala 1929, 1973; Heikurainen and Kuusela 1962).

The present author has indicated earlier (Seppälä 1969), that the age of a tree at the time of draining is of greater importance for its post-drainage radial increment than its diameter. The present paper describes in the light of some examples, the relationship between the breast height diameter of trees at time of draining and their post-drainage increment within the limits of certain age classes (i.e., when the age remains unchanged).

MATERIAL AND METHODS

Detailed information about the sample tree material forming the basis of this study has been previously published (Seppälä 1969). However, some of the most important facts are worth mentioning here. The

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material comes from a relatively small geographical area in the central part of Finland. The sample plots were set up on peatlands that had been drained about 50 years earlier, and were consequently representative of the final stage of vegetational development after drainage. The material was divided into four groups: on the basis of the site fertility: herb-rich spruce swamps, ordinary spruce swamps, ordinary sedge pine swamps and dwarf-shrub pine swamps.

The study was based on the analysis of borer cores extracted at breast height from trees selected in advance. The data for the sample trees was divided into groups on the basis of the site type, tree species and breast height diameter at time of draining as drawn from the breast height age and the length of the radius at time of draining.

The study covered Norway spruce trees growing on spruce swamps and Scots pine growing on pine swamps. In order to minimize the systematic variation in the age of the trees with the diameter variation within each age class, the study was confined to the age classes of 31—50 and 51—70 years, both the lower and the upper limits being fixed for each class. The age figures presented refer to the breast height age of the trees at the time of draining.

The next table shows the number of sample trees in each group of the study.

Site type[1]	RhK	VK	VSR	IR
	Number of sample trees			
Age class				
31—50	74	137	95	81
51—70	42	61	17	78

[1] RhK = Herb-rich spruce swamp
VK = Ordinary spruce swamp
VSR = Ordinary sedge pine swamp
IR = Dwarf-shrub pine swamp

In herb-rich spruce swamps and ordinary pine swamps the number of sample trees was so low in age class 51—70 that they were transferred into the age class 31—50. Thus, the study material was divided into six groups on the basis of site type and the age of the trees. Each of these groups was in turn divided into four subgroups on the basis of the underbark breast height diameter at the time of draining, so that the subgroups within each of the six main-groups contained an equal number of sample trees. In the following the subgroup consisting of the smallest trees is indicated by I, the next two subgroups by II and III and the subgroup formed by the largest trees by IV.

The next table shows the mean diameter of each group at the time of draining.

Site type	Rhk	VK		VSR	IR	
Age class	31-70	31-50	51-70	31-70	31-50	51-70
	Underbark diameter at time of draining, cm					
Subgroup						
I	4.4	3.7	4.6	3.6	3.3	5.5
II	6.4	5.5	6.8	5.9	4.6	8.4
III	8.7	7.4	9.5	8.7	5.9	9.9
IV	12.4	11.0	13.4	12.4	8.4	12.8

It can be seen from the table that the differences in diameter between adjacent subgroups are relatively small. Similarly, it can be seen that even the largest trees are so small in diameter on the average that they belong to the category of trees capable of reviving after drainage as indicated in previous studies (e.g. Heikurainen and Kuusela 1962).

RESULTS

Fig. 1 shows the effect of the tree diameter on the post-drainage radial increment. In this figure the average radial increment in each subgroup is indicated by five-year periods from the time of draining to the time of measuring.

Dividing each age class into four subgroups means of course that chance and factors of minor importance from the point of view of the present study affect the increment curves more than would be the case if all the age classes be examined as such. For this reason, attention is focused in this study on those differences in behavior between the diameter subgroups which repeat themselves in the different site and age classes, and which therefore may be considered as being consequences of differences in the diameter of the trees at the time of draining.

The figure clearly shows that pre-drainage radial increment is greater the larger the diameter attained by the trees of a certain age by the time of draining (cf. Heikurainen and Kuusela 1962). If the term revival is used to mean only the difference between the levels of pre-

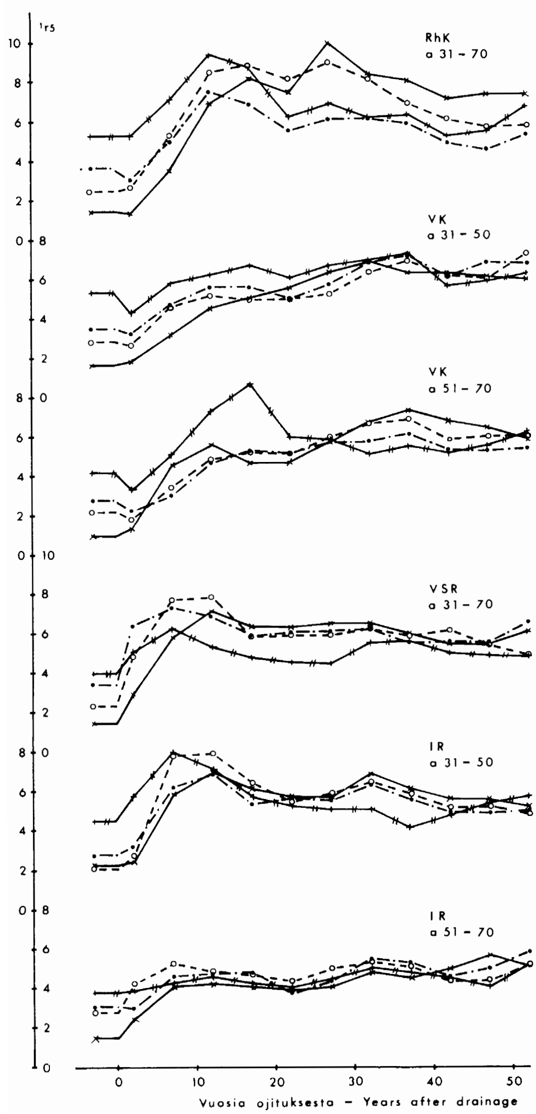

Fig. 1. The post-drainage radial increment of trees of different diameter at the time of draining.

Kuva 1. Ojitushetken läpimitaltaan erikokoisten puiden sädekasvun ojituksenjälkeinen kulku.

Explanations — *selitykset:*

a = breast height age class at the time of draining — *rinnankorkeusikäluokka ojitushetkellä*

i_{r5} = radial increment at a 5 year period — *viisivuotiskauden sädekasvu, mm*

g = basal area — *pohjapinta-ala, cm²*

x—x—x—x	= I	subgroup — *(pienin neljännes)*	
.—.—.—.	= II	»	»
o --- o--- o	= III	»	»
//—//—//	= IV *(suurin)*	»	»
		»	»

drainage and post-drainage radial increment, its magnitude would for this reason alone become smaller with increasing diameter at the time of draining, even if the post-drainage radial increment was of exactly the same magnitude.

The largest trees as regards diameter seem to reach their post-drainage radial increment maximum sooner than smaller trees. For this reason the level of radial growth is higher in the former, at least during the first post-drainage decade, than in the latter. As more time has passed since the draining operation was carried out, however, there is in most cases a change in the situation, inasmuch as the radial increment of small trees becomes greater than that of larger trees of the same age.

On the other hand, Fig. 1 shows that the differences in the average radial increment between the subgroups in each age class were rather small during the period studied. The next table shows the average post-drainage radial growth values for each of the subgroups into which the whole data was divided.

Site type	Rhk	VK		VSR	IR	
Age class	31-70	31-50	51-70	31-70	31-50	51-70
	Average post-drainage radial increment, mm/5 yrs					
Subgroup						
I	7.44	6.62	5.83	6.17	5.98	4.57
II	7.28	5.78	5.58	6.19	6.12	4.86
III	5.81	6.04	5.18	6.18	5.64	4.87
IV	6.89	6.34	6.03	5.12	5.62	4.53

The differences between the subgroups seem to be rather small as far as the average post-drainage radial increment is concerned. Moreover, there is no systematic variation, and so the differences are probably due to chance rather than to the factors examined in this study.

Thus it might be concluded that a variation in the diameter of the trees at the time of draining does not lead to any noteworthy differences in the average post-drainage radial increment when trees of similar age are in question. This, of course, only holds true within those limits within which the diameter varies on average in the groups studied.

Of course, radial growth — just like height growth — does not alone reflect the

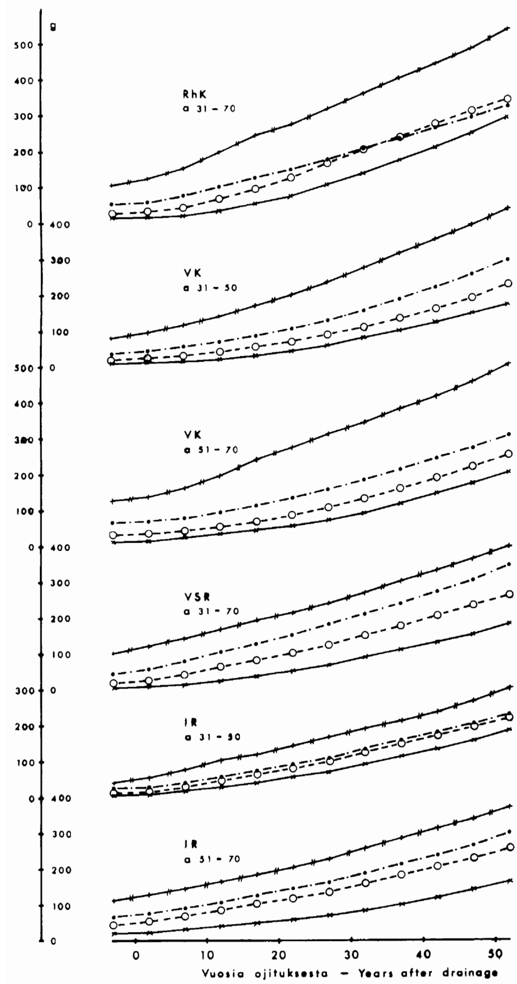

Fig. 2. The post-drainage basal area increment of trees of different diameter at the time of draining. For explanations see fig. 1.

Kuva 2. Ojitushetken läpimitaltaan erikokoisten puiden pohjapinta-alan ojituksenjälkeinen kehitys. Selitykset kuvassa 1.

true increase in the volume of individual trees, and it can only be assessed by determining the volume increment proper. The present data, however, did not permit reliable determination of the volume increment of trees after drainage to be made. For this reason the increment of the basal area of individual trees only was determined, the direction and magnitude of which show a close correlation with those of the volume increment.

Fig. 2 shows the relationship between the stem diameter at the time of draining and the post-drainage basal area increment of trees by site and age classes. On the basis of the initial mean diameter in each subgroup (see table on p. 56) the corresponding basal area at the time of draining was determined, and to the values thus obtained, an area was added which corresponded to the average radial increment during the five-year periods studied.

It can be seen from the figure that the differences in the basal area between the subgroups show the same trend from time of draining to time of measurement in all cases except for subgroups II and III (spruce trees on a herb-rich spruce swamp). The differences between subgroups II and III are usually comparatively small, whereas those between subgroups I and IV are considerable.

The next table shows the basal area increment in all subgroups of the study, calculated for the whole post-drainage period.

Site type	RhK	VK		VSR	IR	
Age class	31-70	31-50	51-70	31-70	31-50	51-70
	Total post-drainage basal area increment, cm²					
Subgroup						
I	277	165	191	176	176	147
II	312	206	219	240	207	208
III	269	258	241	299	207	231
IV	427	352	373	295	255	261

It seems, on the basis of the table, that of trees of similar age those which have the largest diameter will produce a higher basal area increment after drainage than smaller trees.

DISCUSSION

Post-drainage growth responses of individual trees can best be predicted on the basis of the site quality and the vigor of the trees concerned. The latter is reflected, for example, by the existence of a sound leader as well as by the relative size of the crown and its color. In studies concerning trees growing on peaty substrates criteria of a more unambiguous and easily measurable characteristic have been used, mainly the age and size of the trees. These criteria are quite similar in character, and they have similar effects; with increasing age and size, the post-drainage reactions become smaller in both cases (e.g. Heikurainen and Kuusela 1962, Pjateckij 1963, Seppälä 1969). In trees growing on peatlands in a virgin state, however, the age does not regulate growth within such narrow limits as is the case on mineral soils, but the trees' capacity for responding to changes in the growth conditions remain even till the age of 200 years (Pjateckij, op.cit.).

The calculations presented earlier indicated that the average radial increment of trees of similar age, within the limits of the age and diameter class division used in the study, was of similar magnitude despite a variation in their diameter, when examined on a long-term basis. Similar results have been presented by Medvedeva (1974). This means that the post-drainage basal area increment, and consequently, usually also the volume increment, of trees of a certain age are higher the larger the trees at the time of draining. A correlation of this kind between the diameter of trees and their post-drainage volume increment is clearly visible in the data presented by Medvedeva, (op.cit.).

It ought to be noticed that the picture obtained for the relationship between the stem diameter at time of draining and the post-drainage growth of trees is not completely faultless when the data is grouped in the same way as was done in the present study. The size of a tree at a certain age depends to a great extent on the degree of wetness of the site, and for this reason the sample trees representing a certain sample plot are not evenly distributed over all the size classes used, but are usually concentrated into one class. Thus it is possible that there are systematic differences in site fertility between the diameter classes used in the study.

SUMMARY

The study was conducted in order to assess, on the basis of radial increment anlyses carried out on some 600 pine and spruce trees, the relationship between the tree diameter at the time of draining and the post-drainage radial and basal area increment in the case of trees belonging to the same age class as determined at breast height.

The main results obtained for the radial increment are presented in Fig. 1 and the table on p. 57, and those obtained for the basal area increment, in Fig. 2 and the table on p. 58.

On the average it seems that the post-drainage radial increment of trees of similar age is, on a long-term basis (the study covered a period of about 50 years) more or less independent of the tree diameter at the time of draining. On the other hand, there are differences in the post-drainage growth rhythm of trees of different size. Within the limits of variation occuring in the study material, it became obvious that the post-drainage basal area increment of trees of similar age is higher the larger are the trees at the time of draining.

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LYHENNELMÄ:

PUUN OJITUSHETKEN LÄPIMITAN VAIKUTUS SEN OJITUKSENJÄLKEISEEN KASVUUN

Kirjoituksessa tarkastellaan yhteensä noin 600 kuusi- ja mäntykoepuusta suoritetun sädekasvuanalyysin perusteella, miten puiden ojitushetken läpimitta vaikuttaa niiden ojituksen jälkeiseen säde- ja pintakasvuun tapauksissa, joissa puut kuuluvat samaan rinnankorkeusikäluokkaan.

Päätulokset on sädekasvun osalta esitetty kuvassa 1 ja sivun 57 asetelmassa, pintakasvun osalta kuvassa 2 ja sivun 58 asetelmassa.

Näyttää ilmeiseltä, että samanikäisten puiden ojituksenjälkeisen sädekasvun pitkän ajan (tutkitussa tapauksessa n. 50 vuoden) keskiarvot ovat varsin riippumattomia puiden paksuudesta. Kasvun ojituksenjälkeinen rytmi on sen sijaan eripaksuisilla puilla toisistaan poikkeava. Tutkitun aineiston edustamissa vaihtelurajoissa tietynikäisten puiden ojituksenjälkeinen pintakasvu on sitä suurempi, mitä paksumpia ne ovat olleet ojitushetkellä.