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**FORM FACTOR INVESTIGATIONS AND
YIELD TABLES FOR JAPANESE LARCH
IN DENMARK,**

(*FORMTAL OG TILVÆKST FOR JAPANSK LÆRK*).

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Bd. XII. Nr. 104. A. OPPERMANN: Egens Træformer og Racer (Les configurations et races du chêne).

Bd. XIII, H. 1: Nr. 102. C. H. BORNEBUSCH: Dybtgaaende Jordbundsundersøgelser, Hedeskovenes Foryngelse III (Tiefgehende Bodenuntersuchungen), S. 1. — Nr. 103. A. OPPERMANN: Nordmannsgranens Vækst i Danmark (Abies Nordmanniana in Dänemark), S. 51. H. 2: Nr. 105. C. H. BORNEBUSCH: Skovbundsflorena i Mølleskoven (The flora in »Mølleskoven«), S. 57. — Nr. 106. FR. WEIS: Beplantningsforsøg paa et afføgent Sande (Boisement d'un terrain du sable mouvant éventé), S. 63. — Nr. 107. C. H. BORNEBUSCH: Et Udhugningsforsøg i Rødgran (Ein Durchforstungsversuch in Fichte), S. 117. — Nr. 108. MATH. THOMSEN: Sprøjtemidler til Bekämpelse af Chermes paa Ædelgran (Spritzmittel gegen Chermes auf Weisstanne), S. 215. H. 3: Nr. 109. C. H. BORNEBUSCH og FOLKE HOLM: Kultur paa træmetesinficeret Bund med forskellige Træarter (Replanting of areas infected with *Polyporus annosus*), S. 225. — Nr. 110. C. MUHLE LARSEN: To gamle fynske Egeprøveflader (Zwei alte Eichenprobe flächen auf Fünen), S. 265. H. 4: Nr. 111. E. C. L. LØFTING: Bjergfyrbevoksninger paa Hedebund og deres Foryngelse, Hedeskovenes Foryngelse IV (Mountain pine plantations in Jutland and their conversion into forests of more valuable tree-species), S. 305. H. 5: Nr. 112. C. H. BORNEBUSCH: Proveniensforsøg med Rødgran (Ein Provenienzversuch mit Fichte), S. 325. — Nr. 113. FOLKE HOLM: Abies grandis i Danmark (Abies grandis in Denmark), S. 379. — Nr. 114. C. H. BORNEBUSCH: Forsøgs-væsenets Ordning og Ledelse, IX, S. 409.

Bd. XIV, H. 1: Nr. 115. E. C. L. LØFTING: Bevaring af stormfældet Gran (Aufbewahrung von sturmgeschlagenem Fichtenholz), S. 1. — Nr. 116. Poul LARSEN: Regenererende Kulsyre-assimilation hos Askegrene (Regenerierende Kohlensäureassimilation bei Eschenästen), S. 13. — Nr. 117. C. H. BORNEBUSCH: Thuja som dansk Skovtræ (Thuja plicata as a Danish Forest Tree), S. 53. H. 2: Nr. 118. C. H. BORNEBUSCH: Sommerplantning af Naaletræer (Sommerpflanzung von Nadelhölzern), S. 97. — Nr. 119. E. C. L. LØFTING: Rodfordærverangrebene Betydning for Sitkagrans Anvendelighed i Klitter og Heder, Hedeskovenes Foryngelse V (The significance of the attacks of *Polyporus annosus* to the suitability of the Sitka spruce for Dunes and Heaths), S. 133. — Nr. 120. C. H. BORNEBUSCH: Stormskaden paa Udhugningsforsøget i Hastrup Plantage (Sturmschaden in dem Hastruper Durchforstungsversuch), S. 161. — Nr. 121. C. H. BORNEBUSCH: Iagttagelser over Rødgranens Naalefald (Chute d'aiguilles naturelle d'epicea), S. 173. — Nr. 122. W. O. HISEY: Cellulose af europeisk Bøg (Pulping Characteristics of European Beech), S. 177. — Nr. 123. FOLKE HOLM: Bøgeracer (Races de hêtre), S. 193. H. 3: Nr. 124. P. L. KRAMP: Forsøg over forskellige Træsorters Modstandsdygtighed overfor Angreb af Pæleorm og Pælekrebs (Experiment on the Power of Resistance of various kinds of Wood against Attack of Ship-Worm and Gribble), S. 265. H. 4: Nr. 129. AXEL S. SABROE: Rødgranens Form og Formtal (Form und Formzahl bei Fichte), S. 281.

Bd. XV, H. 1: Nr. 125. FOLKE HOLM: Bøgebrændende (Buchenbrennholz), S. 1. — Nr. 126. CECIL TRESCHOW: Undersøgelser over Brintjonkoncentrationens Indflydelse paa Væksten af Svam-

FORM FACTOR INVESTIGATIONS AND YIELD TABLES FOR JAPANESE LARCH IN DENMARK

BY
MOGENS ANDERSEN

INTRODUCTION

(The author also delivered a Danish primary text giving all particulars about the methods employed, and discussions of subjects which are only mentioned briefly in the present text. This will explain its wording. Those interested are invited to communicate with the author, or the Danish Forest Experiment Service).

To-day, Japanese larch holds an important place in Danish forestry, and even if our oldest pure stands of this species are only about 50 years of age the need for form factor tables and yield tables is evident. Hence the issue of this paper which consists of two parts:

In the first part (A) the form factor is investigated in respect of its dependence on various tree or stand characteristics, and on the basis of the results thus obtained a series of form factor tables is calculated and tested. Further, the stem taper is examined and a taper table prepared.

In the second part (B) an empiric yield table is constructed. As in certain respects this table is considered not to represent the most favourable course of production the author proposes a modification of the thinning regime and presents a yield table incorporating this modification.

At the III World Forestry Congress in Helsinki, 1949, the author delivered a paper of a provisional character on the subject in question.

A. FORM FACTOR.

The form factor (f) is the one based on height (h) from ground level, and total over-bark volume of the stem from ground level. Breast height is taken at 1.3 m above ground level, the corresponding over-bark diameter being d or d_0 and the basal area g . $d_1, d_2 \dots d_9$ are the over-bark diameters at each succeeding tenth of the stem above 1.3 m, these diameters being taken as relative diameters, i. e. expressed in percentages of d . d_5 is identical to the form quotient (q) that determines the classification into form classes. When not otherwise stated, h is given in decimetres, d (d_0) in millimetres, and f in thousandths.

1. Material.

The sample stems (411) have been measured in 4 sections beneath breast height (these sections are measured at the middle), and 10 sections above breast height (measured at the ends). Volume and form factor calculated in this way were assumed to be true values (PETRINI 1927/28; JONSON 1928). Some of the

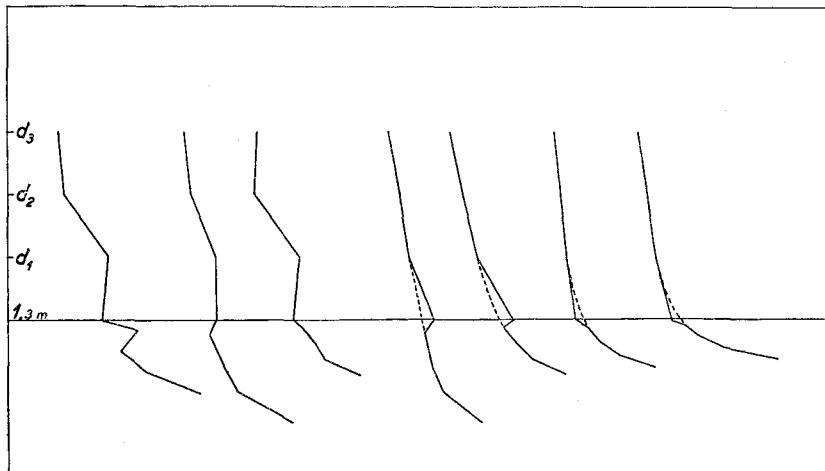


Fig. 1. Examination of breast-high diameter of sample stems. The figure shows 3 stems rejected on account of irregular form, and 4 stems corrected in respect of d . The two corrections to the left increase the form factor by 8 to 10 per cent, and those to the right reduce it by 5 to 6 per cent.

Undersøgelse af udgangsmaterialet. Figuren viser 3 stammer, som er udskudt, og 4 stammer, som er korrigeret på brysthøjdediameteren. De to korrektioner til venstre forhøjer det målte formtal med 8-10 %, medens de to til højre sænker formtallet med 5-6 %.

trees were measured as long as 30 years ago, and as formerly the lower sections were measured on the standing tree and the upper ones on the lying tree after it had been felled it was considered necessary to examine the breast high diameter of all sample stems, and also to exclude the influence of purely local swellings or constrictions at 1.3 m. This was done graphically (fig. 1); 25 stems were rejected, and 59 corrected in respect of d . Hereafter the material consisted of 386 stems (tab. XXIII) originating from forests in all parts of Denmark, except W. Jutland. The data of the individual stems were registered according to the Hollerith system which enables a mechanical sorting and totalling of arbitrary groups. Generally we must examine the form factor as to its dependence on not more than two quantities at a time as otherwise there would not be a sufficient number of observations in the sub-divisions (exception see section 4). Most important are the determination of f from d and h (section 2), because in most cases only these quantities (and the number of stems) are known, and the determination from h and q , extended also to d (section 4), on account of the greater accuracy. Further, the determinations of f from q and d (section 3), from d_1 and h (section 5), from d_7 and d_1 (section 6), and from h alone and d alone (see section 8) are discussed.

While in the first place the form factor tables are intended to be used for stands, the investigation is based on single trees that are at the same time thinning trees. The questions are dealt with (sections 1, 2, and 8) to what extent single trees will be representative of whole stands, and thinnings of the main crop, as regards the form factor. Provided that the sample trees are selected so that their height and diameter are of about the same size as for the main crop, it is probable that they are sufficiently representative of the latter, if height and diameter divergences are taken into account. Also, if the different stands forming part of the material have the same average form factor (form factor level), this level being judged on a height as well as a diameter basis and corrected correspondingly, single trees will be representative of the stands. In order to assess the form factor level of a given stand it is necessary to make a rather comprehensive series of measurements, and in using standard form factor tables it is generally assumed

that considerable divergences of this nature do not occur. Not until much more extensive material is available can this question be settled satisfactorily. As our sample trees have been selected in the way mentioned above, and as our stands seem to show, on the whole, a common form factor level, it is probable that the results obtained will be reliable when used for stands. (Cfr. BORNEBUSCH & HENRIKSEN 1946).

2. Determination of f from d and h.

The observations were sorted into 3 cm diameter classes the serial numbers of which, multiplied by 3, indicate the central values in centimetres of the respective d-classes. Each d-class was sorted into 2 m height classes the serial numbers of which, multiplied by 2, indicate the central values in metres of the respective h-classes. Tab. I and the diagram in fig. 2 show the distribution over d/h-classes, and tab. II gives the number of observations and the class averages. In figures 3 and 4 the values of h and d, respectively, are abscissae, and the lines represent the f-values of the d-classes and the h-classes, respectively, these f-values having been corrected for h- or d-divergences from the central value of the class. Apart from certain details requiring special examination and proving insignificant (upper ends of h-classes 8 to 10), it appears from fig. 4 that within an h-class f decreases approximately in a straight line as d increases, and that the deviations of f from this regression are not consistent, but seem to indicate erratic averages resulting from an insufficient number of observations. Both figures show that within the h-classes 3 to 5, as well as 10 to 12, f is independent of h. Adopting this linear development it is seen that a joint intersection point for the h-classes is indicated by these regressions. The equations of the outer lines, representing h-classes 3 to 5 and h-classes 10 to 12, respectively, were derived analytically and the point of intersection calculated. The intermediate lines were computed from the intersection point and the corrected means (gravity centres) of the respective h-classes (tab. III). For the calculation of f at 1 metre intervals the angles between the h-class lines were examined. The form factor was computed from the equation

$$f = c_1 - c_2d;$$

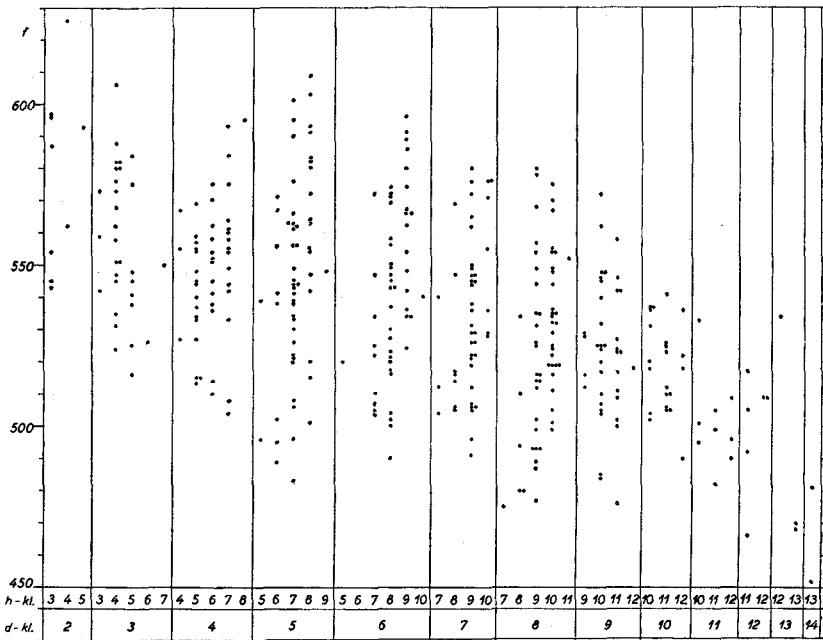


Fig. 2. Diagram showing distribution of observations (values of f) over d/h -classes (cfr. tab. I). Within the individual d/h -classes the spread of points is considerable; this indicates that the characterization of the form factor by given values of d and h is of doubtful accuracy. kl. = class.

Diagram, visende iagttagelsernes fordeling til d/h -klasser (sml. tab. I). Stor spredning inden for de enkelte d/h -klasser. Mindre god formtalskarakteristik.

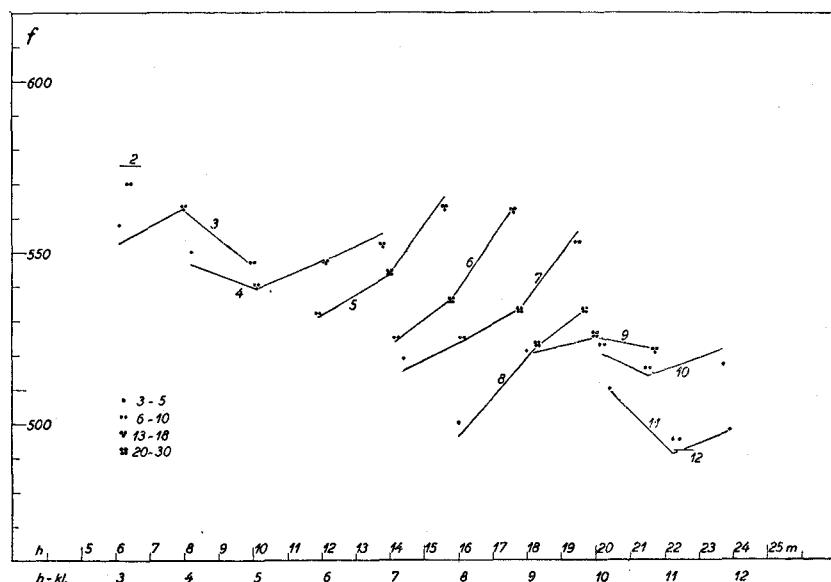


Fig. 3. Plotting on h of form factor by d -classes. Serial numbers of d -classes indicated in the figure. Values of f corrected for d -divergences from class centres.

Weight of sub-classes indicated. kl. = class.

d -klassernes formtalgang ved varierende højde. Kodenumre for d -klasser anført i figuren.

tab. IV gives the values of the constants c_1 and c_2 for varying values of h . The form factor table is tab. V.

As h and d are closely correlated the question arises whether the determination of f from h alone (or d alone) is markedly inferior to the d/h -determination. (Determination of f from h alone was used, e. g., by MØLLER (1933) in his standard yield tables for beech, oak, and spruce in Denmark). As will be shown (section 8) the difference is pronounced. This difference which is to be expected from the above statements (figures 3 and 4) is also due in part to systematic errors arising from the deviation of d/h - from h/d -regression.

Mention is given to the formulas for determining f from h and d , as published by NÄSLUND (1948).

3. Determination of f from q and d .

The form classes (q -classes), like the d -classes, are numbered so that their serial numbers, multiplied by 3, indicate the central values (in percentages of d) of the respective q -classes. Tab. VI and fig. 5 show the distribution over q/d -classes. The mean form quotient is 68.6 ± 4.5 and the distribution over q -classes is quite normal. The spread of the points within the different sub-classes (fig. 5, cfr. fig. 2 and fig. 8) is indicative of the f -determining ability of the respective data combination, q/d , d/h , or h/q . Thus, already from these diagrams it is possible to judge of the quality of the different form factor tables. — The class means for q/d -classes are given in tab. VII, and fig. 6 shows the f -development of the d -classes, the values of q being abscissae. In order to emphasize the main trends by lessening the influence of erratic averages, a greater number of observations was included by the computation of the q/d -points, by means of "broad" d -classes, mutually overlapping; e. g. the q/d -class 22/6 was replaced by 22/5-6-7, and so on (tab. VIII). All f -values were corrected for d -divergences from central class values. The result of this compound calculation is shown in fig. 7. As a control the corrected means of the single d -classes and of the compound ones were compared (tab. IX); the differences were negligible. On the basis of the compound classes the smoothed lines shown in fig. 7 were estimated; from these lines the values of f for the form factor table (tab. X) were read.

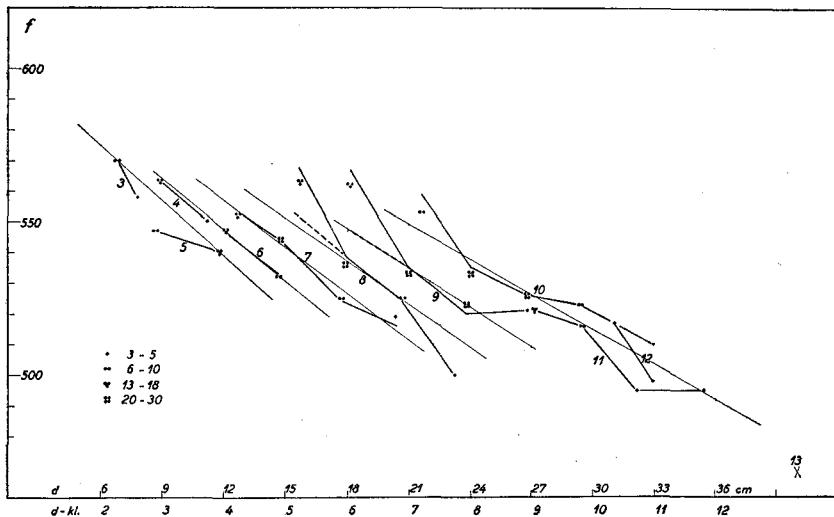


Fig. 4. Plotting on d of form factor by h -classes. Serial numbers of h -classes indicated in the figure. Values of f corrected for h -divergences from class centres. Weight of sub-classes indicated. Smoothing by radiating straight lines is shown, outer lines representing h -classes 3 to 5, and 10 to 12(13), respectively. Broken lines are corrections of upper ends of h -classes 8 and 9, due to certain observations non-typical from a $d/h/f$ -point of view. kl. = class.

h -klassernes formtalgang ved varierende diameter. Kodenumre for h -klasser anført i figuren. De tynde linier er udjævningslinierne (liniebundt); den yderste til venstre repræsenterer h -klasserne 3-5 og den yderste til højre h -klasserne 10-12(13). De stipede liniestykke er korrektioner (se teksten).

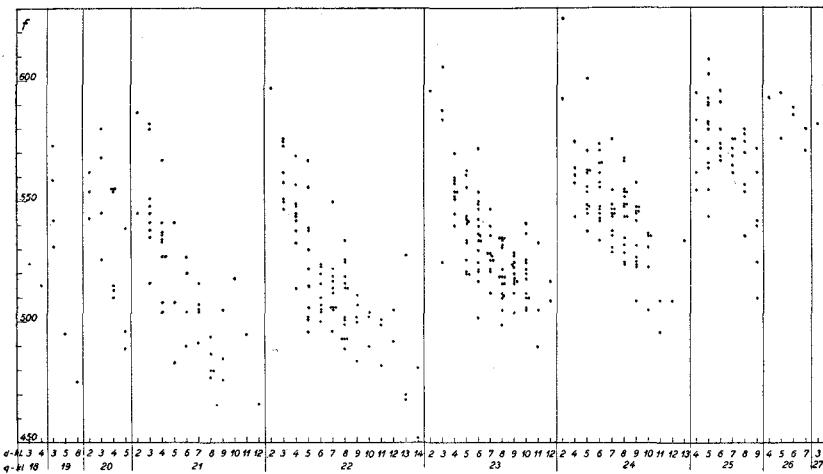


Fig. 5. Distribution of observations over q/d -classes (cfr. tab. VI). As compared to fig. 2 the spread of points within the sub-classes is less; this indicates that the characterization of the form factor by q and d is superior to that by d and h . kl. = class.

Iagttagelsernes fordeling til q/d -klasser (sm. tab. VI). Sammenholdt med fig. 2 er her mindre spredning inden for de enkelte underklasser og bedre formtakarakteristik.

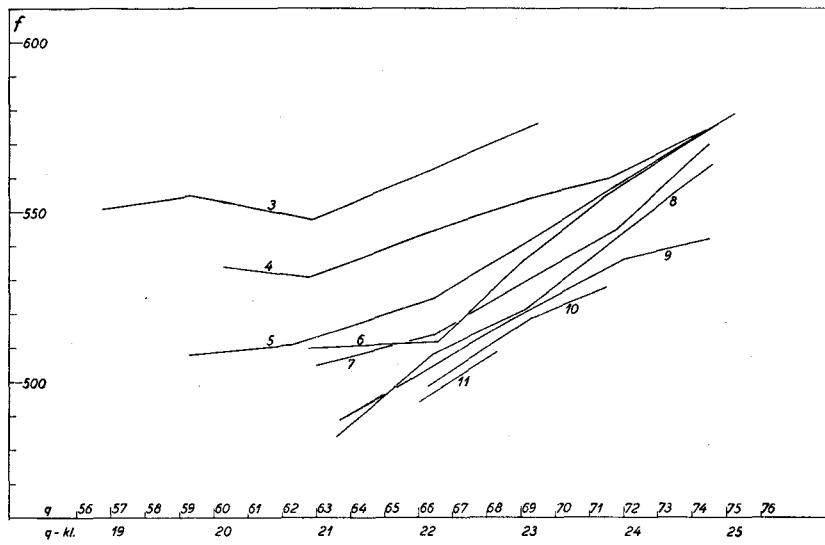


Fig. 6. Plotting on q of form factor by d -classes. Serial numbers of d -classes indicated in the figure. Uncorrected points. $kl.$ = class.
d-klassernes formtalgang ved varierende formklasse. Kodenumre for d-klasser anført i figuren. Punkterne ikke korrigert.

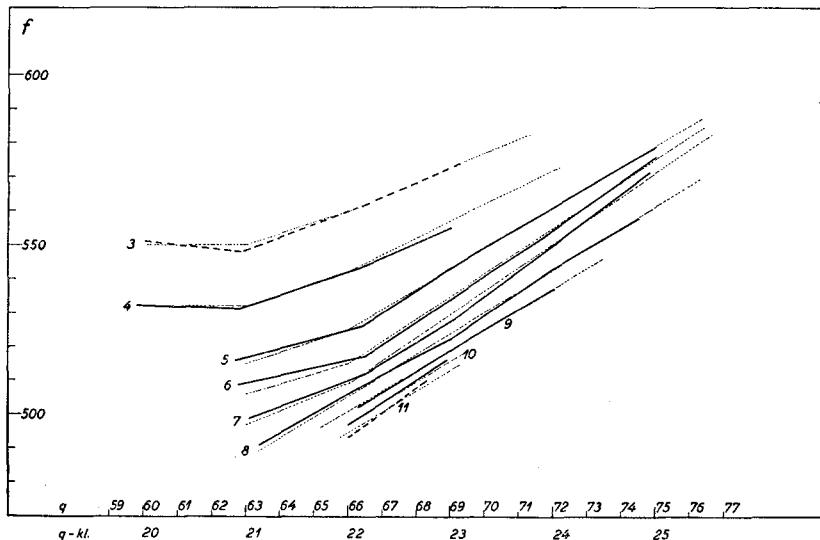


Fig. 7. Plotting on q of form factor by compound d -classes. Values of f corrected for d -divergences from class centres. Smoothing shown by thin lines. $kl.$ = class.

d-klassernes formtalgang, fremstillet ved brede (sammenregnede) d -klasser. Punkterne korrigert for d -afvigelser fra klassemidten. Skematisk udjævning vist ved tynde linier.

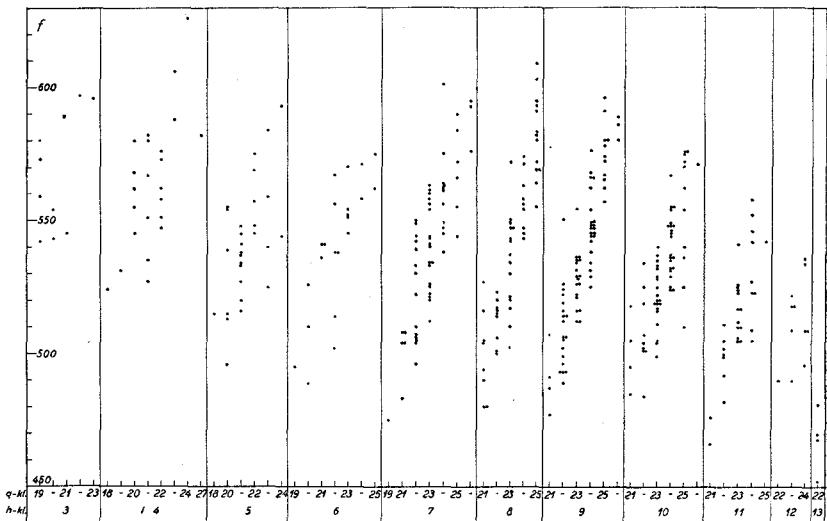


Fig. 8. Distribution of observations over h/q-classes (cfr. tab. XI). The spread of points within the sub-classes is much the same as in fig. 5. kl. = class.
lagttagelsernes fordeling til h/q-klasser (sml. tab. XI). Spredningen inden for de enkelte underklasser af lignende størrelse som i fig. 5.

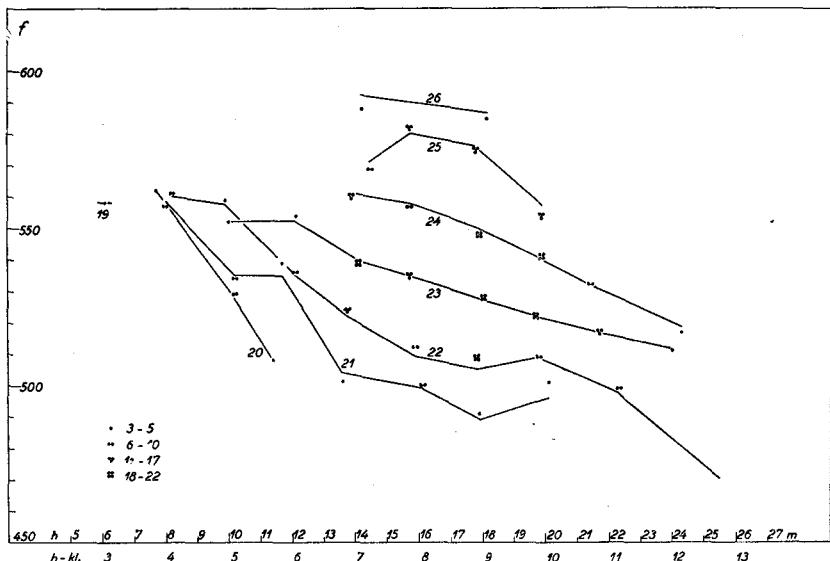
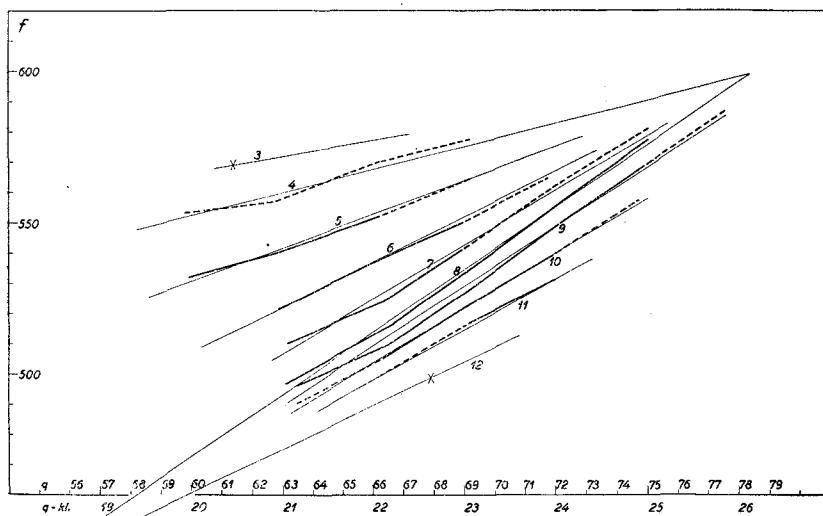
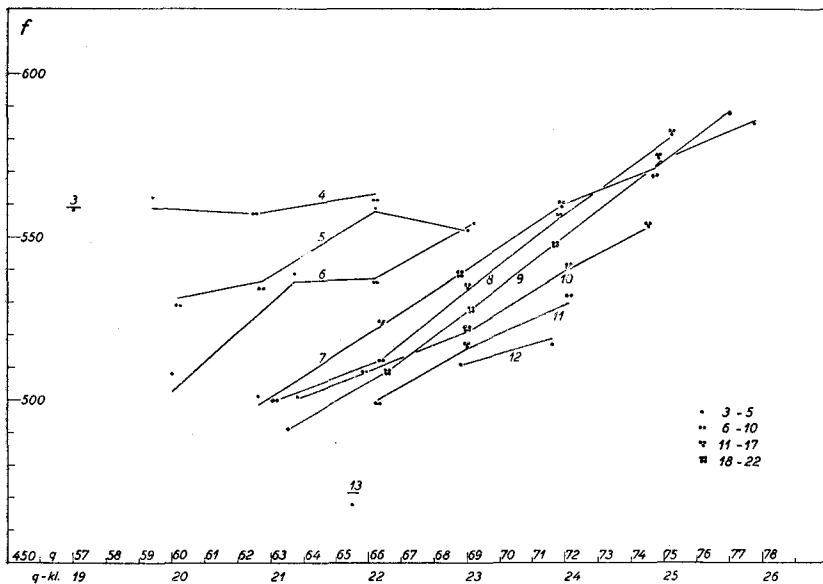


Fig. 9. Plotting on h of form factor by q-classes. Serial numbers of q-classes indicated in the figure. Values of f corrected for q-divergences from class centres. Weight of sub-classes indicated. kl. = class.
q-klassernes formtalgang ved varierende højde. Kodenumre for q-klasser anført i figuren. Korrigeret for q-afvigelser fra klassemidten.



4. Determination of f from h and q (and d).

In tab. XI and fig. 8 the distribution over h/q-classes and the spread of the f-values within the different h/q-classes are shown. Tab. XII gives the class means, and in figures 9 and 10 the values of h and q, respectively, are abscissae, while the lines represent the f-values of the q-classes and the h-classes, respectively, these f-values having been corrected for h- or q-divergences from class centres. As above, the influence of an insufficient number of observations was lessened by means of broad h-classes so that e. g. the h/q-class 23/9 was replaced by 23/8-9-10, etc. (tab. XIII). Tab. XIV demonstrates that the discrepancies introduced by the use of these compound h-classes are negligible. The result is shown in fig. 11; it appears that the h-classes develop approximately as straight lines and that the regressions are in accordance with two joint intersection points, the regression coefficients increasing from h-class 4 to 8 and decreasing from h-class 8 to 11. h-class 8 was adopted as the regression line common to the two radiating systems, and its equation was derived from the values of q and f of the various q-classes within h-class 8. Then the equations of the lines h4.5 and h10.5 were derived and the two intersection points found. The intermediate h-class lines were computed from these points and also the corrected means of the respective h-classes. The form factors were calculated from the equation

$$f = k_1 q + k_2,$$

tab. XV giving the values of the constants k_1 and k_2 for varying values of h. The form factor table is tab. XVI.

The adoption of such radiating systems as well as of the linear development of itself, is of no fundamental significance; use has merely been made of the fact that this smoothing seems to fit our material and is not contradicted by it. Near to the intersection points this system is untenable from a theoretical point of view, but this is unessential since here no real observations will be found.

The determination from h and q was extended to include also d as a determinant. In fig. 12 are shown all h/q-classes comprising at least 2 h/q/d-classes with at least 3 observations each. An examination of this figure shows that as d increases

by 1 millimetre, f decreases at a rate of 0.24 f -units. Consequently, the $h/q/d$ -determined form factor will be

$$f = k_1 q + k_2 + 0.24 (d_t - d),$$

d_t being the »theoretical diameter«, i. e. the diameter most probably corresponding to the actual values of h and q . For the determination of d_t a special table was worked out on the basis of a plotting on q of the average diameter of all h/q -classes (tab. XVII). The following example illustrates the determination of f from h , q , and d :

$h = 20.7$ m, $d = 30.9$ cm, $q = 0.670$. From h and q tab. XVI gives $f = 508$, and, likewise from h and q tab. XVII gives $d_t = 280$ mm. The actual diameter exceeds d_t by 29 mm and, consequently, the form factor will have to be reduced by $29 \times 0.24 = 7$ units. $f = 508 - 7 = 501 (= 0.501)$. As will be shown (section 8), the determination of f from $h/q/d$ is superior to that from h/q .

A different formula for determining f from h and q was used by SCHIFFEL (1905).

5. Determination of f from d_1 and h .

This data combination was examined and deemed unfit for form factor determination.

6. Determination of f from d_7 and d_1 .

From the examination of this data combination it appears that d_7 and d_1 are well qualified for determining f in one part of the interesting field, but unfit in another part (the lower values of d_7); this is due to a different height influence on the d_7 -classes. No form factor table was constructed (cfr. section 10).

7. Taper examination.

As a basis for the taper examination a variant of the formula by BEHRE (1927) was chosen:

$$d_L = \frac{L}{1 - c(1 - L)},$$

in which d_L is an arbitrary relative diameter at distance L from the tip; L is expressed as a fraction of the total height above 1.3 m, and c is a constant varying with the form class.

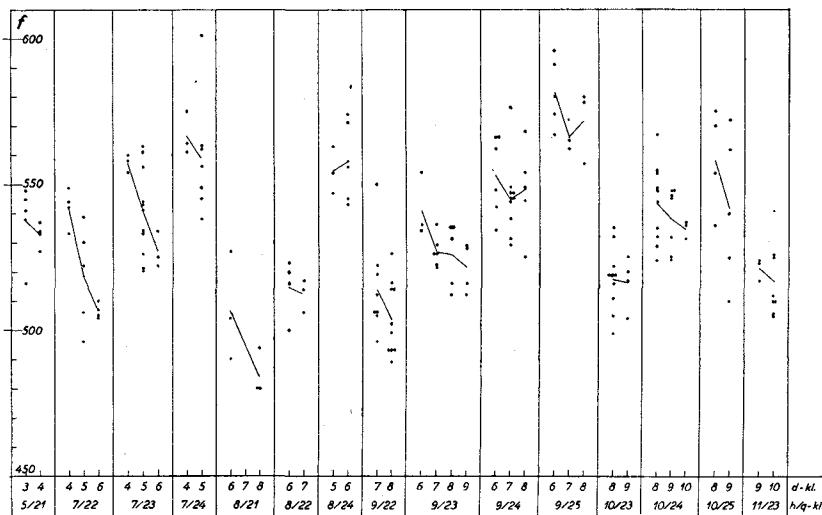


Fig. 12. Diagram showing decrease of form factor as diameter increases, within the h/q -classes, these having been divided into $h/q/d$ -classes. Connecting lines to means of $h/q/d$ -classes. kl. = class.

Diagram, visende formfaldet ved stigende diameter inden for de enkelte h/q -klasser, idet disse er opdelt i $h/q/d$ -klasser. Linierne forbinder $h/q/d$ -klassernes tyngdepunkter.

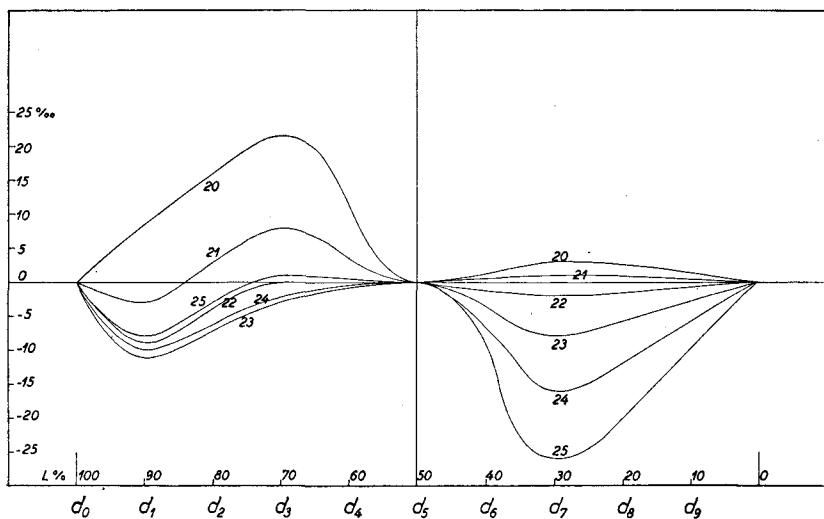


Fig. 13. Correction figure to the taper formula by BEHRE. For the most common form classes (22, 23, and 24, i.e. $q = .66, .69$, and $.72$) the corrections are, in the main, less than 1 per cent.

Korrektionsfigur til BEHREs formel. For de almindeligst forekommende formklasser (22, 23 og 24) er korrektionerne overvejende mindre end 1%.

By substituting for the variables $d_5 = q$ and $L_5 = 0.5$ the following values of c were calculated:

q-class	20	21	22	23	24	25
q	0.60	0.63	0.66	0.69	0.72	0.75
c	0.333	0.413	0.485	0.551	0.611	0.667

In tables XVIII and XIX the relative diameters d_1, d_2, d_3, d_5 , and d_7 as computed from the formula, are compared with the averages from our material. The divergences vary in a regular way; their values, after smoothing, were transformed into the correction figure fig. 13 from which can be read off the corrections to the values given by the formula. Fig. 13 indicates the deviation of the taper formula from the actual tapers of our material. The effect of the correction appears from the reduced divergences, as presented in tab. XX; from this table it is possible to deduce that in by far the great majority of cases the divergences amount to not more than a few mm. Then the taper table was calculated (tab. XXI); from the total height 1 per cent was deducted for the stump so that the horizontal heading of the table refers to length of felled stem (cfr. the spruce table by SABROE 1939). In practice, the taper table can in many cases be of use even if nothing certain is known about the actual form class; in such cases form class .69 should be employed.

The taper table was checked on 10 groups of 10 trees each from our sample plots (p/a-groups, cfr. section 8), giving a standard error of 2.4 mm for d_3 and 2.8 mm for d_7 (tab. XXII). These standard errors refer to group averages in cases when the true form class is known. For single trees the deviations from the group average will correspond to the values given under column II in tab. XXII. Errors arising from miscalculating the form class can be judged directly from tab. XXI.

In some cases it is possible to deduce the mean form class of a given stand from the usual commercial measuring of felled timber.

The form factor can be computed from the taper formula with the aid of integral calculus. As butt swelling is not taken into account by the formula the values calculated in this way will be somewhat lower than the values in tab. XVI.

8. Stand form factors and testing of form factor tables.

As proper stand form factors were not available stands were represented by our groups of sample trees, each group originating from the same stand at the same age (p/a-groups). Tab. XXIII presents all p/a-groups with their averages. The material was divided into two lots, (1) comprising groups with 9 or more observations, and (2) the remaining groups (with 2 to 7 observations). For comparative purposes, tables were elaborated giving the determination of f from h alone, and from d alone; the h-table is this:

height m $f \times 1000$	6	7	8	9	10	11	12	13	14	15
	578	567	557	549	544	542	541	541	541	541
height m $f \times 1000$	16	17	18	19	20	21	22	23	24	25
	540	539	537	534	529	525	519	511	502	490

The form factor tables (tab. V, X, XVI, XVI + XVII, and the h-table) were tested on all p/a-groups. For lot (1) the determination of f from h , d/h , q/d , h/q , and $h/q/d$ is shown in tab. XXIV. The deviations of the table values from the true (measured) values are given in tab. XXV. Further, tables XXVI and XXVII present similar tests for lot (2) of the material, the groups with few observations. The character of the error series for the p/a-groups is of no importance when taken individually, but the standard error based on all determinations of f under each determinant can be regarded as reliable. These standard errors are presented in the following table:

group	standard error in f-units by determination from				
	h	d/h	q/d	h/q	$h/q/d$
a	9.9	7.0	2.6	1.6	1.3
b	13.5	10.5	5.1	4.9	3.9
c	14.3	10.9	5.5	5.2	4.2
d	20.2	12.0	8.3	8.5	8.4

It is seen that there is a clearly marked scaling down from left to right as well as from below and upwards. On an average, the groups titled (d) comprise 4 observations each, the groups (c) 11—12, (b) 15, and (a) 37 observations each; (a)

and (c) are partial groups of (b). That the accuracy of the determination of f increases as the number of observations in the groups increases was to be expected because of the improved averages. The ranging of the five determinants, from h alone (or d alone which gives the same degree of precision) to $h/q/d$, as well as the effect of the absolute or percentile values of these standard errors, are items of central importance. Taking as an example the groups titled (b) of 15 trees each, on an average, the standard errors are:

standard error in	determinants				
	h	d/h	q/d	h/q	$h/q/d$
f-units	13.5	10.5	5.1	4.9	3.9
percentages of f	$2\frac{3}{4}$	2	1	1	$\frac{3}{4}$

Taking into consideration the errors arising from accepting the group as a representative sample of the stand, the erratic determination of the headings, as well as the errors arising from other sources (determination of remaining volume factors) it is evident that the determination of f from h alone should be avoided, if possible, and that the determination from d/h , although markedly better, does not fulfil the demands normally made in Danish forestry. As d and h , but not q , are quantities normally determined in forest enumerations it is to be expected that the d/h -determination of f will for the present be the standard method, but it ought to be replaced by more accurate methods. The combinations q/d and h/q (the latter being slightly better than the former) give a quite acceptable degree of accuracy, but as the determinants $h/q/d$, as compared to h/q , reduce the standard error by 20 per cent this method should be preferred.

The number of stems per hectare is also obtained in a normal enumeration of growing stock. It might be supposed that the form factor determined from d and h could be amended by including the number of stems as a determinant. If this were the case the more troublesome estimation of q could perhaps be avoided. Therefore, this question was given some consideration. Tables XXVIII to XXX and figures 14 to 16 refer to this examination. A method was worked out by

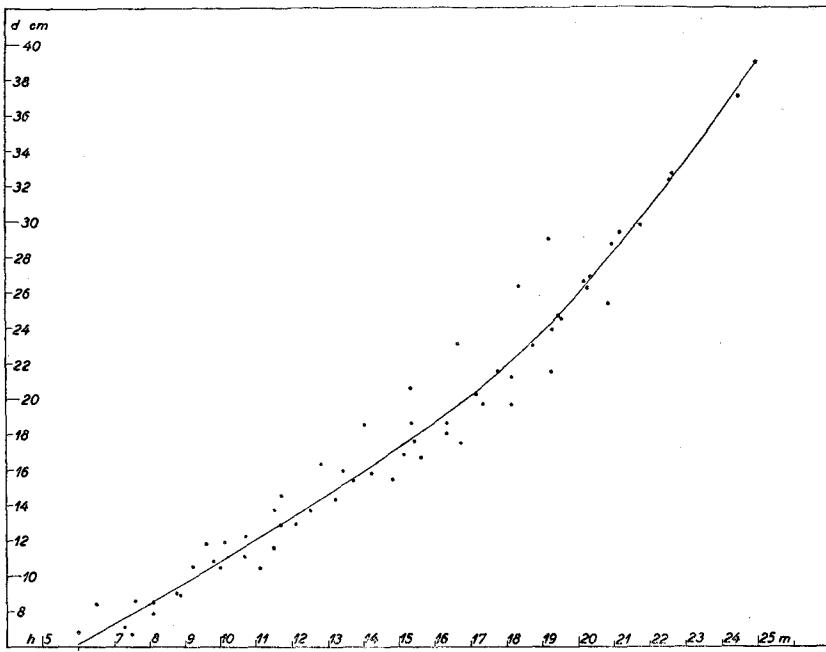


Fig. 14. Curve showing most probable value of diameter of mean basal area for given mean height of the stand (stand situation before thinnings).

Kurve for sandsynligste bevoksningssdiameter ved given bevoksningshøjde. Situation før tynding.

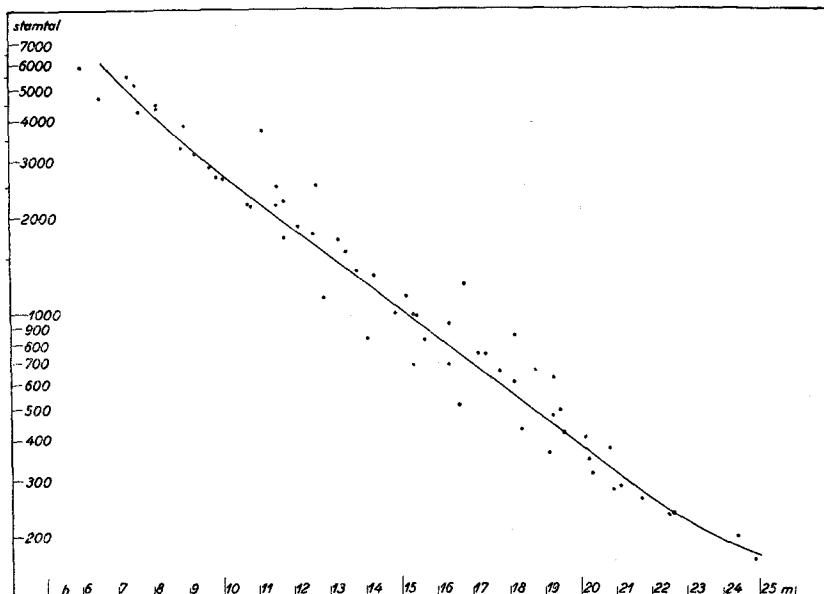


Fig. 15. Curve showing most probable value of number of stems per hectare for given mean height of the stand (stand situation before thinnings). Logarithmic scale for the ordinates. stamtal = number of stems.

Kurve for sandsynligste stamtal pr. ha ved given bevoksningshøjde. Situation før tynning. Logaritmisk skala for ordinaterne.

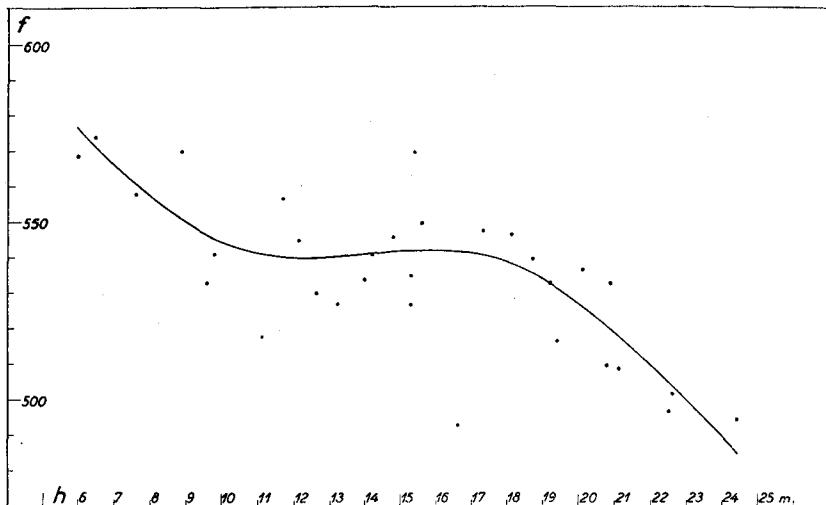


Fig. 16. Curve showing the stand form factor for given height (before thinnings). Single points are sample trees (p/a-groups) averages, corrected for h- and d-divergences from stand data before thinnings.

Kurve for bestandsformtallet ved given bevoksningshøjde og før tynding. De enkelte punkter er prøvetræernes middeltal (p/a-grupperne), korrigeret for h- og d-afvigelser fra bestanden før tynding.

which it is possible to estimate the values of the form factor (tab. XXX) and the number of stems (tab. XXVIII) when d and h are given (number of stems referring to the standing crop before thinnings). A comparison of the last columns of tables XXVIII and XXX shows that no influence of the number of stems on the d/h-determined form factor could be demonstrated.

For a fairly good determination of the stand form factor a minimum of about 20 carefully chosen sample trees are necessary.

Attention is drawn to the question of a possible genetic influence on form factors.

9. Comparisons.

No proper form factor investigation for Japanese larch seem to have been published, but for European larch publications are available, by SCHIFFEL (1905), MATTSSON (1916/17), ZIMMERLE (1941), and SCHOBER (1949). As the measuring methods are different from those here employed corrections had to be made. Comparisons were made with the form factors by SCHIF-

FEL on an h/d-basis, with those by MATTSSON on an h/q-basis, and with very limited Danish material of European larch on an h/q/d-basis. Even if there is a certain influence of the smoothing methods on the results it appears quite clearly from these comparisons that the form factor of the Japanese larch is superior to that of the European larch, the difference being in most cases about 3 per cent.

10. Partial form factors.

In practice, the partial form factors φ (the absolute form factor) and t — these being the form factors for the stem above and below 1.3 m, respectively — would be of interest only if their determination from the usual data were of a greater accuracy than for f . Examinations showed that this is not the case.

The determinants d_7/d_1 might be expected to give a particularly good determination of φ , because of the independence of butt form as well as of the relative value of breast height. A table was calculated giving φ from d_7 and d_1 (tab. XXXI), and tested on the p/a-groups, lot (1). The standard error is, however, slightly greater than by the determination of f from h/q .

11. A complete set of thinning trees. Comments on the selection of sample trees.

In our material, the measurement of sample plot no. 2 at the age of 32 years is exceptional because here all (60) thinning trees were measured by sections. Therefore, in this particular case it is possible to study the structure of a complete set of thinning trees, in respect of height, diameter, form class, and form factor. The following table gives, for 1 hectare, the main data of the stand; it is seen that this thinning was extraordinarily heavy, the thinning intervals of about 3 years being considered:

sample plot GO, 32 years	no. of stems	height dm	diameter mm	basal area m^2
before thinning	477	193	240	21.49
thinning	163	185	221	6.31
remaining crop	314	197	248	15.18

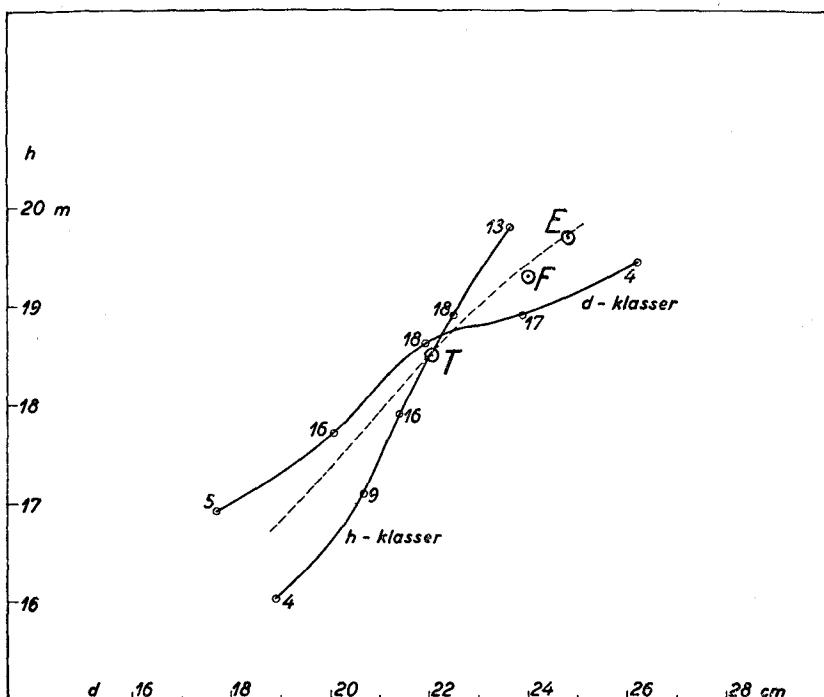


Fig. 17. p/a-group 2/32 (sample plot GO, age 32 years); the thinning, d/h and h/d regression curves. Numbers of observations indicated (total 60 trees). Broken curve is a co-frequency curve. E, F, and T are the means of d and h for the standing crop after thinning, the crop before thinning, and the thinning, respectively. klasser = classes.

Prfl. GO, 32 år; tyndingen. Regressionskurver mellem diameter og højde, samt en ko-frekvenskurve (stiplet). E, F og T er middelværdierne af d og h for henholdsvis bestanden efter tynding, bestanden før tynding samt tyndingen.

In tables XXXV and XXXVI the observations are grouped by 1 m h-classes and 2 cm d-classes, respectively. High form factor values will be found mainly for trees of medium diameter belonging to the upper h-classes, and low form factor values for suppressed trees, and for some of the thickest trees (fig. 18). To be representative of the stand, a group of sample trees must have the same h and d as the stand and, of course, be sufficient in number; in selecting such a group, the simple means of h and d should be adjusted to the values of the standing crop before thinning because in most cases the corresponding values of the stand after thinning will be too high (cfr. figures 17 and 18). It is evident that the representative group must be selected among the highest and thickest trees. The 31 highest trees give

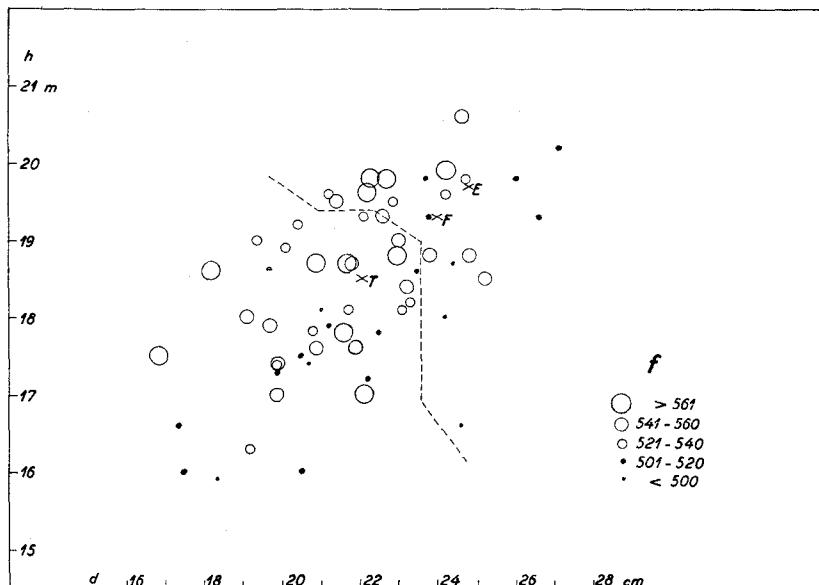


Fig. 18. p/a-group 2/32; the thinning. All 60 thinning trees plotted according to height and diameter. Form factor values of the individual trees are indicated, by classes of 20 f-units. Broken line cuts off the trees of the representative group (tab. XXXVII) the height and diameter of which are identical to those of the standing crop before the thinning (F).

Prfl. GO, 32 år; tyndingen. De 60 tyndingstræer med angivelse af formtalværdien i klasser på 20 f-enheder. Den stiplede linie afskærer den i tab. XXXVII fremstillede repræsentative gruppe, hvis højde og diameter svarer til punktet F.

the right value of h , but d is too small (tab. XXXV, bottom), and the 26 thickest trees give the right value of d , but here h is too small (tab. XXXVI, bottom). Taking, however, the 14 thickest trees and, among the others, the 7 (8) highest ones h and d will fit in with the stand data before thinning (tab. XXXVII). The same composition of the group will result from taking the 13 (14) highest trees and, among the others, the 8 thickest ones (cfr. fig. 18).

As compared to a material consisting of sample trees from a great number of plots, a single and complete set of thinning trees (such as the 60 trees here dealt with) will be of a fundamentally different composition, e. g. the low h -classes will consist mainly of more or less suppressed trees while in the compound material the same h -classes contain all types of trees, etc. Thus, the class form factors as determined from d and h will present a certain obliquity against the true values (tables XXXV and XXXVI). When no form factor tables are available

the representative group of sample trees should fit in exactly with the stand, in respect of d and h , as there is no reason for introducing a systematic error that can be avoided. If tables are available and their suitability for certain plots is to be examined the values of d and h should approximate those of the stand, in order to exclude the influence of the mentioned obliquity when correction is made for the divergences in d and h .

B. INCREMENT

1. An empiric yield table.

An examination of the height growth curves showed that the major part of the permanent sample plots can be regarded as belonging to one and the same quality class. Other permanent plots and temporary ones being too heterogeneous and insufficient in number we are for the present unable to prepare yield tables for a series of quality classes. Our quality class, styled „B“, was based on 10 plots with 63 remeasurements of main crop and thinnings. The following table presents the plots, with the number of remeasurements and the ages at the first and the last remeasurement (all age data to be counted from seed and not from the year of planting):

sample plot	number of remeasurements	age when measured	
		first	last time
GO-Frijsenborg	11	14	44
GV-Giesegaard	15	11	42
HQ-Boller	10	14	37
JM-Gisselfeld	7	31	49
UAc-Nødebo	5	12	18
UB-Nødebo	3	27	31
Corselitz VII-14	2	18	20
Tisvilde H. 199	5	12	20
Ravnholz XV-17	3	28	34
Gisself. Hes. 148*	5	16	22

For the main crop „after thinning“, 3 basic curves were worked out showing height, diameter of mean basal area, and number of stems per hectare (figures 19 to 21). The thinning intervals of the sample plots were analysed, and the divergences in height and in diameter between the thinnings and the main crop were examined graphically and smoothed. From the five elements mentioned and the form factors taken from the h/d-table (tab. V) all other figures of the yield table were computed. (Hereby the form factor of the stand before thinning is determined by two methods which give almost identical results. This indicates that tab. V gives reliable information on the differences in f that correspond to small differences in h and d.)

* KİNDT (1948)

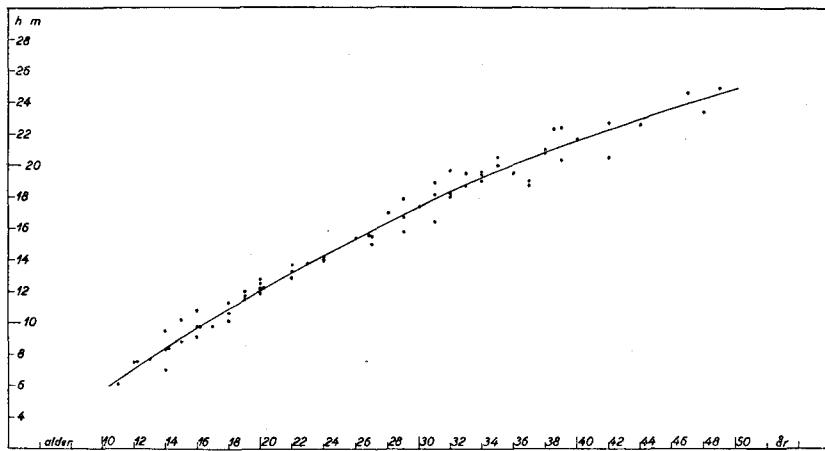


Fig. 19. Basic curve showing, for the stand situation after thinnings, the mean height at a given age (all age data to be counted „from seed“).
alder = age; år = years.

Grundkurve for bestandshøjden efter tynding ved given alder (fra frø).

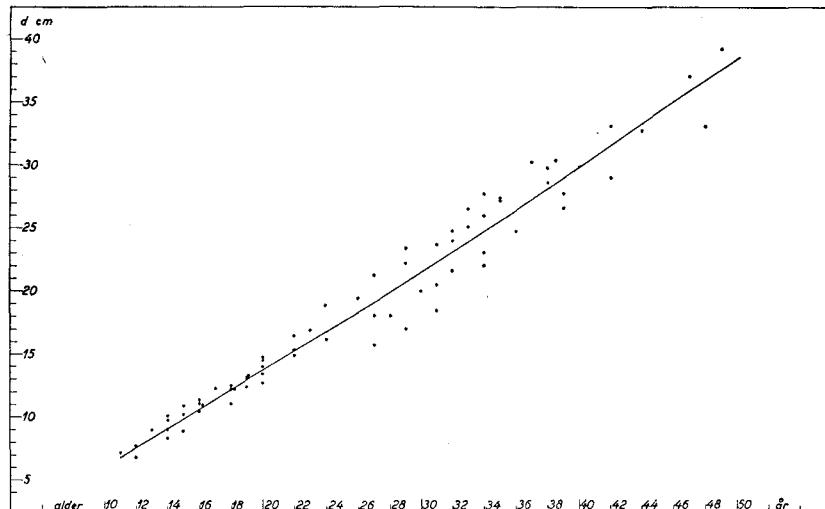


Fig. 20. Basic curve showing, for the stand situation after thinnings, the diameter of mean basal area at a given age. alder = age; år = years.
Grundkurve for diameteren i middelstammegrundfladen efter tynding ved given alder.

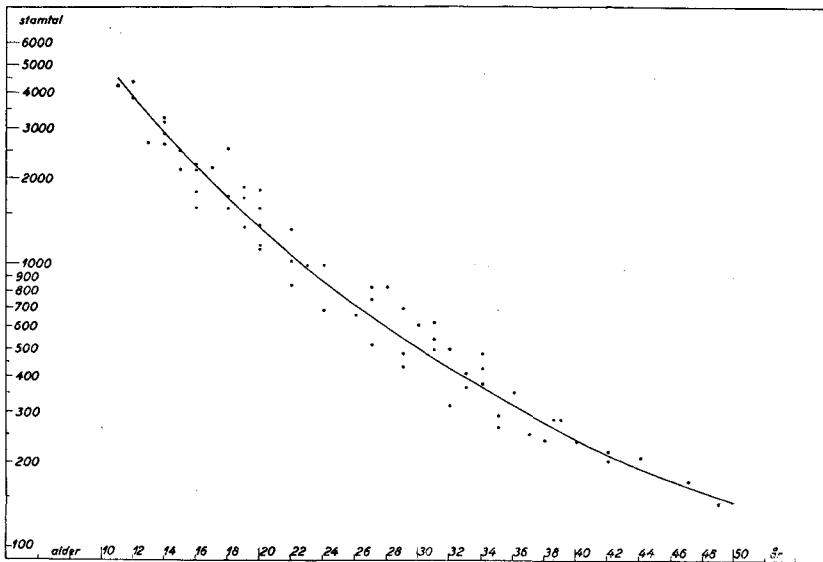


Fig. 21. Basic curve showing, for the stand situation after thinnings, the number of stems per hectare at a given age. Logarithmic scale for the ordinates.
stamtal = number of stems; alder = age; år = years.

Grundkurve for stamtallet pr. ha efter tynding ved given alder. Logaritmisk skala for ordinarterne.

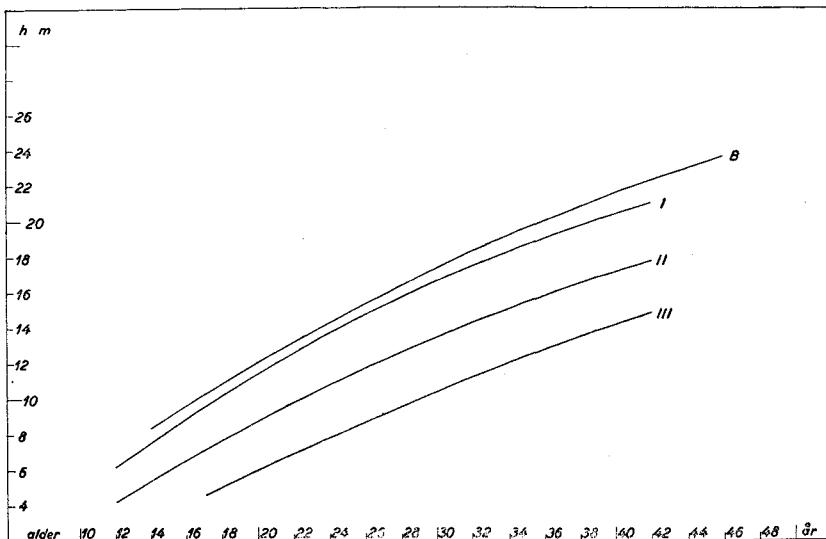


Fig. 22. Height development of Japanese larch in Great Britain, according to British yield tables (1949), as compared with our quality class B. After thinnings.
Age from seed. I, II, and III are the British quality classes. alder = age; år = years.
Sammenligning mellem engelsk og dansk materiale. Bevoksningshøjden efter tynding ved given alder. I, II og III er de engelske boniteter, B dansk.

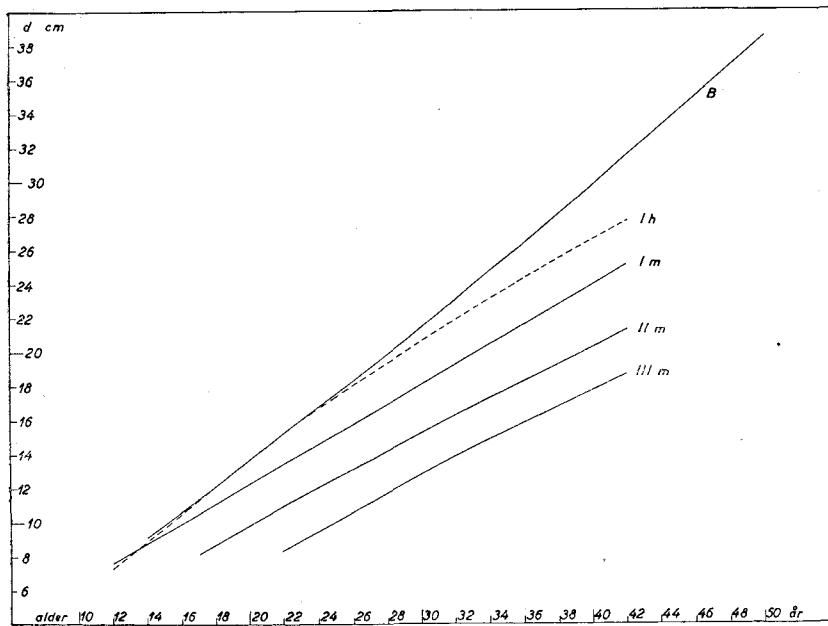


Fig. 23. Diameter of mean basal area, after thinnings, according to the British tables, as compared with B. h = heavy thinnings; m = moderate thinnings.
alder = age; år = years.

Sammenligning mellem engelsk og dansk materiale. Diameteren i middelstammegrundfladen efter tynding ved given alder. h = heavy thinnings; m = moderate thinnings.

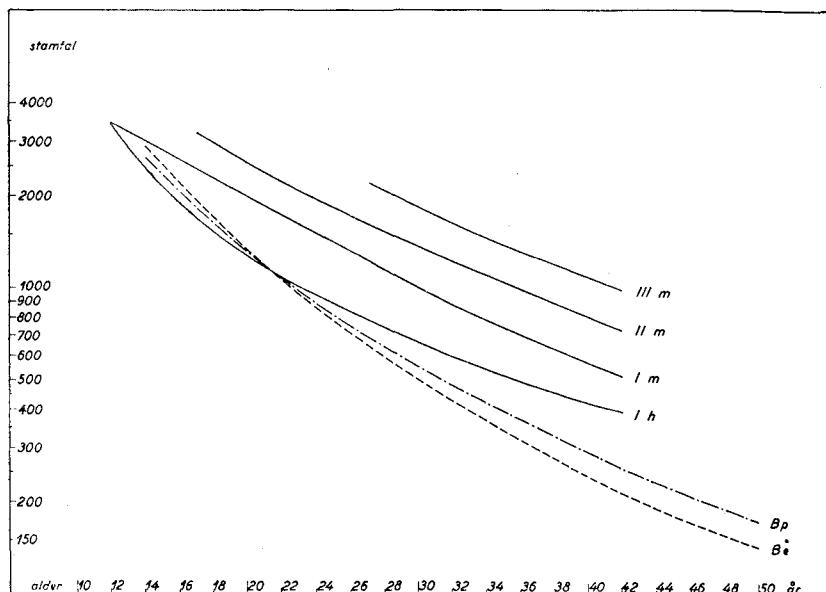


Fig. 24. Number of stems per hectare, after thinnings, according to the British tables, as compared with B. e = empiric; p = prognostic. stamtal = number of stems; alder = age; år = years.

Sammenligning mellem engelsk og dansk materiale. Stamtal pr. ha efter tynding ved given alder. e = empirisk; p = prognostisk.

The yield table is presented in tab. XXXII; it is styled Be, B being the quality class and e = empiric. The development of the different volume and increment factors characterizes this species under Danish silvicultural treatment.

2. Comparisons.

In Great Britain provisional yield tables for Japanese larch have been published in 1920, 1928, and 1935. In 1949 a set of revised tables was prepared (HUMMEL 1949), based on considerably more material*. Quality class I corresponds fairly closely to our quality class B, as regards height development. Height, diameter, and number of stems per hectare for quality class I, II, and III as compared with B are shown in figures 22 to 24 in which additional letters h and m denote »heavy thinnings« and »moderate thinnings«, respectively. From both diameter and stem number curves it can be discerned that Ih represents, from a Danish silvicultural point of view, a heavy thinning treatment only until the age of about 22 years; after that age it appears moderate. The present table shows for the ages 27 and 42 years the situation »after thinning«, all data having been corrected according to Danish units and definitions:

main crop after thinning	age 27 years				age 42 years			
	Im	Ih	Be	Bp	Im	Ih	Be	Bp
number of stems	1236	791	648	691	519	395	212	258
height m	15.2	15.2	15.9	15.9	21.0	21.0	22.3	22.3
diameter cm	16.2	18.6	19.1	19.1	25.1	27.7	31.5	31.5
basal area m ²	25.4	21.9	18.6	19.8	25.4	23.1	16.5	20.1
stem volume m ³	209	176	157	167	284	254	187	229
all thinnings m ³	124	169	181	155	256	283	365	322
production m ³	333	345	338	322	540	537	552	551
curr. incremt. m ³	16.5	16.9	16.7	17.2	10.4**	10.6**	12.4**	13.7**

It will be seen that the total production is roughly the same for the four headings. At the age of 27 years the current volume increment is practically the same while the basal areas differ

* Typescript kindly forwarded by the Forestry Commission. Printed November 1949.

** Averages for the period 37 to 42 years.

greatly; for the situation at the middle of the thinning intervals these basal areas would be about 29 m^2 for Im, and 21 m^2 for Be. At about 40 years of age there is a very marked difference in current volume increment so that at later ages the total production of B will be superior to that of I. At about 40 years, the corresponding values of the basal areas for the situation at the middle of the thinning intervals would be about 28 m^2 for Im, 26 m^2 for Ih, 18 m^2 for Be, and 22 m^2 for Bp (Bp is explained in the following section). For attaining the highest current volume increment at this age the basal areas of Im and Ih are too great and that of Be too small. The connection between basal area and volume increment is dealt with in the following section.

On the European continent proper no yield tables for Japanese larch seem to have been published.

In Japan, yield tables have been prepared by KUMÉ (1907), TERAZAKI (1926), NAKASHIMA (1931), and HAYAO (1933). These tables must be looked upon with some reserve as we have no detailed information on material, methods, or definitions.

For European larch SCHOBER (1949) recently published yield tables for W. Germany. At the age of 50 years total production of the Japanese larch in Denmark exceeds that of the European larch in W. Germany by 25 per cent.

3. Modified thinning treatment and a prognostic yield table.

(In this section, by basal area is meant, consistently, that referring to the stand situation at the middle of the thinning intervals, and to 1 hectare).

In the yield table Be the basal area culminates with 22 m^2 at 19 years of age and then declines to 18 m^2 at 40 years. For various reasons it is believed that this development does not represent the most favourable course of production.

The volume increment in the course of a single year may be written

$$(h + \Delta h) (g + \Delta g) (f + \Delta f) - hgf ,$$

where the Δ 's are the alterations of the year on h, g, and f. As can be seen from the yield table Δf amounts to not more than 3 units or 0.5 per cent of f and is generally (and especially from 20 to 40 years of age) lower. Consequently, Δf is

of minor importance for the volume increment. Letting $\Delta f = 0$, the volume increment is

$$f(h\Delta g + g\Delta h + \Delta h\Delta g)$$

and is, consequently, proportional to

$$(h + \Delta h)\Delta g + g\Delta h$$

As h and Δh are independent of the thinning treatment it is by g and Δg that the volume increment can be influenced. However, it can be demonstrated that Δg is dependent on g and reaches a maximum at a definite value of g , this value being slightly influenced by the age. Correspondingly, there will be a maximum of volume increment at a definite value of g , this value being somewhat higher than the former and, likewise, slightly influenced by the age. The following table shows the relative importance of basal area and basal area increment, as regards the current volume increment:

age	h	g	Δh	Δg	$(h + \Delta h) \times \Delta g$	$g\Delta h$
15	9.0	21.21	0.59	2.40	23.0	12.5
17	10.3	21.68	.56	2.19	23.9	12.1
19	11.5	21.78	.53	1.99	24.1	11.5
21	12.6	21.57	.51	1.79	23.6	11.0
23	13.7	21.02	.50	1.60	22.7	10.5
25.5	15.1	21.25	.48	1.43	22.6	10.2
28.5	16.6	20.55	.46	1.28	22.2	9.5
31.5	18.1	19.89	.43	1.15	21.3	8.6
34.5	19.4	19.31	.40	1.04	20.8	7.7
37.5	20.6	18.66	.36	0.95	19.9	6.7
40.5	21.7	18.18	.33	0.87	19.4	6.0
44	22.9	18.19	.31	0.82	19.0	5.6
48	24.2	18.08	.29	0.78	19.1	5.2

As an example, for the age of 28 years there will be the following series:

g m ²	16	18	20	22	24	26	28
Δg m ²	1.02	1.18	1.25	1.29	1.25	1.18	1.02
$(h + \Delta h)\Delta g$	17.15	19.84	21.01	21.68	21.01	19.84	17.15
$g\Delta h$	7.36	8.28	9.20	10.12	11.04	11.96	12.88
total	24.51	28.12	30.21	31.80	32.05	31.80	30.03

These figures (total) are proportional to the volume increment. From a series of such calculations it was found that, theoretically, the maximum current volume increment would be attained when the basal area culminated with 25-26 m² at about 18 years of age and then declined gradually at a decreasing rate, to about 22 m² at 50 years. Theoretical considerations, however, supported by the sample plot data strongly suggest that this course of action cannot normally be followed without prejudicing the optimum development of the stand and the individual trees of which it is composed, and that the goal of 22 m² will have to be approached „from below“, i. e. by increasing basal area. Fig. 25 shows the basal areas of the different stands in our material, and fig. 26 gives the basal area from the yield table Be together with the derived „desirable“ basal area.

The discussion leads to the construction of a prognostic yield table (styled Bp, B being the quality class and p = prognostic) based on the „desirable“ basal area development (fig. 26 and tab. XXXIII). Height before and after thinnings, and diameter after thinnings, were taken over from the Be table. Tab. XXXIV is the yield table Bp.

4. The empiric and the prognostic tables.

The two yield tables differ in origin but also in construction. As Bp is based upon the basal area the diameter and the number of stems are of a secondary character in this table. The total production at the age of 50 years is practically the same (Be 639 m³, Bp 649 m³) but the current volume increment at this age is 10.5 m³ for Be against 12.0 m³ for Bp (total over-bark volume from ground level). Therefore, at later ages the total production will be markedly greater for Bp. This will be the case even if the basal area of Be increases after the age of 50 years.

Bp is superior from an economic point of view. The following table shows a calculation of relative figures for the difference in value between Bp and Be at 50 years, at rates of interest of 4 or 5 per cent and at prices increasing at a different rate as the diameter increases. Only at a high rate of interest combined with a small increase of prices will there be balance, but even then Bp is, in reality, superior because of the greater current increment in the years after that age. The calculation is

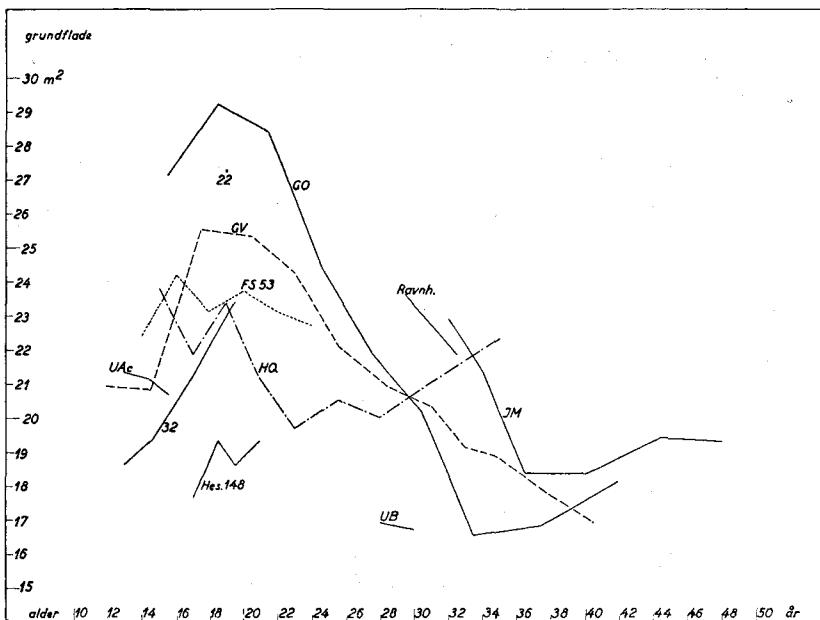


Fig. 25. Development of basal area in different stands. Basal area in m^2 per hectare, for the stand situation at the middle of the thinning intervals.

grundflade = basal area; alder = age; år = years.

Stammegrundfladens udvikling i forskellige beovnsninger. Grundflade pr. ha gældende for tilstanden midt i tyndingsintervallerne.

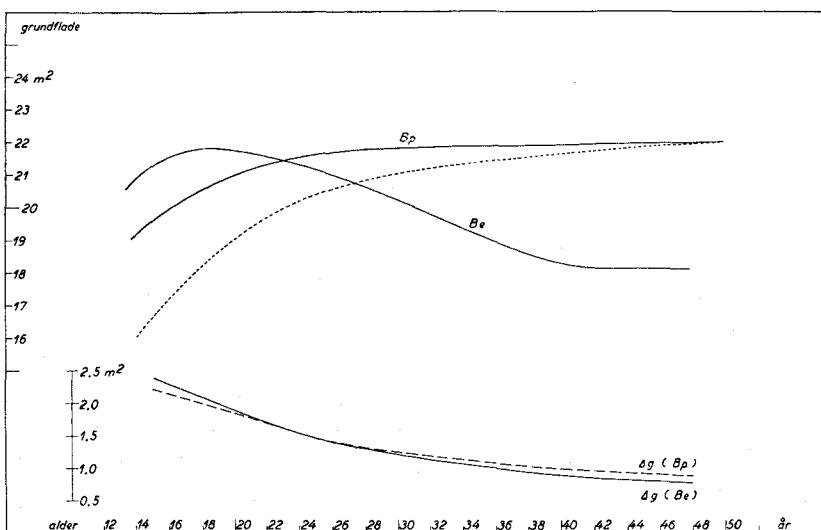


Fig. 26. Basal area in m^2 per hectare, at the middle of the thinning intervals. The figure presents the basal area from the table Be together with the derived „desirable“ basal area (B_p), and a similar curve increasing at a slower rate (dotted curve) and giving a less total production than B_e . Further is shown the current annual basal area increment (Δg) corresponding to B_e and B_p , respectively.

grundflade = basal area; alder = age; år = years.

Stammegrundflade pr. ha, gældende tilstanden midt i tyndingsintervallerne. Figuren viser grundfladen efter den empiriske tilvækstoversigt (B_e), den stipulerede ønskede grundflade (B_p) og en tilsvarende udvikling (punktteret) med langsommere stigning og mindre samlet produktion end B_e . Desuden er vist den løbende årlige grundfladetilvækst (Δg), svarende til henholdsvis B_e og B_p .

simplified by summing up the thinnings into 3 age groups, at 19, 35, and 48 years:

age years	diff. at 50 years		d cm	rel. price figures		value of difference				
				I	II	4 p.c.		4 p.c.		
	4 p. c. in m ³	5 p. c. in m ³				I	II	I	II	
19	-64	-86	10	1	1	-64	-64	-86	-86	
35	-43	-50	20	3	2	-129	-86	-150	-100	
48	13	13	34	5	3	65	39	65	39	
50	41	41	39	6	3 ^{1/2}	246	144	246	144	
						+118	+33	+75	-3	

Technically, and from the point of view of market value Bp is likewise superior because of the higher percentage of the production falling into the higher diameter classes. The following table shows that in Bp 50 per cent, and in Be only 43 per cent of the total production at 50 years fall into diameters of 30 cm and over (breast high diameters):

diameter cm	m ³		per cent	
	Be	Bp	Be	Bp
< 15	141	122	22	19
15—30	224	200	35	31
> 30	274	327	43	50
total	639	649	100	100

From a purely silvicultural point of view the development of the stand and of the individual trees under the course of production shown in Bp is the main point. The practicability of this course of production has not been proved; it has, however, been made probable. It is stressed that Bp, as compared with Be, will broaden the scope for the application of *constructive* thinnings.

As regards the choice of thinning programme, the silvicultural attitude will be influenced by the occurrence of various types or races of the species, notably variations in coarseness of branches and self-pruning ability.

Tab. I. Distribution of the observations over d/h classes.
 (Serial numbers of the d-classes, multiplied by 3, and those of the h-classes, multiplied by 2, indicate the central values of the classes in cm and in m, respectively.)

Materialets fordeling til d/h-klasser.

(d-klassernes numre multipliceret med 3 giver midtværdien i cm; h-klassernes numre multipliceret med 2 giver midtværdien i m.)

d-class d-klasse	h-class h-klasse												total sum
	3	4	5	6	7	8	9	10	11	12	13		
2	6	2	1	.	.	.	.	.	.	.	.	.	9
3	3	18	8	1	1	.	.	.	.	.	.	.	31
4	.	3	16	13	15	1	.	.	.	.	.	.	48
5	.	.	2	8	30	17	1	.	.	.	.	.	58
6	.	.	1	.	9	24	17	1	.	.	.	.	52
7	.	.	.	.	3	7	30	7	.	.	.	.	47
8	.	.	.	.	1	5	25	28	1	.	.	.	60
9	.	.	.	.	.	.	4	20	14	1	.	.	39
10	.	.	.	.	.	.	.	8	10	4	.	.	22
11	.	.	.	.	.	.	.	3	3	3	.	.	9
12	.	.	.	.	.	.	.	.	4	2	.	.	6
13	.	.	.	.	.	.	.	.	.	1	2	.	3
14	.	.	.	.	.	.	.	.	.	.	2	.	2
total sum	9	23	28	22	59	54	77	67	32	11	4	.	386

Tab. II. Numbers of observations and class means for d/h-classes.

Antal iagttagelser og klassemiddeltal for d/h-klasser.

d-class <i>d-klasse</i>	h-class <i>h-klasse</i>	number <i>antal</i>	class means <i>klassens middeltal</i>		
			d	h	f
2	3	6	68	64	570
3	3	3	78	61	558
	4	18	89	80	563
	5	8	87	100	547
4	4	3	112	82	550
	5	16	118	101	540
	6	13	121	121	547
	7	15	127	138	552
5	6	8	147	119	532
	7	30	148	140	544
	8	17	157	156	563
6	7	9	177	142	525
	8	24	179	158	536
	9	17	181	176	562
7	7	3	203	144	519
	8	7	207	161	525
	9	30	210	178	533
	10	7	216	195	553
8	8	5	232	160	500
	9	25	238	183	523
	10	28	240	197	533
9	9	4	268	180	521
	10	20	268	200	526
	11	14	271	217	521
10	10	8	294	202	523
	11	10	295	215	516
	12	4	310	237	517
11	10	3	329	204	510
	11	3	321	222	495
	12	3	329	239	498
12	11	4	354	224	495

Tab. III. Means for the h-classes 6 to 9.
Tyngdepunkter for h-klasserne 6—9.

h-class <i>h-klasse</i>	d-classes <i>d-klasser</i>	number <i>antal</i>	h	d	f	corrected f*) <i>korrigeret f*)</i>
6	4—5	21	120.2	130.9	541.3	541.2
7	4—7	57	140.0	149.9	541.8	541.8
8	5—8	44	158.3	184.9	532.3	534.8
9	6—9	60	180.1	225.1	528.1	528.0

*) values of f corrected for h-divergences from class centres, by means of the regressions of the d-class curves.

*) f-værdierne korrigeres for middelhøjdens afvigelse fra klassens midtværdi ved hjælp af diameterklassekurvernes hældning.

Tab. IV. Constants for the formula $f = c_1 - c_2d$.
Konstanter til beregningsformelen $f = c_1 - c_2d$.

h-class <i>h-klasse</i>	class centre, m <i>midtværdi, meter</i>	c_1	c_2
3—5	6—10	611.0	0.6000
$5\frac{1}{2}$	11	612.1	.5858
6	12	614.2	.5574
$6\frac{1}{2}$	13	616.0	.5319
7	14	617.9	.5074
$7\frac{1}{2}$	15	619.4	.4864
8	16	620.9	.4658
$8\frac{1}{2}$	17	622.4	.4458
9	18	623.9	.4259
$9\frac{1}{2}$	19	626.3	.3925
10—12 (13)	20—24 (26)	627.5	.3764

h/d/f

Tab. V. Table for the determination of the form factor from height and diameter ($h/d/f$ -table).

Formtaltabel med indgang fra højde og diameter ($h/d/f$ -tabel).

Tab. VI. Distribution of the observations over q/d-classes.
 (Serial numbers of the q- or d-classes, multiplied by 3, indicate the central values of the classes in per cent and in cm, respectively.)

Materialets fordeling til q/d-klasser.

(Klassernes numre multipliceret med 3 giver midtværdien henholdsvis i % og i cm.)

d-class <i>d-kasse</i>	q-class (form class) <i>q-kasse (formklasse)</i>										total sum	mean form quotient <i>middle- formkvote</i>
	18	19	20	21	22	23	24	25	26	27		
2	.	.	3	2	1	1	2	.	.	.	9	65.3
3	1	4	4	9	8	4	.	.	.	1	31	63.6
4	1	.	6	10	10	10	5	5	1	.	48	66.8
5	.	1	3	3	11	13	12	13	2	.	58	69.6
6	.	.	.	4	9	17	13	7	2	.	52	69.9
7	.	.	.	5	11	11	12	6	2	.	47	69.6
8	.	1	.	5	14	17	16	7	.	.	60	69.3
9	.	.	.	3	5	12	13	6	.	.	39	69.9
10	.	.	.	1	3	12	6	.	.	.	22	69.2
11	.	.	.	1	3	3	2	.	.	.	9	67.8
12	.	.	.	1	2	2	1	.	.	.	6	67.2
13	.	.	.	.	2	.	1	.	.	.	3	67.3
14	.	.	.	.	2	.	.	.	.	.	2	65.5
total sum	2	6	16	44	81	102	83	44	7	1	386	68.6
per cent %	0.5	1.6	4.1	11.4	21.0	26.4	21.5	11.4	1.8	0.3	100.0	

Tab. VII. Numbers of observations and class means for q/d-classes.
Antal iagttagelser og klassemiddeltal for q/d-klasser.

q-class <i>q-klasse</i>	d-class <i>d-klasse</i>	number <i>antal</i>	class means <i>klassemiddeltal</i>		
			q	d	f
19	3	4	56.8	84	551
20	2	3	60.3	72	553
	3	4	59.3	93	555
	4	6	60.3	121	534
	5	3	59.3	141	508
21	3	9	62.9	87	548
	4	10	62.8	119	531
	5	3	62.3	152	511
	6	4	62.8	179	510
	7	5	63.0	208	505
	8	5	63.6	238	484
	9	3	63.7	272	489
	10	8	66.3	88	562
	11	10	66.2	120	544
22	5	11	66.5	152	525
	6	9	66.6	178	512
	7	11	66.5	211	514
	8	14	66.4	238	508
	9	5	65.8	274	501
	10	3	66.3	304	499
	11	3	66.0	323	494
	12	4	69.5	86	576
	13	10	69.2	121	554
	14	13	68.8	148	539
23	15	17	69.1	180	536
	16	11	69.0	207	529
	17	17	69.1	239	521
	18	12	68.8	266	519
	19	12	69.3	298	519
	20	3	68.3	335	509
	21	5	71.6	121	560
	22	12	71.8	146	558
	23	13	71.5	180	555
24	24	12	71.8	208	545
	25	16	72.3	241	546
	26	13	72.0	272	536
	27	6	71.5	292	528
	28	5	74.4	129	574
	29	13	75.2	156	579
25	30	7	75.1	178	578
	31	6	74.5	216	570
	32	7	74.6	233	564
	33	6	74.5	265	542

Tab. VIII. Compound calculation for q-classes of 3 d-classes at a time.

Beregning for q-klasser af 3 d-klasser ad gangen.

q-class q-klasse	d-classes d-klasser	num- ber antal	means of middeltal af			correc- tion on f korrektion til f	correc- ted f korrigert f
			q	d	f		
20	2— 4 3— 5	13 13	60.0 59.8	101 117	545 534	+ 6 — 2	551 532
21	2— 4 3— 5 4— 6 5— 7 6— 8 7— 9	21 22 17 12 14 13	62.9 62.8 62.7 62.8 63.1 63.4	101 111 139 185 211 234	542 536 523 508 499 493	+ 6 — 5 — 7 + 1 0 — 2	548 531 516 509 499 491
22	2— 4 3— 5 4— 6 5— 7 6— 8 7— 9 8—10 9—11 10—12	19 29 30 31 34 30 22 11 8	66.3 66.3 66.4 66.5 66.5 66.3 66.3 66.0 66.1	103 123 149 181 213 234 255 296 324	554 541 527 517 511 509 505 498 497	+ 7 + 2 — 1 0 + 1 — 1 — 3 — 1 — 1	561 543 526 517 512 508 502 497 496
23	2— 4 3— 5 4— 6 5— 7 6— 8 7— 9 8—10 9—11 10—12	15 27 40 41 45 40 41 27 17	69.3 69.0 69.0 69.0 69.1 69.0 69.0 68.9 68.9	108 128 155 177 209 238 264 288 311	563 550 542 535 528 522 520 518 517	+ 11 + 5 + 1 — 1 0 0 — 1 — 2 — 3	574 555 543 534 528 522 519 516 514
24	4— 6 5— 7 6— 8 7— 9 8—10	30 37 41 41 35	71.7 71.7 71.9 72.0 72.0	157 178 212 241 261	557 553 548 543 539	+ 2 — 1 + 1 0 — 2	559 552 549 543 537
25	4— 6 5— 7 6— 8 7— 9	25 26 20 19	75.0 75.0 74.8 74.5	157 176 209 238	578 577 571 559	+ 1 — 1 0 — 1	579 576 571 558

Tab. IX. Means of the single d-classes, as compared to those of the compound d-classes.

(Corr. (I) is the correction for d-divergences from class centres, and corr. (II) is the correction for different value of q).

Sammenligning af tyngdepunkt for enkelt d-klasse og sammenregnet d-klasse.

d-classes <i>d-klasser</i>	q-classes <i>q-klasser</i>	q	d	f	corr. (I) <i>korr. I</i>	corr. (II) <i>korr. II</i>	difference in f <i>f-differens</i>
3 2—4	20—23	64.5	88.1	558	-1		
		64.7	103.1	551	+7	-1	000
4 3—5	20—23	65.1	120.2	542	0		
		65.3	120.7	542	0	-1	001
5 4—6	21—25	70.2	150.6	549	0		
		69.3	152.6	546	+1	+5	-003
6 5—7	21—25	69.6	179.3	540	0		
		69.7	178.6	541	0	-1	000

q/d/f

Tab. X. Table for the determination of the form factor from diameter and form quotient (form class), ($q/d/f$ -table).

Formfaltabel med indgang fra diameter og formkvote ($q/d/f$ -tabel).

Tab. XI. Distribution of the observations over h/q-classes.
Materialets fordeling til h/q-klasser.

h-class <i>h-klasse</i>	q-class (form class) <i>q-klasse (formklasse)</i>										total <i>sum</i>	mean form quotient <i>middel- formkoote</i>
	18	19	20	21	22	23	24	25	26	27		
3	.	3	2	2	1	1	.	.	.	.	9	61.4
4	1	1	5	6	6	2	1	.	.	1	23	64.0
5	1	.	6	10	5	4	2	.	.	.	28	64.0
6	.	1	3	3	6	5	2	2	.	.	22	66.4
7	.	1	.	5	14	19	11	6	3	.	59	69.1
8	.	.	.	8	9	15	9	13	.	.	54	69.7
9	.	.	.	4	19	18	22	11	3	.	77	70.1
10	.	.	.	4	9	20	22	11	1	.	67	70.3
11	.	.	.	2	7	13	9	1	.	.	32	69.1
12	.	.	.	.	1	5	5	.	.	.	11	69.8
13	.	.	.	.	4	.	.	.	.	.	4	65.5
total <i>sum</i>	2	6	16	44	81	102	83	44	7	1	386	68.6
per cent <i>%</i>	0.5	1.6	4.1	11.4	21.0	26.4	21.5	11.4	1.8	0.3	100.0	

Tab. XII. Numbers of observations and class means for h/q-classes.
Antal iagttagelser og klassemiddeltal for h/q-klasser.

h-class <i>h-klasse</i>	q-class <i>q-klasse</i>	number <i>antal</i>	class means <i>klassemiddeltaal</i>		
			h	q	f
3	19	3	61	57.0	558
4	20	5	77	59.4	562
	21	6	80	62.5	557
	22	6	82	66.2	561
5	20	6	102	60.2	529
	21	10	102	62.7	534
	22	5	99	66.2	559
	23	4	100	69.0	552
6	20	3	114	60.0	508
	21	3	117	63.7	539
	22	6	121	66.2	536
	23	5	121	69.2	554
7	21	5	136	62.6	501
	22	14	138	66.4	524
	23	19	141	68.8	539
	24	11	139	71.9	560
	25	6	145	74.7	569
	26	3	142	77.0	588
8	21	8	161	63.1	500
	22	9	159	66.4	512
	23	15	157	69.0	535
	24	9	157	71.8	557
	25	13	157	75.2	582
9	21	4	179	63.5	491
	22	19	178	66.6	509
	23	18	180	69.1	528
	24	22	179	71.7	548
	25	11	178	74.8	575
	26	3	181	77.7	585
10	21	4	201	63.8	501
	22	9	198	65.9	509
	23	20	197	69.0	522
	24	22	199	72.1	541
	25	11	199	74.5	554
11	22	7	223	66.3	499
	23	13	217	69.0	517
	24	9	214	72.1	532
12	23	5	240	68.8	511
	24	5	243	71.6	517
13	22	4	255	65.5	468

Tab. XIII. Compound calculation for q-classes of 3 h-classes at a time.

Beregning for q-klasser af 3 h-klasser ad gangen.

q-class q-klasse	h-classes h-klasser	num- ber antal	means of middeltal af			correc- tion korrektion	correc- ted f korrigeret f
			q	h	f		
20	3— 5 4— 6	13 14	59.8 59.9	87 96	545 536	+ 8 — 4	553 532
21	3— 5 4— 6 5— 7 6— 8 7— 9 8—10 9—11	18 19 18 16 17 16 10	62.7 62.8 62.8 63.1 63.1 63.4 63.4	91 98 114 145 158 175 196	545 542 526 508 498 498 491	+ 12 — 2 — 5 + 2 — 1 — 2 — 1	557 540 521 510 497 496 490
22	3— 5 4— 6 5— 7 6— 8 7— 9 8—10 9—11 10—12	12 17 25 29 42 37 35 17	66.2 66.2 66.3 66.4 66.5 66.4 66.3 66.1	87 101 126 141 161 178 192 210	563 551 534 523 515 510 507 503	+ 7 + 1 + 4 + 1 0 — 1 — 2 — 4	570 552 538 524 515 509 505 499
23	3— 5 4— 6 5— 7 6— 8 7— 9 8—10 9—11 10—12	7 11 28 39 52 53 51 38	69.1 69.2 68.9 68.9 69.0 69.0 69.0 69.0	88 105 131 145 159 180 196 210	571 561 544 539 534 527 523 519	+ 6 + 3 + 6 + 2 0 0 — 1 — 3	577 564 550 541 534 527 522 516
24	5— 7 6— 8 7— 9 8—10 9—11 10—12	15 22 42 53 53 36	71.7 71.8 71.8 71.9 71.9 72.0	132 145 164 184 193 209	562 559 553 547 542 535	+ 3 + 2 + 1 + 1 — 3 — 4	565 561 554 548 539 531
25	6— 8 7— 9 8—10 9—11	21 30 35 23	75.0 75.0 74.9 74.7	151 162 177 189	577 577 571 564	+ 4 0 — 2 — 7	581 577 569 557
26	7— 9 8—10	6 4	77.3 77.5	162 185	587 582	+ 1 + 5	588 587

Tab. XIV. Means of the single h-classes, as compared to those of the compound h-classes. (Corr. (I) is the correction for h-divergences from class centres, and corr. (II) is the correction for different value of q).

Sammenligning af tyngdepunkt for enkelt h-kasse og sammenregnet h-kasse.

h-classes h-kasse	q classes q-kasse	h	q	f	corr. (I) kor. I	corr. (II) kor. II	difference in f f-differens
4 3-5	20-23	79.4	63.6	564	-1	0	002
		88.3	63.7	553	+8		
5 4-6	20-23	101.1	63.8	541	+1	-2	-002
		99.3	64.2	547	-1		
6 5-7	21-24	120.9	67.3	546	0	0	002
		126.3	67.4	540	+4		
7 6-8	21-24	139.2	68.2	536	0	+2	-002
		143.7	67.9	534	+2		
8 7-9	21-25	157.9	69.7	541	-1	+2	000
		160.0	69.5	538	0		

Tab. XV. Constants for the formula $f = k_1 q + k_2$.

Konstanter til beregningsformlen $f = k_1 q + k_2$.

h-class h-kasse	class centre, m <i>midtværdi,</i> m	k ₁	k ₂
3	6	1.754	461.3
4	8	2.577	396.8
4½	9	3.172	350.2
5	10	3.730	306.5
6	12	5.005	206.7
7	14	6.035	126.0
8	16	6.883	59.5
9	18	6.543	78.0
10	20	6.044	105.1
10½	21	5.787	119.1
11	22	5.532	133.0
12	24.	4.822	171.6

Tab. XVI. Table for the determination
of the form factor from height and form quotient (form class), ($h/q/f$ -table).
Formtaltabel med indgang fra højde og formkvote ($h/q/f$ -tabel).

form quotient, per cent	height, m højde, m																		
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
57	561	552	544	531	519	505	492												
58	563	554	546	534	523	510	497												
59	565	557	549	537	527	514	502												
60	567	559	551	541	530	518	507	497	488	480	472								
61	568	561	554	544	534	523	512	503	494	486	479	478	477						
62	570	563	557	547	538	527	517	508	500	493	486	485	484	482	480	478	476		
63	572	565	559	550	541	531	522	514	506	499	493	492	490	488	486	484	482	479	475
64	574	568	562	553	545	536	527	519	512	506	500	499	497	495	492	489	487	484	480
65	575	570	564	556	549	540	532	525	518	512	507	505	503	501	498	495	493	489	485
66	577	572	567	560	553	545	537	530	524	519	514	512	510	507	504	501	498	494	490
67	579	574	569	563	556	549	542	536	530	525	521	519	516	513	510	507	504	499	495
68	581	576	572	566	560	553	547	541	536	532	528	526	523	520	516	513	509	504	499
69	582	578	575	569	564	558	552	547	542	538	534	532	529	526	522	518	515	510	504
70		577	572	568	562	557	552	548	544	541	539	536	532	528	524	520	515	509	
71		580	575	571	566	562	558	554	551	548	546	543	539	534	530	526	520	514	
72		582	579	575	571	567	564	561	558	555	552	549	545	540	536	531	525	519	
73			582	579	575	572	569	567	564	562	559	556	551	546	542	537	530	524	
74				577	575	573	571	569	566	562	557	552	547	542	535	528			
75					582	580	579	577	576	573	569	564	558	553	548	541	533		
76						585	584	583	579	575	570	564	559	553					
77						591	590	589	586	582	576	570	565	559					
78						597	596	596	592	588	583	577							
79												595	589	583					
80												601							

Tab. XVII. Table for the determination of the theoretical diameter d_t , in mm.Tabel til bestemmelse af den teoretiske diameter d_t (mm).

[47]

form quotient, per cent formkvote % %	height, m højde, m															(23)	
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
57	79	90	101														
58	78	89	99														
59	76	87	98	109	120	134	147										
60	75	86	96	107	118	131	144	159	174								
61	74	84	94	106	117	130	142	157	172	190	208						
62	72	83	93	104	115	128	140	155	169	187	205	226	246	264	281		
63	71	81	91	102	113	126	138	153	167	185	202	223	243	261	278	296	313 (331)
64	70	80	89	100	111	124	136	150	164	182	199	219	239	257	275	293	311 (329)
65	68	78	88	99	109	122	134	148	162	179	196	216	236	254	272	291	309 (327)
66	67	77	86	97	108	120	131	145	159	176	193	213	232	251	270	288	306 (324)
67	65	75	85	96	106	118	129	143	157	174	190	210	229	248	267	286	304 (322)
68	64	74	83	94	104	116	127	141	154	171	188	207	226	245	264	283	302 (320)
69	63	72	81	92	102	114	125	139	152	169	185	204	222	242	261	280	299 (318)
70	61	71	80	90	100	112	123	136	149	166	182	201	219	239	258	278	297 (316)
71		78	88	98	110	121	134	147	163	179	197	215	235	255	275	295	(314)
72		77	87	96	108	119	132	144	160	176	194	212	232	252	272	292	(312)
73			95	106	117	130	142	158	173	191	209	230	250	270	290	310	
74					115	127	139	155	170	188	205	226	247	268	288	(308)	
75						112	125	137	152	167	185	202	223	244	265	285	(305)
76							134	149	164	182	199	220	241				
77								132	147	161	178	195	217	238			
78									159	176	192						

Tab. XVIII. Actual relative diameters for form classes,
as compared to those computed from the formula. Per cent.

Konstaterede og beregnede relative diametre for formklasser. Procent.

q-class <i>q-klasse</i>	num- ber <i>antal</i>	*)	d ₁	d ₂	d ₃	d ₅	d ₇
20	16	I	93.8	87.9	80.2	59.9	38.7
		II	93.1	85.7	77.8	60.0	39.1
		III	0.7	2.2	2.4	— 0.1	— 0.4
21	44	I	93.7	87.9	81.0	63.0	41.3
		II	93.9	87.2	79.9	63.0	42.2
		III	— 0.2	0.7	1.1	0.0	— 0.9
22	81	I	93.6	87.7	81.8	66.3	45.6
		II	94.6	88.6	81.9	66.0	45.4
		III	— 1.0	— 0.9	— 0.1	0.3	0.2
23	102	I	94.4	88.8	83.4	69.0	47.8
		II	95.2	89.9	83.9	69.0	48.8
		III	— 0.8	— 1.1	— 0.5	0.0	— 1.0
24	83	I	94.7	90.3	85.6	71.9	50.5
		II	95.9	91.1	85.7	72.0	52.4
		III	— 1.2	— 0.8	— 0.1	— 0.1	— 1.9
25	44	I	95.6	91.9	87.6	74.8	53.4
		II	96.4	92.3	87.5	75.0	56.3
		III	— 0.8	— 0.4	0.1	— 0.2	— 2.9

*) I: actual values; II: computed values; III: differences.

* I: materialets værdier; II: beregnede værdier; III: differenser.

Tab. XIX. Actual relative diameters for q/d-classes, as compared to those computed from the formula by BEHRE.

Differences in thousandths.

Sammenligning mellem q/d-klassernes relative diametre og de efter BEHRES formel beregnede. Differenser i promille.

q-class q-kasse	d-class d-kasse	num- ber antal	difference in differens på					average for d ₁ , d ₂ and d ₃ gnstl. for $d_1 - d_2 - d_3$
			d ₁	d ₂	d ₃	d ₅	d ₇	
20	4	6	18	35	38	0	12	30
	5	3	4	16	10	0	-16	10
	average - gnstl.		13	29	29	0	3	23
21	4	10	15	16	13	0	-4	15
	5	3	-10	-2	-1	0	23	-4
	6	4	-5	-3	2	0	-23	-2
	7	5	3	22	9	0	6	11
	8	5	-29	-23	7	0	-12	-15
	9	3	-28	-12	-4	0	16	-15
	average - gnstl.		-4	3	7	0	-2	2
22	4	10	9	21	23	0	-2	18
	5	11	-3	-9	-2	0	-1	-5
	6	9	-14	-19	-6	0	11	-13
	7	11	-17	-13	1	0	-4	-10
	8	14	-20	-15	-3	0	5	-13
	9	5	-7	-13	-4	0	17	-8
	10	3	-7	-17	2	0	14	-7
average - gnstl.			-9	-8	2	0	4	-5
23	4	10	-6	7	-6	0	-19	-2
	5	13	-5	-5	-3	0	4	-1
	6	17	-2	-11	3	0	-15	-3
	7	11	-7	-5	-7	0	-8	-6
	8	17	-16	-14	-13	0	-10	-14
	9	12	-9	-11	-1	0	-8	-7
	10	12	-21	-16	-12	0	-1	-16
average - gnstl.			-8	-9	-5	0	-8	-7
24	4	5	-2	21	-12	0	-41	2
	5	12	-3	-8	-3	0	-1	-5
	6	13	11	8	7	0	-21	9
	7	12	-15	-7	5	0	-23	-6
	8	16	-24	-7	4	0	-16	-9
	9	13	-20	-21	-10	0	-13	-17
	10	6	-19	-6	11	0	-26	-5
average - gnstl.			-11	-5	1	0	-17	-5
25	4	5	4	-20	-15	0	-33	-10
	5	13	-3	-5	0	0	-17	-3
	6	7	3	3	11	0	-21	6
	7	6	-4	18	20	0	-47	11
	8	7	-7	13	11	0	-30	6
	9	6	-39	-28	-17	0	-30	-28
	average - gnstl.		-7	-3	2	0	-27	-2

Tab. XX. Divergences of computed relative diameters, after correction, from actual values. q-class averages. In thousandths.
*Gennemsnitlige differenser mellem konstaterede og beregnede relative diameter
 efter korrektion. For q-klasser. Differenser i promille.*

q-class <i>q-klasse</i>	d-classes <i>d-klasser</i>	number <i>antal</i>	difference in <i>differens for</i>					average for d_1, d_2 and d_3 <i>gnslt. for</i> $d_4 - d_5 - d_3$
			d_1	d_2	d_3	d_5	d_7	
20	4— 5	9	4	13	7	0	0	8
21	4— 9	30	-1	0	-1	0	-3	-1
22	4—10	63	0	-4	2	0	6	-1
23	4—10	92	3	-2	-2	0	0	0
24	4—10	77	-1	1	3	0	-1	1
25	4— 9	44	1	0	1	0	-1	1

Tab. XXI. Taper table.
Afsmalningstabell.

Taper table

Tab. XXI. Taper table.

(to be continued)

Afsmalningstabel.

(fortsættes)

height of tree from ground level, m <i>træets totalhøjde, m</i>	form class 0. <i>form- klassse 0.</i>	length of felled stem, m. længde af fældet stamme, m											
		3	4	5	6	7	8	9	10	11	12	13	14
		upper diameter in percentages of breast-high diameter <i>topdiameter i % af bryststøjde-diameter</i>											
9	60	85	74	61	48	33	17						
	63	85	76	64	51	36	19						
	66	87	78	67	54	39	21						
	69	88	80	70	57	42	23						
	72	89	82	73	60	45	25						
	75	91	84	76	63	47	28						
10	60	87	78	66	55	43	30	15					
	63	87	79	69	58	46	32	16					
	66	88	81	71	61	49	35	18					
	69	89	82	74	64	52	38	20					
	72	90	84	77	68	55	41	22					
	75	92	86	80	71	58	43	25					
11	60	88	81	71	60	50	39	27	13				
	63	88	82	73	63	53	42	29	15				
	66	89	83	75	66	56	45	32	16				
	69	90	84	77	69	60	48	34	18				
	72	91	86	80	72	63	51	37	20				
	75	93	88	82	75	66	53	40	22				
12	60	89	83	75	65	56	46	36	25	12			
	63	89	83	76	68	59	49	39	27	13			
	66	90	85	78	70	62	52	41	29	15			
	69	91	86	80	73	65	55	44	32	16			
	72	92	88	82	76	68	58	47	35	18			
	75	93	89	85	79	71	61	50	37	20			
13	60	90	84	78	69	60	52	43	33	22	11		
	63	90	85	79	71	63	55	46	36	25	12		
	66	91	86	80	73	66	58	49	38	27	13		
	69	92	87	82	76	69	61	52	41	29	15		
	72	93	89	84	78	72	64	55	44	32	17		
	75	94	90	86	81	75	68	57	47	35	19		
14	60	91	86	80	72	64	56	48	40	31	21	10	
	63	91	86	81	74	67	59	52	43	33	23	11	
	66	91	87	82	76	70	62	55	46	36	25	12	
	69	92	88	84	78	72	65	58	49	39	27	14	
	72	93	90	86	81	75	69	61	51	42	30	16	
	75	94	91	88	83	78	72	64	54	44	32	17	
15	60	92	87	81	75	67	60	53	45	37	28	19	9
	63	92	87	82	76	70	63	56	48	40	31	21	10
	66	92	88	83	78	72	66	59	51	43	34	23	11
	69	93	89	85	80	75	69	62	54	46	36	25	13
	72	93	90	87	82	78	72	65	57	49	39	28	14
	75	94	92	89	85	80	75	69	60	51	42	31	16

Taper table

Taper table (continued).

Afsmalningstabell (fortsat).

height of tree from ground level, m. <i>træets totalhøjde, m</i>	form class 0. <i>form- klasse 0.</i>	length of felled stem, m. længde af fældet stamme, m																			
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		upper diameter in percentages of breast-high diameter <i>topdiameter i % af brysthøjde-diameter</i>																			
16	63	92	88	83	78	72	66	60	53	46	38	29	20	9							
	66	92	89	85	80	75	69	63	56	49	41	32	22	11							
	69	93	90	86	82	77	72	66	59	51	43	34	24	12							
	72	94	91	88	84	79	75	69	62	54	46	37	26	13							
	75	95	92	89	86	82	77	72	65	57	49	40	29	15							
17	63	92	89	85	80	75	69	63	57	50	43	36	27	18	9						
	66	93	90	86	81	77	71	66	60	53	46	38	30	20	10						
	69	93	90	87	83	79	74	69	63	56	49	41	32	23	11						
	72	94	91	88	85	81	77	72	66	59	52	44	35	25	12						
	75	95	93	90	87	84	79	75	69	62	55	47	38	27	14						
18	63	93	89	85	81	77	71	66	60	54	48	41	34	26	17	8					
	66	93	90	87	83	79	74	69	63	57	51	44	36	28	19	9					
	69	94	91	88	84	80	76	71	66	60	54	47	39	31	21	10					
	72	94	92	89	86	83	79	74	69	63	57	50	42	33	23	12					
	75	95	93	91	88	85	81	77	72	67	59	52	45	36	26	13					
19	63	93	90	86	82	78	73	68	63	57	52	46	39	32	25	16	8				
	66	93	90	87	84	80	75	71	66	60	55	48	42	35	27	18	9				
	69	94	91	88	85	82	78	73	69	64	58	51	45	37	29	20	10				
	72	95	92	90	87	84	80	76	72	67	61	54	47	40	32	22	11				
	75	95	93	91	89	86	83	79	75	70	64	57	50	43	35	24	12				
20	63	93	90	87	84	80	75	70	65	60	55	50	44	37	30	23	15	7			
	66	94	91	88	85	81	77	73	68	63	58	53	46	40	33	26	17	8			
	69	94	92	89	86	83	79	75	71	67	61	56	49	43	36	28	19	9			
	72	95	93	90	88	85	81	78	74	70	64	58	52	46	38	31	21	10			
	75	96	94	92	89	87	84	81	77	73	68	61	55	49	41	33	23	12			
21	63	94	91	88	84	81	77	72	68	63	58	53	47	42	36	29	22	15	7		
	66	94	91	88	85	82	78	74	70	66	61	56	50	44	38	31	24	16	8		
	69	94	92	89	87	84	80	77	73	69	64	59	53	47	41	34	27	18	9		
	72	95	93	91	88	86	83	79	76	72	67	62	56	50	44	37	29	20	10		
	75	96	94	92	90	88	85	82	79	75	71	65	59	53	47	40	32	22	11		
22	63	94	91	88	85	82	78	74	69	65	60	56	51	46	40	34	28	21	14	6	
	66	94	92	89	86	83	80	76	72	68	63	59	54	48	43	37	30	23	15	7	
	69	95	92	90	87	85	81	78	75	71	67	62	57	51	46	39	33	25	17	8	
	72	95	93	91	89	86	84	81	77	74	70	65	60	54	48	42	36	28	19	9	
	75	96	94	92	90	88	86	83	80	77	73	68	63	57	51	45	38	30	21	10	
23	63	94	91	89	86	83	79	75	71	67	63	58	54	49	44	38	33	27	20	13	6
	66	95	92	89	87	84	81	77	74	70	66	61	57	52	47	41	35	29	22	15	7
	69	95	93	90	88	85	82	79	76	73	69	65	60	55	49	44	38	31	24	16	8
	72	95	93	91	89	87	84	81	78	75	72	68	63	58	52	47	41	34	27	18	9
	75	96	94	93	91	89	87	84	81	78	75	71	66	60	55	50	44	37	29	20	10

Tab. XXII. Checking of the taper table on trees grouped according to sample plot and age.

Bedømmelse af afsmalningstabellen efter bevoksningsmateriale.

sample plot no. prøve- flade nr.	age, years alder, år	d ₀ mm	range of diameters, mm <i>mindste og største d₀, mm</i>	*)	d ₁	d ₂	d ₃	d ₅	d ₇
3	11	74	55—98	I	93.6	84.7	77.5	61.2	35.5
				II	3.1	2.1	3.8	4.3	1.9
				III	93.8	87.4	80.2	61.2	40.5
				IV	0	—2	—2	—	—4
2	14	83	74—91	I	96.3	89.1	82.7	67.0	41.5
				II	1.5	1.3	2.6	5.6	4.8
				III	93.8	88.5	82.5	67.0	46.1
				IV	2	0	0	—	—4
3	13	99	82—117	I	93.6	87.4	79.3	60.6	35.9
				II	2.4	4.4	3.8	3.4	5.4
				III	94.0	87.3	80.1	60.6	40.0
				IV	0	0	—1	—	—4
3	27	159	144—162	I	95.8	91.3	87.3	74.3	55.3
				II	1.1	2.1	2.6	2.2	5.8
				III	95.5	91.6	87.1	74.3	53.0
				IV	0	0	0	—	4
3	24	168	155—182	I	94.8	89.5	84.3	70.2	48.2
				II	2.1	1.6	2.0	3.0	3.2
				III	94.4	89.7	84.3	70.2	49.1
				IV	1	0	0	—	—2
2	26	196	172—217	I	95.8	91.2	84.8	68.9	48.3
				II	1.4	2.4	2.6	3.8	2.9
				III	94.1	89.2	83.5	68.9	47.9
				IV	3	4	3	—	1
6	31	236	211—277	I	94.6	90.0	85.3	70.8	50.5
				II	2.4	2.5	3.3	4.2	3.9
				III	94.5	90.0	84.8	70.8	49.7
				IV	0	0	1	—	2
6	35	260	240—292	I	92.1	89.7	86.2	73.1	52.1
				II	2.2	2.5	2.8	1.7	2.7
				III	95.2	91.0	86.3	73.1	51.8
				IV	—8	—3	0	—	1
2	44	297	267—328	I	92.8	86.9	82.0	68.0	46.9
				II	2.4	2.7	2.6	2.7	3.3
				III	94.0	88.9	83.0	68.0	47.1
				IV	—4	—6	—3	—	—1
6	42	304	271—362	I	91.6	87.5	81.9	69.6	48.3
				II	1.7	1.7	1.9	2.3	2.8
				III	94.2	89.4	84.0	69.6	48.5
				IV	—8	—6	—6	—	—1
				means of II <i>middeletal af II</i>	2.0	2.3	2.8	3.3	3.7

*) I: group averages, per cent; II: standard deviation from these averages; III: table values; IV: divergences of table values from group averages, absolute measure (mm).

* I: Gruppemiddeltafel; II: Middelfavigelsen herfra; III: tabelværdierne; IV: differensen mellem I og III i absolut mål (num).

Tab. XXIII. Observations grouped according
to sample plot and age (p/a-groups). Simple means.
All age data to be counted »from seed«.

Bevoksningvis og aldersvis oversigt. Aritmetiske middeltal.

sample plot no. prfl. nr.	age, years <i>alder,</i> <i>år</i>	number of sample trees <i>antal</i> <i>prøvetræer</i>	h dm	d mm	d ₁ % <i>%</i>	d ₅ =q % <i>%</i>	d ₇ % <i>%</i>	f × 1000
2	14	10	78	83	96	67.0	42	574
»	17	12	103	129	96	61.7	37	527
»	26	10	162	196	96	68.9	48	535
»	32	60	184	219	96	69.6	48	534
»	44	10	221	297	93	68.0	47	507
3	11	10	64	74	94	61.2	36	566
»	13	10	81	99	94	60.6	36	551
»	16	9	101	102	95	65.6	41	545
»	19	8	119	140	96	66.8	48	551
»	22	6	135	142	93	67.5	47	529
»	24	10	149	168	95	70.2	48	540
»	27	10	155	159	96	74.3	55	578
»	30	5	172	186	96	72.0	52	553
»	32	18	175	188	95	72.1	52	553
»	42	11	204	274	93	71.0	51	538
5	24	7	136	164	94	69.3	48	542
»	27	5	151	206	96	68.0	45	526
»	29	5	163	212	92	66.0	43	500
6	31	10	191	236	95	70.8	51	541
»	33	5	194	259	93	68.4	48	513
»	35	10	200	260	92	73.1	52	539
»	38	13	205	274	93	69.8	48	516
»	42	10	222	304	92	69.6	48	511
»	47	9	247	374	90	67.7	48	494
9	14	6	93	77	97	68.0	46	577
12	27	27	142	142	95	70.3	50	549
»	29	14	153	157	96	71.1	52	553
14	36	3	185	245	95	69.3	46	525
17	29	3	174	208	97	68.7	47	532
22	18	5	115	109	93	62.2	45	517
»	20	6	127	111	94	65.7	47	536
»	46	5	207	255	92	67.6	49	510
23	19	3	138	151	96	69.7	49	559
25	19	3	145	209	95	64.7	37	504
27	42	5	208	317	93	66.8	48	511
28	23	3	179	254	94	66.7	43	518
30	43	5	207	288	94	69.6	50	520
31	34	4	182	239	92	66.0	48	495
32	20	3	135	142	94	72.0	48	545
33	31	3	180	265	95	66.0	44	513
38	39	4	236	293	94	69.8	49	512
39	14	4	101	130	95	63.0	38	531
41	21	5	137	154	95	67.6	46	526
43	45	2	206	240	95	73.0	53	553

Tab. XXIV. Testing of the form factor tables on the p/a-groups,
lot (1): groups with 9 or more observations.

Afprøvning af formtaltabellerne på bevoksningsmateriale (materialets 1. afdeling).

sample plot no. <i>prfl. nr.</i>	age, years <i>alder,</i> <i>år</i>	number of trees <i>antal, stk.</i>	h dm	d mm	q $\times 1000$	f $\times 1000$	table values of form factor from <i>tabelformtal efter</i>				
							h	d/h	q/d	h/q	h/q/d
2	14	10	78	83	670	574	559	561	568	570	570
	17	12	103	129	617	527	543	534	526	534	531
	26	10	162	196	689	535	540	531	530	533	531
	32	60	184	219	696	534	536	534	532	532	534
	44	10	221	297	680	507	518	516	510	509	510
3	11	10	64	74	612	566	573	567	560	566	566
	13	10	81	99	606	551	556	552	545	552	553
	16—19	17	109	120	661	548	542	542	542	546	546
	22—24	16	144	158	692	536	541	540	541	542	541
	27	10	155	159	743	578	541	544	573	572	573
	30—32	23	174	188	720	553	538	541	553	551	554
	42	11	204	274	710	538	527	524	531	532	530
	5	27—29	10	157	209	670	513	540	522	514	522	516
6	31	10	191	236	708	541	533	534	536	537	538
	33—35	15	198	259	715	530	530	530	535	538	535
	38	13	205	274	698	516	527	524	523	525	523
	42	10	222	304	696	511	518	513	519	517	516
	47	9	247	374	677	494	494	487	502	494	(494)
12	27	27	142	142	703	549	541	547	553	549	551
	29	14	153	158	711	553	541	544	553	551	553
22	18—20	11	121	110	641	527	541	554	541	527	533

Tab. XXV. Deviations of the table values of f from the true (measured) values, as resulting from tab. XXIV.

Formtalbestemmelsens fejl (materialets 1. afdeling).

sample plot no. <i>prfl. nr.</i>	number of trees <i>antal, stk.</i>	differences in f according to determination from <i>f-differens iflg. bestemmelse efter</i>				
		<i>h</i>	<i>d/h</i>	<i>q/d</i>	<i>h/q</i>	<i>h/q/d</i>
2	10	15	13	6	4	4
	12	-16	-7	1	-7	-4
	10	-5	4	5	2	4
	60	-2	0	2	2	0
	10	-11	-9	-3	-2	-3
3	10	-7	-1	6	0	0
	10	-5	-1	6	-1	-2
	17	6	6	6	2	2
	16	-5	-4	-5	-6	-5
	10	37	34	5	6	5
	23	15	12	0	2	-1
	11	11	14	7	6	8
5	10	-27	-9	-1	-9	-3
6	10	8	7	5	4	3
	15	0	0	-5	-8	-5
	13	-11	-8	-7	-9	-7
	10	-7	-2	-8	-6	-5
	9	0	7	-8	0	0
12	27	8	2	-4	0	-2
	14	12	9	0	2	0
22	11	-14	-27	-14	0	-6
standard error (all groups) <i>middefejl (alle)</i>		13.5	11.8	5.9	4.8	4.0
standard error (- plot 22) <i>middefejl (- prfl. 22)</i>		13.5	10.5	5.1	4.9	3.9

Tab. XXVI. Testing of the form factor tables on the p/a-groups,
lot (2): groups with few observations.

*Afprøvning af formtaltabellerne på fåtalligt bevoksningsmateriale
(materialets 2. afdeling).*

sample plot no. prfl. nr.	age, years alder, år	number of trees antal, stk.	h dm	d mm	q ×1000	f ×1000	table values of form factor from tabelformtal efter				
							h	d/h	q/d	h/q	h/q/d
5	24	7	136	164	693	542	541	533	540	546	541
9	14	6	93	77	680	577	547	565	576	564	569
14	36	3	185	245	693	525	535	525	525	529	526
17	29	3	174	208	687	532	538	532	527	529	530
22	46	5	207	255	676	510	526	532	512	512	517
23	19	3	138	151	697	559	541	540	546	547	546
25	19	3	145	209	647	504	541	514	504	513	504
27	42	5	208	317	668	511	526	508	500	506	498
28	23	3	179	254	667	518	537	515	507	514	508
30	43	5	207	288	696	520	526	519	521	523	519
31	34	4	182	239	660	495	536	524	505	509	508
32	20	3	135	142	720	545	541	543	563	562	561
33	31	3	180	265	660	513	537	511	502	510	502
38	39	4	236	293	698	512	506	517	522	510	(510)
39	14	4	101	130	630	531	544	533	526	540	536
41	21	5	137	154	676	526	541	538	532	535	534
43	45	2	206	240	730	553	527	537	549	544	549

Tab. XXVII. Deviations of the table values of f from the true (measured) values, as resulting from tab. XXVI.

Formtalbestemmelsens fejl (materialets 2. afdeling).

Sample plot no. <i>prfl. nr.</i>	number of trees <i>antal, stk.</i>	differences in f according to determination from <i>f-differens iflg. bestemmelse efter</i>				
		<i>h</i>	<i>d/h</i>	<i>q/d</i>	<i>h/q</i>	<i>h/q/d</i>
5	7	1	9	2	— 4	1
9	6	30	12	1	13	8
14	3	— 10	0	0	— 4	— 1
17	3	— 6	0	5	3	2
22	5	— 16	— 22	— 2	— 2	— 7
23	3	18	19	13	12	13
25	3	— 37	— 10	0	— 9	0
27	5	— 15	3	11	5	13
28	3	— 19	3	11	4	10
30	5	— 6	1	— 1	— 3	1
31	4	— 41	— 29	— 10	— 14	— 13
32	3	4	2	— 18	— 17	— 16
33	3	— 24	2	11	3	11
38	4	6	— 5	— 10	2	2
39	4	— 13	— 2	5	— 9	— 5
41	5	— 15	— 12	— 6	— 9	— 8
43	2	26	16	4	9	4
standard error (all groups) <i>middelfejl (alle)</i>		20.2	12.0	8.3	8.5	8.4
standard error (— plot 9) <i>middelfejl (÷ prfl. 9)</i>		19.5	12.0	8.5	8.1	8.5

Tab. XXVIII. Estimation from h and d of the relative value of the number of stems per hectare. Standing crop before thinnings.

Bedømmelse af stamtallets relative størrelse efter h og d. Før tynding

sample plot no. proveflade nr.	age, years alder, år	h	diameter to be expected normal- diameter	actual dia- meter d	dif- ference, per cent. d-dif- ferens, %	number of stems to be expected normal- stamtal, stk.	actual number of stems stamtal, stk.	dif- ference, per cent. n-differens, %	number of stems greater (+) or smaller (-) than to be expected, per cent.
									height (+) eller lævlt (-) stamtal, %
			dm	mm	mm				
2	14	65	68	.84	25	6100	4704	— 23	13
	17	96	103	118	15	2900	2858	— 1	23
	26	153	178	186	5	950	985	4	12
	32	192	243	239	— 2	447	477	7	3
	44	225	322	323	0	240	237	— 1	— 1
3	11	60	63	68	8	7000	5887	— 16	— 1
	13	76	81	86	6	4600	4227	— 8	4
	16	98	106	108	2	2800	2668	— 5	— 1
	19	117	130	129	— 1	1920	2233	16	15
	22	132	149	143	— 4	1440	1695	18	10
	24	142	163	158	— 3	1180	1306	11	5
	27	154	179	176	— 2	935	979	5	1
	30	173	207	197	— 5	645	744	15	6
	32	181	222	212	— 5	555	607	9	1
	42	209	281	287	2	322	281	— 13	— 8
6	31	187	233	230	— 1	490	663	35	33
	33	194	247	247	0	430	496	15	15
	35	201	263	266	1	376	408	9	11
	38	211	287	294	3	310	289	— 7	2
	42	226	325	327	1	238	238	0	1
	47	244	376	371	— 1	186	201	8	6
5	24	140	159	185	16	1230	831	— 32	— 6
	27	153	177	206	16	950	681	— 28	— 2
	29	166	196	231	18	740	515	— 30	— 2
9	14	89	95	89	— 6	3400	3862	14	2
12	27	148	170	154	— 9	1050	993	— 5	— 22
	29	156	181	167	— 8	900	822	— 9	— 23
22	18	111	122	104	— 15	2160	3705	72	47
	20	126	141	121	— 14	1610	2505	56	32
	46	208	279	254	— 9	330	379	15	— 1
32	20	121	134	129	— 4	1780	1851	4	— 3

Tab. XXIX. Form factors of the sample trees, corrected for h- and d-divergences from the standing crop before thinnings.

Prøvetræernes formtal henført til bestandens højde og diameter.

sample plot no. prfl. nr.	age, years alder, år	before thinnings <i>før tynding</i>			table value of f for the sample trees prøvetræernes tabel-formtal	correc- tion korrek- tion	measured f corrected <i>målt formtal korrigeret til bestan- dens h/d</i>
		h dm	d mm	table value of f tabel- formtal			
2	14	65	84	561	561	0	574
	17	96	118	540	534	6	533
	20	115	137	535	.	.	.
	23	134	159	534	.	.	.
	26	153	186	531	531	0	535
	29	177	215	531	.	.	.
	32	192	239	533	534	— 1	533
	35	203	269	526	.	.	.
	40	217	298	516	.	.	.
	44	225	323	506	516	— 10	497
3	11	60	68	570	567	3	569
	13	76	86	559	552	7	558
	16	98	108	546	550	— 4	541
	19	117	129	541	535	6	557
	22	132	143	541	543	— 2	527
	24	142	158	539	538	1	541
	27	154	176	536	544	— 8	570
	30	173	197	536	541	— 5	548
	32	181	212	535	541	— 6	547
	36	195	245	533	.	.	.
	39	202	262	529	.	.	.
	42	209	287	519	524	— 5	533
6	31	187	230	533	534	— 1	540
	33	194	247	531	527	4	517
	35	201	266	528	530	— 2	537
	38	211	294	517	524	— 7	509
	42	226	327	504	513	— 9	502
	47	244	371	488	487	1	495
	49	249	390	481	.	.	.
5	24	140	185	525	533	— 8	534
	27	153	206	521	520	1	527
	29	166	231	517	524	— 7	493
9	14	89	89	558	565	— 7	570
	27	148	154	544	547	— 3	546
12	29	156	167	541	544	— 3	550
	18	111	104	552	551	1	518
	20	126	121	550	556	— 6	530
22	46	208	254	532	532	0	510
	20	121	129	543	543	0	545

Tab. XXX. Estimation from h and d of the relative value
of the form factor. Standing crop before thinnings.

Bedømmelse af formfaktorets relative størrelse efter h og d. Før tynding.

sample plot no. prfl. nr.	age, years alder år	h	dia- meter to be ex- pected	act- ual dia- meter nor- mal- dia- meter	calculated difference from stan- dard form factor, f-units <i>beregnet af- vigelse fra normal- formtal, f-enheder</i>	stan- dard form factor f-units nor- mal- formtal	standard form factor, corrected nor- mal- formtal	form factor according to tab. XXIX „faktisk“ formtal (iflg. tab. XXIX)	form factor higher (+) or lower (-) than to be expected, f-units <i>højt (+) eller lavt (-) formtal, f-enheder</i>
			dm						
2	14	65	68	84	— 10	571	561	574	13
	17	96	103	118	— 9	546	537	533	— 4
	26	153	178	186	— 4	542	538	535	— 3
	32	192	243	239	2	533	535	533	— 2
	44	225	322	323	0	505	505	497	— 8
3	11	60	63	68	— 3	576	573	569	— 4
	13	76	81	86	— 3	561	558	558	0
	16	98	106	108	— 1	545	544	541	— 3
	19	117	130	129	1	540	541	557	16
	22	132	149	143	4	540	544	527	— 17
	24	142	163	158	2	541	543	541	— 2
	27	154	179	176	1	542	543	570	27
	30	173	207	197	4	541	545	548	3
	32	181	222	212	5	539	544	547	3
	42	209	281	287	— 2	520	518	533	15
6	31	187	233	230	1	536	537	540	3
	33	194	247	247	0	532	532	517	— 15
	35	201	263	266	— 1	526	525	537	12
	38	211	287	294	— 2	518	516	509	— 7
	42	226	325	327	— 1	504	503	502	— 1
	47	244	376	371	2	486	488	495	7
5	24	140	159	185	— 13	541	528	534	6
	27	153	177	206	— 15	542	527	527	0
	29	166	196	231	— 15	542	527	493	— 34
9	14	89	95	89	4	550	554	570	16
12	27	148	170	154	7	542	549	546	— 3
	29	156	181	167	7	542	549	550	— 1
22	18	111	122	104	11	541	552	518	— 34
	20	126	141	121	10	540	550	530	— 20
	46	208	279	254	9	521	530	510	— 20
32	20	121	134	129	3	540	543	545	2

Tab. XXXI. Table for the determination of the absolute form factor (φ) from the diameter quotients d_1 and d_7 . In thousandths.

Tabel til bestemmelse af det absolute stammeformtal φ efter diameterkvoterne d_1 og d_7 . Promille.

d_7 , per cent d_7 , %	d ₁ , per cent d_1 , %									
	90	91	92	93	94	95	96	97	98	99
35										
36				405	410	416	423			
37				410	415	421	428			
38				414	419	425	432			
39				419	424	430	437			
40				423	428	434	441			
41	421	424	428	433	439	446	451	454		
42	426	429	433	438	444	451	456	459		
43	427	430	433	437	442	448	455	461	464	
44	432	435	438	442	447	453	460	465	468	
45	436	439	442	447	452	457	464	470	473	
46	441	444	447	451	456	462	469	475	478	
47	445	448	451	456	461	467	474	479	482	
48	450	453	456	461	466	471	478	484	487	490
49	454	457	460	465	470	476	483	488	491	494
50	462	465	470	475	481	488	493	496	499	
51		470	475	480	486	493	498	501	504	
52			479	484	490	497	502	505	508	
53				484	489	495	502	507	510	513
54				488	493	500	507	512	515	518
55				493	498	505	512	516	519	522
56					503	509	516	521	524	
57					507	514	521	526	529	

Yield table BeTab. XXXII. Be: Empiric yield table for Japanese larch, quality class B.
1 hectare.

age, years	14	16	18	20	22	24	27	
<i>after thinnings:</i>								
number of stems	2900	2200	1700	1340	1060	860	648	
height	m 8.4	9.7	10.9	12.1	13.2	14.3	15.9	
diameter	cm 9.1	10.6	12.2	13.7	15.3	16.8	19.1	
basal area	m ² 18.85	19.40	19.87	19.75	19.50	19.09	18.60	
form factor	0. 0.556	547	541	538	536	534	531	
volume	m ³ 88	103	117	129	138	146	157	
<i>thinnings:</i>								
number of stems	1100	700	500	360	280	200	212	
height	m 7.8	9.1	10.3	11.5	12.6	13.7	15.3	
diameter	cm 7.2	8.7	10.2	11.8	13.3	14.8	17.0	
basal area	m ² 4.48	4.16	4.09	3.94	3.89	3.44	4.81	
form factor	0. 0.568	559	551	546	543	541	539	
volume	m ³ 20	21	23	25	27	25	40	
cumulat. volume	m ³ 20	41	64	89	116	141	181	
<i>before thinnings:</i>								
number of stems	4000	2900	2200	1700	1340	1060	860	
height	m 8.3	9.6	10.8	12.0	13.1	14.2	15.8	
diameter	cm 8.6	10.2	11.8	13.3	14.9	16.4	18.6	
basal area	m ² 23.33	23.56	23.96	23.69	23.39	22.53	23.41	
form factor	0. 0.559	550	543	540	537	536	533	
volume	m ³ 108	124	140	154	165	171	197	
<i>current increment:</i>								
height	cm 59	56	53	51	50	48	46	
diameter	mm 5.6	5.6	5.7	5.8	5.9	6.0	6.2	
basal area	m ² 2.40	2.19	1.99	1.79	1.60	1.43	1.28	
volume	m ³ 18.0	18.5	18.5	18.2	17.8	17.1	16.2	
»	per cent 17.0	15.2	13.7	12.4	11.5	10.0	8.9	
average yield (thinnings)	m ³ 1.4	2.6	3.6	4.5	5.3	5.9	6.7	
total production	m ³ 108	144	181	218	254	287	338	
average production	m ³ 7.7	9.0	10.0	10.9	11.5	12.0	12.5	
yearly reduction of number of stems		350	250	180	140	100	71	49
» improper height increment cm		6	5	5	5	4	4	4
» » diameter » mm		3	2	2	2	2	2	2
age, years	14	16	18	20	22	24	27	

Age data to be counted from seed and not from the year of planting. Heights and diameters are those corresponding to the mean basal area. All form factors are table values from h and d (tab. V). Volumes are total over-bark volumes of the stems from ground level; no allowance is made for the stump, or the felling loss. »Improper« increments are due to the fact that height and diameter for the thinning are, normally, less than for the stand before thinning.

Yield table Be*Be: Empirisk tilvækstoversigt for japansk lærk, bonitet B. 1 ha.*

30	33	36	39	42	46	50	alder, år	
500 17.4 21.5 18.15 529 167	395 18.8 23.9 17.74 530 177	315 20.0 26.4 17.23 528 182	257 21.2 28.9 16.86 518 185	212 22.3 31.5 16.51 509 187	172 23.6 35.0 16.55 496 194	145 24.8 38.5 16.88 483 202	<i>efter tynding:</i> stamtal, højde, diameter, grundflade, formtal, vedmasse,	stk. m cm m ² 0, m ³
148 16.8 19.3 4.34 535 39 220	105 18.2 21.7 3.89 533 38 258	80 19.5 24.1 3.65 534 38 296	58 20.7 26.6 3.22 528 35 331	45 21.8 29.1 2.99 518 34 365	40 23.2 32.5 3.32 505 39 404	27 24.5 35.9 2.73 492 33 437	<i>tyndingen:</i> stamtal, højde, diameter, grundflade, formtal, vedmasse, » -sum	stk. m cm m ² 0, m ³ »
648 17.3 21.0 22.49 531 206	500 18.7 23.5 21.63 531 215	395 19.9 25.9 20.88 530 220	315 21.1 28.5 20.08 520 220	257 22.2 31.1 19.50 511 221	212 23.5 34.5 19.87 498 233	172 24.8 38.1 19.61 485 235	<i>før tynding:</i> stamtal, højde, diameter, grundflade, formtal, vedmasse,	stk. m cm m ² 0, m ³
43 6.4 1.15 15.2 8.0	40 6.7 1.04 14.1 7.1	36 7.0 0.95 13.0 6.5	33 7.3 0.87 12.0 5.9	31 7.5 0.82 11.2 5.3	29 7.7 0.78 10.5 4.9		<i>årlig tilvækst:</i> højde, diameter, grundflade, vedmasse, »	cm mm m ² m ³ %
7.3 387 12.9	7.8 435 13.2	8.2 478 13.3	8.5 516 13.2	8.7 552 13.1	8.8 598 13.0	8.7 639 12.8	gennemsnitl. udbytte, samlet produktion, gnstl.	m ³ » »
	35 3 2	27 3 1	19 3 1	15 2 1	10 2 1	6 2 1	årlig stamtalreduktion, » uægte højdetilvækst, cm » » diam. mm	stk. cm mm
30	33	36	39	42	46	50	alder, år	

Alder fra frø. Højde- og diameterangivelser svarende til middelstammegrundfladen. Formtallene er tabelformtal efter h og d (tab. V). Masseangivelserne er total stamme-masse på rod.

Tab. XXXIII. Calculation of the current basal area increment
for the yield table Bp. Between thinnings.

*Beregning af løbende grundfladetilvækst for tilvækstoversigten Bp.
Mellem tyndinger.*

age, years <i>alder, år</i>	basal area, m^2 <i>grundflade</i> m^2	alteration on Δg , as compared to the yield table Be, m^2 <i>ændring på Δg i forhold</i> <i>til Be-oversigten,</i> m^2	Δg m^2
15	19.60	— 0.20	2.20
17	20.30	— 0.12	2.07
19	20.80	— 0.06	1.93
21	21.13	— 0.02	1.77
23	21.40	0.01	1.61
25.5	21.65	0.01	1.44
28.5	21.78	0.02	1.30
31.5	21.82	0.03	1.18
34.5	21.85	0.05	1.09
37.5	21.88	0.07	1.02
40.5	21.90	0.09	0.96
44	21.94	0.09	0.91
48	21.98	0.10	0.88

Tab. XXXIV. Bp:
Prognostic yield table for Japanese larch,
quality class B.

Bp: Prognostisk tilvækstoversigt for japansk lærk,
bonitet B.

Yield table BpTab. XXXIV. Bp: Prognostic yield table for Japanese larch, quality class B.
1 hectare.

age, years	14	16	18	20	22	24	27	
<i>after thinnings:</i>								
number of stems	2677	2051	1620	1310	1081	878	691	
height m	8.4	9.7	10.9	12.1	13.2	14.3	15.9	
diameter cm	9.1	10.6	12.2	13.7	15.3	16.8	19.1	
basal area m^2	17.40	18.23	18.87	19.36	19.79	19.49	19.83	
form factor 0.	556	547	541	538	536	534	531	
volume m^3	82	97	111	126	140	149	167	
<i>thinnings:</i>								
number of stems	923	626	431	310	229	203	187	
height m	7.8	9.1	10.3	11.4	12.5	13.6	15.3	
diameter cm	7.1	8.5	10.2	11.8	13.2	14.9	16.5	
basal area m^2	3.70	3.57	3.50	3.37	3.11	3.52	3.98	
form factor 0.	568	560	551	545	543	540	541	
volume m^3	16	18	20	21	21	26	33	
cumulat. volume m^3	16	34	54	75	96	122	155	
<i>before thinnings:</i>								
number of stems	3600	2677	2051	1620	1310	1081	878	
height m	8.3	9.6	10.8	12.0	13.1	14.2	15.8	
diameter cm	8.6	10.2	11.8	13.4	14.9	16.5	18.6	
basal area m^2	21.10	21.80	22.37	22.73	22.90	23.01	23.81	
form factor 0.	559	550	543	540	537	536	533	
volume m^3	98	115	131	147	161	175	200	
<i>current increment:</i>								
height cm	59	56	53	51	50	48	46	
diameter mm	5.8	5.9	5.9	6.0	6.0	6.0	6.0	
basal area m^2	2.20	2.07	1.93	1.77	1.61	1.44	1.30	
volume m^3	16.7	17.2	17.5	17.7	17.6	17.4	16.9	
,	per cent	17.0	15.1	13.6	12.3	11.2	10.0	8.8
average yield (thinnings) m^3	1.1	2.1	3.0	3.8	4.4	5.1	5.7	
total production m^3	98	131	165	201	236	271	322	
average production m^3	7.0	8.2	9.2	10.1	10.7	11.3	11.9	
<i>yearly reduction of number of stems</i>	313	216	155	115	102	62	46	
» improper height increment cm	6	5	5	5	4	4	4	
» » diameter » mm	2	2	2	2	2	2	2	
age, years	14	16	18	20	22	24	27	

Age data to be counted from seed. Heights and diameters are those corresponding to the mean basal area. All form factors are table values from h and d (tab. V). Volumes are total over-bark volumes of the stems from ground level; no allowance is made for the stump, or the felling loss. «Improper» increments are due to the fact that height and diameter for the thinning are, normally, less than for the stand before thinning.

Yield table Bp*Bp: Prognostisk tilvækstoversigt for japansk lærk, bonitet B. 1 ha.*

30	33	36	39	42	46	50	alder, år	
552 17.4 21.5 20.05 529 185	450 18.8 23.9 20.21 530 202	372 20.0 26.4 20.35 528 215	312 21.2 28.9 20.46 518 225	258 22.3 31.5 20.12 509 229	210 23.6 35.0 20.22 496 237	175 24.8 38.5 20.32 483 243	<i>efter tynding:</i> stamtal, højde, diameter, grundflade, formtal, vedmasse,	stk. m cm m ² 0, m ³
139 16.8 18.4 3.68 539 33 188	102 18.1 20.5 3.38 538 33 221	78 19.3 22.6 3.14 539 33 254	60 20.4 25.0 2.95 533 32 286	54 21.6 27.6 3.22 524 36 322	48 22.9 30.7 3.54 512 42 364	35 24.6 35.3 3.42 495 42 406	<i>tyndingen:</i> stamtal, højde, diameter, grundflade, formtal, vedmasse, » -sum,	stk. m cm m ² 0, m ³ »
691 17.3 20.9 23.73 531 218	552 18.7 23.3 23.59 532 235	450 19.9 25.8 23.49 530 248	372 21.1 28.3 23.41 521 257	312 22.2 30.9 23.34 511 265	258 23.5 34.2 23.76 499 279	210 24.8 37.9 23.74 485 285	<i>før tynding:</i> stamtal, højde, diameter, grundflade, formtal, vedmasse,	stk. m cm m ² 0, m ³
43 6.1 1.18 16.3 7.8	40 6.2 1.09 15.3 6.8	36 6.4 1.02 14.2 6.0	33 6.6 0.96 13.3 5.4	31 6.8 0.91 12.5 4.9	29 7.1 0.88 12.0 4.6		<i>årlig tilvækst:</i> højde, diameter, grundflade, vedmasse, »	cm mm m ² m ³ %
6.3 373 12.4	6.7 423 12.8	7.1 469 13.0	7.4 511 13.1	7.7 551 13.1	7.9 601 13.1	8.1 649 13.0	gennemsnitl. udbytte, samlet produktion, gnstl.	m ³ » »
	34 3 2	26 3 2	20 3 2	18 2 2	12 2 2	9 2 2	årlig stamtalreduktion, » uægte højdetilvækst, » » diam.	stk. cm mm
30	33	36	39	42	46	50	alder, år	

Alder fra frø. Højde- og diameterangivelser svarende til middelstammegrundfladen. Formtallene er tabelformtal efter h og d (tab. V). Masseangivelserne er total stamme-masse på rod.

Tab. XXXV. p/a-group 2/32 (sample plot GO, age 32 years);
the thinning.

Analysis of 1 m height classes.

Prfl. GO, 32 år; tyndingen. Analyse af 1 m højdeklasser.

h-class, m <i>h-klasse,</i> <i>m</i>	number antal, st.k.	h dm	d mm	q ×1000	f ×1000	table form factor <i>tabelformtal</i>			
						d/h	error fejl	h/q/d	error fejl
16	4	161	189	630	509	533	— 24	497	12
17	9	171	207	674	522	531	— 9	522	0
18	16	179	214	697	533	532	1	535	— 2
19	18	189	225	706	541	537	4	539	2
20	13	198	236	715	543	538	5	541	2
19—20	31	193	230	710	542	538	4	540	2

Tab. XXXVI. p/a-group 2/32; the thinning.
Analysis of 2 cm diameter classes.

Prfl. GO, 32 år; tyndingen. Analyse af 2 cm diameterklasser.

d-class, cm <i>d-klasse,</i> <i>cm</i>	number antal, st.k.	h dm	d mm	q ×1000	f ×1000	table form factor <i>tabelformtal</i>			
						d/h	error fejl	h/q/d	error fejl
18	5	169	177	680	533	543	— 10	533	0
20	16	177	201	681	531	537	— 6	529	2
22	18	186	220	714	542	536	6	544	— 2
24	17	189	239	697	531	531	0	530	1
26	4	195	262	685	524	526	— 2	519	5
(22) 24—26	26	190	240	700	533	532	1	532	1

Tab. XXXVII. p/a-group 2/32; the thinning.

Sub-group consisting of the 14 biggest diameters and, of the remaining trees, the 7 (8) biggest heights. This sub-group of 21 (22) trees has the same mean height and the same mean diameter (diameter of mean basal area, respectively), as has the standing crop before thinning.

Prfl. GO, 32 år; tyndingen.

Undergruppe, bestående af de 14 største diameter samt, af de resterende træer, de 7 (8) største højder. Denne undergruppe på 21 (22) træer har samme middelhøjde og samme aritm. middeldiameter (diameter i middelstgrfl.) som bestanden før tynding.

number antal, stk.	h dm	d mm	q $\times 1000$	f $\times 1000$	table form factor tabelformtal			
					d/h	error fejl	h/q/d	error fejl
21	193	240	702	534	534	0	533	1
22	193	240	704	535	534	1	534	1

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SAMMENFATNING

FORMTAL OG TILVÆKST FOR JAPANSK LÆRK

A. FORMTAL.

1. *Materialet.*

Efter udskydning af 25 stammer med uregelmæssig form og grafisk korrektion af brysthøjdediameteren for 59 stammer (fig. 1) består materialet af 386 prøvetræer, hvoraf 320 hidrører fra Forsøgvæsenets 6 faste prøveflader i japansk lærk (se tab. XXIII). Prøvetræerne er opmålt i 4 sektioner under og 10 sektioner over 1.3 m, og den heraf beregnede værdi af stammeformtallet (f) er regnet som sand værdi. De enkelte stammers data er registreret på hulkort efter Hollerith-systemet, der tillader en mekanisk sortering og summering efter vilkårligt valgte data og grænser.

h er træets totalhøjde, d eller d_0 diameteren i 1.3 m højde (brysthøjden), d_1 til d_9 de relative diametre (diameterkvoterne) ved enden af de respektive sektioner over 1.3 m højde, d. v. s. den pågældende diameter i procent af brysthøjdediameteren; specielt er den midterste (d_5) identisk med formkvoten q , der er bestemmende for inddelingen i formklasser. Hvor intet andet er angivet, er h udtrykt i decimeter, d i millimeter, f i tusindedele og diameterkvoterne i procent.

Medens resultaterne (formtaltabellerne) hovedsageligt tænkes anvendt på bevoksninger, er undersøgelsen baseret på opmålinger af enkelttræer, der tillige er tyndingstræer. Spørgsmålene om tyndingstræers evne til i formtalmæssig henseende at repræsentere bestandstræer og enkelttræers evne til at repræsentere bevoksninger diskuteres. Frasæt visse, nærmere påpegede tilfælde må det antages, at et materiale af prøvetræer, der som her er udtaget med højde og diameter i nærheden af bestandens højde og diameter, efter korrektion vil være i tilfredsstillende grad repræsentativt.

Vigtigst er undersøgelsen af formtallets bestemmelse efter h og d samt efter h og q , udvidet til også at omfatte d . Desuden er undersøgt bestemmelsen efter q og d , efter d_1 og h , efter d_7 og d_1 samt efter h alene og d alene (se afsnit 8).

2. Formtalbestemmelse efter diameter og højde.

Materialet er sorteret i 3 cm-diameterklasser, der er nummereret således, at nummeret, multipliceret med 3, giver klassens midtværdi i cm. Hver d-klasse er dernæst sorteret i 2 m-højdeklasser, hvis numre, multipliceret med 2, giver h-klassernes midtværdi i m. Tab. I og diagrammet fig. 2 viser fordelingen til d/h-klasser, medens tab. II viser antal iagttagelser og klassemiddeltal. Fig. 3 og 4 har henholdsvis h og d som abscisse, medens linierne fremstiller henholdsvis d-klassernes og h-klassernes formtalværdier, der er korrigteret for afvigelser fra klassernes midtværdier. Bortset fra nogle detailler, hvis vægt diskutes nærmere, viser fig. 4, at f inden for samme h-klasse er tilnærmelsesvis lineært aftagende med voksende d, og at hældningerne ikke er stridende mod en udjævning ved et liniebundt. Dettes skæringspunkt er fundet ved analytisk beregning af yderlinierne, og de mellemliggende h-klassers linier er lagt gennem skæringspunktet og den pågældende h-klasses tyngdepunkt (tab. III). Af hensyn til bestemmelse af formtallet efter h i 1 m-intervaller er vinkelafstandene mellem de enkelte h-klassers linier undersøgt. Formtallet beregnes efter ligningen

$$f = c_1 \div c_2 d ,$$

hvortil værdierne af konstanterne for varierende h findes angivet i tab. IV. Tab. V er formtaltabellen efter diameter og højde.

3. Formtalbestemmelse efter formklasse og diameter.

Lige som d-klasserne er formklasserne (q-klasserne) nummereret således, at nummeret, multipliceret med 3, giver q-klassens midtværdi i procent. Tab. VI og fig. 5 viser fordelingen til q/d-klasser; middelformkvoten er 68.6 ± 4.5 , og fordelingen til q-klasser stemmer godt med den tilfældige fordeling. Klassemiddeltallene er angivet i tab. VII, og fig. 6 fremstiller d-klassernes formtaludvikling, idet q er abscisse. For at få dette billede lovmaessigheder til at træde tydeligere frem er for de enkelte q-klasser foretaget en sammenregning af 3 d-klasser ad gangen, jfr. tab. VIII og fig. 7; herved bestemmes hvert q/d-punkt af et større antal iagttagelser. Tab. IX viser en kontrolberegning af tyngdepunktet for den enkelte og for den »bredere« d-klasse. Over fig. 7 er foretaget en skønsmæssig, skematisk udjævning, hvoraf f-værdierne til formtaltabellen tab. X er aflæst.

4. Formtalbestemmelse efter højde og formklasse (og diameter).

Tab. XI. og fig. 8 viser fordelingen til og spredningen inden for de enkelte h/q-klasser. Ved sammenligning af figurerne 8, 5 og 2 ses, at f-værdiernes spredning inden for de enkelte underklasser er kendetegnet ved mindre i de to førstnævnte, d. v. s. at et h/q- eller q/d-værdisæt er i højere grad karakteriserende for formtallet end et d/h-værdisæt. Tab. XII giver klassemiddeltallene, og fig. 9 og fig. 10 viser formtaludviklingen for henholdsvis q-klasser og h-klasser, idet henholdsvis h og q er abscisse. For de enkelte q-klasser er h-klasserne sammenregnet 3 ad gangen (tab. XIII) med kontrolberegning af tyngdepunkterne (tab. XIV). Resultatet af beregningen for disse bredere klasser fremgår af fig. 11, der viser, at udjævning kan foretages ved to modsat rettede liniebundter med h-klasse 8 som fælles sidelinie. Beregningen er udført ad analytisk vej og giver de i tab. XV anførte konstanter til formlen

$$f = k_1 q + k_2 ,$$

hvorfra værdierne til formtaltabellen tab. XVI er beregnet.

Herefter er diameteren inddraget i formtalbestemmelsen efter h og q. Fig. 12 viser alle h/q-klasser, der indeholder mindst 2 h/q/d-klasser med mindst 3 iagttagelser hver. Heraf er fundet, at f falder med 0.24 f-enheder pr. 1 mm stigning af diametern, hvorefter det h/q/d-bestemte formtal bliver

$$f_{\text{corr.}} = k_1 q + k_2 + 0.24 (d_t \div d) ,$$

hvor d_t er den »teoretiske diameter«, den til et foreliggende værdisæt af h og q sandsynligst svarende diameter. Til bestemmelse af d_t er udarbejdet en særlig tabel (tab. XVII), og et eksempel på formtalbestemmelse efter h, q og d er givet p. [12].

5. Formtalbestemmelse efter d_1 og h.

d_1/h -kriteriet er undersøgt og efter vort materiale fundet uegnet til formtalbestemmelse.

6. Formtalbestemmelse efter d_7 og d_1 .

Denne kombination er efter vort materiale velegnet til formtalbestemmelse i en del af feltet, men mindre egnet i en anden del (de lavere d_7 -værdier), og der er derfor ikke opstillet en formtalstabell, jfr. dog afsnit 10.

7. Stammens form og afsmalning.

Som udgangspunkt for bedømmelse af afsmalningen er anvendt en variant af BEHRE's formel (p. [12]), der udtrykker en vilkårlig relativ diameter ved dens relative afstand fra toppen samt formklassen. Tab. XVIII og XIX sammenholder de beregnede værdier med materialets værdier. Differenserne varierer regelmæssigt, og deres udjævnede værdier er omsat til korrektionsfiguren fig. 13. Efter korrektion bliver differenserne som vist i tab. XX, hvoraf ses, at afvigelserne i langt de fleste tilfælde kun andrager indtil nogle få mm. Herefter er afsmalningstabellen (tab. XXI) beregnet. Der er fradraget 1 % af totalhøjden til stød således, at tabellens vandrette hoved gælder den fældede stammes længde. Tabellen kan i praksis som regel anvendes, selv om formklassen ikke kendes; der regnes da med $q = 69$.

Afsmalningstabellen er afprøvet på en række af materialets prøveflade/aldersgrupper (p/a-grupper), givende en middelfejl for d_3 på 2.4 mm og for d_7 på 2.8 mm, gældende for sådanne gruppemiddeltal (grupper à 10 træer). Tab. XXII.

f og φ kan udledes af afsmalningsformlen ved integration.

8. Bevoksningsformtal og afprøvning af formtalstabeller.

Formtalstabellerne (tab. V, X og XVI uden og med XVII samt efter h alene iflg. tabellen p.[15]), er afprøvet på det bevoksningsvis grupperede materiale (p/a-grupperne), idet dette er delt i 2 afdelinger. Tab. XXIII viser alle p/a-grupper, hvoraf 1. afdeling omfatter grupperne med 9 og flere iagttagelser, medens 2. afdeling omfatter de øvrige grupper (med 2—7 iagttagelser). Tab. XXIV viser formtalbestemmelsen for 1. afdeling efter de forskellige kriterier, og fejlene er opført i tab. XXV. Tilsvarende indeholder tab. XXVI og XXVII afprøvningen for 2. afdeling, de fåtallige p/a-grupper. Et sammendrag af middelfejlene er givet i tabellen p.[15]. Af denne ses, at formtalbestemmelsens godhed tiltager regelmæssigt og tydeligt fra venstre mod højre efter den anvendte indgang og nedefra opfører efter antallet af træer i grupperne. Bestemmelsen efter h alene er dårlig, men heller ikke bestemmelsen efter d og h opfylder rimelige krav til nøjagtigheden. Det gør derimod de øvrige indgange, og da især $h/q/d$.

Det er undersøgt, om stamtallet har en sådan formtalbestemende indflydelse, at et efter h og d ansat formtal kan forbedres ved en hensyntagen til stamtallet (fig. 14—16 og tab. XXVIII—

XXX). Der kan efter vort materiale ikke påvises nogen sådan indflydelse.

9. Nogle sammenligninger.

Medens der ikke synes at være publiceret egentlige formtalundersøgelser for japansk lærk, foreligger der undersøgelser for europæisk lærk bl. a. af SCHIFFEL (1905) og MATTSSON (1916-17). Der er anstillet sammenligning med SCHIFFEL's formtal på højde/diameter-basis og med MATTSSON's på højde/formklasse-basis samt endvidere med et stærkt begrænset dansk materiale af europæisk lærk på h/q/d-basis. Den japanske lærks formtal synes oftest at være omkring 3% højere end den europæiske lærks.

10. Det absolute stammeformtal φ og stubformtallet t .

Disse formtal ville have interesse, såfremt de efter de sædvanlige indgangsdata lod sig bestemme med større nøjagtighed end f; dette er imidlertid ikke tilfældet.

Der er opstillet en tabel til bestemmelse af φ efter d_7 og d_1 , da man herved kunne forvente en særligt god bestemmelse (tab. XXXI). Afprøvningen viser dog, at middelfejlen ikke er mindre end ved h/q-bestemmelsen af f.

11. Et komplet sæt tyndingstræer. Bemerkninger om prøvetræaudtagning.

Inden for materialet udgør målingen prfl. GO/32 år et særligt tilfælde, idet her samtlige 60 tyndingstræer blev sektioneret (se tab. p.[19]). Denne gruppe er undersøgt med hensyn til højder, diameter, formklasser og formtal (tab. XXXV—XXXVII og fig. 17—18). Et sæt tyndingstræer er konstitutionelt afvigende fra de samme h- og d-klasser i et blandet materiale og vil derfor vise en formtalmæssig skævhed over for h/d/f-tabellen. Foreligger der ikke tabelmateriale, er det vigtigt, at gruppen af prøvetræer, der må være tilstrækkelig talstærk, har samme højde og diameter som bestanden (før tynding; for bestanden efter tynding vil dette i almindelighed ikke kunne opnås). Det omtales, hvorledes en sådan gruppe kan udtages. Tab. XXXVII og fig. 18 viser en sådan repræsentativ gruppe. Findes tabelmateriale, er det tilstrækkeligt, at gruppens højde og diameter ligger nær bestandens, idet korrektion da kan udføres.

B. TILVÆKST

1. En empirisk tilvækstoversigt.

Materialet består af Forsøgsvæsenets 6 faste prøveflader i japansk lærk (48 tyndingsmålinger) samt 4 serier distriktsmålinger (15 tyndingsmålinger); disse bevoksninger tilhører samme bonitetsklasse, betegnet B (tabellen p.[23]). Forhåndenværende materiale for andre bonitetsklasser er for svagt. For tilstanden efter tynding er udarbejdet 3 grundkurver for henholdsvis højde, diameter og stamtal ved given alder fra frø (fig. 19, 20 og 21). Efter disse grundkurver samt en analyse af tyndingsintervallerne i materialets bevoksninger og en undersøgelse af højde- og diameterdifferenserne mellem tyndingen og den blivende bestand er alle tilvækstoversigtsens tal beregnet. Denne oversigt er betegnet Be (e = empirisk) og er gengivet i tab. XXXII.

2. Nogle sammenligninger.

Der er anstillet sammenligning med de af den britiske Forestry Commission udarbejdede tilvækstoversigter (1949) for japansk lærk i Storbritannien, hvis bonitet I i højde og samlet produktion ved ca. 40 år ligger nær B, medens stamtal, diameter og grundflade udvikler sig forskelligt (fig. 22, 23 og 24). Ved 40 års alder er der tillige en betydelig forskel i løbende tilvækst (se tabellen p. [27]). — Nogle japanske oversigter omtales. Der er foreløbig intet, der tyder på, at højdevæksten for dansk japansk lærk på passende jordbund skulle gå i stå ved ca. 50 års alder. — Produktionen overstiger den eur. lærks i Vesttyskland (bon. I) med 25 %.

3. Ændret tyndingsform og en prognostisk tilvækstoversigt.

I Be-oversigten kulminerer grundfladen (grundfladen midt i tyndingsintervallet) ved 19 år og er derefter aftagende til ca. 40 års alder. Det påvises, at denne grundfladeudvikling ikke er den heldigste. Der gøres rede for sammenhængen mellem grundfladen, grundfladetilvæksten og massetilvæksten principielt og efter vort materiale (tabeller p. [29]) og påpeges, at en stor grundflade ved ca. 20 år sandsynligvis er en hindring for opnåelse af det gunstigste produktionsforløb. Fig. 25 viser grundfladeudviklingen i materialets enkelte bevoksninger. Med støtte i eksempler fra materialet anlægges en kurve for det ønskelige grundfladeforløb (fig. 26, jfr. også tab. XXXIII), og efter denne og den givne højdeudvikling udarbejdes tilvækstoversigten Bp (p = prognostisk); den er gengivet i tab. XXXIV.

4. Empiri og prognose.

De to oversigter sammenlignes. De er forskellige i oprindelse og tillige konstruktivt forskellige, idet i Bp diameter og stamtal er sekundært bestemt. Den samlede produktion ved 50 års alder er ens, men den løbende tilvækst ved denne alder større i Bp, som derfor ved aldre over 50 år vil vise større samlet produktion. Bp-oversigten er overlegen såvel fra et driftsøkonomisk som fra et produktionsteknisk og afsætningsmæssigt synspunkt (tabeller p.[32]). Skovdyrkningsmæssigt vil man være interesseret i at følge udviklingen i bevoksninger, hvis grundfladeforløb svarer til Bp-oversigten, idet dennes gennemsørighed ikke er bevist, men nok sandsynliggjort.

pen *Polyporus annosus* (Untersuchungen über den Einfluss des Wasserstoffionenkonzentration auf das Wachstum von *Polyporus annosus*.), S. 17. — Nr. 127. C. H. BORNEBUSCH: Nørholm Hede, Anden Beretning (La Lande de Nørholm, Deuxième Rapport), S. 33. — Nr. 128. KJELD LADEFOGED: Floraundersøgelser i Mølleskoven, Anden Beretning (Florauntersuchungen im »Mølleskoven«, Zweiter Bericht), S. 81. H. 2: Nr. 130. KJELD LADEFOGED: Frostringsdannelser i Vaarveddet hos unge Douglasgraner, Sitkagraner og Lærketræer (Formations of Frost Rings in the spring-wood of young Douglas Fir, Sitka Spruce and Larch), S. 97. — Nr. 131. CARL MAR: MØLLER og D. MÜLLER: Aanding i ældre Stammer (Die Atmung in alten Stammteilen), S. 113. — Nr. 132. C. H. BORNEBUSCH: Egekulturforsøg paa Vallø Stifts Skovdistrikts (Eichenkultur-Versuche) S. 139. H. 3: Nr. 134. E. C. L. LØFTING: Jordbundsbehandlingens Indflydelse paa Rødgranens Vækst og Sundhed i Hedeplantager, Hedeskovenes Foryngelse VI (The Influence of the treatment of the soil on the growth and health of Norway spruce in heathland plantations), S. 165. — Nr. 135. C. H. BORNEBUSCH: Afsvampning af Bøgeolden (Désinfection des faines), S. 190. — Nr. 136. MATHIAS THOMSEN: Angreb af *Tomicus chalcographus* paa unge Sitkagraner, Rødgraner og Douglasgraner (Attack of *Tomicus chalcographus* on young Sitka spruce, Norway spruce and Douglas fir), S. 199. H. 4: Nr. 137. C. H. BORNEBUSCH og KJELD LADEFOGED: Hvidgranens og Sitkagranens Dødelighed i Hede- og Klitplantager i 1938 og 1939 (Frostschäden an Weissfichte und Sitkafichte auf der Heide und in Dünenbepflanzungen), S. 209. — Nr. 138. FOLKE HOLM: Douglasgran, Proveniens og Vækst (Die Douglasie, Proveniens und Wachstum), S. 233. — H. 5: Nr. 139. C. H. BORNEBUSCH: Fremmede Naaletræer paa Søllestedgaard (Fremde Nadelhölzer auf Søllestedgaard) (Foreign coniferous trees on Søllestedgaard estate), S. 313. — Nr. 140. C. H. BORNEBUSCH: Fremmede Løvtræer paa Esrom Skovdistrikts (Arbres feuillus étrangers dans un territoire boisé du nord de Seeland), S. 345. — H. 6: Nr. 141. C. H. BORNEBUSCH: Rødeg i Dansk Skovbrug (Red oak in Danish Forestry), S. 357.

Bd. XVI, H. 1: Nr. 133. KJELD LADEFOGED: Untersuchungen über die Periodizität im Ausbruch und Längenwachstum der Wurzeln bei einigen unserer gewöhnlichsten Waldbäume (Undersøgelser over Periodiciteten i Røddernes Frembrud og Længdevækst hos nogle af vore almindeligste Skovtræer), S. 1. — H. 2: Nr. 142. C. H. BORNEBUSCH: Revision af Haarup-Sande-Forsøget (Revision de l'expérience à Haarup-Sande), S. 257. — Nr. 143. C. H. BORNEBUSCH: Forskellige Bladarters Forhold til Omsætningen i Skovjord (Der Einfluss verschiedener Blätterarten auf die Umsetzung im Waldboden), S. 265. — H. 3: Nr. 144. C. H. BORNEBUSCH: Udhugning og Produktion i Bøgeskov (L'influence de la coupe d'éclaircie sur la production d'une forêt de hêtres) S. 273. — H. 4: Nr. 146. E. C. L. LØFTING: Et Underplantningsforsøg i Gludsted Plantage, Hedeskovenes Foryngelse VII (Une Expérience de plantation d'un sous-étage dans la plantation de Gludsted située dans la lande de Jutland), S. 305. — Nr. 147. E. C. L. LØFTING: Lærkearternes Udvikling i Hedeplantagerne og Japansk Lærks Anvendelighed som Hjælpetræ ved Opbygning af Hedeskov, Hedeskovenes Foryngelse VIII. (Le développement des différentes espèces de mélèze dans les plantations des landes, et le mélèze de Japon utilisé comme

arbre auxiliaire dans la culture de forêts des landes), S. 321.
— **H. 5:** Nr. 148. KJELD LADEFØGED: De enkelte Kronedeles produktionsmæssige Betydning hos Rødgren (The productive importance of the individual parts of the crown in spruce, *picéa excelsa* L.), S. 365.

Bd. XVII, H. 1: Nr. 145. CARL MAR: MÖLLER: Untersuchungen über Laubmenge, Stoffverlust und Stoffproduktion des Waldes. (Undersøgelse over Løvmængde, Stoftab og Stofproduktion i Skov). Dansk Resumé. S. 1. — **H. 2:** Nr. 150. C. MUHLE LARSEN: Experiments with softwood cuttings of forest trees (Forsøg med urteagtige Stiklinger af Skovtræer). Meddelelse Nr. 18 fra Skovtræforædlingen, Arboretet, Hørsholm. S. 289.

Bd. XVIII, H. 1: Nr. 149. C. H. BORNEBUSCH og H. A. HENRIKSEN: Bøgens Vedmassefaktorer, 1. Del: Formtalsbestemmelse ved Hjælp af Standardtabeller for mindre Bevoksninger af Bøg, S. 1. — **H. 2:** Nr. 157. MATHIAS THOMSEN, N. FABRITIUS BUCHWALD og POUL A. HAUBERG: Angreb af *Cryptococcus fagi*, *Nectria galligena* og andre Parasiter paa Bøg i Danmark 1939—43. (Attack of *Cryptococcus fagi*, *Nectria galligena* and other parasites on beech in Denmark 1939—43.) S. 97. **H. 3:** Nr. 158. E. C. L. LÖFTING: Rødgranplantagernes Foryngelse i de jydske Hedeegne. 1. Del: Foryngelsesproblemerne. (Regeneration of Norway Spruce in the Danish heath regions. 1' part: The problems of the regeneration). S. 327.

Bd. XIX, H. 1: Nr. 152. C. H. BORNEBUSCH: Bøgeskovens Behandling paa Boller Skovdistrikt. (Le traitement appliqué par E. Moldenhawer à la forêt de hêtres du domaine forestière de Boller), S. 1. — Nr. 153. F. KRARUP: Langsom Bøgeselvforyngelse. (Régénération naturelle lente d'un peuplement de hêtre). S. 81.

— **H. 2:** Nr. 154. CARL MAR: MÖLLER: Mycorrhizae and nitrogen assimilation (Mycorrhizer og Kvælstofassimilation) S. 105. —

H. 3: Nr. 155. C. H. BORNEBUSCH: Egeprøveflader i Nordsjælland. (Places d'essai de chêne au nordest de Seeland). S. 205. Nr. 156. C. A. JØRGENSEN og CECIL TRESCHOW: Om Bekæmpelse af Rodfordærveren (*Fomes annosus* (FR.) CKE) ved Fladrodplantning og ved Kalk- og Fosfattilskud. (On the control of root- and butt-rot, caused by *Fomes annosus* (FR.) CKE by superficial planting and by the application of lime and phosphate). S. 253. **H. 4:** Nr. 159. IB THULIN: Beskadigelser af Douglasgran (*Pseudotsuga taxifolia*) i Danmark i Vinteren 1946—47. (Damageto Douglasfir (*Pseudotsuga taxifolia*) in Denmark in the winter of 1946—47). S. 285. **H. 5:** Nr. 160. MOGENS ANDERSEN: Form factor investigations and yield tables for Japanese larch in Denmark. (Formtal og Tilyækst for japansk Lærk) S. 331.

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