Auto- and Allotriploid Betula-families, Derived from Colchicine Treatment

By Helge Johnsson

Forest Tree Breeding Institute, Ekebo, Källstorp, Sweden

(Received for publication January 11, 1956)

Treatment of germinating hirch seed with colchicine solution produces effects which are entirely analogous to the symptoms in every other plant. The development of the seedling is retarded, the cotyledons are thickened and the radicula is swollen. At the end of the treatment the seedlings are hardly capable of fiirther growth. Surviving seedlings show characteristic morphological changes. The leaves are very coarsely dentated, often asymetrical and with cordate basal lobes, which partly cover each other (Johnsson 1940, Eifler 1955). The wartiness in glandular species is very pronounced. The main stem is short and stout, and lateral branches are often produced in such profusion that the young trees take on a more or less globular form. The stomata are larger than usual, and cells with the doubled chromosome number are seen in root tips (Johnsson 1940) and stem parts (Eifler 1955). The continued growth is very slow. It is evident that these "C_0"-individuals have no practical value of their own. Nevertheless, they are of great interest from a silvicultural point of view, as they can be used as parents of triploid strains, which might be valuable. On account of this the interest is focused on the generative phase of the C„-individuals. The ligniferous plants, however, do not flower until a comparatively high age, and therefore a number of years must elapse before the reproduction and progenies of the C-trees can be studied. The birches are, however, relatively advantageous in this respect as they flower at an age of about ten years or earlier as a rule. Thus, in a C-material of birch, cultivated at the Ekebo institute in Southern Sweden, a sparse flowering has occurred on three C-trees at an age of 12—13 years. In this way it has been possible to raise a couple of triploid C_1-progenies whose development during the first summer is described in the following pages.

Material *and* methods

The investigation comprise three progenies with C_0-trees as mothers. Of these, two belong to the species B. verrucosa, and one is a representative of the F,-species hybrid B. *japonica* X verrucosa. The trees are growing side by side on an experimental field at the institute, and the progenies have been obtained from open pollination. As fathers, the surrounding growing trees of B. verrucosa must have functioned as no other alternative is present. The few male catkins on one of the C-trees had been removed before the flowering. The three C-progenies are compared with one B. verrucosa family and with one F_1-family of B. japonica X verrucosa. The two last mentioned families have been obtained from artificial pollination. The descent of the progenies is the following:

Progeny No 31: B. verrucosa, C,-tree No 108, Östergötland, Sweden X open pollination

Progeny No 7: B. verrucosa, Krakow, Poland X Skåne, Sweden

Progeny No 32: B. verrucosa, "masur", C_0-tree No 469, Småland, Sweden X open pollination

Progeny No 30: B. *japonica* X verrucosa., C,-tree No 5 X open pollination

Progeny No 10: B. *japonica,* Hokkaido, Japan X B. *verrucosa,* Värmland, Sweden.

The seed, harvested in 1954, was sown in the greenhouse in March 1955, and the seedlings were transplanted into outdoor frames in May. The five progenies were planted in plots with 112 plants in each plot, arranged as a block experiment with three replicates according to Fisher. Measurements of growth have been undertakep after the end of the vegetation period. Chromosome counts have been made in paraffin sections of root tips. The statistical treatment follows in essentials the methods of Fisher (1938).

The C_0-*parents*

The C,-parents have been raised from seeds, laid without pregerminaiion in 0.2% colchicine solution, in which the seedlings were kept during three weeks. Stomata measurements at early stages have given the following results for the three actual C_0-trees:

No 108, B. *verrucosa* in 1942: 18.4 units, 1945: 21.5 units
No 469, B. *verrucosa* in 1942: 15.6 units, 1945: 15.5 units
No 5, *B. japonica* X verrucosa in 1945: 20.0 units.

Normal values for diploid *B. verrucosa* as well as for the diploid hybrid are ca. 15 units, with the magnification used (1 unit = 2.4 μ). Accordingly, the trees Nos. 108 and 5 have about 25% longer stomata than diploid trees, whereas the value for tree No 469 is included in the diploid variation. In conformity to this, Nos. 108 and 5 are very characteristic C-trees. Both trees grow very slowly. No 108 has relatively normal form and is about six meters tall, No 5 exhibits the globular type, often occurring in C-trees, and has a height of two meters only. At this age normal diploid trees are about 10 meters tall. The tree No 469 corresponds closely to diploid B. verrucosa trees of the same age. except for the leaves, which have a slight C-appearancc. The flowering in 1954 was rather scanty, each tree having only some ten female catkins; only No 108 had a couple of male catkins. Pollen samplec from these catkins contain large and homogenous grains. In Fig. 3 a microphotograph of this pollen is represented, and in 1 and 2, for comparicon, pollen from diploid and autotriploid B. verrucosa. The pollen sample of the triploid is from a spontaneous mature tree in Södermanland, Sweden. This pollen is characterized by a high percentage of aborted grains (39.3%) and by its high variability, the coefficient of variation being 0.094. The pollen from the C-tree No 108 has the same frequency of good grains as the pollen of a diploid tree and also the same low variability (the coefficients being 0 075 and 0.077, respectively), but it is distinguished by its size. The mean diameter is 11.50 units compared with 11.15 and 9.62 units for pollen from triploid and diploid B. verrucosa. This means that the average diameters of the three lrinds of pollen stand in relation to each other as 120 : 116 : 100. The corrensponding relations between the pollen volumes are 171 : 156 : 100.

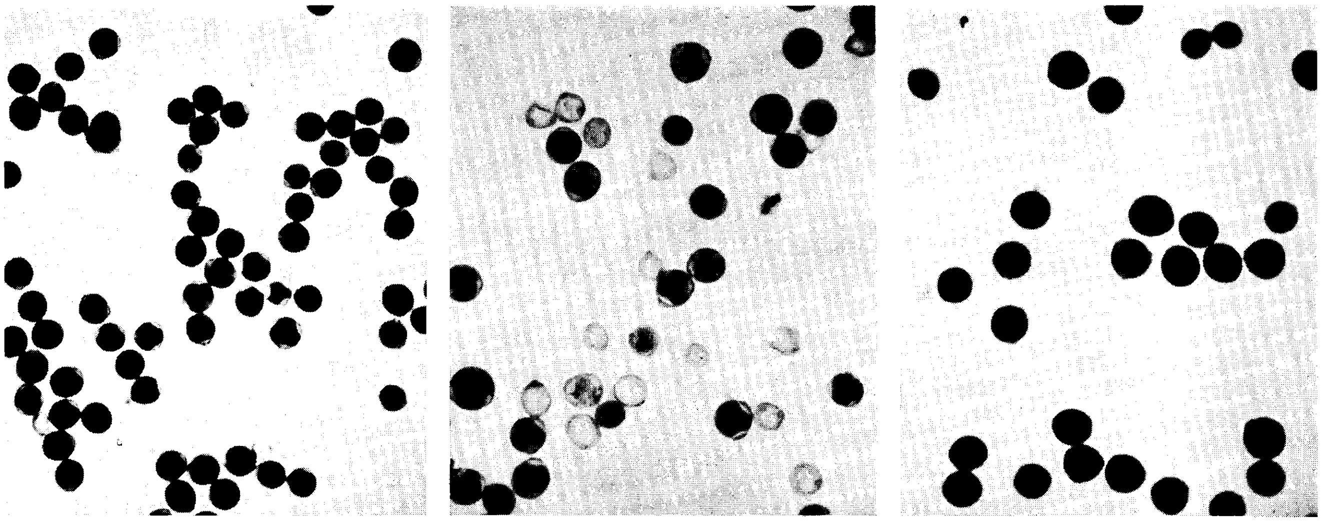

Fig. 1—3. — Microphotographs of pollen. — 1. (left): from diploid. — 2. (middle): from autotriploid. — 3. (right): from C-tree of *Betula verrucosa*.

Table 1. — Pollen characteristics of diploid, triploid and tetraploid *B. verrucosa*

2n	% good grains	diameter units							Mean diameter	Variation coeff.
		8	9	10	11	12	13	14		
2x	98.6	14	70	119	13	1			9.62 ± 0.049	0.075
3x	60.7		9	52	72	60	18	2	11.15 ± 0.072	0.094
4x	99.6		1	22	80	74	20	3	11.50 ± 0.063	0.077

Also the fruits and the bracts from this tree as well as from the C-hybrid are extraordinarily large, whereas the C-tree with small stomata, No 469, has fruits and bracts of normal size. In Fig. 4 the second row from above shows fruits from the C-tree No 108 and the uppermost row fruits of its diploid mother. In the lowest row fruits are represented from the C-treated hybrid, *B. japonica* × *verrucosa,* and in the row above fruits from an untreated sister tree. Bracts, arranged in the same way, are shown in Fig. 5. Thus, the colchicine treatment has caused a very considerable increase in size of fruits and bracts, but — as is seen from the figures — the qualitative characters have remained unchanged. The C-fruits of *B. verrucosa* have preserved the high wings covering the stigma and the oblong nutlets, characteristic of the species. On the other hand the fruits of the C-treated hybrid have the same low wings and the broad nutlets, coming from *B. japonica,* as the untreated sister tree. In an analogous manner the bracts reveal the species.

The frequencies of fruits without embryos have been determined to be:

for No 108, *B. verrucosa* . . . 33.0%
for No 469, *B. verrucosa* . . . 20.7%
for No 5, *B. jap.* × *verr.* . . 83,0%

The percentages of empty nutlets observed for the two C-trees of *B. verrucosa* are to be considered as normal for the species. The seed of the C-hybrid indicates a considerable sterility.

The progenies

Chromosome counts of a number of plants, chosen at random in the three C-progenies have given the following results:

Progeny No 31: *B. verrucosa,* mother tree No 108:
2n = 42, 42, 42, 42, 42, 42, 37, 38, 42, 42, 42.
Progeny No 7: *B. verrucosa,* mother tree No 469:
2n = 27, 28, 29, 28, 32, 28, 31, 29, 30, 28, 28, 28, 28, 28.
Progeny No 30: (*jap.* × *verr.*) × *verr.* mother tree No 5:
2 n = 42, 55, 40, 42, 42, 42, 42, 46, 43, 41, 51, 41, 42.

Thus the progenies of the two typical C-trees are approximately triploid whereas the tree, only slightly influenced by the colchicine, has given a pure diploid progeny. The chromosome numbers are not perfectly exact as the numerous small chromosomes make the counts rather difficult, an uncertainty of about ±2 chromosomes having

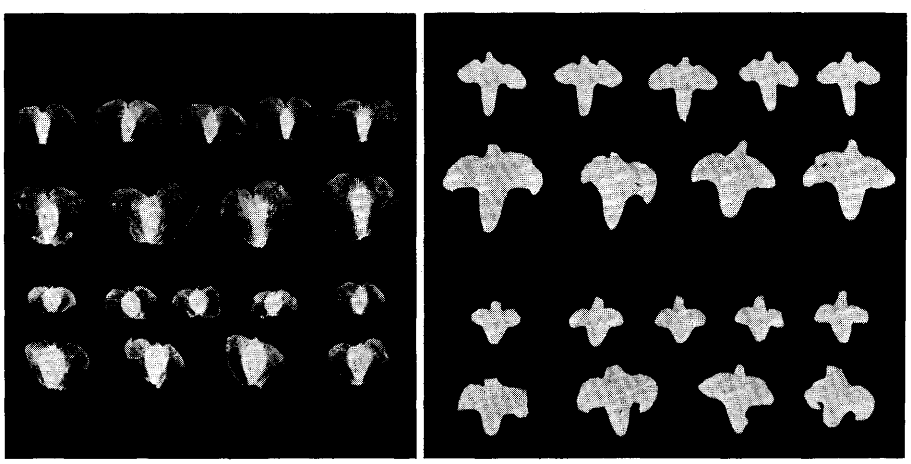

Fig. 4—5. — Fruits and bracts (see text).

to be taken into account. Consequently, numbers stated to be 2n = 27, 29, 30, for instance, are most probably pure diploid, i. e. 2n = 28.

The autotriploid *B. verrucosa* progeny seems to be more exactly triploid than the allotriploid *B. jap.* × *verr.* progeny. For three plants out of 13 belonging to the last-mentioned family the 2n-numbers 55, 46 and 51 have been obtained. This indicates that the amphidiploid tree has a more disturbed meiosis than the autotriploid one. In accordance with this the amphidiploid has lower fertility than the autotriploid.

Table 2. — Plant height of diploid and triploid families, cm

Block	species	*B. verrucosa*			*B. jap.* × *verr.*		Mean
	2n	3x	2x		3x	2x	
	family	31	7	32	30	10	
I		63.8	73.3	61.2	70.0	82.6	—
II		58.0	69.2	62.2	72.6	79.7	—
III		62.2	74.8	64.9	67.5	83.4	—
Mean		61.3	72.4	62.5	70.0	81.9	69.6
R. f.		88	104	90	101	118	100

The average plant heights for plots with somewhat more than 100 plants are presented in table 2. The total mean for the experiment is 69.6 cm. The diploid species hybrid *B. jap.* × *verr.* is the tallest family with a mean height of 81.9 cm or 18% above the total mean. The allotriploid progeny *B. (jap.* × *verr.)* × *verr.* with 70.0 cm coincides closely with the total mean. The autotriploid *B. verrucosa* family is the lowest one, having reached only 61.3 cm, which is to be compared with 72.4 and 62.5 cm, respectively, for the diploid *B. verrucosa* families. Out of these No 7 is to be considered as a particularly fast growing strain under the circumstances, on account of the fact that one of its parents, which comes from Poland, has a much more southern origin than the latitude of the locality where the plants are cultivated. The other diploid *B. verrucosa* family has a slow growing "masur"-birch (tree with curled wood) in its ancestry and is probably slow-growing for this reason.

Analysis of variance of the height measurements give:

	D. F.	Mean squares	S. D.
Blocks	2	8.47	
Varieties	4	209.40	
Error	8	5.94	2.44

It is immediately seen that the significance of the differences between varieties are indisputable. The standard deviation gives an error of 1.41 cm for variety means and without reservation it can be stated that the diploid hybrid has decidedly better height growth than the allotriploid. The autotriploid family is as decidedly inferior to the best diploid *B. verrucosa* progeny.

However, in a case such as this the family means do not tell the whole story. It is very possible that a family with low average height contains a fraction of plants with better growth than the corresponding fraction of a family with higher mean growth. For this reason it is urgent to study the variation within the families. Such a study is carried out in table 3. From this it is seen that the two triploid families have a greater variability than the diploids. The standard deviation for the autotriploid family is 22.15 cm, compared with 17.02 and 15.65 cm, respectively, for the diploid *B. verrucosa*-families. FISHER's z-test gives satisfactory significance for the differences of variance. Also in relation to the mean the triploid family has a greater variation, its coefficients of variability being 0.356 whereas the corresponding values for the diploid families are 0.231 and 0.247. The greater variability of the triploid family depends upon higher frequencies of small plants as is shown in the diagram in Fig. 6. On the plus side the autotriploid family has about the same frequencies of plants as the inferior diploid family and much lower than the superior one. The allotriploid family stands in the same relation to the diploid hybrid. Its standard deviation is 24.10 cm against 16.27 cm, and the z-test gives full significance. The coefficients of variation are 0.338 and 0.197, respectively. Also in this case the variation of the triploid is drawn out in the minus direction (see Fig. 7).

The diameters of the stems have been measured 10 cm above the ground and the measurements are summarised in Table 4. The differences between the families are now much less than was the case for the plant height. The highest variety mean is only 4% above the total mean for all families and the lowest mean only 7% below. The autotriploid family is as good as the diploid *B. verrucosa* progenies and the allotriploid is on the same level as the diploid species hybrid. The analysis of variance confirms that no significant variety differences occur:

	D. F.	Mean squares
Blocks	2	0.0818
Varieties	4	0.1438
Error	8	0.0466

The quotient of the mean squares varieties/error comes to 4.240 only, whereas a significance of 0.01 requires a quotient of 7.01 with the actual degrees of freedom.

As the shorter triploid plants are as thick as the taller diploides, the triploids must be thicker in relation to their height than the diploids. This diameter/height relation has been studied in Table 5. Here an index has been computed for every plant according to: diameter mm/height mm × 100. The mean index for the autotriploid family comes to 0.92 ± 0.011 compared with 0.76 ± 0.008 and 0.83 ± 0.008 for the diploids. Also in this respect the varia-

Table 3. — Intrafamily variation in plant height

Family no.	Species	2n	Plant height cm 5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	Mean cm	S.D. cm	z	Variation coeff.
31	*B. verrucosa*	3x	3	3	5	12	12	10	8	17	21	25	18	26	24	36	22	30	19	12	9	2	4				62.15	22.15		0.356
7	*B. verrucosa*	2x				1	5	5	7	10	9	10	17	21	25	45	42	48	33	29	12	4	2	1			73.53	17.02	0.2634***	0.231
32	*B. verrucosa*	2x			2	1	4	9	8	20	23	26	41	36	44	31	29	35	13	5	1	1					63.31	15.65	9.0835*	0.247
30	*B. jap.* × *verr.*	3x	4	4	4	4	6	5	5	11	12	16	14	23	16	29	28	31	23	21	25	16	6	3			71.24	24.10		0.338
10	*B. jap.* × *verr.*	2x		2	0	0	0	1	3	2	2	7	7	18	27	27	36	41	39	49	32	23	13	4	1	1	82.71	16.27	0.3936***	0.197

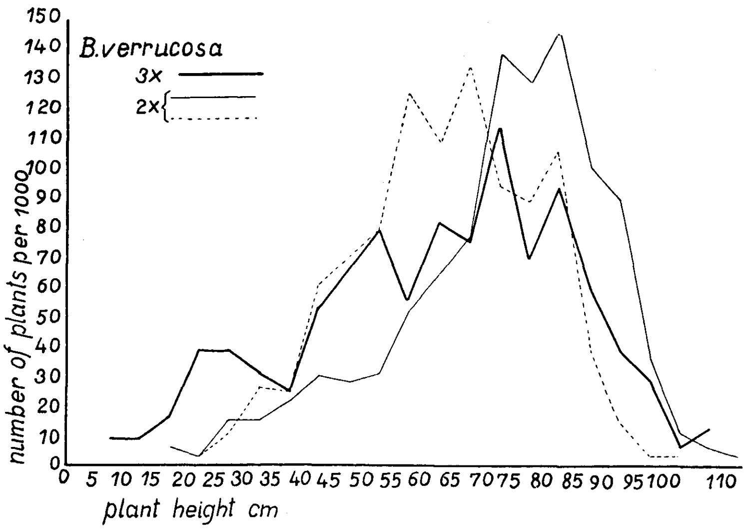

Fig. 6

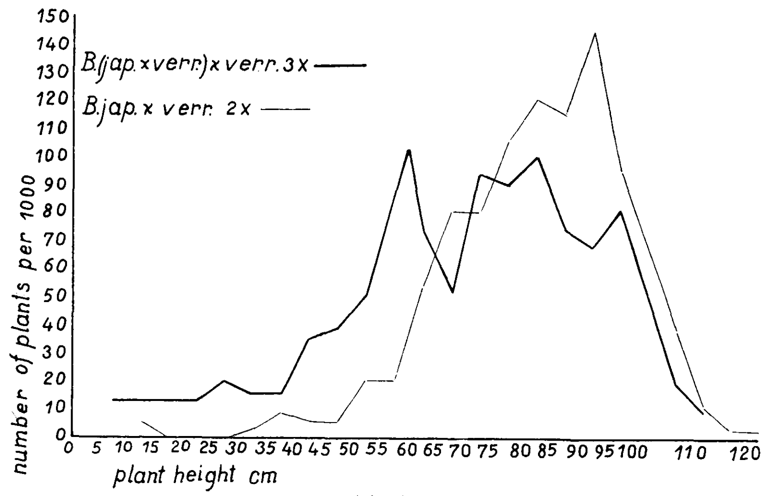

Fig. 7

Table 4. — Stem diameter of diploid and triploid families, 10 cm above the ground, mm

Block	species	*B. verrucosa*			*B. jap.* × *verr.*		Mean
	2n	3x	2x		3x	2x	
	family	31	7	32	30	10	
I		5.37	5.73	5.22	5.57	5.75	—
II		5.27	5.22	4.74	5.72	5.43	—
III		5.68	5.30	5.20	5.31	5.71	—
Mean		5.44	5.42	5.05	5.53	5.63	5.40
R. f.		100	100	93	102	104	101

bility of the triploid is greater than that of the diploids, the standard deviation being 0.180 against 0.149 and 0.138 for the diploids. The z-test proves good significance. The relative variability, however, is not greater for the triploid than for one of the diploid families, the coefficient of variation being 0.196 and 0.197 respectively. The curves in Fig. 8 show that the variation of the triploid progeny is drawn out in the plus direction in this case. A comparison between the allotriploid family and the species hybrid (Table 5 and Fig. 9) produces the same result but with the difference that also the relative variability is greater for the triploid than for the diploid, the coefficients being 0.224 and 0.158.

Birch plants, cultivated according to the method used here, i. e. with sowing and pre-cultivation in the greenhouse, often develop a varying number of lateral branches as early as the first summer, and this has also been true of the experiment under discussion. However, the frequency of plants with lateral branches as well as the number of such branches varies widely in the different families as is seen from Table 6, this variation being independent of the chromosome numbers. The autotriploid progeny has the lowest frequency of plants with branches, 8.9 ± 1.67% only, whereas the allotriploid has the second highest frequency or 67.1 ± 2.82%. The mean number of branches per plant is 0.17 in the autotriploid and 3.19 in the allotriploid. The majority of plants in the diploid species hybrid or 61.5 ± 2.69% have no branches. The average number of branches per plant is 1.17 in this family. Most branchy is one of the diploid *B. verrucosa* families.

Discussion and summary

By means of colchicine treatment tetraploid individuals have been produced in *Betula verrucosa* and *B. japonica* × *verrucosa*, which both originally are diploids with 2n = 28. These artificial tetraploids are characterized by their large, coarsely dentated leaves, large fruits and bracts but are slow-growing and often possess an abnormal form, caused by excessive branchyness. They produce apparently normal pollen but the grains are considerably larger than in the original diploids. The fertility on the female side is reduced, but remains high enough to obtain large progenies. Retarded growth and abnormal form, caused by excessive branchyness, seem to be characteristic features for artificial tetraploids of ligneous plants of angiospermous as well as of gymnospermous genera, as has been observed earlier in *Alnus glutinosa* (Johnsson 1950) and *Picea Abies* (Kiellander 1950).

The C-tetraploid *B. verrucosa* and the C-amphidiploid *B. japonica* × *verrucosa* have been pollinated with diploid *B. verrucosa*, and triploid progenies have been obtained. In the allotriploid progeny, however, individuals with deviating higher chromosome numbers occur in rather a high frequency, indicating that the meiosis in the amphidiploid is irregular. The triploid progenies grow normally without any trace of the retardation, exhibited by the C-tetraploid mothers. During the first summer the growth in height of the triploids has been somewhat less than that of comparable diploid families but the growth in diameter has been equal to that of the diploids. Consequently the triploid yearlings are shorter and more stout, the diploid ones taller and more slender. The autotriploid progeny has developed proleptic branches in an unusually low frequency. The triploids show a greater variability than the diploids. This depends upon the fact that extremely small plants are in excess in the triploid families. Increased variability in autotriploid ligniferous plants has been stated earlier in *Alnus glutinosa* and *Populus tremula* (Johnsson 1950 and 1953) and is explained — at least partly — as being caused by the occurrence of aneuploids with reduced vitality in the triploid progenies.

Of course, it is impossible to draw any conclusions about the future development of the triploid families at this early stage. However, it may be predicted that the triploids will continue to grow "normally" and that they pro-

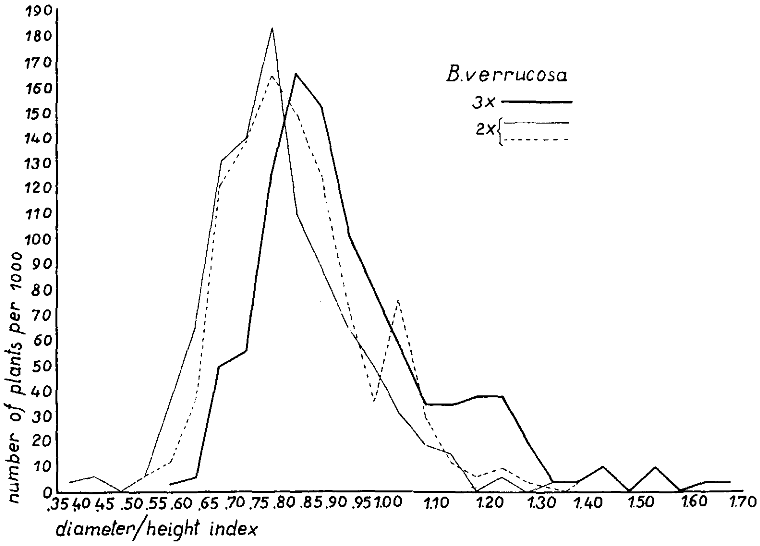

Fig. 8

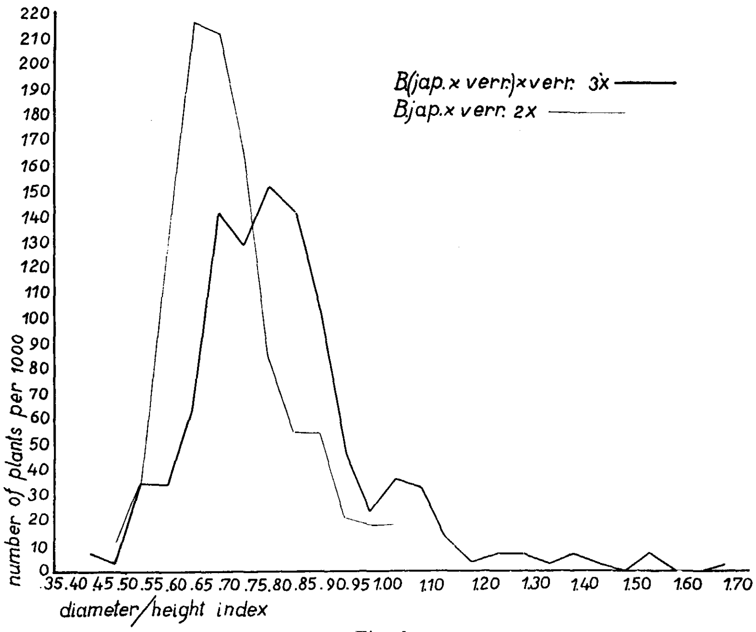

Fig. 9

bably will grow somewhat less in height and somewhat more in diameter than the original diploid strains. In any case it should be stated that artificial, triploid strains of birch seem to be worth testing and that the colchicine method is useful for production of such strains with a varied gene constitution.

Zusammenfassung

Titel der Arbeit: *Nach Colchicinbehandlung entstandene auto- und allotriploide Betula-Familien.* —

Von *Betula verrucosa* und *B. japonica* × *verrucosa*, beides Formen, die ursprünglich diploid mit 2 n = 28 sind, sind tetraploide Individuen durch Colchicinbehandlung hergestellt worden. Diese zeichnen sich durch große, grob gezähnte Blätter, große Früchte und Fruchtschuppen aus (Abb. 4—5); sie wachsen langsam und haben oft eine abnorme Wuchsform. Der Blütenstaub ist augenscheinlich normal, besteht aber aus Körnern, die wesentlich größer als die der diploiden Arten sind (Tab. 1, Abb. 3). Die Fertilität auf der weiblichen Seite ist herabgesetzt, dennoch noch hoch genug, um das Aufziehen großer Nachkommen-

Table 5. — Intrafamily variation in diameter/height index

Family no.	Species	2n	diameter / height index																											Mean	S. D.	z	Variation coeff.
			.35	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65				
31	*B. verrucosa*	3x					1	2	16	18	40	53	50	33	26	19	11	11	12	12	6	1	1	3	0	3	0	1	1	0.92 ± 0.011	0.180		0.196
7	*B. verrucosa*	2x	1	2	0	2	11	21	43	46	60	36	34	21	16	10	11	6	5	0	2	0	1							0.76 ± 0.008	0.149	0.189***	0.197
32	*B. verrucosa*	2x					2	4	12	40	46	54	49	41	24	12	25	10	4	2	3	1	0	1						0.83 ± 0.008	0.138	0.080*	0.167
30	*B. jap.* × *verr.*	3x		2	1	10	10	19	43	39	46	43	31	14	7	11	10	4	1	2	2	1	2	1	0	2	0	0	1	0.80 ± 0.010	0.179		0.224
10	*B. jap.* × *verr.*	2x				12	33	117	216	213	162	84	54	54	21	18	18													0.70 ± 0.006	0.110	0.481***	0.158

Table 6. — Numbers of proleptic branches in diploid and triploid families

Family no.	Species	2n	Numbers of proleptic branches																n	Mean	% plants with 0 branches
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
31	*B. verrucosa*	3x	266	12	10	3	1	2											292	0.17	91.1 ± 1.67
7	*B. verrucosa*	2x	71	19	30	24	27	41	30	29	8	15	7	5	2				309	3.92	23.0 ± 2.39
32	*B. verrucosa*	2x	159	29	35	28	18	19	10	8	3	6	4	1	0	1			321	1.89	49.5 ± 2.79
30	*B. jap.* × *verr.*	3x	91	18	25	28	30	27	17	12	13	4	2	1	3	2	3	1	277	3.19	32.9 ± 2.82
10	*B. jap* × *verr.*	2x	201	37	20	26	19	10	6	3	0	4	1						327	1.17	61.5 ± 2.69

schaften zu ermöglichen. Langsamer Zuwachs und abnorme Wuchsform, die auf sehr reichlicher Zweigbildung beruht, scheinen für künstliche tetraploide Holzpflanzen sowohl bei bedecktsamigen wie bei nacktsamigen Gattungen kennzeichnend zu sein; dies wurde schon früher u. a. für *Alnus glutinosa* (Johnsson 1950) und für *Picea Abies* (Kiellander 1950) angegeben.

Bestäubungen von der C-tetraploiden *B. verrucosa* und der C-amphidiploiden *B. japonica* × *verrucosa* mit diploider *B. verrucosa* haben triploide Nachkommenschaften ergeben. In der allotriploiden Nachkommenschaft kommen Individuen mit abweichenden höheren Chromosomenzahlen häufig vor. Damit wird angedeutet, daß die Reifeteilung der Amphidiploiden unregelmäßig ist. Die triploden Familien wachsen normal ohne solche schweren Zuwachshemmungen, an welchen die C-tetraploiden Mutterbäume leiden. Während des ersten Jahres ist der Höhenzuwachs der Triploiden ein wenig niedriger als bei vergleichbaren diploiden Familien gewesen (Tab. 2), während der Durchmesserzuwachs dieselben Werte wie bei den Diploiden erreicht hat (Tab. 4). Die 1jähr. triploiden Pflanzen sind kürzer und gröber, die diploiden länger und schlanker. Die Triploiden variieren stärker als die Diploiden, was hinsichtlich des Zuwachses darauf beruht, daß besonders kleine Pflanzen in den triploiden Familien überrepräsentiert sind (Tab. 5, Abb. 6—7). Über die vergrößerte Variationsbreite der autotriploiden Holzpflanzen sind schon früher Angaben gemacht worden (Johnsson 1950 und 1953); sie wird wenigstens teilweise dadurch erklärt, daß nur wenig lebensfähige aneuploide Individuen in den triploiden Nachkommenschaften vorkommen.

Die autotriploide Nachkommenschaft hat proleptische Seitenzweige in einem ungewöhnlich niedrigen Prozentsatz ausgebildet (Tab. 6, Abb. 8—9).

Zu diesem frühen Zeitpunkt ist es natürlich nicht möglich, Schlußfolgerungen über die künftige Entwicklung der Triploiden zu ziehen. Immerhin dürfte man doch vorhersagen können, daß die Triploiden normal weiterwachsen werden und daß sie wahrscheinlich einen wenig niedrigeren Höhenzuwachs und einen wenig größeren Durchmesserzuwachs als die diploiden Ursprungsrassen bringen werden. In jedem Falle kann man feststellen, daß künstliche triploide Birkenrassen einer Prüfung wert sind und daß die Colchicinmethode die Herstellung solcher Rassen mit verschiedenen Erbanlagen ermöglicht.

Résumé

Titre de l'article: *Populations de bouleaux auto et allotripoïdes obtenus par traitement à la colchicine.* —

Des individus tetraploïdes ont été obtenus par traitement à la colchicine à partir de *Betula verrucosa* et *B. japonica* × *B. verrucosa* diploïdes (2n = 28). Ces tétraploïdes artificiels sont caractérisés par les grandes dimensions de leurs feuilles, irrégulièrement dentées, de leurs fruits et des bractées, mais ils poussent plus lentement et ont souvent un port anormal, dû à des ramifications plus nombreuses. Ils produisent un pollen d'apparence normale, mais les grains sont beaucoup plus grands que chez les diploïdes. La fertilité femelle est réduite, mais reste assez elevée pour qu'on puisse obtenir des descendances importantes. Le retard de croissance et le port anormal semblent être des traits communs a tous les tétraploïdes artificiels d'espèces ligneuses, aussi bien angiospermes que gymnospermes; les mêmes observations ont déjà été faites sur *Alnus glutinosa* (Johnsson 1950) *et Picea abies* (Kiellander 1950).

Les *B. verrucosa* C. tétraploïdes et les *B. japonica* × *B. verrucosa* C. amplidiploïdes ont été pollinisés par un *B. verrucosa* diploïde, et le croisement a donné des descendants triploïdes. Cependant, dans la descendance allotriploïde, on observe une fréquence assez élevée d'individus avec un nombre de chromosomes supérieur à 3n, ce qui indique que la méiose de l'amphidiploïde est irrégulière. Les descendants triploïdes poussent normalement, sans aucune trace du retard observé chez les mères C. tétraploïdes. Pendant la première saison de végétation, la croissance en hauteur des triploïdes a été légèrement inférieure à celle des populations diploïdes homologues, mais la croissance en diamètre a été aussi forte. Les semis triploïdes sont donc plus courts et plus forts, les diploïdes plus grands et plus minces. Les descendants autotriploïdes ont développé un nombre anormalement faible de branches proleptiques. La variabilité des triploïdes est plus forte que celle des diploïdes, ce qu'on ne peut rattacher au fait que les plants extrêmement petits sont en excès dans les populations triploides.

Cette grande variabilité des plantes ligneuses autotriploïdes a dèjà été constatée chez *Alnus glutinosa* et *Populus tremula* (Johnsson 1950 et 1953) et s'explique — au moins partiellement — par la présence d'aneuploïdes à vitalité réduite. Il est évidemment impossible de conclure aussi tôt sur le développement futur de ces populations triploïdes. On peut cependant prédire que les triploïdes continueront à pousser "normalement", probablement un peut moins en hauteur et un peu plus en diamètre que les lignées diploïdes homologues. On peut conclure d'une part que ces lignées de bouleaux triploïdes artificiels constituent un intéressant matériel d'expérimentation, d'autre part que le traitement à la colchicine permet de produire de telles lignées avec diverses constitutions géniques.

Literature Cited

Eifler, I.: Künstliche Polyploidie-Erzeugung bei *Picea abies* und *Betula verrucosa*. Z. Forstgenetik 4, 162—166 (1955). — Fisher, R. A.: Statistical methods for research workers. London 1948. — Johnsson, H.: Växtförädling av björk — mål och medel. Medd. fr. Fören. f. växtförädl. av skogstr. Svensk Papperstidning 1940. — Johnsson, H.: On the C_0 and C_1 generation in *Alnus glutinosa*. Hereditas 36, 205—219 (1950). — Johnsson, H.: Development of triploid and diploid *Populus tremula* during the juvenile period. Z. Forstgenetik 2, 73—77 (1953). — Kiellander, C. L.: Polyploidy in *Picea Abies*. Hereditas 36, 513—516 (1950).