Przybylski, T.

THE METHOD OF THE PROVENANCE EXPERIMENTS WITH SCOTS PINE (*PINUS SILVESTRIS* L.) FROM POLAND, SET UP BY THE DEPARTMENT OF DENDROLOGY AND KÓRNIK ARBORETUM, POLISH ACADEMY OF SCIENCES

(Metodyka doświadczeń proweniencyjnych z sosną zwyczajną (*Pinus silvestris* L.) z terenu Polski, założoych przez Zakład Dendrologii i Arboretum Kórnickie PAN)

Scots pine is our most important species of forest trees and some of its geographical races from Poland arouse much interest among foresters not only at home but also abroad. This is reflected in the fact that material from Poland and neighboring areas has an important share in the international experiments initiated by the International Union of Forest Research Organizations (IUFRO) in 1936 (Wright and Baldwin, 1957; Langlet, 1959; Veen, 1952). The experimental areas were established in 1938 to 1940 and some of the material is therefore certain to have been lost during the war. The experiment in Lubień (Przybylski and Sztuka, 1968) seems to be the only trace of the provenance experiments with pine in our country of that time.

Exact studies of the variability of Scots pine are very difficult. Tentative studies of this aspect for the entire range of distribution (Novak, 1953; Pravdin, 1964) have yielded inconsistent results. The difficulties become all the greater when they concern a relatively small area, such as in Poland. Past work (Sokołowski, 1931; Staszkiewicz, 1961; Józefaciuk, 1965) considers different facets of this aspect and does not give a synthetic approach.

The differentiation of Scots pine in Poland cannot be doubted. It involves the habitus, dynamic of growth, and resistance to diseases (Siwecki, 1966), although with our present knowledge of the species an accurate determination of this variability in respect of systematic botany as well as geography is still impossible. This variability is probably rooted in differences in the adaptability to the climatic conditions in particular regions.

With this in mind, the Department of Dendrology and Kórnik Arboretum, Polish Academy of Sciences started a provenance experiment, the purpose of which, method, and preliminary documentation I wish to present in this paper.

The unit considered in the experiment is a local population, i.e. provenance, irrespective of its morphological and physiological characters. The term "population" is here of a mathematical character, meaning a group of individuals having one thing in common, their origin. The solution of the problem posed at the beginning requires that the population investigated be representative and, if possible, native. These two requirements are vastly important for the whole experiment.

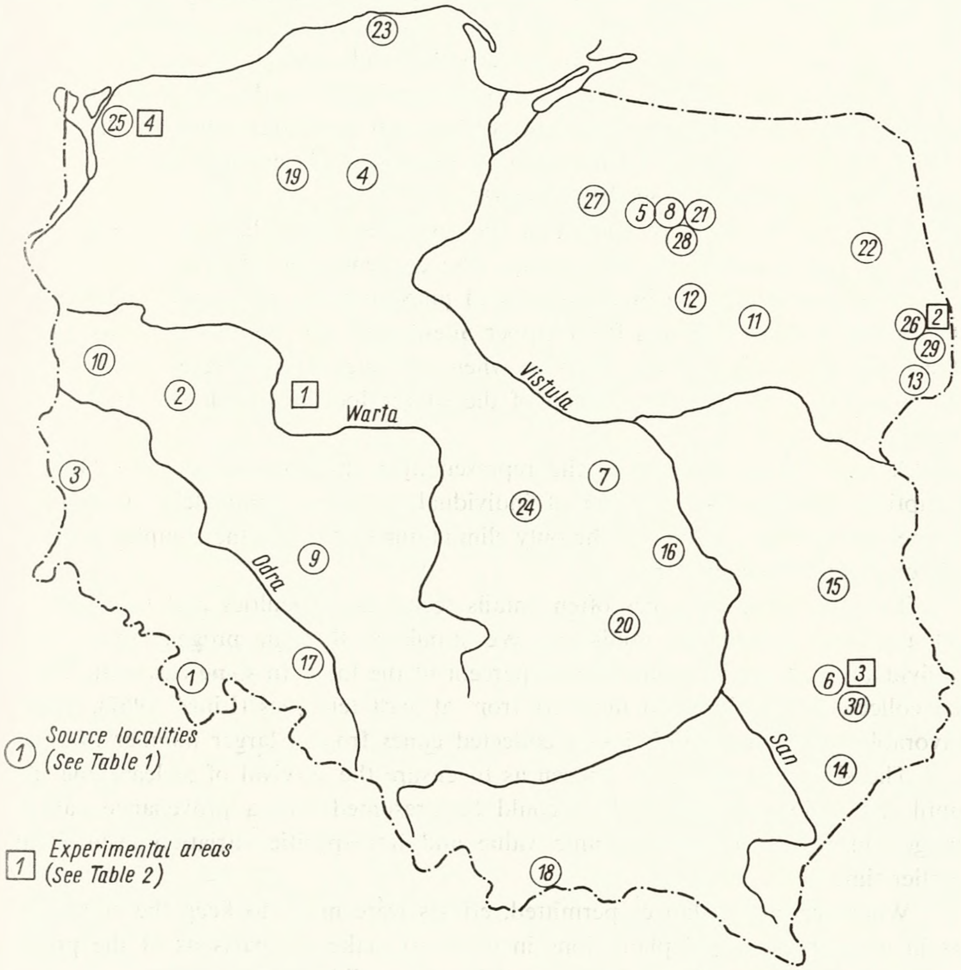


Fig. 1. Distribution of the source localities and experimental areas.

Hence, in selecting the provenances we considered native tree stands. In each case we strove to do this in agreement with the local organs of the forest administration (the State Forest Administration Provincial Unit and the Forest District concerned). However, pine is a species distributed throughout the entire country and long cultivated. Hence there are regions where the local tree stands cannot be said with all certainty to be native. We therefore took the position that when in a given region a doubtfully native tree stand cannot be replaced by a fully certain one, the criterion must be quality. When at harvest-age a tree stand shows good increments and is valuable as far as technical and cultivation requirements go, the population may be regarded as adequately adapted to the local climatic conditions. This reservation concerns only exceptional situations, since on the whole native tree stands can still be found in all regions of the country. Similar criteria were adopted in selecting seed tree stands.

The provenances were chosen in such a maner as to have a possibly most complete representation of the country. The concentration of source localities in the North-East is justified by the quality of pine from this region (Giertych, 1965). The absence of provenances from Upper Silesia and the south of the province of Cracow is due to the fact that the year when the cones were collected was typically sterile in this area. The distribution of the source localities is shown on the map and in Table 1.

A very important point is the representative character of samples. Our assumption was that the selection of individuals must be completely randomized. There was no preselection and the only eliminating factor was the complete absence of cones on a particular tree.

The harvesting of cones often entails technical difficulties and therefore we set a certain quantitative minimum. We stipulated that the progeny of a single individual must not be more than 10 percent of the total. In some cases, therefore, we collected cones in equal numbers from at least ten trees (Lines, 1967). Under favorable conditions we obviously collected cones from a larger number of trees.

The size of plots was so chosen as to ensure the survival of at least one tree until the felling age, although it could be presumed that a provenance can be judged in respect of its economic value and intraspecific variation even at an earlier time.

Wherever circumstances permitted, efforts were made to keep the conditions as in ordinary standard plantations in order to make comparisons of the provenances with current afforestations as reliable as possible.

A comparative plantation of many provenances makes it possible to determine the degree of adaptation of each to the local climatic conditions. Comparison of several plantations of the same age, on the other hand, but located in regions differing in climatic conditions makes it possible to reveal the interaction of provenance with the habitat. This will show the range of the ecological requirements of individual provenances. In starting the experiments the method of ran-

Table 1

List of the Provenances Covered by the Experiment set up by the Department of Dendrology and Kórnik Arboretum, Polish Academy of Sciences

No.	Abbreviation on labels	Source Forest District	State Forest Admin. Prov. Unit	Catalogue No.	Long. E.	Lat. N	Alt., in m
1	BK	Bystrzyca Kłodzka	Wrocław	S-15-162	16°36′	50°17′	580
2	Bo	Bolewice	Poznań	S-08-164	16°03′	52°28′	90
3	Br	Brody	Żary	S-16-163	14°50′	51°46′	80
4	Cz	Czersk	Toruń	S-14-168	17°58′	53°52′	130
5	Dł	Dłużek	Olsztyn	S-07-139	20°39′	53°33′	145
6	JL	Janów Lubelski	Lublin	S-05-154	22°25′	50°40′	250
7	KPN	Kampinoski National Park	Siedlce	S-11-149	20°41′	52°19′	95
8	Kr	Krutyń	Olsztyn	S-07-141	21°28′	53°31′	150
9	Ku	Kubryk	Wrocław	S-15-160	17°18′	51°23′	160
10	Lu	Lubniewice	Żary	S-16-165	15°16′	52°35′	40
11	Ło	Łomża	Białystok	S-01-144	22°15′	53°05′	208
12	My	Myszyniec	Siedlce	S-11-143	21°12′	53°20′	
13	Nu	Nurzec	Białystok	S-01-148	23°09′	52°25′	170
14	Ol	Oleszyce	Przemyśl	S-09-156	23°00′	50°15′	220
15	Pa	Parczew	Lublin	S-05-153	22°55′	51°35′	150
16	Pi	Pionki	Radom	S-10-152	21°20′	51°30′	140
17	Pr	Prószków	Opole	S-17-161	17°48′	50°35′	190
18	PPN	National Park of Pieniny	Kraków	S-04-157	19°20′	49°20′	770
19	Rad	Radawnica	Szczecinek	S-12-169	16°58′	53°30′	110
20	Rat	Rataje	Radom	S-10-151	21°05′	51°00′	250
21	Ru	Ruciane	Olsztyn	S-07-140	21°31′	53°51′	145
22	Se	Serwy	Białystok	S-01-145	23°08′	53°51′	130
23	Sm	Smołdzino	Szczecinek	S-12-167	17°29′	54°45′	3
24	Sp	Spała	Łódź	S-06-150	20°10′	51°32′	150
25	St	Stepnica	Szczecin	S-13-166	14°41′	53°40′	4
26	Su	Supraśl	Białystok	S-01-146	23°07′	53°15′	165
27	Tb	Tabórz	Olsztyn	S-07-138	20°00′	53°34′	110
28	Wb	Wilcze Bagno	Olsztyn	S-07-142	21°36′	53°32′	
29	ZwB	Zwierzyniec	Białystok	S-01-147	23°45′	52°42′	160
30	ZwL	Zwierzyniec	Lublin	S-05-155	23°00′	50°38′	260
31	V-170		Värmland	S-26-170		59°30′	100–200
32	V-171		,,	S-26-171		59°	0–100
33	V-177		,,	S-26-177		60°	100–200
34	V-178		,,	S-26-178		59°30′	200–300
35	V-179		,,	S-26-179		60°	300–400
36	Kó	Planting stock used by the Zwierzyniec Forest Subdistrict					

domized blocks in octuplicate was used, which enables the statistical significance of the differences between the elements compared to be calculated (Włoczewski and Kędzierski, 1965).

During the experiment any measurements and observations relating to the living material can be made at any time and material for laboratory investigations can be collected at certain periods under strictly controlled conditions. The purpose is to investigate the anatomical and physiological characters. During cultivation operations, such as cleaning and thinning, certain dendrometric analyses can be made.

This kind of procedure enables material to be collected which shows the hereditary intraspecific variability of Scots pine in Poland. Its accurate knowledge is a condition for rational forest management.

The cones were collected in autumn 1965 in regular felling areas agreed upon beforehand with the State Forest Administration Provincial Units concerned. The collecting was always conducted and supervised by the Department's scientific staff.

The seeds were extracted from cones in the Department of Dendrology in winter 1965/66 and kept in sealed bottles in a refrigerator.

The seeds were sown in the Department's Forest Subdistrict Zwierzyniec in spring. With the planned number of seedlings in mind, 40 g of seeds were used in random-distributed quadruplicates of 10 g each. Since the amounts of seeds of particular provenances available to us varied, sometimes leaving nothing to spare, their standard evaluation (germination capacity and energy) was impossible; the percentage of germination was determined approximately by counting the seedlings in the nursery rows.

In spring 1967 the seedlings were lifted and pitted. The material prepared in this manner was used to start comparative plantations in the following localities (see also Table 2).

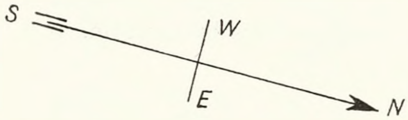
Table 2

Location of the Experimental Areas

No.	Locality or Forest District	State Forest Admin. Prov. Unit.	Forest Subdistrict	Section	Long. E	Lat. N	Alt., in m
1	Experimental Forest Subdistrict of the Dept. of Dendrol., Kórnik near Poznań	Poznań		5	17°11′	52°14′	75
2	Sokółka	Białystok	Klin	196	23°34′	53°18′	185
3	Janów Lubelski	Lublin	Momoty	318	22°05′	50°41′	175
4	Stepnica	Szczecin	Rybitwa	25	14°42′	53°43′	20

(1) The Department's Forest Subdistrict Zwierzyniec, near Kórnik, Section 5c. The original pine stand was cleared and the soil ploughed up thoroughly in preparation for planting. The grid patern was 1.20 m by 0.50 m and the whole plantation area was screened by several rows. The randomized distribution of the plots is shown in Fig. 2.

(2) The Forest District Sokółka of the State Forest Administration Provincial Unit Białystok, Forest Subdistrict Klin, Section 196f. The area, cleared in

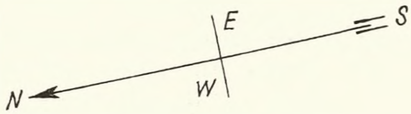


Block I	Br Pa 178	179 Kr Cz	Ru 177 Lu	Ło Pi 171	Ol KPN Sp	Rat Dł Kó	PPN Sm ZwL	Su St My	170 Pr Tb	Bo Ku ZwB	Bk Rad JL	Se Nu WB
Block II	Sm Cz Sp	Ol BK Kó	JL KPN 171	Pa Pi 177	Nu My ZwB	Ku St 179	Lu ZwL Bo	178 170 Dł	PPN Pr Tb	Su Ło Rad	Rat Kr Ru	Se Br WB
Block III	Br Pr Ol	Se Pa Lu	Tb WB BK	178 ZwL Pi	171 Ku Bo	Rad Rat Su	ZwB JL PPN	Ru My Kr	170 177 179	KPN Cz Dł	Nu Sm Kó	Ło Sp St
Block IV	ZwB Ku BK	Sm St Pi	Ru 178 Bo	170 ZwL Kó	KPN My Dł	Nu 171 179	Ło 177 Kr	Cz Rad PPN	WB Sp Br	Pr Tb Rat	Pa Lu Ol	JL Se Su
Block V	Nu Rat My	Ło Pr 177	Ru JL Sm	KPN BK Pi	179 Br Ol	Se Tb ZwL	Pa Bo ZwB	170 Kó WB	Su 178 Sp	Kr 171 St	Ku Rad PPN	Lu Cz Dł
Block VI	Br Su 170	PPN Bo ZwB	Cz 178 Ku	Lu Rat Pr	Dł St WB	171 Sp ZwL	Kó Se Ło	Ru Pa Rad	My 177 Kr	JL Pi Tb	BK Sm Nu	179 KPN LO
Block VII	Nu Bo 178	Pa Ku ZwL	Ol ZwB 177	Kr Dł Sp	St Ru KPN	JL PPN WB	Pr Pi 170	Rad Sm Tb	Br Lu Cz	Rat Ło 179	Se My 171	Kó Su BK
Block VIII	Rat 170 PPN	Tb Ru 179	WB Se ZwL	Cz Sm 177	BK Sp 171	Ku St Su	KPN Pr Br	Lu Rad Pa	Ło Bo Ol	178 ZwB Nu	Kó Dł My	Pi JL Kr

Fig. 2. Complete randomized block pattern of the experiment with pine provenances in the Zwierzyniec Forest Subdistrict.

winter 1966/67, was prepared by ploughing up strips as is the usage in afforestation. The experimental area is situated in a major plantation surrounded on three sides by a regular forest plantation. A screening belt was set up along the section line which marked the border of the experimental plantation. Figure 4 shows the distribution of the plots and blocks in Sokółka.

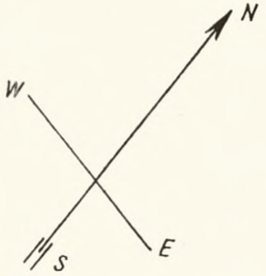
(3) The Forest District Janów Lubelski of the State Forest Administration Provincial Unit Lublin, Forest Subdistrict Momoty, Section 318. The area in a pine stand was cleared in winter 1966/67 and was very carefully prepared by hand work in strips. The experimantal area is surrounded on two sides by a regular plantation and on the other two sides by screening belts. The situation in Janów Lubelski is shown in Fig. 3.



Nu	179	Lu	My	WB	BK	Pr	Ol	Rat	Cz	WB	My	Pi	Dł	Lu	Pi
Rad	178	WB	Pi	Rad	Pa	My	Dł	Rad	WB	Ło	177	Pr	177	Tb	Ru
Pr	Br	Ol	Cz	179	Su	Pi	Sm	BK	Pi	Sp	Kr	ZwB	Tb	Su	KPN
Dł	Pa	ZwL	Nu	Sm	ZwL	Cz	Kr	Pa	177	Tb	Sm	Bo	JL	Pr	Dł
170	Sp	Ru	Sm	St	Pr	Rat	JL	Ku	Sp	Pa	170	Se	WB	Br	Ło
Bo	Se	Se	St	Kr	170	177	Lu	KPN	Ol	Su	Rat	Sp	Ol	Sp	Rad
171	St	Sp	178	Dł	Bo	Rad	171	Se	Ło	JL	Cz	179	Sm	171	BK
Kr	Su	ZwB	Rat	Sp	Nu	St	Sp	Su	St	Rad	Lu	ZwL	Rad	179	WB
Rat	Cz	Ło	Kr	Ku	My	Ku	170	Dł	178	Se	ZwB	Nu	178	170	My
ZwL	Ol	Su	Bo	JL	Br	BK	Bo	Lu	Pr	BK	Dł	Pa	Ru	St	Nu
Ku	177	BK	170	171	Tb	Su	WB	Ru	Bo	Bo	Pi	Kr	Br	JL	Rat
JL	Sm	171	KPN	KPN	Cz	ZwL	Ru	My	ZwB	Nu	178	KPN	171	ZwL	Se
KPN	Tb	Rad	JL	Rat	Ło	Nu	Br	ZwL	Sm	Pr	179	St	Cz	Pa	Cz
BK	My	Tb	Br	Se	Ru	ZwB	Ło	170	Kr	Br	ZwL	BK	170	177	Bo
Ru	Ło	177	Ku	ZwB	Ol	178	Tb	Nu	179	St	Ku	Rat	Su	Ol	ZwB
ZwB	Pi	179	Dł	Pi	178	Pa	179	171	Tb	Ol	171	Lu	My	Sm	Ku
Lu	WB	Pa	Pr	177	Lu	Se	KPN	Br	JL	Ru	KPN	Ku	Ło	Kr	178
Block I		Block II		Block III		Block IV		Block V		Block VI		Block VII		Block VIII	

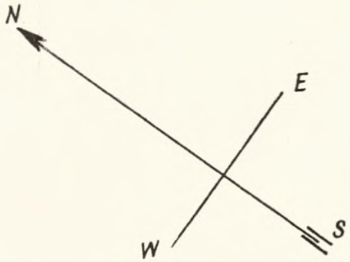
Fig. 3. Complete randomized block pattern of the experiment with pine provenances in the Forest District of Janów Lubelski.

(4) The Forest District Stępnica of the State Forest Administration Provincial Unit Szczecin, Forest Subdistrict Rybitwa, Section 25. The recently cleared area was prepared by ploughing up strips by tractors. It is surrounded on three sides by a regular plantation and on the fourth side it is separated from a pine stand by a screening belt (Fig. 5).



Bl. I	St	Cz	Sm	ZwL	ZwB	WB	BK	Ru	My	177	Su	Rat	Br	Ło	Bo	Ol	179	Rad	Pi	Pa	Se	Lu	KPN	Dł	Tb	178	Sp	170	Ku	171	Kr	JL	Pr	Nu
Bl. II	179	My	171	177	Pi	178	Se	KPN	Bo	ZwL	Ru	St	Nu	Tb	Su	Pr	Rat	BK	Sm	Ku	170	JL	Rad	Kr	Pa	ZwB	Ło	Sp	Lu	Dł	Cz	WB	Ol	Br
Bl. III	Ło	Bo	JL	Ol	Pa	Cz	Sm	ZwL	Dł	My	170	179	Rad	Br	Pi	Nu	Lu	Tb	WB	Kr	178	Sp	St	171	Pr	KPN	ZwB	Ku	Rat	177	Se	Ru	BK	Su
Bl. IV	Bo	Ol	Rat	Su	BK	Pi	Kr	Sp	178	Tb	171	Pr	170	177	Br	Nu	St	Pa	My	Cz	Sm	ZwL	WB	Ku	Lu	ZwB	JL	Ru	179	Ło	Rad	KPN	Se	Dł
Bl. V	Lu	BK	Pa	Bo	Sm	Ol	Su	Ło	Se	177	Rat	Ku	Pi	Sp	Br	Dł	My	170	Nu	Pr	Rad	179	ZwL	WB	Tb	St	Cz	Ru	171	JL	KPN	Kr	178	ZwB
Bl. VI	WB	St	Ku	KPN	Sm	179	ZwL	Su	Ru	BK	Pi	Kr	Sp	178	Se	Tb	171	Bo	Pa	Lu	ZwB	Rad	Ol	JL	Dł	Pr	177	My	Nu	Br	Rat	170	Ło	Cz
Bl. VII	Pa	Se	Ru	Dł	JL	Rad	179	Ol	Ku	Bo	Sm	BK	WB	ZwL	170	Cz	ZwB	Br	Ło	My	171	Su	Tb	Pi	Rat	Nu	Lu	KPN	Pr	178	Sp	177	Kr	St
Bl. VIII	Ol	Br	179	170	Ło	Pr	Rat	Nu	Dł	Sm	178	Sp	171	Lu	Su	ZwB	Pa	177	Rad	JL	Tb	KPN	Bo	BK	WB	Cz	Kr	Pi	St	Ru	My	Ku	Se	ZwL

Fig. 4. Complete randomized block pattern of the experiment with pine provenances in the Forest District of Sokółka



Bl. I	Dł	Kr	Bo	Lu	Sm	KPN	ZwL	171	WB	178	Su	Tb	Nu	Pr	St	Pa	Cz	179	Rat	Ru	Sp	JL	Pi	170	Br	PPN	My	177	Ku	ZwB	Rad	Se	Ol	BK	Ło
Bl. II	Cz	Pr	BK	St	Ło	171	ZwB	Pa	KPN	PPN	Lu	Kr	170	Ol	Se	JL	Ru	Dł	My	Nu	WB	Su	Bo	179	178	Br	Tb	Ku	177	Sp	Sm	Rat	ZwL	Rad	Pi
Bl. III	Pa	Se	171	Rad	Pr	Kr	Sm	Rat	Pi	ZwL	179	Su	Sp	My	KPN	178	Br	Ło	OL	PPN	JL	Cz	177	170	ZwB	Nu	Ru	BK	WB	Ku	St	Dł	Lu	Tb	Bo
Bl. IV	Sp	JL	Cz	St	178	Pi	Ru	Ku	Bo	WB	ZwL	170	Se	Lu	Br	My	PPN	Sm	KPN	Kr	Tb	Pr	Nu	Rat	177	171	ZwB	Rad	BK	Pa	Ło	Su	Ol	Dł	179
Bl. V	171	Br	Sp	Dł	179	Ło	BK	Rad	ZwB	Ku	Pi	Bo	St	178	Su	Pa	Ol	ZwL	177	Rat	Nu	Kr	Ru	Tb	KPN	Sm	WB	170	PPN	Cz	My	JL	Lu	Se	Pr
Bl. VI	179	JL	Se	Pa	Nu	Pi	Dł	KPN	ZwL	Su	Rad	WB	Bo	PPN	Ru	171	Ło	Sp	ZwB	Kr	Sm	Ku	177	Pr	St	Rat	Tb	Br	BK	178	170	My	Lu	Ol	Cz
Bl. VII	Rad	Rat	My	Pi	Su	Pa	ZwB	PPN	178	Sm	JL	Nu	179	Lu	Bo	Kr	Cz	177	Ku	BK	Tb	Sp	Se	KPN	Dł	ZwL	St	Ol	Ło	Pr	171	Br	170	Ru	WB
Bl. VIII	Lu	WB	Tb	178	Ol	KPN	Sp	Ru	Rad	My	Rat	Ku	Nu	PPN	171	St	Pr	Kr	177	Dł	Pi	Sm	JL	Pa	Su	ZwB	Ło	170	179	Se	Bo	Cz	ZwL	Br	BK

Fig. 5. Complete randomized block pattern of the experiment with pine provenances in the Forest District of Stepnica.

All the experimental areas are situated in forest habitats of the second productivity class cleared of the original pine stands, i.e., in habitats most congenial to pine. For screening belts local pines were planted in the same grid pattern as that of the experimental plantation. Each plot is marked with a peg and a tablet with an abbreviation of the name of the native forest district of the particular provenance (see Table 1). Reserve material, if available, was planted immediately on the other side of screening belts for replacing possible losses in the first year of the experimental plantation.

Before concluding I wish to stress the kindliness and assistance shown to the Department by Forest District Superintendents Płotnicki, of Sokółka, J. Basiak, of Janów Lubelski, and J. Grabowski, of Stepnica, as well by the authorities of the State Forest Administration Procincial Units concerned.

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Translated by W. Kulerski

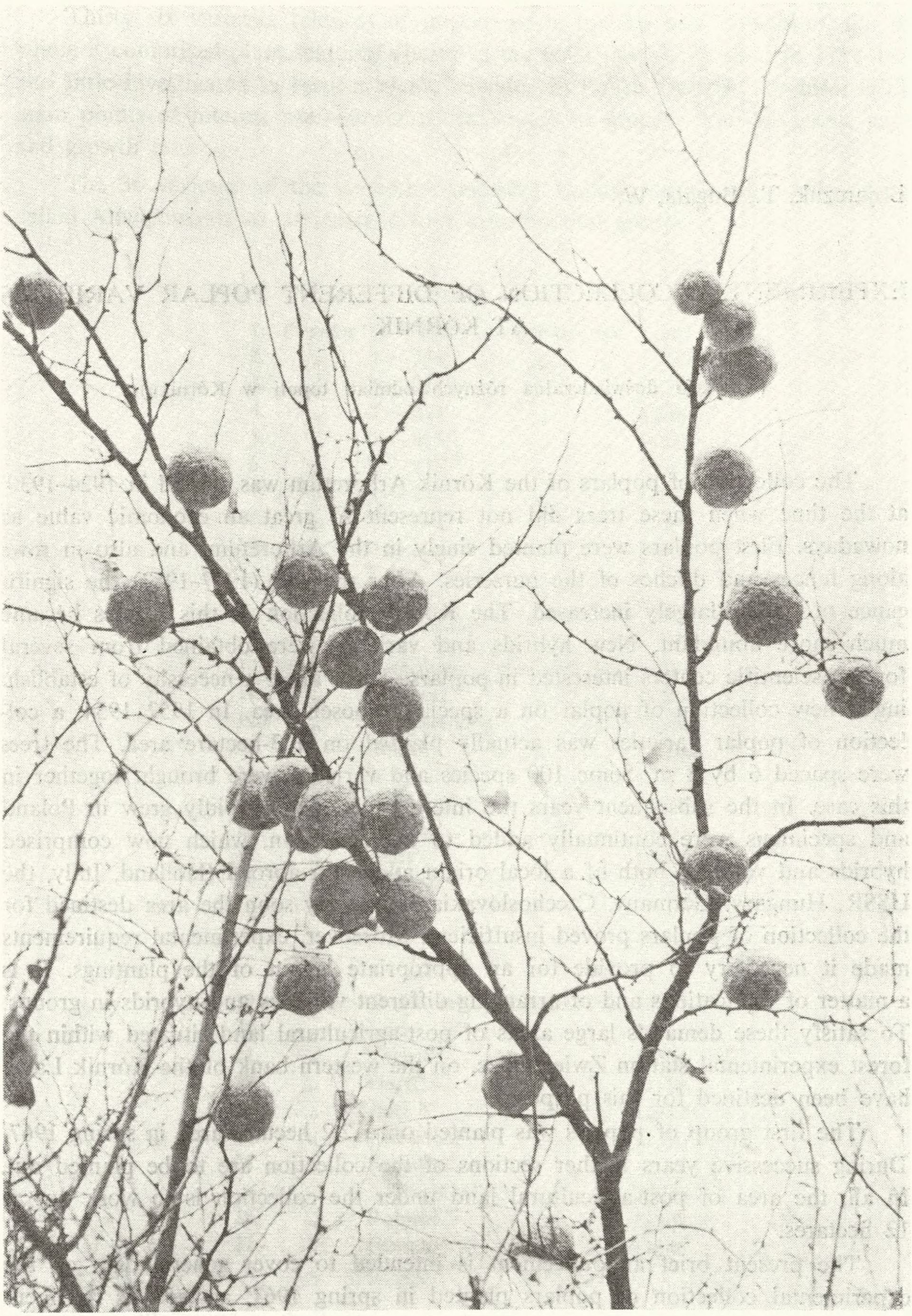
SUMMARY

In autumn 1965 cones were collected from Scots pine of 30 Polish provenances (Table 1). The seeds that were extracted from them were sown in the Institute forest nursery in the Zwierzyniec Forest Subdistrict near Kórnik.

In spring 1967 comparative provenance areas were planted. These included the Polish provenances and five provenances from Sweden the seeds for which were obtained from exchange. The experimental plantations were lied out in a complete block design using eight replications. There were 49 plants per plot. Four such experimental areas were established in:

(1) the Institute experimental Zwierzyniec Forest Subdistrict near Kórnik,
(2) the Forest District Sokółka, close to the Supraśl provenance,
(3) the Forest District Janów Lubelski,
(4) the Forest District Stepnica.

Detailed localization data for the individual field experiments are presented in Table 2.



Fruits on osage orange tree (*Maclura pomifera* Schn.) defoliated twigs. Photo by K. Jakusz.