by ERIKSSON *et al.* (1973) for Norway spruce and JONSSON *et al.* (1976) for Scots pine in Sweden.

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Intersectional Hybridization of Populus Sections, Leuce-Aigeiros and Leuce-Tacamahaca[1])

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Summary

Production of intersectional *Leuce-Aigeiros, Leuce-Tacamahaca* hybrids is described using species of the *Leuce* section as the female parent. Two female clones which are complex hybrids derived from crossing three aspen and white poplar species proved outstanding in crosses, producing more seed than two of their parental species. Several tri-sectional *Populus* crosses *(Leuce-Aigeiros-Tacamahaca)* involving up to five species are reported as well as a range of new interspecific crosses involving two sections. These hybrids have intermediate morphology between parental species. Their growth rate is satisfactory and preliminary propagation studies indicate that such hybrids could be used to transfer rooting factors to *Leuce* poplars providing the F_1 hybrids prove fertile.

Key words: Populus, hybridization, intersectional, breeding significance, forestry, horticulture.

Zusammenfassung

Die Herstellung von intersektionalen *Leuce-Aigeiros, Leuce-Tacamahaca* Hybriden wird beschrieben, bei denen Arten der *Leuce*-Sektion als weiblicher Elter benutzt wurde. Zwei weibliche Klone, die komplexe Hybriden aus Kreuzungen von 3 Aspen und Weißpappeln darstellen, bewiesen hervorragende Kreuzbarkeit, indem sie mehr Saatgut als zwei ihrer Elternarten produzierten. Verschiedene Pappel-Kreuzungen dreier Sektionen *(Leuce-Aigeiros-Tacamahaca),* die bis zu fünf Arten einschließen, werden als ebenso gut wie eine Serie neuer interspezifischer Kreuzungen zwischen zwei Sektionen angesehen. Diese Hybriden haben intermediäre morphologische Eigenschaften zwischen den Elternarten. Ihr Wachstum ist ausreichend und vorläufige Untersuchungen über die Vermehrung ergaben, daß solche Hybriden zum Transfer von Bewurzelungsfaktoren in Leuce-Pappeln geeignet sind, vorausgesetzt die F_1-Hybriden erweisen sich als fertil.

Introduction

The search for hybrid vigor or heterosis has encouraged forestry breeders to investigate a wide range of interspecific crosses. Perhaps no greater efforts have been made than in the genus *Populus,* a genus in which many hybrids can be propagated readily as clones, permitting the full utilization of heterosis due to additive and dominance gene effects. Interspecific hybridization is intriguing in *Populus* for this complex genus has more than 30 species in 5 taxonomic sections. *Turanga* and *Leucoides,* sections consist of few species with limited distributions and minor economic value. The three remaining sections contain many species with widespread native range and important economic value in forestry and horticulture. These three sections, *Leuce* (consisting of both Eurasian and North American aspen species and Eurasian and North African white poplars), *Tacamahaca* (represented by the balsam poplars of Asia and North America), and *Aigeiros* (represented by the European black poplar and North American cottonwood) are of major interest to tree breeders in every continent.

Although interspecific hybridization is considered generally to be a widespread natural and induced phenomenon in *Populus,* it is in fact limited mostly to intrasectional crosses and to intersectional *Tacamahaca-Aigeiros* crosses; intersectional *Leuce-Aigeiros* and *Leuce-Tacamahaca* cros-

[1]) Contribution No. J-175.

ses have been difficult (Stettler, 1968; Zufa 1975; Willing and Pryor, 1976). In addition to obtaining hybrid vigor, these latter crosses have been considered potentially valuable in efforts to transfer ease of vegetative propagation to aspens, recombine aspens adaptability to low nutritional sites with fast growth of the *Tacamahaca-Aigeiros* sections, and generally improve disease resistance. Since poplars are an important horticultural and forestry tree worldwide, any procedure to facilitate genetic recombination between different sections has important implications for poplar breeders.

The interest in difficult intersectional crosses involving the *Leuce* section has led to studies utilizing pollen mixes of viable incompatible and inviable compatible pollen. These "mentor" (Stettler, 1968) and "recognition" (Knox, Willing and Ashford, 1972) pollen techniques, in which *Aigeiros* and *Tacamahaca* species were used as the female parent in crosses to *Leuce* species, resulted in seed yield of 15—30% of a compatible cross. More recently, treating stigmas with chemical solvents has given encouraging seed yield in crosses regarded as incompatible including two intersectional crosses of the *Leuce* section made by Whitecross and Willing (1975) and several crosses made by Willing and Pryor (1976). However, in spite of much research on intersectional hybridization of the *Leuce* section with either *Aigeiros* or *Tacamahaca* the number of successful crosses has been restricted. In general, much of the crossing has been made using the aspen *(Leuce)* species as the male parent and the late-flowering *Aigeiros* and *Tacamahaca* species as females. Explanations for the low success of these intersectional crosses include failure in catkin development (Stettler and Guries, 1976) and failures in pollen tube growth (Guries and Stettler, 1976; Stettler, Koster and Steenacker, 1980).

In 1975, as part of our *Populus* interspecific hybridization studies, a cross of a white poplar-aspen hybrid (CAG 1715—69) to *P. nigra* L. 'Italia' produced a quantity of viable seeds and seedlings. This contrasted with poor results obtained by using *Aigeiros* and *Tacamahaca* as female parents in crosses to *Leuce* species (Ronald, unpublished). These crossing results suggested the possible importance of directional crossing barriers, a phenomenon known as unilateral incompatibility or unilateral hybridization. Unilateral hybridization has been widely described in several plant families but only rarely in *Populus* (Zufa 1975) or other trees (Hagman, 1975). These preliminary results led to further investigations of the nature of intersectional breeding barriers in crosses of the three major sections of the genus *Populus*. This paper reports on the production of hybrids from a range of *Leuce-Aigeiros* and *Leuce-Tacamahaca* crosses in which the *Leuce* poplar is used as the female parent. Preliminary assessments of growth and ease of propagation are given and the possible significance of these crosses to forestry and horticulture is discussed.

Materials and Methods

Parental species:

These experiments utilized *Populus* cultivars and clones from the Morden Research Station Arboretum and surrounding native stands.

All of these poplars are available in the collection of the Morden Research Station. Five *Leuce* poplars were used as female parents and are identified by common name and native origin as follows:

P. alba L. 'Nivea' (white poplar, Europe), *P. tremuloides* Michx. (trembling aspen, North America), *P. grandidentata* Michx. (large-toothed aspen, North America), and two complex hybrids, *P.* × *canescens* (Ait.) Smith × *(alba* × *grandidentata)* accessions 1715—69 and 1717—69 (white poplars and aspens, Europe/North America). These two poplars are hereafter referred to as CAG 1715—69 and CAG 1717—69. The *P. grandidentata* clone used in crosses originated from a native stand at Betula Lake, Manitoba; the *P. tremuloides* came from a native stand at Morden, Manitoba. The CAG hybrids were produced by Dr. C. Heimburger formerly of the Ontario Ministry of Natural Resources, Maple, Ontario. These two hybrids have the code number CAG 135 (CAG 1715—69) and CAG 144 (CAG 1717—69) in the Maple, Ontario collection.

Thirteen male poplars used in crosses are identified by section, common name and native origin as follows:

Leuce

1. *P. tremula* L. 'Erecta' (Columnar European aspen, Europe) as a control.

Aigeiros

2. *P. deltoides* Marsh. *occidentalis* Rydbg. "A" plains cottonwood, North America).
3. *P. deltoides occidentalis* "B" (plains cottonwood, North America).
4. *P. deltoides occidentalis* "C" (plains cottonwood, North America).
5. *P. nigra* L. 'Italica' (black poplar, Europe).
6. *P. nigra* L. 'Viadri' (black poplar, Europe).

Aigeiros × *Aigeiros*

7. *P. canadensis* Moench 'Serotina de Selys' (Serotina de Selys poplar, Europe/North America).
8. *P.* × *canadensis* 'Vernirubens' (Vernirubens poplar, Europe/North America).

Tacamahaca

9. *P. balsamifera* L. (balsam poplar, North America).
10. *P. angustifolia* James (narrowleaf poplar, North America).
11. *P. tristis* Fisch. (brown twig poplar, Asia).

Aigeiros × *Tacamahaca*

12. *P. jackii* Sarg. 'Northwest' (Northwest poplar, North America).
13. *P. deltoides occidentalis* × *petrowskiana* (Reg.) Schneid. (Russian hybrid, North America/Asia).

The sources of native *P. deltoides occidentalis, P. balsamifera, P. angustifolia* represented local adapted sources. 'Northwest' is a hybrid originating in nearby North Dakota, U.S.A. and the *P. deltoides occidentalis* × *petrowskiana* clone was a natural hybrid discovered from a local hybrid population (Ronald and Steele, 1974).

Crossing Techniques:

Pollen of male poplars was obtained in the greenhouse by forcing detached branches in water during February and March of 1976 and 1977, about 2—3 months prior to natural anthesis. The pollen was air-dried for 24—36 hours and then stored in vials at 4° C.

The detached branch method which is readily adaptable for aspen seed production was utilized for all crossing studies. Branches of the female parents 60—90 cm long, harvested on mild February and March days from mature trees, were placed in containers of water and were forced in growth rooms and greenhouses. This early crossing was conducted about 2 months ahead of natural wind-borne pollen. As an additional check on contamination, each crossing was done in isolation and some catkins were left

unpollinated as a check. The basal ends of detached branches were cut back twice weekly to facilitate water uptake and water was changed in the holding vessels each time. After 3—4 weeks maturation at 21° C, the catkins were harvested just prior to dehiscence and placed in small paper bags for seed dehiscence. Seeds were separated from the cotton and germinated either on moist filter papers in petri dishes or in sterile media in flats.

Hybridization:

In a preliminary assessment of crossibilities, the five female parents were crosses to 13 males by pollinating 20 catkins on one or two branches for each cross. The seed yield for two representative catkins was counted and its germination determined on filter paper in petri dishes. Seed from the remaining catkins was cleaned and sown in flats.

Following encouraging preliminary crosses a replicated experiment was conducted in which four of the same females which had remaining flowering branches were crossed to five (Numbers 1, 2, 7, 11 and 12) of the 13 male poplars used in preliminary crosses. In order to reduce branch-to-branch variation, uniform branches were selected and all but three catkins removed. Each of the crosses was then replicated three times for a total of nine catkins and 20 crosses. The seed yield for each cross was recorded and seed was sown in sterile flats as previously noted.

Seedling Characteristics:

The seedling height and stem diameter after 1 season of growth consisting of 2 months in greenhouse and 4 months in outdoor frames, were measured for one intrasectional cross and three intersectional crosses with each of the two CAG hybrids. Morphological leaf and twig characteristics of seedlings were observed to document the hybrid nature of the cross. Softwood cuttings from several intersectional crosses were placed under mist to observe adventitious root formation.

Observations

Seed Yield and Germination:

A wide range of intersectional crosses produced seed in the preliminary crosses *(Table 1). P. tremuloides,* CAG 1715-69 and CAG 1717-69, produced the highest seed yields

Fig. 1. — Catkin development following intersectional crosses, CAG 1715-69 × *P. deltoides occidentalis* (left) and CAG 1717-69 × *P. jackii* 'Northwest' (right).

with many showing more than 50% germination. The seed yield and germination were lower for *P. alba* 'Nivea' and *P. grandidentata* and these crosses were often characterized by catkin abscission at an early stage of development. The two complex CAG parents gave the most encouraging crossing results as seedlings were obtained for all male parents with at least one of these females. In five of these wide crosses with CAG 1717-69 the seed yield exceeded the control cross with seed germination ranging from 25% to 99%.

The use of fewer catkins on replicated branches resulted in a marked improvement in catkin maturation and seed yield. Examples of well-developed catkins obtained in intersectional crosses are shown in *Fig. 1.* These crosses were repeated in 1976 and 1977 with closely similar results; only the results of 1976 are shown *(Table 2).*

The intrasectional control crosses ranged from a low of 29.3 seeds/catkin in *P. alba* 'Nivea' to a high of 116.3 seed/catkin in CAG 1715-69, giving evidence of the general fertility of all female parents. Seed yield in intersectional crosses exhibited a wide variation. As noted in preliminary crosses, *P. alba* 'Nivea' produced the lowest seed yield in intersectional crosses; all were much lower than the control cross to *P. tremula* 'Erecta'. In general, the *P. alba* 'Nivea'

Table 1. — Seed yield and germination percentage of seed from 2 catkin of one intra- and 12 intersectional crosses with five females of section *Leuce* in *Populus.*

Male / Female	Intrasectional	Intersectional											
	Leuce	Aigeiros					Aigeiros x Aigeiros		Tacamahaca			Aigeiros x Tacamahaca	
	1	2	3	4	5	6	7	8	9	10	11	12	13
Leuce													
alba 'Nivea'	29 (60%)	12 (8%)	4 (0%)	0	-	-	-	9 (0%)	47 (18%)	-	0	-	-
tremuloides	55 (90%)	17 (55%)	70 (28%)	81 (40%)	0	47 (90%)	107 (33%)	28 (22%)	0	5 (0%)	45 (35%)	10 (20%)	11 (20%)
grandidentata	143 (85%)	0	65 (4%)	-	29 (0%)	-	52	-	4 (0%)	-	-	14 (6%)	-
CAG 1715-69	185 (78%)	2 (0%)	4 (0%)	6 (15%)	60 (78%)	75 (68%)	15 (50%)	-	30 (30%)	39 (50%)	85 (88%)	83 (42%)	135 (60%)
CAG 1717-69	55 (90%)	17 (55%)	70 (28%)	81 (40%)	x	3 (0%)	59 (99%)	25 (80%)	4 (0%)	9 (58%)	x	75 (75%)	82 (25%)

(-) catkins failed to mature
(x) cross not made

Table 2. — Mean seed yield per catkin and standard error of mean in one intra- and four intersectional groups of *Populus* crosses.

Female \ Male	Intrasectional	Intersectional				Mean (females)
		Aigeiros		Tacamahaca	Aigeiros x Tacamahaca	
	Leuce tremula 'Erecta	deltoides occidentalis	canadensis 'Serotina de Selys'	tristis	jackii 'Northwest'	
	1	2	7	11	12	
Leuce						
alba 'Nivea'	29.3 ± 11.9	4.0 ± 4.0	0.0 ± 0.0	2.7 ± .7	1.7 ± 1.7	7.5
tremuloides	95.0 ± 11.6	3.3 ± 2.4	46.3 ± 4.8	24.3 ± 15.5	29.3 ± 13.4	39.6
CAG 1715-69	116.3 ± 46.5	18.6 ± 1.7	50.0 ± 8.5	26.3 ± 6.4	80.0 ± 18.4	59.1
CAG 1717-69	36.0 ± 8.1	18.3 ± 2.8	23.0 ± 4.6	39.3 ± 7.7	38.6 ± 11.6	31.0
Mean (Males)	69.2	11.1	29.8	23.2	37.4	

intersectional crosses exhibited poor catkin maturation, low quality seed and unthrifty seedlings.

P. tremuloides produced a seed yield of 95.0 seeds/catkin for the intrasectional control cross. Seed yield in intersectional crosses to 'Serotina de Selys', 'Northwest' and *P. tristis* ranged from about 25% to 50% of the control intrasectional cross. *P. deltoides occidentalis* produced a few seedlings in crosses to *P. tremuloides*.

The crosses involving the complex CAG 1715-69 and CAG 1717-69 hybrids gave moderate to high seed yields in most intersectional crosses. For CAG 1715—69, the seed yield in the cross to 'Northwest' averaged about 68% of the control cross to *P. tremula* 'Erecta'. In crosses with CAG 1717-69, the seed yield for 'Northwest' and *P. tristis*, both partly or wholly *Tacamahaca* types, actually exceeded the control intersectional crosses to *P. tremula* 'Erecta'.

A comparison of the male parents indicates that the *P. deltoides occidentalis* cross produced the lowest seed yield, less than 20% of the intrasectional control cross. Seed yield for the other three males ranged from about 35 to 55% of the intrasectional control cross. In all cases the means for the intersectional males were depressed by the low seed yield with the *P. alba* 'Nivea' female. Comparison of means for the four female parents indicated that CAG 1715-69 gave the highest overall seed yield followed by *P. tremuloides* and CAG 1717-69.

Table 3. — Seedling height and stem diameter for one intrasectional and three intersectional crosses with each of two aspen-white poplar hybrid*)

Parentage	Mean height (cm) and mean diameter (mm)	Standard error of mean
CAG 1715-69		
x tremula 'Erecta' 1	49.2	± 4.7
	4.4	± .4
x canadensis 'Serotina de Selys' 7	38.4	± 9.3
	4.8	± .6
x deltoides occidentalis 2	42.0	± 9.6
	5.6	± 1.0
x jackii 'Northwest' 12	42.8	± 7.7
	5.2	± .4
CAG 1717-69		
x tremula 'Erecta' 1	53.2	± 9.7
	6.0	± 1.1
x canadensis 'Serotina de Selys' 7	61.6	± 9.4
	6.2	± .9
x deltoides occidentalis 2	41.8	±10.7
	5.4	± 1.0
x jackii 'Northwest' 12	48.8	±13.2
	6.2	± 1.3

*) Means based on 5 seedlings

Seedling Characteristics:

Young seedlings from intersectional crosses were generally vigorous, particularly those from the CAG 1715-69 and CAG 1717-69 female parents. Seedling growth after one growing season for six intersectional progenies was not greatly different from the control intrasectional crosses *(Table 3)*, however, there was a general tendency for intersectional seedlings to be slightly shorter in height and thicker in diameter than the intrasectional seedlings.

The foliage, buds and bark were intermediate between the two parents of the newly synthesized intersectional hybrids. Foliage samples for three such progenies and their parents are shown in *Fig. 2*.

Preliminary evaluation of adventitious root formation indicated that softwood cuttings of several intersectional hy-

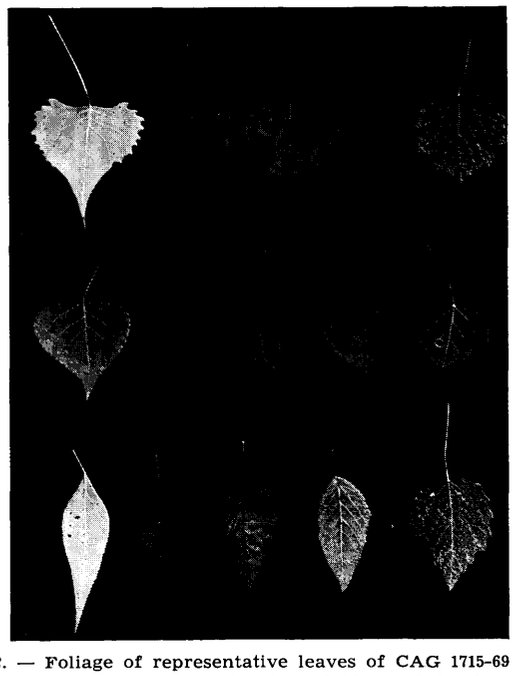

Fig. 2. — Foliage of representative leaves of CAG 1715-69 crossed with *P. angustifolia* (row 1), of *P. tremuloides* with *P. nigra* 'Viadri' (row 2), and of CAG 1715-69 with *P. deltoides occidentalis* (row 3). Female parent is at left, male parent at right and three seedlings in middle.

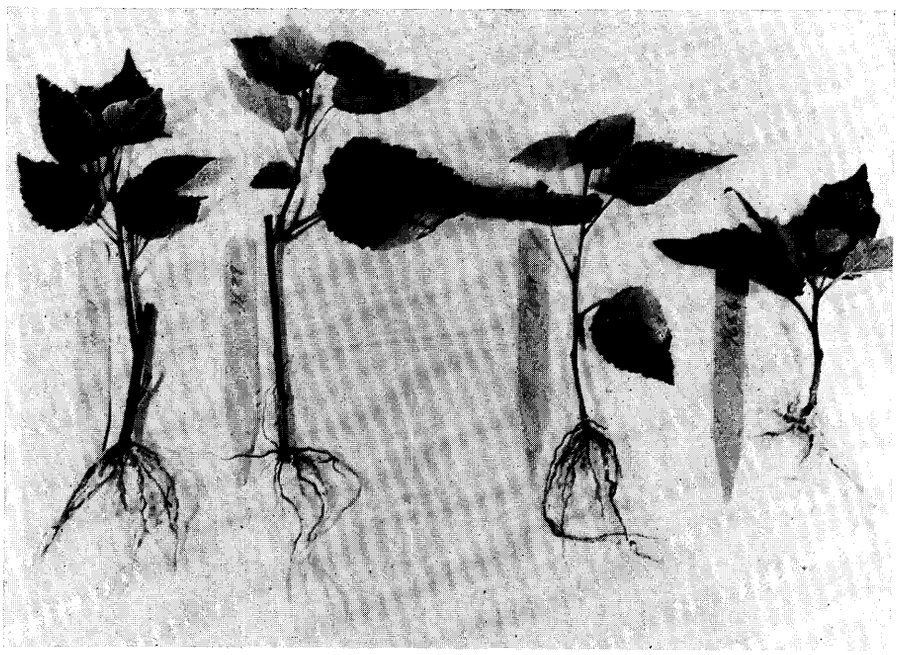

Fig. 3. — Adventitious root development on softwood cuttings of four intersectional seedlings rooted under intermittent mist.

brids including those of *P. tremuloides* and *P. grandidentata* rooted readily from softwood cuttings *(Fig. 3)*. The relative rooting ease of these hybrids stands in contrast to the poor rooting of softwood cuttings from most aspen species including *P. tremuloides* and *P. grandidentata* (unpublished results). Improved ease-of-rooting in aspens could enable use of regular softwood cuttings for aspens rather than necessitating the use of juvenile etiolated softwood cuttings from root pieces (Farmer, 1963) and use of grafting or budding (Ronald and Cumming, 1971).

Discussion

Crossing barriers:

Reversing the usual direction of intersectional crosses *(Aigeiros* × *Leuce, Tacamahaca* × *Leuce)* appears of value in obtaining intersectional hybrids of these sections. By utilizing the *Leuce* poplars as females, seedlings of more than 20 interspecific crosses have been obtained. These include a few hybrids of the North American species *P. grandidentata* and *P. tremuloides* with species of the *Aigeiros* and *Tacamahaca* sections. Intersectional hybrids involving the two native North American aspens have not been found under natural conditions in Manitoba (Ronald *et al.*, 1973a, 1973b). These newly synthesized hybrids add to those reported in previous reviews (Zufa, 1975; Joennoz and Vallee, 1972).

The use of complex *Leuce* section hybrids such as the CAG hybrids, rather than the pure species, appears beneficial in achieving the type of wide crosses reported here. The use of complex hybrids has been mentioned previously as having possible value in wide hybridization of *Populus* (Zufa, 1968) and this is borne out the present study.

In terms of species integrity, it appears that the early flowering *Leuce* poplars when used as female parents have not developed stylar barriers to pollen of later flowering *Aigeiros* and *Tacamahaca* poplars. The reciprocal crosses have shown barriers to interspecific crossing. It appears that seasonal flowering barriers combined with seedling weakness and inviability have maintained the natural isolation of *Leuce* species from sympatric species of the other two sections.

Crossing Efficiency:

As compared to the earlier-mentioned "mentor" and "recognition" techniques, the crossing procedures reported in this paper appear advantageous in terms of efficiency. This study indicates that a high frequency of certain intersectional seedlings can be obtained without the use of crossing aids such as recognition and mentor pollen. Secondly, the detached branch technique works well for ripening seeds on *Leuce* species. This avoids the delay and additional expenses associated with grafting scions of *Aigeiros* and *Tacamahaca* females, a procedure which has been often used to support the slower seed maturation when species of these two sections are utilized as female parents. The faster seed maturation with *Leuce* branches can also reduce labour and allows for two sets of crosses to be made in a similar time span and space as one set with the *Aigeiros* or *Tacamahaca* females.

A considerable improvement in catkin development and seed quality was visually noted by choosing vigorous branches and stripping excess catkins from these branches.

Breeding Significance:

Breeders working with the genus *Populus* have long sought to extend the number of intersectional crosses so as to recombine desirable characteristics of the three major sections. The results reported in this paper indicate that the use of *Leuce* poplars, particularly complex hybrids such as CAG 1715-69 and 1717-69, as the female parents can lead to numerous hybrids without the use of crossing aids.

Transfer of rooting factors to the *Leuce* section from the other two sections is of prime concern as clonal propagation of aspens has in the past been difficult or expensive (Ronald and Cumming, 1971). Preliminary tests indicate that several of these hybrids root readily from softwood cuttings and hardwood cuttings. Further studies on propagation will be reported in a subsequent paper. The adaptation of aspen species to certain boreal soil types would be a valuable characteristic to recombine with the general adaptation of the *Aigeiros-Tacamahaca* species to grow in fertile alluvial soils. Each of the three sections represent different sources

for resistance to fungal and bacterial diseases, a factor of great importance in intensively managed clonal stands. The transfer of hardiness from *P. tremuloides* into less hardy but fast-growing *Aigeiros* species is of particular interest to northern cold areas of North America and Eurasia.

Seedlings from intersectional crosses appear intermediate between the two parents in morphology, therefore, contamination or apomixis can be ruled out. The early seedling growth rate was satisfactory for most intersectional crosses although many of these intersectional progenies had a large proportion of weak seedlings that succumbed as small seedlings. Personal observations of field plantings showed higher mortality rates for intersectional than intrasectional progenies. The low vigour noted for the *P. trichocarpa* × *P. alba* crosses of STETTLER and GURIES (1976) was also most apparent in crosses involving *P. alba* 'Nivea'. Seedlings of the complex aspen-white poplar hybrids CAG 1715-69 and CAG 1717-69 appear most promising in growth rate and field survival.

Due to seedling juvenility it has not been possible to determine the fertility of seedlings from these intersectional crosses. Fertility of the F_1 intersectional hybrids will determine the extend of backcrossing and advanced generation breeding possible.

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Buchbesprechungen

Ökologische Botanik. Einführung in die angewandte Botanik. Von LORE STEUBING und HANS OTTO SCHWANTES. (UNI-Taschenbücher Bd. 888). Verlag Quelle & Meyer, Heidelberg. 1981. 408 Seiten mit 130 Abbildungen und 53 Tabellen. DM 29.80.

Im vorliegenden Buch wird die „Angewandte Botanik" unter ökologischen Gesichtspunkten betrachtet. Die Pflanze ist das wichtigste Glied des Ökosystems. Daher werden Evolutionen, Gesetzmäßigkeiten und Zusammenhänge für die Energiegewinnung, Stoffkreisläufe und das Anpassungsvermögen der Pflanzen an unterschiedliche Umweltbedingungen ökologisch gesehen. Die Gliederung des Stoffes folgt dieser Linie: die Stellung der Pflanze im Ökosystem, Entstehung der Biosphäre, die Pflanze im aquatischen Bereich und im terrestrischen Bereich (Kormophyten), der Wasserhaushalt der Pflanze, Nährstoffversorgung, Wechselbeziehungen innerhalb der Lebensgemeinschaften, Stoffkreislauf sowie Anpassungen an besondere Standortbedingungen. Schließlich wird noch auf die Pflanzen als Bioindikatoren für Umweltbelastungen eingegangen. Eine dreiseitige Zusammenstellung von Übersichts- und weiterführender Literatur und ein Sachregister beschließen das Buch.- Sicherlich ist dies eine etwas ungewohnte und von der klassischen abweichende Betrachtungsweise. Manchmal bleibt für den Leser der direkte Bezug zur Ökologie etwas unklar. Dennoch ist das Buch gerade wegen seiner unkonventionellen Darstellungsart interessant zu lesen und sicherlich eine Bereicherung unter den Botanikbüchern. Es kann allen an ökologischen Fragen Interessierten empfohlen werden. B. R. STEPHAN

Provenance variation in growth, timber and pulp properties of Pinus caribaea Morelet in South Africa. By E. R. FALKENHAGEN. South African For. Res. Inst., Direction of Forestry and Environment. Conservation. Bull. 59, 65 pp., 1979.

At the age of 16 and 17 years all three varieties from various replicated and unreplicated field trials of *Pinus caribaea* could be analysed. The most important results are as follows: Volume production diminishes and stem form improves with the height of the latitude of the origin of the tested provenances, for the longitude the reverse was true. In general *P. c. var. hondurensis* provenances were most productive but had the poorest form. The adverse trend showed *P. c. var. bahamensis* and *var. caribaea*. A strong correlation between growth traits of various ages permitted a selection as early as the age of eight years. Only height and percentage of foxtailing trees interacted with the sites. — The following wood properties have been studied in three provenances from each variety and compared with *P. elliottii var. elliottii*: Spirality, fibre length, density strength property and pulp yield. Spirality was no problem and fibre length varied only little between *P. c.* provenances. *P. elliottii* had significant shorter fibres than *P. c.* provenances which showed a lower density and little variation between provenances. Details on radial and vertical density are reported; all of them were strongly correlated with the strength properties. The ranks for the pulp yield occurs from *var bahamensis*, followed by *P. elliottii* to the *var. caribaea* and finally to the *var. hondurensis*. The strongest paper was produced by *P. elliottii, P. C. var. hondurensis* was superior to all other varieties in terms of pulp yield/ha. G. H. MELCHIOR

Genetisches Grundpraktikum. Von P. LANGE und K. WÖHRMANN. Gustav Fischer Verlag Stuttgart - New York 1979, 155 S., 70 Abb., 19 Tab., kart. DM 24.—.

Das Praktikumsbuch deckt in übersichtlicher Weise ein breites Spektrum der Genetik von der Bestimmung des Umfangs von Kreuzungsnachkommenschaften für genetische Untersuchungen, über DNS und zytologische Grundlagen der Vererbung, Geninteraktionen und -Kartierung bei Pilzen bis zur Analyse des Erbgangs beim Menschen, um einige Teilgebiete zu nennen. Dabei wird die Darstellung anerkennenswerterweise nicht nur auf Mikroorganismen, sondern ebenso auf Tiere und höhere Pflanzen abgestellt und so einmal die Durchführbarkeit von Experimenten mit höheren Arten und die Vielfältigkeit biologischer Systeme hervorgehoben, welche durch die jüngsten spektakulären Fortschritte besonders an Mikroorganismen überdeckt werden. Die Erwähnung einer Mendelspaltung bei Aureaformen der Fichte könnte diesen Aspekt noch verstärken helfen.

Zu fragen ist hier jedoch vor allem, aus welchem Grunde diese für Studenten und die Oberstufen von Gymnasien gedachte