paper gives results of work on early tests for "bud number".

This "bud number" is a measure for the time of growth cessation at the shoot of spruce seedlings by formation of a bud at the end of the vegetation period. By repeated mapping of this sign the sure recognition is guaranteed, at which the formation of Lammas is considered too. The "bud number" shows a strict dependence upon the altitude. Provenances from higher sites are stopping earlier their growth so the number gets larger.

This sign serves for relative comparisons of several provenances when taken in nursery culture. But above all at controlled culture chamber environment this measure is ascertained as an absolute sign for the altitude of provenances. At defined conditions in the chamber every seed lot can get classified for reason of identification and simultaneous an appropriate recommendation is possible for the special application of the seed lot.

Key *words: Picca* abies (L.) KARST., Provenances, Identification, Bud number.

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Adaptive Acid Phosphatase Polymorphism in Conifer Seeds

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Introduction

It is generally recognized that forest tree species, especially conifers, are characterized by a considerable variation, both across their native range, and from tree to tree within stands. This potential reflects a mechanism of the adaptive strategy specific for these typically long-lived organisms which mostly respond with a wide genetic variety to environments heterogeneous in site and time (see, e. g. STERN and ROCHE 1974). Thus, we may find varying phenotypes in ecologically different parts of the distribution range of a tree species, however, such different types need not be widely separated geographically. In the case of the altitudinal differentiation of Norway spruce in the Alps, for example, the different well adapted forms are located within a relatively small area (HOLZER 1964, 1974).

Unfortunately, the variations of our forest tree species which are found to be related to environmental factors are mostly associated with so-called quantitative characters that are controlled by many genes and often modified by the environment. Therefore, it is necessary to investigate the ecological relevance of the well-known genetic polymorphisms, in order to get a deeper insight into the relationships between relevant environmental factors, optimal adaptation, and the genetic variation pattern of a tree

* This abbreviation results from the German term.

species. In particular, isoenzyme polymorphisms have the advantage to possess a relatively simply segregating genetic basis, and to indicate the metabolic function in the organism in many cases. Furthermore, it is reasonable to assume that a few of the protein and isoenzyme polymorphisms frequently occurring also in forest trees (FERET and BERGMANN 1976) have a function important for adaptation and respond therefore specifically to effective environmental factors.

In the following, some preliminary data are presented demonstrating a drastic environmentally-dependent variation at one isoenzyme gene locus in Norway spruce *(Picea abies)* as well as in Douglas-fir *(Pseudotsuga menziesii)*. This investigation concerns genes controlling acid phosphatases (SAP)*, which are found to be active in the haploid endosperm of dormant conifer seeds.

Genetic variation at the SAP-B locus in spruce seeds

In the endosperm of dry spruce seeds, two polymorphic gene loci could be identified coding for enzymes of acid phosphatase (BERGMANN 1974). However, one of these gene loci (SAP-A) is characterized by mostly constant, environmentally independent allele frequencies, whereas the other SAP-locus (SAP-B) exhibits allele frequencies that can considerably vary between different ecological sites. At this isoenzyme locus, a total of five alleles could as yet be detected which are phenotypically expressed as single-band enzymes (SAP-B_1, SAP-B_2), double-band enzymes (SAP-B_3, SAP-B_4) and without enzyme activity (SAP-B_5) in the zymogram (BERGMANN 1974). The frequencies of the alleles SAP-B_1 and SAP-B_2, as well as SAP-B_3 and SAP-B_4, were combined in order to obtain larger and more pronounced values, since no essential frequency differences could be found between these allelic types, respectively. However, marked variations always exist exclusively between these two allele groups.

The characteristic of this SAP-locus is the evident correlation between its alleles and some particular climatic factors. As is shown in *Tab. 1*, the allele group SAP-B_1/B_2 coding for single-band enzymes occurs with relatively high frequency in northern areas and higher elevations of the spruce range, whereas the allele group SAP-B_3/B_4 coding for double-band enzymes predominates in all other parts of the distribution range. The close relationship between one or more climatic factors and these SAP isoenzymes can especially be observed in zones characterized by a gradual change of climate, where, as in Sweden and Finland, the allele frequencies vary clinally *(Tab. 1)*. Probably, one or more temperature parameters are responsible for this significant genetic variation pattern.

Genetic variation at a SAP-locus in Douglas-fir seeds

In the dry endosperm of Douglas-fir seeds, one clearly discernible SAP zone could be found using the same methods as with spruce seeds. In this zone several characteristic isoenzyme variants appear, which are controlled by different alleles of the corresponding gene locus (SAP-locus). It has so far been possible to identify four allelic types, two of which code for single-band enzymes (SAP-1, SAP-2), one for a double-band enzyme (SAP-3), and one appears to be an inactive allele (SAP-0) (BERGMANN, in preparation). Similarly to the SAP system of Norway spruce, this SAP polymorphism also shows an evident environmentally-dependent variation pattern in the North American range of Douglas-fir. The populations located in the interior areas and/or at higher elevations possess the alleles SAP-1 and SAP-2, here combined in the same manner as in spruce, with a frequency of more than 90%, whereas the coastal provenances from lower sites exhibit this allele group in decreased frequencies (50—60%) (Tab. 2). On the other hand, the allele SAP-3 appears with a frequency of 30—40% in coastal provenances, but is detectable only with minute frequencies in provenances from colder parts of the distribution range *(Tab. 2)*.

Conclusion

The enzyme system of acid phosphatases active in the endosperm of Norway spruce and Douglas-fir seeds appears to be particularly dependent on environmental factors. This is demonstrated by the fact that in both forest tree species, different SAP alleles dominate in the various climate zones of the distribution ranges, respectively. Thereby, a surprising conformity can be seen : in spruce as well

Tab. 1. — Geographic data for 18 European Norway spruce provenances and the allele frequencies at the SAP-B locus found in seed samples from these provenances (200 seeds per provenance)

Provenance Name	Region/Country	Geographic Data			Allele Frequencies at SAP-B Locus		
		Lat.	Long.	Alt.	SAP-$B_{1/2}$	SAP-$B_{3/4}$	SAP-B_5
Kåbdalis	Northern Sweden	66°11'	20°03'	410 m	78.0	15.3	6.7
Sörliden	Northern Sweden	65°49'	19°14'	450 m	74.2	20.2	5.6
Bergsjö	Central Sweden	62°01'	16°58'	60 m	48.1	49.9	2.0
Edsbyn	Central Sweden	61°22'	15°47'	250 m	41.5	54.3	4.2
Västanfors	Southern Sweden	59°57'	15°49'	120 m	30.4	66.2	3.4
Kittilä-Pallasj.	Northern Finland	68°02'	24°05'	480 m	76.9	23.1	-
Kolari	Northern Finland	67°16'	23°51'	150 m	53.5	42.9	3.6
Suomussalmi	Central Finland	64°50'	29°35'	220 m	39.2	57.4	3.4
Pihtipudas	Central Finland	63°17'	25°27'	160 m	20.0	80.0	-
Juva	Southern Finland	61°55'	27°58'	100 m	14.7	83.1	2.2
Tuusula	Southern Finland	60°21'	24°59'	50 m	4.8	95.2	-
Istebna	Beskiden/Poland	49°34'	18°53'	600 m	17.1	82.9	-
Witow	Tatra/Poland	49°13'	19°48'	1420 m	68.9	31.1	-
Oderholz, Abt. 399	Harz/Central Germany	51°47'	10°33'	800 m	38.4	61.6	-
Westerhof, Abt. 40	Harz-foreland/ Central Germany	51°44'	10°08'	180 m	6.2	93.8	-
Westerhof, Abt. 48	Harz-foreland/ Central Germany	51°44'	10°08'	180 m	4.5	95.5	-
Eschenmoos	Black Forest/ Southern Germany	47°49'	8°07'	1150 m	19.7	80.3	-
Seegatterl	Bavarian Alps/ Southern Germany	47°41'	12°28'	1000 m	26.8	73.2	-

Tab. 2. — Geographic data for 6 American Douglas-fir provenances and the allele frequencies at a SAP-locus found in seed samples from these provenances (200 seeds per provenance).

Provenance Name	Region/Country	Geographic Data			Allele Frequencies at SAP-Locus		
		Lat.	Long.	Alt.	SAP-1/2	SAP-3	SAP-0
Dunster	Br. Columbia/Canada	53°07'	119°50'	820 m	92.7	2.6	4.7
Merritt	Br. Columbia/Canada	50°04'	120°51'	900 m	91.1	3.3	5.6
Franklin River	Vancouver Island/Canada	49°06'	124°46'	150 m	58.5	34.9	6.6
Cedar District	Vancouver Island/Canada	49°10'	124°30'	100 m	54.5	38.9	6.6
Corvallis	Oregon/USA	44°42'	123°13'	80 m	62.3	31.3	6.4
Happy Camp	California/USA	41°57'	123°30'	980 m	91.7	8.3	-

as in Douglas-fir, the allelic types coding for double-band enzymes in the zymogram occur predominantly in moderate climate zones, whereas the alleles coding for single-band enzymes are more frequently found in colder areas. However, the frequency values of the corresponding alleles in both tree species do not reach the same levels (see *Tab. 1 and 2)*, which may be dependent on the probable differences in intensity of the effective climatic factors or is related to a species-specific enzyme behaviour. The so-called null-alleles (without enzyme activity in the zymogram) appearing in both tree species nearly always have a constant but low frequency, which can be explained as a constant rate of negative mutations. Although the selective climatic factors responsible for the different allele preferences are not yet identified, this marked genetic variation should be a valuable help for the necessary provenance differentiation. In further investigations, we are trying to detect the one or more temperature factors that are correlated with the allele frequencies determined at the SAP-loci in forest tree seeds.

Summary

In the endosperm of dormant seeds of Norway spruce and Douglas-fir, a gene locus coding for acid phosphatases (SAP) could be identified, which shows a marked environmentally-dependent variation. In both tree species, the SAP-alleles coding for single-band enzymes in the zymogram dominate in colder zones, whereas the alleles coding for double-band enzymes are more frequent in all moderate climate zones of the ranges, respectively. It is assumed that one or more temperature parameters represent the selective factors.

Key words: Adaptive Isoenzyme Polymorphism, Acid Phosphatases, Conifer Seeds, Genetic Variation, Climate Zones.

Zusammenfassung

Im Endosperm von Fichten- und Douglasien-Samen konnte ein saure Phosphatasen (SAP) steuernder Isoenzym-Genlocus identifiziert werden, der eine deutliche umweltabhängige Variation aufweist. Dabei zeigte es sich, daß sowohl bei Fichte als auch bei Douglasie die SAP-Allele, die sich phänotypisch im Zymogramm als Einband-Enzyme ausprägen, in kälteren Zonen des jeweiligen Verbreitungsgebietes dominieren, während die SAP-Allele, die sich als Doppelband-Enzyme ausprägen, jeweils in den gemäßigten Klimazonen häufiger vorkommen. Man kann daraus schließen, daß ein oder mehrere Temperatur-Parameter für eine derartige Selektion an diesem Isoenzym-Locus der Koniferen-Samen verantwortlich sind.

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Möglichkeiten der Früherkennung quantitativer Saatgutertragsleistungen bei Klonen von Pinus sylvestris L. in Samenplantagen

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Einleitung

Die Anlage von Samenplantagen als Möglichkeit zur Verbesserung der Saatgutversorgung gehört heute zum festen Bestandteil der Forstpflanzenzüchtung. Hierbei sind zwei Forderungen zu erfüllen:

- das Saatgut aus Samenplantagen muß in seinen Nachkommenschaften eine deutliche Leistungssteigerung gegenüber vergleichbaren Bestandesabsaaten bringen
- die Saatguterträge der Samenplantage müssen ökonomisch vertretbar sein.

Im allgemeinen geht man beim Aufbau einer Samenplantage von verklontem Plusbaummaterial aus, das zunächst meist nach rein phänotypischen Merkmalen ausge-

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