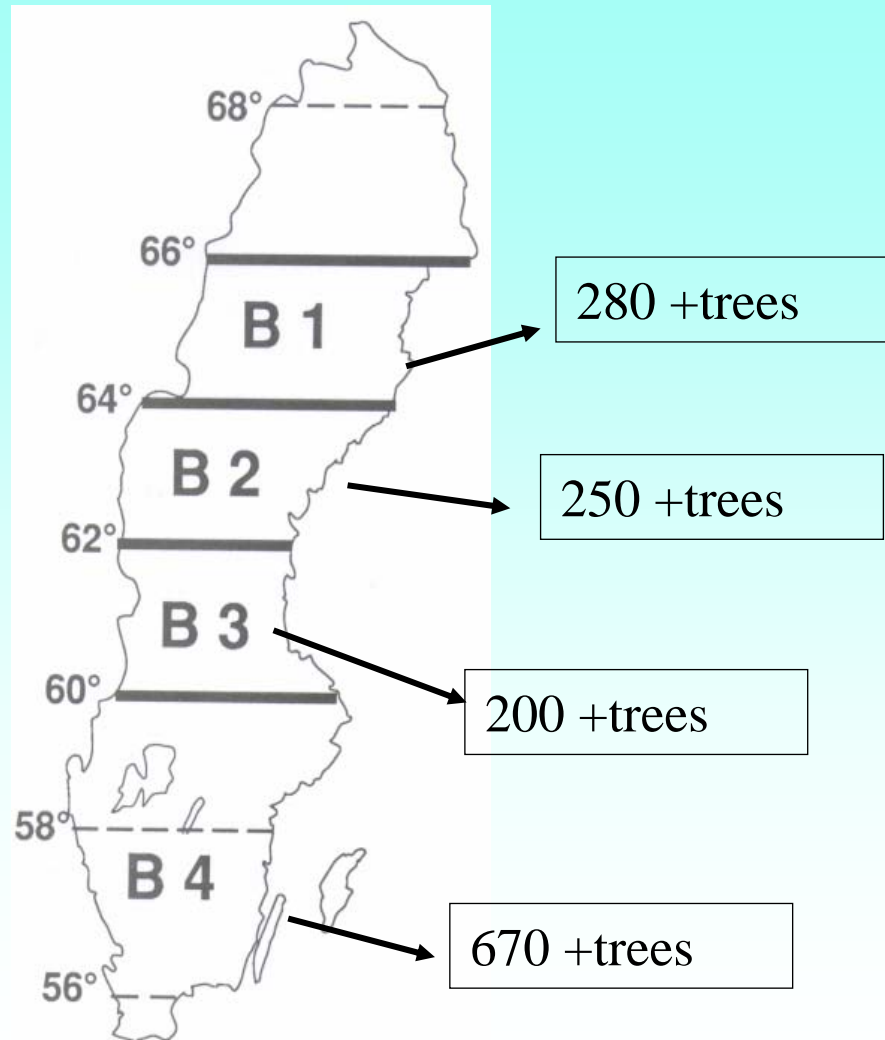




**Results from
genetic tests of
Betula pendula and
its impact on
breeding in
southern Sweden**

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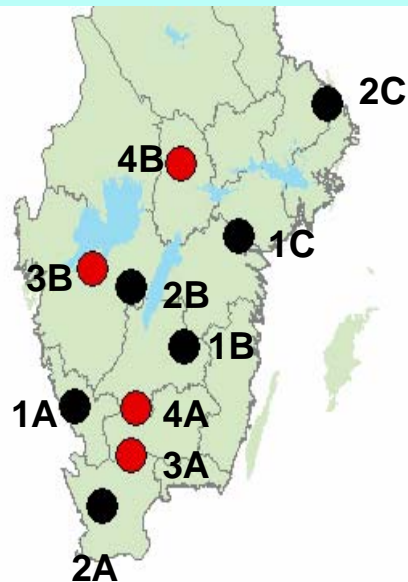
Betula pendula breeding project



Started 1988

**Objective:
to improve vitality,
yield and stem
quality in all of
Sweden**

Information about trials used for estimations of genetic parameters



Trial no	Plant. year	Land type	Clones	Replic.
Clonal tests				
1A	1990	Agr	78	4.3
1B	1990	For	83	4.3
1C	1990	For	74	3.4
2A	1991	Agr	43	2.7
2B	1991	Agr	45	3.3
2C	1991	Agr	41	3.0
Progeny tests				
3A	1995	For	57	10.0
3B	1995	Agr	59	12.7
4A	1998	For	44	13.3
4B	1998	For	39	13.1

Methods

- ◆ The statistical analysis was based on individual tree observations according to the models:

$$y_{ijk} = \mu + b_i + c_j + d \cdot h_{ijk} + e_{ijk} \quad (\text{clones})$$

$$y_{ijk} = \mu + b_i + f_j + e_{ijk} \quad (\text{progenies})$$

y_{ijk} = observation k , in block i for clone or progeny j

μ = trial mean

b_i = fixed effect of block i

c_j = random effect of clone j

f_j = random effect of progeny

d = regression coefficient

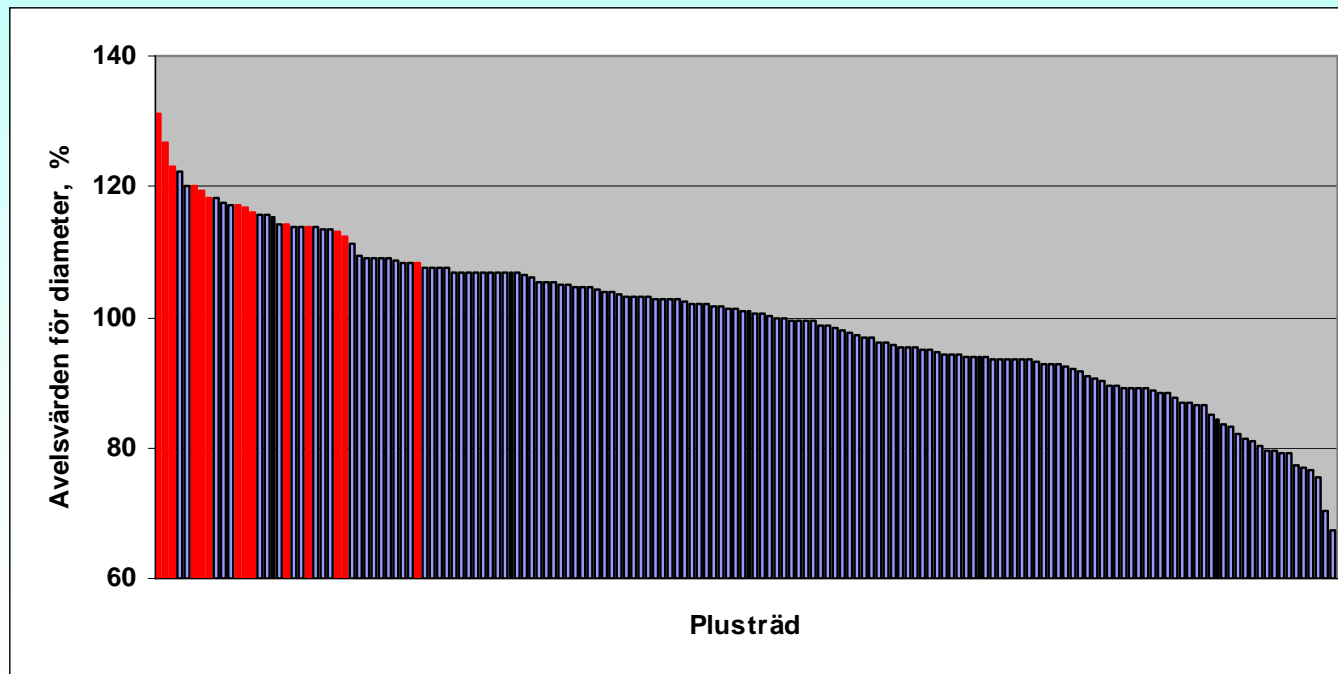
h_{ijk} = height at age 1 or 2 years for observation ijk

e_{ijk} = random error term for observation ijk

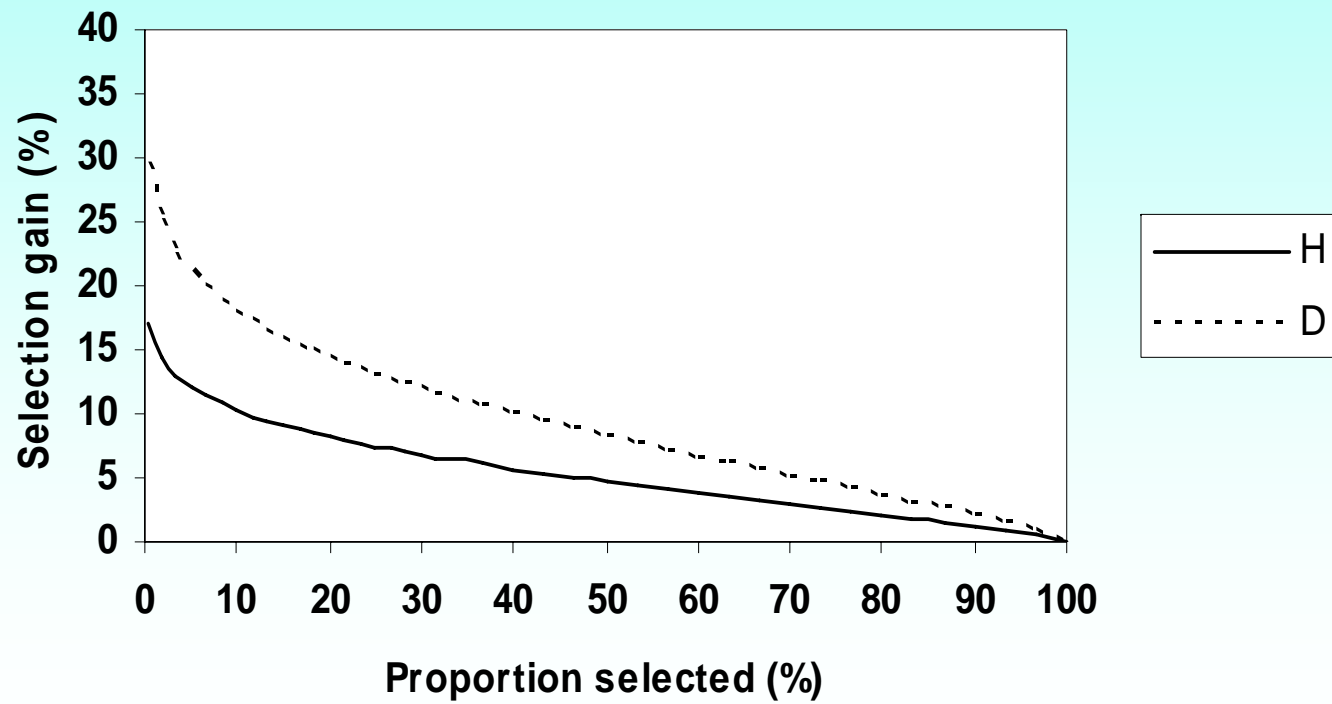
Genetic parameters

Trial	Survival			Height				Diameter			
	Mean %	H^2	s.e.	Mean dm	H^2	s.e.	CV_G	Mean mm	H^2	s.e.	CV_G
Clonal tests											
1A	95	0.07	0.04	95	0.25	0.07	4.9	81	0.42	0.06	11.7
1B	95	0.12	0.05	80	0.30	0.06	5.7	70	0.43	0.06	11.8
1C	82	0.03	0.04	71	0.21	0.08	5.2	62	0.22	0.07	9.2
2A	72	0.10	0.07	74	0.07	0.10	4.6	60	0.25	0.12	12.9
2B	86	0		80	0.47	0.09	9.6	67	0.46	0.09	16.1
2C	86	0.22	0.09	47	0.56	0.09	13.3				
Mean	86	0.09	0.06	75	0.31	0.08	7.2	68	0.35	0.08	12.3
	Mean %	h^2	s.e.	Mean dm	h^2	s.e.	CV_A	Mean mm	h^2	s.e.	CV_A
Progeny tests											
3A	79	0.12	0.08	56	0.08	0.10	5.1	47	0.11	0.10	11.1
3B	98	0.10	0.07	66	0.54	0.14	8.2	56	0.59	0.14	15.3
4A	91	0.09	0.08	50	0.47	0.15	14.0	34	0.33	0.13	20.5
4B	92	0		40	0.21	0.11	8.7	28	0.14	0.10	12.4
Mean	90	0.08	0.07	53	0.32	0.13	9.0	41	0.29	0.12	14.8

Breeding values of diameter for 164 plus-trees at age 9 yrs. The mean diameter of 7 cm represents the relative value of 100 %



Selection gain



Genetic Age x Age correlations for height

Trait1	Trait2	Trial			
		1A	1B	1C	2B
H(4)	H(6)	0.85	0.93		
H(4)	H(10)	0.60	0.75	0.47	
H(5)	H(10)				0.92
H(6)	H(10)	0.93	0.96		

Other age x age correlation studies

- ◆ **Johnsson (1967)**

 - $r_p = 0.58$ for height at 7 and 18 yrs

 - $r_p = 0.84$ for height at 11 and 18 yrs

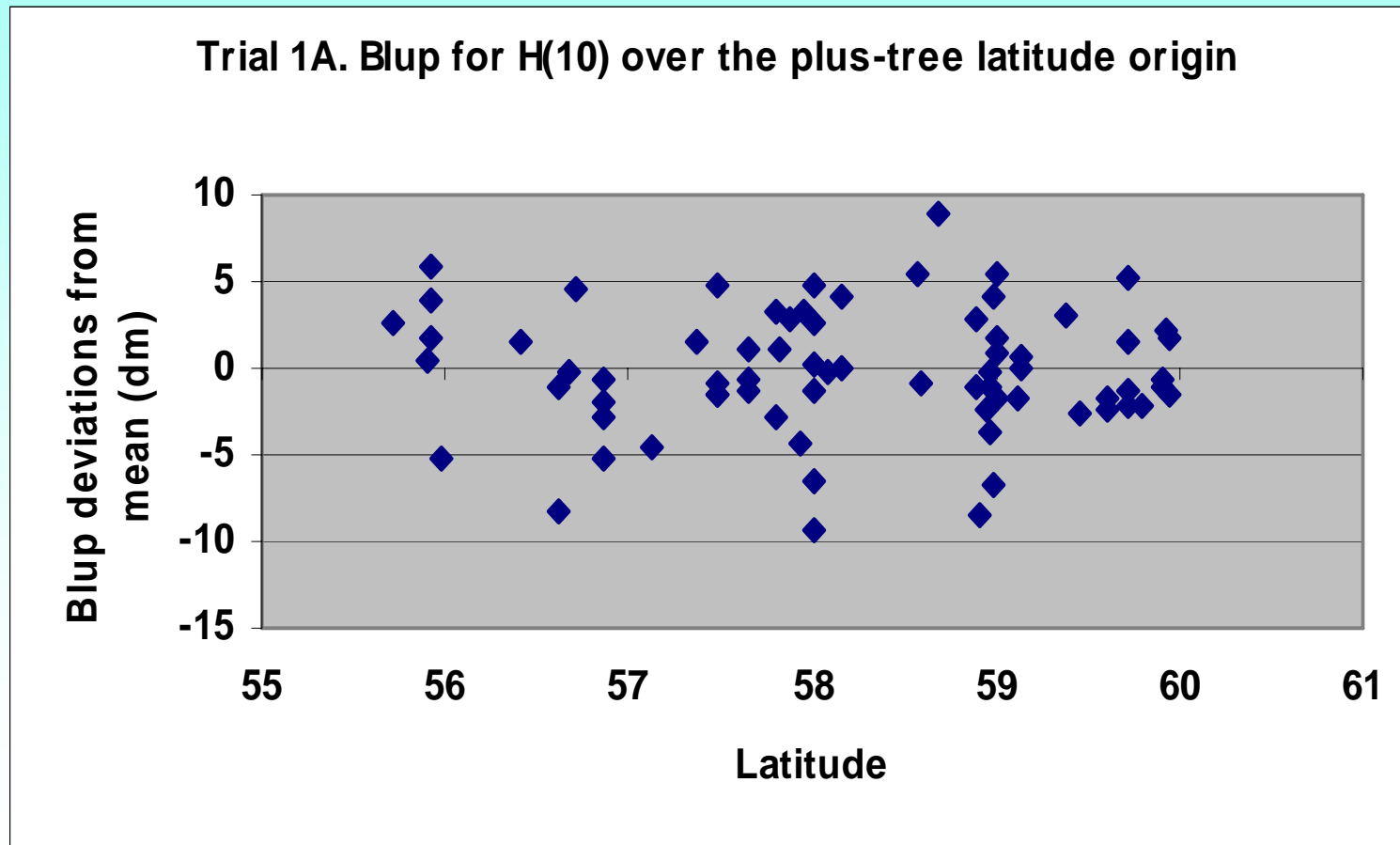
- ◆ **Erken (1972)**

 - $r_p = 0.75$ to 0.86 for height at 9 to 26 yrs

Genotype x Environment correlations

Trial	Height	Diameter
1A x 1B	0.87	0.91
1A x 1C	0.81	0.89
1B x 1C	0.81	0.93
2A x 2B	-	0.98
2A x 2C	-	
2B x 2C	0.65	
3A x 3B	1.22	0.93
4A x 4B	0.52	0.50

Transfer effects



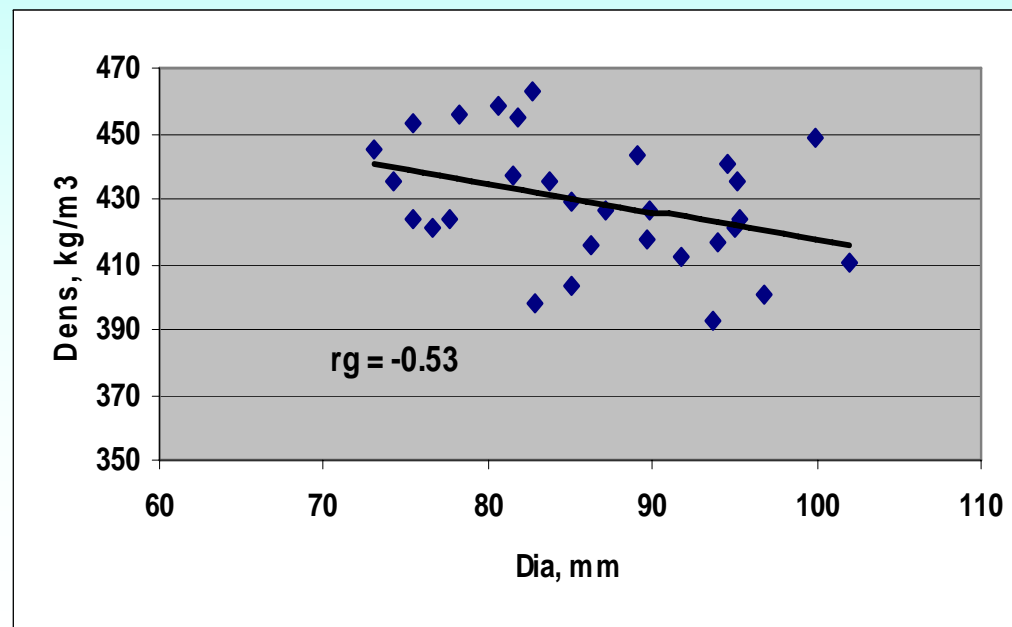
Genetic correlation for H x D at the same age

Trait1	Trait2	Trial								
		1A	1B	1C	2A	2B	3A	3B	4A	4B
H(10)	D(10)	0.58	0.62	0.44	0.87	0.92				
H(7)	D(7)						0.13	0.90	0.84	0.83

Genetics of fibre traits of silver birch

(30 clones, 3 trees/clone, disc at 1.3 m, 11 yrs old)

Trait	Unit	Mean	Min	Max	H2	S.e.of H2	CVG, %
Dens	kg m ⁻³	429	368	474	0.73	0.08	4.7
Fi-le	mm	0.873	0.748	0.994	0.68	0.08	4.5
Fi-wi	µm	20.4	18.1	22.9	0.66	0.09	3.5



Conclusions

- ◆ **Growth traits are mostly under strong genetic influence, they show substantial genetic variation and high potential for genetic gain.**
- ◆ **Strong age x age correlations indicate that it should be possible to use short test periods.**
- ◆ **The non-significant transfer effects among clones of different origin in combination with weak GxE interaction indicate that southern Sweden can be treated as a single test and utilization zone, and that few sites are needed for genetic tests.**
- ◆ **Survival seem to be a trait of minor importance when breeding birch in southern Sweden.**

Conclusions

- ◆ The variation in heritability among trials was due to differences in success of establishment. Thus, for efficient breeding – see to that the trials are established in a good way
- ◆ There was a negative and significant genotypic correlation between diameter and basic density ($r_G = -0.53$). However, the reduction in density was modest when height or diameter was used as selection criteria.
- ◆ These findings suggest that developing an efficient birch breeding program for southern Sweden should be relatively straightforward. However, further investigations are needed to confirm the results

Selection efficiency

$$CR_Y / R_X = H_Y \cdot r_G / H_X$$

$$CR_Y / R_X = (H_Y \cdot r_G / T_Y) / (H_X / T_X)$$

Trial	Age	r_G	$H^2(\text{Age})$	$H^2(10)$	Relative gain	
					Total	Per year
Trial 1A	4	0.60	0.17	0.25	0.50	1.24
	6	0.93	0.16	0.25	0.73	1.22
Trial 1B	4	0.75	0.17	0.29	0.57	1.44
	6	0.96	0.23	0.29	0.85	1.42
Trial 2B	5	0.92	0.19	0.47	0.59	1.19

Heritability for stem quality

Trial	Age	Straightn		BrThickn		BrAngle		BrNumber	
		H^2 h^2	s.e.	H^2 h^2	s.e.	H^2 h^2	s.e.	H^2 h^2	s.e.
1A	10	0.09	0.05	0.12	0.05	0.18	0.05	0.38	0.06
1B	10	0.27	0.06	0.27	0.06	0.33	0.06	0.33	0.06
1C	10	0.17	0.07	0.32	0.07	0.41	0.07	0.19	0.06
2A	10	0.19	0.10	0.45	0.10	0.21	0.11	0.23	0.10
2B	10	0.16	0.09	0.37	0.09	0.23	0.1	0.36	0.09
2C	10	0.27	0.10						
Mean	10	0.19	0.08	0.31	0.08	0.27	0.08	0.30	0.08
3A	7	0.04	0.09	0.05	0.09	0.19	0.11	0.38	0.14
3B	7	0.01	0	0.51	0.13	0.25	0.1	0.19	0.09
3B	9								
4A	7								
4B	7								
Mean	7	0.02	0.04	0.28	0.11	0.22	0.1	0.28	0.12

Genetic correlation for growth x stem quality

Trial	Trait	Trait			
		Str	BrT	BrA	BrN
1A	H	-0.72	-0.27	0.31	0.15
	D	-0.69	-0.84	-0.25	-0.43
1B	H	-0.45	0.17	0.36	0.23
	D	-0.26	0.02	0.22	-0.3
1C	H	-0.05	0.56	-0.01	0.11
	D	0.13	0.19	-0.16	-0.44
2A	D	-0.11	-0.1	0.2	-0.99
2B	H	-0.12	0	0.8	-0.21
	D	-0.01	-0.1	0.71	-0.25
2C	H	0.71			
3A	H			0.39	0.61
	D			0.68	-0.43
3B	H		0.26	-0.09	-0.07
	D		0	0.11	-0.19