

Breeding for disease resistance



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Origin of black cottonwood in Iceland

Southern Alaska

Kenai peninsula
(1944)

Cordova region (1963)

Yakutat (1963)



Climate conditions in the areas of origin

Kenai clones most continental

Cordova clones intermediate

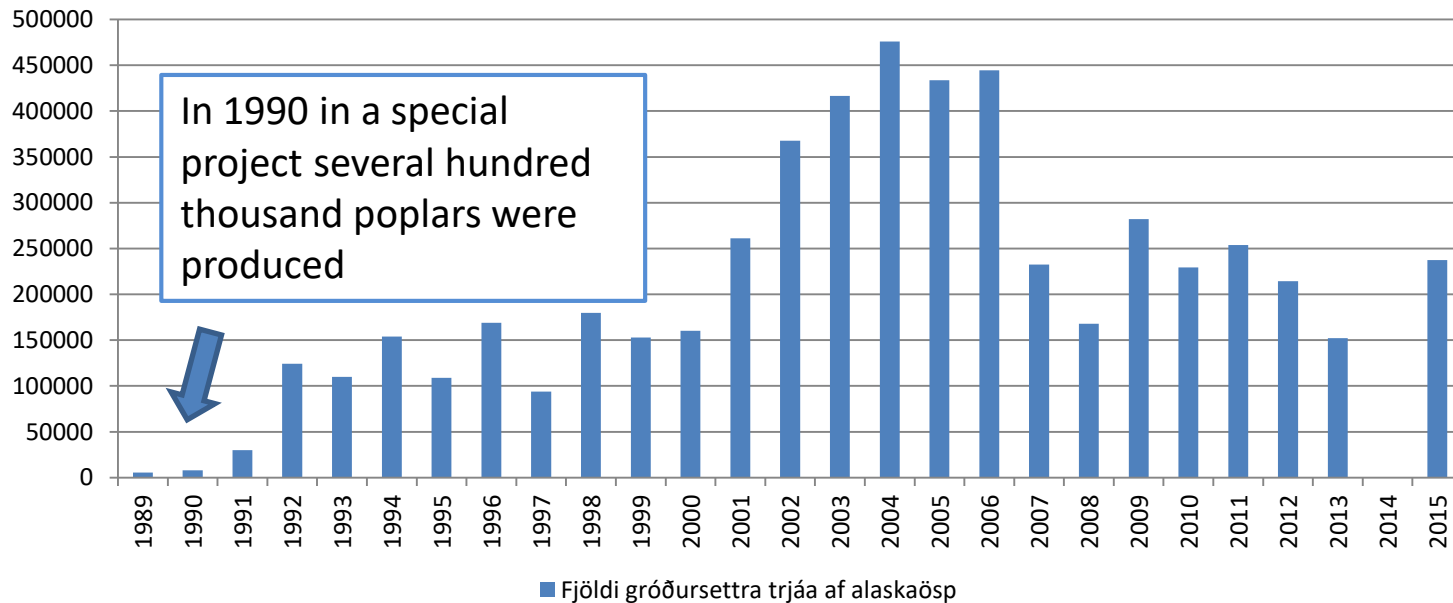
Yakutat clones most maritime

Planting of poplars and aspen in Iceland

Poplars planted 1944 to 2011: 5.058.797 (plus 8-9 hundred thousand in the 1990 project)

Aspen planted 1990 to 2011: 3.387

Number of planted poplars

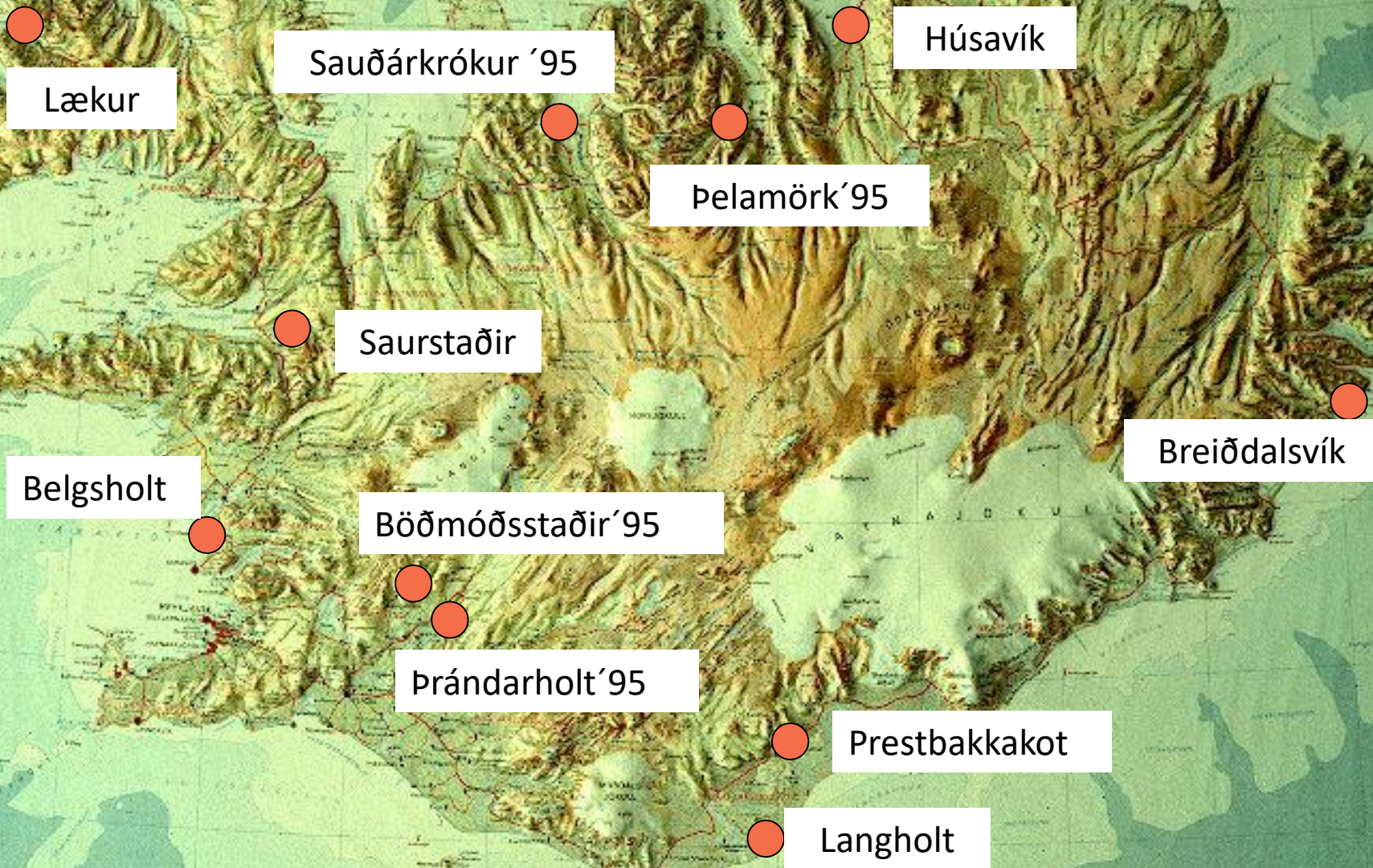


Why grow poplars?

- Fast growth (up to 25 m³/ha/yr)
- Many uses – reforestation, recreation, shelter – and now even timber production
- Fast growing market for wood biomass
Silicon and silicon alloy fabrics



Clonal trials established 1992-1995



Clonal trial in Prestbakkakot in South-East Iceland plantet 1992-1993



Photo: Halldór
Sverrisson August 2014

Experimental forest in South-Iceland

An aerial photograph showing a large, rectangular experimental forest plot in South-Iceland. The forest is composed of dense, young trees, likely spruce or fir, planted in a regular grid pattern. The plot is surrounded by open fields and a road. The sky is clear and bright.

This forest was
planted with plants
from the special
project in 1990

History of poplar breeding in Iceland

Collection of seeds from Icelandic trees since 1979

First controlled crossings in 1988

Crossing southern clones 1995

Crossing various clones in 2002, 2004 and 2006 with emphasis on rust resistance

Crossing black cottonwood and eastern cottonwood in 2007

The rust arrives

In 1999 poplar leaf rust (*Melampsora larici-populina*) was found for first time in Iceland in two towns in the South

In the following years the rust spread out mostly in the southern part of the country

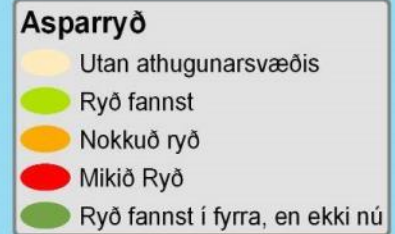
Now, 20 years after the rust arrived, although most common the South, it is gradually spreading in North and East.

Distribution of poplar leaf rust in 2004

Growing rust intensity

In the period since the rust arrived the years 2010, 2014 and 2016 have been the most serious rust years

Bjarki Þór Kjartansson
2005



Effects of poplar leaf rust

- Reduction of leaf photosynthesis
- Reduced tree growth
- Increased frost damages
- Loss of autumn colors

‘Iðunn’ from the Cordova region has been a popular clone in Iceland

There is no poplar rust in Alaska. The poplars are therefore very susceptible to rust, but there is much variation between individuals. Some clones can have heavy rust infestation without other consequences than growth reduction.



No autumn
colors!



Finding resistant clones

Soon after the arrival of the rust the Forest Research at Mógilsá began to look for resistant clones in the clonal trials in South Iceland

One clone, '*Sæland*', was found to have good resistance and a few other clones had some resistance against rust

Intraspecific crossings

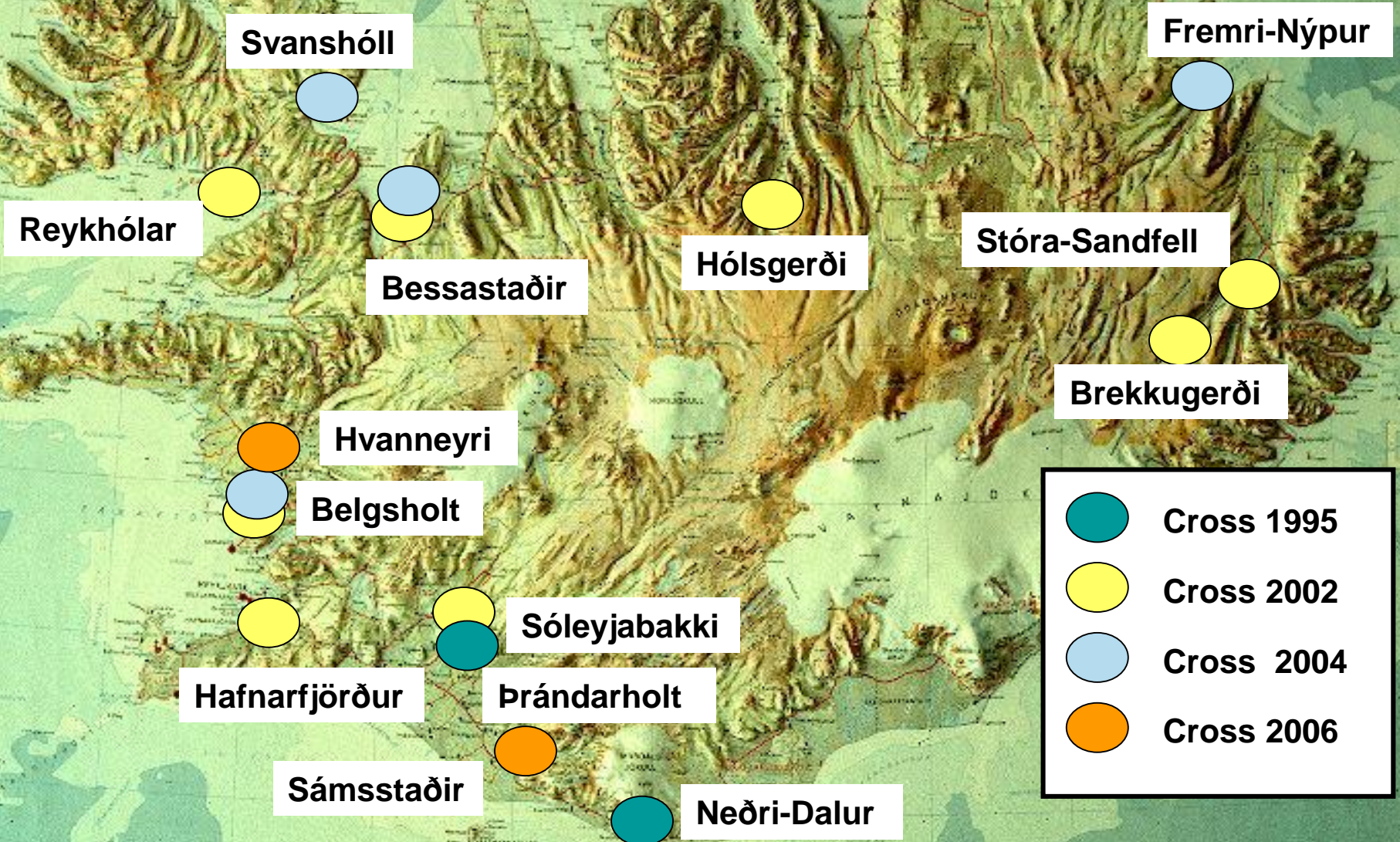
2002, 2004 and 2006

Current breeding program started in 2002
Since then several crosses have been done

The progeny have been planted in trials all
over the country, the first in 2003

Plus trees were selected from 2009 to 2012
and planted in a collection

The progeny trials



Selection of plus trees

Trees were selected and cuttings taken when the trials were 6-8 years old



Selected clones from the progeny trials were planted in one collection in the southern region where rust is frequently a problem





The cone collection in
Hrosshagi in autumn 2017

Planted 2009 to 2012

The progeny collection

In the collection of the plus trees in Hrosshagi in South-Iceland there are 350 clones

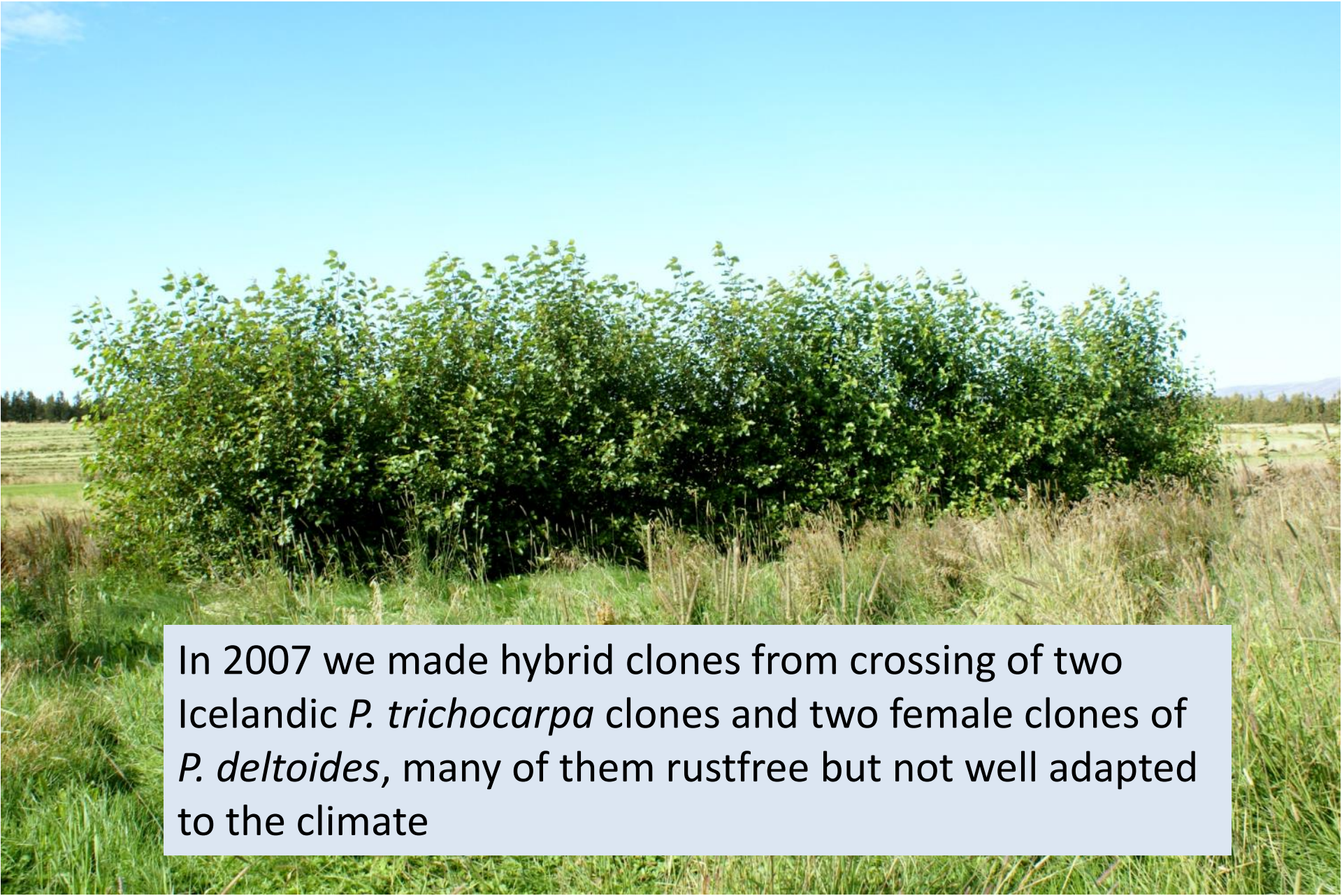
Four trees of
each clone



In the vicinity of the clone collection larch has been planted in mixture with poplars which is resipe for the rust



Interspecific hybrids

A large, dense, green bush or shrub is the central focus of the image, situated in a field of tall, dry grass. The background shows a clear blue sky and a distant treeline. The bush has a rounded, bushy appearance with many small green leaves.

In 2007 we made hybrid clones from crossing of two Icelandic *P. trichocarpa* clones and two female clones of *P. deltooides*, many of them rustfree but not well adapted to the climate

Evaluation of rust in the clone collection in Hrosshagi

The best evaluation was done in late August 2014 when the whole area was infected with the rust

This was the first summer since the establishment of the collection that the rust appeared so early as beginning of July

The uniform spread of rust in the whole collection gave an excellent opportunity to evaluate rust resistance in all progeny selected from the trials

The estimation of rust in the clone collection

Index points 1-5

1 = no or very little rust

5 = heavy rust



Evaluation of frost damage

After a bad rust year many clones get severe frost damage. This picture is from the summer 2015.



Keisari

Location of trial	Number of selected clones	Number of clones with high or complete rust resistance
	From the 2002 crosses	
Sóleyjabakki	44	4
Reykhólar	15	0
Brekkugerði	11	0
Stóra-Sandfell	17	1
Hólsgærði	20	2
Bessastaðir	31	2
Belgsholt	16	2
	Total 144	Total 11
	From the 2004 crosses	
Fremri-Nýpur	18	3
Bessastaðir	19	0
Belgsholt	20	0
Svanshóll	24	0
	Total 81	Total 3
	From the 2006 crosses	
Hvanneyri	22	12
Sámsstaðir	22	14
	Total 44	Total 26

Sámsstaðir

Clone	Mother	Father
1	A-566-06	Haukur
10	A-566-06	Haukur
4	Skegla	Haukur
6	A-421-01	Haukur
19	A-421-01	Haukur
2	A-566-06	Vigfús
3	A-566-06	Vigfús
11	A-566-06	Vigfús
12	A-566-06	Vigfús
20	A-566-06	Vigfús
5	Iðunn	Vigfús
8	Iðunn	Vigfús
9	Iðunn	Vigfús
13	Iðunn	Vigfús
14	Iðunn	Vigfús
15	Iðunn	Vigfús
17	Iðunn	Vigfús
21	Iðunn	Vigfús
7	Skegla	Vigfús
16	Skegla	Vigfús
18	Skegla	Vigfús
22	Skegla	Vigfús

Hvanneyri

Clone	Mother	Father
3	A-520-01	Haukur
4	A-520-01	Haukur
5	Skegla	Haukur
22	Skegla	Haukur
11	A-566-06	Haukur
1	A-566-06	Vigfús
2	A-566-06	Vigfús
9	A-566-06	Vigfús
10	A-566-06	Vigfús
15	A-566-06	Vigfús
6	Iðunn	Vigfús
8	Iðunn	Vigfús
13	Iðunn	Vigfús
14	Iðunn	Vigfús
19	Iðunn	Vigfús
20	Iðunn	Vigfús
21	Iðunn	Vigfús
7	Skegla	Vigfús
12	Skegla	Vigfús
16	Skegla	Vigfús
17	Skegla	Vigfús
18	Iðunn	A-676

The superfather 'Vigfús'



The resulting „rust free“ clones

Of the 350 clones 40 proved to have high or almost complete resistance for poplar leaf rust

26 of them were from the 2006 crossings out of 44 plus clones selected

25 of these 26 are progeny of one single father tree, 'Vigfús'

Testing poplars from other countries breeding

In recent years we have been testing some poplar clones which have been bred in other countries. Also some aspen hybrids. Some examples here.

40 clones from British Columbia, Canada. Only a few of them survived. The only survivors are pure *P. trichocarpa*.

23 clones from SLU Sweden. Planted summer 2017 in Mógilsá. Many survived last two winters. Should be rust resistant.

Aspen hybrids from Germany are also being tested.

The Swedish clones in test field at Icelandic Forest Research, Mógilsá

(from Almir Karacic, SLU)



August 2019

Discussion and conclusions

Poplars, especially black cottonwood, will be important in Icelandic forestry in the future. It is crucial to use the best available genetic material.

In the current breeding program has proved that it is possible to produce clones with good resistance against poplar rust.

The yield of rust resistant clones is 15% of the selected progeny and emphasis should be on resistant clones in the future although the rust is now absent from large parts of the country.

The progeny trials are a treasure of genetic resources for the future.

Thanks for your attention!

