EAAP, Stavanger, 1 September 2011, Session 48 no. 5, page 342.

Selection strategies against categorically scored hip dysplasia in dogs: a simulation study

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What is hip dysplasia (HD)?

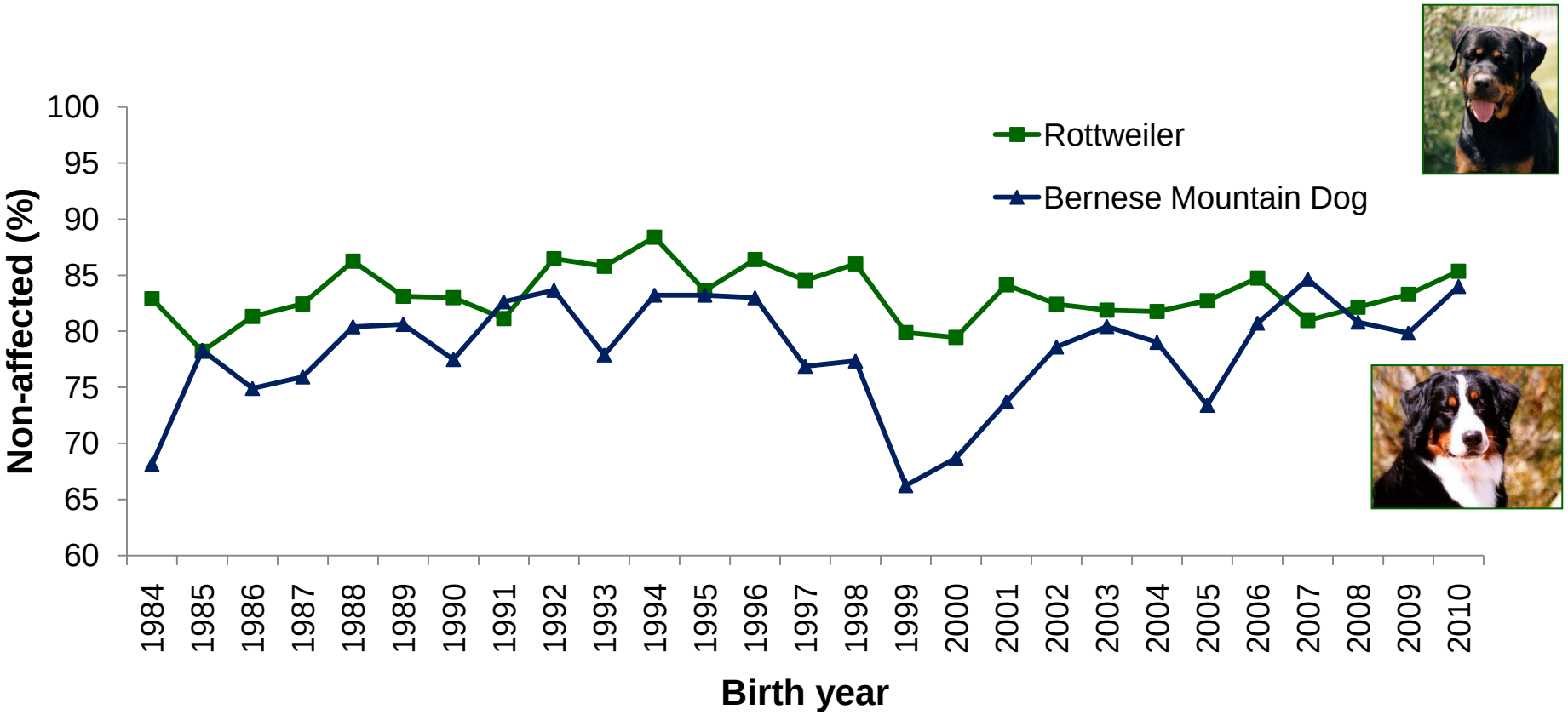
- ✓ One of the most common hereditary disorders in dogs
- ✓ Prevalence varies widely between breeds
- ✓ Heritability estimates ranging from 0.2 to 0.6
- ✓ Painful for dogs, costly for dog owners
- ✓ Screening programmes based on phenotypic selection

HD is a categorical trait

Grading of HD according to the Fédération Cynologique International (FCI):

- A = Normal
- B = Normal
- C = Mild HD
- D = Moderate HD
- E = Severe HD

Has selection been effective?



Selection based on the phenotypic record alone is ineffective for categorical traits

Objective

How would introduction of BLUP breeding values for categorically scored hip dysplasia influence the genetic progress and inbreeding rate?

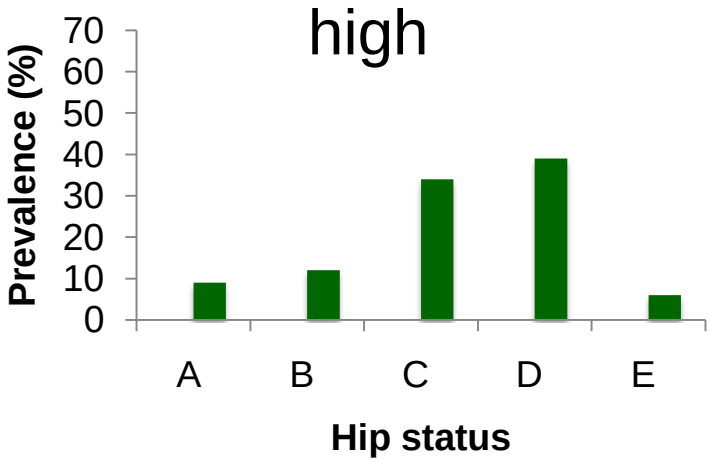
Comparison of selection strategies using stochastic simulation:

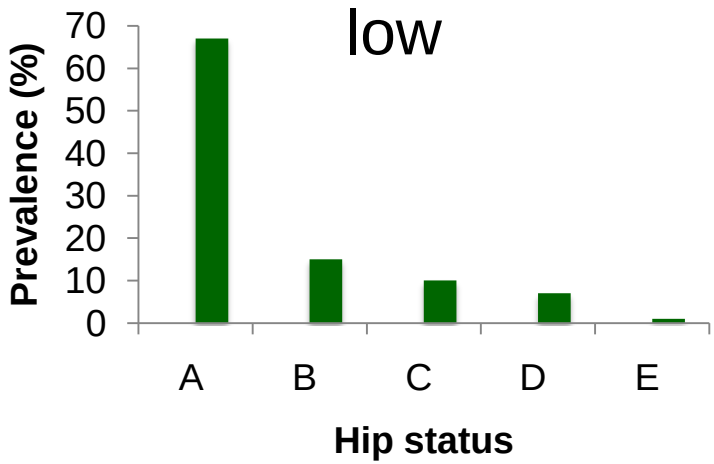
- Truncation selection based on
  - phenotypic records
  - BLUP breeding values
- Optimum contribution selection (OCS) based on BLUP

Selection scenarios

Four main scenarios were designed based on:

1) Initial prevalence of HD





2) Population size

large: 3000 dogs born/year

small: 300 dogs born/year

Population structure

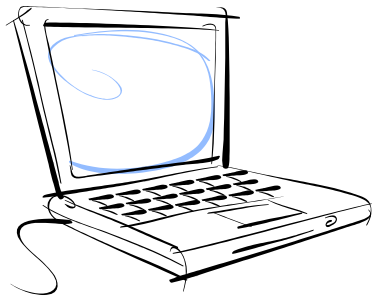
	Large pop.	Small pop.
No. males selected	200	20
No. females selected	600	60
Average litter size	5	5
No. litters per male and year	3	3
No. litters per female and year	1	1
No. males born per year	1500	150
No. females born per year	1500	150
Max. No. offspring per male (overall)	150	15
Max. No. litters per female (overall)	5	5

Traits

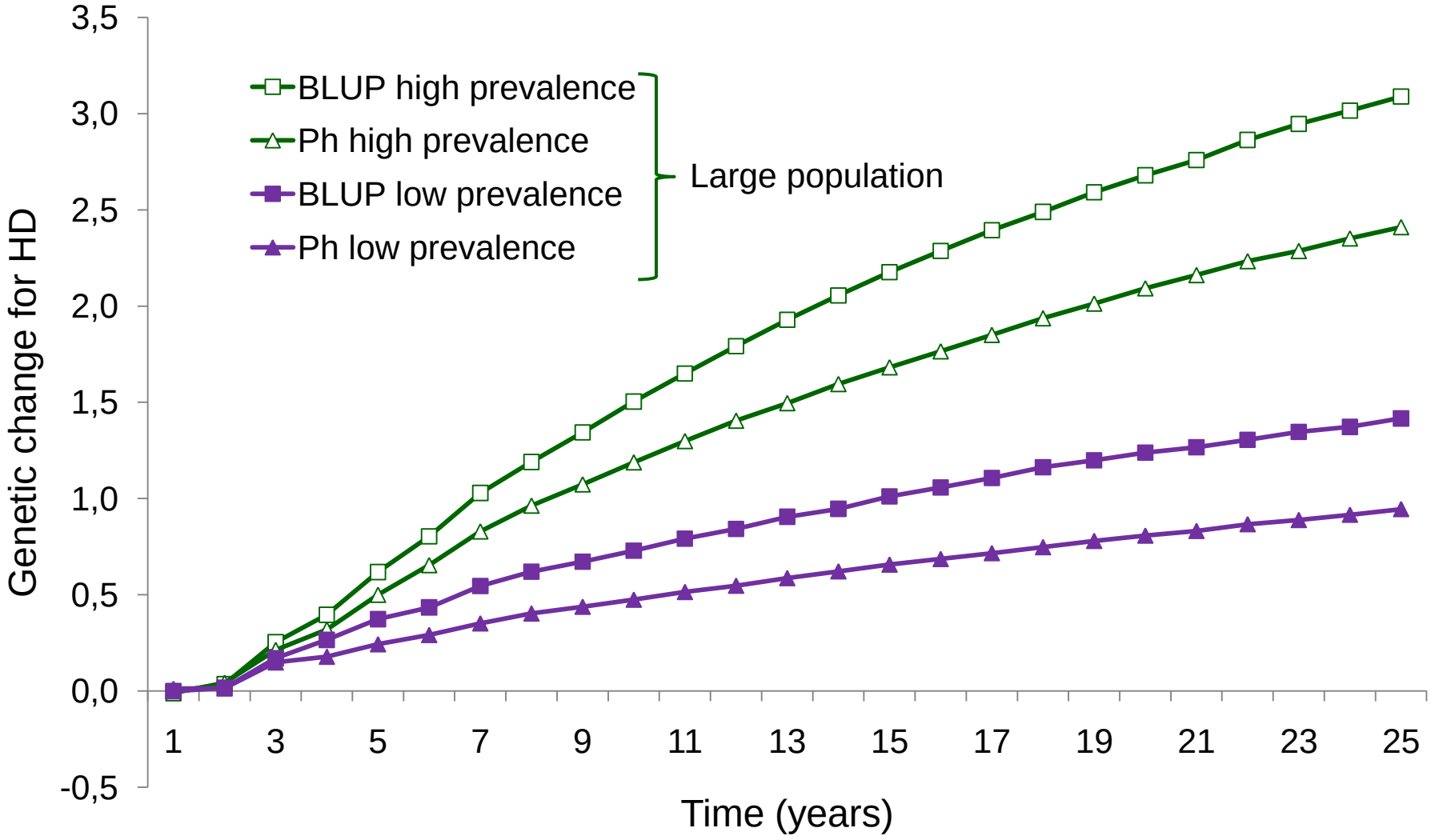
- ✓Two traits were considered:
  1) HD as a categorical trait (A=5, B=4, etc.)
     $h^2 = 0.45$ (liability scale)
  2) "Breed characteristic" as a continuous trait
     $h^2 = 0.25$ (liability scale)
- ✓ Genetic correlation set to zero in all main scenarios
- ✓ Selection based on index
  - Equal economic weights

Simulation and data analysis

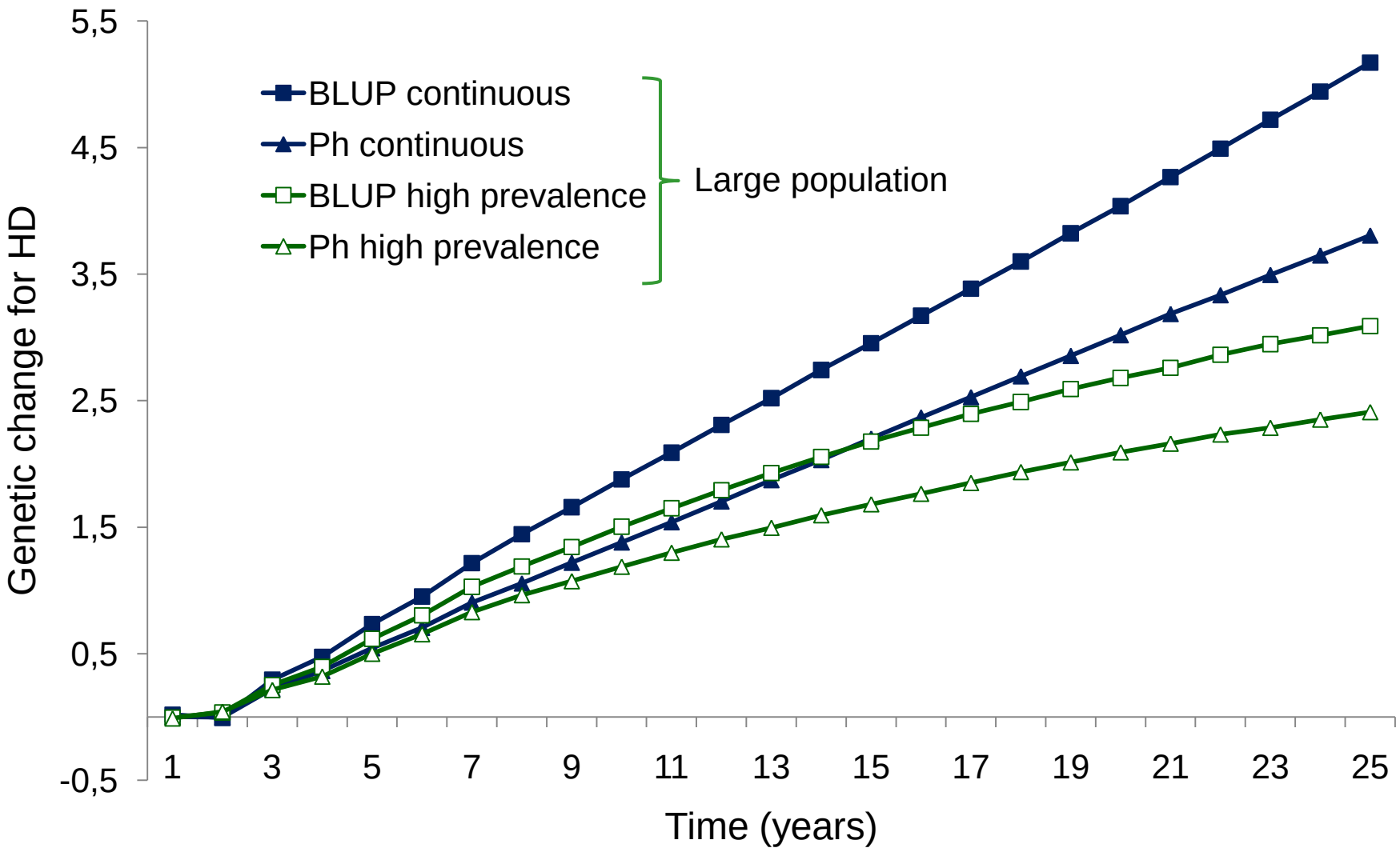
- ✓ All scenarios were modeled over a period of 25 years using the software package ADAM
- ✓ A mixed linear animal model was used to predict BLUP breeding values with the DMU package
- ✓ OC selection based on BLUP breeding values performed using the software package EVA
- ✓ Each scenario was replicated 50 times



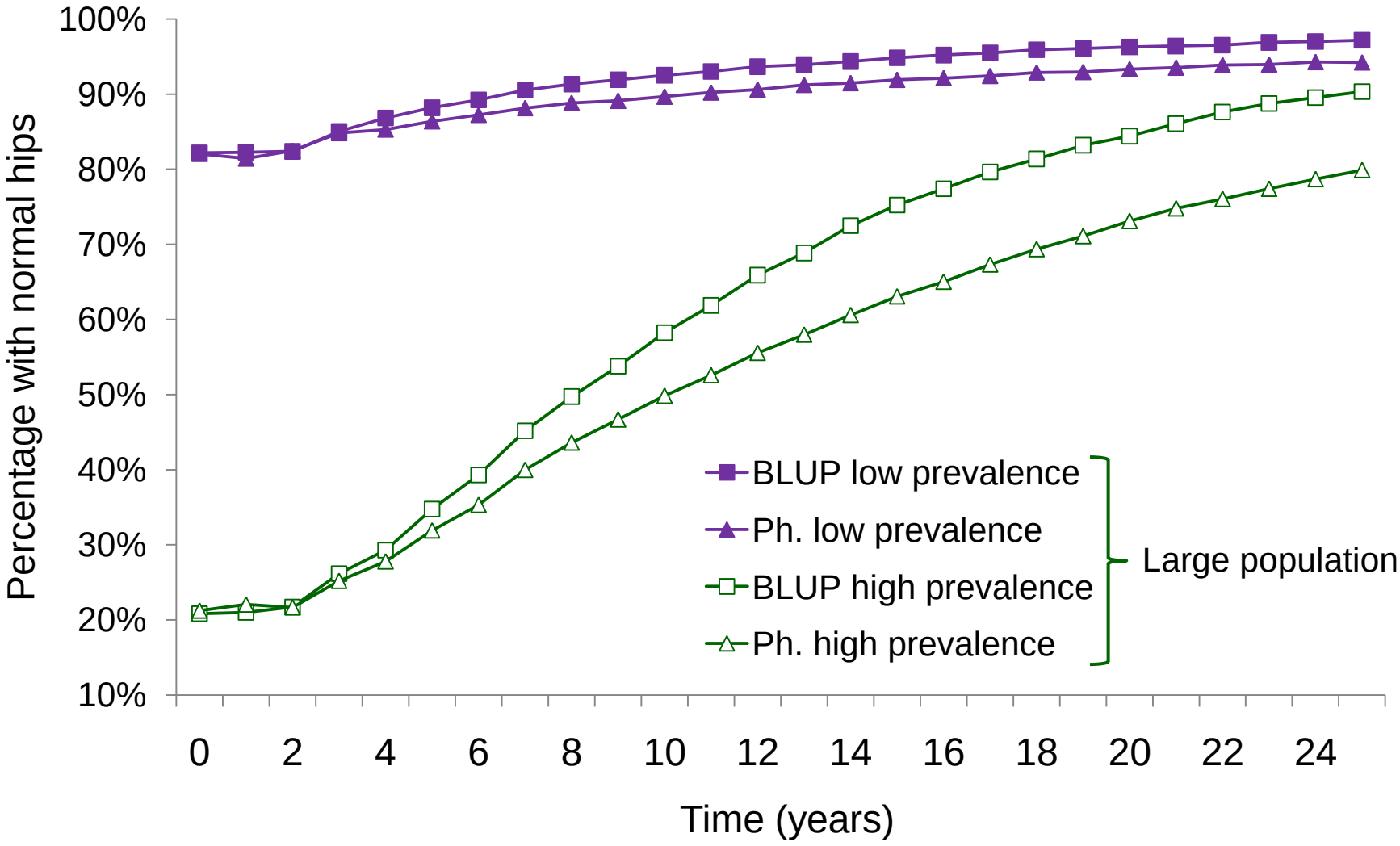
Rate of genetic progress



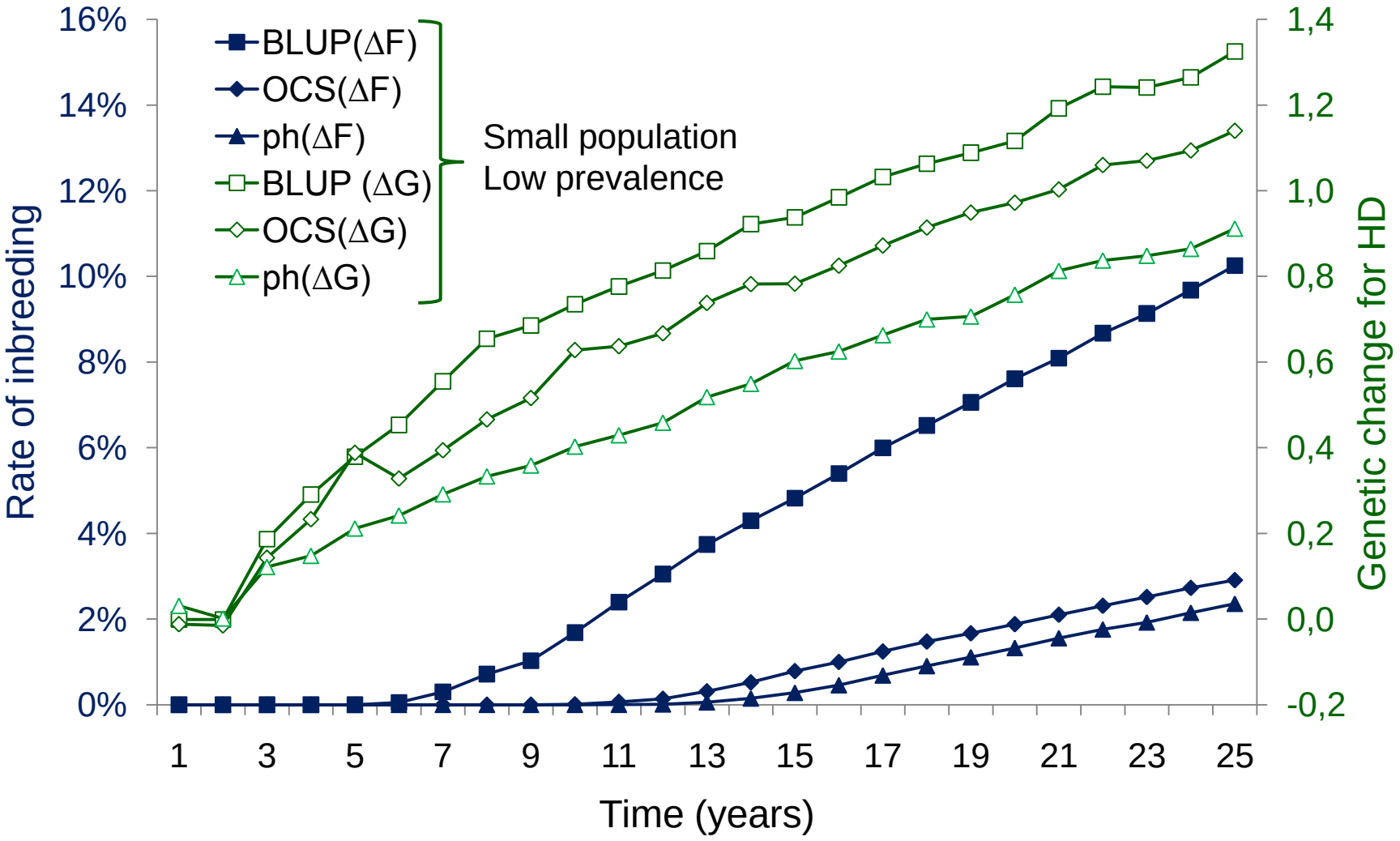
Rate of genetic progress



Phenotypic trend



Genetic trend and rate of inbreeding using OCS



Conclusions

BLUP was superior to phenotypic selection, also for a categorical trait such as HD.

In small populations, BLUP should be used together with OCS or similar strategy to maintain genetic variation.

The categorical nature of HD caused a considerably lower genetic gain.