

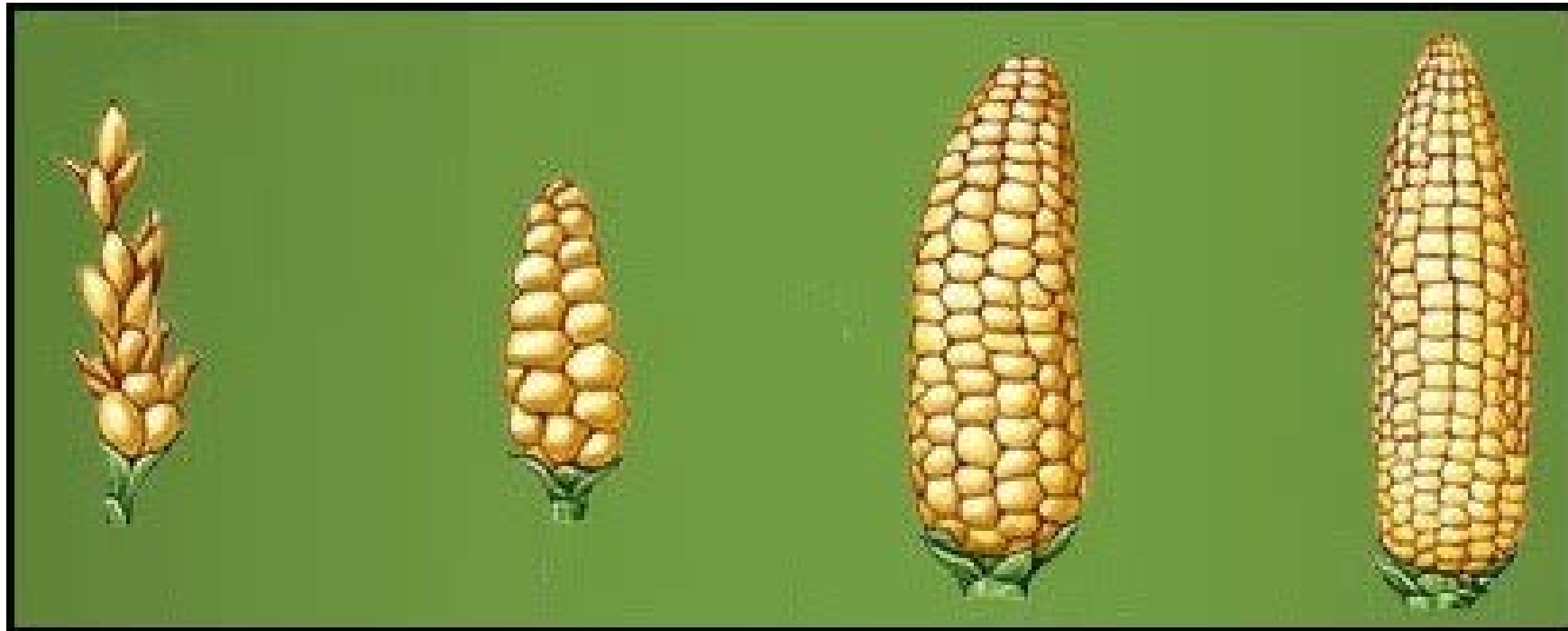
Towards selective breeding of sugar kelp

Åshild Ergon – Norges miljø- og biovitenskapelige universitet (NMBU)

SIG Seaweed 7

Trondheim 15 November 2022

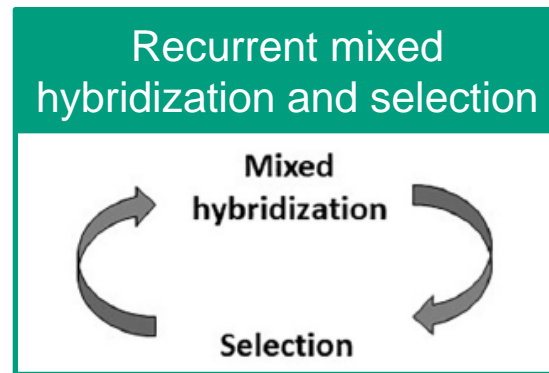
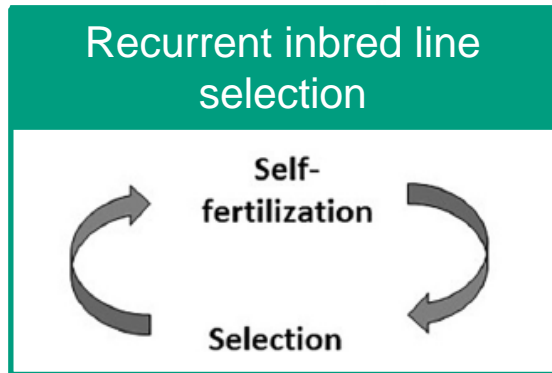
Plant breeding



Breeding schemes used in Asian kelp breeding

More labour-intensive
Requires more cultivation and maintenance facilities

		Hybrid breeding / selective crosses			
♀	♂	1	2	3	4
1					
2		Which combination expresses heterosis?			
3					
4					



Less control of unintended selection

Example: Huangguang No. 1



Kontrollsort

Huangguang No. 1

Selection criteria (sporophytes):

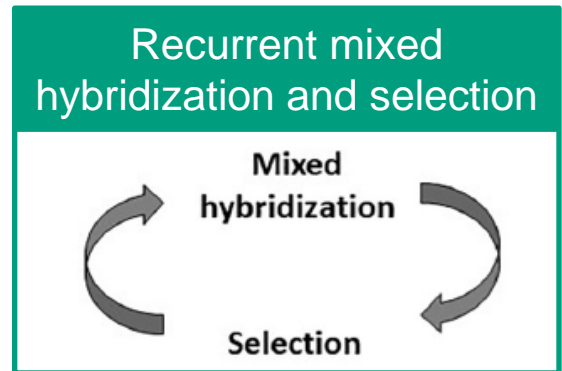
- Healthy
- No sori at harvest
- Thickness
- Colour
- Robust stipe and holdfast
- Survival at high temperature

Method

- Initial collection of 150 selected cultivated individuals from a large area
- Mixed hybridization and selection in 5 generations

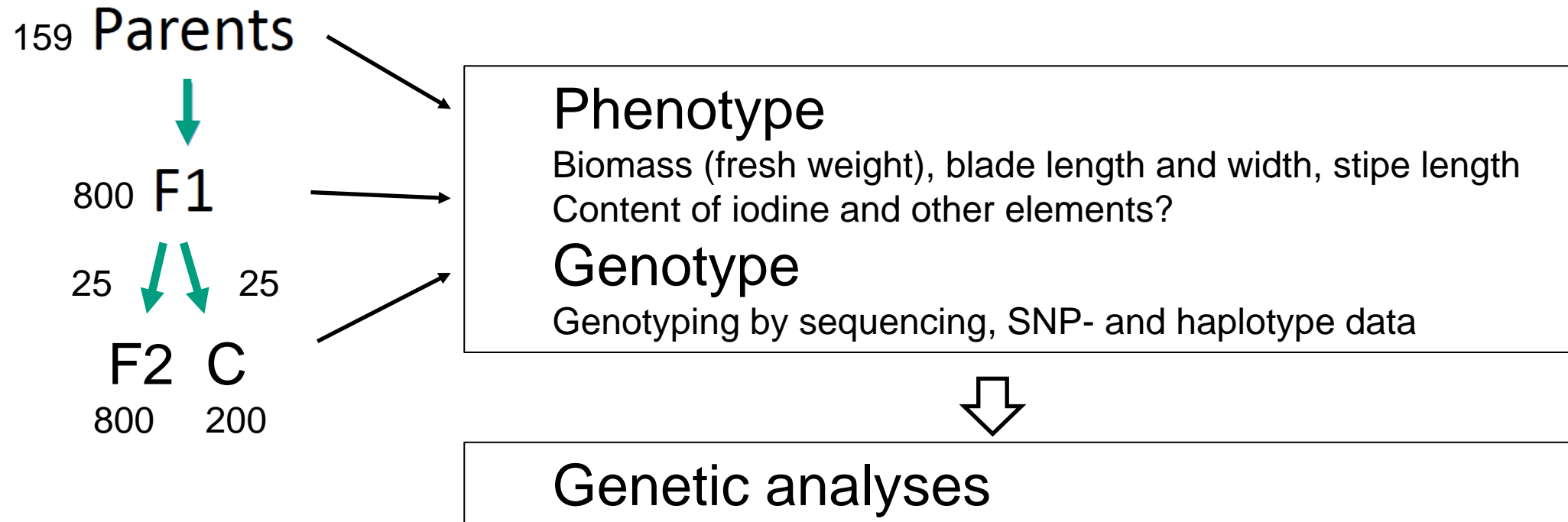
Result

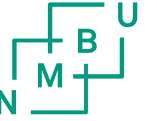
- **71% increase in wet weight** per individual compared to base population
- **30-35% higher yield** than control cultivar (tonn per hectar)
- «Attractive» morphology
- Less variation among sporophytes than in control cultivar and base population





Breed4Kelp2Feed: Selection experiment and genetic analyses





Selection experiment and genetic analyses

Examples of questions we try to answer:

- How much genetic variation is there in the parental population?
- What happens to this variation from generation to generation?
- If there is any inbreeding depression or heterosis, how large is it?
- Can we identify associations between genes and traits?
- How big is the effect of the environment compared to the effect of genes?



Information which is useful in future selective breeding

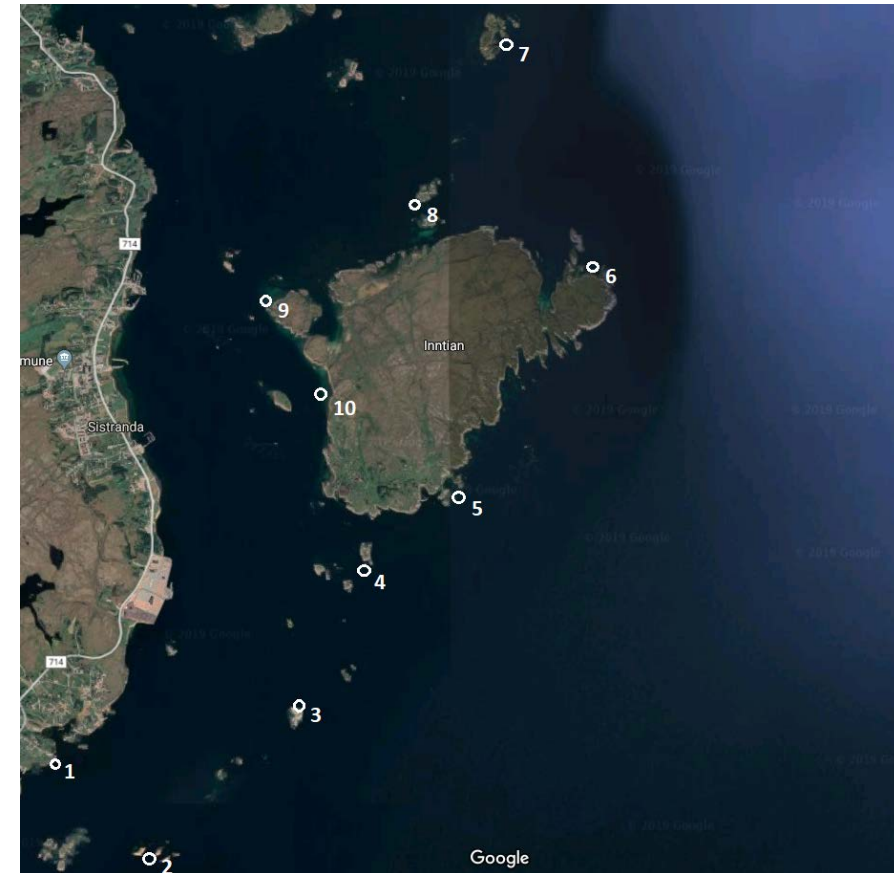
Genetic variation in the parental population

- Genotyping-by-sequencing data from 151 parental individuals from 10 subpopulations
- Approx. 21 000 SNPs and 12 000 short haplotypes
 - Markers for analyses of all generations
 - Population genetic analysis at a very local scale
 - Large amount of genetic diversity
 - Subpopulation differentiation?
 - Slight outbreeding (excess of heterozygotes)

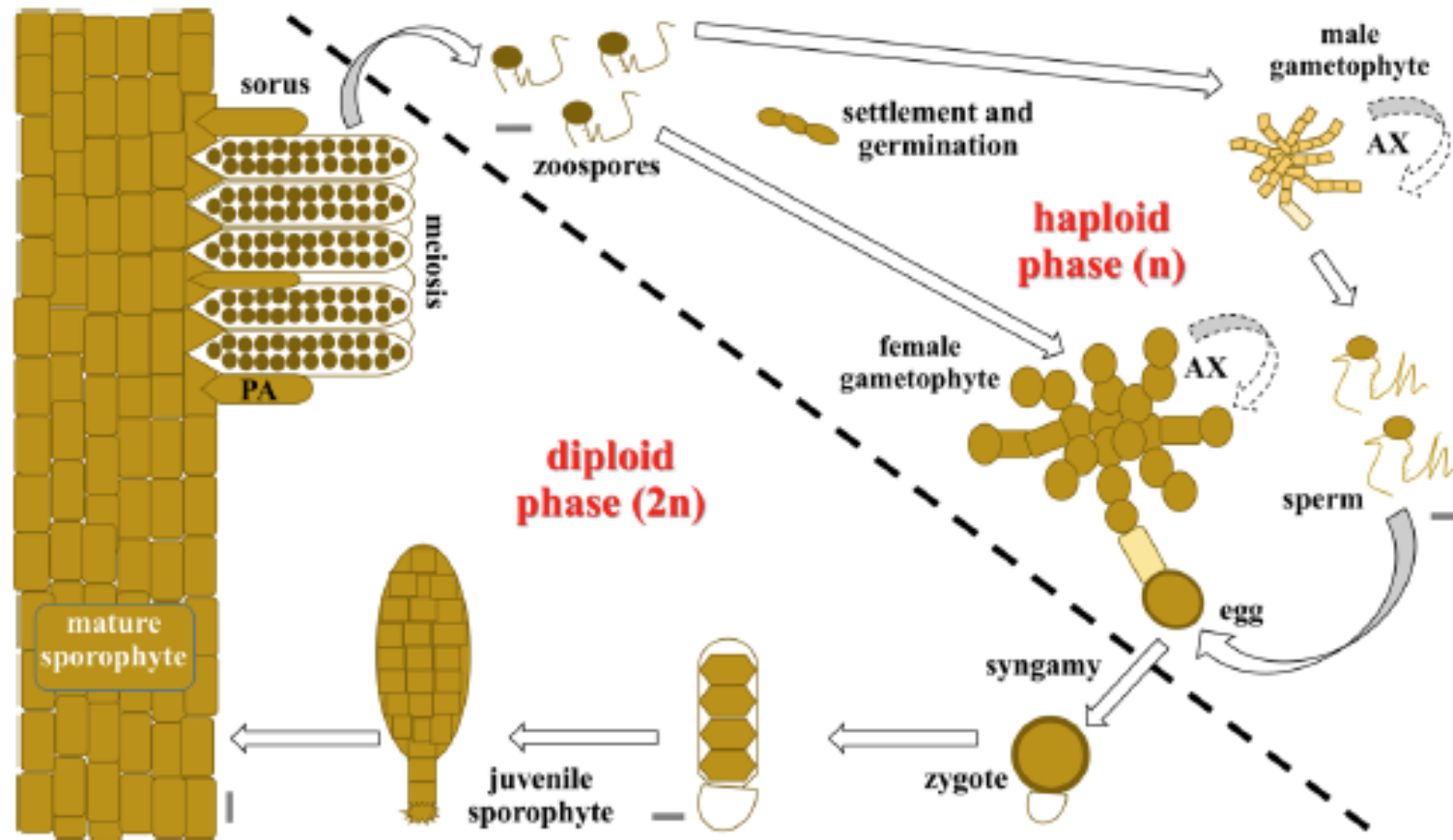
AAGTCCGTAGCTGCTA
AAGACCGTAGCGGCTA

AAGTCCGTAGCTGCTA
AAGACCGTAGCTGCTA

Image approx. 7 x 7 km

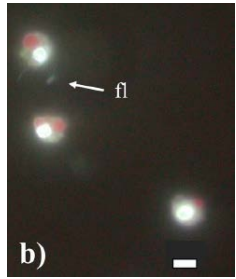
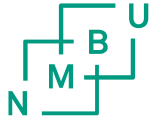


Breed4Kelp2Feed: Development of sterile sugar kelp



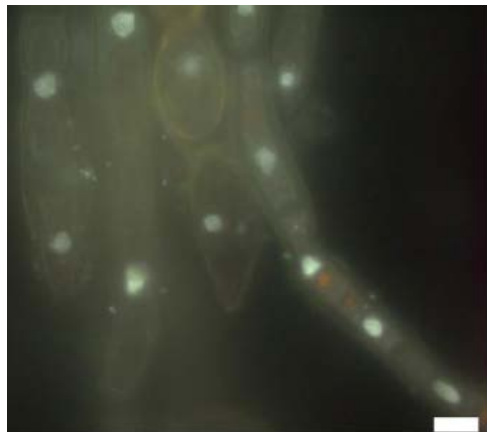
Researcher Franz Goecke

Variation in nuclear DNA content



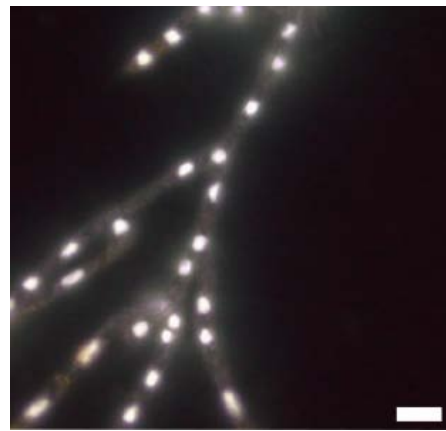
Spores (n)
0.76 pg DNA (1C)

5 μ m



10 μ m

Female gametophytes (n)
2.27 pg DNA on average (~2C)
Larger nuclei, more variation
Some >2C



10 μ m

Male gametophytes (n)
2.01 pg DNA (~2C)

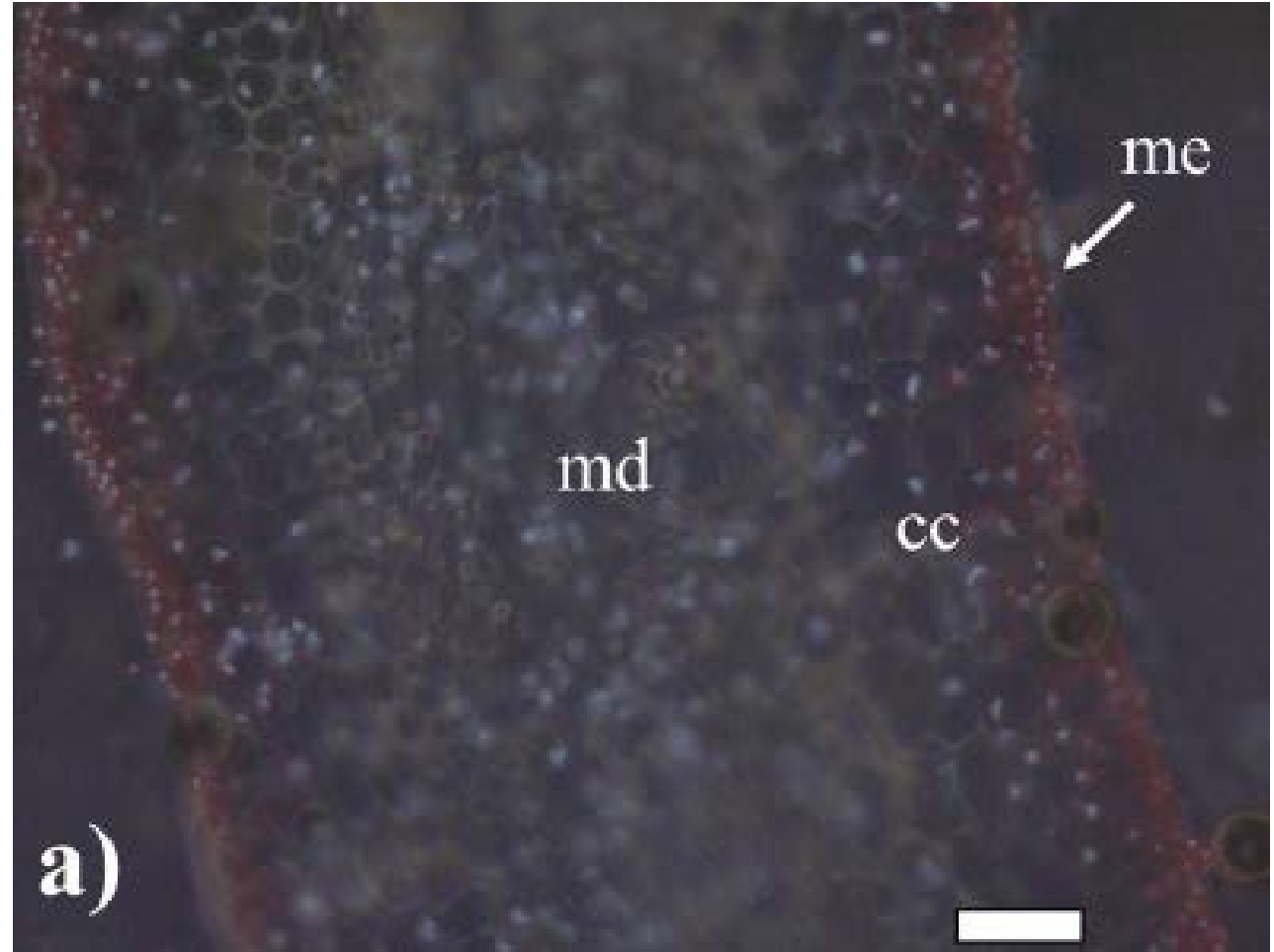
Sporophytes (2n)

Tissue variation

Meristoderm: 1.51 pg DNA (2C)

Cortex and medulla: 2.40 pg DNA on average, variable

Some >2C

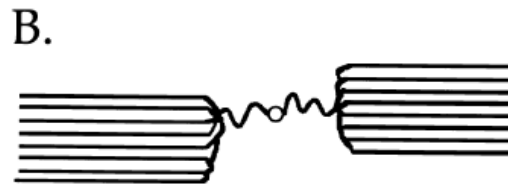
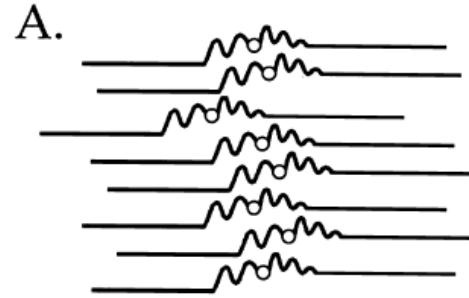


Goecke et al., Marine Biotechnology 2022

100 μ m

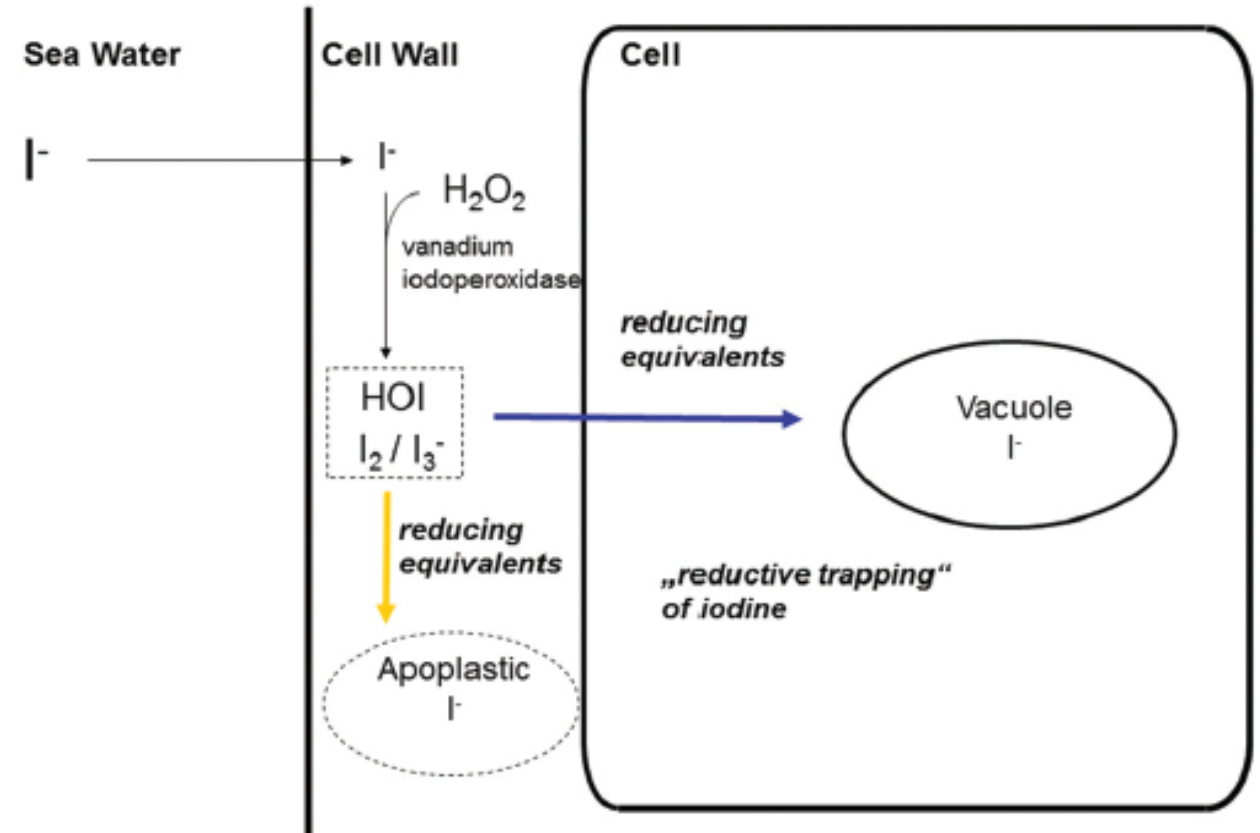
Endoreduplication?

- More DNA, but same number of chromosomes



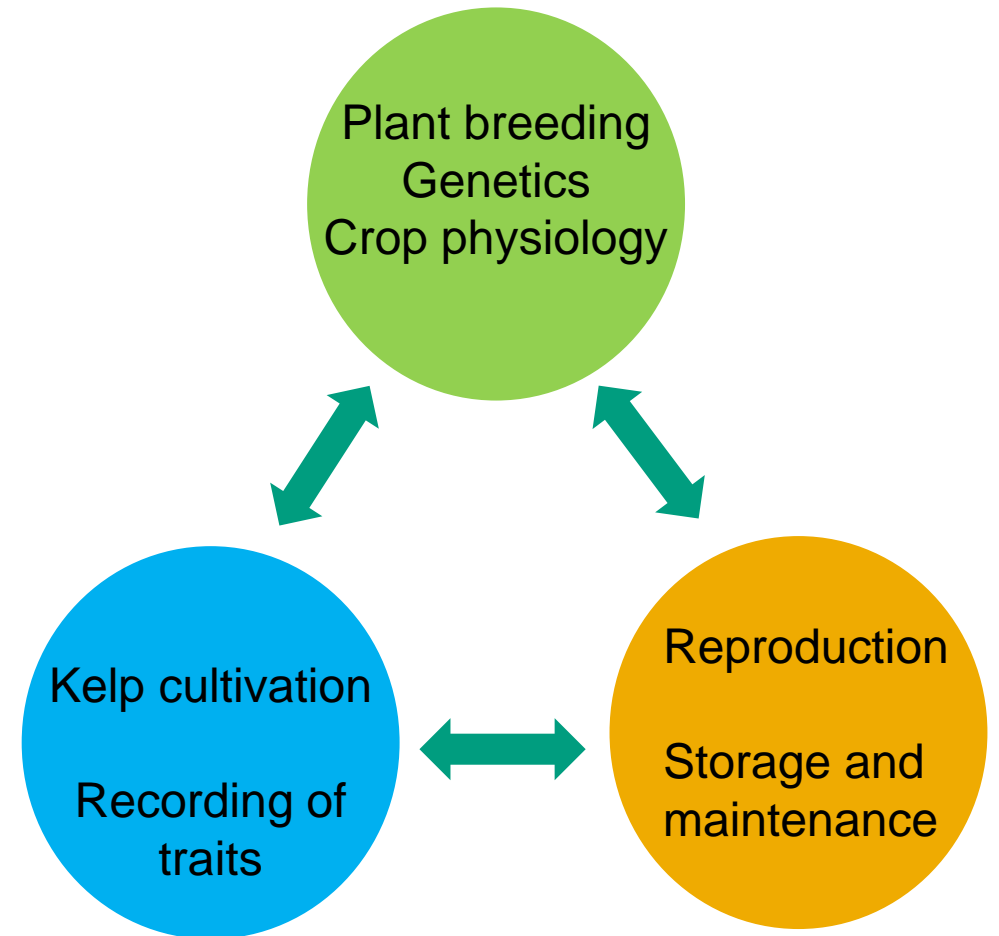
SafeKelp: Can we select for lower iodine content?

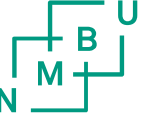
- Variation in content?
- Iodid (I^-) can play a role in stress tolerance in kelp – as an antioxidant
- Stress experiments
 - changes in element profile
 - changes in the transcriptome



What is needed now?

- Collaboration
- Methodology: standardization of cultivation, replication and registration, both gametophyte and sporophyte stages
- Understanding of crop physiology and genetics behind yield and quality
- Investigate various routes to non-reproductive sporophytes





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Breed4Kelp2Feed
SafeKelp

Eckbos Legat