Direct and social genetic parameters for growth and fin damage traits in Atlantic cod (*Gadus morhua*)

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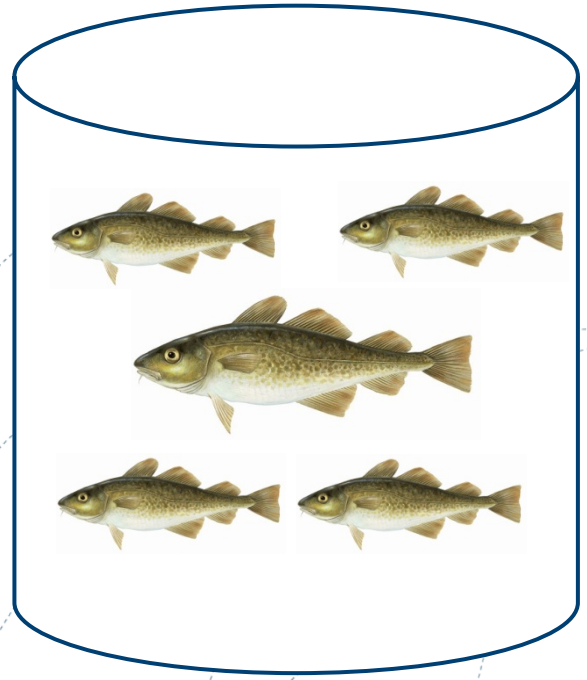
Introduction

- **Atlantic cod:** newly farmed specie
- Norwegian breeding program started in 2002 based on wild fish
- Omnivorous and shows cannibalistic behavior
- Social interactions e.g. aggressions between fish when reared in tanks or net-cages
- Genetic component?



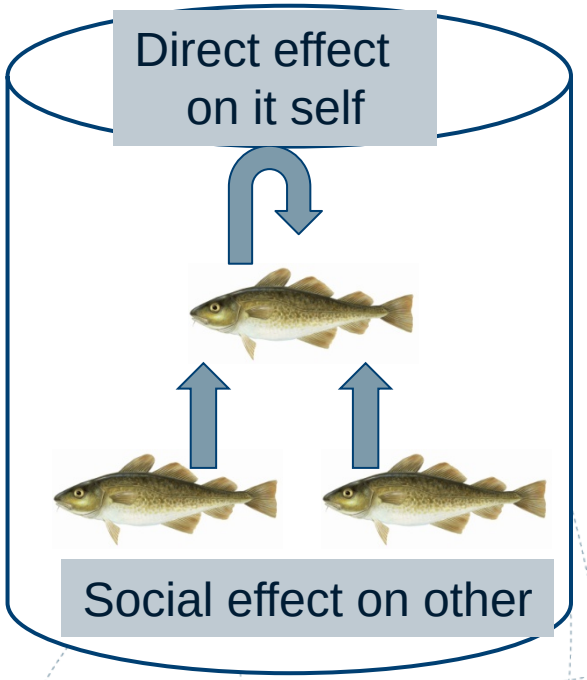
Introduction

Socially affected traits:

The phenotype of an individual may depend on genes in other individuals

Each fish has:

1) Direct effect on self
2) Social effect on others = social interactions



- How well the fish is growing also depends on the other fish in the tank

- Classical models for BV estimation only accounts for the direct effects

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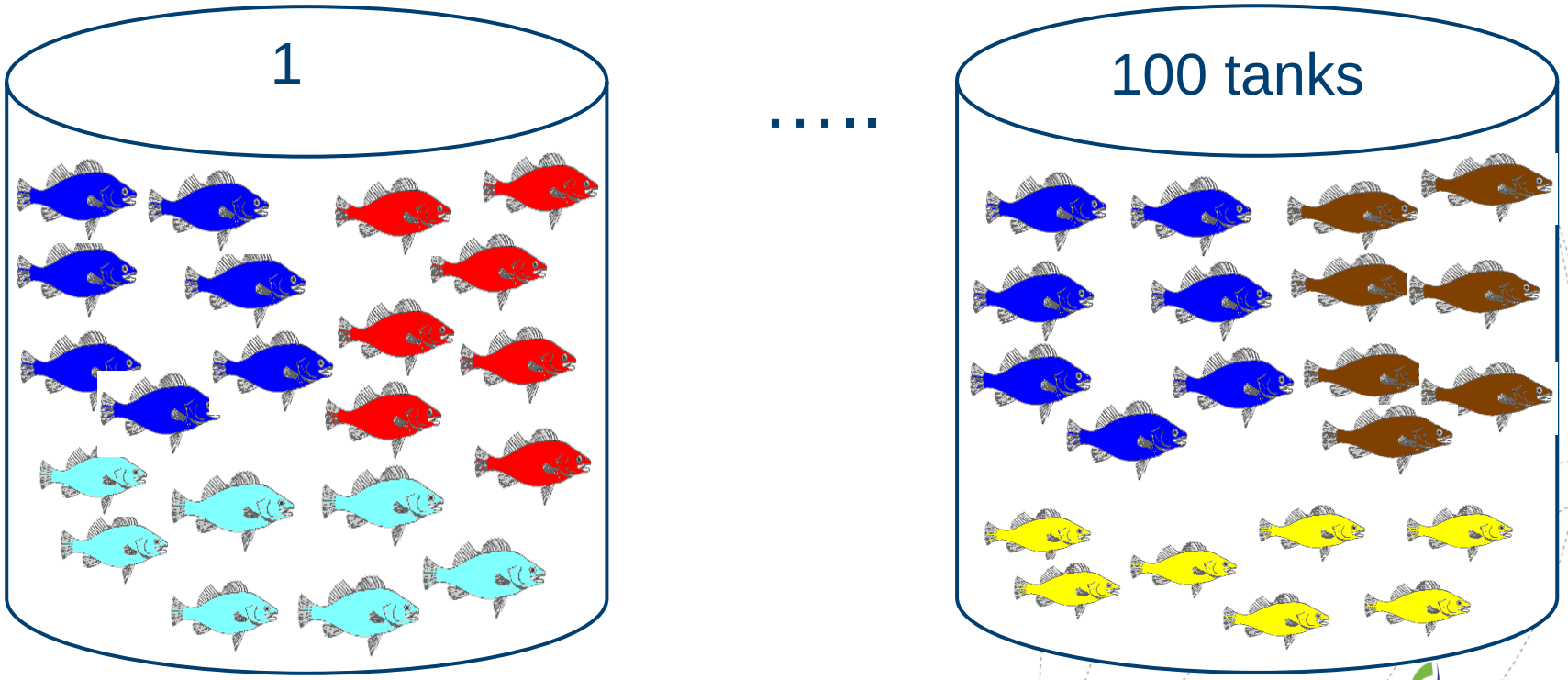
Aim

To test if there were indications of social genetic effects for traits affecting fish welfare and growth in Atlantic cod

Experimental design

- 2100 cod (6 month, 34.5 g) from 100 full and half sib families (21 fish/family)
- 100 tanks each with 21 fish
- The 21 fish /family were distributed randomly in 3 tanks
- Each tank contained 21 fish from 3 different families (7 fish/family)



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Recordings and traits

- 6 weeks of experiment
- Fish were fed restricted in order to facilitate interactions

3 Recordings: 1) at start of experiment (Recording 1)

2) after 2 weeks (Recording 2)

3) At the end of experiment (Recording 3)

Traits: Weight (g)

Fin damage: **(indicator of welfare due to agression and cannibalism)**

Fin erosion: (0 -100% erosion), scored at the end of the experiment

Fin length: measured at all 3 recordings

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Digital analysis of fin length

- Photo of fish to measure fin length by digital analysis
- Fish were placed on a uniform and white background with the left side of fish facing up
- A reference ruler was found in the bottom

Fins measured:
1) First dorsal fin
2) Second dorsal fin
3) Third dorsal fin
4) Caudal fin

- Digital analysis tool (MATLAB) to measure fin length
- Fin length scored by 3 different persons

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Statistical analysis

1) Traditional animal model
2) Animal model including a social genetic effect } Compared using Log likelihood

Fixed effect of person

Random common rearing effect

Residual

Random social additive genetic effect

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z_D a_D} + \mathbf{W_c c} + \mathbf{W_t t} + \mathbf{e} + \mathbf{Z_S a_S}$$

Observations

Random direct additive genetic effect

Random experimental tank effect

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Estimated parameters – social model

$\tilde{A}^2_{A(D)}$ = Direct additive genetic variance

$\tilde{A}^2_{A(S)}$ = Social additive genetic variance

$\tilde{A}_{A(DS)}$ = direct -social additive genetic covariance

$\tilde{A}^2_{TBV}$ = Total heritable variance

$= \tilde{A}^2_{A(D)} + [\, 2(n-1) \times \tilde{A}_{A(DS)} + (n-1)^2 \tilde{A}^2_{A(S)} \,]$, (n=21)

$\tilde{A}^2_{P}$ = Phenotypic variance

$= \tilde{A}^2_{A(D)} + [\, (n-1) \times \tilde{A}^2_{A(S)} \,] + \tilde{A}^2_{e} + \tilde{A}^2_{tank} + \tilde{A}^2_{c,}$ (n=21)

T^2 = The total heritable variance relative to phenotypic variance

$$= \frac{\tilde{A}^2_{TBV}}{\tilde{A}^2_{P}}$$

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Results: Weight

No significant social effects !

	Recording 2	Recording 3
LogL (P >)	(0.38)	(0.23)
h^2	0.33 œ0.14	0.24 œ0.13

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Results: Fin erosion-social model

FIN

Parameter	First dorsal	Second dorsal	Third dorsal	Caudal
LogL (P<)	(0.15)	(0.001)	(0.001)	(0.57)
$\tilde{A}^2_{A(S)}$	0.07 œ0.09	0.19 œ0.10	0.03 œ0.02	0.05 œ0.05
$\tilde{A}_{A(DS)}$	1.79 œ1.19	0.54 œ0.44	0.04 œ0.09	0.09 œ0.23
T^2	1.29 œ0.33	1.37 œ0.60	0.48 œ0.39	0.43 œ0.36

Results: Fin length – social model

LogL < 0.001 for all 4 fins at both recording 2 and 3!

Recording		Fin: First Dorsal	Second dorsal	Third dorsal	Caudal
2	$\sigma_{A(DS)}$	0.03 œ0.06	0.03 œ0.01	0.03 œ0.02	0.004 œ0.06
	T^2	1.35 œ0.27	0.76 œ0.14	0.94 œ0.20	0.73 œ0.12
3	$\sigma_{(AS}$	0.03 œ0.01	0.05 œ0.04	0.03 œ0.01	0.01 œ0.01
	T^2	2.49 œ0.54	2.22 œ0.57	2.31 œ0.35	0.70 œ0.20

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Conclusion

- Significant social effects for fin erosion for 2 fins and for length of the four fins

However, a larger experiment is need to get more precise estimates

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