Body weight deviations as resilience indicator in chickens

August 30, 2018

Tom Berghof

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Co-authors/Acknowledgement

Wageningen University & Research

- Han Mulder
- Henk Bovenhuis
- Henk Parmentier
- Jan van der Poel
- Joop Arts
- Francois Karangali
- Michael Aldridge
- Marieke Poppe

ERA-NET SusAn/NWO-ALW
NWO-TTW
Hendrix Genetics

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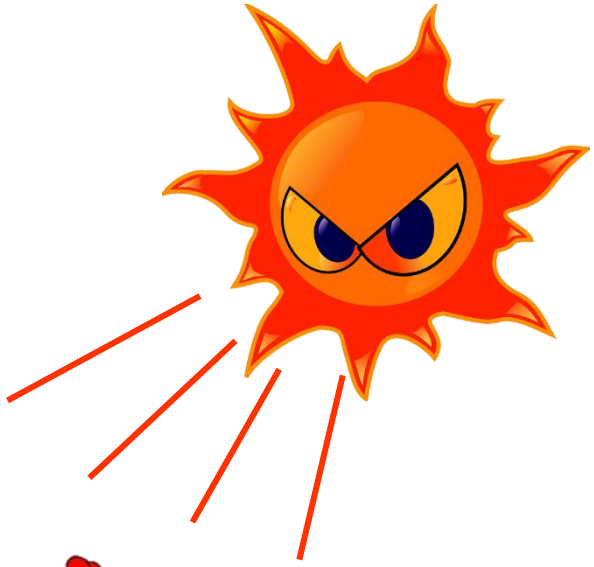
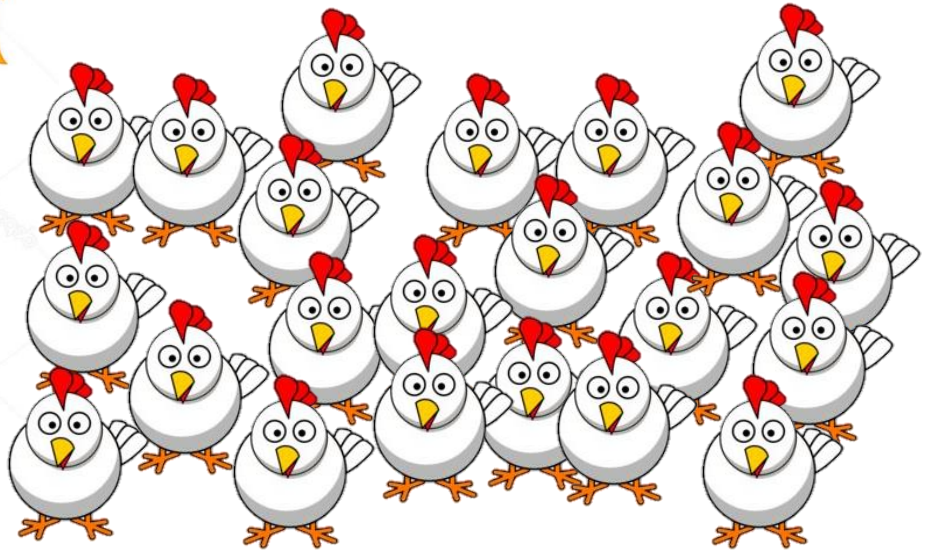
Resilient livestock





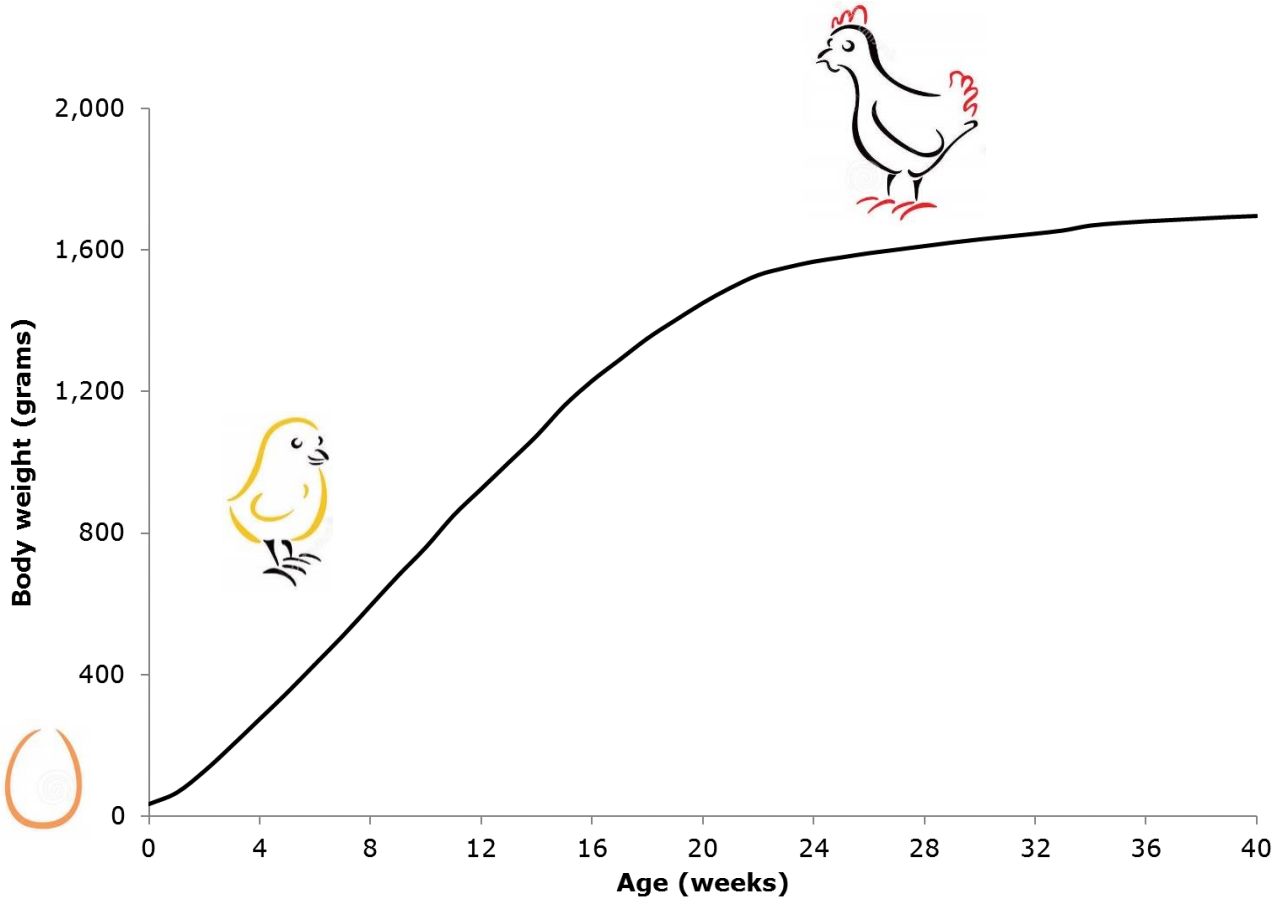
Resilience

"the capacity of an animal

to be minimally affected by disturbances,

(adjusted from Colditz and Hine, 2016, Anim Prod Sci)

Growth curve layer chicken



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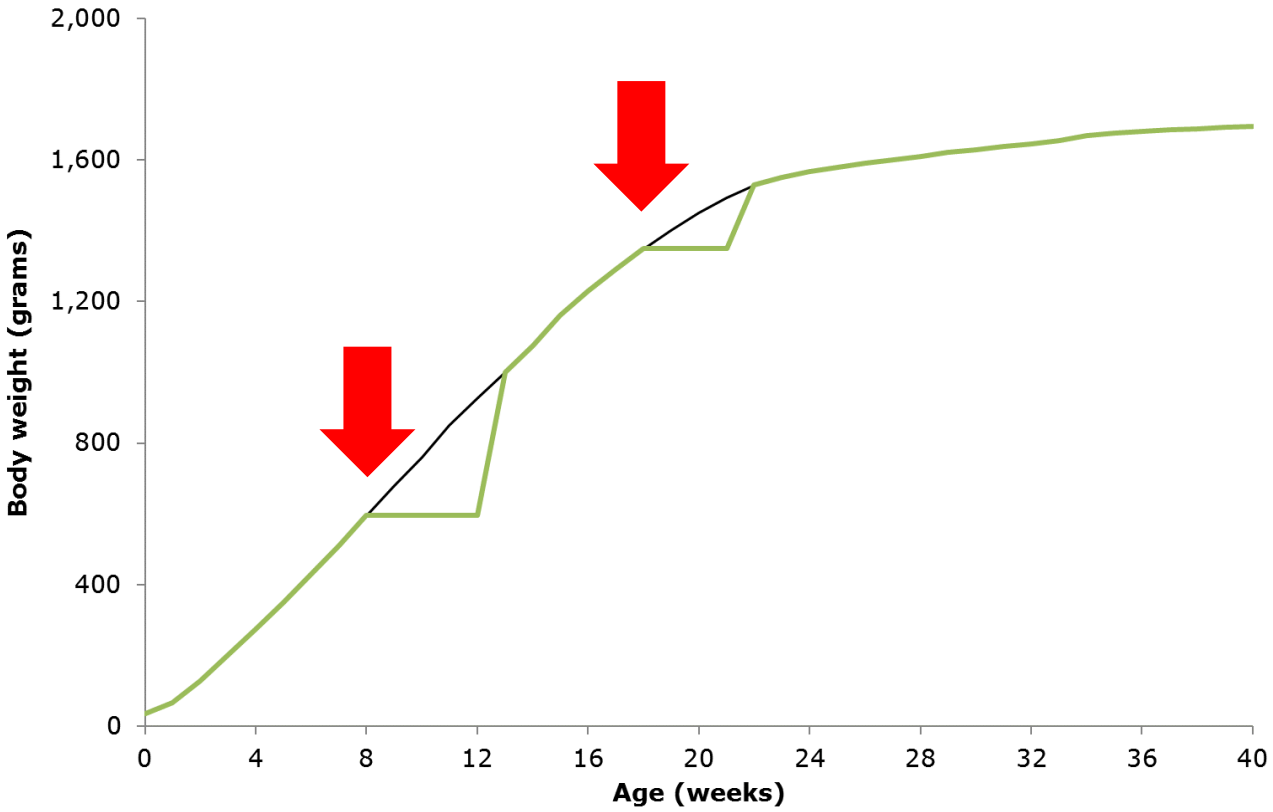
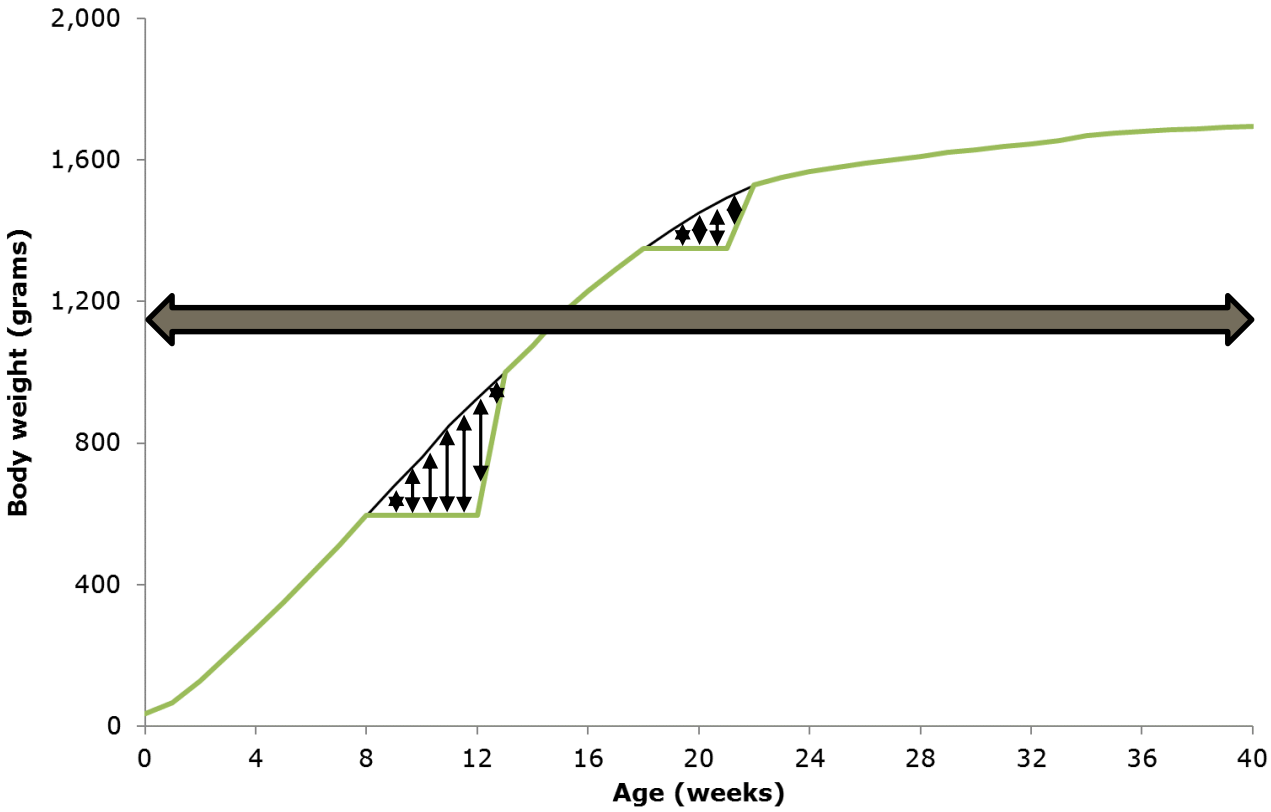
Based on: Dekalb White cs product guide cage

https://www.dekalb-poultry.com/en/product/dekalb-white/

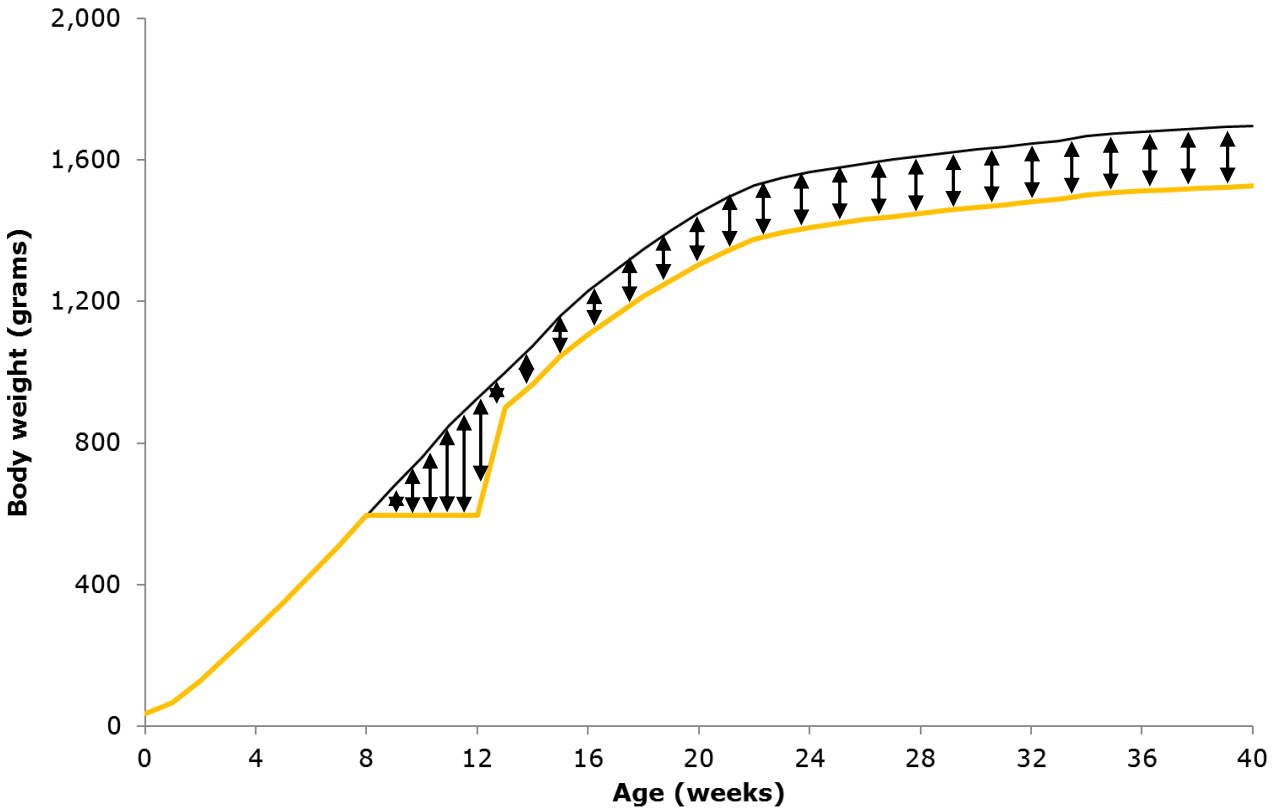
Disturbances cause deviations



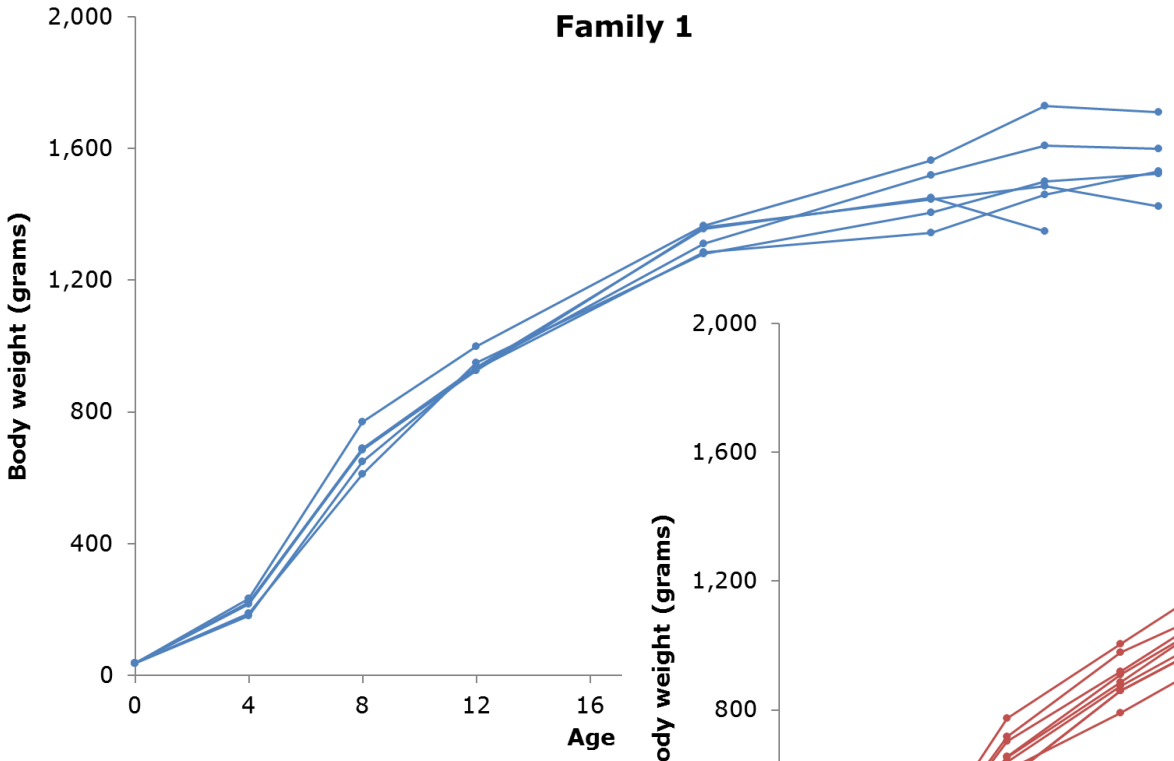
Disturbances cause deviations

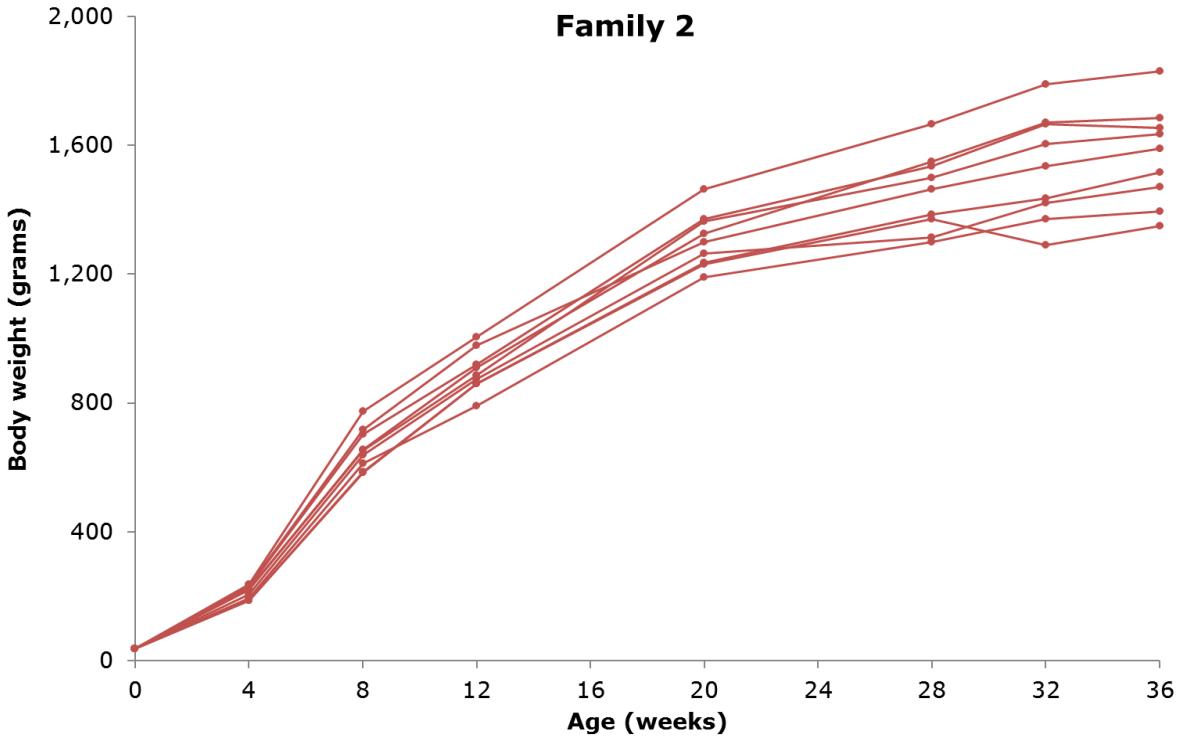


Disturbances cause deviations



Within-family variance of body weight





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Aim

1. Estimate genetic variance of body weight deviations

2. Investigate the potential of these deviations as resilience indicators

Proposed resilience indicators

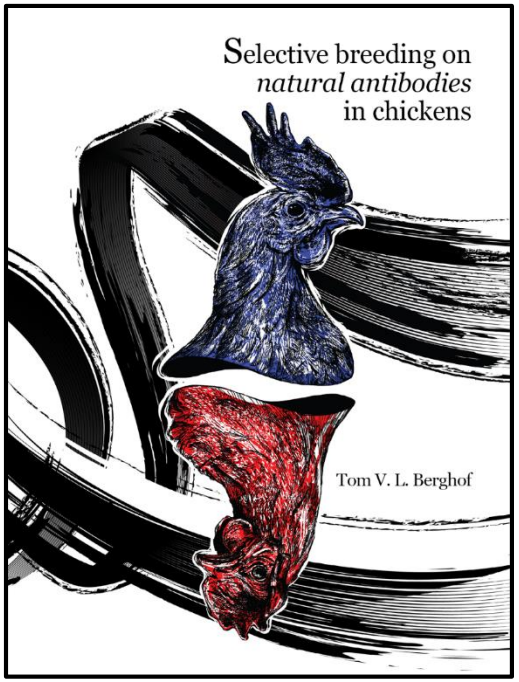
- Proposed resilience indicators (Berghof *et al.*, submitted)
  - Variance of deviations (var)
    (f.e. Elgersma *et al.*, 2018, J Diary Sci; Putz *et al.*, 2018, WCGALP; submitted)
  - Skewness of deviations (skew)
    (based on Scheffer *et al.*, 2015, Annu Rev Ecol Evol Syst)
  - (lag-one) Autocorrelation of deviations (r_{auto})
    (based on Scheffer *et al.*, 2015, Annu Rev Ecol Evol Syst)

- Resilient animals have few(er) or small(er) deviations

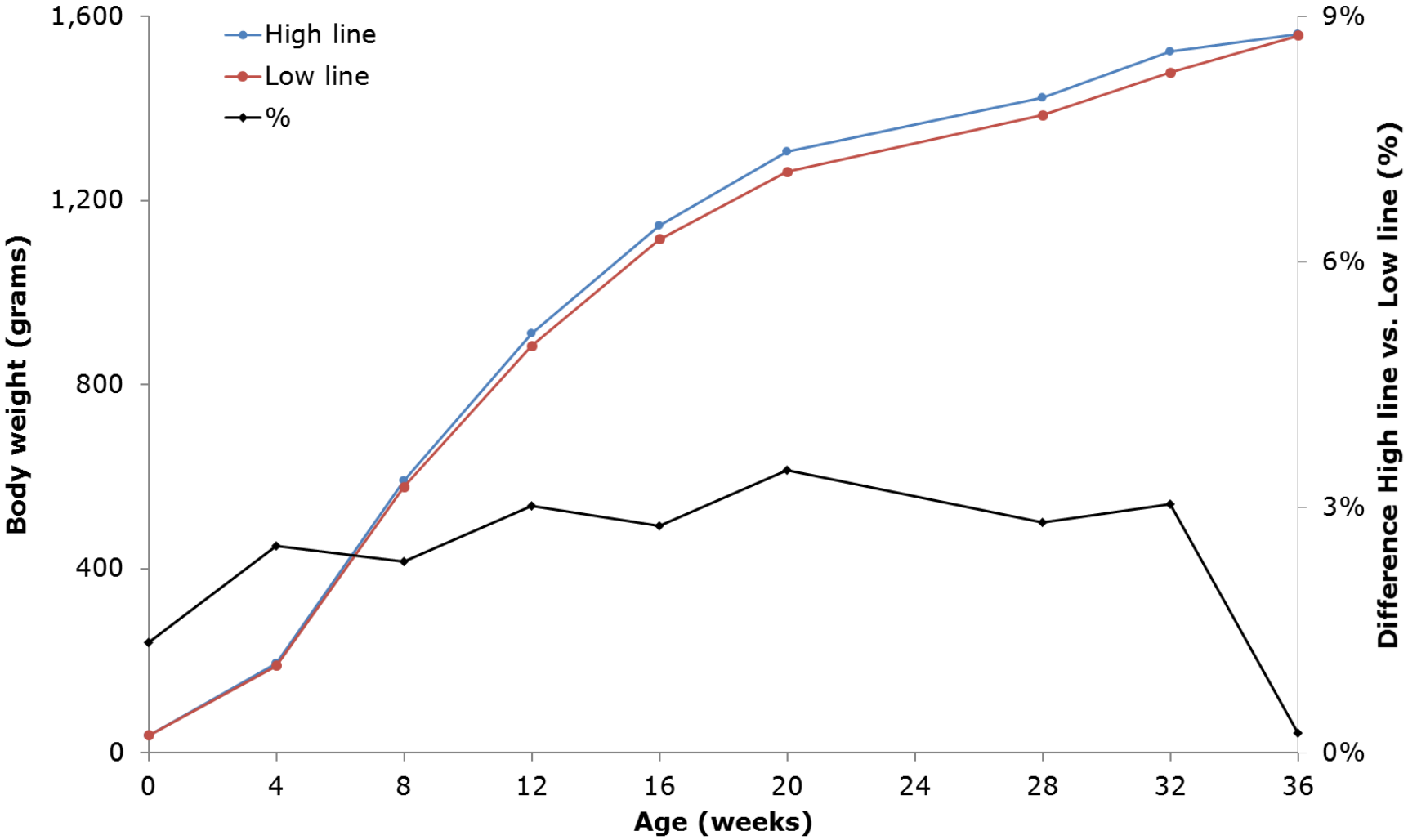
Natural antibody-selection lines

- High line and Low line selected on natural antibody levels
  (Berghof, 2018, PhD thesis)
  - Base population and 5 generations: 8,007 individuals
  - $h^2 = 0.12$
  - Difference in *E. coli* resistance

Hypothesis:
Selection lines differ in resilience



Material


High line
Low line
%
1,600
1,200
800
400
0
Body weight (grams)
9%
6%
3%
0%
Difference High line vs. Low line (%)
0
4
8
12
16
20
24
28
32
36
Age (weeks)

Methods

- Method 1 ('simple' method)
    1. Expected production based on average of line*generation*age
    2. Deviations = Observed – Expected
    3. Standardize deviations
    4. Calculate ln(var), skew, and r_{auto}

    → Univariate

Methods

- Method 1 ('simple' method)

  → Univariate

- Method 2 ('complex' method)

  1. Standardize body weights based on line*generation*age

  → DHGLM

  (Rönnegård *et al.*, 2010, Genet Sel Evol; Felleki *et al.*, 2012, Genet Res)

  → ln(var)

Methods

- Resilience indicators
  - ln(var)1
  - skew1
  - $r_{auto}1$
  - ln(var)2

Additive genetic variation

	ln(var)1	skew1	$r_{auto}1$	ln(var)2
σ_a^2	**0.09** (0.04)	**0.06** (0.03)	**0.02** (0.01)	**0.07** (0.03)
h^2	0.11 (0.05)	0.09 (0.04)	0.08 (0.04)	-
			(NS)	

Genetic correlations

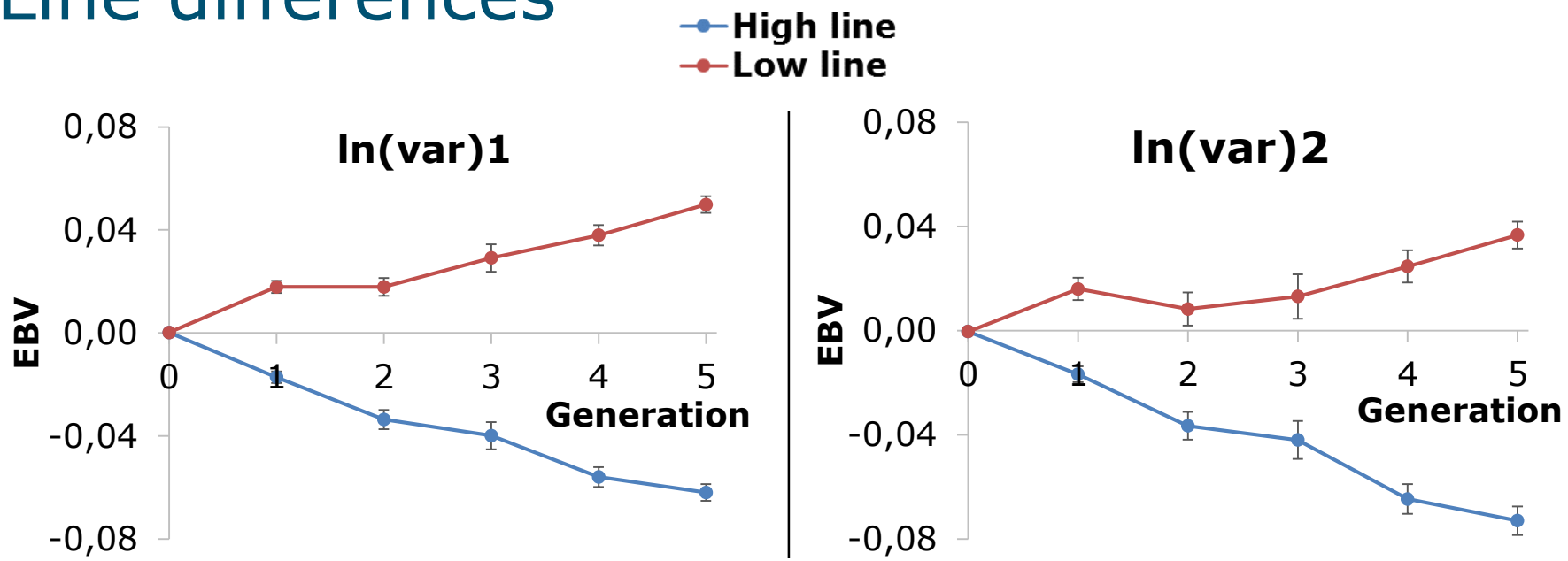
	ln(var)1	skew1
skew1	–0.22 (0.30)	-
$r_{auto}1$	0.45 (0.26)	0.27 (0.33)

	ln(var)1
ln(var)2	0.998 (0.003)

Genetic correlations natural antibodies

	Natural antibodies
ln(var)1	−0.33 (0.18)
skew1	−0.04 (0.20)
$r_{auto}1$	0.02 (0.20)
ln(var)2	−0.33 (0.16)

Line differences



Take-home messages

Body weight deviations have a heritable component

Body weight deviations are genetically correlated to a physiological characteristics of the immune system

Body weight deviations might be used as resilience indicators

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tom.berghof@wur.nl


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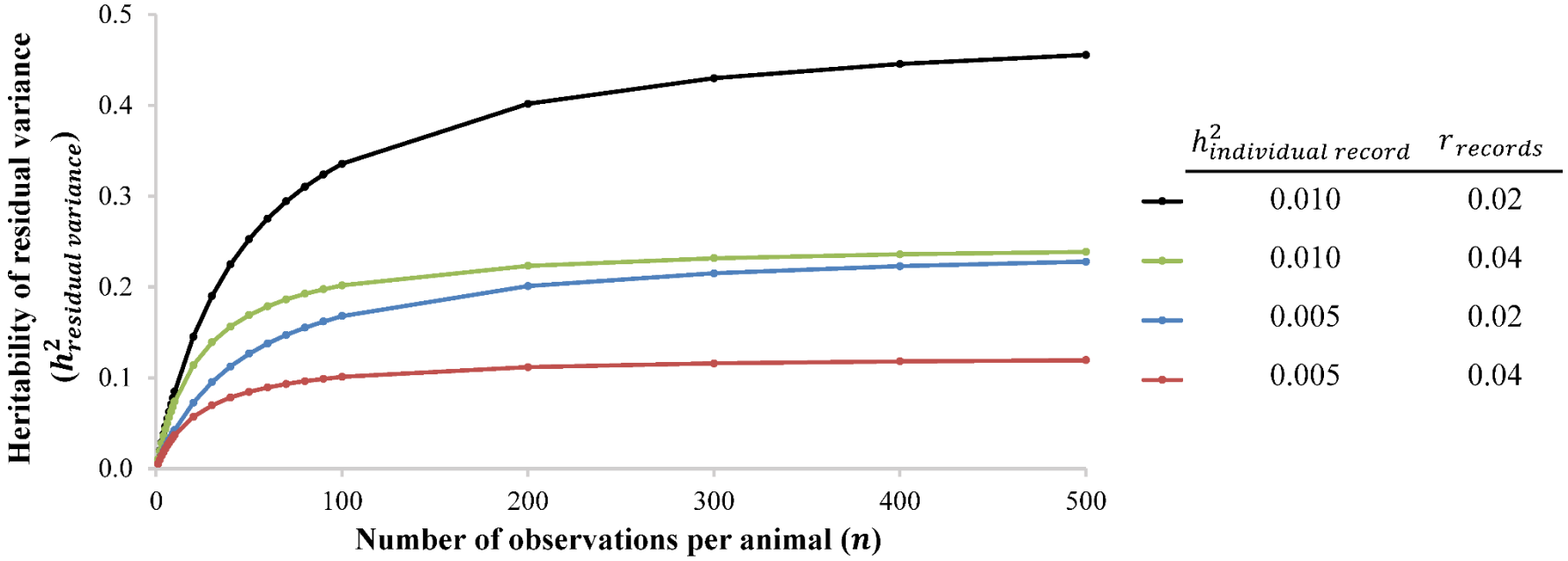
Repeated measurements and heritability



Berghof *et al.*, submitted

Additive genetic variation

	ln(var)1	skew1	$r_{auto}1$	ln(var)2
σ_a^2	**0.09** (0.04)	**0.06** (0.03)	**0.02** (0.01)	**0.07** (0.03)
σ_{pe}^2	-	-	-	0.46 (0.04)
σ_e^2	0.72 (0.04)	0.69 (0.04)	0.20 (0.01)	0.61 (0.01)
h^2	0.11 (0.05)	0.09 (0.04)	0.08 (0.04)	-

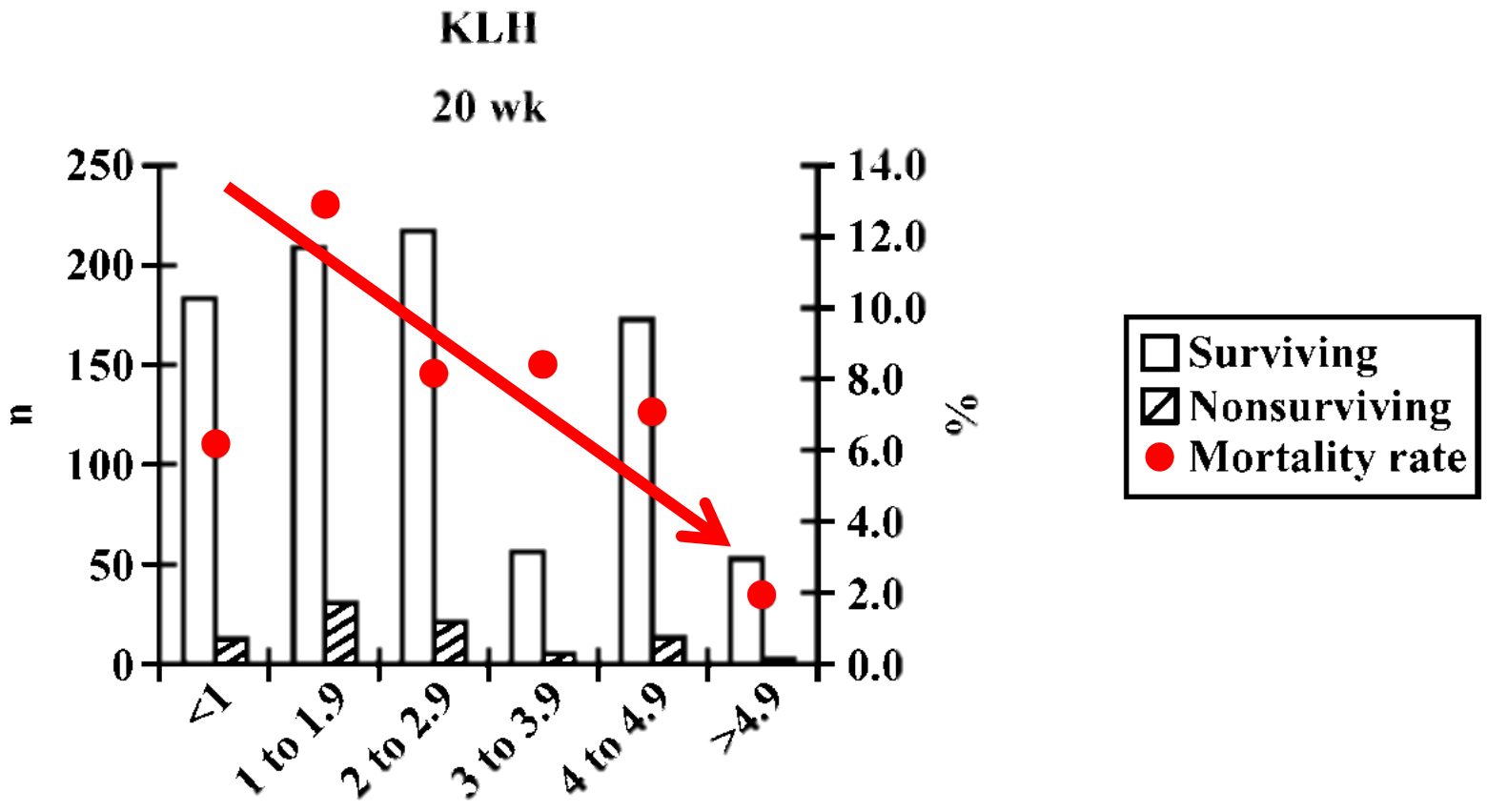
(NS)

Perspective

- Different resilience indicators → different information
- Resilience indicators (i.e. deviations) depend on frequency and variety of disturbances
- Number of observations is low and influences estimations
- 'Simple' method gives similar results to 'complex' method

Natural antibodies!!!

Star *et al.*, 2007, Poult Sci



Sun *et al.*, 2011, Poult Sci

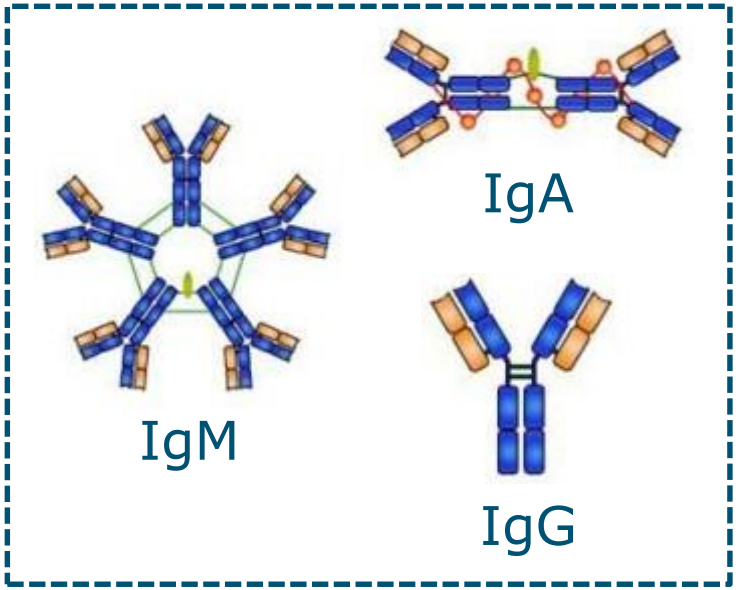
Wondmeneh *et al.*, 2015, Poult Sciv

Natural antibodies binding KLH

Antigen binding antibodies present in individuals without exposure to this antigen

Keyhole Limpet Hemocyanin (KLH)

- Plasma titers
  - IgTotal → Total levels (IgTotal)
  - IgM
  - IgA
  - IgG



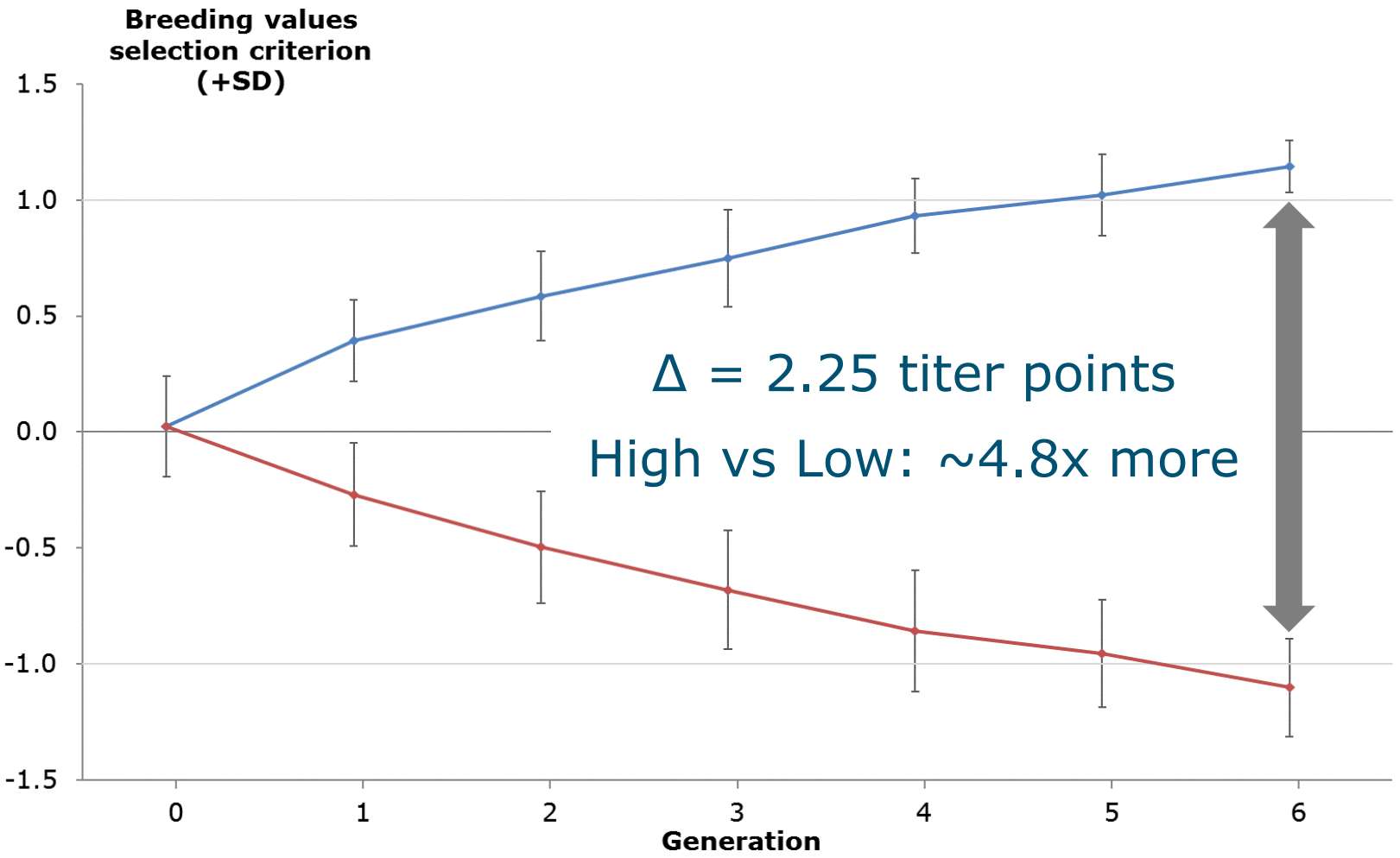
Natural antibody-selection lines

Each generation:

- ~500 individuals per line
- Selection on own observation
- Selection of 25 'best' males per line and
  50 'best' females per line
- No exchange between lines
- Housed together, randomized and mixed

More information: Berghof *et al.*, 2018, Vaccine

Selection progress



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Genetic correlations natural antibodies

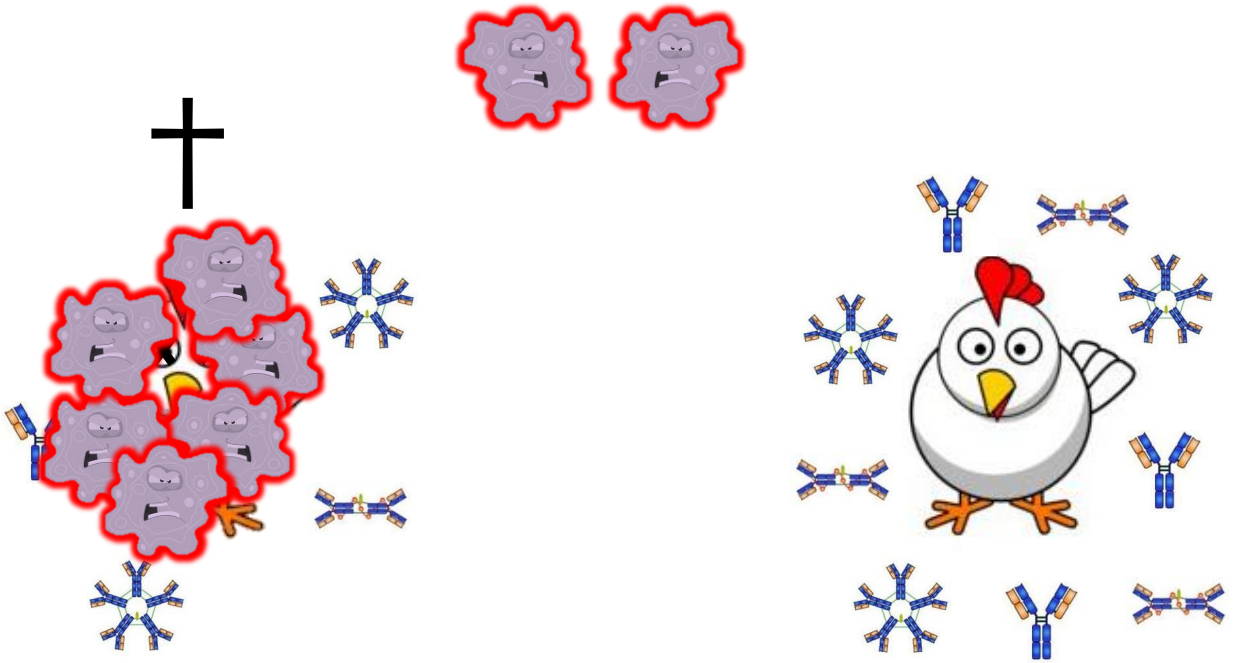
	Total Ig	IgM	IgG
ln(var)1	−0.33 (0.18)	−0.33 (0.17)	−0.34 (0.21)
skew1	−0.04 (0.20)	−0.07 (0.18)	−0.03 (0.23)
$r_{auto}1$	0.02 (0.20)	0.07 (0.18)	0.04 (0.23)
ln(var)2	−0.33 (0.16)	−0.20 (0.16)	−0.33 (0.18)

Variance of deviations

- Low variance in milk production deviations
  → less production-related diseases and higher longevity in dairy cows (Elgersma *et al.*, 2018, J Diary Sci)
- High variance in daily feed intake and duration at feeder
  → higher mortality and more health treatments in pigs in a 'natural challenge environment'
  (Putz *et al.*, 2018, WCGALP; submitted)

- **Resilience might be measured on any trait with frequent observations**

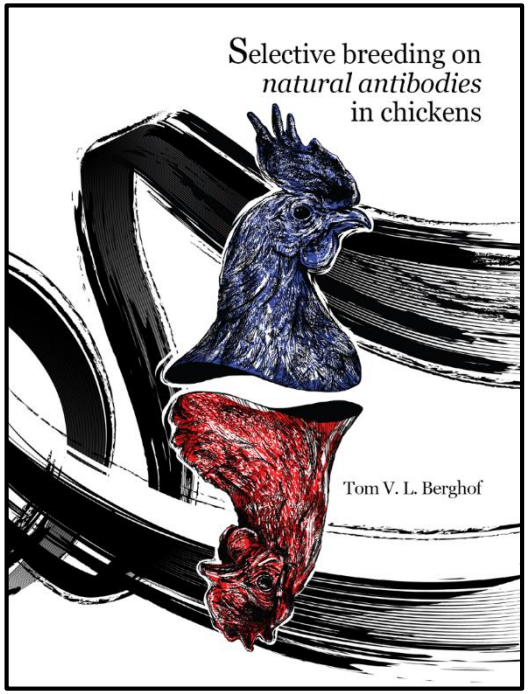
Natural antibodies?



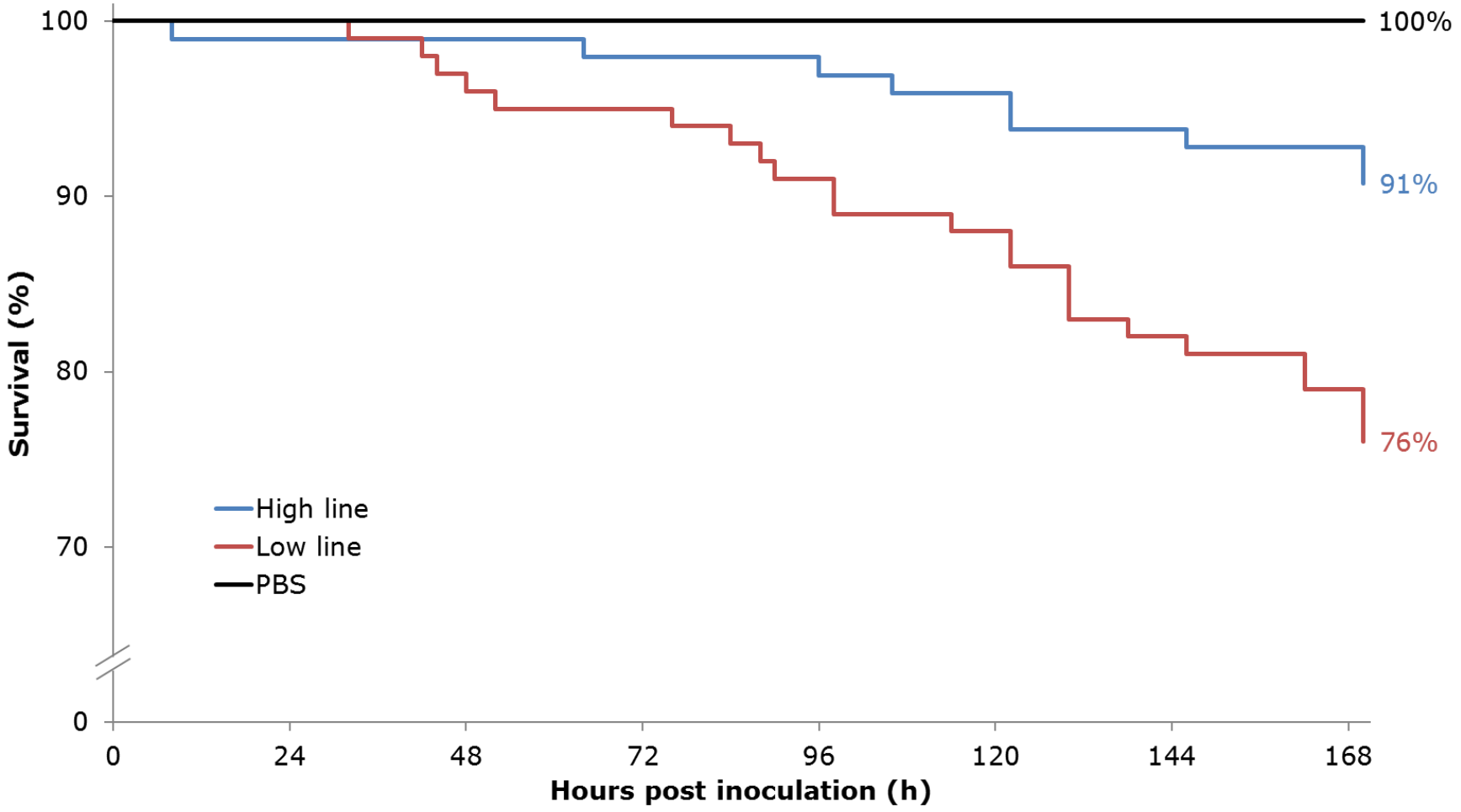
Remaining questions

- Functional protection or biomarker?
- Life-long effect?
- All diseases, including viral diseases?
- Physiological limits or optimum?

- Other species?



Mortality Experiment I



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