






## Genetics and genomics of behavioural traits related to domestication and welfare

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### Domestication - a model of rapid evolution

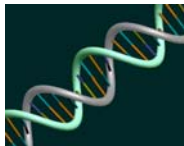


### The domestic phenotype:

- Size
- Colour
- Reproduction (early maturity, higher rate)
- Less fearful
- Less active
- Increased social tolerance
- Reduced brain size

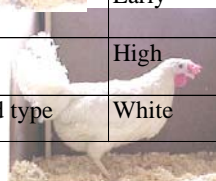


Possible mechanisms for correlated selection responses:

1. **Pleiotropy** – selection acts on single genes with several phenotypic consequences
2. **Linkage** – selection acts on chromosomal regions, where genes are co-located
3. **Regulatory pathways** – selection acts on regulatory regions affecting expression levels of several genes

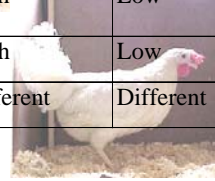

### Model species: Fowl (*Gallus gallus*)

Variable	Jungle fowl character	White leghorn character
Growth	Low	High
Sexual maturity	Late	Early
Egg production	Low	High
Colour	Wild type	White

### Model species: Fowl (*Gallus gallus*)

Variable	Jungle fowl character	White leghorn character
Feeding behaviour	Extensive	Intensive
Explorative behaviour	High	Low
Fearfulness	High	Low
Sociality	Different	Different

**Pleiotropy and linkage: QTL-analysis**

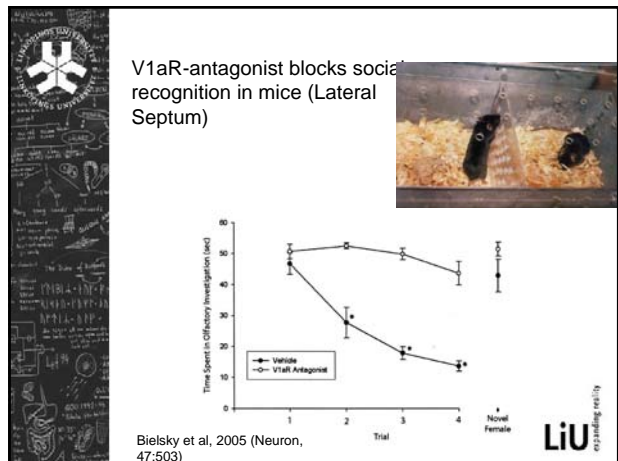
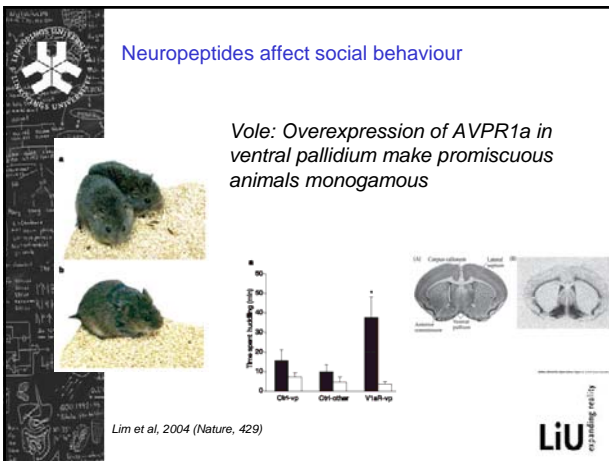
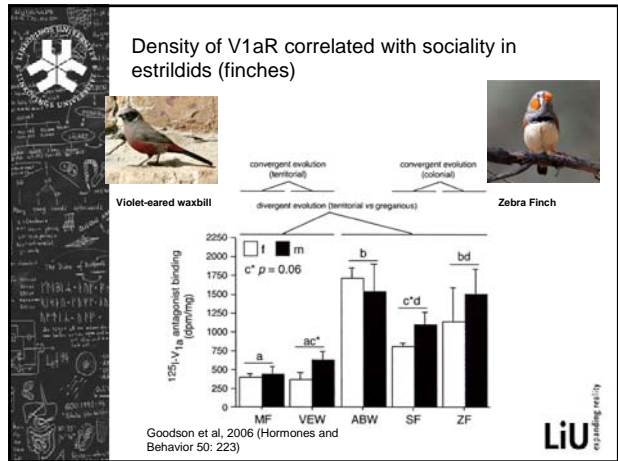
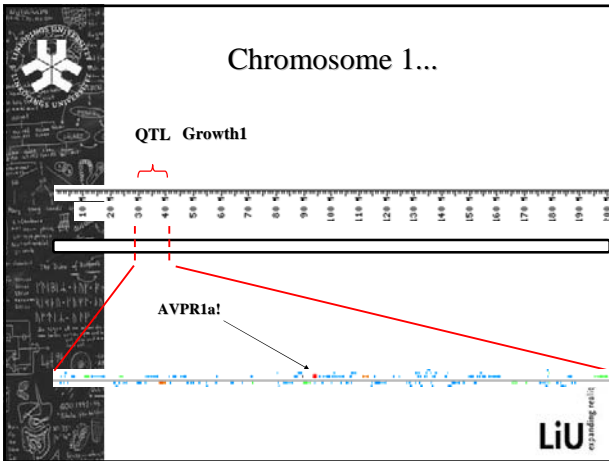
RJF male x WL female  
 800 F2  
 150 markers (microsat)  
 Behaviour, production, appearance

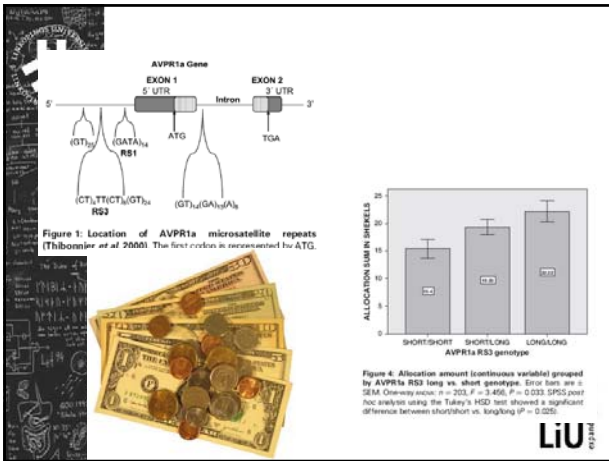
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Chromosome	Position (cM)	Behavioural trait affected	Observed pleiotropic trait effects
1	67	Tonic immobility**	Growth** Egg mass**
1	237	Tonic immobility*	-
1	480	Tonic immobility*	Gr
1	467	Novel object reaction**	Gr
1	394	Headlick frequency*	-
1	176	Restraint inactivity*	-
3	272	Restraint defecation*	-
6	51	Restraint activity*	-
7	174	Foraging behaviour**	-
11	0	Restraint reaction**	-
13	14	Open field activity*	-
26	32	Victim of feather-pecking**	Plumage melanization**
27	0	Sociality**	-

Affects many traits!

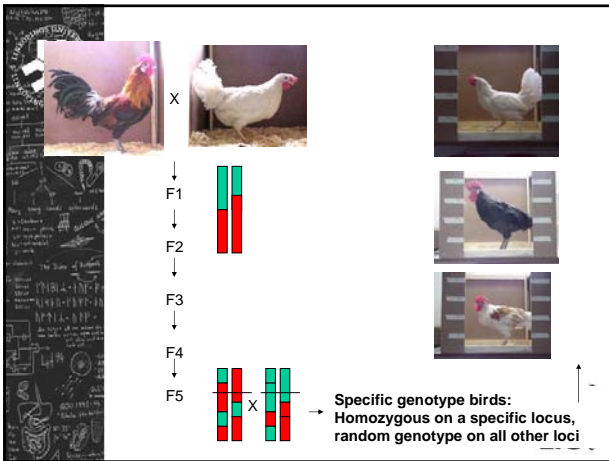
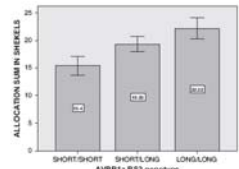
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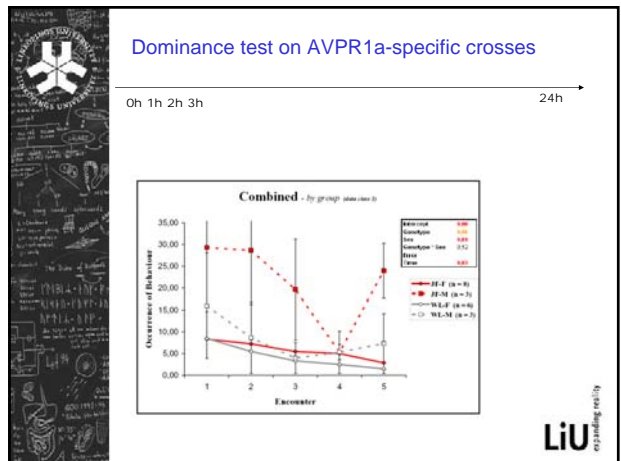
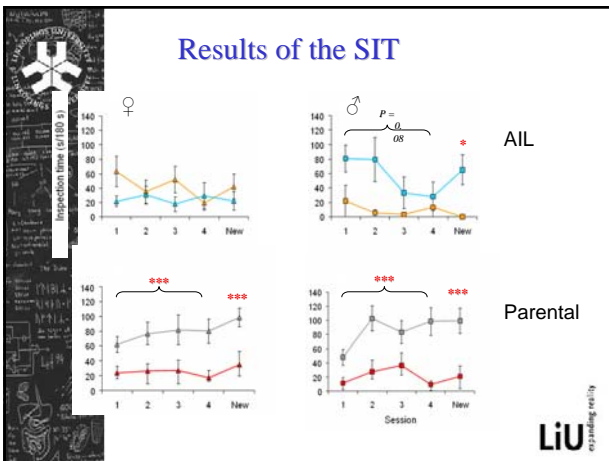
Social behaviour is central to domestication!  
 Does the genotype on the QTL1-locus affect social recognition and aggression?

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Social interactions

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**Pleiotropy:**  
 Vulnerability to feather-pecking is partly determined by a pigment related gene

Keeling et al Nature

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Could induced stress modifications of behaviour be inherited?  
 Can stress "preadapt" offspring to an unpredictable environment?

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– Prenatal stress –

Lindqvist, C., Jancsak, A. M., Nätt, D., Baranowska, I., Lindqvist, N., Wichman, A., Lundeberg, J., Lindberg, J., Törjessen, P. A., and Jensen, P. 2007. Transmission of stress-induced learning impairment and associated brain gene expression from parents to offspring in chickens. PLoS ONE 10.1371/journal.pone.0000364.

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Test of spatial learning capacity at 30 w of age, offspring at 4 weeks

Criteria: Right choice in 5 out of 6 consecutive trials

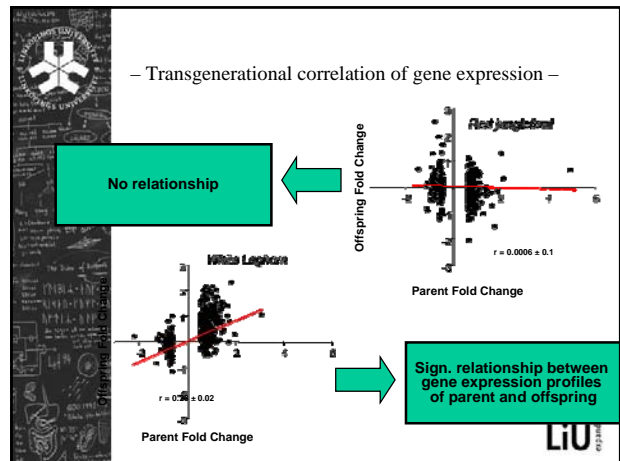
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Results:  
 – Spatial Learning –

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 – Spatial Learning –

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Summary of results

- Offspring of stressed birds:
  - *More conservative foraging*
  - *More dominant*
  - *Preferred high energy food*
  - *Higher growth rate*

Adaptive response

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No behavioural or epigenetic effects in RJF

- Stress treatment not severe enough?
- Domestication selects for adaptability?

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Fundaments of neo-darwinism:

- Variation
- Heredity
- Natural selection

Variation arises by random mutation which are selected by environment

**Epigenetics suggest:**

- Environmental stress may increase variability
- Environment contributes information to the genome, perhaps mutations do not need to be random

**Epigenetics can cause adaptive changes!**

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