


5th International Workshop on Linear Profiling
in the Warmblood Horse, Flyinge, Sweden

Linear profiling and genomic tools as drivers of collaboration



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Outline

- ❖ development of linear profiling in the studbooks (examples)
- ❖ genetic parameters
- ❖ genetic evaluation for linear traits
- ❖ collaboration across studbooks (and borders)
- ❖ further research towards genomics
- ❖ challenges and opportunities

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Linear Profiling in Oldenburg



- ❖ development of own linear system
 - extensive scheme (conformation, gaits, jumping, behavior)
 - linear profile as part of the official assessment (judging commission + documentation assistance, no extra-time)
 - mobile device for recording (tablet PC)
- ➔ routine linear profiling at regular breeding events of the Oldenburg studbooks (OL, OS) since 2012

Formel und Vorderglied	Oberlinie	Fundament	Wirk. d. Gangart	Beugung im Hinter	Freie Beugung	Beugung unter dem Hinter
Gruppe	Bereich	- extrem		1 2 3 4 extrem		
SCHRITT	Takt	unregelmäßig		geringt		geringt
	Fließ	Pass		deutlicher Zwickel		
	Geschwindigkeit	schleppend		flüchtig schreitend		
	Raumgriff Vorhand	steif		durch den Körper		
	Raumgriff Hinterhand	begrenzt		raumgreifend		
	Raumgriff Hinterhand	sehr unterständig		deutlich überständig		
TROT	Takt	unregelmäßig		geringt		geringt
	Raumgriff Vorhand	begrenzt		raumgreifend		
	Vorderhand-Mechanik	gerades Vorderbein		viel Knieaktion		



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Linear Profiling in Sweden (SWB)



- ❖ comparison of traditional scoring and LP (student thesis in 2010)
- ❖ theoretical introduction of LP to judges and breeders (2010-2011)
- ❖ extensive theoretical and practical training of judges, information in Swedish horse media and directly to breeders (2012-2013)
- ➔ Introduction of linear profiling protocol in 2013

MOVEMENT	Obvious	Average									Obvious	Comment
		A	B	C	D	E	F	G	H	I		
22 Walk: cadence	even	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	uneven	
23 Walk: stride length	long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	short	
24 Walk: suppleness	supple	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	stiff	
25 Walk: elasticity	elastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	unelastic	
26 Trot: length of stride	long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	short	<input type="checkbox"/> irregular
27 Trot: elasticity	elastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	unelastic	<input type="checkbox"/> movement tight to the ground
28 Foreleg activity	shoulder free	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Short	
29 Trot: hind leg position	under the body	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	behind the body	
30 Trot: hind leg activity	active	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	inactive	
31 Canter: rhythm	even	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Uneven	
32 Canter: stride length	Long	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Short	
33 Canter: action	round	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Flat	
34 Canter: elasticity	elastic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	stiff	
35 Canter: balance	well balanced	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	unbalanced	
36 Movement direction	uphill	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	downhill	



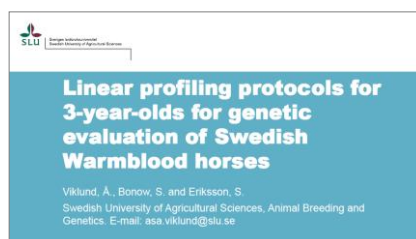
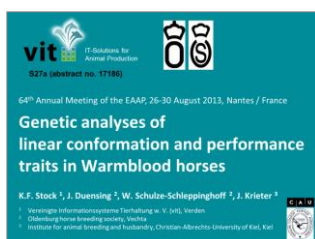
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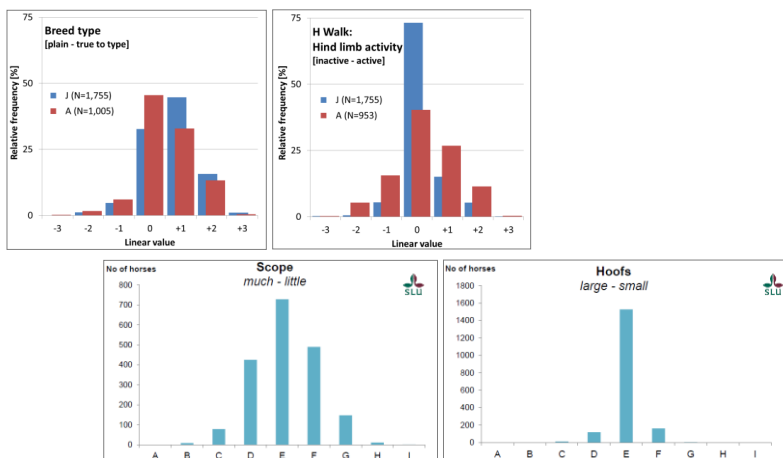
Genetic analyses (I)


- ❖ aim in both countries: estimation of genetic parameters
 - first presentation from Germany in 2013 (64th EAAP Annual Meeting, Nantes / France: Stock et al.)
 - first presentation from Sweden in 2015 (66th EAAP Annual Meeting, Warsaw / Poland: Viklund et al.)



Genetic analyses (II)

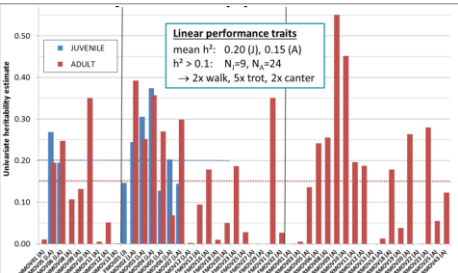
- ❖ distribution of linear traits (Oldenburg, 2 age groups: juvenile and adult)

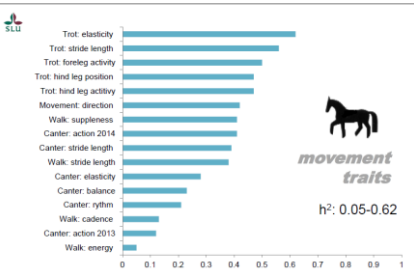





Genetic analyses (III)

- ❖ distribution of linear traits (Oldenburg, 2 age groups: juvenile and adult)
- ❖ heritability estimation







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Genetic analyses: Correlations

- ❖ different focus in the correlation analyses
 - *Oldenburg*: between corresponding traits in juvenile and adult horses → favorable genetic correlations (mostly $r_g > 0.5$)
 - *SWB*: between traditionally scored traits and linear traits → good complement to traditional scoring, especially for gaits and jumping traits (-0.50 to -0.99)

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Genetic evaluation (I)



- ❖ publication of Genetic Stallion Profiles in 2018
 - linear data basis from 2012-2017 (17,113 linear profiles)
 - 46 linear traits (conformation, gaits, free jumping)
 - standardization: mean of 100, standard deviation of 20
- ❖ 18 young sires (first crop of foals, minimum of 8 foals)
- ❖ 111 older sires (frequently used, minimum of 20 progeny)



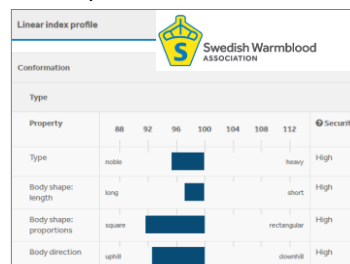
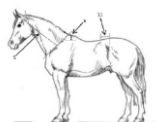
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Genetic evaluation (II)




- ❖ publication of breeding values in March 2017
 - based on young horse test for 3 year olds (4,000 horses)
 - 50 traits (conformation, movements, jumping)
 - standardization: mean of 100, genetic standard deviation of 4
- ❖ stallions – minimum of 10 offspring with linear assessment (in total at least 15 offspring at young horse test)
- ❖ since Jan 2018:
 - mares – with own linear assessment
 - stallions – minimum of 10 offspring with linear assessment




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Collaboration across studbooks



- ❖ joint presentation in 2016 (67th EAAP Annual Meeting, Belfast / Ireland: Sperrle et al.)
- ❖ idea : across-studbook genetic correlation study on linear traits using estimated breeding values (EBVs)
- ❖ EBVs at this point of time from prototypes of genetic evaluations for linear conformation and performance traits



Implications of across-studbook genetic correlations between linear traits for sport horse breeding

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- plausible correlation patterns within and across studbooks (several EBV correlations of 0.5 to > 0.7)
- strong support of comparability of important linear traits across studbooks

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Genomic studies (I)



- ❖ further research in both countries towards genomic applications
 - on the basis of refined linear profiling as high quality phenotypes
- ❖ first presentation from Germany in 2017: "Assembling of a reference population for genomic selection" (DGfZ conference, Stuttgart / Germany: Wobbe et al.)
- ❖ first presentation from Sweden in 2016 (67th EAAP Annual Meeting, Belfast / Ireland: Eriksson et al.)



Aufbau einer Lernstichprobe zur genomischen Selektion beim Pferd

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A genome-wide association study of young horse test traits in Swedish Warmblood

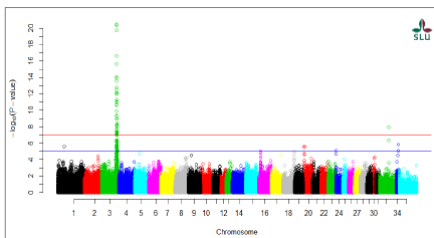
Susanne Eriksson¹, Åsa Viklund² & Sofia Mikko³

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Genomic studies (II)

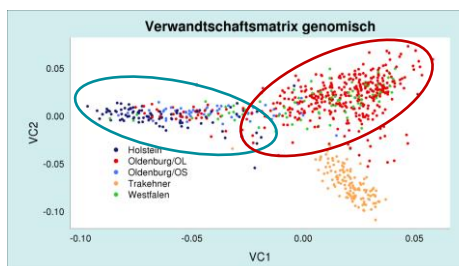
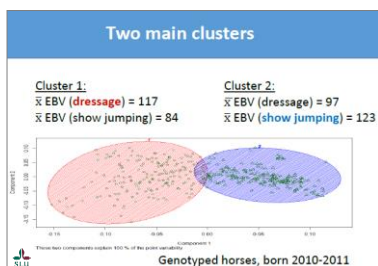
- ❖ confirmed published region on equine chromosome 3 (ECA3) highly significant for height at withers
 - same idea: height at withers as a reference trait
 - proof of concept




- ❖ analyses of population structure
- ❖ linking of genotypes and phenotypes (search for associations)

Challenges and opportunities (I)

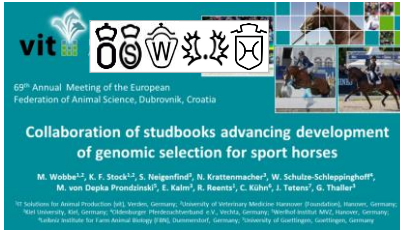
- ❖ population structure: Be aware of possible clustering!
 - SWE: dressage and show jumping
 - GER: different studbooks / dressage and show jumping (?)
- ❖ knowledge required for appropriate interpretation of results





Challenges and opportunities (II)

- ❖ increasing number of studbooks working with linear profiling
 - regular meetings such as IWSLP for exchange of experiences
- ➔ similarity / comparability of linear traits as basis of closer collaboration
- ❖ first joint projects demonstrate the opportunities of collaboration
- ❖ linear profiling as possible basis for genomic applications
 - synergies through joint reference population and joint evaluation systems
 - motivation of new approaches of collaboration



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Thank you !

Take home:
Linear profiling and genomic tools as potential drivers for national and international collaboration!

