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Breed Differences in Semen Quality Characteristics in Commercial Boars

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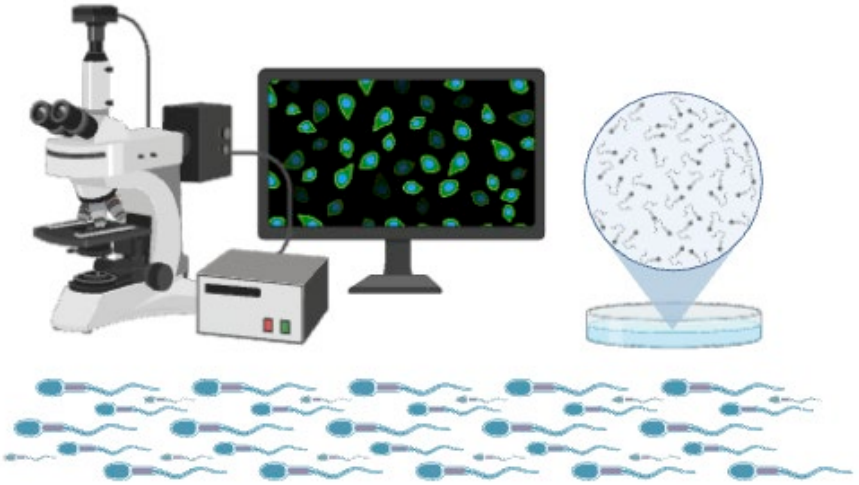


Outline

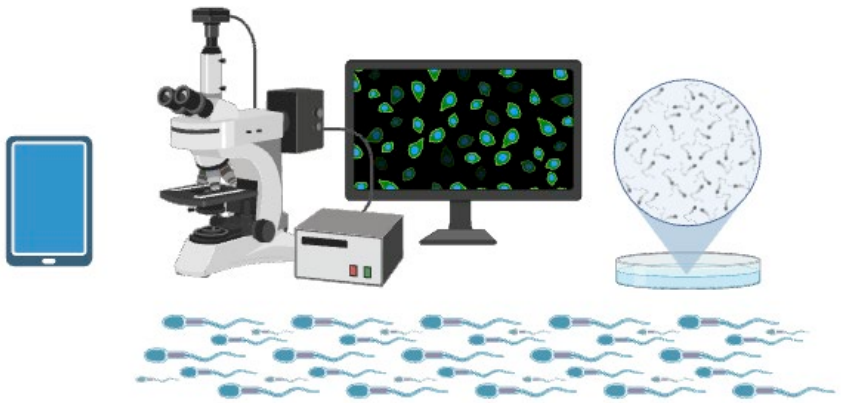
- Context
- Semen Quality Parameters
- Materials and Methods
- Model
- Results
- Conclusions
- Acknowledgments

Context: What is the Issue?

- The world needs feeding and it likes bacon.
- Growing need for **sustainably produced** protein.
- ***Boar reproduction*** is a key part of the production chain.
- Good industry knowledge of production but little large scale data in the literature.
- Contribute to understanding breed and environmental variation.
- My PhD, understanding within breed variation from spermatogenesis to ultimate fertility.

CASA – Standard Measures

- Male reproductive quality is measured via CASA machine.
- Waiting for actual feedback is too slow – Issues in the pipeline.
- Computer Assisted Semen Analysis (CASA):
  - Much faster and more reliable than manual assessment.
  - Most commercial studs use them to collect basic parameters.
  - CASA technology continues to develop: Future more traits



Semen Quality Parameters

- Commonly measured in studs:
  - Volume
  - Total Normal Cells Per Ejaculate
  - Concentration
  - Motility
  - Progressive Motility
  - Age
  - Rest Days
  - Proximal Droplets
  - Distal Droplets
  - Tail Morphology

DATA CONTAINED CASA INFORMATION DIRECTLY OBTAINED FROM THE STUD FARMS.

MULTIPLE DATA SETS WERE OBTAINED FROM VARIOUS STUD FARMS AROUND THE WORLD.

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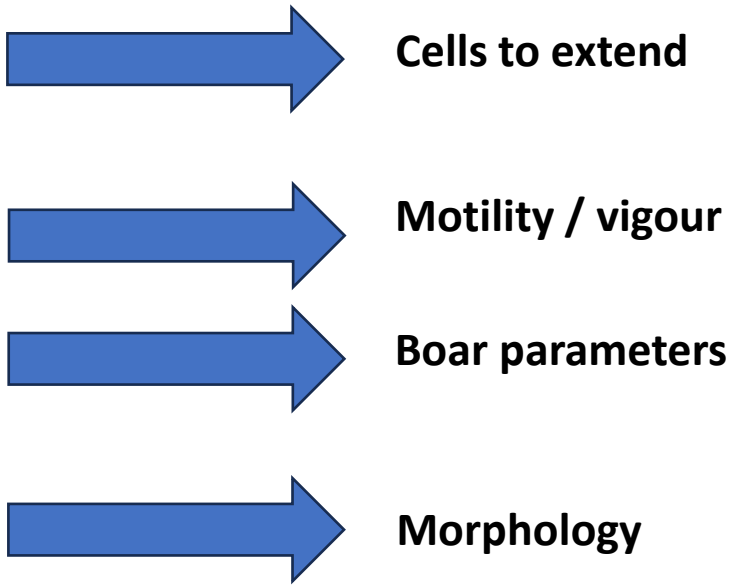

Data Cleaning & Inclusion Criteria

- Descriptive statistics for all traits and factors.
- QC removed data 3 standard deviations from the mean.
- Any studs containing less than 100 data points were also excluded.
- Entries that were made in the southern hemisphere were excluded.
- Boars only included if they had greater than **20 collections**.
- **31 studs** in total were included
- 99,137 observations in total were included

Breed	Total Boars	Total Collections
Duroc	1,717	43,899
Hampshire	166	4,253
Landrace	688	17,809
Large White	277	7,098
Pietrain	214	5,469
Maternal Synthetic	835	20,609
TOTAL	3,897	99,137

Data Description

Trait	N	Mean	SD
Volume (ml)	91,583	243.67	119.70
Total Normal (cells)	24,467	86.54	6.90
Conc. (Bill cells per ml)	84,410	0.35	0.18
Motility (% good)	92,085	89.23	6.41
Prog. Motility (% good)	76,918	79.97	13.10
Boar Age (days)	97,294	582.42	236.35
Rest Days (days)	63,560	6.24	1.25
Proximal (% good)	80,385	96.39	3.59
Distal (% good)	78,508	94.89	5.39
Tail Morphology (% good)	78,414	97.55	2.80

- The inverse of % good would be the % of the sample with this defect.

Linear Mixed-Effects Model

Included Fixed Effects

- Breed
- Season
- Collection week-day

Included Covariates

- Age
- Age^2 (to account for any non-linear effects of age on each variable.)
- Rest days
- $Rest\ days^2$ (As above, to account for non-linear effects of age on each variable)

Included Random Effects

- Boar Stud
- Boar ID within Boar Stud
  - To account for repeated records

- All included parameters significant for all traits.

Results- Breed Effects

Breed	Volume	Total Normal	Conc.	Motility	Prog. Motility	Prox.	Dist.	Tail Morph.
Duroc	295.1^{a}	85.00^{ab}	0.36^{c}	89.51^{ab}	82.40^{b}	96.30^{b}	94.29^{a}	98.39^{b}
Hampshire	373.7^{d}	82.41^{a}	0.28^{a}	88.73^{a}	79.96^{a}	96.32^{abc}	93.77^{a}	97.85^{b}
Landrace	308.2^{b}	86.67^{b}	0.37^{c}	89.57^{ab}	81.77^{b}	97.10^{c}	95.70^{a}	97.94^{a}
Large White	335.8^{c}	85.55^{ab}	0.32^{b}	89.61^{abc}	82.10^{b}	96.70^{bc}	93.90^{a}	97.03^{a}
Pietrain	320.8^{abc}	88.47^{c}	0.34^{bc}	90.55^{bc}	82.12^{ab}	97.45^{abc}	95.65^{ab}	98.12^{ab}
Maternal Synthetic	317.1^{b}	86.49^{bc}	0.33^{b}	90.31^{c}	82.71^{b}	97.50^{a}	95.01^{b}	98.20^{b}

- Superscripts indicate statistical significance $P<0.01$.

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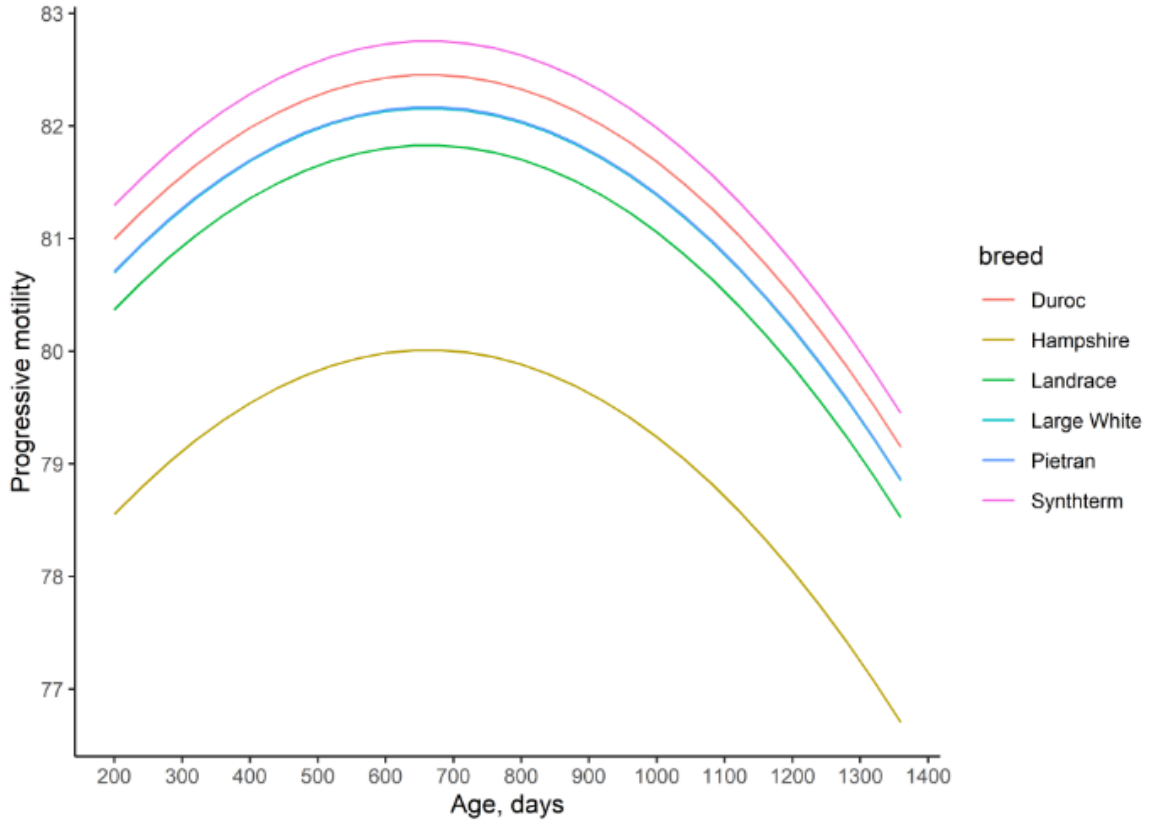
Progressive Motility With Age



- Relationship between progressive motility and age by line.

Seasonal Effects

Breed	Volume	Total Normal	Conc.	Motility	Prog. Motility	Prox.	Dist.	Tail Morph.
Winter	316.3^{a}	86.04^{c}	0.34^{c}	89.66^{c}	79.89^{a}	96.83^{c}	94.88^{b}	97.86^{bc}
Spring	315.0^{a}	86.04^{b}	0.33^{b}	89.45^{b}	80.51^{b}	96.70^{b}	94.79^{b}	97.67^{a}
Summer	336.7^{b}	84.11^{a}	0.31^{a}	88.73^{a}	84.09^{c}	96.04^{a}	93.01^{a}	97.70^{ab}
Autumn	332.1^{b}	86.57^{bc}	0.36^{c}	91.01^{d}	82.89^{d}	96.91^{bc}	95.24^{b}	97.99^{c}

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Summer	336.7^{b}	84.11^{a}	0.31^{a}	88.73^{a}	84.09^{c}	96.04^{a}	93.01^{a}	97.70^{ab}
Autumn	332.1^{b}	86.57^{bc}	0.36^{c}	91.01^{d}	82.89^{d}	96.91^{bc}	95.24^{b}	97.99^{c}

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Random effects

- Traits where stud explained more variation than individual boar:
  - Volume
  - Concentration
  - Motility and Progressive Motility
- Traits where individual boar explained more variation than stud:
  - Proximal and Distal Droplets
  - Total normal cells
  - Tail Morphology
- This helps to target interventions when troubleshooting issues in systems.

Conclusions

- Continued improvement of traits associated with semen quality is important for the global pig industry.
- The importance of boar fertility will only increase, due to ongoing developments in reproductive technologies, increased leverage of boars, and novel genetic technologies.
- Clearly there is between breed variation in semen quality, and other work shows there is within breed variation = Selection.
- However, this study shows temporal / seasonal / management impacts can be larger than between breed variation so continual refining the environment / management practices in semen production is important.
- The ideal situation would be improvement via selection directly on the quality traits in association with novel traits associated with environmental resilience for fertility traits in boars.

Acknowledgements

Lab at the University of Kent

Genus PIC

Co-authors of the project

Thanks For Listening!