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Identification of host-characteristics influencing rumen microbiota composition in dairy goats

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PLAN

- INTRODUCTION AND CONTEXT
- EXPERIMENTAL DESIGN
- RESULTS
- CONCLUSIONS AND PERSPECTIVES

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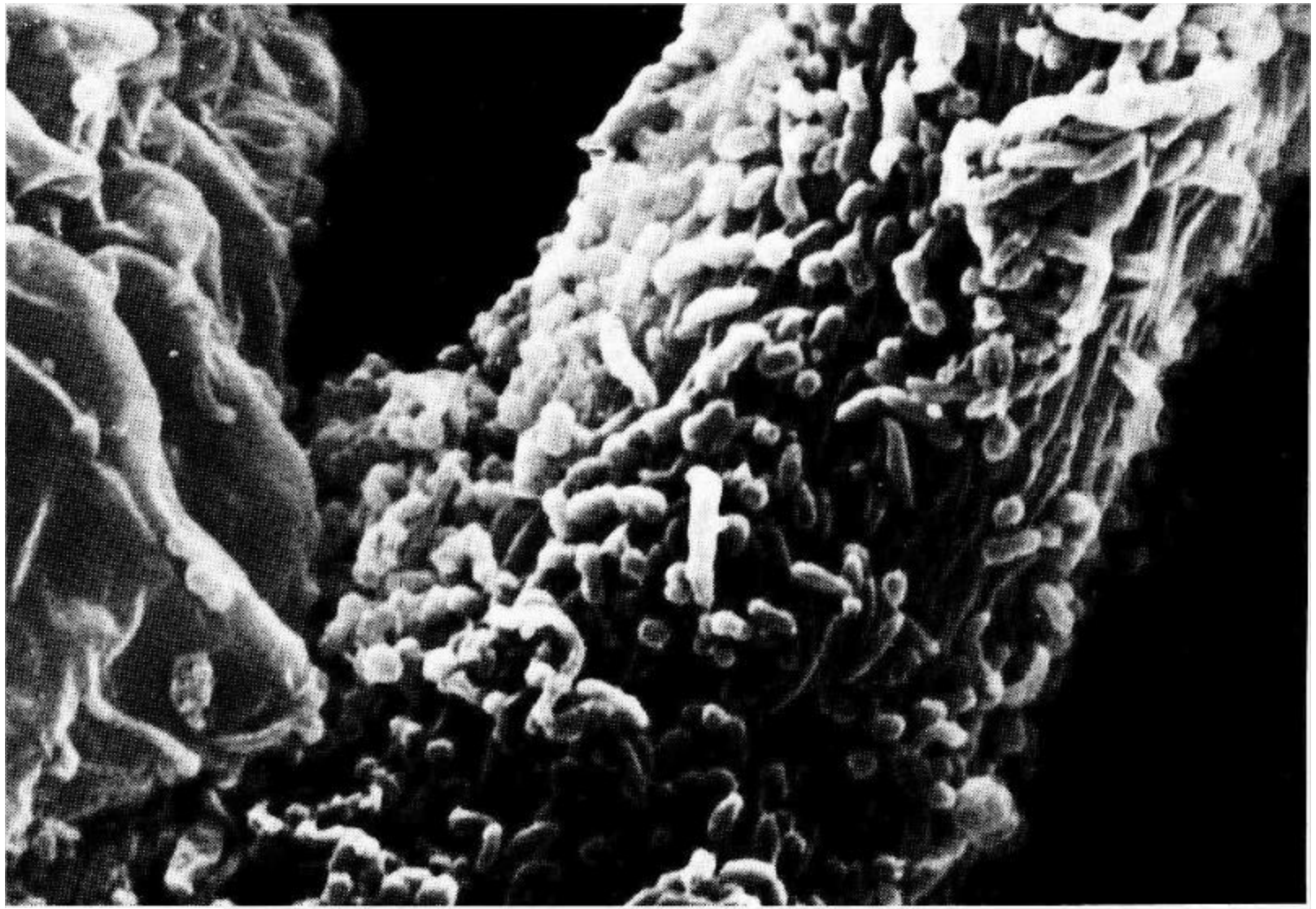
INTRODUCTION AND CONTEXT



View of different bacteria fixed on a cell of soybean hull stayed 48h in the rumen (x4 200) (Picture of E. Grenet and P. Barry).

P. Thivend, G. Fonty, J. P. Jouany, Michelle Durand, Ph. Gouet. Le fermenteur rumen. Reproduction Nutrition Développement, 1985, 25 (4B), pp.729-753. hal-00898313

INTRODUCTION AND CONTEXT

- High **specificity** and **resilience** of the rumen microbiota within its host (Weimer et al. 2010, 2015, and 2017)**.**

- **Do host traits shape the rumen microbiota structure ?**

  ➔ Focus on production traits and rumen content dynamics.

Weimer PJ, Stevenson DM, Mantovani HC, Man SLC. Host specificity of the ruminal bacterial community in the dairy cow following near-total exchange of ruminal contents. J Dairy Sci. 2010;93:5902-12.

Weimer PJ. Redundancy, resilience, and host specificity of the ruminal microbiota: Implications for engineering improved ruminal fermentations. Front Microbiol. 2015;6:296.

Weimer PJ, Cox MS, de Paula TV, Lin M, Hall MB, Suen G. Transient changes in milk production efficiency and bacterial community composition resulting from near-total exchange of ruminal contents between high- and low-efficiency holstein cows. J Dairy Sci. 2017;100:7165-82.

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EXPERIMENTAL DESIGN

The rumen microbiota trial was conducted by V. Berthelot and L. Broudiscou in 2014.

Animals:

- 10 goats (phenotypic variability)
- Rumen cannulated
- 2 breeds (4 Saanen & 6 Alpine)
- Average milk yield at the peak: 4.0 ± 0.7 kg/d

Diet: Total mixed ration (23% grass hay, 29% sugar beet pulp silage, 28% alfalfa hay, and 20% commercial concentrate)

EXPERIMENTAL DESIGN

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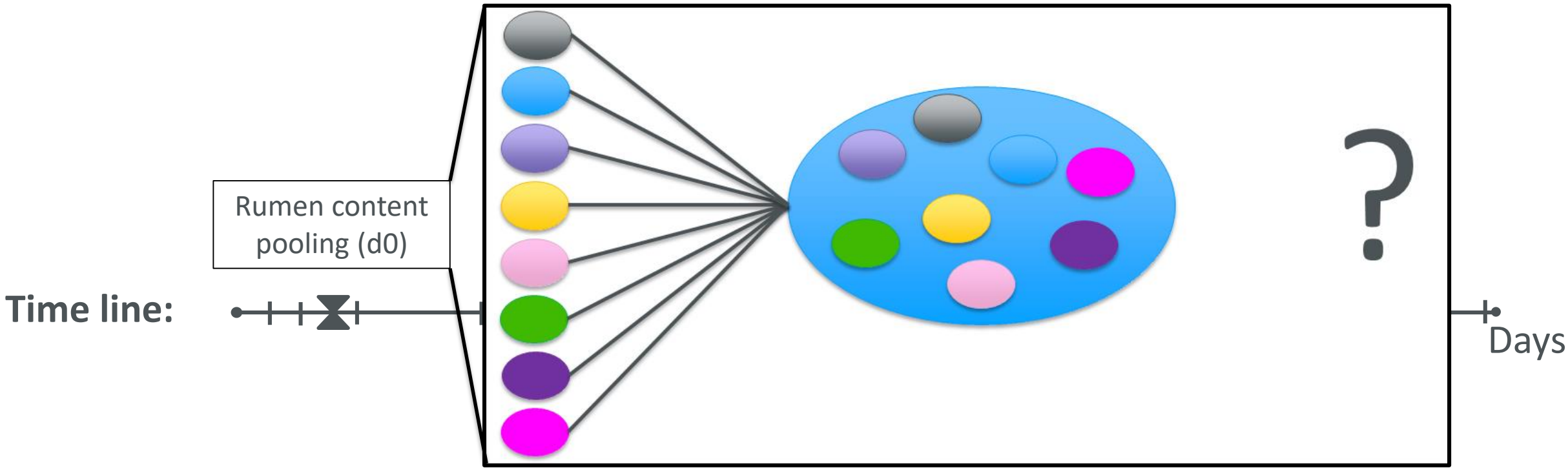

EXPERIMENTAL DESIGN – MICROBIOTA COMPOSITION

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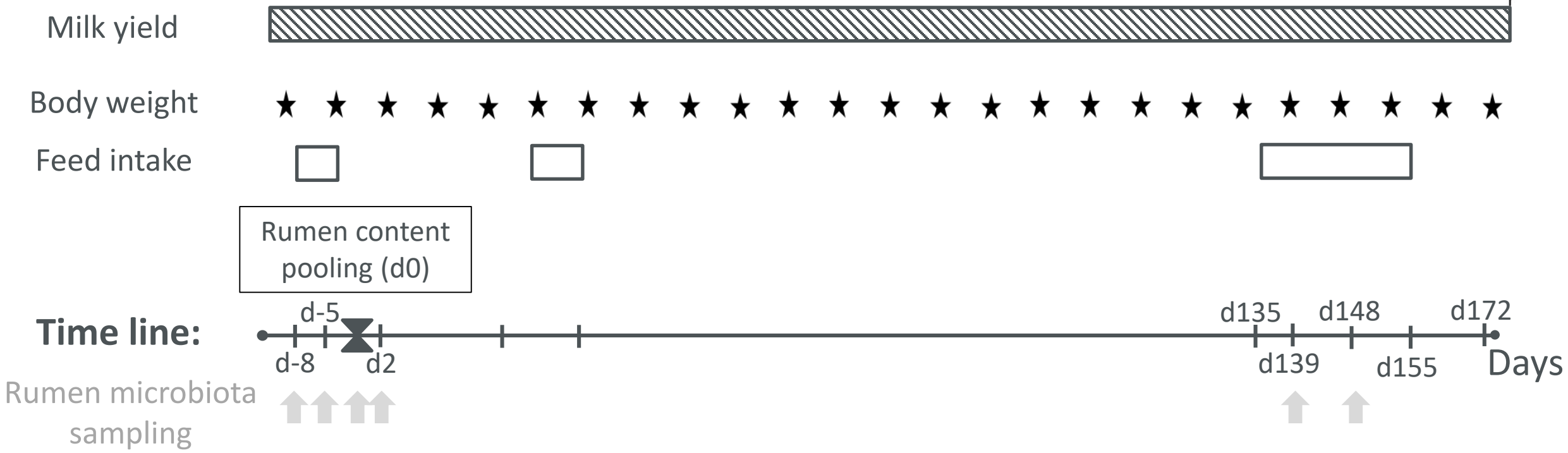
Microbiota composition:

- V4-V5 hyper variable regions of archaeal and bacterial 16S rRNA genes
- Miseq Illumina sequencer
- Sequence processing with FROGS pipeline (Find, Rapidly, OTUs with Galaxy Solution)
- 1 558 OTUs detected

EXPERIMENTAL DESIGN – ANIMAL CHARACTERISTICS AND PRODUCTION TRAITS

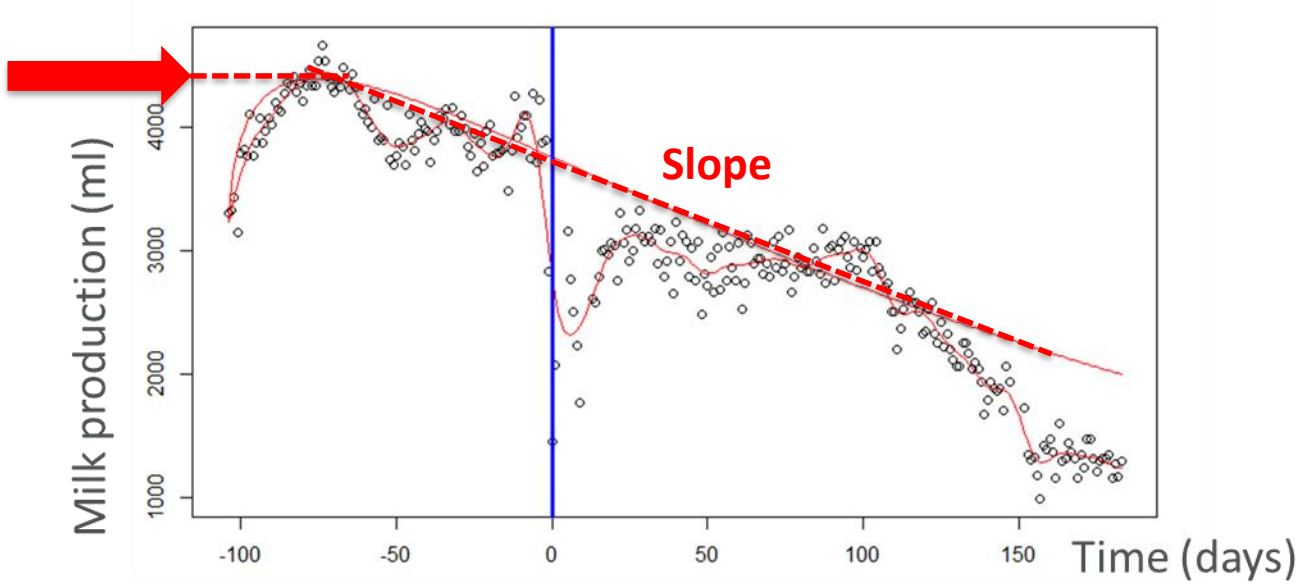


EXPERIMENTAL DESIGN – ANIMAL CHARACTERISTICS AND PRODUCTION TRAITS

- Breed
- Body weight (BW)
- Dry matter intake (DMI)

EXPERIMENTAL DESIGN – ANIMAL CHARACTERISTICS AND PRODUCTION TRAITS

- Breed
- Body weight (BW)
- Dry matter intake (DMI)
- Milk yield potential (MYPot) ➔ production at the peak of lactation
- Milk yield persistency (MYPer) ➔ individual goat capacity to maintain its milk production



EXPERIMENTAL DESIGN – RUMEN CONTENT DYNAMICS

Milk yield

Body weight

Feed intake

Rumen content pooling (d0)

Time line:

d-8 d-5 d2 d20 d31 d135 d139 d148 d155 d172 Days

Rumen microbiota sampling

Feeding behaviour

Rumen turnover rates

EXPERIMENTAL DESIGN – RUMEN CONTENT DYNAMICS

Feeding behaviour:

- The intake rate ➔ estimated by the **T**ime to eat **80**% of the DMI during afternoon meal (**T80**)
- The variability of the intake rate ➔ **sd(T80)**
- The **B**etween eating **B**out **I**ntervals (**BBI**) ➔ average duration of the non-feeding periods during T80

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Rumen turnover rates:

- **L**iquid **T**urnover **R**ate (**LTR, % h^{-1}**)
- **S**olid **T**urnover **R**ate (**STR , % h^{-1}**)

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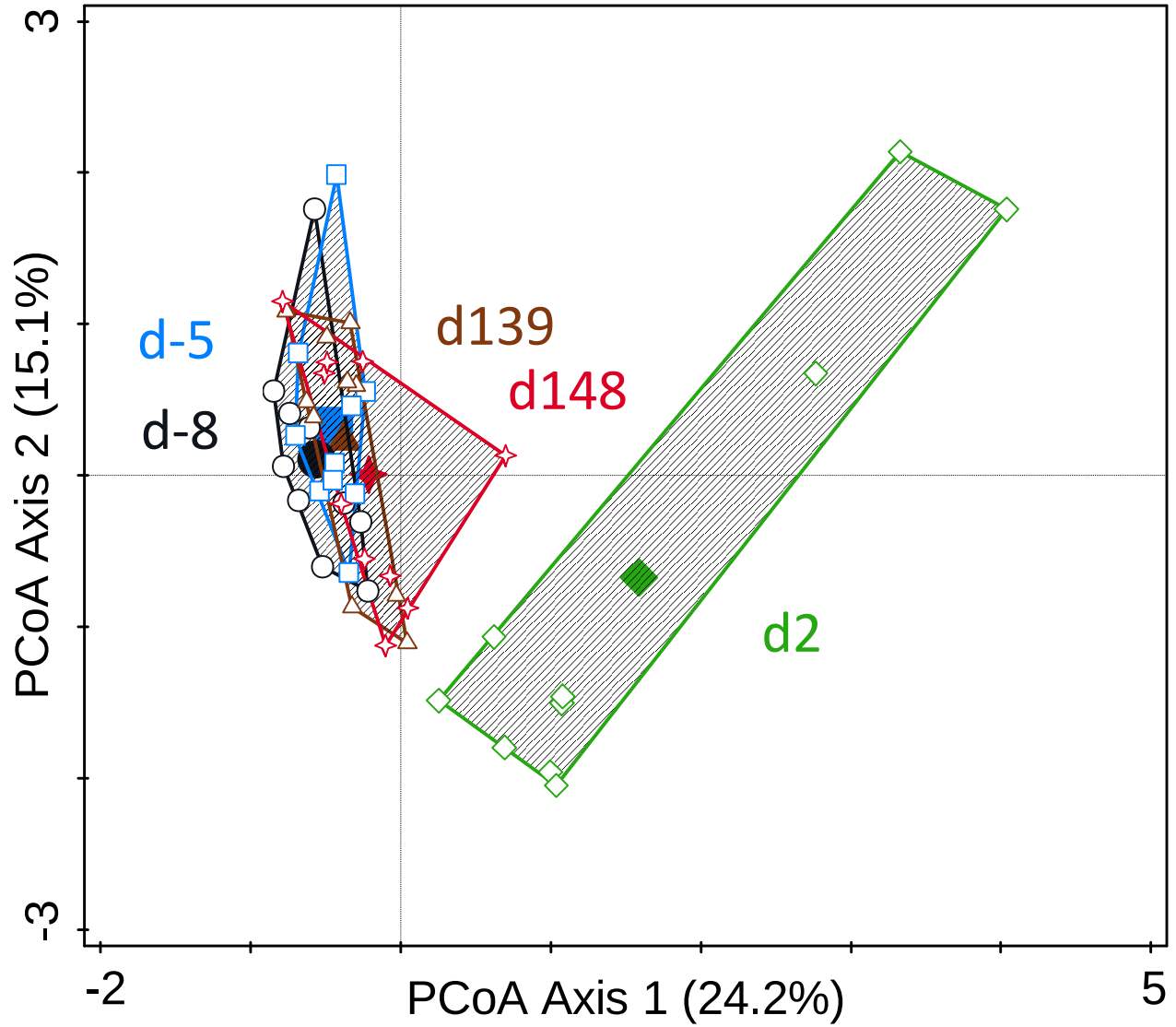
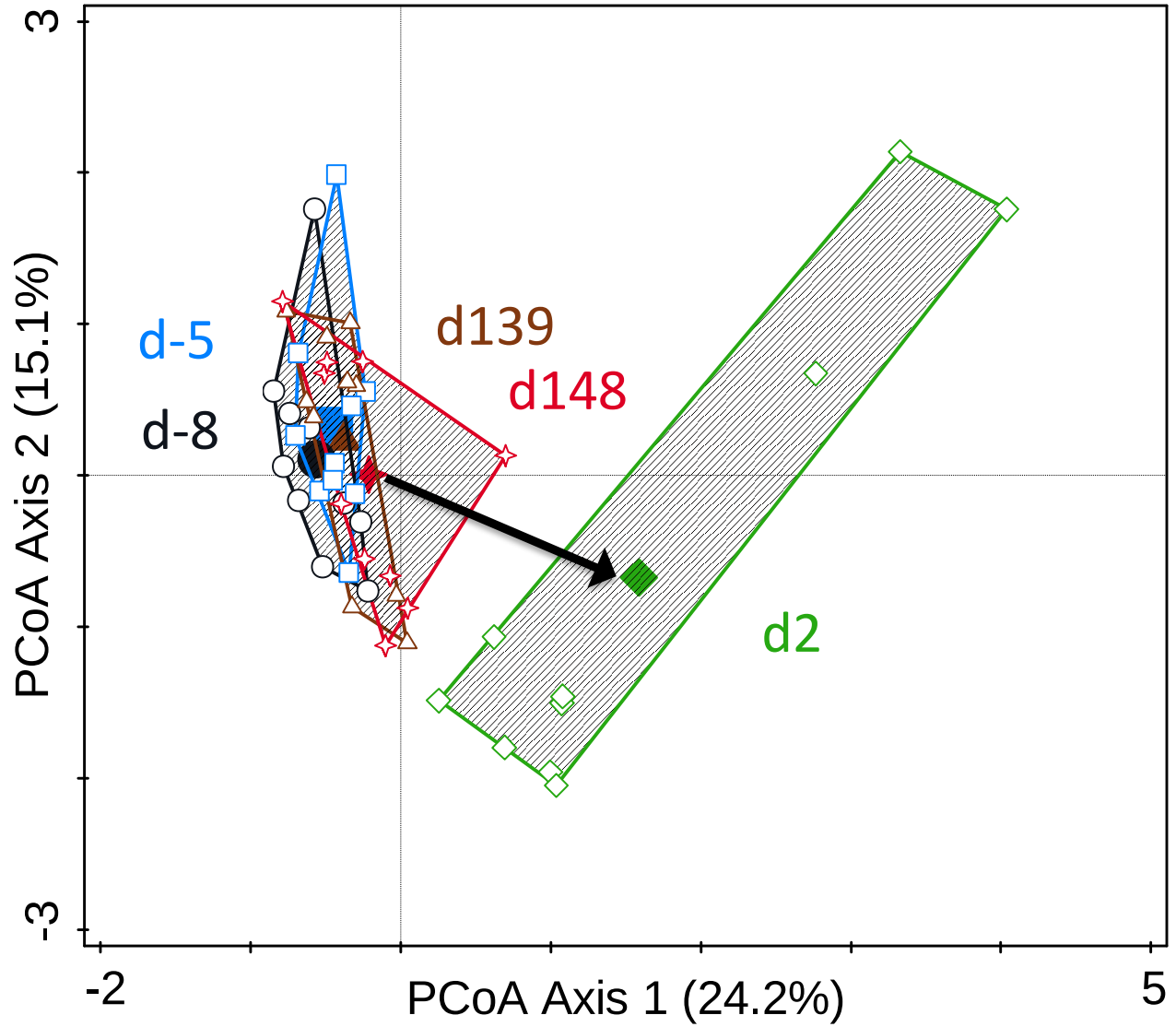
β-DIVERSITY ANALYSIS



Principal **Co**ordinates **A**nalysis (**PCoA**)of rumen microbiota samples based on OTUs community dissimilarities (Bray Curtis).

β-DIVERSITY ANALYSIS



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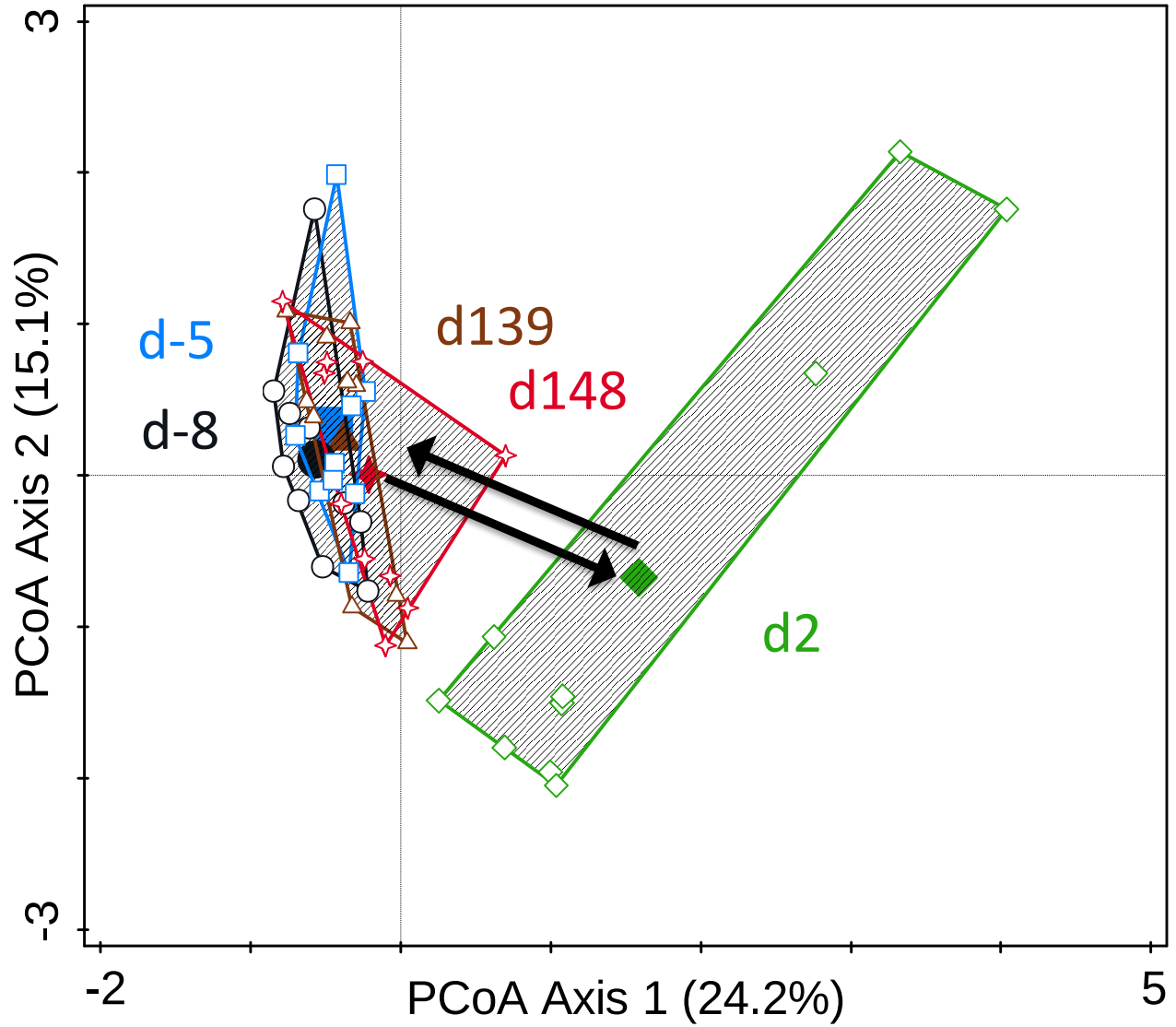

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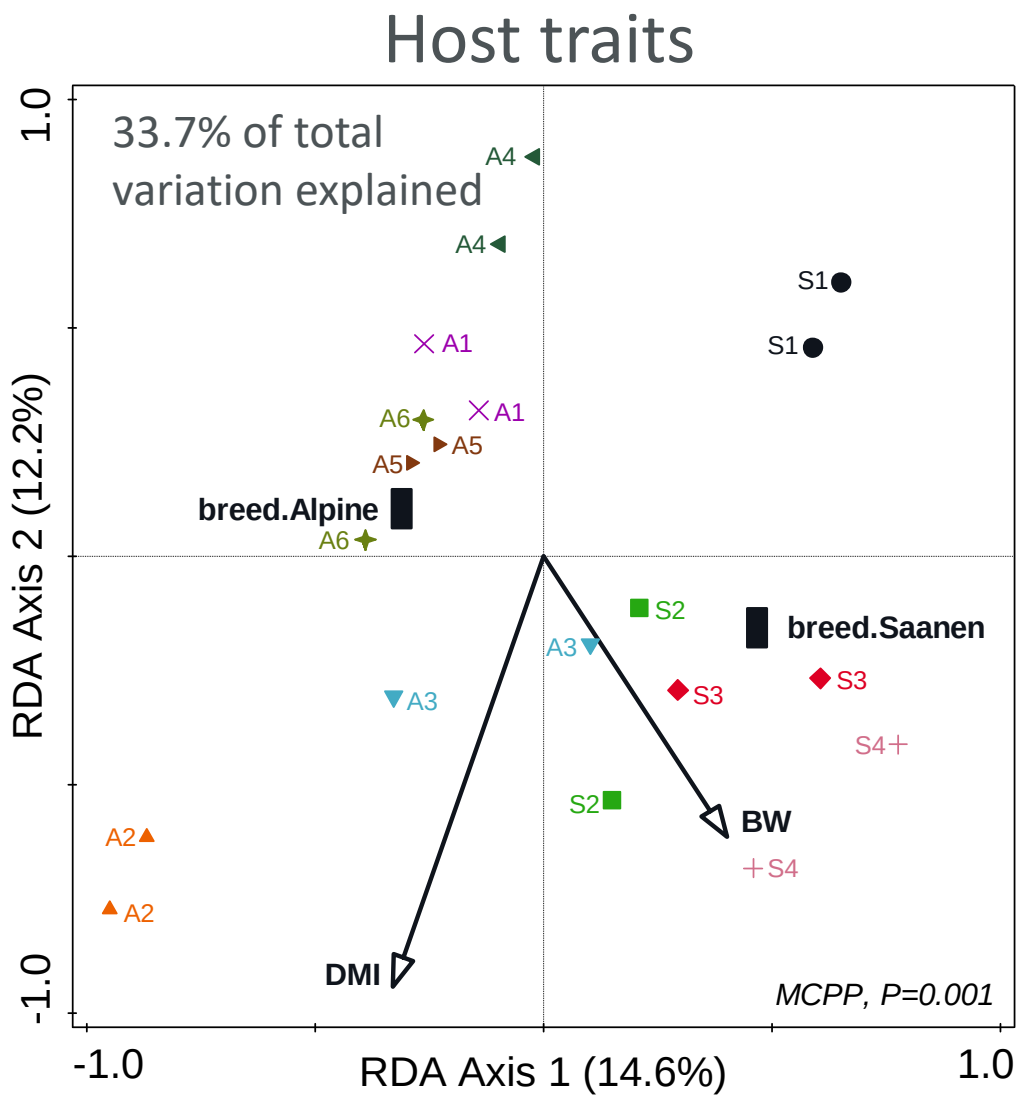
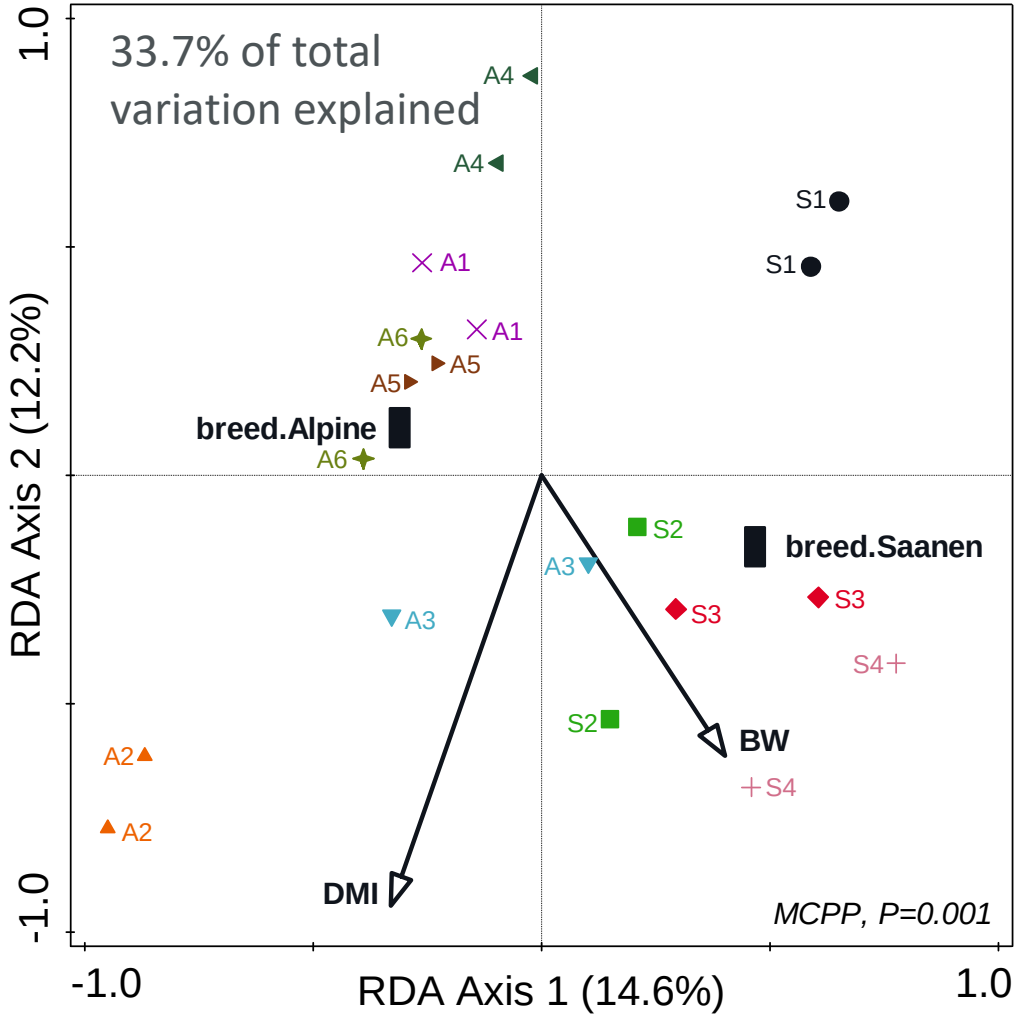
INTERRELATIONS BEFORE RUMEN CONTENT POOLING



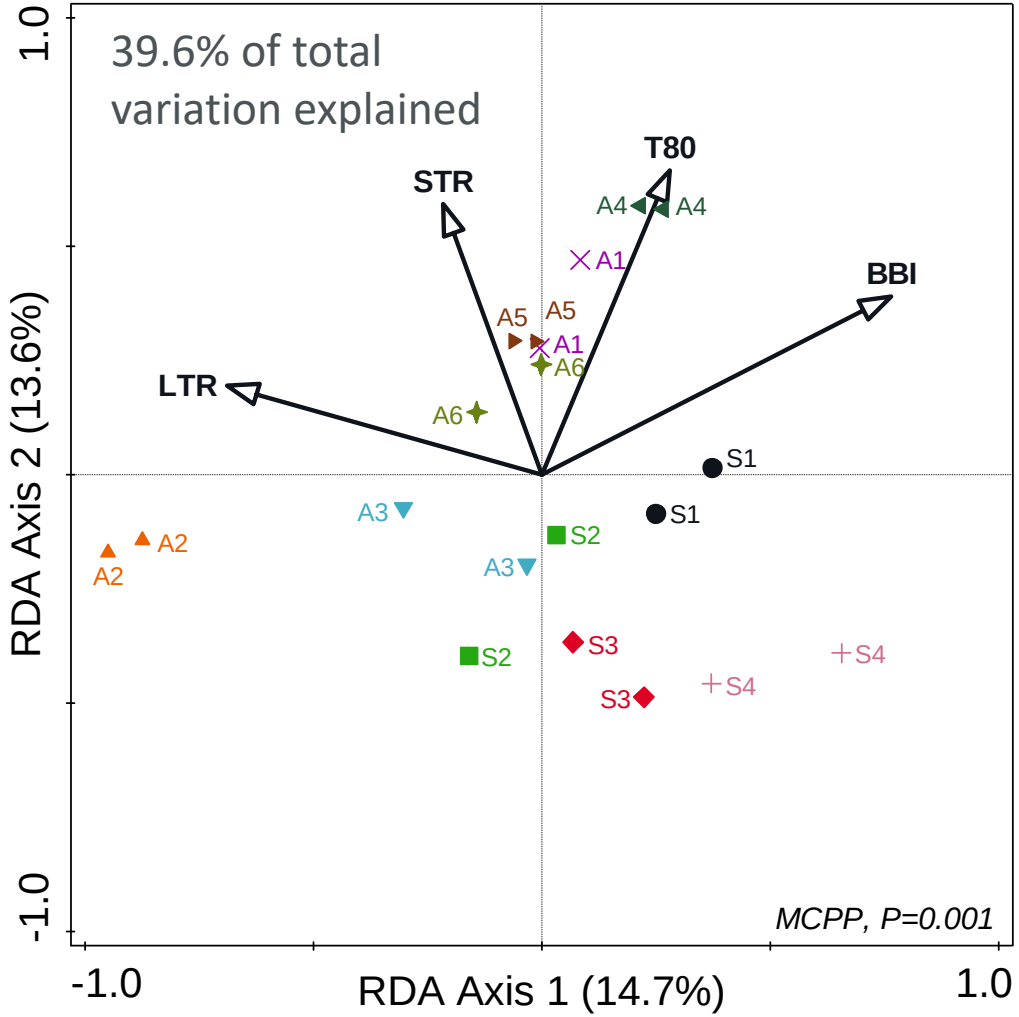
Breed
BW
DMI
MYPot
MYPer

INTERRELATIONS BEFORE RUMEN CONTENT POOLING

Host traits



Rumen content dynamics

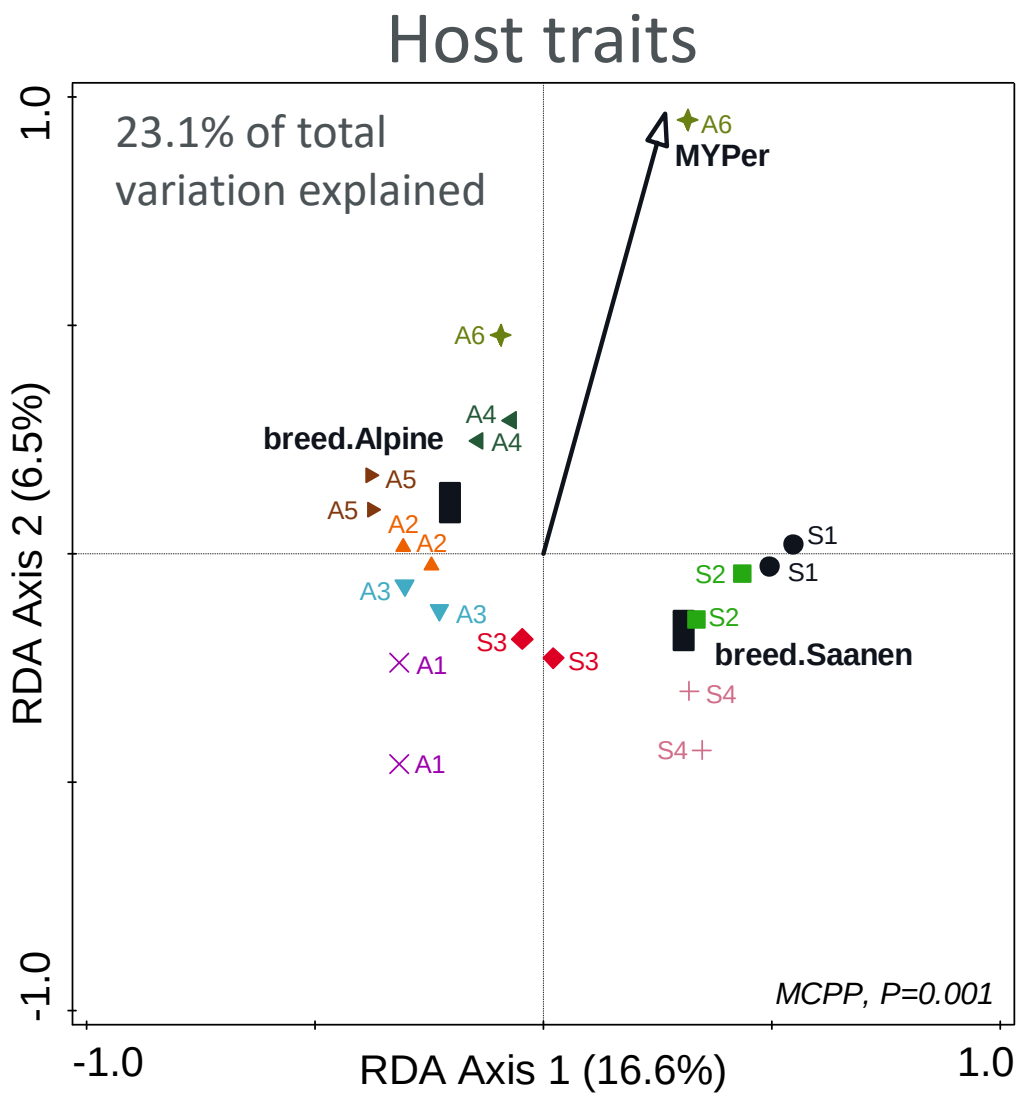


LTR
STR
T80
Sd(T80)
BBI

INTERRELATIONS 2 DAYS AFTER RUMEN CONTENT POOLING

➔ 2 days after the rumen content pooling, none of these host traits influenced the microbiota composition.

INTERRELATIONS 5 MONTHS AFTER RUMEN CONTENT POOLING



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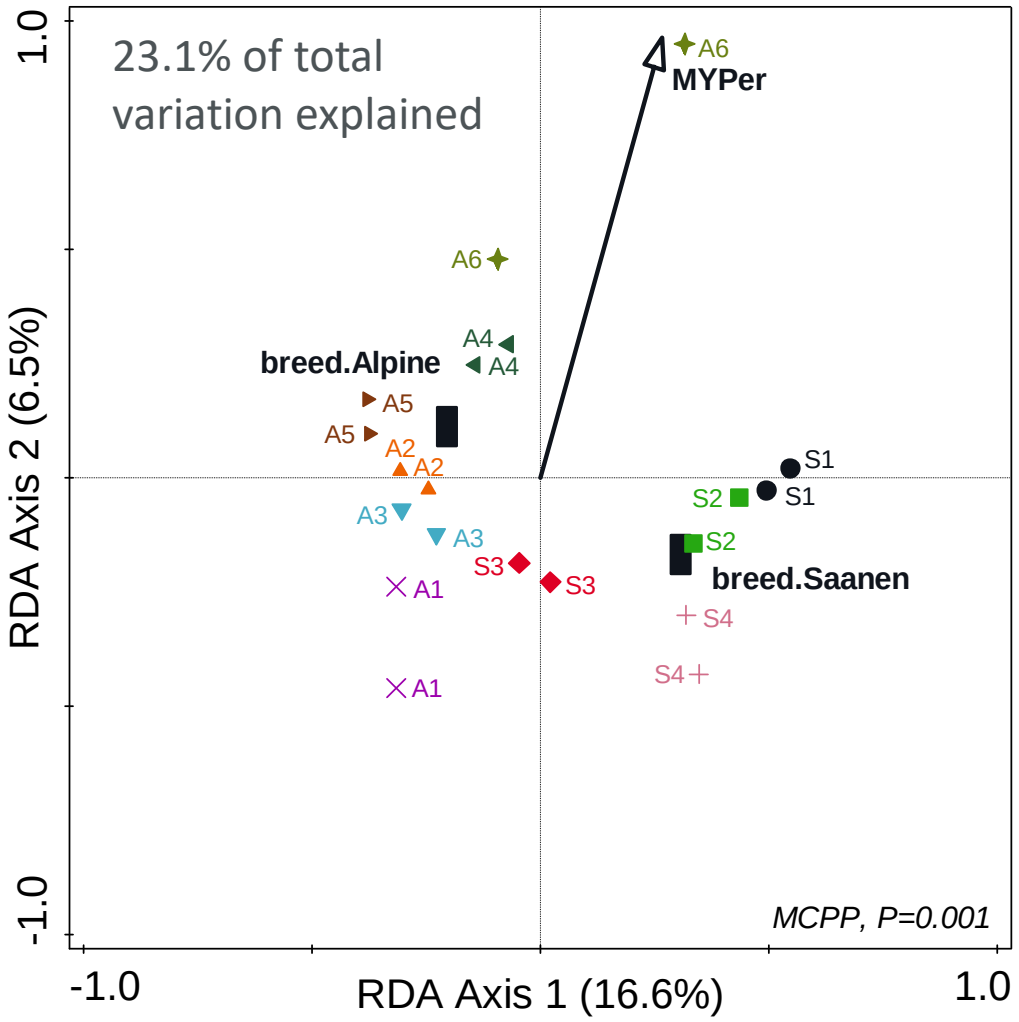
INTERRELATIONS 5 MONTHS AFTER RUMEN CONTENT POOLING

Host traits



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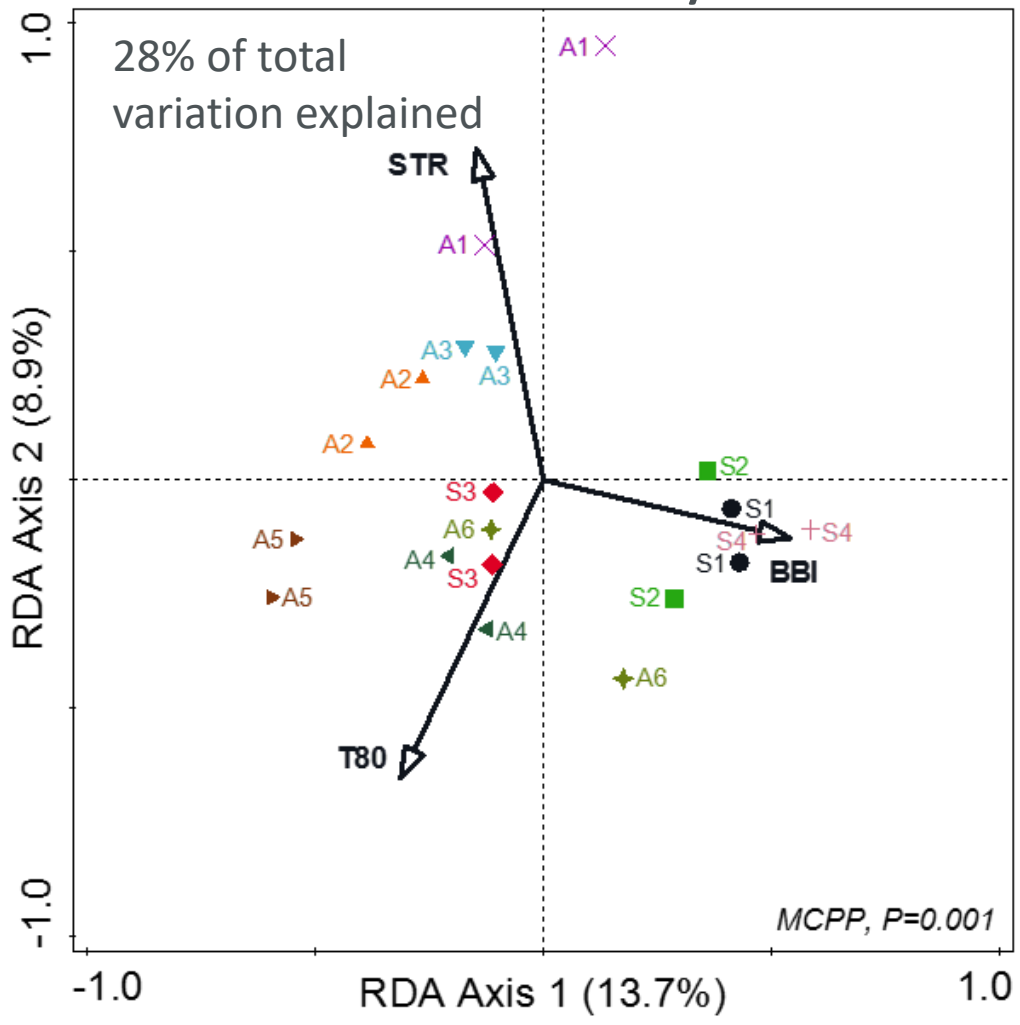

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T80
Sd(T80)
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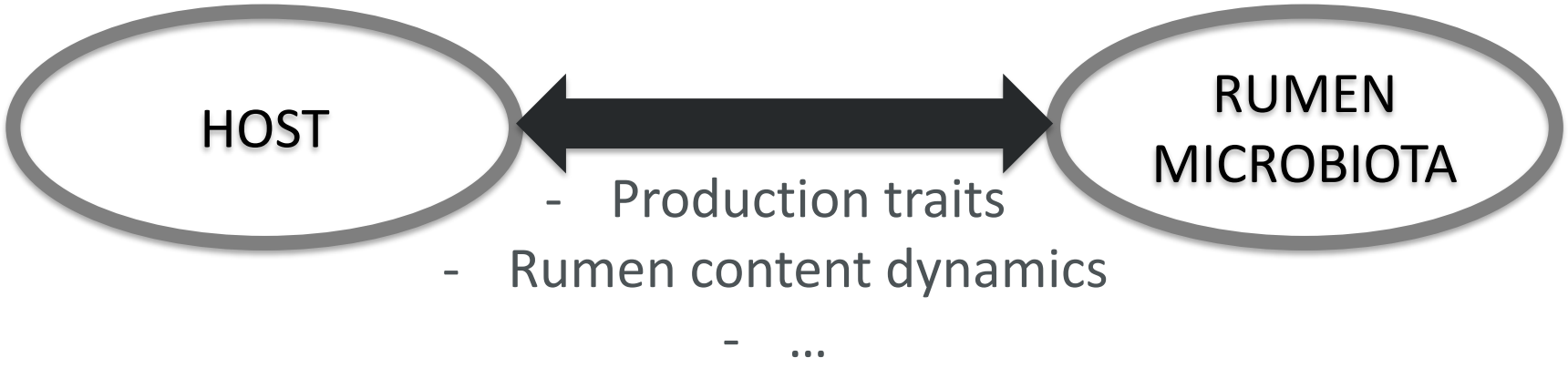
CONCLUSIONS AND PERSPECTIVES

- Rumen content pooling is a good design to challenge interrelations.
- The high resilience of the rumen microbiota within its host is found in lactating goats.
- **Do host traits shape the rumen microbiota structure ?**

➔ Yes, animal host traits and rumen content dynamics shape a part of the rumen microbiota structure.



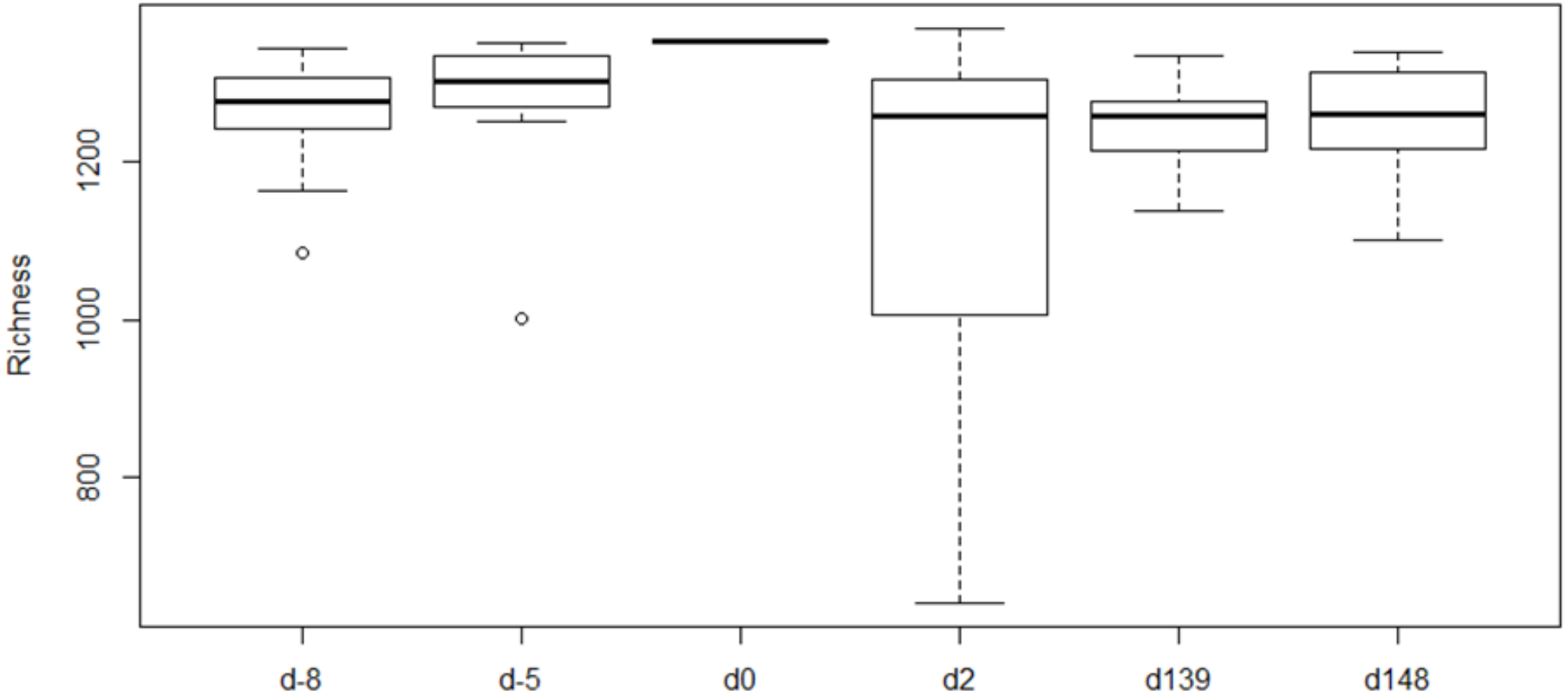
ADDITIONAL SLIDES

	Husbandry and production traits					Rumen contents dynamics				
goat	breed	BW (kg)	DMI (kg/day)	MYPeak (l)	MYPer (ml/day)	LTR (%/h)	STR (%/h)	T80 (min)	sd(T80) (min)	BBI (min)
S1	Saanen	58.1	2.4	3.4	-6.9	26.0	8.2	335	69	35.8
S2	Saanen	69.3	2.9	3.7	-10.8	26.0	7.7	282	76	27.4
S3	Saanen	59.5	2.6	4.4	-11.2	21.3	6.0	258	54	25.6
S4	Saanen	79.4	3.0	4.7	-11.9	18.0	6.5	274	40	37.1
A1	Alpine	56.3	2.8	4.1	-13.4	22.6	11.2	221	42	34.1
A2	Alpine	62.7	3.0	4.8	-9.2	28.5	8.8	267	70	23.0
A3	Alpine	64.2	2.8	4.7	-9.6	25.1	7.3	267	94	21.1
A4	Alpine	63.8	2.2	2.7	-8.1	25.8	9.2	519	103	43.3
A5	Alpine	57.0	2.8	3.8	-10.4	23.4	7.4	388	33	24.4
A6	Alpine	59.2	2.7	3.2	-2.4	20.2	6.1	331	72	25.9
mean		63.0	2.7	4.4	-9.4	23.7	7.8	314	65	29.8
SD		7.0	0.3	0.5	3.1	3.2	1.6	86	23	7.3

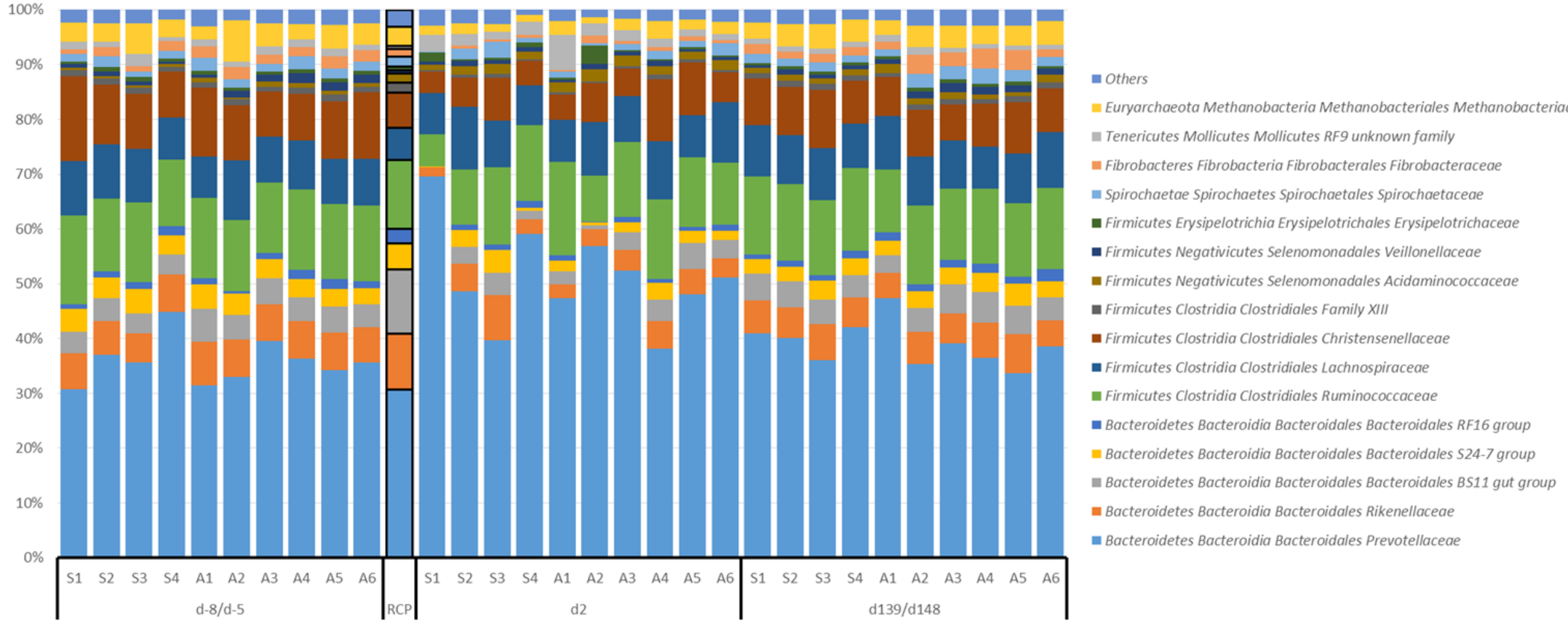
ADDITIONAL SLIDES

	d-8	d-5	d2	d139	d148
d-8		R=0.027 (*p*=1)	**R=0.592 (*p*=0.002)**	**R=0.370 (*p*=0.004)**	**R=0.397 (*p*=0.002)**
d-5			**R=0.555 (*p*=0.001)**	R=0.125 (*p*=0.296)	R=0.144 (*p*=0.152)
d2				**R=0.568 (*p*=0.001)**	**R=0.457 (*p*=0.001)**
d139					R=0.028 (*p*=1)
d148					

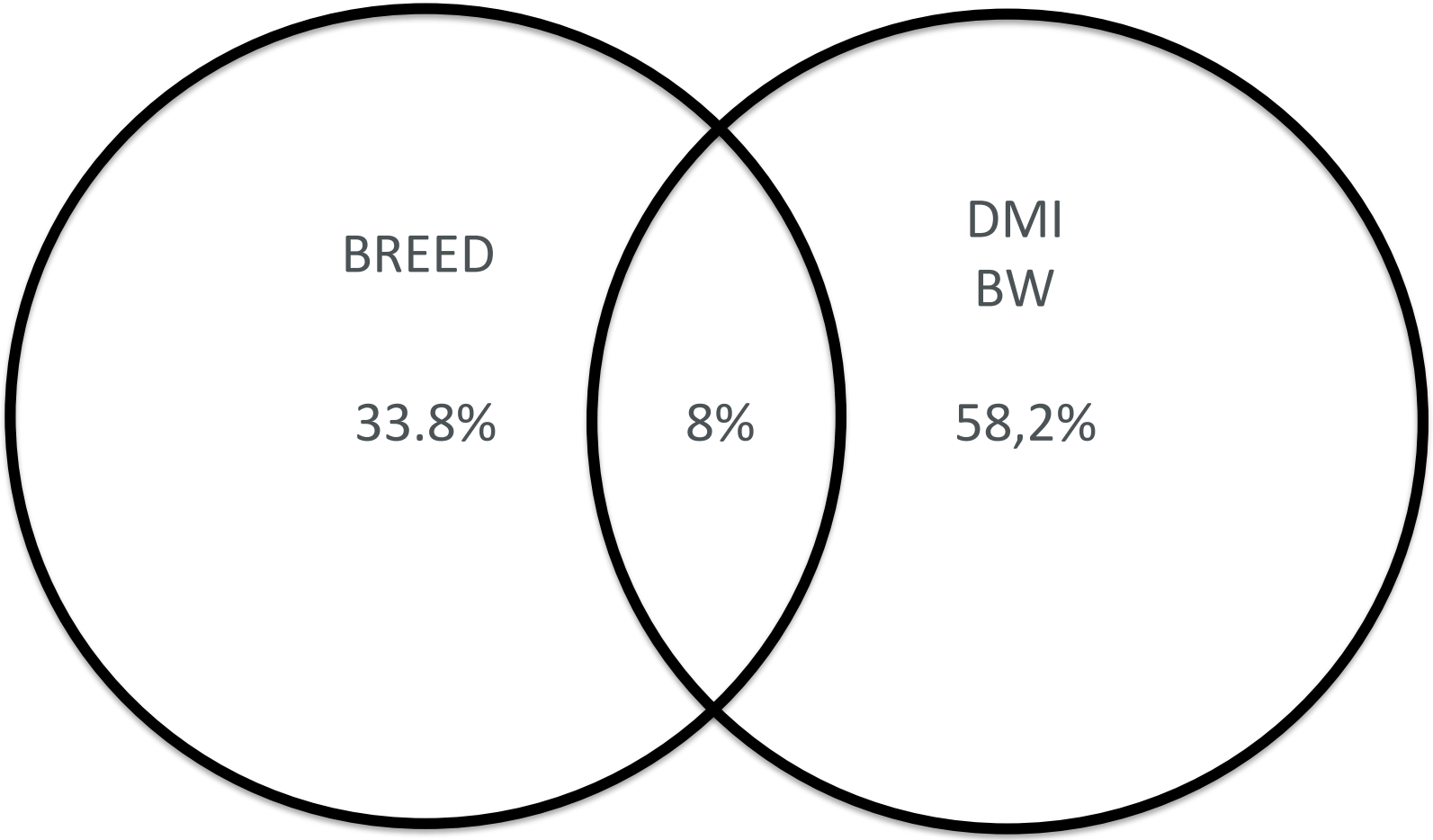
ADDITIONAL SLIDES



ADDITIONAL SLIDES

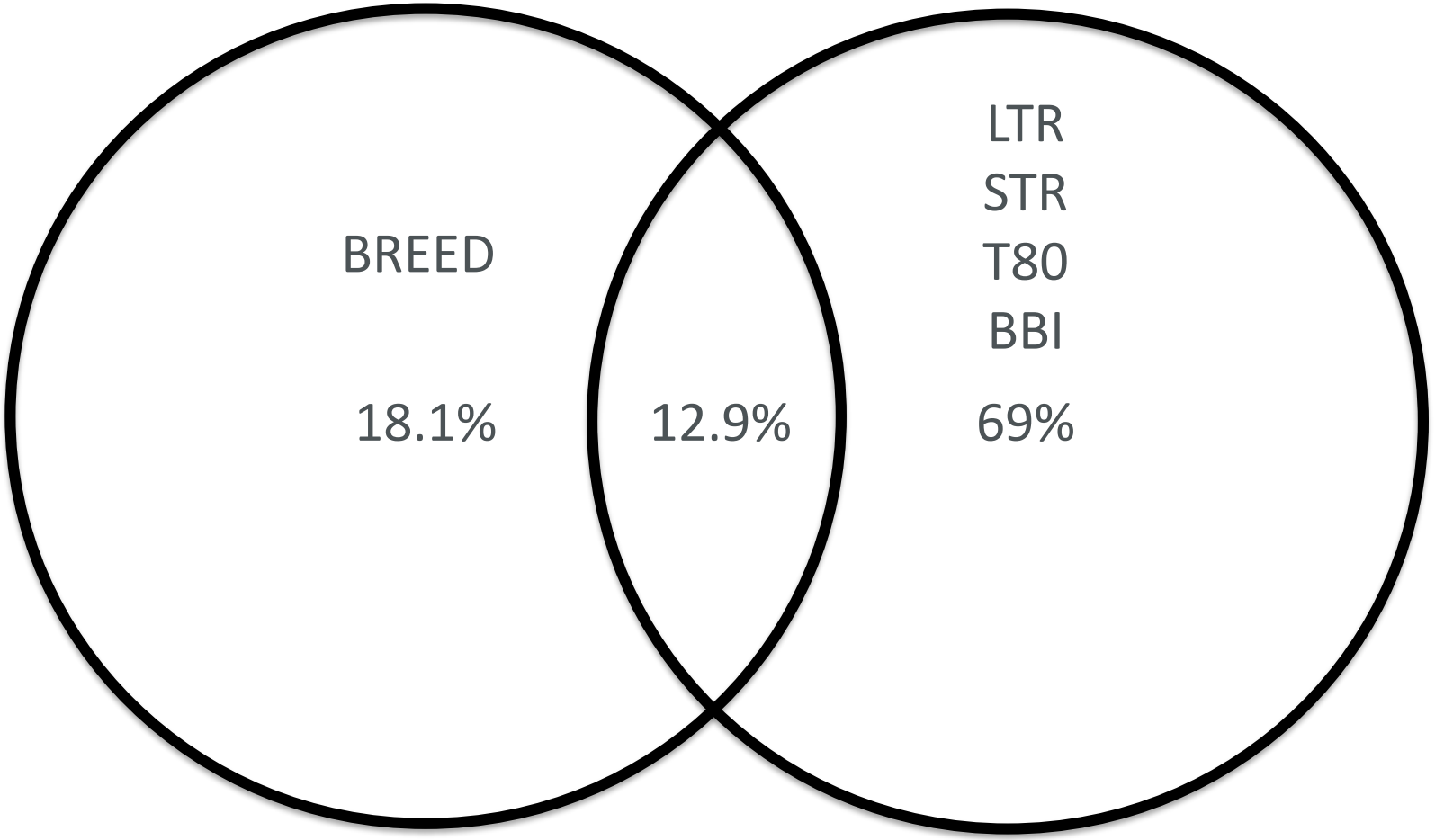


ADDITIONAL SLIDES



Variation partitioning before rumen content pooling

ADDITIONAL SLIDES



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