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Changes in pH and microbial composition in the ruminal and reticular fluids of SARA cattle



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A radio-transmission pH-measurement system

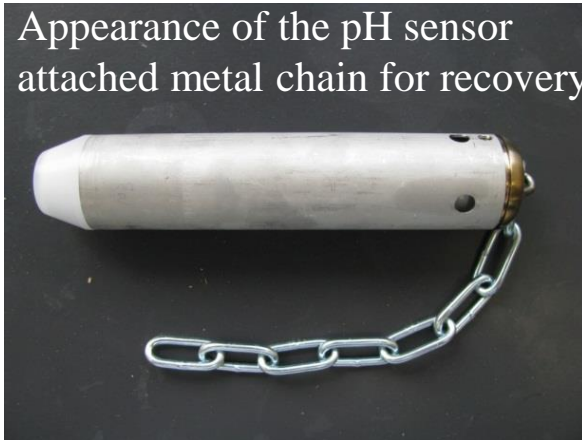
145mm in length, 30mm in diameter, and 220g in weight



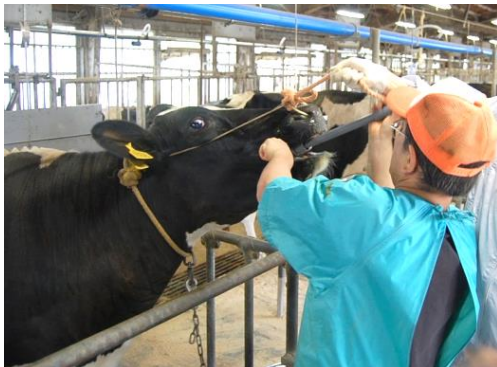
Glass electrode



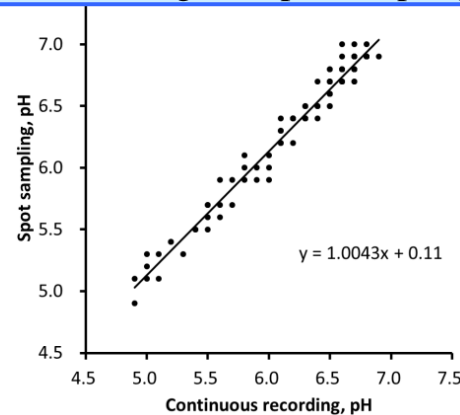
Appearance of the pH sensor attached metal chain for recovery



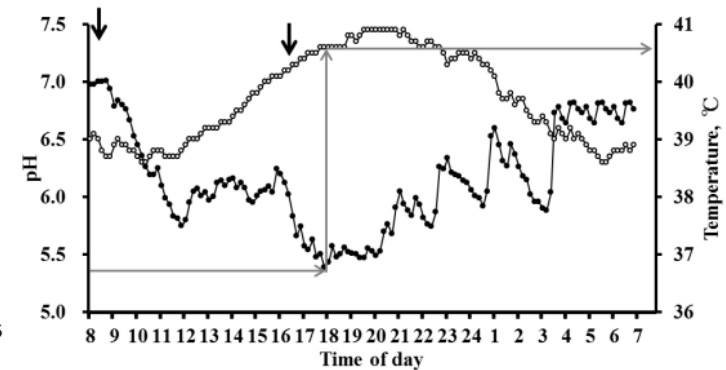
Oral administration of the sensor



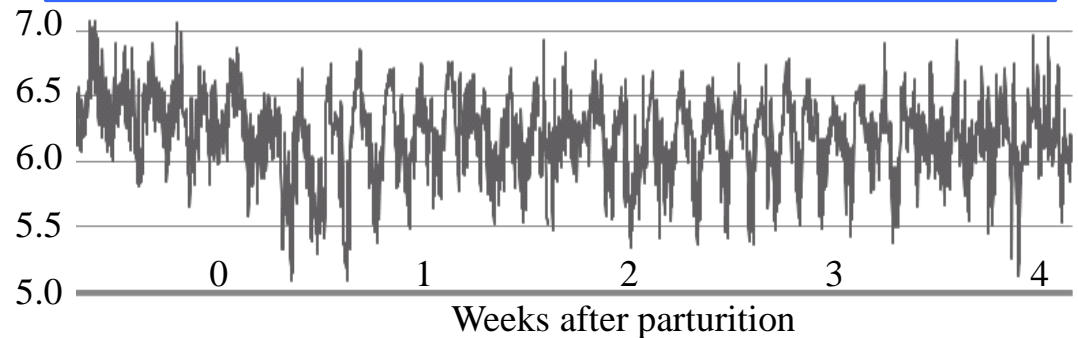
pH correlation between continuous recording and spot sampling



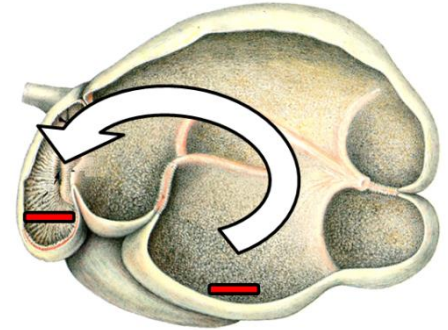
Circadian changes in ruminal pH and temperature of a cattle fed SARA-diet



Changes in ruminal pH of a periparturient cow



Background (1)



- The pH sensor could enter the reticulum or could move from the rumen to reticulum when administered orally.
- The reticular pH is slightly higher than the ruminal pH (Krause et al., 2005; Lane et al., 1968) due to mixing and dilution with saliva (Duffield et al., 2004)
- However, the relations between ruminal and reticular pH are unknown.



- Ruminal and reticular pH were investigated in cattle with repeated induced SARA to reveal the relations between the both pH.

Background (2)

- Several studies have been conducted on the rumen microbial community in SARA cows (Chen et al., 2012; Golder et al., 2014; Mao et al., 2013; Hernandez-Sanabria et al., 2012).
- Studies about microbial community in SARA cattle are based on long-term induction, however, the community in cattle with short-term induced SARA is unknown.

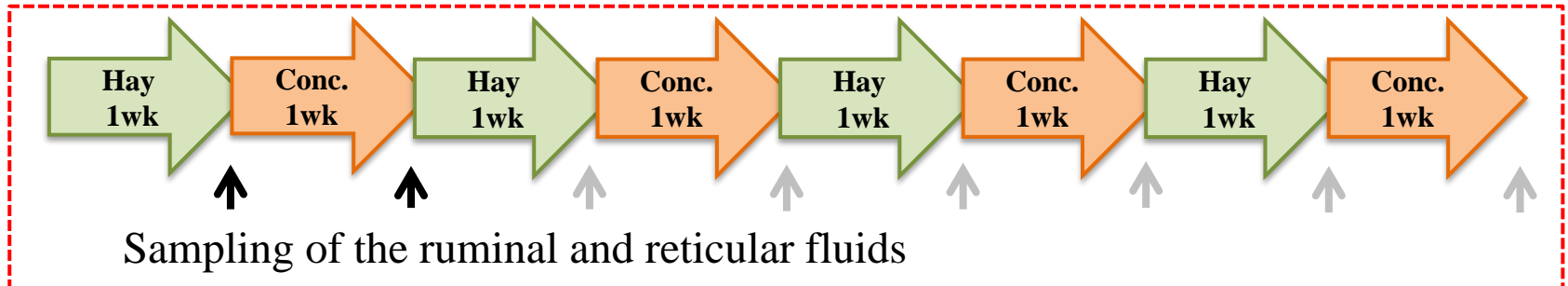


- Bacterial composition in cattle with induced SARA were investigated to reveal changes in composition of the rumen and reticulum against acute and short-term change in feeding.

Materials and Methods (1)

Cattle examined: Eight rumen-cannulated Holstein steers (age, 8-10 months; weight, 180-200 kg)

Feeding and experimental calves: Cattle fed hay- or concentrate-rich diet (20% hay and 80% concentrate) for every 7 days during 4th-consecutive times.



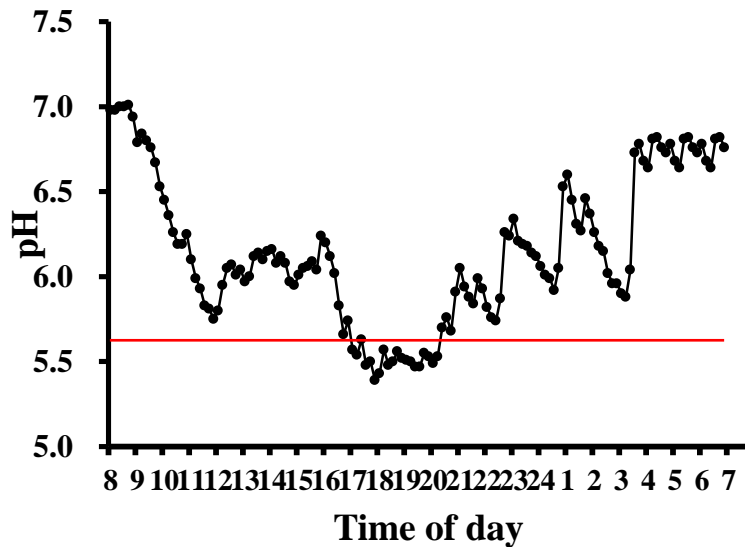
Measurements:

- **Ruminal and reticular pH** : A radio-transmission pH-sensor (DKK-Toa Yamagata, Japan) was placed in the ventral sac of the rumen and the reticulum, and pH was measured every 10 min.

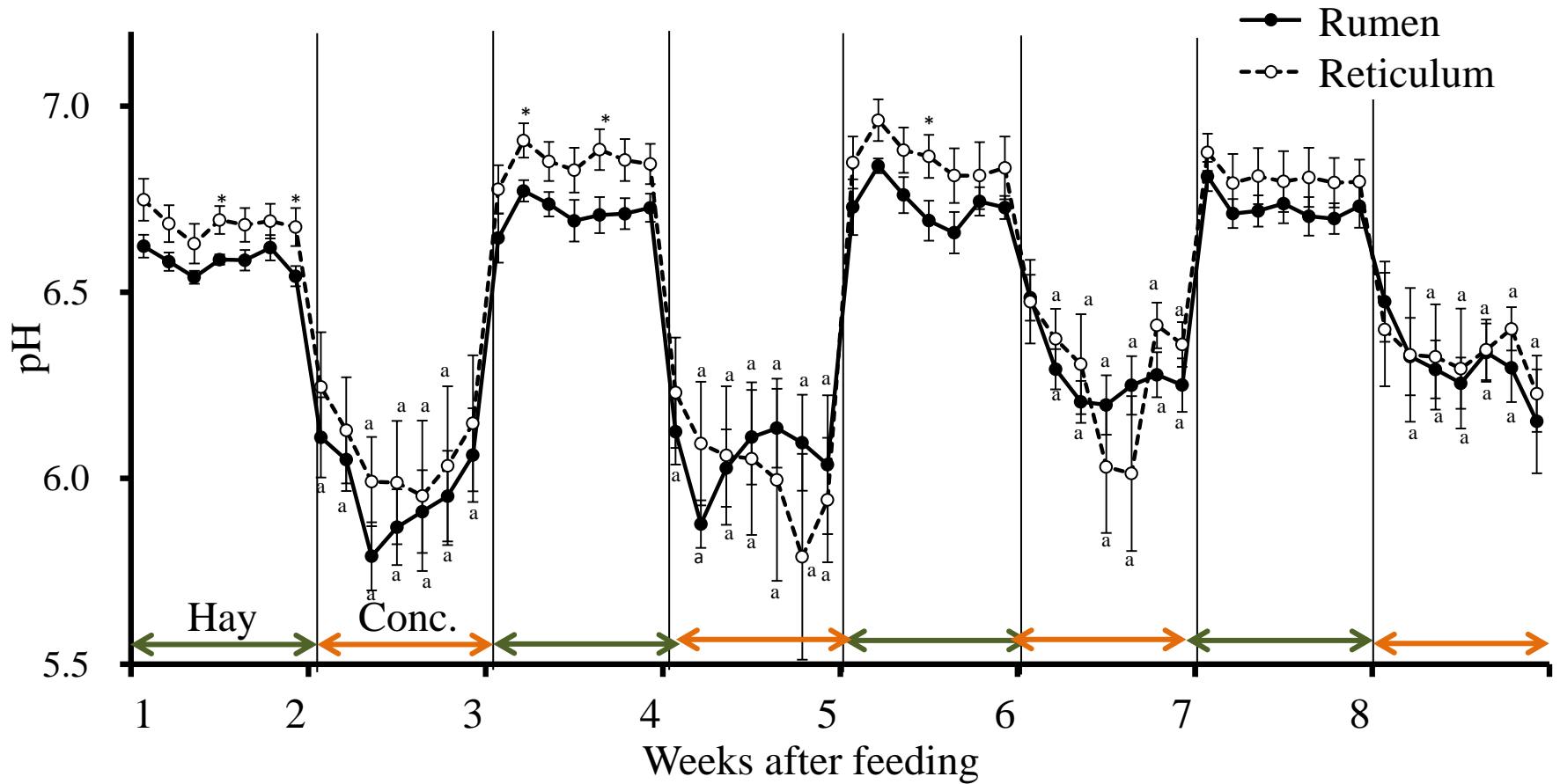


Materials and Methods (2)

- **Circadian pH change:** Cattle was divided into 3 groups by circadian changes of the ruminal pH in all hay- and concentrate-fed period, and the ruminal and reticular pH were compared every 3 groups.

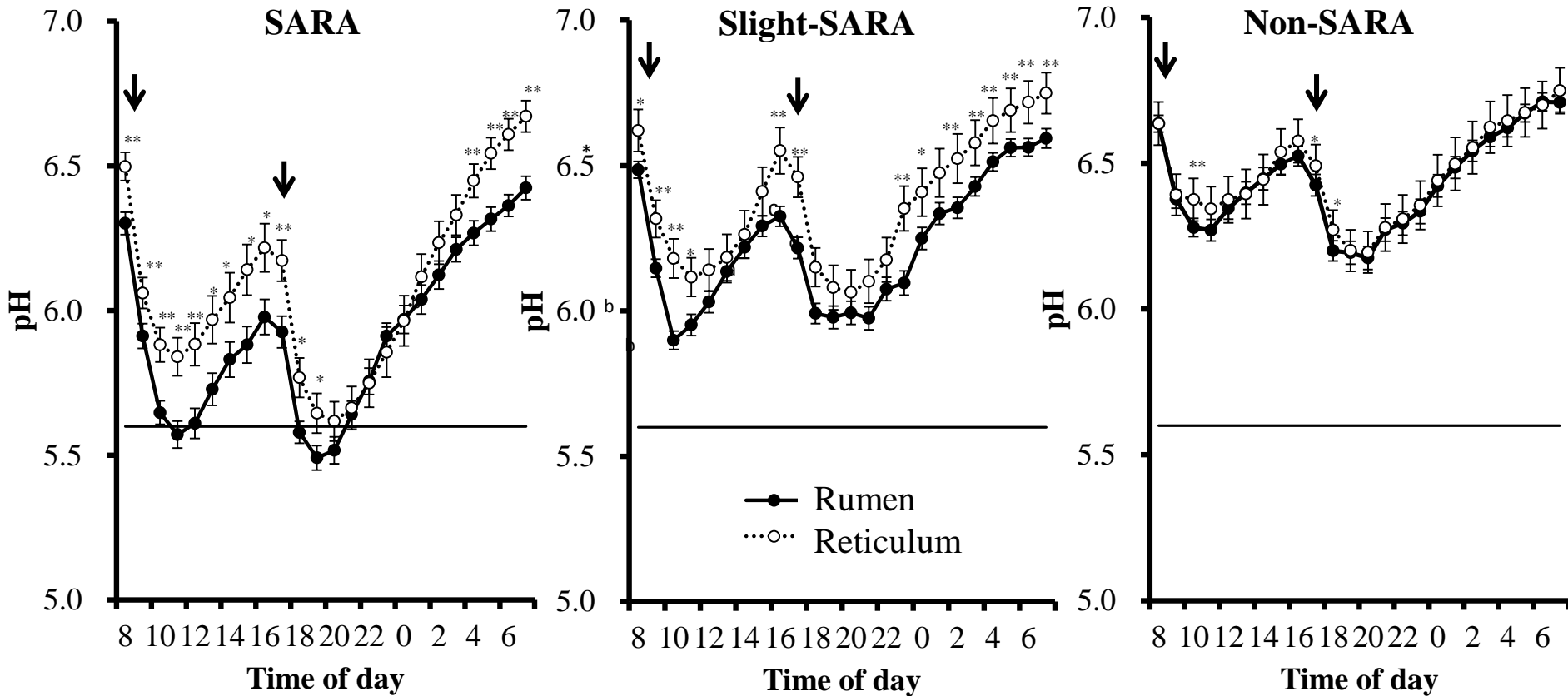


		pH, duration in a day
SARA	(n=8, 57 sample)	pH <5.6, 3 hrs <
Slight-SARA	(n=8, 32 sample)	pH <5.6, <3 hrs
Non-SARA	(n=8, 37 sample)	pH <5.6, 0 hr



Changes in 24-hr mean ruminal and reticular pH of cattle with repeated induced SARA at hay- and concentrate-fed period.

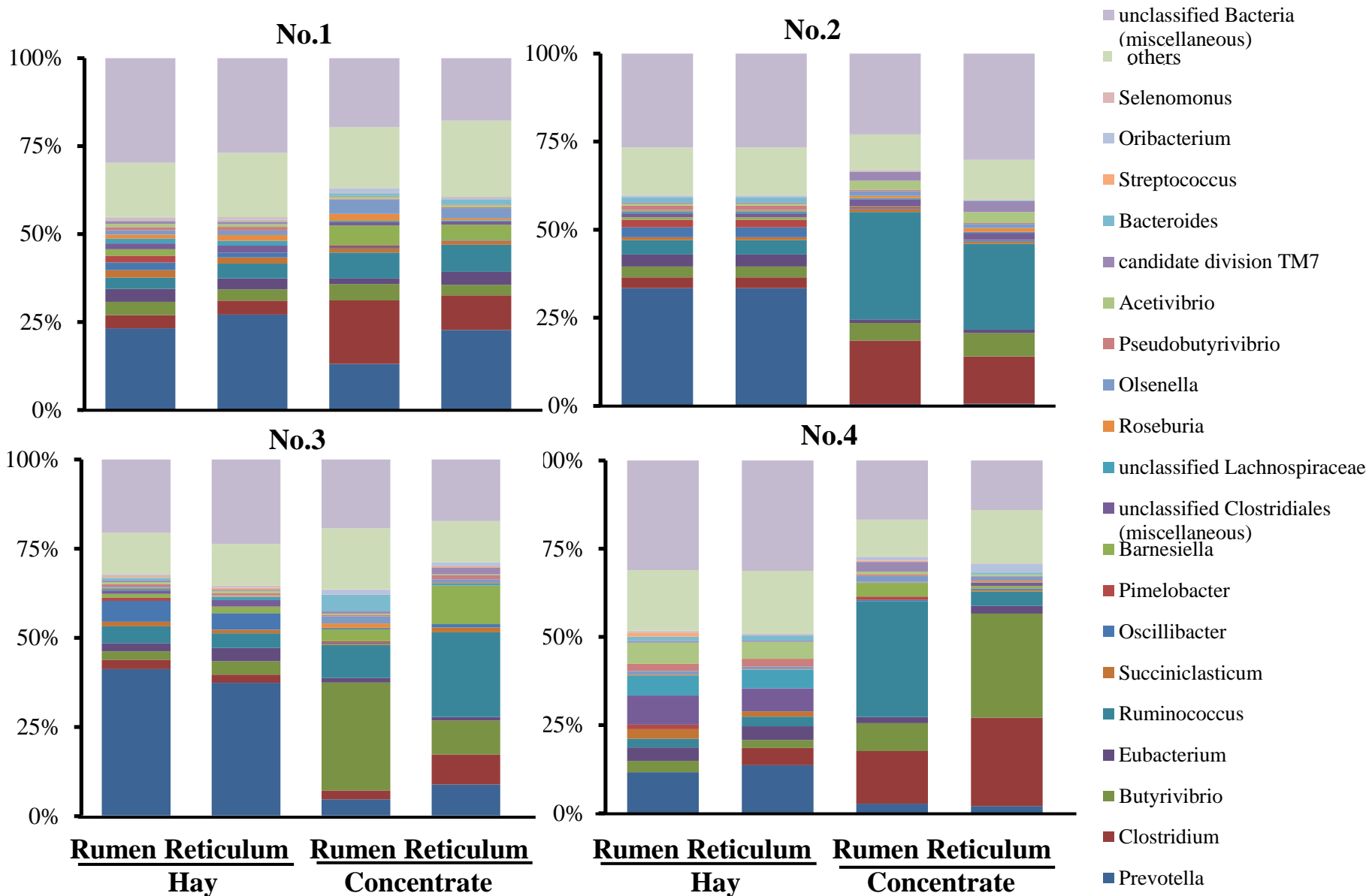
M ± SE (n=8), *P<0.05 (vs. rumen in the same day),
^aP<0.05 (vs. one day before feeding change in the same site)



Circadian changes in 1-hr mean ruminal and reticular pH of cattle with SARA, slight SARA and non-SARA.

$M \pm SE$, * $P < 0.05$ (vs. rumen in the same time)

		SARA	Slight-SARA	Non-SARA
Rumen	24-hr mean	5.92 \pm 0.02 ^a	6.23 \pm 0.02 ^a	6.44 \pm 0.03
	Hours (<pH5.6)	6.89 \pm 0.46 ^a	1.04 \pm 0.15 ^a	0.00 \pm 0.00
Reticulum	24-hr mean	6.08 \pm 0.05 ^{b**}	6.37 \pm 0.03 ^{a**}	6.47 \pm 0.04
	Hours (<pH5.6)	5.47 \pm 1.05 ^b	1.33 \pm 0.32 ^b	0.64 \pm 0.28 [*]

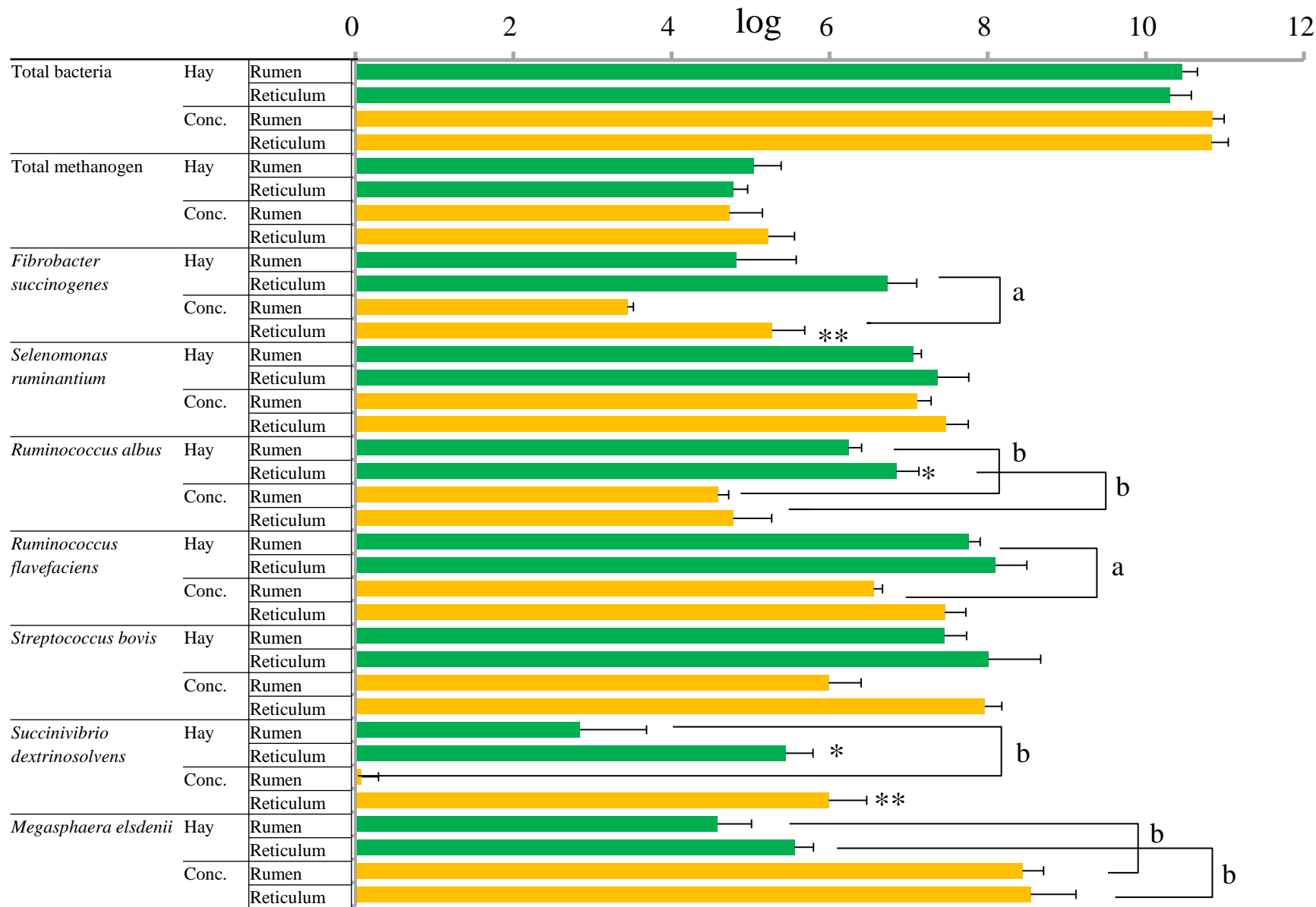


Comparison of bacterial community (genus) in the ruminal and reticular fluid of cattle (n=4) with hay- and concentrate-fed period at 1st experiment by 16S rRNA gene pyrosequencing.

Numbers of bacterial phylum, genus and species in cattle with hay- and concentrate-fed period at 1st experiment by 16S rRNA gene pyrosequencing

Cattle No.	Phylum				Genus				Species			
	Hay		Concentrate		Hay		Concentrate		Hay		Concentrate	
	I	II	I	II	I	II	I	II	I	II	I	II
1	16	20	11	9	144	164	97	94	371	416	229	284
2	16	17	7	8	145	143	75	85	325	359	165	223
3	11	15	9	8	132	145	77	84	317	335	177	242
4	10	13	5	6	97	107	81	68	237	254	358	195
Mean	13.3	16.3	8.0*	7.8*	129.5	139.8	82.5*	82.8*	312.5	341.0	232.3	236.0*
SE	1.6	1.5	1.3	0.6	11.2	11.9	5.0	5.4	27.8	33.6	44.2	18.7

I : Rumen, II : Reticulum, * $P < 0.05$ (vs. hay-fed period in the same site)



Comparison of bacterial numbers in the ruminal and reticular fluids of cattle with hay- and concentrate-fed period at 1st experiment by real time PCR.

M ± SE (n=8), * P<0.05, **P<0.01 (vs. rumen in the same feeding period), ^aP<0.05, ^bP<0.01 (vs. hay feeding period in the same site).

Conclusion

- Ruminal pH was lower than that of the reticulum, however, significant positive correlation was observed between the ruminal and reticular pH.

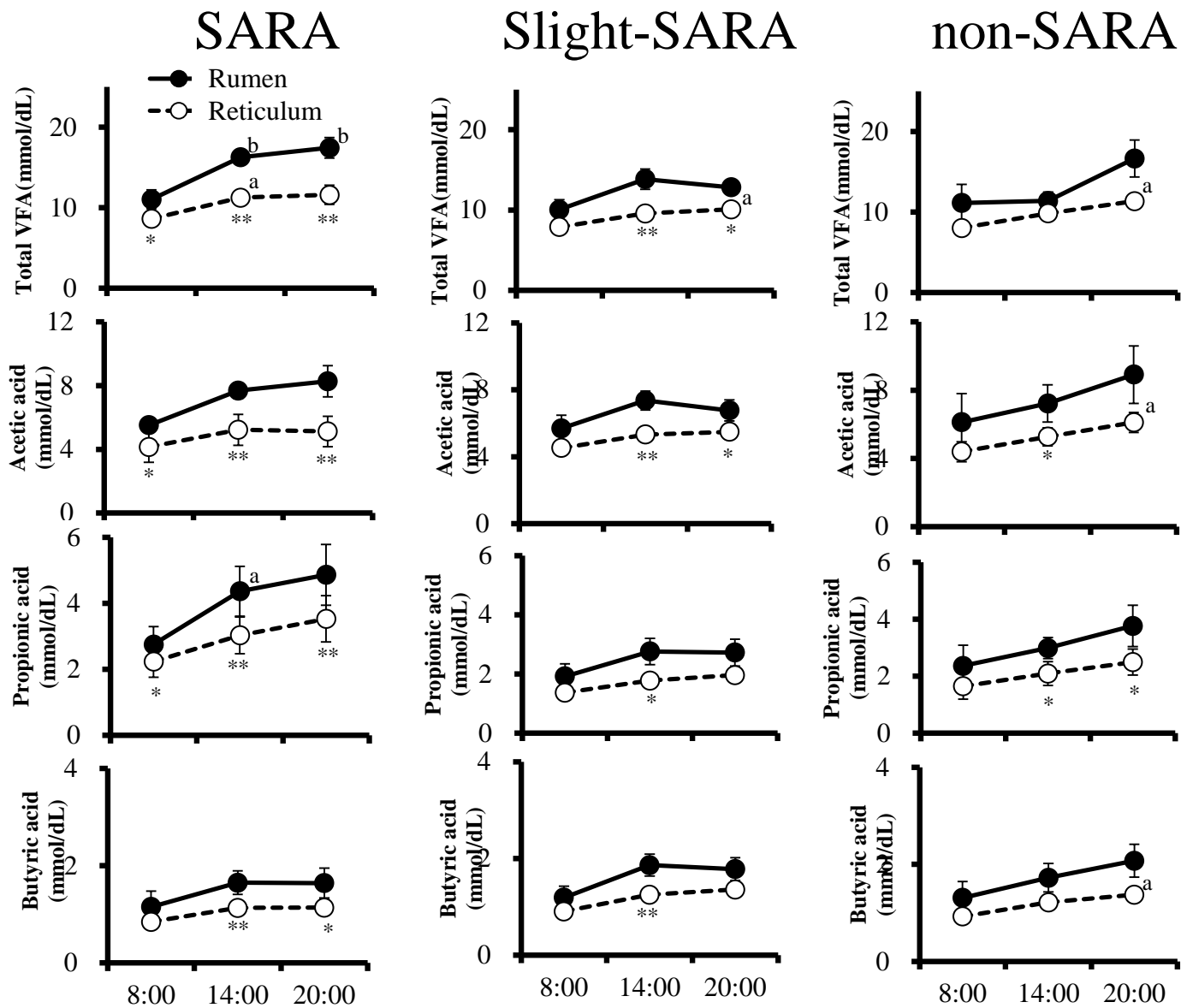


The reticular pH could be used to detect SARA cattle, as opposed to using the ruminal pH.

- Bacterial diversity and composition were similar in the rumen and reticulum, and were lower and simpler in concentrate-fed period.



Changes in bacterial composition of SARA cattle might be related to the decrease in number of bacteria that occur following marked changes in the ruminal and reticular pH.



Concentration of total VFA, acetic, propionic and butyric acid in the ruminal and reticular fluid of cattle with SARA, slight SARA and non-SARA. $M \pm SE$ (n=8), * $P < 0.05$, ** $P < 0.01$ (vs. rumen in the same time), ^a $P < 0.05$, ^b $P < 0.01$ (vs. 8:00 in the same site)