Effects of grazing on the structure and function of soil nematodes in a wet meadow rangeland.

Rafael Otfinowski, Victory Coffey, Ryan Nykvist
Department of Biology, University of Winnipeg

Wet meadow rangelands provide important ecosystem services that depend on the health of their soils. A growing human population and changing climate continue to increase grazing pressures on marginal rangelands worldwide. We focus our research on soil nematodes, an abundant and functionally diverse group of soil invetebrates, to study the effect of grazing on soil health. Specifically, we tested whether morphological & metabolic traits of soil nematodes can be used as indicators of the physical and chemical changes in wet meadows following grazing.

HYPOTHESES

I. Grazing will alter the structure and composition of soil nematode communities.

II. Grazing will alter the traits of soil nematode communities.

III. Interactions between grazing and plants will affects traits of soil nematodes.

METHODS

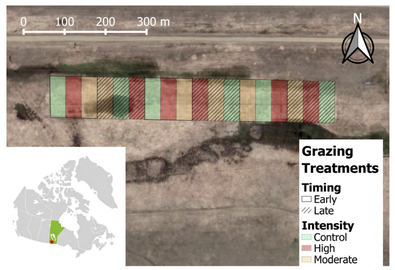

Figure 1. Wet meadow grassland (Brandon, MB). Each plot (0.17 ha) was assigned one of three grazing intensities (High, Moderate, Control) & one of two grazing periods (Early, Late).

Table 1. Dominant nematode genera used to calculate community weighted traits.

	Genera
1	*Tylenchus*
2	*Tylenchorhynchus*
3	*Acrobeloides*
4	*Filenchus*
5	*Nothotylenchus*
6	*Metateratocephalus*
7	*Prismatolaimus*
8	*Eucephalobus*
9	*Criconemella*
10	*Acrobeles*
11	*Aphelenchoides*
12	*Mesorhabditis*
13	*Plectus*
14	*Teratocephalus*
15	*Panagrolaimus*

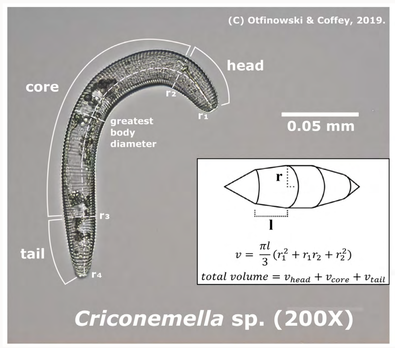

Figure 2. Morphological traits of nematodes (length, volume, mass) measured from images. Metabolic traits (body/esophagus length, gonad number) were collected from literature.

RESULTS

Table 2. Community weighted means (± S.D.) of morphological & metabolic traits of soil nematodes in a grazed wet meadow grassland (DOF 2, 69).

	EARLY			LATE			Intensity		Timing		Intensity:Timing	
	Control	Moderate	High	Control	Moderate	High	F value	p-value	F value	p-value	F value	p-value
Average length (mm)	0.40 ± 0.05	0.40 ± 0.03	0.43 ± 0.05	0.39 ± 0.06	0.41 ± 0.03	0.42 ± 0.06	2.04	0.138	0.08	0.782	0.82	0.443
Average GBD (mm)	0.016 ± 0.003	0.017 ± 0.002	0.018 ± 0.002	0.016 ± 0.003	0.017 ± 0.002	0.018 ± 0.003	3.09	0.052	0.001	0.979	0.20	0.819
Average volume (pL)	74.4 ± 25.5	84.1 ± 24.2	95.3 ± 29.9	86.1 ± 33.4	81.8 ± 15.6	90.2 ± 31.9	1.38	0.260	0.05	0.826	0.64	0.529
Average mass (ng)	33.8 ± 11.6	38.2 ± 11.0	43.3 ± 13.6	39.1 ± 15.2	37.2 ± 7.1	40.9 ± 14.5	1.38	0.260	0.05	0.825	0.64	0.530
Average b-ratio	4.47 ± 0.42	4.40 ± 0.47	4.61 ± 0.68	4.17 ± 0.56	4.56 ± 0.31	4.50 ± 0.54	1.26	0.291	0.52	0.475	1.28	0.285
Number of gonads	1.2 ± 0.2	1.1 ± 0.2	1.2 ± 0.3	1.1 ± 0.2	1.2 ± 0.2	1.2 ± 0.3	0.62	0.541	0.95	0.333	1.34	0.270

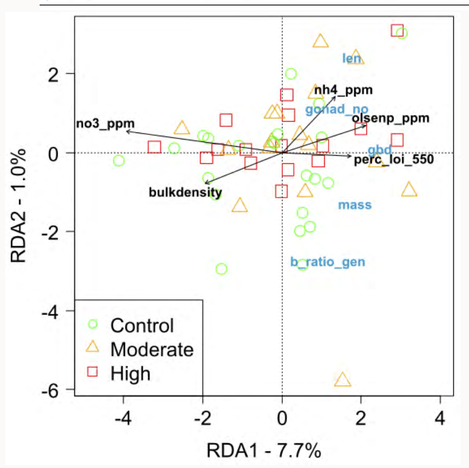

Figure 3. Redundancy analysis of nematode traits (blue vectors) constrained by soil variables (black vectors) for grazing treatments. Nematode traits: total body length, greatest body diameter, total body mass, number of gonads, body length/esophagus length. Soil parameters: bulk density, phosphorus, nitrate & ammonium nitrogen, loss on ignition carbon. (RDA 1: F=4.04, p=0.359; RDA 2: F=0.51, p=0.995).

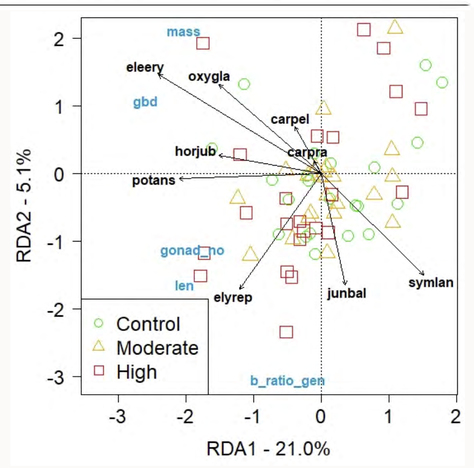

Figure 4. Redundancy analysis of nematode traits (blue) constrained by the abundance of dominant plants (black vectors). Nematode traits: total body length, greatest body diameter, total body mass, number of gonads, body length/esophagus length. Dominant plants: Potentilla anserina, Hordeum jubatum, Elymus repens, Eleocharis erythropoda, Oxybasis glauca, Juncus balticus, Symphyotrichum lanceolatum, Carex pellita, C. praegracilis. (RDA 1: F=19.21, p=0.003; RDA 2: F=4.66, p=0.584).

SIGNIFICANCE

- Community weighted means of nematode morphological and metabolic traits were not affected by the intensity or timing of grazing.
- Community weighted means of nematode morphological and metabolic traits were not affected by soil variables.
- Changes in the community weighted means of nematode traits were more strongly related to vegetation.
- Nematodes signal changes in the function of wet meadow related to the effect of grazing on dominant plants.
- Sustainable grazing of wet meadow rangelands will require measuring belowground plant traits to link the effect of grazing on soil foodwebs.

REFERENCES

1. Brown S, Pedley KC, Simcock DC. 2016. Estimation of surface area and volume of a nematode from morphometric data. Scientifica 2016.
2. Bongers, T. 1988. De Nematoden van Nederland, Utrecht, Koninklijke Nederlandse Naturrhistorische Vereniging.
3. Olsen SR, Cole CV, Watanabe FS, Dean LA. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Department of Agriculture circular 939.
4. Maynard DG, Kalra YP. 1993. Nitrate and exchangeable ammonium nitrogen. In: Carter MR (ed) Soil sampling and methods of analysis. CRC Press, Boca Raton.
5. Nelson DW, Sommers LE. 1996. Total carbon, organic carbon, and organic matter. In: Sparks DL (ed) Methods of soil analysis: part 3 - chemical methods. Soil Science Society of America and American Society of Agronomy, Madison.

ACKNOWLEDGEMENTS
We thank the Manitoba Beef and Forage Initiatives (MBFI) for their logistic and in-kind assistance with the project. We especially acknowledge Jane Thornton, Kim Wolfe, Mary-Jane Orr, Kristelle Harper, Leah Rodvang, and Dr. Stephen Crittendon (AAFC) for their help. Additional funding was provided by The University of Winnipeg and the CAP Manitoba Ag Action Plan.