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Using NIRS to identify rodent species from fecal pellets

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BACKGROUND

Small rodents are central for boreal and arctic ecosystem functioning and resilience. With the ongoing acceleration of environmental change in northern terrestrial ecosystems, large-scale monitoring and research efforts become ever more important. Yet, methods for monitoring small rodent species are laborious and costly. Non-invasive, more time and cost-effective methods are therefore highly needed.

RESEARCH QUESTION: Can readily available traces of small rodent presence, fecal pellets, be used to identify species and sex by means of near-infrared reflectance spectroscopy (NIRS)?

METHODS

We compiled a spectral library of over 1300 individual fecal pellets using NIRS. The pellets were dissected from nearly 500 trapped rodent individuals, representing a sub-arctic rodent guild of five species, i.e. both female and male *Lemmus lemmus*, 2 *Microtus* and 2 *Myodes* species. Animals were trapped across a heterogeneous landscape, during a full population cycle. NIR-spectra were recorded using a FieldSpec 3 (Fig.1, ASD Inc., Boulder, Colorado, USA) as reflectance in the 350-2500nm range (Fig. 2).

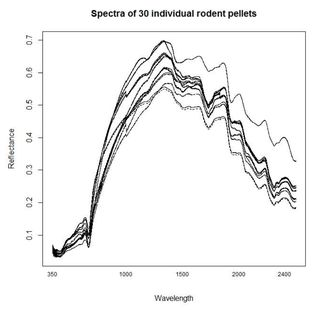

Figure 1&2. FieldSpec3 and raw spectra of 30 individual pellets.

The spectra were analyzed using multivariate adaptive regression splines (MARS), where we applied a hierarchical approach (see Fig. 3). The models were validated both internally (10-fold cross-validation) and externally, against a subset of original data not included in building the model.

In addition, we tested if fecal scans of pellets being exposed to 1 to 6 weeks of weathering still provide information on species identity.

Finally, we assess if diet is distinctly different between the small rodent species, possibly confounding the identification of species and sex and hence reducing the prediction accuracy (work in process).

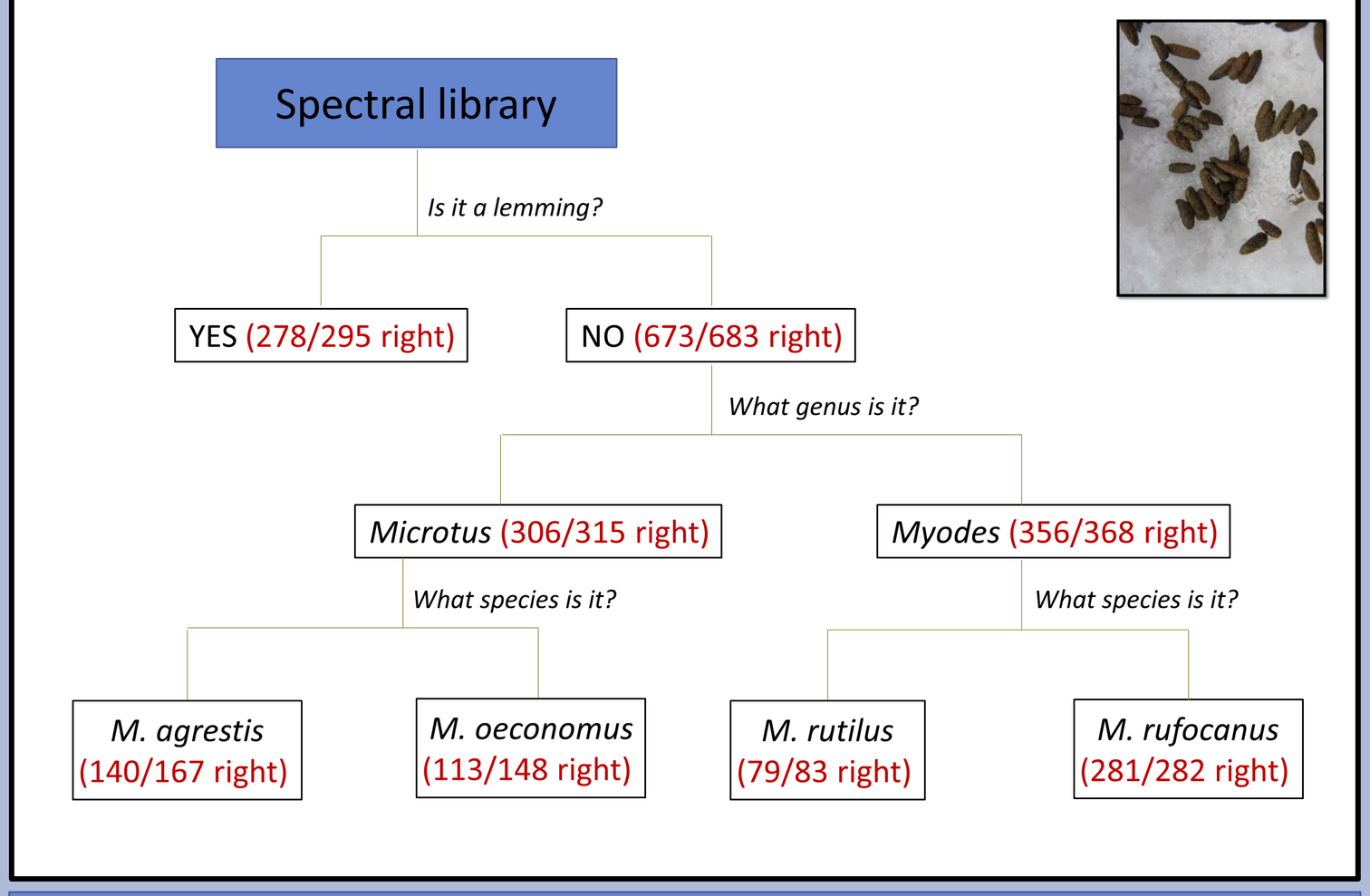

Figure 3. Prediction accuracy of the calibration model (n=968) for rodent species identity. Results for external validation (n=340) are similar, indicating model robustness and a high accuracy for species identification.

RESULTS

NIRS predicted rodent genus identity as well as **species identity** for *L. lemmus* and *Myodes* sp. with high accuracy (94,2-99,6%). Model performed acceptably for the 2 ecologically similar *Microtus* species (83,8% and 76,4%). The proportions of misclassified individuals in the full model seem to be evenly distributed accross weathering weeks (results not shown).

Weathering decreased accuracy considerably (Fig. 4). Calibration based on intestinal samples only was not able to predict species identity of the weathered samples. Inclusion of weathered samples in the calibration model is therefore necessary for field applications. Interestingly, the loss of accuracy seems to saturate after 2-4 weeks.

Internal cross-validation of the calibration models indicated good prediction accuracy for **sex**. However, external validation resulted in even odds, possibly because the sample size (ca. 50/species) was not sufficient.

A	Llem	Micr	Myod	Mruf	Mrut	Magr	Moec
Llem	100						
Micr		100					
Myod		1.1	98.9				
Mruf				100			
Mrut					100		
Magr						86.6	13.4
Moe						14	86

B	Llem	Micr	Myod	Mruf	Mrut	Magr	Moec
Llem	74	26					
Micr		96	4				
Myod		24	76				
Mruf				88	12		
Magr						88	12
Moe						80	20

C	Llem	Micr	Myod	Mruf	Mrut	Magr	Moec
Llem	56.3	43.7					
Micr		96	4				
Myod		12	88				
Mruf				92	8		
Magr						96	4
Moe						96	4

D	Llem	Micr	Myod	Mruf	Mrut	Magr	Moec
Llem	48	52					
Micr		94.4	5.6				
Myod		24.4	75.6				
Mruf				84.4	15.6		
Magr						100	
Moe						100	0

Figure 4. Effect of weathering on predictions (column-wise, as % of analyzed samples) when calibration is based on intestinal samples. 4A = intestinal samples ; 4B-D = 2, 4 and 6 weeks of weathering, respectively.

CONCLUSIONS

Fecal NIRS has previously been used to identify species and sex of large mammalian herbivores (e.g. Tolleson et al. 2005, Wiedower et al. 2012). Our results indicate that NIRS can accurately predict rodent species from feces. Moreover, we demonstrate the methods versatility for analyzing extremely small samples and accuracy despite high environmental variation in animal condition and diet. Fecal NIRS appears a promising method for cost-efficient monitoring and research of rodent populations.

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Literature

Tolleson et al. 2005. Determination of sex and species in red and fallow deer by near infrared reflectance spectroscopy of the faeces. *Small Ruminant Research* 57 Vol.2-3:141-150.

Wiedower et al. 2012. Fecal Near Infrared Spectroscopy to Discriminate Physiological Status in Giant Pandas. *PLoS ONE* 7 Vol. 6

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