



Use of novel computer-based footprint identification technology (FIT) for non-invasive monitoring of small mammals

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Introduction

Small mammal diversity can be a useful indicator of ecosystem integrity. The primary method for studying small mammals is live trapping. It is however labor-intensive and invasive for the animals. Track tunnels have been used to determine small mammal communities, but one of the challenges of this method is the difficulty of differentiating tracks from similar species. We present preliminary findings on the potential of a novel computer-based footprint identification technology (FIT) to distinguish among three abundant yet difficult to separate species (*Apodemus sylvaticus*, *Apodemus flavicollis* and *Mus musculus*).



Fig. 1: *Apodemus flavicollis*

Methods

We collected 5,947 footprints from 71 known individuals of the three species, photographed them and digitally marked seven landmark points (paw pads) using the FIT add-in, developed by WildTrack, in JMP statistical software. Using an automated script we generated 185 variables in the form of distances, angles and areas. Using a stepwise function in JMP we used 10 variables with the highest F-ratios using Linear Discriminant Analysis. The species identification performance of the best models for front and rear tracks was assessed using a subset of the individuals as testing dataset.



Fig.2: (A) Hind left *Apodemus flavicollis* footprint (with 7 landmark points marked)
(B) Front left *Apodemus flavicollis* footprint (with 7 landmark points marked)
(C) Trackplate with multiple footprints

Results

The resulting models exhibit clear distinction between the *Apodemus* and *Mus* genus (Fig. 3A & 3C), as well as between the more similar *Apodemus sylvaticus* and *Apodemus flavicollis* species (Fig. 3B & 3D). Furthermore the FIT program can correctly assign footprints to their species and genus at a very high precision rate (Table 1).

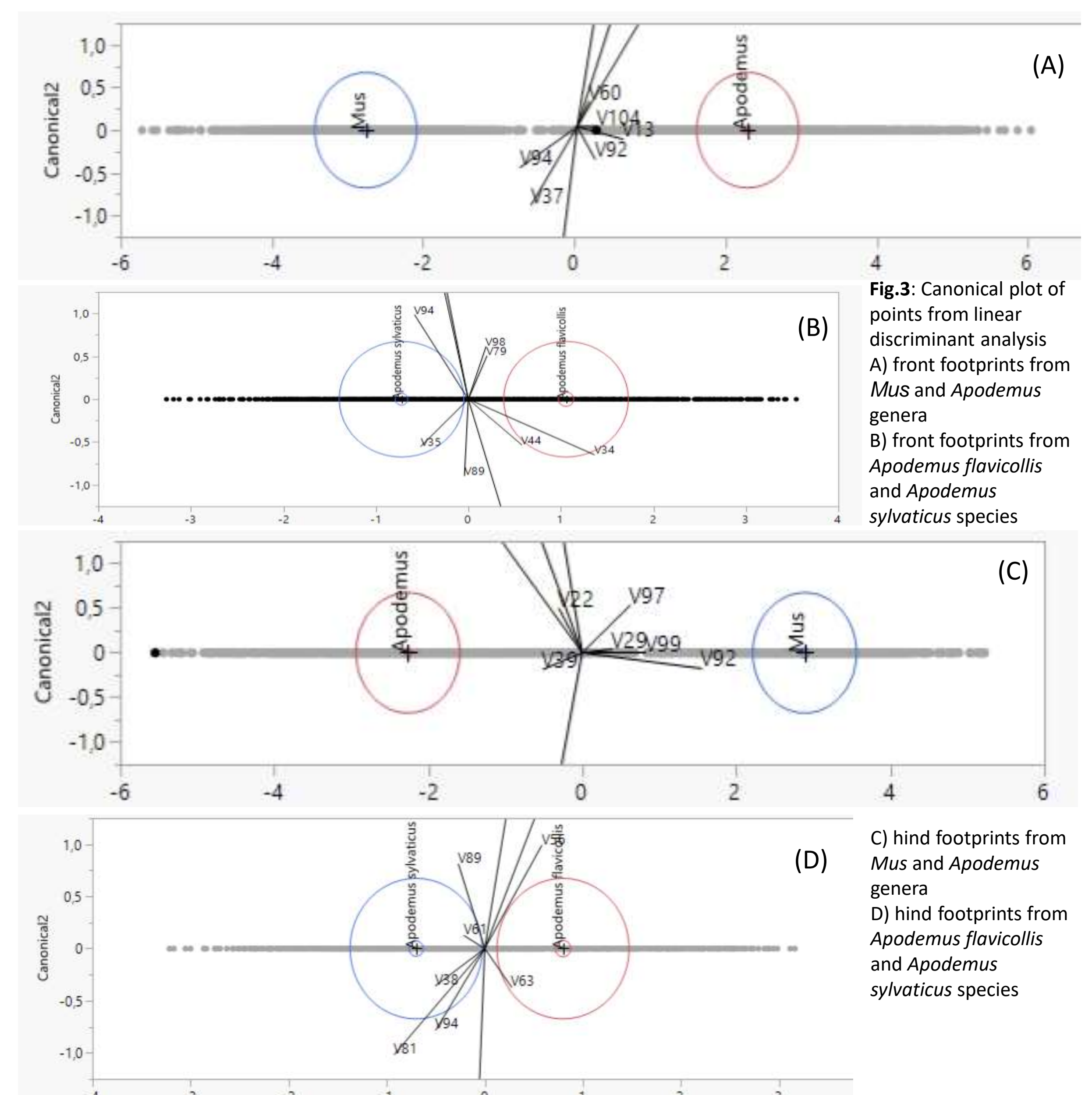


Fig.3: Canonical plot of points from linear discriminant analysis
A) front footprints from *Mus* and *Apodemus* genera
B) front footprints from *Apodemus flavicollis* and *Apodemus sylvaticus* species
C) hind footprints from *Mus* and *Apodemus* genera
D) hind footprints from *Apodemus flavicollis* and *Apodemus sylvaticus* species

Table 1: Predicted rates of identification by FIT

	Predicted Rate							
	Front		Front		Hind		Hind	
	Apodemus	Mus	Apodemus flavicollis	Apodemus sylvaticus	Apodemus	Mus	Apodemus flavicollis	Apodemus sylvaticus
Correct	0.988	0.999	0.756	0.777	0.984	0.998	0.768	0.834
False	0.012	0.001	0.244	0.223	0.016	0.002	0.232	0.166

Discussion – Recommendations

Our study highlights the potential for the footprint identification technology, a non invasive, time saving and user friendly method. We hope to make this a more common practice to help researchers by creating a more extensive and robust database.

By expanding the database and improving the species identification algorithms, differentiating small mammal species could be as easy as taking a photo of its tracks and using an app on your phone.



Fig.4: *Apodemus sylvaticus* being released. Photo by Christos Karoulis

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