Intraspecific functional diversity of common species enhances community stability

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Introduction

+ Diversity enhances ecological stability[1], and functional diversity is more important than species richness[1,2].

+ Common species are fundamental to the structure and function of their communities.

+ Intraspecific functional diversity (IFD) of common species is an important aspect of community stability.

+ Using two common small mammal species, the Deer Mouse (*Peromyscus maniculatus*) and the Southern Red-backed Vole (*Myodes gapperi*), we asked the following questions:

1| At what spatial scale do species respond to environment?

  + Landscape scale = high local variation = high local IFD

  + Local scale = low local variation = low local IFD

2| Does local IFD affect population stability?

  + Low local IFD = low population stability

3| What mechanisms explain patterns of IFD?

  + Internal filters increase trait variation

  + External filters decrease variation

Methods

+ Ten transects (450-1450m) spanning northern hardwoods, boreal forest, and alpine tundra in the northern Appalachian Mountains

+ Trap grids randomly located within each habitat type; sampled over two summers

+ Hair samples analyzed for ^{15}N and ^{13}C isotope signatures

1| + Modeled $\delta^{15}N$ and $\delta^{13}C$ at landscape and local scale with linear regression

2| + Compared abundance between years with Chi-square tests

3| + Used T-statistics[3], which quantify the strength of environmental filters, to explain patterns of IFD

Left: Deer Mouse
Below: Bigelow Mountain, ME
Inset: Sampling locations
Photos: C.Wood

Results

1 + Mice respond locally to their environment; IFD is locally low

  + Voles respond at landscape and local scales; IFD is locally high

Functional Diversity of Mice	a-R^2	Scale
$\delta^{15}N$ weight + $\delta^{13}C$ + moss + h.stems	0.67	Local
habitat + weight + date	0.55	Landscape
$\delta^{13}C$ grass + BA(beech)	0.23	Local
habitat + weight + date	0.13	Landscape

Functional Diversity of Voles	a-R^2	Scale
$\delta^{15}N$ habitat + body length	0.39	Landscape
body length + grass + CWD	0.33	Local
$\delta^{13}C$ body condition + CWD + moss	0.48	Local
habitat + date	0.16	Landscape

Note: 16 models for each species at each scale were ranked by adjusted R^2; top models are shown.

Right: Southern Red-backed Vole
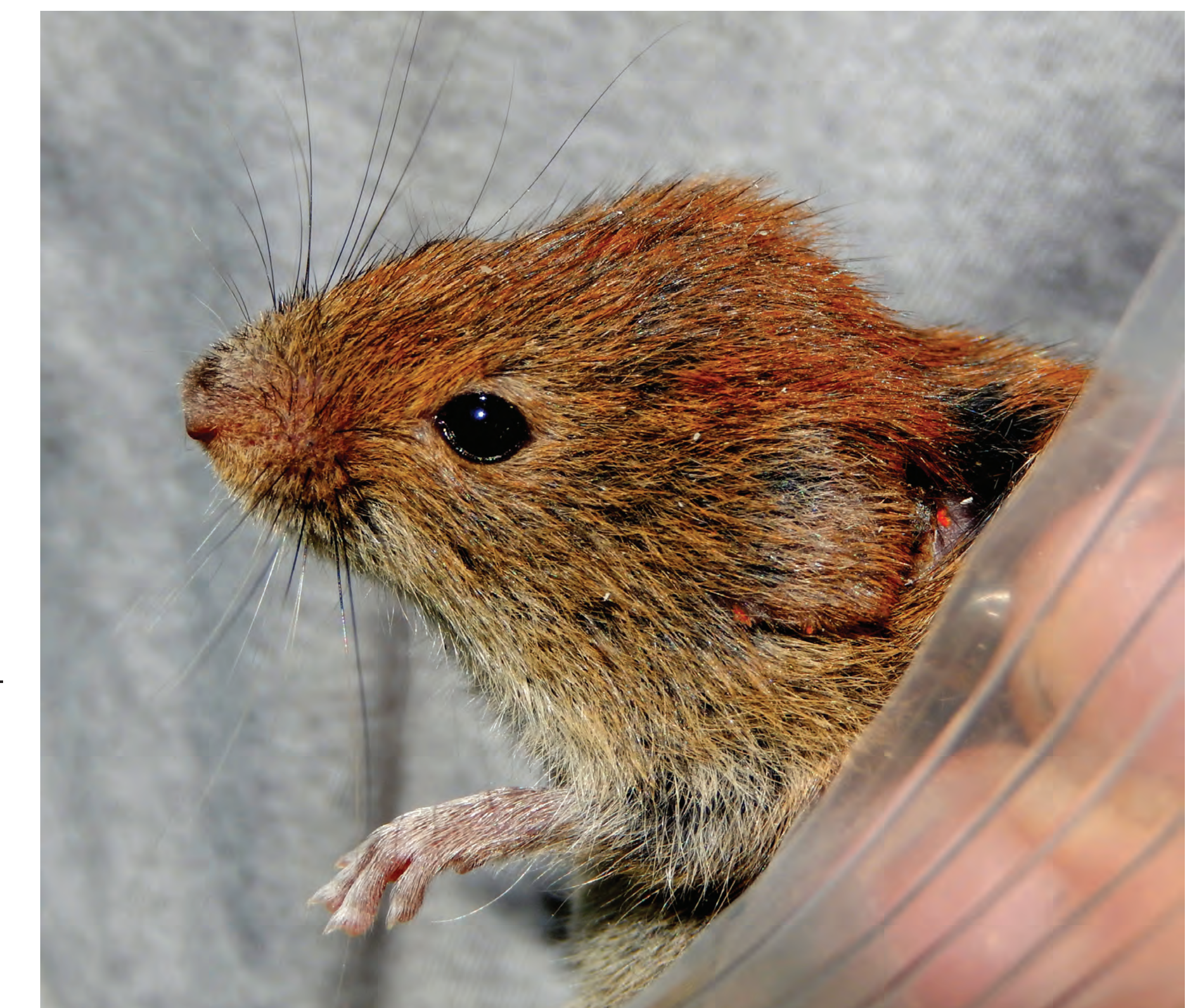
2 + Between years, mouse abundance decreased while vole abundance was similar
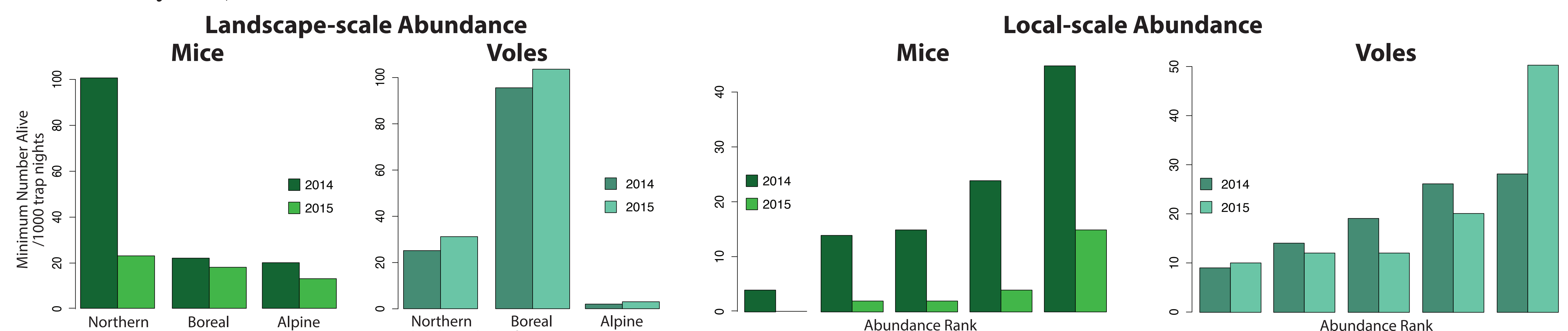
Note: Mouse abundance changed significantly between years (p=0.001); vole abundance did not (p=0.861).

Note: Abundance within optimal habitat, northern hardwoods for mice, boreal forest for voles. On average, mouse populations changed -84.5% and vole populations changed 3.1%.

3 + Mouse populations regulated by external filters, voles by internal filters

Internal Filters: $T_{IP/IC}$

Habitat	Species	$\delta^{15}N$	$\delta^{13}C$
N. Hardwoods	Mouse	0.79	0.75
	Vole	1.14	1.31
Boreal	Mouse	0.55	0.28
	Vole	0.61	0.82

External Filters: $T_{IC/IR}$

Habitat	$\delta^{15}N$	$\delta^{13}C$
N. Hardwoods	0.42	0.40
Boreal	0.68	0.97

Note:
$$T_{IP/IC} = \frac{var(\text{individuals in population})}{var(\text{individuals in community})} = \text{strength of internal filters}$$
$$T_{IC/IR} = \frac{var(\text{individuals in community})}{var(\text{individuals in region})} = \text{strength of external filters}$$
See (3) for further details.

Discussion

+ Mouse populations regulated by local factors (e.g. mast cycles[5]); vole populations regulated by local and landscape factors (e.g. food availability and density dependent factors[6]).

+ Deer mice are "generally specialized" (low local IFD); southern red-backed voles are "especially general"[4] (high local IFD).

+ Intraspecific functional diversity is manifested at different spatial scales by different species.

+ High local IFD contributes to population stability in a varying environmental.

+ Species resilient to environmental variability enhance community stability.

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References
1. K.S. McCann, *Nature* 405, 6783 (2000)
2. D. Tilman, J. Knops, D. Wedin, P. Reich, M. Ritchie, and E. Siemann, *Science* 277, 5330 (1997)
3. C. Violle, E.J. Enquist, B.J. McGill, L. Jiang, C.H. Albert, C. Hulshof, V. Jung, and J. Messier, *TREE* 27, 4 (2012)
4. J.E. Paterson, B.D. Steinberg, and J.D. Litzgus, *Can. J. Zoo.* 90, 2 (2012)
5. S.P. Elias, J.W. Witham, M.L. Hunter, *J. Mam.* 85, 4 (2004)
6. S.P. Elias, J.W. Witham, M.L. Hunter, *J. Mam.* 87, 3 (2006)