Measuring Niche Overlap in a Community of Invertebrate Eating Snakes

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Abstract

Competition for resources exerts significant influence in the structure of biological communities, particularly when species having similar habitat requirements are involved. Despite their widespread abundance and role as successful predators, there is a paucity of information about niche partitioning among snake species. The dietary ecology of invertebrate specialists, in particular, is difficult to study because of the relatively rapid digestion of prey. Using stable isotope analysis, we quantified the dietary niche overlap between five different species of invertebrate eating snakes (genera: *Coluber*, *Diadophis*, *Opheodrys*, and *Storeria*). We collected blood, scale, and tail tissue from wild-caught snakes, as well as a range of whole prey specimens to assess niche partitioning between species across a broad temporal scale. All samples were freeze-dried, homogenized, and analyzed using mass spectroscopy. We used an ANOVA to assess whether or not food-resource partitioning was present in this community. We discuss our findings as they pertain to the co-existence of these snakes in a single habitat. Similar analyses can reveal fine-scale shifts in diet that have the potential to alter the dynamics of the trophic web within a given community.

Introduction

- Interspecific competition can structure ecological communities, where sympatric species partition dietary resources [3].
- Quantifying the dietary ecology of invertebrate-eating snakes presents challenges because of their unique life-history traits and small body sizes [1].
- Stable isotope analysis is a relatively new technique used to examine niche overlap between species by comparing retained levels of carbon (C) and nitrogen (N) found in consumer tissues to those occurring in potential prey items.

Purpose

- We determined the degree of dietary niche overlap among five invertebrate-eating snake species (*Storeria dekayi*, *S. occipitomaculata*, *Diadophis punctatus*, *Opheodrys aestivus*, and *Coluber constrictor*) by comparing isotopic ratios of C^{13} and N^{15} across tissue types.
- We predicted that snake species of different genera would occupy different positions in isotopic space.

Methods

Study Area – Fox Ridge State Park (FRSP) in Coles Co., Illinois (Fig. 1).

Capture / Marking / Measuring

- We sampled snakes along an ecotone habitat using a combination of nine 100-m drift fences outfitted with pitfall and funnel traps (Fig. 1c), and daily visual encounter surveys from March – November 2012.
- We used sweep sampling to survey those invertebrate prey species not collected from the traps along the fences.
- Upon capture, we measured and marked all specimens and, where possible, obtained tail, scale, and blood tissue samples.

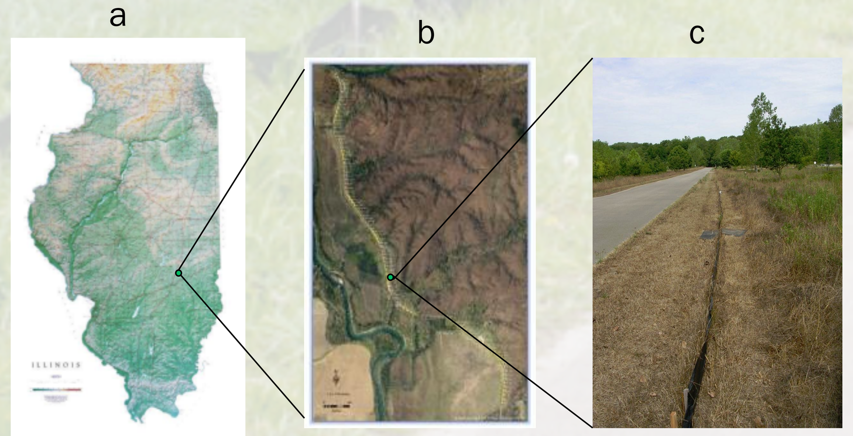

Fig. 1. Study site at FRSP: (a) locality within the state of Illinois; (b) locality of study site within FRSP; (c) drift fence array.

Stable Isotope Analysis

- We generated a uniform matrix of each freeze-dried sample using a cryogrinder, and then weighed out allotments ranging from 0.06–1.2 mg.
- We determined the C and N ratios of each sample using an isotope ratio mass spectrometer.

Statistical Analysis

- We used an ANOVA to detect differences in isotope ratios between species and tissues.
- A Bayesian mixing model in MixSIR was used to determine what percentage of each species diet was made up of the sampled prey items.

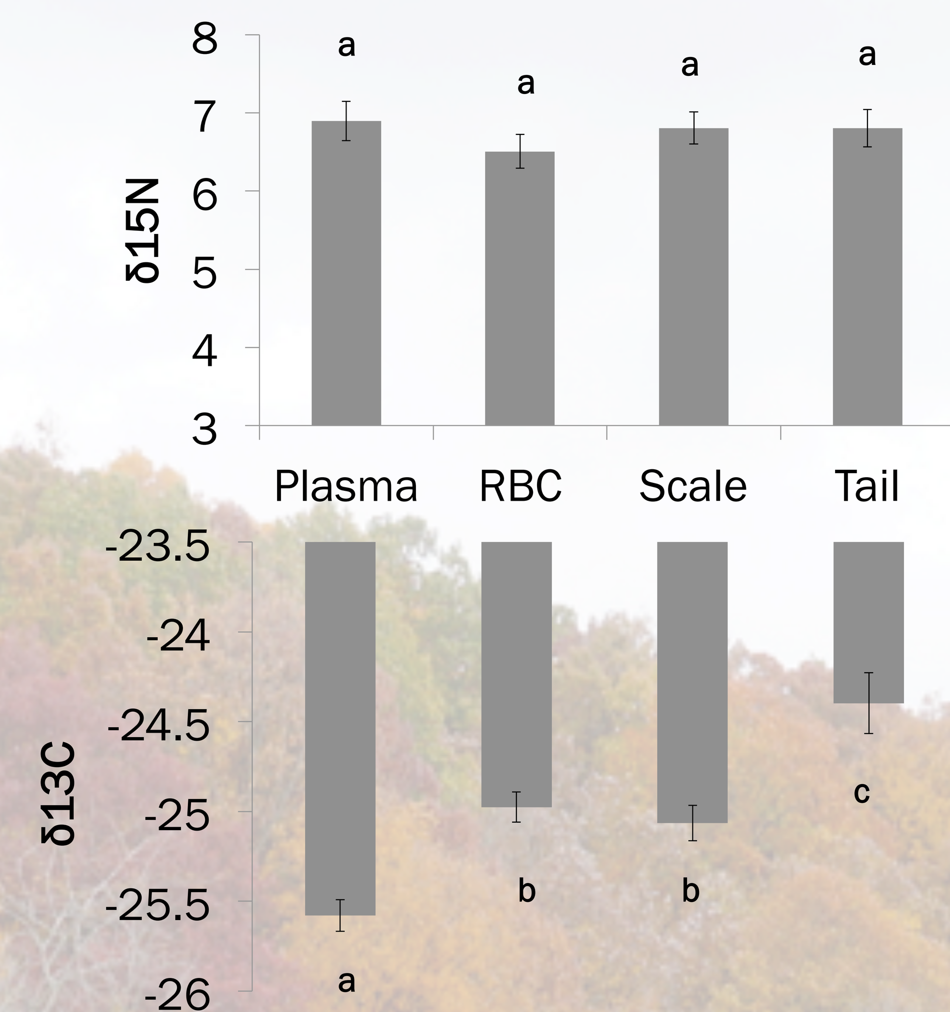

Fig. 2. Mean stable isotope values across tissue types in the 5 species of snakes sampled (RBC = red blood cells). Super-/subscripts of the same letter denote no differences between species' isotopic values.

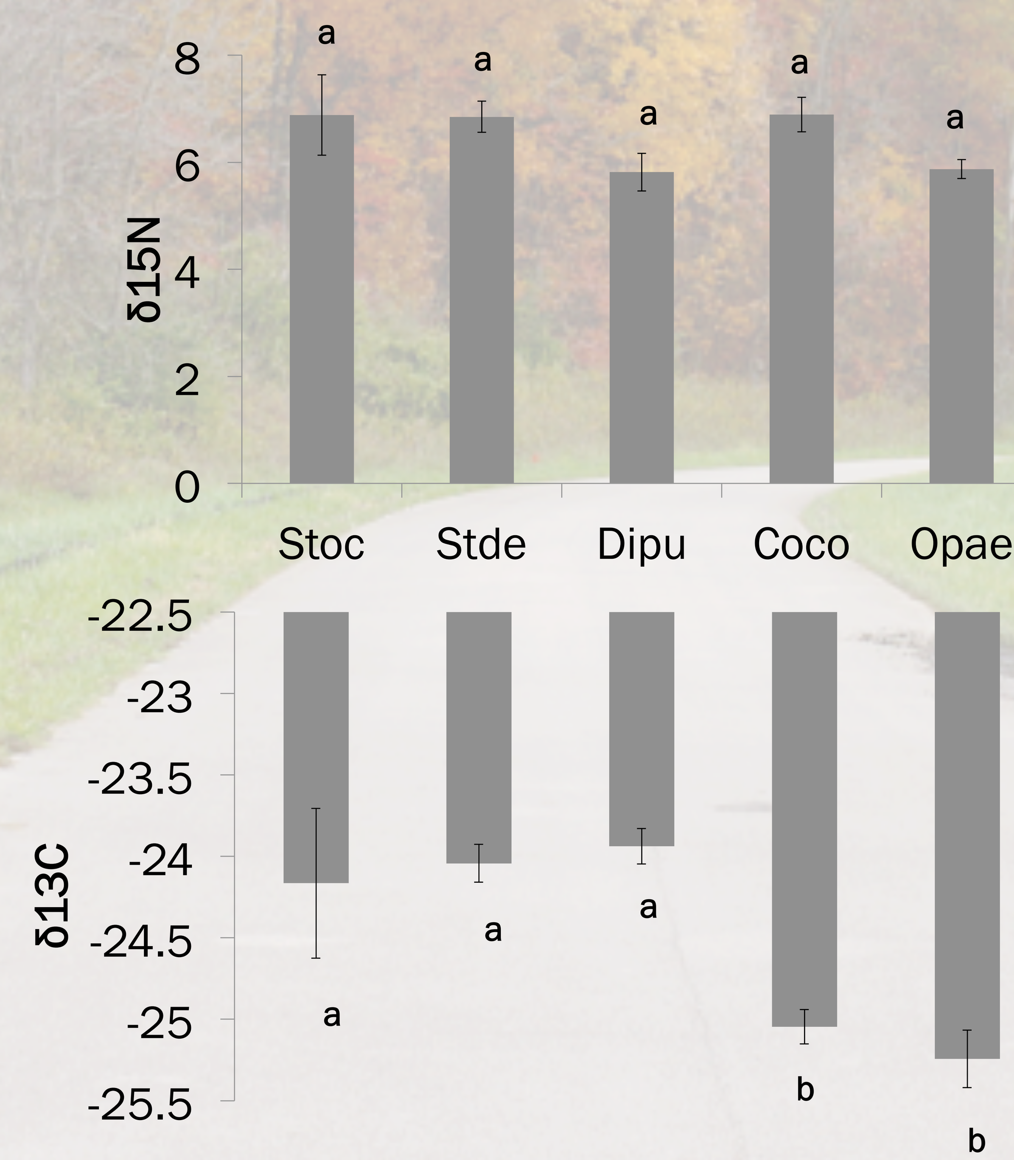

Fig. 3. Mean stable isotope values for C^{13} and N^{15} in 5 species of invertebrate eating snakes (Stoc = *Storeria occipitomaculata*, Stde = *S. dekayi*, Dipu = *Diadophis punctatus*, Coco = *Coluber constrictor*, and Opae = *Opheodrys aestivus*).

Results

- Snakes allocated nutrients across body tissues at different rates. Tissues varied in isotopic levels of C^{13} ($F = 10.84$, $p<0.01$), but not N^{15} ($F = 0.18$, $p = 0.67$; Fig. 2).
- Species varied in their isotopic values of C^{13} ($F = 7.26$, $p<0.001$), but not in their N^{15} isotopic values ($F = 0.42$, $p=0.79$; Fig. 3,4).
- The mixing models predicted that snails contribute the most to the diet of all five species (20 – 60 %).

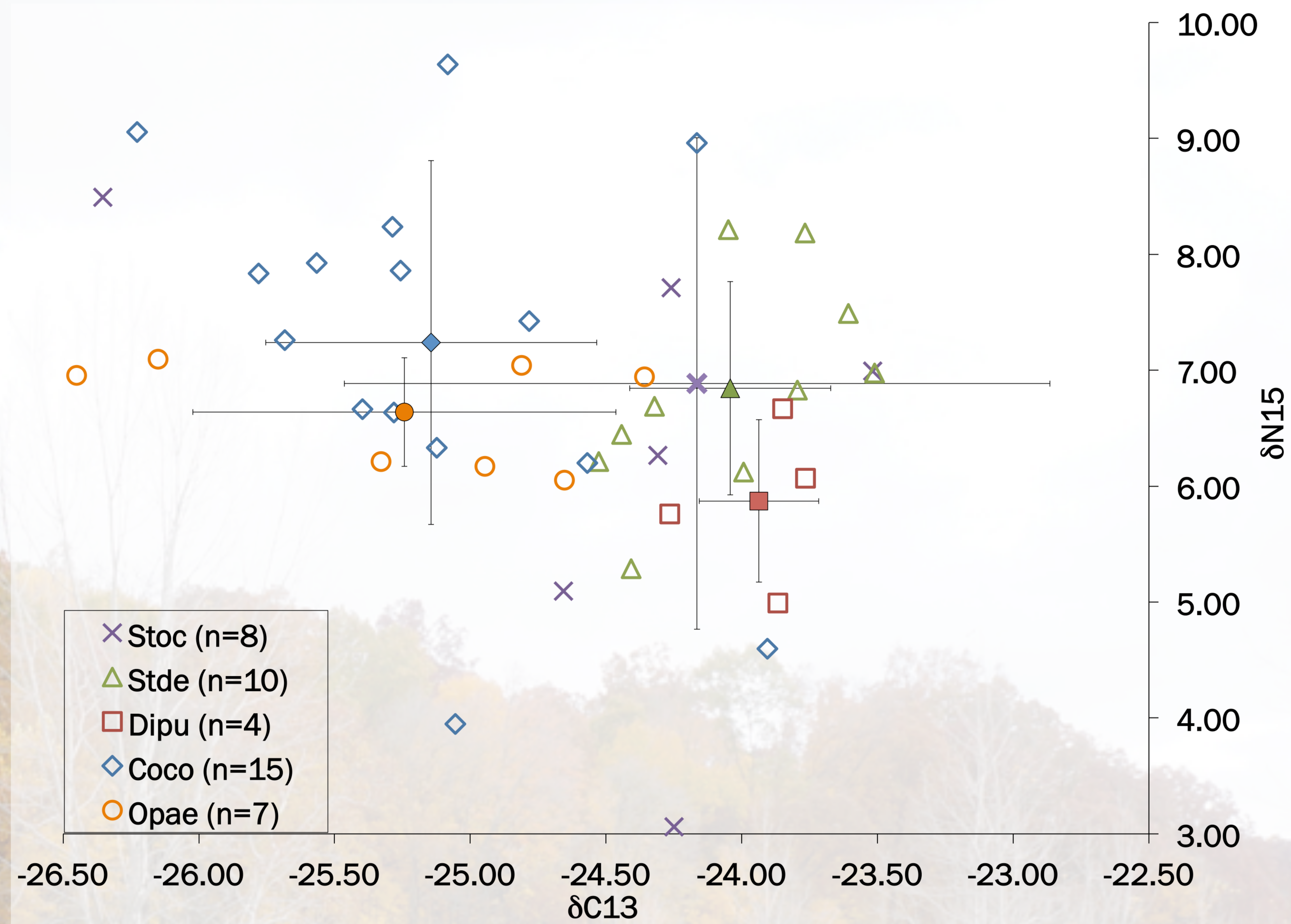

Fig. 4. Stable isotope values for C^{13} and N^{15} in five species of invertebrate eating snakes (species codes as in Fig. 3). Symbols without error bars represent individual data points, and symbols with error bars represent means ±1 standard deviation.

Discussion

- Despite differences in body morphology and behavior, the snake species we examined appear to be occupying the same trophic level.
- We suggest that niche partitioning is present in this community of invertebrate-eating snakes. The similarities in the ratios of C^{13} between leaf-litter specialists (*i.e.*, *Storeria dekayi*, *S. occipitomaculata*, and *Diadophis punctatus*), however, indicate that dietary partitioning is more closely associated with life-history traits, than phylogenetic ancestry [2].
- The mixing model predictions that snails contribute the most to the diets of these five snake species should be interpreted with caution, as gut contents, fecal samples, and previous literature indicates otherwise [4].
- We recommend that future research concerning snake dietary ecology incorporate the use of stable isotope analyses in an attempt to improve the understanding of the trophic positions occupied by various species.

Literature Cited

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Acknowledgments

We thank members of the EIU herpetology lab for their assistance, and the staff at FRSP and the Illinois Department of Natural Resources (IDNR) for logistical support and permitting. We are grateful to the University of Illinois – Energy Biosciences Institute for their assistance with stable isotope analyses. Partial funding was provided by IDNR and EIU's Department of Biological Sciences and the Graduate School.