Niche interests: the ecological niches of bats

Phillip J. Oelbaum
York University
5 November 2025

YORK U

My background

- Dalhousie University (2012-2016), BSc

  Dr. Hugh Broders – isotope ecology of bats at Lamanai, Belize

- University of Waterloo (2017-2019), MSc

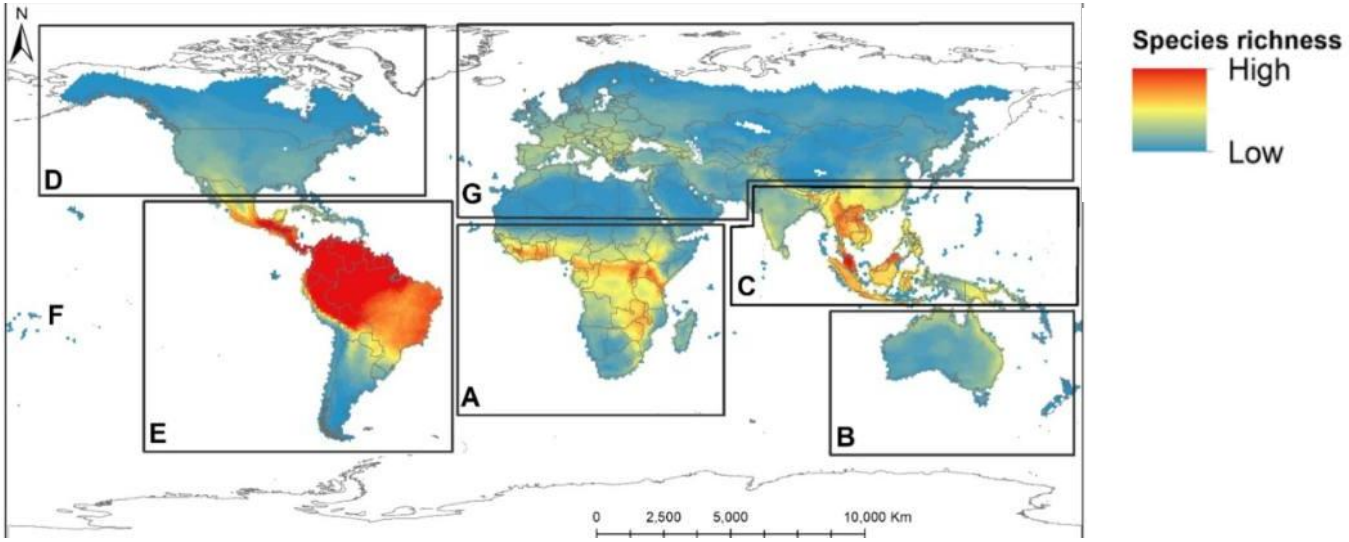
  Dr. Hugh Broders – isotope ecology of Neotropical bats

- University of Toronto (2020-2025), PhD

  Dr. Kenneth Welch – Niche occupancy, partitioning, and the role of trophic flexibility in coexistence of Neotropical bats

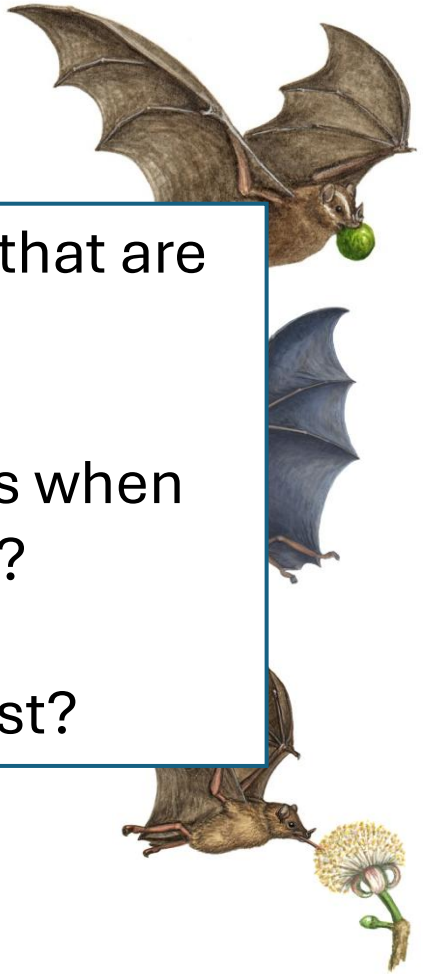
Bats are Diverse

- +1500 species of bat (Simmons and Cirranello 2025)
- Form diverse communities (particularly in the Neotropics)



Martinez-Foneseca et al. (2024)

Photographs by José Gabriel Martínez-Fonseca



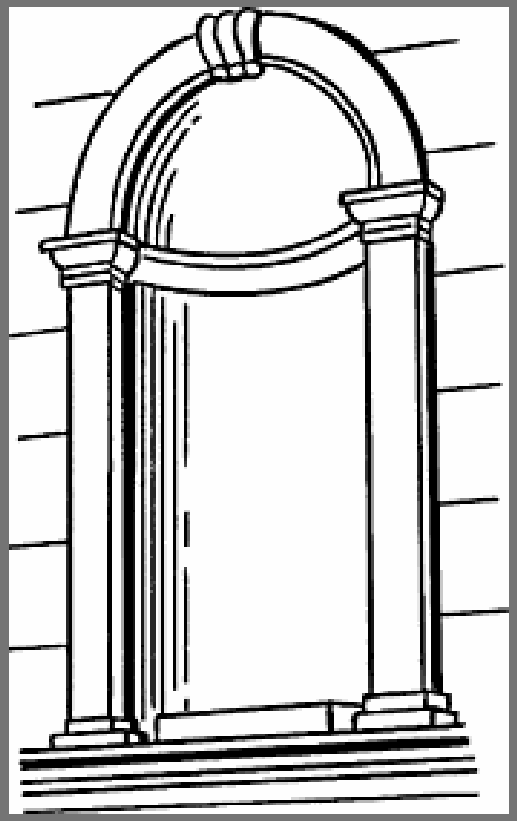
What is the role of trophic flexibility in bats that are specialized?

How do similar species partition their diets when they occupy the same trophic guilds?

How do so many similar species coexist?

Photographs by José Gabriel Martínez-Fonseca
Artwork by Fiona A. Reid

What is a niche?



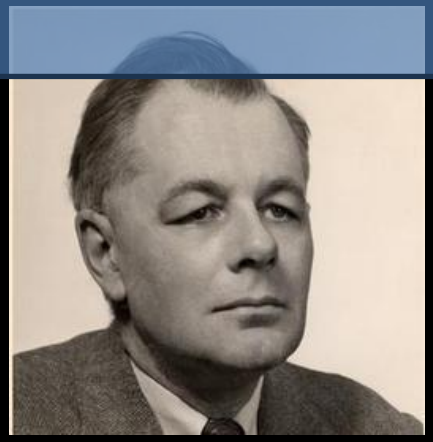
“Nitch”

Niche concepts

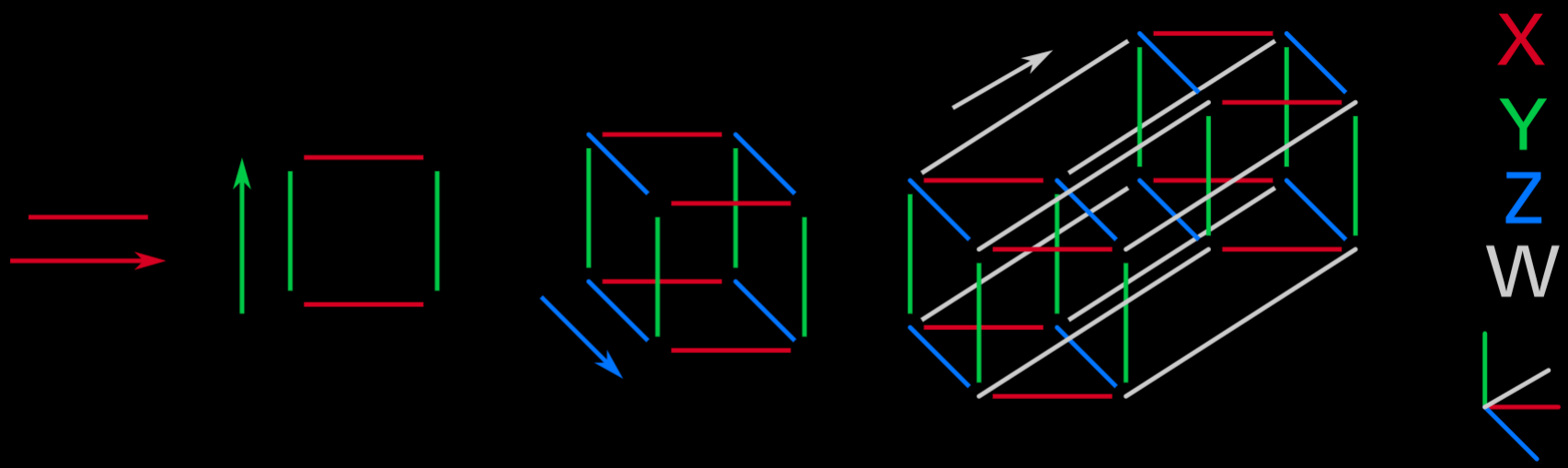
Grinnellian Niche (1917)**:** the niche of a species is encompassed by the habitat in which it is found and its behaviour

Eltonian Niche (1927): the place of an organism in relation to its food and its enemies

Hutchinsonian Niche: the *n* – dimensional hypervolume which defines all axes in which an organism exists in its environment



Hutchinsonian niche



All species exist within *n*-dimensions

The more dimensions you examine, the better the resolution

Typically applied at the population level

Hutchinsonian niche

Biology & Philosophy (2022) 37: 25
https://doi.org/10.1007/s10539-022-09849-y

Check for updates

Hutchinson's ecological niche for individuals

Elina Takola[1] · Holger Schielzeth[1]

Received: 6 April 2021 / Accepted: 2 April 2022 / Published online: 23 June 2022

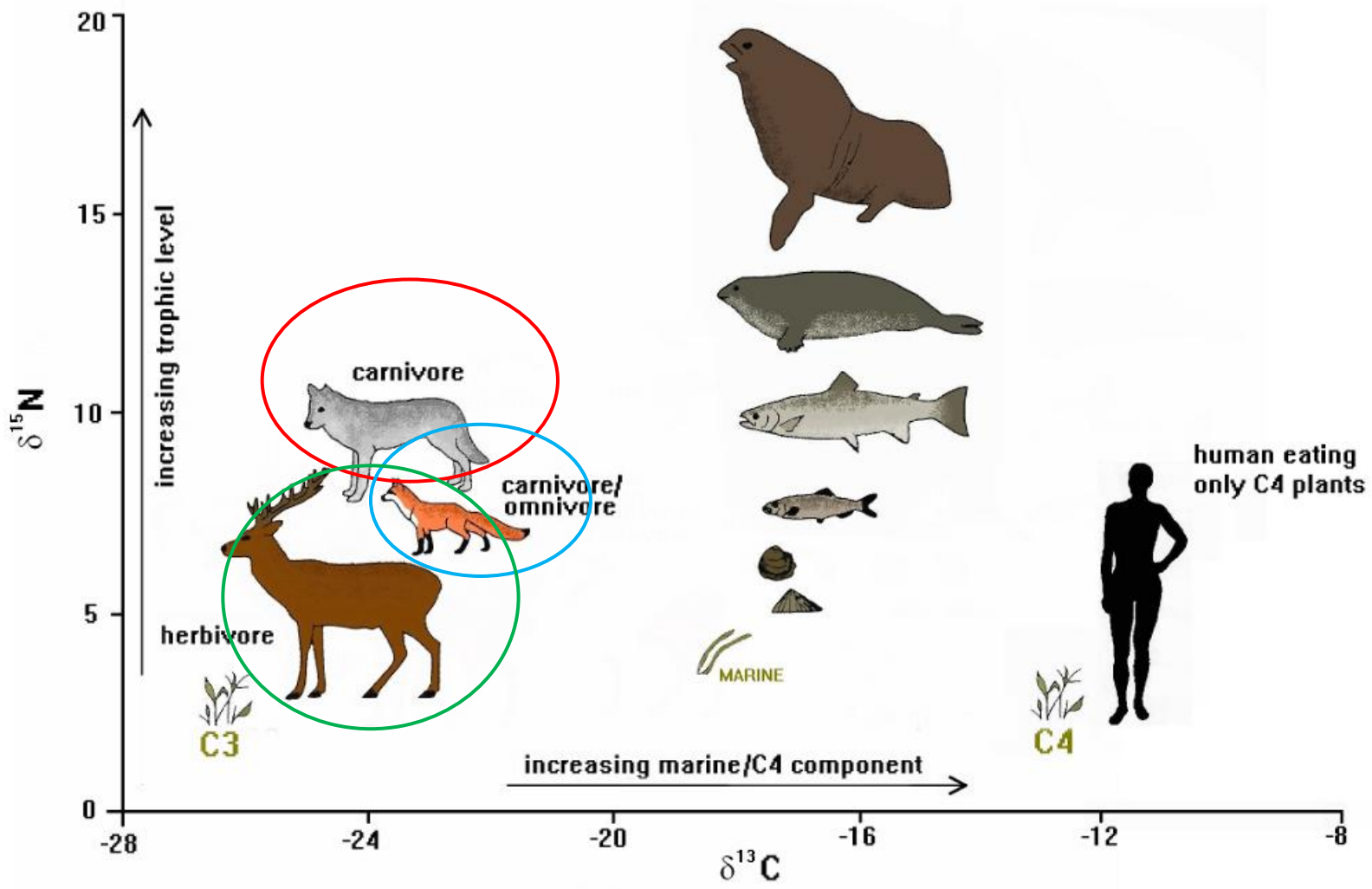
Hutchinsonian niche

- Movement (foraging, migration)
  - Range
- Diet
  - Categorizing what animals eat is often easy
  - Quantifying it less so…
- Roosting
- Environment
  - Temp/humidity

Hutchinsonian niche

Stable Isotope Analysis

Stable Isotope Analysis



(Schulting 1998)

animals

MDPI

How do we use these metrics to examine shared niches across various ranges?

How do animals in the same communities partition resources if they are foraging together?

$\delta^{34}S$

Movements of Bats

- Nightly movements
- Seasonal migrations

Foraging Range

- Most bats forage close to home, but still capable of long-distance movements

Carollia perspicillata
approx. 500m

Artibeus lituratus
approx. 1.3km

Glossophaga soricina
approx. 3.1km

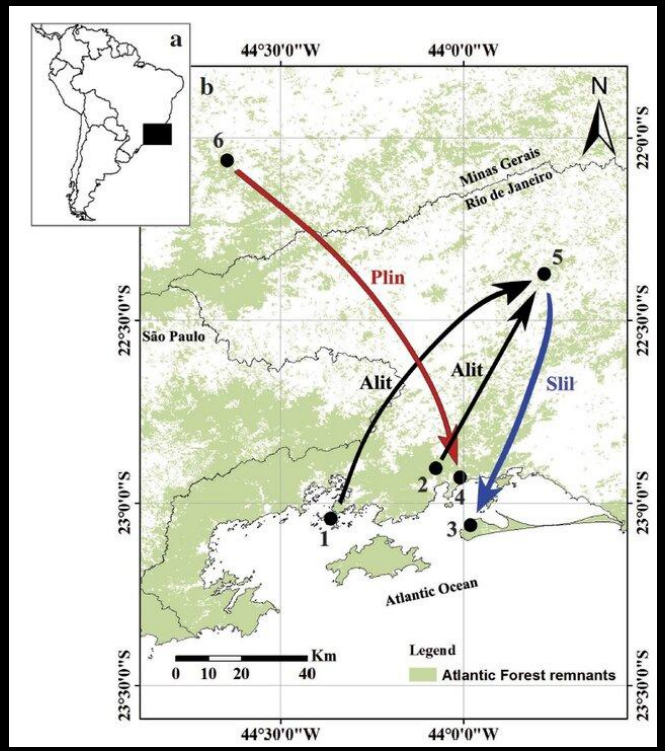
(Trevellin et al. 2013; Aguillar et al. 2014)

Foraging Range

- Most bats forage close to home, but still **<u>capable of long-distance movements</u>**

Artibeus lituratus
approx. 1.3km

Longest recorded distance is **113km**



(Esberard et al. 2017)

Foraging Range

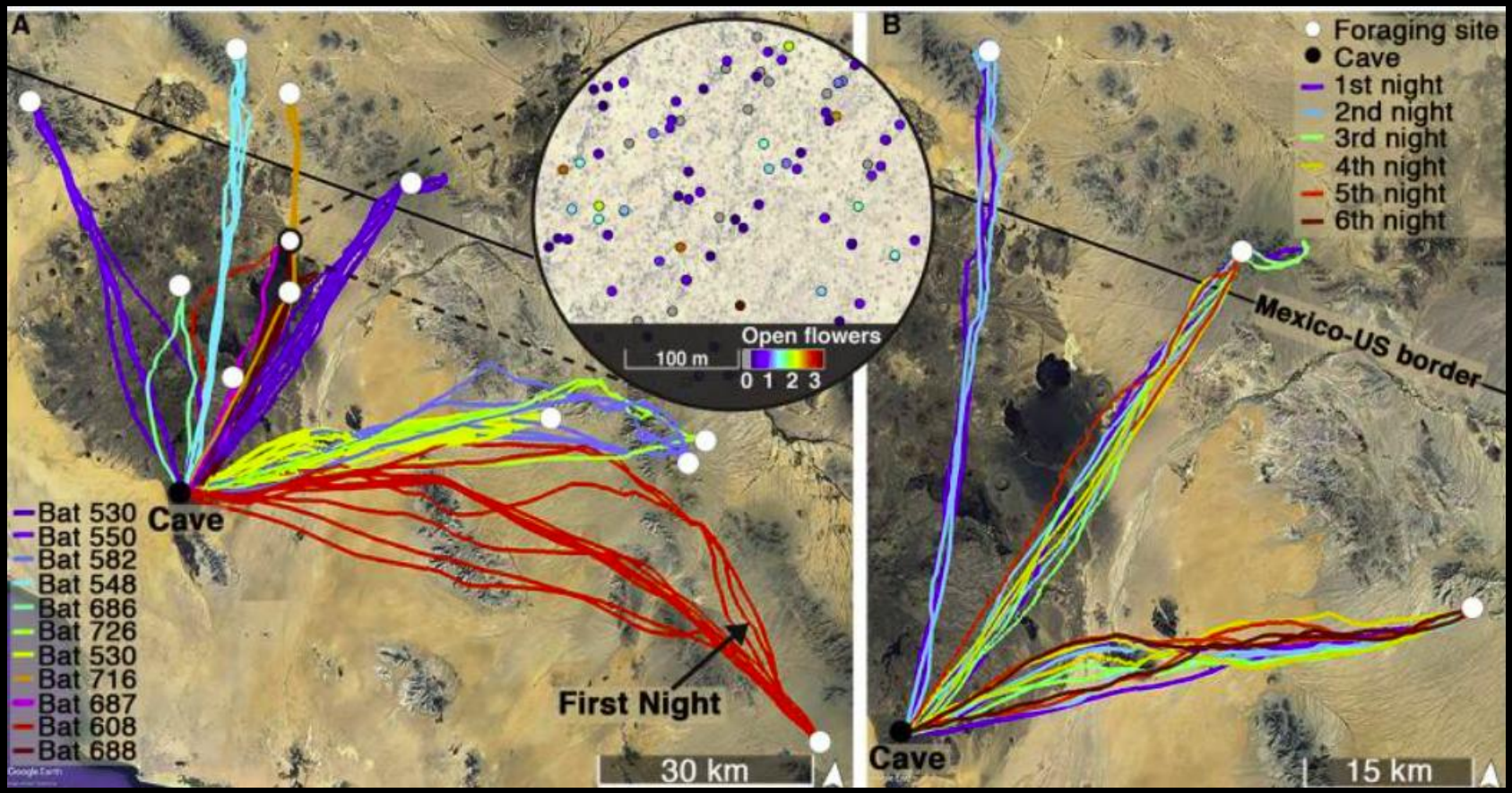
Leptonycteris yerbabuenae
Lesser long-nosed bat
20g, wingspan approx. 25cm

Journal of Mammalogy, 99(2):306–311, 2018
DOI:10.1093/jmammal/gyy016
Published online February 28, 2018

Follow me: foraging distances of *Leptonycteris yerbabuenae* (Chiroptera: Phyllostomidae) in Sonora determined by fluorescent powder

Rodrigo A. Medellin,* Marina Rivero, Ana Ibarra, J. Antonio de la Torre, Tania P. Gonzalez-Terrazas, Leonora Torres-Knoop, and Marco Tschapka

Foraging Range



Over 200km round trip in one night!!!!

(Goldshtein et al. 2020)

PLOS ONE

RESEARCH ARTICLE

Carbon ($\delta^{13}C$) and Nitrogen ($\delta^{15}N$) Stable Isotope Signatures in Bat Fur Indicate Swarming Sites Have Catchment Areas for Bats from Different Summering Areas

Jordi L. Segers, Hugh G. Broders*

Department of Biology, Saint Mary's University, Halifax, Nova Scotia, Canada

* hugh.broders@smu.ca

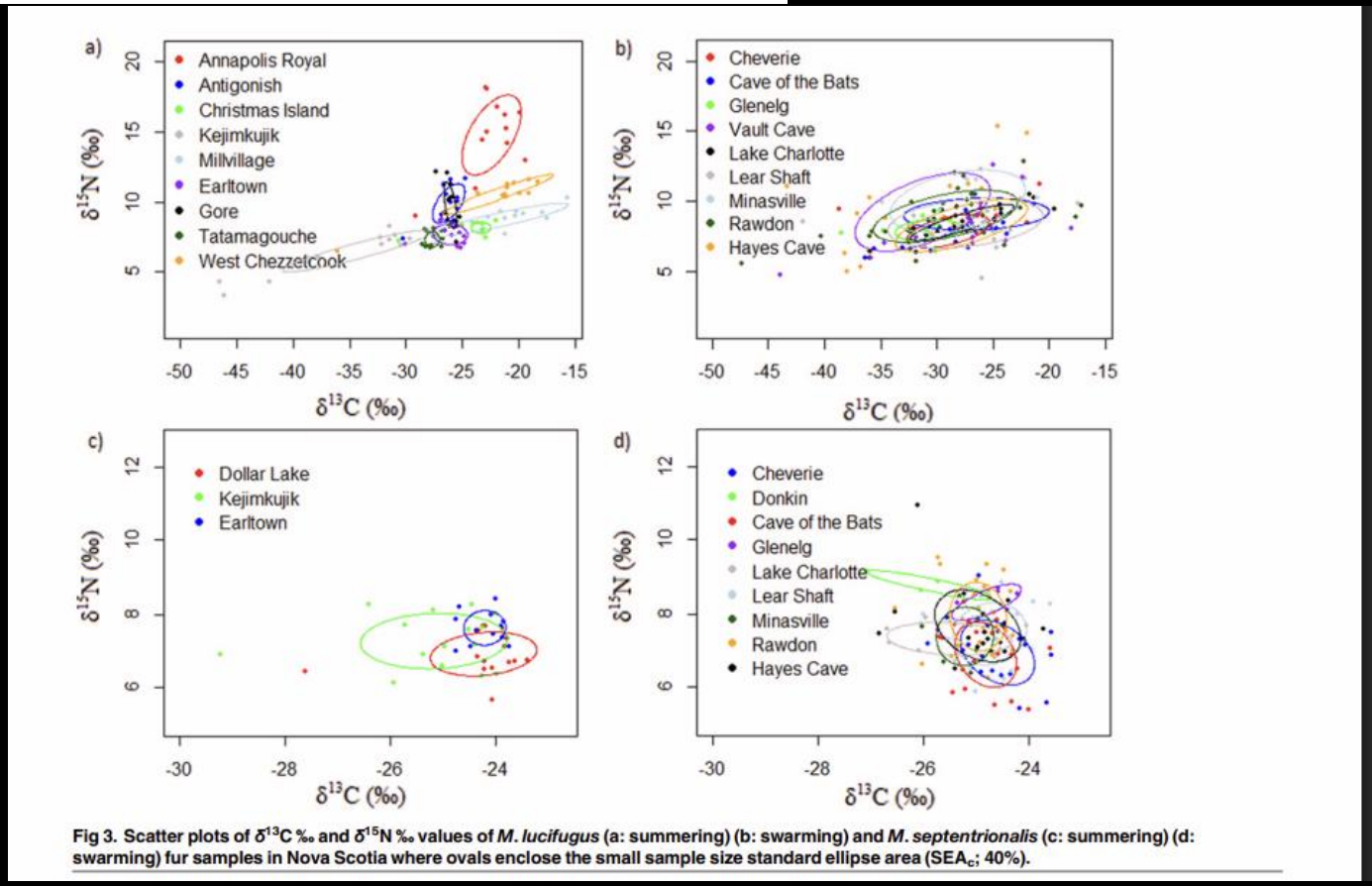


Fig 3. Scatter plots of $\delta^{13}C$ ‰ and $\delta^{15}N$ ‰ values of *M. lucifugus* (a: summering) (b: swarming) and *M. septentrionalis* (c: summering) (d: swarming) fur samples in Nova Scotia where ovals enclose the small sample size standard ellipse area (SEA_c; 40%).

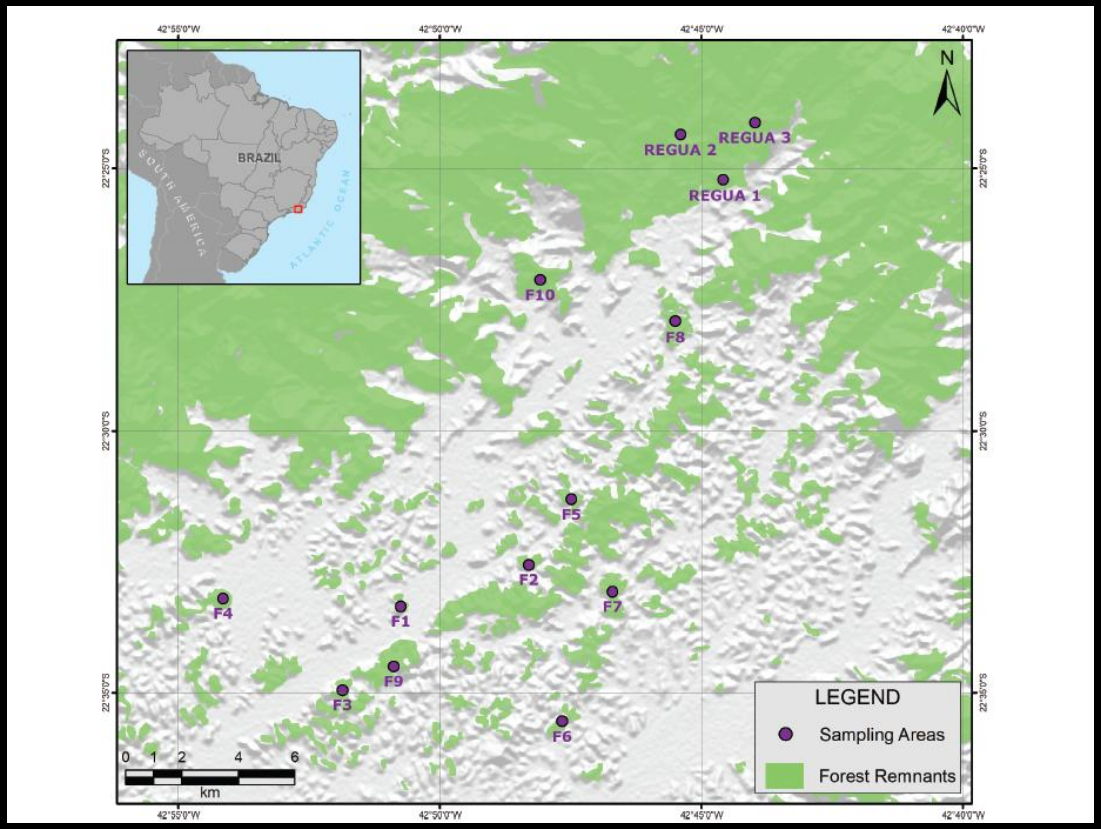
Journal of Mammalogy, XX(X):1–13, 2022
https://doi.org/10.1093/jmammal/gyac024

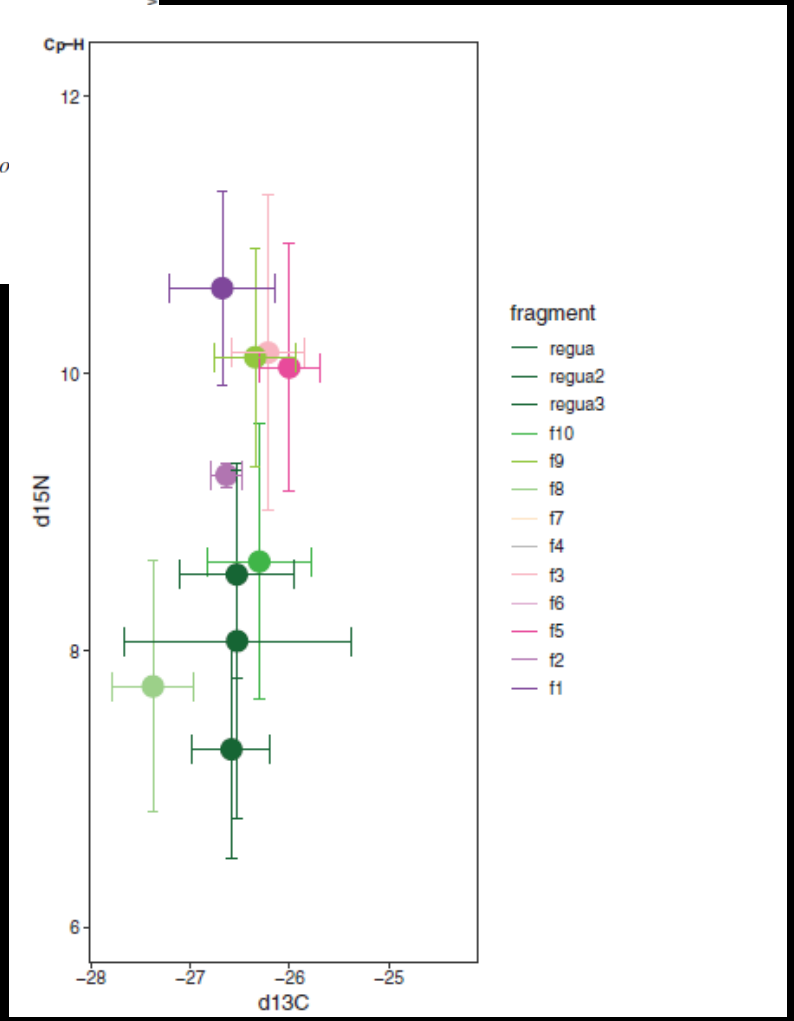
Variation in diet of frugivorous bats in fragments of Brazil's Atlantic Forest associated with vegetation density

PHILLIP J. OELBAUM,[1,3] TIAGO S.M. TEIXEIRA,[2] ELIZABETH L. CLARE,[2,4] AND HUGH G. BRODERS[1,*]

[1]*Department of Biology, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada*
[2]*School of Biological and Chemical Sciences, Queen Mary University of London, London E1 4NS, United Kingdom*
[3]*Present address: Department of Cell and Systems Biology, University of Toronto, 25 Harbord Street, Toronto, Ontario Canada*
[4]*Present address: Department of Biology, York University, Toronto, Ontario, M3J 1PS, Canada*

**To whom correspondence should be addressed: hugh.broders@uwaterloo.ca*



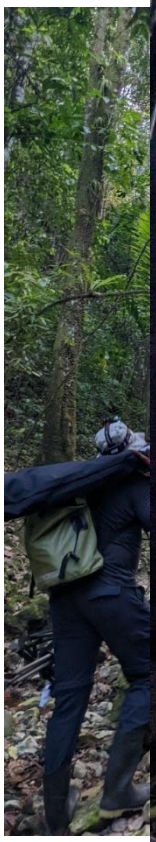


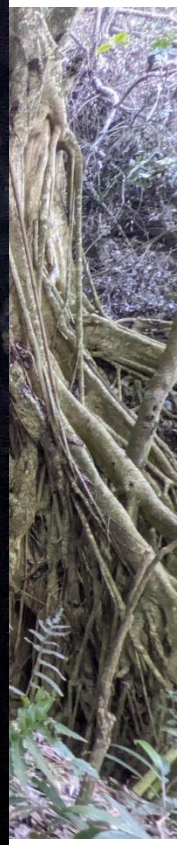
What happens to the isotopic niche when bats share a common roost?

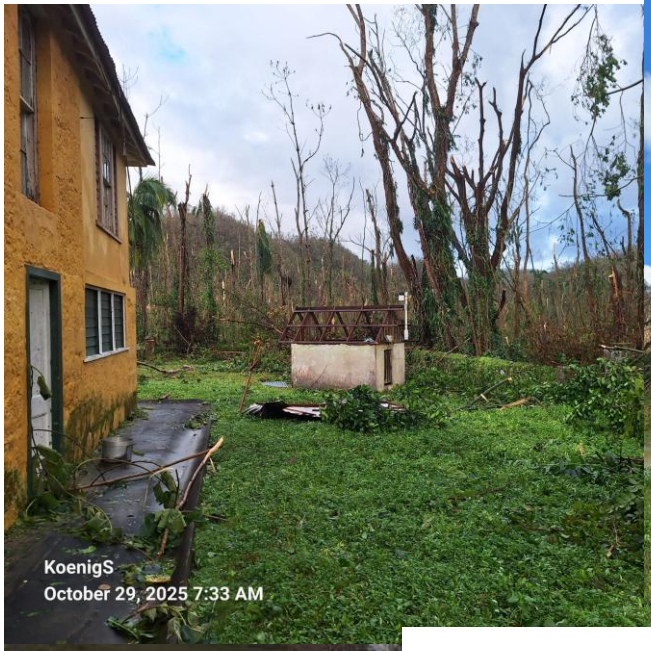
One dimension of *n*-dimensional niche is shared across the entire community

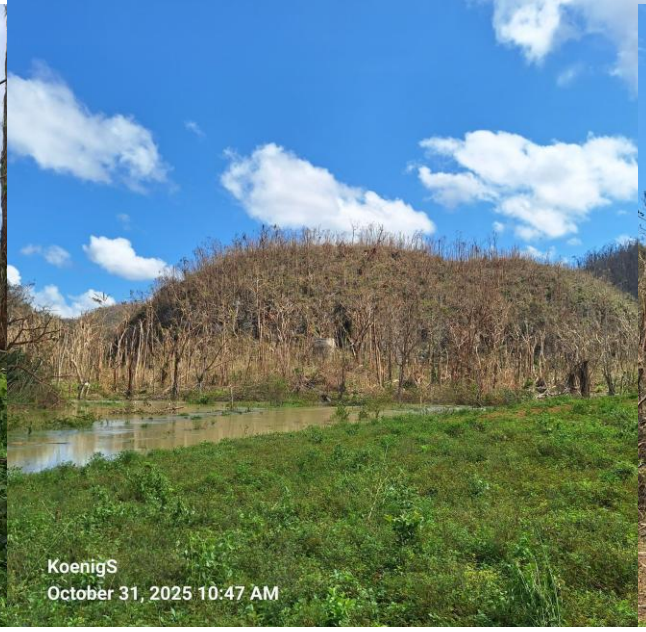

LES GRANDS CÉTACÉS
GREAT WHALES
ROM


The Bat Cave | La Grotte des chauves-souris









supportjamaica.gov.jm

Niche occupancy of Jamaican bat caves: diversity increases isotopic niche packing (Oelbaum et al., *In Review*)

How do so many similar species coexist?

Photographs by Brock and Sherri Fenton

BRITISH ECOLOGICAL SOCIETY | Journal of Animal Ecology

Volume 92, Issue 4
Special Feature: Mechanisms and Consequences of Infection-induced Phenotypes
April 2023
Pages 863-874

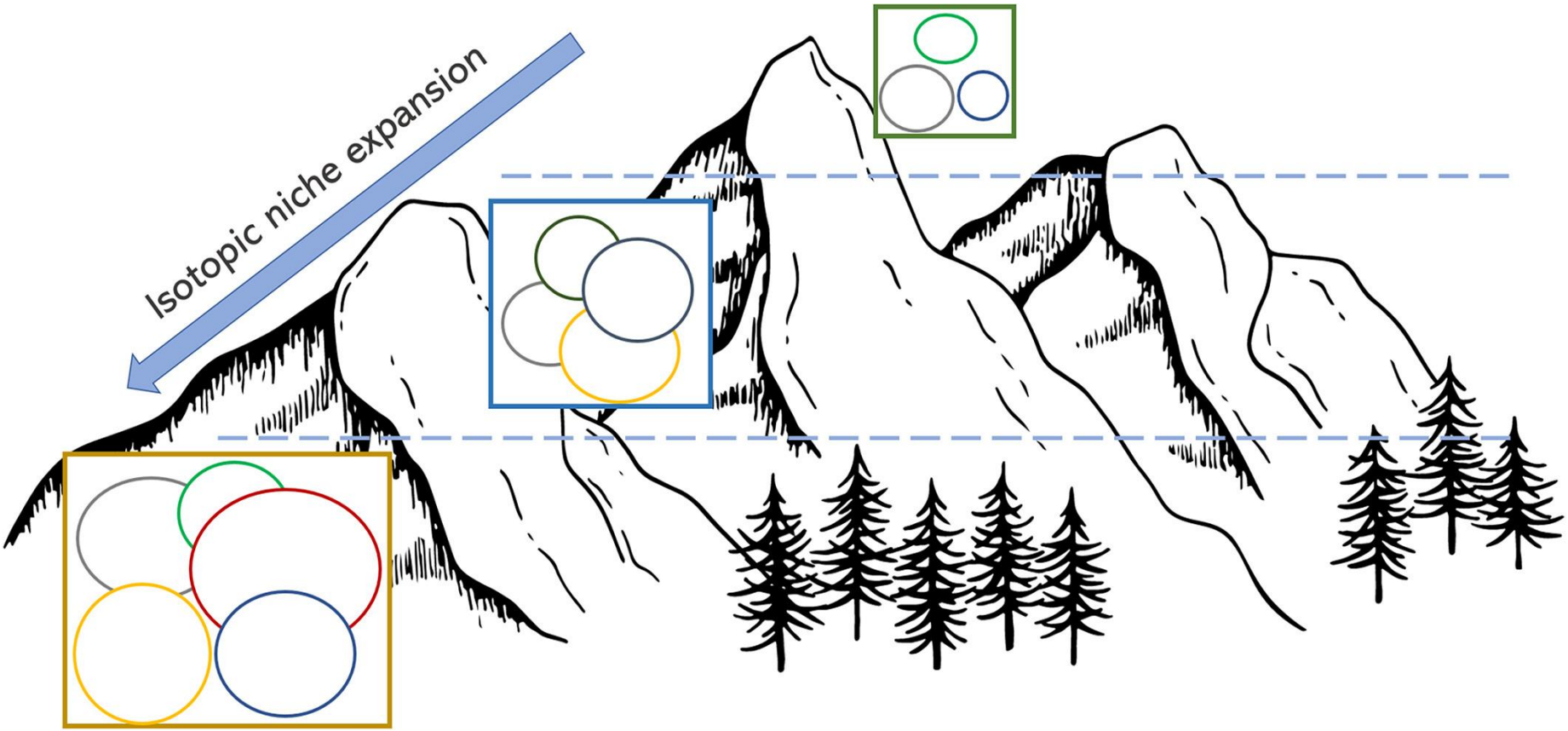
RESEARCH ARTICLE | Open Access

Increasing species richness along elevational gradients is associated with niche packing in bat assemblages

Correction(s) for this article

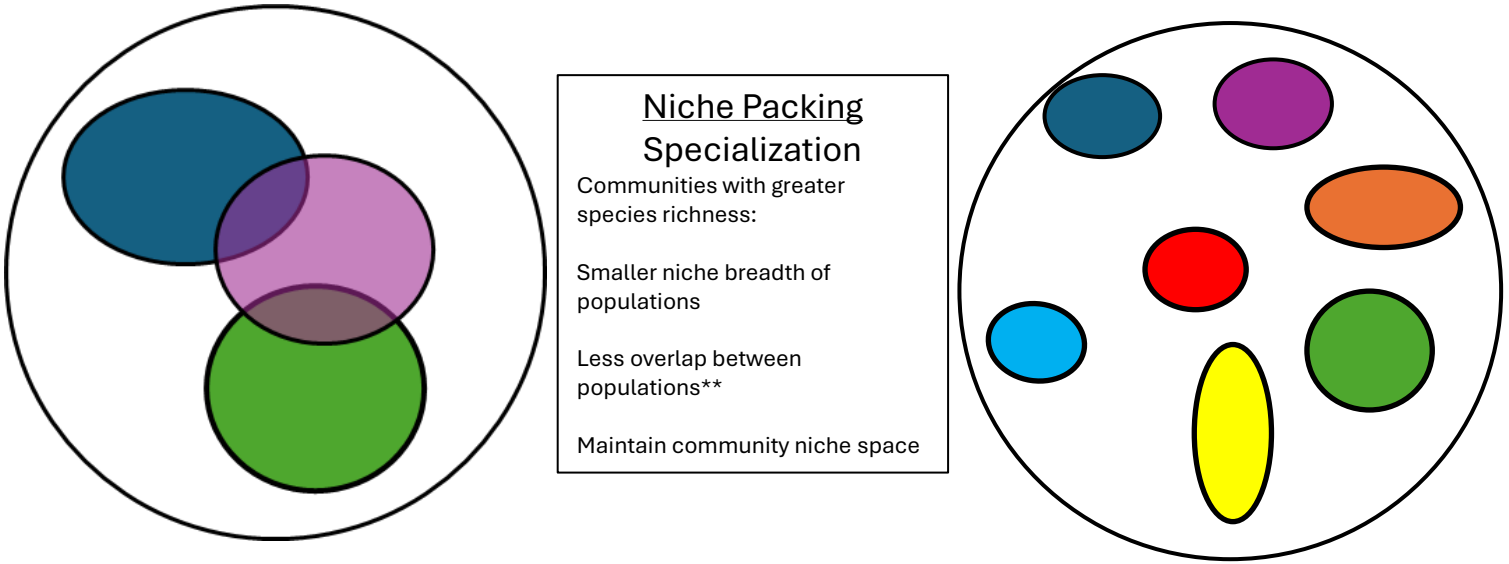
Rohit Chakravarty, Viktoriia Radchuk, Shreyas Managave, Christian C. Voigt

First published: 07 February 2023 | https://doi.org/10.1111/1365-2656.13897 | Citations: 7



Hypothesis – Niche Packing **Specialization** (MacArthur 1965)

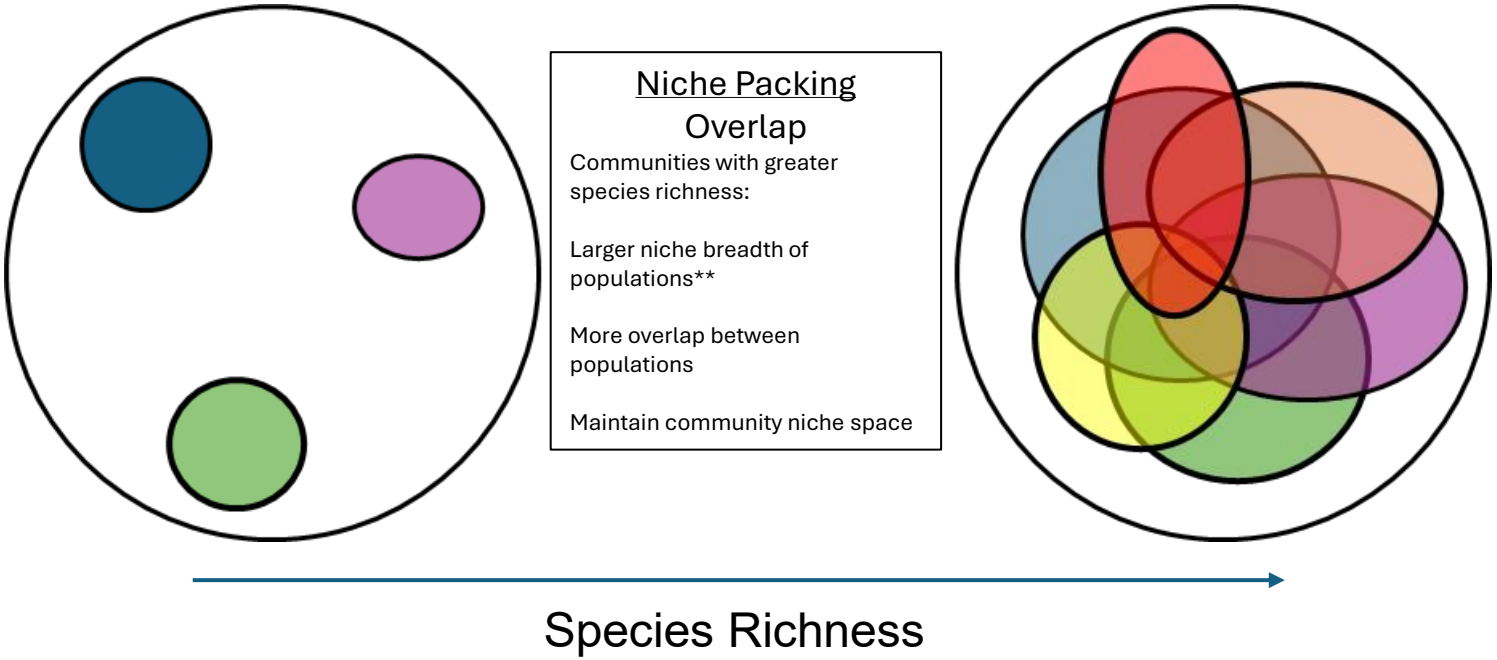
1



Sánchez González et al. 2023

Hypothesis – Niche Packing **Overlap** (MacArthur 1965)

2



Sánchez González et al. 2023

R. S. Stewart

Methods

- Isotope data from 500 individual hair samples
- Individuals were sampled across 13 unique sites
- 12 of 21 species known from Jamaica represented in data set
- Used GLMs to test relationship between isotope data and species richness (S)

Mean Overlap (%)

Mean Niche Breadth (SEA.B, $‰^2$)

Within family:
Phyllostomidae, Mormoopidae

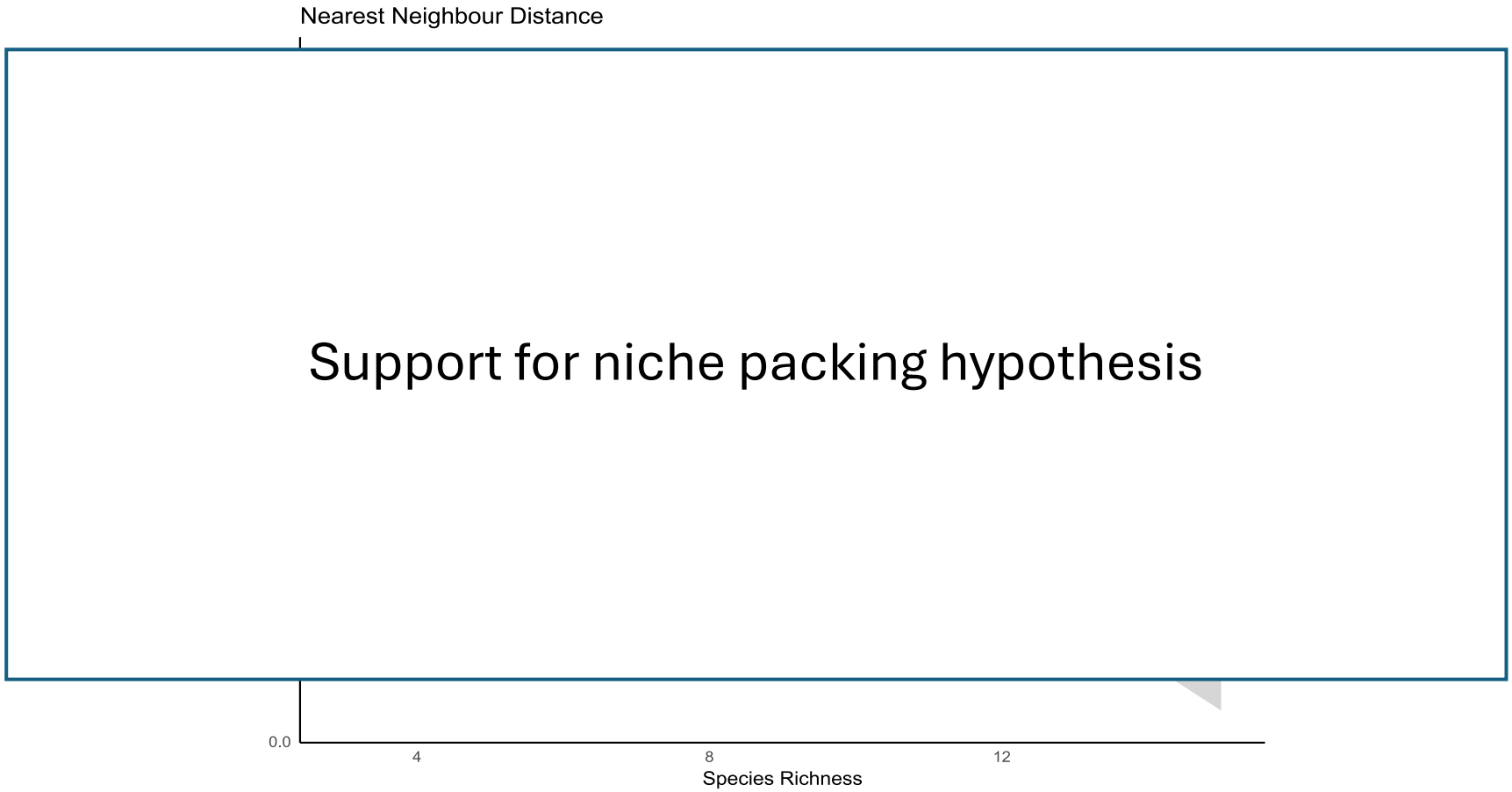
Within trophic guild:
Nectarivores, Insectivores

Mean Nearest Neighbour Distance

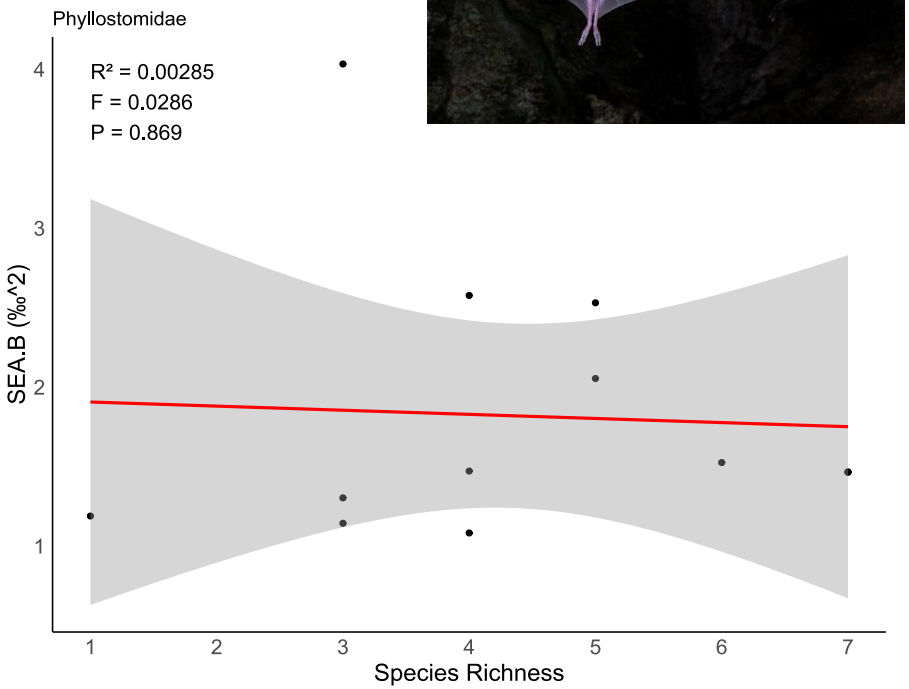
Full Fauna

(Layman et al. 2007; Chakravarty et al. 2023)

Results – Nearest Neighbour Distance

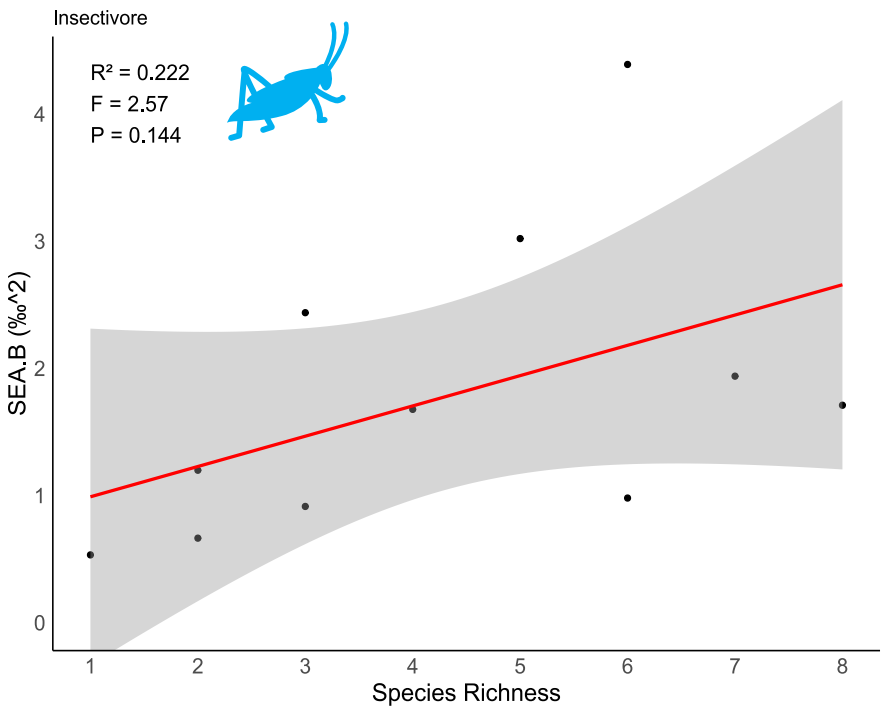


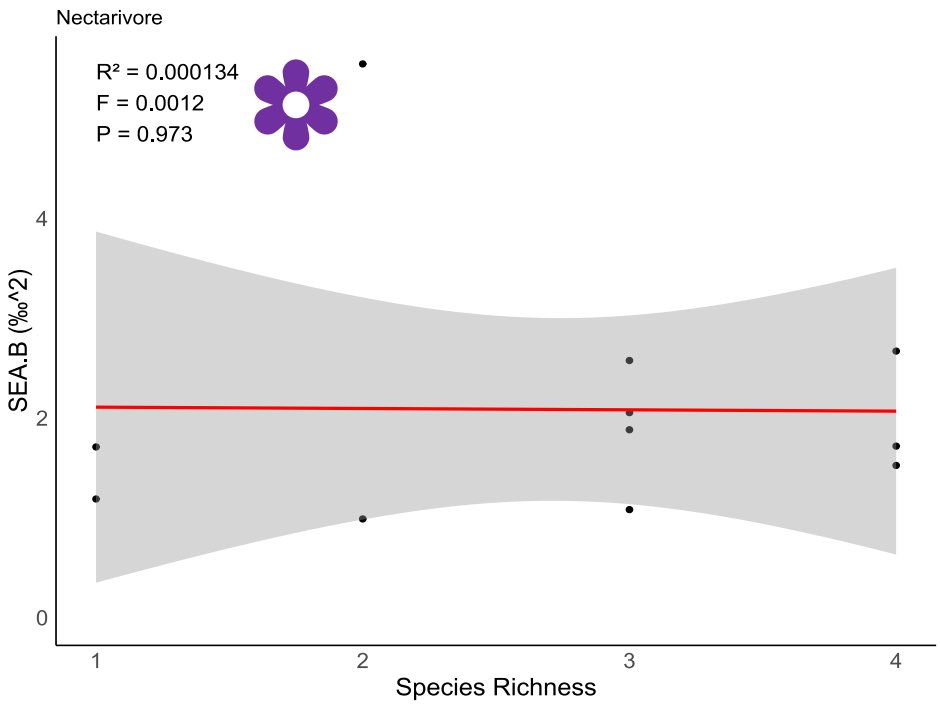
Results – Niche Breadth (Family)



Photographs by Brock and Sherri Fenton

Results – Niche Breadth (Guild)





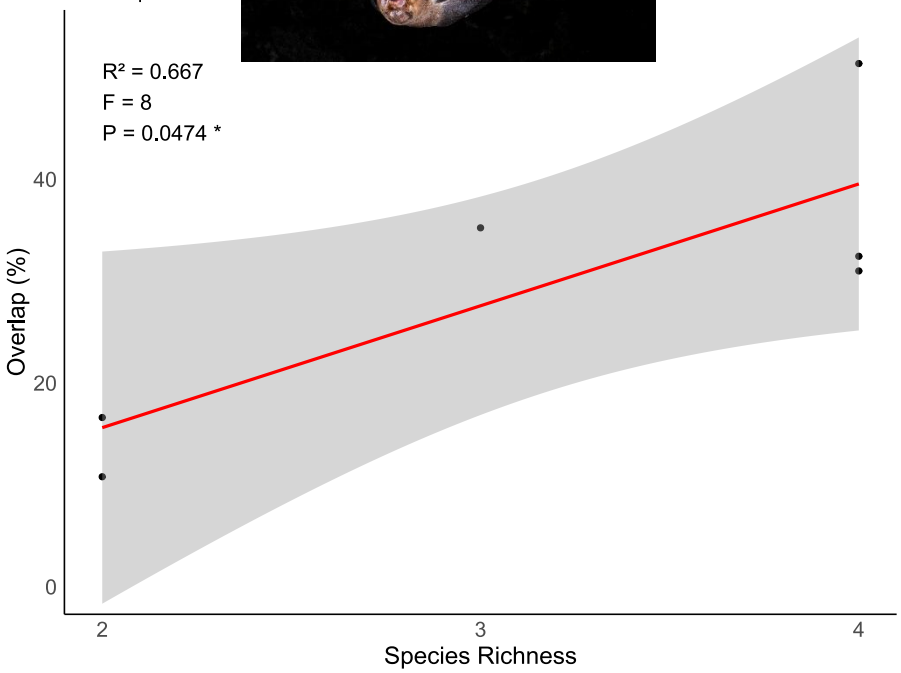
Results – Niche Breadth

Reject niche packing through specialization

Results – Overlap (Family)

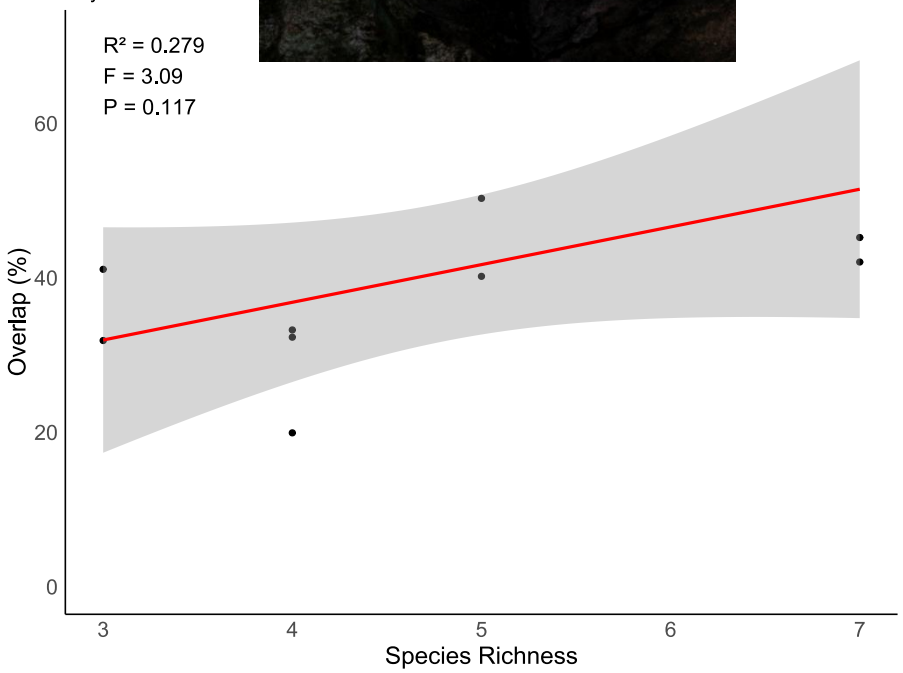
Mormoopidae

$R^2 = 0.667$
F = 8
P = 0.0474 *



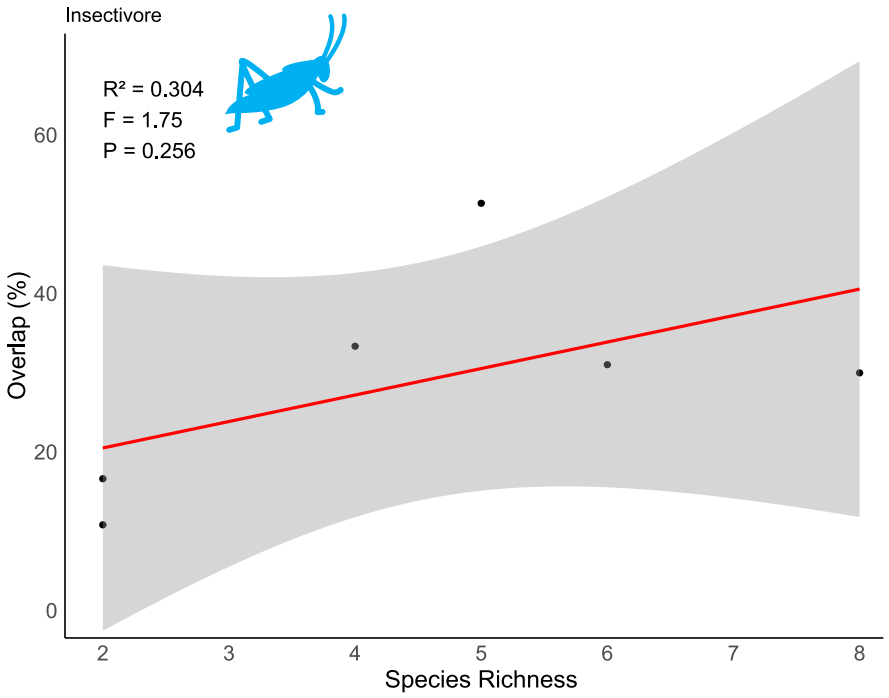
Phyllostomidae

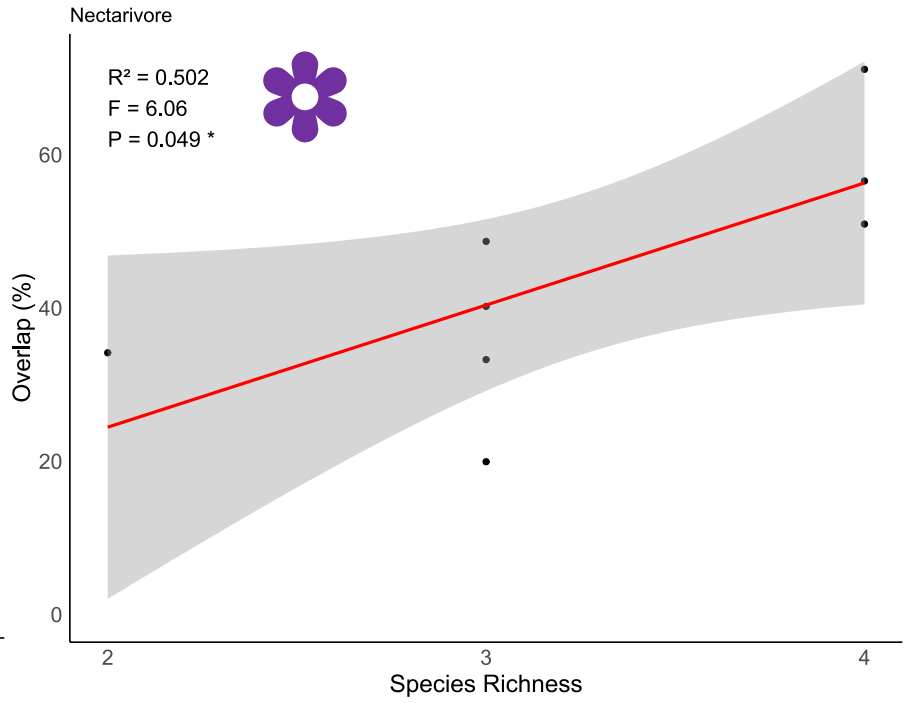
$R^2 = 0.279$
F = 3.09
P = 0.117



Photographs by Brock and Sherri Fenton

Results – Overlap (Guild)





What happens when bats share both foraging space, roosting space AND diet??

How do they partition niches in diverse faunas when so many of *n*-dimensions overlap?

Omnivory

Received: 31 December 2018 | Revised: 15 April 2019 | Accepted: 22 June 2019

DOI: 10.1111/btp.12700

ORIGINAL ARTICLE

WILEY bioTROPICA ASSOCIATION FOR TROPICAL BIOLOGY AND CONSERVATION

Community structure of a Neotropical bat fauna as revealed by stable isotope analysis: Not all species fit neatly into predicted guilds

Phillip J. Oelbaum[1] | M. Brock Fenton[2] | Nancy B. Simmons[3] | Hugh G. Broders[1]

Received: 19 January 2021 | Revised: 26 March 2021 | Accepted: 30 March 2021

DOI: 10.1002/ece3.7579

ORIGINAL RESEARCH

Ecology and Evolution Open Access WILEY

Molecular diet analysis of neotropical bats based on fecal DNA metabarcoding

Melissa R. Ingala[1,2,3,4] | Nancy B. Simmons[3] | Claudia Wultsch[5,6] | Konstantinos Krampis[6,7,8] | Kaiya L. Provost[2,9,10] | Susan L. Perkins[4,5]

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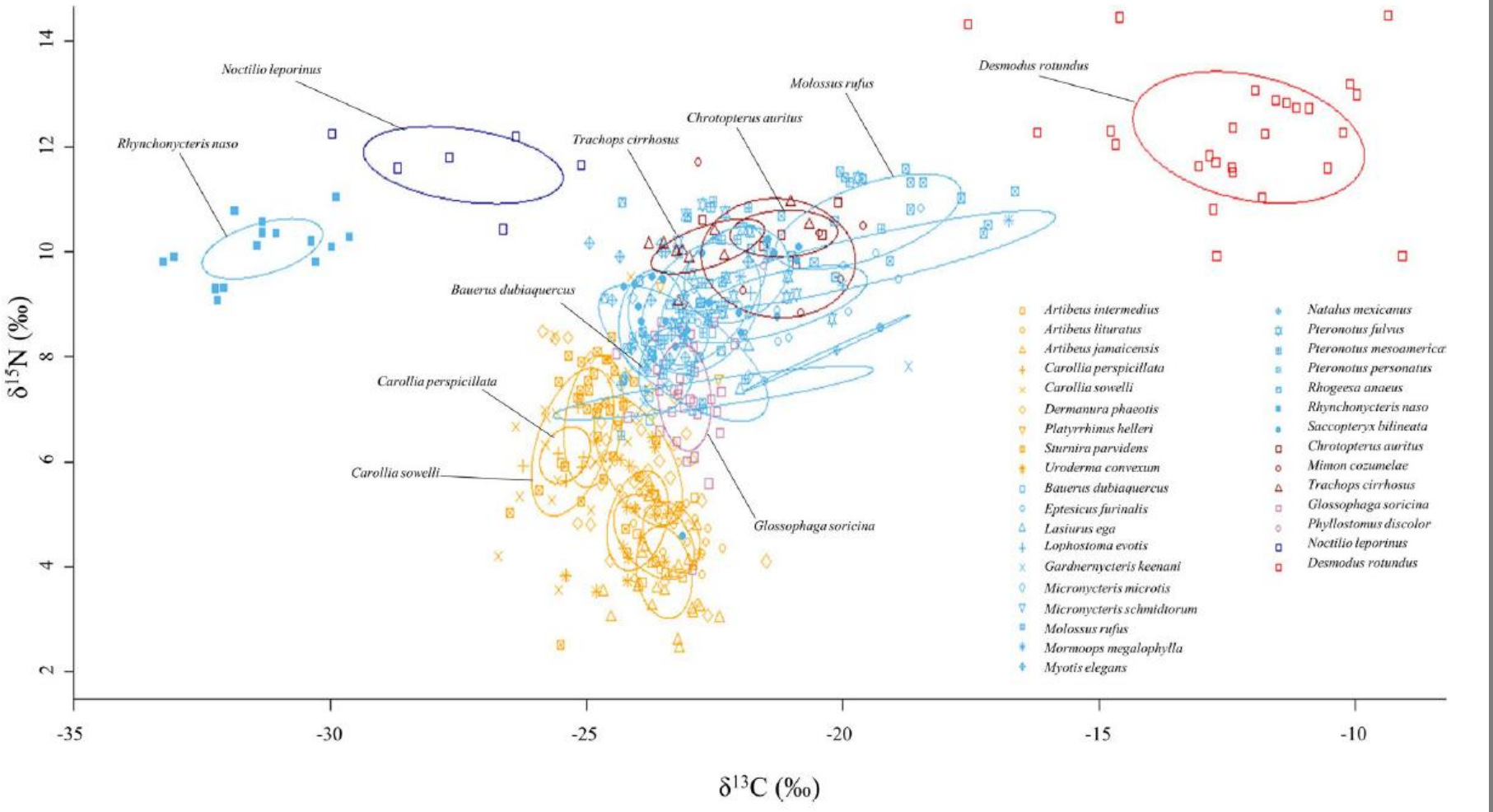

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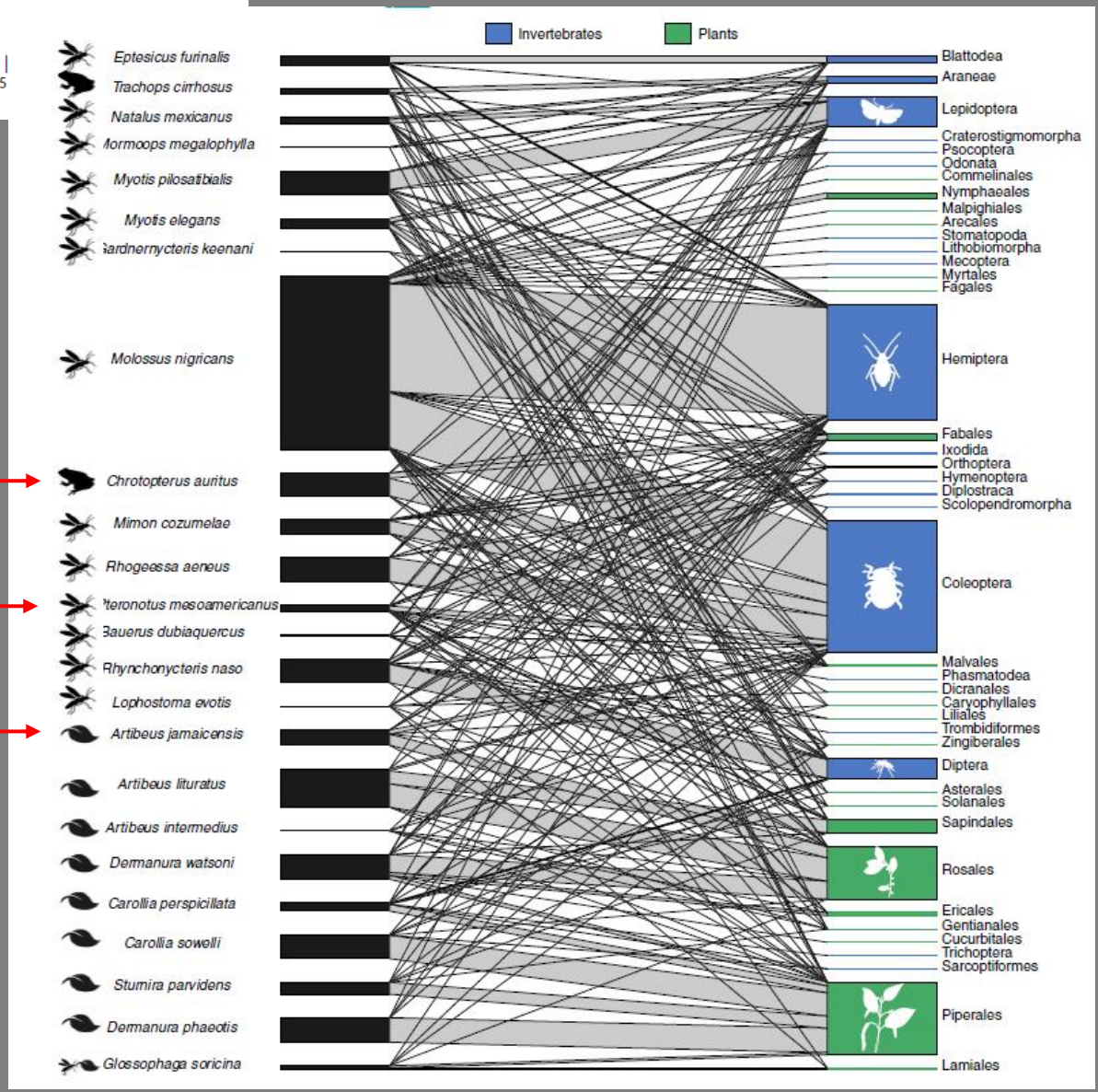


Dietary Guilds

Frugivores, Nectarivores, Insectivores, Piscivores, Carnivores, Sanguinivores (Allen 1931)

CHAPTER

The diets of bats: Think outside the guild

13

Elizabeth L. Clare[1], **Phillip J. Oelbaum**[2]

[1]*Department of Biology, York University, Toronto, ON, Canada;* [2]*Department of Cell and Systems Biology, University of Toronto, Toronto, ON, Canada*

Are Sanguinivores a Guild?

Vampire Bats

Desmodus rotundus
Common vampire bat

Diaemus youngii
White-winged vampire bat

Diphylla ecaudata
Hairy-legged vampire bat

JUST EAT BLOOD

Are Insectivores a Guild?

Are Insectivores a Guild?

1. Open-space foragers
2. Edge-space aerial foragers
3. Edge-space tralwers
4. Narrow-space flutter detectors
5. Narrow-space active gleaners
6. Narrow-space passive gleaners

Denzinger and Shnitzler (2013)

Are Insectivores a Guild?

Antrozous pallidus
Pallid bat

Arid landscapes
Believed to be scorpion, centipede specialists

Are Insectivores a Guild?

Only 2% of flower visits involved interaction with insects – nectar is the goal!

Frick et al. (2009)

Are Insectivores a Guild?

Insectivores eat much more than just insects!

Are Nectarivores a Guild?

Are Nectarivores a Guild?

Are Nectarivores a Guild?

Phyllostomus discolor
Pale spear-nosed bat

Insectivore? 99% of stomach contents was insect (Fleming et al. 1972)

Omnivore? Vertebrates and fruits, pollen reported in diet (Aguirre et al. 2003)

Nectarivore? 70% of diet comes from pollen and nectar (Stevens 2022)

Are Nectarivores a Guild?

Lonchophylla robusta
Orange flower bat

Insectivore? 90% of stomach contents was insect (Fleming et al. 1972)

Seasonal diet switching is common among ‘nectar’ bats…

Nectar feeding bats are extremely good insectivores (Clare et al. 2014)

Are Nectarivores a Guild?

Nectarivores eat much more than just sugar!

Are Frugivores a Guild?

Are Frugivores a Guild?

What is missing from an all-fruit diet?

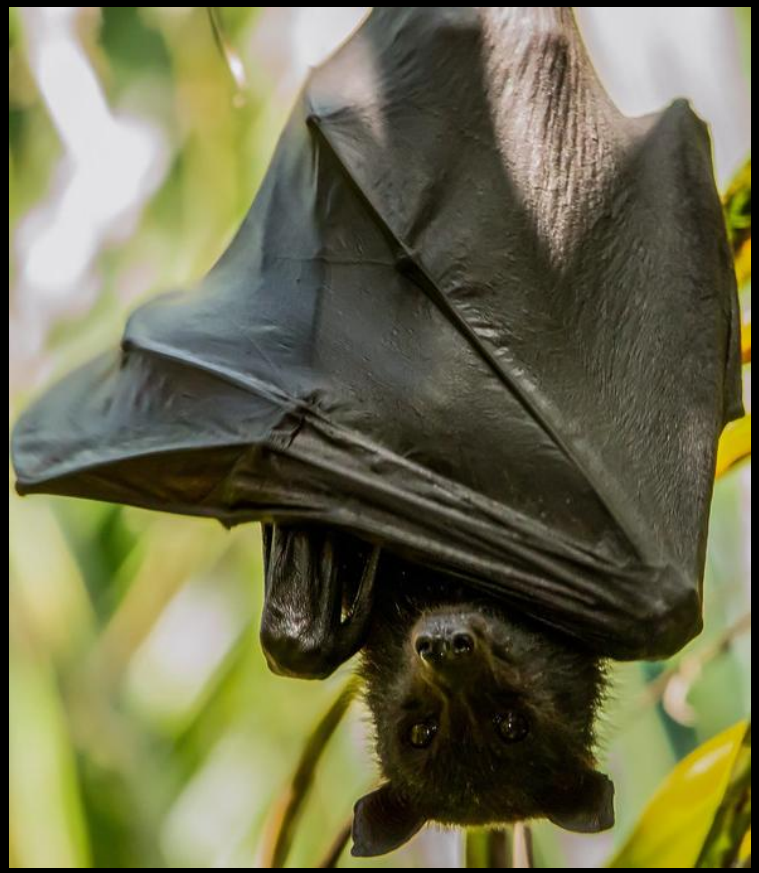
- Protein
- Phosphorous
- Calcium
- Sodium
- Iron
- Vitamin D
- Vitamin B12
- Vitamin E

Are Frugivores a Guild?

Carollia perspicillata
Seba's short-tailed fruit bat

Artibeus lituratus
Great fruit-eating bat

Are Frugivores a Guild?



Pteropus alecto
Black flying fox

Pteropus poliocephalus
Grey-headed flying fox

Are Frugivores a Guild?

Rousettus aegyptiacus
Egyptian fruit bat

Observed feeding on chafer beetles in Cape Town, South Africa

Also records of *Rousettus* sp. feeding on fish and molluscs

Barclay et al. (2006)

Are Frugivores a guild?

Frugivores eat more than just fruit!

Are Carnivores a Guild?

Photo credit: Alex Baugh

Are Carnivores a Guild?

Piscivory

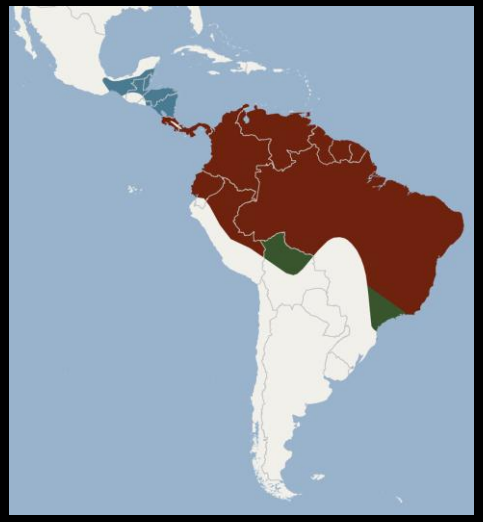
Highly adapted form of carnivory

Noctilio have been reported feeding on molluscs, arthropods, even other bats

Rodriguez-Duran and Rosa (2020)

Are Carnivores a Guild?

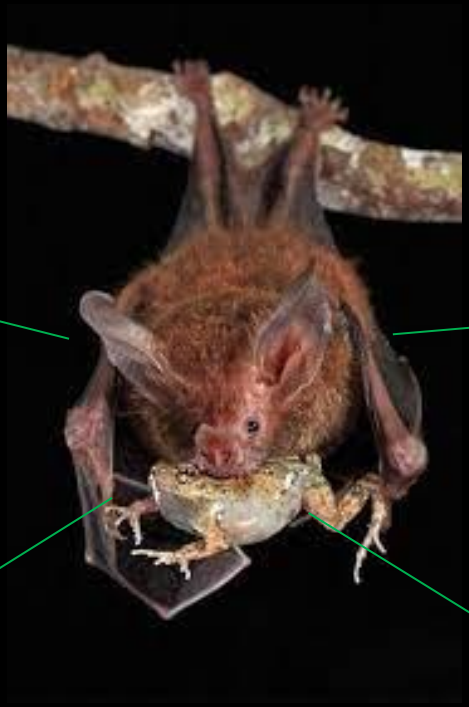
Trachops cirrhosus
Fringe-lipped bat



‘Frog eating bat’

Specialized eavesdropping behaviour

Are Carnivores a Guild?



Pristimantis frogs
(27% of diet)

Anolis lizards
(22% of diet)

Jones et al. 2020

Are Carnivores a Guild?

Other studies have estimated that the majority of *Trachops* prey items are insects (>80%)

Kalko et al. 1999; Oelbaum et al. 2019; Ingala et al. 2021

Are Carnivores a Guild?

Chrotopterus auritus
Woolly false-vampire bat

Vampyrum spectrum
Spectral bat

(Ingala et al. 2021)

Are Carnivores a Guild?

Carnivores eat much more
than just meat

A World With More Omnivores?

- Trophic guilds work for simple explanation, but in reality most bats do not fit neatly into boxes – niches overlap!
- All bats (except vampires) are to some degree omnivorous – how do we best define omnivory?
- Consider bat species have more than a single ecological role to play and niches can be flexible temporally, seasonally

YORK U

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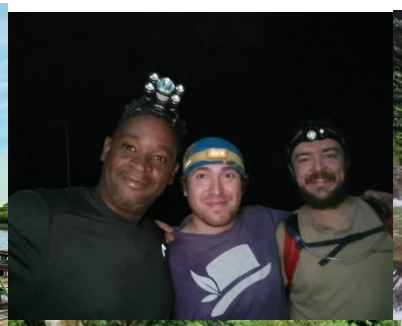
LAMANAI OUTPOST LODGE

AMERICAN MUSEUM of NATURAL HISTORY



BAT CONSERVATION INTERNATIONAL

nepa

National Environment and Planning Agency

THE UNIVERSITY OF THE WEST INDIES
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The Jamaican Caves Organisation

Speleology and Cave Exploration in Jamaica

THE BAT JUNGLE

Monteverde Costa Rica