NUTRIENTS IN SPIDERS AND INSECTS AT An MSCP RESTORATION SITE

Bill Wiesenborn
USBR
Boulder City, Nevada

I thank
Amy Stephenson
USBR Regional Lab
for chemical analyses
Willow flycatcher diets in 2004

Mean no. arthropods in fecal samples

- Pahranagat NWR
- Virgin River, Mesquite
- Topock Marsh, Havasu NWR

Plotted log Y + 1
Six macroelements are required by living organisms:

- Carbon
- Hydrogen
- **Nitrogen**
- Oxygen
- Phosphorus
- **Sulfur**

Carbon is abundant (in air and in plants)

Hydrogen and Oxygen are obtained as water and with Carbon in carbohydrates

Nitrogen, Phosphorus, and Sulfur may be limiting

Nitrogen is absorbed by plants as ammonia and nitrate in soil or as N₂ in air and incorporated into proteins
Nitrogen in insects occurs mostly in protein and chitin.

Proteins polymerize amino acids and average 16% N.

Chitin polymerizes a carbohydrate with 7% N.

Protein and chitin combine in different proportions to produce insect exoskeleton, or cuticle.
Objective was to examine variation in Nitrogen content among spiders and insects in an MSCP restoration site.

I collected spiders and insects at the Beal Restoration Site during April–August 2009.

I swept arrowweed, cottonwood, both willows, mesquite, tamarisk, and trapped insects with a Malaise trap.
I first determined the relationship between nitrogen content and body dry mass.

Nitrogen mass was determined by Kjeldahl analysis: nitrogen was converted to ammonia by digesting dried and weighed specimens in hot acid, and the amount of ammonia was measured with an indicator in a flow analyzer.
log mg N
= -1.01 + 1.04(log mg dry mass)

Slope > 1

Backtransforming produces the allometric equation:

mg N = 0.10(mg dry mass) ^ 1.04

Nitrogen mass is allometrically increasing with body mass
Nitrogen content increases allometrically, and not linearly, with increasing body mass

Suggests Nitrogen content is mostly driven by exoskeleton mass

Heavier insects require a thicker exoskeleton to support themselves

Cannot use %N to compare spider and insect taxa

Taxa were compared after adjusting N mass for body mass
Variation in N content (adjusted for allometry) was partitioned among taxonomic levels with analysis of variance

Orders (flies, beetles, wasps, etc) explained 21% of variation

Families (fruit flies, deer flies, etc) explained 22% of variation
- an improvement of only 1%

Trophic level explained 1% of variation in N content across orders

N contents differed among trophic levels in flies
Fruit flies
Long‐legged & lauxaniid flies
Deer & robber flies
H, Herbivore
P, Predator
D, Detritivore

Adjusted N mass (mg)

Avannae, Odonata, Orthoptera, Heteroptera, Homoptera, Neuroptera, Coleoptera, Diptera, Hymenoptera

Fruit flies
Long‐legged & lauxaniid flies
Deer & robber flies
H, Herbivore
P, Predator
D, Detritivore
Resilin (insect rubber) is high-protein cuticle found in insect joints
Resilin fluoresces under UV light

long-exposure photo
Sulfur resides primarily in the earth’s crust

-- taken up by plants as sulfate from decomposed rock

Sulfur occurs in 2 amino acids incorporated into proteins

\[
\text{Methionine} \quad \text{H}_3\text{C} - \text{S} - \text{CH}_2 - \text{CH}_2 - \text{COOH}
\]

\[
\text{Cysteine} \quad \text{HS} - \text{CH}_2 - \text{CH}_2 - \text{COOH}
\]
Sulfur occurs in taurine, an “amino acid” not incorporated into proteins found in insects & spiders

spiders > insects

inhibits nerve impulses in insects; found in spider venom & silk
Sulfur was measured in spiders and insects from the Beal Site during 2011.
Specimens digested in acid in microwave bomb.
Sulfur concentration measured with Atomic Emission Spectrometer.

\[
\log (S \text{ ug}) = 0.86 + 1.024 (\log \text{ body mg})
\]

Slope = 1
Backtransforming produces the linear equation

\[
S \text{ ug} = 7.2(\text{body mg})
\]

Most S not in cuticle.
Variation in %S content was partitioned among taxonomic levels.

Classes (spiders & insects) explained 45% of variation.

Orders (flies, beetles, wasps, etc) explained 57% of variation.
- an improvement of 12%.

Families (fruit flies, deer flies, etc) explained 68% of variation.
- an improvement of 11%.

Genera explained 71% of variation.
- an improvement of 3%.

Trophic level explained 10% of variation in N content across orders.
Oedemerid beetles & Syritta flies
Spiders and insects provide insectivorous birds with a range of nitrogen & sulfur contents.

Nitrogen concentration is high in dragonflies (also large mass), spiders, bees and wasps.

Sulfur concentration is especially high in spiders.

Stresses the importance of providing a variety of arthropods for bird food, including those from marshes (dragonflies) and plants (spiders).

Restoration areas should include both marsh and riparian.