You are what you eat: Tracking the fate of food in the red mason bee

Michał Filipiak
Michal Woyciechowski
Marcin Czarnolesk

Video Abstract

Keywords: Scientific Reports, stoichiometric niche, nutrient partitioning, resource allocation, solitary bee, Osmia bicornis, red mason bee, phosphorus, larva, pollen, life history, elemental phenotype, assimilation, ecological stoichiometry, cocoon, fitness, holometabolous insects, conservation, sexual dimorphism, nutritional ecology

Posted Date: October 13th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-966068/v1

Abstract

Life, in all its forms, is a constant balance of energy and matter. A look at any food web reveals how organisms are tightly connected to each other and their environment. On the smallest and most fundamental scale, the process is cyclical. Atoms representing vital minerals flow in a never-ending circuit from one sink to the next. Understanding this flow helps scientists answer questions about how organisms transform food into energy and body mass for growth and survival. But while these strategies tend to vary with species, life stage, and sex, studies often treat members of a population as being, for all intents and purposes, the same. Researchers from Jagiellonian University in Poland are taking a different approach. By tracking the assimilation, excretion, and allocation of the individual minerals found in pollen, they're beginning to understand how the diet of the red mason bee contributes to its growth and survival and how the nutritional budget differs with life stage and sex. The red mason bee is uniquely suited for this type of chemical accounting. Mother bees seal their eggs with enough food to complete the pupal and larval stages. Each tiny bee incubator is thus a virtually closed system, as all or most of their pollen store is converted into body mass, cocoon material, or excrement. This enabled the research team to monitor the biological flow of various elements through the bee life cycle. The most striking result was how much phosphorus bees allocate to their adult body versus their cocoon. Only 25 to 45% of phosphorus assimilated from pollen during larval development wound up in the adult body compared to 55 to 75% in the cocoon. From a development point of view, this disparity makes sense. Larvae assimilate large amounts of phosphorus from pollen to sustain their rapid growth and development, much of which is likely allocated into the cocoon to enhance its mechanical strength. Therefore, the adult body is not as rich in phosphorus as one would expect. The extent to which bees assimilated different nutritional minerals also varied by sex, with males incorporating more phosphorus, calcium, sodium, and sulfur and females taking up more potassium and copper. The sexes also differed in their allocation to the adult body and cocoon. Such variation in nutritional demand could explain sex-based differences in bee physiology and even behavior. For instance, the relatively high demand of female larvae for specific nutrients may explain why mother bees fill female larval chambers with a mixture of pollen species tailored to their nutritional needs. Gaining insight into bee metabolism at this scale is critical, as it not only helps scientists understand how bees and other insects survive and thrive in their environment but also provides important clues for conserving rapidly dwindling bee populations across the world. The nutritional needs of bees are not as simple as often assumed, and the variable nutritional needs of larvae and adults and of bees of different sexes should be considered when developing effective strategies for bee conservation.