

Nutrition as an evolutionary force

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Until recently, evolutionary biologists have not been much interested in nutrition. Although food ultimately provides the energy for survival growth and reproduction, many physiologists have been frustrated by the difficulty of defining exactly what contributes to variance in nutritional quality of different diets. Instead they have focussed on other aspects of animal performance such as thermal and locomotory capabilities that are easier to define and measure.

However, many animals face prolonged periods without food and the realization of the extraordinary and rapid responses of the gut in some species have resulted in a renewed emphasis on how the gut of wild species has evolved to match fluctuating food supplies, energetic demands and different food types that are the of wild vertebrates.

The most spectacular changes in gut anatomy and physiology have been observed in large sit and wait predators such as pythons. In those species the absorptive capacity of the gut can double within hours of ingesting a meal along with up-regulation of metabolic rate, digestive enzymes, nutrient transporters and other organs such as kidneys. However other snakes that feed more regularly don't show the same magnitude of regulatory response. Many other species such as migratory birds must up- or down-regulate their nutrient uptake capacity to meet requirements for activities and changing food availability.

These findings illustrate that maintenance of gut tissues is a large energetic and nutritional burden on animals and one that is borne only when there is food to process. But if the gut is so flexible when food is not available how does it respond when greater quantities of food must be processed? Other major evolutionary questions have asked whether the gut ever sets the ultimate limit to animal activity. Studies of animals in cold and those lactating at maximal capacity show rapid enhanced capacity of the gut to digest and transport nutrients to meet higher energy requirements. Peripheral processes (e.g. capacity of the mammary glands to make milk) have been argued to limit energy expenditure by animals under these conditions rather than the capacity of the gut to transport nutrients.

In wild species, periods of under-nutrition provide the best means of observing selection on nutritional status in wild species. However, there are surprisingly few examples of the fitness consequences of variation in foraging traits, despite their importance for survival of wild species. The best example is in Soay sheep where broader incisor width is strongly selected during population crashes, as is resistance to parasites. Individual variation in parasite resistance is in turn under genetic control but there is much uncertainty about the mechanisms and stability of these selective forces.

Overall, our ability to ask specific questions about the evolutionary impact of nutrition in wild species is hampered by a lack of understanding of what constitutes nutritional quality. There are many examples of wild animals with restricted or unusual diets (e.g. toxic constituents) but understanding how the interaction between consumer and diet has evolved is challenging.