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## Evolution of linoleic acid biosynthesis in Collembola and different species of arthropods

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# Abstract

To recognize underlying mechanisms of the trait dynamic (loss and/or gain) for understanding its driving forces and evolutionary consequences in the context of ecological interactions we need to study trait acquisition and evolutionary novelties. If an essential trait is supplied by symbiotic relationship with other organism or due to abundance in species environment, the trait is prone to loss or despite its abundant accessibility is still maintained. The trait can be conserved because food sources and metabolic requirement for a species differ thus consumers have to balance the costs and benefits of nutrient acquisition and utilization. The diet of organisms generally provides a sufficient supply of energy and building materials for healthy growth and development, but should also contain essential nutrients. Species differ in their exogenous requirements, but it is not clear why some species are able to synthesize essential nutrients, while others are not. The polyunsaturated essential fatty acid, linoleic acid (LA; 18:2n-6) plays an important role in functions such as cell physiology, immunity, and reproduction. LA is readily synthesized in bacteria, protozoa and plants, but it was long thought that all animals lacked the ability to synthesize LA *de novo* and thus required a dietary source of this fatty acid. Over the years, however, an increasing number of studies have shown active LA synthesis in animals, including insects, nematodes and pulmonates. Despite continued interest in LA metabolism, it has remained unclear why some organisms can synthesize LA while others cannot.

Here, I review the mechanisms by which LA is synthesized and which biological functions LA supports in different organisms to answer the question why LA synthesis was lost and repeatedly gained during the evolution of distinct invertebrate groups. I proposed several hypotheses and compile data from the available literature to identify which factors promote LA synthesis within a phylogenetic framework. By investigating a dietary composition and requirements of an early arthropod group, Collembola, and some other arthropods, I have found that there is no clear

evidence for a relationship between LA synthetic ability and the natural diet of species. However, since LA plays also important role in sex pheromone production, during my studies I have hypothesize that LA synthesis may evolved as a selective pressure of sexual selection. Through studying spermatophore choices in Collembola females, I have revealed that LA might be an important component in sexual selection for some collembolan species. Moreover, by functionally characterizing a gene in a jewel wasp, *Nasonia vitripennis*, known as a key enzyme for sex pheromone production, I have shown that in that species LA has evolved as a selective pressure of sexual selection. Therefore, we can assume that LA biosynthesis is a secondarily derived character which has re-evolved in some invertebrate taxa. Most likely, this trait has been acquired independently by some species as a result of adaptation to LA shortage in their diet or by metabolic/physiological requirements specific for a species. Future studies of trait should focus on ancestral populations to identify principles in which an environmental shift removes a source of selection, leading to loss of function in the new environment and/or what selection pressures underlined evolving of new trait.