The evolutionary ecology of fatty-acid variation: implications for consumer adaptation and diversification

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The nutritional diversity of resources can affect the adaptive evolution of consumer metabolism and consumer diversification. The omega-3 long-chain polyunsaturated fatty acids eicosapentaenoic acid (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3) have a high potential to affect consumer fitness, through their widespread effects on reproduction, growth and survival. However, few studies consider the evolution of fatty acid metabolism within an ecological context. In this review, we first document the extensive diversity in both primary producer and consumer fatty acid distributions amongst major ecosystems, between habitats and amongst species within habitats. We highlight some of the key nutritional contrasts that can shape behavioural and/or metabolic adaptation in consumers, discussing how consumers can evolve in response to the spatial, seasonal and communitylevel variation of resource quality. We propose a hierarchical trait-based approach for studying the evolution of consumers' metabolic networks and review the evolutionary genetic mechanisms underpinning consumer adaptation to EPA and DHA distributions. In doing so, we consider how the metabolic traits of consumers are hierarchically structured, from cell membrane function to maternal investment, and have strongly environment-dependent expression. Finally, we conclude with an outlook on how studying the metabolic adaptation of consumers within the context of nutritional landscapes can open up new opportunities for understanding evolutionary diversification.
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