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EDITORIAL

Stable isotope analysis reveal hidden reliance on scyphozoan jellyfish in a commensal fish: editorial comment on the feature article by D'Ambra et al.

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We know very little about the ecology of jellyfish and other gelatinous zooplankton and how they interact with other taxa: many biologists consider that their role in ecosystems is likely underestimated (Pauly et al. 2009). As citizens and marine biologists, we are continually exposed to stories (via the news media and even the scientific literature) where jellyfish are shown in a negative light and even as indicators of impending ecological doom. The negative impacts of jellyfish blooms on aquaculture and fisheries are well documented, but sometimes I feel that we are approaching a point where (to some observers) the presence of normal densities of jellyfish in marine ecosystems is considered an indication of perturbation, even though jellyfish and associated taxa are natural components of such systems.

Some marine biologists have worked hard to counter the consistent negative spin regarding jellyfish. Condon et al. (2013) examined the veracity of the well-reported global rise of jellyfish, and in a recent book chapter, Doyle et al. (2014) highlighted the positive side of jellyfish in terms of their important ecological roles and the goods and services they provide to human society. The wider public are well aware of the importance of jellyfish as prey to some charismatic megafauna including leatherback turtles and sunfish (although recent studies show that relationship between jellyfish and sunfish may be less clear than previously thought (Harrod et al. 2013; Nakamura and Sato 2014)). Less well known, at least by those not working on jellyfish, is the fact that individual jellyfish are often found in association with a diverse range of commensal organisms, including invertebrates (e.g. crabs, amphipods) and early life stages of fish, many of which are ecologically and economically important (Doyle et al. 2014).

A long debate has revolved around the precise form of the primary relationship between commensal taxa and their jellyfish hosts. Does the host provide habitat in the form of a refuge for commensal taxa in the otherwise open pelagic habitat, allowing them to feed on prey from the surrounding waters whilst providing protection from predators? This seems reasonable, especially when the mobile refuge comes equipped with the added capacity to sting or kill potential predators. Alternatively, the host may also provide a source of food for commensal taxa: indeed commensal fish and other taxa have been observed to feed on their jellyfish hosts. Pulling the relative importance of these potential relationships (which are not mutually exclusive) apart has been complicated by the fact that gelatinous tissues are digested quickly and are not easily identified in gut or stomach contents (Arai et al. 2003). Furthermore, such tissues are considered to be of limited nutritional value (Pitt et al. 2009), and it has been generally considered that they do not contribute significantly to the diet of commensal fish (Purcell and Arai 2001). Hence, to date, many workers have concluded that the primary interaction between commensal taxa and their jellyfish hosts is likely to be one of the provisions of habitat.

The feature article by Isabella D'Ambra and her co-authors successfully turns this assumption on its head, at least in the case of their study system. In a short but solid study, they examine the assimilated diet of Atlantic bumper (*Chloroscombrus chrysurus*), an abundant carangid fish from the Gulf of Mexico that lives commensally with jellyfish hosts (*Aurelia* sp. and *Drymonema larsoni*) during the fish's juvenile life stage (Tolley 1987). Rather than examining stomach contents, D'Ambra et al. compared the stable

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isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) in the tissues of the fish with that of various putative foods including the jellyfish host and pelagic plankton. Their results are striking and through the use of isotope mixing models, the authors provide strong evidence that between 80 and 100 % of the carbon and nitrogen in juvenile Atlantic bumper muscle tissue was derived from the jellyfish host.

Although the consumption of jellyfish hosts has been observed previously, this is the first time that a reliable estimate of the scale of consumption of host tissues has been made in the sensitive early life stage of a commercially important fish. Furthermore, the authors have revealed that this fish relies primarily on host jellyfish for the growth of somatic tissues, raising the issue that a major trophic link in the well-studied Gulf of Mexico ecosystem has been overlooked. Worldwide, numerous other economically and ecologically important fishes are associated with jellyfish hosts, and the authors rightly highlight that such potential trophic relationships are in need of re-examination and if shown to exist, to be included in ecosystem models.

The study by D'Ambra and her colleagues joins a limited pool of isotopic studies that also show assimilation of jellyfish host tissues by of commensal crabs and amphipods (Towanda and Thuesen 2006; Fleming et al. 2014). As such, the prevailing view that commensal taxa primarily use their hosts as habitat is clearly due for some rethought. Finally, as an isotope ecologist, I am happy to note how this study highlights the utility of stable isotope analysis to reveal cryptic trophic relationships that have the potential to completely change our understanding of even well-studied taxa and ecosystems.

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