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Growth-related trophic changes of Thunnus thynnus as evidenced by stable carbon and nitrogen isotopic values in the first dorsal spine

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The bluefin tuna, *Thunnus thynnus* (Linnaeus, 1758), is a highly migratory and long-living fish at the top of the pelagic food web. As top predator, it plays a key role in the stability of marine food webs by exerting top-down control on its prey. However, the diet composition of bluefin tuna varies in relation to its growth, seasons and migratory patterns, making it difficult to evaluate spatial and temporal effects. This latter aspect is further complicated to be determined during the first months of life, when *Thunnus thynnus* specimens have a rapid growth rate leading to changes in the tropic status.

A methodological approach, based on the analysis of stable carbon and nitrogen isotopes (δ^{13}C and δ^{15}N) of the first dorsal spine of bluefin tuna, is adopted in the present study and provides useful information on the trophic dynamics, from early to adult life stage.

Furthermore, the potential collagen-related effects on δ^{15}N and δ^{13}C values were evaluated on the whole spine of adult specimens (FL $>$ 50 cm) collected in the Central Mediterranean sea. Obtained results showed no significant differences between extracted and non-extracted collagen samples for δ^{15}N in whole spine, allowing to adopt such methodology both for *annuli* in the spine section and for younger specimens (FL $<$ 50 cm), whose spine size does not permit the collagen extraction.

Specifically, isotopic analysis of whole spine of tuna specimens with FL $<$ 50 cm showed a rapid change in δ^{15}N values with length, while for longer specimens (FL $>$ 50 cm) δ^{15}N values varied slowly with length, likely due to a higher specificity in the choice of prey. Such trend was also mirrored in *annuli* of spines sections of adult tunas.

As far as δ^{13}C values are concerned, a strong collagen-related effect was evidenced, likely highlighting the influence of lipids. Therefore, the δ^{13}C values may be used only on adult specimens where collagen extraction is possible. The observed high variability of δ^{13}C values in adults allowed hypothesizing a wide range of foraging habitats, in agreement with behavioral studies evidencing patterns of vertical and horizontal migrations.

This research showed how isotopic analysis of both whole sample and sequence of *annuli* in the cross-section of dorsal spine may produce isotopic profiles useful to detect trophic status and foraging habitat changes along the development of bluefin tuna. The proposed approach may support the adoption of isotopic analysis where the amount of sample material is not enough to perform the collagen extraction, such as in archeological studies based on paleodiet.