ISOTOPIC OFFSET BETWEEN MUSCLE AND SCALES OF THREE MEDITERRANEAN FISHES: *DENTEX DENTEX, ARGYROSOMUS REGIUS* AND *XYRICHTYS NOVACULA*, AT MARINE PROTECTED AREAS

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Abstract
The present work test fish-scale sampling as a non-lethal technique for trophic level assessment instead of muscle isotopic determinations in fishes *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula*. The isotopic offset (Δ^{13}Cand Δ^{15}N) between muscle and scales indicate that the application of scales instead of muscle allow to apply non-lethal methods on isotopic studies regarding fish species for conservation purposes. This technique has been proven to be appropriate for trophic studies of fishes at marine protected areas

Keywords: Carbon, Food Webs, Trophic Relations

Introduction
Stomach content analysis provides information on recently ingested food sources while stable isotope analyses, particularly carbon and nitrogen, provides information on the long-term diets of organisms. Environmental conditions preserve chemical recording in animal tissues [1]. The analysis of different tissues gives the advantage of revealing the timescale needed to assimilate a new nutrient source [2]. Studies on fish tissue-diet isotope offset of endangered or protected fish species allows us to focus on conservation management.

Material and Methods
Fishes *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula* were selected owing to their wide distribution in Mediterranean waters, their economic importance and their value in the recreational fisheries of the Balearics. Isotopic composition (δ^{13}C and δ^{15}N) of white muscle and scales of *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula* are represented in Figure 1.

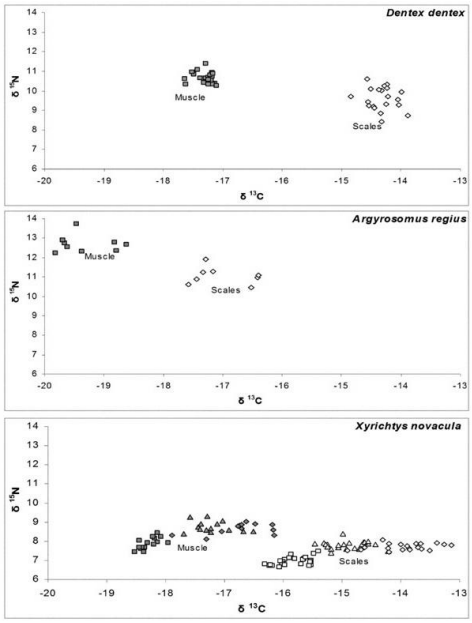

Fig. 1. Distribution of carbon and nitrogen stable isotope ratios (δ^{13}C and δ^{15}N) of farmed *Dentex dentex* (n = 20), farmed *Argyrosomus regius* (n = 9) and wild *Xyrichtys novacula* (n = 41), significant differences ($p < 0.001$) observed between tissues. Squares represent free-bone white muscle and rhombuses represent fish scales.

Results and Discussion
The present work shown significant correlation between stable isotope muscle tissue and scales signatures in *A. regius* ($p < 0.01$) and in *Xyrichtys novacula* ($p < 0.001$). No correlation was found in the muscle and scale stable isotope signatures of *Dentex dentex*. Nonetheless, all the species sampled showed significant differences between muscle and scale stable isotope (δ^{13}C and δ^{15}N) signatures (Paired t-test, $p < 0.01$). Tissue offset of ^{13}C and ^{15}N values derived from isotopic analyses of *D. dentex* did not varied significantly (Figure 2) and presented a constancy in the offset values (enriched 3.02 ± 0.06‰ for ^{13}C and depleted 0.91 ± 0.14‰ for ^{15}N). *A. regius* and *X. novacula* presented a linear regression (^{13}C enrichment of 2.27 ± 0.07‰ and 2.52 ± 0.04‰ and ^{15}N depletion of 1.69 ± 0.06‰ and 0.96 ± 0.03‰, respectively). The present work has yielded a correction factor for isotopic analyses that may be applied to marine fish species *Argyrosoums regius* and*Xyrichtys novacula*. The constancy in isotopic offset values of the farmed fish *Dentex dentex* (with a linear regression close to $R^2 = 0$; Figure 2) was related with the straight length values of the sampled individuals. Those results implie that lethal sampling is unnecessary, since other non-lethal tissues can provide a measure of the δ^{13}C and δ^{15}N signatures without affecting abundances by removing resources from the ecosystem or reducing their gene pools [3].

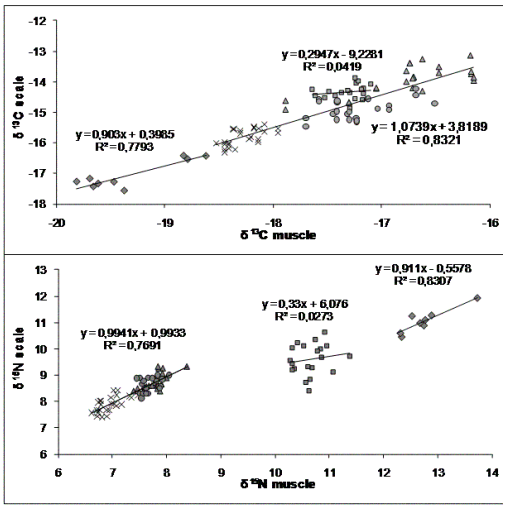

Fig. 2. Isotopic offset for δ^{13}C (A) and δ^{15}N (B) between free-bone white muscle and scales from *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula*

References
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