TROPHIC RELATIONS OF WILD FISH ASSOCIATED TO AN OPEN-WATER FISH FARM IN THE SOUTHWESTERN MEDITERRANEAN

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Abstract
The aim of this work was to determinate the trophic relationships of wild fishes associated to an open sea fish farm. We take samples of cultured and wild fishes in an ecological gradient to analyze his contents of stable isotopes of carbon and nitrogen. This study showed how the influence of the uneated feed of net-cages change the normal trophic behaviour of associated wild fishes.
Keywords: Aquaculture, Food Webs, Fishes

Introduction
The fish farms in open sea attract an unusual ichthyc biomass [1]. The reason of this attraction is not clearly identified, nevertheless is possible that the high protein food lost through the cages could have an elevated attractable effect on the wild fishes. The presence of a high number of fish-farms in the Mediterranean Sea, make indispensable more studies related to this system and the trophic structures in wild fish associates [2].

In studies of marine ecology, stable isotopes analyses have emerged as reliable tools for elucidating trophic structure and inferring pathways of energy flow in food webs. $\delta^{13}C$ allows differentiates the carbon source, while $\delta^{15}N$ permit us assess the relative trophic position of an organism. Thus nitrogen and carbon stable isotopes can provide us the time-integrating fish's trophic interactions [3].
The objectives of this study were to determinate if the fish consume the products of the net-cages and to trace its influence related to the distance of the culture. It was measured by the content of stable isotopes in pelagic fish associated to the fish farm, which also allows us an approaching to explain at specific and community level how the net cages influences on the trophic relationships of wild fish.

Materials and methods
This study was carried out in the surroundings of a marine fish farm located in Águilas, SE Spain, (western Mediterranean; 37º 24' 56.2" N, 1º 32' 4.0" W), which produces gilthead sea bream (*Sparus aurata*) and European sea bass (*Dicentrarchus labrax*). We defined four stations for analyses: (I) Inside the cages, (O) Outside the cages (ca, 90 m around the net-cages), (F) Fraile Island (750 m to the west to the net-cages), and (C) Cape Cope (2500 m to the east from the net-cages) as control station. At each station, the diversity and abundance of the fish community were valuated by visual techniques. Also we take samples of white muscle of each species of fish and freeze-dried it for stable isotopes analyses. The carbon and nitrogen isotope ratios of the samples were measured with an elemental spectrometer of isotopic relationships Delta^{plus} (ThermoFinnigan). All the isotopic data were reported in the conventional δ notation. δ13C values were reported as the deviation relative to the Vienna Pee Dee Belemnite Limestone Standart (v-PDB), while δ15N standards were calibrated and results were reported relative to atmospheric nitrogen.

Results and discussion
The higher wild fish abundance was found closed to the fish farm, demonstrating the attraction effect of the open water aquaculture. The community structure of wild fish also changed depending of distance from fish farm. The isotopic analyses of $\delta^{13}C$ and $\delta^{15}N$ showed a tendency to major accumulation of carbon isotopic in fishes of stations away from the net cages.
The spatial pattern of $\delta^{15}N$ did not exhibit clear differences between stations (Figure 1). The changes in the isotopic concentrations were accompanied by a notorious compression of the trophic niche of fish communites closer to the artificial feed source (Figure 2).

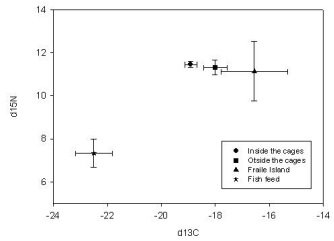

Fig. 1. Bi-plot of $\delta^{13}C$ and $\delta^{15}N$ accumulation (mean ± SE n=4), for European sea bass (*Dicentrarchus labrax*) and fish feed

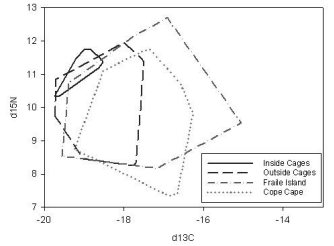

Fig. 2. Dispersion of fish community content of carbon and nitrogen stable isotopes in each station. These results are representative of 89 fish and 19 species

This adaptative behaviour of wild fishes to an artificial source of food would imply ecological consequences that should be deeply analyzed.

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