TROPHIC TRANSFER OF POPS IN PLANKTON AND SMALL PELAGIC FISH IN THE WESTERN MEDITERRANEAN AND ADRIATIC SEA

J. Tronczynski [1]*, F. Carlotti [2], G. Kušpilic [3], K. Vorkamp [4] and J. Cadiou [5]
[1] Ifremer, Centre Atlantique, Unité Biogéochimie et Ecotoxicologie, 44311 Nantes, Cedex 03, France - Jacek.Tronczynski@ifremer.fr
[2] Aix Marseille Université, CNRS, Université de Toulon, IRD, MIO UM 110, 13288, Marseille, France
[3] Institute of Oceanography and Fisheries, IOF, Šetalište I. Meštrovica 63, 21000 Split; Croatia.
[4] Aarhus University, Department of Environmental Science, 4000 Roskilde, Denmark
[5] Ifremer, Centre de Méditerranée Zone Portuaire de Brégaillon ; 83507 La Seyne sur Mer, France

Abstract
Transfer of persistent organic pollutants within the plankton and the short food web of small pelagic fish (anchovies and sardines) was studied in the areas of the Western Mediterranean and Adriatic Sea. Spatial variations in the levels of POPs were observed. Relationships between POP concentrations and size class of plankton and plankton $\delta^{15}N$ signatures were examined. The highest concentrations of POPs were found in bacteria /nano and picoplankton and small pelagic fish. The results indicate that it is difficult to clearly distinguish prey-predator contaminant transfer in plankton. Anchovy plays a pertinent role in the transfer of contaminants to the open seas. Moreover, this study provides valuable insight for better understanding of interactions between the planktonic prey species and their predators.

Keywords: Food webs, Bio-accumulation, Plankton, Pcb, Mediterranean Sea

Introduction
Recent assessments of the present status and trends show that pollution by harmful substances continues to degrade coastal as well as remote areas of the Mediterranean and Black Seas [1]. In the open seas, a main concern with persistent organic pollutants (POPs) is related to their strong propensity to bioaccumulate in marine organisms, and to biomagnify up to the food chains [2]. Interaction between plankton and their predators have a key role in the trophic link between the planktonic ecosystems and the trophic levels of fish. The present study is aimed at better understanding of the bioaccumulation of POPs within the first levels of the marine trophic chain, including pico- and nanoplankton, and planktivorous small pelagic fish in the Gulf of Lion (GoL), Western Mediterranean and Eastern Adriatic Sea.

Material and Methods
Plankton and water samples were collected in the GoL and Adriatic Sea in spring and winter, during several research cruises in 2011 and 2014 (Costeau 5 and 7 and Persmed 1 and2). ** Plankton (phytoplankton and zooplankton) was collected with a net of 60 µm mesh size and fractionated on a sieve column to four size-classes (60-200, 200-500, 500-1000, 1000-2000 µm). The smallest plankton fraction, 0.7 - 63 µm, was obtained by *in situ* large volume pumping sampler (McLane WTS-LV). Small pelagic fish (mainly anchovies and sardines) were caught in the narrow size range, in the Gulf of Lions and in the Adriatic Sea, during reproduction and the resting seasons (cruises: PELMED-10 and -14; MEDITS -14).

Results and Discussion
The results show that levels of PCBs and PBDEs in phytoplankton and zooplankton in the GoL are spatially influenced by the distance from contamination source and that marine plankton seems to be able to assimilate rapidly POP compounds at the sites near the source of contaminants. Such spatial trend is not found in the smallest fraction of plankton, 0.7 - 63 µm. This fraction shows significantly different $\delta^{13}C$ and $\delta^{15}N$ signatures compared to other plankton fractions, indicating a high contribution of bacteria /nano and picoplankton to organic carbon pool in these samples. The relationships between POP concentrations and size class of plankton and plankton $\delta^{15}N$ signatures are found to be compound, season and location dependant. The highest concentrations of POPs were determined in the smallest fraction, 0.7 - 63 µm, of plankton (Figure 1). So far, the role of this fraction in the transfer of contaminants within plankton communities has been poorly documented. Furthermore, our results indicate that it is difficult to clearly distinguish the prey-predator contaminant transfer within planktonic food-webs. Larger zooplankton size classes are composed of organisms with different feeding habits, including herbivores, carnivores and detritivores, prone to adapt their diet to the quantity of the available resources. Additionally, size class and isotope signatures of field samples do not necessarily reflect a prey-predator relationships, complex ecology and ecosystem interactions within plankton communities. The highest concentrations of selected POPs (PCBs and PBDEs) were found in small pelagic fish tissues with higher total lipid content (liver, viscera and remaining carcass). The results also show that distribution of toxic substances in tissue of small pelagic fish is affected by metabolic processes. Differences in concentrations between male and female specimens are related to the loss of contaminants in females during spawning. Finally, the trophic transfer of selected POPs between plankton and small pelagic fish is assessed for an entire range of PCB congeners, along with the corresponding biomagnification factors, log(BMF fish/plankton), and their octanol water partition coefficients, log(Kow).

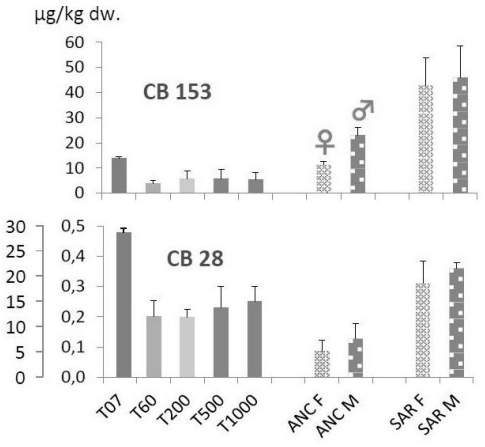

Fig. 1. CB153 and CB28 mean concentrations (µg/kg dw.) in the different size class of plankton (including 0.7- 63 µm of pico – nanoplankton and bacteria) compared to their concentrations in the muscle tissue of small fish and sardine (male and female); Second ordinate for CB28 in 0.7-63 µm fraction.

** Cruises performed within COSTAS-ANR and PERSEUS-EU projects.

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