DETECTION OF ZOOPLANKTON PREDATOR-PREY INTERACTIONS IN ALBORAN SEA BY COMBINING ACOUSTIC BACKSCATTER DATA AND DIFFERENT BIOLOGICAL SAMPLING SYSTEMS

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Abstract
Multifrequency acoustic technology was used to detect the summer epipelagic scattering layer associated with a heterogenic zooplankton community in Alboran Sea. Simultaneously, identification hauls by means of two different plankton net (bongo 40 equipped with 250 and 333 µm mesh and bongo 90 equipped with 500 and 2000 µm mesh) were performed to obtain taxonomical and quantitative characteristics of the zooplankton community. Collected data revealed a strong correlation between the abundance of small crustacean (prey) captured by the 250 µm mesh with the abundance of chaetognaths, siphonophores and fish larvae (predators) captured by 500 µm mesh.

Keywords: Zooplankton , Acoustics, Trophic relations, Alboran Sea, Mediterranean Sea

Introduction
In economic terms, the plankton may be less important than fish, but they are central to ecological research, being at or near the bottom of the food chain. Acoustic methods for the study of plankton in their natural environment have developed rapidly in recent years and are now well established as a remote-sensing and unobtrusive means of observation in biological oceanography. Plankton produce echoes by the same scattering laws as any other target. Since they are chiefly small to microscopic objects in close proximity to one another, the echoes overlap to form the diffuse cloud-like marks often seen on echograms (plankton layers). Some non-acoustic evidence, such as net samples, is normally required to determine the species composition of echo traces [1]. The choice of net mesh size is an important issue. No one single net is suitable to sample across a wide size range of zooplankton from small mesozooplankton forms to macrozooplankton [2]. The combined use of acoustic data and different net samplers let us study the zooplankton community through different trophic levels and move forward to the integrated pelagic ecosystem understanding.

Material and methods
The study was carried out in the Spanish continental shelf (from 30 to 200 meters depth) of Alborán Sea during the summer of 2013 and 2014. An EK60 scientific echosounder operating at five frequencies (18, 38, 70, 120 and 200 kHz) was employed to locate the zooplankton epipelagic community. In order to identify multiples trophic levels, two different nets with four different meshes were employed: a bongo 90 with a quadrangular mouth (90 cm) opening equipped with 500 and 2000 µm meshes, and a bongo 40 (40 cm diameter) with a 250 and 333 µm meshes. From every sample collected on the 36 tows (20 in 2013 and 16 in 2014) three subsamples were analyzed for zooplankton composition by microscope. For the purpose of this study and taking into account the acoustic properties of different types of scatterers [3], nine categories of zooplankton were considered: small crustaceans (smaller than 1.2 mm), big crustaceans (larger than 1.2 mm), chaetognaths, siphonophores, apendicularias, doliolids, fish eggs, fish larvae and heteropods. The number of individuals of each category per cubic meter of water was calculated according to the number of individuals caught and the volume of water filtered. Multiple Correlation analysis between the organism abundance captured by one net with the others was carried out to detect trophic interactions in the zooplankton community sampled.

Results and discussion
The smaller mesh sizes (250 and 333 µm) captured mainly small crustaceans and apendicularias, which represented the primary consumers. The 500 and 2000 µm mesh captured the largest and less common organisms (mainly big crustacean, chaetognaths, siphonorores and fish larvae) which could be understood as secondary consumers. The sample multiple correlation coefficient revealed a strong association between the small crustacean captured by the 250 µm mesh with the chaetognats (r=0.74, p-value=0.002), siphonophores (r=0.67, p-value=0.03) and fish larvae (r=0.64, P-value=0.05) captured by 500 µm mesh.

Tab. 1. Multiple correlation analysis between the organism abundances captured by Bongo 40 (250 µm mesh size) and Bongo 90 (500 µm mesh size). Ap: Apendicularias, Bc: Big crustaceans, Sc: Small crustaceans, Do: Doliolids, He: Heteropods, Eg: Fish eggs, La: Fish larvae, Ch: Chaetognaths, Si: Siphonophores.

		Bongo 40, 250 µm								
		Ap	Bc	Sc	Do	He	Eg	La	Ch	Si
Bongo 90, 500 µm	Ap	0.05	-0.05	-0.28	-0.35	0.14	0.04	-0.02	0.12	-0.07
	Bc	0.32	0.90	0.52	-0.13	-0.40	0.64	-0.15	-0.11	0.20
	Sc	0.06	0.18	-0.07	-0.11	-0.14	0.43	0.11	0.23	-0.12
	Do	0.29	-0.21	-0.03	0.81	-0.33	0.03	0.23	-0.06	0.01
	He	0.10	-0.23	0.35	-0.11	0.53	-0.36	0.63	0.74	0.34
	Eg	0.19	-0.20	-0.18	0.76	-0.45	0.17	-0.02	-0.32	-0.11
	La	0.42	0.24	**0.64**	-0.36	0.14	0.09	0.07	0.45	0.12
	Ch	-0.13	-0.08	**0.74**	-0.26	0.34	-0.13	0.42	0.86	0.29
	Si	0.02	-0.11	**0.67**	-0.16	0.25	-0.22	0.47	0.73	0.47

This study demonstrates that the summer epipelagic scattering layer is composed of a complex and heterogeneous zooplankton community in which, interactions between different trophic levels can be distinguished.

References
1 - Simmonds E.J. and MacLennan D.N. 2005. Fisheries acoustics. (2nd ed.). Oxford: Blackwell Science Ltd.
2 - Skjoldal H.R., Wiebe P.H., Postel L., Knutsen T., Kaartvedt S., Sameoto D.D. 2013. Intercomparison of zooplankton (net) sampling systems: Results from the ICES/GLOBEC seagoing workshop. Prog. Oceanogr., 108: 1−42.
3 - Martin L. V., Stanton T. K., Wiebe P. H. and Lynch J. F. 1996. Acoustic classification of zooplankton. ICES Journal of Marine Science, 53: 217–224.