OBSERVATIONS OF PHYSICAL AND BIOLOGICAL ROUGHNESS ON THE EBRO DELTA INNER SHELF

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Abstract

Time series of video observations of the sea bottom in the Ebro Delta inner shelf were analyzed in order to estimate the bottom roughness associated with both physical and biological morphological components. Video images display, for the most of the time, the ripples development on the bottom as active or relict bedforms.. Biological roughness is mainly caused by ophiuroids and shells tanatocenosis that change their abundance through the study period. Bottom physical roughness associated to ripples ranges between 0 and 3.2 cm whereas the total biological roughness ranges between 0.27 and 0.81 cm.

Keywords: Ripples, Benthic communities, Bottom Roughness, Ebro Delta

Introduction

Bottom roughness could be understood as a measure of the morphological variability with respect to a flat bottom. The bottom roughness is a crucial parameter because it determines the shear stress of waves and currents on the bottom and, consequently, the rate of sediment transport in the bottom boundary layer.

It has been identified three kinds of roughness (1,2): grain roughness, moveable bed roughness and form drag roughness. In sandy bottoms and under high energetic conditions moveable bed roughness would be the most important type of roughness, while form drag roughness would be for intermediate-low ones. On the other hand, silty bottoms roughness is usually dominated by bioturbation and, as a consequence of that, form drag roughness would be the main type of roughness (2).

In this paper changes in the physical and biological bottom roughness in a sandy bottom of the Ebro Delta inner shelf are studied.

Materials and Methods

One benthic tripod was deployed and an oceanographic cruise was carried out in November 2001 in the Ebro Delta (NW Mediterranean) during 9 days. Bottom sediment grain size and time-series of waves, currents and time-lapse video images were monitored at 9 m depth. Using time-lapse video images morphological features and biological components on the bottom were analyzed in order to obtain bottom physical roughness values (K_b). The Grant and Madsen (1) expression was used for the estimation of the physical roughness: $K_b = 27.7\ \eta_r^2/\lambda_r$, being λ_r the observed ripple wavelength and η_r the ripple height (which has been measured by divers and considered constant (1 cm). On the other hand, the biological roughness (K_{bio}) was estimated from measurements of density and sizes of main biological components using a modified Grant and Madsen expression (2), η_{bio} (the biological obstacles height) was assumed constant ($\eta_{bio} = 0.3$ cm) and λ_{bio} (distance between biological obstacles) was calculated as the square root of the inverse obstacles density.

Results

Observed ripple wavelength varies between 8.6 and 12.9 cm. As a result of this, observed physical bottom roughness takes values between 2.14 and 3.23 cm. When the bottom was completely flat it was assigned to K_b the value of median grain size (D_{50}) (Fig. 1).

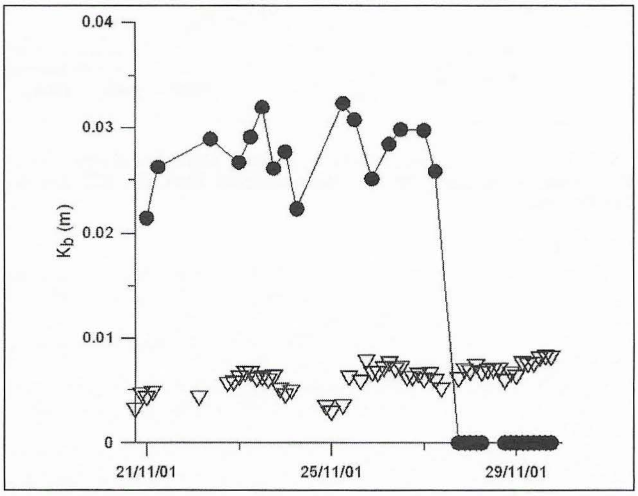

Fig. 1. Observed physical (●) and biological (▽) bottom roughness during the study period.

Ophiuroids and pieces of shells are the most important biological components that affect bottom roughness during the study period. Ophiuroids density has reached values near 170 individuals per square meter, causing a K_{bio} that oscillates between 0.05 and 0.32 cm. Pieces of shells are very abundant (maximum values near 650 pieces per square meter) and contribute to bottom biological roughness in ranges between 0.15 and 0.64 cm. Figure 2 shows tendencies in both kinds of biological roughness. Ophiuroids do not present a marked tendency through the study period while pieces of shells increase its values in time. Total K_{bio} (sum of K_{bio} obtained by ophiuroids and shells) displays values from 0.27 to 0.81 cm.

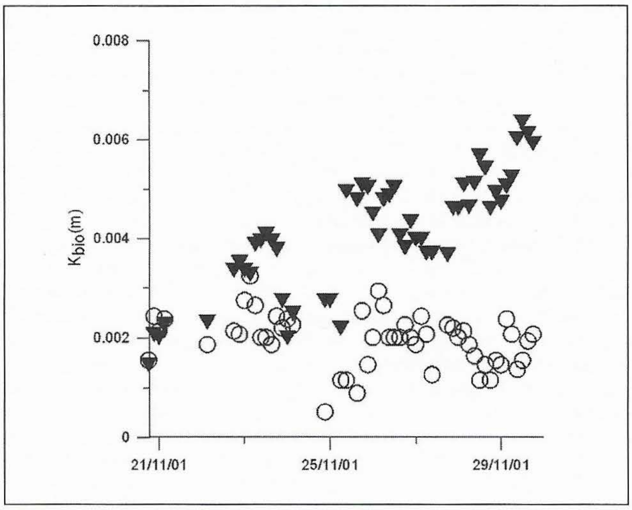

Fig. 2. K_{bio} for ophiuroids (O) and shells pieces (▼)during the study period.

Discussion and conclusions

The present work shows the relative contribution of biological components and sedimentary structures tothe bottom roughness. Ripple morphology remains relatively constant during the study period, although they are flattened by ophiuroids bioturbation. Ophiuroids density is rather steady during the study period whereas pieces of shells increase its abundance (and its contribution to the bottom roughness) as a consequence of being inert biogenic material appearing after storm periods in the bottom surface.

The biological roughness represents a subordinate but not negligible amount (about 20%) of the form drag roughness. Therefore, physical and biological roughnesses coexist and both should be taken into account for sediment transport studies.

References

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