INERTIAL BIOLUMINESCENCE RHYTHMS AT THE CENTRAL MEDITERRANEAN KM3NET DEEP-SEA NEUTRINO TELESCOPE

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Abstract

Here, we used data from the prototype tower detector installed 80 km off-shore Capo Passero in the abyssal Central Mediterranean KM3NeT neutrino telescope (3500 m depth), to portray bioluminescence rhythms at different depths of the structure. The tower raises 420 meters above the bottom and contains 8 floors (3349-3069 m). We focused on 10-min bioluminescence readings for June 2013, as detected by Photo Multiplier Tubes. A significant periodicity in bioluminescent intensity, equivalent to ca. 20.27h, was detected. A time-lag in phase timing appears from shallower to the deeper floors, with progressive dampening of bioluminescence fluctuations. The presence of structured peaks in overall bioluminescence suggests that drifted organisms travel in discontinuous swarms and bursts are provoked by currents bringing animals against the tower.

Keywords: Abyssal, Deep sea ecology, Vertical migration, Ionian Sea

Introduction

Presently, the ecological relevance of bioluminescence emitted by deep pelagic fauna and its temporal pattern due to the interaction of animals with cyclic water flow changes are poorly known. In the Mediterranean Sea tidal forces are almost negligible and may be replaced by sea winds producing inertial currents. We used data from the prototype tower detector installed in Capo Passero site (80 km off-shore) in the abyssal Central Mediterranean KM3NeT deep-sea neutrino telescope, deployed at 3500 m depth (KM3NeT; www.km3net.org), to portray bioluminescence rhythms at different depths of the structure. Therefore, detected temporal variations in bioluminescent intensity were used here for the first time as a proxy of deep vertical displacements of abyssopelagic fauna.

Materials and Methods

The Cherenkov neutrino telescopes are deep-sea research infrastructures, belonging to the KM3Ne network in the Mediterranean Sea. Their primary goal is the detection of high energy neutrinos of astrophysical origin into dark marine backgrounds. Each tower raises 750 mab and contains 8 floors separated by 40 m (from 3349 to 3069 m of depth). We focused on 10-min bioluminescence readings for the month of June 2013, as detected separately by Photo Multiplier Tubes. We also recorded by 10 min tower movements as a proxy for currents.

Results

We obtained a total of 32,970 bioluminescence readings by 10 min at the 8 telescope floors. We detected a significant fluctuation periodicity in bioluminescent intensity, corresponding to inertial currents at the latitude of the telescope site (i.e. periods between equivalent to 20.27±0.12 h at all 8 floors). Waveform analysis outputs (Fig. 1), based on mean periodogram results (i.e. time series subdivided into sub datasets of 20.5 h length. equivalent to 1230 min), clearly indicate the presence of mean pattern of fluctuations in bioluminescence at each telescope floor. A progressive dampening of mean bioluminescence fluctuations occurs from shallower to the deeper floors, with the exception of floor no. 5. A time lag in phase timing seems to appear as function of depth.

Discussion

The inertial-related periodicity here found points out a strict relationship between currents and the phenomenon of bioluminescence, based on mechanical stimulation. Results suggested that organisms drifted by currents hit the deployed telescope infrastructures, resulting emission peaking at collision (Tamburini et al., 2013). Further, the presence of temporally structured peaks and troughs in average overall bioluminescence suggests that drifted organisms travel in discontinuous swarms and bursts are provoked by currents bringing animals against the tower structure. A question still to be solved is related to the identification of which organisms are responsible for the reported bioluminescence temporal patterns.

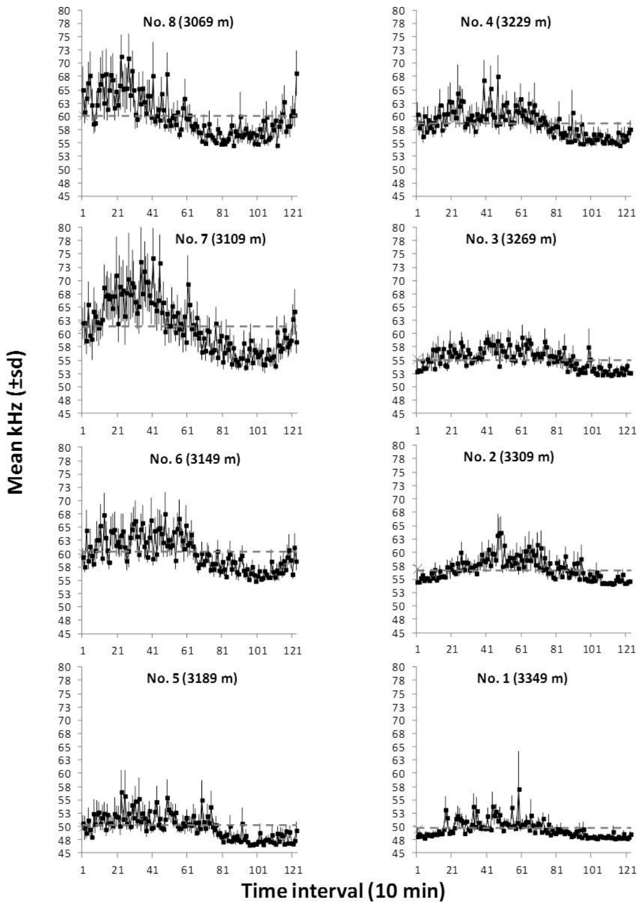

Fig. 1. Waveform analysis outputs indicating the occurrence of bioluminescence phase and amplitude. Horizontal dashed lines define peaks temporal amplitudes.

References

1 - Tamburini C., Canals M., Durrieu de Madron X., Houpert L., Lefèvre D., Martini S., et al. 2013. Deep-sea bioluminescence blooms after dense water formation at the ocean surface. *PLoS ONE*, 8(7): e67523.