

# BENTHIC FORAMINIFERAL FAUNAS ALONG THE FRENCH MEDITERRANEAN COASTS: A NEW BIOTIC INDEX IN THE EU WATER FRAMEWORK DIRECTIVE

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## Abstract

Along the French Mediterranean coast, we monitored ecological quality based on living benthic foraminifera. We reassessed the Foraminiferal Index (FI) including smaller stress-tolerant species, and investigated the interest of dead assemblages to evaluate the historical evolution of the studied ecosystems.

*Keywords: North-Western Mediterranean, Foraminifera, Bio-indicators, Monitoring, Zoobenthos*

## Introduction

Benthic foraminifera are excellent biomonitoring tools. They are short living and react rapidly to environmental changes. They occur in high numbers and are preserved in the sediment record, allowing the reconstruction of the historical evolution of the investigated area. We studied recent benthic foraminiferal faunas on the French Mediterranean coast, in order to improve a new ecological biomonitoring index, FI (Foraminiferal Index) [1]. In the context of the European Union Water Framework Directive, our aims were (i) to monitor the ecological quality along the French Mediterranean coast; (ii) to improve the FI; (iii) to use the dead foraminiferal faunas for the reconstruction of past ecological conditions.

## Material & Methods

In April 2012, 36 stations were sampled along the French Mediterranean coast (Figure 1). This study follows a previous survey from 2009 in the same area [1]. Sampling and samples were processed respecting recommendations of the FOBIMO (FORaminiferal BIO-MONitoring initiative) group [2]. Three replicates were taken from different Reineck box-core launches at each station. Our study focusses on the topmost first centimetre of the sediment (sub-cores of 7.1 cm in diameter). Samples were preserved in ethanol and stained with 2 g/l Rose Bengal. Living foraminifera from the 125-150 and 150-500 µm fractions were wet-picked and determined at a species level using earlier Mediterranean studies. To characterise foraminiferal faunas, we calculated several diversity indices, defined indicative species groups based on literature (sensitive, stress-tolerant and epiphytic species), and calculated FI. This index is based on the relative proportions of stress-tolerant species and includes a correction for the sediment grain size. Finally, the succession of dead foraminiferal assemblages was studied at three sites, in <sup>210</sup>Pb dated sediment cores.

## Results and Discussion

Two strongly contrasting zones have been studied: the Gulf of Lion (West) and the PACA (Provence-Alpes-Côte d'Azur) area (East) (Figure 1). Corsica is associated to the eastern area. Stations from the Gulf of Lion have an average depth of 17 m and are characterized by sandy sediment. Stations from the PACA area are on average 37 m deep and mainly constituted of clayey to silty sediment. These different sedimentary environments resulted in very different foraminiferal assemblages, largely complicating the attribution of ecological quality classes. Since the coarser sediments in the east naturally host much lower percentages of stress-tolerant taxa, the correction on the basis of grain size characteristics is an essential part of our bio-indication method.

At some stations we observed high variability of the foraminiferal fauna between replicates. This can be due to small scale spatial variability, but also partly due to sampling bias (partial loss of the sediment surface layer containing rich foraminiferal faunas). Our data underline the need to sample at least three independent replicates per station. In total we observed 261 species. The study of the 125-150 µm (not studied in 2009) yielded 8 ± 4 new species per station. This fraction is not only characterised by juveniles, but also by small-sized species which are often known for their opportunistic tendency. Therefore, the study of the 125-150 µm produces important additional information.

In 2009, the FI (FI<sub>2009</sub>) was defined on the base of the 150-500 µm fraction. The FI<sub>2009</sub> shows a good constancy in the replicates, except at three stations. In general, there are few differences in FI<sub>2009</sub> values between the same stations in 2009 and 2012. Only stations Carry, Carteau, Cap Canaille, Leucate and Toulon have a lower ecological quality status in 2012. In order to also take into account the 125-150 µm fraction (including additional stress-tolerant species), the reference conditions for FI calculation was reassessed using only the data from the 2012 survey (FI<sub>2012</sub>). For most stations, the FI<sub>2012</sub> values were slightly higher than the FI<sub>2009</sub> values. However, in most cases, the ecological quality status remained unchanged.

The three studied sediment cores go back in time for 20 to 65 years. Direct comparison between dead and living faunas is difficult because of important bias due to taphonomic processes. Nonetheless, this study has the merit to place the one-time observations of the composition of the living foraminiferal faunas and the ecological quality index in a historical perspective.

## References

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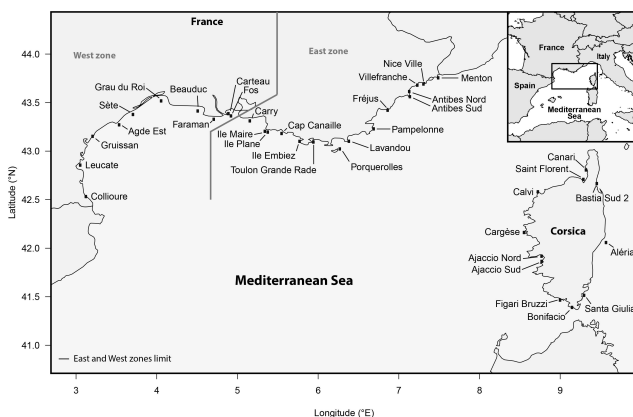


Fig. 1. Sampled stations during the survey in 2012. Two zones are shown, Gulf of Lion (West) and PACA (Provence-Alpes-Côte d'Azur) + Corsica (East).