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BENFES, a new biotic index for assessing ecological status of soft-bottom communities. Towards a lower taxonomic complexity, greater reliability and less effort

J.E. Sánchez-Moyano*, I. García-Asencio, I. Donázar-Aramendía, J.M. Miró, C. Megina, J.C. García-Gómez

Laboratorio Biología Marina, Dpto. Zoología, Facultad de Biología, Universidad de Sevilla, Avd. Reina Mercedes 6, 41012 Sevilla, Spain

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ABSTRACT

The new biotic index BENFES (Benthic Families Ecological Status Index) for assessing the ecological status of soft-bottom communities based on presence/absence at the taxonomic family level, is described. BENFES was primarily developed for the communities from the Guadalquivir estuary (South-western Spain), but the aim of the present work was to evaluate the reliability and validity of this index for its application in the Water Framework Directive (WFD), especially as a preliminary and rapid assessment method for monitoring the ecological status of transitional and coastal waters. BENFES was compared with five widely used indices (BOPA, BO2A, BENTIX; AMBI and M-AMBI) in several studies from Southwestern Spain. In addition, we have also established comparisons between these indices and the most commonly used Shannon–Wiener diversity. M-AMBI and BENFES showed the best agreement in ecological status assignation and were the most useful and discriminant between the studied areas. BENTIX was a good discriminant in coastal areas but was severe with the environmental condition from estuaries; BOPA/BO2A did not show clear trends in most of the zones; and AMBI tended to provide overestimations of the ecological status. In conclusion, BENFES shows several advantages such as lower taxonomic resolution, greater reliability and only requiring presence/absence. All this implies a huge possibility to perform a simplified monitoring routine for the control of the ecological quality of water bodies.

1. Introduction

The Water Framework Directive (WFD, 2000/60/EC) and the Marine Strategy Framework Directive (MSFD, 2008/56/EC) established ecological status as the main tool for the management and monitoring of European coastal and transitional waters, integrating both biological and physico-chemical elements (Borja et al., 2009). In this context, soft-bottom macrofauna are considered a key element of marine and estuarine monitoring programmes (Ysebaert and Herman, 2002) because of their high ability to reflect the ecological status of the environment (Dimitriou et al., 2012) due to limited dispersal or sessile habits, sufficiently long life-cycles, relatively high abundance and diversity, a variety of traits and their importance in cycling nutrients and materials between sediments and the water column (Birk et al., 2012; Dauvin et al., 2012; Sousa et al., 2008; Sánchez-Moyano and García-Asencio, 2010).

In order to establish the environmental quality of European waters, several biotic indices, mainly based on the diversity and abundance of benthic communities (see Borja et al., 2015 and references and supplementary data therein), have been developed and tested in diverse habitats and different human disturbance or geographical regions (Borja et al., 2015; Dauvin et al., 2012; Pinto et al., 2009; among others). Although the different indices tend to provide similar characterization of the environmental quality (Dimitriou et al., 2012), none of them should be considered ideal for its measurement. Hence, many authors recommend the joint use of various indices and, even, simpler measures such as the professional judgement of experts (Dauvin et al., 2012; Teixeira et al., 2010). Other authors, such as Diaz et al. (2004) and Borja and Dauer (2008), consider that there are already too many indices and that the more correct option would be optimizing rather than creating new ones.

One of the main problems is that the more widely used indices, such as AMBI (Borja et al., 2000), BENTIX (Simboura and Zenetos, 2002) or BQI (Rosenberg et al., 2004), require work over a long period of time

* Corresponding author.
E-mail address: smoyano@us.es (J.E. Sánchez-Moyano).

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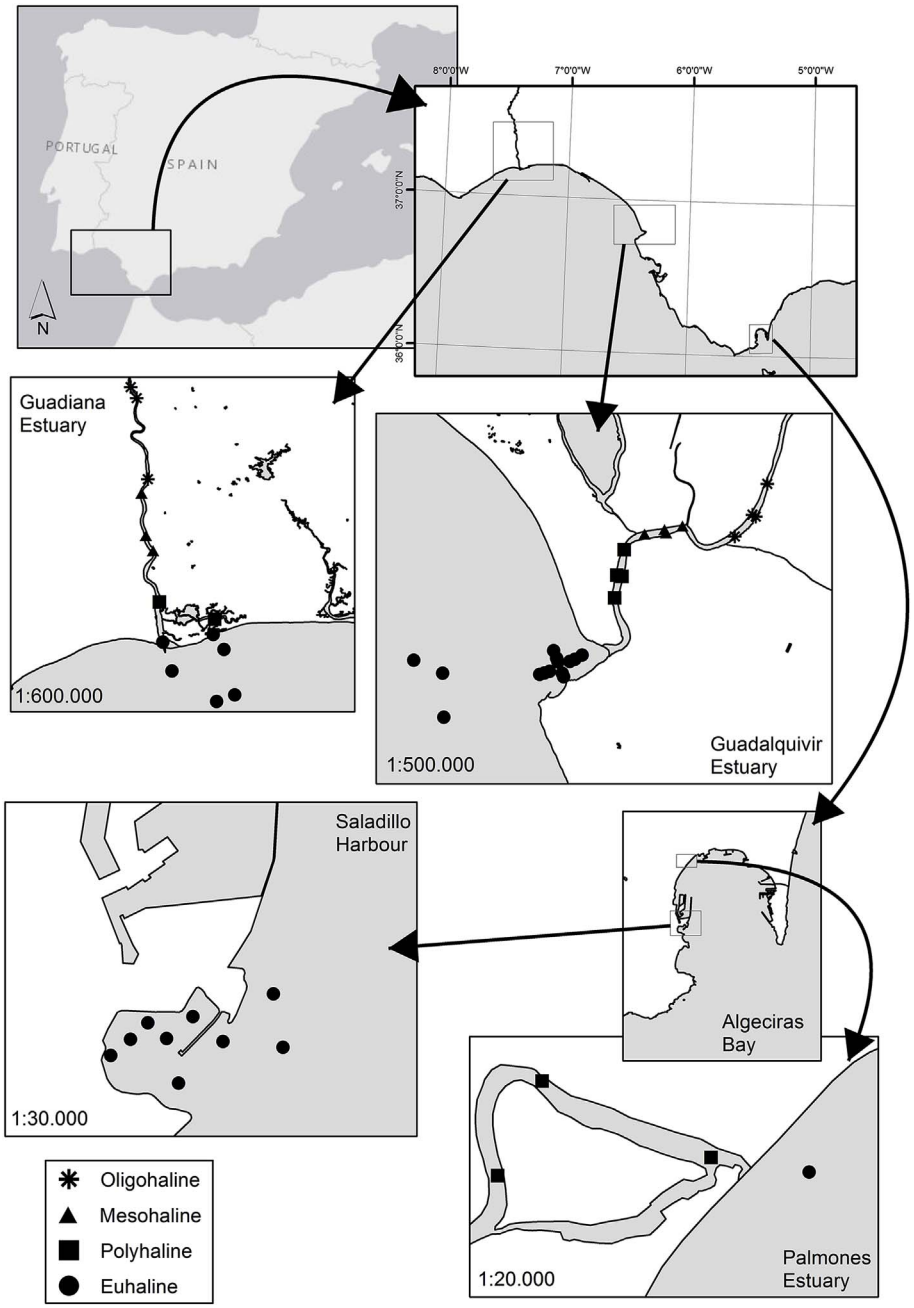

Fig. 1. Localization of the four study sites along the south Atlantic coast of Iberian Peninsula and Strait of Gibraltar. Salinity range of each sampling point is shown by a symbol.

and, in most cases, taxonomy experts for identifying the fauna to species level. Other indicators are based on the taxonomy sufficiency concept such as BOPA (Dauvin and Ruellet, 2007) or BPOFA (Dauvin et al., 2016), BITS (Munari et al., 2009) and BQI-family (Dimitriou et al., 2012), or they have been compared at the species and family level (see for example, BOPA and BENTIX comparisons in de-la-Ossa-Carretero et al., 2012), or are non-taxonomically based such as the size spectra index (Basset et al., 2012), but all of them involve the calculation of abundance. To date, the presence/absence of taxa has not been used mainly due to one of the premises of WFD that recommends that taxa abundance should be measured. The unique exception has been the Indicator species index (ISI) (Rygg, 2002) which takes into account only presence/absence data although it needs a previously collected abundance data set to calculate the sensitivity value of each species. However, Rygg and Norling (2013) have modified this index, later called the Norwegian Sensitivity Index (NSI), giving importance to abundance.

To manage and control the resources of any natural system, it is necessary to have good knowledge of its biological and physical structures, their ecological relationships and, consequently, the influence of socio-economic activities (de Jonge, 2000). According to Dauvin and Ruellet (2009), this question is especially complex in estuarine systems where we find naturally stressed environments due to the interaction of local physical, geological, chemical and biological factors with anthropogenic impacts. It is what these authors called the *estuarine quality paradox*. Consequently, estuarine macrofauna communities exhibit high resistance to pollution and interpretation of the effects of disturbance on these ecosystems is difficult (Dauvin, 2008; Tweedley et al., 2014). Several indices have been used to define the ecological status of these transitional environments (Borja et al., 2008; Costa-Dias et al., 2010; de Paz, et al., 2008; Feebarani et al., 2016; Puente and Diaz, 2008), and they often show discrepancies or inconsistencies in relation to classification (Blanchet et al., 2008; Brauko et al., 2015; Hutton et al., 2015; Nebra et al., 2014; Tweedley et al., 2015) since being naturally stressed environments, they can show a