

Macroinvertebrate indicators of ecological status in Mediterranean temporary stream types of the Balearic Islands



Liliana García*, Isabel Pardo, Cristina Delgado

Department of Ecology and Animal Biology, University of Vigo, Campus As Lagoas Marcosende, 36310 Vigo, Spain

ARTICLE INFO

Article history:

Received 25 June 2013

Received in revised form 19 May 2014

Accepted 28 May 2014

Keywords:

Bioindication

Macroinvertebrates

Multimetric index

Temporary streams

Water Framework Directive

ABSTRACT

In the last years the Water Framework Directive (WFD) has encouraged the development of classification systems to assess the ecological status in permanent rivers and streams, but in temporary streams development has been scarce. Here, we constructed an Invertebrate Multimetric index (INVMIB) to assess the ecological status of temporary streams in Mediterranean Islands based on benthic invertebrates following the WFD guidance. We studied 60 temporary streams in different seasons ($n=270$ samples), corresponding to three different stream types that were a priori established using topographical and valley information: lowland, canyon and mountain streams. We collected invertebrates with a multihabitat-based macroinvertebrate sampling standardised for a sampling area of 2.5 m², and stream water to analyse most relevant water chemistry variables. The analyses of benthic macroinvertebrate assemblages confirmed our stream typology (ANOSIM, $R=0.363$, $p<0.001$). The reference community of lowland streams was defined by taxa belonging to the order Diptera, the gastropod *Ancylus fluviatilis*, and several beetles and EPT taxa. Canyons showed a high diversity strongly dominated by dipterans and aquatic mites together with mayflies. Finally, the amphipod *Echinogammarus sicilianus-monomerus*, many dipterans of the Chironomidae family, together with beetles, mayflies, stoneflies and caddisflies were highly represented in the reference communities from mountain streams. The developed INVMIBs consisted of a combination of individual metrics that included diversity, tolerance/sensitivity and composition measures. The metrics and developed type-specific multimetric indices responded significantly to the gradients of pressures obtained from PCAs (i.e., general and organic degradation), as an integrated response to the physico-chemical variables, hydromorphological parameters and land uses. Indeed, the classification system obtained with the INVMIBs reflected the ecological quality of temporary streams of the Balearic Islands. The multimetric indices are considered a valid and accurate tool for the assessment of temporary Mediterranean streams, being currently used by the water authorities of the Balearic Islands.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

The implementation of the European Water Framework Directive (WFD; European Commission, 2000) plays a key role in the conservation of freshwater ecosystems, by promoting the development of classification systems to assess the ecological status of European rivers and streams. One of the keystones of the WFD classification systems is the identification of the reference condition, defined as the state where there are no, or only very minor, deviation of the biological, physicochemical and hydromorphological characteristics of the surface water body from those observed in the same stream type under undisturbed conditions

(European Commission, 2000). The reference condition constitutes the benchmark against which to evaluate deviations from the highest ecological quality expected in the absence of significant human-induced stress (Pardo et al., 2011, 2012). It subsequently constitutes the environmental objectives for maintaining or restore the ecological status of aquatic ecosystems (Hering et al., 2003; Borja, 2005; Buffagni and Furse, 2006; Erba et al., 2009; Nöges et al., 2009). Moreover, the biological characteristics of reference streams vary according to their biogeographic and geomorphological features (Verdonschot and Nijboer, 2004). Thus, type-specific biological reference conditions, that represent the values of the biological quality elements for that surface water body type at high ecological status, shall be established.

The main purpose of the development of a water body typology is to enable type-specific reference conditions to be defined. Among the obligatory environmental factors used to characterise water body types, the geographical position is relevant due to its

* Corresponding author. Tel.: +34 986812585; fax: +34 986812550.

E-mail addresses: lilizar@uvigo.es, lilianagarcialago@hotmail.com (L. García), ipardo@uvigo.es (I. Pardo), cdelgado.cristina@gmail.com (C. Delgado).

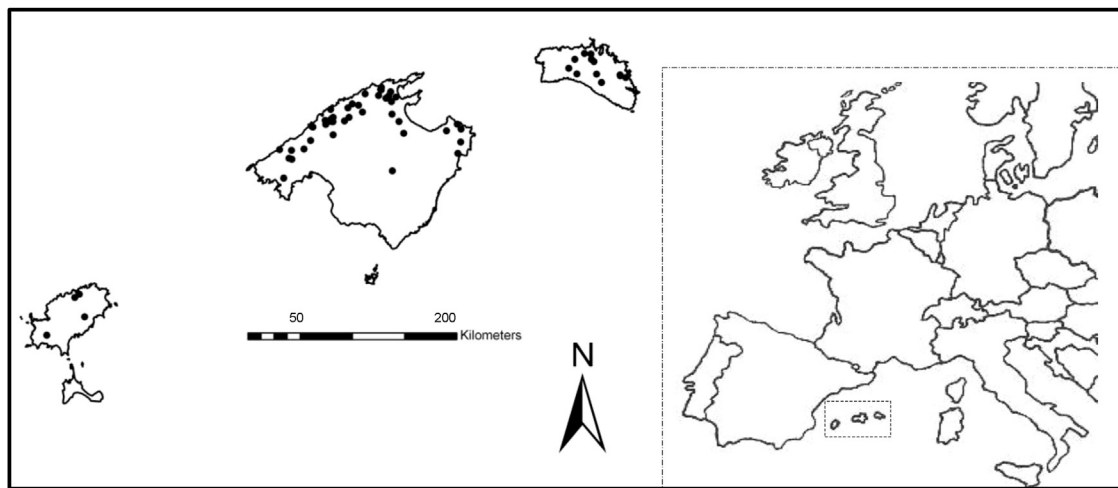


Fig. 1. Localisation and distribution of the 60 sites sampled in three of the Balearic Islands during this study.

direct relationship with the biogeography of aquatic species. In this sense, the WFD promoted the use of the ecoregions map – adapted from Illies (1967/1978) zoogeographical delineations – to facilitate a standardised surface water typology for ecological assessment and a reporting scheme for all European inland waters (European Commission, 2000). This present concept of ecoregion is too broad for an effective ecological data-based management of systems at small biogeographical scales, and smaller fluvial ecoregions should be established (Moog et al., 2004; Hughes, 2005). In addition, the case of the Island regions should be particularly assessed due to their unique ecological conditions and historical effects (Hughes, 2005).

The Mediterranean climate is characterised by sudden episodic heavy rains that generally take place during the autumn and spring months with the driest conditions prevailing during summer, which implies a periodical and predictable seasonal flood-drought sequence (Williams, 1996; Gasith and Resh, 1999; Lake, 2003; Morais et al., 2004; Pardo and Álvarez, 2006). The geology and particular precipitation patterns determine the nature of the inland waters in the Balearic Islands to be temporary streams. The effect of these hydrological events and its direct or indirect influence on other environmental parameters such as food resources, and water temperature, determines the structure and function of invertebrate communities in Mediterranean streams (Langton and Casas, 1999; García et al., 2008; Alvarez and Pardo, 2009). In particular, the temporary streams show a high natural spatial and temporal variability on their invertebrate assemblages (Alvarez and Pardo, 2007; Munné and Prat, 2011; Sánchez-Montoya et al., 2011), which makes necessary to establish a clear distinction between the influence of human impacts and typological differences in order to properly assess their ecological status.

A diversity of biologic indicators including macrophytes, fish and diatoms have been used to assess the water quality in European rivers and streams (Schaumburg et al., 2004; Breine et al., 2007; Delgado et al., 2010, 2012), but the most widely used are those based on the invertebrate community (Metcalf, 1989; Hering et al., 2003; Brabec et al., 2004; Ofenböck et al., 2004; Bennett et al., 2011; Birk et al., 2012). Indeed, benthic macroinvertebrates have proved to be suitable bioindicators in responding to multiple stressors, based on their ability to respond to a variety of environmental variables (Morais et al., 2004; Hering et al., 2006a; Johnson et al., 2007; Pardo et al., 2014).

The present approach promotes the importance of the ecological response of invertebrate assemblages to multiple pressures, allowing the assessment of the ecological status of streams in islands,

as required by the WFD (European Commission, 2000). Therefore, we combined individual metrics in a multimetric index based on its individual capacity to respond to multiple environmental pressures (Hering et al., 2006b). The main objectives of this study were (i) to identify and compare macroinvertebrate communities across the different temporary stream types existing in the Balearic Islands: lowland, canyon and mountain streams, (ii) to assess the response of the biotic assemblages along quantified gradients of human pressures, (iii) to develop a multimetric index and a classification system that accurately respond to the existing pressures, that fulfils all obligatory biological parameters of WFD normative definitions, and (iv) to assess the relevance of macroinvertebrates as indicators of the ecological status of temporary streams.

2. Materials and methods

2.1. Study area

This study was conducted in the archipelago of the Balearic Islands (Spain) that is composed by five islands located in the Western part of the Mediterranean Sea (Fig. 1). The Balearic Islands are included in the Iberic-Macaronesian ecoregion (Annex XI, European Commission, 2000). They are influenced by the Mediterranean climate and the discharge regime of these streams exhibits a strong seasonal and annual variability. These islands have a karst geology and large amounts of water stored in subterranean aquifers. Thus, the hydrological system of the Balearic Islands is marked by its climate and geomorphology, configuring the existence of temporary streams, denoted “torrents”, which during the hot and dry summer cease to flow, except for those sustained by springs that are present in the north of Majorca Island (Delgado et al., 2013).

The Balearic Islands comprise a wide spatial variation due to its topography and local geomorphology. Lowland streams are the most abundant type, located at low altitude and close to the most populated areas. The other stream types (canyon and mountain) are located only in the North of Majorca Island within the Tramuntana mountain range. Canyons are deep valleys between cliffs carved in the mountains, isolated and with high slopes, while mountain streams are located in the mountains having intermediate slopes.

2.2. Field sampling and laboratory processing

The sampling design included minimally disturbed sites (*sensu* Stoddard et al., 2006) in a spatial network used as reference sites (Pardo et al., 2011, 2012) and other stream sites influenced by

Download English Version:

<https://daneshyari.com/en/article/4373108>

Download Persian Version:

<https://daneshyari.com/article/4373108>

[Daneshyari.com](https://daneshyari.com)