Diatom diversity and ecological status of Mediterranean rivers in central Italy

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Introduction

Characterization of communities of benthic algae for all types of river water body in order to assess the ecological quality status is one of the requirements of the Water Framework Directive 2000/60/EC (WFD). The main purposes of this study was to analyse diatom diversity and to identify the characterizing diatoms of different river types in Umbria. We investigated if: i) there were differences in species diversity among river types and hydroecoregions, ii) there was difference in the Intercalibration Common Metric Index (ICMi), IPS and TI value among sites, iii) there was a relationship between the observed ICMi, IPS and TI value and diatom diversity. This study represented a contribution to diatom-based river quality assessment following the WFD in Italy and to evaluation of diatom diversity communities in Mediterranean river types.

Study Area and Methods

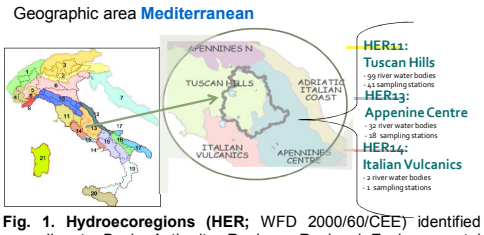


Fig. 1. Hydroecoregions (HER; WFD 2000/60/CEE) identified according to Basin Authority, Regions, Regional Environamental Agency and Italian Ministry of Environment

The Umbria Region (Central Italy) belongs to the Mediterranean area and it's included in three hydroecoregions (Tuscan Hills, Appennines Centre and Italian Vulcanics; Fig. 1). 135 river waterbodies belonging to 19 types grouped in five river Mediterranean macrotypes (M1-M5), were identified (Tab. 1). The diatom-based river monitoring network is composed by 52 sampling stations distributed on 36 watercourses. Data were collected between 2009 and 2012.

Tab 1. River Mediterranean macrotypes identified in the Region

Macrotype	River Macrotype Description	Number of waterbodies	Sampling sites
M1	Small mid-altitude streams (200-800 m a.s.l.)	45	20
M2	Small and medium lowland streams (<400m a.s.l.)	23	12
M3	Large lowland rivers	11	10
M4	Small and medium mountain streams (400-1500m a.s.l.)	2	2
M5	Small, lowland, temporary (<300m a.s.l.)	54	8

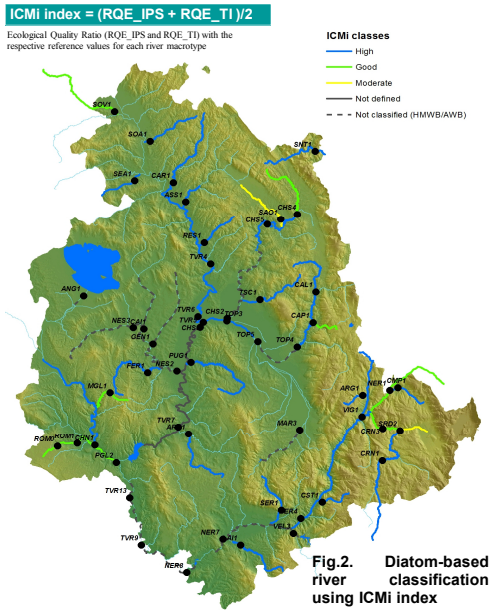
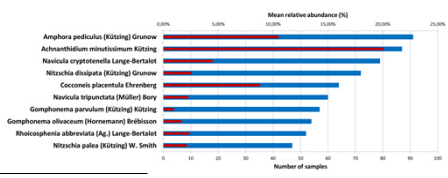


Fig.2. Diatom-based river classification using ICMi index

Results and Discussion

The first ecological status evaluation based on ICMi classified 36 water bodies (69%) in high or good class (Fig. 2). About 200 diatom species and varieties were identified (100 collected samples). The number of species per samples ranged from 10 to 38. The most frequent and abundant species is reported in Fig. 3 and each macrotype showed some peculiar species. (Tab. 2). Significant differences in diversity and ICMi, IPS and TI value among macrotypes and HER were found (Fig.4; Fig. 5). Shannon Index showed a significant negative correlation with the ICMi Index and IPS, while TI showed a significant positive correlation with both species richness and Shannon Index (Fig. 6) based on diatoms.

Fig. 3. Precence and abundance of most frequent spescies. Only species found in more than 2/3 of sampling sites are listed.



Tab. 2. Characteristic species, defined by Indicator Species Analysis, for the five Mediterranean river macrotypes

River Macrotype Species
M1- Small mid-altitude streams
Achnanthidium pyrenaicum (Hustedt) Kobayasi
Amphora inariensis Krammer
Encyonema silesiacum (Bleisch in Rabh.) D.G. Mann
M2- Small and medium lowland streams
Cymatopleura solea (Brébisson) W. Smith
Gomphonema parvulum (Kützing) Kützing
Navicula tripunctata (Müller) Bory
M3- Large lowland rivers
Cyclotella meneghiniana Kützing
Navicula capitatoradiata Germain
Navicula cincta (Ehrenberg) Ralfs
Navicula cryptocephala Kützing
Navicula cryptotenella Lange-Bertalot
Nitzschia frustulum (Kützing) Grunow
M4- Small and medium mountain streams
Denticula tenuis Kützing
Encyonema minutum (Hilse in Rabh.) D.G. Mann
Nitzschia fonticola Grunow
Nitzschia palea (Kützing) W. Smith
M5 – Small, lowland, temporary
Achnanthidium minutissimum (Kützing) Czarnecki
Encyonopsis microcephala (Grunow) Krammer
Fragilaria recapitellata Lange-Bertalot & Metzeltin
Gomphonema tergestinum Fricke

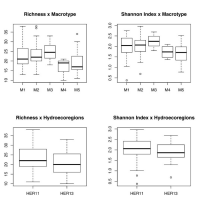
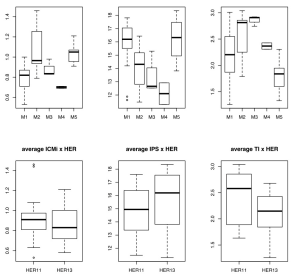


Fig. 4. Box plot of species richness and Shannon Index among river macrotypes and among hydroecoregions.

Our results indicated that the diatom diversity metrics could be considered complementary parameters in river biomonitoring for the ecological status assessment

Fig. 5. Box plot of ICMi, IPS, TI among macrotypes and among hydroecoregions (HER).



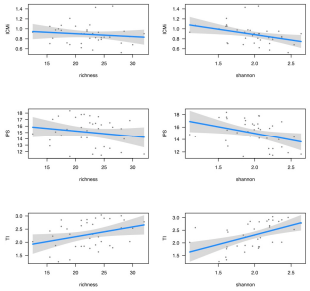


Fig. 6. Predicted values (blue continuous line) and confidence intervals (95%, light grey area) for species richness and Shannon Index of diatoms in relation to the ICMi, IPS and TI index values