About the Bacillariophyceae from natural wells in the Delta of the River Ebro

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SUMMARY

The Baltasar wells are water uprisings found on the Mediterranean Spanish coast, wich are closely connected with the River Ebro. These environments have variying leveles of chloride, high concentrations of calcium, and low levels of phosphates. Sixty two Bacillariophyceae taxa have been identified from three wells; the composition and ecological preferences of the diatom flora are discussed.

KEY WORDS: Bacillariophyceae, wells, flora, ecology, Ebro River Delta.

RESUMEN

Sobre las Bacilariofíceas de ojos de agua en el Delta del Ebro. Los *Ullals* de Baltasar son surgencias de agua localizadas en la costa mediterránea española y relacionadas con el río Ebro. Estos ambientes muestran variables concentraciones de cloruros, elevados concentraciones de calcio y bajos niveles de fosfatos. La flora diatomológica de tres *ullals* fue estudiada, identificándose 62 táxones; su composición y características ecológicas son discutidas.

PALABRAS CLAVE: Bacilariofíceas, surgencias, *ullals*, flora, ecología, Delta del Ebro.

INTRODUCTION

There has been little reference made to the diatoms of the water uprisings found on the Mediterranean coast and commonly known as *ullals* or wells, despite the fact that the group is both diverse and numerous (Comín,1989; Moubayed,1978). These small bodies of water appear in alluvial valleys close to the marine littoral. In this study reference is made to those wells known as Ullals de Baltasar, which are closely connected with the River Ebro. These environments possess an high turnover rate (hours to days), a relatively constant temperature and special chemical characteristics (Rodrigues Capítulo *et al., 1994*). The waters come from a karstic area and emerges on the surface as a result of the pressure exercised by the waters towards the sea (Canicio, 1991). From a chemical perspective, these waters are characterized by varying levels of Cl^-, high concentrations of calcium and low levels of phosphates (Margalef, 1983). In this paper the main ecological characteristics are outlined and information is presented concerning the diatom flora of the three wells studied.

MATERIAL AND METHODS

Of the 21 wells studied in the delta of the Ebro river, only 3 were selected to be used in this first paper (Fig.1). These are

numbers 5, 8 and 12, which have already been shown to be of particular interest for further in-depth study, owing to their location, size and residence time (Rodrigues Capítulo *et al., 1994*). The samples were collected in the centre of the wells using a plankton net of 32 µm pore size, during December 1992. The material collected was treated according to the method proposed by Barber & Haworth (1981) and for definitive preparations Hyrax was used. With the aim of determining which species were dominant, 300 frustules were identified and counted at random and percentages calculated (Table I).

The principal physico-chemical characteristics are shown in Table II whilst further data can be found in Rodrigues Capítulo *et al.* (*1994*). The species diversity (H´) was calculated using the Shannon-Wiener index (Shannon & Weaver, 1963). For the systematic determination the following bibliography was consulted: Hustedt (1930), Krammer & Lange-Bertalot (1986, 1988, 1991a, 1991b), Patrick & Reimer (1966, 1975).

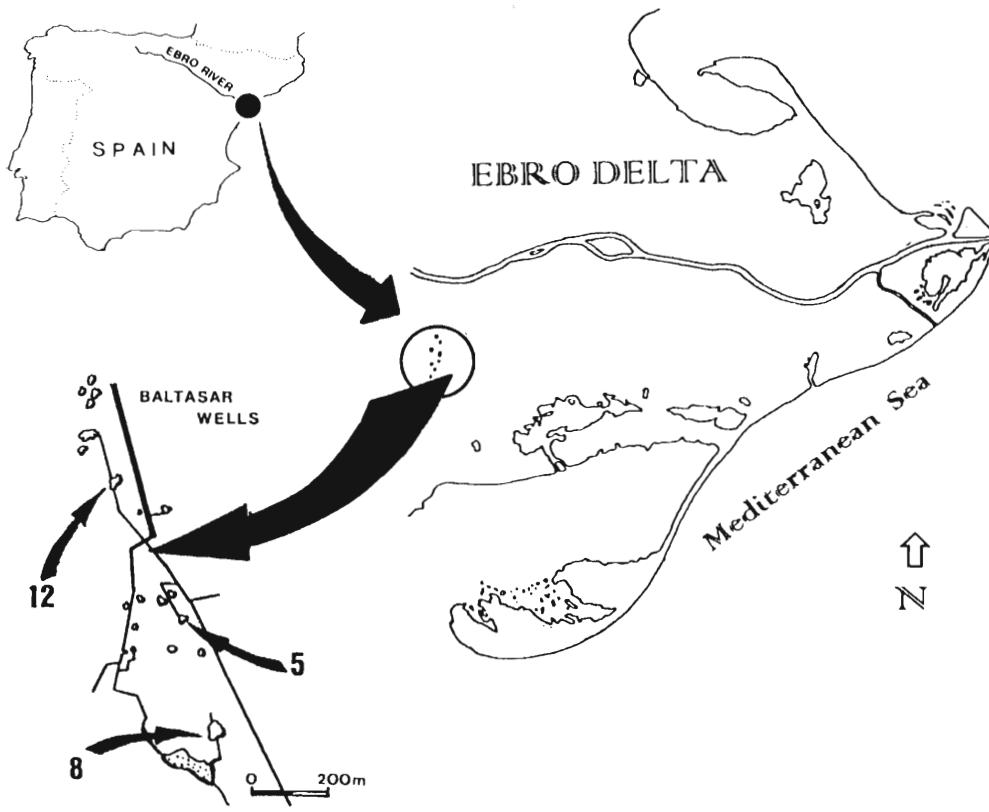

FIGURE 1. Locality map, showing location of the Ebro River Delta and the wells studied. *Mapa con la localización del Delta del Ebro y los* ullals *estudiados.*

Well	5	8	12
Cocconeis placentula var. lineata (Ehr) V.Heurk			
Bacillaria paradoxa Gmelin			
Fragilaria ulna (Nitzsch) Lange-Bertalot			
Cymbella affinis K,tzing			
Cyclotella cf. distinguenda			
Achnantes minutissima K,tzing			
Nitzschia sigmoidea (Nitzsch) W. Smith			
Cymbella cymbiformis Agardh			
Amphora ovalis (K,tzing) K,tzing			
Synedra ulna var. chaseana Thomas			
Gomphonema angustatum Agardh			
Cymatopleura solea (BrÈbisson & Godey) W.Smith			
Mastoglia smithii Thwaites			
Amphora pediculus (K,tzing) Grunow			
Cyclotella meneghiniana K,tzing			
Cocconeis placentula var. euglypta (Ehrenberg) Grunow			
Epithemia argus (Ehrenberg) K,tzing			
Eunotia glacialis Meister			
Navicula cryptocephala K,tzing			
Pinnularia gibba Ehrenberg			
Gyrosigma acuminatum (K,tzing) Rabenhorst			
Cocconeis pediculus Ehrenberg			
Gomphonema clavatum Ehrenberg			
Amphora coffeaeformis (Agardh) K,tzing			
Cocconeis placentula var. klinorhaphis Geitller			
Campylodiscus hibernicus Ehrenberg			
Nitzschia microcephala Grunow			
Fragilaria delicatissima (W. Smith) Lange Bertalot			
Gomphonema gracile Ehrenberg			
Cyclotella striata (K,tzing) Grunow			
Surirella tenera Gregory			
Nitzschia fonticola Grunow			
Navicula cincta (Ehrenberg) Ralfs			
Eunotia sp			
Epithemia sorex K,tzing			
Gomphonema acuminatum Ehrenberg			
Neidium iridis var. subundulatum (Cleve-Euler) Reimer			
Diploneis oblongella (N‰geli) Cleve-Euler			
Diploneis petersenii Hustedt			
Diatoma tenuis Agardh v. elongatum Lyngbye			
Navicula laevissima K,tzing			
Fragilaria brevistriata Grunow			
Fragilaria virescens Ralfs			
Caloneis amphisbaena (Bory) Cleve			
Achnanthes pinnata Hustedt			
Navicula cuspida var major Meister			
Amphiprora alata (Ehrenberg) K,tzing			
Pinnularia maior (K,tzing) Rabenhorst			
Pinnularia subcapitata Gregory			
Surirella biseriata BrÈbison			
Peronia fibula BrÈbisson & Arnot			
Denticula elegans K,tzing			
Anomoeoneis sphaerophora (Ehrenberg) Pfitzer			
Navicula radiosa K,tzing			
Cocconeis placentula Ehrenberg			
Nitzschia palea (K,tzing) W. Smith			
Gyrosigma spencerii (Quek.) Cleve			
Cymbella tumida (BrÈbisson) Van Heurck			
Surirella ovalis BrÈbisson			
Pleurosira laevis(Ehrenberg) Compere			
Melosira varians Agardh			
Pleurosigma elongatum W. Smith			

TABLE I. List of Bacillariophyceae species found in the wells with an indication of their relative abundance. *Lista de especies de bacillariophyceae en los* ullals *con indicación de su abundancia relativa.*

0%

0.01-1.99%

2-4.99%

5-9.99%

10-20.99%

> 21%

TABLE II. Means and standard deviations (between brackets) of the physico-chemical variables in the wells studied. *Medias y desviaciones típicas (entre paréntesis) de las variables físico químicas en los ullals estudiados.*

WELL	5	8	12
Depth (m)	4.43 (0.29)	5.05 (0.49)	2.30 (0.20)
Secchi (m)	4.18 (0.47)	3.0 (0.96)	1.04 (0.13)
Temperature (°C)	16.5 (1.63)	16.9 (2.14)	16.9 (1.05)
Conductivity ($\mu S\ cm^{-1}$)	2308 (57.1)	2209 (95.7)	2081 (85.6)
Alkalinity ($meq\ l^{-1}$)	4.7 (0.25)	4.8 (0.63)	4.8 (0.23)
TSS ($mg\ l^{-1}$)	2.3 (0.95)	3.8 (1.04)	10.9 (6.62)
Ca^{++} ($mg\ l^{-1}$)	108.2 (25.1)	106.5 (13.6)	93.9 (14.3)
Mg^{++} ($mg\ l^{-1}$)	44.15 (5.4)	45.6 (2.1)	38.03 (6.1)
K^{+} ($mg\ l^{-1}$)	8.77 (0.75)	8.95 (0.47)	7.6 (1.05)
Na^{+} ($mg\ l^{-1}$)	255.5 (32.9)	259 (10.2)	210.4 (45.7)
Cl^{-} ($mg\ l^{-1}$)	492.9 (12.5)	451.4 (118.9)	394.3 (63.9)

RESULTS AND DISCUSSION

The dominant and common taxa found in the 3 studied wells were *Cocconeis placentula* var. *lineata, Bacillaria paradoxa, Synedra ulna, Cymbella affinis, Cyclotella* cf. *distinguenda, Achnanthes minutissima, Nitzschia sigmoidea, Amphora ovalis, Fragilaria ulna* var. *chaeseana, Gomphonema angustatum, Cymatopleura solea, Mastoglia smithii* (Table I). The diatoms found in these environments showed a high level of cosmopolitanism, demostrating similaraties to that of other carbonate rich environments (Gasse, 1983, 1986; Sabater & Roca, 1992). The alkalinity of these waters was high, with a high HCO^{-}_{3} content (4,5-5 $mg\ l^{-1}$) owing to the karstic origin of the waters. Common mesohalobio taxa were found: *Bacillaria paradoxa, Navicula cuspidata* var. *maior, Nitzschia microcephala, Mastogloia smithii, Pleurosira laevis, Pleurosigma elongatum, Amphiprora alata, Caloneis amphisbaena, Cyclotella striata, Amphora coffeaeformis* and *Anomoeoneis sphaerophora* (Lowe, 1974). When the Cl^{-} content was between 0.27 and 0.7 $g\ l^{-1}$ the halophilic elements increased (Margalef, 1983). In the wells this anion oscillated between 0.39 and 0.49 $g\ l^{-1}$ during the studied period.

These environments are influenced by human activity, especially agricultural practices. In those assemblages mesosaprobic species occurred, which indicated nutrient enrichment: *Cyclotella meneghiniana, Amphora ovalis, Nitzschia palea, Melosira varians, Achnantes minutissima, Navicula cryptocephala.*

The plankton in these environments was found to be constrained by the rapid flow of the water, therefore the plankton development was limited to only a few taxa. 89% of the diatoms found were mainly epiphytic and this is due to the development of macrophytes such as *Nymphaea alba, Myriophillum spicatum, Potamogeton pectinatus, P. nodosus, Ceratophyllum demersum.* Of the 3 wells studied that which showed the greatest species diversity was number 5 (H´= 4,39), followed by 8 (H´= 3,99) and finally 12 (H´=3,44). The well 5 is the smallest, it has a lower renewal rate ($0.025\ hour^{-1}$), more transparency and also shows a major development of *Nymphaea alba* (60%), whereas well 8 shows only 30% and well 12 completely lacks this macrophyte and has a highest renewal rate ($0.72\ hour^{-1}$).

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