



RESEARCH ARTICLE

## Picoplanktonic cyanobacteria in different Adriatic brackish environments

Del Negro P.<sup>1</sup>, Paoli A.<sup>1</sup>, Celussi M.<sup>1</sup>, Crevatin E.<sup>1</sup>, Valeri A.<sup>1</sup>, Larato C.<sup>1</sup>, Fonda Umani S.<sup>2</sup>

<sup>1</sup>Dipartimento di Oceanografia Biologica - Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS), Via A. Piccard 54, I-34014 Trieste, Italy

<sup>2</sup>Dipartimento di Biologia – Università di Trieste, Via A. Valerio 28/A, I-34127 Trieste, Italy

### Abstract

- 1 - We investigated picoplanktonic cyanobacteria (PC) distribution related to some physical-chemical parameters (temperature, salinity and dissolved oxygen) in seven transitional systems all along the Italian coast of the Adriatic Sea.
- 2 - PC mean abundances were generally more than one order of magnitude higher ( $>5 \times 10^7$  cells L<sup>-1</sup>) than those found in coastal and offshore waters of the Adriatic Sea.
- 3 - PC populations appeared well adapted to ample variations in salinity (5-87) and even oxygen concentrations close to hypoxia did not seem to negatively affect PC abundances.
- 4 - Because of their ability in adapting to extreme conditions, PC may become the prevailing fraction of the phototrophic plankton in these transitional systems like lagoons, marshes and solar salterns.

### Introduction

Picoplanktonic cyanobacteria (PC) are the major primary producers in the world's oceans. Their ubiquitous distribution, from the upper open ocean to the offshore and coastal surface waters of semi-enclosed seas, is well documented (Magazzù & Decembrini 1995). In the Adriatic Sea the PC abundances ranged between  $10^5$  and  $10^8$  cells l<sup>-1</sup> (Vanucci *et al* 1994, Del Negro *et al* 1996, Bernardy Aubry *et al* 2006, Nincevic Gladan *et al* 2006, Paoli & Del Negro 2006,) with a distribution pattern characterized by clear seasonality and high annual variability. Only few information are available about PC distribution and ecology in the Adriatic lagoon environments (Sorokin *et al* 1996, Caroppo *et al* 2000, Pugnetti *et al* 2005) although Sorokin *et al* (2004) described dense bloom of PC causing mass mortality of benthic fauna.

The aim of this work was to assess the PC abundances in seven Adriatic brackish systems (lagoons, salt marshes and salt pans) along the

Italian Adriatic coasts from northernmost Grado Lagoon to southern salt pans and salt marshes. PC densities are discussed in relation to hydrographic conditions.

### Material and methods

Samplings were carried out during autumn 2004 (late November – early December) and spring 2005 (late March – early April) in Adriatic transitional systems (Tab. 1). The fall sampling was missing for the Piailassa Baiona Lagoon.

The Grado and Marano system, located along the Northern Adriatic Friuli Venezia Giulia coast, is composed by two basins (Grado Lagoon and Marano Lagoon) separated by a long and deep navigable canal. The surface of the system reaches about 160 km<sup>2</sup> with a maximum depth of 20 m. The Piailassa Baiona Lagoon covers an area of 11 km<sup>2</sup> along the Emilia Romagna coast. The Margherita di Savoia salt pan, located in Puglia region, covers an area of about 45 km<sup>2</sup>. The Torre Guaceto

wetland, declared Special Protected Area since 1971, is characterised by a salt marsh area which extension of about 1.2 km<sup>2</sup>. The Cesine Lagoon covers a surface of 6.2 km<sup>2</sup>. Lake Alimini Grande is a salt marsh with a surface area of 1.4 km<sup>2</sup>. It is connected with the sea through its mouth and with a freshwater lake, Alimini Piccolo, through a natural canal.

Water temperature (T), salinity (S), and dissolved oxygen (DO) were recorded *in situ* using multiparametric probes. Water samples were collected at the subsurface (-50 cm) depth with a Niskin bottle, equipped with silicon elastic and red silicon O-rings. Samples (200 ml) were fixed with 2% final concentration borate-buffered formalin (pre-filtered through a 0.2 µm Acrodisc filter) and aliquots of variable volumes (5-20 ml) filtered in quadruplicate onto

0.2 µm black-stained polycarbonate filters (Nuclepore). The filters were observed using an Olympus BX 60 epifluorescence microscopy (Waterbury *et al* 1979). Under blue light excitation (BP 420-480 nm, BA 515) cyanobacterial cells fluoresce yellow-orange. At least 25 microscopic fields at 1000X magnification were counted for each preparation. The replicate samples showed a dispersion lower than 0.07.

## Results

The range of variability of temperature, salinity, dissolved oxygen and picocyanobacterial abundances among the investigated transitional systems are reported in Tab 2.

Table 1: Geographic locations and typology of seven Adriatic brackish systems .

AREA	TIPOLOGY	LAT	LONG	SEASON
Grado	Lagoon Fish farm	45°40' - 45°45' N	13°05' - 13°14' E	Fall 2004 Spring 2005
Marano	Lagoon	45°40' - 45°45' N	13°15' - 13°35' E	Fall 2004 Spring 2005
Pialassa Baiona	Lagoon	44°30' N	12°15' E	Spring 2005
Margherita di Savoia	Saltpan	41°23' N	16°06' E	Fall 2004 Spring 2005
Torre Guaceto	Saltmarsh	40°42' N	17°48' E	Fall 2004 Spring 2005
Cesine	Lagoon	40°21' N	18°23' E	Fall 2004 Spring 2005
Alimini Lakes	Saltmarsh	40°19' - 40°22' N	18°44' - 18°46' E	Fall 2004 Spring 2005

## Discussions

Despite the different hydrodynamism, freshwater/seawater inputs and human influence, all the studied environments are characterized by the presence of PC. The PC abundances are higher than in coastal and offshore waters of the Adriatic Sea ranging from 10<sup>5</sup> - 10<sup>9</sup> cells l<sup>-1</sup> vs 10<sup>5</sup>-10<sup>8</sup> cells l<sup>-1</sup> in the marine environment (Vanucci *et al* 1994, Del Negro *et al* 1995, Bernardi-Aubry *et al* 2006, Nincevic Gladan *et al* 2006, Paoli & Del Negro

2006). Significant seasonal differences in PC abundances were observed in the southern environments with low values in autumn (10<sup>5</sup>-10<sup>6</sup> cells l<sup>-1</sup>) and higher values in spring (10<sup>7</sup>-10<sup>9</sup> cells l<sup>-1</sup>). In the lagoons of Grado and Marano differences between seasons were not significant. On the contrary the north Adriatic open waters generally experienced the highest PC abundances during autumn (Bernardi-Aubry *et al* 2006, Paoli & Del Negro 2006). PC community appeared well adapted to ample variations in salinity (5-87) and in particular the

highest abundances (close to  $10^9$  cell  $l^{-1}$ ) were found at extremely high/low salinity values. Even low oxygen concentrations close to hypoxia did not affect PC distribution.

The results of this study show that PC characterize the phytoplankton community in

the transitional systems of the Italian Adriatic coast. For these reasons the role of PC in the brackish environments should be further explored.

Table 2: Variability range of temperature (T), salinity (S), dissolved oxygen (DO) and picocyanobacterial abundances (PC) in the Adriatic brackish waters.

AUTUMN	T (° C)	S	DO (mg $l^{-1}$ )	PC ( $10^7$ cell $l^{-1}$ )
Grado	-	29.0 - 35.0	-	0.03 - 0.32
Marano	5.3 - 7.7	23.0 - 30.0	9.7 - 10.6	0.3 - 0.7
Pialassa Baiona	-	-	-	-
Margherita di Savoia	8.2 - 14.4	26.4 - 45.2	4.1 - 8.1	0.04 - 0.22
Torre Guaceto	11.7 - 12.9	5.2 - 5.4	6.5 - 7.6	0.06 - 0.17
Cesine	12.7 - 15.8	6.0 - 6.3	8.8 - 9.5	0.08 - 0.14
Alimini	14.3 - 15.6	27.4 - 31.3	8.5 - 8.7	5.9 - 13.4
SPRING	T (° C)	S	DO (mg $l^{-1}$ )	PC ( $10^7$ cell $l^{-1}$ )
Grado	20.1 - 24.6	26.0 - 32.8	6.3 - 8.7	0.1 - 0.9
Marano	19.4 - 21.3	17.6 - 30.2	6.3 - 8.3	0.03 - 1.40
Pialassa Baiona	12.2 - 12.3	44.5	7.4 - 12.2	0.8 - 8.0
Margherita di Savoia	19.1 - 23.1	53.7 - 86.8	5.5 - 8.6	0.2 - 30.3
Torre Guaceto	17.08	40.7	2.9 - 3.3	0.3 - 1.9
Cesine	18.8 - 20.7	4.7 - 4.8	7.0 - 9.4	81.8 - 119.1
Alimini	17.4 - 18.1	22.3 - 28.3	7.0 - 7.5	5.5 - 7.0

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