Biología Pesquera 20: 61-64, 1991 ISSN Nº 0067 - 8767

VERTICAL DISTRIBUTION OF DISSOLVED FREE AMINO ACIDS AND PHYTOPLANKTON AND ZOOPLANKTON BIOMASSES*

DISTRIBUCION VERTICAL DE AMINOACIDOS LIBRES DISUELTOS Y BIOMASAS FITO Y ZOOPLANCTONICAS*

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ABSTRACT

Dissolved Free Amino Acids (DFAA) concentrations were measured in the water column during a night and day sampling period, following a Lagrangian drogue within Concepción Bay (Chile). For the night-time sampling period no correlations between DFAA and either chlorophyll-*a* or zooplankton were observed, although a positive and significant correlation between phytoplankton and zooplankton biomass did exist. During the day chlorophyll-*a* and DFAA were correlated throughout the water column, suggesting that excretion, enhanced by photosynthetic activity of primary producers was occurring.

Key words: DFAA, Chlorophyil, Copepods, Concepción Bay, Chile.

RESUMEN

La distribución vertical de aminoácidos libres disueltos (DFAA) fue medida y correlacionada con la biomasa zoo- y fitoplanctónica en la columna de agua de la Bahía de Concepción (Chile).

En la noche no se encontró correlación entre DFAA y clorofila-*a*, tampoco con la biomasa de zooplancton, aunque existe una correlación positiva entre la biomasa zooplanctónica y la fitoplanctónica.

Durante el día, clorofila-*a* y DFAA se correlacionaron positivamente en superficie, sugiriendo procesos de excreción estimulados por la actividad fotosintética de los productores primarios.

Palabras claves: DFAA, Clorofila, Copépodos, Bahía de Concepción, Chile

INTRODUCTION

Dissolved free amino acids (DFAA) are key components supporting heterotrophic growth in the pelagic ecosystem and, hence undergo rapid consumption by heterotrophic bacteria (Fuhrman, 1987; Kirchman, 1990). DFAA are produced in the water column by excretion of both zooplankton (during the night) and phytoplankton (during the day) as well as by spillage during grazing by herbivorous zooplankton (sloppy feeding) during the night.

The vertical distribution of DFAA and their relation with the phyto- and zooplankton

Financial support by grants DIUC INB-088-a, to V.A. Troncoso (Dirección de Investigación, Pontificia Universidad Católica de Chile) and FONDECYT 646/87 to P. Bernal (Fondo Nacional de Ciencia y Tecnología).

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biomasses (Figure 1) were studied in Concepción Bay. Changes in the DFAA concentrations between night and day water column profiles, and their co-variantion with chlorophyll-*a* and zooplankton biomass are described.

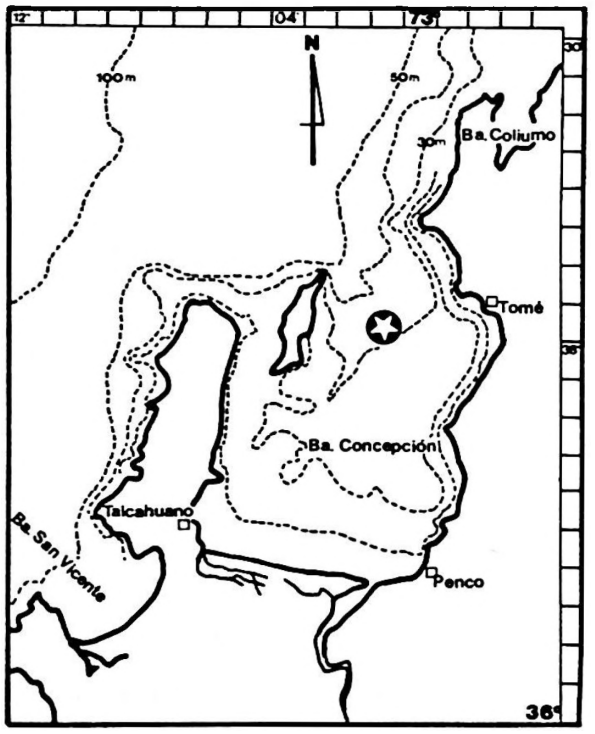

Figure 1. Concepción Bay (36°40'S, 73°01'W), showing the position where the screen droge was installed.

MATERIALS AND METHODS

A Lagrangian sampling was carried out within Concepción Bay (36°40'S, 73°01'W) during October 1987. A 6 m^2 screen drogue, set at the maximum chlorophyll-*a* layer (9 m) was followed over 24 hours. Nocturnal (03.07 h) and diurnal (11.40 h) samples were collected at 1, 3, 6, 9, 12, 15, 20 and 25 m, using an on board pumping-system fitted with a 2' hose. Zooplankton samples were obtained with a deck-mounted collector device provided with a 335 µm mesh net. Zooplankton samples were concentrated to a final volume of 0.33 m^3 and preserved in 4% neutralized formalin. Zooplankton biomass was determined as wet weight (mg (ww) m^{-3}).

Triplicate samples (20 ml) for DFAA were analyzed following the methodology described by Dawson *et al.* (1983). DFAA were derived with o-phthalaldehyde and 2-mercaptoethanol (OPT/2MERC), and quantified as Glycine equivalent concentrations (µM-Gly) after adjustments for blanck correction (OPT/2MERC-Buffer). Measurements were done onboard immediately after collection, using a Fluorometer (Turner Designs, Mod. 10.000R).

For chlorophyll-*a* determinations, duplicate 50 ml samples of seawater were filtered (0.45 µm, Millipore HAWP). Filters were stored at low temperature (-5°C) before extraction. Chlorophyll-*a* determinations (mg Chl. -*a* m^{-3}) were carried out using the fluorometric method of Yentsch & Menzel (1963).

The Spearman rank correlation coefficient (r_s) (Conover, 1980) was used to assess the association between DFAA concentrations and both phytoplankton and zooplankton biomasses. The Wilcoxon paired-samples test (Conover, 1980) was used to compare night and day DFAA concentrations in the water column.

RESULTS AND DISCUSSION

The mean concentration (night-day) of DFAA observed in the standardized water column was 1.35 mM-Gly m^{-3}. Vertically, DFAA ranged from 0.37 to 2.37 µM-Gly. These concentrations are one or two orders of magnitude higher than previous measurements for open and coastal waters (Lee & Bada, 1975, 1977; Williams & Poulet, 1986) and the Baltic Sea (Mopper & Lindroth, 1982). Our measurements are similar to those found by Bohling (1972) in surface waters of the North Sea (near Helgoland), with a maximum of 6 µM (for one depth.).

The vertical distribution of Chl.-*a*, DFAA, and zooplankton biomass (night-day) are shown in Figure 2. The daytime averages of phytoplankton and zooplankton biomasses and DFAA were higher than at night (29.4, 33.8 and 17%, respectively).

The nighttime vertical distribution of DFAA showed a maximum that coincides with the maximum of chlorophyll and zooplankton biomass. During the day, higher DFAA concentrations were observed with a clear increase at surface, similar to what was observed

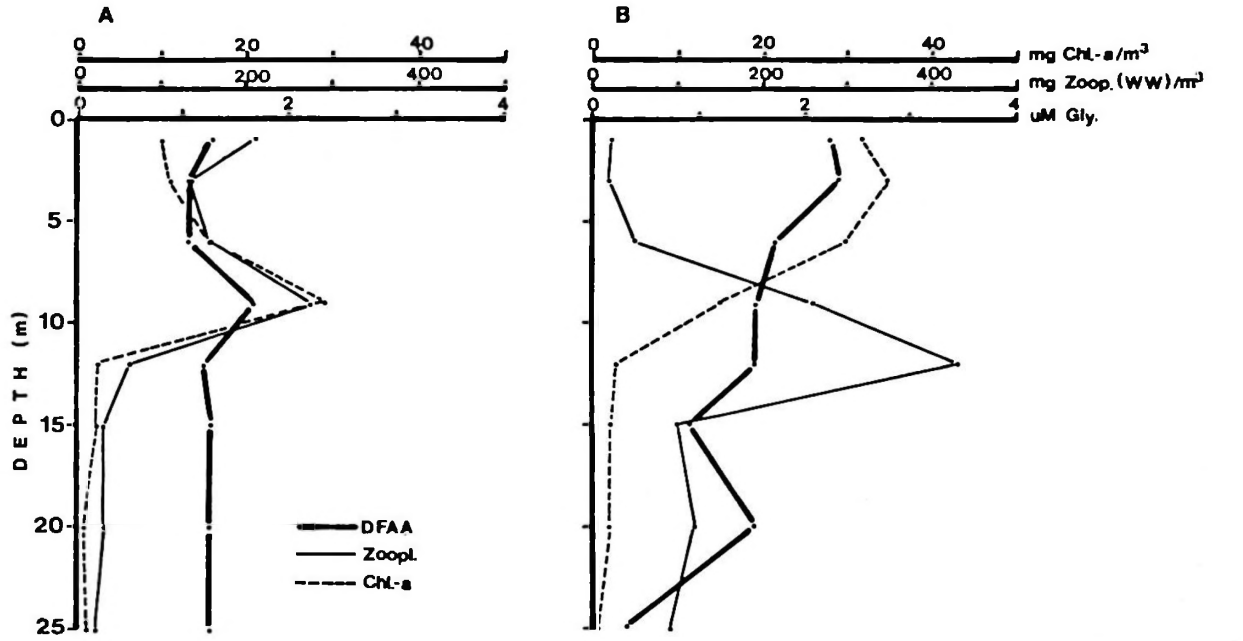

Figure 2. Vertical distribution of DFAA (µM-Gly), zooplankton biomass (mg (ww) m^{-3}) and phytoplankton biomass (mg Chl.-*a* m^{-3}). A.- at night (03.00 h local time). B. at day (11.40 h local time).

for the chlorophyll distribution. However, considering only the upper six meters, higher DFAA concentration by app. a factor of 2 were observed during the day relative to the night.

The correlation between zooplankton biomass and Chl.-*a* at night is positive and significant (Spearman $r_s = 0.9$, $P < 0.05$, $n = 8$, see Table 1). Similar results obtained in Arauco Gulf were attributed to the vertical migration of herbivorous copepods that aggregate at subsurface levels close to the phytoplankton maximum (Troncoso & Castro, 1985; Bernal *et al.*, 1986).

A conspicuous increase of DFAA was found to be associated with the Chl. *a*- zooplankton maximum at 9 m depth (Figure 2). This finding indicates the importance of sloppy feeding as an input source of DFAA at night at te chlorophyll maximum layer. At night, in the upper three meters, the low values of Chl.-*a* and the high zooplanktonic biomass observed (three- and eight-fold increase, respectively) suggests that active grazing is likely to be occurring.

Vertical distribution of DFAA during the day was positively correlated with phytoplankton biomass (Table 1). On average, no differences in DFAA concentrations between night and day in the water column were

Table 1. Spearman rank correlation coefficients (rs) between dissolved free amino acid (DFAA) in seawater, phytoplankton biomass (Chl.-*a*) and zooplankton biomass (Zoo), n = 8.

	NIGHT			DAY		
	DFAA	Chl.-*a*	Zoo	DFAA	Chl.-*a*	Zoo
DFAA		.04	.23		.93**	-.55
Chl.-*a*			.90*			-.57

*P < 0.05, ** P < 0.01

observed (Wilcoxon T = 11, P =.3285, n = 8). High concentrations of DFAA in the first three meters were coincident with high concentrations of Chl.-*a* (between 32.07 and 35.18 mg Chl.-*a* m^{-3}). The low zooplankton biomass in these depths during the daytime suggests that production of DFAA is caused mainly by photosynthetic activity (exudation of low molecular weight metabolites), as it has been previously reported by Hellebust (1974).

The pool of DFAA in the water column is strongly modified by biological processes, such as phytoplankton exudation (EOC) which in turn is related to photosynthetic activity, and zooplankton excretion (Webb & Johannes, 1967; Small *et al.*, 1983 and Andersson *et al.*, 1985) and grazing (Lampert,1978). The importance of removal processes such as the uptake by heterotrophic bacteria (Hagström *et al.*, 1984) and phytoplankton (North, 1975) and oxidation of amino acids by cell-surface amino oxidases in phytoplankton (Palenik & Morel, 1990; Pantoja, 1992) needs to be considered.

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