

Resumen

El análisis sistemático del fitoplancton y de las variables ambientales constituye una herramienta adecuada para detectar patrones y tendencias en los ciclos biológicos y evaluar el estado de los ecosistemas naturales. En las últimas décadas se han registrado cambios en la fenología y estructura del fitoplancton en diferentes ambientes costeros en respuesta a modificaciones antrópicas y al cambio climático global. El estuario de Bahía Blanca, localizado en la costa bonaerense Argentina, es un sistema mesomareal, somero y templado, caracterizado por aguas turbias y eutróficas. El fitoplancton ha sido estudiado quincenalmente desde 1978 en la zona interna del estuario y ha mostrado un patrón estacional recurrente caracterizado por una floración de diatomeas en invierno dominada por la especie *Thalassiosira curviseriata*. La ocurrencia de la floración ha sido relacionada con altos niveles de nutrientes disueltos y baja presión de pastoreo por parte del zooplancton.

En la última década se han observado cambios en la composición del fitoplancton como así también modificaciones hidroclimáticas en el estuario de Bahía Blanca. Sobre la base de estos antecedentes, los objetivos de esta Tesis fueron: analizar la estructura y composición del fitoplancton en los últimos años (2006-2008), identificar los factores y procesos que regulan su dinámica estacional, comparar los datos históricos (1978-2002) con el período muestreado para esta Tesis (2006-2008) y evaluar cambios en la fenología del fitoplancton en relación con las modificaciones hidroclimáticas. Se analizó el fitoplancton sobre la base de la concentración de clorofila, la composición específica, la abundancia celular y la biomasa junto con las variables ambientales (e.g. temperatura, salinidad, turbidez, disponibilidad de radiación PAR en la columna de agua, material particulado en suspensión (MPS), nutrientes disueltos y variables atmosféricas).

Los resultados mostraron que la ocurrencia de la floración invernal es favorecida por el aumento de la disponibilidad de radiación y de la relación zona eufótica/zona de mezcla (Z_{eu}/Z_m) causada por la marcada reducción del MPS en la columna de agua. La concentración del MPS en la zona interna del estuario está regulada principalmente por los procesos de mezcla y erosión provocados por el efecto del viento y las mareas.

El análisis de la serie temporal (1978-2008) reveló cambios significativos en la fenología, estructura y composición de la comunidad fitoplanctónica en años

recientes. Los cambios observados fueron: 1) disminución y/o ausencia de las especies causantes de la floración invernal, principalmente de *Thalassiosira curviseriata*, 2) ocurrencia de una floración invernal caracterizada por especies pequeñas no comunes en el sistema (e.g. *Cyclotella* sp.), 3) adelantamiento del inicio de la floración invernal (ca. 1 mes) y 4) ocurrencia de una floración estival dominada por *Thalassiosira minima*. Estos cambios parecen estar asociados con el clima más cálido y seco de la última década en la región de Bahía Blanca. Las condiciones atmosféricas afectaron las características hidrológicas en la zona interna del estuario (aguas más cálidas y salobres y cambios en la turbidez) lo que eventualmente pudo haber promovido la reorganización de la comunidad del fitoplancton. Se sugieren y discuten posibles mecanismos que implican cambios en los nichos ecológicos, las interacciones específicas, las relaciones de los nutrientes, la comunidad del zooplancton y las condiciones de radiación. Esta Tesis representa la base para futuras investigaciones sobre el funcionamiento integrado del estuario que incluyan transferencia de energía a través de la cadena trófica, ciclos biogeoquímicos y uso de bioindicadores de cambios en el estado del ecosistema.

Abstract

The periodic monitoring of phytoplankton and environmental variables is an adequate tool to detect patterns and tendencies in the biological cycles and to evaluate the state of natural ecosystems. In recent decades, changes in the phenology and composition of the phytoplankton have been registered in different coastal systems in response to anthropogenic modifications and global climate change. The Bahía Blanca estuary, located on the Atlantic coast of Argentina, is a mesotidal, shallow and temperate system characterized by turbid and eutrophic waters. The phytoplankton has been studied on a fortnightly basis since 1978 in the inner zone of the estuary and has shown a recurrent annual pattern characterized by a diatom bloom in winter dominated by *Thalassiosira curviseriata*. The occurrence of the bloom has been related to high dissolved nutrients concentrations and low zooplankton grazing pressure.

In the last decade, changes in the phytoplankton composition and modifications in the hydroclimatic conditions have been detected in the Bahía Blanca estuary. Based on these observations, the goals of this Thesis were: to analyze the phytoplankton structure and composition in recent years (2006-2008), to identify the potential factors and processes that regulate the phytoplankton seasonality, to compare the historical data (1978-2002) with the period 2006-2008 and to evaluate possible changes in the phytoplankton phenology in relation to the hydroclimatic modifications. The phytoplankton was analyzed considering: chlorophyll concentration, species composition, cellular abundance and biomass, together with the environmental variables (e.g. temperature, salinity, turbidity, light availability (PAR) in the water column, particulate suspended matter (PSM), dissolved nutrients and atmospheric parameters).

The results showed that the occurrence of the phytoplankton bloom in winter is promoted by an increase in the availability of radiation and a reduction in the euphotic zone/mixed zone ratio (Z_{eu}/Z_m) induced by a significant reduction of the PSM concentration in the water column. The PSM concentration in the inner zone of the estuary is mainly regulated by mixing and erosion processes caused by the effects of winds and tides.

The analysis of the temporal series (1978-2008) revealed significant changes in the phenology, structure and composition of the phytoplankton community in recent

years. The changes were: 1) the diminution and/or absence of the blooming species in winter, specially *Thalassiosira curviseriata*, 2) the replacement of the dominant diatom species by smaller ones during the winter bloom (e.g. *Cyclotella* sp.), 3) the earlier inception of the winter bloom (ca. 1 month) and 4) the occurrence summer blooms dominated by *Thalassiosira minima*. These changes seem to be related to the warmer and drier weather conditions registered in the last decade in the Bahía Blanca region. The atmospheric modifications affected the hydrological features in the inner zone of the estuary (warmer and saltier waters and changes in turbidity) and, eventually, promoted the reorganization of the phytoplankton community. Potential mechanisms are suggested and discussed to explain these changes, including shifts in the ecological niches, species interactions, nutrient ratios, zooplankton community and radiation conditions in the water column. This Thesis represents the base for future investigations of the functioning of the estuary, considering trophodynamic relationships, biochemical cycles and the use of plankton bioindicators to evaluate the ecosystem state.

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