RESUMEN

Se determinaron las concentraciones de cadmio, cobre y plomo en el material particulado en suspensión y en el zooplancton en la zona interna del estuario de Bahía Blanca, una de las zonas costeras más industrializadas de la Argentina. Simultáneamente se midieron y determinaron las variables físico-químicas tales como temperatura, salinidad, pH, oxígeno disuelto, materia orgánica particulada, material particulado en suspensión, clorofila *a*, feopigmentos y nutrientes (nitrito, nitrato, amonio, fosfato y silicato). Además, se estudió la composición y distribución espacio temporal de la abundancia del meso y macrozooplancton.

Por otra parte, se realizaron ensayos de toxicidad letal aguda de 96 hs. con cadmio y plomo disuelto y/o particulado en ejemplares adultos de los copépodos *Acartia tonsa* y *Eurytemora americana*.

Respecto de las concentraciones de cadmio en el material particulado en suspensión, todas las estaciones de muestreo presentaron sus máximas concentraciones a fines de marzo-mayo y noviembre. A su vez, las estaciones más cercanas al Polo Industrial -Ing.White y Pto.Galván- presentaron las concentraciones más elevadas. Estos resultados, indicarían la existencia de fuentes externas de cadmio en el estuario, con un ingreso permanente al sistema y un aumento de las concentraciones en el material particulado en suspensión en el tiempo. Las máximas concentraciones de cobre en la fracción particulada fueron en los meses de agosto y marzo y noviembre, en todas las estaciones, y podrían deberse al aporte de metales de origen antrópico. En cuanto al plomo en esta misma fracción, las estaciones próximas al Polo Industrial, Ing. White y Pto. Galván presentaron las concentraciones más bajas, sin embargo, las importantes concentraciones registradas en el resto de las estaciones, indicarían aportes antropogénicos de plomo provenientes de las descargas urbanas e industriales.

Las concentraciones de metales en el mesozooplancton presentaron importantes variaciones a lo largo del período de estudio y en las distintas estaciones de muestreo. Las fuentes más importantes de metales para el zooplancton fueron el MPS y/o el fitoplancton, dependiendo de la época del año. La mayoría de las concentraciones de cadmio en el mesozooplancton se encuentran dentro del rango registrado en otras regiones, pero en algunos casos, las del presente trabajo son superiores. Algunos valores de cobre en el mesozooplancton, se encuentran dentro de las concentraciones citadas para otras regiones del mundo con impacto antrópico. Las concentraciones de plomo en el mesozooplancton son en

general, superiores a las de otras regiones con cierto grado de contaminación, lo que indicaría una fuente importante de plomo de origen antrópico biodisponible para los organismos.

Los niveles de cadmio en el macrozooplancton en la mayoría de las estaciones fueron bajos. No se observó un patrón significativo a lo largo del período de muestreo y principalmente en noviembre se registraron las concentraciones más altas, posiblemente debido a las altas concentraciones de cadmio en el MPS y en el mesozooplancton. Los niveles de cadmio en el macrozooplancton, se encuentran en general, dentro de los valores normales registrados por otros autores. Las concentraciones de cobre en esta misma fracción fueron significativas durante todo el período de estudio. En general, los valores del presente trabajo se encuentran dentro de las concentraciones registradas por otros autores. Los niveles de plomo presentaron cierta tendencia de aumento hacia las estaciones más cercanas a los asentamientos industriales. En comparación con los trabajos de otros autores, las concentraciones del presente estudio son en general mayores.

La abundancia total del mesozooplancton presentó el patrón de distribución característico del estuario de Bahía Blanca, con máximos valores en otoño, primavera y verano. A su vez, el macrozooplancton también presentó el comportamiento típico, con máximos valores en primavera-verano y mínimos en invierno.

A partir de los ensayos de toxicidad se determinó que la toxicidad del plomo disuelto en *A. tonsa* varía de acuerdo a las condiciones ambientales al momento de recolección de los organismos. A su vez, el cadmio presentó una toxicidad letal mayor en comparación con el plomo. *A. tonsa* resultó más sensible al plomo, mientras que *E. americana* resultó más sensible al cadmio. Sin embargo, es necesario tener en cuenta que durante el ensayo con cadmio en *E. americana,* la salinidad fue significativamente inferior. *E. americana* presenta una alta resistencia al plomo disuelto. A su vez, *E. americana* y *A. tonsa*, son más sensibles al cadmio en fase disuelta, en comparación con otras especies estuarinas.

ABSTRACT

Concentrations of cadmium, lead and copper in the suspended particulate matter and zooplankton were studied in the inner zone of the Bahía Blanca estuary, one of the most industrialized coastal areas all over Argentina. Simultaneously, physico-chemicals variables such as pH, temperature, salinity, dissolved oxygen, particulate organic matter, suspended particulate matter, chlorophyll *a*, phaeopigments and nutrients (nitrite, nitrate, ammonium, phosphate and silicate) were also measured and determined. The composition and spatio-temporal distribution of meso and macrozooplankton abundance were also studied.

On the other hand, acute toxicity tests were carried out for 96 hs. with the copepods *Acartia tonsa* and *Eurytemora americana* exposed to dissolved and or particulate cadmium and lead.

Cadmium concentrations in the suspended particulate matter were high at the end of March, May and November in all the sampling stations. Moreover, the nearest stations to the industrial area, Pto. Ing. White and Pto. Galván presented the highest concentrations. The results would indicate the presence of external cadmium sources with a permanent income to the system and an increase in the concentrations of cadmium in the particulate matter suspended in time. The highest concentrations of copper in the particulate fraction were in the months of August and March and November in all sampling stations, and could be due to the contribution of metals generated by human activities. With regard to lead in this same fraction, the stations close to the Industrial Pole, Ing. White and Pto. Galvan had the lowest concentrations, however, significant levels in the rest of the stations, would indicate anthropogenic inputs of lead from urban and industrial discharges.

The concentrations of metals in the mesozooplankton showed significant variations throughout the study period and in the different sampling stations. The most important sources of metals for zooplankton were the suspended particulate matter and/ or phytoplankton, depending on the season. Most of the concentrations of cadmium in the mesozooplankton are within the range recorded in other regions, but in some cases, the values of the present study are higher. Copper in the mesozooplankton, are within the concentrations cited for other regions of the world with anthropic impact. The concentrations of lead in the mesozooplankton are generally higher than those of other coastal areas with some degree of contamination, which would indicate a major source of lead generated by human activities and bioavailable to the organisms.

The levels of cadmium in the macrozooplankton in most of the stations were low. There was no significant pattern throughout the sampling period and mainly in November the highest concentrations were recorded, possibly due to high concentrations of cadmium in the MPS and the mesozooplankton. The levels of this metal are generally within the normal values registered by other authors. The concentrations of copper in the same fraction were significant throughout the study period. In general, the values of this work are within the recorded concentrations by other authors. Lead levels showed a trend of increase towards the stations close to the industrial settlements. Compared with the work of other authors, the concentrations of this study are generally higher.

Total mesozooplankton abundance showed the characteristic distribution pattern of the estuary of Bahía Blanca, with maximum values in autumn, spring and summer. Besides, macrozooplankton also presented the typical behaviour, with maximum values in spring-summer and minimum in winter.

The toxicity of dissolved lead in *A. tonsa* varies according to environmental conditions at the time of collection of the organisms. Cadmium presented a more lethal toxicity compared with lead. *A. tonsa* was more sensitive to lead, while E. *americana* was more sensitive to cadmium. However, it is necessary to take into account that during the assay with cadmium in *E. americana*, salinity was significantly lower. *E. americana* has a high strength to dissolved lead. Besides, *E. americana* and *A. tonsa*, are more sensitive to cadmium in the dissolved phase, compared with other estuarine species.

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