BENTHIC OSTRACOD ASSEMBLAGES AS BIOINDICATORS OF ANTHROPOGENIC IMPACTS IN INTERTIDAL ENVIRONMENT

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ABSTRACT: Sediment samples intertidal current of 4 locations in the estuary of Bahia Blanca were studied; with different degree of disturbance due to anthropic action. A total of 4 genera were obtained with 5 autochthonous species; on the basis of the results obtained it can be concluded that *Neocytherideis ruidis* and *Leptocythere darwini* are two species very sensitive to the contamination by human activity since it was only found in the samples taken from the intertidal Canal Tres Brazas that is characterized as the area with the least degree of modification. In the sites with greater degree of disturbance *Cyprideis salebrosa hartmanni* was the one that more development.

KEY WORDS: Ostracod, estuary, Bahía Blanca, anthropic action

Ostracods are small crustaceans, provided with a calcareous shell, live in marine, brackish and freshwater environments. They are very useful in paleoecological and paleostratigraphic research, since they are sensitive to ecological changes and have a very wide stratigraphic range, since they are recorded from the Cambrian to the present (Horne, 2002; Laprida, 2006, 2007). They can be used as environmental tracers of the changes that occur in their environment. Coastal areas constitute a very changing environment and are often influenced by human activity. For this reason, the characterization of the associations of these areas is of great interest, since these studies make possible the characterization of natural evolution episodes and others Anthropic influence in these environments (Rubio et al., 2006). The objective of this study is to analyze the ostracofauna present in marshes with different degree of disturbance by human action and to detect those species which are more sensitive to pollutants.

STUDY AREA

The Bahía Blanca estuary is located in the southern end of the province of Buenos Aires, Argentina. It is a mesomareal system conformed by channels of diverse dimensions and oriented in direction Northwest-Southeast. These channels have sinusoidal channels separated by islands and extensive tidal plains composed in general by silt-loamy sediments that are in constant morphodynamic evolution. Freshwater inputs come from the Sauce Chico river and the Napostá Grande stream, which contribute with low volumes of water and sediments (Ginsberg & Perillo, 1990).

The islands are composed of plant communities typical of the halophilous steppe (Verettoni, 1961; Verettoni & Aramayo, 1976). The tidal flats in the topographically higher areas are covered by dense Spartina vegetation, while in the lower areas there is no vegetation cover. The salinities are vertically homogeneous except in the sectors associated to the mouths of streams where the waters have a marked stratification (Piccolo et al., 1987). The longitudinal distribution of salinity in the main channel presents a homogeneous pattern except at the head of the estuary where the lowest salinity concentrations are recorded. Within the main channel is the Tres Brazas channel, which is one of the longest that flows into the aforementioned channel. El canal Tres Brazas no presenta descarga de agua dulce y su circulación es totalmente mareal dominante. This channel is highly sinuous and has numerous tributary channels that drain the tidal plains, including the Tierra Firme channel (Ginsberg & Perillo, 1990) (Fig. 1).

Anthropogenic action in the study area

Estuaries, such as the one under study, usually serve as a geochemical trap for materials dissolved in water, first increasing their concentration and eventually transferring them to cohesive sediments through different processes. Many of the pollutants of anthropic origin are associated with the fine fraction of the sediment, or at least present a similar dynamic in their behavior. As a consequence, potentially dangerous substances tend to disperse and are concentrated in those areas where the lower energy flows allow the sediment to settle, for example in tidal flats and marshes. Once the contaminated material has been deposited, it can be considered that there are no negative effects on the environment because the substance is immobilized (Grecco, 2011). In the study area, the main access routes of exogenous substances to the system are mainly effluents from urban nuclei (sewage effluents) and industrial effluents. They all do it through freshwater courses, which drain into the estuary. It is important to mention that the dredging of the Main Navigation Channel is another important activity in the area with the potential to influence the transportation of pollutants, since it suspends much of the sediment which may be contaminated.

Some studies have reported increases in secondary productivity as a result of nutrient enrichment (Nixon & Buckley, 2002), while in other cases eutrophication has evidenced reductions in benthic invertebrate diversity and abundance, as proposed by the Pearson & Rosenberg (1978).

Eutrophication has consequences for systems that are often evident through changes in biological communities, but nutrient enrichment can also alter the physical and chemical conditions of sediments and this, in turn, may have an impact on The cycling of nitrogen and phosphorus (Eyre & Ferguson, 2002). When organic matter input increases in response to nutrient enrichment, benthic microbial metabolism is stimulated and this phenomenon can lead to profound changes in nutrient release dynamics and oxygen consumption rates (Cloern, 2001). Jørgensen & Richardson (1996) concluded that sediments and benthic communities are the most sensitive elements to eutrophication and hypoxia. The importance of eutrophication in an environment and many of its consequences is known, but little is known about the possible response of benthic communities to this new state of the system and the consequences for the dynamics of nutrient fluxes. Pearson & Rosenberg (1978) developed a qualitative model, based on changes in abundance, biomass and number of species in a given environment, as enrichment with organic matter increases (Fig. 2). As a qualitative model it can be used as a conceptual framework for the analysis of changes in the benthic communities. According to this model, changes in the variables mentioned follow a typical pattern that can be described as follows: in the early stages of eutrophication, as the organic contribution increases, the quantity of species and the total biomass also increase. This trend continues until reaching a relative maximum from which, if organic enrichment increases, both biomass and species richness decrease. If the eutrophication process progresses, the reducing conditions in the sediments intensify and a secondary peak of biomass and abundance of individuals is observed, associated to small and opportunistic species, generally polychaete. If the enrichment continues, at the end of the gradient all fauna disappears, and the sediment becomes azoic.

MATERIALS AND METHODS

In this work, four zones were sampled, covering an interesting variability of environmental conditions, both in terms of their hydrological and sedimentary characteristics and the biological environment, characterized by the dominant vegetation type. Zone 1: Villa del Mar (V) (38º52'S-62º06'O) is found in the external sector of the Principal Canal, in the transition between environments dominated by fine sediments and sandy coasts. Zone 2: Club Almirante Brown (B) (38º 45' S-62º 18' O). Zone 3: Canal Maldonado (M) (38º 44' S-62º 19' O). Zone 4: Canal Tres Brazas (CTB) (38°55'S–62°14'O).

For the extraction of the samples a metal hoop of 10 cm of diameter by 2 cm of height was used, and the superficial 2 cm were collected. The material collected in the containers was washed with a set of sieves of 500 and 63 micrometers mesh light in order to remove the coarse and fine fractions, following the recommendations. All the present ostracods were separated by the picking technique, and sorted in portamicrofósiles.

For taxonomic identification, the generic classification proposed by Moore and Pitrat, 1961 was followed. For the specific determination, updated local bibliography was used (Bertels et al., 1990, 1997, 1999; Ferrero, 2006, 2009; Laprida, 2006, 2007, 2009; Whatley et al., 1975, 1987, 1988, 1995).

RESULTS

The salinity (UPS) varied between 46.6 in the Almirante Brown bread basin (B2) and 10.6 in the marshes of Villa del Mar; The content of organic matter (MO%) gave values between 4 and 9 corresponding the lowest values to the samples of marshes with Sarcocornia perennis of the localities of Canal Maldonado and Villa del mar. The PH yielded values between 7.80 and 8.35 the lowest value corresponds to the tidal flats of the Tres Brazas Canal and the highest values to the salt marshes with *Sarcocornia perennis* of Villa del Mar.

Six autochthonous species were found with live specimens at the time of sampling; *Cyprideis salebrosa hartmanni* was very abundant in the samples of tidal plain of the Canal Maldonado , Almirante Brown and Canal Tres Brazas; Marshes with *Sacocornia perennis* of theCanal Maldonado. *Leptocythere darwini* and *Neocytherideis ruidis* are found in the tidal and marshy plains of the Canal Tres Brazas; *Loxocythere variosculpta* was more abundant in the marshes and tidal flats of the Canal Maldonado (See appendix 1) (Fig. 3).

DISCUSSION

The higher salinity in the Admiral Brown saline can be due to the high evaporation rate at this site and therefore the concentration of salts added to the lack of *S. perennis* mats that protect the bucket from desiccation and, Consequently, produce a moderating effect on salinity as proposed by Calvo & Pratolongo (2009). The number of species of atrophic present in the different sampling points was lower in the sites with greater degree of antropic action; Coinciding with that proposed by Ruiz (2012) who studied the diversity of the atrophic present in sites with high degree of contamination in water bodies of Africa. The absence of *L. darwini* and *N. ruidis* in the samples of Canal Maldonado, Almirante Brown and Villa del Mar may be due to the great anthropic impact of these places; In the lower marsh of the Maldonado Calvo Marcilese Channel, 2011 finds foraminifera specimens assigned to *Haynesina germanica*, *Ammonia tepida* and *Elphidium gunteri*, species that are currently considered opportunistic in zones with marked contamination and anthropic impact (Cearreta et al., 2000; Armynot du Châtelet et al., 2004; Calvo Marcilese & Langer, 2010). These sites are under the direct influence of the Canal Maldonado, which flows into this sector of the estuary after crossing an agricultural area and crossing the city of Bahía Blanca. Associated with this discharge, high levels of various pollutants and in particular polycyclic aromatic hydrocarbons have been recorded (Arias et al., 2008), a fact that at one point could have caused the proliferation of opportunistic species such as *Cyprideis salebrosa hatmanni*, but that with the passage of time and the increase of the contaminating focus, could prevent the survival of them. The fine sediments (silts and clays) in the estuary are deposited in the tidal plains and marshes; because many of the pollutants of anthropic origin are associated with the fine fraction of the sediment, or at least present a similar dynamic in their behavior. The environments mentioned above are those that retain more contaminants and therefore the benthic ostracod in these sites is more affected since they live in direct relation with the substrate; species such as *Neocytherideis ruidis* and *Leptocythere darwini* are characterized by being in marshes; the *Spartina* that is covering the marshes fulfills the function of retaining more fine sediment, which also can accumulate more pollutants in the sites sampled with a high degree of anthropic impact.

CONCLUSIONS

Based on the results obtained we can conclude that sites with more disturbance have shown a decrease in the diversity of benthic ostracod species and proliferation of opportunistic species. Samples taken from the tidal flats and marshes of the Three Brazes Canal were the ones with the greatest diversity. This is the first contribution on ostriches and contamination for the study site.

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Appendix 1. Studied species of ostracods.

Loxocythere variasculpta Whatley, Moguilevsky, Toy, Chadwick y Ramos, 1997
Cyprideis salebrosa hartmanni Ramírez, 1967
Cyprideis multidentata Hartmann, 1955
Neocytherideis ruidis Whatley, Moguilevsky, Chadwick, Toy y Ramos 1998
Leptocythere darwini Whatley, Moguilevsky, Toy, Chadwick y Ramos
Callistocythere litoralensis (Rossi de García, 1966)

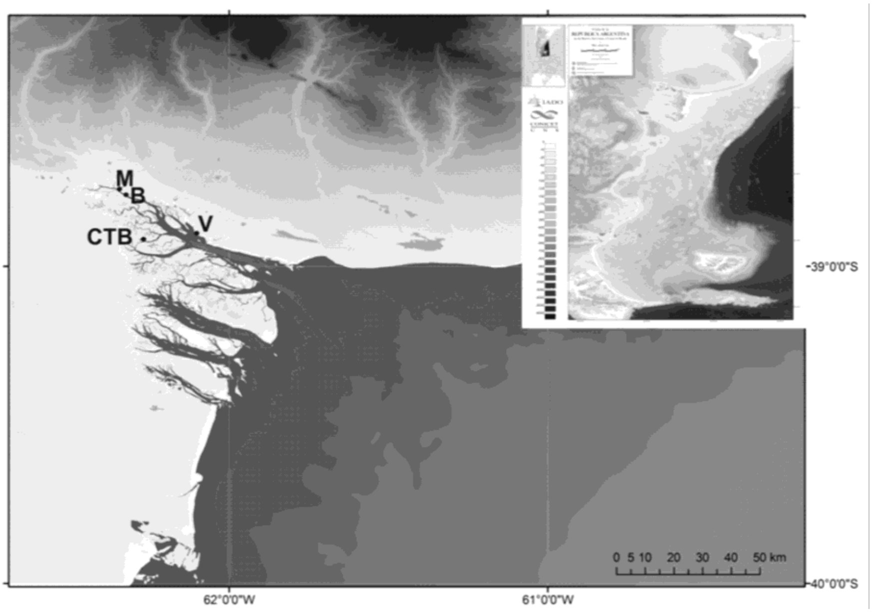

Figure 1. Map showing the sites sampled. M: Canal Maldonado; B: Admiral Brown; V: Villa del Mar; CTB: Canal Tres Brazas.

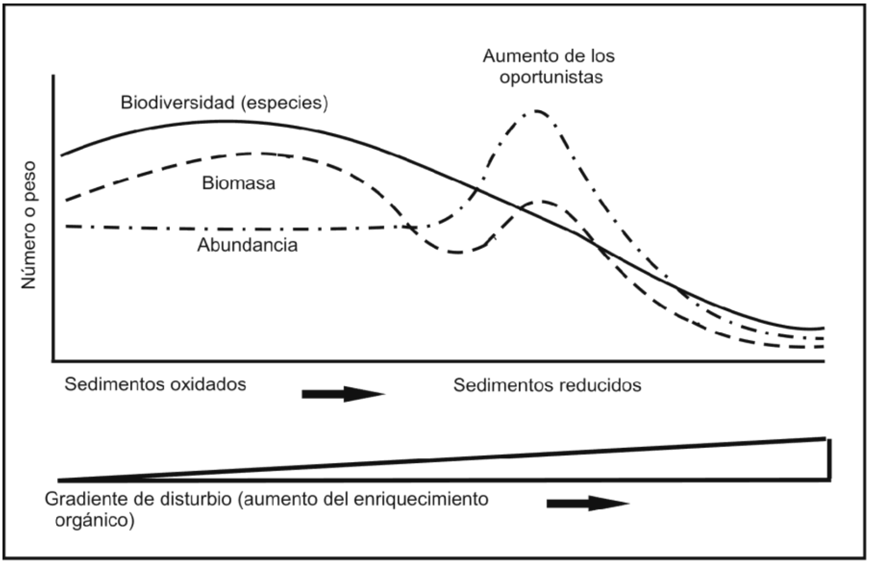

Figure 2. Model of SAB (species, abundance and biomass) by Pearson & Rosenberg (1978). Modified by Pearson & Rosenberg (1978).

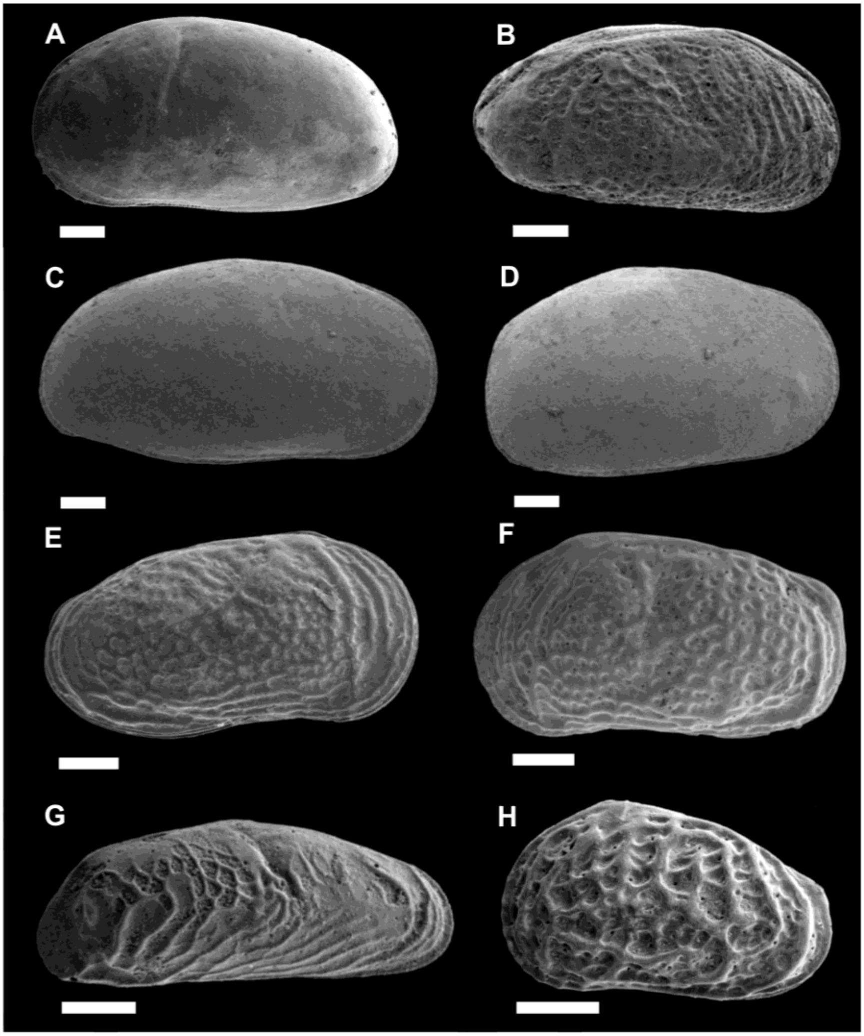

Figure 3. A. *Cyprideis multidentata* Hartmann, 1955 (x321), external view left valve (MiUNS 309, CMD); B. *Loxocythere variasculpta* Whatley et al., 1997 (x706), side view carapace (MiUNS 304, CTB); C. *Cyprideis salebrosa hartmanni* Ramírez, 1967 (x329), external view right valve (MiUNS 308, CMD); D. *Cyprideis salebrosa hartmanni* Ramírez, 1967 (x390), external view left valve (MiUNS 308, CMD); E. *Leptocythere darwini* Whatley et al., 1997, external view left valve (MiUNS 328, CTB); F. *Leptocythere darwini* Whatley et al., 1997, external view right valve (MiUNS 328, CTB); G. *Neocytherideis ruidis* Whatley et al., 1998 (x660), external view right valve (MiUNS 310, CTB); H. *Callistocythere litoralensis* (Rossi de Garcia, 1966) (x868), external view left valve (MiUNS 329, CMD). Scale: 100 μm.