Río de la Plata estuary. In that area, more than 300 point sources of pollution have been identified as the primary cause of the eutrophication through the anthropic input from domestic, industrial, and urban discharges (Kurucz *et al.*, 1998). In contrast, we found that the biomasses of the microphytoplankton (diatoms) and mesozooplankton (copepods) correlated positively with the high turbidity and conductivity levels in the estuary's outer and less polluted area.

Alonso *et al.* (2010) reported that the highest bacterial abundance (1x10^6 cells mL^{-1}) was found in the frontal zone of southeast region of the Río de la Plata estuary in conjunction with high concentrations of organic matter and chlorophyll a. In addition, the authors suggested that the bacterial productivity and diversity would be higher in that particular area of estuaries. Instead, we found that the highest bacterial density (1x10^8 cells mL^{-1}) was significantly associated to higher concentrations of nitrate and phosphate measured in that same inner part of the Río de la Plata estuary. Our estimation is far higher than the

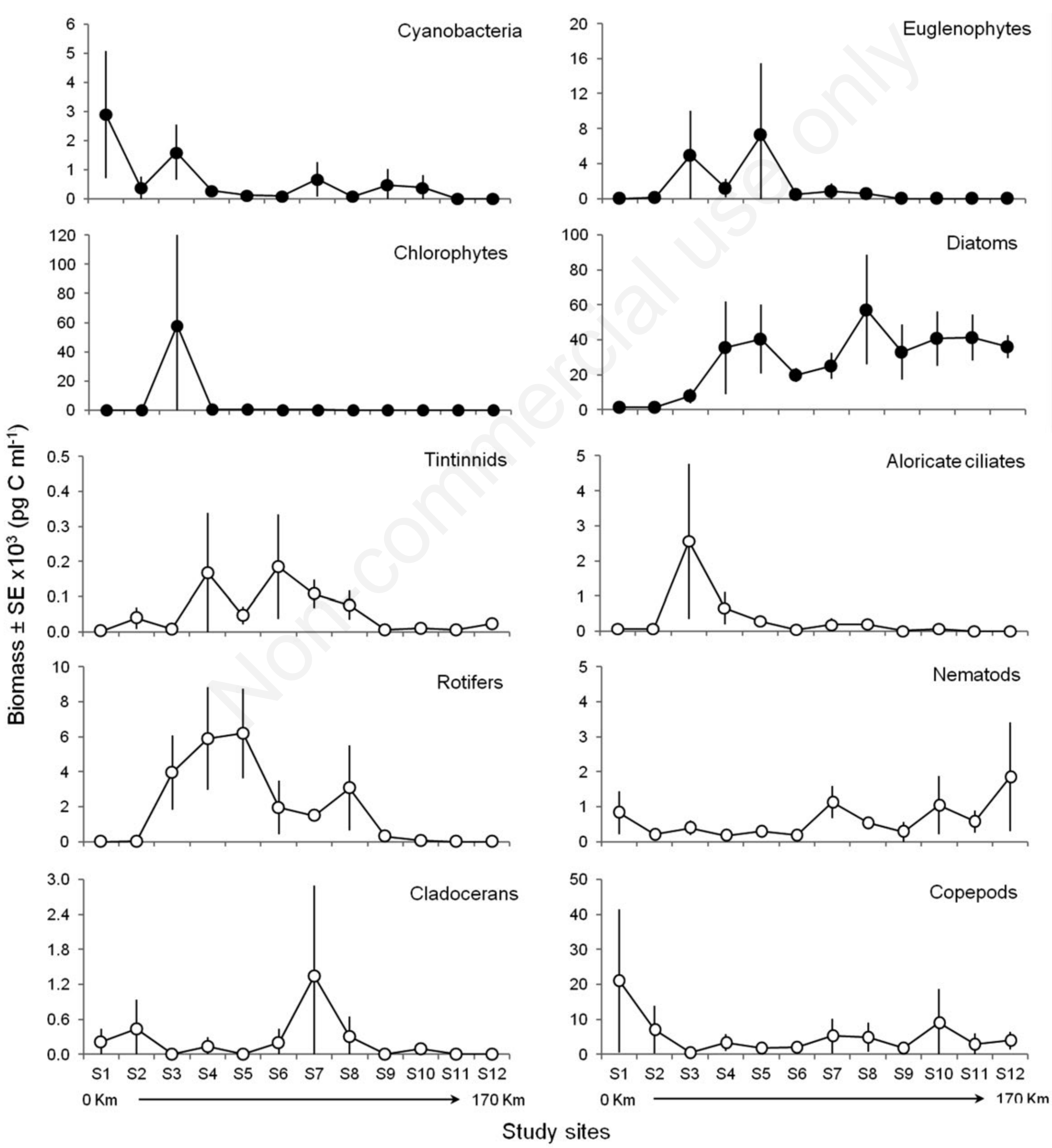

Fig. 4. Biomass of the major taxonomic groups of plankton from the intertidal coast of the Río de la Plata estuary. Black circles indicate the taxonomic groups of phytoplankton, white circles the taxonomic groups of zooplankton. SE, standard error.

bacterial abundance estimated by Alonso *et al.* (2010) and approaches to the value of $1x10^9$ cells mL^{-1} for wastewater (Hagstrøm *et al.*, 1979; Fuhrman and Azam, 1982). We assume that this atypical value estimated for the most polluted area could be related to other variables, besides that positive correlation with nitrate and phosphate, not included in this study. For instance, a higher availability of organic substrates resulting from anthropic pollution and/or originated *in situ* by other plankton groups could also significantly increase bacterial abundance. We therefore believe that this atypical value could be considered as an useful indicator of the water quality conditions in that particular area of the estuary

The average phytoplankton density (*ca.* 1,100 cell mL^{-1}) along the intertidal coast of the Río de la Plata estuary was ten-times higher than the density observed along the fluvial-mixohaline axis (Gómez *et al.*, 2004) and four-times higher than along the coastal fringe (Gómez and Bauer, 1998) in the same system. In these studies, however, the authors observed that density significantly increase in environmentally eutrophic sites located in the upper zone of the Río de la Plata. We also observed that phytoplankton density was higher at the most polluted area. Nevertheless, our estimation was twentyfold higher than the highest density observed by Gómez *et al.* (2004), three-times higher than that estimated by Gómez and Bauer (1998), and about thirtyfold higher than the average value estimated for the other eleven sites in this study. In contrast, the density was lower in the outer portion of the estuary mouth, where the salinity level was higher. The density of phytoplankton has been reported to be enhanced by the input of inorganic nutrients as consequence of anthropic impact and by a decreased abundance of phytoplankton consumers as a result of low oxygen levels (Paerl *et al.*, 2003; Kromkamp and Peene, 2005). Likewise, we found that density was positively correlated with $P\text{-}PO_4^{-3}$ levels, but negatively so with conductivity and zooplankton density. Site 3 is characterized by the highest level of eutrophication and organic pollution and, as such, dissolved oxygen level would be a limiting variable. We therefore believe that the condition of significantly low-dissolved oxygen at that site probably had negatively affected the abundance of phytoplankton consumers and, in that way, facilitated the development of high densities of phytoplankton.

The average phytoplankton biomass over the entire in-

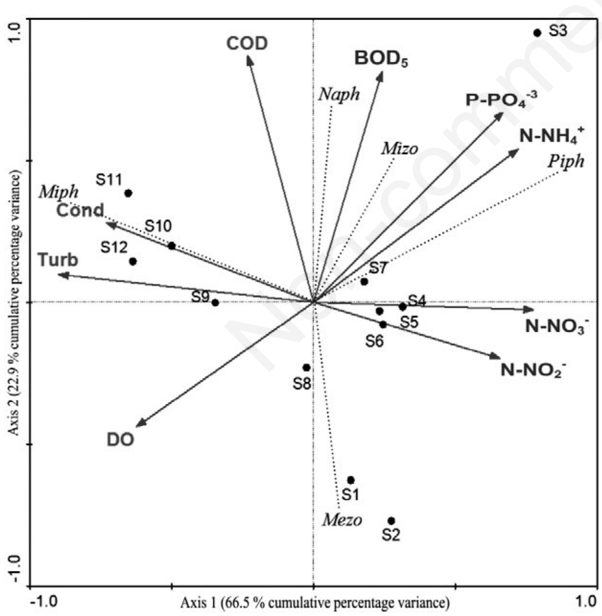

Fig. 5. Redundancy-analysis (RDA) triplot of biomass of plankton size fraction, the study sites (S), and the physicochemical variables. DO, dissolved oxygen (mg L^{-1}); BOD_5, biological oxygen demand (mg L^{-1}); COD, chemical oxygen demand (mg L^{-1}); Cond, conductivity (µS cm^{-1}); Turb, turbidity (NTU); $N\text{-}NO_3^-$, nitrate (mg L^{-1}); $N\text{-}NO_2^-$, nitrite (mg L^{-1}); $N\text{-}NH_4^+$, ammonium, (mg L^{-1}); $P\text{-}PO_4^{-3}$, phosphate (mg L^{-1}). *Piph*, picophytoplankton; *Naph*, nanophytoplankton; *Miph*, microphytoplankton; *Mizo*, microzooplankton; *Mezo*, mesozooplankton..

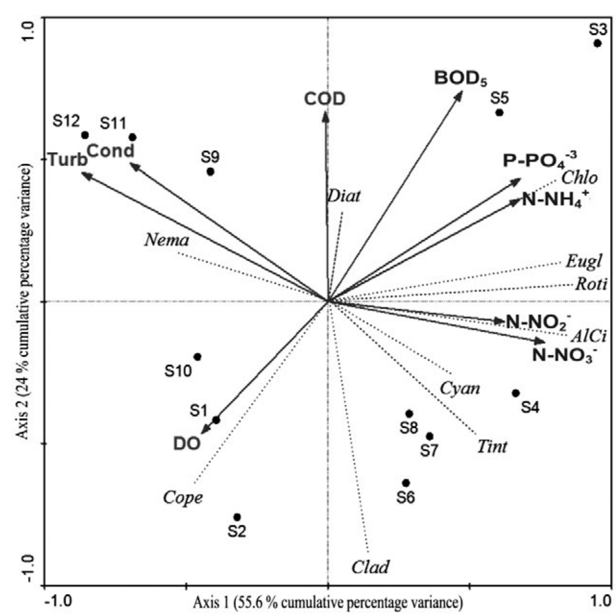

Fig. 6. Redundancy analysis (RDA) triplot of biomass of major taxonomic groups of plankton, study sites (S), and physicochemical variables. *Diat*, diatoms; *Eugl*, euglenophytes; *Chlo*, chlorophytes; *Cyan*, cyanobacteria; *Roti*, rotifers; *AlCi*, aloricate ciliates; *Cope*, copepods; *Clad*, cladocerans; *Tint*, tintinnids; *Nema*, nematodes. Abbreviations for the physicochemical variables are indicated in Fig. 5.

tertidal coast was about $3.5x10^3$ pg C mL^{-1}, but the highest biomass of the phytoplankton was *ca.* twofold higher at the most polluted area of the estuary. Nonetheless, our estimations are lower than those reported for the freshwater tidal zone ($56x10^3$ pg C mL^{-1}) as well as the mixohaline zone ($231x10^3$ pg C mL^{-1}) of the Río de la Plata estuary (Gómez *et al.*, 2004). The nanophytoplankton biomass, mostly comprised of small diatoms and cyanobacteria, represented a large proportion (84%) of the total phytoplankton biomass. A similar proportion had also been reported for other regions of the Río de la Plata estuary (Gómez *et al.*, 2004) and other communities of estuarine phytoplankton (Detmer and Bathmann, 1997; Tarran *et al.*, 2001). The biomass of picophytoplankton and nanophytoplankton (mainly consisting of chlorophytes chlorococcales, cyanobacteria, and small diatoms, respectively) was positively associated with the most polluted area characterized by high concentrations of $P\text{-}PO_4^{-3}$ and $N\text{-}NH_4^+$ and the greatest bacterial density and biomass. In agreement with Jacquet *et al.* (1998), we adopt the idea that phosphorus availability regulates the biomass and density of the smaller-sized plankton groups such as the bacteria, the pico-, and nanophytoplankton.

The highest microphytoplankton biomass, mainly composed of large diatoms, was positively correlated with study sites located within the outer part of the study area with higher levels of conductivity and turbidity. This distribution pattern was also observed by Carreto *et al.* (2003) and Calliari *et al.* (2005, 2009) in the outer zone of the Río de la Plata estuary, where lower levels of nutrients were recorded along with the highest turbidity and conductivity levels. Large cells that have a high growth-to-size relationship are generally disfavored by stratification because they need turbulence to keep them suspended in the euphotic zone (Capriulo *et al.*, 2002). The high biomass of microphytoplankton observed in areas with lower concentrations of nutrients and high turbidity may be attributable to a higher response to the fluctuating light in turbulent zones than smaller cells are capable of (Kiørboe, 1993). In the outer area of the Río de la Plata, the high speed of the tidal current and wind cause turbulence inducing a resuspension of sediments and creating a zone of maximum turbidity and salinity along with a stratification influencing flocculation and the sedimentation speed of particulate matter (Simionato *et al.*, 2011). We thus believe that the prevalence of large cells of diatoms observed in the outer sites would have contributed to an increase in the total phytoplankton biomass despite the low phytoplankton density registered in that area.

We observed that the biomass of large-sized diatoms, mainly constituted by the genera *Skeletonema*, *Actinocyclus*, *Cyclotella*, and *Aulacoseira*, represented some 81% of total phytoplankton biomass, and the biomass of this group was also greater at the coastal sites close to the mouth of the Río de la Plata estuary. This diatom assemblage had also been recorded along the fluvial-mixohaline axis of the same study system (Gómez and Bauer, 1998; Gómez *et al.*, 2004) and in the outer area of other estuaries worldwide (Mallin and Paerl, 1994; Muylaert and Sabbe, 1999; Domingues *et al.*, 2005; Guinder *et al.*, 2010). The success of these genera in competition with other taxa might be related to those diatoms' adaptive response to stressful environments. Indeed, diatoms have a higher efficiency in capturing the light within turbid habitats, a higher tolerance to a wide range of salinity levels, and a chain structure that favors resuspension through a turbulent mixing of the water column, thus delaying sedimentation to the estuary bottom (Kiørboe, 1993).

The Chlorophyta was the second most prevalent group contributing to the total biomass of the phytoplankton and were registered in a single peak at Site 3, the most eutrophic and polluted study site. We found that *Dictyosphaerium* was the more frequent genus within this taxonomic group. Consistent with our finding, this same genus had furthermore been reported to be one of the most frequent genera present in the inner section of the coastal fringe of the Río de la Plata estuary (Gómez and Bauer, 1998). We believe that the prevalence of this group, and that representation occurring in a highly environmentally disturbed area, could be related to that genus' high growth rate, nutrient uptake, and tolerance to low salinities (Paerl *et al.*, 2003).

The Cyanophyta are generally known to thrive in environments rich in nutrients and of low salinities (Paerl *et al.*, 2003; Sidik *et al.*, 2008). Nevertheless, the biomass estimated in this study represented only 1.7% of the total phytoplankton value. We observed that the most frequent genera within this group were *Oscillatoria* and *Merismopedia*. According to our estimation, these genera, as well as some potentially toxic individual species like *Microcystis aeruginosa* and *Planktothrix agardhii*, have been previously recorded in the Río de la Plata (Gómez and Bauer, 1998; Gómez *et al.*, 2004) and in other estuaries (Muylaert and Sabbe, 1999; Domingues *et al.*, 2005). Like the Chlorophytes, the cyanobacteria tolerate low salinity levels and high nutrient uptake, conditions that allow them to inhabit polluted environments. Thus, we believe that these biologic features would explain why the biomass was higher in polluted and environmentally eutrophic sites characterized by less turbulent waters than in the outer area. Although the biomass of cyanobacteria was low in the phytoplankton, the concentration of cyanotoxins produced by *M. aeruginosa* and *P. agardhii* could significantly increase with algal blooms once long residence times are establish in late spring and summer (Andrinolo *et al.*, 2007). Moreover, the mere presence of these potentially toxic species is indicative of poor water quality.

The composition, biomass, and size structure of zooplankton are strongly influenced by eutrophication (Pinto-Coelho *et al.*, 2005). In this study, the biomass of microzooplankton represented about 45% of the total biomass of zooplankton. The microzooplankton in the Río de la Plata is mainly modulated by food resources; which items, in turn, are subjected to environmental conditions in each area of the estuary (Kogan, 2005). We found that the highest biomass was associated to the most polluted area in the intertidal coast of the estuary (6.9×10^3 pg C mL^{-1}) and coincided with high bacterial and picophytoplankton biomasses. Nevertheless, the biomass estimated in this study was five-times lower than that reported by Kogan (2005) for the fluvial-mixohaline axis (37.8×10^3 pg C mL^{-1}). We believe that the condition of significantly low-dissolved oxygen registered at highly eutrophic and polluted study sites might have negatively affected the abundance of microzooplankton so as to yield a lower biomass than that reported by Kogan (2005).

Organisms belonging to microzooplankton like ciliates and rotifers are capable of feeding on picophytoplankton-sized particles (Froneman, 2001). These phytoplanktonic groups along with detritus constitute the main rotifer food resource (Arndt, 1991). The redundancy analysis showed that the biomass of rotifers was related to the highly eutrophic and polluted sites and to high biomasses of chlorophytes and euglenophytes. This result is in agreement with the distribution pattern observed by Kogan (2005) for the fluvial-mixohaline axis in the Río de la Plata estuary. We also recorded microzooplanktonic species, such as *Codonella cratera*, *Vorticella* spp., and *Keratella tropica,* in sites where the nutrient concentrations and phytoplankton biomasses were high. In addition, aloricate ciliates are also capable of consuming smaller phytoplankton, including cyanobacteria, picoplanktonic chlorophytes, and bacteria (Callieri *et al.*, 2002). We likewise observed that the biomass of the aloricate ciliates was associated with higher biomasses of cyanobacteria and chlorophytes and in close relationship with study sites having higher concentrations of $N\text{-}NO_2^-$ and $N\text{-}NO_3^-$. Furthermore, tintinnids have also been reported to have a higher density and biomass at sites with lower salinity and higher nutrient concentrations (Pierce and Turner, 1994; Kogan, 2005). We accordingly observed the highest biomass of tintinnids at sites with higher concentrations of nutrients.

The mesozooplankton biomass represented 55% of the total zooplankton value and was mainly constituted by planktonic copepods that were associated with sites located at innermost part of the estuary, though we did find a peak of biomass at Site 10. In general, planktonic copepods prefer to feed on cells larger than 10 µm (Bautista and Harris, 1992). For instance, diatoms such as *Thalassiosira* spp., *Cyclotella meneghiniana*, and *Skeletonema costatum* are the most frequently selected food source for copepods and other zooplankton groups (Mallin and Paerl, 1994). We found that central diatoms dominated at sites located in the middle and outer area of the intertidal coast of the estuary. This trophic interaction might explain why we observed a peak of copepods' biomass at Site 10. According to this observation, we would have expected a significant association between copepods and diatoms, but the redundancy analysis showed no significant correlation between them. For instance, the diatom biomass was the lowest at the innermost part of the estuary, where we found the copepod biomass to be two-times higher in that area than in the outer region.

CONCLUSIONS

This work constitutes the first ecological study analyzing the spatial distribution of density and biomass of the plankton community along the freshwater intertidal coast of the Río de la Plata estuary. The evidence presented in this study would indicate that the eutrophication and organic pollution resulting from anthropic inputs increases the density and biomass of planktonic organisms such as the bacteria, the small-sized phytoplankton, and the microzooplankton species. Thus, the differences found in the taxonomic composition and size structure of the planktonic-community assemblage between the most polluted and less polluted sites highlights the significant impact of human activities in modifying the functioning of this coastal ecosystem.

Nevertheless, in order to understand completely the causality of the spatial variation documented in the present study, experimental manipulations, both *in situ* and *in vitro*, of the multitude of conditions and influences that could conceivably affect the size fraction and major taxonomic groups of intertidal plankton would be needed. We consider, however, that our findings provide new information on the utility of plankton as an indicator of water quality in estuaries and would constitute an excellent baseline for further ecological and water-quality research.

ACKNOWLEDGMENTS

We thank the anonymous reviewers for their critical review and helpful suggestions of the manuscript. We want also to express our gratitude to Drs. Mónica Hoffmeyer and Valeria Guinder for their detailed comments and corrections. Dr. Donald F. Haggerty, a retired career investigator and native English speaker, edited the final version of the manuscript. Financial support for this study was provided by the grant PICT 32077 to Dr. Nora Gómez, head of the laboratory where this work was done. MDG is a doctoral fellow in CONICET; NB is a postdoc fellow in CONICET.

REFERENCES

Alonso C, Gómez-Pereira P, Ramette A, Ortega L, Fuchs BM, Amann R, 2010. Multilevel analysis of the bacterial diversity along the environmental gradient Rio de la Plata-South Atlantic Ocean. Aquat. Microb. Ecol. 61:57-72.

APHA, 1998. Standard methods for examination of water and wastewater. American Public Health Association, American Water Works Association and Water Pollution Control Federation, Washington: 1220 pp.

Andrinolo D, Pereira P, Giannuzzi L, Aura C, Massera S, Caneo M, Caixach J, Barco M, Echenique R, 2007. Ocurrence of *Microcystis aeruginosa* and microcystins in the Río de la Plata (Argentina). Acta Toxicol. Arg. 15:13-18.

Arndt H, 1991. Population dynamics and production of estuarine planktonic rotifers in the southern Baltic: *Brachionus quadridentatus* (Hermann, 1783). Acta Ichthyol. Piscatoria 21:7-15.

Bautista B, Harris RP, 1992. Copepod gut contents, ingestion rates and grazing impact on phytoplankton in relation to size structure of zooplankton and phytoplankton during a spring bloom. Mar. Ecol. Prog. Ser. 82:41-50.

Beaugrand G, 2005. Monitoring pelagic ecosystems using plankton indicators. ICES J. Mar. Sci. 62:333-338.

Beers JR, Stewart GL, 1970. Numerical abundance and estimated biomass of microzooplankton. In: J.D.H. Strickland (ed.) The ecology of the plankton off La Jolla, California, in the period April through September 1967. Bull. Scripps Inst. Oceanogr. 17:67-87.

Borja A, Basset A, Bricker S, Dauvin JC, Elliot M, Harrison T, Marques JC, Weisberg SB, West R, 2012. Classifying ecological quality and integrity of estuaries. Treatise on Estuarine and Coastal Science 1:125-162.

Bottrell H, Duncan A, Gliwicz Z, Grygierek E, Herzig A, Hillbricht-Ilkowska A, Kurasawa H, Larsson P, Weglenska T, 1976. A review of some problems in zooplankton production studies. Norw. J. Zool. 24:419-456.

Bratbak G, Dundas I, 1984. Bacterial dry matter content and biomass estimations. Appl. Environ. Microb. 48:755-757.

Calliari D, Brugnoli E, Ferrari G, Vizziano D, 2009. Phytoplankton distribution and production along a wide environmental gradient in the South-West Atlantic off Uruguay. Hydrobiologia 620:47-61.

Calliari D, Gómez M, Gómez N, 2005. Biomass and composition of the phytoplankton in the Río de la Plata: large-scale distribution and relationship with environmental variables during a spring cruise. Cont. Shelf Res. 25:197-210.

Callieri C, Karjalainen SM, Passoni S, 2002. Grazing by ciliates and heterotrophic nanoflagellates on picocyanobacteria in Lago Maggiore, Italy. J. Plankton Res. 24:785-796.

Capriulo GM, Smith G, Troy R, Wikfors GH, Pellet J, Yarish C, 2002. The planktonic food web structure of a temperate zone estuary, and its alteration due to eutrophication. Hydrobiologia 475/476:263-333.

Carreto JI, Montoya NG, Benavides HR, Guerrero R, Carignan MO, 2003. Characterization of spring phytoplankton communities in the Río de La Plata maritime front using pigment signatures and cell microscopy. Mar. Biol. 143:1013-1027.

De Jonge VN, Elliot M, Orive E, 2002. Causes, historical development, effects and future challenges of a common environmental problem: eutrophication. Hydrobiologia 475/476:1-19.

Detmer AE, Bathmann UV, 1997. Distribution patterns of autotrophic pico- and nanoplankton and their relative contribution to algal biomass during spring in the Atlantic sector of the Southern Ocean. Deep-Sea Res. Pt. II 44:299-320.

Domingues RB, Barbosa A, Galvão H, 2005. Nutrients, light and phytoplankton succession in a temperate estuary (the Guadiana, south-western Iberia). Estuar. Coast. Shelf. S. 64: 249-260.

Dumont H, Van De Velde I, Dumont S, 1975. The dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from the plankton, periphyton and benthos of continental waters. Oecologia 19:75-97.

Dutto MS, López Abbate MC, Biancalana F, Berasategui AA, Hoffmeyer MS, 2012. The impact of sewage on environmental quality and the mesozooplankton community in a highly eutrophic estuary in Argentina. ICES J. Mar. Sci. 69:399-409.

Feller RJ, Warwick RM, 1988. Energetics, p. 181-196. In: R.P. Higgins and G. Thiel (eds.), Introduction to the study of meiofauna. Smithsonian Institution Press.

Framiñán MB, Brown OB, 1996. Study of the Río de la Plata turbidity front, Part I: spatial and temporal distribution. Cont. Shelf Res. 16:1259-1289.

Froneman PW, 2001. Seasonal changes in zooplankton biomass and grazing in a temperate estuary, South Africa. Estuar. Coast. Shelf S. 52:543-553.

Fuhrman JA, Azam F, 1982. Thymidine incorporation as a measure of heterotrophic bacterioplankton production in marine surface waters: evaluation of field results. Mar. Biol. 66:109-120.

Gómez N, Bauer DE, 1998. Phytoplankton from the "Southern Coastal Fringe" of the Río de la Plata (Buenos Aires, Argentina). Hydrobiologia 380:1-8.

Gómez N, Bauer DE, Licursi M, Hualde PR, 2002. Planktonic and periphytic coastal algae of the Río de La Plata, Argentina. Int. Ver. Theor. Angew. 28:250-253.

Gómez N, Hualde PR, Licursi M, Bauer DE, 2004. Spring phytoplankton of Río de la Plata: a temperate estuary of South America. Estuar. Coast. Shelf. S. 61:301-309.

González-Ortegón E, Pascual E, Cuesta JA, Drake P, 2006. Field distribution and osmoregulatory capacity of shrimps in a temperate European estuary (SW Spain). Estuar. Coast. Shelf. S. 67: 293-302.

Guerrero MA, Acha ME, Framiñan MB, Lasta C, 1997. Physical oceanography of the Río de la Plata Estuary. Cont. Shelf Res. 17:727-742.

Guinder VA, Popovich CA, Molinero JC, Perillo GME, 2010. Long-term changes in phytoplankton phenology and community structure in the Bahía Blanca Estuary, Argentina. Mar. Biol. 157:2703-2716.

Hagstrøm A, Larsson U, Horstedt P, Norwalk S, 1979. Frequency of dividing cells, a new approach to the determination of bacterial growth rates in aquatic environments. Appl. Environ. Microb. 37:805-812.

Heinbokel JF, Coats DW, Henderson KW, Tyler MA, 1988. Reproduction rates and secondary production of three species of the rotifer genus *Synchaeta* in the estuarine Potomac River. J. Plankton Res. 10:659-674.

Hillebrand H, Dürselen CD, Kirschtel D, Pollingher U, Zohary T, 1999. Biovolume calculation for pelagic and benthic microalgae. J. Phycol. 35:403-424.

Jacquet S, Lennon JF, Marie D, Vaulot D, 1998. Picoplankton population dynamics in coastal waters of the northwestern Mediterranean Sea. Limnol. Oceanogr. 43:1916-1931.

Jaime P, Menéndez AN, Natale OE, 2001. [Balance y dinámica de nutrientes principales en el Río de la Plata interior].[Report in Spanish]. Instituto Nacional del Agua, Argentina. Available from: http://www.ina.gov.ar/pdf/LH-it_rdplata_balance_ sep01.pdf

Kiørboe T, 1993. Turbulence, phytoplankton cell size, and the structure of pelagic food webs. Adv. Mar. Biol. 29:2-61.

Kogan M, 2005. [Estudio de la composición específica, abundancia y distribución especial del microzooplancton (Protozoos y micrometazoos) en el estuario del Río de La Plata (Argentina/Uruguay)].[Thesis in Spanish]. Universidad Nacional de Buenos Aires.

Kromkamp J, Peene J, 2005. Changes in phytoplankton biomass and primary production between 1991 and 2001 in the Westerschelde estuary (Belgium/The Netherlands). Hydrobiologia 540:117-126.

Kurucz A, Masello A, Méndez S, Cranston P, Wells PG, 1998. [Calidad ambiental del Río de La Plata, p. 71-86]. In: P.G. Wells and G.R. Daborn (eds.), El Río de La Plata, una revisión ambiental. Un informe de Antecedentes del Proyecto EcoPlata].[Book in Spanish]. Dalhousie University, Halifax.

Lepš J, Šmilauer P, 2003. Multivariate analysis of ecological data using CANOCO. Cambridge University Press.

Lund JWG, Kipling C, Le Cren ED, 1958. The inverted microscope method of estimating algal numbers and the statistical basis of estimations by counting. Hydrobiologia 11:143-170.

Mackereth FJH, Heron J, Talling JF, 1978. Water analysis: some revised methods for limnologists. Freshwater Biological Association: 120 pp.

Mallin MA, Paerl HW, 1994. Planktonic trophic transfer in an estuary: seasonal, diel, and community structure effects. Ecology 75:2168-2184.

Margalef R, 1955. [Los organismos indicadores en la limnología. Biología de las aguas continentales].[Book in Spanish]. Ministerio de Agricultura, Instituto Forestal de Investigaciones y Experiencias: 300 pp.

Margalef R, 1983. [Limnología].[Book in Spanish]. Omega, Barcelona: 1010 pp.

Marques SC, Azeiteiro UM, Leandro SM, Queiroga H, Primo AL, Martinho F, Viegas I, Pardal MÂ, 2008. Predicting zooplankton response to environmental changes in a temperate estuarine ecosystem. Mar. Biol. 155:531-541.

Mc Cauley E, 1984. The estimation of the abundance and biomass of zooplankton in samples, p. 228-265. In: J. Downing and F. Rigler (eds.), A manual on methods for the assessment of secondary productivity in fresh waters. Blackwell Scientific Publications.

Menden-Deuer S, Lessard EJ, 2000. Carbon to volume relationships for dinoflagellates, diatoms and other protist plankton. Limnol. Oceanogr. 45:569-579.

Mianzan H, Lasta C, Acha E, Guerrero R, Macchi G, Bremec C, 2001. The Río de la Plata Estuary, Argentina-Uruguay, p. 185-204. In: U. Seeliger and B. Kjerfve (eds.) Coastal marine ecosystems of Latin America. Ecological studies. Springer.

Muylaert K, Sabbe K, 1999. Spring phytoplankton assemblages in and around the maximum turbidity zone of the estuaries of the Elbe (Germany), the Schelde (Belgium/The Netherlands) and the Gironde (France). J. Marine Syst. 22:133-149.

Norland S, 1993. The relationship between biomass and volume of bacteria, p. 303-307. In: P.F. Kemp, B.F. Sherr, E.B. Sherr and J.J. Cole, (eds.) Handbook of methods in aquatic microbial ecology. Lewis Publishers.

Paerl HW, Valdes LM, Pinckney JL, Piehler MF, Dyble J, Moisander PH, 2003. Phytoplankton photopigments as indicators of estuarine and coastal eutrophication. BioScience 553:953-964.

Paerl HW, Rossignol KL, Hall SN, Peierls BL, Wetz MS, 2010. Phytoplankton community indicators of short-and long-term ecological change in the anthropogenically and climatically impacted Neuse River Estuary, North Carolina, USA. Estuar. Coast. 33:485-497.

Pierce RW, Turner JT, 1994. Plankton studies in Buzzards Bay, Massachusetts, USA. IV. Tintinnids, 1987 to 1988. Mar. Ecol.-Prog. Ser. 112:235-240.

Pinto-Coelho RM, Bezerra-Neto JF, Morais-Jr CA, 2005. Effects of eutrophication on size and biomass of zooplankton in a tropical reservoir. Braz. J. Biol. 65:325-338.

Porter KG, Feig YS, 1980. The use of DAPI for identifying and counting aquatic microflora. Limnol. Oceanogr. 25:943-948.

Putt M, Stoecker DK, 1989. An experimentally determined carbon: volume ratio for marine 'oligotrichous' ciliates from estuarine and coastal waters. Limnol. Oceanogr. 34:1097-1103.

Riemann F, Ernst W, Ernst R, 1990. Acetate uptake from ambient water by the free-living marine nematode *Adoncholaimus thalassophygas*. Mar. Biol. 104:453-457.

Roggiero MF, 1988. [Fitoplancton del Río de la Plata, I].[Article in Spanish]. Lilloa 37:137-152.

Ruttner-Kolisko A, 1977. Suggestions for biomass calculations of plankton rotifers. Archr. Hydrobiol. 8:71-76.

Sidik MJ, Rashed-Un-Nabi Md, Azharul Hoque Md, 2008. Distribution of phytoplankton community in relation to environmental parameters in cage culture area of Sepanggar Bay, Sabah, Malaysia. Estuar. Coast. Shelf. S. 80:251-260.

Simionato CG, Moreira D, Piedra-Cueva I, Fossati M, Re M, Sabarots Gerbec M, Menendez AN, Cayocca F, 2011. [Proyecto FREPLATA-FFEM Modelado numérico y mediciones in-situ y remotas de las transferencias de sedimentos finos a través del Río de la Plata. Parte B: Simulaciones numéricas].[Article in Spanish]. Revista Frente Marítimo 22:265-304.

Tarran GA, Zubkov MV, Sleigh MA, Burkill PH, Yallop M, 2001. Microbial community structure and standing stocks in the NE Atlantic in June and July of 1996. Deep-Sea Res. Pt II 448:963-985.

Ter Braak CJF, Verdonschot PFM, 1995. Canonical correspondence analysis and related multivariate methods in aquatic ecology. Aquat. Sci. 57:255-289.

Verity PG, Langdon C, 1984. Relationship between lorica volume, carbon, nitrogen, and ATP content of tintinnids in Narragansett Bay. J. Plankton Res. 6:859-868.

Verlecar XN, Desai SR, Sarkar A, Dalal SG, 2006. Biological indicators in relation to coastal pollution along Karnataka coast, India. Water Res. 40:3304-3312.

Wieser W, 1960. Benthic studies in Buzzards Bay. II. The meiofauna. Limnol. Oceanogr. 5:121-137.

Wilson JG, 1994. The role of bioindicators in estuarine management. Estuaries 17:94-101.