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COMPARISON OF CARBON AND NITROGEN CONTENT IN NATURAL AND *AULACOMYA ATRA* (MOLINA) BIODEPOSITS

COMPARACION DEL CONTENIDO DE CARBONO Y NITROGENO EN BIODEPOSITOS NATURALES Y DE *AULACOMYA ATRA* (MOLINA)

Catalina T. Pastor de Ward [1]

ABSTRACT

Biodeposition "in situ" of *Aulacomya atra* (Molina), the subantarctic ribbed mussel, is studied by collector cylinder system. In order to evaluate the contribution of this species to the organic carbon and nitrogen flux in Puerto Madryn bay ecosystem, the organic carbon and organic nitrogen contents in biodeposits were measured and compared with those from natural biodeposits of the area. Mean annual values were 3.03 g C. m^{-2}. day^{-1} and 0.23 g N. m^{-2}. day^{-1} in mussel biodeposits and 3.16 g C. m^{-2}. day^{-1} and 0.25 g N. m^{-2}. day^{-1} in natural biodeposits. The mean annual concentration were 9.24 g C and 0.58 g N in 100g of mussel biodeposists and 6.68 g C and 0.44g N in 100g of natural biodeposits. From Friedman's test results the carbon and nitrogen contents and concentrations were similar both in mussel and natural biodeposists. The C/N ratio for mussel biodeposits was smaller than that of natural biodeposits only in summer months.

Key words: biodeposition, *Aulacomya atra*, Chubut, Argentina.

RESUMEN

En el presente trabajo se estudia, mediante el método de cilindros colectores, el biodepósito "in situ" del bivalvo subantártico *Aulacomya atra* (Molina). La finalidad del mismo ha sido evaluar la contribución de esta especie al flujo de carbono y nitrógeno orgánico de la bahía de Puerto Madryn. El contenido de carbono y nitrógeno total en valores netos en biodepósitos del bivalvo, ha sido comparado con los del biodepósito natural del área. Los valores medios anuales hallados en biodepósitos del bivalvo fueron 3,03 g C. m^{-2}. $día^{-1}$ y 0,23 g N. m^{-2}. $día^{-1}$, mientras que en biodepósitos natural 3,16 g C. m^{-2}. $día^{-1}$ y 0,25 g N. m^{-2}. $día^{-1}$. Los valores medios anuales de las concentraciones de carbono y nitrógeno en 100g de biodepósito del bivalvo fueron 9.24 g C y 0.58 g N respectivamente. En 100 g de biodepósitos naturales dichas concentraciones fueron 6.68 g C y 0.44g N. De los resultados de un test de Friedman se obtuvo que el contenido y la concentración de carbono y nitrógeno entre biodepósitos del bivalvo y naturales no presentaron diferencias significativas. El cociente C/N de los biodepósitos presentó valores menores que los de la sedimentación natural sólo en los meses de verano.

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Palabras clave: biodepósito, *Aulacomya atra*, Chubut, Argentina.

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INTRODUCTION

Special attention to the study of biodeposition in bivalve filter feeders has been paid recently, (Dame, 1992), because they are the dominant species in shallow estuaries and coastal ecosystems and it has been demonstrated that they play an important role in the benthic-pelagic coupling mechanism (Kautsky & Evans, 1987). Several "in situ" studies related to the quantity and the composition of mussel biodeposition have been done: in the oysters *Crassostrea gigas* (Sornin *et al.* 1983, 1986, Deslous-Paoli, 1987 and Smaal *et al.* 1997), in the infaunal bivalve *Laternula eliptica* (Ahn, In Young, 1993) and in the mussels *Mytilus edulis* (Kautsky & Evans, 1986; Deslous-Paoli, *et al.* 1987; Jaramillo *et al.* 1992; ten Brinke *et al.* 1995; Smaal *et al.* 1997), *Perna canalicularis* (Kaspar *et al.* 1985), *Mytilus galloprovincialis* (Collazo *et al.* 1993), *Choromytilus chorus* (Jaramillo *et al.* 1992) and *Modiolus modiolus* (Navarro *et al.* 1997). A good review of some of these papers and on the quantitative comparison of biodeposits is given by Smaal & Prins (1992).

This is the first paper related to the "in situ" study of *Aulacomya atra* (Molina) biodeposition. The ribbed mussel is a very abundant and widely distributed mussel of subantarctic coasts which has been usually found in rocky shores from the littoral fringe to the subtidal (Zaixso, 1975; Zaixso & Pastor, 1977; Vinuesa *et al.* 1977; Zaixso *et al.* 1978; Erkom-Schurink, 1990). This ribbed mussel is always related to very diverse communities, even in sedimentary substrate. In Puerto Madryn Bay coasts the *Aulacomya atra* (Molina) community is a very common association of organisms present on the sandy beds bottom with a mean natural mussel density of around 60-80 ind. $m^{-2} \pm 9.68$ (Zaixso, pers. comm.). On human-made substrata (such as docks or artificial reefs) and on suspending habitats, this density can be very different, for instance in the Almirante Storni Port 's docks, where the mean density is 1001 ind. $m^{-2} \pm 36.08$ (unpublished data).

A knowledge of the quantities and composition of *Aulacomya atra* biodeposition is crucial for understanding how this community interacts with the pelagic-benthic system, in a low nutrient area like Puerto Madryn Bay (Charpy-Roubauld *et al.* 1982; Pastor & Bala, 1995, 1996) producing high densities and also high biomasses in floating docks.

On the other hand the knowledge about this interaction could help in a sustainable future mariculture of mussels resources while maintaining environmental quality.

MATERIALS AND METHODS

Puerto Madryn bay is located on the West coast of Golfo Nuevo (42 45' South and 64 55' West) on the Atlantic coast of South America, Chubut province, Argentina (Fig. 1A). The bay is 0-40 m deep and presents

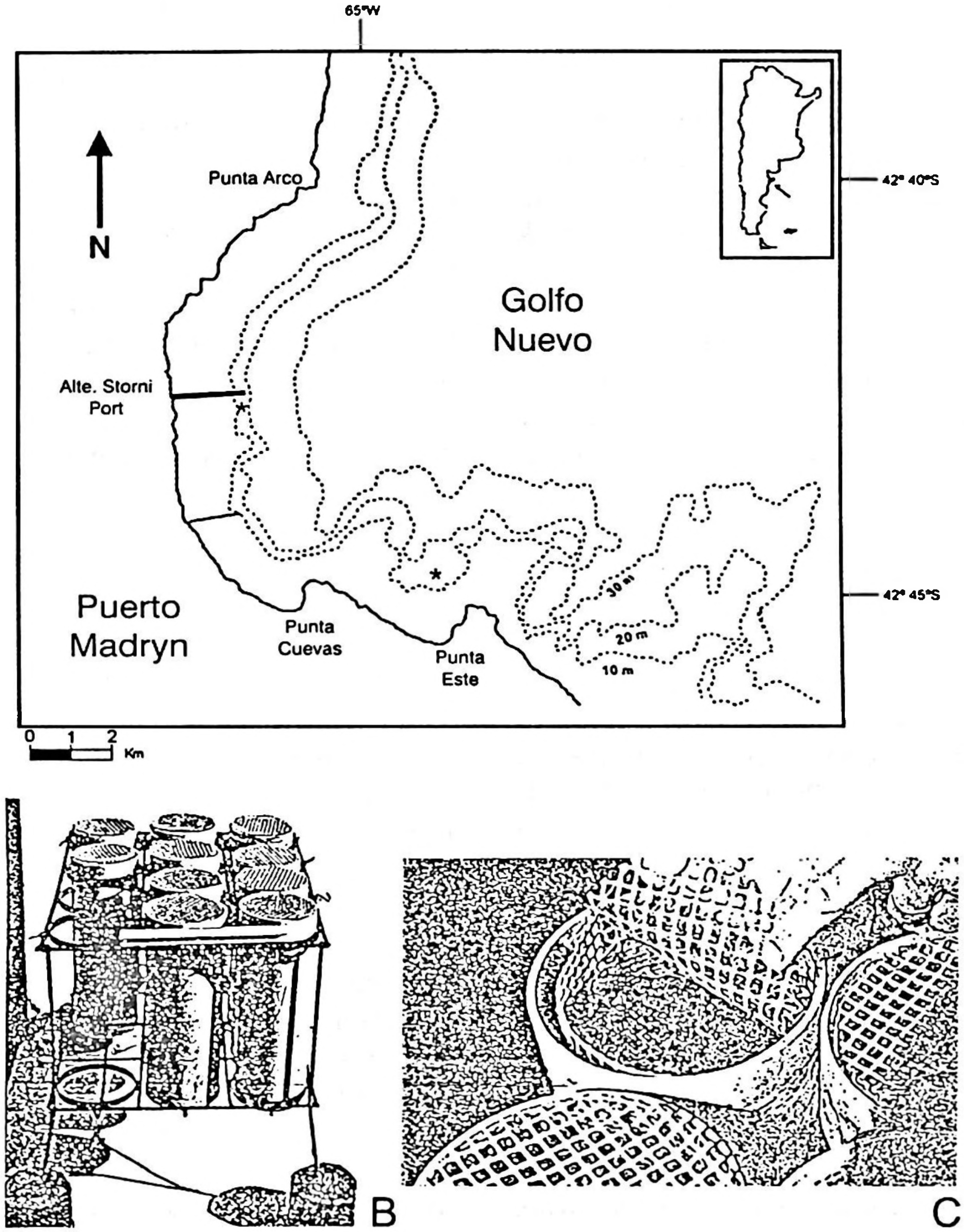

Figure 1: A Schematic map of Puerto Madryn and sampling sites (*). B Submerged apparatus. C Neflon cages.

A Mapa de Puerto Madryn y áreas de muestreo (*). B Aparato sumergido. C Canastas plásticas.

sublittoral sediments dominated by fine sand with patches of pebbles (Mouzo *et al.* 1978). The tidal regime is semi-diurnal and the mean tidal range is 4.62 m. The bottom currents are dominant in winter and spring, whereas the rest of the year surface currents are the most important (Barros & Krepper, 1978).

The Puerto Madryn area is situated in a semiarid Patagonian region, characterized by low and irregular rainfall regimes (173 mm per year) and strong, constant winds. The introduction of continental sediments into the sea and the resuspension of surface bottom sediments by strong winds, is usual along the coastal area.

The present paper is based on methodology similar to that of Kautsky & Evans (1987). The six PVC cylinders used (15 cm diameter and 50 cm high), were fixed to an iron-concrete framework to the sea bottom floor, near Punta Este site (Figs. 1, 1B). Six neflon net cages (0.7 cm mesh and 7.5 cm high) (Fig. 1C) were fastened to the top of the cylinders. In three of these cylinders a group of 20 selected mussels (between 4-5 cm length) from Alte. Storni Port (Fig.1) were deposited each month (previously cleaned of epibionts). The other three cylinders, with the empty cages, were deposited in the same framework, to collect natural biodeposits.

The mussels number in the cages were chosen to simulate density in floating docks community and the mussels minimum length of 4 cm were selected to assure sexual maturity, following Vinuesa & Tortorelli (1981).

These cylinders were allowed to stay in the sea during a period of 15 days. After this period they were sealed with rubber stops and transported by a diver to the sea surface and then to the lab. After a stabilization period of 24 h at 7 °C, the sediments were removed by centrifugation and the obtained material was dried at 100 °C during 24 h. After that they were dissolved with distilled water several times to dilute the salt content, and then centrifugated again.

All the cylinders were cleaned and dried before to be fixed again the next month to the iron-concrete framework on the sea bottom floor. This was done, each month, during the three years period.

The organic matter content (ash-free dry weight) was obtained after ashing at 550 °C for 5h. The carbon content was determined considering 57% of organic matter (Parson *et al.* 1984).

The organic nitrogen content in the sediments was analysed as NH^4-H after a modified Kjeldahl combustion.

The organic carbon and organic nitrogen contents in biodeposition *of Aulacomya atra* were obtained by difference between the sedimentation in cylinders with and without mussels. Carbon (OC) and nitrogen (ON) contents of mussel biodeposits (B) and natural biodeposits (NB) are expressed as dry weight ($g \cdot m^{-2} \cdot day^{-1}$). The missing values were due to cylinders being lost during storms.

Annual organic carbon and organic nitrogen in biodeposits of *Aulacomya atra* and natural biodeposits of the area were recorded from september 1989 to september 1992.

The ribbed mussels used in the study throughout the three-year period were measured and weighed monthly (dry weight).

Bottom water ammonium and cylinder water ammonium were determined simultaneously to the study following methodology given by Strickland & Parsons (1972).

To analyze statistical differences between OCNB-OCB and ONNB-ONB, which presented heterogeneity of variances, a Friedman two-way test was used (Siegel, 1979).

RESULTS

The temporal variation in organic carbon (OCB) and organic nitrogen (ONB) content in *Aulacomya atra* M. biodeposits and in natural biodeposits (OCNB; ONNB) during the present study, are shown in Figs. 2 and 3 respectively.

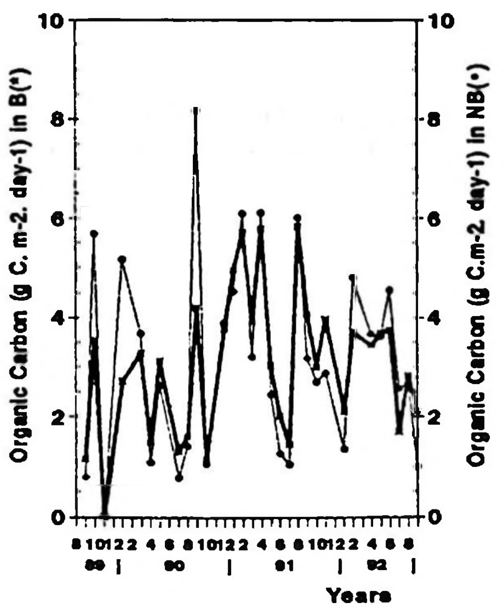

Figure 2: Monthly variation in organic carbon content in mussel biodeposits (*) and in natural biodeposits (●).

Variación mensual de carbono orgánico en biodepósito de cholga (*) y en sedimentación natural (●).

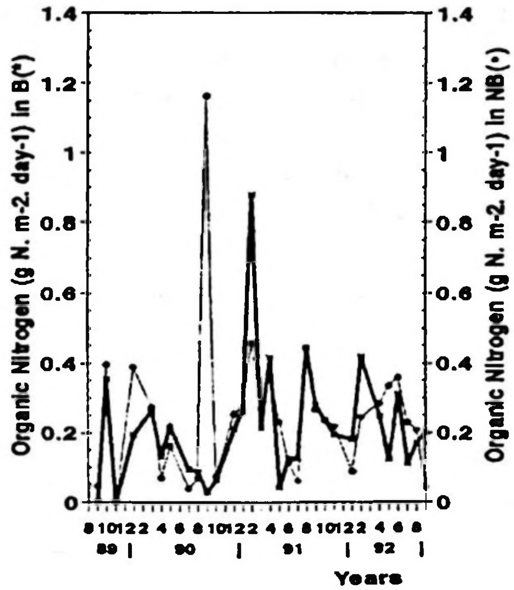

Figure 3: Monthly variation in organic nitrogen content in mussel biodeposits (*) and in natural biodeposits (●).

Variación mensual de nitrógeno organico en biodepósito de cholga (*) y en sedimentación natural (●).

The organic carbon contents in biodeposits (OCB) of ribbed mussel, are in general smaller than those of natural biodeposits. A similar situation occurs with organic nitrogen, which presents a periodicity with peaks at the summer months.
The annual means of OCB, ONB, OCNB and ONNB contents and C/N ratios are shown in Table 1.

Table 1 - Mean values of organic nitrogen (ON), organic carbon (OC), %ON, %OC and C/N ratios means of the *Aulacomya atra* biodeposits (B) and natural biodeposits (NB), at Puerto Madryn bay during the three years period .

- Valores medios de nitrogeno orgánico (ON) y de carbono orgánico (OC), porcentajes y cocientes C/N en biodepósitos de *Aulacomya atra* (B) y en biodepósitos naturales (NB), en la bahía de Puerto Madryn, durante los años del estudio.

Period	9/89-8/90	9/90-8/91	9/91-8/92	9/89-8/92
	n=9	n=11	n=10	n=31
NB*	35.11	77.81	59.78	57.47
ON**	0.16	0.34	0.25	0.25
OC***	2.35	3.98	3.19	3.16
OC/ON	16.20	13.39	13.17	14.39
ON/100g NB	0.46	0.43	0.41	0.44
OC/100g NB	6.70	5.11	5.34	6.68
B*	26.38	38.08	40.23	34.85
ON**	0.15	0.25	0.23	0.23
OC***	2.01	3.79	3.22	3.03
OC/ON	13.38	24.95	15.59	21.22
ON/100g B	0.57	0.67	0.56	0.58
OC/100g B	7.64	9.95	8.00	9.24

*g Dry wt. m^{-2}. day^{-1} **g N. m^{-2}. day^{-1} ***g C. m^{-2}. day^{-1}

The seasonal mean of OCB, ONB, OCNB and ONNB contents during the three year period are shown in Table 2.

Table 2 - Mean values of organic nitrogen (ON) and organic carbon (OC), %ON, %OC and C/N ratio of the *Aulacomya atra* biodeposits (B) and natural biodeposits (NB), at Puerto Madryn bay and during seasons.

- Valores medios de nitrógeno (ON) y carbono orgánico (OC), %ON, %OC y cociente C/N de biodepósitos de *Aulacomya atra*(B) y biodepósitos naturales (NB) en la bahía de Puerto Madryn durante las diferentes estaciones del año.

	Spring	Summer	Autumn	Winter
Period	(Oct.Nov.Dec.)	(Jan.Fev.Mar.)	(Apr.May.Jun.)	(Jul.Aug.Sep.)
	n=5	n=7	n=8	n=9
NB*	40.03	59.14	57.27	72.80
ON**	0.23	0.28	0.24	0.28
OC***	2.70	4.11	3.16	2.98
OC/ON	11.71	14.44	13.21	10.64
ON/100g NB	0.58	0.48	0.42	0.38
OC/100g NB	6.74	6.95	5.53	4.09
B*	31.28	34.06	38.56	36.51
ON**	0.21	0.34	0.20	0.17
OC***	2.56	3.76	3.28	2.78
C/N	12.10	10.91	16.24	16.24
ON/100g B	0.68	1.01	0.52	0.47
OC/100g B	8.19	11.04	8.50	7.62

* g Dry wt. m^{-2}. day^{-1} ** g N. m^{-2}. day^{-1} *** g C. m^{-2}. day^{-1}

The mussel biodeposits presented similar mean values throghout the three years and during the four seasons. The natural biodeposits presented the highest values in the winter season and in the 1990-91 year period.

It is important to note that sediments collected from the cylinders were black and anoxic during the three year period. In natural sediments of the bay, the black layer was present on the surface under man-made constructions of Alte. Storni Port or 2-7 cm depth in the Punta Este study site.

In Fig. 4, the seasonal variation of ammonium water bottom content and ammonium concentration in cylinders with and without mussels are presented for a one year period (Pastor *et al.* 1995). In bottom ammonium the highest values are in spring whereas ammonium in cylinders presents, for natural biodeposits, their higher values in winter and for cylinders with biodeposits in summer.

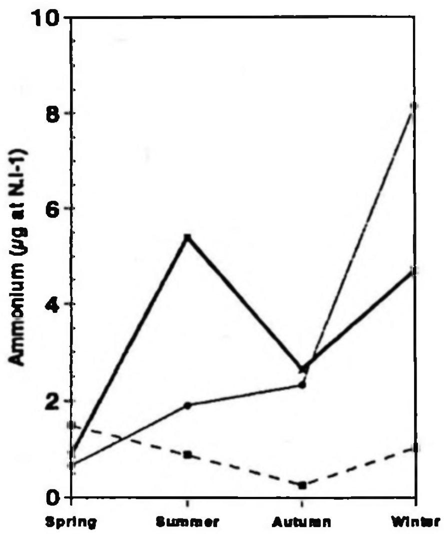

Figure 4: Seasonal variations in water ammonium concentrations in cylinders with mussels (●) and without mussels (⁎), and in bottom water (—).

Variación estacional de la concentración de amonio en el agua contenida en los cilindros con cholga (⁎); sin cholga (●) y en el agua circundante (—).

The seasonal variation of *Aulacomya atra* biomass and length during the three year study are given in Fig. 5. The seasonal variation of chlorophyll "a" and water temperature are detailed in Pastor & Bala (1996). The maximum temperature was found in summer. While chlorophyll "a" presents higher values in autumn and winter.

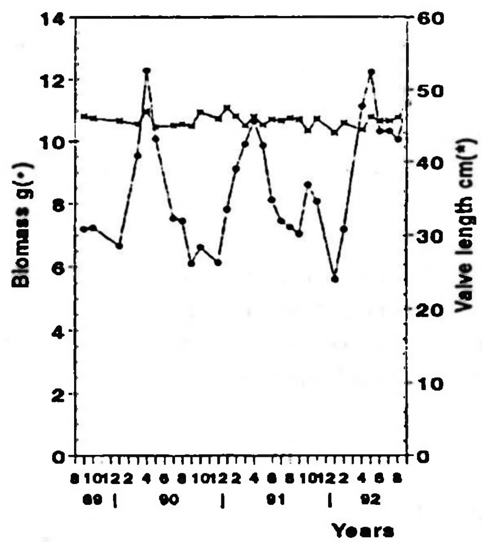

Figure 5: Monthly variations in *Aulacomya atra* valve length (●) and biomas (⁎) in cylinders.

Variación mensual en cilindros del largo de valva y biomasa de *Aulacomya atra*.

The seasonal variation of C/N (Tables 1-2, Fig. 6) ratio in biodeposits presents the smallest value in summer months and the highest in autumn and winter months. The C/N in natural biodeposits have a different behaviour, being high in summer and small in winter. In natural biodeposits this ratio was high in the first year and very similar for the second and the third year. In mussel biodeposition the highest values were in the second and third year.

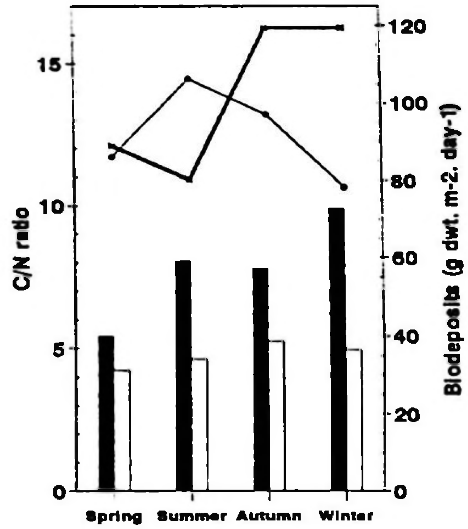

Figure 6: Seasonal variations of C/N ratios in mussel biodeposits (*) and natural biodeposits (●). In bar graphic, seasonal variations of biodeposits (□) and natural biodeposits (■).

Variaciones estacionales de C/N en biodepósito de cholga (*) y en sedimentación natural (●). En gráfico de barras, variación estacional de biodepósito de cholga (□) y en sedimentación natural (■).

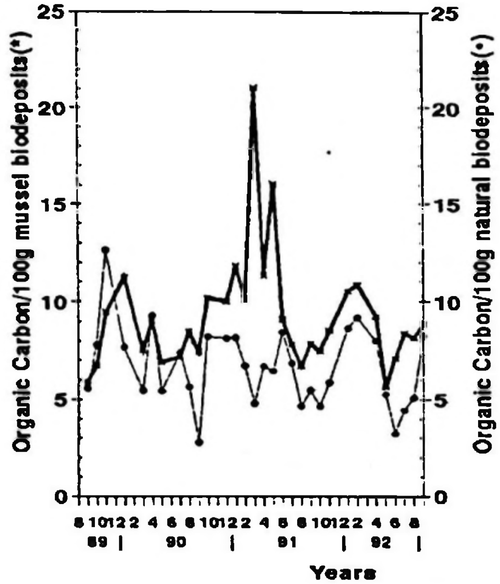

Figure 7: Monthly variation in percentages of organic carbon in mussel biodeposits (*) and in natural biodeposits (●).

Variaciones mensulaes en porcentajes de carbono orgánico en biodepósito de cholga (*) y en sedimentación natural (●).

The OC and ON contents in 100 g of sediment were compared montly in natural biodeposits and mussel biodeposition (Figs. 7-8; Tables 1-2). In order to detect wether OCBN-OCB and ONBN-ONB contents and percents differed between them, a Friedman two-way analysis was applied. The results are given in Table 3. We found that OC and ON contents and percents between mussels biodeposits and natural biodeposits do not present significant differences.

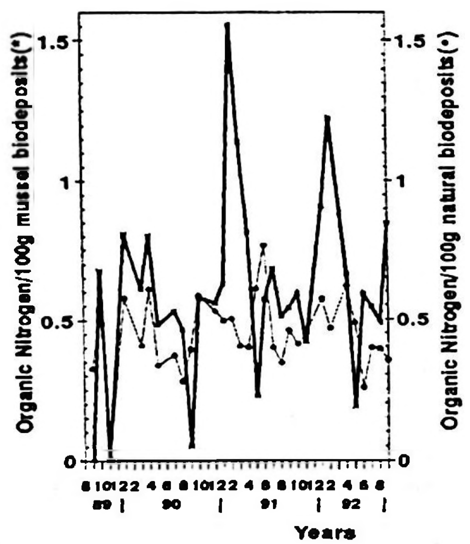

Figure 8: Monthly variation in percentages of organic nitrogen in mussel biodeposits (*) and in natural biodeposits (●).

Variación mensual en porcentajes de nitrógeno orgánico en biodepósito de cholga (*) y en sedimentación natural (●).

Table 3 - Results of Friedman Two-way test performed on organic carbon, organic nitrogen and percentages between biodeposits and sedimentation.

- Resultados del test de Friedman realizado sobre carbono orgánico, nitrógeno orgánico y porcentajes de los mismos entre biodepósitos del bivalvo y naturales.

Ho:	Friedman's test	N	Significance Level
OCB = OCNB content	0.80645	31	0.36917
ONB= ONB content	1.20000	31	0.27332
OCB/100g B= OCNB/100g NB	17.06450	31	0.00004
ONB/100g B= ONNB/100g NB	9.32258	31	0.00226

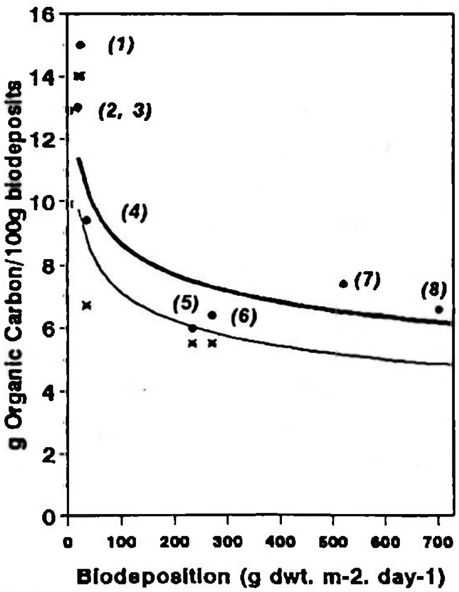

Figure 9: Concentrations of organic carbon in Mytilidae species biodeposits (●) and in natural biodeposits (⁎) registered in previous papers: (1) *Mytilus edulis* Asko, Baltic Sea (Kautsky & Evans, 1987); (2) *Mytilus edulis* (Dahback & Gunnarsson, 1981); (3) *Aulacomya atra* Puerto Madryn, Argentina; (4) *Chroromytilus chorus* Quele river Estuary (Jaramillo *et al.* 1992); (5) *Mytilus chilensis* Quele river Estuary (Jaramillo *et al.* 1992); (6) *Mytilus galloprovincianus* Ria de Arosa (Perez & Camacho, 1991); (7) *Mytilus galloprovincianus* Gulf of Fos (Grenz, 1989).

Concentraciones de carbono orgánico en biodepósito (●) y en biodepósitos naturales (⁎) halladas para especies de la familia Mytilidae en trabajos previos:(1) *Mytilus edulis* Asko, Baltic Sea (Kautsky & Evans, 1987); (2) *Mytilus edulis* (Dahback & Gunnarsson, 1981); (3) *Aulacomya atra* Puerto Madryn, Argentina; (4) *Chroromytilus chorus* Quele river Estuary (Jaramillo *et al.* 1992); (5) *Mytilus chilensis* Quele river Estuary (Jaramillo *et al.* 1992); (6) *Mytilus galloprovincianus* Ria de Arosa (Perez & Camacho, 1991); (7) *Mytilus galloprovincianus* Gulf of Fos (Grenz, 1989).

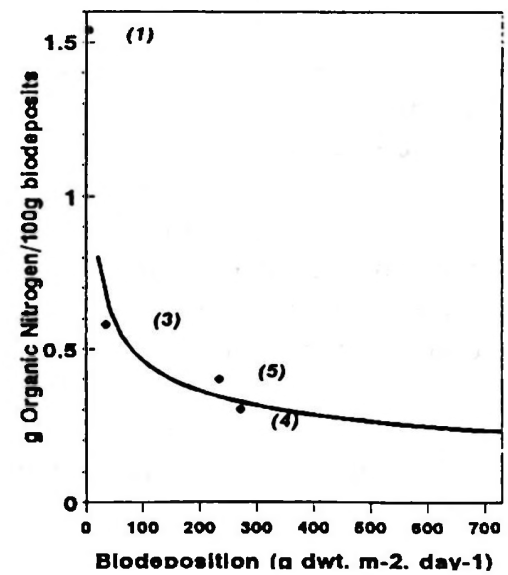

Figure 10: Concentrations of organic nitrogen in Mytilidae species biodeposits (●) registered in previous papers: (1) *Mytilus edulis* Asko, Baltic Sea (Kautsky & Evans, 1987); (Dahback & Gunnarsson, 1981); (2)*Aulacomya atra* Puerto Madryn, Argentina; (3)*Mytilus chilensis* Quele river Estuary (Jaramillo *et al.* 1992); (4) *Chroromytilus chorus* Quele river Estuary (Jaramillo *et al.* 1992).

Concentraciones de nitrógeno orgánico en biodepósito (●) halladas para especies de la familia Mytilidae en trabajos previos: (1) *Mytilus edulis* Asko, Baltic Sea (Kautsky & Evans, 1987); (Dahback & Gunnarsson, 1981); (2)*Aulacomya atra* Puerto Madryn, Argentina; (3)*Mytilus chilensis* Quele river Estuary (Jaramillo *et al.* 1992); (4) *Chroromytilus chorus* Quele river Estuary (Jaramillo *et al.* 1992).

DISCUSSION

In this "in situ" study it has been assumed that the chemical and biological reactions, with and without mussels (such as fermentation and ammonification as main processes), occurring inside the cylinders, are similar between them and similar to processes of anoxic sediments.

Anoxia conditions in surface sediments are not usual near Puerto Madryn Bay coasts, except below the Alte. Storni Port where the sunlight does not reach the sediments and they support a very diverse floating community. However, contact between mussel faeces and pseudofaeces with anoxic environment in an area like this Bay, are highly probable, taking into account tidal currents, resuspention and the natural habitat (on subtidal sedimentary substrata, Zaixso, pers. com.) of the ribbed mussel.

From the obtained results the ribbed mussels *Aulacomya atra* (Molina) with their biodeposits, are able to contribute to the sediments of Puerto Madryn Bay, under anoxic conditions, with an organic matter load (in organic carbon and nitrogen content, per square meter and per day) similar to that of the natural biodeposits.

Owing to the tidal ranges the natural biodeposits in the area is formed, in addition to phyto and zooplancton, by phyto and zoobenthos, mineral sediments and other detritus coming from macroalgae or marine organisms which are resuspended from the bottom floor. This means that the ribbed mussels, with their biodeposits, in densities similar to those of the study, likely play an important role in contributing organic carbon and nitrogen to this ecosystem.

Recent studies of granulometric characteristics of sediments under the Puerto Madryn docks (Pastor, in prep.) have found a smaller particle size, significantly greater organic matter content and a break redox layer much nearer to the surface sediments under docks than in undisturbed sites of the Bay. Based on the results obtained in this paper all these processes could be associated with the high density and biomass of the ribbed mussels on docks and probably their effect, by biodeposition, can be compared with those which evolve in anoxic areas from intensive mussels, oysters and fishes aquaculture (Mattsson & Linden, 1984; Kaspar *et al.* 1985; Brown *et al.* 1987; Sornin *et al.* 1983). Probably the effect of mussel biodeposition could increase in the future if more man-made constructions are introduced to the Bay. The content of organic carbon in natural biodeposits and in biodeposition are very constant during the yearly period and during seasons. Something different happens with their organic carbon and nitrogen concentrations. These variations between the proportions of assimilable organic matter to inorganic fraction or non assimilable natural biodeposits are responsible for the changing concentration of organic nitrogen and carbon in the mussel food.

A good argument to understand how the ribbed mussel can contribute with similar carbon and nitrogen contents to those from natural biodeposits has been given by Kautsky & Evans (1987) and Navarro & Iglesias (1992). The first authors observed in *Mytilus edulis* from the Baltic sea, the ability to do a pre-ingestive sorting and selection of smaller particles with higher organic contents. This allows mussels by selectiveness, to sedimentate the smaller particles of high organic content that would otherwise stay in suspension and in this way they are able to increase the quality (as a future food) and the quantity of deposited material on benthic sediments. In the particular case of *Aulacomya atra* (Table Bay Cape Town, South Africa), it has been demonstrated that it is very well adapted to absorb 50 % of kelp detritus, and it could optimize its nitrogen uptake by retention of particles of less than 20 µm in diameter (Stuart & Klumpp, 1984).

On the other hand, Navarro & Iglesias (1992) develop a model in *Ceratodesma edule* which explains the physiological behaviour of bivalves in relation to the quality of food. They state that: " at high concentrations of high quality particles, regulation is mainly based on controlling rates of filtration through adjustments of pumping activity; conversely, no such adjustments appear associated with low quality suspensions and ingestion becomes regulated by high rates of pseudofaecal production that acts to counterbalance the high unrestrained filtration rates."

If we assume that the increase in pseudofaecal and faecal production is related with an increase in organic matter concentration in biodeposits (Haven & Morales de Alamo, 1966), following Navarro & Iglesias's (1992) statement, we could expect higher organic matter concentrations in bivalve biodeposits from areas with low quality suspension than from those with high quality food. In Fig. 9 , the distribution of the concentrations of carbon in biodeposits and the total biodeposition rates (Smaal & Prins, 1992) of Mytilidae species, studied are given. The natural biodeposits values (in % of carbon) were added. We see that the relation between quantity of biodeposition and the percentages of carbon are not lineal. It is regulated by concentrations of food probably following an non-linear trend curve type. This would mean that for high quality suspensions, the concentration of carbon in biodeposits would be constant and bivalves could counterbalance poor quality sedimentation rates by incresing concentrations of biodeposits. A similar curve has been found for %TON in biodeposits (Fig. 10).

This phenomenon is related to each particular environment and from the obtained results we think that probably it plays a more important role in mussel biology than has previously been considered.

This is probably related to the bioseston production (Hildreth, 1980) and the quality of the net flux, which is a consequence of resuspension of biodeposits, predominantly pseudofaeces, and selective ingestion of phytoplancton (Asmus & Asmus, 1992) . This can be one of the explanations of how a phytoplancton poor area (Charpy *et al.* 1982; Pastor & Bala, 1995b) like Puerto Madryn bay, can sustain their highly diverse benthic assemblages. And probably due to this fact, poor natural biodeposits sites are not directly related with poor mussel production for mariculture, as has been stated by Charpy *et al.* (1982).

Unfortunately the information is still scarce and more work is needed to understand this phenomenon.

The C/N ratio:

The mussel contribution in C/N biodeposition ratios has been found to have smaller values than those of natural biodeposits only in the summer months whilst during the rest of the year they are equal or higher. This suggests a summer enrichment of biodeposits. This feature has been found in previous records for the summer months in very different ecosystems (Dahlblack & Gunnarsson, 1981, Kautsky & Evans, 1987, Kaspar *et al.* 1985). And probably can be also related to other physiological mussel behaviour which allow them to react to different suspensions qualities and quantities of organic matter in natural biodeposits by modifying their metabolism. We know that mussels are adapted to seasonal variations modifying the digestive cells morphology, rate of ingestion or gut passage times (Bayne, 1992). *Mytilus edulis* is able to optimize the energy intake according to the quantity and quality of the consumed food (Boromthanarat, 1986). In *Aulacomya atra* the growth and net growth efficienty has been demostrated by Navarro & Ulloa (1992) to be mainly affected by the different quality and quantity of the seston in Yaldad Bay, southern Chile. The seasonal variations of temperature and primary production has been found to be important factors which define total *Aulacomya atra* weight and increases of glycogen contents in summer months in Puerto Madryn Bay (De Vido de Mattio, 1980). Erkom-Schurink **et al** (1991, 1992, 1993) have found that temperature, circulation, silt content, concentration of food and mussel density are important factors too which affect *Aulacomya atra* growth.

This summer enrichment is more evident in organic nitrogen which duplicates their concentration in biodeposits. The dissolved ammonium in cylinders with mussels also increase (Fig. 4). Something similar happens in oyster beds, where organic matter enrichment of sediments by biodeposition, in winter, is followed by intensive amonification in summer with very limited nitrification, and this ammonium enrichment from sediment to the overlying water is an order of magnitude higher than the initial supply in the water (Sornin *et al.* 1990; Lerat *et al.* 1985).

The mean values of C/N ratios of biodeposition found in Puerto Madryn Bay agree with those found by Jaramillo *et al.* (1992), for Chilean coasts in *Mytilus chilensis*. But TOC and TON percents in biodeposits are greater in Puerto Madryn Bay (C=6%; N=0.4% for Chile versus C=9.24; N=0.58 in Argentina).

From another point of view the enrichment of bivalves faeces and pseudophaeces in summer months could be related to a trap derived situation by bacterial attack. In the cylinders with mussels there is a greater surface area to be colonized than in the traps without mussels, this means greater bacterial growth (ZoBell, 1946). On the other hand it is known that bivalves can contribute to the bacteria content by other ways. They have cellulocytic enzimes that help them digest cellulosic material (Crosby *et al.* 1989), making faeces more atractive to bacteria and gut bacteria (Hylleberg & Gallucci, 1975) that can contribute with the bacteria pool, stimulating bacterial growth (Hylleberg & Riis-Vestergard, 1984).

The biodeposition in ribbed mussel has presented more constant values between seasons than between the three year study. This can be related to the fact that 1991- 1992 were "El Niño" years with a measurable increase in precipitations in the area (Pastor & Bala, 1996), and a subsequent increase in the organic matter imput from the continent. The natural biodeposits had shown a higher variability in both studies.

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