# STUDIES ON BIOFOULING AT MAR DEL PLATA HARBOR. MONTHLY SETTLEMENT OF CALCAREOUS SPECIES ALONG A YEAR

## *"BIOFOULING" DEL PUERTO DE MAR DEL PLATA:ASENTAMIENTO MENSUAL DE ORGANISMOS CALCÁREOS*

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## SUMMARY

*Monthly settlement of calcareous species was followed in Mar del Plata harbor (Argentina) along a year. Large number of calcareous organisms recruited onto ceramic panels.* ***Balanus amphitrite*** *and* ***Hydroides elegans*** *were the most representative species settled on the primary space. Other barnacles,* ***B. glandula*** + ***B. improvisus*** *followed in importance, but the number of recruits per panel was always low. All of them were measured and total occupied areas estimated. The species showed different settlement cycles, different preferences by both depth levels and surface texture.*

*The maximum peak of density for* ***B. glandula*** + ***B. improvisus*** *was in December, for* ***B. amphitrite*** *in February and for* ***Hydroides elegans*** *in March. Virtually no settlement took place during colder months (June-September). Barnacles preferred to settle on the back side of the panels, with grooves and pits, while serpulids showed no texture preferences. In relation with depth all species preferred to colonize the three deepest levels. Data corresponding to growth rates indicated a rapid development during warmer months.*

**Keywords**: *macrofouling, calcareous species, test panels, barnacles, serpulids.*

## INTRODUCTION

The settlement of macrofouling calcareous species on artificial submerged structures should be taken into account because of their rapid colonization and growth. The attachment of these organisms generate serious problems not only from the point of view of fouling, e.g. increase in frictional resistance and loss of hydrodynamics but also due to corrosion phenomena, bacteria living under calcareous coating consume the oxygen due to its respiratory activity and promote localized corrosion processes **[1]**.

The planktonic larval stages of many sessile marine invertebrates are recruited to surfaces in response to surface associated stimuli. Gregarious settling behavior are generally

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mediated by chemical signals [2,3] and are responsible for aggregation of barnacles, serpulids, hydroids, and a host of other sessile invertebrates. Physical and chemical stimuli are important in determining a substratum for barnacle settlement and metamorphosis [3,4]. In addition, one source of cues for settlement is some component of the attached microflora [5-7].

The local current adjacent to the substratum, the conditions in water column and the physical characteristics of the substratum either prevent the attachment of the planktonic propagules or make it more attractive [8-14]. Furthermore, earlier successional species may enhance or inhibit the arrival of later species by providing suitable or unsuitable environmental conditions.

The calcareous species alter the topography of hard substratum, increasing its heterogeneity and trapping sediment particles in the interstices among them.

Barnacles are among the commonest fouling organisms and are nearly world-wide in distribution. Their larvae settle in great numbers on newly exposed surfaces and grow so rapidly that the surfaces are covered completely in a short time. On ships, barnacles are usually the first forms to appear in numbers if the protective paints are inadequate or become so. The firm attachment of barnacles to the surface also favors their persistence on ships in active use [15]. The barnacle larval stage known as the cyprid is non-feeding and specialized for dispersal, settlement, and metamorphosis to the adult [16]. Barnacle cyprids use their antennules for settlement on a substratum and for subsequent permanent attachment to it [17]. These antennules secrete a proteinaceous adhesive [18].

Due to their frequency and to their covering rate, tube-worms (serpulids) are considered as an important group in fouling communities all over the world. *Hydroides elegans* (often as *H. norvegica*), a cosmopolitan species, occurs throughout tropical and temperate seas and was probably widely distributed on the bottom of ships. Rapid and dense colonization of submerged surfaces, natural and experimental, by this species has been recorded in Australia [19], India [20,21], Egypt [22,23], South Atlantic and elsewhere. In Pearl Harbor, Hawaii, it is probably the major problem fouler of Navy ships, being able to colonize submerged surfaces and build up layers several centimeters thick in one to two months [24].

The tubiculous worms have a larval swimming stage known as trocophore that settles on a hard substratum in large number; under favorable conditions, the growth rate may be 10 times quicker in summer than in winter [25] and the tubes reach 2 to 3 cm in length [26]. Dean [27] suggested that both barnacle and serpulid tube-worm settlements are inhibited by the presence of other species, and they settled only in abundance on bare surfaces. Some serpulids proved to be an indicator for the oil polluted water [22,23].

In a previous paper [28] recruitment patterns of dominant macrosessile foulers and the seasonal developmental sequence of the community at Mar del Plata harbor were studied. Multivariate cluster analysis revealed two trends, one from late autumn to spring and the other from summer to early autumn. During winter months *Ciona intestinalis* had an important functional role in the community, as an adult might enhance the arrivals of some species as secondary space recruiters; however, in summer, its larvae were poor competitors for seasonal space occupiers and this situation favored the invasion of calcareous exoskeleton organisms, such as *Balanus* and *Hydroides*.

The aim of the present research is to study the recruitment trends of calcareous macrosessile foulers on the primary space all the year round, and their preferences for different textures and depth at the time of settlement.

## MATERIALS AND METHODS

Mar del Plata harbor is situated in the Buenos Aires province (38° 02'S-57° 32'W). It is an important harbor which is affected by a naval complex, fishery industries and nautical recreation. The study site was located within the harbor at the Club de Motonáutica (Fig. 1).

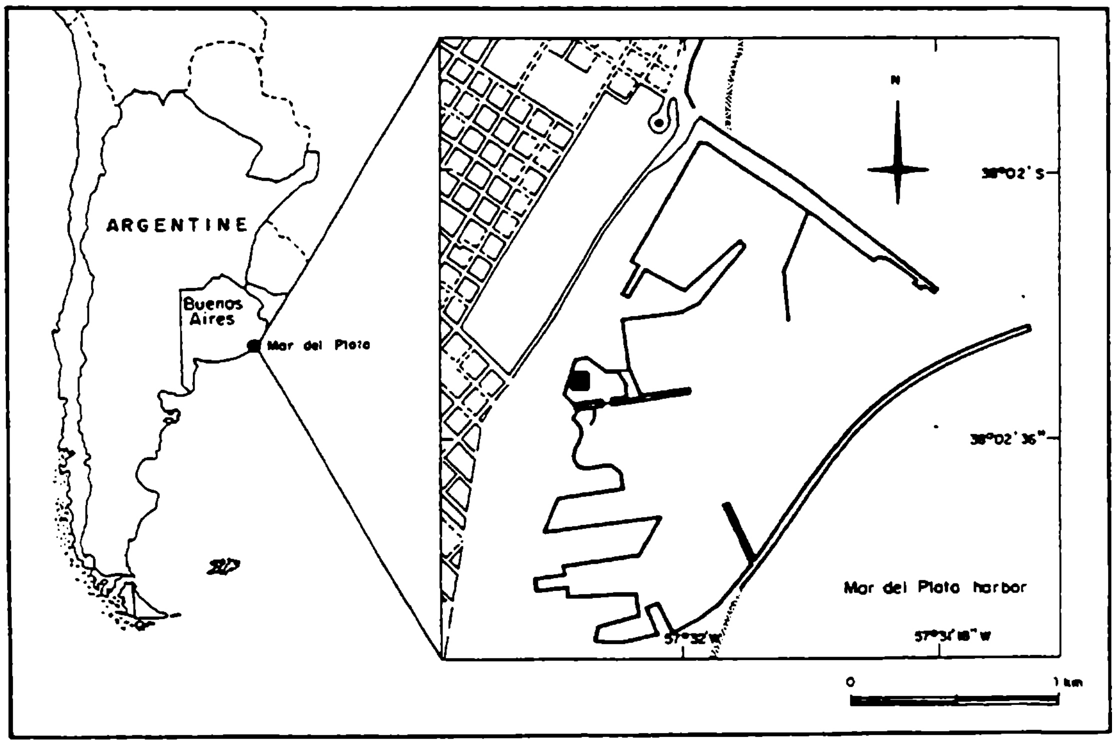


**Fig. 1.** -Site of study and location of test panels series (■).

The study was carried out since May 1991 up to April 1992. Fouling organisms were collected by submerging 128 cm$^2$ unglazed ceramic tiles (panels). A sample series included three ropes with four panels separated 20 cm one from each other. The series were vertically hung from a floating dock, about 0.3 m to 1.5 m below the water surface to provide the record of macrofouling organisms for four different depths (Fig. 2). Each series of panels was immersed for one month, then removed and transported in plastic cages in 4% neutral solution of formalin in sea water. A new series of clean panels was immersed at the same time. In order to check the density of barnacles and serpulids larvae, monthly plankton samples were taken with a 50 µm zooplankton net.

The front and the back surface of the panels have different rugosity. The front is smooth (total rugosity: 49.84 µm) and the back is with a design of 7 mm side-squares of 0.83 mm depth (with four edges each). The front and the back surface of the panels, from the top to the bottom were labeled as: **A,a**; **B,b**; **C,c** and **D,d**, respectively.

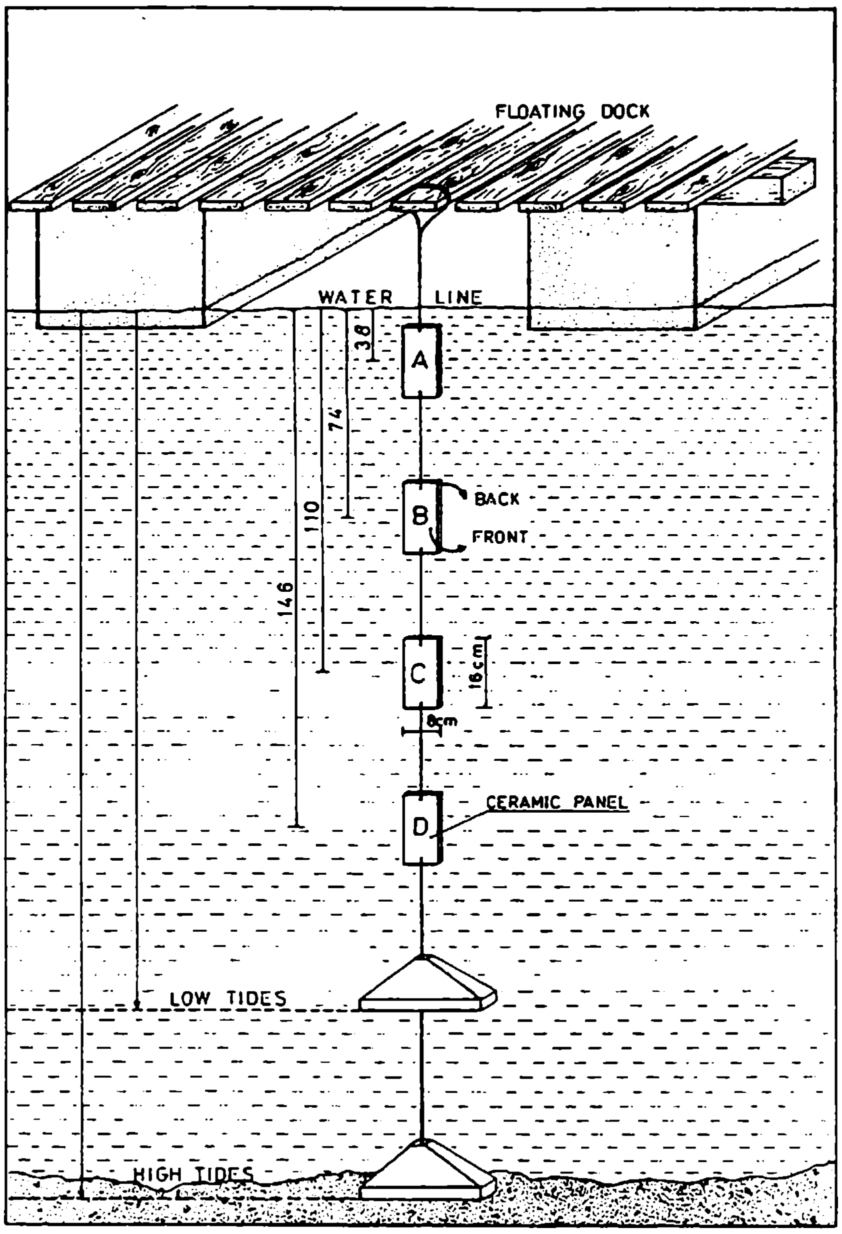


**Fig. 2. -Ceramic panels series design.**

After removing soft macrofouling organisms the panels were dried at room temperature. All sessile calcareous species growing on the primary space were counted and measured by a stereomicroscope with a 10x ocular micrometer. The outer 1 cm margin of the plates was excluded from examination to avoid an "edge effect" [10]. The rostral-carinal length and the lateral-lateral width of each barnacle were registered and then basal area was estimated. In the case of serpulids length and width of the calcareous tube for each serpulid were measured.

Because of it could not be determined exactly the age of each individual settled on panels, it was assumed that largest size specimens were 30 days old. In order to standardize the choice of those largest individuals a size frequency distribution of basal area was done. After considering the mean area occupied by larger size group by panel by month, it could be calculated the daily mean increase in basal area.

Temperature, pH and salinity were measured at sample time with a Luftman P300 Digital Meter, and a HI 8733 Portable Conductivity Meter. Mean water and air temperature were also supplied by Centro Argentino de Datos Ocenográficos (Servicio de Hidrografia Naval).

Statistical analysis of the results was done with ANOVA and contrast LSD test (Fisher test) using SYSTAT program. In ANOVAs, the effect of temporal variation of recruitment, substratum texture and preference for depth were examined.

## RESULTS

Large number of calcareous organisms recruited onto the tiles in Mar del Plata harbor. They showed different settlement cycles and different preferences by levels and surface texture. *Balanus amphitrite* (Cirripedia, Balanidae) and *Hydroides elegans* (Polychaeta, Serpulidae) were the most representative species settled on the primary space. Other barnacles, *B. glandula* and *B. improvisus*, were the third most abundant colonizers and they were considered together because of their settlement cycles were similar and the number of recruits per panel was always low. Some species like *B. trigonus* and *Conopeum* sp. (Bryozoa, Membraniporidae) were rare, only settled at low densities, and will not be considered in any detail.

Mean sea water temperature varied between 9.1 °C in July and 20.7 °C in January and mean air temperature ranged between 6.9 °C in July and 22.2 °C in March. The pH values maintained fairly constant between 7.9-8.2 and salinity ranged between 35.1-36.7 $^{0}/_{00}$.

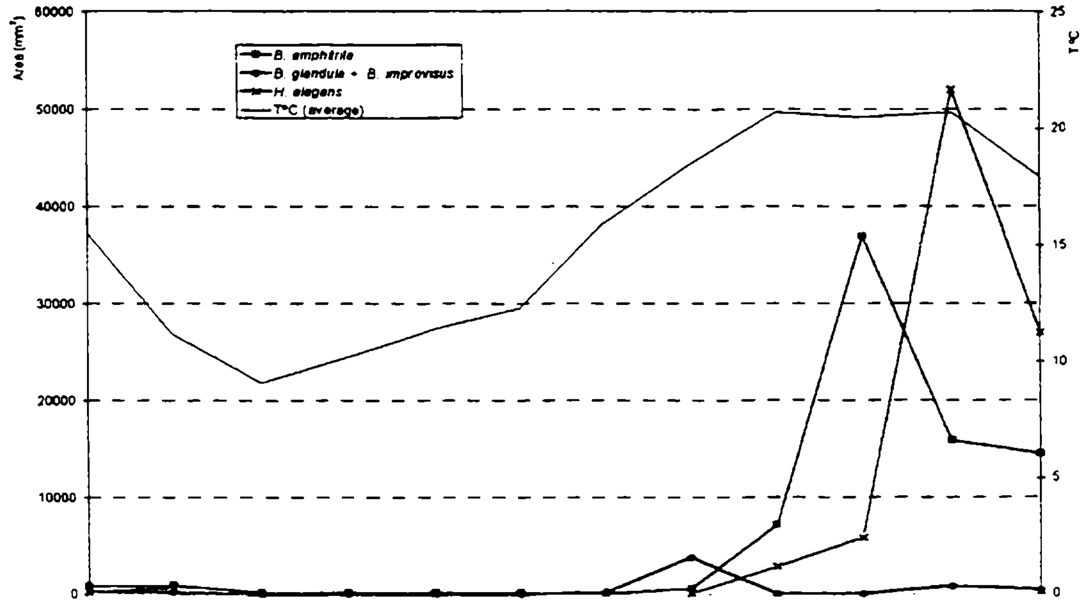


**Fig. 3. -Mean water temperature from May 1991 to April 1992 and monthly total occupied area (A+B+C+D, levels) for each calcareous species.**

Figure 3 shows a graphic with the recruitment of *B. amphitrite*, *B. glandula* + *B. improvisus* and *H. elegans* along a year. The total curves were very similar from May to October, in November they increased slowly with some oscillation in the first period and then *B. amphitrite* and *H. elegans* rapidly grew reaching the maximum in summer. Settlement cycles of these species were seasonal, and the peaks of recruitment were in accordance with the highest records of mean water temperature. The total cover area by calcareous species in Mar del Plata harbor was characterized by three successive peaks every time higher, the first one corresponded to *Balanus glandula* + *B. improvisus*, the second to *B. amphitrite*, and the third to *Hydroids elegans*.

### *Barnacles*

In May-June (Autumn) less than one third of the panels was colonized by *B. amphitrite*, reaching values about zero during colder months. From December to April maximum values of occupied area were observed. This species had its peak of attachment during January-February ($P<0.001$) and March-April ($P<0.05$) (Fig. 4 ).

In relation to substratum texture, larvae showed a strongly preference to adhere on the back side of the panels, with grooves and pits; thus, back sides had a heavier settlement than the front sides ($P<0.001$). However, a heavy colonization on the front side of February panels was registered ($P<0.05$). In plankton samples taken at the study area could be observed a great concentration of cyprids. When they explore the substratum, the more favorable sites are occupied during settlement before the less favorable ones; then, this behavior could explain the heavy colonization in plane surfaces.

On front side of the panels the adults were present at maximum densities of about 1.6 individuals per $cm^2$ in February, 1.7 individuals per $cm^2$ in March and 2.1 individuals per $cm^2$ in April, in all cases at **C** level. On the other hand, on the back side of the panels maximum density values were 2.6 individuals per $cm^2$ in February, 3.0 individuals per $cm^2$ in March and 2.3 individuals per $cm^2$ in April, these values were registered at **d** level.

The maximum occupied area was obtained during February when 306 barnacles covered about 70% of the **c** panel. Settlement data for *B. amphitrite* by levels on front and back sides of the panels are presented in Table I.

**Table I**

**Total area occupied ($mm^2$) by *Balanus amphitrite*, total number of individuals in brackets**

| | Front side | | | | Back Side | | | |
|---|---|---|---|---|---|---|---|---|
| Date | A | B | C | D | a | b | C | d |
| May 91 | 2.6 (4) | 2.0 (4) | 11.3 (6) | 17.6 (6) | 29.8 (26) | 168.9 (87) | 137.0 (50) | 234.0 (70) |
| Jun 91 | 2.9 (5) | 2.7 (6) | 14.7 (7) | 23.5 (8) | 41.8 (33) | 200.6 (106) | 148.2 (55) | 262.5 (82) |
| Jul 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.7 (2) | 4.1 (8) | 0.0 (0) | 0.0 (0) |
| Aug 91 | 0.6 (1) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 9.5 (23) | 2.5 (6) | 0.0 (0) | 0.0 (0) |
| Sep 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 15.8 (9) | 0.0 (0) |
| Oct 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 1.6 (3) | 0.0 (0) | 0.0 (0) | 11.9 (3) | 3.9 (2) |
| Nov 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 4.8 (5) | 0.8 (1) | 0.0 (0) | 0.4 (1) | 20.4 20) |
| Dec 91 | 0.0 (0) | 0.0 (0) | 14.0 (2) | 134.8 (14) | 9.0 (1) | 78.8 (6) | 130.3 (13) | 214.7 (19) |
| Jan 92 | lost | 2.5 (1) | 32.7 4) | 4.7 (6) | lost | 2060.7 (48) | 1089.6 (44) | 3990.7 (105) |
| Feb 92 | 1595.5 (39) | 2627.6 (129) | 3424.0 (201) | 2654.4 (152) | 5405.6 (123) | 4992.4 (189) | 9053.8 (306) | 7184.8 (333) |
| Mar 92 | 69.0 (12) | 1635.9 (82) | 878.0 (212) | 257.8 (157) | 1156.2 (131) | 659.0 (134) | 3944.6 (253) | 7265.6 (386) |
| Apr 92 | 606.1 (64) | 2742.5 (163) | 2355.8 (271) | 2079.1 (167) | 1233.4 (109) | 558.8 (101) | 1093.5 (125) | 3827.3 (294) |

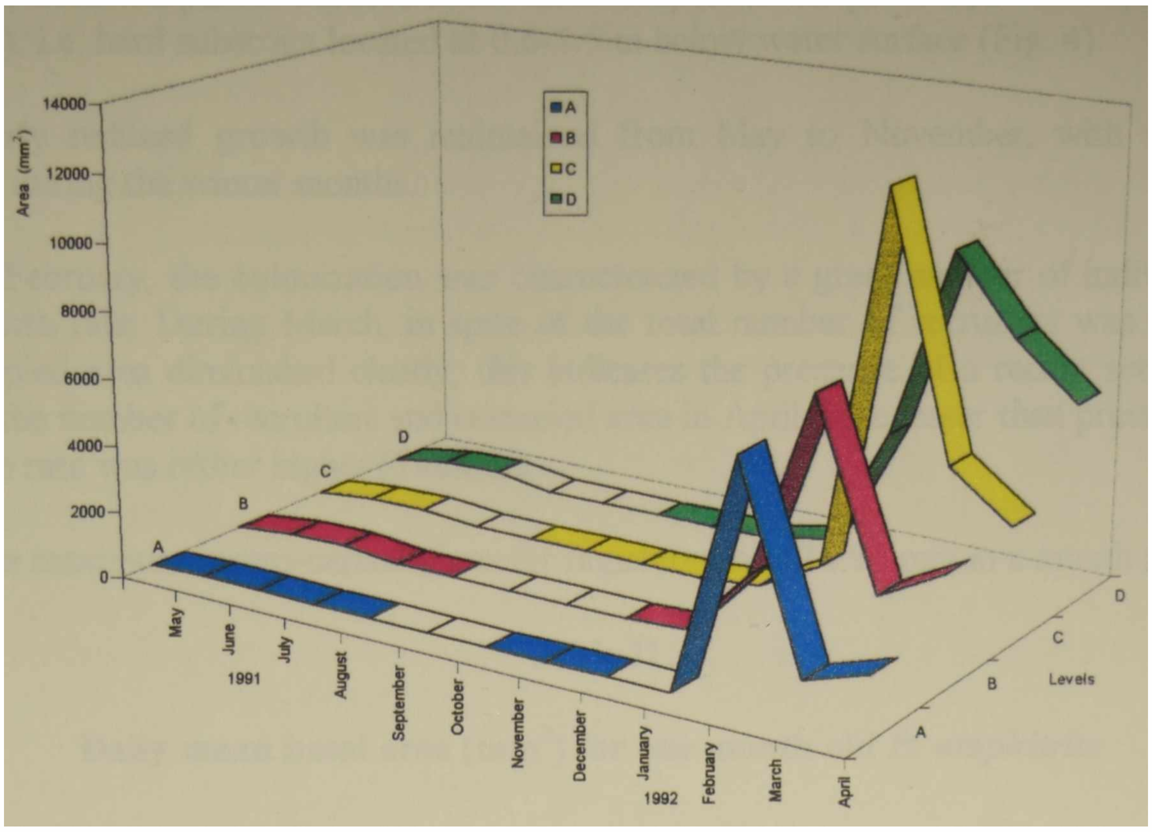


**Fig. 4.** -*Balanus amphitrite*, monthly total occupied area for level A (0.30-0.46 m), level B (0.66-0.82 m), level C (1.02-1.18 m) and level D (1.38-1.54 m).

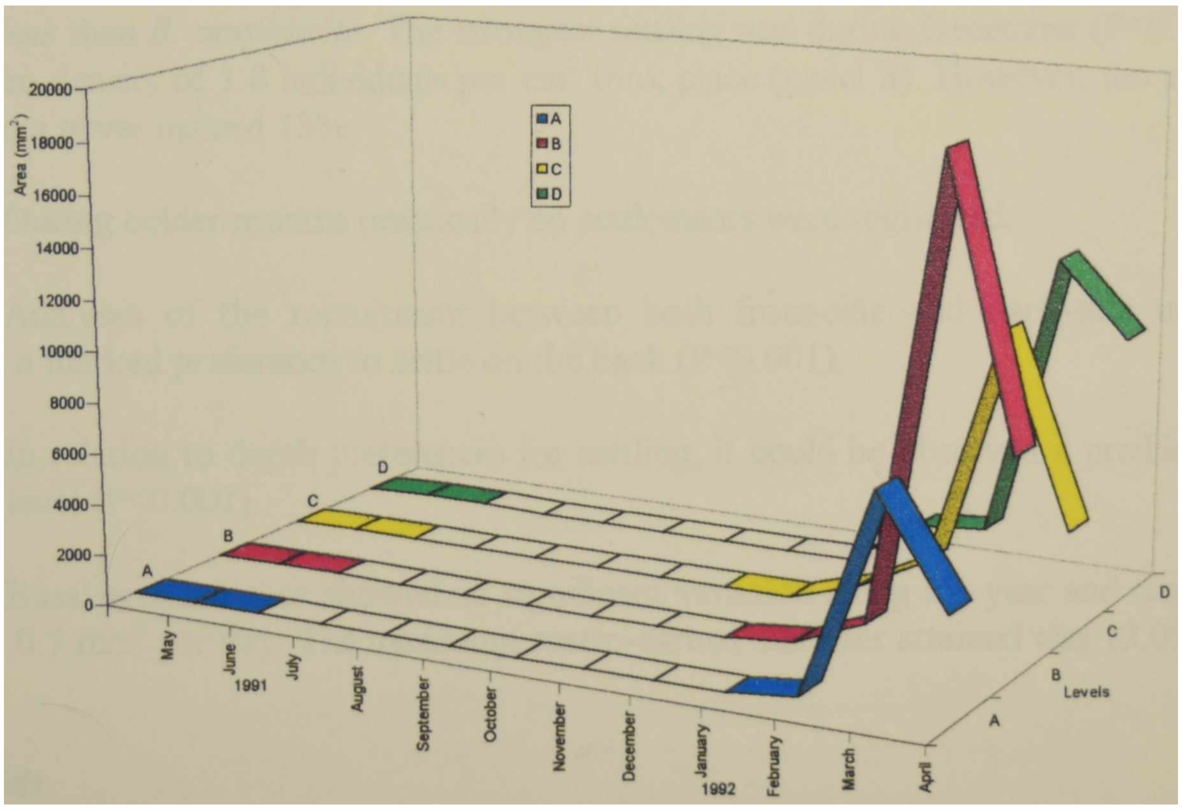


**Fig. 5.** -*Hydroides elegans*, monthly total occupied area for level A (0.30-0.46 m), level B (0.66-0.82 m), level C (1.02-1.18 m) and level D (1.38-1.54 m).

During the course of twelve months observations, *Balanus amphitrite* has mainly been observed to settle on panels exposed at the three deepest levels (level C, $P<0.001$; levels B and D, $P<0.05$), i.e. hard substrata located at 0.6-1.5 m below water surface (Fig. 4).

Fairly reduced growth was maintained from May to November, with virtually no settlement during the winter months.

In February, the colonization was characterized by a great number of individuals with faster growth rate. During March, in spite of the total number of recruiters was rather high, total occupied area diminished clearly, this indicates the presence of a recent settled cohort. Although the number of recruiters and occupied area in April were lesser than previous months the growth rate was rather higher (Table II).

The maximum rostro-carinal diameter registered was 14.95 mm in a month (February).

**Table II**

**Daily mean basal area ($mm^2$) for one month old *B. amphitrite***

| | Panels | | | | Panels | | | |
|---|---|---|---|---|---|---|---|---|
| Date | A | B | C | D | a | b | c | d |
| Dec | 0.0 | 0.0 | 0.2 | 0.7 | 0.0 | 0.7 | 0.6 | 1.0 |
| Jan | lost | 0.1 | 0.3 | 2.5 | Lost | 2.3 | 1.9 | 3.1 |
| Feb | 2.6 | 2.4 | 3.3 | 2.7 | 5.1 | 3.3 | 2.9 | 3.1 |
| Mar | 0.6 | 2.7 | 0.6 | 0.3 | 1.2 | 0.8 | 2.8 | 2.8 |
| Apr | 2.7 | 2.7 | 3.0 | 3.0 | 2.2 | 1.1 | 1.2 | 1.6 |

The number of individuals and occupied area were much lesser for *B. glandula* + *B. improvisus* than *B. amphitrite*. The strongest settling was during December ($P<0.001$) when a maximum density of 1.8 individuals per $cm^2$ took place (panel **b**). However, the percentage of cover area never exceed 13%.

During colder months practically no settlements were registered.

Analyses of the recruitment between both front-side and back-side of the panels showed a marked preference to settle on the back ($P<0.001$).

In relation to depth preferences for settling, it could be observed a predilection by the second level ($P<0.001$).

Basal area increase showed no significant variation along the year and ranged between 0.1 and 0.7 $mm^2$ per day. The maximum rostro-carinal diameter attained was 12.09 mm.

### *Serpulids*

The temporal trend of serpulids showed a sudden increase at the beginning of summer, reaching a maximum in March when *Hydroides elegans* was the dominant species on panels. In this month maximum density ranged between 1.4- 4.3 individuals per $cm^2$. A period of stability followed during May-June, then no individual was registered during winter and spring months (Table III).

**Table III**

**Total area occupied (mm$^2$) by *Hydroides elegans*, total number of individuals in brackets**

| Date | Front side A | Front side B | Front side C | Front side D | Back Side a | Back Side b | Back Side C | Back Side d |
|---|---|---|---|---|---|---|---|---|
| May 91 | 3.2 (2) | 10.0 (7) | 13.4 (8) | 35.4 (20) | 11.0 (6) | 22.0 (18) | 19.6 (9) | 55.8 (30) |
| Jun 91 | 3.7 (2) | 21.8 (11) | 16.2 (9) | 35.4 (20) | 14.2 (8) | 22.0 (18) | 19.6 (9) | 50.0 (26) |
| Jul 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) |
| Aug 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) |
| Sep 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) |
| Oct 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) |
| Nov 91 | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) | 0.0 (0) |
| Dec 91 | 0.0 (0) | 0.0 (0) | 12.1 (3) | 0.0 0) | 0.0 (0) | 0.0 (0) | 8.1 (3) | 0.0 (0) |
| Jan 92 | lost | 129.8 (12) | 523.5 (45) | 923.8 (55) | lost | 89.6 (15) | 312.5 (39) | 894.1 (75) |
| Feb 92 | 178.2 (33) | 764.5 (76) | 1314.6 (105) | 1212.9 (97) | 107.9 (20) | 593.7 (45) | 911.8 (78) | 777.4 (79) |
| Mar 92 | 4469.5 (223) | 7460.5 (376) | 6607.9 (370) | 8305.1 (370) | 3794.6 (174) | 11720.8 (555) | 4866.5 (276) | 4847.6 (235) |
| Apr 92 | 241.6 (36) | 5534.5 (256) | 501.7 (54) | 4847.7 (237) | 3917.6 (168) | 2842.3 (128) | 3678.0 (171) | 5453.5 (256) |

In relation with the depth, it could be observed that this species preferred the three deepest levels (P<0.001) (Fig. 5).

Settlement cycle was similar in smooth and rough side of the panels (P>0.05). Tubes are sinuous, often coiling in one or two regular turns at the beginning and then running fairly straight either along the panel or standing erect from it. Moreover, this disposition favored the increase of calcareous deposit and thicknesses about 1.5 cm for only one month were detected.

In spite of *Hydroides elegans* are single individuals which build white, contorted, calcareous tubes they are frequently found growing up straight the substratum in large masses. As a consequence it was difficult to measure exactly the length of the tubes. However, it could be estimated the daily mean increase in basal area (Table IV). On the back side of March and April panels the highest values happened.

The maximum length and width registered in a month were 48.6 mm and 1.5 mm, respectively.

**Table IV**

**Daily mean increase in basal area (mm$^2$) for *Hydroides elegans***

| Date | Panels A | Panels B | Panels C | Panels D | Panels a | Panels b | Panels c | Panels d |
|---|---|---|---|---|---|---|---|---|
| Dec | 0.0 | 0.0 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Jan | lost | 0.7 | 1.0 | 1.1 | lost | 0.4 | 0.6 | 1.1 |
| Feb | 0.5 | 0.9 | 0.9 | 0.8 | 0.5 | 0.8 | 0.7 | 0.6 |
| Mar | 1.5 | 1.5 | 1.7 | 1.7 | 1.8 | 1.7 | 1.6 | 1.6 |
| Apr | 0.7 | 1.6 | 1.0 | 1.6 | 1.7 | 1.6 | 1.8 | 1.9 |

## DISCUSSION

In this study the relationship between the seasonal increase in number of calcareous settlers and the temperature was evident.

A comparison carried out among settlement registered during summer months indicated that panels were alternately recruited by barnacles and tube-worm species. Calcareous organisms colonization began at the end of spring, when *Balanus glandula* + *B. improvisus* arrived to the tiles. In January both *B. amphitrite* and *Hydroides elegans* maintained in low abundances. In February *B. amphitrite* invaded the panels and during March, serpulids had a great peak and colonized rapidly the primary space. One possible source of this could be that high densities of both barnacles and serpulids larvae occurred in the plankton. Cyprids compete avidly for whatever space is free and spend their energy only in searching a place to settle, as a consequence result best competitors to colonize the panels. Then, when barnacle cyprids found an adequate hard substratum their density diminished in the plankton and serpulid larvae recruited and grew rapidly on all the panels. In April, serpulids diminished in abundance and showed, as barnacles, a fast growth rate.

The present results confirmed that the texture of the surface does indeed affect the amount of fouling which may attach under comparable conditions. Observations made along a year showed that barnacles were settled on the back of the panels with concavities and grooves, the choice of a rough substratum offer protection during the period immediately after metamorphosis. This is clearly demonstrated by maximum densities values obtained for back (2.3- 3.0 *B. amphitrite* per $cm^2$, 0.8- 1.8 *B. glandula* + *B. improvisus* per $cm^2$), and front sides (1.6- 2.1 *B. amphitrite* per $cm^2$, 0.1 *B. glandula* + *B. improvisus* per $cm^2$). Pomerat & Weiss **[29]** studied the attachment of barnacles and other fouling forms to various types of surfaces at Miami, Florida, found that smooth, non-porous, non-fibrous surfaces, especially if also hard, were relatively poor collectors of sedentary organisms. In addition, Crisp **[30]** and Crisp & Bourget **[31]** suggested that at the time of settlement, one of the last act of the still mobile cyprid is to orientate itself to the contour of the surface, they are capable of aligning to the long axis of a cylindrical cavity whose radius of curvature is many times the length of the cyprids itself, though narrow grooves into which it can fit snugly are preferred. Ardizzone & Chimenz **[32]** established that the substrates preferred by barnacles were those affected by water flow (cavities, angles) and only afterwards they did colonize the remaining surface. The present data support this conclusion because of in February panels not only the rough side of the panels were invaded by barnacles but also the plane side. It is noticeable that in the front sides of April tiles the total occupied area by *B. amphitrite* was higher than the back sides, this situation could be explained due to a great abundance of others non-calcareous species like the polychaete *Polydora ligni* **[28]**. In contrast with barnacles, *H. elegans* appeared to settle equally readily on rough and smooth surfaces, this observation is in accordance with those carried out by Pyefinch **[33]**.

Data corresponding to growth rates presented in this paper indicated a rapid development during warmer months, when the best conditions are given. Continuous immersion (e.g. ships anchored at harbors, raft trials, test panels), food availability and the range of temperature over which processes such as feeding and respiration can be carried out are the chief factors which influence on growth rate. Bourget & Crisp **[34]** established that growth rates in barnacles dropped sharply when they were placed in air and normal growth was resumed soon after immersion.

Particularly interesting is a comparison of the present study with others conducted in 1966-69, 1969-70, 1973-74, 1976-77 periods in the same study area **[35-38]**. Their observations differed in a few aspects from the present study. They used sandblasted acrylic panels (460 $cm^2$ for level A, and 360 $cm^2$ for levels B, C and D), suspended vertically in a raft. It has been found **[39,40]** that ceramic and acrylic have about the same suitability for attachment and growth of organisms. In those experiences, *Balanus amphitrite* clearly preferred the upper levels A and B and only a few specimens settled on panel D. In the present study it showed preference to settle at the three deepest levels (B, C and D). Another difference is related to the size reached by individuals after one month exposure: in the period 1991/92 the maximum rostro-carinal diameter was 14.95 mm in February, and in the period 1973/74 this diameter attained 12 mm in January. Settlement peak was coincident in February and mean density value (taken as an average of panels A, B, C and D) was rather similar: 1.33 *B. amphitrite* per $cm^2$ in this research and 1.22 individuals per $cm^2$ in previous studies **[37]**.

In earlier studies four tube-worm species were registered: *Ficopomatus enigmaticus, Hydroides elegans, H. plateni* and *Serpula vermicularis*. During 1973-74 and 1976-77 periods serpulids were virtually absent in Mar del Plata harbor and filter-feeding mollusks, like *Mytilus edulis* colonized monthly panels in February-March. After a gap of fourteen years without any research, only *H. elegans* was registered again with a heavy recruitment in March and none mollusk was found. *B. trigonus* was found in both studies but with much higher number in 1973/74.

As regards to the distribution of the calcareous species on panels, in both serpulids and barnacles survival is thus limited by crowding. As a consequence of crowding changes in shell shape were detected, in the case of barnacles, the shell became tubular and the base narrow. At low population densities, barnacles may have troubles finding mates, since they are internally fertilized and have limited penis length in this sense, crowding may enhance the probability of cross-fertilization. Formation of great deposits of calcareous tubes is due to the ability of serpulids to build layers without damaging those pioneers which settled first and formed the base of the crust. Virtually the first settlers of *Hydroides* form the most strongly attaching layer, the tubes developed straight the substratum in order to expose branchial crown to water column **[22]**. Their importance is probably less than that of barnacles in that a given mass of tube-worms offers less resistance, but they have a tendency to settle on propellers from which they are not easily dislodged by rotation when well-established. This is one of the main problems on ships at Club de Motonáutica.

It is important to make short-term studies and to follow researches in order to achieve a more accurate information on recruitment tendencies. It is clear that a thorough knowledge on the composition of the fouling community at a given locality, their seasonal intensity, vertical distribution, growth and preferences to settle is an essential prerequisite for developing effective control methods. A concerted effort in this direction with interdisciplinary collaboration on a long term basis may yield methods that could be employed against the deleterious effect of the marine foulers. Nowadays, all over the world the trend is to check the biofouling by means of alternative methods; the development of new antifouling outlines by using non-toxic natural or artificial substances. In this sense, we are studying the effect of new substances at laboratory scale in order to control biofouling at Mar del Plata harbor. However, further experiments are neccesary to integrate lab results with field tests.

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