# Distribution, abundance and adaptations of three species of Actiniidae (Cnidaria, Actiniaria) on an intertidal beach rock in Carneiros beach, Pernambuco, Brazil

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*Distribution, abundance and adaptations of three species of Actiniidae (Cnidaria, Actiniaria) on an intertidal beach rock in Carneiros beach, Pernambuco, Brazil.– Bunodosoma cangicum* Corrêa in Belém & Preslercravo, 1973; *Actinia bermudensis* (McMurrich, 1889) and *Anthopleura krebsi* Duchassaing & Michelotti, 1860 were studied in an intertidal beach rock at Carneiro's beach, Pernambuco, Brazil. According to the environmental factors five microhabitats occupied by the species were identified. Random surveys were made and a framework was used to calculate the mean specific density of each species in the different habitats. Ten specimens of each species were measured. The Mann-Whitney test was used to compare size and density of *B. cangicum* from different habitats. Specimens of *B. cangicum* were found in three different habitats, with the lowest density (1.1 ind/m$^2$) and the lowest size (1.2x3.8 cm, diam x height) in pools on the flats of the beach rock, exposed to the sun and to the rainfall. In this habitat, there was an increase in the temperature and salinity of water during dry seasons and the species was almost absent during rainy seasons. In habitats 4 and 5, which were more protected, the mean density was 6.0 and 6.4 and the mean size of 4.5x6.3 cm and 5.3x6.4 cm, respectively. *A. krebsi* was present in two habitats with high density (24.5 ind/m$^2$) in the habitat with longest air exposure time and this density seems to be associated with asexual reproduction. *A. bermudensis* was present in only one habitat with low density (1.4 ind/m$^2$) and size of 2.0x2.2 cm. No differences were observed in the statistical comparison of the density of *B. cangicum* in two protected zones ($P > 0.05$) which were thus used as one and compared with another unprotected zone. The results showed significant differences ($P \leq 0.05$). The comparison of size showed differences among the three zones ($P \leq 0.05$).

Key words: Actiniaria, Ecology, Pernambuco, Brazil.

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## Introduction

Benthic organisms like sea-anemones are submitted to environmental factors that influence or determine their distribution, such as the type of substrate and competitivity for it. The fluctuation of tides is also important because it influences food availability, gamets and larval dispersion and some adaptation is required to resist or avoid wave and current action (WAINWRIGH & KOEHL, 1976). Several studies have evaluated the actions of these factors. STOTZ (1979) analysed the zonation of three species of sea-anemones correlating with their morphological adaptations. HARRIS (1991) considered that water flow is a factor of speciation in some populations of *Metridium senile* Linneus, 1767. These studies were intensified on organisms of the intertidal zone, which present higher stress due to desiccation than those that are submerged (BARNES et al., 1963). The intertidal zone is a special place because the intertidal organisms need to develop morphological, physiological and behavioural adaptations to survive in this environment. The principal adaptations developed by intertidal sea-anemones are related to: 1. Reproductive biology with different reproductive patterns (SHICK et al, 1979); 2. Different strategies for colonization (SEBENS, 1982); 3. Intra and interspecific aggression generally associated to the presence of marginal spherulae (BIGGER, 1980; BRACE, 1981); 4. The search for new habitats by displacement capacity (FUJII, 1985; WILLIAMS, 1992) and 5. Several mechanisms to decrease the wave and desiccation action (OTTAWAY, 1973; ZAMPONI, 1981).

The present paper examines how environmental conditions influence the distribution of three intertidal species of sea-anemones from a beach rock at Carneiros beach (State of Pernambuco, Brazil) and the adaptations developed by each species in different microhabitats.

## Study area

The area studied was an intertidal beach rock (sensu GUILCHER, 1985) at Carneiros beach (8°45' S 35°05' W), State of Pernambuco, Brazil. It was 46 m long, 11 m wide and 0.60 m high (maximum height). It was submerged all year round during high tide. When uncovered during low tide, five zones were identified, according to environmental conditions, forming different microhabitats. These zones did not represent the total area of the beach rock but the more conspicuous habitats occupied by sea-anemones.

The study area was located on the south coast of the State of Pernambuco, which has warm humid weather with temperatures varying from 25°C to 30°C with an average about 26°C; two defined seasons throughout the year, one dry (September-February) and one rainy (March-August) and a high mean annual rainfall of about 2,500 mm. The water temperature varied from 25°C to 32°C reaching 34°C in summer in the shallow rock pool in the flats of beach rock, and salinity fluctuated in the approximate range of 36.4‰ - 37‰.

## Material and methods

On the basis of previous work (GOMES & MAYAL, 1997) and according to observations of environmental factors, five zones were identified during low tides representing different microhabitats on the beach rock. The characteristics of each microhabitat were analysed and correlated with the species presents and their size and density.

Three species were studied: *Bunodosoma cangicum* Corrêa in Belém & Preslercravo, 1973; *Anthopleura krebsi* Duchassaing & Michelotti, 1860 and *Actinia bermudensis* (McMurrich, 1889).

Random surveys were carried out in the study area on the following dates: 3 VIII 93, 18 IX 93, 14 X 93 and 12 I 94. The temperature and salinity of water were measured in August 93 (rainy season) and January 94 (dry season). The following measurements were made at each time point and in each of the five microhabitats:

1. The diameter just above the pedal disk and the height of ten specimens of each species was measured. The specimens were randomly selected among sea anemones with common aspect, avoiding specimens contracted or with distended column.

2. A framework (50x50 cm) was randomly positioned ten times and all sea anemones present were counted.

For each species in each microhabitat, the specific density ($\bar{D}e$) was calculated, according to ODUM (1959). Only the mean specific density is presented since the seasonal fluctuations are usually caused by varied reproductive patterns or different mechanisms of settlement of larvas and juveniles.

Finally, a Mann-Whitney test (SOKAL & ROHLF, 1981) was applied with a significant level of 0.05 to compare the size and density of *B. cangicum* in different microhabitats at each time point.

This was done to determine whether there were differences between the protected and unprotected zone. *B. cangicum* was the only species used because of its distribution in three habitats. *A. krebsi* was present in two habitats but the density and size of this species is influenced by its capacity for asexual reproduction. For the comparison of size, only diameter was used since it is more stable than the height of the sea-anemone.

## Results

According to environmental conditions, five different microhabitats occupied by sea anemones were identified on the beach rock.

### Habitat 1

Characteristics: small caverns in the lateral wall on the sea side.

Wave action: very strong during the rise of the tide, but the caverns provided protection for sea-anemones.

Time of air exposure: short, as it was the first sector of the beach rock covered by water.

Species present: *A. bermudensis* and *A. krebsi;* both were randomly distributed with low specific density ($\bar{D}e$ = 1.4 ind/m$^2$ and $\bar{D}e$ = 3.0 ind/m$^2$, respectively).

Observations: species showed no preference for different heights on the wall.

### Habitat 2

Characteristics: shallow rock pools formed at low tide in the flats of the beach rock.

Wave action: there was no direct wave action. During the rise of tide there was no impact of waves in the area.

Time of air exposure: this habitat was exposed for two or three hours, but sea-anemones were permanently submerged in the pools, not suffering desiccation. These pools had the temperature and salinity of water affected by exposure to the sun and rainfall, during low tides.

Species present: *B. cangicum* ($\bar{D}e$ = 1.1 ind/m$^2$).

Observations: during rainy seasons the mean temperature in these pools was 32°C when sea water was 29°C. During dry seasons there was an increase in water temperature (34°C in pools and 32°C in sea-water) with a slight increase in salinity in the pools from 36.7‰ to 36.9‰. The number of sea-anemones in this habitat decreased during the rainy season.

### Habitat 3

Characteristics: horizontal crevices on the lateral wall on the shore side.

Wave action: no wave action in this habitat.

Time of air exposure: very prolonged; this was the last sector to be submerged.

Species present: *A. krebsi* ($\bar{D}e$ = 24.5 ind/m$^2$).

Observations: density of this anemone was high, forming a gregarious population in the crevices with 0.40-0.50 m high.

### Habitat 4

Characteristics: great crevice of 0.60 m deep perpendicular to the ocean. The sea-anemones were low on the lateral walls.

Wave action: very little; there was a small channel at low tide and rising tide.

Time of air exposure: individuals located at the bottom of the crevice were covered by the water of the small channel. Other individuals located on the lateral walls of the crevice suffered varied degrees of desiccation according to their height on the wall.

Species present: *B. cangicum* ($\bar{D}e$ = 6.0 ind/m$^2$).

Observations : some anemones on the low sector of the lateral wall extended their tentacular crown towards the water channel.

### Habitat 5

Characteristics: the low sector of the vertical wall on the shore side near remnant water on the bottom.

Wave action: during the rising tide, a small current was formed due to water entering on both sides of the wall.

Time of air exposure: moderate; it was the last side reached by the water, but sea-anemones, on the bottom, recovered quickly.

Species present: *B. cangicum* ($\bar{D}e$ = 6.4 ind/m$^2$).

Observations: some specimens presented a distended column with the oral disk in the remnant water on the bottom.

The annual mean size and annual mean specific density of all species in each microhabitat are shown in table 1. Table 2 shows the mean density and size (only diameter) of *B. cangicum* from protected (microhabitats 4 and 5) and unprotected (microhabitat 2) zones at each time point. The results of the Mann-Whitney test showed no differences in densities between microhabitats 4 and 5 ($P > 0.05$ in all time points). These two habitats were thus used as one protected zone and compared with microhabitat 2. At all time points there were differences between the two zones (for all U calculated, $P \leq 0.05$).

Table 1. Mean size (diameter of column just above the basal disk x height of column) and mean specific density ($\bar{D}e$) of sea-anemones in the five habitats.

*Tamaño medio (diámetro de la columna por sobre el disco basal x altura de la columna) y densidad media específica ($\bar{D}e$) de las anémonas de mar en los cinco hábitats.*

| Species Habitats | Mean size (cm) | $\bar{D}e$ (ind/m$^2$) |
|---|---|---|
| *B. cangicum* | | |
| 2 | 2.2x3.8 | 1.1 |
| 4 | 4.5x6.3 | 6.0 |
| 5 | 5.3x6.4 | 6.4 |
| *A. krebsi* | | |
| 1 | 0.9x1.1 | 3.0 |
| 3 | 1.3x1.4 | 24.5 |
| *A. bermudensis* | | |
| 1 | 2.0x2.2 | 1.4 |

Comparison of the anemone size showed that the three microhabitats are statistically different ($P \leq 0.05$).

## Discussion

The density of all species fluctuated throughout the year, but no uniformity was observed. This fluctuation could be caused by differences in the reproductive patterns of each species or in their displacement capacity in response to unfavourable environmental conditions, as discussed by Fujii (1985).

The species *B. cangicum* was almost absent in microhabitat 2 during the winter. In this habitat the individuals were exposed to rainfall which directly affected the temperature and salinity.

Wave action and desiccation caused by air exposure seem to be the most important factors characterizing each microhabitat. The great diversity of microhabitats probably meets the needs of all species, thus keeping them separate. Only microhabitat 1 was shared by two species that were randomly distributed atlow densities.

*B. cangicum* occupied a high number of different microhabitats. This could be interpreted as indicating this species adapts better than others. One of these adaptations is its aggressive capacity due to the large size and the presence of marginal spherulae. For the same species Belém & Preslercravo (1973) observed aggressive behaviour in specimens kept in aquariums. Furthermore, this species needs a mechanism to resist the rise of temperature and salinity during summer in the microhabitat 2. In this habitat the virtual absence of *B. cangicum* in the winter could be interpreted as indicating movements of individuals into less exposed microhabitats in response to the decrease of salinity or mortality of anemones in more exposed areas. Microhabitats 4 and 5 were more protected from wind and sun but the anemones were exposed to air for some time and needed efficient mechanisms to attenuate the effects of desiccation. During low tides some specimens acquired a dome shape, which allowed them to keep water in the coelenteron and decreased their exposed area. This is important due to their large size and coincides with findings by Dayton (1971).

Table 2. Mean density ($\bar{D}e$, ind/m$^2$) and mean size (Ms, cm)($\bar{x}$. Mean; s.d. Standard desviation) of *B. cangicum* in protected and unprotected zones at each time point. Results of Mann-Whitney test for the comparison of the densities of *B.cangicum* from habitats 4 and 5, and (4+5) and 2 (U and its probability).

*Densidad media ($\bar{D}e$, ind/m$^2$) y talla media (Ms, cm) ($\bar{x}$. Media; s.d. Desviación estándar) de* B. cangicum *en zona protegida y desprotegida en cada muestreo. Resultados del test de Mann-Whitney para la comparación de las densidades de* B. cangicum *provenientes de los hábitats 4 y 5 y (4+5) y 2 (valores de U y sus probabilidades).*

| | Protected zone (Habitats 4 and 5) | | Unprotected zone (Habitat 2) | | Habitats 4x5 | Habitats (4+5)x2 |
|---|---|---|---|---|---|---|
| Dates | $\bar{D}e$ | Ms ($\bar{x}$±s.d.) | $\bar{D}e$ | Ms ($\bar{x}$±s.d.) | U(p) | U(p) |
| 3 VIII 93 | 7.1 | 4.72±0.60 | 0.7 | 1.98±0.13 | 20 P>0.05 | 0 P≤0.05 |
| 18 IX 93 | 6,5 | 5.02±0,50 | 1.0 | 2.16±0.22 | 27 P>0.05 | 1.5 P≤0.05 |
| 14 X 93 | 5.6 | 4.86±0.48 | 1.6 | 2.21±0.18 | 31.5 P>0.05 | 8 P≤0.05 |
| 12 I 94 | 5.6 | 5.00±0.48 | 1.2 | 2.35±0.10 | 25.5 P>0.05 | 7 P≤0.05 |

Another adaptation to intertidal life is the presence of vesicles on the column. These works like a unit of water retention, by capillarity, during the contraction period. The secretion of mucus to which small particles, such as grains of sand, adhere, acts as protection from the effects of wind and solar radiation. This agrees with observations by STOTZ (1979) for the anemone *Phymactis clematis* Dana, 1849. ACUÑA & ZAMPONI (1995) and ZAMPONI & PEREZ (1996), studying this same species, found a larger sized and greater abundance of individuals in protected zone as compared to exposed areas. This was also observed by BRACE & QUICKE (1986) in *Actinia equina* (Linné, 1758), by ZAMPONI & PEREZ (1997) in *Aulactinia marplatensis* (Zamponi, 1977) and *Aulactinia reynaudi* (Milne-Edwards, 1857) and also in *B. cangicum* in the present study. The mean size of this species in protected zones (habitats 4 and 5) was bigger than that in unprotected ones (habitat 2). Nevertheless, there were also differences between the two protected zones. Since these two habitats showed similar environmental patterns, this could be associated with stages of development of species.

Some authors (BRACE & QUICKE, 1986; MULLER-PARKER, 1987) associated the larger size with the low rate of respiration of anemones in protected zones compared with exposed zones. In this way individuals conserve more energy which can then be channelled into greater growth.

The behaviour in some individuals of distending their tentacular crown into the remnant water has been described previously by BELÉM & PRESLERCRAVO (1973) and seems to be related to food catch, the presence of light, sea tides and avoidance of desiccation during low tides.

All these mechanisms presented by *B. cangicum* justify its great distribution along the Brazilian coast and also in Uruguay (TRALDI & SCHLENZ, 1990; ZAMPONI et al., in press). The low density seems to be caused by reproductive patterns or settlement capacity, and a detailed study is needed. Until the present study asexual reproduction in this species had not been observed.

*A. krebsi* was present in two habitats with a high density in microhabitat 3. In this zone anemones were seen in the crevice without any distance between them. This very close distribution and the smaller size of specimens, as compared to these from others beaches in Pernambuco State (first author's personal observations) seem to be related to its great capacity for asexual reproduction by longitudinal fission described by Belém & Pinto (1990) and observed in some individuals in the study area. It seems that in this region *A. krebsi* used a reproductive strategy based on asexual reproduction, probably due to the stress conditions to which it is submitted. Excoffon & Zamponi (1995) observed the same pattern in the anemone *Tricnidactis errans* Pires, 1988 in Mar del Plata, Argentine. A detailed study of the reproduction strategies of this species is needed to clarify this question.

The presence of marginal spherulae in *A. krebsi* indicates an aggressive capacity, probably lower than that presented by *B. cangicum* due to the difference in size between them. This capacity could contribute to the numerical superiority of this species compared with others and also to its isolation, with apparently clonal behaviour.

Other studies on species from the genus *Anthopleura* (Francis, 1973; Smith & Potts, 1987) demonstrated that clonal behaviour is very common in this genus.

In both microhabitats occupied by *A. krebsi*, this species is in protected zones such as small caverns (microhabitat 1) or in crevices (microhabitat 3). The small size and the contraction capacity allow this species to occupy very protected zones and also decrease the amount of body surface exposed to desiccation. In spite of this, individuals, specially in microhabitat 3, were exposed to a very long period to air and needed some adaptations. In the column there are numerous verrucaes to which particles, such as pieces of shells and calcareous algae adhere, thereby forming a protective layer which protects against desiccation.

*A. bermudensis* was only observed in microhabitat 1 and few individuals were found, suggesting this species is not well adapted to this environment. In fact, this dark red anemone clearly absorbs solar heat and its smooth column favours desiccation. The only adaptations presented by this species are the domeshape during low tide and its location in a microhabitat quickly covered by water, thus resisting the wave impact and being in protected zones such as small caverns.

The results of the present study confirm the need for sea anemones in the intertidal zone to develop mechanisms which allow them to occupy microhabitats on the basis of their ecological preference and the environmental conditions.

## Resumen

*Distribución, abundancia y adaptaciones de algunos Actiniidae (Cnidaria, Actiniaria) en un arrecife intermareal de la playa de los Carneiros, Pernambuco, Brasil*

En este trabajo fue analizada la distribución y abundancia de *Bunodosoma cangicum* Corrêa in Belém & Preslercravo, 1973; *Anthopleura krebsi* Duchassaing & Michelotti, 1860 y *Actinia bermudensis* (McMurrich, 1889) en un arrecife de arenito intermareal de la playa de los Carneiros, Pernambuco, Brasil. Según las condiciones ambientales fueron identificados cinco microhábitats distintos donde se ubicaban las especies, con distintos tiempos de exposición al aire y acción de las olas.

A lo largo de un año se realizaron censos con la utilización de un cuadrado de 50x50 cm para el cálculo de la densidad específica media de cada especie en los diferentes microhábitats. *In situ* se midió la talla (diámetro y altura) de diez ejemplares de cada especie en cada hábitat (tabla 1).

La especie *B. cangicum* estuvo presente en tres hábitats distintos con menor densidad (1,1 ind/m$^2$) y menor talla (2,2x3,8 cm, diam x alt) en el hábitat 2, formado por pozas en la plataforma superior del arrecife y el más expuesto a la acción del sol y de la lluvia. En estas pozas hubo un incremento de la temperatura y salinidad del agua durante el verano y una casi ausencia de la especie en el período lluvioso. En los hábitats 4 y 5, más protegidos, tuvo densidad media de 6,0 y 6,4 ind/m$^2$ y tallas medias de 4,5x6,3 cm y 5,3x6,4 cm, respectivamente.

*A. krebsi* se presentó en dos hábitats diferentes con talla pequeña y densidad baja en cavernas ubicadas en la pared del arrecife que miraba al mar (0,9x1,1 cm y 3,0 ind/m$^2$) y gran densidad en el ambiente con mayor tiempo de exposición al aire, donde esta densidad parece estar relacionada con la capacidad de reproducción asexuada presentada por dicha especie.

*A bermudensis* estuvo presente en un solo

hábitat com pequeña densidad (1,4 ind/m$^2$) y talla media de 2,0x2,2 cm.

El test de Mann-Whitney fue utilizado para comparar las tallas y densidades de la especies *B. cangicum* en los distintos hábitats (tabla 2). La densidad de esta especie en las dos zonas protegidas no mostró ninguna diferencia significativa (P > 0,05). Estas dos zonas fueron comparadas con otra zona desprotegida y se observaron diferencias significativas (P ≤ 0,05).

Con relación a la talla, las tres zonas presentaron diferencias entre sí (P ≤ 0,05). Se observó que la distribución y densidad de las especies están relacionadas principalmente con la incidencia de las olas y el tiempo de exposición al aire. Se discuten las adaptaciones morfológicas, fisiológicas y comportamentales de las especies según su distribución en los distintos hábitats.

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## References

ACUÑA, F. H. & ZAMPONI, M. O., 1995. Ecología de anémonas intermareales. Densidad, dispersión y autoecología de *Phymactis clematis* Dana, 1849 (Anthozoa: Actiniaria). *Ciencias Marinas*, 21(1): 1-12.

BARNES, H., FINLAYSON, D. M. & PIATIGORSKY, J., 1963. The effect of desiccation and anaerobic conditions on the behaviour, survival and general metabolism of three common cirripedes. *J. Anim. Ecol.*, 32: 233-252.

BELÉM, M. J. & PINTO, S. M., 1990. Morphological and microanatomical study of *Anthopleura krebsi* Duchassaing & Michelotti, 1860 (Cnidaria, Anthozoa, Actiniidae), a new record in Brazil. *An. Acad. Bras. Ci.*, 62(2): 183-192.

BELÉM, M. J. & PRESLERCRAVO, J. C., 1973. Contribuições ao conhecimento da fauna de Cnidarios do Espírito Santo, Brasil. I. Considerações sobre Actiniaria do Município de Aracruz, ES. *Bol. Mus. Biol. Prof. Mello Leitão, S. Zoologia*, 80: 1-14.

BIGGER, C. H., 1980. Interspecific and intraspecific acrorhagial aggressive behaviour among sea anemones: a recognition of self and not-self. *Biol. Bull.*, 159: 117-134.

BRACE, R .C., 1981. Intraspecific aggression in the colour morphs of the anemone Phymactis clematis from Chile. *Mar. Biol.*, 64: 85-93.

BRACE, R. C. & QUICKE, D. L. J., 1986. Seasonal changes in dispersion within an aggregation of the anemone *Actinia equina* with a reappraisal of the role of intraspecific aggression. *J. Mar. Biol. Ass. U.K.*, 66: 49-70.

DAYTON, P. K., 1971. Competition, disturbance, and community organization: the provision and subsequent utilization of space in a rocky intertidal community. *Ecol. Monogr.*, 41: 351-389.

EXCOFFON, A. C. & ZAMPONI, M. O., 1995. The reproductive biology of Tricnidactis errans (Actiniaria, Haliplanellidae) from rocky shore of Mar del Plata (Argentina). *Cah. Biol. Mar.*, 36: 175-179.

FRANCIS, L., 1973. Clone specific segregation in the sea anemone *Anthopleura elegantissima*. *Biol. Bull.*, 144: 64-72.

FUJII, H., 1985. Locomotion and distribution of sea anemone *Anthopleura asiatica* (Uchida) in microhabitat. *Special Publication of the Mukaishima Marine Biological Station*, 252: 167-172.

GOMES, P. B. & MAYAL, E. M., 1997. Levantamento preliminar das anêmonas-do-mar (Cnidaria, Actiniaria) da costa de Pernambuco, Brasil. *Biociências*, 5(2): 45-52.

GUILCHER, A., 1985. *Coral reef geomorphology. I-XIII.* John Wiley & Sons, New York.

HARRIS, L. G., 1991. Comparative ecology of subtidal actiniarians from the coasts of California and the Gulf of Maine, USA. *Hydrobiologia*, 216/217: 271-278.

MULLER-PARKER, G., 1987. Seasonal variation in light-shade adaptation of natural populations of the symbiotic sea anemone *Aiptasia pulchella* (Carlgren,1943) in Hawaii. *J. Exp. Mar. Biol. Ecol.*, 112: 165-183.

ODUM, E. P., 1959. *Fundamentals of Ecology*. W. B. Saunders Co., Philadelphia & London.

OTTAWAY, J. R., 1973. Some effects of temperature, desiccation and light on the intertidal anemone Actinia tenebrosa Farquhar (Cnidaria: Anthozoa). *Aust. J. Mar. Fresh. Res.*, 24: 103-126.

SEBENS, K. P., 1982. Recruitment and habitat selection in the intertidal sea anemones, *Anthopleura elegantissima* (Brandt) and *A. xanthogrammica* (Brandt). *J. Exp. Mar. Biol. Ecol.*, 59: 103-124.

Shick, J. M., Hoffmann, R. J. & Lamb, A. N., 1979. Asexual reproduction, population structure, and genotype environment interactions in sea anemones. *Amer. Zool.*, 19: 699-713.

Smith, B. L. & Potts, D. C., 1987. Clonal and solitary anemones (Anthopleura) of Western North America: population genetics and systematics. *Mar. Biol.*, 94(4): 537-546.

Sokal, R. R. & Rohlf, F. J., 1981. *Biometry*. W. H. Freeman, New York.

Stotz, W. B., 1979. Functional morphology and zonation of three species of sea anemones from Rocky Shores in southern Chile. *Mar. Biol.*, 50: 181-188.

Traldi, E. S. & Schlenz, E., 1990. Estratégias de ocupação de um costão rochoso por cinco espécies de anêmonas no litoral sul do estado de São Paulo. *II Simpósio de ecossistemas da costa sul e sudeste brasileira: estrutura, função e manejo. Resumos*, 3: 67-74.

Wainwright, S. A. & Koehl, M. A. R., 1976. The nature of flow and the reaction of benthic Cnidaria to it. In: *Coelenterate Ecology and Behaviour*: 5-21 (G. O. Mackid, Ed.). Plenum Press, New York.

Williams, R. B., 1992. Pedal disk detachment of the sea anemone Anemonia viridis: a newly recognized response to tentacular contact between colour varieties. *Sci. Mar.*, 56(4): 337-346.

Zamponi, M. O., 1981. Estructuras anatómicas adaptativas en anémonas (Coellenterata, Actiniaria). *Neotrópica*, 27(28): 165-169.

Zamponi, M. O., Belém, M. J. C., Schlenz, E. & Acuña, F. H. (in press). Occurrence and some ecological aspects of Corallimorpharia and Actiniaria from shallow waters of the south American Atlantic Coasts. *Physis. (Sec. A)*, 56.

Zamponi, M. O. & Perez, C. D., 1996. Comparative morphological study of different species of Actiniaria between the intertidal zone from Mar del Plata and Santa Clara del Mar (Argentine). I. *Phymactis clematis* Dana, 1849 (Anthozoa; Actiniidae). *Biociências*, 4(1): 91-102.

- 1997. Comparative morphological study of different species of Actiniaria between the intertidal zone from Mar del Plata and Santa Clara del Mar (Argentine). II. *Aulactinia marplatensis* (Zamponi, 1977) and *Aulactinia reynaudi* (Milne-Edwards, 1857) (Anthozoa; Actiniidae). *Biociências*, 5(1): 165-171.