

**BARNACLES (CIRRIPEDIA BALANOMORPHA) OF THE ESTUARINE  
REGION OF RECIFE, PERNAMBUCO, BRAZIL**Cristiane Maria R. **FARRAPEIRA**

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**RESUMO**

As regiões estuarinas das grandes cidades litorâneas estão sujeitas a fortes agressões ambientais, especialmente de fontes poluidoras provenientes de esgotos domésticos, hospitalares e industriais. A fauna presente geralmente é muito resistente a estes fatores antrópicos e, particularmente entre os cirrípedes, existem muitas espécies utilizadas como indicadoras de poluição. O objetivo deste trabalho foi listar as espécies de cirrípedes que ocorrem nos rios Capibaribe, Pina, Jiquiá, Tejipió e Jordão, bem como aqueles presentes nas bacias do Pina e portuária da cidade do Recife, Pernambuco. Os cirrípedes foram coletados no período de janeiro de 2005 a outubro de 2006, por meio de espátula e martelo, em todos os substratos consolidados disponíveis. Foram identificadas as seguintes espécies: *Euraphia rhizophorae*, *Chthamalus bisinuatus*, *C. proteus*, *Tetracita stalactifera*, *Amphibalanus amphitrite*, *A. eburneus*, *A. improvisus* e *A. venustus*. Com exceção de *C. bisinuatus* e *T. stalactifera*, que são típicas de ambientes marinhos, todas as espécies são encontradas caracteristicamente em estuários tropicais, sendo reconhecidamente resistentes a baixas salinidades e citadas como tolerantes a diversas fontes de poluição.

**Palavras Chaves:** Cirrípedes, estuário, ecologia, inventário.

**ABSTRACT**

The estuarine regions of the great cities are under intense environmental aggressions, especially polluting sources from domestic, hospital and industrial sewers. The present fauna usually is very resistant to these anthropic factors and, particularly among the barnacles, there are many species used as pollution indicators. The aim of this work was to list the species of Cirripedia Balanomorpha that occur in the Capibaribe, Pina, Jiquiá, Tejipió and Jordão

Rivers, as well as those found in the basins of the Pina and of the Port of Recife, Pernambuco, Brazil. The barnacles were collected between January 2005 and October 2006, using spatula and hammer in all consolidated substrata available. The following species have been identified: *Euraphia rhizophorae*, *Chthamalus bisinuatus*, *C. proteus*, *Tetraclita stalactifera*, *Amphibalanus amphitrite*, *A. eburneus*, *A. improvisus*, *A. reticulatus* and *A. venustus*. With exception of *C. bisinuatus* and *T. stalactifera*, typical of marine environments, all the species are found commonly in tropical estuaries, being known as resistant to low salinities and cited as tolerant to several pollution sources.

**Key words:** Barnacles, estuarine region, ecology, inventory

## INTRODUCTION

In the marine environment the barnacles an important and characteristic group in the intertidal zone of hard substrata, through the world's oceans, being a successful group in terms of abundance and diversity (MARCHINKO; NISHIZAKI; BURNS, 2004). They are found in almost all marine environments from the tropics to the poles and from the highest reaches of the intertidal to the depths of the ocean (NEWMAN; ROSS, 1976). They settle and grow on a wide range of substrata in the sea, and as a result form a distinct problem as fouling organisms of ships and industrial installations (CRISP, 1976). In the estuarine environment the barnacles, together with the oysters, are dominant in the intertidal zone (GARDUÑO, 1980) settling on mangroves (trunks and roots) as almost the only hard substrata for the establishment of these animals (FARRAPEIRA-ASSUNÇÃO, 1991).

There are many references for species of Cirripedia Balanomorpha that live preferentially in estuary environments (YOUNG, 1987) and it can be deduced that the absence of these species can be used as bioindicators of organic pollution (LACOMBE; MONTEIRO, 1974; SILVA-BRUM, 1988). Otherwise, balanids species may cause significant changes to ecological processes in any environment by increasing the area and volume available for associated meio- and macro-fauna, and enhancing the detritus-based food chains by supplying their habitat with particulate detritus (GOLLASCH; LEPPÄKOSKI, 1999).

The estuarine regions located in coastal metropolis are submitted to the strong environmental impacts and the sessile fauna needs to develop certain physiological mechanisms to resist, as much to the salinity variations (during the high and low tides), as to the anthropic factors (domestic, industrial and hospital pollution). Bioinventory and monitoring both create and allow comparisons with baseline information critical to any management, use, or investigation of the world's biodiversity (STORK; SAMWAYS; EELEY, 1996). Considering these facts, the present work was done with the aim to inventory the fauna of barnacles of the estuarine area in the Metropolitan Region of Recife, Pernambuco, Brazil, in order to identify the resistant species in the region and its ecological characteristics, and the possible use as indicator of new species invasion in the area.

## STUDIED AREA

Recife is situated in the state of Pernambuco, Brazil (08°04'03" to 08°05'06" S and 34°52'16" to 34°53'58 W). According to Coutinho (1980) and Silva (2004) it is a long coastal plain constituted of fluvial-marine sediments. In this area, the mangroves represent one of the most important deposition systems that provided substrata for urban development. It has a warm, wet tropical climate with an annual average air temperature around 25°C and water temperature between 23.5 to 32.0°C. The relative air humidity is ~80% and the area has an average precipitation of 1763mm, of which, 80% falls during the period of April to July, corresponding to the winter months (or during the Southern Hemisphere's winter months), with rare rain events occurring during the months of September and February (summer) (SOMERFIELD et al., 2003).

This area become detached from the Pina basin, formed by the confluence of the south branch of the Capibaribe River and by the Jiquiá, Tejipió, Jordão and Pina Rivers in the south part of the city, and the north and principal branch of the Capibaribe River, of great dimension. All of these rivers courses flow towards the Atlantic Ocean through a single opening situated on the Port of Recife (FARRAPEIRA-ASSUNÇÃO, 1991). This port basin is enclosed by an artificial rocky dyke located on a natural sandstone reef parallel to the coast and by another perpendicular pier in the city of Olinda (Fig. 1). This basin has a maximum depth of 4.5m, a semidiurnal tide with maximum amplitude of 2.5 m and salinities ranging from 0.4 to 37.2 (NASCIMENTO, 2001).

The rivers edges possess a very narrow band of mangrove trees, however, the Mangrove Park, located in the Zone of Special Environmental Protection (ZEPA), between Pina and Jordão Rivers, is permanently preserved and has 225.82 ha of forested land that is considered the greater urban mangrove of Brazil. The park also possesses representative animal species (FARRAPEIRA-ASSUNÇÃO, op.cit.) and was considered as a hipereutrophic area with a high phytoplanktonic primary productivity (NASCIMENTO, 2001). This area is the last remnant of the mangrove ecosystem in the city of Recife, surrounded by slum quarters and being an object of developmental interest whose intentions of utilization prove doubtful to the ecological balance of the estuarine complex of the Capibaribe River.

However, because of its proximity to the city, the estuarine region suffers from extreme environmental degradation, distinguishing the mangroves degradation, the natural substratum for the barnacles, and the aquatic pollution, especially of domestic organic sewage; according Kater (1989), more than 450 tons of not treated sewers are produced by a population of about 3 million inhabitants, as well as hospital and industrial waste.

## MATERIAL AND METHODS

Thirteen stations and neighboring areas were characterized as bridges, mangroves patches, walls, and artificial piers, along the estuarine area of the

Capibaribe, Tejiptió, Jiquiá, and Pina Rivers and the Pina and Port Basins of Recife: A- rocky wall of IAA- Sugar and Alcohol Institute, in front of the opening of Port Basin in the confluence area of Capibaribe and Beberibe Rivers and Atlantic Ocean, B- rocky walls of the Port Basin, C- Dike of rocks, D- Giratória Bridge and small rocks, confluence of Capibaribe River, Pina Basin and Port Basin, E- bridges, small rocks and hatchery dikes of the Pina Basin, F- wood piles and small rocks of the Deus Island, G- Mangrove Park, H- bridge and wood piles of the Tejiptió River, I- mangrove of south branch of the Capibaribe River, J- mangrove, bridges and rocky walls of Jaqueira Park of the Capibaribe River, K- mangrove and bridges of the north branch of the Capibaribe River, L- mangroves near the Government Palace, M- mangrove and bridge pillars of Capibaribe River (Fig. 1).

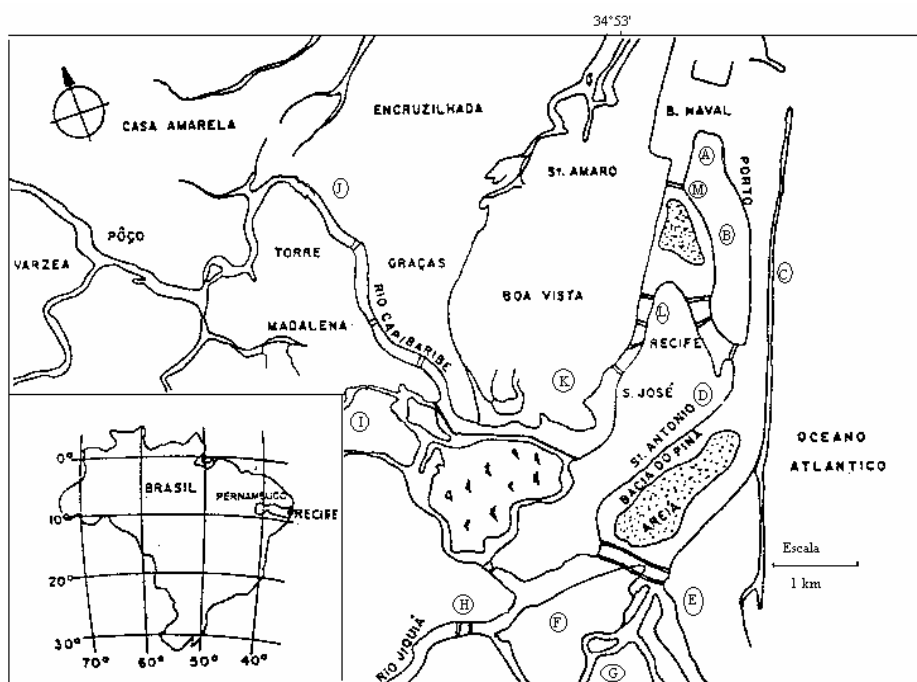


Figure 1- Map of the Region Metropolitan of Recife (Pernambuco, Brazil), with the samples' station: A- Instituto do Açúcar e do Alcool, B- Port Basin, C- Breakwater, D- Giratória Bridge, E- Pina bridges, F- Deus' Island, G- Mangrove Park, H- Motocolombó Bridge, Tejiptió River, I- South branch of the Capibaribe River, J- Jaqueira Park of the Capibaribe River, K- North branch of the Capibaribe River, L- Government Palace, M- Limoeiro Bridge, Capibaribe and Beberibe rivers

Barnacles were collected by means of spatula and hammer in all natural hard substrata available (mangrove, carapaces of crustaceans, or shells of mollusks) and artificial substrata (small rocks, rocky walls, wood piles, bridge

pillars, wharf, and boat's bottoms), between January 2005 to October 2006, in low tides periods

Ecological observations, such as their position in the littoral zone, relationships with other animals and certain physical factors (wave and sun exposure, type of substrate, natural shading) were taken. The animals were fixed in 70% alcohol and preserved with a 4%-by-volume formalin solution. Specimens were dissected and studied under stereomicroscope for taxonomic identification. The diagnosis were based in works of Henry; McLaughlin (1975), Young (1993, 1994), and Pitombo (2004). For most species determinations, only the characteristics of the shell wall, scutum and tergum were used.

In the scheme of littoral zonation, the upper limit of barnacles by quantity was used as the line of demarcation between the supralittoral fringe and the midlittoral (or intertidal) zone, and the top of the infralittoral fringe was marked by the upper limit of any convenient dominant organism as recognized by Coutinho (2002). The classification of species according to their salinity tolerance was based in Day (1967) as: Stenohaline marine component, restricted to water of high salinity near the mouth of estuary; euryhaline marine component, extending from the sea throughout the estuary, and estuarine component, which has evolved from marine forms but now is restricted to estuaries and is never found in the sea.

## RESULTS

This work identified nine species of barnacles in the estuarine region of the city of Recife, according to the follow key:

1. Parietal plate solid; rostrum with alae; basis membranous .....2
- 1'. Parietal plate tubiferous; rostrum with radii; basis membranous or calcareous.....4
2. Scutum more high than wide; scutum-tergal articulation straight; mandible tridentoid ..... *Euraphia rhizophorae*
- 2'. Scutum more wide than high; scutum-tergal articulation with sinuosity; mandible quadridentoid .....3
3. Shell with longitudinal basal ribs; parietal plates distinct; scutum-tergal articulation with a slight sinuosity internally; bidenticulate setae of the cirrus II with basal guards ..... *Chthamalus proteus*
- 3'. Shell smooth or corroded, sometimes ribbed or columnar; parietal plates generally indistinct, fused; scuto-tergal articulation with double sinuosity; bidenticulate setae of the cirrus II without basal guards ..... *Chthamalus bisinuatus*
4. Shell with four plates fused or corroded externally; plates with two or more rows of tubes; basis membranous ..... *Tetraclita stalactifera*

- 4'. Shell with six detached plates; plates with one row of tubes; basis calcareous ..... 5
5. Shell without stripes; scutum strongly striated longitudinally; tergum excavated on carinal margin ..... *Amphibalanus eburneus*
- 5'. Shell with hyaline or colored stripes, scutum never strongly striated longitudinally; tergum not excavated on carinal margin ..... 6
6. Shell with evident, at least basally, brownish or purplish stripes in the plates ..... 7
- 6'. Shell with hyaline or slightly colored narrow stripes ..... 8
7. Shell with continuous longitudinal colored stripes in two groups on either side of a median and white band; radii wide, summits horizontal; tergal spur wider than long; labrum multidenticulate ..... *Amphibalanus amphitrite*
- 7'. Shell with colored stripes with a reticulate pattern; radii narrow, summits very oblique; tergal spur longer than wide; labrum simple ..... *Amphibalanus reticulatus*
8. Shell with hyaline stripes; radii narrow, summits thin, smooth, very oblique; tergal spur furrow open, longer than wide, end obtuse or rounded; labrum multidenticulate ..... *Amphibalanus improvisus*
- 8'. Shell with hyaline or slightly colored stripes; radii wide, summits thick, rough, moderately oblique; tergal spur fasciole, wider than long, end obliquely truncated; labrum simple ..... *Amphibalanus venustus*

Suborder Balanomorpha Pilsbry, 1916  
 Superfamily Chthamaloidea Darwin, 1854  
 Family Chthamalidae Darwin, 1854  
 Subfamily Euraphiinae Newman & Ross, 1976  
 Genus *Euraphia* Conrad, 1837  
*Euraphia rhizophorae* (Oliveira, 1940)

**Diagnosis:** shell conic flattened, grey-white or brownish, smooth; six plates solid; rostrum and carina with summits outwards recurved; orifice wide, kite-shape; basis membranous; scutum-tergal articulation straight; scutum triangular as high as wide, growth ridges fine and crenulate, articular ridge thick and rounded, articular furrow and adductor muscle pit deep; tergum triangular, apex thick, growth ridges fine and crenulate, spur fasciole open almost imperceptible, articular ridge conspicuous, articular furrow wide and deep, crests for depressors muscles high; mandible tridentoid (fig. 2- a, b, c).

**Size:** The maximum of carino-rostral diameter was 20.1 mm and height of 7.5 mm; the basal diameter and the height average were 8.1 and 2.3 mm, respectively.

**Remarks:** *Euraphia rhizophorae* is a estuarine component, very common, occurring in all places examined: Port Basin, Pina Basin, Pina, Jordão, Tejipló, Jiquiá and Capibaribe Rivers, always in the high midlittoral levels fixed directly in mangrove trees and rocky walls of pillars of bridges (Fig. 5), in the shaded regions or cryptic habitats, in slight depressions or cracks and crevices. Its position was the biological demarcation between supralittoral fringe and midlittoral zone.

Genus *Chthamalus* Ranzani, 1817  
*Chthamalus bisinuatus* Pilsbry, 1916

**Diagnosis:** shell very flattened with circular or irregular contour, when isolated, or cylindrical and tall, when grow aggregate; grey-whitish; six plates solid corroded, usually fused together; orifice oval or kite-shape; basis membranous; articulation between scutum and tergum extremely sinuous, usually with double sinuosity; scutum triangular elongated long the occludent margin, tergal margin sinuous, articular furrow very deep; adductor ridge reduced or absent; tergum triangular, narrow, with scutal margin sinuous, spur fasciole open, very short, crests for depressor muscles; mandible quadridentoid; cirrus I with a row of conical spines on the inner side of the basal segments; cirrus II with bidenticulate and bipectinate setae without basal guards (Fig. 2- d, e, f, g).

**Size:** The maximum of carino-rostral diameter was 11.9 mm and height of 3.0 mm in the flattened forms and 5.8 mm and 10.9 mm in the cylindrical ones, respectively.

**Remarks:** *Chthamalus bisinuatus* is a stenohaline marine component that occurred in granite rocks, in the artificial pier of the Port Basin and Pina Basin, on the rocky walls of Port of Recife and polihaline regions, always in the upper midlittoral zone (Fig. 5), below *Euraphia rhizophorae* zone, settled on barnacles shells: *Tetraclita stalactifera* (Lamarck, 1818) and *Amphibalanus amphitrite* (Darwin, 1854), oysters shells: *Crassostrea rhizophorae* Guilding, 1828, and mussels shells *Brachidontes solisianus* D'Orbigny, 1846 and *Mytella guyanensis* Lamarck, 1819, in euhaline regions and *B. exustus* (Linnaeus, 1758), in Pina Basin, submitted preferentially to sunstroke.

*Chthamalus proteus* Dando & Southward, 1980

**Diagnosis:** shell grey-whitish, conic or flattened, basally ribbed, sutures distinct between compartments, even when presents corroded walls; six plates solid; orifice kite-shape; basis membranous; articulation between scutum and tergum usually slightly sinuous; scutum triangular higher than wide, narrow, growth ridges low and inconspicuous, articular furrow deep and wide, adductor ridge indistinct; tergum almost triangular, wider than high, spur fasciole open very short and broad, articular furrow wide, crests for depressor muscle moderately developed not projecting below basal margin; mandible

quadridentoid; cirrus I without conical spines on the inner side of the basal segments; cirrus II with bidenticulate setae with basal guards in distal segments in both rami (Fig. 2- h, i, j).

**Size:** The maximum basal diameter was 9.0 mm and height of 4.1 mm, the basal diameter and height average was 4.8 mm and 1.9 mm, respectively.

**Remarks:** *Chthamalus proteus* is a common and euryhaline marine component, occurring in all places examined: Port Basin, Pina Basin, Pina, Jordão, Tejipió, Jiquiá and Capibaribe Rivers; it was found settled on a large number of living substrates in the high region of midlittoral zone, above the *Euraphia rhizophorae* settlement zone, mainly on shells of oysters *Crassostrea rhizophorae* (Fig. 4H), mussels *Brachidontes exustus* and barnacles *Amphibalanus amphitrite* (Fig. 5), wood piles and pillars of bridges and rocky walls of the Port, granite rocks in the artificial pier of the port basin, only in the shaded regions.

Superfamily Tetraclitoidea Gruvel, 1903

Family Tetraclitidae Gruvel, 1903

Subfamily Tetraclitinae Gruvel, 1903

Genus *Tetraclita* Schumacher, 1817

*Tetraclita stalactifera* (Lamarck, 1818)

**Diagnosis:** shell plumbeous black with fine whitish ridges, conic; walls corroded and fused together; four plates with sutures deep and six rows of large tubes; orifice ovate and very small; basis membranous; radii and alae inconspicuous; scutum white with violet bands, with growth ridges fines, articular ridge moderately broad and long, adductor ridge long and low, articular furrow very deep, six crests strong and oblique in the lower part of occludent margin; tergum white with beak and carinal half purple, narrow, with growth ridges fines, spur fasciole open, distal end obliquely truncate, articular ridge high and strong, articular furrow narrow and deep, crests for the depressor muscles very prominent and long, projecting slightly below basal margin (Fig. 2- k, l, m).

**Size:** The basal diameter and height average was 13.8 mm and 14.4 mm.

**Remarks:** *Tetraclita stalactifera* is a rare stenohaline marine component that occurred only on granite rocks in the artificial pier of the Port Basin and the rocky walls of Port of Recife, in the media midlittoral zone, submitted to weak wave hydrodynamism and sunstroke factors.



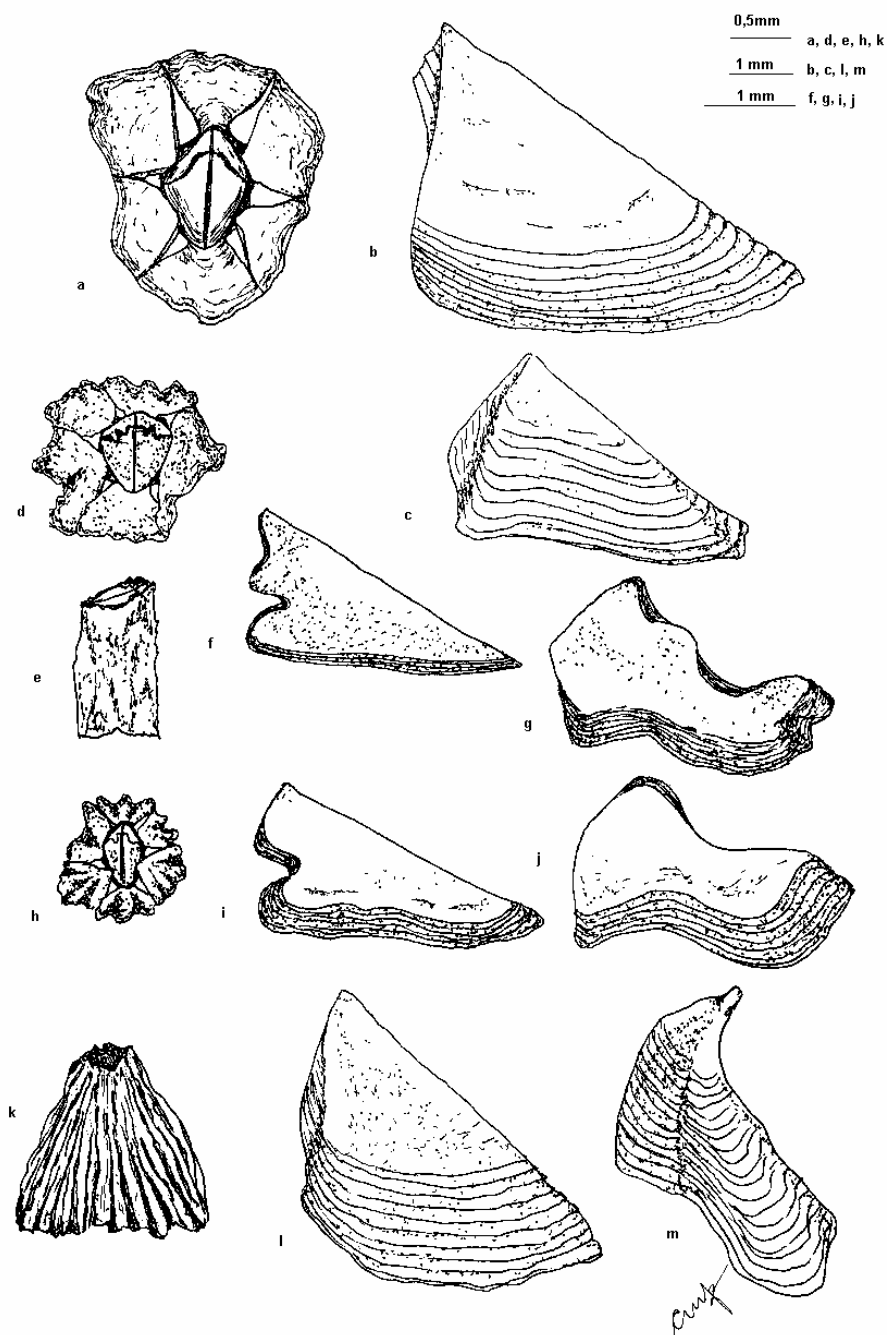


Figure 2 – Cirripedia of the estuarine region of Recife, Pernambuco: *Euraphia rhizophorae*: a- Shell, top view, b-c- scutum and tergum; *Chthamalus bisinuatus*: d- shell flattened, top view, e- shell cylindrical, oblique view, f-g- scutum and tergum; *C. proteus*: h- shell, top view, i-j- scutum and tergum; *Tetraclita stalactifera*: k - shell, oblique view, l-m- scutum and tergum.

Superfamily Balanoidea Leach, 1817  
 Family Balanidae Leach, 1817  
 Subfamily Amphibalaninae Pitombo, 2004  
*Amphibalanus* Pitombo, 2004  
*Amphibalanus amphitrite* (Darwin, 1854)

**Diagnosis:** Shell truncated-conical or subcylindric, white with longitudinal brownish or purplish continuous longitudinal stripes in two distinct groups in any or all plates; in eroded specimens, the stripes remain only toward the base; six plates smooth with a single uniform row of tubes between inner and outer laminate without transverse septa; orifice slightly toothed; radii white with brownish flecks, wide, summits slightly oblique, thick, crenulate, sutural edges with septa strongly denticulate on lower side; alae with summits oblique to subhorizontal, sutural edges septate; calcareous basis with radial tubes and transverse septa; scutum with growth ridges fines and slightly crenulated, articular ridge reflexed, adductor ridge straight moderately long and thick, articular furrow shallow; tergum broad with growth ridges fines, carinal margin convex, spur fasciole, end truncate, articular ridge prominent, articular furrow wide, crests for the depressor muscles projecting slightly below basal margin; labrum multidenticate; cirrus III-IV with erect teeth below posterodistal angles (Fig. 3- a, b, c).

**Size:** The basal diameters were between 25.0 mm (from Tejipló River) and 6.4 mm, and the heights between 23.5 mm and 3.9 mm.

**Remarks:** *Amphibalanus amphitrite* is the most euryhaline marine component and occurred in all sampling stations: Port Basin, Pina Basin, Pina, Jordão, Tejipló, Jiquiá and Capibaribe Rivers, always occupying a large band in the media region of the midlittoral zone; it settled directly on mangroves trees, bivalves shells: *Crassostrea rhizophorae* (Fig. 4G), *Mytella charruana* D'Orbigny, 1846 (Fig. 4B, E) and *Mytilopsis leucophaeta* (Conrad, 1831) (Fig. 4E), wood and bridges pillars, rocky and granite walls of the Port Basin (Fig. 5), in the midlittoral zone. This species showed an ecomorphosis, with eroded shell and plates in always places.

*Amphibalanus eburneus* (Gould, 1841)

**Diagnosis:** Shell cylindrical to conic, white, surface smooth or with shallow horizontal grooves; six plates with parietal tubes in single uniform row with transverse septa; orifice toothed; radii white solid narrow to moderately wide, summits oblique transversely striate, with septa strongly denticulate on lower margin; alae white with summits oblique to subhorizontal, sutural edges strongly septate; basis calcareous with radial tubes and transverse septa; scutum with growth ridges strongly crenulate and strong longitudinal striae, conspicuous articular ridge and adductor ridge short, articular furrow deep; tergum broad with growth ridges moderates, carinal margin convex, protuberant in upper third to half, spur fasciole truncate, basal margin concave or deeply excavated on carinal side, prominent articular ridge, articular furrow wide, several crests for the depressor muscles not projecting below basal

border; labrum multidenticulate; cirrus III-IV without erect teeth below posterodistal angles (Fig. 3-d, e, f).

**Size:** The barnacles have the basal diameters between 35.0 mm (from Tejipló River) and 8.3 mm and heights between 25.1 mm and 11.1 mm.

**Remarks:** *Amphibalanus eburneus* is an estuarine component, occurring in all places examined: Port Basin, Pina Basin, Pina, Jordão, Tejipló, Jiquiá and Capibaribe rivers stations, always occupying the media and lower region of the midlittoral zone. It settled directly on mangroves roots, bivalves shells: *Crassostrea rhizophorae*, *Mytella charruana*, *M. guyanensis* and *Mytilopsis leucophaeta*, shells of *Neritina virginea* (Linnaeus, 1758) and *Cerithium atratum* (Born, 1778) (Fig. 4F), wood piles and pillars of bridges, rocky walls of the Port Basin, artificial pier of the port basin and scattered rocks in the mud. The specimens settled near the mud showed erosion in all calcareous plates.

#### *Amphibalanus improvisus* (Darwin, 1854)

**Diagnosis:** Shell conic, white with hyaline longitudinal lines, surface smooth; six plates with parietal tubes in single row with transverse septa; orifice diamond-shaped, slightly toothed; radii white solid, narrow, transversely striate, summits oblique, smooth and arched, sutural edges with septa weakly denticulate on lower margin; alae white with summits horizontal, sutural edges finely septate; basis calcareous with radial tubes and transverse septa; scutum with growth ridges low, longitudinal striae, articular and adductor ridge high, articular furrow narrow; tergum broad with growth ridges fine, carinal margin protuberant, spur furrow open, end truncate or rounded, basal margin straight on both sides of spur, articular ridge low, articular furrow wide, crests for the depressor muscles prominent and projecting slightly below basal margin; labrum multidenticulate; cirrus III-IV without erect teeth below posterodistal angles (Fig. 3- g, h, i, j).

**Size:** The maximum carino-rostral diameter was 11.7 mm and height of 5.9 mm; the basal diameter and height average were 5.2 mm and 3.1 mm, respectively.

**Remarks:** *Amphibalanus improvisus* is a euryhaline marine component occurred in all sampling stations examined: Port Basin, Pina Basin, Pina, Jordão, Tejipló, Jiquiá and Capibaribe Rivers, always occupying the lower band of the midlittoral zone and infralittoral fringe; it settled directly on mangroves roots, shells of *A. amphitrite* and *A. eburneus*; crustaceans carapaces: *Hexapanopeus schmitti* Rathbun, 1930, *Eurytium limosum* (Say, 1818), *Pachygrapsus gracilis* (Saussure, 1858), *Callinectes danae* Smith, 1869 and *C. larvatus* Ordway, 1863; gastropod shells: *Cerithium atratum* (Fig. 4F), *Stramonita haemastoma* (Linnaeus, 1758), *Neritina virginea* (since one specimen to 119 small barnacles) (Fig. 4A), *N. zebra* (Bruguère, 1792) and *Pugilina morio* (Linnaeus, 1758) (Fig. 4I); bivalves shells: *Crassostrea rhizophorae*, *Mytella charruana* (Fig. 4D), *M. guyanensis*, *Brachidontes exustus* and *Mytilopsis leucophaeta* (Fig. 4E) and empty shells in the mud of *Anomalocardia brasiliensis* (Gmelin, 1791), *Macoma constricta* (Bruguère, 1792), *Protothaca pectorina* Lamarck, 1818 and *Chione cancellata* (Linnaeus,

1767) (Fig. 4C); wood piles and pillars of bridges, rocky walls of the wharf of the Port, artificial pier of the port basin and scattered rocks.

*Amphibalanus reticulatus* (Utinomi, 1967)

**Diagnosis:** Shell subcylindric, white with purplish longitudinal stripes intersected by alternating transverse lines in a reticulate pattern; surface smooth; six plates with parietal tubes in single row; orifice toothed; radii white to purple on parietal edges, moderately large, transversely striate, summits beveled, oblique, sutural edges with septa strongly denticulate on lower margin; alae purplish with summits oblique, sutural edges septate; basis calcareous with radial tubes; scutum higher than wide, growth ridges low, crenulate longitudinal striae fine, articular ridge long, adductor ridge short, both high, articular furrow deep; tergum broad with growth ridges fine, carinal margin slightly convex, spur fasciole very shallow, longer than wide, end obliquely truncate, basal margin straight on both sides of spur, articular ridge conspicuous moderately long, articular furrow wide, crests for the depressor muscles prominent and projecting slightly below basal margin; labrum multidenticulate; cirrus III-IV with erect teeth below posterodistal angles (Fig. 3- k, l, m).

**Size:** The maximum basal diameter was 18.8 mm and height of 11.0 mm (a specimen settled in the midlittoral zone); the basal diameter and height average were 8.8 mm and 5.4 mm, respectively, mainly among the specimens on the infralittoral fringe.

**Remarks:** *Amphibalanus reticulatus* is a stenohaline marine component, which occurred only in polyhaline stations of the Port Basin, always settled in the lower band of the midlittoral zone and infralittoral fringe; it fixed directly on oyster shells, pillars of bridges, rocky surfaces of the Port basin and scattered rocks.

*Amphibalanus venustus* (Darwin, 1854)

**Diagnosis:** Shell conic to subcylindric, white with hyaline or bluish longitudinal stripes narrow and approximate, surface smooth; six plates with parietal tubes in single row without transverse septa; orifice toothed large; radii white with two colored stripes near parietes, moderately wide, with fine transversely striae, summits oblique, thick, rough, sutural edges with septa strongly denticulate on lower margin; alae white with summits oblique; basis calcareous with radial tubes and transverse septa; scutum with slightly recurved apex, growth ridges low, longitudinal striae fine, articular ridge high and reflexed, adductor ridge high and long; articular furrow moderately deep; tergum with growth ridges fine, carinal margin convex, spur fasciole, end obliquely truncate, basal margin sloping slightly to spur, articular ridge low, articular furrow wide and deep, crests for the depressor muscles strong and projecting below basal margin; labrum simple; cirrus III-IV with erect teeth below posterodistal angles (Fig. 3- n, o, p).

**Size:** The barnacles are very small, with the basal diameters between 8.5 mm and 7.1 mm, and heights between 4.7 mm and 3.4 mm.

**Remarks:** *Amphibalanus venustus* is a stenohaline marine component; it was rare and occurred only in polyhaline stations of Pina Basin, in the lower midlittoral zone and infralittoral settled on oysters and gastropod shells (*Cerithium atratum* and *Neritina virginea*) presents on the mud.

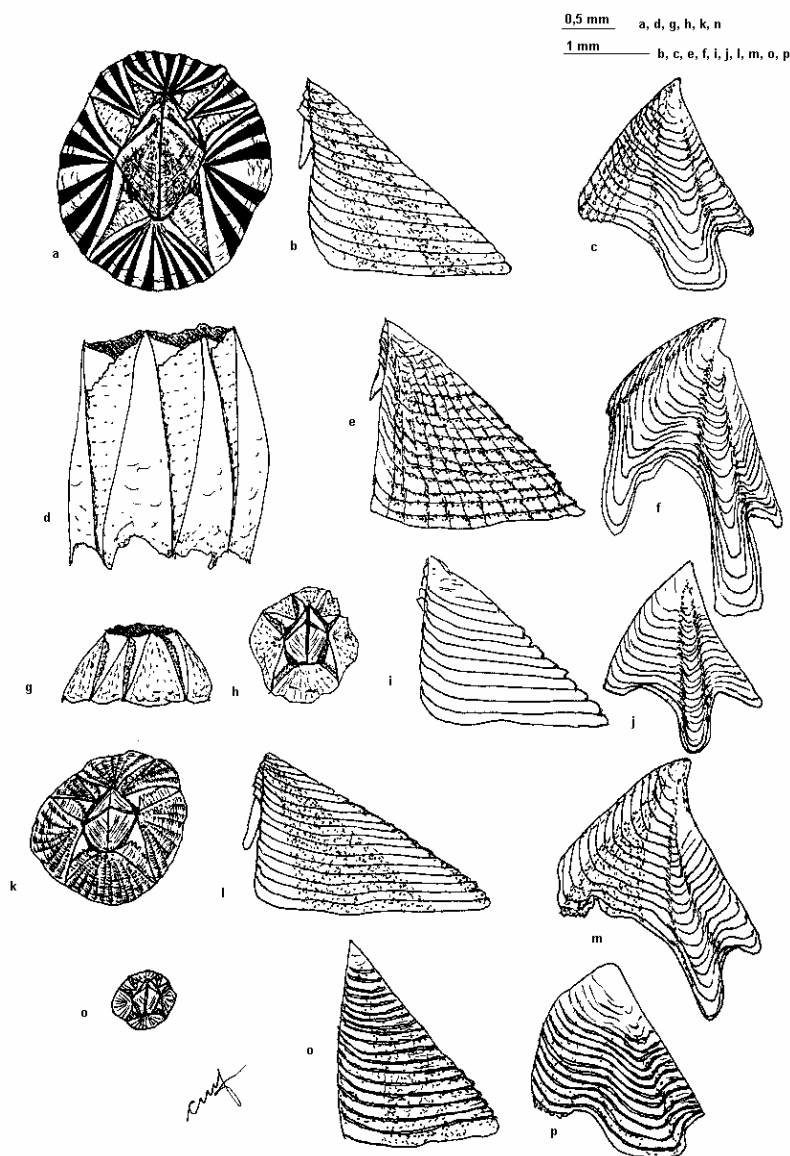


Figure 3 – Cirripedia of the estuarine region of Recife, Pernambuco. *Amphibalanus amphitrite*: a- shell, top view, b-c- scutum and tergum; *A. eburneus*: d- shell oblique view, e-f- scutum and tergum; *A. improvisus*: g-h shell, oblique and top view, i-j- scutum and tergum; *A. reticulatus*: k- shell, top view, l-m- scutum and tergum; *A. venustus*: n- shell, top view, o-p- scutum and tergum.



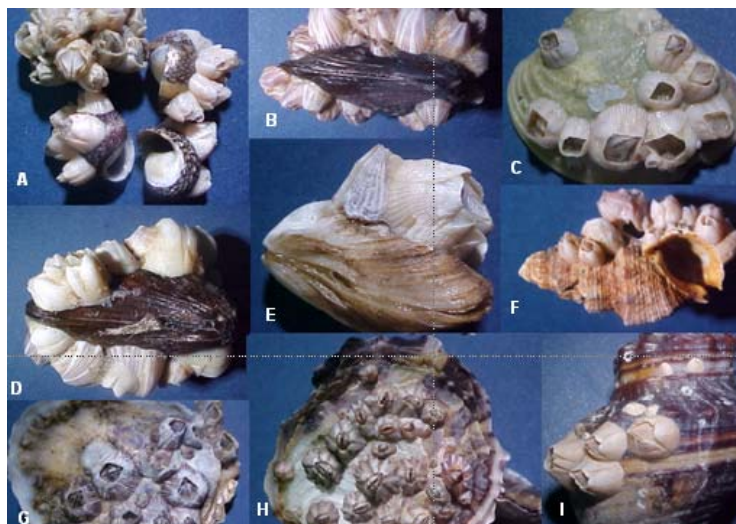


Figure 4 – Cirripeds epibionts from the estuarine region of Recife, Pernambuco. A- *Amphibalanus improvisus* on shells of *Neritina virginea*; B- *A. amphitrite* on *Mytella charruana*; C- *A. improvisus* on empty shell of *Chione cancellata*; D- *A. improvisus* (upper face) and *A. amphitrite* on *M. charruana*; E- *A. amphitrite* and *A. improvisus* on *Mytilopsis leucophaeta*; F- *A. improvisus* and *A. eburneus* on *Cerithium atratum*; G- *A. amphitrite* on *Crassostrea rhizophorae*; H- *Chthamalus proteus* on *C. rhizophorae*; I- *A. improvisus* on *Pugilina morio* (Photographs not in the same scale).

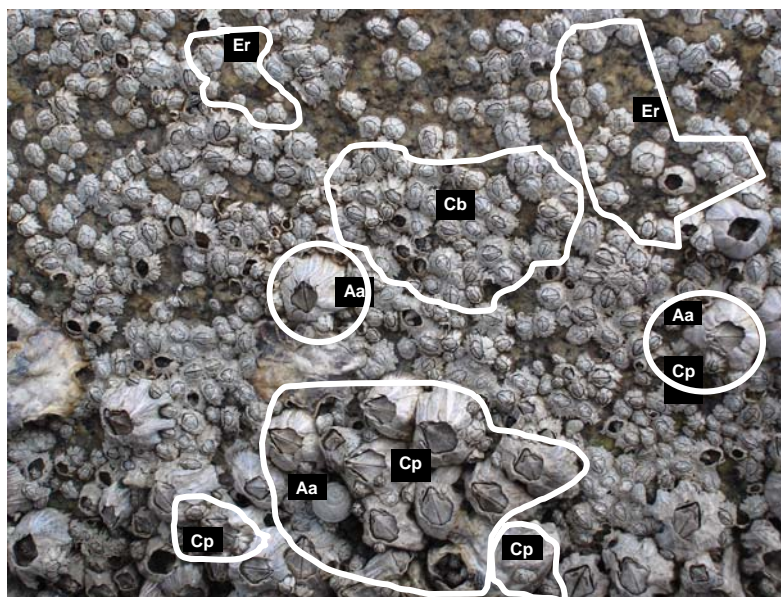


Figure 5 – Cirripedia of the rocky walls of Port of Recife, Pernambuco in the upper midlittoral zone: Aa- *Amphibalanus amphitrite*; Er- *Euraphia rhizophorae*; Cb- *Chthamalus bisinuatus*; Cp- *C. proteus*.

## DISCUSSION

The number of barnacle species (nine) in the estuarine region of the metropolitan area of the city of Recife was astonishing, even for a tropical region of the world. The majority of the species herein included were reported in a previous paper (FARRAPEIRA-ASSUNÇÃO, 1991), but now there is a record of two new species for the region, *Amphibalanus reticulatus* and *Tetraclita stalactifera*. Southward (1975) found twenty-five species in the Caribbean region, of which eleven had been designated for estuaries. Laguna (1985) studying the fauna of cirripeds from the Pacific and Atlantic coasts of Panama, mentioned nine species in areas of mangroves for the Atlantic coast. Young (1987) described thirty-eight species of Balanomorpha to the Brazilian coast, of which nine had been found in this ecosystem. Farrapeira (2005) found eleven species in the estuary of Paripe River, Itamaracá Island, but this estuary is free of pollution.

In all works mentioned, the balanids *Amphibalanus amphitrite*, *A. eburneus*, *A. improvisus* and *Fistulobalanus pallidus* (Darwin), or the Brazilian equivalent *F. citerosum* (Henry), are distinguished as the species most representative in environments of mangroves. Of these species, only *F. citerosum* was not found in the studied area. *Euraphia rhizophorae* and *Chthamalus proteus* also are considered typical or confined to mangroves, bays of calm waters, and estuaries (DANDO; SOUTHWARD, 1980; ACHITUV, 1984).

Almost all the species found in the estuarine area of Recife had ecological requirements compatible with observations of several authors, including its vertical zonation, as observed by Nunes; Almeida (1979), Silva-Brum (1988), and Rosa Filho; Farrapeira-Assunção (1998). The upper midlittoral zone, the *Chthamalus* zone, was occupied almost totally by *Euraphia rhizophorae*, *Chthamalus bisinuatus* and *C. proteus*; in the middle region, the "balanoid zone", the species *Amphibalanus amphitrite* were dominant; the others species, *A. eburneus*, *A. improvisus*, *A. reticulatus* and *A. venustus*, were found in the lower zone of midlittoral and infralittoral fringe. Farrapeira; Coelho Filho; Santos (2000) noted similar results to this at the estuary of Paripe River, with a high spatial competition became evident by the epibiosis between the fouling and sessile species. According to the description of Luckens (1975), the competition is the endeavor of two or more animals to gain the same particular thing and, for a sessile filter feeding animals, such as barnacle, the main requirement is space, primarily for attachment, but also as a place for feeding and reproduction. Wahl; Mark (1999) complemented this opinion, saying that the direct and indirect interaction of the species in a place act on as a limiting factor.

Ross (1962) found *Amphibalanus amphitrite* as a common fouling organism in competition with *A. eburneus* and/or *A. improvisus*, fact observed between the latter two species in the lower midlittoral zone. *A. amphitrite* is a biofouling barnacle (ZULLO, 1966), distributed world-wide in warm and temperate seas and it is also commonly found in the intertidal zone in polluted areas and, rarely, in non polluted areas, settling on several substrates such as mangrove roots, rocky shores and artificial substrates (SILVA-BRUM, 1988). *A. eburneus* and *A. improvisus* are very common in estuarine regions, in the low

midlittoral zone, attached to several substrates such as rocks, on mollusk and other barnacles' shells, crustaceans' carapaces, wood, mangroves, and artificial substrates. YOUNG (1994) cited *A. eburneus* as typical in brackish water, in low intertidal zone, found in much polluted areas of Rio de Janeiro. *A. venustus*, ranging from the infralittoral zone to the continental shelf, settles on mollusk shells and small rocks (HENRY; MCLAUGHLIN, 1975; FARRAPEIRA, 2005; YOUNG, 1994).

The presence of *Amphibalanus reticulatus* deserves note; Henry; McLaughlin (op. cit.) mentioned it as a common species in harbor installations and on ships and Utinomi (1967) found this species in the upper subtidal zone in highly saline bays of Japan. FARRAPEIRA-ASSUNÇÃO (1990), however, found this species inhabiting the estuary of the Paripe River, in the mouth of the river but mainly in the infralittoral fringe, submitted to a range of the salinity between 8.9 and 36.7 ppm. Its presence in the studied area is recent, not having been mentioned for FARRAPEIRA-ASSUNÇÃO (1991), when the author inventoried the benthonic macrofauna of the region. This species has a wide geographic distribution, probably because of its settling on ships, which propagates its dispersion for long distances (UTINOMI, 1967; FOSTER; WILLIAM, 1979, LAGUNA, 1985). Although it already occurs on the coast of the state of Pernambuco, its presence in a harbor area indicates its form of arrival in the region.

As opposed to observations of Day (1967), the rocky shores at the mouth of the estuary do not have a fauna similar in composition to that of an exposed reef, but poorer in species. Local observations on the other side of an artificial dyke of rocks and natural reefs near the mouth of the Port Basin showed other species, including *Chthamalus bisinuatus* and *Tetraclita stalactifera*, which are truly stenohaline marine components. The small number of *T. stalactifera* specimens found in the study area probably can be explained by its ecological requirements, occurring preferentially in areas in the intertidal zone, subjected to all degrees of wave action (ROSS, 1962).

In the studied estuary an horizontal zonation was clearly observed in the upstream direction, with gradual decrease of the species number, most drop out as one moves from sea water to fresh water up and the species dominating the community are those more resistant to fresh water. Thus in the Port basin, a polyhaline region, it had been found nine species of cirripeds and in the regions of great variation of salinity only five species had been observed: *Euraphia rhizophorae*, *Chthamalus proteus*, *Amphibalanus amphitrite*, *A. eburneus* and *A. improvisus*. The same observations were made by Farrapeira (2005), which noted the decrease of the species number in the estuary of Paripe River, with eleven species in the mouth of the river, five (*E. rhizophorae*, *C. proteus*, *A. amphitrite*, *A. eburneus* and *A. reticulatus*) in the mesohaline regions and only one, *E. rhizophorae*, in the limnetic zone. Similarly, Stubbings (1964) observed this gradual reduction of the number of species in the estuary of the Congo River (Africa), with three species in estuary and only two in the medium portions of the estuary. Laguna (1985) observed that a few marine species are found at the mouth of estuaries, but they rapidly drop out as the salinity decreases up the estuary. Curiously, SILVA-BRUM (1988) showed that the communities of Balanomorpha of the Guanabara Bay



(Rio de Janeiro, Brazil) differed little in the species composition in the direction beginning of the bay until the end one. Also Correia (1998), working with four stations in the neighborhoods of the sea mouth and in the end of the Mundaú/Manguaba Estuarine-lagoon complex, Alagoas, Brazil, observed a small variation of species, having found three species in the area of sea influence and two, in the area with lesser contents of salinity.

Species presenting lower resistance to the great variations of salinity and/or pollution of waters were not found in all the stations. If present, they were dead or exhibited a decreased density of organisms. In the study area, in all stations of collection and observation, the lower midlittoral and infralittoral fringe contained dead barnacles and, living on them, other individuals of its proper species possibly indicating its resilience as euryhaline species.

### CONCLUSIONS

In the estuarine area of the Recife nine species of Cirripedia Balanomorphs were recorded. Two of these species were designated as new occurrences for this area: *Amphibalanus reticulatus* and *Tetraclita stalactifera*. The species better adapted to the estuarine environment and that had a wider distribution were *Euraphia rhizophorae*, *Chthamalus proteus*, *Amphibalanus amphitrite*, *A. eburneus* and *A. improvisus*, compatible with its requirements or tolerance ecological.

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