ISABELA BACALHAU DE OLIVEIRA

ESTUDO DA ESTRUTURA POPULACIONAL DO MARISCO *Anomalocardia brasiliana* (GMELIN, 1791) NA PRAIA DE MANGUE SECO, LITORAL NORTE DE PERNAMBUCO-BRASIL

Recife, PE

Fevereiro, 2010

Universidade Federal Rural de Pernambuco
Departamento de Pesca e Aqüicultura
Programa de Pós-Graduação em Recursos Pesqueiros e Aqüicultura

ESTUDO DA ESTRUTURA POPULACIONAL DO MARISCO *Anomalocardia brasiliana* (GMELIN, 1791) NA PRAIA DE MANGUE SECO, LITORAL NORTE DE PERNAMBUCO-BRASIL

ISABELA BACALHAU DE OLIVEIRA

Dissertação apresentada ao Programa de Pós-Graduação em Recursos Pesqueiros e Aqüicultura da Universidade Federal Rural de Pernambuco, para obtenção título de Mestre em Recursos Pesqueiros e Aqüicultura.

Área de concentração: Recursos Pesqueiros e Aquicultura.

Orientador: Alfredo Olivera Gálvez
Co-orientador: Silvio Ricardo Maurano Peixoto

Recife, PE
Fevereiro, 2010

Ficha catalográfica

O48e Oliveira, Isabela Bacalhau de
Estudo da estrutura populacional do marisco *Anomalocardia brasiliana* (Gmelin, 1791) na praia de Mangue Seco, litoral norte de Pernambuco – Brasil / Isabela Bacalhau de Oliveira. – 2010.
x, 66 f. : il.

Orientador: Alfredo Oliveira Gálvez.
Dissertação (Mestrado em Recursos Pesqueiros e Aqüicultura) – Universidade Federal Rural de Pernambuco, Departamento de Pesca, Recife, 2010.
Inclui referências e anexo.

1. Moluscos bentônicos 2. Distribuição 3. Densidade 4. Métodos de pesca I. Gálvez, Alfredo Oliveira, orientador II. Título

CDD 639

Universidade Federal Rural de Pernambuco
Departamento de Pesca e Aqüicultura
Programa de Pós-Graduação em Recursos Pesqueiros e Aqüicultura

ESTUDO DA ESTRUTURA POPULACIONAL DO MARISCO *Anomalocardia brasiliana* (GMELIN, 1791) NA PRAIA DE MANGUE SECO, LITORAL NORTE DE PERNAMBUCO-BRASIL

ISABELA BACALHAU DE OLIVEIRA

Esta dissertação foi julgada para a obtenção do título de **Mestre em Recursos Pesqueiros e Aqüicultura** e aprovada em 23 de fevereiro de 2010 pelo Programa de Pós-Graduação em Recursos Pesqueiros e Aqüicultura, em sua forma final.

_____
Prof. Dr. Paulo Paula Mendes
Coordenador do Programa

BANCA EXAMINADORA

_____
Prof. Dr. Alfredo Olivera Gálvez- Orientador
Universidade Federal Rural de Pernambuco

_____
Prof. Dr. Silvio Ricardo Maurano Peixoto - Membro interno
Universidade Federal Rural de Pernambuco

_____
Prof. Dr. Rodrigo Silva da Costa – Membro externo
Universidade Federal Rural do Semi-Árido

_____
Prof. Dr. Paulo Guilherme Vasconcelos de Oliveira – Membro interno
Universidade Federal Rural de Pernambuco

_____
Prof. Dr. Roberta Borda Soares - (Suplente)
Universidade Federal Rural de Pernambuco

Dedico este trabalho as pessoas mais importantes de minha vida e que sempre estarão presentes em meu coração.

Minha mãe Maria das Graças Bacalhau;

Meu pai Moisés Cavalcanti;

Meu irmão Márcio Bacalhau;

Minha irmã Fabiane Bacalhau;

Meu sobrinho Otávio Bacalhau e

Minha sobrinha Alice Bacalhau.

AGRADECIMENTOS

- À Universidade Federal Rural de Pernambuco e ao Programa de Pós-Graduação em Recursos Pesqueiros e Aqüicultura, em especial a Selma Santiago (secretária) pela enorme atenção e carinho;

- À Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) pela concessão da bolsa de mestrado;

- Ao orientador Alfredo Olivera Gálvez, pela amizade e confiança, pelas inúmeras correções de trabalhos, mas, principalmente, pelos valiosos ensinamentos que serão eternos;

- Ao Co-Orientador, Silvio Peixoto, primeiramente por aceitar ser sua orientada direta por um ano em uma nova linha de pesquisa para nós dois e pelas inúmeras correções deste trabalho;

- Aos membros que fizeram parte da Banca Examinadora, os professores Dr. Gustavo Henrique Gonzaga da Silva, Dr. Silvio Peixoto, Dr. Paulo Oliveira e Dr. Alfredo Olivera Gálvez, e a suplente Prof[a]. Dr[a]. Roberta Soares pelas sugestões e colaborações para este trabalho.

- À prof[a]. Dr[a]. Roberta Soares, pelas contribuições metodológicas para realização deste estudo;

- Aos que fazem o Laboratório de Maricultura Sustentável, pela cumplicidade e pelos agradáveis momentos de coleta em Mangue Seco, que certamente tornaram este trabalho melhor, em especial à equipe marisco, Henrique, Sérgio, Leônidas, Antônio e Ricardo;

- A minha tia Marilene que amorosamente preparava um grande almoço para a equipe marisco, nos dias de coleta e ainda com direito a sobremesa "Manga".

- Ao querido Emanuell Felipe, por pacientemente me ajudar nas análises estatísticas, pelos momentos de descontração sentados no banquinho do DEPAq destilando nosso veneno (risos) e por estar presente nos momentos mais importantes durante minha vida acadêmica;

- Ao Projeto Gente da Maré, em especial ao Dr. Joaquim Carosfeld, que através dele foi possível realizar um intercâmbio no Centre Shellfish Research – Canadá;

- Aos meus amigos e companheiros de profissão e de turma: Anailza, Mirna, Suzianny, Hozana, Alexandre, Fabrício, Thales, Emanuell, Joana, Adriana, Leilane, Ricardo, Danielli, Wanessa, André, Suzana, Janilson e Fabiana Penalva.

- Em especial a Wanessa de Melo que mesmo de longe pode me ajudar nas correções deste trabalho.

- E a todos aqueles que injustamente não foram citados.

RESUMO

O presente estudo objetivou analisar a distribuição espaço-temporal do marisco *Anomalocardia brasiliana* e avaliar a recomposição do estoque desta espécie em relação ao número e ao tamanho dos mariscos capturados no verão e inverno na praia de Mangue Seco, Pernambuco. No primeiro estudo, a linha de praia (1.800 m) foi dividida em três trechos (T), sendo T1 de 0 a 600m, T2 de 600 a 1200m e T3 de 1200 a 1800m. Durante a pesquisa foram coletados um total de 1.016 espécimes nos meses de Janeiro (verão) e Agosto (inverno) de 2009. Desse total, 636 mariscos foram coletados no verão e 380 no inverno. Os valores máximos de densidade registrados no período de verão foram 414,91 ± 82,48 ind.m^{-2} no T3 e 323,49 ± 90,11 no T1, sendo ambos diferentes significativamente do T2 (156,12 ± 28,72 ind.m^{-2}). No inverno ocorreram os menores valores de densidade com 102,67 ± 5,07 ind.m^{-2} e 122,37 ± 36,86 ind,m^{-2} para T1 e T2, respectivamente, ambos diferindo significativamente do T3 (296,76 ± 45,20 ind.m^{-2}). No segundo estudo foram avaliados três tratamentos correspondendo a uma área de 18,75m² cada, onde: os mariscos foram retirados manualmente pelas pescadoras, coletados com auxílio de um apetrecho de pesca, e onde não houve a coleta de mariscos. A amostragem dos mariscos nestes tratamentos foi realizada em três momentos: antes das coletas pelas marisqueiras, após uma hora e 24 horas após estas coletas. Foram observados mariscos com tamanho menor (15,46 ± 0,86 mm), após a coleta manual, sem diferença significativa entre o tamanho dos animais encontrados após a coleta com o apetrecho (18,16 ± 0,92 mm). A quantidade de animais capturados com tamanho maior que 20 mm foi superior a 80% no inverno, e inferior a 20 % no verão, sem diferença entre os tipos de coleta para ambas as estações. Os indivíduos da espécie *A. brasiliana* apresentaram uma distribuição espacial característica, com uma maior abundância de juvenis no período de verão enquanto que os adultos foram mais abundantes no período de inverno. O tipo de coleta avaliado e o momento da extração não influenciaram na quantidade de mariscos, visto que o estoque de *A. brasiliana* da praia de Mangue Seco ainda é bem denso e tendo capacidade de se recompor após um período de 24h da atividade de coleta pelas marisqueiras. As estações de inverno e verão exercem influencia na abundância de *A. brasiliana*, com maior quantidade de mariscos com tamanho recomendado para pesca (> 20 mm) no período do inverno.

Palavras chaves: Moluscos bentônicos, distribuição, densidade e métodos de pesca

ABSTRACT

This study aimed to analyze the spatial and temporal distribution of the clam *Anomalocardia brasiliana* and evaluate the stock recovery of this species in relation to the clam number and size after extraction in summer and winter in Mangue Seco, Pernambuco. In the first study, the beach (1800 m) was divided into three sections (S): S1 0 to 600m, S2 600 and 1200m and S3 1200 to 1800m. During this research a total of 1,016 specimens were collected in January (summer) and August (winter) of 2009, corresponding to 636 clams collected in the summer and 380 in the winter. The maximum density recorded in the summer period were 414.91 ± 82.48 ind.m^{-2} at S3 and 323.49 ± 90.11 ind.m^{-2} at S1, both were significantly different from S2 (156.12 ± 28.72 ind.m-²). In winter, the lowest densities were observed with 102.67 ± 5.07 ind.m^{-2} and 122.37 ± 36.86 ind m^{-2} for S1 and S2, respectively, both significantly different from S3 (296.76 ± 45.20 ind.m^{-2}). The second study evaluated three treatments corresponding to an area of 18.75 m² each, where: the clams were removed manually by the fishers, collected using a fishing gear, and where there was no harvesting of clam. The sampling of the clams in these treatments was conducted in three moments: before extraction by fishers, after an hour and after 24 hours. Clams showed a smaller size (15.46 ± 0.86 mm) after manual collecting, but no significant difference in the size of the animals was found after the collection with the fishing gear (18.16 ± 0.92 mm). The number of the animals collected with size larger than 20 mm was greater than 80% in the winter and lower than 20% in the summer, without significant differences between the collection type tested for both seasons. The *A. brasiliana* showed a characteristic spatial distribution, with a greater abundance of juveniles during the summer while the adults were more abundant during the winter. The collection type and the extraction period did not influence the clam amount, as the stock of *A. brasiliana* in Mangue Seco is still quite dense and probably has the capacity to reconstitute itself after a period of 24 hours without clam extraction. The winter and summer seasons have a great influence on the abundance of *A. brasiliana*, with the largest number of animals within the recommended fishing size (> 20 mm) during the winter.

Keywords: Benthic molluscs, distribution, density and fishing methods

SUMÁRIO

LISTA DE TABELAS

LISTA DE FIGURAS

Artigo científico 1: Spatial and temporal distribution of shellfish *Anomalocardia brasiliana* (Gmelin, 1791) in Mangue Seco beach, Pernambuco - Brazil

Artigo científico 2: Evaluation of replenishment of stocks of shellfish *Anomalocardia brasiliana* in fishing area in Mangue Seco beach, north coast of Pernambuco, Brazil

1. INTRODUÇÃO

No Brasil muitas espécies de bivalves presentes em áreas intermareais são comestíveis e têm sido amplamente coletados em várias regiões do país. Estudos sobre a reprodução e ecologia de bivalves marinhos são tidos como o alicerce para o estabelecimento de programas de manejo desses invertebrados, pois podem favorecer a manutenção de estoques naturais e, assim, contribuir para o desenvolvimento de atividades extrativistas e de maricultura (ARAÚJO, 2001).

Um considerado esforço tem sido colocado no desenvolvimento sustentável de técnicas para um cultivo efetivo e comercialização de uma variedade de animais aquáticos e espécies de vegetais, incluindo, por exemplo, varias espécies de algas, moluscos, camarões, e peixes (ROSENTHAL et al., 1995). Em contraste, pouco esforço tem sido colocado para ajudar no processo crucial de selecionar um local adequado para o crescimento em campo da espécie escolhida (KAPETSKY et al., 1987, 1988; MEADEN e KAPETSKY, 1991; ROSS et al., 1993; FRIDLEY, 1995; KAPETSKY e NATH, 1997; AGUILAR-MANJARREZ e NATH, 1998; PARKER et al., 1998; RUBEC et al., 1998).

O local onde há maior abundância de moluscos bentônicos como a espécie *Anomalocardia brasiliana* é a região entre marés que é caracterizada pela interação de fatores ambientais de origem terrestre e os de origem marinha, sendo o mais importante dos fatores ambientais, sem dúvida, a maré (NIBBAKEN, 1994). Todos os fatores, interagindo entre si, propiciam um ecossistema com uma grande variedade de manchas de *micro-habitats*.

As comunidades de invertebrados intertidais apresentam padrões temporais e espaciais que são o resultado da habilidade da espécie de lidar com as mudanças nos fatores físicos e biológicos associados com as principais interações ambientais, tais como a influência maré, a taxa de exposição, e as características da água e do substrato (RODIL et al, 2008).

A distribuição espacial de organismos bentônicos em ambientes inconsolidados tem sido associada a diversos fatores biológicos, tais como comportamento reprodutivo e disponibilidade de alimento, e também a fatores físico-químicos como hidrodinamismo, granulometria, quantidade de matéria orgânica e umidade da área (MCLACHLAN, 1983), ou ainda a uma combinação dos mesmos.

No elo principal da cadeia produtiva de moluscos está o extrativismo de mariscos onde a coleta é geralmente feita por mulheres chamadas marisqueiras que extraem diferentes espécies de moluscos da região entre marés, trabalham em grupos, usam canoas para se deslocar, utensílios rudimentares para extrair os moluscos dos bancos naturais, utilizam mão de obra familiar e exploram ambientes ecológicos localizados dentro do estuário (MOREIRA, 2007). A mariscagem de bivalves está entre as atividades de subsistência mais comuns nos ecossistemas costeiros (PEDROZA-JÚNIOR, 2002).

Diversos estudos já foram realizados sobre a biologia de *A. brasiliana*, considerando-se os aspectos morfofuncionais adaptativos e ecológicos, os estudos de dinâmica populacional nos litorais baiano (PESO, 1980), paulista (NARCHI 1972, 1974 e 1976; HIROKI, 1977; SCHAEFFER-NOVELLI, 1976, 1980; ARRUDA-SOARES et al., 1982; LEONEL et al., 1983), catarinense (PEZZUTO e ECHTERNACHT, 1999; BOEHS e MAGALHÃES, 2004 e ROSA, 1989), paranaense (LANA et al., 1989; NETTO & LANA, 1994; BOEHS, 2000), paraibano (GROTTA e LUNETTA, 1980), norte rio grandense (CARNEIRO, 1994 e RODRIGUES, 2009), cearense (ARAÚJO e ROCHA-BARREIRA, 2004; BARREIRA e ARAÚJO, 2005) e as observações sobre distribuição demográfica, crescimento e repovoamento na região caribenha (MONTI et al.,1991).

O estado de Pernambuco, localizado na região do Nordeste do Brasil, a ostra nativa *Crassostrea rhizophorae*, o marisco *Anomalocardia brasiliana*, e o marisco redondo *Lucina pectinata* são naturalmente encontrados nos estuários e praias do estado, sendo a extração

desses moluscos uma fonte de alimento e renda para muitos pescadores, o que torna seus estoques já bastantes explorados.

A *A. brasiliana* segue como principal recurso pesqueiro entre os bivalves no estado de Pernambuco, sendo a principal fonte de renda para as marisqueiras, e teve sua exploração quase que dobrada entre os anos de 2003 a 2005. Dentre as principais espécies de maior produção no estado, o marisco é a que mais se destaca, com uma produção de 2.479,2t responsável por 20% da produção total de moluscos (CEPENE, 2006).

A exploração desordenada deste recurso pode comprometer os estoques naturais, alterando o ambiente costeiro através do grande esforço de pesca exercido por centenas de pescadores presentes nesta região e pela escassez de pesquisas relacionadas a esta espécie voltada para o estado.

Segundo Nishida (2000), a exploração extrativista destes bivalves ao longo do ano, a degradação ambiental crescente e a falta de estudos que subsidiem sua regulamentação têm comprometido os estoques desse molusco em diversas regiões do litoral brasileiro. Devido à alta extração em muitos locais do litoral o marisco não é mais encontrado facilmente, e segundo relatos das marisqueiras da região estes organismos vêm apresentando um tamanho cada vez menor, mesmo nas áreas de grandes concentrações como no litoral norte do estado.

Apesar do grande consumo de mariscos no Brasil, não há cultivo do grupo dos venerídeos, o qual se enquadra a espécie nativa *A. brasiliana* que é tradicionalmente explorada por diversas comunidades litorâneas (RIGHETTI, 2006). Sendo assim, novas alternativas que tenham como objetivo o manejo e a recomposição dos estoques naturais do marisco *A. brasiliana* devem ser imediatamente pesquisadas. As medidas legais até então tomadas em relação a este tema não têm apresentado um resultado prático na preservação dos estoques naturais da espécie (RIGHETTI, 2006).

Sendo o litoral brasileiro, a base de vida para gerações de povos, catadores de caranguejos, ostras, mariscos e outros animais, essas pessoas, são uma parte integral dos ecossistemas costeiros. Tendo visualizado a importância dos recursos costeiros, iniciativas como o Projeto Gente da Maré, uma cooperação entre o governo brasileiro e o governo canadense, nas suas diversas parcerias vem buscando meios para reduzir a pobreza e auxiliar as comunidades que dependem destes recursos marinhos para sua sustentabilidade, por meio de diálogo equitável, gestão participativa e tecnologias apropriadas e inovadores. Segundo Vinatea (2000), o manejo integrado poderá garantir a conservação dos recursos naturais costeiros e, simultaneamente, melhorar a qualidade de vida de todos os atores vinculados aos recursos em questão.

O presente trabalho se propõe a realizar o estudo da estrutura populacional do molusco bivalve *A. brasiliana* no litoral norte do estado de Pernambuco. Este estudo servirá como base para a realização de futuros estudos sobre a dinâmica populacional desta espécie, representando uma importante ferramenta para o gerenciamento costeiro integrado e um melhor desempenho dos aspectos sócio-econômicos da população local.

2. OBJETIVOS

2.1. Objetivo geral

- Identificar a estrutura da população do bivalve *Anomalocardia brasiliana* no município de Igarassu, litoral norte do Estado de Pernambuco.

2.2. Objetivos Específicos

- Avaliar a estrutura quantitativa da população de *A. brasiliana* na praia de Mangue Seco, Igarassu - PE;
- Estimar a densidade populacional de *A. brasiliana* durante as estações verão e inverno.
- Avaliar a recomposição do estoque de *A. brasiliana* após a coleta pela pesca extrativista do marisco na região;

3. REVISÃO DE LITERATURA

A. brasiliana se enquadra dentro da família Veneridae (Mollusca, Bivalvia) que reúne aproximadamente 500 espécies viventes, pertencentes à aproximadamente cinquenta gêneros e doze subfamílias (CANAPA et al, 1996); essa diversidade está relacionada à grande variedade de habitats para os quais estão adaptados, como praias arenosas, areno-lodosas, manguezais e fundos arenosos em ambientes coralíneos (CANTERA, 1991). No Brasil foram registradas 35 espécies de venerídeos, pertencentes a quatorze gêneros e sete subfamílias (RIOS, 1994).

A espécie *A. brasiliana* distribui-se desde a costa das Antilhas até o Uruguai (RIOS, 1994). Assim como os demais moluscos bivalves da família Veneridae, a espécie possui hábitos suspensívoros, habitam fundos areno-lodosos costeiros localizados em enseadas, baías e desembocadura de estuários e ficam confinados ao sublitoral ou a níveis intermareais baixos por não resistirem a temperaturas acima de 42°C (READ, 1964; NARCHI, 1972; RIOS, 1994; PEZZUTO & ECHTERNACHT, 1999). *A. brasiliana* é um organismo eurihalino (SCHAEFFER-NOVELLI, 1976) e apresenta grande resistência a baixos níveis de oxigênio e condições de anoxia (HIROKI,1971). A espécie é dióica, porém não apresenta dimorfismo sexual aparente e somente estudos histológicos permitem a sexagem dos indivíduos (GROTTA & LUNETTA, 1980).

Leonel et al. (1983) verificaram a capacidade de *A. brasiliana* de tolerar o estresse hiposmótico e confirmaram a possibilidade de sua ocorrência em ambientes de água salobra sujeitos a variações de salinidade. Barreias e Araújo (2005) observaram que a diminuição da salinidade, devido a um aumento na pluviosidade, aumentou o percentual de machos de *A. brasiliana*. Carneiro (1994) verificou que as maiores densidades populacionais de *A. brasiliana* na praia de Barra/Grossos/RN, ocorreram no período chuvoso e principalmente nos meses de menor salinidade. As populações de *A. brasiliana* encontram-se em manchas com grandes densidades de indivíduos onde dificilmente co-ocorrem outras espécies (SCHAEFFER-NOVELLI, 1976).

Estudos sobre o ciclo reprodutivo da espécie foram realizados em vários estados brasileiros, incluindo regiões litorâneas de São Paulo (NARCHI, 1976), na Paraíba (GROTTA, 1979), na Bahia (PESO, 1980), no Paraná (BOEHS, 2000), em Santa Catarina (ARAÚJO, 2001) e no Ceará (BARREIRA e ARAÚJO, 2005). Entretanto ainda não foram realizados estudos em populações de *A. brasiliana* no litoral de Pernambuco.

No Estado de São Paulo ocorrem dois picos reprodutivos ao ano com a liberação de gametas, que podem permanecer até quatro semanas no plâncton, na primavera e verão. No Estado da Paraíba, próximo a Linha do Equador, a espécie apresenta indivíduos produzindo gametas o ano todo, características atribuída às condições ambientais favoráveis (NARCHI, 1976; GROTTA & LUNETTA, 1980 e 1982). Em Florianópolis (SC), Araújo (2001) obteve como resultados que *A. brasiliana* apresenta gametogênese, maturação e eliminação dos gametas simultaneamente entre primavera e outono. Além disso, obteve que a maturidade dos indivíduos ocorre quando alcançam 15 mm de largura com a diferenciação sexual iniciada quando os indivíduos alcançam 7 mm. Finalmente Barreiras e Araújo (2005) obteve como resultados no Fortim (CE), que *A. brasiliana* possui ciclo reprodutivo contínuo, na qual as quatro fases de desenvolvimento das gônadas foram observadas quase que simultaneamente

em um ano de estudos, mas podendo observar com maior intensidade dois picos reprodutivos de julho a outubro e de fevereiro a abril.

Arruda-Soares et al. (1982) recomendaram a captura de espécimes de *A. brasiliana* com comprimento acima de 20 mm, quando os indivíduos já têm alcançado um grau de desenvolvimento gonadal que possibilite a reprodução. Entretanto Martins e Souto (2006) encontraram que 6% dos indivíduos capturados de *A. brasiliana* no manguezal de Acupe, Bahia, estavam abaixo de 20 mm. Estes autores relataram que as marisqueiras coletam os indivíduos menores para garantir, ao menos, uma pequena quantidade para comer. Neste caso, mesmo que haja a intencionalidade de conservar o recurso, a necessidade de sustentar a família é preponderante em relação à preocupação ecológica (MARTINS E SOUTO, 2006).

Dias et al. (2007) analisando aspectos socioeconômicos e perspectivas das mulheres marisqueiras na Reserva de Desenvolvimento Sustentável (RDS) Ponta do Tubarão no Rio Grande do Norte, verificaram que a partir dos dados de produção diária fornecida pelas entrevistadas, estimou-se uma produção diária média de 47,9kg/ dia de *A. brasiliana*, resultando em 3,2kg/pessoa/dia. Considerando-se que as coletas ocorrem pelo menos durante 15 dias por mês, a produção mensal pode chegar a 670,6kg, com uma média mensal de 459,8kg.

Silva-Cavalcanti e Costa (2009) através da aplicação de questionários com os pescadores da praia de Mangue Seco contataram que as mulheres vão mais vezes a pesca de *A. brasiliana* do que os homens e além de que elas passam mais tempo na pesca do que eles. No verão as mulheres extraem em média 15Kg/dia e no inverno 10Kg/dia em quanto os homens conseguem extrair 17,5 Kg/dia no verão e 13Kg/dia no inverno. Tradicionalmente mariscos entre 10 e 31 mm são coletados. Estes autores ao comparem a praia de Mangue Seco (área não protegida) com o estuário do rio Goiana (área protegida) em Pernambuco relataram haver

diferenças significativas entre as médias declaradas de kg de carne produzida no verão e no inverno, o rendimento familiar, semanalmente, no verão, o preço do verão, o tempo gasto no comércio e a freqüência de colheita. A média da renda familiar, verão e inverno rendimentos semanais, produção da carne no verão e no inverno foram maiores na área não protegida. No entanto, os preços da carne independentemente da estação do ano, foram maiores na área protegida. A freqüência da coleta e tempo gasto no comércio também foram superiores na área protegida.

Moreira (2007), avaliando os impactos do extrativismo de *A. brasiliana* nos estuários dos rios Paciência e Cururuca em São Luís no Maranhão, constatou que no estuário do rio Paciência o comprimento dos indivíduos de *A. brasiliana* coletados pelas pescadoras variou de 17 a 35 mm, enquanto que no estuário do rio Cururuca o tamanho variou de 20 e 23 mm. Em ambos os estuários as marisqueiras capturavam indivíduos de *A. brasiliana* com mais freqüência do que as demais espécies, provavelmente por serem mais abundantes na região, podendo ser capturados o ano todo.

Rodrigues e Henry-Silva (2008) constataram que nas praias próximas ao estuário do rio Apodi/Mossoró no estado do Rio Grande do Norte os indivíduos coletados pelas marisqueiras variaram entre 16 e 28 mm de comprimento com um valor médio de 20 mm. Esta preferência por indivíduos maiores provavelmente deve-se a possibilidade de obter maior lucro com a comercialização da matéria prima, bem como com a preocupação ambiental de permitir que indivíduos de *A. brasiliana* atinjam um tamanho mínimo para a sua reprodução. De-Jesus et al. (2004) ao realizarem a análise biométrica de populações de *A. brasiliana* na região estuarina de São Francisco do Conde, localizado na porção Nordeste da Baía de Todos os Santos, encontraram indivíduos com comprimento médios de 20.9 mm (período seco) e 19.72 mm (período chuvoso) e largura dos de 25.02 mm (período seco) e 22.93 mm (período chuvoso).

Os indicadores sociais para a área de estudo revelam a predominância de uma população de baixa renda familiar, com elevado percentual de analfabetos, sobretudo na zona rural; moradias de baixo padrão de construção e condições sanitárias precárias. Este quadro se tem agravado nas últimas décadas como resultado, entre outros fatores, do descompasso entre a dinâmica demográfica e a economia litorânea, decorrente de uma oferta insuficiente de bens e serviços básicos às comunidades urbanas e rurais (ALMEIDA e GÁLVEZ, 2007).

A concentração fundiária na região e as condições de trabalho somadas às poucas opções presentes geram o deslocamento da população rural para os núcleos urbanos, em busca de emprego e melhores condições de vida (CPRH, 2001).

Por isso, o desenvolvimento da maricultura deve ser planejado em consonância com os princípios de gestão integrada dos ambientes costeiros e marinhos, de forma a evitar os conflitos de uso entre as atividades que competem pela ocupação dos espaços e utilização dos recursos naturais costeiros e marinhos, tais como: extrativismo, pesca, turismo, tráfego aquaviário (TOVAR et al, 2000).

Conseguir unir a gestão deste recurso pesqueiro com novas tecnologias de maricultura, em busca do crescimento e do desenvolvimento sustentável desta espécie, contribuirá pra a melhoria da renda familiar dos principais atores desta atividade, as marisqueiras.

4. ARTIGOS CIENTÍFICOS

4.1. Spatial and temporal distribution of shellfish *Anomalocardia brasiliana* (Gmelin, 1791) in Mangue Seco beach, Pernambuco - Brazil

Isabela Bacalhau*, Antônio Amorim, Henrique Lavander, Leônidas Oliveira, Silvio Peixoto e Alfredo O. Gálvez

4.2. Evaluation of replenishment of stocks of shellfish *Anomalocardia brasiliana* in fishing area in Mangue Seco beach, north coast of Pernambuco, Brazil

Isabela Oliveira*, Sérgio Silva-Neto, Roberta Soares, Silvio Peixoto e Alfredo Gálvez

Spatial and temporal distribution of shellfish *Anomalocardia brasiliana* (Gmelin, 1791) in Mangue Seco beach, Pernambuco - Brazil

Isabela Bacalhau*, Antônio Amorim, Henrique Lavander, Leônidas Oliveira, Silvio Peixoto e Alfredo O. Gálvez

Universidade Federal Rural de Pernambuco, Departamento de Pesca e Aqüicultura, Laboratório de Maricultura Sustentável, 52171-900, Recife, PE, Brazil

*Corresponding author – contact information:

Phone: +55 81 3320-6504

Email: isabelabacalhau@gmail.com

Abstract

This study aims to analyze the spatial and temporal distribution of *Anomalocardia brasiliana* along the Mangue Seco beach (Igarassu, PE, Brazil). The 1800 meters beach line, in the south-north, was divided into three sections (S) of 600 meters each, and S1 0 to 600, S2 600 to 1200m and S3 1200 to 1800m. In all, 540 were samples taken in different parts, levels and seasons. Being collected a total of 1,016 specimens in January (summer) and August (winter) 2009. Of this total, 636 clams were collected in summer, 55% juvenile size less than 15 mm, and 380 in winter 57% were adult size between 21 and 25 mm in length. The maximum density recorded in the summer period were 414.91 ± 82.48 ind.m^{-2} at S3 and 323.49 ± 90.11 ind.m^{-2} at S1, both being significantly different from S2 (156.12 ± 28.72 ind.m-^{2}). In winter there were the lowest density with 102.67 ± 5.07 ind.m^{-2} and 122.37 ± 36.86 ind m^{-2} for S1 and S2, respectively, both significantly different from S3 (296.76 ind.m^{-2} ± 45.20). The relationship between the stations S3 obtained the highest rates of biomass with 1,248.47 ± 305.82 g.m^{-2} and 1,136 ± 191.14 g.m^{-2} for the summer and winter, respectively, being significantly different from the other sections for the two stations. The rains exert an influence on the distribution of the bivalve *A. brasiliana*, with lower density after this period, however the animals are larger (> 20mm) increase in size due to food availability during rainy seasons.

Keywords: Seasons, Density, Biomass.

1. Introduction

On all continents at least one clam from exposed beaches is extensively collected as part of a recreation, artisanal or commercial fishery (Mclachlan *et al*., 1996). These same authors define a recreational fishery as collection for bait or food without sale or dependence on the resource; a artisanal fishery as collection for subsistence or sale by individuals or groups using traditional methods; and a commercial as collection for sale by corporate or collective organizations.

The mollusc *Anomalocardia brasiliana* is a species well accepted for human consumption, easy to locate and arrest and is operated by hand in various regions of the country, both for subsistence and for sale (Pezzuto and Echternacht, 1999). On the Brazilian coast, several species of molluscs from the estuarine regions are explored in a rough manner by traditional communities, without the use of management measures to ensure sustainable use of resources (Araújo, 2001).

The Brazilian coast has widely spread and intense fisheries of *A. brasiliana*, important for large groups of economic and socially disfavoured families. The meat is sold, and represents the main (often the only and irreplaceable) source of monetary income for entire small traditional communities (Silva-Cavalcanti and Costa, 2009). In Pernambuco state coast, the clam's fishery has a great socio-economic importance, being marketed at different scales, especially for coastal communities, who use it also in the family diet.

This species, *A. brasiliana*, because they distribute in unconsolidated environments has been associated with several biological factors such as reproductive behavior and food availability, as well as physical and chemical factors such as hydrodynamics, particle size, amount of organic matter and moisture from the area or to a combination thereof (Mclachlan, 1983). Soares-Gomes and Pires-Vanin (2003) when studying abundance and diversity

patterns of molluscs, reported that the fauna of bivalves can be safely employed in representing the benthic community structure in general.

Intertidal invertebrate communities show temporal and spatial patterns that are the result of the ability of species to cope with changes in physical and biological factors associated with major environmental gradients, such as tidal influence, exposure rate, and water and substrate characteristics (Rodil *et al*, 2008).

Studies of biology and ecology of *A. brasiliana* were carried out on the coast of the state of Sao Paulo (Pereira-Smith *et al.* 1982; Narchi, 1972 and 1974, and Schaeffer-Novelli, 1976), Santa Catarina (Rosa, 1989) and Paraná (Boehs, 2000; Lana *et al.*, 1989; Netto and Lana, 1994). Also observations were made about their demographic distribution, growth and spawning in the Caribbean (Monti *et al*., 1991).

This study aims to analyze the spatial and temporal distribution of *A. brasiliana* along the Mangue Seco beach (Igarassu, PE, Brazil), this place is one of the main areas of the shellfish catch in the state.

2. Material and Methods

2.1. Study area

The Igarassu city locality on the north Pernambuco coast, doing part of the Recife metropolitan area, distant 28 km to capital, has an area of 302.9 km², a population of 86,519 inhabitants and a tropical climate type with rainy summer dry. In the city there are three conserved areas use sustainable: Environmental Protection Area (APA) of channel Santa Cruz estuary, APA Timbo river estuary and APA of Nova Cruz. The most famous beach of the city, the Captain's beach, also known as Mangue Seco, is located in Nova Cruz (S

07°49'44,19" e W 035°50'03,06" has approximately 2.000m of the beach line, shallow water with small wave and intensive tide, with a tide variation in the low-water mark above the 500m (Figura 1). It covers a multitude of highly productive ecosystems and is considered the green region, where one can find segments of plains covered by coconut trees, with extensive mangrove estuaries, coral sands, crowns, islands and reefs, among other (http://www.pe-az.com.br).

Insert figure 1.

2.2. Sample methods

The 1800 meters beach line, in the south-north, was divided into three sections (S) of 600 meters each, and S1 0 to 600, S2 600 to 1200m and S3 1200 to 1800m, the beach was divided by to present differences in the amount of fishermen present in each section. Parallel to the beach were delineated three levels sample (L) contained in the range of tidal variation and the levels distribution to distance 20m for each, L1 20m , L2 40m and the L3 60m from the beach line. Along the beach were built 90 transversal lines imaginary (transects), and each point of intersection between the transect and the level was a collection point. Sampling was carried out during low tide, during two time intervals: January 2009, representing the summer season (no rain), and August 2009, representing the winter (rain).

Specimens were collected using a cylindrical tube, 20cm long by 10 cm diameter (0.0079 m^2) excavating the sediment down to 10-cm-depth. The sediment was sieved using a 2-mm-mesh net. The collected material was analyzed at the Laboratory of Mariculture Sustainable, Universidade Federal Rural de Pernambuco, Brazil.

Maximum length of the anterior-posterio axis (Shell length, SL) of each individual was mensured to the nearest 0.01 mm with digital venier callipers and weighed in a analogue balance with accuracy of 0.25 g and distributed in five size classes: C1 (≤ 15 mm), C2 (16 to 20 mm), C3 (21 to 25 mm), C4 (26 to 30 mm) and C5 (> 30 mm). Individuals caught in this study were classified as juveniles when their shell length to 20 mm and as adult with length greater than 20 mm, classification developed by Arruda-Soares *et al.* (1982).

Sea-surface temperature (SST) and salinity were recorded in situ at each sampling point. The water temperature was obtained with a mercury thermometer and salinity using a refractometer Model S10 - Atago. Were removed sediment samples of the collection sites for particle size analysis using a cylindrical tube with 5 cm in diameter, excavating the sediment down to 10-cm-depth and stored in plastic bags.

2.3. Data analysis

Data from distribution communities were analyzed in terms of number of *A. brasiliana*, abundance (individuals per m^2), and biomass ($g.m^{-2}$). Data on number, abundance and biomass were analyzed by factorial analysis of variance (ANOVA), followed by Duncan's Multiple Range Test to determine differences among station, levels and seasons.

3. Results

The water temperature measured in the collection's days, for study area, during the summer recorded a minimun 27 ° C and a maximum of 32 ° C. In winter the minimum water temperature was 25 ° C and maximum 30 ° C. The salinity ranged between 38 and 40 in

January (summer) and between 26 and 35 in August (winter). There was significant difference between the mean values salinity for the study area (Table 1).

The rainfall (mm) observed for the city of Igarassu during the period January to December 2009 is shown in Figure 2, these data were obtained from the Meteorological Laboratory of Pernambuco (LAMEPE), associated with the Technology Institute of Pernambuco (ITEP).

Insert figure 2

The mean grain size for each section, in Mangue Seco beach, with greater representation, were 70.15% of coarse sand and medium sand 16.74% average for the section 1. For section 2, 85.80% and 6.29% of coarse sand and gravel, respectively, and the third section (S3) 60.83%, 17.35% and 13.05% of coarse sand, medium sand and fine sand, respectively (Figure 3).

Insert table 1

Insert figure 3

In all, 540 were samples taken in different parts, levels and seasons. Being collected a total of 1,016 specimens in January (summer) and August (winter) 2009. Of this total, 636 clams in the summer representing a percentage of 63% and 380 individuals (equivalent to 37%) in winter.

In the two seasons studied were collected from individuals with widely varying size. In summer, the class C1 (≤ 15 mm) was the most abundant, with 347 specimens captured, representing about 55% of the total organisms collected and for classes C2, C3 and C4 showed values of 96, 114 and 76 animals collected (Figure 4a, b, c).

In winter, the class C3 (21 to 25 mm) was more abundant with 218 individuals, representing 57% of animals captured and the classes C1, C2 and C4 presented 64, 48 and 47 animals collected (Figure 4 d, e, f). However, in the two seasons, the class C5 (> 30 mm) was the one with the least amount of clam with only three animals per season, a total of 0.5% and 0.8% for the summer and winter, respectively (Figure 4).

For the tidal level studied (L1, L2 and L3) was not significant difference between the average values of biomass and density of clam caught (Table 2). For the summer, although there is no difference, we see a trend with higher biomass in intertidal levels (L2> L3> L1) and density (L2> L1> L3). In winter, the pattern of biomass between the levels was the same, differing only in density (L2> L3> L1). Figures 4 and 5 show the values of biomass and density of levels for each section.

Insert table 2

Insert figure 4 and 5

Comparing the periods of summer and winter there were no significant differences in population density of *A. brasiliana* in the study area, with 298.17 ± 53.00 ind.m^{-2} and 173.93 ± 35.17 ind.m^{-2}, respectively. However significant differences were found comparing the section S1, S2 and S3 and the interaction of it with the seasons (Table 3). The maximum

density recorded in the summer period were 414.91 ± 82.48 ind.m^{-2} at S3 and 323.49 ± 90.11 ind.m^{-2} at S1, both significantly different from S2 (156.12 ± 28.72 ind.m^{-2}). In winter the lowest densities occurred with 102.67 ± 5.07 ind.m^{-2} and 122.37 ± 36.86 ind.m^{-2} for S1 and S2, respectively, both significantly different from S3 (296.76 ± 45 , 20 ind.m^{-2}). The density showed seasonal fluctuation, with higher values during summer and lower values during winter seasons (Figure 5).

With respect to biomass, there was no significant difference between the two studied periods, with of 730.40 gm^{-2} for the summer and 729.13 gm^{-2} for the winter (Figure 6). The results showed a significant difference between sections and between the interactions of the sections with the seasons (Table 3). The S3 was significantly different between the stations and between the section, S1 and S2, being the main section with the higher number of clam and consequently higher biomass.

Insert Table 3

4. Discussion

Significant differences were observed in mean salinity over the sections in two seasons. The drop in salinity during winter is related to increased rainfall in the months prior to collect. Filho (2001) reported that in estuaries, drastic changes in salinity (daily, seasonal, interannual) influence markedly the distribution of benthic associations. Leonel *et al.* (1983) proved experimentally that, *A. brasiliana* tolerate variations in salinity from 17 to 42‰. Monti *et al.* (1991), in Guadeloupe, verified the occurrence of *A. brasiliana* in areas with salinity between 17 and 38‰.

In the present study did not observe a difference in the standard grain size in the three stretches of beach. Magalhães *et al.* (1998) observed the absence of this species in locations with substrate composed of thicker sand and higher densities in substrates composed of fine-grained and with lots of organic matter. In the same way Boehs *et al.*, (2008) observed this pattern predominantly in the aggregate population of *A. brasiliana* of intertidal non-vegetated estuarine complex of Paranaguá Bay, Paraná - Brazil.

The rainfall precipitation observed for the year 2009 influenced the pattern of distribution of *A. brasiliana*, for the month of August, there was a greater number of clam larger than 20 mm and in the collect in January, which typically follows a period of drought , the dominance was clam with size less than 20 mm. Terrestrial runoff, river discharge and resuspension of bottom sediments by tidal currents are the principal source of nutrients in tropical estuarine ecosystems (Von Prahl *et al.* 1990; Cantera and Blanco 2001; Medeiros *et al.* 2001). Thus, it can be assumed that highest primary productivity (and thus food availability) is associated to rainy seasons, as observed by Gocke *et al.* (2001) in a tropical estuary in Costa Rica and Hernández and Gocke (1990) in a coastal lagoon at the Caribbeean coast of Colombia. Riascos (2006) related these studies to the reproductive cycle of the tropical bivalve *Donax dentifer* at the Colombian Pacific, where by this author, food availability during rainy seasons would play an important role within the chronology of reproductive events, and this conclusion can be too used for the *A. brasiliana* specie.

The density and biomass of *A. brasiliana* in relation to tidal level showed a distribution pattern more frequently at level 2 (L2>L1>L3). Corroborating the results of Rodil *et al.* (2008) to analyze the distribution pattern of macrobenthic community, noted a higher density of mollusks at the interdital level (L2>L3>L1), differing only from level 1 to 3.

The density of *A. brasiliana* was lower in winter, this reduction may be related to the fishing activity of this species, because the month of August preced the summer period where there is more demand for this product in the region. Rodil *et al* (2008), in estuarine beach in Spain, reached the same conclusion that the bivalves were scarce in April, probably because of the local clam gathering activities during the previous months. These mollusks are used by fishing communities for subsistence consumption and sale to the consumer market (Pezzuto & Echternacht, 1999; Rosa, 1989;). Another factor that may have influenced the lower density is the increase in rainfall during the winter, which alters the salinity of the sea leading to increased mortality rates and consequently lower density of individuals collected during this period (Barreira and Araújo, 2005; Bezerra, 1998; Boehs *et al*., 2008; Estrada, 2001; Monti, 1991; Möueza *et. al.*, 1988; 1999). The value of density can also be reduced by natural self-limitation which is imposed, mainly for adult classes, which are present in high densities, cause reduction of space and food for small animals (Pezzuto e Echternacht, 1999).

5. Conclusion

The rains exert an influence on the distribution of the bivalve *A. brasiliana*, with lower density after this period, however the animals are larger (> 20mm) increase in size due to food availability during rainy seasons. These results can serve as a basis for future management programs for the species, through the maintenance of natural stocks and fishing activity in the region.

Acknowledgments

This study was financed by Brazilian Council for Scientific and Technological Development (CNPq) through the project approved in the Announcement CNPq/MAPA/SDA

Nº 064/2008. The Coordination of Improvement of Higher Education Personnel (CAPES) for scholarship and the project Gente da Maré, by the exchange in Centre for Shellfish Research - Canada.

6. **Literature Cited**

Araújo, C. M. Y. 2001. Biologia reprodutiva do berbigão *Anomalocardia brasiliana* (Mollusca, Bivalvia, Veneridae) na Reserva Extrativista Marinha do Pirajubaé. PhD thesis. Instituto de biociências, Universidade de São Paulo, USP.

Arruda-Soares, H.; Schaeffer-Novelli, Y.; Mandelli, JR.J. 1982. "Berbigão" *Anomalocardia brasiliana* (Gmelin, 1791), bivalve comestível da região da Ilha do Cardoso, Estado de São Paulo, Brasil: aspectos biológicos de interesse para a pesca comercial. Boletim do Instituto de Pesca, São Paulo, 9: 21-38.

Barreira, C. A.; Araújo, M. L. R. 2005. Ciclo reprodutivo de *Anomalocardia brasiliana* (Gmelin, 1791) (Mollusca, Bivalvia, Veneridae) na praia do canto da Barra, Fortim, Ceará, Brasil. Boletim do Instituto de Pesca, 31(1): 9-20.

Bezerra, T.F.M. 1998. Estudo comparativo do ciclo sexual de *Tivela mactroides* (Born, 1778) e *Anomalocarida brasiliana* (Gmelin, 1791) (Bivalvia, Veneridae) do litoral do Estado da Paraíba, Brasil. Master's thesis. Universidade Federal da Paraíba.148p.

Boehs, G.; Absher, T. M.; Cruz-Kaled, A. C. 2008. Ecologia populacional de *Anomalocardia brasiliana* (Gmelin, 1791) (Bivalvia, Veneridae) na Baía de Paranaguá, Paraná, Brasil. B. Inst. Pesca, São Paulo, 34(2): 259 - 270.

Cantera JR, Blanco JF. 2001. The estuary ecosystem of Buenaventura Bay, Colombia. In: Seeliger U. Kjerfve B (Eds). Coastal marine ecosystems of Latin America. Ecological studies, vol 144. Springer, Berlin Heidelberg New York, PP 264-280.

273 Filho, J. S. R. 2001. Variações espaço-temporais das associações de macroinvertebrados
274 bentônicos de fundos moles dos estuários do Rio Grande do Sul (Brasil). Influência de
275 fatores naturais e introduzidos e modelos para sua predição. PhD thesis. Fundação
276 Universidade Federal do Rio Grande.
277 Gocke, K.; Cortéz, J.; Murillo, M. 2001. The annual cycle of primary production in a tropical
278 estuary: the inner regions of the Golfo de Nicoya, Costa rica. Rev. Biol. Trop. 49:289-
279 306.
280 Hernandéz, C. A.; gocke, K. 1990. Productividad primaria em La Ciénaga Grande de Santa
281 Marta, Colombia. An. Inst. Invest. Mar. Punta Betín. 19-20:101-119.
282 Lana, P.C.; Almeida, M.V.O.; Freitas, C.A.F.; Couto, E.C.G.; Conti, L.M.P; Gonzalez-
283 Peronti, A.L.; GILES, A.G.; LOPES, M.J.S.; SILVA, M.H.C.; PEDROSO, L.A. 1989.
284 Estrutura espacial de associações macrobênticas sublitorais da Gamboa Perequê (Pontal
285 do Sul, Paraná). Nerítica, Curitiba, 4 (1): 119-136.
286 Leonel, R.M.V.; Magalhaes, A.R.M.; Lunetta, J.E. 1983. Sobrevivência de *Anomalocardia*
287 *brasiliana* (Gmelin, 1791) (Mollusca: Bivalvia), em diferentes salinidades. Bolm. Fisiol.
288 Animal. Universidade de São Paulo, 7: 63-72.
289 Magalhães, A.R.M. 1998. Efeito de parasitose por trematoda Bucephalidae na reprodução,
290 composição bioquímica e índice de condição de mexilhões *Perna perna* (L.). PhD
291 thesis. Universidade de São Paulo, São Paulo.
292 Medeiros, C.; Kjerfve, K.; Araujo, M.; Newmann-Leitao, S. 2001. The Itamaracá estuarine
293 ecosystem, Brazil. In Seeliger U, Kjerfve B (Eds) Coastal marine ecosystems of Latin
294 America. Ecological studies, vol 144. Springer, Berlin Heidelberg New York, pp 71-81.
295 Mclachlan, A. 1983. Sandy beach ecology – a review. In: McLachlan, A.; Erasmus, T. (eds.),
296 Sandy beaches as ecosystems. The Hague: W. Junk p. 321-380.

297 Monti, D.; Frenkiel, L.; Mouëza, M. 1991. Demography and growth of *Anomalocardia*
298 *brasiliana* (Gmelin) (Bivalvia, Veneridae) in a mangrove, in Guadeloupe (French West
299 Indies). J. Moll. Stud., Londres, 57: 249-257.
300 Mouëza, M.; Frenkiel, L., Monti, D. 1988. Reproduction et dynamique des population des
301 mollusques bivalves d'interet comercial en Guadalupe *Anomalocardia brasiliana*
302 Gmelin et *Lucina pectinata* Gmelin. Repport. Action Concertée Oceanologie
303 Commision CODERT; MRT, 66p.
304 Mouëza, M.; Gros, O.; Frenkiel, L. 1999. Embryonic, larval and postlarval development of
305 the tropical clam, *Anomalocardia brasiliana* (Bivalvia, Veneridae). Journal of
306 Molluscan Studies, New York: Oxford University Press p. 73-88.
307 Narchi, W. 1972. Comparative study of the functional morphology of *Anomalocardia*
308 *brasiliana* (Gmelin, 1971) and *Tivela mactroides* (Born, 1778) (Bivalvia:Veneridae).
309 Bull. Mar. Sci., Miami, 22(3): 643-670.
310 Narchi, W. 1974. Aspectos ecológicos e adaptativos de alguns bivalves do litoral paulista.
311 Papéis Avulsos Zool., São Paulo, 27: 235-262.
312 Netto, S.A. and Lana, P.C. 1994. Effects of sediment disturbance on the structure of benthic
313 fauna in a subtropical tidal creek of southeastern Brazil. Mar. Ecol. Prog. Ser., Berlin,
314 106: 239-247.
315 Prahl von, H.; Cantera, JR.; Contreras, R. 1990. Manglares y hombres del Pacífico
316 Colombiano. Colciencias & Fondo FEN Colômbia , Bogotá.
317 Pezzuto, P. R. e Echternacht, A. M. 1999. Avaliação de impactos da construção da Via
318 Expressa SC-SUL sobre o berbigão *Anomalocardia brasiliana* (Gmelin,1791)
319 (Mollusca: Bivalvia) na Reserva Extrativista Marinha do Pirajubaé, (Florianópolis, SC-
320 Brasil). Revista Atlântica, Rio Grande, 21: 105-119.

321 Riascos, J. M. V. 2006. Effects of El Niño-Southern oscillation on the population dynamics of
322 the tropical bivalve *Donax dentifer* from Málaga bay, Colombian Pacific. Marine
323 Biology. 148: 1283-1293.
324 Rodil, I. F.; Cividanes, S.; Lastra, M. and López, J. 2008. Seasonal Variability in the Vertical
325 distribution of benthic Macrofauna and Sedimentary Organic Matter in an Estuarine
326 Beach (NW Spain). Estuaries and Coasts: J CERF 31: 382-395.
327 Rosa, G.J.H. 1989. Distribuição e densidade do berbigão *Anomalocardia brasiliana*
328 (Gmelin,1791) (Mollusca:Bivalvia) na Lagoa da Conceição, Florianópolis, SC.
329 Monograph. 53 p. Universidade Federal de Santa Catarina.
330 Silva-Cavalcanti, J.S. and Costa, M.F., 2009. Fisheries in protected and non-protected areas:
331 is it different? The case of *Anomalocardia brasiliana* at tropical estuaries of Northeast
332 Brazil. Journal of Coastal Research, SI 56 (Proceedings of the 10th International Coastal
333 Symposium), 1454 – 1458. Lisbon, Portugal.
334 Soares-Gomes, A.; Pires-Vanin, A.M.S. 2003. Padrões de abundância, riqueza e diversidade
335 de moluscos bivalves na plataforma continental ao largo de Ubatuba, São Paulo, Brasil:
336 uma comparação metodológica. Revista Brasileira de Zoologia, 20(4): 717-725.
337 Schaeffer-Novelli, Y. 1976. Alguns aspectos ecológicos e análise da população de
338 *Anomalocardia brasiliana* (Gmelin, 1791) na praia do Saco da Ribeira, Ubatuba Estado
339 de São Paulo. PhD thesis. Universidade de São Paulo, São Paulo.
340
341
342
343
344

345 Table 1: Mean (± SD) water temperature (° C) and salinity (‰) in Mangue Seco (Pernambuco
346 - Brazil), during the summer and winter, the three sections (S1 to S3).

	Summer			Winter		
	Mean ± SD			Mean ± SD		
	S1	S2	S3	S1	S2	S3
Temperature	29.1 ±1,38[a*]	28.5 ±1.07[a]	28.9 ±0.59[a]	27.3 ±1.2[a]	28.3 ±3.9[a]	28.3 ±1.0[a]
Salinity	39.8 ±0.36[a]	38,3 ±0.76[b]	37.5 ±0.51[b]	30.4 ±1.8[b]	38.3 ±0.76[a]	34.0 ±3.3[b]

347 * Different letters among lines indicate significant differences (p<0,05)

348

349 Table 2: Mean (± SE) density (ind.m^{-2}) and biomass (g.m^{-2}) to levels (L1, L2 and L3) in
350 summer and winter.

	Summer		Winter	
Tidal Level	g.m^{-2}	ind.m^{-2}	g.m^{-2}	ind.m^{-2}
L1	430.37 ± 124.28[a*]	289.73 ± 110.52[a]	526.00 ± 197.49[a]	132.21 ± 42.91[a]
L2	995.70 ± 385.79[a]	354.53 ± 98.98[a]	864.63 ± 326.33[a]	192.67 ± 89.31[a]
L3	765.13 ± 288.67[a]	250.35 ± 94.31[a]	796.77 ± 119.36[a]	196.91 ± 60.92[a]

351 * Different letters among columns indicate significant differences (p<0,05)

352

353

354

355

356

Table 3: Biomass and population density (Mean ± SE) of *A. brasiliana* one way S1 (0-600m), S2 (600-1200) and S3 (1200-1800m), the season (S = Summer and W = Winter) and the interaction between section and the seasons in the Beach Mangue Seco, Pernambuco - Brazil.

	Biomass	Density
Sections	$g.m^{-2}$	$ind.m^{-2}$
S1	462,71 ± 40,07[a]	213,08 ± 64,92[ab*]
S2	533,95 ± 105,01[a]	139,24 ± 22,22[a]
S3	1192,63 ± 163,21[b]	355,84 ± 49,67[b]
Seasons	$g.m^{-2}$	$ind.m^{-2}$
S	730,40 ± 165,43[a]	298,17 ± 53,00[a]
W	729,13 ± 126,44[a]	173,93 ± 35,17[a]
Sections x Seasons	$g.m^{-2}$	$ind.m^{-2}$
S1 S	412,10 ± 51,79[a]	323,49 ± 90,11[c]
S2 S	530,63 ± 165,53[a]	156,12 ± 28,72[ab]
S3 S	1248,47 ± 305,82[b]	414,91 ± 82,48[c]
S1 W	513,33 ± 52,76[a]	102,67 ± 5,07[a]
S2 W	537,27 ± 166,53[a]	122,37 ± 36,86[a]
S3 W	1136,80 ± 191,14[b]	296,76 ± 45,20[bc]

* Different letters among columns indicate significant differences ($p<0,05$)

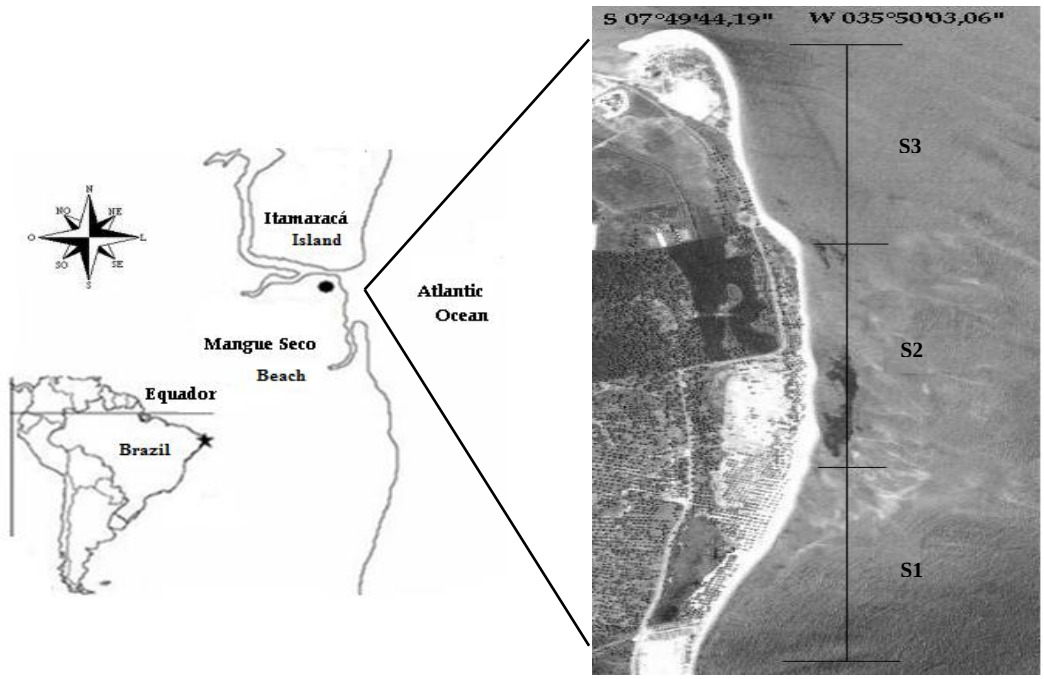


Figure 1: Map showing location and satellite image of study area in Mangue Seco Beach north coast of Pernambuco. The vertical line indicates the sections of 600 meters (S1, S2 and S3) analyzed along the beach.

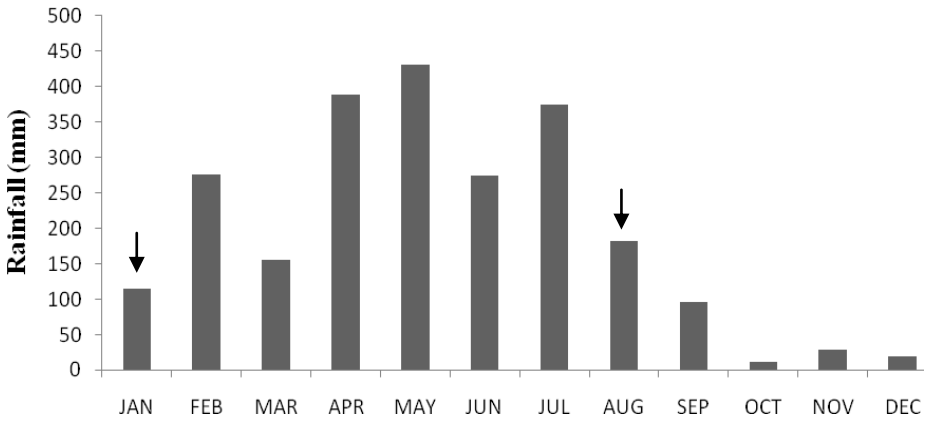


Figure 2: Rainfall (mm) recorded for the period January to December 2009. Arrows indicate the months of collection. Source: LAMEPE.

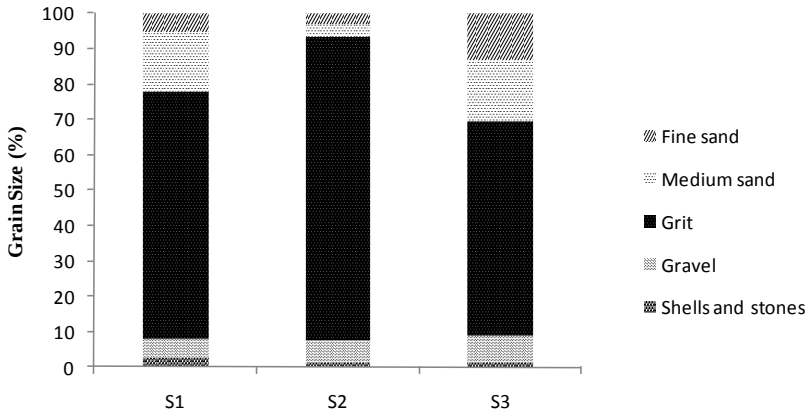


Figure 3: Particle size of the three areas studied (S1, S2 and S3) of Mangue Seco.

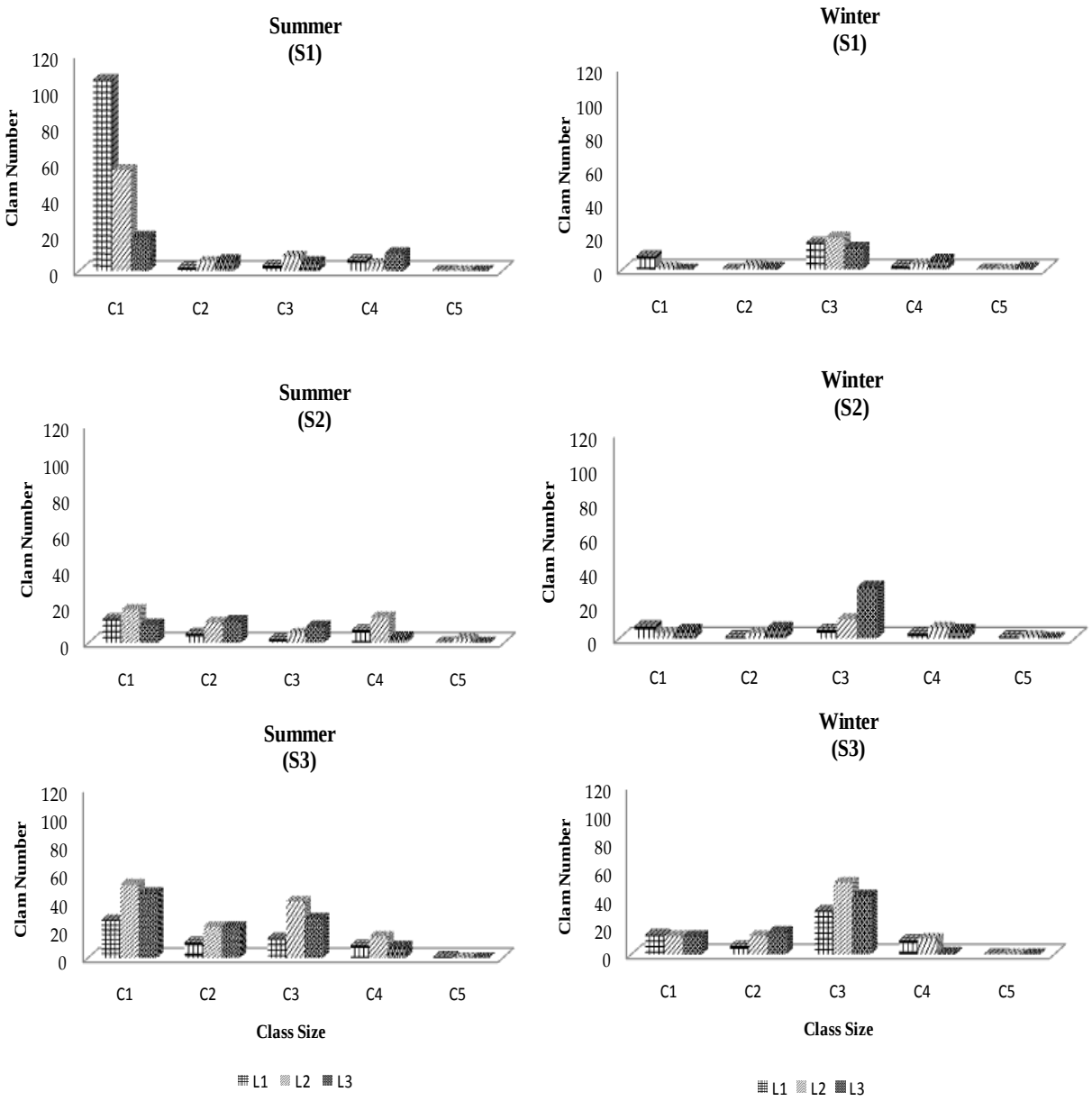


Figure 4: Clam Number, *A. brasiliana*, collected during the months of January (summer) and August 2009 (winter), separated for class size in the sections S1 (0-600m), S2 (600-1200m) and S3 (1200-1800m) in Mangue Seco beach. L = sample levels. C1 (<15 mm), C2 (16-20 mm), C3 (21-25 mm), C4 (26-30 mm) and C5 (>30 mm).

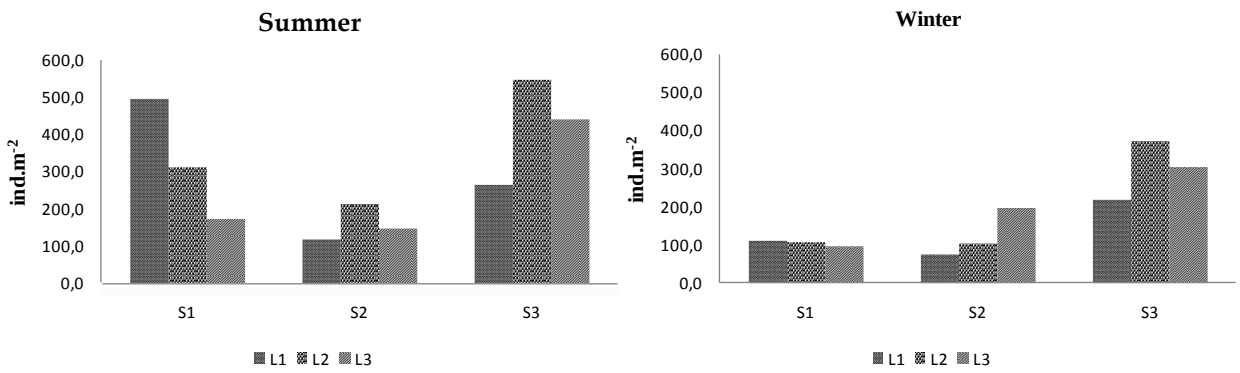


Figure 5: Population density of *A. brasiliana* by sections (S1, S2 and S3) levels (L1, L2 and L3) of Mangue Seco beach, during the summer and winter.

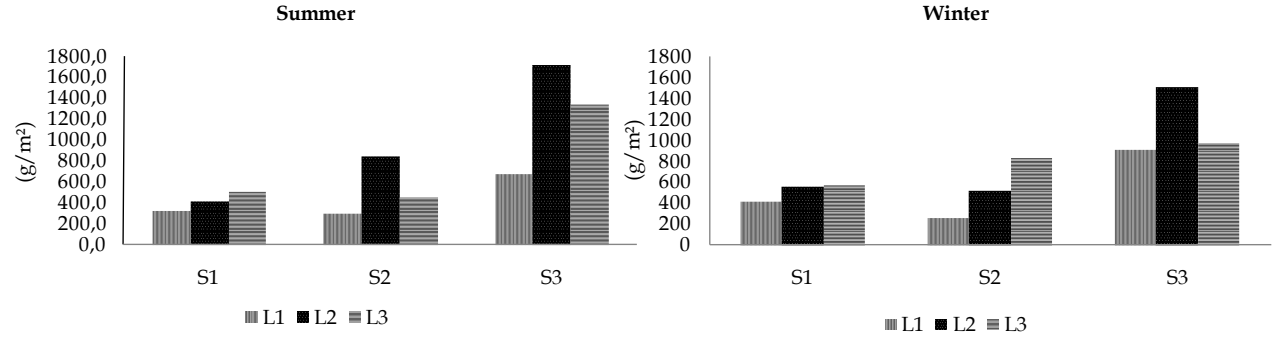


Figure 6: Biomass of *A. brasiliana* by sections (S1, S2 and S3) and levels (L1, L2 and L3) of Mangue Seco beach, during the summer and winter.

An evaluation of the replenishment of shellfish stocks *Anomalocardia brasiliana* in fishing area in Mangue Seco beach, north coast of Pernambuco, Brazil

Isabela Oliveira*, Sérgio Silva-Neto, Leônidas Cardoso, Silvio Peixoto e Alfredo Gálvez

Universidade Federal Rural de Pernambuco, Departamento de Pesca e Aqüicultura, Laboratório de Maricultura Sustentável, 52171-900, Recife, PE, Brazil

*Corresponding author – contact information:

Phone: +55 81 3320-6504

Email: isabelabacalhau@gmail.com

Abstract

The aim of the study was to evaluate the recovery of the *Anomalocardia brasiliana* stock looking at the number and size of clams harvested in summer and winter, after extraction with different methods of capture. Three treatments were evaluated corresponding to an area of 18.75 square meters each, representing where; the clams were removed manually by the fishermen, were collected by a gillnet fishery, and harvesting was not common. The samples were taken at three moments for each treatments: before the fishermen had harvested the clams, an hour after the harvest and finally after 24 hours. The clams were smaller after the manual extraction (15.46 ± 0.86 mm) however there was not a significant difference between the size of the animals found after the collection carried out with a gillnet (18.16 ± 0.92 mm). There were more captured animals with a size larger than 20 mm in winter (80%), than in summer (20%) with no difference between the types of collect for both stations. The type of collect and the moment of extraction didn't influence the number of clams, since the *A. brasiliana* stock found in the Mangue Seco is large and has the capacity to recover after a period of 24 hours of harvesting. The winter and summer exert influence on the abundance of *A. brasiliana*, with greater amounts of clams with recommended size for fishing (> 20 mm) found in winter.

Keywords: Shellfish benthic, density and fishing methods.

1. Introduction

Clams are being extensively collected from exposed beaches throughout the world as part of recreation, artisanal activity or commercial fishery (Mclachlan *et al*., 1996). These same authors define recreational fishery as the collection of bait or food without sale or dependence on the resource; artisanal fishery as collection for subsistence or sale by individuals or groups using traditional methods; and commercial as collection for sale by corporate or collective organizations.

The mollusc, *Anomalocardia brasiliana* is easy to locate and extract, and so is commonly consumed in Brazil. The harvesting is carried out in various regions of the country, both for subsistence and for sale (Pezzuto e Echternacht, 1999). On the Brazilian coast, several species of molluscs from the estuarine regions have been explored extensively, providing the livelihood for large groups of economically and socially disfavoured families however without the use of management measures needed to ensure the sustainable use of resources (Araújo, 2001; Silva-Cavalcanti and Costa, 2009).

The uncontrolled exploitation of this specie may compromise the remaining natural stocks, altering the coastal environment. This exploitation is carried out by hundreds of fishermen who live in this region and unfortunately there is a lack of research related to this species facing the state. Due to the amount of extraction that has taken place it is already harder to find the clam in many parts of the north coast of Pernambuco, and according to reports from the region's fisherwoman, even areas of large concentration are showing a reduction in size.

On the Mangue Seco Beach, north coast Pernambuco, the harvesting of the *A. brasiliana* is done in two ways: manually, usually done by women, and the collect using a gillnet fishery, known as netting, usually held by men and requiring a more physical effort. In the period

before the summer there is an increase in fishing for clams on this beach, because in summer there is a greater demand for this product in bars and restaurants of the region.

Studies focused on the biology of marine bivalves are important for establishing management programs in order to ensure the maintenance of natural stocks, and thus contribute to the development of extractive activities and mariculture (Moreira, 2007). This study is aimed to evaluate the recomposition of stock *A. brasiliana* regarding the number and size of clam harvested in winter and summer, after extraction with two different methods of fishing.

2. Material and Methods

2.1. Study area

Igarassu city on the north Pernambuco coast is part of the Recife metropolitan area being 28 km from the capital, and has an area of 302.9 km², a population of 86,519 inhabitants and a tropical climate type with rainy winters and dry summers. In the city there are three protected areas: Environmental Protection Area (APA) of channel Santa Cruz estuary, APA Timbo river estuary and APA of Nova Cruz. The most famous beach of the city, the Captain's beach, also known as Mangue Seco, is located in Nova Cruz (S 07°49'44,19" e W 035°50'03,06". It has a beach length of approximately 2km, has shallow water with small waves and an intensive tide, with a tide variation in the low-water mark above the 500m (Figura 1). It consists of a multitude of highly productive ecosystems and is considered the green region, where one can find areas covered by coconut trees, with extensive mangrove estuaries, coral sands, crowns, islands and reefs, among other (http://www.pe-az.com.br).

Insert Figure 1

2.2. Experimental Design

The study was conducted in August 2009 and January 2010, and represents both the summer and winter seasons. Each of these three treatments/methods (T) was carried out three times (6.25 m^2, 3 times) , corresponding to an area of 18.75 m^2 per treatment. The three method a being; the clams removed manually by fisherwoman (T1) (Figura 2a), those collected with a gillnet fishery popularly known as netting (T2) (Figura 2b), and where no extraction of clam (T3). The clams were sampled at three specific moments for each method: before the clams were collected (M_0), after one hour (M_{1h}) and 24 h after the sampling (M_{24h}).

Insert Figure 2

The samples of *A. brasiliana* were taken randomly with a cylindrical collector, which had a 25 cm diameter and a depth of 10 cm (0.049 m^2). Each treatment was performed 9 times. The clams were measured with a caliper, precision 0.01 mm, using the maximum length of the shell on its anterior-posterio axis (Shell length, SL), and sorted into five size classes: C1 (≤ 15 mm), C2 (16 to 20 mm), C3 (21 to 25 mm), C4 (26 to 30 mm) and C5 (> 30 mm). Individuals caught in this study were classified as juveniles when their shell length was smaller than 20 mm and as adult when larger than 20 mm, classification developed by Arruda-Soares *et al.* (1982).

2.3. Data analysis

The stock data was analyzed in terms of amount, size and method of fishing. Data regarding the amount, size and method of fishing was analyzed by factorial analysis of variance (ANOVA), followed by Duncan's Multiple Range Test to determine differences between the treatments, moment of collection and seasons.

3. Results

458 clams were collected during winter, with; 112, 169 and 177 representing the treatments T1, T2 and T3, respectively. In the summer 904 clams were collected; 319, 241 and 344 representing the T1, T2 and T3, respectively.

There was not a significant difference when comparing the number of clams caught between the treatments and between the time of collection. There was also no difference with the size of animals collected (Table 1). The collected data shows how the seasons impact the number of animals, with the largest amount collected in summer (11.16 ± 0.63) (5.63 ± 0.55 in winter). However the average size of animals collected in summer were 15.55 ± 0.39 and 19.78 ± 0.82 in winter, and so there is no significant difference (Table 1).

Insert Table 1

The interaction of treatments and moment of collect with the season, showed the effect of seasons on the number of clams present. There was a greater quantity in the summer with 11.81 ± 1.15 (T1), 8.93 ± 0.91 (T2) and 12.74 ± 1.08 (T3), which differed greatly from data

obtained for the same treatments in the winter. This same pattern was observed for moment of collection, with 12.78 ± 1.04 (M_0), 9.44 ± 1.07 (M_{1h}) and 11.26 ± 1.08 (M_{24h}) in the summer, differing significantly to the winter results (Table 2).

A significant change between T2 and T3 in winter and T2 in summer was observed when comparing the effect of seasons on the length of the clams, with average size of *A. brasiliana* from 20.83 ± 1.48 mm and 22.59 ± 0.57 mm for the winter and 15.48 ± 0.85 mm in summer (Table 2). However there was no great difference in the size of clams collected when looking at the time of collection.

The number of animals collected in winter 82 (n = 112) for the T1 treatment was larger than 20 mm, and represented approximately 82% of the clams caught. During the same period the amount of clams larger than 20mm for T2 and T3 were 158 (n = 168) and 162 (n = 177), representing approximately 94% and 91% of the clams collected (Figure 3). During the summer the number of clams collected that were larger than 20 mm, in T1, T2 and T3 was 28 (n = 319), 41 (n = 241) and 63 (n = 344), representing approximately 8.8% , 17% and 18% respectively, with the number of adult animals collected far less than in winter. Neither station revealed animals larger than 30 mm.

Insert figure 3

4. Discussion

The decrease in the density of *A. brasiliana* during the winter may be related to the fishing activity of this species, as these areas are located in places accessible to humans and its catch requires a low capital investment. These molluscs are used by fishing communities for

156 consumption and sale to the consumer market (Pezzuto and Echternacht, 1999; Rosa, 1989).
157 Silva-Cavalcanti and Costa (2009) reported that it is more common to find women fishing for
158 clams than men, however the women's harvest on average is, 15.0 kg / day in summer and
159 10.0 kg / day in winter, and men 17.5 kg / day in summer and 13.0 kg / day in winter. The
160 highest catches in the summer are related to the greater abundance of *A. brasiliana* in this
161 period, which too can be related to the gillnet fishery utilized. Smaller quantities of clams
162 were found 7.59 ± 0.69 after this method of collection.

163 Studies conducted by Barrera and Araújo (2005) in Ceará, report that the species *A.*
164 *brasiliana* has two spawning peaks, one in spring and one in the fall. There are no studies
165 about the reproductive biology of this species in Pernambuco. However when comparing
166 these results from Ceará, we can see a similarity in the abundance of *A. brasiliana* juveniles
167 in the summer of 2010 due to a possible spawning peak of this species during the winter of
168 2009, which may have influenced the variation in the size and number of animals found.

169 In general, during the winter of each year the juveniles are recorded at approximately 1
170 mm shell length. They show a rapid growth reaching 6 to 8 mm even in spring, 20 mm in
171 about eight to nine months in the summer / autumn of the following year (recruitment fishery)
172 and 30 mm at 2 years, when their life expectancy drops dramatically, not exceeding 3 years of
173 age (Pezzuto and Echternacht, 1999; Souza, 2003; Nandi, 2005).

174 The average size of the clams harvested at T1 was 15.46 ± 0.86 and T2 was 18.16 ± 0.92
175 when they was collect by fishermen. This can be related to a possible reduction in the size of
176 this species, even without significant difference between treatments. This data corresponds to
177 that found by Silva-Costa and Cavalcanti (2009); the daily extraction of clam was indicated
178 (63.4%) as responsible for the reduction in shell length and traditionally, and thus animals
179 between 10 and 31 mm were collected.

Rodrigues (2009) evaluated the population of *A. brasiliana* in Barra Beach in the state Rio Grande do Norte, and found that adult animals with a length of 23 to 28 mm prevailed in the months of September and October/07. In the period between October/07 to March/08 the largest entry of young individuals in the population was found. Between January to May/08 a greater abundance of individuals with size from 4 to 12 mm in length were found. The same can also be observed in this study, as there was a greater abundance of clams above 20 mm in August 2009, and in January 2010 with a greater frequency was noted (size between 5 and 16 mm).

Barletta and Costa (2009) reported that molluscs (*A. brasiliana*, *Tagelus plebeius*) in the Goiana river estuary in Pernambuco are extracted by hand during low tide (at least 4 hours per day), with primarily women and children carrying out the harvesting. In the same way one can see the same trend for the Mangue Seco beach, differing only with the entry of men in this activity, which mainly use the gillnet for their collection of clams. This is one of the most important fishing activities in the region, both for subsistence income and financial.

It was not possible to demonstrate a reduction in the density of stock *A. brasiliana* due to time restraints, because the number of clams collected after 24 hours was the same as the baseline. This is mentioned by Silva-Costa and Cavalcanti (2009) who reported that the depletion of *A. brasiliana* in Mangue Seco cannot be predicted, due to migration for banks within the same area. However, successful resource management involves social organization within protected territories, and there should be a better management of areas with a high presence of fishermen, or even diary ordering of local fisheries.

5. Conclusion

The method of collection and the estimated time of extraction did not influence the amount of clams, since the *A. brasiliana* stock of the Mangue Seco is still abundant and could be regenerate after a period of 24 hours. The winter and summer seasons have a great influence on the abundance of *A. brasiliana*, with the largest number of animals with the recommended size for fishing found during the winter period. There is need for further studies to assess the carrying capacity of this resource at this beach.

Acknowledgments

This study was financed by Brazilian Council for Scientific and Technological Development (CNPq) through the project approved in the Announcement CNPq/MAPA/SDA Nº 064/2008. The Coordination of Improvement of Higher Education Personnel (CAPES) for scholarship and the Gente da Maré project, by the exchange in Centre for Shellfish Research - Canada.

7. Literature Cited

Araújo, C. M. Y. - 2001. Biologia reprodutiva do berbigão *Anomalocardia brasiliana* (Mollusca, Bivalvia, Veneridae) na Reserva Extrativista Marinha do Pirajubaé. PhD thesis. Instituto de biociências, Universidade de São Paulo, USP.

Arruda-Soares, H.; Schaeffer-Novelli, Y.; Mandelli, JR.J. - 1982. "Berbigão" *Anomalocardia brasiliana* (Gmelin, 1791), bivalve comestível da região da Ilha do Cardoso, Estado de São Paulo, Brasil: aspectos biológicos de interesse para a pesca comercial. B. Inst. Pesca, São Paulo, 9: 21-38.

227 Barletta, M. and Costa, M.F. - 2009. Living and non-living resources exploitation in tropical
228 semi-arid estuaries. Journal of Coastal Research, SI 56 (Proceedings of the 10th
229 International Coastal Symposium), 371 – 375. Lisbon, Portugal, ISSN 0749-0258.
230 Barreira, C. A. R. and Araújo, M. L. R. - 2005. Ciclo Reprodutivo de *Anomalocardia*
231 *brasiliana* (GMELIN, 1791) (MOLLUSCA, BIVALVE, VENERIDAE) na Praia do
232 Canto da Barra, Ceará, Brasil. Boletim Instituto de Pesca. São Paulo. 31(1) 9-20.
233 Moreira, I.C.N. - 2007. Impactos do extrativismo de *Anomalocardia brasiliana* (Gmelin,
234 1791) nos estuários dos Rios Paciência e Cururuca, São Paulo, Maranhão: Uma visão
235 etnoconservacionista. Master's thesis. 60 p.
236 Nandi, R. R. - 2005. Ecologia populacional do berbigão *A. brasiliana* (Gmelin, 1791)
237 (Bivalvia: Veneridae) na praia da Base – Reserva Extrativista Marinha de Pirajubaé,
238 Florianópolis, SC. Universidade Federal de Santa Catarina. Monograph. 58p.
239 Pezzuto, P. R. and Echternacht, A. M. - 1999. Avaliação de impactos da construção da Via
240 Expressa SC-SUL sobre o berbigão *Anomalocardia brasiliana* (Gmelin,1791)
241 (Mollusca: Bivalvia) na Reserva Extrativista Marinha do Pirajubaé, (Florianópolis, SC-
242 Brasil). Revista Atlântica, Rio Grande, 21: 105-119.
243 Rodrigues, A.M.L. - 2009. Ecologia populacional do molusco bivalve Anomalocardia
244 brasiliana (Gmelin, 1791) (Bivalvia,Veneridae) em praias da região estuarina do rio
245 Apodi/Mossoró-RN. Universidade Federal Rural do Semi-Árido. Master's thesis. 93p.
246 Rosa, G.J.H. - 1989. Distribuição e densidade do berbigão Anomalocardia brasiliana
247 (Gmelin,1791) (Mollusca:Bivalvia) na Lagoa da Conceição, Florianópolis, SC.
248 Universidade Federal de Santa Catarina. Monograph. 53 p.
249 Silva-Cavalcanti, J.S. and Costa, M.F. - 2009. Fisheries in protected and non-protected areas:
250 is it different? The case of Anomalocardia brasiliana at tropical estuaries of Northeast

Brazil. Journal of Coastal Research, SI 56 (Proceedings of the 10th International Coastal Symposium), 1454 – 1458.

Souza, D. S. - 2003. Dinâmica populacional do berbigão *A. brasiliana* (Gmelin, 1791) (Bivalvia: Veneridae) na Reserva Extrativista Marinha de Pirajubaé (Florianópolis, SC). Universidade do Vale do Itajaí. Monograph. 75p.

Table 1: Mean (± SE) of the number and length of clams collected between treatments (T1, T2 and T3) for two seasons (S = summer and W = winter) in different moments (M_0 - samples taken before collected by fisher, M_{1h} - samples taken after collect of fisher, M_{24h} - samples removed after 24 hours).

Tratament	N° of Clams	Size (mm)
T1	7.98 ± 0.86[a*]	15.46 ± 0.86[a]
T2	7.59 ± 0.69[a]	18.16 ± 0.92[a]
T3	9.61 ± 0.86[a]	19.38 ± 0.60[a]
Seasons	N° of Clams	Size (mm)
W	5.63 ± 0.55[a]	19.78 ± 0.82[a]
S	11.16 ± 0.63[b]	15.55 ± 0.39[a]
Moment	N° of Clams	Size (mm)
M_0	9.02 ± 0.85[a]	17.99 ± 0.82[a]
M_{1h}	7.07 ± 0.71[a]	17.17 ± 0.86[a]
M_{24h}	9.09 ± 0.85[a]	17.84 ± 0.83[a]

* Different letters among columns indicate significant differences ($p<0,05$)

Table 2: Mean (± SE) of the interaction between seasons, treatments and moments through of the number and length of clams caught in Mangue Seco.

Tratament / Seasons	Nº of Clams	Size (mm)
T1 W	$4.15 \pm 0.76^{a*}$	15.93 ± 1.65^{ab}
T2 W	6.26 ± 0.98^{a}	20.83 ± 1.48^{ac}
T3 W	6.48 ± 1.05^{a}	22.59 ± 0.57^{c}
T1 S	11.81 ± 1.15^{b}	14.99 ± 0.55^{ab}
T2 S	8.93 ± 0.91^{b}	15.48 ± 0.85^{b}
T3 S	12.74 ± 1.08^{b}	16.17 ± 0.59^{abc}
Moment / Seasons	**Nº of Clams**	**Size (mm)**
M_0 W	5.26 ± 0.88^{a}	20.05 ± 1.47^{a}
M_{1h} W	4.77 ± 0.70^{a}	18.63 ± 1.47^{a}
M_{24h} W	6.79 ± 1.17^{a}	20.60 ± 1.24^{a}
M_0 S	12.78 ± 1.04^{b}	15.93 ± 0.47^{a}
M_{1h} S	9.44 ± 1.07^{b}	15.43 ± 0.70^{a}
M_{24h} S	11.26 ± 1.08^{b}	15.28 ± 0.83^{a}

* Different letters among columns indicate significant differences ($p<0,05$)

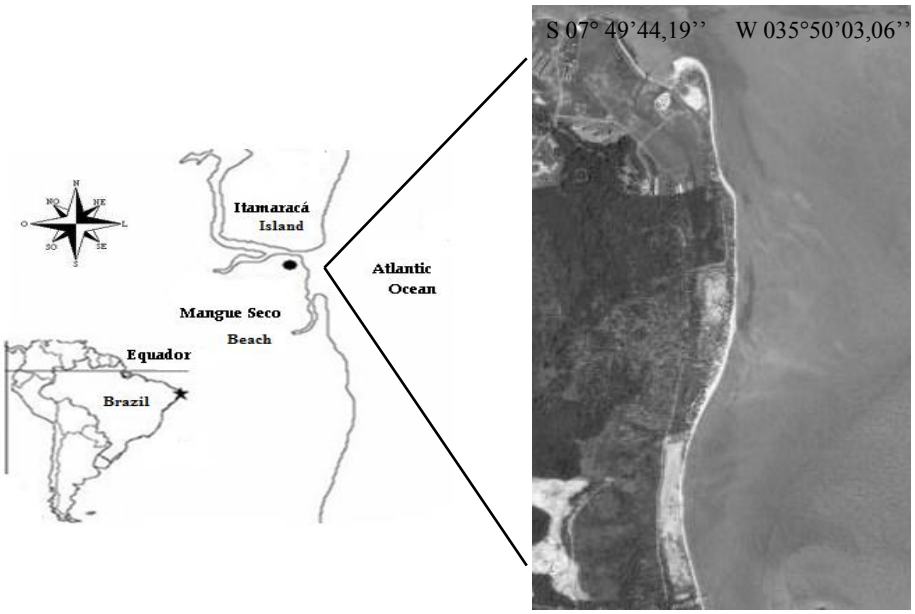
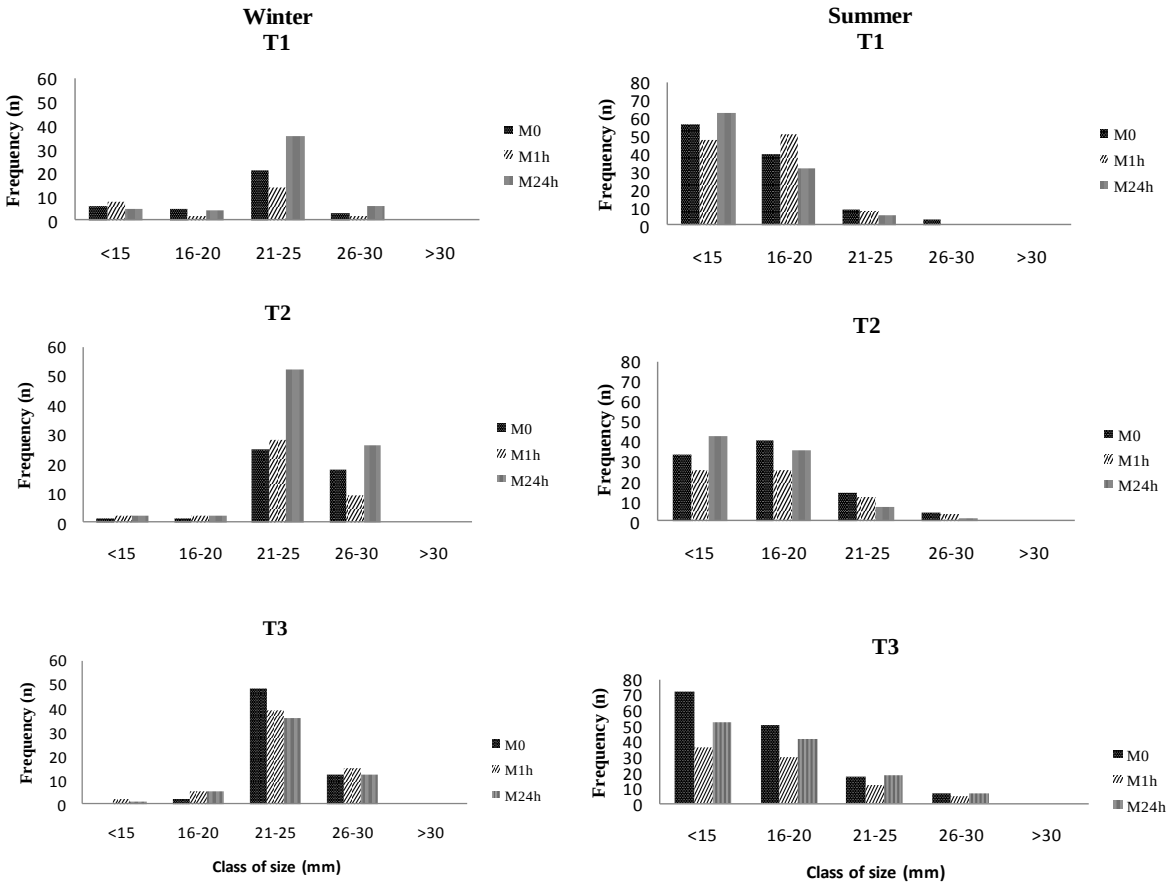


Figure 1: Map showing location and satellite image of study area in Mangue Seco Beach north coast of Pernambuco.

Figure 2: Photo A - Fisherwoman making manual collection of clams (T1) and Photo B - Fisherman doing collecting shellfish using the gillnet (T2).



327

328 Figure 3: Frequency of size classes (mm) observed for clams collected during the months of
329 August 2009 (winter) and January 2010 (summer). M_0 - samples taken before the collections
330 by fisher, M_{1h} - samples taken after collection of fisher and M_{24h} - samples removed after 24
331 hours.

6. CONSIDERAÇÕES FINAIS

Os indivíduos da espécie *A. brasiliana* apresentam uma distribuição espacial característica, com uma maior abundância de juvenis no período de verão enquanto que os adultos são mais abundantes no período de inverno. As estações inverno e verão têm grande influência na abundância de *A. brasiliana*, com maior quantidade de animais em tamanho recomendado para pesca (> 20 mm) no período do inverno.

O tipo de coleta e o tempo estimado de extração não influenciaram na quantidade de moluscos, uma vez que o estoque *A. brasiliana* da praia de Mangue Seco ainda é abundante e pôde se recompor após um período de 24 horas, sem extração.

Há necessidade de novos estudos para avaliação da capacidade de suporte deste recurso nesta praia. Os resultados encontrados podem servir como base para futuros programas de manejo da espécie, através da manutenção dos estoques naturais e atividades pesqueiras na região.

6. REFERÊNCIAS BIBLIOGRAFICAS

AGUILAR-MANJARREZ, J. e NATH, S.S. 1998. A strategic assessment of fish farming potential in Africa. CIFA Tech. Paper No.32, FAO, Rome, p. 170.

ALMEIDA, I.C.S.; GÁLVEZ, A.O. 2007. Delimitação de parques aqüícolas para o cultivo de ostra *Crassostrea rhizophorae* (Guilding, 1828) no Estado de Pernambuco, Brasil. Revista Brasileira de Ciências Agrárias, v.2, n.2, p.161-167.

ARAÚJO, C. M. Y. 2001. Biologia reprodutiva do berbigão *Anomalocardia brasiliana* (Mollusca, Bivalvia, Veneridae) na Reserva Extrativista Marinha do Pirajubaé. Tese de doutorado. Instituto de biociências, Universidade de São Paulo. 204p.

ARAÚJO, M.L.R.; ROCHA-BARREIRA, C.A. 2004. Occurrence of Bucephalus sp. (Trematoda: Bucephalidae) in *Anomalocardia brasiliana* (Gmelin, 1791) (Mollusca: Veneridae) at Canto da Barra Beach, Fortim, Ceará State, Brazil. Arq. Ciênc. Mar, Fortaleza, 37: 35-37.

ARRUDA SOARES, H., Y. SCHAEFFER-NOVELLI & J. MANDELLI Jr. 1982. "Berbigão" *Anomalocardia brasiliana* (Gmelin, 1791), bivalve comestível da região da Ilha do Cardoso, Estado de São Paulo, Brasil: Aspectos Biológicos de interesse para a pesca comercial. B. Inst. Pesca 9: 21-38.

BARREIRA, C. A. R. e ARAÚJO, M. L. R. 2005. Ciclo reprodutivo de *Anomalocardia brasiliana* (Gmelin, 1971) (Mollusca, Bivalvia, Veneridae) na praia do Canto da Barra, Fortim, Ceará, Brasil. B. Inst. Pesca, São Paulo, 31(1): 9 – 20.

BOEHS, G. 2000. Ecologia populacional, reprodução e contribuição em biomassa de *Anomalocardia brasiliana* (Gmelin, 1791) (Bivalvia: Veneridae) na Baía de Paranaguá, Paraná, Brasil. Curitiba. 201p. (Tese de Doutorado. Universidade federal do Paraná).

BOEHS, G. ABSHER, T. M. AND CRUZ-KALED A. 2004. Composition and distribuition of benthic molluscs on intertidal flats of Paranagua Bay (Parana, Brazil). Scientia Marinha, 68 (4): 537-543.

BOEHS, G.; MAGALHÃES, A.R.M. 2004. Simbiontes associados com *Anomalocardia brasiliana* (Gmelin) (Mollusca, Bivalvia, Veneridae) na Ilha de Santa Catarina e região continental adjacente, Santa Catarina, Brasil. Rev. Bras. Zool., Curitiba, 21(4): 865-869.

BORGHETTI, N. R. B.; OSTRENSKY, A.; BORGHETTI, J. R. 2003. Aqüicultura: uma visão geral obre a produção de organismos aquáticos no Brasil e no mundo. Curitiba. Grupo Integrado de Aqüicultura e Estudos Ambientais. 129p.

BRANDINI, F. P.; SILVA, A. S.; PROENÇA, L. A. O. 2000. Oceanografia e Maricultura. In: Valentin, W. C. Aqüicultura no Brasil: base para um desenvolvimento sustentável. Brasília: Brasília. Editora, p. 37-40.

CANAPA, A., MAROTA, I., ROLLO, F. & OLMO, E. 1996. Phylogenetic analysis of Veneridae (Bivalvia): comparison of molecular and paleontological data. J. Mol. Evol. 43: 517-522.

CANTERA, J.R. 1991. Shallow-water venerid clams (Bivalvia: Veneridae) from the pacific coast of Colombia. The Veliger. 34:78-84.

CPRH. 2001. Companhia Pernambucana de Recursos Hídricos. Diagnóstico sócio-ambiental do litoral norte de Pernambuco. Recife, 214p.

CARNEIRO, C. R. 1994. Densidade populacional da *Anomalocardia brasiliana* (Gmelim, 1791) na praia de Barra, município de Grossos – RN. (Monografia de Graduação), Escola Superior de Agricultura de Mossoró-ESAM/RN, 45 p.

FAO. 2006. SOFIA - The state of World fisheries And aquaculture.

Disponível em: <http://www.fao.org/servlet/static?dom=root&xml=aquaculture/index.xml

FRIDLEY, R.B. 1995. The opportunities for engineering and technology in addressing the environmental, institutional, and economic constraints of marine aquaculture in the United States. Estuaries 18, 18–24.

GESAMP (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP. 2001. Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Planning and management for sustainable coastal aquaculture development. Rep. Stud. GESAMP, v. 68. p. 90.

GROTTA, M. 1979. Histologia da reprodução de *Anomalocardia brasiliana* (Gmelin, 1791) do litoral do Estado da Paraíba. João Pessoa. 138p. (Tese de Doutorado. Universidade de São Paulo).

GROTTA, M. & LUNETTA, J.E. 1980. Ciclo sexual de *Anomalocardia brasiliana* (Gmelin, 1791) do litoral do Estado da Paraíba. Rev. Nordest. Biol. 3(1): 5-55.

GROTTA, M. & LUNETTA, J.E. 1982. Reproductive physiological variation of *Anomalocardia brasiliana* (Gmelin, 1791) (Mollusca-Bivalvia), in different latitudes. Rev. Nordest. Biol. 5(1): 21-28.

HIROKI, K. 1971. Fisiologia de invertebrados marinhos, resistência à anoxia. Bol. Zool. Biol. Mar., n.,s.,28 p. 315-341.

HIROKI, K. 1977. On the resistance of isolated bivalve gill pieces to oxygen deficiency and hydrogen sulphide. Bolm. Fisiol. Animal Univ. S. Paulo, São Paulo, 1: 9-20,

KAPETSKY, J.M., MCGREGOR, L., HERBERT, N.E. 1987. A geographical information system and satellite remote sensing to plan for aquaculture development: a FAO-UNEP:GRID cooperative study in Costa Rica. FAO Fish. Tech. Pap. No. 287, FAO, Rome, p. 51.

KAPETSKY, J.M., HILL, J.M., WORTHY, L.D. 1988. A geographical information system for catfish farming development. Aquaculture 68, 311–320.

KAPETSKY, J.M., NATH, S.S. 1997. A strategic assessment of the potential for freshwater fish farming in Latin America. COPESCAL Tech. Paper No. 10, FAO, Rome, p. 128.

LANA, P.C.; ALMEIDA, M.V.O.; FREITAS, C.A.F.; COUTO, E.C.G.; CONTI. L.M.P; GONZALEZ-PERONTI, A.L.; GILES, A.G.; LOPES, M.J.S.; SILVA, M.H.C.; PEDROSO, L.A . Estrutura espacial de associações macrobênticas sublitorais da Gamboa Perequê (Pontal do Sul, Paraná). Nerítica, Curitiba, v.4 n.1/2, p.119-136, 1989.

LEONEL, R. M. V.; MAGALHÃES, A. R. M. & LUNETTA, J. E. 1983. Sobrevivência de *Anomalocardia brasiliana* (Gmelin, 1791) (Mollusca: Bivalvia) em diferentes salinidades. Biol. Fisiol. Anim. Univ. S. Paulo,v. 7: p. 63-72.

LUCAS, A. & BENINGER, P.G. 1985. The use of physiological condition indices in marine bivalve aquaculture. Aquaculture, 44: 187-200.

MARTINS, V.S. e SOUTO, F.J.B. 2006. Uma análise biométrica de bivalves coletados por marisqueiras no manguezal de Acupe, Santo Amaro, Bahia: uma abordagem etnoconservacionista. Sitientibus Série Ciências Biológicas 6 (Etnobiologia): 98-105.

MEADEN, G.J., KAPETSKY, J.M. 1991. Geographical information systems and remote sensing in inland fisheries and aquaculture. FAO Fish. Tech. Pap. No. 318, FAO, Rome, p. 262.

MONTI, D., FRENKIEL, L. AND MOUEZA, M. 1991. Demography and growth of *Anomalocardia brasiliana* (Gmelin) (Bivalvia: Veneridae) in a Mangrove, in Guadaloupe (French West Indies). J. Moll. Stud. 57, 249-257.

MOREIRA, I.C.N. 2007. Impactos do extrativismo de *Anomalocardia brasiliana* (Gmelin, 1791) nos estuários dos Rios Paciência e Cururuca, São Paulo, Maranhão: Uma visão etnoconservacionista. 60 f. Dissertação (Mestrado em Biodiversidade e Conservação) – Universidade Federal do Maranhão, São Luís.

MCLACHLAN, A. Sandy beach ecology – a review**.** 1983. In: McLachlan, A.; Erasmus, T. (eds.), Sandy beaches as ecosystems. The Hague: W. Junk, p. 321-380.

NARCHI, W. 1972. Comparative study of the functional morphology of *Anomalocardia brasiliana* (Gmelin, 1971) and *Tivela mactroides* (Born, 1778) (Bivalvia:Veneridae). Bull. Mar. Sci., 22(3): 643-670.

NARCHI, W. Aspectos ecológicos e adaptativos de alguns bivalves do litoral paulista. Papéis Avulsos Zool., São Paulo, 27: 235-262, 1974.

NARCHI, W. 1976. Ciclo anual da gametogênese de *Anomalocardia brasiliana* (Gmelin, 1791) (Mollusca Bivalvia). Bolm. Zool. 1: 331-350.

NETTO, S.A.; LANA, P.C. Effects of sediment disturbance on the structure of benthic fauna in a subtropical tidal creek of southeastern Brazil. Mar. Ecol. Prog. Ser., Berlin, v. 106, p. 239-247,1994.

NISHIDA, A.K. 2000. Catadores de moluscos do litoral paraibano. Estratégias de subsistência e formas de percepção da natureza. Tese (Doutorado) – UFSCar, São carlos. In: NISHIDA, A.K; NORDI, N; ALVES, R.R.N.A. Abordagem etnoecológica da coleta de moluscos no litoral paraibano. 2004. Tropical Oceanography , Recife: v.32,n.1, p.53-66.

ODUM, E. P. 1986. Ecologia. Rio de Janeiro: Guanabara, Tradução Christopher Tribe, 434p.

PARKER, M.R., BEAL, B.F., CONGLETON, W.R. JR, PEARCE, B.R., MORIN, L. 1998. Utilization of GIS and GPS for shellfish grow out site selection. J. Shellfish Res. 17, 1491–1495.

PEDROZA-JÚNIOR, H. S.; SOARES, M. G.; MELO-JÚNIOR, M.; BARROS, H. M. e SOARES, A. P . 2002. Aspectos etnobiológicos da pesca e comercialização de moluscos e crustáceos do canal de santa cruz, Itapissuma – PE. UFPE.

PESO, M. C. 1980. Bivalves comestíveis da Baía de Todos os Santos: Estudo quantitativo com especial referência à *Anomalocardia brasiliana* (Gmelin, 1791) (Bivalvia-Veneridae). 174p. il. Tese (Mestrado em Zoologia) - Universidade Federal do Paraná, Curitiba.

PEZZUTO, P. R.; ECHTERNACHT, A. M. 1999. Avaliação de impactos da construção da Via Expressa SC-SUL sobre o berbigão *Anomalocardia brasiliana* (Gmelin,1791) (Mollusca: Bivalvia) na Reserva Extrativista Marinha do Pirajubaé, (Florianópolis, SC-Brasil). Atlântica, 21:105-119.

READ, K. R. H. 1964. Ecology and environmental physiology of some Puerto Rican bivalve molluscs and a comparisson with boreal forms. Carib. Sci. Mayaguez, Puerto Rico, 4(4): 459-465.

RIGHETTI, B. G. 2006. Desenvolvimento da tecnologia de produção de indivíduos jovens (sementes) do berbigão *Anomalocardia brasiliana* (gmelin,1791) em laboratório. Monografia

RIOS, E. C. 1994. Seashells of Brasil. 2. ed. Rio grande, RS: Editora da Fundação Universidade do Rio Grande, Segunda edição, 492p.

RODRIGUES, A. M. L. 2009. Ecologia populacional do molusco bivalve *Anomalocardia brasiliana* (Gmelin, 1791) (Bivalvia, Veneridae) em praias da região estuarina do Rio Apodi/Mossoró-RN. 93 f. Dissertação (Mestrado em Ciência Animal: Área de concentração: Aqüicultura e Ecologia Pesqueira) – Universidade Federal Rural do Semi-Árido.

ROSA, G.J.H. 1989. Distribuição e densidade do berbigão *Anomalocardia brasiliana* (Gmelin,1791) (Mollusca:Bivalvia) na Lagoa da Conceição, Florianópolis, SC. Monografia de Especialização, Curso de Especialização em Hidroecologia, Universidade Federal de Santa Catarina, 53 p., Florianópolis.

ROSENTHAL, H., ALLEN, J.H., HELM, M.M., MCINERNEY-NORTHCOTT, M. 1995. Aquaculture technology: its application, development, and transfer. In: Boghen, A.D. (Ed.), Cold-Water Aquaculture in Atlantic Canada, 2nd Edition. Universite de Moncton, New Brunswick, Cananda, pp. 395–448.

ROSS, L.G., MENDOZA, Q.M., BEVERIDGE, M.C.M. 1993. The application of geographical information systems to site selection for coastal aquaculture: an example based on salmonid cage culture. Aquaculture 112, 165–178.

RUBEC, P.J., CHRISTENSEN, J.D., ARNOLD, W.S., NORRIS, H., STEELE, P., MONACO, M.E. 1998. GIS and modeling: coupling habitats to Florida fisheries. J. Shellfish Res. 17, 1451–1457.

SANTOS, E. P. dos. 1978. Dinâmica de populações aplicada à pesca e piscicultura. São Paulo: EDUSP / HUCITEC, 129p.

SCHAEFFER-NOVELLI, Y. 1976. Alguns aspectos ecológicos e análise da população de *Anomalocardia brasiliana* (Gmelin,1791) na praia do Saco da Ribeira, Ubatuba Estado de São Paulo. Tese de doutorado. Instituto de Biociências da Universidade de São Paulo. 119p.

SCHAEFFER-NOVELLI, Y. 1980. Análise populacional de *Anomalocardia brasiliana* (Gmelin, 1791) (Mollusca: Bivalvia), na praia do Saco da Ribeira, Ubatuba, Estado de São Paulo. Boletim do Instituto de Oceanografia, 29(2): 351-355.

SCHERRER, B. 1984. Biostatistique. Gaëtan Morin ed., Canada.

SOARES, C.N.C. e PERET, A.C. 1998. Tamanho médio da primeira maturação da lagosta *Panulirus laevicauda* (Latreille), no litoral do estado do Ceará, Brasil. Arq. Cienc. Mar., Fortaleza, v. 31, n. 1-2, p. 17-27,

TOVAR, A.; MORENO, C.; MÁNUEL-VEZ, M.P.; GARCÍA-VARGAS, M. 2000. Environmental impacts of intensive aquaculture in marine waters. Water Research, Great Britain, v.34, n.1, p.334-342.

VINATEA, L. A. A. 2000. Modos de apropriação e gestão patrimonial de recursos costeiros: estudo de caso sobre o potencial e os riscos do cultivo de moluscos marinhos na Baía de Florianópolis. Florianópolis: Universidade Federal de Santa Catarina. 241. Tese de Doutorado.

ANEXOS:

Revista Fisheries Research

ISSN: 0165-7836, Fator de Impacto: 1,434

O artigo científico 1 “Spatial and temporal distribution of the shellfish *Anomalocardia brasiliana* (Gmelin, 1791) in Mangue Seco beach, Pernambuco – Brazil” foi submetido a revista Fisheries Research

NORMAS

Guide for Authors

An International Journal on Fisheries Science, Fishing Technology and Fisheries Management

Introduction

Types of paper

1. Original research papers (Regular Papers)
2. Review articles
3. Viewpoints
4. Short Communications
5. Technical Notes
6. Letters to the Editor
7. Book Reviews
8. Conference Reports

Regular papers should report the results of original research. The material should not have been previously published elsewhere, except in a preliminary form.
Review articles should cover subjects falling within the scope of the journal which are of active current interest. They may be submitted or invited.
Viewpoint contributions provide an opportunity to offer a personal perspective on topical issues relevant to the interests of the Journal.

A Short Communication is a concise but complete description of a limited investigation, which will not be included in a later paper. Short Communications should be as completely documented, both by reference to the literature and description of the experimental procedures employed, as a regular paper. They should not occupy more than 6 printed pages (about 12 manuscript pages, including figures, tables and references).
Conference Reports provide an analytical review of the significant outcomes of important conferences. They may be submitted by conference associates or solicited by the Editor-in-Chief.
Technical Notes should be brief descriptions of experimental procedures, technical operations or applied activities within laboratories or in the field.
Letters to the Editor offering comment or appropriate critique on material published in the journal are welcomed. The decision to publish submitted letters rests purely with the Editor-in-Chief.
Book Reviews are included in the journal on a range of relevant books which are not more than 2 years old. Book reviews will be solicited by the Book Review Editor. Other publications read will be listed. Unsolicited reviews will not usually be accepted, but suggestions for appropriate books for review may be sent to the Book Review Editor:

A.D. McIntyre
Emeritus Professor of Fisheries and Oceanography
Zoology Department
University of Aberdeen
Aberdeen, AB24 2TZ
UK
E-mail: a.d.mcintyre@abdn.ac.uk

Before You Begin

Ethics in Publishing

For information on Ethics in Publishing and Ethical guidelines for journal publication see ⊟→http://www.elsevier.com/publishingethics and ⊟→http://www.elsevier.com/ethicalguidelines.

Policy and Ethics

The work described in your article must have been carried out in accordance with *The Code of Ethics of the World Medical Association*
(Declaration of Helsinki) for animal experiments
⊟→http://europa.eu.int/scadplus/leg/en/s23000.htm; *Uniform Requirements for manuscripts submitted to Biomedical journals* ⊟→http://www.nejm.org/general/text/requirements/1.htm.
This must be stated at an appropriate point in the article.

Conflict of interest

All authors are requested to disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, their work. See also http://www.elsevier.com/conflictsofinterest.

Submission declaration

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere including electronically in the same form, in English or in any other language, without the written consent of the copyright-holder.

Contributors

Each author is required to declare his or her individual contribution to the article: all authors must have materially participated in the research and/or article preparation, so roles for all authors should be described. The statement that all authors have approved the final article should be true and included in the disclosure.

Copyright

Upon acceptance of an article, authors will be asked to complete a 'Journal Publishing Agreement' (for more information on this and copyright see http://www.elsevier.com/copyright). Acceptance of the agreement will ensure the widest possible dissemination of information. An e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a 'Journal Publishing Agreement' form or a link to the online version of this agreement.
Subscribers may reproduce tables of contents or prepare lists of articles including abstracts for internal circulation within their institutions. Permission of the Publisher is required for resale or distribution outside the institution and for all other derivative works, including compilations and translations (please consult http://www.elsevier.com/permissions). If excerpts from other copyrighted works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article. Elsevier has preprinted forms for use by authors in these cases: please consult http://www.elsevier.com/permissions.

Retained author rights

As an author you (or your employer or institution) retain certain rights; for details you are referred to: http://www.elsevier.com/authorsrights.

Role of the funding source

You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication. If the funding source(s) had no such involvement then this should be stated. Please see http://www.elsevier.com/funding.

Funding body agreements and policies

Elsevier has established agreements and developed policies to allow authors whose articles appear in journals published by Elsevier, to comply with potential manuscript archiving requirements as specified as conditions of their grant awards. To learn more about existing agreements and policies please visit http://www.elsevier.com/fundingbodies.

Language Services

Manuscripts should be written in English. Authors who are unsure of correct English usage should have their manuscript checked by someone proficient in the language. Manuscripts in which the English is difficult to understand may be returned to the author for revision before scientific review.
Authors who require information about language editing and copyediting services pre- and post-submission please visit http://www.elsevier.com/languagepolishing or our customer support site at http://epsupport.elsevier.com for more information. Please note Elsevier neither endorses nor takes responsibility for any products, goods or services offered by outside vendors through our services or in any advertising. For more information please refer to our Terms & Conditions: http://www.elsevier.com/termsandconditions.

Submission

Submission to this journal proceeds totally online and you will be guided stepwise through the creation and uploading of your files. The system automatically converts source files to a single PDF file of the article, which is used in the peer-review process. Please note that even though manuscript source files are converted to PDF files at submission for the review process, these source files are needed for further processing after acceptance. All correspondence, including notification of the Editor's decision and requests for revision, takes place by e-mail removing the need for a paper trail.

Please submit your article via http://ees.elsevier.com/fish/

Referees

Please submit, with the manuscript, the names and addresses of 4 potential referees.

Page Charges

Fisheries Research has no page charges

Preparation

Use of wordprocessing software

It is important that the file be saved in the native format of the wordprocessor used. The text should be in single-column format. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the wordprocessor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. Do not embed "graphically designed" equations or tables, but prepare these using the wordprocessor's facility. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier: http://www.elsevier.com/guidepublication). Do not import the figures into the text file but, instead, indicate their approximate locations directly in the electronic text and on the manuscript. See also the section on Electronic illustrations.
To avoid unnecessary errors you are strongly advised to use the "spell-check" and "grammar-check" functions of your wordprocessor.

Article structure

Subdivision - numbered sections

Divide your article into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2, ...), 1.2, etc. (the abstract is not included in section numbering). Use this numbering also for internal cross-referencing: do not just refer to "the text". Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

Material and methods

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

Theory/calculation

A Theory section should extend, not repeat, the background to the article already dealt with in the Introduction and lay the foundation for further work. In contrast, a Calculation section

represents a practical development from a theoretical basis.

Results
Results should be clear and concise.

Discussion
This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Conclusions
The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

Appendices
If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on.

Essential title page information

• ***Title.*** Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.
• ***Author names and affiliations.*** Where the family name may be ambiguous (e.g., a double name), please indicate this clearly. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name, and, if available, the e-mail address of each author.
• ***Corresponding author.*** Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. **Ensure that telephone and fax numbers (with country and area code) are provided in addition to the e-mail address and the complete postal address.**
• ***Present/permanent address.*** If an author has moved since the work described in the article was done, or was visiting at the time, a "Present address" (or "Permanent address") may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract

A concise and factual abstract is required. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be

avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Keywords

Immediately after the abstract, provide a maximum of 5 keywords, using American spelling and avoiding general and plural terms and multiple concepts (avoid, for example, "and", "of"). Be sparing with abbreviations: only abbreviations firmly established in the field may be eligible. These keywords are important because they will be used for indexing purposes.

Abbreviations

Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

Nomenclature and units

Follow internationally accepted rules and conventions: use the international system of units (SI). If other quantities are mentioned, give their equivalent in SI. You are urged to consult IUPAC: Nomenclature of Organic Chemistry: http://www.iupac.org/ for further information.

Authors and Editors are also, by general agreement, obliged to accept the rules governing biological nomenclature, as laid down in the *International Code of Botanical Nomenclature*, the *International Code of Nomenclature of Bacteria*, and the *International Code of Zoological Nomenclature*. All biota (crops, plants, insects, birds, mammals, etc.) should be identified by their scientific names when the English term is first used, with the exception of common domestic animals.
All biocides and other organic compounds must be identified by their Geneva names when first used in the text. Active ingredients of all formulations should be likewise identified.

Accession numbers

Accession numbers are unique identifiers in bioinformatics allocated to nucleotide and protein

sequences to allow tracking of different versions of that sequence record and the associated sequence in a data repository [e.g., databases at the National Center for Biotechnical Information (NCBI) at the National Library of Medicine ('GenBank') and the Worldwide Protein Data Bank]. There are different types of accession numbers in use based on the type of sequence cited, each of which uses a different coding. Authors should explicitly mention the *type of accession number together with the actual number*, bearing in mind that an error in a letter or number can result in a dead link in the online version of the article. Please use the following format: accession number type ID: xxxx (e.g., MMDB ID: 12345; PDB ID: 1TUP). Note that in the final version of the *electronic copy*, accession numbers will be linked to the appropriate database, enabling readers to go directly to that source from the article.

Math formulae

Present simple formulae in the line of normal text where possible and use the solidus (/) instead of a horizontal line for small fractional terms, e.g., X/Y. In principle, variables are to be presented in italics. Powers of e are often more conveniently denoted by exp. Number consecutively any equations that have to be displayed separately from the text (if referred to explicitly in the text).

Footnotes

Footnotes should be used sparingly. Number them consecutively throughout the article, using superscript Arabic numbers. Many wordprocessors build footnotes into the text, and this feature may be used. Should this not be the case, indicate the position of footnotes in the text and present the footnotes themselves separately at the end of the article. Do not include footnotes in the Reference list.
Table footnotes
Indicate each footnote in a table with a superscript lowercase letter.

Artwork

Electronic artwork
General points
• Make sure you use uniform lettering and sizing of your original artwork.
• Save text in illustrations as "graphics" or enclose the font.
• Only use the following fonts in your illustrations: Arial, Courier, Times, Symbol.
• Number the illustrations according to their sequence in the text.
• Use a logical naming convention for your artwork files.
• Provide captions to illustrations separately.
• Produce images near to the desired size of the printed version.
• Submit each figure as a separate file.

A detailed guide on electronic artwork is available on our website:
http://www.elsevier.com/artworkinstructions

You are urged to visit this site; some excerpts from the detailed information are given here.

Formats

Regardless of the application used, when your electronic artwork is finalised, please "save as" or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):

EPS: Vector drawings. Embed the font or save the text as "graphics".

TIFF: color or grayscale photographs (halftones): always use a minimum of 300 dpi.

TIFF: Bitmapped line drawings: use a minimum of 1000 dpi.

TIFF: Combinations bitmapped line/half-tone (color or grayscale): a minimum of 500 dpi is required.

DOC, XLS or PPT: If your electronic artwork is created in any of these Microsoft Office applications please supply "as is".

Please do not:

• Supply embedded graphics in your wordprocessor (spreadsheet, presentation) document;

• Supply files that are optimised for screen use (like GIF, BMP, PICT, WPG); the resolution is too low;

• Supply files that are too low in resolution;

• Submit graphics that are disproportionately large for the content.

Color artwork

Please make sure that artwork files are in an acceptable format (TIFF, EPS or MS Office files) and with the correct resolution. If, together with your accepted article, you submit usable color figures then Elsevier will ensure, at no additional charge, that these figures will appear in color on the Web (e.g., ScienceDirect and other sites) regardless of whether or not these illustrations are reproduced in color in the printed version. **For color reproduction in print, you will receive information regarding the costs from Elsevier after receipt of your accepted article.** Please indicate your preference for color in print or on the Web only. For further information on the preparation of electronic artwork, please see http://www.elsevier.com/artworkinstructions.

Please note: Because of technical complications which can arise by converting color figures to "gray scale" (for the printed version should you not opt for color in print) please submit in addition usable black and white versions of all the color illustrations.

Figure captions

Ensure that each illustration has a caption. Supply captions separately, not attached to the figure. A caption should comprise a brief title (**not** on the figure itself) and a description of the illustration. Keep text in the illustrations themselves to a minimum but explain all symbols and abbreviations used.

Text graphics

Present incidental graphics not suitable for mention as figures, plates or schemes at the end of the article and number them "Graphic 1", etc. Their precise position in the text can then be indicated. See further under Electronic artwork. If you are working with LaTeX and have

such features embedded in the text, these can be left, but such embedding should not be done specifically for publishing purposes. Further, high-resolution graphics files must be provided separately.

Tables

Number tables consecutively in accordance with their appearance in the text. Place footnotes to tables below the table body and indicate them with superscript lowercase letters. Avoid vertical rules. Be sparing in the use of tables and ensure that the data presented in tables do not duplicate results described elsewhere in the article.

References

In the case of publications in any language other than English, the original title is to be retained. However, the titles of publications in non-Latin alphabets should be transliterated, and a notation such as "(in Russian)" or "(in Greek, with English abstract)" should be added.

Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. References concerning unpublished data and "personal communications" should not be cited in the reference list but may be mentioned in the text. MSc or BSc dissertations are not allowed as bibliographic references, however, theses from higher degrees (e.g. PhD) are allowed. Citation of a reference as "in press" implies that the item has been accepted for publication.

Web references
As a minimum, the full URL should be given and the date when the reference was last accessed. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

References in a special issue
Please ensure that the words 'this issue' are added to any references in the list (and any citations in the text) to other articles in the same Special Issue.

Reference management software
This journal has standard templates available in key reference management packages EndNote (http://www.endnote.com) and Reference Manager (http://www.refman.com). Using plug-ins to wordprocessing packages, authors only need to select the appropriate journal template when preparing their article and the list of references and citations to these will be formatted according to the journal style which is described below.

Reference style
Text: All citations in the text should refer to:
1. *Single author:* the author's name (without initials, unless there is ambiguity) and the year of

publication;
2. *Two authors:* both authors' names and the year of publication;
3. *Three or more authors:* first author's name followed by "et al." and the year of publication.
Citations may be made directly (or parenthetically). Groups of references should be listed first alphabetically, then chronologically.
Examples: "as demonstrated (Allan, 1996a, 1996b, 1999; Allan and Jones, 1995). Kramer et al. (2000) have recently shown ...."
List: References should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters "a", "b", "c", etc., placed after the year of publication.
Examples:
Reference to a journal publication:
Van der Geer, J., Hanraads, J.A.J., Lupton, R.A., 2000. The art of writing a scientific article. J. Sci. Commun. 163, 51–59.
Reference to a book:
Strunk Jr., W., White, E.B., 1979. The Elements of Style, third ed. Macmillan, New York.
Reference to a chapter in an edited book:
Mettam, G.R., Adams, L.B., 1999. How to prepare an electronic version of your article, in: Jones, B.S., Smith , R.Z. (Eds.), Introduction to the Electronic Age. E-Publishing Inc., New York, pp. 281–304.

Journal abbreviations source
Journal names should be abbreviated according to
Index Medicus journal abbreviations: http://www.nlm.nih.gov/tsd/serials/lji.html;
List of serial title word abbreviations: http://www.issn.org/2-22661-LTWA-online.php;
CAS (Chemical Abstracts Service): http://www.cas.org/sent.html.

Video data

Elsevier accepts video material and animation sequences to support and enhance your scientific research. Authors who have video or animation files that they wish to submit with their article are strongly encouraged to include these within the body of the article. This can be done in the same way as a figure or table by referring to the video or animation content and noting in the body text where it should be placed. All submitted files should be properly labeled so that they directly relate to the video file's content. In order to ensure that your video or animation material is directly usable, please provide the files in one of our recommended file formats with a maximum size of 30 MB and running time of 5 minutes. Video and animation files supplied will be published online in the electronic version of your article in Elsevier Web products, including ScienceDirect: http://www.sciencedirect.com. Please supply 'stills' with your files: you can choose any frame from the video or animation or make a separate image. These will be used instead of standard icons and will personalize the link to your video data. For more detailed instructions please visit our video instruction pages at http://www.elsevier.com/artworkinstructions. Note: since video and animation cannot be embedded in the print version of the journal, please provide text for both the electronic and

the print version for the portions of the article that refer to this content.

Supplementary data

Elsevier accepts electronic supplementary material to support and enhance your scientific research. Supplementary files offer the author additional possibilities to publish supporting applications, high-resolution images, background datasets, sound clips and more. Supplementary files supplied will be published online alongside the electronic version of your article in Elsevier Web products, including ScienceDirect: http://www.sciencedirect.com. In order to ensure that your submitted material is directly usable, please provide the data in one of our recommended file formats. Authors should submit the material in electronic format together with the article and supply a concise and descriptive caption for each file. For more detailed instructions please visit our artwork instruction pages at http://www.elsevier.com/artworkinstructions.

Submission checklist

It is hoped that this list will be useful during the final checking of an article prior to sending it to the journal's Editor for review. Please consult this Guide for Authors for further details of any item.

Ensure that the following items are present:

One Author designated as corresponding Author:

• E-mail address
• Full postal address
• Telephone and fax numbers

All necessary files have been uploaded

• Keywords
• All figure captions
• All tables (including title, description, footnotes)

Further considerations

• Manuscript has been "spellchecked" and "grammar-checked"
• References are in the correct format for this journal
• All references mentioned in the Reference list are cited in the text, and vice versa
• Permission has been obtained for use of copyrighted material from other sources (including the Web)
• Color figures are clearly marked as being intended for color reproduction on the Web (free of charge) and in print or to be reproduced in color on the Web (free of charge) and in black-and-white in print
• If only color on the Web is required, black and white versions of the figures are also supplied for printing purposes

For any further information please visit our customer support site at http://epsupport.elsevier.com.

After Acceptance

Use of the Digital Object Identifier

The Digital Object Identifier (DOI) may be used to cite and link to electronic documents. The DOI consists of a unique alpha-numeric character string which is assigned to a document by the publisher upon the initial electronic publication. The assigned DOI never changes. Therefore, it is an ideal medium for citing a document, particularly 'Articles in press' because they have not yet received their full bibliographic information. The correct format for citing a DOI is shown as follows (example taken from a document in the journal *Physics Letters B*):
doi:10.1016/j.physletb.2003.10.071
When you use the DOI to create URL hyperlinks to documents on the web, they are guaranteed never to change.

Proofs

One set of page proofs in PDF format will be sent by e-mail to the corresponding author. Elsevier now sends PDF proofs which can be annotated; for this you will need to download Adobe Reader version 7 (or higher) available free from http://www.adobe.com/products/acrobat/readstep2.html. Instructions on how to annotate PDF files will accompany the proofs. The exact system requirements are given at the Adobe site: http://www.adobe.com/products/acrobat/acrrsystemreqs.html#70win.
If you do not wish to use the PDF annotations function, you may list the corrections (including replies to the Query Form) and return to Elsevier in an e-mail. Please list your corrections quoting line number. If, for any reason, this is not possible, then mark the corrections and any other comments (including replies to the Query Form) on a printout of your proof and return by fax, or scan the pages and e-mail, or by post. Please use this proof only for checking the typesetting, editing, completeness and correctness of the text, tables and figures. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor. We will do everything possible to get your article published quickly and accurately. Therefore, it is important to ensure that all of your corrections are sent back to us in one communication: please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed. Proofreading is solely your responsibility. Note that Elsevier may proceed with the publication of your article if no response is received.

Offprints

The corresponding author, at no cost, will be provided with a PDF file of the article via e-mail. For an extra charge, paper offprints can be ordered via the offprint order form which is sent once the article is accepted for publication. The PDF file is a watermarked version of the published article and includes a cover sheet with the journal cover image and a disclaimer outlining the terms and conditions of use.

Author's Discount

Contributors to Elsevier journals are entitled to a 30% discount on most Elsevier books, if ordered directly from Elsevier.

Author Inquiries

For inquiries relating to the submission of articles (including electronic submission where available) please visit this journal's homepage. You can track accepted articles at http://www.elsevier.com/trackarticle and set up e-mail alerts to inform you of when an article's status has changed. Also accessible from here is information on copyright, frequently asked questions and more. Contact details for questions arising after acceptance of an article, especially those relating to proofs, will be provided by the publisher.

Revista Scientia Marina

O artigo científico 2 "An evaluation of the replenishment of shellfish stocks *Anomalocardia brasiliana* in fishing area in Mangue Seco beach, north coast of Pernambuco, Brazil" foi submetido a revista Scientia Marina.

NORMAS

SCIENTIA MARINA

scimar@icm.csic.es
http://www.icm.csic.es
ICM - Passeig Marítim de la Barceloneta, 37-49. E-08003 Barcelona (Spain)

INSTRUCTIONS TO AUTHORS

Scope

Scientia Marina welcomes original manuscripts on marine research in the following fields: Marine Biology and Ecology, Fisheries and Fisheries Ecology, Systematics, Faunistics and Marine Biogeography, and Physical Oceanography, Chemical Oceanography, and Marine Geology. Preference will be given to manuscripts of a multi-disciplinary nature and to those of general interest to marine scientists throughout the world. Studies of local interest and/or of descriptive nature may also be acceptable if significant general implications are included. The preferential geographic study areas are the Mediterranean Sea and adjacent Atlantic Ocean. The following types of contribution can be published in *Scientia Marina*: Articles, Reviews, News and Comments and Book Reviews.

Editorial Policy

Manuscripts that do not fall within the scope of *Scientia Marina* and those which do not follow the Instructions to Authors will be returned to the authors. Manuscripts will be assigned to one of the Scientific Editors, who will critically evaluate their scientific merits, choose at least two appropriate referees and evaluate the reviewer's comments. The Editor-in-Chief decides to accept or reject them based on the reports and recommendations of the Scientific Editor.

Online publication

Accepted articles appear online as "Forthcoming articles" as soon as the galley proofs have been approved by the authors and the Editor-in-Chief. No changes can be made after online publication. The dates of submission, acceptance and online publication will appear at the end of each article. The corresponding author will receive galley proofs and will be responsible for the final version of the published articles. Twenty-five reprints will be sent to the corresponding author free of charge.

Submission of Manuscripts

- Submission of a manuscript implies that all authors have approved and agree on the contents of the submitted text. It is the responsibility of the corresponding author that all co-authors have the correct information on the submitted manuscript. Manuscripts must not be submitted simultaneously to any other journal.
- A single file in pdf format (including text, tables and figures) must be sent electronically to scimar@icm.csic.es.
- Language: Contributions must be in English. Submitted manuscripts will first be checked for language. Scientists who use English as a foreign language are strongly recommended to have their manuscript read by a native English-speaking colleague. Manuscripts which are substandard in this respect will be returned without review.

First page

- Please include the title, the complete name (first name and family name) and postal address of the author(s), and the fax number and e-mail address of the corresponding author
- Title: Titles which include species names must also specify the necessary taxa and subtaxa, so that readers not acquainted with the species may at least know the zoological/botanical group the species belongs to.
- Summary: No longer than 200 words, in a single paragraph.
- Resumen: A Spanish translation of the title, summary, and keywords must be provided.
- Running title: A short title not exceeding 50 characters must be included.
- Keywords: Please provide 6 to 8 keywords. In agreement with the recommendations of the IOC-UNESCO, we recommend that the authors use the ASFA Thesaurus to identify the right keywords for their articles.

Text of the article

- Length: The total number of typed pages should not exceed 30 and will usually be lower (fewer than 7000 words, including references and figure legends). Font size 12 is recommended. Leave 25 mm margins on all sides. Manuscripts must be printed double-spaced throughout. Pages and lines must be numbered.
- Sections: Follow the usual sections (INTRODUCTION, MATERIALS AND METHODS, RESULTS, DISCUSSION). Avoid a single section on Results and Discussion. Avoid numbering sections. Main headings should be in capital letters,

subheadings in bold type sentence case.

- Do not use ampersands (&); instead use the word "and"
- Some Latin abbreviations are set in roman type because they have been thoroughly incorporated into English (note that no comma follows the abbreviations). These include: e.g./ i.e./ ca./ in situ/ vs/ per se/.
- Figures and tables should be numbered sequentially in the order that they appear in the text. Do not place figures or tables in the main body of the text, but at the end of the manuscript. Place every table and every figure in separate pages. References to figures in the main body of the text: (Fig. 1), (Fig. 1a, b) or (Figs. 1 and 2) or full Figure 9.
- Note the style of citing figures in the following examples: "The Balearic Islands (Fig. 1) are separated from the Iberian Peninsula by…"; "The bathymetric distribution of the species is shown in Figure 3."

Units and numeric values

- Use International System units (km, m, kg, g, etc.).
- Use the symbol "t" for metric tons.
- The symbols h, min and s must be used for hours, minutes and seconds.
- Use spaces between the quantity and the units (e.g. 2 m, 3 kg, 7 g). Exceptions: degree Celsius °C, latitude or longitude units and % (e.g. 37°C; 41°N, 1°17'E and 10%).
- Do not include spaces between the following symbols and numeric values: >, < (e.g. >7, <7).
- Use a dot "." as a decimal marker: Do not use any symbol to separate thousands (e.g. 5200 or 10300).
- Salinity is a dimensionless unit, and should not have units such as ‰. It is valid to state once in the paper that salinity was measured in practical salinity units (psu), but thereafter no units should be used. This applies to both text and figure legends and axes.

References in the text

- When several references are cited between brackets they must follow a chronological order. Note the style of punctuation in the following examples:

  ... poses systematic problems (Hulley, 1981; Smith and Millar, 1995; Carter *et al.*, 2001).
  ... in coastal upwelled waters (Olivieri, 1983a,b; Salat, 2000, 2002; Horstman, SFRI unpublished data).
  ... following the opinions expressed by Margalef (1978).
  Roel *et al.* (1985) reported that...

- The expression *et al.* should always be in italics.
- Ensure that there is a perfect match between references in the text and in the reference list. All references cited in the text, both published and in press (including tables and figures), must be included in the reference list. It is not necessary to include the reference when the scientific name of a species is cited in full (e.g. *Liocarcinus depurator* (Linnaeus, 1758)).

Reference List

- We recommend a maximum rate of 1 page of citations for every 4 pages of text in the manuscript (from Introduction to Discussion).
- References must be ordered alphabetically.
- Journal names must always be abbreviated.
- Papers "in preparation" or "submitted" are not acceptable as references. Once accepted, they may be quoted as "in press", but not before.
- The format of the references must be strictly followed.
- The list of references should include the complete list of authors, year of publication, title (in the original language), journal, volume and page numbers. Journal abbreviations should be in accordance with the WORLD LIST OF SCIENTIFIC PERIODICALS.
- Follow the punctuation and style shown in the examples below:

Gili, J.M., J. Murillo and J.D. Ros. – 1989. The distribution pattern of benthic Cnidarians in the western Mediterranean. *Sci. Mar.*, 53(1): 19-35.
Delgado, M. and J.M. Fortuño. – 1991. Atlas de Fitoplancton del Mar Mediterráneo. *Sci. Mar.*, 55(Suppl. 1): 1-133.
Pomeroy, L.R. – 2004. Building bridges across subdisciplines in marine ecology. *Sci. Mar.*, 68(Suppl. 1): 5-12.
Margalef, R. – 1986. *Ecología*. Ediciones Omega, Barcelona.
Saiz, E. – 1991. *Importància de l'energia auxiliar en la dinàmica dels sistemes pelàgics: turbulència i zooplàncton*. Ph.D. thesis, Univ. Barcelona.

- Please pay especial attention to the citation of articles within books according to the following examples. Do not forget to give the publisher and place of publication and to check the punctuation:

Margalef, R. – 1975. Diversity, stability and maturity in natural ecosystems. In: W.H. van Dobben and R.H. Lowe-McConnell (eds.), *Unifying concepts in ecology*, pp. 139-150. Junk, The Hague.
Boyd, A.J, J. Salat and M. Masó. – 1987. The seasonal intrusion of relative saline water on the shelf off northern and central Namibia. In: A.I.L. Payne, J.A. Gulland and K.H. Brink (eds.), *The Benguela and Comparable Ecosystems. S. Afr. J. mar. Sci.*, 5: 107-120.

- ENDNOTE users would like to make use of this style: scimar.ens.

Tables

- Tables should be consecutively numbered with Arabic numerals and typed on separate pages.
- Table headings should be given above each table.
- Tables should be designed to fit in the format of the printed page.
- Vertical lines should not be used.

Figures

- When submiting a manuscript, figures must be placed at the end of the

manuscript and each figure must include its legend in the lower part. Once the manuscript has been accepted for publication, figures and their legends must be placed separately.

- Figures presenting the study area should include a small general map showing a larger geographical region. Maps must show the locations cited in the text, the names of seas or oceans and the main isobaths. Please, avoid political maps.
- Drawings, graphs and photographs should be carefully presented on separate sheets. Figures must be prepared so that, after reduction to fit the size of the journal page (print area is 16.9 cm or 8.1 cm width), characters and symbols will still be readable.
- All figures included in a manuscript should use the same font type.
- Avoid very thin or very thick lines.
- Do not use colour if an illustration is to be reproduced in black and white.
- Please do not draw with hairlines. The minimum line width is 0.2 mm (0.5 pt) measured at the final scale.
- Map figures must indicate ºN, ºS, ºE or ºW.
- Colour photographs can be published at moderate fees.
- Colour illustrations are welcome, but have a cost of 240 € per page.

Electronic Submission

Once the manuscript has been accepted for publication, authors will be asked to send the final version. It may be sent by e-mail, or on CD-ROM or DVD.

Text must be sent in "Word" format. Please save any .docx file as .doc. The illustrations must be sent separately from the text. Image files should not be embedded in a word-processor file.

Vector graphics exported from a drawing program should be stored in EPS (Encapsulated PostScript) format. Fonts used in the graphics (use preferably Times) must be included. Suitable programs include Freehand, Illustrator and Corel Draw.

Most presentation programs, such as Excel and Power Point, produce data that cannot be processed since they do not support the export of EPS data.

Halftone images Store colour illustrations as CMYK and monotone as greyscale in TIFF or JPEG format. Whenever you use JPEG format, choose maximum quality instead of high compression in the options window. Suitable programs include Photoshop, Picture Publisher and Photo Paint.

Table of resolutions for images and scans

Original	Mode	Final resolution	Format
Colour	CMYK	300 dpi	TIFF or JPEG
Monotone	Greyscale	300 dpi	TIFF or JPEG
B/W line drawing	Line	900-1200 dpi	TIFF or EPS

Please, send comments to scimar@icm.csic.es
ICM (CSIC) - Passeig Marítim de la Barceloneta, 37-49. E-08003 Barcelona (Spain)