UNIVERSIDADE FEDERAL DO RIO GRANDE DO NORTE
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PROGRAMA DE PÓS-GRADUAÇÃO EM PSICOBIOLOGIA
DOUTORADO EM PSICOBIOLOGIA

JOSÉ TICIANO ARRUDA XIMENES DE LIMA

DINÂMICA REPRODUTIVA E PARASITÁRIA DE QUATRO ESPÉCIES DE PEIXES DAS ÁGUAS COSTEIRAS DO SUDOESTE DO OCEANO ATLÂNTICO, BRASIL

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico

NATAL/RN

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UFRN

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Tese apresentada à Universidade Federal do Rio Grande do Norte como requisito para obtenção do Titulo de Doutor em Psicobiologia

NATAL/RN

Julho, 2008

FICHA CATALOGRÁFICA

Catalogação da publicação na fonte. UFRN / Biblioteca Central Zila Mamede.
Divisão de Serviços Técnicos.

Lima, José Ticiano Arruda Ximenes de

Dinâmica reprodutiva e parasitária de quatro espécies de peixes das águas costeiras do Sudoeste do Oceano Atlântico, Brasil. / José Ticiano Arruda Ximenes de Lima, Natal: o Autor, 2008.

p. IX, 149, il. 34.

Orientadora: Profa. Dra. Sathyabama Chellappa (UFRN) e Co-orientador Prof. Dr. Arrilton Araújo (UFRN) – Tese (Doutorado) – Universidade Federal do Rio Grande do Norte. Centro de Biociências. Departamento de Fisiologia. Programa de Pós-Graduação em Psicobiologia.

1. Reprodução dos peixes – Tese. 2. Ictioparasitismo - Tese. 3. Palombeta, *Choloroscombrus chrysurus* - Tese. 4. Serra, *Scomberomorus brasiliensis* - Tese. 5. Tibiro, *Oligoplites* spp.

RN/UF/BCZM CDU

DEFESA DE DOUTORADO

Título: **"Dinâmica reprodutiva e parasitária de quatro espécies de peixes das águas costeiras do Sudoeste do Oceano Atlântico, Brasil."**

Autor: **José Ticiano Arruda Ximenes de Lima**

Data da defesa: **04 de julho de 2008.**

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Natal, RN
2008

AGRADECIMENTOS

A Deus, pela oportunidade da vida, que nos permite aprender e sempre progredir.

À minha esposa Keliane, a meus pais Ximenes e Miax, a Marlene, e a meus familiares pelo apoio e incentivo, que muito me fortaleceu nos momentos cruciais dessa pesquisa.

À Universidade Federal do Rio Grande do Norte e a Coordenação do Programa de Pós-Graduação em Psicobiologia pela oportunidade da realização do Doutorado.

Ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) pela bolsa e apoio financeiro concedido durante o curso, que facilitou a efetivação da pesquisa e da participação em congressos no Brasil.

A Profa. Sathyabama Chellappa, pela orientação, dedicação, estímulo e acima de tudo pela amizade.

Ao Prof. Arrilton Araújo, pela co-orientação, amizade, por toda a disposição e incentivos durante a pesquisa.

Ao Prof. Naithirithi Chellappa pelo apoio e pela disponibilização de recursos que deram suporte nesta pesquisa.

Aos amigos: Márcia, Emíli, Elizete, Dayse, Gustavo, Paula, Liliane, Sabrina, Nirley, Fabiana, Karen, Patrícia, Socorro, Renato, que acompanharam de perto o desenvolvimento da pesquisa no laboratório de ictiologia.

Aos amigos e demais companheiros do Curso de Pós-graduação em Psicobiologia.

A todos os professores e funcionários do Departamento de Fisiologia e do Departamento de Oceanografia e Limnologia, CB/UFRN.

Aos funcionários do DOL que contribuíram direta ou indiretamente com a realização deste trabalho, colaborando com a limpeza do laboratório, segurança e a pesquisa bibliográfica.

Ao Departamento de Metereologia e Recursos Hídricos da UFRN e aos técnicos da Empresa de Pesquisa Agropecuária do Rio Grande do Norte (EMPARN) por contribuírem com a obtenção dos dados pluviométricos referentes à área de estudo.

SUMÁRIO

RESUMO

O presente trabalho investigou a dinâmica reprodutiva e parasitária de quatro espécies de peixes marinhos: serra, *Scomberomorus brasiliensis*, tibiros, *Oligoplites saurus* e *O. palometa* e palombeta, *Chloroscombrus chrysurus,* durante os messes de agosto de 2005 a julho de 2007, nas águas costeiras do Sudoeste do Oceano Atlântico, Brasil. Os peixes foram medidos, pesados, dissecados, as gônadas pesadas e examinadas para separação do sexo. Foram avaliados o índice gonadossomática (IGS), fecundidade, tipo e época de desova e a caracterização macro e microscópica do desenvolvimento das gônadas dos peixes. Os ectoparasitos da câmara branquial e cavidade bucal dos peixes foram coletados, medidos, pesados e identificados. A proporção sexual dos peixes estudados foram aproximadamente 1M:1F, enquanto ocorreu um predomínio de machos de *O. palometa* (3:2). Os peixes apresentaram IGS variando de acordo com seu ciclo reprodutivo e seu estádio de maturação gonadal. Os maiores valores de IGS e a época reprodutiva coincidiram com período das chuvas da região. As fêmeas apresentaram desova total e fecundidade com correlação positiva para o peso das gônadas e do corpo. Quatro estádios de desenvolvimento das gônadas foram identificados macroscopicamente: imaturo, em maturação, maduros e esgotados, e os estudos microscópicos mostraram o desenvolvimento ovocitário dentro de cada estádio. Três espécies de parasitos isopodos foram identificadas nas quatro espécies de peixes: *Livoneca redmmanni, Rocinela signata* e *Cimothoa spinipalpa.* As primeiras duas espécies ocorreram na cavidade branquial de *C. chrysurus* e *S. brasiliensis.* Parasitismo por isopodo *C.spinipalpa, (*uma espécie nova) foi registrado na cavidade bucal de *O. saurus* e *O. palometa*. O micro-hábitat preferido pelos parasitos isópodos foram à câmara branquial e a cavidade bucal do hospedeiro, áreas mais protegidas. Os isopodos parasitaram os peixes nos estádios imaturo, em maturação e maduros. A prevalência de infecção de isopodos nos hospedeiros variou de 16 a 21%, enqunato que em *O. palometa* foi de 60%. No período das chuvas foi registrada a maior ocorrência de parasitismo por isopodos, porem, o parasitismo não prejudicou o ciclo reprodutivo normal dos hospedeiros.

Palavras-chave: *S. brasiliensis*, *O. saurus*, *O. palometa, C. chrysurus,* reprodução, desenvolvimento das gônadas, parasitismo por isópodos, índices parasitários.

ABSTRACT

The present study investigated the reproductive dynamics and parasitism of four species of marine fishes: serra Spanish mackerel, *Scomberomorus brasiliensis*, Atlantic leatherjacks, *Oligoplites saurus* and *O. palometa,,* and Atlantic bumper, *C. chrysurus,* during the period of August, 2005 to July, 2007, in the coastal waters of Southwest Atlantic Ocean, Brazil. The collected fish samples were measured, weighed, dissected, the gonads were weighed and examined to separate the sex. The gonadosomatic index (GSI), fecundity, type of spawning, the breeding season, the macro and microscopic characterization of the gonads were determined. The ectoparasites from the branchial chambers and bucal cavity of the fish were collected, measured, weighed and identified. The sex ratio of the study fish species were approximately 1M:1F, however, there was a predominance of males of *O. palometa* (3M:2F). The GSI of fishes varied according to their reproductive cycle and the stage of gonadal maturation. The highest values of GSI and the spawning period coincided with the rainy period of the region. The females presented total spawning and the fecundity was positively correlated with the weight of the ovary and the body. Four stages of development of the gonads immature, maturing, mature and spent were identified macroscopically and histological analyses of ovaries revealed the different phases of oocyte development. Three species of isopod parasites were identified in the study fishes: *Livoneca redmmanni, Rocinela signata* and *Cimothoa spinipalpa.* The first two species occurred in the branchial cavities of *C. chrysurus* and *S. brasiliensis.* The isopod *C.spinipalpa* (a new species) was registered for the first time in the bucal cavity of *O. saurus* and *O. palometa*. The parasitic isopods preferred the branchial chambers and the bucal cavity of the host fishes as these were protected microhabitats. The isopods parasitized the immature, maturing and mature fishes. The prevalence of infection of isopods in the hosts varied from 16 to 21%, though in *O. palometa* it was 60%. In the rainy period the highest isopod parasitic occurrence was registered, however, this did not prejudice the normal reproductive cycle of the host fish.

Key Words: *S. brasiliensis*, *O. saurus*, *O. palometa, C. chrysurus,* reproduction, gonadal development, isopod parasites, parasitic indices.

RELAÇÃO DE FIGURAS

1. INTRODUÇÃO GERAL

O sucesso alcançado pelos peixes nos mais distintos ambientes é relacionado à dinâmica reprodutiva desenvolvida pelo grupo (Potts & Wootton, 1984; Vazzoler, 1996; Luksenburg & Pedersen, 2002). Os peixes tropicais apresentam uma distribuição uniforme de tamanhos durante as estações de estiagem e chuvosa, com um período de desova prolongado. A proporção entre machos e fêmeas e comprimento da primeira maturação sexual são importantes aspectos da dinâmica reprodutiva dos peixes. Os períodos e locais de desova variam de acordo com a distribuição da espécie e em função do compromisso entre dinâmica do processo reprodutivo e das exigências ambientais (Murua & Motos, 2006).

A reprodução dos peixes é influenciada por várias modificações do ambiente, tais como as variações na pluviosidade, na temperatura, no fotoperíodo, na disponibilidade de alimento e na qualidade da água que inibe ou estimula a reprodução (Araújo & Chellappa, 2002). Em condições desfavoráveis, várias etapas do ciclo reprodutivo podem ser bloqueadas, como gametogênese, maturação de ovócitos e espermatozóides, ovulação e desova (Billard *et al*., 1981). Assim, para a realização de estudos básicos e aplicados sobre a fisiologia reprodutiva dos peixes, é necessário o conhecimento preliminar de seu habitat natural, o qual está sujeito à ação de grande variação nos fatores ambientais, responsáveis pelo desencadeamento da reprodução da espécie.

A co-ocorrência de organismos de diferentes espécies pode ser considerada como relação de simbiose (beneficio um com o outro) num sentido amplo, no entanto, o parasitismo é o modo de vida que apenas o parasito recebe vantagens da relação com o hospedeiro e não deseja a morte de suas vítimas, assim contrastando com o predador. O nível de agressão patogênica do parasito não depende apenas dele, mas também do estado geral de saúde do hospedeiro (Margolis *et al*., 1982). O parasito se transforma

morfologicamente para possibilitar sua fixação nos micro-habitatos do hospedeiro (Machado *et al.*, 1996).

Os peixes se adaptam ao meio aquático devido à interação com os fatores bióticos e abióticos do ambiente, que podem influenciar nos processos de ajuste entre as espécies interdependentes, como ocorre na relação ecológica do parasito e hospedeiro. A interação entre os parasitos por um hospedeiro resulta numa competição e esta conduta de interação resulta num efeito negativo provocado pelo parasito para o hospedeiro (Prenter *et al*. 2004). O hospedeiro age como reservatório para o parasito, onde o parasito causa alto impacto no hospedeiro definitivo e baixo impacto para o hospedeiro intermediário (Hudson & Greenman, 1998; Morris *et al*. 2004).

Os parasitos são classificados como ectoparasitos e endoparasitos, onde os ectoparasitos ficam aderidos externamente no seu hospedeiro enquanto os endoparasitos vivem no interior do hospedeiro (Möller & Anders, 1986). Entre os peixes parasitados, a maioria possui uma pequena quantidade de parasitos, no entanto, existem casos em que pequenos grupos de hospedeiros possuírem uma alta carga parasitária (Zubem, 1997). Nos processos dependentes da densidade populacional dos parasitos há supressão da fecundidade ou sobrevivência do parasito, e alta densidade parasitária influencia na sobrevivência ou fecundidade do hospedeiro, fatos constatados na população da truta ártica *Salvelinus alpinus* (Linnaeus, 1758) (hospedeiro), onde pequenos grupos populacionais albergam uma alta densidade de parasitos cestódeos *Diphyllobothrium ditremum* (Creplin, 1825) (Dobson, 1985).

A distribuição da abundância de populações parasitárias ocorre pela aleatoriedade demográfica e ambiental. Esta aleatoriedade demográfica culmina com a probabilidade do parasito morrer ou com o determinado intervalo de tempo para uma nova infestação, e a aleatoriedade ambiental depende dos fatores ambientais que

determinam os processos de crescimento populacional do parasito. A distribuição dos parasitos no hospedeiro em determinado ponto do tempo será resultante da vida em equilíbrio com o hospedeiro, sobrevivendo a fatores que influenciam na dispersão dos parasitos, tais como: os micro-habitatos disponíveis no hospedeiro, a susceptibilidade do hospedeiro a infestação, reprodução direta do parasito dentro do hospedeiro, há habilidade dos hospedeiros em eliminar os parasitos através de uma resposta imunológica (Anderson & Gordon, 1982; Pacala & Dobson, 1988).

Os micros habitats no hospedeiro possuem diferentes suscetibilidades para o parasitismo. As respostas do hospedeiro são específicas para cada tipo de parasito resultando em vulnerabilidades específicas para o parasito (Bauer *et al*., 2000). O hospedeiro possui micro habitats que são ricos para a alimentação do parasito e alguns micros habitats ofereçam poucos recursos. Quando não existe competição, o parasito que primeiro alcançar o território alimentar fica com o melhor lugar, que lhe proporcionará maior taxa de retomo. O micro habitat pode ser limitado pelo tamanho do espaço físico e/ou número de indivíduos que o ocupam, ou competem. É mais vantajoso parasitar sozinho um recurso pobre do que competir com mais indivíduos por um recurso rico (Krebs & Davies, 1996). A co-ocorrência dos parasitos existe quando duas ou mais espécies de parasitos convivem no mesmo hospedeiro, competindo de forma atenuada por recursos comuns. Normalmente o parasito com maior efeito inibidor eliminará o outro do espaço, ou o próprio ambiente se encarregará de privilegiar a espécie mais competitiva, através da ação climática das chuvas, ou outros fatores tais como: salinidade das águas superficiais, a temperatura, velocidade dos ventos, fases da lua, marés, pH, oxigênio dissolvido e a saturação do oxigênio (Odum, 2001).

A invasão parasitária em um hospedeiro é um fenômeno global que pode ocorrer tanto no ambiente aquático (marinho ou dulcícula) como no terrestre (Kolar & Lodge,

2001; Jenkins, 2003). O ambiente aquático apresenta características tais como, alta capacidade para solubilização de compostos orgânicos e inorgânicos, gradientes verticais e horizontes da luz, temperatura, nutrientes e gases, com alta densidade e viscosidade da água. Esse ambiente facilita a dispersão, reprodução e complementação do ciclo de vida dos organismos parasitos. Dentre os vertebrados aquáticos, os peixes apresentam os maiores índices de infecção causada por parasitos (Thatcher, 1981; Machado *et al*., 1996).

Os parasitos aquáticos estão distribuídos em sete grupos: protozoa 18%, monogênea 16%, digênea 18%, cestoda 10%, nematoda 7%, acanthocephala 4% e crustácea 27% (Eiras, 1994). Os parasitos dos peixes são classificados em protozoários e metazoários (Barros & Lira, 1998). Os metazoários estão distribuídos em platelmintos (trematódeos e os cestóideos), asquelmintos (helmintos acanthocephalos e os nematóides), anelídeos (hirudíneos-hematófago temporário) e artrópodes. Os artrópodes são redistribuídos em quatro grupos: pentastornídeos, crustáceos copépodos (ergasilídeos), braquiúros e isópodos (Pavanelli *et al*., 1999).

Os crustáceos isópodos (Ordem Isopoda) fazem parte do principal grupo de parasitos dos peixes (Eiras *et al*., 2000). Os isópodos medem entre 0,5 a 500,0 mm de comprimento e a análise filogenética dos fósseis deste grupo sugere que existam desde o período Carbonífero da era Paleozóica, com aproximadamente 300 milhões de anos (Brusca & Wilson, 1991). Na América do sul foram registradas cerca de 8 gêneros com 17 espécies de isópodos parasitos de peixes em ecossistemas marinhos e 10 gêneros com 25 espécies de isópodos parasitos de peixes dulcículas (Thatcher, 2002). Três espécies de parasitos isópodos novas nos ecossistemas marinhos foram descritas em Santa Catarina (Thatcher *et al*., 2003), Pernambuco (Thacther & Fonseca, 2005) e Rio Grande do Norte (Thatcher *et a*l., 2007).

Dentre os grupos de parasitos, poucos estudos se importam com a relação comportamental do parasito-hospedeiro e o conhecimento dos efeitos que os parasitos produzem no hospedeiro, ambos são fatores de grande importância, pois, são condutas preventivas e reparatórias para as questões ao combate das contaminações zoonóticas (Barros *et al*., 2002).

Os estudos relacionados com os parasitos do pescado ainda são escassos, principalmente em relação à ictiofauna marinha do nordeste brasileiro, podendo existir uma gama de gêneros ou espécies de parasitos a serem identificados e relatados para o âmbito científico. Aspectos parasitários dos peixes do Rio Grande do Norte foram abordados em alguns trabalhos publicados de Figueiredo *et al*., (2000) que registraram a ocorrência de altos índices parasitários do ectoparasito *Dolops carvalhoi* (Lemos de Castro, 1949) (Crustácea: Branchiura) no peixe tambaqui, *Colossoma macropomum* (Cuvier, 1818) cultivado no Rio Grande do Norte.

Cavalcanti *et al*., (2003) registraram a ocorrência de ectoparasitos isópodos (Cymothoidae) e copépodos nos peixes marinhos serra, *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin, 1978) e Palombeta, *Chloroscombrus chrysurus* (Linnaeus, 1766). Cavalcanti *et al*., (2004) registraram a ocorrência de ectoparasitos em peixes marinhos de valor comercial das águas costeiras do Rio Grande do Norte.Os peixes mais parasitados foram o coro, *Pomadasys corvinaeformis* (Steindachner, 1868) e a tainha, *Mugil curema* (Cuvier & Valenciennes, 1836), seguidos do palombeta, *C. chrysurus,* serra, *S. brasiliensis* e tibiro, *Oligoplites saurus* (Bloch & Schneider, 1801). Cavalcanti *et al*., (2006a) verificaram a presença de *Lernanthropus rathbuni* (Copepoda: Lernanthropidae) no coro, *Pomadasys corvinaeformis* (Osteichthyes, Haemulidae) em águas costeiras do Rio Grande do Norte. Cavalcanti *et al*., (2006b) identificaram no *M. curemas* quatro espécies de copépodos *(Ergasilus versicolor, E.*

lizae, Caligus bonito e Caligus sp.). Lima *et al*., (2006) e Araújo (2008) registram a ocorrência de mais de duas espécies de isópodos em diferentes micro-habitatos dos hospedeiros serra, palombeta e tibiro.

O registro da co-ocorrência de mais de duas espécies de parasitos no mesmo peixe marinho nas águas costeiras do Rio Grande do Norte (Cavalcanti *et al*., 2005) despertaram o interesse de investigar se o mesmo fato existe em outras espécies de peixes marinhos, o tipo de interação parasito-hospedeiro, competição entre parasitos no mesmo hospedeiro, influencia dos parasitos nos estádios de maturação gonadal dos hospedeiros e a influência dos fatores ambientais.

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2. OBJETIVOS

Objetivo geral

Esta pesquisa teve como objetivo investigar a dinâmica reprodutiva e parasitária de quatro espécies de peixes marinhos: serra, *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin, 1978) (Osteichthyes Scombridae); tibiros, *Oligoplites saurus* (Bloch & Schneider, 1801) e *O. palometa* (Cuvier, 1832) (Osteichthyes Carangidae); e palombeta, *Choloroscombrus chrysurus* (Linnaeus, 1766) (Osteichthyes Carangidae) das águas costeiras do Sudoeste do Oceano Atlântico, Natal, Rio Grande do Norte, Brasil.

Objetivos específicos

- Investigar a dinâmica reprodutiva do peixe serra, *S. brasiliensis* das águas costeiras do Rio Grande do Norte;

Artigo 1: Biologia reprodutiva da serra, *Scomberomorus brasiliensis* (Osteichthyes Scombridae), em águas costeiras do Rio Grande do Norte.

Autores: J. T. A. X. Lima., Fonteles Filho, A. A. & Chellappa, S.

Arquivos de Ciências do Mar, 40 (1): 24 – 30, 2007.

Artigo 2: Capítulo do Livro: Reproductive biology of *Scomberomorus brasiliensis* (Perciformes: Scombridae).

Autores: S. Chellappa., Lima, J. T. A. X., Araújo, A. & N. T. Chellappa.

Nome do livro: **Advances in Fish and Wildlife Ecology and Biology** Vol. 5, 2008. (Ed. B. L. Kaul), Daya Publishing House, Delhi, India.

Artigo 3: Ovarian development and spawning of the Serra Spanish mackeral in the Southwest Atlantic coastal waters.

J. T. A. X. Lima., A. Araújo., N. T. Chellappa & S. Chellappa.

Em preparação para a Revista **Fisheries Research**.

- Verificar o parasitismo no peixe marinho serra, *S. brasiliensis* e palombeta, *C. chrysurus*;

Artigo 4: *Livoneca redmanni* Leach (Isopoda, Cymothoidae) e *Rocinela signata* Schioedte & Meinert (Isopoda, Aegidae), ectoparasitos de *Scomberomorus brasiliensis* Collette, Russo & Zavala-Camin (Osteichthyes, Scombridae) no Rio Grande do Norte, Brasil.

Autores: J. T. A. X. Lima., S. Chellappa & V. E. Thatcher.

Revista Brasileira de Zoologia. 22 (4): 1104 – 1108, 2005.

Artigo 5: Tendências evolutivas do parasito isópodo *Livoneca redmanni* Leach (Isopoda, Cymothoidae) em dois hospedeiros peixes marinhos.

Em preparação para a Revista **Austral Ecology.**

- Verificar o parasitismo no peixe marinho tibiro, *O. saurus*;

Artigo 6: *Cymothoa spinipalpa* sp. nov. (Isopoda, Cymothoidae) a buccal cavity parasite of the marine fish, *Oligoplites saurus* (Bloch & Schneider) (Osteichthyes: Carangidae) *o*f Rio Grande do Norte State, Brazil. Autores: Vernon E. Thatcher., Gustavo Soares de Araújo., J. T. A. X. Lima & S. Chellappa.

Revista Brasileira de Zoologia. 24 (1): 238 - 245, 2007.

- Investigar a dinâmica reprodutiva e parasitismo no peixe marinho tibiro, *O. palometa.;*

Artigo 7: Occurrence of *Cymothoa spinipalpa* (Isopoda, Cymothoidae) and reproductive aspects of the marine fish *Oligoplites palometa* (Cuvier).

Araújo, G.S., Lima, J.T.A.X., Cavalcanti, E.T.S., Damasceno, D. N.F., Araújo, A. & Chellappa, S.

Em preparação para a Revista **Journal Fish Biology.**

3. MATERIAL E MÉTODOS GERAIS

3.1 Área de estudo

Durante o período de agosto de 2005 a julho de 2007, exemplares de peixes marinhos foram mensalmente capturados nas águas costeiras entre latitudes 0º00' e 10º00'S, longitudes 32º00' e 40º00'W no Oceano Atlântico Sudoeste, subdivisão Natal Nordeste do Brasil (1.2) (Fig. 1).

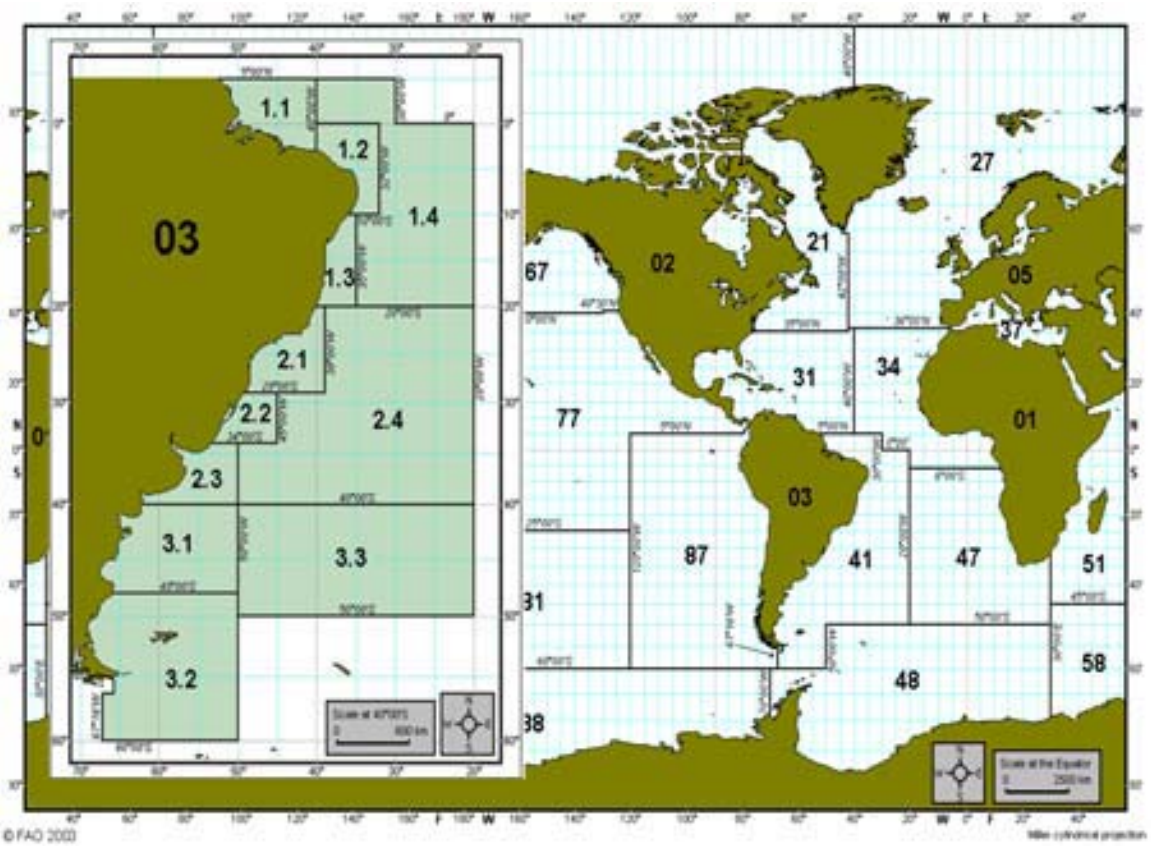


Figura 1. Distribuição das áreas segundo FAO (2003): Região 03, América do Sul; áreas de captura dos peixes marinhos na subdivisão Natal (1.2) nas águas costeiras do Nordeste do Brasil, Oceano Atlântico Sudoeste.

3.2 Coleta de dados pluviométricos

Para a caracterização do regime pluviométrico e separação dos períodos de estiagem e chuvoso, foram obtidos os dados de precipitação pluviométrica da área de estudo, através do Departamento de Metereologia e Recursos Hídricos da Universidade Federal do Rio Grande do Norte (UFRN) e da Empresa de Pesquisa Agropecuária do Rio Grande do Norte S/A (EMPARN).

3.3 Hospedeiros e parasitos em estudo

As espécies de hospedeiros em estudo são os peixes: serra, *Scomberomorus brasiliensis;* tibiro, *Oligoplites palometa* e *O. saurus*; e palombeta, *Choloroscombrus chrysurus*. Todos os quatro peixes estudados são espécies marinhas das águas costeiras capturadas através de arrastões-de-praia.

A serra, *S. brasiliensis* (Collette, Russo & Zavala-Camin, 1978) (Fig. 2) é uma espécie da família Scombridae, com valor comercial e de interesse para a prática esportiva. São encontrados na maior parte do litoral brasileiro distribuídos entre as Latitudes 20^{o} Norte a 35^{o} Sul, (Carpenter, 2002). *S. brasiliensis* possui escamas pequenos na região lateral constituindo uma tonalidade prateada e apresentam manchas escuras circulares da cor amarelo bronze, com a primeira nadadeira dorsal preta. As manchas formam uma linha dorso lateral de sentido crânio-caudal. Apresentam 17 a 19 espinhas dorsais, 15 a 19 raios moles da nadadeira dorsal e 16 a 20 raios moles da nadadeira anal. A bexiga natatória é ausente (Collette, Russo & Zavala-Camin, 1978; Lima, 2004).

Os tibiros, *O. saurus* (Fig. 3) são peixes costeiros que vivem nas águas rasas das praias arenosas, baías e áreas estuarinas. São encontrados em cardumes, dando saltos para fora da água. Apresentam coloração prateada com a região dorsal azulada e nadadeiras amarelas. O corpo é alongado, relativamente alto e comprimido lateralmente, com focinho estreito e pontiagudo. Os olhos são relativamente pequenos e o final da maxila superior esta prolongado até a margem posterior do olho. A maxila superior possui duas séries distintas de dentes.

100 mm

Posição taxonômica:
Superclasse: Pisces,
Classe: Actinopterygii,
Ordem: Percifomes,
Família: Scombridae,
Gênero: *Scomberomorus,*
Espécie: *Scomberomorus brasiliensis*

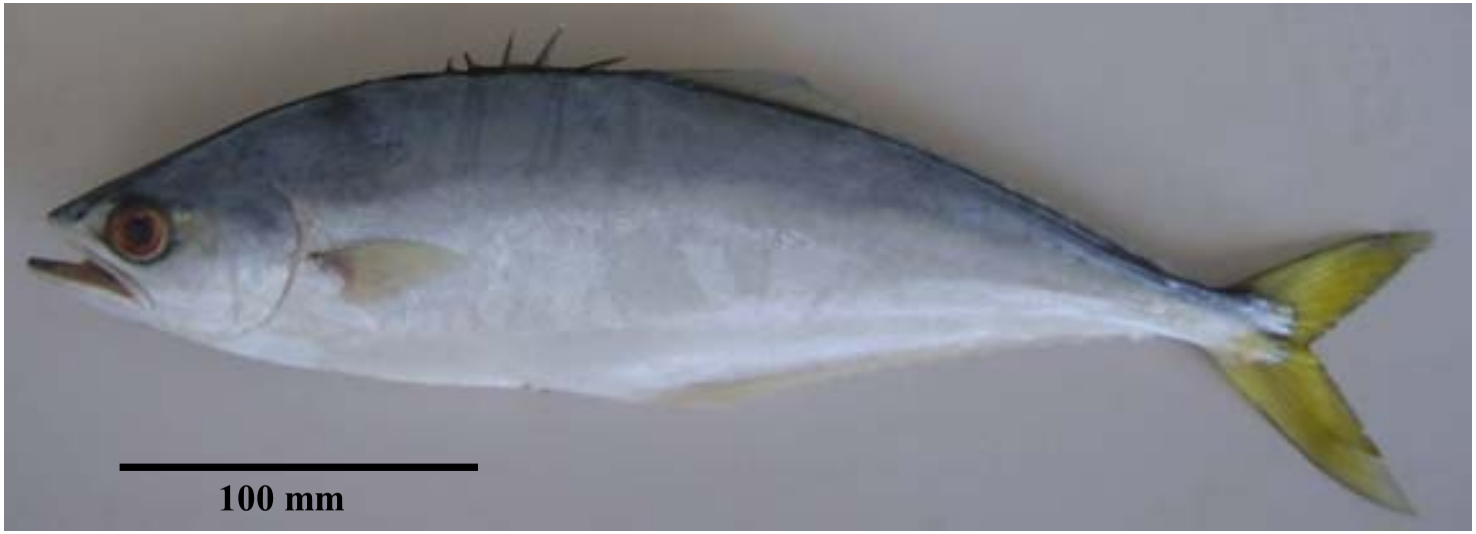
Figura 2. Espécie em estudo serra, *Scomberomorus brasiliensis* e sua distribuição geográfica (pontos vermelhos no mapa).

As bases da nadadeira anal e da segunda dorsal de *O. saurus* possuem o mesmo tamanho. A primeira nadadeira dorsal apresenta espinhos escuros com membranas claras. A segunda nadadeira dorsal e a nadadeira anal são claras. A linha lateral não apresenta escudos, é levemente arqueada acima da nadadeira peitoral e reta até o pedúnculo caudal (Araújo *et al*., 2004).

A espécie *O. palometa* (Fig. 4) é encontrada principalmente em águas doces e salobras, e sobre fundos enlameados de águas marinhas costeiras. É um peixe carnívoro que regressa ao mar para reproduzir. *O. palometa* carrega glândulas venenosas em espinhos dorsais e anais. Os jovens apresentam uma coloração castanha escuro quando próximos de algas deterioradas, constituindo um exemplo de mimetismo. Apresenta coloração castanha amarelado quando estão sobre o fundo arenoso colorido e claro. Ficam escuros quando em advertência (Araújo *et al*., 2004).

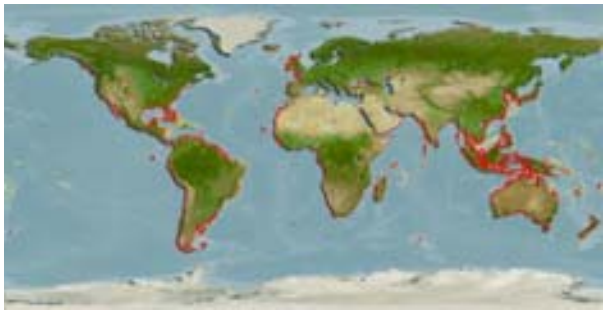
Os tibiros, da espécie *O. palometa* apresenta coloração prateada, com a nadadeira caudal com um tom alaranjado. Possui o corpo alongado, alto, bastante afilado na metade posterior e com o focinho pontiagudo. Pré-maxilar com várias séries de dentes viliformes, formando uma faixa, mais larga anteriormente que posteriormente. As nadadeiras peitorais são curtas com uma linha lateral desprovida de escudos (Araújo *et al*., 2004).

O palombeta, *C. chrysurus* (Fig. 5) pertence à família Carangidae, habita as águas costeiras e esta distribuído desde os Estados Unidos da América até a Argentina (Carpenter, 2002). Possui corpo prateado com região dorsal azul-esverdeado e uma mancha negra superiormente no pedúnculo caudal. A sua fenda bucal é posicionada vertical. Corpo apresenta forma oval com o perfil ventral mais convexo que o dorsal. A primeira nadadeira dorsal apresenta 9 espinhos sendo 1 espinho junto a segunda nadadeira dorsal que é composta de 27 raios. A nadadeira anal tem 2 espinhos isolados. Linha lateral sem escudos com algumas escamas na região do pedúnculo caudal (Araújo *et al*., 2004).



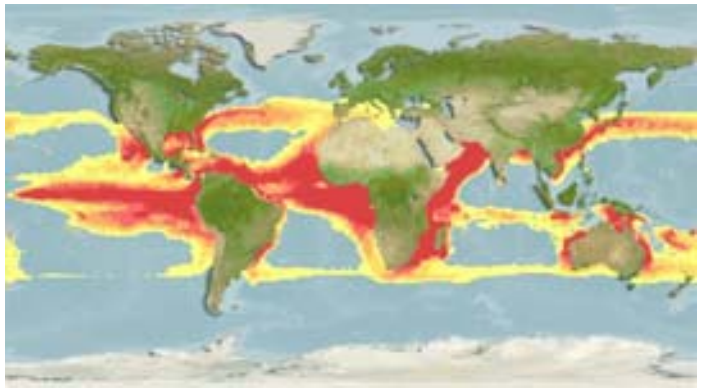
Posição taxonômica:
Superclasse: Pisces,
Classe: Osteichthyes
Ordem: Perciformes
Família: Carangidae
Gênero: *Oligoplites*
Espécie: *Oligoplites saurus*

Figura 3. Espécie em estudo tibiro, *Oligoplites saurus* e sua distribuição geográfica (pontos vermelhos no mapa).



Posição taxonômica:
Superclasse: Pisces,
Classe: Osteichthyes
Ordem: Perciformes
Família: Carangidae
Gênero: *Oligoplites*
Espécie: *Oligoplites palometa*

Figura 4. Espécie em estudo tibiro, *Oligoplites palometa* e sua distribuição geográfica (pontos vermelhos no mapa).



Posição taxonômica:
Superclasse: Pisces,
Classe: Actinopterygii,
Ordem: Perciformes,
Família: Carangidae,
Gênero: *Chloroscombrus,*
Espécie: *Choloroscombrus chrysurus*

Figura 5. Espécie em estudo palombeta, *Chloroscombrus chrysurus* e sua distribuição geográfica (pontos vermelhos no mapa).

Os parasitos em estudo foram os crustáceos isópodos (Ordem Isopoda) que parasitam os peixes marinhos das águas costeiras. Os crustáceos isópodos medem entre 0,5 a 500,0 mm de comprimento total. Os parasitos isópodos são hematófagos hermafroditos protândricos (jovens isópodos são machos com posterior reversão sexual para fêmeas). Ambos os sexos são encontrados infectando os peixes (Brusca & Wilson, 1991).

Os isópodos jovens nadam ativamente a procura de um hospedeiro para fixação. Sendo pioneiros no micro-habitat, o jovem macho reverte diretamente para fêmea. O segundo jovem que infecta o mesmo hospedeiro se torna macho funcional. A fêmea possui um par de espermateca para armazenar espermatozóides, e a fertilização ocorre internamente. (Thatcher, 2006). Os ovos são transferidos para bolsa de incubação (marsúpial), onde os embriões em desenvolvimento são retidos até se tornarem larvas independentes. As larvas nadam livremente durante 30 a 60 segundos a procura de hospedeiros. Após este tempo ficam imobilizados por perder a atividade natatória, e por algumas horas esperam a aproximação de um hospedeiro ocasional. Os isópodos parasitos são geralmente encontrados no tegumento, nas nadadeiras, cavidade bucal e câmaras branquiais (Thatcher, 2004).

3.4 Coleta das amostras

As coletas dos peixes foram realizadas mensalmente durante o período de agosto de 2005 a Julho de 2007. Os peixes foram capturados com ajuda de pescadores da região. A rede-de-arrastão utilizada pelos pescadores foi do tipo tresmalho, com malha central de 10 mm e extremidades com 70 mm, medindo média de 110 metros de comprimento por 3 metros de altura, confeccionada com mono náilon. A rede foi conduzida por uma catraia, embarcação artesanal sem vela e sem acessórios, e lançada aproximadamente 110 metros de distância da costa em uma profundidade de 5 metros. O arrasto contou com o esforço de 6 a 12 pescadores, que através de dois cabos fixos na extremidade da rede-de-arrastão a tracionaram para a terra. Todo processo, desde a organização da rede até a despesca durou em torno de 1 hora e 30 minutos (Fig. 6).

Figura 6. Atividades de pesca artesanal nas praias de Natal, Rio Grande do Norte. a) aparelhos de pesca; b-c) pescadores organizando a rede-de-arrasto do tipo tresmalhos em cima da catraia; d) catraia sendo conduzida para pesca; e-f) rede-de-arrasto tracionada por pescadores; g) pescado na rede e h) peixes no cesto.

Os peixes coletados foram transportados para o laboratório de Ictiologia do DOL (Departamento de Oceanografia e Limnologia) da Universidade Federal do Rio Grande do Norte. Todos os peixes foram submetidos à biometria para registrar o peso total (Wg g) e comprimento total (Lt mm). As posições taxonômicas das quatro espécies de peixes foram verificadas e confirmadas com auxílio de chaves de identificação de Carpenter, (2002) e Araújo *et al*., (2004).

3.5 Aspectos reprodutivos, crescimento e fator de condição dos hospedeiros

Verificação do sexo e proporção sexual: A necropsia dos peixes foi realizada através de uma incisão precisa no encontro das musculaturas na região ventral a partir da abertura urogenital, no sentido caudal-crânial. Após a dissecação dos peixes o sexo foi identificado. De cada coleta mensal foi registrado o número de machos e fêmeas a fim de determinar a diferença na proporção sexual.

Verificação dos estádios de maturação gonadal, análise histológica das gônadas: As gônadas foram retiradas, pesadas, observadas em relação a seus aspectos macroscópicos. As análises macroscópicas dos estádios de maturação gonadal foram determinadas a fim de caracterizar os estádios das gônadas de acordo com Vazzoler (1996) e Mackie & Lewis (2001). Para a análise histológica, fragmentos (25 mm) das porções cefálica, mediana e caudal de 20 testículos e 30 ovários em diferentes fases de desenvolvimento gonadal foram fixados em solução de Bouin, embebidos em blocos de parafina, seccionados em cortes de 2 a 5 μm e corados em lâminas por Hematoxilina-Eosina (HE) (Yoshida, 1964).

As lâminas histológicas foram confeccionadas no Laboratório de Técnicas Histológicas do Hospital Universitário da Universidade Federal do Rio Grande do Norte (UFRN) e analisadas no Laboratório de Ictiologia, Departamento de Oceanografia e Limnologia, UFRN. As terminologias utilizadas na identificação dos ovócitos foram baseadas nas descrições histológicas de West (1990) e Palmer *et al*., (1995).

Verificação do Índice gonadossomático (IGS), fecundidade, tipo e período de desova: Segundo Wootton *et al*., 1978, o Índice gonadossomático é a relação percentual entre o peso das gônadas e o peso do corpo do peixe menos o peso das gônadas do peixe; dado pela relação: IGS = Wg / Wc x 100, onde: Wg é peso das gônadas (em g) e Wc é peso do corpo menos o peso das gônadas (em g).

Para a determinação da fecundidade (potencial reprodutivo) foram utilizadas 10 fêmeas cujos ovários estavam em estádio maduro. Foi feita uma incisão longitudinal nas gônadas e em seguida colocadas em solução de Gilson. Depois de 3 dias os ovócitos foram liberados do estroma ovariano, foram lavados e colocados e contados utilizando uma placa de Bogorov.

O tipo de desova é o modo como as fêmeas liberam os ovócitos maduros em um período reprodutivo, sendo determinado pela a freqüência das desovas dentro do período de reprodução. O período de desova foi determinado através da avaliação dos maiores valores mensais de IGS segundo Vazzoler (1996).

Tipo de crescimento: A relação peso/comprimento foi estabelecida através da equação $\mathbf{Wt = \varphi Ls\theta}$, os dados de peso total (Wt) e comprimento padrão (Ls) foram usados na equação potencial onde; φ é o coeficiente fator de condição e θ é o coeficiente angular ou coeficiente de crescimento, que permite determinar o tipo de crescimento de cada espécie (Santos, 1978).

Fator de condição (K): Foi calculado o fator de condição através da equação $\mathbf{K=(Wt/Lt^3)100.}$ K é o fator de condição de Fulton, Wt é o peso total (g) e Lt é o comprimento total (cm). (Nash *et al.,*2006).

3.6 Identificação e biometria dos parasitos

Foram feitas necropsias nos hospedeiros a procura de parasitos seguindo as técnicas sugeridas por Pavanelli, Eiras & Takemoto (1999) e Eiras, Takemoto & Pavanelli (2000). Os parasitos encontrados foram devidamente rotulados (o número do hospedeiro, área de fixação, local e data da coleta), medidos, pesados, fotografados e acondicionados em tubos de ensaio com álcool a 70%. Os parasitos foram identificados com chaves taxonômicas apropriadas e confirmados com o Professor Dr. Vernon Thatcher da Universidade Federal do Paraná (UFPR).

3.7 Índices ecológicos parasitários

Os índices ecológicos parasitários foram calculados e expressos conforme Margolis *et al*., (1982), Bush *et al*., (1997) e Pavanelli & Takemoto (2000).

Prevalência foi determinada utilizando a relação percentual entre o número de hospedeiros infectados com um ou mais indivíduos de um grupo taxonômico (espécie de parasito em particular) e o número de hospedeiros examinados para aquela espécie de parasito, dado pela relação:

$$\textbf{Prevalência} = \frac{\textbf{nº de hospedeiros infectados}}{\textbf{nº de hospedeiros examinados}} \times 100$$

Intensidade média foi determinada utilizando a relação entre o número de parasitos de um grupo taxonômico (espécie de parasito em particular) e o número de hospedeiros infectados com aquela espécie de parasito, dado pela relação:

$$\textbf{Intensidade média} = \frac{\textbf{nº total de parasitos}}{\textbf{nº de hospedeiros infectados}}$$

Abundância média foi determinada utilizando a relação entre o número total de parasitos de um grupo taxonômico (espécie de parasito em particular) em um hospedeiro especifico e o numero total de hospedeiros examinados (infectados e não infectados), dado pela relação:

$$\textbf{Abundância} = \frac{\textbf{nº total de parasitos}}{\textbf{nº de hospedeiros examinados}}$$

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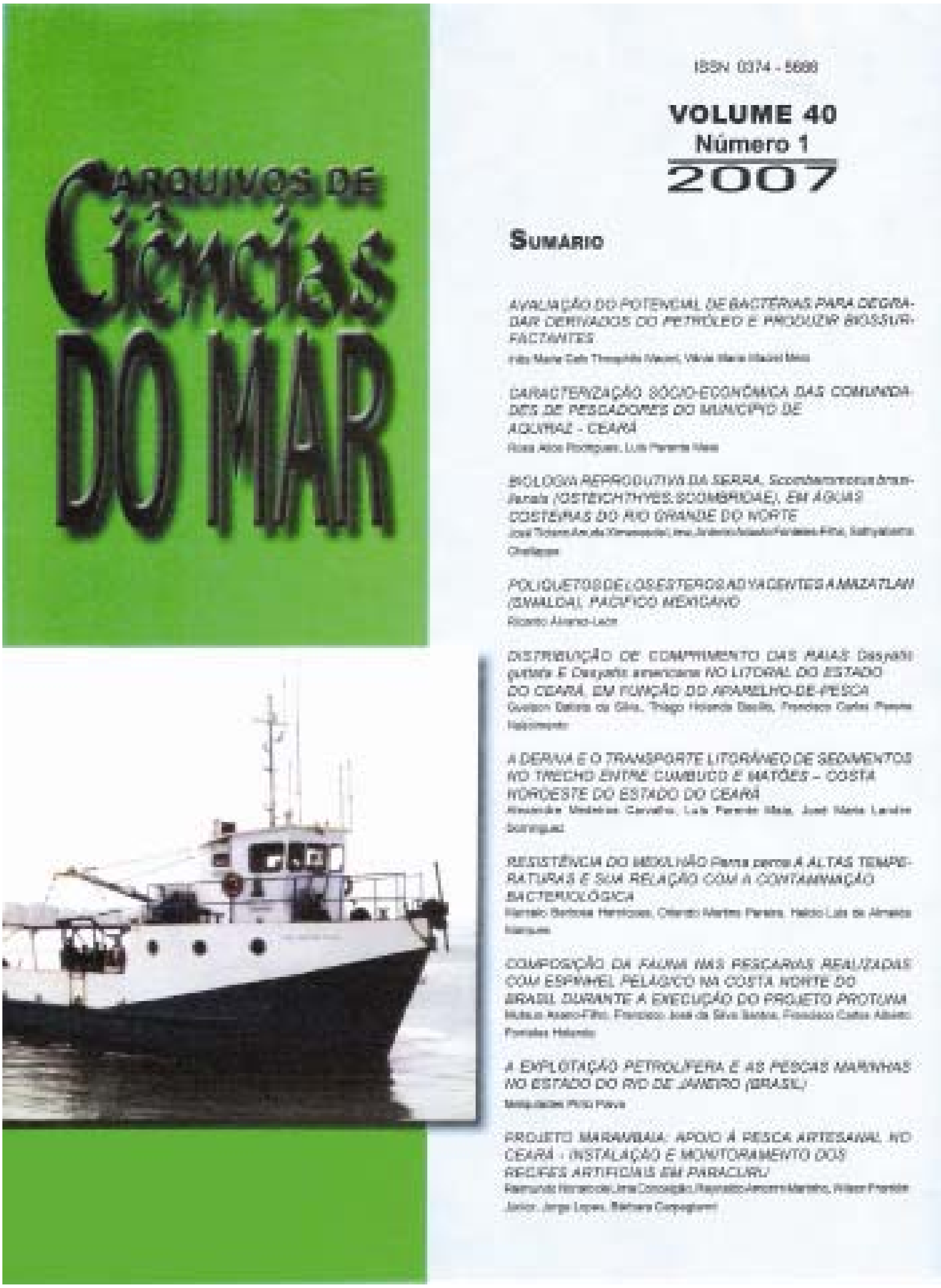
4. RESULTADOS



ARQUIVOS DE CIÊNCIAS DO MAR

ISSN 0374 - 5686

VOLUME 40
Número 1
2007

SUMÁRIO

Arquivos de Ciências do Mar

BIOLOGIA REPRODUTIVA DA SERRA, Scomberomorus brasiliensis (OSTEICHTHYES:SCOMBRIDAE), EM ÁGUAS COSTEIRAS DO RIO GRANDE DO NORTE

Reproductive biology of Brazilian mackerel, *Somberomorus brasiliensis* (Osteichthyes:Scombridae), off Rio Grande do Norte State

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RESUMO

A serra, Scomberomorus brasiliensis, *é uma espécie marinha de valor comercial que habita o litoral brasileiro tropical. Tendo como objetivo estudar sua sua biologia reprodutiva nas águas costeiras do Rio Grande do Norte, a amostragem foi realizada mensalmente durante o período de agosto de 2003 a julho de 2004. Os exemplares foram medidos, pesados e dissecados; suas gônadas foram pesadas e examinadas para separar o sexo e avaliar o comprimento médio na 1ª maturidade sexual, índice gonadossomático, fecundidade, e tipo e época de desova. Com base na análise do material amostrado e analisado, foram obtidos os seguintes resultados; (a) os comprimentos médios na 1ª maturidade sexual foram 345 mm CT (machos) e 280 mm CT (fêmeas); (b) as estimativas do Índice Gonadossomático variaram nas faixas de 1,10 - 4,66 (machos) e 1,18 - 13,54 (fêmeas); (c) as fecundidades absoluta e relativa foram estimadas em 871.523 óvulos e 952 óvulos por grama; (d) a espécie apresentou desova do tipo total, verificada através da distribuição de freqüência relativa do diâmetro dos ovócitos vitelogênicos; (e) a reprodução ocorre durante o ano todo, com incidência do pico durante o mês de dezembro; (f) o uso de redes com malhas pequenas propicia a captura de serras imaturas, prejudicando o recrutamento da espécie.*

Palavras-chaves: *serra,* Scomberomorus brasiliensis, *biologia reprodutiva, Rio Grande do Norte.*

ABSTRACT

The Spanish mackerel, Scomberomorus brasiliensis, *is a marine species of commercial importance, which inhabits a major part of the coastal waters of Brazil, except for the extreme north and south. The objective of the present study was to determine its reproductive biology in the coastal waters of Rio Grande do Norte. Fish samples were collected on a monthly basis, during August, 2003 to July, 2004. The fish were measured, weighed, dissected and the gonads were removed, weighed and examined for the sex and for estimating such variables as mean size at first sexual maturity, gonadossomatic index, fecundity, type of spawning and breeding season. The results indicate that the females of S. brasiliensis attained gonad maturity at 280 mm and males at 345 mm of total length. The gonadossomatic index (GSI) ranged from 1.18 to 13.54 in females and from 1.10 to 4.66 in males. The absolute and relative fecundities were estimated as 871,523 oocytes and 952 oocytes per gram of fish weight. The relative frequency distribution of the oocyte diameter sizes indicates that Brazilian mackerel is a total spawner. Breeding of this species occurred all year round, with a peak coinciding with the month of December. The use of small-meshed nets accounts for the capture of immature fishes, which impairs the recruitment process of this species.*

Key words: *Brazilian mackerel,* Scomberomorus brasiliensis, *reproductive biology, Rio Grande do Norte State.*

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INTRODUÇÃO

A serra, *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin, 1978) é uma espécie marinha comercial e bastante explorada na costa nordestina, povoando a maior parte do litoral brasileiro, com exceção das extremidades norte e sul (Collette & Russo, 1979; Zavala-Camin, 1983; IBAMA, 1994; Sampaio, 1996). Sua taxonomia e distribuição geográfica são distintas de *Scomberomorus maculeatus* (Mitchill, 1815), antes conhecidas como uma única espécie (Collette *et al.*, 1978; Fonteles-Filho,1988). Trata-se de uma espécie veloz e conhecida como predadora de sardinhas e peixes voadores (Suzuki, 1983; Araújo & Chellappa, 2002), de hábitos costeiros e realizando migração para águas mais profundas do Nordeste do Brasil num circuito que deve ser superior a 300 milhas náuticas (Batista & Fabre, 2001).

Os dados de produção demonstram que os volumes desembarcados da serra apresentaram uma tendência de crescimento nos estados do Rio Grande do Norte, Ceará, Piauí, Maranhão e Pará (IBAMA, 2003; Oliveira *et al.* 2004), o que pode ser devido à evolução tecnológica na costa nordestina através de novas técnicas pesqueiras. Qualquer forma de pesca explora apenas indivíduos dentro de uma faixa de comprimento e idade que representa o estoque disponível, e deste, só o estoque capturável está acessível aos aparelhos-de-pesca. O ideal é que se capture apenas indivíduos adultos, mas, na prática ocorre captura do estoque adulto juntamente com uma parte do estoque jovem. A pesca tradicional litorânea explora um elevado número de espécies sem distinção de tamanho, devido à alta biodiversidade específica e à pequena biomassa de estoques pesqueiros explorados (Fonteles-Filho, 1989; MMA, 1997).

A captura abusiva de peixes imaturos pode comprometer o estoque, refletindo-se no desenvolvimento cíclico das gônadas representativo dos estádios de maturidade (Adams, 1980; Vazzoler, 1996). A capacidade de recuperação de *S. brasiliensis* varia na faixa de 1,4 – 4,4 anos (Collette & Nauen, 1983), por isso, estudos sobre sua reprodução assumem grande importância devido ao fato de ser a função vital que assegura a preservação e a abundância das espécies (Wootton, 1989). O presente trabalho descreve a biologia reprodutiva da serra, *Scomberomorus brasiliensis*, capturadas nas águas costeiras do Rio Grande do Norte.

MATERIAL E MÉTODOS

Coleta das amostras

As coletas foram realizadas por meio de arrastões-de-praia do tipo tresmalho com 110 m de comprimento, malhas de 10 mm no centro e 70 mm nas extremidades. O modo de operação consiste do seu lançamento através de pequena balsa (catraia), a cerca de 100 m de distância da praia, com 5 m de profundidade. Dois cabos ficam na terra para serem arrastados por pescadores e todo o processo, desde a arrumação até a retirada da rede com os peixes, dura em torno de 1:30 h, contando com o esforço de 6 a 12 pescadores.

Entre agosto de 2003 a julho de 2004 ocorreram 12 coletas na costa da Praia de Ponta Negra em Natal-RN, totalizando 145 peixes, exceção feita aos meses de novembro/2003, devido a grande florescência de macroalgas que deixou a água turva com coloração amarelada, exatamente na região de lance do arrasto de praia, e fevereiro/2004, devido à ocorrência de chuvas acompanhadas de fortes ventos.

Os peixes foram transportados em caixas térmicas com gelo e água do ambiente ao Departamento de Oceanografia e Limnologia da UFRN, onde foram medidos (mm), pesados (g). Com base nos valores médios dos dados morfométricos e merísticos foi feita a identificação taxonômica da espécie (Suzuki, 1983; Szpilman, 2000) e, posteriormente, os peixes foram dissecados para a observação e estudo das gônadas segundo a metodologia de Vazzoler (1996).

Proporção sexual

Numa população, espera-se uma ocorrência teórica de machos e fêmeas em freqüências esperadas de 50% para cada sexo (Santos, 1978), de modo que a avaliação estatística das diferenças apresentadas pelas frequências observadas foi feita por meio do teste χ^2 ao nível de significância, $\alpha = 0,05$ e $GL = n - 1$ (Ivo & Fonteles-Filho, 1997).

Primeira maturidade sexual (L_{50})

As freqüências de machos e fêmeas foram agrupadas de acordo com as categorias de gônadas imaturas (estádio imaturo) e gônadas em atividade reprodutiva (estádios em maturação, maduro e esvaziado), sendo estas últimas lançadas em gráfico e ajustados em curvas do tipo sigmóide, para determinação do valor de L_{50} indicativo da frequência de 50% de indivíduos com gônadas em atividade reprodutiva (Santos, 1978; Fonteles-Filho, 1989; Vazzoler, 1996).

Índice gonadossomático

Este índice de maturidade sexual é representado pela razão percentual entre o peso das gônadas (W_g) e o peso do corpo do peixe sem as gônadas ($W_t - W_g$), de acordo com a fórmula: $IGS = [Wg/(Wt-Wg)] \times 100$ (Wootton *et al.*, 1978).

Fecundidade e tipo de desova

A estimativa das fecundidades absoluta e relativa foi estimada com base na contagem absoluta dos ovócitos e na determinação de classes de diâmetros dos ovócitos. Os ovários de fêmeas maduras e em maturação com comprimento e peso médios de 768 mm e 3.250 g foram retirados, pesados e preservados em solução de Gilson modificada por 24 horas para uma completa dissociação dos ovócitos (Simpson, 1951), que posteriormente foram lavados e preservados em álcool etílico a 70% (Vazzoler,1996). O tipo de desova foi avaliado através da análise dos resultados da medição do diâmetro dos ovócitos.

Época de desova

A informação sobre a provável época de desova foi realizada pela distribuição das freqüências relativas (%) de cada estádio de maturação das gônadas, considerando os sexos separados. A época de desova foi determinada com o período mensal em a freqüência das fêmeas no estádio de desova foi mais elevado (Vazzoler, 1996).

Pluviosidade

Os dados de pluviosidade referentes ao período de agosto/2003 – julho/2004 foram obtidos junto à Empresa de Pesquisa Agropecuária do Rio Grande do Norte S/A (EMPARN).

RESULTADOS E DISCUSSÃO

A amplitude do comprimento total variou de 135 a 805 mm nas fêmeas e de 140 a 598 mm nos machos. O maior número de indivíduos do sexo feminino foi observado na classe de 100 - 200 mm de comprimento total (CT), média de 333,8 mm e desvio padrão de 18,2 mm. Os machos tiveram seu maior número de indivíduos nas classes de 100 - 200 mm e 400 - 500 mm CT, com média de 315,6 mm e desvio padrão de 13,6 mm.

A amplitude do peso total variou de 15 a 3.385 g (fêmeas) e 16 a 1.310 g (machos). O maior número de indivíduos do sexo feminino foi observado na classe de 10 a 500 g de peso total, média de 363,6 g e desvio padrão de 542,7 g. Os machos tiveram seu maior número de indivíduos nas classes de 10 - 500 g de peso total, com média de 255,2 g e desvio padrão de 257,6 g. As fêmeas da serra alcançam comprimentos e pesos superiores aos machos.

Os valores mínimo, máximo e médio, e o desvio padrão das medidas morfométricas para machos e fêmeas da serra estão na Tabela I. Na análise merística os lepdotríquios apresentaram raios duros, representados por algarismos romanos, e moles, representados por algarismos arábicos (Tabela II).

Tabela I - Valores mínimos, máximos, médios e desvios padrão das medidas morfométricas para machos e fêmeas da serra, *S. brasiliensis* coletados nas águas costeiras do Rio Grande do Norte.

Caracterização morfométrica	Valor mínimo		Valor máximo		Valor médio ± Desvio Padrão	
	♀	♂	♀	♂	♀	♂
Comprimento total (mm)	135	140	805	598	333,7 ± 18,17	315,5 ± 13,55
Comprimento zoológico (mm)	124	125	710	531	290,4 ± 15,58	273,7 ±11,56
Comprimento padrão (mm)	100	115	657	492	262,2 ± 14,43	251,7 ± 10,72
Comprimento da cabeça (mm)	29	30	134	102	58,2 ± 2,67	55,6 ± 2,0
Comprimento do focinho	11	11	57	40	22,9 ± 1,14	21,0 ± 0,78
Diâmetro do olho 6	6	42	19		11,9 ± 0,62	11,2 ± 0,37
Altura máxima do corpo	25	26	130	99	56,4 ± 2,79	52,8 ± 2,08
Comprimento pré-dorsal	31	33	162	123	65,4 ± 3,12	63,7 ± 2,40
Comprimento pré-peitoral	28	31	330	102	68,9 ± 5,32	57,7 ± 2,09
Comprimento pré-ventral	29	33	149	117	65,7 ±3,07	62,8 ± 2,28
Comprimento pré-anal	65	70	369	267	153,2 ± 7,87	143,8 ± 5,80
Base da dorsal	48	50	101	210	127,3 ± 12,42	108,5 ± 4,60
Maior acúleo nadadeira dorsal	10	10	101	101	37,3 ± 11,92	36,07 ±11,35
Base da peitoral	4	4	31	21	12,4± 7,32	11,5± 5,25
C. da nadadeira peitoral	10	12	78	59	32,3± 1,86	30,5± 1,48
Base da ventral	1	1	69	70	5,4± 0,86	5,09± 0,81
C. da nadadeira ventral	4	4	101	101	41,0 ± 16,87	50,8± 19,57
Base da anal	11	12	75	56	31,33± 1,64	30,4± 1,33
C. da nadadeira anal	12	11	82	55	28,8± 1,70	27,5± 1,30

Tabela II - Valores médios das medidas merísticas da serra, *S. brasiliensis* coletados nas águas costeiras do Rio Grande do Norte.

Caracterização Merística	Valores Médios
Lepidotríquios dorsais	XVII a XIX (XVIII)+15 a 19 (17)
Lepidotríquios peitorais	21
Lepidotríquios ventrais	II + 4 a 5
Lepidotríquios anais	II + 16 a 20 (18)
Pínulas dorsais - anais	8 a 9 - 8 a 9
Quilhas dérmicas	3

A proporção sexual demonstrou uma leve predominância numérica dos machos (52%) sobre as fêmeas (48%). No período de estudo foi observado que a frequência de fêmeas foi maior nos meses de outubro/2003 e junho-julho/2004, com predominância dos machos no restante dos meses (Figura 1). Para o período total de estudo não houve diferença significativa na proporção sexual ao nível de 5% ($\chi^2 < 3,84$).

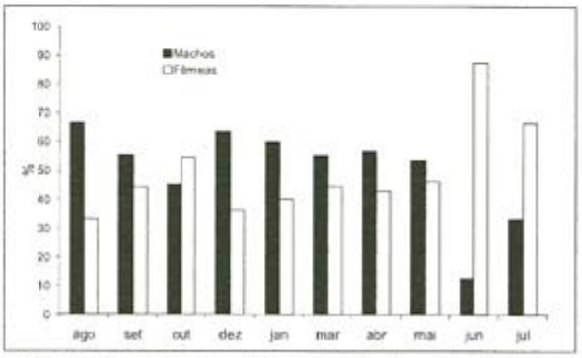

Figura 1 - Proporção sexual da serra, *Scomberomorus brasiliensis*, em frente a Natal, no período agosto/2003 - julho/2004.

O comprimento médio na 1ª maturidade sexual (L_{50}) apresentou valores de 345 mm (machos) e 280 mm de comprimento total (fêmeas) (Figura 2). Dentre o total de 145 peixes capturados 52% estavam com tamanho igual ou inferior a média e 48% possuíam valor superior à média da maturação gonadal, indicando um aumento da captura dos imaturos. Entre os anos de 1963-1986 a média da L_{50} foi 520 mm CT e a participação de juvenis foi de 8,1% (Gesteira & Mesquita, 1976); entre 1970-1975 o percentual foi de 14,2% de imaturos capturados, com indivíduos da espécie atingindo até 1.200 mm CT (Fonteles-Filho, 1988); entre 1998-2000 a média do comprimento decresceu para 382 mm e os indivíduos da costa do Nordeste brasileiro não atingiram medidas acima de 860 mm (Lucena *et al.*, 2001). O presente estudo confirma essa tendência de decréscimo do comprimento médio individual, estimado em 312,5 mm CT. A moda do comprimento total registrou-se na faixa de 100 - 200 mm, fato corroborado pela elevada proporção de juvenis na captura (52%), demonstrando uma possível ocorrência de sobrepesca do crescimento, que causa uma redução no recrutamento da serra para o estoque capturável e no número potencial de indivíduos para iniciar o ciclo reprodutivo. Os aparelhos-de-pesca (tresmalhos), com baixa seletividade, visam a capturar camarões marinhos e, por consequência, atingem indivíduos imaturos da serra como fauna acompanhante.

O índice gonadossomático (IGS) teve seus valores médios analisados e demonstraram uma variação de 1,18 a 13,54 para fêmeas, com três picos de ocorrência, sendo o maior no mês de dezembro e outros dois menores, nos meses de abril e junho. Os machos tiveram um IGS variando entre 1,10 a 4,66, com dois picos de ocorrência, sendo um em dezembro e outro em julho (Figura 3). O IGS demonstra o estado funcional das gônadas em relação ao peso do indivíduo de forma a indicar o período de desova. Os valores médios do IGS mostram que machos e fêmeas da serra realizam atividade reprodutiva durante todo o ano.

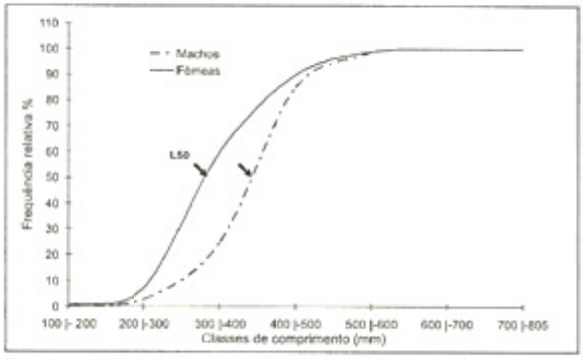

Figura 2 - Ogivas do comprimento total de machos e fêmeas Distribuição de freqüência do comprimento total de jovens e adultos da serra, *Scomberomorus brasiliensis*, em frente a Natal, no período agosto/2003 - julho/2004. Setas indicam os pontos correspondentes a L_{50}.

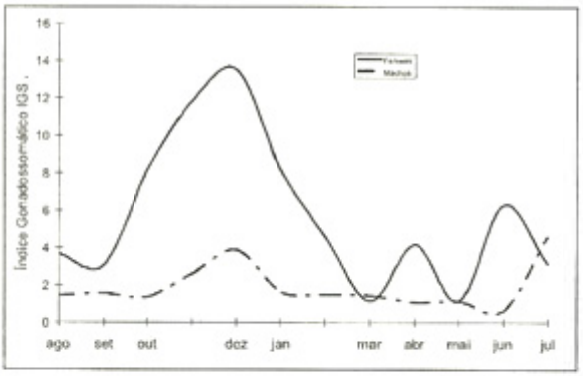

Figura 3 - Valores médios mensais do Índice Gonadossomático de machos e fêmeas da serra, *Scomberomorus brasiliensis*, em frente a Natal, em alguns meses do período agosto/2003 - julho/2004.

A fecundidade absoluta foi estimada em 871.523 óvulos, tendo sido determinada utilizando gônadas pesando em média 127 g retiradas de fêmeas maduras e em maturação com comprimento e peso médios de 768 mm e 3.250 g. A fecundidade relativa foi avaliada em 952 óvulos por grama do peso do indivíduo. Gesteira (1972) estimou as fecundidades absoluta e relativa da serra em 2.047.000 óvulos e 1.892 óvulos por grama do indivíduo, para o Estado do Ceará.

A espécie *S. brasiliensis* possui gônadas com desenvolvimento de forma sincrônica, com dois grupos de ovócitos onde se encontra o estoque de reserva (ninhos germinativos e Fase II) com diâmetros inferiores a 120 µm, e outros ovócitos que iniciam na vitelogênese nas fases III, IV e V, até alcançar a fase VI com diâmetros entre 650 a 750 µm de diâmetro (Figura 4). Estes são eliminados em desova total, verificada através da distribuição de freqüência relativa do diâmetro dos ovócitos vitelogênicos.

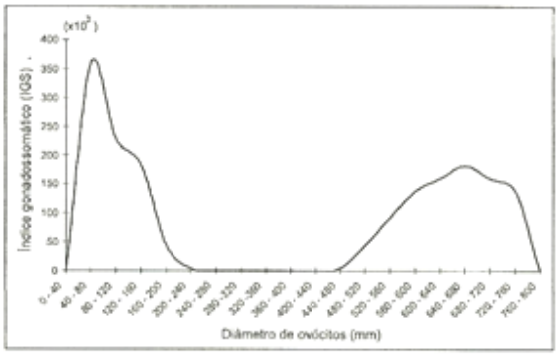

Figura 4 - Distribuição de freqüência do diâmetro dos ovócitos presentes em ovários maduros da serra, *Scomberomorus brasiliensis*, em frente a Natal, no período agosto/2003 - julho/2004.

Nas águas costeiras do Rio Grande do Norte a desova da serra ocorre em meses diversos durante o ano todo, com uma época principal que se estende de setembro a março, com pico em dezembro, informações semelhantes às obtidas por Mota Alves & Tomé (1968). A reprodução dos peixes ocorre na época do ano em que as condições ambientais são favoráveis à maximização da produção de descendentes durante seu ciclo reprodutivo (Wootton, 1990), de modo a que suas pós-larvas tenham um suprimento alimentar adequado, proteção contra predadores e condições abióticas favoráveis.

Gesteira & Mesquita (1976) afirmam que a serra apresenta condições de reprodução durante todo o ano e que tem uma estação de desova mais intensa de setembro a março. Collette & Nauem (1983) também afirmam que a reprodução dessa espécie ocorre por todo o ano, com pico de julho a setembro.

Durante o período de estudo, os maiores índices pluviométricos foram registrados nos meses de agosto/2003 (49,6 mm) e junho/2004 (642,9 mm) e os menores, em novembro/2003 (16,1 mm) e maio/2004 (160,3 mm), em maio, evidenciando-se a ocorrência de estações seca (agosto - dezembro) e chuvosa (janeiro - julho).

O período de desova da espécie antecedeu as condições ambientais favoráveis, de forma que o seu pico coincidiu com o último mês de estiagem (dezembro), adentrando no período chuvoso e corroborando as informações de Costa *et al.* (1995). A desova coletiva ocorreu nos meses de setembro a março, coincidindo com o período de interfase entre as estações seca e chuvosa (Figuras 5 e 6). Em regiões tropicais, onde as variações estacionais da temperatura são pouco significativas, a precipitação pluviométrica desempenha um papel decisivo na determinação de ciclos reprodutivos (Parsons *et al.*, 1984).

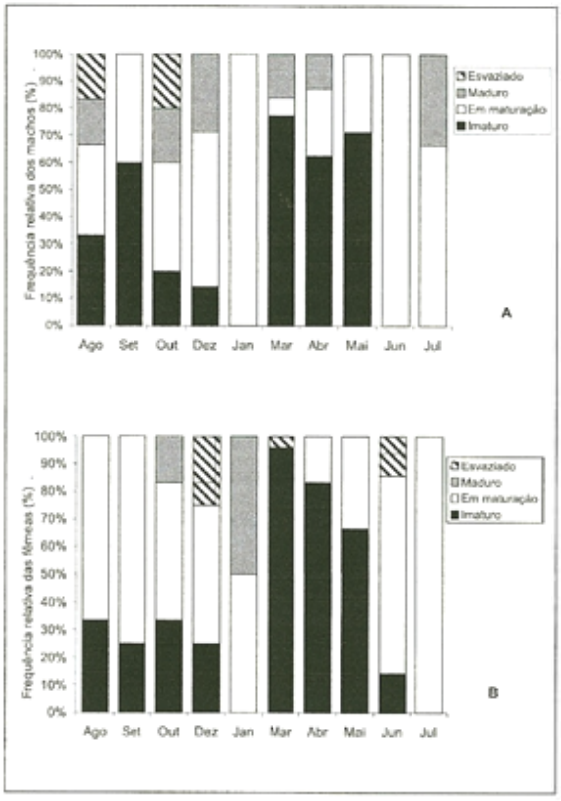

Figura 5 - Distribuição mensal da freqüência relativa (%) de machos (A) e fêmeas (B) da serra, *Scomberomorus brasiliensis*, em função do estádio de maturação gonadal, no período agosto/2003 - julho/2004.

CONCLUSÕES

1. Os comprimentos médios na 1ª maturidade sexual foram 345 mm CT (machos) e 280 mm CT (fêmeas), havendo equilíbrio na proporção sexual de 1M : 1F.
2. O Índice Gonadossomático variou nas faixas de 1,10 - 4,66 (machos) e 1,18 - 13,54 (fêmeas).
3. A serra apresentou desova do tipo total, com época principal de ocorrência no período setembro-março, com pico em dezembro.
4. As fecundidades absoluta e relativa foram estimadas em 871.523 óvulos e 952 óvulos por grama.
5. O emprego de redes com malhas pequenas na área de ocorrência da serra determina a captura de juvenis, o que prejudica o recrutamento da espécie.

Agradecimentos - O primeiro autor agradece a CAPES/MEC pela Bolsa de Mestrado concedida à Universidade Federal do Rio Grande do Norte; o terceiro autor agradece ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) pela Bolsa de Produtividade em Pesquisa.

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ADVANCES IN FISH AND WILDLIFE ECOLOGY AND BIOLOGY

VOLUME 5

EDITOR DR. BANSI LAL KAUL

Reproductive biology of *Scomberomorus brasiliensis* (Perciformes Scombridae)

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2008

Reproductive biology of *Scomberomorus brasiliensis* (Perciformes Scombridae)

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Running Title: Reproductive biology of *Scomberomorus brasiliensis*
6 Figures

ABSTRACT

Scomberomorus brasiliensis is a commercially important species, which occurs in the coastal waters of the Western Atlantic, along the Caribbean and Atlantic coasts of Central and South America, from Belize to Rio Grande do Sul, Brazil. This study verified the macroscopic and histological characterization of gonads, body size, sex ratio, gonadosomatic index, fecundity and spawning season of this species. A total of 424 males (51.3%) and 402 females (48.7%) were collected, total body length of males ranged from 92 to 661 mm and of females from 93 to 805 mm. There was a balanced sex ratio, with females slightly bigger and heavier than males and the onset of sexual maturity in males occurred earlier. Total fecundity was 871,523 mature eggs while relative fecundity was 952 eggs female g^{-1}. Ovaries revealed five stages of gonadal maturation and testes showed four stages. Relative frequency distributions of the oocyte diameter sizes indicate total spawning. Monthly values of GSI, gonadal maturation pattern and period of reproductive activity suggest that reproduction is influenced by the rainy season.

Key Words: *Scomberomorus brasiliensis*; reproduction; gonadal development; histology of gonads.

INTRODUCTION

Scomberomorus brasiliensis (Collette, Russo & Zavala-Camin) (Osteichthyes: Perciformes: Scombridae) occurs in the Western Atlantic, along the Caribbean and Atlantic coasts of Central and South America, from Belize to Rio Grande do Sul, Brazil (Collette *et al*., 1978). *S. brasiliensis* is an important fishery resource of the western Central Atlantic waters and of Northeastern Brazil. It is a major component of the Brazilian northeast artisanal fishery and has high commercial value (Lucena *et al*., 2004; Lima *et al*., 2005).

Although *S. brasiliensis* is an important food fish throughout most of its distributional range, limited details are available about the reproductive characteristics of this species (Gesteira & Mesquita, 1976; Fonteles-Filho, 1988). Description of reproductive characteristics was a major aspect of the current study, since this information is required for stock assessment and for management controls. Information on fecundity and spawning are also required for stock assessments, which is insufficiently described in the literature available for this species. Considering this plethora of factors, the main objective of this study was to provide a comprehensive description of the reproductive biology of *S. brasiliensis.* Furthermore, this work presents and extends information on gonad development based on macroscopic stages and histological characteristics, sex ratio, size at sexual maturity, fecundity, spatial and temporal patterns in gonadosomatic index (GSI), type of spawning and reproductive period of *S. brasiliensis*.

MATERIALS AND METHODS

SAMPLE COLLECTION

During the period of August 2005 to July 2006, monthly samples of *S. brasiliensis* were collected from artisanal fishermen at various locations in the coastal waters situated between latitudes 05º 52’ 30’’ - 05º 45’ 00’’ S, and longitudes 35º 08’ 00’’ - 35º 10’ 35’’ W, northeastern Brazil. Fish were caught by local fishermen using beach-seines from the coastal

waters of approximately <10 m depth. The beach-seines were 110 m in length, 3 m in height, with a mesh size of 1 cm in the central part and 7 cm in the extremities. Fish collected from the beach-seine fishing process were transported to the laboratory on ice. They were numbered, measured, weighed and samples of whole fish were used for morphometric analysis to confirm the taxonomical identification of the species based on Collette *et al.* (1978) and Carpenter (2002). Rainfall data of the region during the study period were obtained from the Meteorological Department of Natal, Brazil.

MEASUREMENTS

A total of 826 fish was collected during the study period and the sample size was sufficiently large to allow accurate estimations. The total body lengths of fish sampled were measured (± 1 mm) and body mass recorded (± 1 g). Fish were dissected within a few hours of capture, and gonads were removed, weighed (± 0.1 mg) and examined to separate the sex. Sex ratio was verified based on the monthly distribution of relative frequency of males and females. The length and weight composition of the males and females were determined based on the mean distribution of their class frequencies and grouped with intervals of 100 mm and 500 g (Vazzoler, 1996).

DETERMINATION OF SIZE AT MATURITY

Size at sexual maturity (ℓ_{50} & ℓ_{100}) was established by calculating the percentage of mature and immature gonads observed for fish of given size classes, using total length (mm), sex and stages of gonad development of each individual. Both ℓ_{50} (when 50% of individuals were with gonads in maturing stages) and ℓ_{100} (when all individuals were ready to participate actively in reproduction) were determined. Logistic curves were fitted to data by the use of a non-linear least-squares procedure weighted by the number of fish in each length-class (Fonteles-Filho, 1989).

MACROSCOPIC AND HISTOLOGICAL EXAMINATIONS OF GONADS

The location and general aspects of the ovaries and testes were noted and stage of reproductive maturity determined using a macroscopic staging system. The degree of turgidity, colour and presence of blood vessels of the gonads were observed (Vazzoler, 1996; Mackie & Lewis, 2001). In order to avoid possible variation in the developmental stage of oocytes due to their position in the ovaries, histological examinations were carried out on sections from the anterior (cephalic), middle (central), and posterior (caudal) regions of 20 ovaries in different developmental stages (Yoshida, 1964). Development of sperm tissue throughout the testes was compared by microscopic examination of sections taken from anterior, middle and posterior sections of each lobe (n = 20). These data were later compared in order to determine whether samples taken from mid-section of the gonad of either lobe were representative of gamete development throughout the ovaries.

The gonads were preserved in Bouin's solution, later embedded in paraffin, sectioned at 3 – 5 μm thickness, and stained with Harris hematoxylin and eosin (H&E). Ovarian developmental stages were assessed microscopically with the help of light microscope (Taimin, model TM 800), coupled with a video camera (Kodo Digital). The terminology used for stages of oogenesis followed that of West (1990) and Palmer *et al*. (1995).

ESTIMATION OF GONADOSOMATIC INDEX

Periodicity of gonadal development and seasonal reproductive activity were estimated by the gonadosomatic index for each fish. GSI was estimated by dividing the weight of gonads by its body weight and multiplying by 100 (Wootton *et al*., 1978).

ANALYSIS OF FECUNDITY AND BREEDING

For each stage of development, the diameters of oocytes from different ovaries (n =20) were measured with an ocular micrometer ($\pm$ 1 μm). The diameter of 60 oocytes at different stages of development was done using fresh ovaries. Each oocyte was measured twice on perpendicular axes, and the mean of the two measurements was used to represent the average

diameter of the oocyte. In addition, the relative proportion of oocytes sizes present were estimated and size frequency distribution of the oocytes was plotted (Palmer *et al*., 1995).

Period of breeding was determined by the temporal relative frequency distribution of the different stages of maturation of gonads of males and females. This study focused more on ovaries since their developmental stages were easier to distinguish than in testes, and because ovarian development usually defines the spawning season and number of offspring produced during spawning (De Martini & Fountain 1981).

DATA ANALYSIS

Sex ratio (M**:**F) was tested using χ^2 test at 5% level. Gonadosomatic indices of males and females during rainy and dry periods were compared at 5% level using Kruskal-Wallis One Way Analysis of Variance on Ranks (Software Statistica, version 7.0 Windows).

RESULTS

SEX RATIO

A total of 826 samples of *S. brasiliensis* were collected during the study period, out of which 424 were males (51.3%) and 402 were females (48.7%). The monthly distribution frequency of occurrence of males and females show that sex ratio for the total sample was equivalent to 1M:1F as expected, although with a slight predominance of males (Fig. 1). During the drought period males occurred more (52%, n =275) than females (48%, n =249). On the other hand, females occurred more (51%, n =153) than males during the rainy season (49%, n =149). However, the overall difference was not significant statistically at 5% level ($P>0.05$).

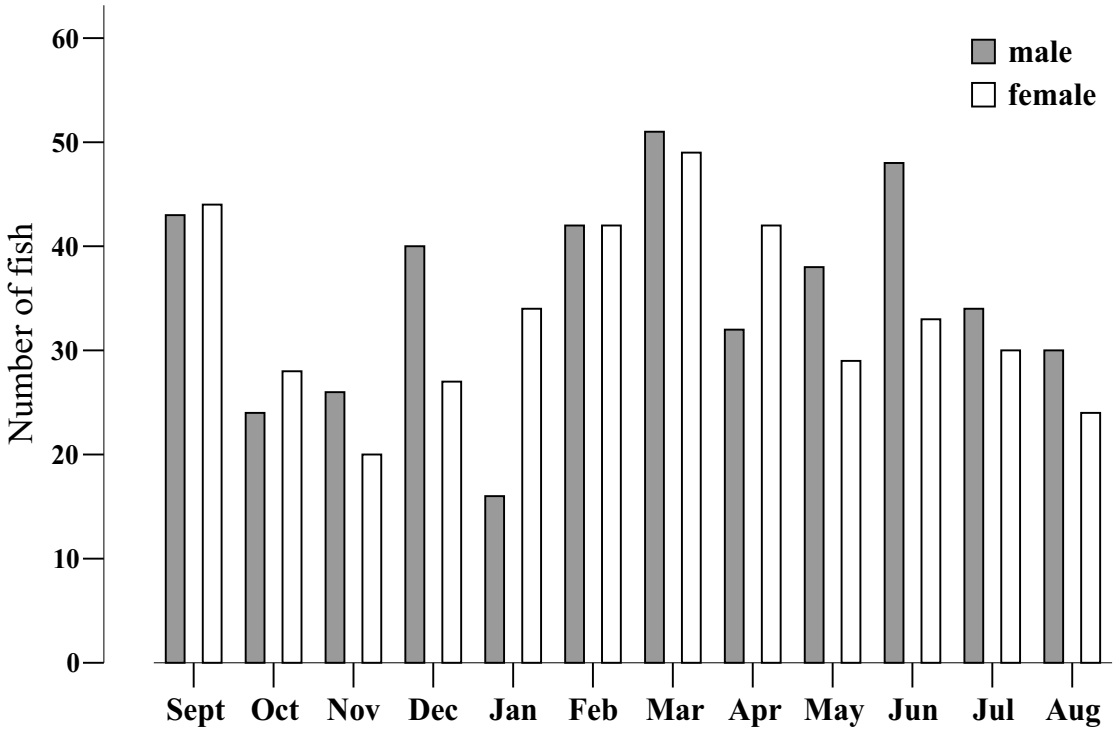

FIG. 1. Monthly frequency of occurrence of males and females of *Scomberomorus brasiliensis* during September 2005 to August 2006.

TOTAL BODY LENGTH AND WEIGHT

Amplitude of total body length (Lt) of both males and females varied from 92 to 805 mm (mean 298.0 ± S.D. 146.8), that of males alone ranged from 92 to 661 mm (306 ± 139) and of females from 93 to 805 mm (289.2 ± 153.4) (Fig. 2). During the drought period, total body length of males and females ranged from101 to 598 mm (344.4 ± 136.4) and 107 to 805 (312.2 ± 176.5) respectively. During the rainy season, total length of males and females varied from 92 to 661 mm (285.9 ± 37.5) and from 93 to 565 mm (275.0 ± 135.9) respectively. A higher frequency of occurrence of total body length for males was registered in the class intervals between 100-200 mm and 400-500 mm during the wet and dry periods respectively, whereas the same for females was observed throughout the year in the class intervals between 100-200 mm.

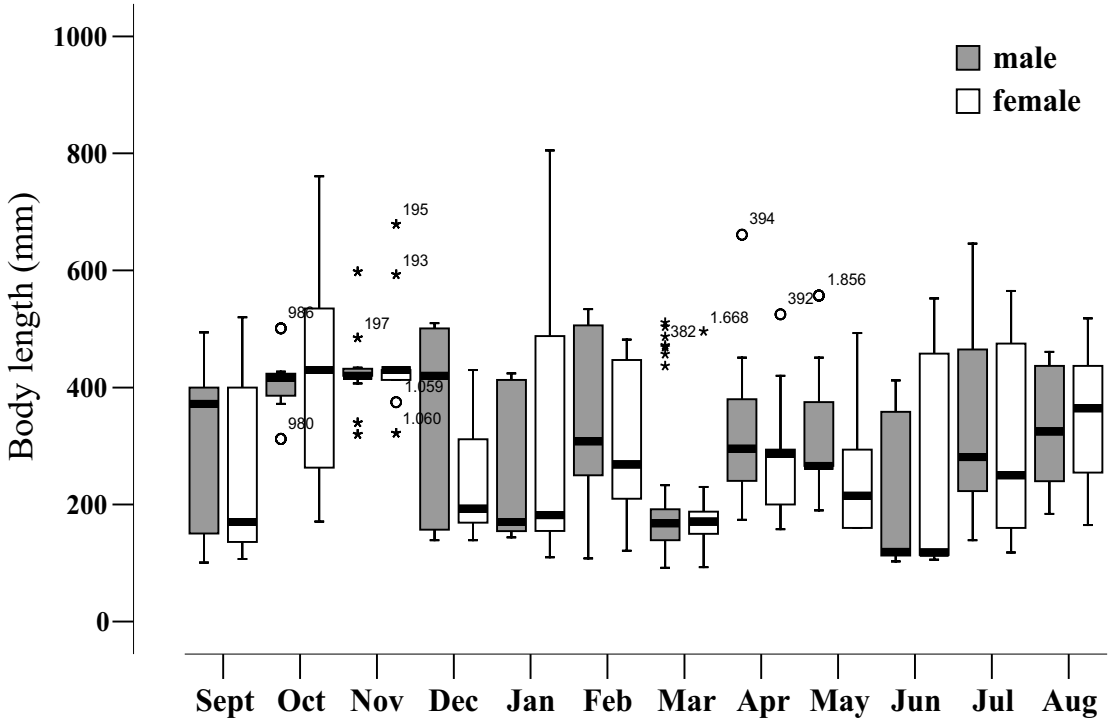

FIG. 2. Monthly variation in amplitude of total body length of males and females of *S. brasiliensis* during September 2005 to August 2006

The amplitude of total body weight (Wt) of males and females ranged from 7.7 to 3385 g (256.4 ± 358.9), that of males varied from 7.7 to 1493.5 g (250.0 ± 274.2) and of females varied from 8.1 to 3385 g (265.6 ± 430.9) (Fig. 3).Thus females were significantly heavier than males. During the drought period, total body weight of males and females varied from 14.6 to 1310 g (313.4 ± 243.9) and 8.1 to 4390 g (382.4 ± 692.5) respectively. During the rainy season, total weight of males and females varied from 7.7 to 1493.5 g (215.6 ± 83.8) and 11 to 1015.8 g (206.5 ± 250.9) respectively. A higher frequency of occurrence of total body weight of males and females was observed in the class intervals between 7 to 500 g.

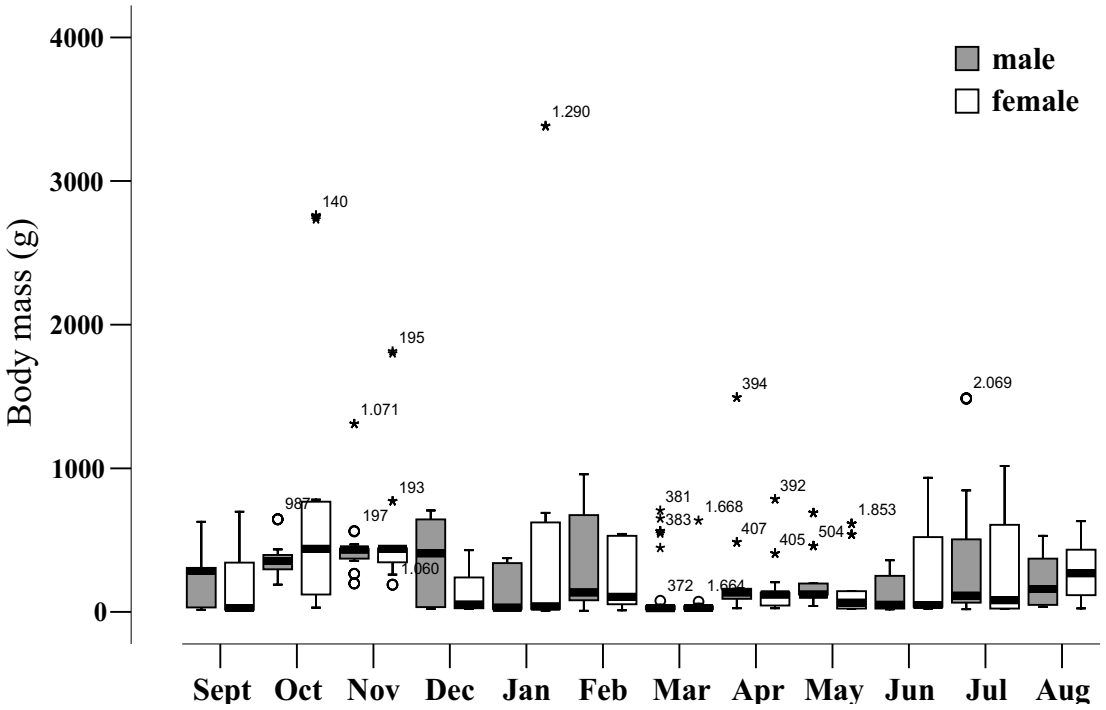

FIG. 3. Monthly variation in amplitude of total body mass of males and females of *S. brasiliensis* during September 2005 to August 2006.

SIZE AT MATURITY (ℓ_{50} & ℓ_{100})

Fifty percent maturity was attained by males and females of *S. brasiliensis* at 280.5 mm. In case of males 50% maturity was attained at 246 mm and females at 315 mm. All males and females were mature (ℓ_{100}) at 440 and 520 mm respectively. Onset of maturity for males were earlier during the dry period at 255 mm (ℓ_{50}) and 450 mm (ℓ_{100}) and during the rainy season they mature later at 246 (ℓ_{50}) and 460 mm (ℓ_{100}). A similar pattern was observed for females, they mature earlier during dry season at 315 and 500 mm (ℓ_{50} and ℓ_{100}) and at 320 and 515 mm during rainy season.

MACROSCOPIC AND HISTOLOGICAL EXAMINATIONS OF GONADS

The gonads of male and female *S. brasiliensis* were bi-lobed, elongate, and joined posteriorly to form a short gonoduct leading to the urogenital pore. The macroscopic staging of ovaries and testes based on the external appearance showed four stages: immature,

developing, mature and spent (Fig 4). Classification and description of the macroscopic aspects of gonad maturity stages in the females and males of *S. brasiliensis* are given in Table I and II.

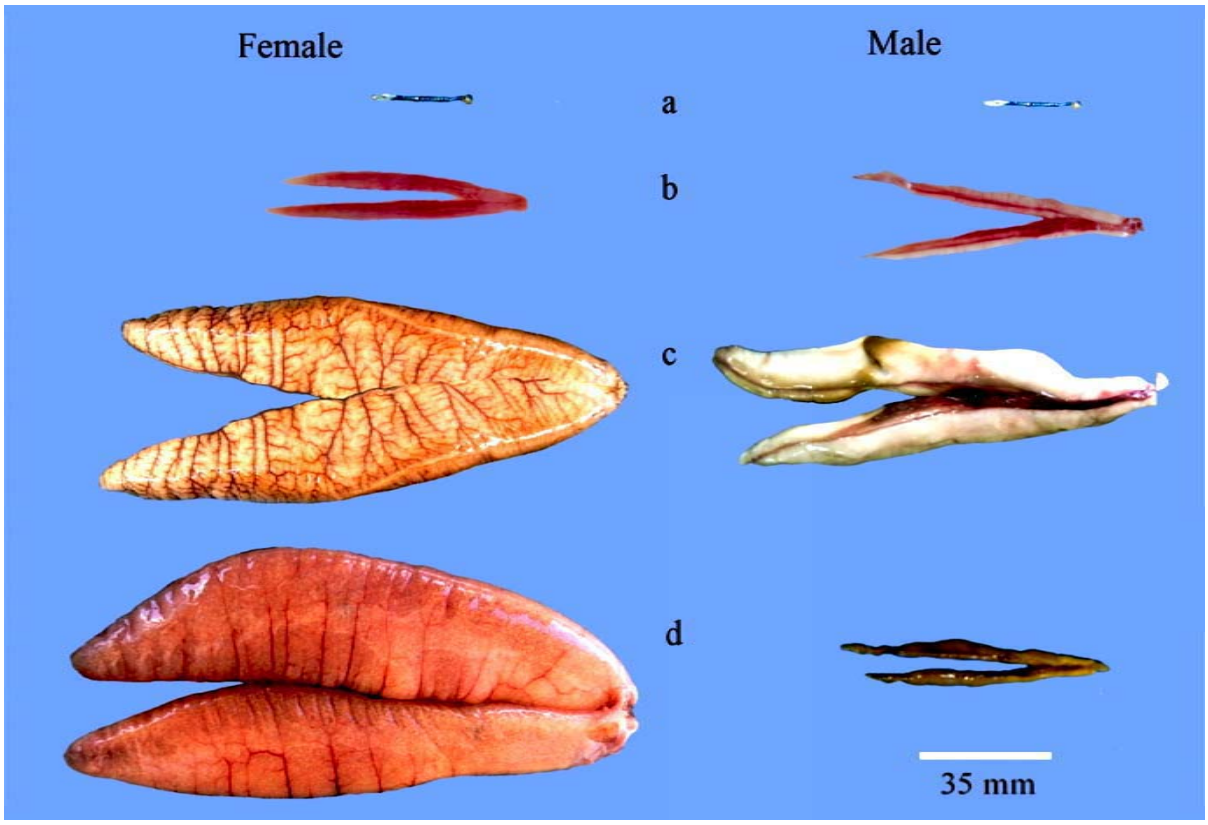

FIG. 4. Macroscopic aspects of gonads in females (left) and males (right) of *S. brasiliensis:* (a) Immature gonads, (b) developing gonads, (c) mature gonads and (d) spent and resting gonads (Scale bar =35mm).

Microscopic examination of histological sections of ovaries showed that the oocyte development was consistent along the whole length of the ovary depending on the degree of ovarian maturation. Ovaries revealed five stages of development: immature, early developing, late developing, mature, spent and resting. (Tab. I, Fig. 5 a-f). Testes showed four stages of development of spermatogonia, spermatocytes, spermatids and spermatozoa: immature, developing, mature, spent and resting (Tab. II).

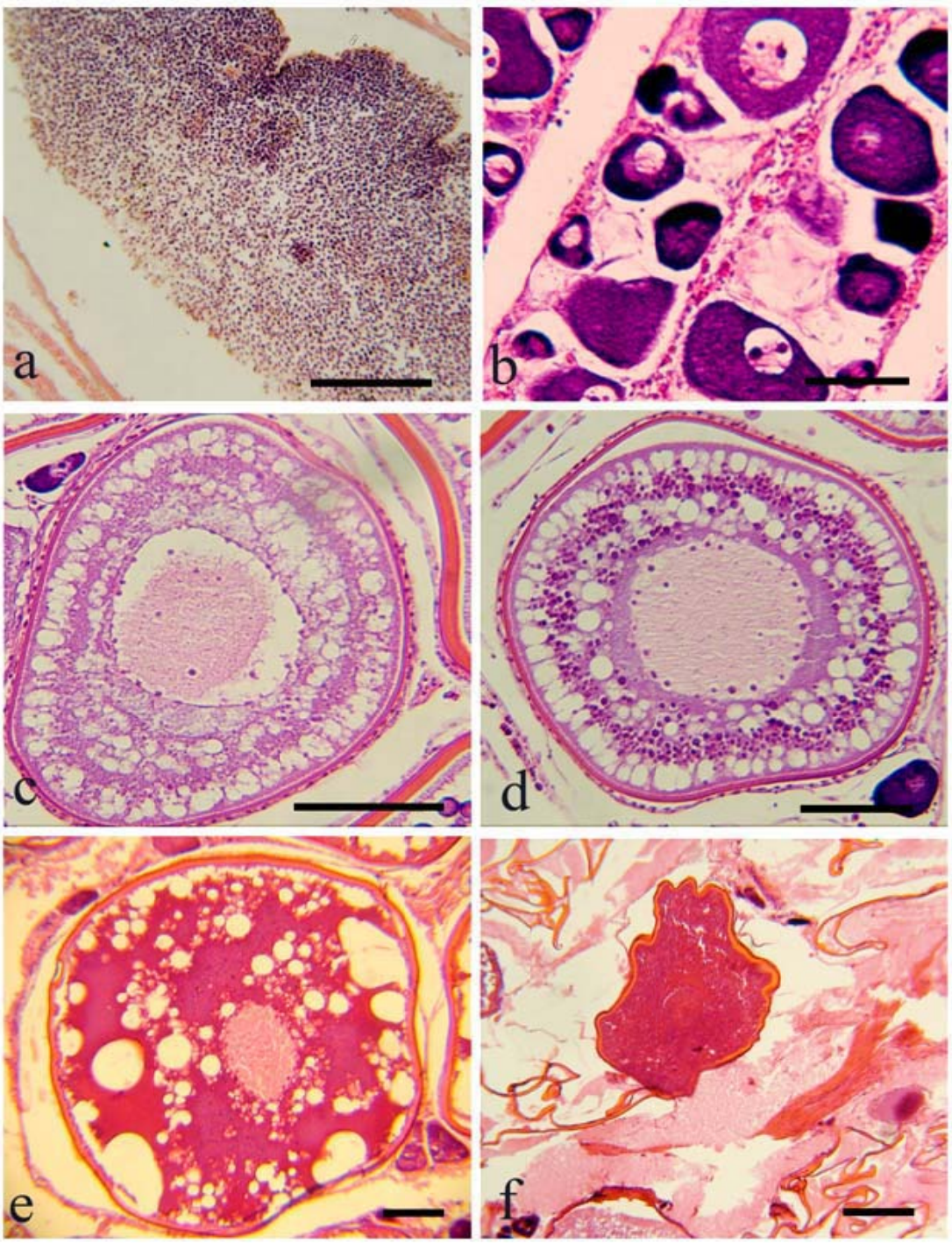

FIG. 5. Histological aspects of oocyte stages in ovarian development of *S. brasiliensis*: (a) nest of oogonia; (b) chromatin nucleolus stage and early perinucleolar stage oocytes; (c) oocyte in yolk vesicle stage; (d) oocyte with yolk granules and oil vesicles stage; (e) mature oocyte; (f) oocyte in the process of atresia in a spent ovary (Scale bar =100 μm).

TABLE I. Macroscopic and histological classification and descriptions of the ovarian maturity stages of *S. brasiliensis.*

Stage	Macroscopic description	Histological description
Immature	Ovaries small thread-like and translucent (Fig. 4a). Found in fish <200 mm.	Chromatin nucleolar stage, clusters of very small oocytes found lying just beneath the ovigerous lamella; young germ cells compactly fill the ovaries (Fig. 5a).
Early Developing:	Ovaries pinkish red and translucent (Fig. 4b).	Perinucleolar stage, oocytes with nucleoli at periphery of nucleus and cytoplasm thickens (Fig. 5b). Cortical alveoli stage, oil vesicles appear (Fig. 5c). Ovaries with early yolk globule and previtellogenic stage oocytes.
Late Developing:	Large ovaries with small opaque oocytes visible to the naked eye.	Yolk stage, oocytes show the presence of yolk granules near the periphery and oil vesicles within the inner region of the cytoplasm (Fig. 5d). Cytoplasmic vesicles with a uniform distribution.
Mature	Ovaries big and turgid, reddish with numerous oocytes, and intense superficial vascularization (Fig. 4c).	Nuclear migration and hydration stages, maturation into this stage is marked by the migration of the nucleus to the periphery of the oocyte, fusion of yolk granules into yolk plates and coalescence of oil droplets. (Fig. 5e). Nucleus breaks down when it reaches the periphery, hydration occurs.
Spent & Resting	Ovaries flaccid, pink and wrinkled (Fig. 4d).	Central region of the ovaries show hemorrhaging areas, empty spaces and residual oocytes in the reabsorbing process of atresia (Fig. 5f).

TABLE II. Macroscopic and histological classification and descriptions of the testicular maturity stages of *S. brasiliensis.*

Stage	Macroscopic description	Histological description
Immature	Testes small, extremely thin and translucent (Fig. 4a).	Grups of germinative cells (spermatogonia) inside the testes, with basophylic nucleus and reduced cytoplasm.
Developing	Testes are lobed, whitish with blood vessels appearing in the periphery (Fig. 4b).	Cysts of spermatocytes and spermatids in the tubes and central canal of the testes.
Mature	Testes large and turgid, whitish with presence of blood vessels (Fig. 4c).	Testes with plenty of spermatozoa in the tubes and central canal.
Spent & Resting	Testes flacid, light brown with blood vessels (Fig. 4d).	Testes with residual spermatozoa in the central canal.

GONADOSOMATIC INDEX (GSI)

Mean GSI for grouped sex was 0.25%, which varied from 0.01 % to 7.14 % (± 0.66). GSI of males varied from 0.01 to 2.2 (0.16 ± 0.25) and females from 0.02 to 7.14 (0.34 ± 0.91). Monthly values of GSI of developing, mature and spent females showed a period of peak reproductive activity during March-June. In April the adult females (n =4) had GSI varying from 0.14 to 3.24 (1.69 ± 1.78) and in June (n =16) from 0.08 to 4.14 (1.10 ± 1.81). GSI of adult males in February (n =24) varied from 0.11 to 1.18 (0.51 ± 0.40) and in July (n =15) from 0.10 to 1.16 (0.46 ± 0.44) (Fig. 6). Reproductive activity occurred during rainy season which lasted from February to August. During the rainy period GSI of males varied from 0.01 to 2.2 (0.16 ± 0.25) and that of females from 0.02 to 4.14 (0.27 ± 0.67). During drought GSI of males varied from 0.01 to 1.36 (0.16 ± 0.18), and that of females from 0.02 to 7.14 (0.46 ± 1.19). The highest GSI of females registered was in November (7.14) due to the

presence of only one mature individual with high GSI. The differences in the median values of GSI did not show significant difference (P >0,05).

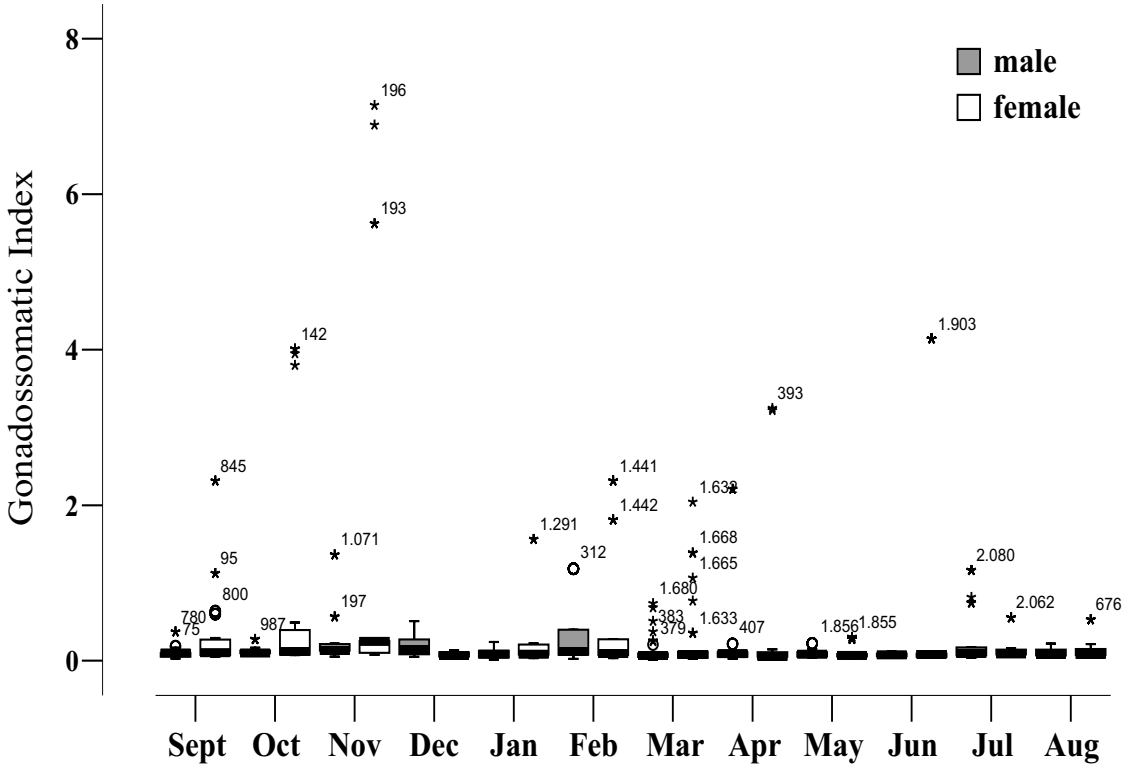

FIG. 6. Monthly variation in GSI in females and males of *S. brasiliensis* during September 2005 to August 2006.

FECUNDITY AND BREEDING

Mature females had a total body length of 712.7 mm (± 117.3) and weighed 2476.9 g (± 1043.82), with ovaries on an average weighing 71.3 g (± 36.8). Total fecundity was 871,523 mature eggs and relative fecundity was 952 mature eggs g^{-1}. Mature ovaries showed the reserve stock of perinucleolar stage oocytes (phase II) with diameter size <120 μm and mature oocytes with diameters ranging from 600 μm to 750 μm. Relative frequency distributions of the oocyte diameter sizes indicate that *S. brasiliensis* is a total spawner. Evidence of spawning was found in the histologically processed ovaries. The period of peak

reproductive activity occurred during March – June, coinciding with the rainy season which lasted from February to August.

RAINFALL

During the study period rainfall varied from 1.2 mm in November, 2005 to 427.9 mm in April, 2006 (138.9 ± 135.9). During this period northeastern Brazil experienced 5 months of drought, from September to January with rainfall ranging from 1.2 mm to 43.9 mm (21.3 ± 17.4), and 7 months of rain, from February to August ranging from 87.2 mm to 427.9 mm (206.7 ± 128.1).

DISCUSSION

The present study documents the sex ratio, onset of sexual maturity, changes in the reproductive activity, fecundity and breeding in *S. brasiliensis* occurring in the coastal waters of Northeastern Brazil.

Sex ratio and size structure constitute basic information in assessing reproductive potential and estimating stock size in fish populations. A balanced (1male to 1female) sex ratio was observed for *S. brasiliensis* with no significant temporal differences. Regional differences in fishing gear can affect catch and probably more females can be caught due to the type of fishing gear used, thus resulting in biased sex ratios as have been observed by several workers. For *S. maculatus* captured in Venezuela, Franco (1992) observed a sex composition of 54.9% of males and 44.1% of females. In the Maranhão coast of Brasil, a significant difference in sex ratio for *S. brasiliensis* was recorded (Silva *et al*., 2005), where females were predominant and outnumbered the males (1M:2F).

Fish population size structure is very important to assess the stock. This study establishes that females of *S. brasiliensis* are slightly bigger and heavier than males, in accordance with previous works carried out on this species (Fonteles-Filho, 1988; Franco, 1992). Growth of females most probably reflect the reproductive cycle, and as the ovaries mature they increase in weight and hence in total weight of fish. Differences in growth

patterns of males and females can thus provide a mechanism for an adaptive phenotypic response to changes in tropical coastal environments (Araújo & Chellappa, 2002).

The onset of sexual maturity represents a critical transition in the life history, since resource allocation is related mainly to growth before and to reproduction after the sexual maturity (Potts & Wootton, 1984). Thus, size at maturity of males and females is an important reproductive characteristic of fishes (Luksenburg & Pedersen, 2002; Chellappa *et al*., 2005; Murua & Motos, 2006). In the current study, the onset of sexual maturity in males *S. brasiliensis* was earlier than in females, as development of testes occurred at a smaller body size than for ovaries. The males matured earlier than the females both during the rainy and drought periods. All males were mature at 440 and females at 520 mm and all fish below 200 mm were immature, in accordance with works conducted with on this species (Gesteira & Mesquita, 1976; Franco, 1992). Fish can achieve sexual maturity at sizes which are small in comparison with those found in other populations of the same species due to phenotypic plasticity, which allows them to respond adaptively to the environmental change. Detailed information on size at sexual and maturity gonad development of fish permits the calculation of minimum size at capture, in order not to deplete the breeding stock.

The present study establishes four macroscopic stages for males and females and five stages of ovarian follicle development for females of S. *brasiliensis.* The macroscopic classification and histological analyses of the ovaries and testes suggest that there is a regular pattern of gonadal development for each maturity stage, the immature, developing, mature and spent stages. Dias *et al*. (1998) discussed the possible omissions of the various gonadal developmental stages due to macroscopic analyses and high-lighted the importance of histological studies involving microscopic observations in order to correct the same. Macroscopic analyses of gonads enable only gross information and may involve errors and omissions, whereas, histological studies have revealed various ovarian developmental stages for fishes, such as, in blue warehou, *Seriolella brama* (Günther) (Knuckey & Sivakumaran,

2001), flying fish, *Hirundichthys affinis* (Günther) (Araújo & Chellappa, 2002) and Argentine hake, *Merluccius hubbsi* Marini (Honji *et al*., 2006).

Fecundity plays a key role as both a critical parameter of stock assessment based on egg production and as a fundamental aspect of fish population dynamics. Fecundity in *S. brasiliensis* show a decreasing tendency since 1972, from a total fecundity of 2,047,000 eggs and relative fecundity of 1,892 eggs female g^{-1} (Gesteira, 1972) to a total fecundity of 871,523 mature eggs and relative fecundity of 952 eggs female g^{-1} in the present study. The following reasons can possibly be contributing to this situation. First, the indiscriminate harvesting of *S. brasiliensis* populations in the coastal waters of northeastern Brazil is possibly leading to a situation where the number of fish that reach maturity is being progressively reduced, thereby lowering their reproductive capacity. Second, the decrease in fecundity over the period 1972-2006 in *S. brasiliensis* can indicate a decrease in reproductive effort among spawning females during the latter period. This also suggests that the decrease in fecundity was primarily due to a decrease in the number of eggs g^{-1} in the ovaries. *S. brasiliensis* is a total spawner releasing all of mature oocytes at the same time, on the other hand multiple spawners are characterised by the temporal pattern of ovarian stages, with the release of mature oocytes in batches as in *Cichla monoculus* Spix & Agassiz (Chellappa *et al*., 2003).

The reproductive process, such as gonad maturation, in tropical fishes is influenced by various environmental changes induced by the onset of rains. Drought is a natural climatic situation which is characteristic of northeastern Brazil, with irregular distribution of rain in the region (Serhid, 2006). The spawning characteristics of males and females of *S. brasiliensis* showed that the peak period of reproductive activity was during March-June coinciding with the rainy season and very few spawning fish were found outside these months. The macroscopic and histological analysis of gonads equally confirmed that breeding season commenced with the onset of rains.

It is interesting to observe that the peak breeding season of *S. brasiliensis* in northeastern Brazil takes place in a sequential manner, March-June in the coastal areas of Natal, September in the littoral of Ceará and October in Maranhão coastal waters (Gesteira & Mesquita, 1976; Batista & Fabré (2001). A similar trend was observed in Australia for Spanish mackerel S. *commerson* Lacepède (Mackie *et al*., 2005). These probably reflect their migration for feeding and reproductive purposes. In tropical regions the rainfall plays an important role in determining the reproductive cycles of fishes and collective reproduction occurs during the time when environmental conditions are favorable for the survival of juvenile forms and when adequate food is available, besides protection from predators. Monthly variations of GSI of *S. brasiliensis* showed that peak breeding coincides with rainy season and possibly better environmental conditions.

Conservation of fish stocks in their natural habitat are usually endangered by abusive fishing of immature fishes which have not yet completed their reproductive cycle, as recruitment via reproduction is the means by which the resource is renewed (Lucena *et al*., 2004). The traditional fishing communities depend on small scale artisanal fishery, which reflects their way of making a living and sustain their lifestyle. Though it is important to preserve this, it is also vital to programme the sustainability and conservation of the fisheries resource. In the predatory fishing technique of beach seine nets with small mesh size are used, in order to catch shrimps, which accounts for a large by-catch of small sized immature *S. brasiliensis*. Measures should be taken to regulate this fishery in order to conserve this valuable fishery resource.

ACKNOWLEDGMENTS

The authors wish to thank the National Council for Scientific and Technological Development of Brazil (CNPq) for the financial support awarded during the study period (J. T.

A. Ximenes de Lima, Grant nº. 141651/2005-9**)** and for the Research grants awarded (S. Chellappa, Grant nº. 307497/2006-2, A. Araújo, Grant nº. 302012/2006-0 and N. T. Chellappa, Proc.No.306274/2003-5).

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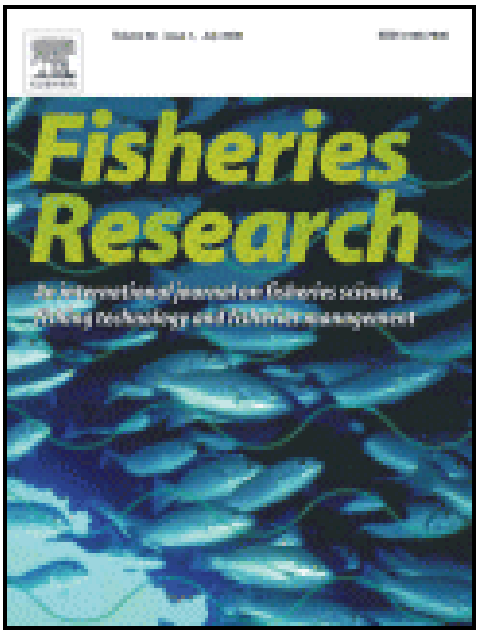
FISHERIES RESEARCH



Editor-in-Chief:*
A. D. McIntyre

ARTIGO EM PREPARAÇÃO

Ovarian development and spawning of the Serra Spanish mackeral in the Southwest Atlantic coastal waters

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Ovarian development and spawning of the Serra Spanish mackeral in the Southwest Atlantic coastal waters

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Running headline: Ovarian development of Serra Spanish mackerel

Abstract

The Serra Spanish mackerel, *Scomberomorus brasiliensis* is an important fishery resource of the Atlantic Ocean and is a major component of the Brazilian artisanal fishery. Ovarian development and spawning period of *S. brasiliensis* in the Southwest Atlantic coastal waters were investigated using both macroscopic and histological techniques. Mean monthly values of GSI and ovarian maturation indicate that the main spawning period occurs during the rainy season.

Keywords: Serra Spanish mackerel; spawning period; ovarian development; histology of ovary.

1. Introduction

The Serra Spanish mackerel, *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin) (Osteichthyes: Scombridae) occurs in the Western Atlantic, along the Caribbean in Central Atlantic coasts and Southwest Atlantic from Belize to Rio Grande do Sul, Brazil (Collette *et al*., 1978). It is an important fishery resource of the Atlantic Ocean and is a major component of the Brazilian artisanal fishery with high commercial value.

Although *S. brasiliensis* is an important food fish throughout most of its distributional range, limited details are available about the gonadal development of this species. Information on ovarian maturity is required for stock assessments, which is insufficiently described in the literature available for this species. Some aspects of the reproductive biology of *S. brasiliensis* have been studied throughout its geographical range. In Southwest Atlantic coastal waters, females of *S. brasiliensis* attain gonad maturity at 280 mm and males at 345 mm of total body length (Lima et al., 2007). Estimates of absolute and relative fecundity have been made (Gesteira, 1972; Gesteira & Mesquita, 1976; Lima et al., 2007). Despite these studies, a complete description of the reproductive cycle of *S. brasiliensis* including oogenesis and spawning strategy has not been documented.

The objective of this study was to provide a comprehensive description of the macroscopic and histological aspects of ovarian maturation of Serra Spanish mackerel, *S. brasiliensis* of the Atlantic Ocean coastal waters of northeastern Brazil. This study also examines the annual variation in the gonadosomatic index focusing on spawning season. An attempt is made to correlate the spawning season of this species with rainfall, one of the environmental factors known to modulate the duration and timing of the spawning period of tropical fish.

2. Materials and methods

2.1 *Sample Collection*

During the period of September 2005 to August 2006, monthly samples (n = 20) of Serra Spanish mackerel were collected from artisanal fishery at various locations in the coastal waters situated between latitudes 0º00' and 10º00'S, longitudes 32º00' and 40º00'W in the Southwest Atlantic specifically from Natal Division of Northern Sub-area (Figure 1). The samples collected were random subsamples of a larger catch landed by fisherman. Fish were caught by local fishermen using beach-seines from the coastal waters of approximately <10 m depth. The beach-seines were 110 m in length, 3 m in height, with a mesh size of 1 cm in the central part and 7 cm in the extremities. Fish collected from the beach-seine fishing process were numbered, measured, weighed and samples of whole fish were used for morphometric analysis to confirm the taxonomical identification of the species (Carpenter, 2002). Rainfall data of the region was obtained from the Meteorological Department of Natal, Brazil.

Figure 1. Fish collection site in the coastal waters of the Southwest Atlantic.

2. 2 *Measurements*

A total of 826 fish was collected during the study period and the sample size was sufficiently large to allow accurate estimations. The total body length (Lt) of fish were measured to the nearest 1 mm and body mass (Wt) recorded (± 1 g). Fish were dissected within a few hours of capture, and gonads were removed, weighed (Wg ± 0.1 mg) and examined to separate the sex. A total

of 402 females collected were separated for detailed studies.

2.3 *Macroscopic and histological examinations of ovaries*

The location and general aspects of the ovaries were noted and stage of reproductive maturity determined using a macroscopic staging system.

The degree of turgidity, colour and presence of blood vessels of the ovaries were observed (Mackie & Lewis, 2001). In order to avoid possible variation in the developmental stage of oocytes due to their position in the ovaries, histological examinations were carried out on sections from the anterior (cephalic), middle (central), and posterior (caudal) regions of 20 ovaries in different developmental stages (Yoshida, 1964).

These data were later compared in order to determine whether samples taken from mid-section of the ovary of either lobe were representative of oocyte development. The gonads were preserved in Bouin's solution, later embedded in paraffin, sectioned at 3 – 5 μm thickness, and stained with Harris hematoxylin and eosin (H&E).

Ovarian developmental stages were assessed microscopically with the help of light microscope (Taimin, model TM 800), coupled with a video camera (Kodo Digital). The terminology used for stages of oogenesis followed that of West (1990) and Palmer *et al*. (1995).

2.4 *Estimation of Gonadosomatic index and spawning period*

The gonadosomatic index (GSI) was calculated using the formula of Wootton *et al*. (1978): GSI = weight of ovary (g) / body weight of fish (g) - weight of gonads (g) X 100. Period of breeding was determined by the temporal relative frequency distribution of the different stages of ovarian maturation (De Martini & Fountain 1981).

2.5 *Statistical analyses*

Gonadosomatic indices of females during rainy and dry periods were compared at 5% level using Kruskal-Wallis One Way Analysis of Variance on Ranks (Software Statistica, version 7.0 Windows). Pearson's correlation tests were performed to determine the correlation between the variables weight and length of host fish and number of parasites. The t-test was applied to compare the mean condition factor of the parasitized and non-parasitized fish. The χ^2 (chi-square) test was used to verify the differences and their significance (5%) in the proportion between parasitized male and female host fish. The statistical analyses were conducted using Statistica 7.0 software.

3. Results

3.1 *Rainfall*

During the study period rainfall varied from 1.2 mm in November, 2005 to 427.9 mm

in April, 2006 (138.9 ± 135.9). During this period northeastern Brazil experienced 5 months of drought, from September to January with rainfall ranging from 1.2 mm to 43.9 mm (21.3 ± 17.4), and 7 months of rain, from February to August ranging from 87.2 mm to 427.9 mm (206.7 ± 128.1).

3.2 *Total body length and weight*

Amplitude of total body length (Lt) of the sampled females over the whole year varied from 93 to 805 mm (289.2 ± 153.4). During the drought period, their total body length ranged from 107 to 805 (312.2 ± 176.5), and during the rainy season from 93 to 565 mm (275.0 ± 135.9). A higher frequency of occurrence of females in the class intervals 100 - 200 mm. of total body length was registered throughout the year. The amplitude of total body weight (Wt) of the females varied from 8.1 to 3385 g (265.6 ± 430.9) over the year. During the drought period, total body weight of females varied from 8.1 to 4390 g (382.4 ± 692.5) and during the rainy season from 11 to 1015.8 g (206.5 ± 250.9). A higher frequency of occurrence of females in the class intervals 8 to 500 g of body weight was observed throughout the year.

The amplitude of gonad weight (Wg) varied from 0.005 to 119.99 g (2.97 ± 0.72) over the year. The analize of the figure 2a and b shows the positive correlations (r^2>0.7) of body mass and length and of gonad weight and body mass of females *S. brasiliensis*.

3.3 *Macroscopic and histological aspects of ovaries*

The ovaries were bi-lobed, elongate, and joined posteriorly to form a short gonoduct leading to the urogenital pore.

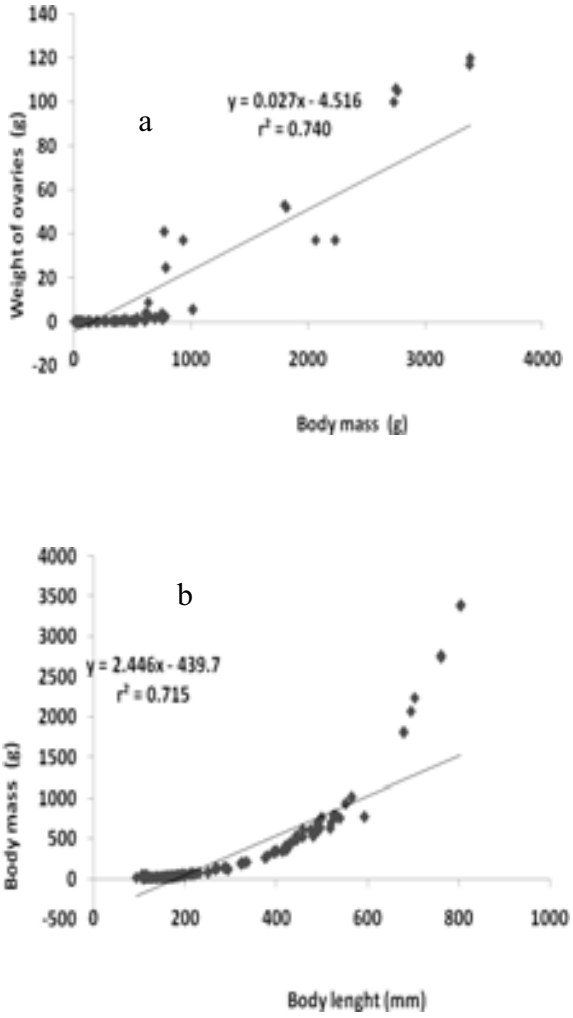

Figure 2. Correlations of (a) body mass (Wt) and length (Lt); (b) gonad weight (Wg) and body mass (Wt) of females *S. brasiliensis*.

The macroscopic staging of ovaries based on the external appearance monthly showed four stages: immature, developing, mature and spent (Figure 3). Classification and description of the macroscopic aspects of ovarian development stages are given in table I.

The figure 4 shows the monthly frequency of ovarian maturity stages in *S. brasiliensis* during 2005 to 2006.

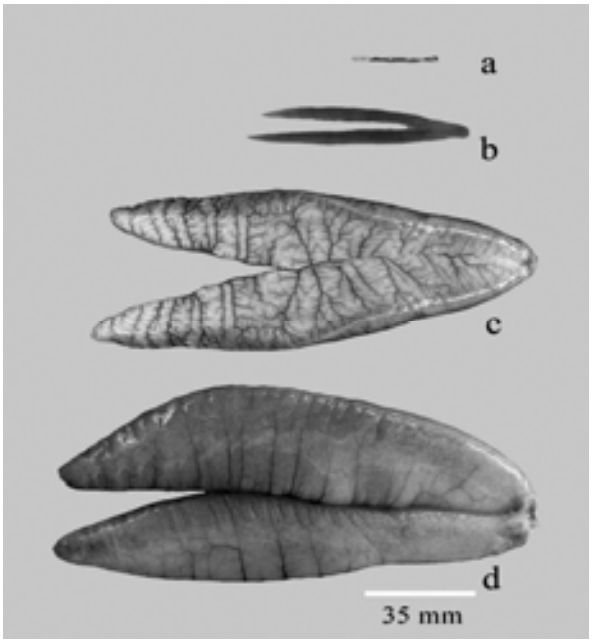

Figure 3. Macroscopic aspects of ovaries of *S. brasiliensis* (a) immature, (b) developing, (c) mature and (d) spent (Scale bar = 35mm).

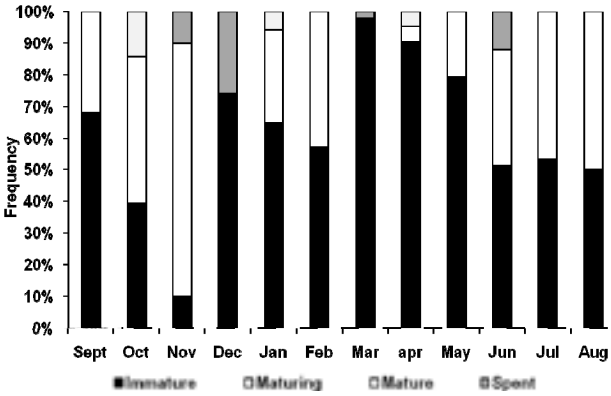

Figure 4. Monthly frequency of ovarian maturity stages in *S. brasiliensis* during 2005 to 2006.

Microscopic examination of histological sections of ovaries showed that the oocyte development was consistent along the whole length of the ovary depending on the degree of ovarian maturation. Ovaries revealed five stages of oocyte development: immature, early developing, late developing, mature, spent & resting (Table I, Figure 5a-d).

3.4 *Gonadosomatic Index (GSI)*

GSI of females varied from 0.02 to 7.14 (0.34 ± 0.91). Monthly values of GSI of developing, mature and spent females showed a period of peak reproductive activity during the months of March to June. In April the adult females (n =4) had GSI varying from 0.14 to 3.24 (1.69 ± 1.78) and in June (n =16) from 0.08 to 4.14 (1.10 ± 1.81) (Figure 6). Reproductive activity occurred during rainy season which lasted from February to August. During the rainy period, GSI of females varied from 0.02 to 4.14 (0.27 ± 0.67) and during the dry season, GSI ranged from 0.02 to 7.14 (0.46 ± 1.19). The highest GSI of females registered was in November (7.14) due to the presence of only one mature individual with high GSI. The differences in the mean values of GSI did not show significant difference (P >0,05) (Figure 6).

3.5 *Spawning period*

Mature females had a total body length of 712.7 mm (± 117.3) and weighed 2476.9 g (± 1043.82), with ovaries on an average weighing 71.3 g (± 36.8). Mature ovaries showed the reserve stock of perinucleolar stage oocytes (phase II) with diameter size < 120 µm and mature oocytes with diameters ranging from 600 to 750 µm.

Evidence of spawning was found in the histologically processed ovaries. The period of peak reproductive activity occurred during March – June, coinciding with the rainy season which lasted from February to August.

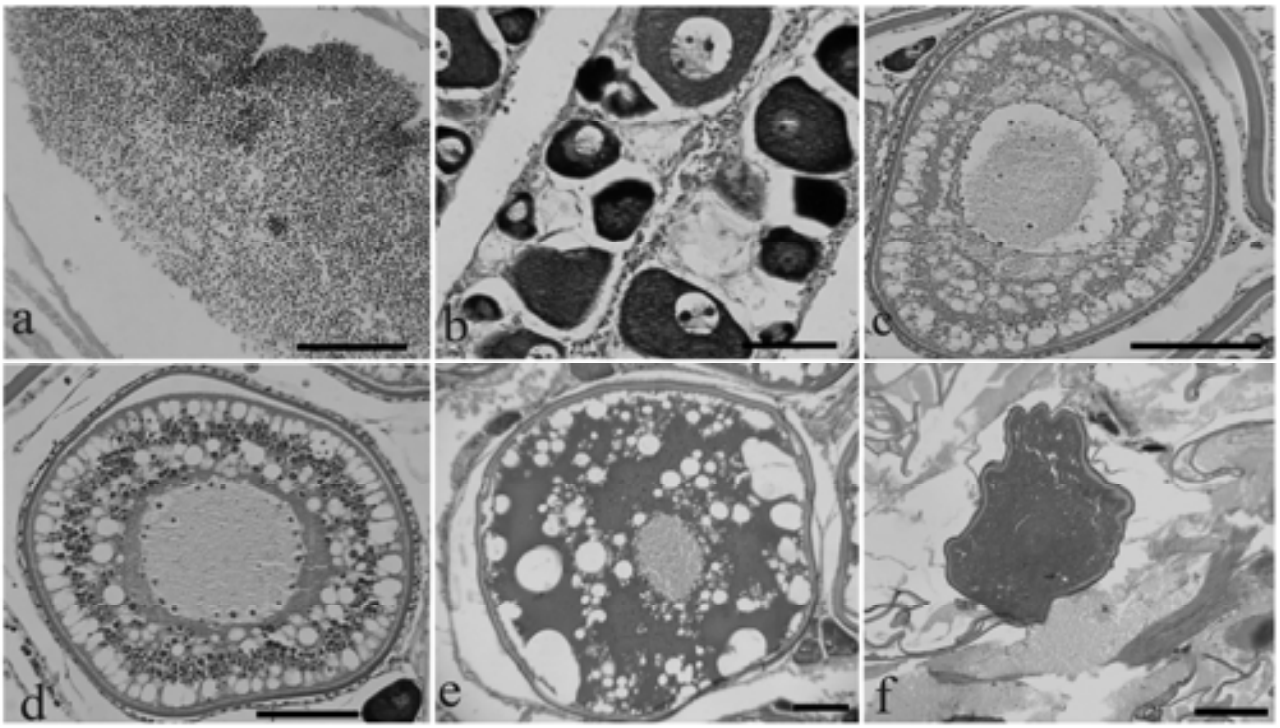

Figure 5. Histological aspects of oocyte developmental stages of *S. brasiliensis*: (a) nest of oogonia; (b) chromatin nucleolus stage and early perinucleolar stage oocytes; (c) oocyte in yolk vesicle stage; (d) oocyte with yolk granules and oil vesicles stage; (e) mature oocyte; (f) oocyte in the process of atresia in a spent ovary (Scale bar =100 μm).

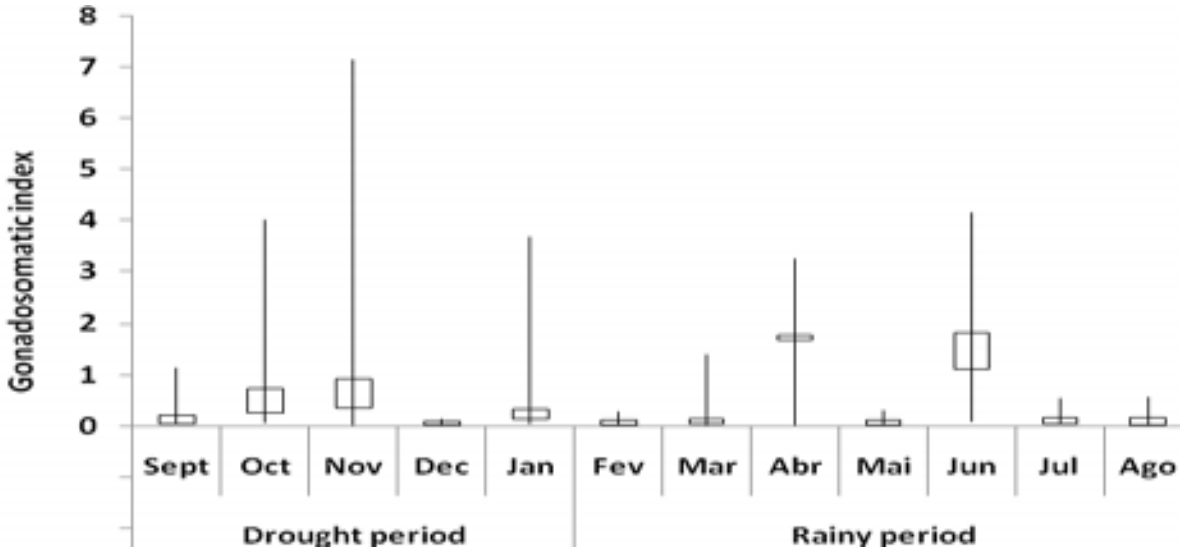

Figure 6. Monthly variation in Gonadossomatic Index (GSI) of *S. brasiliensis* during 2005 to 2006.

4. Discussion

The present study documents the changes in the ovarian activity and spawning in Serra Spanish mackeral occurring in the coastal waters of Atlantic Ocean off northeastern Brazil. Growth of females reflect the reproductive cycle, since as the ovaries mature they increase in weight and hence in total weight of fish.

TABLE I. Macroscopic and histological classification and description of the ovarian maturity stages of *S. brasiliensis.*

Stage	Macroscopic description	Histological description
Immature	Ovaries small thread-like and translucent (Figure 3a). Found in fish <200 mm.	Chromatin nucleolar stage, clusters of very small oocytes found lying just beneath the ovigerous lamella; young germ cells compactly fill the ovaries (Figure 5a).
Early Developing:	Ovaries pinkish red and translucent (Figure 3b).	Perinucleolar stage, oocytes with nucleoli at periphery of nucleus and cytoplasm thickens (Figure 5b). Cortical alveoli stage, oil vesicles appear (Figure 5c). Ovaries with early yolk globule and previtellogenic stage oocytes.
Late Developing:	Large ovaries with small opaque oocytes visible to the naked eye.	Yolk stage, oocytes show the presence of yolk granules near the periphery and oil vesicles within the inner region of the cytoplasm (Figure 5d). Cytoplasmic vesicles with a uniform distribution.
Mature	Ovaries big and turgid, reddish with numerous oocytes, and intense superficial vascularization (Figure 3c).	Nuclear migration and hydration stages, maturation into this stage is marked by the migration of the nucleus to the periphery of the oocyte, fusion of yolk granules into yolk plates and coalescence of oil droplets. (Figure 5e). Nucleus breaks down when it reaches the periphery, hydration occurs.
Spent and Resting	Ovaries flaccid, pink and wrinkled (Figure 3d).	Central region of the ovaries show hemorrhaging areas, empty spaces and residual oocytes in the reabsorbing process of atresia (Figure 5f).

Differences in growth patterns of females can thus provide a mechanism for an adaptive phenotypic response to changes in tropical coastal environments. The onset of sexual maturity represents a critical transition in the life history, since resource allocation is related mainly to growth before and to reproduction after the sexual maturity (Potts & Wootton, 1984). The present study establishes four macroscopic stages and five stages of ovarian oocyte development for females of Serra Spanish mackerel. The

macroscopic classification and histological analyses of the ovaries suggest that there is a regular pattern of gonadal development for each maturity stage, such as the immature, developing, mature and spent stages. Histological studies have revealed various ovarian developmental stages for fishes, as in blue warehou, *Seriolella brama* (Günther) (Knuckey & Sivakumaran, 2001), Argentine hake, *Merluccius hubbsi* Marini (Honji *et al*., 2006) and the white mullet, *Mugil curema* in the South Caribbean (Solomon & Ramnarine, 2007).

The reproductive process, such as gonad maturation, in tropical fishes is influenced by various environmental changes induced by the onset of rains. Drought is a natural climatic situation which is characteristic of northeastern Brazil, with an irregular pattern of distribution of rain in the region.

The spawning characteristics of females of Serra Spanish mackerel showed that the peak period of reproductive activity was during March-June coinciding with the rainy season and very few spawning fish were found outside these months. The macroscopic and histological analysis of ovaries equally confirmed that breeding season commenced with the onset of rains.

In tropical regions the rainfall plays an important role in determining the reproductive cycles of fishes and collective reproduction occurs during the time when environmental conditions are favorable for the survival of juvenile forms and when adequate food is available, besides protection from predators. Monthly variations of GSI of Serra Spanish mackerel showed that peak breeding coincides with rainy season and possibly better environmental conditions.

It is interesting to observe that the peak breeding season of Serra Spanish mackerel in northeastern Brazil takes place in a sequential manner, in the coastal areas of Natal the spawning season is from March-June whereas in the Maranhão coastal waters of Brazil spawning has been reported in October (Batista & Fabré, 2001). A similar trend was observed in Australia for Spanish mackerel S. *commerson* Lacepède (Mackie *et al*., 2005). These probably reflect their migratory route for feeding and reproductive purposes.

Conservation of fish stocks in their natural habitat are usually endangered by abusive fishing of immature fishes which have not yet completed their reproductive cycle, as recruitment via reproduction is the means by which the resource is renewed.

The traditional fishing communities depend on small scale artisanal fishery, which reflects their way of making a living and sustain their lifestyle. Though it is important to preserve this traditional fishery, it is also vital to programme the sustainability and conservation of the coastal fisheries resources. In the predatory fishing technique of beach

seine nets where small mesh sizes are used, in order to catch shrimps, which account for a large by-catch of small sized immature Serra Spanish mackerel. Measures should be taken to regulate this fishery in order to conserve this valuable fishery resource.

Acknowledgements

The authors wish to thank the National Council for Scientific and Technological Development of Brazil (CNPq) for the financial support awarded during the study period (J. T. A. Ximenes de Lima, Grant nº. 141651/2005-9**)** and for the Research grants awarded (S. Chellappa, Grant nº. 307497/2006-2, A. Araújo, Grant nº. 302012/2006-0 and N. T. Chellappa, Grant nº. 306274/2003-5).

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Revista Brasileira de Zoologia

ISSN 0101-8175
ISSN 1806-969X

Revista Brasileira de Zoologia, Curitiba, 22 (4): 821–1224, dezembro 2005

Livoneca redmanni Leach (Isopoda, Cymothoidae) e *Rocinela signata* Schioedte & Meinert (Isopoda, Aegidae), ectoparasitos de *Scomberomorus brasiliensis* Collette, Russo & Zavala-Camin (Ostheichthyes, Scombridae) no Rio Grande do Norte, Brasil

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ABSTRACT. ***Livoneca redmanni*** **Leach (Isopoda, Cymothoidae) and** ***Rocinela signata*** **Schioedte & Meinert (Isopoda, Aegidae), ectoparasites of** ***Scomberomorus brasiliensis*** **Collette, Russo & Zavala-Camin (Ostheichthyes, Scombridae) in Rio Grande do Norte, Brazil.** Among the crustacean isopoda there exists ectoparasites which are easy to observe due to their size. They cause lesions on the host that could lead to death. The present study verified the occurrence of parasitic isopods on the fish Serra Spanish mackerel, *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin, 1978) from the coastal waters of Rio Grande do Norte, Brazil. Indices of parasitic infection by isopods were calculated and correlated to the body size, weight and the stage of gonadal maturity of the host. *Livoneca redmanni* (Leach, 1818) (Cymothoidae) and *Rocinela signata* (Schioedte & Meinert, 1879) (Aegidae) were registered for the first time in the coastal waters of Rio Grande do Norte. *L. redmanni* was encountered both in the oral cavity and in the gill chambers of the host, whereas *R. signata* was found only in the gill chambers. Parasitic isopods were encountered on 31% of *S. brasiliensis* captured, wherein 86% was *L. redmanni* and 14% was *R. signata*. The maximum parasitic intensity was four with a minimum of one isopods per host. The isopods showed a preference for immature and maturing stages of the host *S. brasiliensis*.

KEY WORDS. Gill chamber, isopod marine, oral cavity, parasites, parasitic infection.

RESUMO. Entre Isopodas Crustaceas existem ectoparasitos que são de fácil observação devido ao seu tamanho. Eles causam lesões mecânicas no hospedeiro que podem resultar em morte. Este trabalho verificou a existência de parasitismo por isópodos no peixe serra, *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin, 1978) das águas costeiras do Rio Grande do Norte, Brasil. Os índices de infestação parasitária dos isópodos foram calculados e relacionados com o tamanho, peso e o estado gonadal do hospedeiro. *Livoneca redmanni* (Leach, 1818) (Cymothoidae) e *Rocinela signata* (Schioedte & Meinert, 1879) (Aegidae) foram registradas pela primeira vez nas águas costeiras do Rio Grande do Norte. Os locais de fixação de *L. redmanni* no hospedeiro foram a cavidade bucal e a câmara branquial, enquanto *R. signata* sempre foi encontrada na câmara branquial. Dos exemplares de *S. brasiliensis* capturados 31 % estavam parasitados, onde 86 % eram de *L. redmanni* e 14 % de *R. signata*. Foi registrado uma intensidade mínima de um e máxima de quatro isópodos por hospedeiro. Os isópodos apresentaram uma preferência pelos hospedeiros imaturos e em maturação de *S. brasiliensis*.

PALAVRAS CHAVE. Câmara branquial, cavidade bucal, isopodas marinhos, parasitos, infestação parasitária.

Na ictiofauna marinha da região sul do Brasil foi registrado a ocorrência de espécies de ectoparasitos de Cymothoidae (Thatcher *et al.* 2003) e as espécies de Aegidae foram encontradas no sudeste do Brasil (Moreira 1972, 1977). Os crustáceos isópodos parasitos habitam a câmara branquial, cavidade bucal e tegumento dos peixes, sendo facilmente detectados a olho nu (Eiras *et al.* 2000, Thatcher 2000). As formas jovens dos parasitos podem penetrar mais intensamente abaixo das escamas

dos peixes, e à medida que crescem ocupam boa parte da cavidade visceral, o que compromete o crescimento do animal. A quantidade e o local de fixação dos parasitos, bem como o tamanho do hospedeiro, causa alterações na capacidade respiratória dos peixes, emagrecimento, redução na taxa de crescimento e alteração na capacidade natatória. Em geral os parasitos acarretam lesões, cujos resultados podem levar à instalação de infecções que propiciam a morte do peixe (Pavanelli *et al.* 1999).

Scomberomorus brasiliensis é uma espécie marinha de valor comercial que habita a maior parte do litoral brasileiro, com exceção das extremidades do norte e do sul (Zavala-Camin 1983). Os dados da produção pesqueira demonstram que a quantidade desembarcada apresentou uma tendência de crescimento no Rio Grande do Norte, Ceará, Piauí, Maranhão e Pará (Ibama 2003).

Scomberomorus brasiliensis foi uma das espécies de peixes marinhos das águas costeiras do Rio de Janeiro, Brasil, que foram estudadas em relação à biodiversidade parasitária (Luque *et al.* 2004), no entanto, existe uma carência de informações sobre o parasitismo do Scombridae no Rio Grande do Norte.

Foi verificada a existência do parasitismo por isópodos em *S. brasiliensis* capturados nas águas costeiras do Rio Grande do Norte. Os índices de infestação parasitária dos isópodos foram calculados e relacionados com o tamanho, peso e o estado gonadal do serra.

MATERIAL E MÉTODOS

As coletas dos peixes-serra foram realizadas mensalmente durante o período de agosto de 2003 a julho de 2004, nas águas costeiras da Praia de Ponta Negra (05°52'30"S e 35°08'00"W), localizada na região urbana no município de Natal, Rio Grande do Norte, Brasil. Os peixes foram capturados por meio de redes de arrasto de praia do tipo tresmalho com 110 m de comprimento, 3 m de altura com malha central de 10 mm e 70 mm nas extremidades. A rede foi lançada a 100 m de distância da praia, em uma profundidade de 5 m, utilizando uma pequena balsa chamada catraia. Todo o processo, desde a arrumação até a retirada da rede com os peixes, dura em torno de uma hora e 30 minutos. Mensalmente as coletas foram realizadas com o uso de três arrastos-de-praia consecutivos com o esforço de seis a 12 pessoas.

No Laboratório de Ictiologia da Universidade Federal do Rio Grande do Norte os peixes foram medidos (comprimento total em mm) e pesados (peso total em g). Os valores morfométricos e merísticos dos peixes foram utilizados para confirmar a taxonômia da espécie (Fontelles-Filho 1988). Posteriormente, os peixes foram dissecados para a sexagem e a determinação dos estádios de maturação gonadal seguindo a metodologia de Vazzoler (1996).

Foi realizada uma procura minuciosa de ectoparasitos na superfície corporal, na cavidade bucal e na câmara branquial dos peixes, seguindo as técnicas propostas por Eiras *et al.* (2000). Os isópodos foram cuidadosamente retirados e acondicionados em tubos de ensaio com álcool a 70%, posteriormente sendo identificados através da utilização de chaves de identificação (Thatcher 2000).

Os cálculos dos índices parasitários foram efetuados a partir do formulário de necropsia dos peixes que contêm informações tais como: o número de parasitos isópodos em cada hospedeiro e o respectivo local de fixação destes. Os índices calculados foram os seguintes: Prevalência ($P = npp / n_{\_} 100$), onde npp = número de peixes parasitados, e n = número de peixes examinados; Intensidade (mínimo e máximo); Intensidade média de parasitos por peixes (Im = tpp/ npp), onde tpp = número total de parasitos na amostra; Abundância (A = tpp/ ntp), onde ntp = número total de peixes (parasitados ou não) na amostra (Bush *et al.* 1997). Foram registradas também a relação parasito-hospedeiro, o tamanho, o peso e os estádios de maturação gonadal dos hospedeiros.

RESULTADOS E DISCUSSÃO

A variação do peso total de *S. brasiliensis* capturados neste estudo foi de 15 a 3,385 g e a de comprimento total foi de 135 a 805 mm, e observou-se a presença dos estádios gonadais imaturos, em maturação, maduros e esvaziados.

Os parasitos identificados em *S. brasiliensis* pertencem a duas famílias: Cymothoidae, com a espécie *L. redmanni* (Leach, 1818) e Aegidae, com a espécie *R. signata* (Schioedte & Meinert, 1879).

Dos peixes serras capturados 31 % estavam parasitados, totalizando 67 isópodos fixados nas lamelas branquiais do peixe; a maioria estava na câmara branquial (Figs 1-2) e apenas um na cavidade bucal do peixe (Fig. 3). Uma fêmea da serra apresentava duas espécies de isópodos aderidas às brânquias, o que corresponde a um caso de coexistência parasitária.

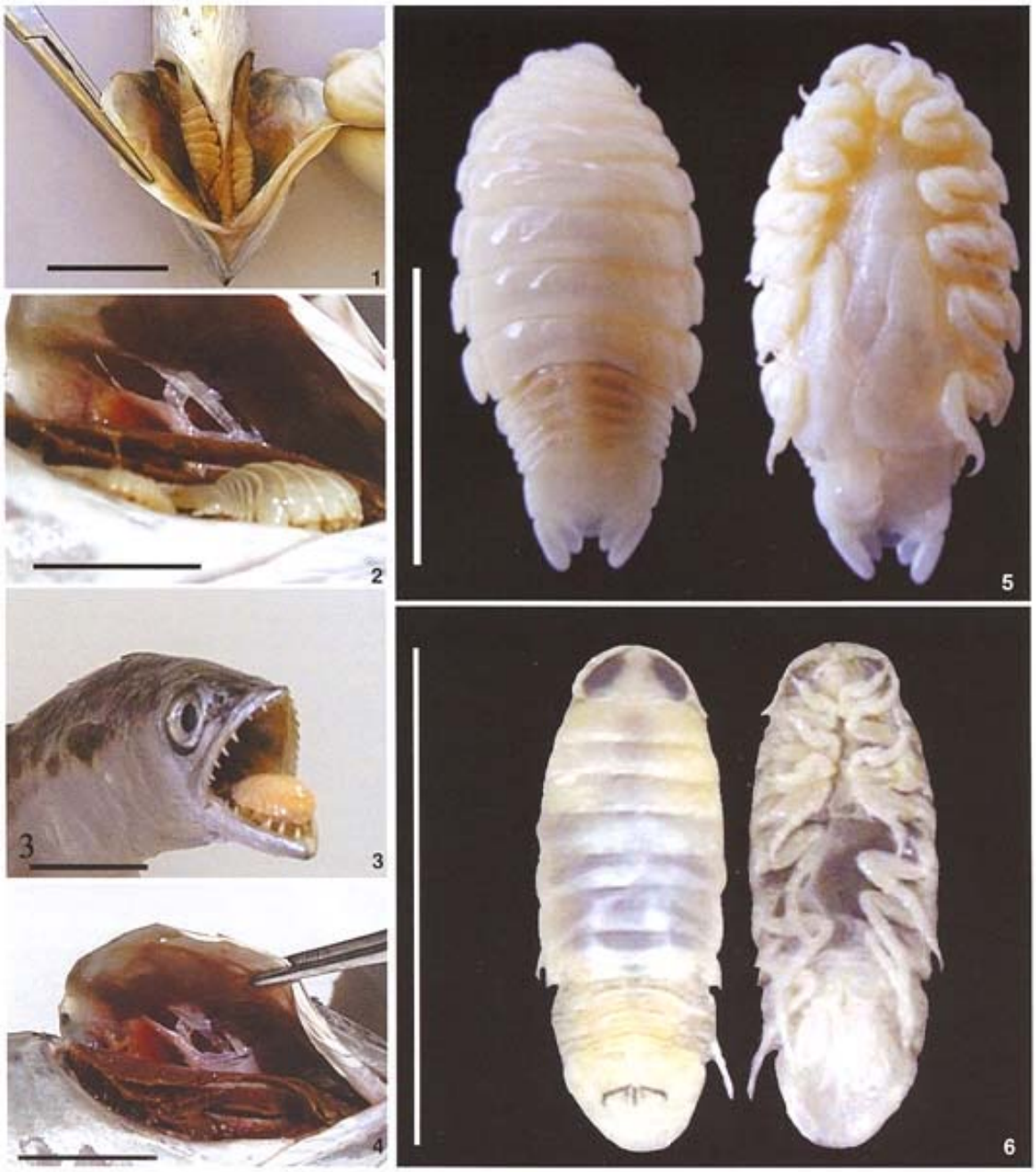
Foram constatadas algumas alterações na cavidade branquial, dentre estas: lesões mecânicas com produção excessiva de secreção mucosa e falha nos filamentos brânquias ou lacunas no arco branquial, em decorrência da fixação dos isópodos nestes locais (Fig. 4).

Em termos de ocorrência, foram constatados 86% *L. redmanni* (Cymothoidae) (Fig. 5) e 14% de *R. signata* (Aegidae) (Fig. 6) nos indivíduos de *S. brasiliensis* parasitados. Destes peixes foram observados 23 machos e 21 fêmeas, com uma proporção sexual equivalente a 1:1.

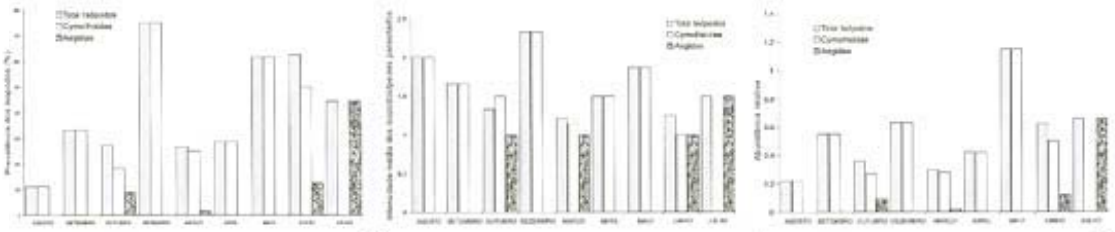
No presente estudo foi verificada a ausência de correlação entre o parasito e o sexo do hospedeiro, além de ser registrado a co-existência de espécies de parasitos em peixes marinhos igualmente constatados por Oliva & Luque (1998) e Luque *et al.* (2004).

Índices de infestação parasitária

Foi observada a maior prevalência de Cymothoidae em dezembro de 2003, onde 75 % dos peixes capturados estavam parasitados (Fig. 7). No mesmo mês as serras apresentaram a maior intensidade média de 2,3 *L. redmanni* por peixe parasitado (Fig. 8). A maior abundância de *L. redmanni* ocorreu em maio de 2004, com valor de 1,1 (Fig. 9).



Figuras 1-6. Parasitos *Livoneca redmanni* e *Rocinela signata* em *Scomberomorus brasiliensis* capturados nas águas costeiras do Rio Grande do Norte. (1-2) *Livoneca redmanni* aderida às brânquias através da câmara branquial (escala = 20 mm); (3) *Livoneca redmanni* aderido às brânquias pela cavidade bucal (escala = 2 0 mm); (4) lacunas nos arcos branquiais do hospedeiro, decorrente de lesões mecânicas pela fixação do isópodo (escala = 20 mm); (5) posição dorsal e ventral de *Livoneca redmanni* (lado a lado) (escala = 10 mm); (6) posição dorsal e ventral de *Rocinela signata* (lado a lado) (escala = 5 mm).



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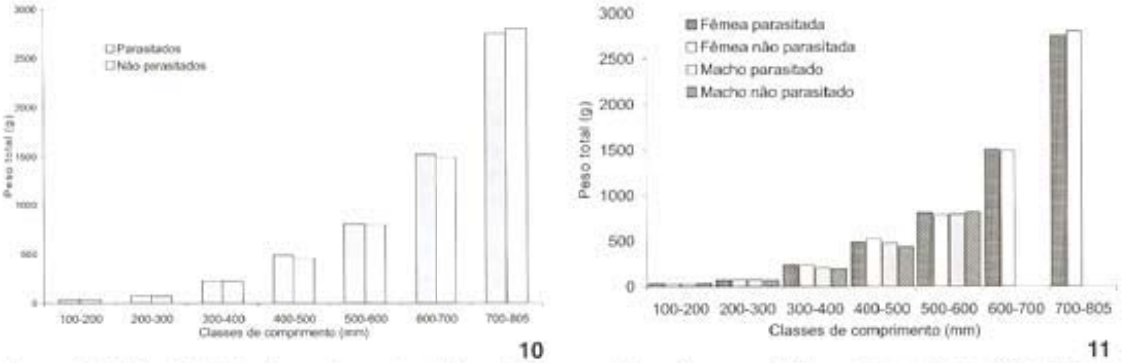
Figuras 7-9. Índices de infestação parasitária de *Livoneca redmanni* e *Rocinela signata* na serra, *Scomberomorus brasiliensis* capturados nas águas costeiras do Rio Grande do Norte, no período de agosto de 2003 a julho 2004: (7) variação da prevalência; (8) variação da intensidade média; (9) variação da abundância relativa.



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Figuras 10-11. Peso total (g) e classe de comprimento (mm) de serras machos e fêmeas parasitados e não parasitados: (10) machos e fêmeas não parasitados e parasitados por isópodos nas águas costeiras do Rio Grande do Norte em relação às classes de comprimento total (mm); (10) serras não parasitados e parasitados por isópodos nas águas costeiras do Rio Grande do Norte em relação às classes de comprimento total (mm).

A maior prevalência de Aegidae ocorreu em julho de 2004, onde 44,44 % dos peixes capturados estavam parasitados (Fig. 7). No mesmo mês as serras tiveram a maior intensidade média de 1,5 *R. signata* por peixe parasitado (Fig. 8). A maior abundância de *R. signata* foi registrado em julho de 2004, equivalente a 0,7 (Fig. 9).

O número mínimo de isópodos por peixe foi de um e a máxima foi de quatro em um mesmo hospedeiro. Em geral os isópodos apresentaram uma intensidade média de 1,5 isópodos por peixe parasitado. Neste estudo foi registrado uma abundância geral de 0,5 parasito por peixe. Este estudo está em concordância com os resultados relatados por Cavalcanti *et al.* (2003, 2004) na serra, *S. brasiliensis* e palombeta, *Shloroscombrus chrysurus* (Linnaeus, 1766).

Relação parasitismo com tamanho, peso e estádio de desenvolvimento das gônadas do hospedeiro

As classes de comprimentos totais dos peixes que mais estavam parasitados variaram entre 200 a 400 mm, com um número máximo de quatro isópodos por hospedeiro com intensidade média em 2,15 isópodos por peixe parasitado. O local de fixação pode determinar o emagrecimento do indivíduo parasitado em ambiente confinado (Pavanelli *et al.* 1999). No entanto, neste estudo em ambiente natural, a fixação dos isópodos na cavidade bucal e na câmara branquial não influenciou o emagrecimento do hospedeiro, haja vista que não foram observadas diferenças significativas ao nível de 0,05 (p valor > 0,05) com o teste-t entre comprimento total, peso total e sexo dos peixes parasitados por isópodos e os não parasitados (Figs 10 e 11).

Os isópodos apresentaram uma preferência pelos hospedeiros em estádio inicial de desenvolvimento gonadal (51%), seguido pelos peixes em estádio em maturação (38%), estádios maduros (9%) e esvaziados (2%) (Fig. 12). A preferência dos parasitos pelos hospedeiros mais jovens possivelmente ocorre por estes apresentarem mais recursos energéticos, em relação aos maduros e esvaziados. Estes últimos apresentam menos reservas energéticas devido à mobilização destas para a maturação gonadal e a reprodução (Chellappa *et al.* 1995, Huntingford *et al.* 2001).

Este estudo é o primeiro registro de isópodos marinhos das espécies *L. redmanni* e *R. signata* no estado do Rio Grande do Norte.

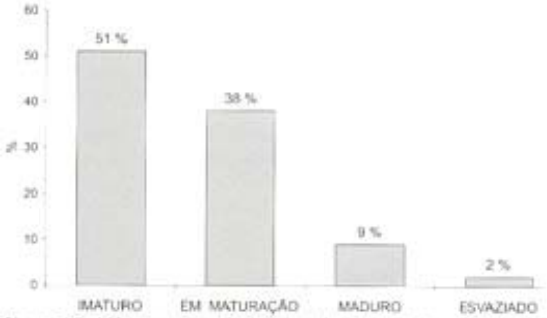

Figura 12. Número percentual dos peixes serra, *Scomberomorus brasiliensis*, parasitados por isópodos, em relação aos estádios de maturação gonadal.

AGRADECIMENTOS

O primeiro autor agradece a CAPES/MEC pela bolsa de Mestrado concedida, a Universidade Federal do Rio Grande do Norte e ao Departamento de Zoologia da Universidade Federal do Paraná, pelo apoio proporcionado. A segunda autora agradece ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) pela bolsa de Produtividade em Pesquisa.

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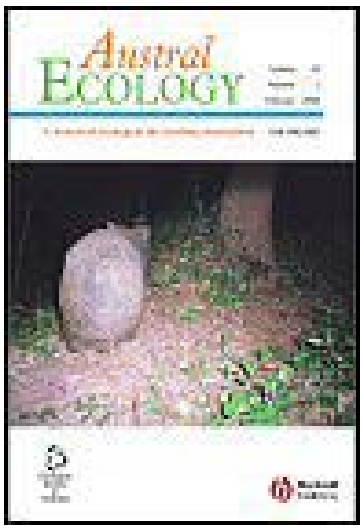
Recebido em 06.V.2005; aceito em 14.XI.2005.

Austral Ecology



Edited by:

Michael Bull

ARTIGO EM PREPARAÇÃO

Tendências evolutivas do parasito isópodo *Livoneca redmanni* Leach (Isopoda: Cymothoidae) em dois hospedeiros peixes marinhos

(Evolutionary trends of the isopod parasite *Livoneca redmanni* (Isopoda: Cymothoidae) in two marine host-fishes)

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Tendências evolutivas do parasito isópodo *Livoneca redmanni* Leach (Isopoda Cymothoidae) em dois hospedeiros peixes marinhos

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Resumo O presente trabalho investigou a estratégia reprodutiva dos ectoparasitos isópodos em duas espécies de peixes marinhos *Choloroscombrus chrysurus* e *Scomberomorus brasiliensis*. Foram enfatizados os índices ecológicos parasitários, o tamanho e fecundidade dos isópodos em peixes-hospedeiros com tamanhos corporais diferentes. O isópodo *Livoneca redmanni* foi encontrado parasitando as câmaras branquiais dos hospedeiros e apresentou valores diferentes da prevalência, intensidade e abundância média para os dois hospedeiros. *S. brasiliensis* (Lt média 314,2 ± SD 97,1 mm) apresentou tamanho corporal superior em relação a *C. chrysurus* (124,2 ± 25,1 mm), disponibilizanso relativamente maior espaço na câmara brânquial. Foram registrados *L. redmanni* com tamanhos maiores (Lt média 16,3 ± SD 5,5 mm) em *S. brasiliensis* e tamanhos menores em *C. chrysurus* (10,8 ± 4,5 mm). Isópodos fêmeas tiveram fecundidade relacionada positivamente com o seu tamanho. Durante a época chuvosa ocorreram maiores números de isópodos fêmeas em reprodução. O tamanho corporal dos hospedeiros determina o espaço da câmara branquial, porém, não influenciou o espaço ocupado pelo isópodo, uma vez que eles ocuparam um espaço entre 35 - 36% a câmara branquial independente do tamanho corporal verificados dos hospedeiros.

Palavras chave: Isópodo ectoparasito, *Livoneca redmanni*, índices ecológicos parasitários, fecundidade de isópodos.

INTRODUÇÃO

Os isópodos Cymothoides são parasitos hermafroditas protândricos, sua fase juvenil natatória dispersa e fixa em um peixe. Os Cymothoides habitam a cavidade bucal, câmara branquial ou o tegumento do corpo (Thatcher, 2006). Estes parasitos são hematofágos e completam seu ciclo de vida em um hospedeiro (ciclo holoxeno) (Ramdane et al, 2007). Cymothoidae Flabelifera do gênero *Livoneca* (Leach, 1818) inclui ectoparasitos que ocorrem em regiões como Gulf of Eliat no Mar Vermelho (Colorni et al, 1997), Kuwait (Mathews & Samuel, 1987), América do Norte (Brusca, 1981) e Brasil (Thatcher, 2002; Lima et al, 2005).

Os peixes marinhos *Choloroscombrus chrysurus* (Linnaeus, 1766) pertence à família Carangidae, distribuídos desde os Estados Unidos da América até a Argentina, e *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin, 1978) pertence à família Scombridae, distribuidos no Atlântico Ocidental ao longo do Caribe e das costas atlântica da América central e do Sul (Carpenter, K.E. (ed.) 2002).

O hospedeiro é o habitat para os parasitos e as pequenas áreas deste hospedeiro são consideradas micro habitats (Sasal et al, 2004). O parasito é um inimigo do hospedeiro e sua interação resulta em efeito negativo no hospedeiro (Prenter et al. 2004). O parasito e o hospedeiro apresentam co-evolução ecológica interespecífica. O parasito em geral não causa a morte do hospedeiro, porém tentar equilibrar a interação parasitária para prolongar a vida do hospedeiro (Kurtz et al, 2002).

O presente trabalho investigou a estratégia reprodutiva dos ectoparasitos isópodos em duas espécies de peixes marinhos *C. chrysurus* e *S. brasiliensis,* enfatizando os índices ecológicos parasitários, o tamanho e fecundidade dos isópodos em hospedeiros com tamanhos corporais diferentes.

MÉTODOS

Entre o período de setembro de 2005 a agosto de 2006, exemplares dos peixes marinhos foram coletados mensalmente em águas costeiras situadas entre latitudes 0º00’ e 10º00’S, longitudes 32º00’ e 40º00’W na região Sudoeste do Oceano Atlântico, nordeste do Brasil, América do Sul (Fig.1).

FIG. 1. Área de coleta dos peixes marinhos nas águas costeiras do Sudoeste do Oceano Atlântico, nordeste do Brasil.

Os peixes foram capturados através da pesca artesanal com uso de redes de arrasto-de-praia. Os peixes capturados foram numerados, medidos, pesados e examinados para a separação dos sexos. A taxonomia das espécies foi confirmada (Carpenter, 2002). Os isópodos foram cuidadosamente removidos do hospedeiro, registrados, medidos e preservados em álcool a 70% (Lima et al, 2005; Thatcher et al, 2007).

Para calcular a área das câmaras branquiais do hospedeiro foi adotado o seguinte: para *C. chrysurus*, a câmara branquial foi considerada como uma área de meio circulo para cada lado do peixe (direito e esquerdo) ($A = \pi r^2$) e para *S. brasiliensis,* o triângulo retângulo para cada lado ($A = bxh$) , onde: h = altura, r = metade da altura e b = a base da brânquia.

Os índices ecológicos parasitários, tais como, prevalência, intensidade média e abundância média, foram calculados conforme Margolis et al (1982) e Bush et al (1997).

Nas fêmeas isópodos fecundas, os ovos do marsúpio foram tirados e a fecundidade foi calculada através da contagem absoluta destes ovos.

Análise de dados

Foi realizado o teste χ^2 (Qui-quadrado, $p \leq 0,05$) para testar se houve diferenças significativas na proporção entre machos e fêmeas parasitados. O tamanho do parasito e o tamanho do hospedeiro foram testados com o teste t ($p \geq 0,05$). A correlação entre o tamanho do isópodo e sua fecundidade foi determinada através do teste da correlação de Pearson. Os testes foram realizados com nível de significância igual a 5%. As análises estatísticas foram realizadas com o uso do Programa *STATISTIC* 7.0.

RESULTADOS

O parasito isópodo *Livoneca redmanni* foi encontrado parasitando as câmaras branquiais de ambos os hospedeiros *C. chrysurus* e *S. brasiliensis*.

Entre 1258 *C. chrysurus* capturados, 206 foram infectados por 221 isópodos *L. redmmani*. Peixes-hospedeiros *C. chrysurus* atingiram tamanho entre 78 e 212 mm (média 124,2 ± SD 25,1 mm). Foi registrado um pico de ocorrência dos isópodos no mês de fevereiro, que coincidiu com o iniciou as chuvas (Fig. 2a). Os índices parasitários de *C. chrysurus* foram 16,4 % de prevalência com intensidade média de 1,1 e abundância média de 0,2. Foi observada maior prevalência no período das chuvas. Não houve diferença significativa na proporção de hospedeiros machos e fêmeas *C. chrysurus* parasitados ($p>0,05$), indicando que *L. redmmani* apresentou uma prevalência sem especificidade ao sexo deste hospedeiro (Fig. 3a).

De 826 *S. brasiliensis* capturados, 175 estavam infectados com 256 *L. redmanni*. Peixes-hospedeiros *S. brasiliensis* parasitados mediram entre 160 e 525 mm (314,2 ± 97,1 mm). Os índices parasitários de *S. brasiliensis* calculados foram prevalência de 21,2%, intensidade média de 1,5 e abundância média de 0,3. Também para este hospedeiro se observou maior prevalência no período das chuvas. Houve diferença significativa na proporção de hospedeiros machos e fêmeas *S. brasiliensis* parasitados ($p<0,05$), indicando que *L. redmmani* apresentou especificidade ao sexo macho do hospedeiro *S. brasiliensis* (Fig. 2b e 3b).

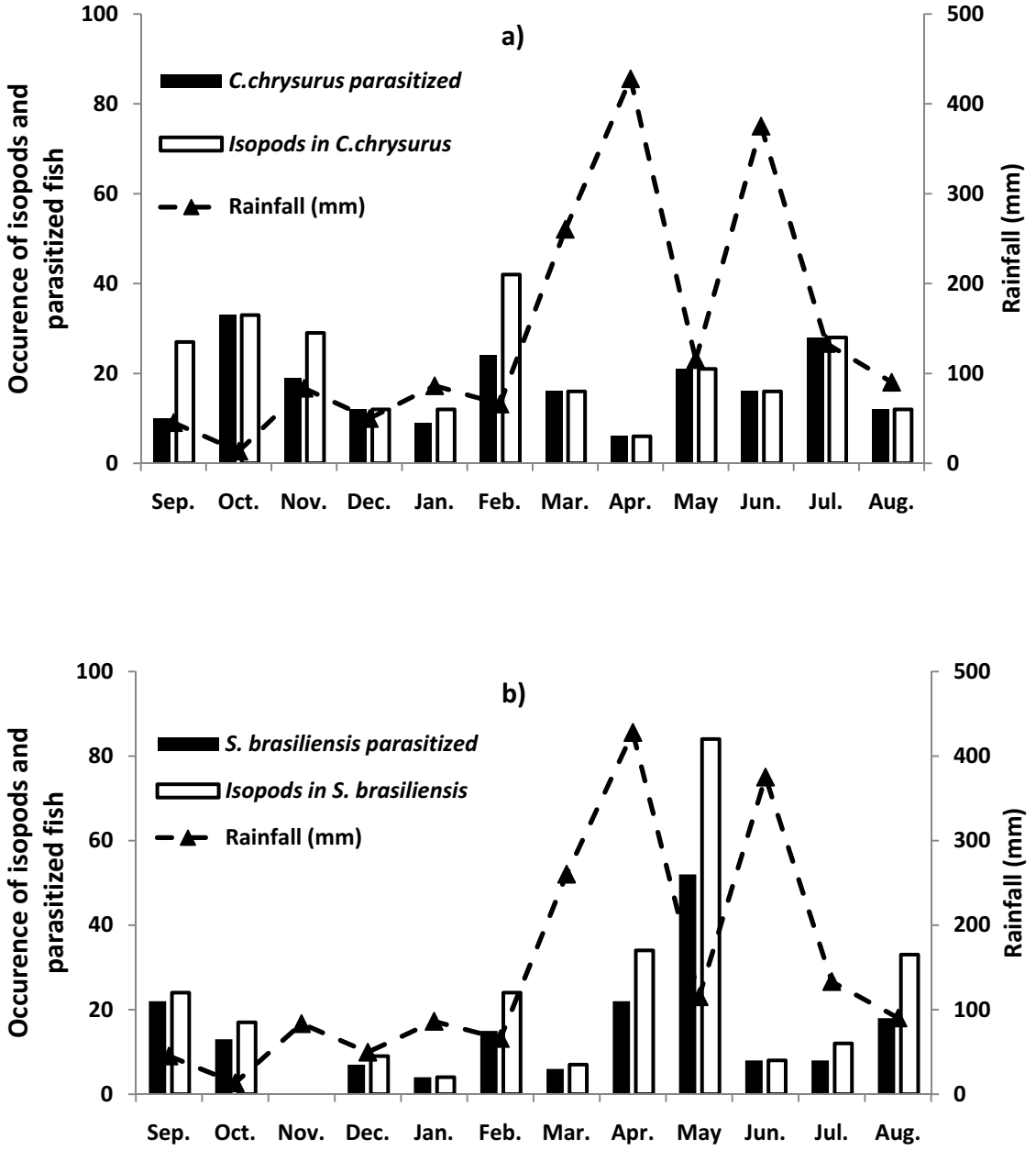

FIG. 2. Número de isópodos e peixes capturados mensalmente em relação ao índice pluviométrico mensal da área de coleta. **a)** *Choloroscombrus chrysurus* e **b)** *Scomberomorus brasiliensis*.

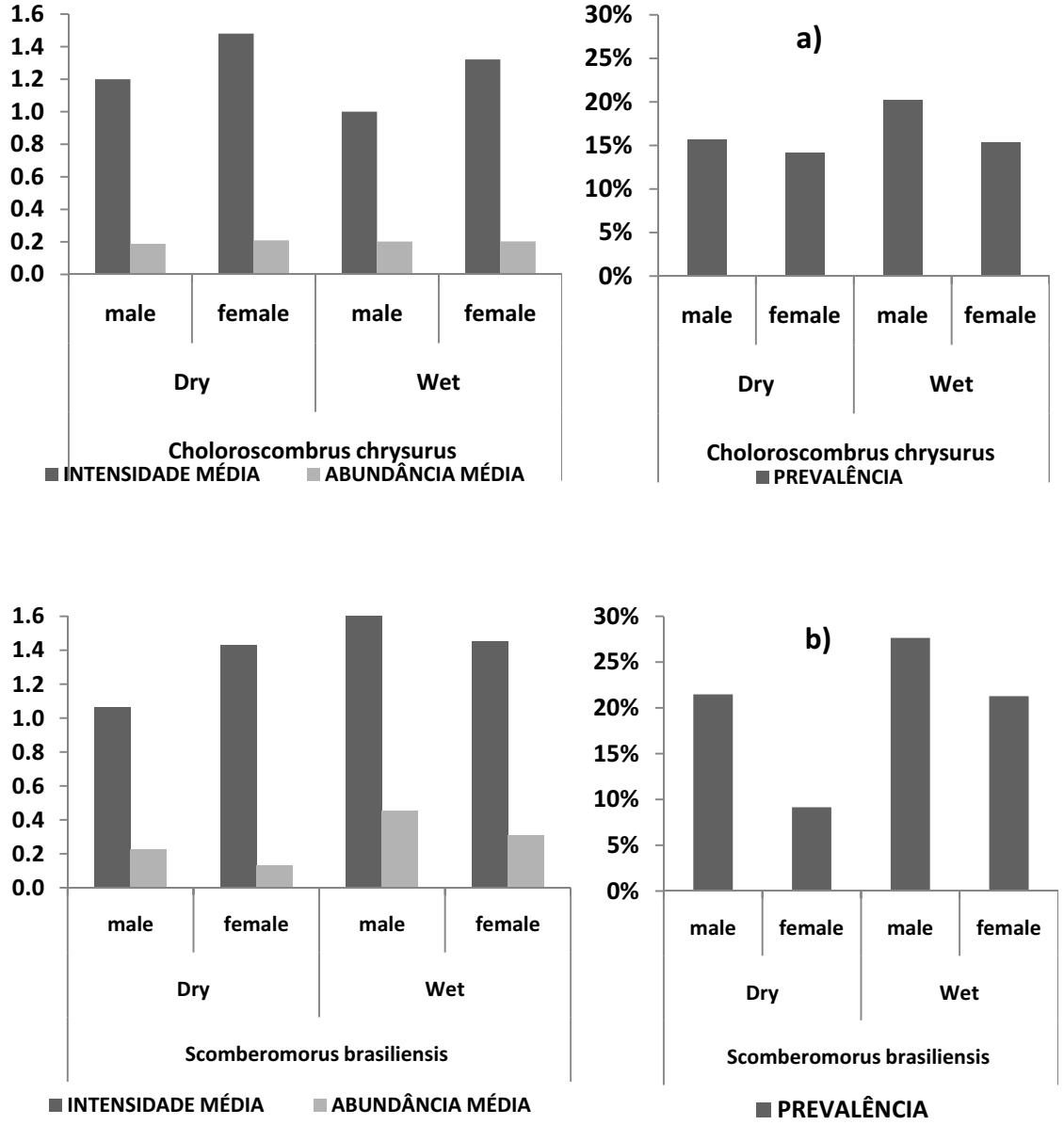

Fig. 3. Índices parasitários dos peixe-hospedeiro de macho e fêmea no período de estiagem e chuvoso: intensidade média e abundância média parasitária, e prevalência parasitária. . **a)** *Choloroscombrus chrysurus* e **b)** *Scomberomorus brasiliensis*.

Os isópodos em *C. chrysurus* tiveram amplitude de tamanho corporal entre 1 e 20 mm (10,8 $\pm$ 4,5 mm). A câmara branquial de *C. chrysurus* mediu no máximo 1254 mm^2, na qual o parasito ocupou aproximadamente 35,3% (442 mm^2). Amplitude de tamanho de *L. redmmani* em *S. brasiliensis* variou entre 2 e 29 mm (16,3 $\pm$ 5,5 mm). A câmara branquial deste hospedeiro mediu 6394mm^2, na qual o parasito

ocupou aproximadamente 35,6% (2278 mm^2).

A reprodução de *L. redmanni* ocorreu durante todo ano, no entanto, 71,43 % das fêmeas maduras com ovos ou larvas no marsúpio (Fig. 4) ocorreram no período das chuvas. As larvas (manca) mediram 1 mm em *C. chrysurus* e 2 mm em *S. brasiliensis*.

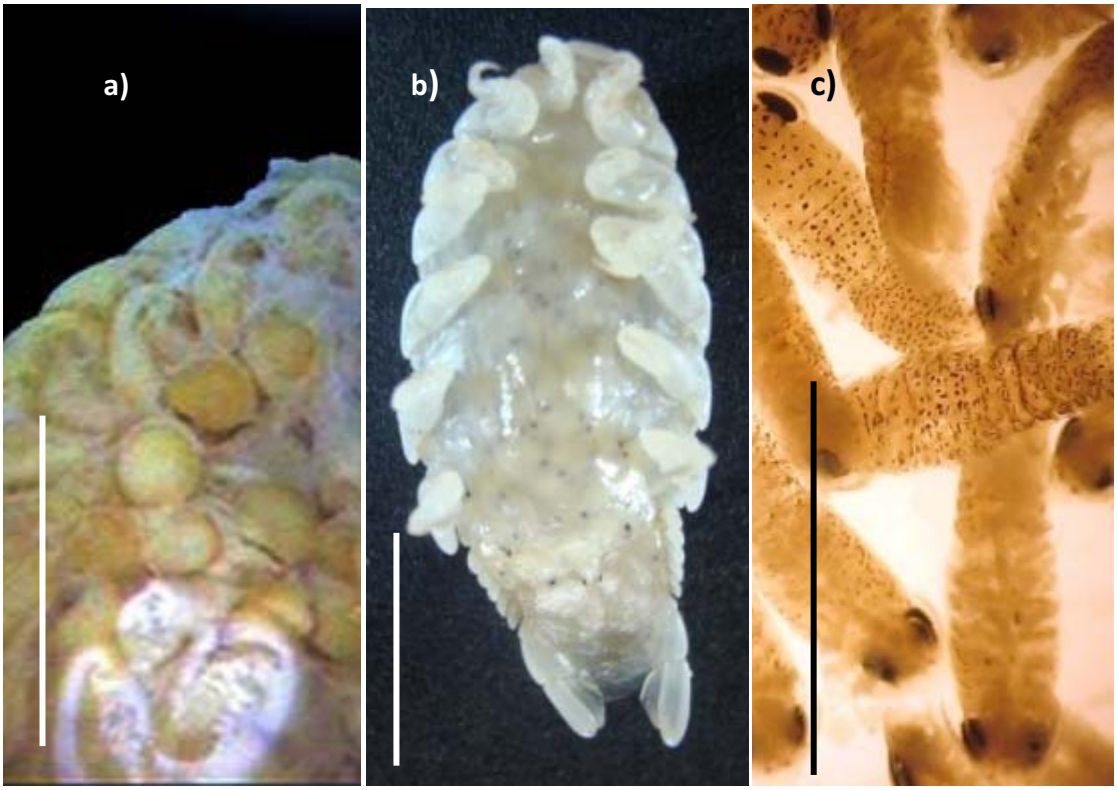

Fig. 4. Fêmeas de isópodos *Livoneca redmanni* em reprodução: a) ovos na bolsa marsupial da fêmea isopodo (escala: 5 mm); b) pontos pretos no abdômen do isópodo, são os olhos das larvas dentro do marsúpio da fêmea (escala: 5 mm) e c) detalhe das larvas extraídas do marsúpio, aptas a natação (escala: 2 mm).

Os ovos dos isópodos no marsúpio foram contados e sua fecundidade variou de acordo com o tamanho do isopodo fêmea. A fecundidade de *L. redmmani* mostrou uma correlação positiva com o tamanho do seu corpo (r^2 = 0,84) resultando em uma fecundidade do *L. redmmani* menor no hospedeiro *C. chrysurus* que em *S. brasiliensis*. As fêmeas de *L. redmanni* foram observadas a partir de 11 mm de tamanho em *C. chrysurus* e em *S. brasiliensis* foram identificadas as fêmeas a partir de 19 mm (Fig. 5).

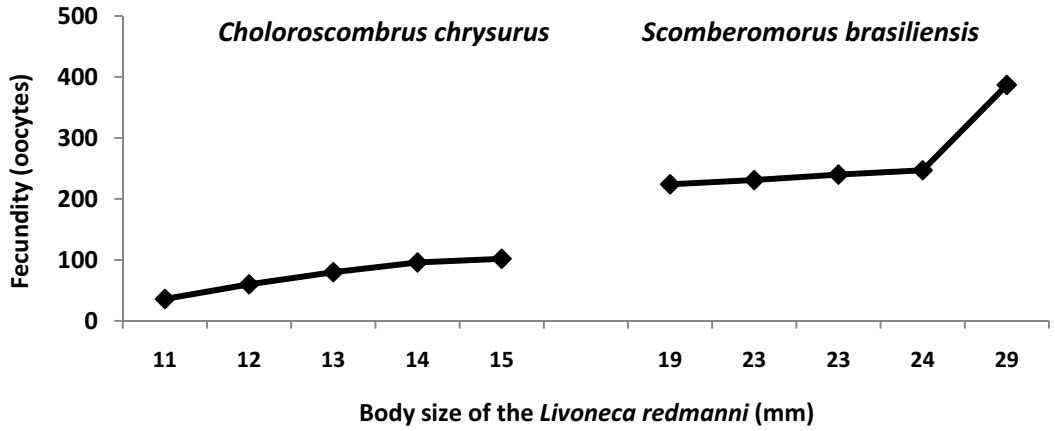

Fig. 5. Fecundidade e tamanho do isopodo parasito *Livoneca redmanni*.

As garras dos parasitos isópodos são adaptações para fixação em tecidos do hospedeiro e *L. redmanni* foi encontrado fixado na musculatura mandibular do hospedeiro (Fig. 6a), ocasionando macroscopicamente uma área isquêmica, e histologicamente se verifica infiltrados inflamatórios. O maior tamanho da fêmea prejudica o desenvolvimento normal dos filamentos brânquias do hospedeiro, uma vez que foram observados filamentos branquiais atrofiados e escassos nos quatro arcos branquiais. Os machos atrofiam os filamentos brânquias do segundo ao quarto arco branquial, devido a seu tamanho (Fig. 6b).

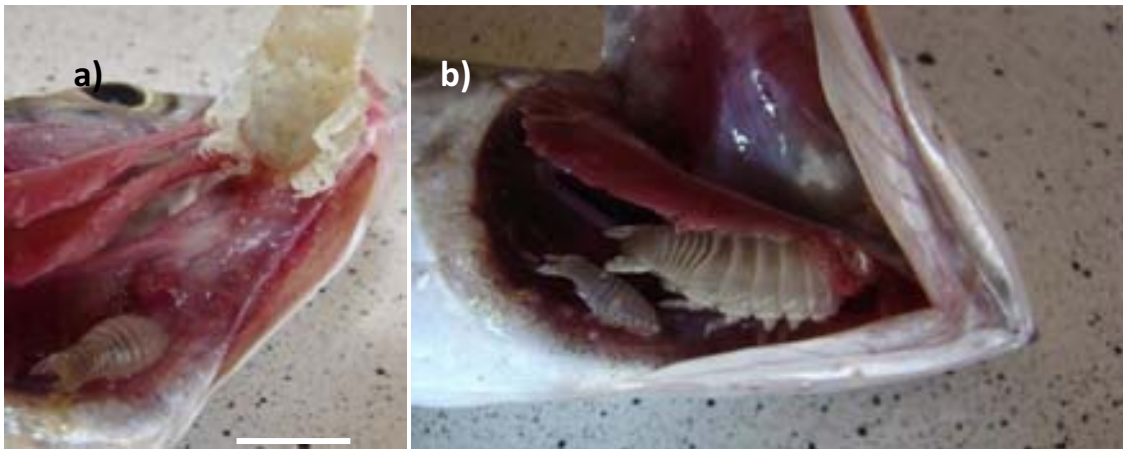

Fig. 6. Casal de isópodos *Livoneca redmanni* na câmara branquial do hospedeiro. a) área isquêmica por fixação das garras do isopodo no tecido muscular da mandíbula; b) brânquia com filamentos atrofiados e escassos na área de fixação do isopodo de maior tamanho – à fêmea (escala 10 mm).

DISCUSSÃO

O isópodo *L. redmanni* mostrou uma tendência evolutiva para os dois hospedeiros-peixes marinhos. *L. redmanni* foi encontrado no micro habitat câmara branquial dos dois hospedeiros, ocupando no máximo 1/3 das câmaras branquiais. Os índices ecológicos parasitários de *L. redmanni* foram diferentes para as duas espécies, onde o hospedeiro de tamanho maior teve índices parasitários superior ao hospedeiro de tamanho menor. Os hospedeiros machos tiveram índices parasitários superiores aos das fêmeas, tanto no período de estiagem como no período das chuvas para ambos os sexos. Madi & Silva (2005) pesquisando o parasito Anisakidae observou índices parasitários diferentes para três espécies de peixes em um mesmo reservatório.

A espécie hospedeira *C. chrysurus* tem menor tamanho em relação ao hospedeiro *S. brasiliensis*. O isópodo *L. redmanni* desenvolveu distintamente nas duas espécies de hospedeiros, sendo maior em relação ao tamanho no hospedeiro *S. brasiliensis.* O tamanho corporal dos hospedeiros determinou o espaço das câmaras branquiais, porém não influenciou no espaço ocupado pelo isopodo, uma vez que eles ocuparam entre 35 - 36% da câmara branquial independente do tamanho corporal do hospedeiro. Verificou-se uma tendência evolutiva da espécie *L. redmmani*, que ocupou valor menor que 36% da câmara branquial, possivelmente para preservar o equilíbrio parasito-hospedeiro. Tsai et al (2001) descrevem que o isópodo é capaz de adaptar sua estrutura corpórea de acordo com a área de exploração no hospedeiro.

A época da reprodução de *L. redmanni* ocorreu entre fevereiro a agosto, época de chuvas, coincidindo com a época da reprodução dos peixes marinhos da região. A fecundidade da espécie *L. redmmani* teve relação positiva com o tamanho do isópodo, onde o número de ovos aumentou com o tamanho do isópodo. Desta forma, a fecundidade, o tamanho dos isópodos adultos e das mancas (larvas) de *L. redmanni* no hospedeiro *C. chrysurus* foi menor. Para a espécie de isopodo *Elthusa alvaradoensis*, Chávez-Lopez et al, (2005) relataram que os valores da fecundidade não teve relação com o tamanho das fêmeas.

Observou que a presença de *L. redmanni* fêmeas na câmara branquial atrofiou os filamentos branquiais dos quatro arcos branquiais, e *L. redmanni* machos atrofiou os filamentos

branquiais do segundo ao quarto arco branquial. As garras causaram lesões mecânicas que deixam a área isquêmica e histologicamente com infiltrados inflamatórios na musculatura mandibular do hospedeiro. Thatcher et al (2003) e Carvallho et al (2004) observaram que o isópodo causa destruição extensa dos filamentos branquiais e que reduz a capacidade metabólica do hospedeiro.

CONCLUSÕES

O isópodo *L. redmanni* parasitou o mesmo micro habitat câmara branquial nos dois hospedeiros, mas mostrou uma tendência evolutiva diferente para ambos hospedeiros, onde a espécie hospedeira *C. chrysurus* teve menor tamanho corporal que o hospedeiro *S. brasiliensis*.

Isopodo *L. redmanni* apresentou índices parasitários maior para *S. brasiliensis* e teve tamanho maior em *S. brasiliensis* que em *C. chrysurus.*

A ocorrência de isópodos fêmeas em *C. chrysurus* foi com 11 mm e na espécie *S. brasiliensis* foi com 19 mm. Estes isópodos fêmeas reproduziram durante todo ano, porém, registramos uma época reprodutiva que teve o maior número de isópodos fêmeas em reprodução na época chuvosa.

Isópodos fêmeas *L. redmanni* tiveram sua fecundidade relacionadas positivamente com o seu tamanho corporal, tendo uma fecundidade menor em *C. chrysurus* que em *S. brasiliensis.*

O tamanho corporal do hospedeiro determina o espaço da câmara branquial, porém, não influenciou o espaço ocupado pelo isópodos, uma vez que *L. redmanni* ocupou no máximo um espaço da câmara branquial entre 35-36%, independente do tamanho corporal dos hospedeiros.

AGRADECIMENTOS

Os autores agradecem ao Conselho Nacional de Desenvolvimento Científico e Tecnológico do Brasil (CNPq) por o apoio financeiro durante o período de estudo (J. T. A. Ximenes de Lima, nº. 141651/2005-9; S. Chellappa, nº. 307497/2006-2 e A. Araújo, nº. 302012/2006-0).

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Revista Brasileira de Zoologia

ISSN 0101-8175
ISSN 1806-969X

Revista Brasileira de Zoologia, Curitiba, 24 (1): 1–263, março 2007

Cymothoa spinipalpa sp. nov. (Isopoda, Cymothoidae) a buccal cavity parasite of the marine fish, *Oligoplites saurus* (Bloch & Schneider) (Osteichthyes, Carangidae) of Rio Grande do Norte State, Brazil [1]

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ABSTRACT. *Cymothoa spinipalpa* **sp. nov.** (Isopoda, Cymothoidae) a buccal cavity parasite of the marine fish, *Oligoplites saurus*, is described on the basis of eight male specimens and one female. The fish hosts were captured in the coastal waters of Natal, Rio Grande do Norte State, Brazil. In the new species, the anterior margin of the cephalon is doubled ventrally over the bases of the antennae. In this respect, it resembles *C. recifea* Thatcher & Fonseca, 2005. It differs from that species, however, in being much smaller and having basal carinae on the pereopods 4 to 7 that are small and rounded (not large and pointed). Also, pleopods 2-4 lack the folds and pockets that are present in *C. recifea*. The new species can be distinguished from all known *Cymothoa* spp. by the mandibular palps which are entirely covered with small spines in adult males. The mancas of the new species resemble those of *Cymothoa oestrum* since they have elongate antennae but they are wider and have shorter uropods.
KEY WORDS. Atlantic Ocean; isopod parasite; marine fish parasite.

RESUMO. ***Cymothoa spinipalpa* sp. nov. (Isopoda, Cymothoidae) um parasito da cavidade bucal do peixe marinho, *Oligoplites saurus* (Bloch & Schneider) (Osteichthyes, Carangidae) do Estado do Rio Grande do Norte, Brasil.** *Cymothoa spinipalpa* **sp. nov.** (Isopoda, Cymothoidae), um parasito da cavidade bucal do peixe marinho, *Oligoplites saurus*, é descrita baseada em oito espécimes machos e uma fêmea Os peixes foram capturados nas águas costeiras de Natal, Rio Grande do Norte, Brasil. Na nova espécie, a margem anterior do cefalon é dobrada ventralmente sobre as bases das antenas. Neste aspecto, ela assemelha-se a *C. recifea* Thatcher & Fonseca, 2005. Distingue-se dessa espécie, no entanto, pelo menor tamanho e pelas carinas dos pereópodos 4 a 7 que são relativamente pequenas e arredondadas (não grandes e ponte agudas). Aliás, os pleópodos 2-4 carecem das dobras e bolsos que são presentes em *C. recifea*. *Cymothoa spinipalpa* **sp. nov.** distingue-se de todas as demais espécies de *Cymothoa* por ter palpos mandibulares completamente cobertos por espinhos nos machos adultos. As mancas têm antenas compridas e por isso parecem com as de *Cymothoa oestrum* mas distinguem-se por serem mais largas e de terem urópodos mais curtos.
PALAVRAS-CHAVE. Oceano Atlântico; isópodo parasito; parasito de peixe marinho.

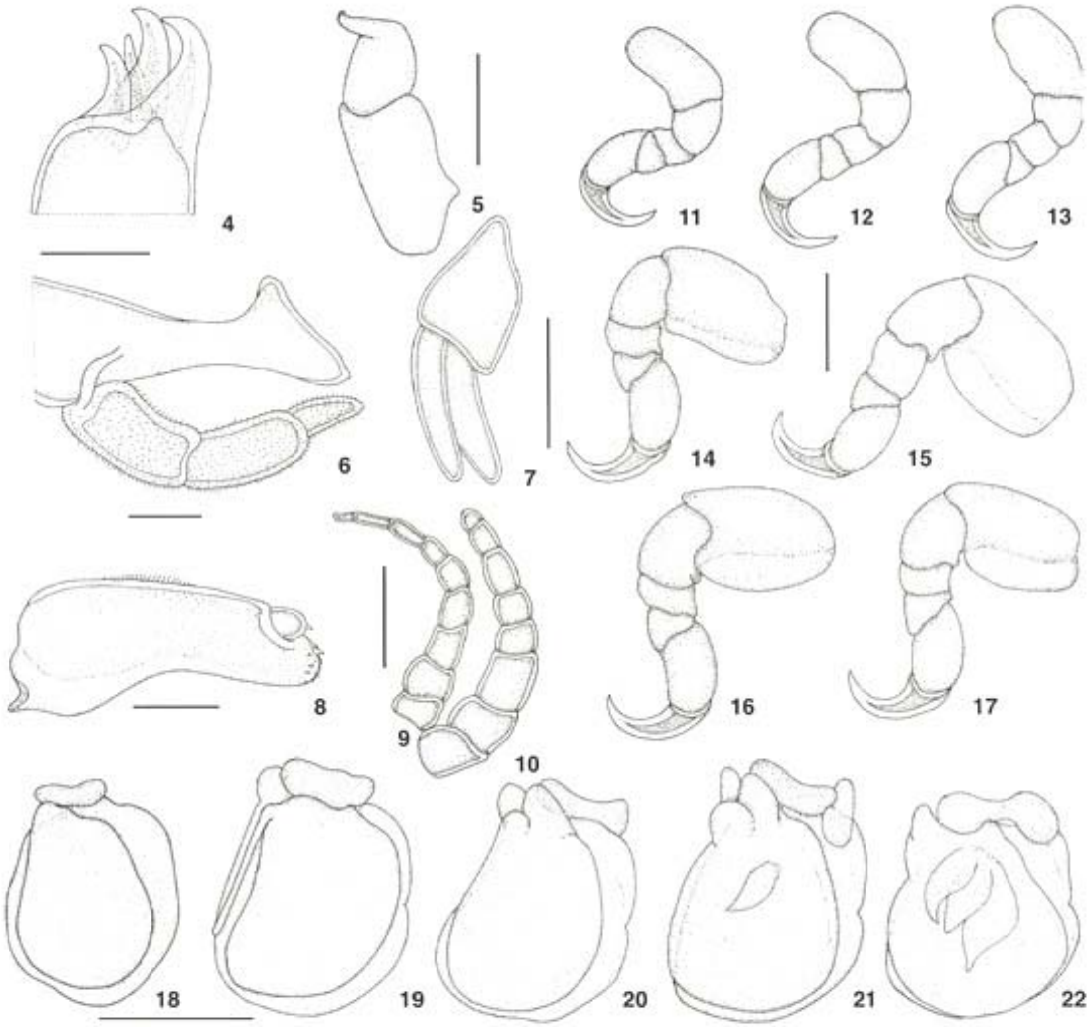
Trilles (1991) listed 32 species of *Cymothoa* Fabricius, 1793, from marine fishes world-wide with 5 of these said to occur in Brazilian waters. Thatcher *et al.* (2003) described a new species from Santa Catarina State and compared it to 6 other species that have been atributed to Brazil. Thatcher & Fonseca (2005) described an additional species from marine fishes of Pernambuco State bringing the total of species to 8. The present paper describes the ninth Brazilian species of *Cymothoa* from the waters of Rio Grande do Norte State.

MATERIAL AND METHODS

Fish hosts, *Oligoplites saurus* (Bloch & Schneider, 1801) (Osteichthyes: Carangidae) were netted from the coastal waters at Ponta Negra, Natal, Rio Grande do Norte State, Brazil. They were taken on ice to the Ichthyology Laboratory of the Federal University of Rio Grande do Norte. The isopod parasites were removed from the mouths of the fish and fixed in 70% alcohol. These specimens were sent to the Zoology De-

Figures 1-3. *Cymothoa spinipalpa* **sp. nov.**, male: (1) dorsal (2) ventral (3) lateral. Scale bar = 5 mm.

partment of the Federal University of Paraná, Curitiba, Brazil, for study. There, dissections of the mouthparts, pereopods, pleopods and uropods were made and these parts were cleared in pure phenol for study. Photographs were made with a digital camera at five megapixels and some of these were used in making the drawings. Measurements are in micrometers (μm) except where designated as millimeters (mm).

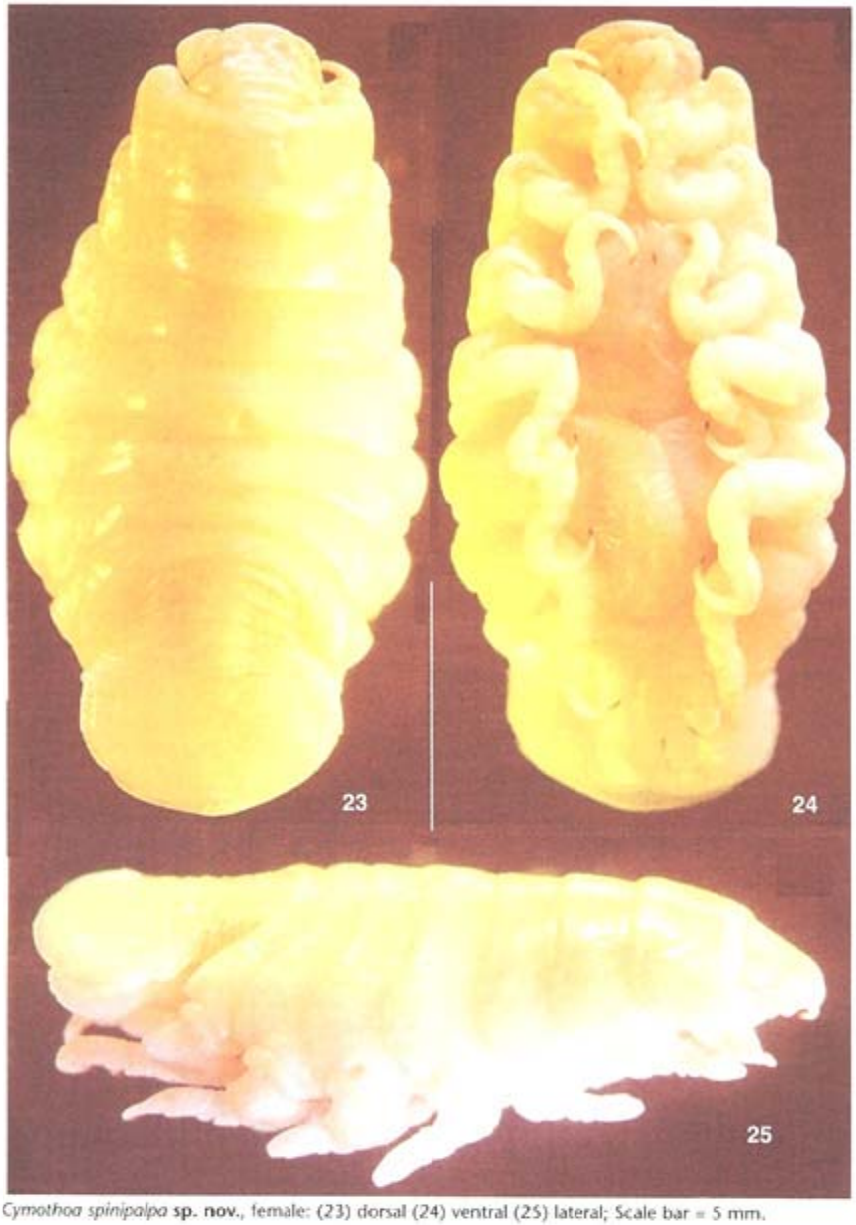


Figures 4-22. *Cymothoa spinipalpa* **sp. nov.**, male: (4) tip of maxillule (5) maxilliped (6) mandible and palp (7) uropod (8) maxilla (9) antennule (10) antenna; (11-17) pereopods 1-7; (18-22) pleopods 1-5. Scale bars: (4) = 50 µm; (5, 9 and 10) = 500 µm; (6 and 8) = 200 µm; (7, 11-17) = 1000 µm; (18-22) 2000 µm.

Cymothoa spinipalpa sp. nov.

Figs 1-48

Species description (based on eight males and one female). Male (Figs 1-3: measurements in table I): body elongate, widest at level of pereonite 5. Cephalon immersed in pereonite 1; frons doubled downward over bases of antennae; eyes covered except in very young specimens. Antennule (Fig. 10) stout, of eight articles; antenna (Fig. 9) slender, of nine articles. Mouthparts (Figs 4-6 and 8): mandible with rounded incisor and molar process; mandibular palp about as long as mandible, of three articles with terminal one much shorter; all three articles of palp covered with small spines (Fig. 6); maxillule (Fig. 4) with four recurved spines distally; maxilla (Fig. 8) bilobed, with one



Figures 23-25. *Cymothoa spinipalpa* **sp. nov.**, female: (23) dorsal (24) ventral (25) lateral; Scale bar = 5 mm.

to three recurved spines and spinules on each lobe;. maxilliped (Fig. 5) slender with two to five recurved spines distally. Pereon (Fig. 1): pereonite 1 longest; 2-4 subequal in length; 5-7 shorten progressively with seven being very short. Antero-lateral margins of pereonite 1 rounded. Pereopods (Figs 11-17): 1-3 small, slender, without carinae; 4-7 larger and with low carinae. Pleon immersed in pereonite 7. Pleopods (Figs 18-22) all bilaminate; 1-3 simple, without folds or pockets; 2 with slender appendix

Table I. Measurements in millimeters of eight males of *Cymothoa spinipalpa* **sp. nov.**

Males	Length	Width
1	18	8
2	13	5
3	12	6
4	11	5
5	11	5
6	10	5
7	10	4
8	7	3
	Mean = 11.5 ± 3.16	Mean = 5.1 ± 1.46

masculinum: 4 with small pocket; 5 with several folds and pockets. Uropod (Fig. 7) with slender subequal rami.

Pleotelson rounded posteriorly, about twice as wide as long.

Female (Figs 23-45: based on a single specimen having well formed mancas in its marsupium): body elongate, 16 mm long and 9 mm wide at the level of pereonite 5. Cephalon immersed in pereonite 1; frons doubled down over bases of antennae; eyes covered and invisible. Antennule (Fig. 39) stout, of seven articles, with spinules on articles 4-7; antenna (Fig. 40) slender, of eight articles; with few spinules on 7-8. Mouthparts (Figs 26-29): mandible with rounded incisor and molar process; palp about as long as mandible, of three articles with distal one very short; few spines present on terminal article (Fig. 29); maxilla bilobed (Fig. 28) with two to three recurved spines on each lobe; maxillule (Fig. 26) with four recurved spines distally, one of which is slightly smaller than the rest; maxilliped (Fig. 27) with three segmented palp, terminal segment with five spines, flattened part bordered by setae. Pereon (Fig. 23) as in male; pereopods (Figs 31-37) similar to those of male but carinae on 4-7 more pronounced. Pleon immersed in pereonite 7; pleopods (Figs 41-45) similar to those of male, showing pockets only on 4-5 and lacking appendix masculinum on 2. Uropod (Fig. 38) with slender, subequal rami. Pleotelson about twice as wide as long.

Manca = Pullus II (Figs 46-48): body elongate 2.37-2.51 mm long and 0.92-0.94 mm wide at the level of pereonite 4; pleon 0.54 mm wide. Six subequal pereonites present; dactyls 1-3 toothed, 4-6 without teeth. Cephalon wider than long, not immersed; eyes large, black. Mandibular palp (Fig. 47) of three articles, provided with setae and spinules. Antennule of eight articles, reaches to level of pereonite 2; antenna of 12 articles, reaches to level of pereonite 5. Uropods elongate, (Fig. 48) bases extend beyond pleotelson posteriorly, rami subequal in length.

Site: buccal cavity, over tongue.

Host: *Oligoplites saurus* (Cuvier, 1832); Carangidae.

Locality: Ponte Negra, Atlantic Ocean, near Natal, Rio Grande do Norte State, Brazil.

Type material: Holotype male, 5 paratype males and 1 paratype female deposited in the Crustacean Collection of the Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil.

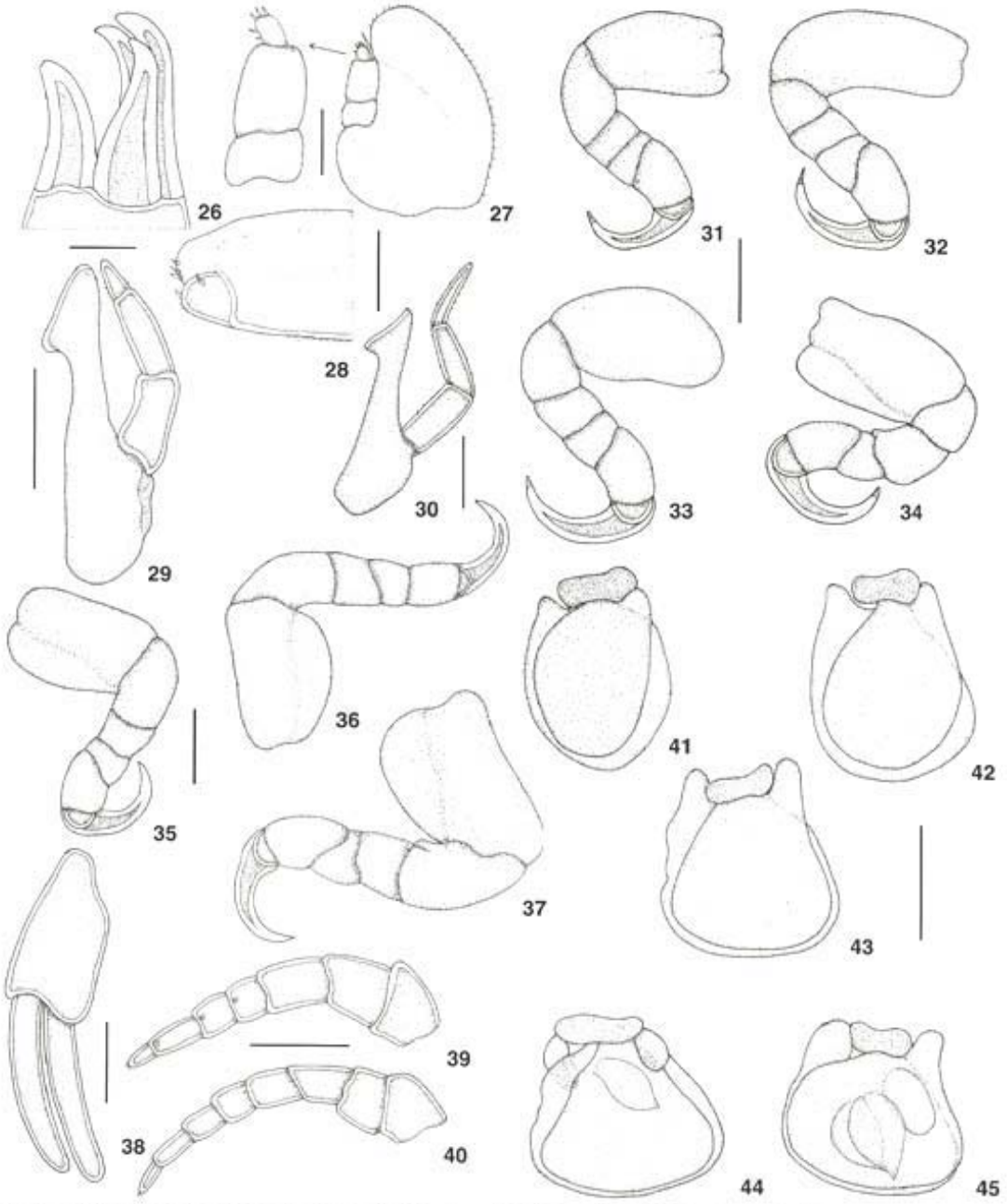
Etymology: the species name derives from the fact that in males the mandibular palp is unusually spinous.

DISCUSSION

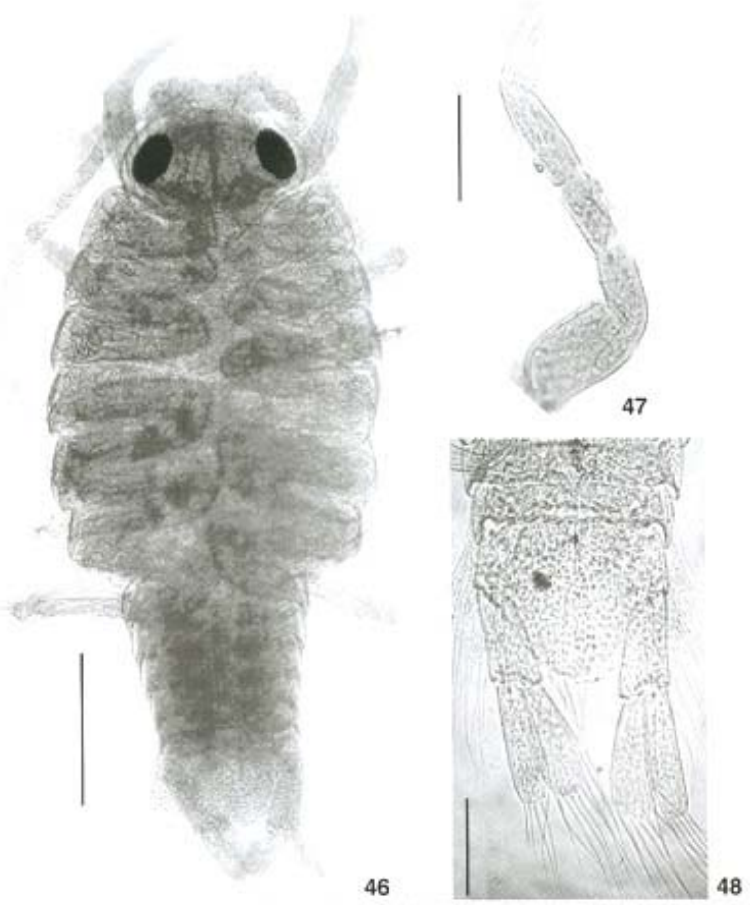
Cymothoa spinipalpa **sp. nov.** superficially resembles *C. recifea* Thatcher & Fonseca, 2005 but differs from the latter in a number of important features. The new species is much smaller (7-18 mm long) not 11-32, with a mean of 20, as in *C. recifea*. The pleopods of the new species have pockets and folds only on 4-5, whereas pleopods 2-5 have such structures in the other species. The basal carinae on the pereopods of the new species are low and rounded and smaller than those of *C. recifea*. In the new species, the mandibular palps of adult males are covered with small spines. This is a characteristic that has not been reported for other species of *Cymothoa*.

The morphology of mancas has been studied for only a few species of Cymothoidae. The present series of specimens demonstrates some aspects of cymothoid growth. In addition to getting larger, profound morphological changes occur in several structures. In the manca, both the antennule and antenna are elongate; the former having eight articles and the latter 12 (Fig. 46). In adults, both the length and number of articles are reduced. In the adult female, the antennule has seven articles and the antennule eight (Figs 49 and 40). Mancas have only six pairs of pereopods of which dactyls 1-3 are serrate and 4-6 lack basal carinae. Adults, on the other hand, have seven pairs of pereopods, the dactyls are not serrate and basal carinae are found on 4-7. In mancas, the uropods extend posteriorly well beyond the pleotelson (Fig. 48) but in adults they do not reach the posterior margin of that structure (Figs 1-3). The pleopods and uropods are abundantly provided with setae in mancas and these setae are lost in the adults. The mandibular palp of the manca (Fig. 47) consists of three subequal articles the terminal one of which is provided with 4-5 elongate setae. The middle article also has a single elongate seta and all three articles have a few spinules. The mandibular palp in young males (Fig. 30) continues to have three subequal articles, extends well beyond the mandible and shows an increase in spination. In older males, the mandibular palp (Fig. 6) has become short, the terminal article is shorter than the other two and all three have become covered with spinules. In the adult female, the palp is similar to that of the male (Fig. 29) but the terminal article has become even smaller in relation to the other two and few spinules are present.

Not all species of *Cymothoa* have mancas with long antennae and uropods. Richardson (1905) presented drawings of the mancas of *C. excisa* Perty, 1830, and *C. oestrum* (Linnaeus, 1758). The first of these is shown to have short antennae and the second long antennae. Thatcher *et al.* (2003) offered photographs



Figures 26-45 *Cymothoa spinipalpa* **sp. nov.**, female: (26) tip of maxillule (27) maxilliped (28) tip of maxilla (29) mandible and palp (30) mandible and palp from young male; (31-34) pereopods 1-4; (35-37) pereopods 5-7; (38) uropod; (39) antennule; (40) antenna; (41-45) pleopods 1-5. Scale bars: (26) 25 µm; (27, 29 and 38-40) 500 µm; (28 and 30) 200 µm; (31-37) 1000 µm; (41-45) 2000 µm.



Figures 46-48. *Cymothoa spinipalpa* **sp. nov.**, manca stage: (46) entire, dorsal (47) mandibular palp; (48) pleotelson and uropods. Scale bars: (46) = 500 µm; (47) = 100 µm; (48) = 200 µm.

of the mancas of two species, namely: *C. catarinensis* Thatcher, Loyola, Jost & Souza-Conceição, 2003, and *C. oestrum*. The first of these also has short antennae. Sartor & Pires (1988) described and figured the manca stage of their species called, *Cymothoa liannae* and it also has long antennae. The mancas of *Cymothoa spinipalpa* **sp. nov.**, therefore, resemble those of *C. oestrum* and *C. liannae*. Reliable characters to separate the mancas of these three species have not been defined but there are probably differences in the form of the pleotelson and uropods.

ACKNOWLEDGEMENT

The authors wish to thank the CNPq-MCT (National Council for Scientific Research and Technological development of the Ministry of Science and Technology, Brazil) for the grants provided during the study period.

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Received in 21.III.2006; accepted in 09.III.2007.

JOURNAL OF FISH BIOLOGY

Edited by:
J.F. Craig

ARTIGO EM PREPARAÇÃO

Occurrence of *Cymothoa spinipalpa* (Isopoda Cymothoidae) and reproductive aspects of the marine host fish *Oligoplites palometa* (Osteichthyes: Carangidae)

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Occurrence of *Cymothoa spinipalpa* (Isopoda: Cymothoidae) and reproductive aspects of the marine host fish *Oligoplites palometa* (Osteichthyes: Carangidae)

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Studies on marine fish parasites could still be considered scarce in relation to the vast fish diversity in Brazil. The present work registers the occurrence of an isopod parasite on the leather jack, *Oligoplites palometa* (Cuvier) (Osteichthyes: Carangidae) in the coastal waters of Rio Grande do Norte State, Brazil. During the period of May, 2006 to July, 2007, 78 fish samples were captured from the coastal waters of Natal, RN. The crustacean isopod parasite, *Cymothoa spinipalpa* (Isopoda: Cymothidae) was encountered on the tongue in the oral cavity of the hosts. The parasitic indices of *C. spinipalpa* on *O. palometa* were: 64.1 % of prevalence, mean intensity of 2.02 parasites per host and abundance of 1.29 parasites per fish sampled. *O. palometa* presented negative alometric growth. Significant correlations were observed between body mass and length of hosts and the number of parasites, besides a positive correlation between body length of hosts and body lengths of female parasites. A higher proportion of female hosts were parasitized than males. The hosts presented a high parasitic prevalence for *C. spinipalpa*, with a higher frequency of occurrence in females and the parasites were always found on the tongue in the oral cavity of the hosts. Macroscopic analyses of gonads showed four stages of gonadal development for both sex of *O. palometa*: immature, maturing, mature and spent.

Key Words: Ectoparasitic isopod, *Cymothoa spinipalpa*, *Oligoplites palometa*.

INTRODUCTION

The marine pelagic fish Maracaibo leatherjack (*Oligoplites palometa*) belongs to the family Carangidae, occurs in schools near the coast and is captured by the beach-seines. It is an important component of the Brazilian northeast artisanal fishery and has high commercial value, and is an important source of protein. This species is found in tropical and temperate seas, and despite its wide geographical distribution (Duque-Nivia *et al.,* 1995), there are few studies related to parasitism or reproductive aspects of *O. palometa*.

Among the marine fish parasites, approximately 25% are crustaceans, represented by copepods, branchyurus and isopods (Eiras *et al.,* 2000). The order isopoda consists around ten thousand species divided into ten suborders. Phylogenetic analysis and fossil records suggest that this group dates from the Carboniferous Period in the Paleozoic Era, approximately three hundred million years ago (Brusca & Wilson, 1991). The suborder Flabellifera includes the family Cymothoidae, whose individuals inhabit the branchial chamber and bucal cavity of the fish, as such they easy to detect with the naked eye. Isopods belonging to the family Cymothoidae are one of the most diversified lineages of the order Isopoda, and currently include 42 genera and more than 325 described species (Keitmaier *et al.,* 2007). The Cymothoidae parasitize numerous families and species of fish, many of which are commercially important, particularly in tropical and subtropical regions (Horton & Keymer, 2003). The effect of these ectoparasitic infestations varies according to the state of equilibrium and host-parasite interaction (Leonardos & Trilles, 2003). There are four areas of attachment of the parasite on the host fish: the tegument or fins, the branchial cavity, the bucal cavity or tongue, and the cavities or pouches that they produce inside the body cavity (Eiras *et al.,* 2000). The presence of isopods alter these sites (Rhode, 2005), for example, atrophy of the branchial filaments, removal of the branchial arches and destruction of the tongue (Chavez-Lopez *et al*., 2005).

Reproduction is an important aspect in the biology of species and its success depends on recruitment and consequently, on maintaining viable populations, indispensable to preserving environmental equilibrium. Failure in reproduction of host fish for consecutive years may lead to the depletion of natural stocks or even to their extinction (Esper *et al.,* 2000). The success achieved by fish depends on their reproductive strategies and tactics (Araújo & Chellappa, 2002).

The reproductive biology of marine fish from the Southwest Atlantic coastal waters have not been well documented (Duque-Nivia *et al.,* 1995, Lima *et al.,* 2005; Souza *et al.,* 2007),

and are mainly related to commercially valuable species. However, this issue has yet to be investigated in the crustacean fish hosts, such as the Maracaibo leatherjacket (*O. palometa*), even though it is an important fish for the coastal fishermen of Brazil.

The present study records the ecological indices of parasites and the effect of parasitism on the body mass, length and host condition factor of *O. palometa,* in addition to the type of growth and reproductive aspects, such as, sex ratio, gonadosomatic index and gonadal development.

MATERIAL AND METHODS

Study area and sample collection

The study was conducted in the coastal waters of Ponta Negra Beach (05°52'30'' S and 35°08'00'' W) and of Redinha Beach (05°45'00'' S and 35°10'35'' W), located in the urban zone of Natal, Brazil. Monthly fish collections were carried between May 2006 and July 2007. A beach seine net (110 m long and 3 m high) with a fine inner mesh of 10mm and a coarse mesh of 70mm at the extremities was used. The fishermen, using a small raft, cast the net 100m from the beach in a water depth of 5 m. The net was hauled by ropes attached to the extremities. The entire fishing procedure, from the beginning until the removal of the net lasted about 1 hour. Three consecutive fishing trails were performed monthly involving between 6 and 12 fishermen on each occasion.

Confirm the identification of *O. palometa* was based on biometric, morphometric and meristic measures (Araújo et al., 2004). The isopod crustaceans were removed, measured (mm) and fixed in 70% alcohol. The vials containing the parasites were identified with the number of the host, sex of the parasite, attachment area, collection site and date (Chavez-Lopez *et al.,* 2005) and the data were recorded on necropsy charts. Identification of the isopods was carried out with the assistance of Professor Vernon E. Thatcher of the Department of Zoology, Federal University of Parana, Brazil.

Rainfall

The rainfall data of the study area was obtained from the Department of Meteorology and Hydric Resources of EMPARN (Agriculture Research Enterprise of Rio Grande do Norte, Natal, Brazil), in order to characterize the rainfall regime and to separate the dry and rainy seasons.

Ecological indices of parasites

The parasitic indices calculated were: prevalence (number of parasitized fish/number of fish examined x 100), mean intensity (total number of parasites/total number of parasites/total number of parasitized fish) and mean parasitic abundance (prevalence x mean intensity). These indices were calculated according to Bush *et al.,* (1997).

Type of growth

The weight / length relation was established by the equation, **Wt =** φLsθ; where Wt is total weight, Ls is standard length, φ is the condition factor coefficient and θ is the angular coefficient or growth coefficient, which allows us to determine the type of growth of each species (Santos, 1978).

Condition factor (K)

The condition factor was calculated according to Nash *et al.,* (2006), K = (W/L^3) x 100, where K = Fulton's condition factor, W = total weight (g) and L = total length (cm).

Sex ratio

The fish were dissected and the gonads removed, weighed and examined to identify the sex. The proportion between the males and females was determined by analyzing their monthly relative distribution frequency during the study period (Vazzoler, 1996).

Macroscopic aspects of gonad development

Macroscopic examination was performed to classify gonad development (Vazzoler, 1996).

Gonadosomatic Index (GSI)

The gonads were removed and weighed (g). GSI was determined using the percentage relation between gonad weight (Wg) and fish body weight (Wt) minus gonad weight (Wg), given by the relation: GSI = [Wg/(Wt-Wg] x 100, according to Wooton *et al.* (1978).

Statistical analyses

Pearson's correlation tests were performed to determine the correlation between the variables weight and length of host fish and number of parasites. The *t*-test was applied to compare the mean condition factor of the parasitized and non-parasitized fish. The χ^2 (chi-

square) test was used to verify the differences and their significance (5%) in the proportion between parasitized male and female host fish. The statistical analyses were conducted using Statistica 7.0 software.

RESULTS AND DISCUSSION

Rainfall

During the entire study period mean annual rainfall was 120 mm, the rainy season was from March to August and the dry season between September to February (Fig. 1). During the rainy period the mean rainfall was 171.3 mm, and in the dry period it was 59.02 mm. The rainfall pattern recorded during the study period was normal for a semi-arid climate.

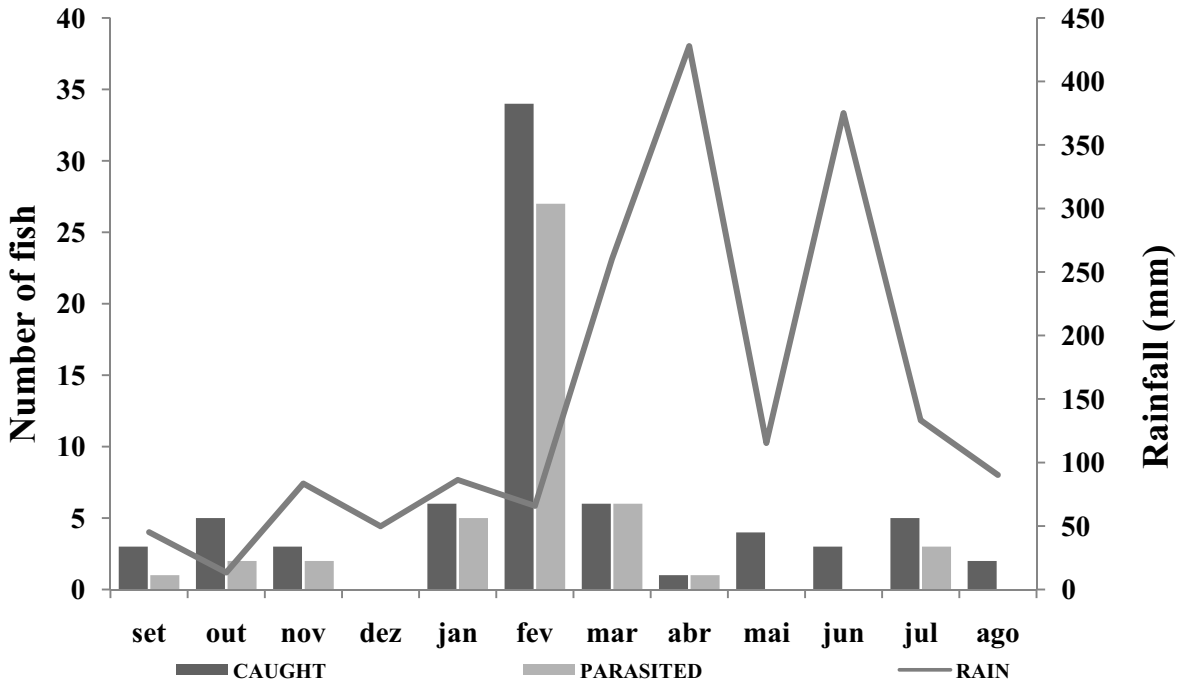

Figure 1. Occurrence of parasitized fish in relation to monthly variation in rainfall.

Parasitism by isopod and ecological indices of parasites

Figure 1 shows the monthly variation of fish captured and parasitized (grouped sex). Of the 78 specimens of *O. palometa* captured, 49 (63%) were males and 29 (37%) females, of these 31 males and 19 females were parasitized. The number of fish captured, parasitized and the number of isopods found in relation to the males and females on the host.

The occurrence of a single species of isopod ectoparasite was observed in *O. palometa*. This was identified as *Cymothoa spinipalpa* (Thatcher, Araújo, Lima & Chellappa, 2007) (Fig. 2). Despite the great similarity of the new species with *C. recifea* (Thatcher & Fonseca, 2005), *C. spinipalpa* distinguishes itself from *C. recifea* by its small round carina (between 4 and 7). It also distinguishes from all the other species of the family *Cymothoa* by the presence of mandibular palpi, completely covered with thorn-like projections in the adult males (Thatcher *et al.,* 2007). This is the first record of occurrence of *C. spinipalpa* in O. *palometa.*

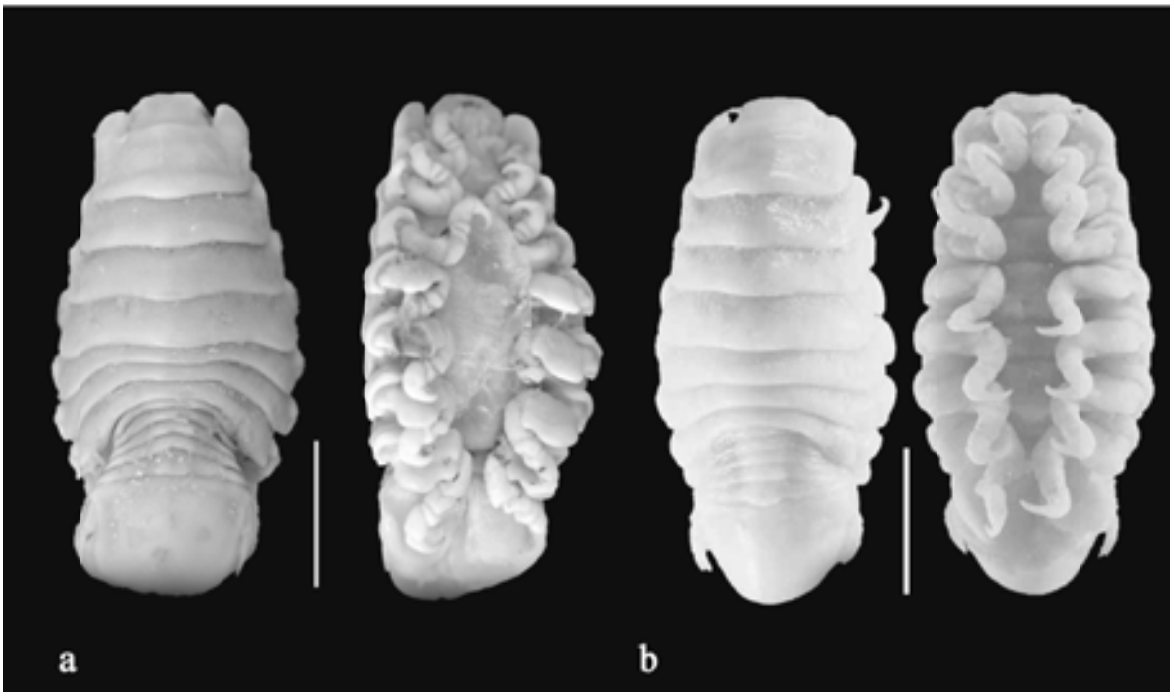

Figure 2. Isopod *C. spinipalpa* a) Dorsal and ventral view of female; b) Dorsal and ventral view of male (scale 5 mm).

The parasitic indices of *O. palometa* showed a prevalence of 64.1%, mean intensity of 2.02 parasites per fish and mean abundance of 1.29. In the dry period these indices showed a prevalence rate of 72.6%, mean intensity of 1.01 parasites per fish and mean abundance of 1.39, whereas in the rainy period these indices showed a prevalence rate of 50%, mean intensity of 2.25 parasites per fish and mean abundance of 1.13. Table I shows the values of the parasitic indices during dry and rainy periods of *C. spinipalpa* in *O. palometa.*

Table I. Parasitic indices of *C. spinipalpa* on host fish *O. palometa* during the dry and wet seasons.

Season	Mean intensity	Mean abundance	Percentage of prevalance
Dry	1.9	1.4	72
Wet	2.3	1.2	50

The dry season had higher parasitic and abundance indices, whereas mean intensity remained practically constant between the two seasons. The same result was found by Azevedo *et al.* (2002), studying parasitism by the isopod *Riggia paranaensis* in the host *Cyphocharax gilbert*. The author suggests that the increased prevalence of the parasite observed during the dry season may reflect the large occurrence of infestation by larvae born in the rainy season.

In other studies conducted with isopods from the family *Cymothoidae,* the prevalence rate was 20% for *Cymothoa catarinensis* in the host *Menticirrhus litoralis* and 13% for *Cymothoa excise* in the host *Micropogonias furnieri* (Thatcher *et al.,* 2003a). Parasitism by *Lironeca redmanni* in *Cetengraulis edentulous* showed a prevalence rate of 17.06% (Thatcher *et al.,* 2003b) and parasitism by *Lironeca* sp in *Atherinomorus lacunosus* was 3.6% (Coloni *et al.,* 1997). In the Serra Spanish mackeral, *Scomberomorus brasiliensis*, the prevalence rate was 31% for *Lironeca redmanni* (Lima *et al.,* 2005).

Considering the results of Cordoni *et al.* (1997), Thatcher *et al.* (2003a), Thatcher *et al.* (2003b) and Lima *et al.* (2005), *O. palometa* showed a high parasitic prevalence rate by *C. spinipalpa.*

Attachment site and parasitic specificity

C. spinipalpa showed parasitic specificity for the attachment area only on the tongue and in the oral cavity of the host. *C. spinipalpa* was the only species found in *O. palometa*; as such, there was no coexistence of other parasite species.

The isopods of the genus *Cymothoa* are commonly found in the oral cavity of their hosts; however, some studies report that Cymothoid males and females differ as to location on their hosts (Sartor, 1986; Bunkley-Williams *et al*., 2006). For example, females of the isopod *Cymothoa* attach themselves in the oral cavity of the host *Orthopristis ruber*, whereas the male isopods fasten themselves in the branchial cavity (Bunkley-Williams *et al.,* 2006). In the present study, both sexes of the parasite *C. spinipalpa* were found in the bucal cavity of the

host, corroborating the results of Leonardos & Trilles (2003), who found males and females of the isopod *Mothocya epimerica* in the oral cavity of the host *Atherina boyeri.*

Length and weight of the fish

The total weight of male *O. palometa* ranged from 51.6 g to 942.0 g (mean 154.3 ± SD 153.3), whereas the total weight of the females varied from 45.3 g to 243 g (mean 116.07 ± SD 47.33). The total length of *O. palometa* ranged from 198 mm to 575 mm (mean 26.1 ± SD 6.68), whereas the total length of the females varied from 200 mm to 320 mm (mean 24.5 ± SD 2.85). The males weighed more and were longer than the females, possibly because more males were collected, which allowed for the register of males in various weight and length classes.

Relation between host weight and length and the number of parasites

There was a significant correlation between host weight and the number of parasites ($p < 0.05$) and between host length and the number of parasites ($p < 0.05$).

There was a slightly positive correlation between host weight and the number of parasites ($r = 0.25$) and between host length and the number of parasites in *O. palometa* ($r = 0.22$). This result indicated that the parasites had a preference for hosts with higher body weight and body length. Paraguassú *et al.* (2002) studied the ecology of metazoan parasites of *Pagrus pagrus* and found a positive correlation between parasitic prevalence by *Cymothoa* sp. and the total body length of *Pagrus pagrus.*

The occurrence of a greater number of isopods in large fish may be due to the their larger body surface area.

Relation between host and parasite length

There was a positive correlation between the total length of the hosts and the length of the female isopod parasites ($r = 0.64$). According to Alvarez & Flores (1997), there is a positive correlation between the length of females of the isopod *Cymothoa exgua* and the total body length of the host *Lutjanus peru.* Females of the family Cymothoidae grow until they fill the entire space available in the oral cavity of the host, since the greater their growth the greater will be their fecundity (Kittlein, 1991). The growth of female isopods was, therefore, limited by the space available in the oral cavity of *O. palometa.*

There was no significant correlation between the length of male *C. spinipalpa* and the total length of *O. palometa.* Similar results were found by Chávez-Lopez *et al* (2005) in parasitism

by the isopod *Elthusa alvaradoensis* in the host *Synodus foetens*. This indicates that, in contrast to female parasites, which need a large space for growth and gonad development, the males *C. spinipalpa* are smaller and do not require much space.

Condition factor (K)

The condition factor in *O. palometa* varied from 4.96 to 11.04 (7.57 ± 1.17) in parasitized individuals and from 5.26 to 9.10 (6.66 ± 1.05) in non-parasitized individuals. There was a significant difference between the condition factor of parasitized and non-parasitized fish (t-test = 2.99; $p < 0.05$). The condition factor has been used by several authors to quantify the effect of parasitism on the host. Horton & Okamura (2001) used the condition factor to assess the effect of parasitism by the isopod *Ceratothoa oestroides* on the host *Dicentrarchus labrax*. Some studies indicate that the condition factor is a very accurate tool for measuring the effect of parasitism by Cymothoidae isopods on many hosts, as in the case of parasitism by *Livoneca redmanii* in the host *Scomberomorus regalis* (Williams & Bunkley-Williams, 2000). In the present study, the condition factor was not an accurate tool for measuring the effect of parasitism by *C. spinipalpa* in *O. palometa.*

Type of growth

O. palometa males and females exhibited negative allometric growth ($\theta = 0.996$ and 0.913, respectively). According to Benedito-Cecílio & Agostino (1997), if θ is equal to 3, growth is isometric; if θ is greater than 3, it is positive allometric; and if it is less than 3, growth is negative allometric. This means that, if growth is isometric, the increase in weight follows the growth in length, but if it is positive allometric, there is a greater increase in weight than in length. In this study, *O. palometa* displayed negative allometric growth, meaning that there was a lower increase in weight than in length.

Sexual ratio

Since there were more males than females there was a significant difference in the sex ratio of the fish ($P < 0.05$). There was no significant difference in the proportion of parasitized males and females ($P < 0.05$), which suggests that *C. spinipalpa* had no specificity in relation to host sex.

During the life cycle of the fish, sexual proportion may vary as a function of various factors that act differently on each sex (Souza *et al.,* 2007). The females of *O. palometa* spawn far from coastal waters throughout the year (Duque-Nivia *et al.,* (1995), which might

explain the greater occurrence (nearly twice as many) of males captured in the coastal collection area.

Macroscopic aspects of gonad development in O. palometa

In both sexes of *O. palometa* macroscopic analysis enabled us to identify the four distinct gonad maturation stages: immature, maturing, mature and spent (Figure 3, Table II).

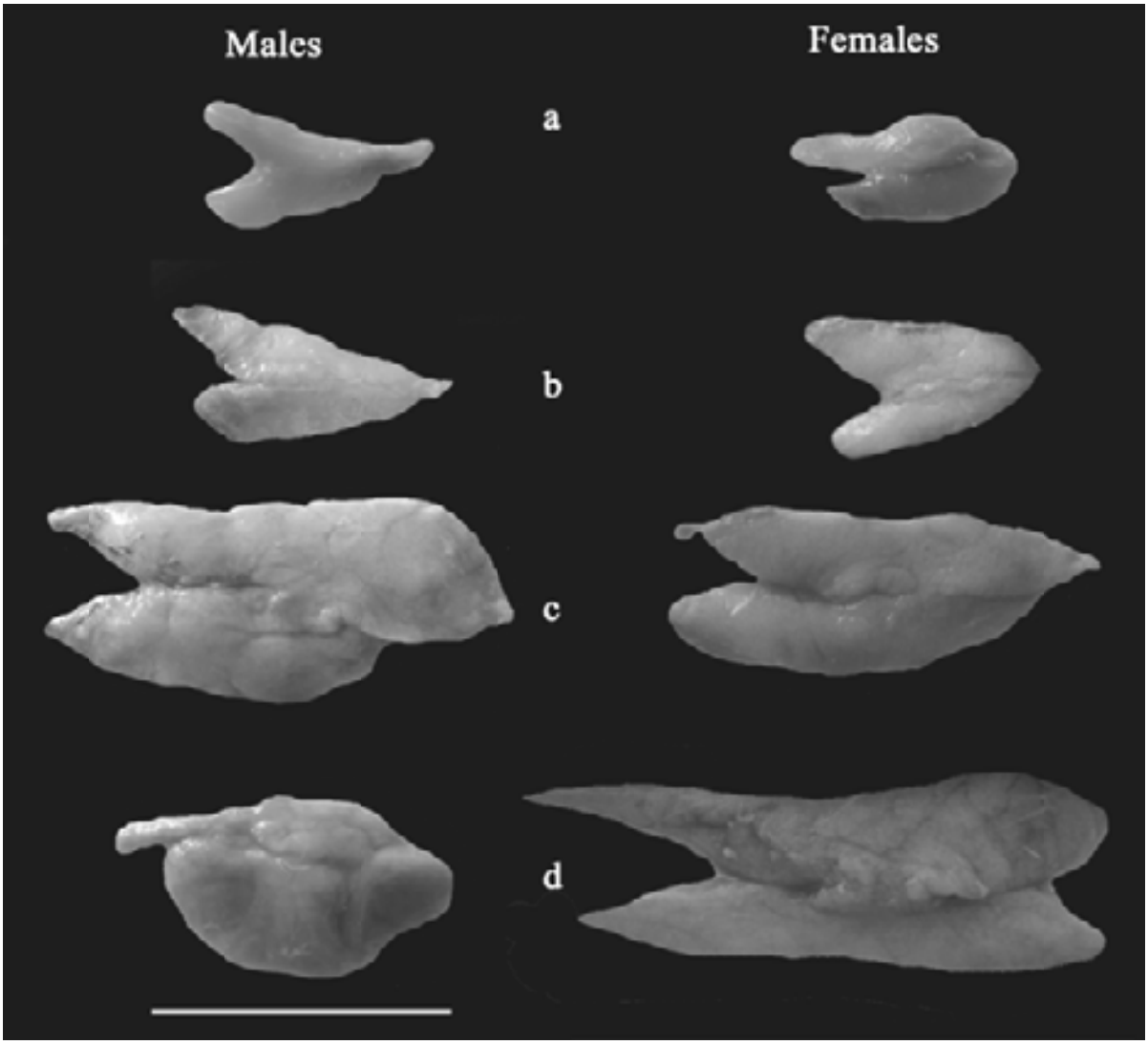

Figure 3. Macroscopic aspects of gonads in various developmental stages of males and females of *O. palometa*: (a) Immature, (b) developing, (c) mature (d) spent and resting gonads (Scale bar =30mm).

Table II. Macroscopic classification and description of the ovarian and testicular maturity stages of *O. palometa*.

Stage	**Macroscopic description of ovaries**	***Macroscopic description of testicules***
Immature	Ovaries small thread-like and translucent, no oocytes were observed	Testes small, extremely thin and translucent.
Maturing	Ovaries occupied 1/3 of the coelomic cavity, oocytes were visible.	Testicles occupied 1/3 of the coelomic cavity.
Mature	Ovaries were well vascularized and occupied 2/3 of the coelomic cavity with visible oocytes.	Testicles were large, whitish in colour with blood vessels appearing in the periphery and occupied 2/3 of the coelomic cavity.
Spent	Ovaries were flacid with signs of hemorrhage.	Testicles were smaller occupied 1/3 of the coelomic cavity with signs of hemorrhage.

Gonadosomatic index (GSI) x Condition factor (K)

The GSI values varied from 0.07 to 1.64 in the females (0.42 ± 0.51) and from 0.07 to 0.15 in the males (0.12 ± 0.03). In the dry season the males had mean GSI of 0.13 (± 0.03), whereas in the rainy season it was 0.11 (± 0.03). There was no significant difference ($P > 0.05$) between the GSI of the males in the dry and rainy seasons. The same results were found for the females.

The condition factor of male *O. palometa* ranged from 4.96 to 10.05, with a mean value of 7.2 (± 1.37). Both male and female *O. palometa* showed a low correlation between the condition factor (K) and the gonadosomatic index (GSI), with $r = 0.03$ and 0.06, respectively.

According to Duque-Nivia *et al* (1995), *O. palometa* showed no correlation between the condition factor and GSI, possibly due to the variation in condition factor that is more influenced in this species by food than by reproductive cycle.

ACKNOWLEDEMENTS

The authors wish to thank CAPES/MEC, the National Council for Scientific and Technological Development of Brazil (CNPq) for the financial support awarded during the study period (J. T.A. Ximenes de Lima, Grant nº. 141651/2005-9**)** and for the Research grants awarded (S.Chellappa, Grant nº. 307497/2006-2, A. Araújo, Grant nº. 302012/2006-0 and N.T. Chellappa, Proc.No.306274/2003-5). Prof. Vernon Thatcher of the Departament of Zoology, Federal University of Parana, for help given in identification of the fish parasites.

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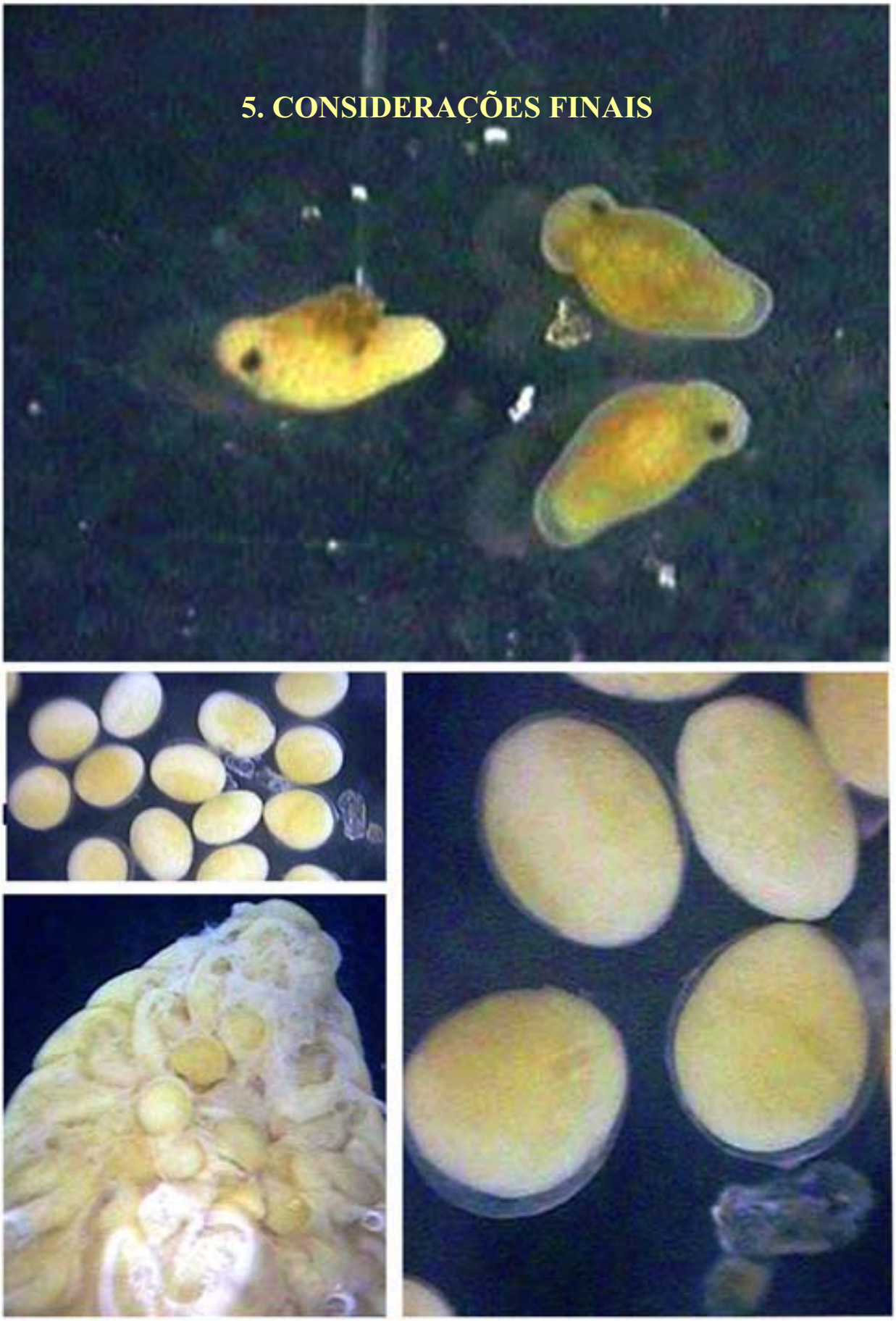
5. CONSIDERAÇÕES FINAIS



Os estudos realizados para investigar a dinâmica reprodutiva e parasitária de quatro espécies de peixes marinhos serra, *S. brasiliensis*, tibiros, *O. saurus* e *O. palometa* e palombeta, *C. chrysurus* das águas costeiras do Sudoeste do Oceano Atlântico, Brasil, permitiram chegar as seguintes considerações finais:

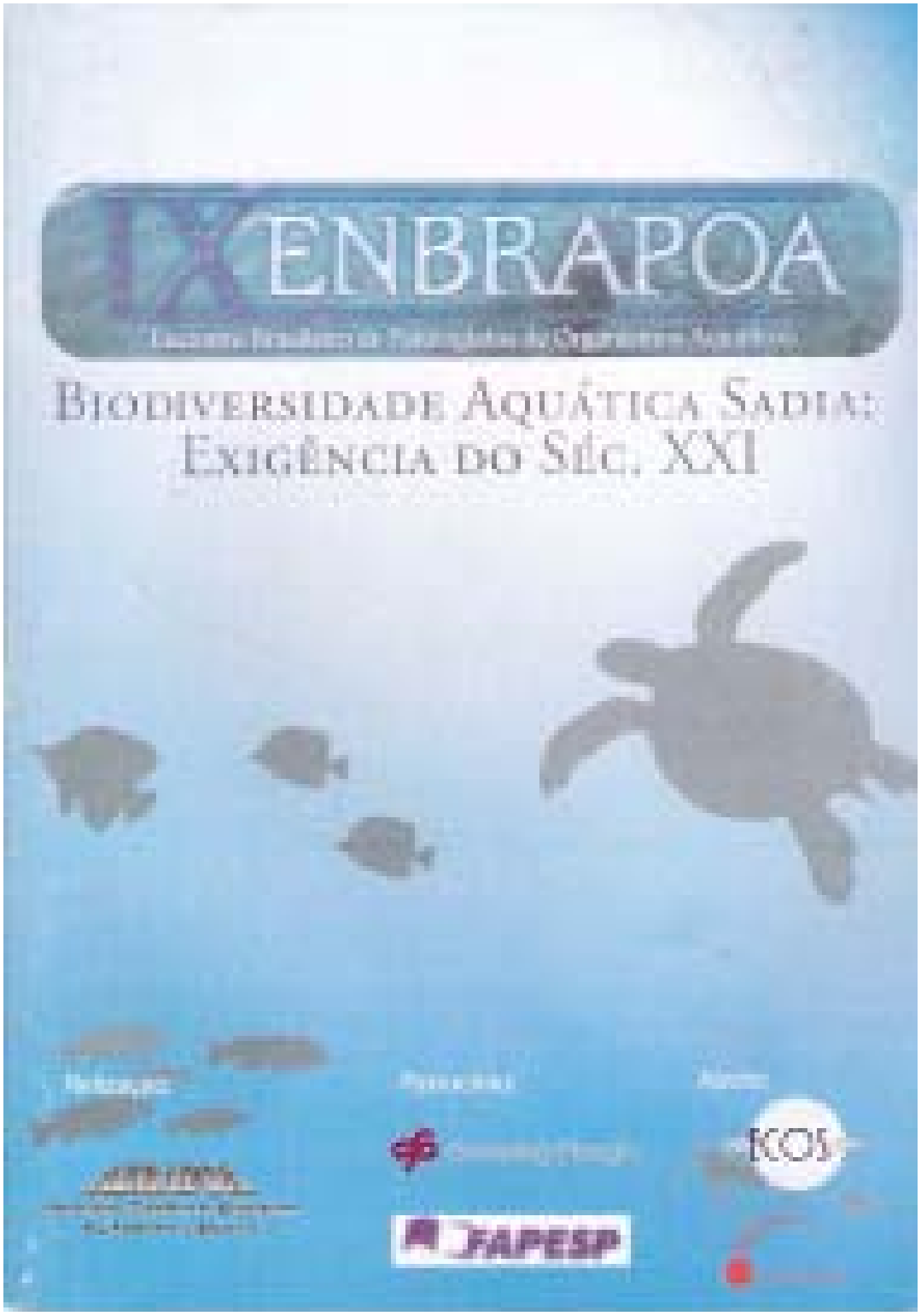
* Em relação aos aspectos reprodutivos, foram avaliados a proporção sexual, o índice gonadossomática (IGS), fecundidade, tipo e época de desova e a caracterização macro-microscópica do desenvolvimento gonadal dos peixes. A proporção sexual em três espécies de peixes foi a esperada 50% para cada sexo (1M:1F), ocorrendo um predomínio de machos apenas na espécie *O. palometa* (3M:2F). IGS variou de acordo com o ciclo reprodutivo de cada espécie onde a pluviosidade foi o fator ambiental que modulou a época reprodutiva, ocasionando os maiores valores do IGS no período das chuvas da região. As fêmeas apresentaram desova total e a fecundidade teve correlação positiva com o peso das gônadas e do corpo. Quatro estádios de desenvolvimento das gônadas (imaturo, em maturação, maduro e esgotado) foram identificados macroscopicamente e os estudos microscópicos mostraram os detalhes do desenvolvimento ovocitário em cada estádio de maturação.

* Em relação aos aspectos parasitários, os isópodos parasitaram os peixes imaturos, em maturação e maduros. Foram identificadas três espécies de parasitos isopodos: *Livoneca redmmanni*, *Rocinela signata* e *Cimothoa spinipalpa.* As primeiras duas espécies ocorreram na cavidade branquial de *C. chrysurus* e *S. brasiliensis.* A terceira espécie de isópodo *C. spinipalpa* (Thatcher; Araújo; Lima & Chellappa, 2007) é uma nova espécie de parasito identificada e relatada pela a primeira vez. Este isópodo foi encontrado na cavidade bucal de *O. saurus* e *O. palometa* nas águas costeiras do Sudoeste do Oceano Atlântico, Brasil. Os microhabitatos preferidos pelos parasitos isópodos foram à câmara branquial e a cavidade bucal dos hospedeiros, sendo áreas mais protegidas com maior disponibilidade de oxigênio e irrigação sanguínea. A prevalência de infecção de isópodos nos três espécies

de hospedeiros variou de 16 a 21%, entretanto, a prevalência de infecção alcançou 60% em *O. palometa*. No período das chuvas foi registrada a maior ocorrência de parasitismo por isópodos, que não prejudicou o ciclo reprodutivo normal dos hospedeiros.

* O tamanho corporal do hospedeiro determina o espaço da câmara branquial, porém, não influenciou o espaço ocupado pelo isópodos, uma vez que eles ocuparam um espaço entre 35-36% da câmara branquial independente do tamanho corporal dos hospedeiros.

ANEXOS


IX ENBRAPOA
Encontro Brasileiro de Patologistas de Organismos Aquáticos
BIODIVERSIDADE AQUÁTICA SADIA:
EXIGÊNCIA DO SÉC. XXI
FAPESP

IX ENBRAPOA
BIODIVERSIDADE AQUÁTICA SADIA:
EXIGÊNCIA DO SÉC. XXI

Apresentação oral

COMPORTAMENTO DE ESCOLHA DE MICRO-HABITAT DOS PARASITOS ISÓPODOS NOS PEIXES *Scomberomorus brasiliensis* & *Chloroscombrus chrysurus* NAS ÁGUAS COSTEIRAS DO RIO GRANDE DO NORTE, BRASIL

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O presente trabalho teve como objetivo verificar a relação entre especificidade parasito-hospedeiro e coexistência de parasitos em micro-habitats do hospedeiro. Foram capturados 306 peixes palombeta, *Chloroscombrus chrysurus* (Linnaeus, 1766) (Osteichthyes: Carangidae) e 178 peixes serra, *Scomberomorus brasiliensis* (Collette, Russo & Zavala-Camin, 1978) (Osteichthyes: Scombridae) por arrasto-de-praia de agosto-2005 a fevereiro-2006 nas águas costeiras do Rio Grande do Norte. Comprimento total das palombetas variou entre 88 – 210 mm e das serras 14 – 809 mm. Os peixes foram necropsiados e os parasitos retirados, identificados e preservados em álcool 70%. Foi avaliada a preferência da área de fixação parasitária nos hospedeiros. Os resultados que os hospedeiros foram infestados por três espécies de isópodos com escolha diferente do micro-habitat. O isópodo *Lironeca redmanni* se adaptou em ambos hospedeiros. *Rocinela signata* foi específico na serra e *Cymothoa* sp. na palombeta. Ambos isópodos da serra coexistiram nas brânquias, mas cada uma em brânquias opostas. Os isópodos da palombeta escolheram micro-habitats diferentes, *L. redmanni* na câmara branquial e *Cymothoa* sp. na cavidade oral. Os isópodos da palombeta coexistem no mesmo hospedeiro com adaptações distintas para diferente micro-habitat. Os parasitos isópodos demonstram comportamento de escolha de micro-habitat evitando competição por espaço e alimento.

Bolsa do CNPq - Doutorado em Psicobiologia - UFRN

IX Encontro Brasileiro de Patologistas de Organismos Aquáticos

BIODIVERSIDADE AQUÁTICA SADIA: EXIGÊNCIA DO SÉCULO XXI"

Maceió - 23 à 27 de Outubro de 2006

Relação dos Trabalhos "Orais" escolhidos para serem apresentados. Os orais que não fazem parte desta lista serão apresentados em forma de "Pôster":

Nº	ORAIS
01	Susceptibilidade de cepas de Escherichia coli, isoladas de água, camarão e sedimento de viveiros de três fazendas do Estado do Ceará, a diferentes antimicrobianos - Carvalho, E.M.R.; Carvalho, F.C.T.; Rodrigues, D.P.; Festivo, M.L. & Vieira, R.H.S.F.
02	ISOLAMENTO E IDENTIFICAÇÃO DE BACTÉRIAS EM PEIXES ORNAMENTAIS COMERCIALIZADOS EM BELO HORIZONTE - Velasco, F.O.; Lima, L.C.; Costa, A.A.P.; Fernandes, A.A.; Leite, R.C. & Lage, E.P.
03	avaliaçao DE bacterina e BACTERIAS PROBIÓTICAS FRENTE À infecção experimental POR Vibrio harveyi Em Litopennaeus vannamei - Buglione, C.C.; Vieira, F.N.; Monguilliot, J.P.; Martins, M.L.; Pedrotti, F.S.; Beltrame, E. & Mouriño, J.L.P.
04	USO DE DIETA SUPLEMENTADA COM BACTÉRIAS PROBIÓTICAS NO CONTROLE DE BACTÉRIAS PATOGÊNICAS EM CAMARÕES MARINHOS (Litopenaeus vannamei) - Vieira, F.N.; Buglione, C.C.; Jatobá, A.; Pedrotti, F.S.; Beltrame, E.; Vinatea, L.A.; Martins, M.L.; Barracco, M.A. & Mouriño, J.L.P.
05	DOENÇAS EM PEIXES LISTADAS PELA OIE NO ESTADO DO AMAZONAS - Belém-Costa, A. & Gomes, A.L.S.
06	ABUNDÂNCIA DE HELMINTOS INTESTINAIS EM TRÊS ESPÉCIES DE PEIXES COM DIFERENTES HÁBITOS ALIMENTARES na área do Catalão, Iranduba, AM - Vital, J. F.; Anselmo, A.A.S.; Pimpão, D.M.; Schneider, L. & Oliveira, S.R.
07	SURTO EPIZOOTICO PROVOCADO POR SCUTICOCILIATIA EM RODOVALHO (Scopthalmus maximus L.) DE CULTURA EM PORTUGAL - Ramos, M. F.; Costa, A. R.; Barandela, T.; Saraiva, A. & Rodrigues, P.N.
08	DIDYMOZOIDAE (DIGENEA) PARASITANDO Thunnus obesus (SCOMBRIDAE) DO LITORAL DO RIO DE JANEIRO - Justo, M. C. N.; Lopes, M. S. & Kohn, A.
09	NEMATÓIDES PARASITOS DE Acestrorhynchus lacustris (LÜTKEN, 1875) (CHARACIFORMES: ACESTRORHYNCHIDAE) DO RESERVATÓRIO DE TRÊS MARIAS, MG, BRASIL - Corrêa, R.F.S.S.; Santos, M.D. & Brasil-Sato, M.C.
10	Parasitofauna de Pimelodus maculatus (Osteichthyes: Pimelodidae) do Rio Itajaí-Açu em Blumenau, SC, Brasil - Bachmann, F.; Greinert, J.A.; Bertelli, P.W.; Silva Filho, H.; Lara, N.O.T.; Ghiraldelli, L. & Martins, M.L.
11	COMPORTAMENTO DE ESCOLHA DE MICRO-HABITAT DOS PARASITOS ISÓPODOS NOS PEIXES Scomberomorus brasiliensis & Chloroscombrus chrysurus NAS ÁGUAS COSTEIRAS DO RIO GRANDE DO NORTE, BRASIL - Lima, J.T.A.X. de; Araújo, S.G.; Costa, E.F.S.; Souza, A.A. & Chellappa, S.
12	ECOLOGIA DE METAZOÁRIOS PARASITAS DE BRANQUIAS DE Arapaima gigas (SCHINZ, 1822): RIQUEZA DE ESPÉCIES E INFLUÊNCIA SAZONAL NA COMPÓSIÇÃO DAS INFRACOMUNIDADES - Gomes, A.L.; Santos, M.S.; Malta, J.C. & Villacorta-Correa, M.A.
13	DIAGNÓSTICO DE ECTOPARASITAS E BACTÉRIAS EM TILÁPIAS (Oreochromis niloticus) CULTIVADAS NA REGIÃO DE PAULO AFONSO – BAHIA - Lemos, J.B.; Rodrigues, M.E.B.; Lopes, J.P. & Tenório, R.A.
14	PARASITOLOGIA DE PEIXES EM SISTEMAS AQUÁTICOS DA ÁREA DO CAMPUS DA UNIVERSIDADE FEDERAL DO ACRE (ACRE/BRASIL) - Lima, M.A. & Santos, F.G.A.
15	INCIDÊNCIA DE Lithophaga aristata DILLWYN (MOLLUSCA: BIVALVIA: MYTILIDAE) EM CONCHAS DE VIEIRAS Nodipecten nodosus LINNAEUS CULTIVADAS EM UBATUBA, LITORAL NORTE DE SÃO PAULO – SP - Alvarez, I.L.A.; Marques, H.L.A.; Gelli, V.C.; Roma, R.P.C. & Novais, A.B.G.
16	ASPECTOS BIOQUÍMICOS E MOLECULARES DO INIBIDOR DE PROTEASES PLASMÁTICO, a2-MACROGLOBULINA, EM QUATRO ESPÉCIES DE CRUSTÁCEOS - Perazzolo, L.M.; Rosa, R.D.; Lorenzini, D.M.; Daffre, S. & Barracco, M.A.
17	DETECÇÃO PRELIMINAR POR ABORDAGEM GENÔMICA DO FATOR ANTI-LIPOPOLISSACARÍDEO EM DIFERENTES ESPÉCIES DE CRUSTÁCEOS NATIVOS - Rosa, R.D. & Barracco, M.A.
18	ANÁLISE COMPARATIVA DE ALGUNS PARÂMETROS HEMATO-IMUNOLÓGICOS EM REPRODUTORES DE VIEIRA Nodipecten nodosus ANTES E APÓS A DESOVA - Schleder, D.D.; Kayser, M.; Suhnel, S.; Ferreira, J.F.; Rupp, G.S. & Barracco, M.A.
19	HEMATOLOGIA DE TILÁPIAS CULTIVADAS NA REGIÃO DE JOINVILLE, SANTA CATARINA - Jerônimo, G.T.; Ghiraldelli, L.; Yamashita, M.M.; Adamante, W.B. & Martins, M.L.
20	HISTOPATOLOGIA DE FÍGADO, RIM CEFÁLICO E BAÇO DE Piaractus mesopotamicus, Prochilodus lineatus e Pseudoplatystoma fasciatum DO RIO AQUIDAUANA, PANTANAL SUL MATO-GROSSENSE - Campos, C.F.M.; Moraes, J.R.E. & Moraes, F.R.
21	TOXICIDADE DO ALUMÍNIO EM CURIMBAS (Prochilodus lineatus -Valenciennes, 1847) - ALTERAÇÕES HEMATOLÓGICAS, METABÓLICAS E OSMO-IÔNICAS - Camargo, M.M.P.; Fernandes, M.N. & Martinez, C.B.R.
22	PAPEL DA QUALIDADE DE ÁGUA NA RECUPERAÇÃO DE TILÁPIAS ACOMETIDAS POR AEROMONOSE - Lima, L.C.; Velasco, F.O.; Costa, A.A.P.; Fernandes, A.A. & Leite, R.C.

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IX ENBRAPOA
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BIODIVERSIDADE AQUÁTICA SADIA:
EXIGÊNCIA DO SÉC. XXI

PARASITOS ISÓPODOS (ISOPODA: CYMOTHIDAE) ENCONTRADOS NO PEIXE TIBIRO, *Oligoplites saurus* (BLOCH & SCHNEIDER, 1801) (OSTEICHTHYES: CARANGIDAE) DAS ÁGUAS COSTEIRAS DO RIO GRANDE DO NORTE

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O trabalho verificou a ocorrência de isópodos em *Oligoplites saurus*, que é um peixe pelágico capturado por pesca artesanal de Natal, Rio Grande do Norte. Os peixes foram coletados mensalmente durante novembro de 2004 a outubro de 2005, com o auxilio da rede-de-arrasto tipo tresmalho. Os peixes foram levados para o Laboratório de Ictiologia do Departamento de Oceanografia e Limnologia da UFRN. Os isópodos parasitos foram coletados e preservados em álcool 70% e os índices parasitários foram calculados. Foram capturados 45 tibiros, 21 em Ponta Negra e 24 na Redinha. Os resultados indicam a ocorrência de duas espécies de isópodos na Praia de Ponta Negra, *Lironeca redmmani* (Leach, 1918) e *Cymothoa* sp. (Fabricius, 1793). Na Praia da Redinha ocorreu *Cymothoa* sp. As áreas de fixação dos isópodos foram diferentes para as duas espécies. *L. redmmani* foi encontrado nas brânquias enquanto *Cymothoa* sp. foi encontrado na língua do tibiro. O comprimento total dos peixes machos variou de 149 a 283 mm em Ponta Negra e de 109 a 234 mm em Redinha, das fêmeas variou de 171 a 283 mm em Ponta Negra e de 200 a 253 mm em Redinha. Houve ausência de associação entre comprimento ($\chi 2$= 7,54; df=3; p> 0,05) e sexo ($\chi 2$= 1,94; df=2; p> 0,05) do hospedeiro com a prevalência parasitária. Em Ponta Negra a prevalência foi 9,5%, intensidade média de 1 parasito por peixe e abundancia de 0,09 para *L. redmmani* e para o *Cymothoa* sp., a prevalência foi de 42,85%, intensidade média de 1,33 parasito por peixe e abundância de 0,57. Na Redinha a prevalência foi de 25%, intensidade média de 1,5 parasitos por peixe e abundância de 0,38 para *Cymothyoa* sp.

PARASITOS ISÓPODOS CYMOTHOIDES ENCONTRADOS NO PEIXE TIBIRO, *Oligoplites saurus* (BLOCH & SCHNEIDER, 1801) DAS ÁGUAS COSTEIRAS DO RIO GRANDE DO NORTE

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INTRODUÇÃO & OBJETIVO

Existem cerca de dez mil espécies de parasitos de peixes, dessas 2590 são Crustácea (EIRAS, 1994). Os crustáceos que parasitam os peixes são ectoparasitos, mesmo que sua localização não seja perceptível no exterior do individuo, podendo os mesmos estar alocados em orifícios ou em região subcutânea através de lesão mecânica (EIRAS *et al*., 2000). Sua ação sobre os peixes pode ser direta, ou em outros casos podem funcionar como vetores de doenças causadas por vírus ou bactérias. Os principais grupos de crustáceos parasitos são copépodos, branquiurus e isópodos. (PAVANELLI *et al*, 1998). No presente trabalho foi registrada a ocorrência de isópodos parasitos no peixe marinho tibiro, *Oligoplites saurus* (Bloch & Schneider, 1801) pertencente à família Carangidae da ordem perciformes, das águas costeiras do Rio Grande do Norte, através de coletas mensais realizadas na Praia de Ponta Negra e na Praia da Redinha, ambas localizadas na região urbana no município de Natal, RN, Brasil.

MATERIAIS & MÉTODOS

As coletas dos peixes tibiros foram realizadas mensalmente durante o período de novembro de 2004 a outubro de 2005, nas águas costeiras da Praia de Ponta Negra (05º52'30" S e 35º08'00" W) e da Praia da Redinha (05 45' 00" S e 35 10' 35" W), localizada na região urbana no município de Natal, RN, Brasil (Figura 1).

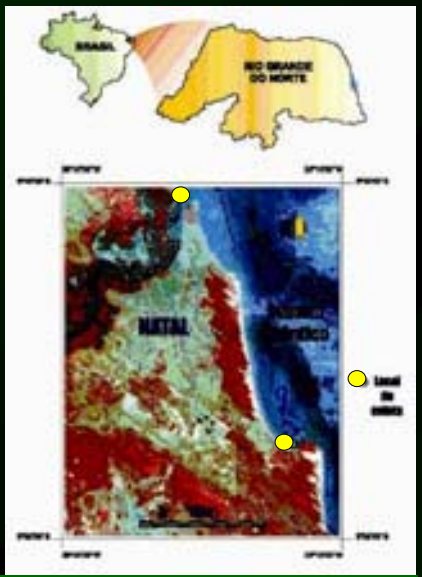

Figura 1. Localização das áreas de estudo: Praia de Ponta Negra e Praia da Redinha, Natal, RN (Cena SPOT: 731.362-1994). Fonte: SUDENE.

Figura 2. Vista dorsal de um macho (esquerda) e uma fêmea (direita) de *Cymothoa* sp.

Figura 3. *Cymothoa* sp. na cavidade oral do *O. saurus*

Os peixes foram capturados utilizando redes de arrasto de praia do tipo tresmalho. Os peixes foram transportados em caixas de isopor com água do mar e gelo para o Laboratório de Ictiologia do Departamento de Oceanografia e Limnologia da Universidade Federal do Rio Grande do Norte. Foram realizadas a pesagem e biometria dos peixes coletados e em seguida foram examinados macroscopicamente para que os crustáceos isópodos fossem removidos e fixados em álcool a 70%, rotulados com o número do hospedeiro, área de fixação, local e data, sendo todos os dados referentes registrados em um formulário (EIRAS *et al*., 2000).

Os índices parasitários calculados foram a prevalência (número de peixes parasitados / número de peixes examinados X 100), intensidade média (número total de parasitas / número total de peixes parasitados) e abundância parasitária (Prevalência x Intensidade média). Estes índices foram calculados segundo Bush *et al* (1997).

RESULTADOS & CONCLUSÃO

Durante o período de estudo foram capturados um total de 45 tibiros, sendo 21 capturados na Praia de Ponta Negra e 24 capturados na Praia da Redinha. De 45 peixes capturados 18 foram parasitados. Duas espécies de parasitos (Isopoda: Cymothidae) ocorreram em *O. saurus* capturados nas águas da Praia de Ponta Negra, *Lironeca redmmani* e *Cymothoa* sp. (Fig. 2), enquanto uma espécie (Isopoda: Cymothidae) ocorreu na Praia da Redinha, *Cymothoa* sp.

Os isópodos apresentaram especificidade parasitaria com relação à área de fixação. A espécie *L. redmmani* foi encontrada nas câmaras brânquias enquanto que a espécie *Cymothoa* sp. foi encontrada sobre a língua na cavidade oral do hospedeiro (Fig. 3).

Os índices parasitários de *L. redmmani* mostraram uma prevalência de 9,5%, intensidade média de um parasita por peixe e abundância de 0,09, enquanto os índices parasitários de *Cymothoa* sp. mostraram prevalência de 42,85%, intensidade média de 1,33 parasita por peixe e abundância de 0,57 na praia de Ponta Negra. Os índices parasitários de *Cymothoa* sp. mostraram uma prevalência de 25 %, intensidade média de 1,5 parasita por peixe e abundância de 0,38 na Praia da Redinha.

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ÍNDICES PARASITÁRIOS DE ISÓPODOS (ISOPODA: FLABELLIFERA: CYMOTHOIDADE) EM *Chloroscombrus chrysurus* (LINNAEUS, 1766) (OSTEICHTHYES, CARANGIDAE) NAS ÁGUAS COSTEIRA DE PONTA NEGRA, RIO GRANDE DO NORTE, BRASIL

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Este trabalho teve como objetivo avaliar os índices de infestação parasitária por isópodos no peixe marinho palombeta, *Chloroscombrus chrysurus* (Linnaeus, 1766) capturado nas águas costeiras de Ponta Negra, Rio Grande do Norte. Para verificar a ocorrência de isópodos foram examinados 194 espécimes de *C. chrysurus* no período de agosto de 2005 a julho de 2006. Os peixes capturados foram levados para análises no Laboratório de Ictiologia do Departamento de Oceanografia e Limnologia da Universidade Federal do Rio Grande do Norte. Os isópodos encontrados foram separados cuidadosamente e colocados em frascos de vidro de 25 e 50 ml contendo álcool 70%. Os dados de pluviometria foram obtidos na UFRN. Os índices de infestação parasitária foram relacionados com a pluviosidade da região. Dos exemplares de *C. chrysurus* capturados 23,1% estavam parasitados. Comprimento total dos hospedeiros parasitados variou de 84 a 200 mm. Os locais de fixação dos isópodos foram à cavidade oral e a câmara branquial do hospedeiro. Dentre os isópodos encontrados 52% parasitavam a câmara branquial e 48% a cavidade oral. Foi registrada uma carga parasitária mínima de 1,0 e máxima de 2,0 isópodos por hospedeiro. Houve uma prevalência parasitária média de 23,1%, intensidade média de 1,13 isópodos por hospedeiro e uma abundância relativa de 0,23 isópodo por peixe amostrado. Os maiores índices de prevalência dos isópodos ocorreram no período de estiagem.

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ÍNDICES PARASITÁRIOS DE ISÓPODOS (ISOPODA: FLABELLIFERA: CYMOTHOIDAE) EM *CHLOROSCOMBRUS CHRYSURUS* (LENNEAUS, 1766) (OSTEICHTHYES, CARANGIDADE) NAS ÁGUAS COSTEIRAS DE PONTA NEGRA, RIO GRANDE DO NORTE, BRASIL.

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INTRODUÇÃO

Os peixes marinhos constituem, em nível mundial, um dos recursos alimentares de maior qualidade e abundância, conseqüentemente, este grupo de vertebrados vem sendo alvo de numerosas pesquisas relacionadas a seus mais diversos aspectos biológicos. Entretanto, o aspecto de influência do parasitismo na biologia dos peixes marinhos tem sido relativamente pouco estudado (RAZANI- PAIVA *et al*, 2004).

Os estudos ictioparasitológicos e sanitários nos peixes são de imprescindível importância. No estado do Rio Grande do Norte existe ainda uma carência de estudos ligados à parasitologia dos peixes marinhos (CAVALCANTI *et al*, 2003; LIMA *et al* 2005). Este trabalho teve como objetivo avaliar os índices de infestação parasitária por isópodos no peixe marinho palombeta, *Chloroscombrus chrysurus* (Linnaeus, 1766) capturado nas águas costeiras de Ponta Negra, Rio Grande do Norte.

MATERIAIS & MÉTODOS

Os exemplares do Palombeta, *C. crysurus*, foram capturados nas águas costeiras da Ponta Negra , localizada na área urbana do Município de Natal, Rio Grande do Norte. As coletas foram realizadas mensalmente no período de agosto de 2005 a julho de 2006. Os peixes foram capturados com auxílio dos pescadores da região, que utilizaram como método de captura uma rede de arrastão. Os dados pluviométricos foram obtidos na UFRN.

O teste *t* foi utilizado para saber se existe diferenças significativas entre o local de fixação dos parasitos e o coeficiente de correlação de Pearson foi usado para relacionar os índices pluviométricos e os índices parasitários.

Os índices de infestação parasitária foram calculados conforme proposto Margolis *et al.*(1982) revisado por Bush *et al.*(1997).

RESULTADOS

O comprimento total dos espécimes analisados variou de 37 a 260 mm (127,73 ± 33,65). Do total dos peixes capturados 23,1 % estavam parasitados por isópodos, sendo 52% encontrado parasitando a cavidade branquial, 48% a cavidade bucal ($t = 0,14$, $p < 0,05$).

No que concerne aos índices de infestação parasitaria, foi observado uma prevalência parasitária média de 23,1%, uma intensidade de 1,13 isópodos por peixe parasitado e um abundância de 0,23 por peixe amostrado.

Tabela 1: Coeficiente de correlação de Pearson (*r*) entre a pluviosidade média (PM) e os índices médios de infestação parasitária (IP), $p < 0,05$.

	IP	PM	*R*
Prevalência	23,1	128,08	- 0,2517
Intensidade média	1,33	128,08	- 0,06838
Abundância relativa	0,23	128,08	- 0,2556

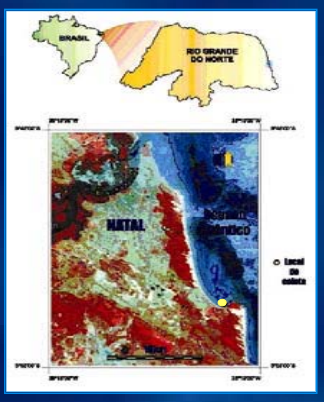

Figura 1. Localização da área de estudo: praia de Ponta Negra, Natal/RN (Cena SPOT: 731.362-1994). Fonte: SUDENE

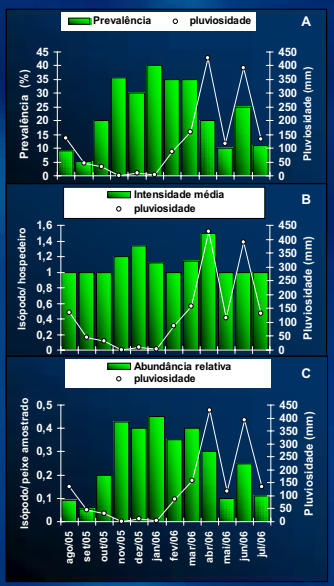

Figura 3. Relação de índices de infestação parasitária dos isópodos e índices pluviométricos para o peixe marinho palombeta, *C. chrysurus* capturados nas águas costeiras de Ponta Negra Rio Grande do Norte. (A) Prevalência parasitária; (B) Intensidade média; (C) Abundância relativa

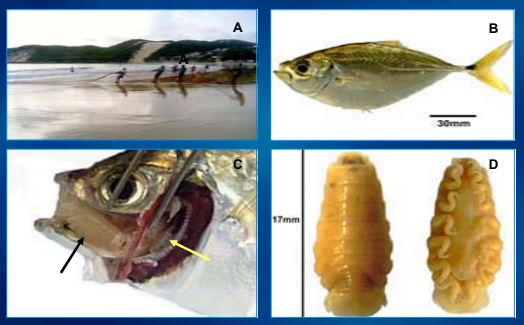

Figura 2. Pesca artesanal por rede de arrasto nas águas costeiras da de Ponta Negra, Rio Grande do Norte (A); O peixe marinho Palombeta, *C. chrysurus* (B); Isópodos fixos na câmara branquial e cavidade oral (C); Isópodo da Família Chymotoidae (D).

CONCLUSÕES

- **O parasitismo por isópodos no *C. chrysurus* ocorre todos os meses do ano**
- **Os isópodos não apresentam preferências pelo local de fixação**
- **O maior número de peixes parasitados foram encontrados no período de estiagem.**

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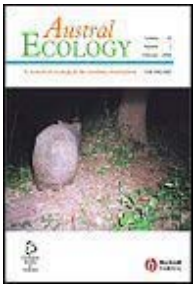

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Austral Ecology

A Journal of ecology in the Southern Hemisphere

Published on behalf of The Ecological Society of Australia (ESA)

Edited by:
Michael Bull

Print ISSN: 1442-9985
Online ISSN: 1442-9993
Frequency: Eight times a year
Current Volume: 33 / 2008
ISI Journal Citation Reports® Ranking: 2006: 51/114 (Ecology)
Impact Factor: 1.771

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Journal of Fish Biology

The official journal of the Fisheries Society of the British Isles

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Edited by:
J.F. Craig

Print ISSN: 0022-1112
Online ISSN: 1095-8649
Frequency: Monthly
Current Volume: 72 / 2008
ISI Journal Citation Reports® Ranking: 2006: 15/41 (Fisheries)
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