CLÁUDIO DELLA VEDOVA

COMPOSIÇÃO, ABUNDÂNCIA RELATIVA E DISTRIBUIÇÃO DE ESPÉCIES DEMERSAIS DE PROFUNDIDADE NO ESTADO DE PERNAMBUCO

RECIFE, 2019

UNIVERSIDADE FEDERAL RURAL DE PERNAMBUCO

PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO

PROGRAMA DE PÓS-GRADUAÇÃO EM RECURSOS PESQUEIROS E AQUICULTURA

COMPOSIÇÃO, ABUNDÂNCIA RELATIVA E DISTRIBUIÇÃO DE ESPÉCIES DEMERSAIS DE PROFUNDIDADE NO ESTADO DE PERNAMBUCO

Cláudio Della Vedova

Dissertação apresentada ao Programa de Pós-Graduação em Recursos Pesqueiros e Aquicultura da Universidade Federal Rural de Pernambuco como exigência para obtenção do título de Mestre.

Prof. Dr. Fábio Hissa Vieira Hazin

Orientador

Dra. Danielle de Lima Viana

Co-orientadora

Recife,

Maio /2019

Dados Internacionais de Catalogação na Publicação (CIP)
Sistema Integrado de Bibliotecas da UFRPE
Biblioteca Central, Recife-PE, Brasil

V416c Vedova, Cláudio Della
Composição, abundância relativa e distribuição de espécies demersais de profundidade no estado de Pernambuco / Cláudio Della Vedova. – 2019.
51 f. : il.

Orientador(a): Fábio Hissa Vieira Hazin.
Coorientador(a): Danielle de Lima Viana.
Dissertação (Mestrado) – Universidade Federal Rural de Pernambuco, Programa de Pós-Graduação em Recursos Pesqueiros e Aqüicultura, Recife, BR-PE, 2019.
Inclui referências.

1. Pesca – Pernambuco 2. Ictiologia 3. Crustáceos 4. Teleósteos 5. Elasmobrânquios I. Hazin, Fábio Hissa Vieira, orient. II. Viana, Danielle de Lima, coorient. III. Título

CDD 636.3

UNIVERSIDADE FEDERAL RURAL DE PERNAMBUCO

PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO

PROGRAMA DE PÓS-GRADUAÇÃO EM RECURSOS PESQUEIROS E AQUICULTURA

COMPOSIÇÃO, ABUNDÂNCIA RELATIVA E DISTRIBUIÇÃO DE ESPÉCIES DEMERSAIS DE PROFUNDIDADE NO ESTADO DE PERNAMBUCO

Cláudio Della Vedova

Dissertação julgada adequada para a obtenção do título de mestre em Recursos Pesqueiros e Aquicultura. Defendida e aprovada em 14/05/2019 pela seguinte Banca Examinadora.

____

Prof. Dr. Fábio Hissa Vieira Hazin

Orientador

Departamento de Pesca e Aquicultura/ Universidade Federal Rural de Pernambuco

____

Profa. Dra. Sigrid Neumann Leitão

Membro externo

Departamento de Oceanografia/ Universidade Federal de Pernambuco

____

Prof. Dr. Paulo Guilherme Vasconcelos de Oliveira

Membro interno

Departamento de Pesca e Aquicultura/ Universidade Federal Rural de Pernambuco

Dedicatória

"Mariana Crema Pinto, companheira que sempre esteve ao meu lado, com muito amor e paciência. Yorgos Crema Stathis, o meu grande professor!"

Agradecimentos

Agradeço à Universidade Federal Rural de Pernambuco e ao Departamento de Pesca e Aquicultura, por todos esses 10 anos de alegria. Ao Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) e a Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), pelo suporte financeiro aos projetos e à concessão de bolsas para os pesquisadores envolvidos.

Agradeço ao Professor Fábio Hazin por todas as oportunidades, pelas aulas de oceanografia, pelas orientações, pelo Arquipélago São Pedro e São Paulo, por tudo.

Ao Professor Paulo de Oliveira, que também me acompanha desde a graduação, sempre dando conselhos e abrindo portas, sua aula é incrível!

Agradeço ao Professor Diogo Nunes e ao Pesquisador Rômulo Pires, pois estou aqui graças aos seus conselhos para fazer a seleção do mestrado.

À Danielle Viana, trazendo boas ideias, novos trabalhos, novas fronteiras. Seus conselhos e orientações ajudaram muito.

À Ilka Nunes, com toda sua didática, grande parceira de trabalho, aprendi muito com você.

Agradeço à toda equipe dos demersais: Pollyana, Alessandra, Rômulo, Sara, Sidney, Marcos, Jefferson, Vitória, João, entre outros. Aos Engenheiros de Pesca Rafael Muniz e Bruno Cesar, pelo apoio logístico das expedições, ao Mestre do Sinuelo (Gleicinho) e toda a tripulação.

À toda Família Rural, que sempre está presente. Em especial: Augusto Cesar, Anderson Felix, Daniel Carapeba, Derick Sávio, Leonardo Silveira, Gabriel Crema, Sâmara, Carol, Heitor, Laura Tribist, Leandro (Caborja), Bruna Vidal, Renato Santiago (Renatito), Mariana Rêgo, Bento, entre outros.

Agradeço aquele cara que sempre solta uma gracinha, Tiago Hilário, ao Lenardo Fidelis, Bruno César, Rafael Muniz e a Nathalia Castro, pelas risadas e troca de idéias.

Agradeço aos meus pais, Ignazio Vedova, Claudia Vedova, a minha mãe preta “Tonha”, aos meus irmãos Marcelo e Daniela Vedova e em especial a Mariana Crema e Yorgos Crema, pois tiveram muita paciência ao longo do mestrado, amo vocês!

Resumo

A fim de ampliar o atual conhecimento sobre as comunidades demersais de águas profundas, e gerar informações que auxiliem na gestão dos recursos pesqueiros de profundidade, a presente pesquisa objetiva investigar a composição, abundância relativa e a distribuição de crustáceos, elasmobrânquios e teleósteos demersais, capturados no talude superior de Pernambuco. As prospecções ocorreram no barco de pesquisa "Sinuelo" da FADURPE/UFRPE, de outubro de 2014 a março de 2018. Nesse período, foram realizados 24 cruzeiros e 77 lances de pesca, distribuídos ao longo do talude superior de Pernambuco, dos 200 aos 600 metros de profundidade. Os espécimes foram coletados com o auxílio de dois aparelhos de pesca: o espinhel de fundo, com anzol pequeno e grande, e armadilhas de fundo do tipo covo, nos modelos: grande, médio, redondo e cilíndrico. Nos 77 lances foram capturados 1050 indivíduos, dos quais 976 (92,95%) foram pescados nas armadilhas de fundo e 74(7,04%) no espinhel de fundo. Foram capturados crustáceos e peixes, teleósteos e elasmobrânquios. Os crustáceos foram o grupo mais capturado (n= 690, 65,71%), seguidos dos elasmobrânquios (n= 261, 24,86%) e dos teleósteos (n= 99, 9,43%). Analisando as capturas das armadilhas de fundo, a CPUE para as espécies em conjunto foi maior para o modelo grande, não apresentando diferenças significativas (Kruskal-Wallis chi-squared= 6,5562, df = 3, p= 0,08747). Entre os grupos, só os teleósteos apresentaram diferenças significativas ((Kruskal-Wallis, chi-squared = 9,0063, df = 3, p= 0,02921), sendo o covo grande e o médio, significativamente maior que o redondo (Teste de Dunn; p= 0,0303, p= 0,0432). A CPUE das principais espécies capturadas foi testada entre os fatores estação de coleta, estratos de profundidade e mês. O *Plesionika edwardsii*, foi mais na estação norte. Nos estratos de profundidade, teve maiores capturas no estrato "300-349 m" e ao longo do ano, no mês de junho, não apresentando diferenças significativas em nenhum dos fatores. O segundo mais capturado foi o *Bathynomus miyarei*, se concentrando ao norte do Recife, nos estratos "400-449 m" e "500-549 m", e no mês de abril. Porém, não apresentou diferenças significativas entre os fatores. O tubarão *Squalus albicaudus*, também não apresentou diferenças significativas em relação aos fatores, mas teve suas maiores taxas de capturas no Norte do estado, nos estratos de profundidade "300-349 m" e "400-449 m", e nos meses de maio e agosto. O peixe teleósteo mais capturado, foi o *Physiculus kaupi*, no Norte do estado, no estrato de profundidade "300-349 m" e no mês de abril, não apresentando nenhuma diferença significativa. Ao analisar o espinhel de fundo, percebe-se que o anzol pequeno teve maiores taxas de captura para as espécies agrupadas, elasmobrânquios e teleósteos, porém não apresentou diferenças significativas. Dentre as principais capturas do espinhel, o *Squalus mitsukurii* teve maiores valores de CPUE no sul de Pernambuco, apenas no estrato "400-449 m", e no mês de agosto. Semelhante as outras espécies, nenhum dos fatores apresentou diferenças significativas. O *Cirrhigaleus asper*, foi o segundo mais capturado, concentrando suas capturas no norte do estado, nos estratos "300-349 m" e "400-449 m", em julho e novembro. Os fatores estudados não apresentaram um padrão claro de variação, sendo necessário maiores esforços de pesquisa para aprofundar os conhecimentos sobre as águas profundas e os indivíduos que nela habitam.

Palavras-chave: Pesca, demersais, profundidade, armadilhas de fundo.

Abstract

In order to increase current knowledge about deep water demersal communities, and to generate information to assist in the management of deep water resources. This research aims to investigate the composition, relative abundance and distribution of demersal crustaceans, elasmobranchs and teleosts caught in the upper slope of Pernambuco. The surveys occurred on the "Sinuelo" research vessel, of FADURPE / UFRPE, from October 2014 to March 2018. During this period, 24 cruises and 77 sets were carried out along the upper slope of Pernambuco from 200 to 600 meters of depth. The specimens were collected with two fishing gear: the bottom longline, with small and large hook, and bottom traps, in the models: large, medium, round and cylindrical. In the 77 sets, 1050 animals were collected, which 976 (92.95%) were fished by bottom traps and 74 (7,04%) in the bottom longline. Were catched crustaceans, teleost's and elasmobranchs. Crustaceans were the most captured group (n= 690, 65,71%), followed by elasmobranchs (n= 261, 24,86%) and teleost's (n= 99, 9,43%). Analyzing the captures of the bottom traps, the CPUE for the joint species, was higher for the large model, showing no significant differences (Kruskal-Wallis chi-squared= 6,5562, df = 3, p= 0,08747). Among the groups, only the teleosts presented significant differences (Kruskal-Wallis, chi-squared = 9,0063, df = 3, p= 0,02921), being the CPUE of the larger and medium model´s, larger than the round model (Teste de Dunn; p= 0,0303, p= 0,0432). The CPUE of the main species collected was tested among the factors, collection station, depth stratum and month. *Plesionika edwardsii* was catched in the north station. In the depth strata, it had higher catches in stratum "300-349 m" and throughout the year in June, showing no significant differences in any of the factors. The second most captured was the *Bathynomus miyarei*, concentrating in the north of Recife, in strata "400-449 m" and "500-549 m", and in the month April. However, there were no significant differences between the factors. *Squalus albicaudus* also showed no significant differences in relation to the factors but had the highest catch rates in the north of the state, in depths stratum "300-349 m" and "400-449 m", in May and August. The most catched teleost fish was the *Physiculus kaupi*, in the north of the state, in depth stratum "300-349 m" and in the month of April, presenting no significant difference. When analyzing the bottom longline, it is noticed that the small hook had higher catch rates for the joint species, elasmobranchs and teleosts, but did not present significant differences. Among the main catches of the bottom longline, the *Squalus mitsukurii* had higher CPUE values in the south of Pernambuco, in the strata "400-449 m", and in the month of August. Like the other species, none of the factors presented significant differences. The *Cirrhigaleus asper,* was the second most caught, concentrating their catches in the northern state, in strata "300-349 m" and "400-449 m", in July and November. The factors studied did not show a clear pattern of variation, requiring major research efforts to increase knowledge of the deep water and the individuals who inhabit it.

Keywords: Fishing, demersal, depth, bottom traps.

Lista de figuras

Lista de tabelas

Sumário

Página

Introdução

Contextualização da pesquisa

No final da Segunda Guerra Mundial ocorreu a segunda revolução industrial, propiciando várias descobertas tecnológicas, que permitiram o desenvolvimento de materiais sintéticos mais resistentes e de menor custo, como as fibras de poliamida (náilon), além da mecanização da pesca e da consequente melhoria significativa da eficiência das embarcações pesqueiras (GORDON *et al.*, 2003). As primeiras prospecções pesqueiras em água profundas no Oceano Atlântico foram conduzidas por embarcações soviéticas operando com redes de arrasto de fundo, no início da década de 60, na região norte da Dorsal Meso-Atlântica (TROYANOVSKY e LISOVSKY, 1995).

No Brasil, pesquisas sobre espécies demersais de águas profundas não são recentes, tendo se iniciado desde 1873, com expedições de navios estrangeiros de pesquisa, cujos registros se estendem até meados de 1960, a exemplo do Challenger, Le Travailleur, Le Talisman e Albatross (GÜNTHER, 1880; VAILLANT, 1888; GARMAN, 1899). A pesca comercial em águas profundas no Brasil, porém, só se iniciou no século XX, com a pesca com linha de mão, trazida pelos portugueses dos arquipélagos de Madeira e Açores (BERNARDES, 1940; DIEGUES, 1983). Centrada inicialmente no Arquipélago de Abrolhos, essa pesca no chamado "Mar Novo", se estendeu para o Rio de Janeiro e de lá até o Paraná (BARCELLOS *et al.*, 1991). Até os anos 80, no entanto, a exploração pesqueira de espécies demersais de águas profundas no País ainda era bastante restrita, com as primeiras operações comerciais de larga escala tendo sido desenvolvidas por embarcações japonesas arrendadas para a pesca com armadilhas de fundo, visando à captura de caranguejos de profundidade da família *Geryonidae*, principalmente o *Chaceon notialis* (caranguejo vermelho) e o *C. ramosae* (caranguejo real) (PEZZUTO *et al.*, 2006; ARANA *et al.*, 2009).

Em 1993 o IBAMA/CEPSUL desenvolveu a "pesca com boinha", um espinhel vertical que operava até 450 m de profundidade (PERES e HAIMOVICI, 1998). Já no ano seguinte, em 1994, foi introduzido no Brasil o espinhel de fundo com cabo de aço e guincho hidráulico, tendo como alvo principalmente o peixe-batata, *Lopholatilus villarii*. O experimento, conduzido na costa sudeste, pelo N/Pq Orion, do Instituto de Pesca do Estado de São Paulo (ÁVILA-DA-SILVA *et al.*, 2001) disseminou-se na região, com várias embarcações comerciais passando a direcionar o seu esforço de pesca com espinhel de fundo, principalmente para o cherne (*Epinephelus* spp. e *Polyprion americanus*), para o peixe-batata (*Lopholatilus villarii*) e para o namorado

(*Pseudopersis numida*) (PEREZ e HAIMOVICI, 1998; ÁVILA-DA-SILVA *et al.*, 2001). Já no fim da década de 1990, várias licenças de arrendamento para diversos tipos de pescarias foram concedidas pelo governo brasileiro, incluindo: covos, emalhe e espinhel de fundo e arrasto de profundidade, para estimular a pesca no talude de espécies demersais.

Do ponto de vista científico, de 1995 a 2005, o Programa REVIZEE (Programa de Avaliação do Potencial Sustentável dos Recursos Vivos na Zona Econômica Exclusiva), desenvolveu prospecções experimentais em águas profundas, atuando desde São Luís do Maranhão até Cabo Frio, no Rio de Janeiro, visando à exploração dos recursos demersais de profundidade presentes na plataforma continental e no talude superior da Zona Econômica Exclusiva (ZEE), em profundidades de até 600 m, utilizando armadilhas e espinhel de fundo (BOECKMAN *et al.*, 2001; OLIVEIRA *et al.*, 2015). O programa possibilitou a identificação de diversos estoques pesqueiros potencialmente importantes nesses ambientes (FIGUEIREDO *et al.*, 2002; HAIMOVICI, 2004; MINCARONE *et al.*, 2008; BRAGA *et al.*, 2008; TAVARES e SEREJO, 2007; MELO *et al.*, 2010; PAIVA *et al.*, 2011), com destaque para o cherne-poveiro, *Polyprion americanus* (BLOCH e SCHNEIDER, 1801) e o peixe-batata *Lopholatilus villarii* (MIRANDA RIBEIRO, 1915), além de capturas elevadas de outras espécies não explotadas comercialmente, como os isópodas do gênero *Bathynomus* e o cação *Squalus mitsukurii* (JORDAN e SNYDER, 1903).

Outro exemplo, mais ao sul, foi a pesca do *Lophius gastrophysus* (Miranda Ribeiro, 1915), cujo elevado valor comercial no mercado externo resultou em um rápido aumento do esforço de pesca por embarcações nacionais e arrendadas, utilizando redes de arrasto e de emalhar para a sua captura. Como consequência do desenvolvimento abrupto e desordenado dessa pescaria, sem informações prévias a respeito da sustentabilidade do estoque, houve uma redução acelerada da abundância do recurso, em razão da sua sobrepesca (PEREZ *et al*., 2009).

No estado de Pernambuco, porém, as prospecções do REVIZEE foram efetuadas somente até 238 m de profundidade (NÓBREGA, *et al*., 2009), jamais tendo sido realizada qualquer prospecção em profundidades superiores a essa. Apesar do volume relativamente limitado de informações, porém, os dados gerados foram extremamente relevantes para a compreensão da fauna de profundidade nesse trecho da costa brasileira, indicando, por exemplo, uma clara segregação batimétrica para algumas espécies de peixes e crustáceos. Atualmente, a atividade pesqueira em águas profundas no Brasil se concentram nas regiões sul e sudeste, com suas frotas direcionadas para: peixe sapo *(Lophyus gastrophysus*), bacalhau brasileiro (*Urophycis mystacea*), cherne poveiro (*Polyprion americanus*), caranguejo real (*Chaceon ramosae*), e caranguejo vermelho (*Chaceon notialis*), entre outras (Perez et al., 2009).

Como em outras partes do mundo, a maioria das pesquisas no Brasil em águas profundas se concentraram historicamente em locais onde a pesca possui grande potencial econômico, ou seja, nas regiões sul e sudeste, com foco na distribuição batimétrica, registro de novas espécies e diagnóstico da biodiversidade, com um esforço comparativamente muito mais reduzido na região nordeste (FIGUEIREDO *et al.*, 2002; HAIMOVICI *et al*., 2004; BERNARDES *et al*., 2005; COSTA *et al.*, 2006; PEREZ, 2009). O alto investimento requerido, os desafios tecnológicos e as dificuldades logísticas envolvidas na exploração desses ambientes são alguns dos fatores que limitam o desenvolvimento da pesca e consequentemente de pesquisas em águas profundas. Nesse contexto, a fim de ampliar os conhecimentos sobre a comunidade de espécies demersais presentes no mar profundo, na costa de Pernambuco, e com isso gerar informações importantes para a conservação e para o melhor aproveitamento dos recursos pesqueiros da região nordeste, a presente pesquisa fez um levantamento de espécies demersais no talude superior na costa do estado.

Objetivos do trabalho

Geral

Compreender a composição e a estrutura de comunidades demersais de águas profundas, analisando a captura de três grandes grupos de maior interesse à pesca: Crustáceos, Elasmobrânquios e Teleósteos, no estado de Pernambuco.

Específicos

- Identificar as espécies da fauna demersal de águas profundas presente no início do talude continental da costa pernambucana;

- Analisar a distribuição e a abundância relativa das espécies capturadas por espinhel de fundo e covos de profundidade.

Composition, relative abundance and distribution

of demersal deepwater species in Pernambuco, Brasil

Resumo

A fim de ampliar o atual conhecimento sobre as comunidades demersais de águas profundas, e gerar informações que auxiliem na gestão dos recursos pesqueiros de profundidade, a presente pesquisa objetiva investigar a composição, abundância relativa e a distribuição de crustáceos, elasmobrânquios e teleósteos demersais, capturados no talude superior de Pernambuco. As prospecções ocorreram no barco de pesquisa "Sinuelo" da FADURPE/UFRPE, de outubro de 2014 a março de 2018. Nesse período, foram realizados 24 cruzeiros e 77 lances de pesca, distribuídos ao longo do talude superior de Pernambuco, dos 200 aos 600 metros de profundidade. Os espécimes foram coletados com o auxílio de dois aparelhos de pesca: o espinhel de fundo, com anzol pequeno e grande, e armadilhas de fundo do tipo covo, nos modelos: grande, médio, redondo e cilíndrico. Nos 77 lances foram capturados 1050 indivíduos, dos quais 976 (92,95%) foram pescados nas armadilhas de fundo e 74(7,04%) no espinhel de fundo. Foram capturados crustáceos e peixes, teleósteos e elasmobrânquios. Os crustáceos foram o grupo mais capturado (n= 690, 65,71%), seguidos dos elasmobrânquios (n= 261, 24,86%) e dos teleósteos (n= 99, 9,43%). Analisando as capturas das armadilhas de fundo, a CPUE para as espécies em conjunto foi maior para o modelo grande, não apresentando diferenças significativas (Kruskal-Wallis chi-squared= 6,5562, df = 3, p= 0,08747). Entre os grupos, só os teleósteos apresentaram diferenças significativas ((Kruskal-Wallis, chi-squared = 9,0063, df = 3, p= 0,02921), sendo o covo grande e o médio, significativamente maior que o redondo (Teste de Dunn; p= 0,0303, p= 0,0432). A CPUE das principais espécies capturadas foi testada entre os fatores estação de coleta, estratos de profundidade e mês. O *Plesionika edwardsii*, foi mais na estação norte. Nos estratos de profundidade, teve maiores capturas no estrato "300-349 m" e ao longo do ano, no mês de junho, não apresentando diferenças significativas em nenhum dos fatores. O segundo mais capturado foi o *Bathynomus miyarei*, se concentrando ao norte do Recife, nos estratos "400-449 m" e "500-549 m", e no mês de abril. Porém, não apresentou diferenças significativas entre os fatores. O tubarão *Squalus albicaudus*, também não apresentou diferenças significativas em relação aos fatores, mas teve suas maiores taxas de capturas no Norte do estado, nos estratos de profundidade "300-349 m" e "400-449 m", e nos meses de maio e agosto. O peixe teleósteo mais capturado, foi o *Physiculus kaupi*, no Norte do estado, no estrato de profundidade "300-349 m" e no mês de abril, não apresentando nenhuma diferença significativa. Ao analisar o espinhel de fundo, percebe-se que o anzol pequeno teve maiores taxas de captura para as espécies agrupadas, elasmobrânquios e teleósteos, porém não apresentou diferenças significativas. Dentre as principais capturas do espinhel, o *Squalus mitsukurii* teve maiores valores de CPUE no sul de Pernambuco, apenas no estrato "400-449 m", e no mês de agosto. Semelhante as outras espécies, nenhum dos fatores apresentou diferenças significativas. O *Cirrhigaleus asper*, foi o segundo mais capturado, concentrando suas capturas no norte do estado, nos estratos "300-349 m" e "400-449 m", em julho e novembro. Os fatores estudados não apresentaram um padrão claro de variação, sendo necessário maiores esforços de pesquisa para aprofundar os conhecimentos sobre as águas profundas e os indivíduos que nela habitam.

Palavras-chave: Pesca, demersais, profundidade, armadilhas de fundo.

Abstract
In order to increase current knowledge about deep water demersal communities, and to generate information to assist in the management of deep water resources. This research aims to investigate the composition, relative abundance and distribution of demersal crustaceans, elasmobranchs and teleosts caught in the upper slope of Pernambuco. The surveys occurred on the "Sinuelo" research vessel, of FADURPE / UFRPE, from October 2014 to March 2018. During this period, 24 cruises and 77 sets were carried out along the upper slope of Pernambuco from 200 to 600 meters of depth. The specimens were collected with two fishing gear: the bottom longline, with small and large hook, and bottom traps, in the models: large, medium, round and cylindrical. In the 77 sets, 1050 animals were collected, which 976 (92.95%) were fished by bottom traps and 74 (7,04%) in the bottom longline. Were catched crustaceans, teleost's and elasmobranchs. Crustaceans were the most captured group (n= 690, 65,71%), followed by elasmobranchs (n= 261, 24,86%) and teleost's (n= 99, 9,43%). Analyzing the captures of the bottom traps, the CPUE for the joint species, was higher for the large model, showing no significant differences (Kruskal-Wallis chi-squared= 6,5562, df = 3, p= 0,08747). Among the groups, only the teleosts presented significant differences (Kruskal-Wallis, chi-squared = 9,0063, df = 3, p= 0,02921), being the CPUE of the larger and medium model´s, larger than the round model (Teste de Dunn; p= 0,0303, p= 0,0432). The CPUE of the main species collected was tested among the factors, collection station, depth stratum and month. *Plesionika edwardsii* was catched in the north station. In the depth strata, it had higher catches in stratum "300-349 m" and throughout the year in June, showing no significant differences in any of the factors. The second most captured was the *Bathynomus miyarei*, concentrating in the north of Recife, in strata "400-449 m" and "500-549 m", and in the month April. However, there were no significant differences between the factors. *Squalus albicaudus* also showed no significant differences in relation to the factors but had the highest catch rates in the north of the state, in depths stratum "300-349 m" and "400-449 m", in May and August. The most catched teleost fish was the *Physiculus kaupi*, in the north of the state, in depth stratum "300-349 m" and in the month of April, presenting no significant difference. When analyzing the bottom longline, it is noticed that the small hook had higher catch rates for the joint species, elasmobranchs and teleosts, but did not present significant differences. Among the main catches of the bottom longline, the *Squalus mitsukurii* had higher CPUE values in the south of Pernambuco, in the strata "400-449 m", and in the month of August. Like the other species, none of the factors presented significant differences. The *Cirrhigaleus asper*, was the second most caught, concentrating their catches in the northern state, in strata "300-349 m" and "400-449 m", in July and November. The factors studied did not show a clear pattern of variation, requiring major research efforts to increase knowledge of the deep water and the individuals who inhabit it.

Keywords: Fishing, demersal, depth, bottom traps.

Introduction

The distribution, diversity and abundance of pelagic and demersal fish have been widely studied in recent decades, in coastal reef environments. However, the knowledge about deep-water communities off the shelf break and continental slope, is still scarce and fragmented (FUJITA *et al.*, 1995; KINGSTON and MANIKANDAVELU, 1998; BELLWOOD and HUGHES 2001; MORA et al., 2003). Research conducted in the deep-sea, beyond the continental shelf break, from depths over 200 m (VAN DOVER *et al.*, 2014), however, have revealed levels of biodiversity much higher than have been imagined (KITAHARA, 2009). A large number of studies carried out in deep waters, have also evidenced that depth is a determinant factor in the specific composition of the communities of different taxonomic groups, in addition to consequently influencing the population dynamics (SNELGROVE and HAEDRICH, 1985; CARNEY, 2005; OLIVEIRA, 2005).

In Brazil, research on deep-water demersal species is not recent and began in 1873 with expeditions from foreign research vessels, whose records extend into the mid-1960s, such as the Challenger, Le Travailleur, Le Talisman, and Albatross (GÜNTHER, 1880; VAILLANT, 1888; GARMAN, 1899). In 1984, leased Japanese vessels, performed the first fishing operations with deep traps to capture the red crab, *Chaceon notialis* and real crab, *C. ramosae* (PEZZUTO *et al.*, 2006; ARANA *et al.*, 2009). The bottom long-line, in turn, was introduced later in Brazil in 1994, with main steel cable and hydraulic hoist, targeting primarily the potato fish, *Lopholatilus villarii* (ÁVILA-DA-SILVA *et al.*, 2001).

As in other parts of the world, most of the research in Brazil in deep waters has historically concentrated in places where fishing has great economic potential, that is, in the south and southeast regions, with a focus on bathymetric distribution, registration of new species and diagnosis of biodiversity, with a comparatively much lower effort in the Northeast region (FIGUEIREDO *et al.*, 2002; HAIMOVICI *et al.*, 2004; BERNARDES *et al.*, 2005; COSTA e*t al.*, 2006; PEREZ, 2009). The high investment required, technological challenges and logistical difficulties are some of the factors that limit the development of fisheries and consequently research in these environments.

Among the main studies on deep-water demersal communities already carried out in Brazil is the REVIZEE (Program for Evaluation of the Sustainable Potential of Living Resources in the Exclusive Economic Zone), which, since 1995, has enabled the identification of various important fisheries stocks in these environments

(FIGUEIREDO *et al.*, 2002; HAIMOVICI, 2004; MINCARONE *et al*., 2008; BRAGA *et al.*, 2008; TAVARES e SEREJO, 2007; MELO *et al*., 2010; PAIVA *et al*., 2011). The Atlantic wreckfish, *Polyprion americanus* (BLOCH and SCHNEIDER, 1801), the Tile fish, *Lopholatilus villarii* (MIRANDA RIBEIRO, 1915), isopods of the genus *Bathynomus* and the *Squalus mitsukurii* (JORDAN and SNYDER, 1903) were some of the species caught in the greatest amount during the scientific expeditions carried out mainly in the outer margin of the continental shelf and in the upper slope in depths of up to 500 m. In the state of Pernambuco, but, the surveys of the REVIZEE Program were carried out only up to 238 m depth (NÓBREGA, *et al.*, 2009), never having been prospected at depths higher than this. Despite the relatively limited volume of data, however, the REVIZEE Program detected clear bathymetric segregation for some species of fish and crustaceans.

In both fishing and scientific, one of the most common methods for catching deep-sea species is the bottom trawling. However, where the platform is excessively sloped or has rocky and rugged bottoms, as in the case of the Pernambuco slope, are use to fixed fishing gear, such as bottom long-line and traps (LORANCE *et al.,* 2001; MENEZES *et al.,* 2006; NUNES *et al.,* 2015), both of which are efficient fishing gear in regions with rugged relief and uneven bottoms, where trawling is not possible (OLIVEIRA, 2005; OLIVEIRA *et al.*, 2007; NUNES *et al.,* 2015). These devices allow the capture of species that inhabit various types of substrate, thus a good alternative for experimental surveys aimed to obtain information about vertical distribution of demersal deep water (GUNDERSON, 1993; HOVGARD and LASSEN, 2000), as in the present case. Despite the high catch rates recorded by Nunes *et al.* (2015) for crustaceans, the bottom traps were equally efficient in catching bone fish, such as *Physiculus cirm* and *Conger esculentus* (Nunes *et al.,* 2015).

In this work, in order to fill knowledge gaps about deep water species in the state of Pernambuco, fishing prospecting were carried out with traps and bottom long-line, with the objective of investigating the composition of species, their relative abundance and vertical distribution, essential information to support the adoption of management measures, able to ensure their conservation and sustainability of any fishing activity that will eventually focus on their stocks.

Materials e Methods

The fishing sets were made along the upper slope of Pernambuco, at depths ranging from 200 to 600 m, between October 2014 and March 2018, during which were performed 77 fishing sets, distributed in 24 cruises, with 3 days each. Fishing operations were carried out on board Research Boat "Sinuelo"(FADURPE/ UFRPE), with autonomy to navigate to the slope and equipped with: hydraulic hoist, to assist in the collection of the equipment; an echo sounder, with a range of 800 m for topographic reading of the launch site; and Global Positioning System (GPS), in order to obtain the geographical coordinates of the launching and picking positions of the fishing gear.

All specimens were catched with a bottom long-line and traps of different shapes and sizes. Initially, in each operation were launched 3 different types of traps, all made of galvanized iron and polyamide fabric, with 10mm mesh between knots, with the following formats and dimensions: large trap (rectangular format), with 2,00 x 0,90 x 0,90 m and opening of the entrance of 0,30 m; medium trap (rectangular format), 2.00 x 0.60 x 0.60 m and entrance opening of 0.20 m; and the conical-round trap, with 1.00 x 0.60 x 0.60 m and entrance opening of 0.30 m. In 2017, after 44 fishing sets, traps were modified, being launched three equal traps, with cylindrical shape, smaller and lighter, with dimensions of 1.00 x 0.50 m, made of galvanized steel screen, externally coated with PVC, and internally with a polyamide screen mesh 10 mm.

The bottom long line used also changed, having initially been employed a horizontal bottom long-line, with a main line made of polyethylene (PE) 12 mm multifilament cable, with 25 hooks and 5 m spacing between them. The secondary line consisted of a snap nº135, 1 m of polyamide (PA) 3 mm monofilament, followed by a rolling swivel 8/0 and 0.5m of steel cable, finalized in a Circle hook Mustad 13/0. In March 2017, the artifact was modified, to having two conjugated parts: the first being a horizontal long-line and the second a vertical long-line (“pargueira” type), connected to each other, thus allowing the capture of individuals in different depth strata. The parts of the long-line had kept the configuration, but with "Circle Mustad hooks" nº 9/0 and 13/0, alternating along the entire length of the line, with 25 hooks on the horizontal segment and 25 on the vertical segment.

The launch of the fishing gear was carried out once a day, by the stern of the boat, with the boat adrift, starting at about five o'clock in the afternoon and picking up around five o'clock in the morning. At the beginning and at the end of the launch and collection, the data always were recorded : date, time, position of vessel (latitude and longitude), depth and temperature of the surface of the sea. At the end of the collection, the captured specimens were placed in urns with ice and taken to the Fishery Oceanography Laboratory (LOP), Federal Rural University of Pernambuco (UFRPE), for analysis. Such research was authorized by the Ethics Committee on Animal Use - CEUA, of Federal Rural University of Pernambuco (UFRPE).

As bait were used mackerel (*Scomber scombrus*) and moray (*Gymnothorax spp*). In the long-line, the bait remained attached to the hook, while in the bottom traps, the bait was placed inside bags traced inside (0.5 kg / trap).

As an index of relative abundance, the catch per unit effort (CPUE) was used, in terms of the number of individuals caught per 1,000 hooks (individuals / 1,000 hooks), for the bottom long-line; and number of individuals caught per trap per hour in the case of traps (individuals / trap / hour).

The time of immersion of the bottom long-line had a great variation (0.7 to 22.0 hours), due to the factors such as environmental conditions, currents intensity, among others. To minimize this variation in the CPUE of the artifact, the hooks with the immersion time less than 8 and greater than 16 hours were discarded (Figure 1). The mean time of immersion with the remaining data was 11.54h, with a standard deviation of 1.89h.

The immersion time of the bottom traps ranged from 0.7 to 19.1 hours, directly influencing capture rates (Figure 2). In order to minimize their influence on CPUE, traps with immersion time below 7 hours and above 18 hours were also eliminated from the sample and the immersion time, for that reason, incorporated in the catch index. After these modifications, the mean immersion time was 12.85h with a standard deviation of 3.07h.

The catch data were grouped and later analyzed by taxonomic group (crustaceans, elasmobranchs and teleosts) and the most captured species, and had been analyzed separately for each artifact used, separated between catches of types of hook (small hook and large hook) and between types of traps (large, medium, round and cylindrical), collection station (North and South), deep strata (“200-249 m”, “250-299 m”, “300-349 m”, “350-399 m”, “400-449 m”, “450-499 m”, “500-549 m” e “550-600 m”) and per month, for all years grouped.

The effort with the bottom traps varied considerably along the depth strata, there was no effort in the "450-499 m" and only 6 traps having been launched in the "550-600 m" stratum. The strata with the greatest efforts were in the "400-449 m", with 30 traps thrown, and in the "300-349 m", with 48 pitched traps. The spatial variation of the launches, had 96 traps thrown to the North and 45 traps in the South. Throughout the year, there were launches every month, although in June, September and November only 6 traps were released. In the months of January, August and October, 18 traps were launched each month (Figure 3). As the effort applied to the traps of the large, medium and round model were the same along the studied factors, the three models were grouped, being called the old trap, analyzed separately from the new model (cylindrical).

In the case of the bottom long-line, fishing effort was much higher in the north of the state than in the south. In relation to the vertical distribution, the effort varied from 25 hooks, in the stratum "200-249 m", increasing to the maximum value in the "300-349 m" (375 launched hooks), and decreasing again with the increase of the depth of action, up to the minimum value of 25 hooks in the stratum "550-600 m". As in the case of the traps, there was no effort in the "450-499 m". In relation to the month, grouped for all years, the greatest fishing efforts occurred with 150, 250 and 325 hooks launched in January, February and March respectively (Figure 4). As the effort applied to the small and large hooks were not the same along the factors studied, in the distribution analysis, were used only the data before the modification of the artifacts (until 2016), when only the big hook was used.

For the statistical treatment of the results, the CPUE values, for both the long-line and the traps, for the species grouped, for the main taxonomic groups and species identified were evaluated by the Levene test, to identify the homogeneity of the variances, followed by the David test, to evaluate the normality of the data distribution. Since the premise of normality and homogeneity of data was not confirmed, the non-parametric Wilcoxon and Kruskal-Wallis tests (ZAR, 1996) were applied to compare the medians, and Dunn to identify the differences between the analyzed factors. All analyzes were performed in statistical software "R" (R Development Core Team, 2017), with the results evaluated at the 95% confidence level ($p < 0.05$).

Results

During the 77 fishing sets, 1,050 individuals were caught, of which 976 (~ 92.9%) were caught by the bottom traps, with 535 in the large trap, 180 in the middle trap, 144 in the round trap and 117 in the cylindrical trap. The bottom long-line captured 74 (7.1%) specimens, 45 in the large hook and 29 in the small hook (Table 1). The catch consisted of three major taxonomic groups: a) crustaceans, a clearly predominant group, with 690 (65.7%) specimens captured; b) elasmobranchs, with 261 specimens (24.9%); and c) teleosts, with 99 (9.4%) specimens (Table 1).

The crustaceans identified belong to 7 different families: *Cirolanidae*, *Diogenidae*, *Epialtidae*, *Pandalidae*, *Parapaguridae*, *Polybiidea* e *Pylochelidae*, showing the greatest diversity in number of species (12), with one being identified only at the genus level, *Parapagurus sp*. (Smith, 1879) of the family *Parapaguridae*. The shrimp, *Plesionika edwardsii* (Brandt, 1851) from the *Pandalidae* family, was the specie with the greatest abundance (n = 307, 29.2%), followed by the isopods, *Bathynomus miyarei* (Lemos de Castro, 1978), from the Cirolanidae family (n = 289, 27.5%) (Table 1).

Elasmobranchs were distributed in five families: *Carcharhinidae*, *Hexanchidae*, *Scyliorhinidae*, *Squalidae* and *Triakidae*. The *Squalidae* family was the most frequent, with 177 (16.9%) specimens captured, among which *Squalus albicaudus* (Viana, Carvalho & Gomes, 2016) was the species with the highest relative abundance (n = 124, 11.8%) (Table 1).

The group of teleosts group (n = 99; 9.43%), although presenting the smallest number of specimens, obtained the greatest diversity in the number of families with eight distinct families: *Caproidae*, *Congridae*, *Lutjanidae*, *Malacanthidae*, *Moridae*, Muraenidae, Polyprionidae e Scorpanidae. The Moridae family was the most frequent among teleosts, with particularly high catches of *Physiculus kaupi* (Poye, 1865) (n = 58, 5.5%) (Table 1).

No statistically significant differences were found between CPUE values for the different types of traps used, for grouped species (Kruskal-Wallis, chi-squared= 6,5562, df = 3, p= 0,08747) , with relatively low values for the four models. The highest CPUE value per trap per group, was reached for crustaceans with the large trap (1.00 person / trap / time), followed by the same group in the medium trap (0.34 individuals / trap / time), although the difference was not statistically significant (Kruskal-Wallis, chi-squared= 3,7221, df = 3, p= 0,2931). Regarding teleosts, however, the CPUE of the large trap (0.10 individuals / trap / hour) was significantly higher than that of the medium trap (0.07 individuals / trap), which, in turn, was greater than CPUE of round (0.01 individuals / trap) (Kruskal-Wallis chi-squared= 9,0063, df= 3, p= 0,02921; Teste de Dunn: p= 0,0303, p= 0,0432) (Figure 5, Table 2). The *Plesionika edwardsii* and *Bathynomus miyarei* were the most caught species among crustaceans. The elasmobranchs and teleosts capture rates were well below those of crustaceans, with the bony fish *Physiculus kaupi* and the shark *Squalus albicaudus* being the most abundant species in these groups. Among the trap models used, although the old coves obtained higher catch rates for the main species, the differences were only statistically significant for *Bathynomus miyarei* (W = 161, p = 0.04025).

The *Plesionika edwardsii* shrimp, representing 32.3% of the traps, was more captured south of Pernambuco (~ 0.43 individuals / trap / hour), considering only the old traps, since the cylindrical were only released to the north. In relation to depth, the highest catch rates of the species were observed at "300-349 m", with 0.84 individuals / trap / hour with the old traps and 0.17 individuals / trap / hour with the cylindrical traps. During the year, *Plesionika edwardsii* had the highest catch rates in June (1.81 individuals / trap per hour), July (0.42 individuals / trap per hour) and August (0.30 individuals / trap per hour) (Figure 6). The differences found, however, were not significant for any of the analyzed factors (Table 3, 4 and 5).

The isopod *Bathynomus miyarei*, had a higher catch rate in the North, having been practically captured only with the old traps, with an average CPUE of 0.24 individuals / trap / hour. Along the depth strata, the isopod was found at greater depths in the strata "400-449 m", "500-549 m" and "550-600 m", with a higher average CPUE value in the stratum "500-549 m "(0.53 individual / trap / hour). In relation to the months, *Bathynomus miyarei* was more captured on April (2.24 individuals / trap / hour) (Figure 7). As with *Plesionika edwardsii*, however, there were no statistically significant differences between the months, depth strata or collection stations for the CPUE of *Bathynomus miyarei* (Table 3, 4 and 5).

The shark *Squalus albicaudus*, representing 11.8% of the specimens captured in the present study, had a higher catch rate in the north of Pernambuco, with 0.07 individuals / trap / hour with the old trap and 0.05 individuals / trap / hour, with the cylindrical. The vertical distribution of the catch rates of *Squalus albicaudus* showed higher values in the strata "300-349 m" (0.14 individuals / trap / hour) and "400-449 m" (0.11 individuals / trap / hour). The average monthly CPUE grouped for all years, in turn, was higher in May and August, with 0.19 individuals / trap / hour (Figure 8). As in the case of the two previous species, none of the factors studied presented significant statistical differences in *Squalus albicaudus* CPUE (Table 3, 4 and 5).

The fish *Physiculus kaupi,* was the main teleost captured, representing 5.5% of the total catch. Its highest catch rate by region was observed in the north of the state

(0.06 individuals / trap / hour). Along the depth strata, *P. kaupi* was most captured in the stratum "300-349 m" (0.08 individuals / trap / hour) and at "400-449 m" (0.05 individuals / trap / hour). In relation to the average monthly CPUE, the highest values were obtained in April (0.22 individuals / trap / hour) and July (0.14 individuals / trap / hour). In the same way, however, no significant differences were found in the CPUE of *Physiculus kaupi*, for region, depth or month (Figure 9, Table 3, 4 and 5).

In the groups captured with long-line, elasmobranchs had the highest catch rates, particularly *Squalus mitsukurii*, which was the most species caught in this type of fishing gear. In addition to the most frequent species, some species were captured only by the bottom spine, being: *Polyprion americanus, Lopholatilus villarii, Carcharhinus signatus, Heptranchias perlo e Mustelus canis.*

In the comparison between the hooks used in the bottom long-line, for grouped species, the highest catch rates were observed for the small hook, although the differences found were not statistically significant (Wilcoxon, W = 223, p= 0,2445). The catch rate of each group was also compared between the types of hook (Figure 10), with the highest mean CPUE values for the elasmobranchs obtained with the small hook (74.56 individuals / 1,000 hooks x 49.65 / 1,000 hooks), without differences, however, were equally significant (Table 7,8 and 9).

In the analysis of CPUE of the main species collected until 2016, when only the big hook was used, *Squalus mitsukurii* and *Cirrhigaleus asper* were the most captured species. The catches of the *Squalus mitsukurii* only occurred in the south of the state (8 ind./ 1.000 hooks). Regarding the vertical distribution, *Squalus mitsukurii* was only found in the stratum "400-449 m", with a CPUE of 10 ind./ 1.000 hooks. In relation to the months, there was only capture in August (20 ind./ 1.000 hooks) (Figure 11). None of the factors analyzed, however, showed statistically significant differences in the catch of *Squalus mitsukurii* (Table 7,8 and 9).

Cirrhigaleus asper was the second most captured species, with the highest average CPUE in the northern region (22.85 ind./ 1.000 hooks). In relation to depth, the species was only found in the strata "300-349 m" and "400-449 m", with the highest mean of CPUE in the "300-349 m" (26,66 ind./ 1.000 hooks). During the year, *Cirrhigaleus asper* had the highest catch rates in July (40,00 ind./ 1.000 hooks) and in November (53,33 ind./ 1.000 hooks), when the monthly mean CPUE reached its highest value (Figure 12). None of the factors analyzed, however, resulted in significant differences in CPUE from *Cirrhigaleus asper* (Table 7,8 and 9).

Discussion

The results showed a greater efficiency of the bottom traps, especially of the large and medium model, to capture deep-sea specimens when compared to the bottom long-line in terms of number of individuals, but not in terms of biomass, since species such as *Polyprion americanus*, *Lopholatilus villarii*, *Carcharhinus signatus*, *Mustelus canis* e *Heptranchias perlo*, captured only with the long-line, have a high weight, besides a much greater economic importance (particularly the first two). The combined use of these artifacts, however, allows the capture of individuals inhabiting various types of substrate, in irregular backgrounds, representing, therefore, a good alternative for experimental explorations that aim the study of the vertical distribution of depth species(GUNDERSON, 1993; HOVGARD and LASSEN, 2000).

Similar results were obtained in the first deep-sea fishing surveys of the REVIZEE Program that used the traps of the models: large, medium and round, also used in the current research. For both fish and crustaceans, the large and medium traps had the highest catch rates (HAZIN *et al.*, 2009). Nunes *et al.* (2015) also found more significant catch values in the large-type trap in the São Pedro and São Paulo Archipelago in the Equatorial Atlantic, where both crustaceans and teleosts fish were captured. In general, the best results were achieved by the large trap, which from the commercial point of view, would be the most indicated (HAZIN *et al*, 2009). The low efficiency achieved from the bottom long-line, however, diverged from the results obtained previously for the same equipment in the region, since Oliveira *et al.* (2007), from the use of different types of long-line, in experimental cruises in Pernambuco, recorded much higher values of CPUE, concluding that it is feasible to use it in small vessels typical of the state's artisanal fleet (OLIVEIRA, 2005, JUCÁ-QUEIROZ *et al*, 2011; OLIVEIRA *et al*, 2007). The capture of commercially important species such as *P. americanus*, *L. villarii*, however, opens the perspective of assimilation of these fishing gears by the artisanal fishing sector, with the possibility of generating employment and income, from fishing for a new resource , still untapped in the region.

The greatest abundance of crustaceans in relation to fish (elasmobranchs and teleosts) can be explained by the fact that most of the specimens have been trapped in the bottom traps, an apparatus with high efficiency in capturing this zoo group (OLIVEIRA *et al.*, 2011; OLIVEIRA *et al.*, 2014; RAMOS-PORTO *et al.*, 2014; OLIVEIRA *et al.*, 2015).

For fishes, the predominance of elasmobranchs capture in relation to teleosts, found in the present research, was similar to the trend observed by Oliveira (2005), in operations performed on the external platform and slope of northeastern Brazil. Specifically for the elasmobranchs, the diversity observed here, composed of 5 families (*Carcharhinidae*, *Hexanchidae*, *Squalidae*, *Scyliorhinidae*, *Triakidae*) and 7 species (*Carcharhinus signatus*, *Heptranchias perlo*, *Cirrhigaleus asper*, *Scyliorhinus sp*., *Squalus albicaudus*, *Squalus mitsukurii* e *Mustelus canis*), was similar to that reported by a study carried out in Ceará (JUCÁ-QUEIROZ *et al*, 2011). Even with a capture rate achieved with the long-line have been relatively low, there was a significant capture of elasmobranchs, especially the genus *Squalus*, similarly to that previously observed by others authors (OLIVEIRA *et al.*, 2007; JUCÁ-QUEIROZ *et al*, 2011).

The teleosts presented a diversity of species much larger than that observed for the elasmobranchs, although the number of specimens was much smaller. The predominance of specimens of the *Moridae* family, however, diverged from most of the research conducted at similar depths in this region, in which the *Lutjanidae* family was considered predominant (OLIVEIRA, 2005), with a particularly high abundance of *Lutjanus vivanus*, which in this work contributed only 0.2% of total catches and 2.7% of catches with a long-line.

The bathymetric stratification of the catch for the three major categories evaluated, showed a greater relative abundance between 300 and 450 m, especially *Plesionika edwardsii*, between 300 and 350 m, and *Bathynomus miyarei* between 400 and 450 m. These results differ from those found by Oliveira *et al*. (2014) for shrimp *P. edwardsii*, on the northeast coast, which found a higher relative abundance of the same species at shallower depths, between 100 and 300 m. This difference, however, may result from the greater depths reached in the present study. In deeper strata, however, the CPUE values were significantly reduced in the same way as reported by Paulmier and Gervain (1994), Martinique Island. According to Arrasate-López *et al.* (2012), this fishing resource can be commercially exploited in a sustainable way in deep water up to 300 m.

The spatial distribution of catch rates was not the same in all cases. Crustaceans concentrated further south of the state, while for teleosts and elasmobranchs the highest values of CPUE were obtained in launches made on the north of the coast of Pernambuco. This result also differs from that observed by Oliveira *et al.* (2015) who found, on the coast of Pernambuco, a greater relative abundance of crustaceans in the north of Recife.

Conclusion

The fishing implements proved to be efficient for use in small vessels, typical of the artisanal fleet, allowing the launch of other artifacts, such as the hand line, for example. In addition, the use of the bottom long-line and traps allowed the capture of individuals of different species. This functionality of the artifacts used optimizes deep-sea demersal fishing that needs to be disseminated, to reduce fishing effort on species traditionally exploited in the region, as well as increasing productivity, contributing to the income distribution in the artisanal fishing sector.

By the vertical distribution of the catches, it is perceived that the depth is a determining factor in the specific composition of communities, having found a great diversity of species along the depth strata.

Even with all the data available, the study environment is still poorly accessible, requiring major research efforts to increase knowledge of the deep water and the individuals who inhabit it. Taking into account the fragility of the species found and their reduced distribution, it is important to use methods not dependent on fishing (RUDERSHAUSEN et al., 2010; BACHELER et al., 2013). These techniques use cameras coupled to rigid structures (BRUV's - Baited Remote Underwater Video) (HARVEY et al., 2009), even the use of marine vehicles (ROV's).

Acknowledgements

We thank the National Council for Scientific and Technological Development (CNPq) and the Coordination for the Improvement of Higher Education Personnel (CAPES), financial support for the project and granting scholarships to the researchers involved.

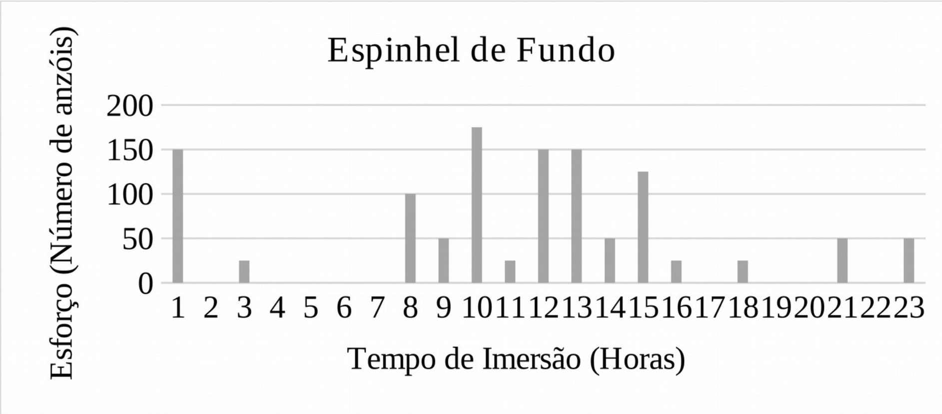

Figure 1. Distribution of the effort (number of hooks launched) by the time of immersion (hours) of the bottom long-line, in the upper slope of Pernambuco, from October 2014 to March 2018.

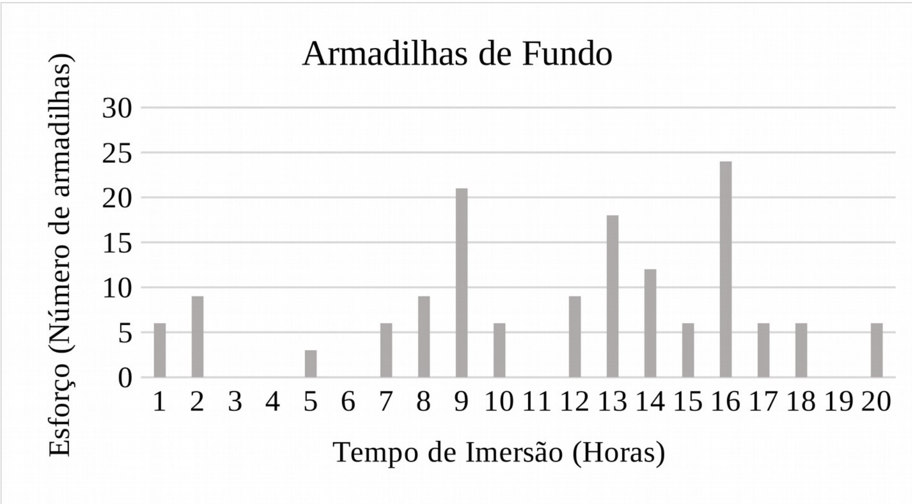

Figure 2. Distribution of effort (number of traps dropped) by the time of immersion (hours) of bottom traps, in the upper slope of Pernambuco, from October 2014 to March 2018.

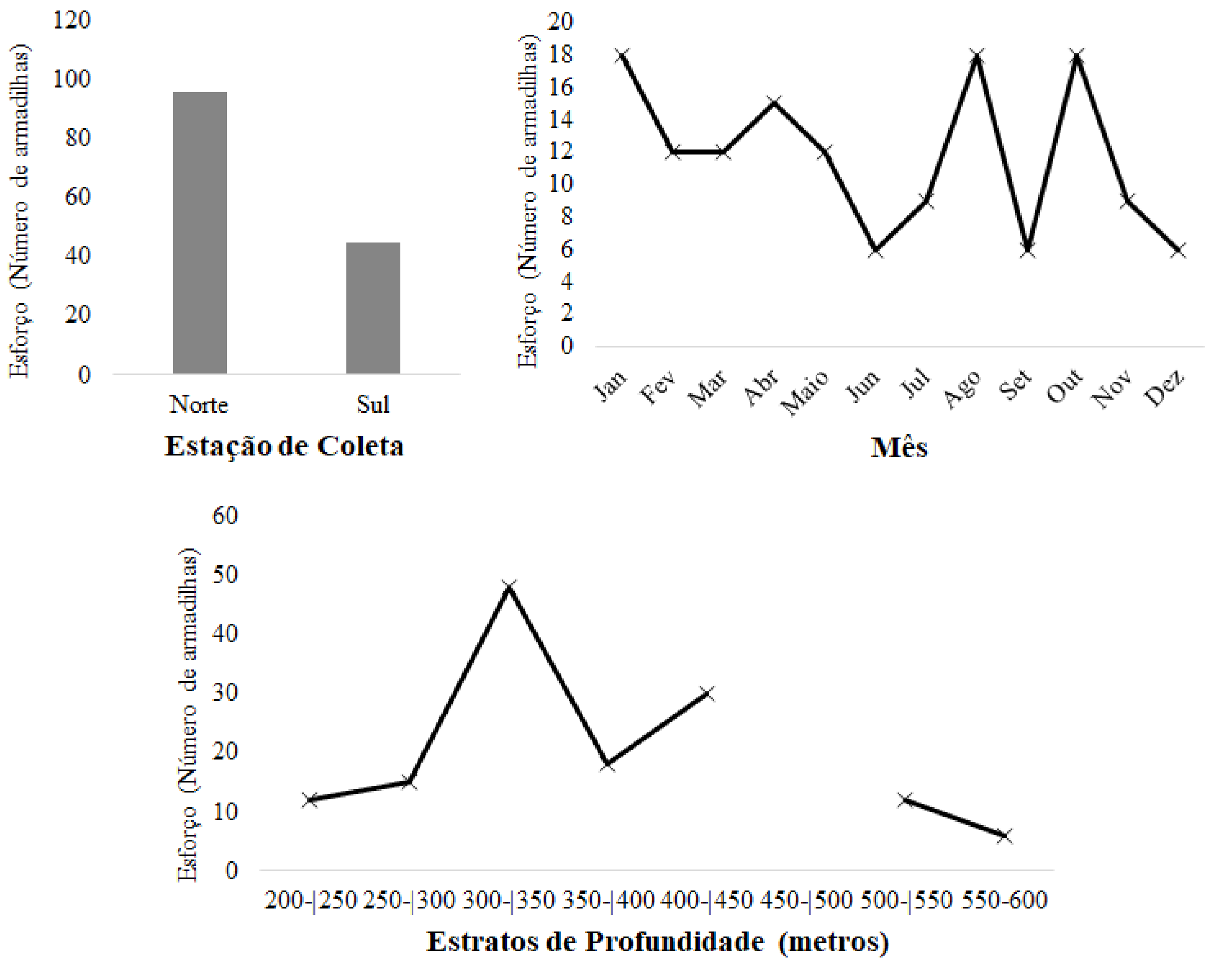

Figure 3. Distribution of fishing effort with bottom traps (number of traps launched), by collection season, depth stratum and month, in the upper slope of Pernambuco, from October 2014 to March 2018.

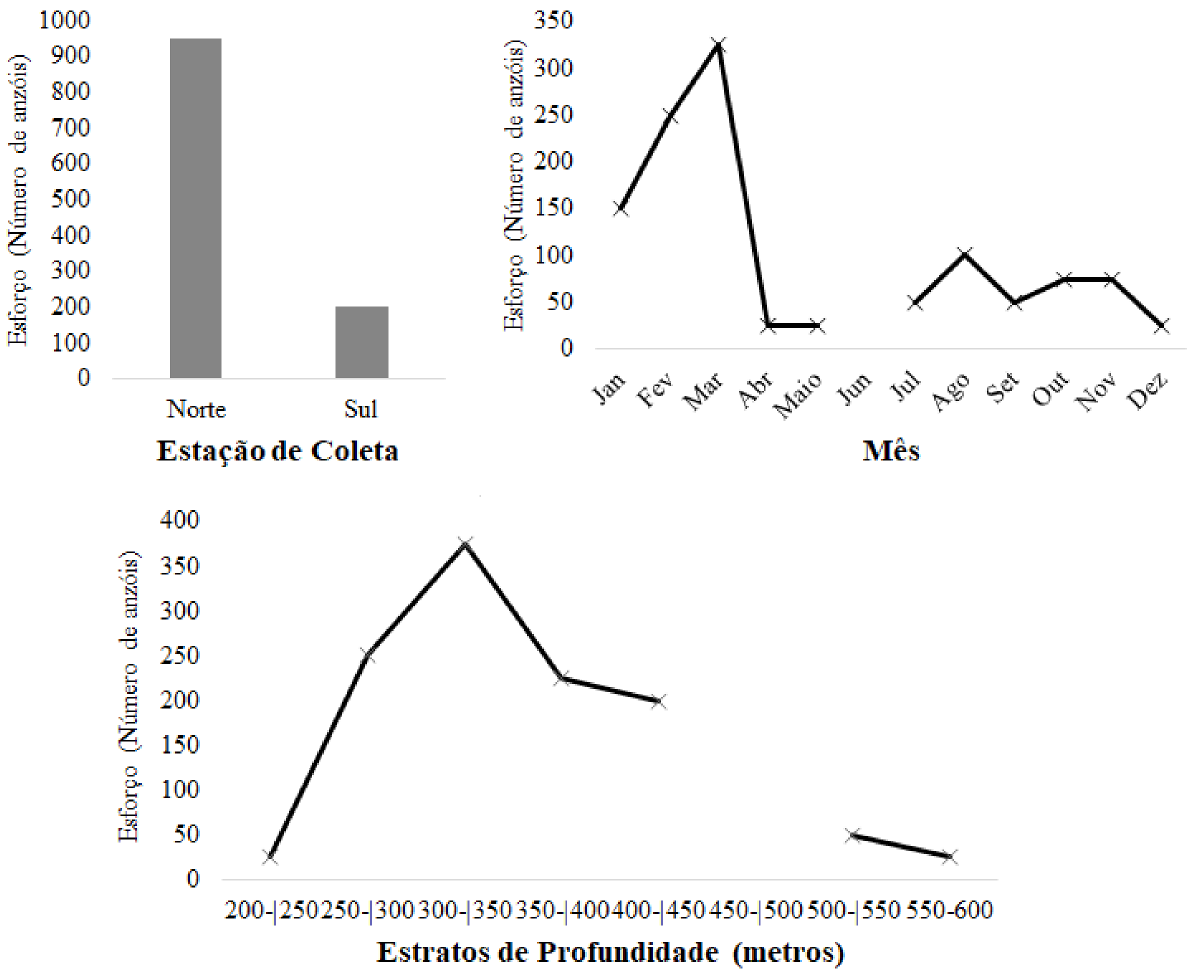

Figure 4. Distribution of fishing effort with bottom long-line (number of hooks launched), by collection season, depth stratum and month, in the upper slope of Pernambuco, from October 2014 to March 2018.

Table 1. Composition of catches in number and percentage for deep water species caught in research cruises on the upper slope of Pernambuco, Brazil, from October 2014 to March 2018.

Family/Class	**Specie**	**n**	**%**
	Crustaceans		
Cirolanidae	*Bathynomus giganteus* (A. Milne-Edwards, 1879)	1	0,10
	Bathynomus miyarei (Lemos de Castro, 1978)	289	27,52
	Bathynomus obtusus (Magalhaes & Young, 2003)	1	0,10
Diogenidae	*Paguristes inconstans* (McLaughlin & Provenzano, 1975)	36	3,43
Epialtidae	*Rochinia crassa* (A. Milne-Edwards, 1879)	4	0,38
	Rochinia gracilipes (A. Milne-Edwards, 1875)	2	0,19
	Stenocionops spinosissimus (Saussure, 1857)	42	4,00
Pandalidae	*Heterocarpus ensifer* (A. Milne-Edwards, 1881)	3	0,29
	Plesionika edwardsii (Brandt, 1851)	307	29,24
Parapaguridae	*Parapagurus sp.* (Smith, 1879)	1	0,10
Polybiidae	*Bathynectes longispina* (Stimpson, 1871)	3	0,29
Pylochelidae	*Mixtopagurus paradoxus* (A. Milne-Edwards, 1880)	1	0,10
Total Crustaceans		**690**	65,71
	Teleosts		
Caproidae	*Antigonia capros* (Lowe, 1843)	1	0,10
Congridae	*Conger esculentus* (Poey, 1861)	4	0,38
Polyprionidae	*Polyprion americanus* (Bloch & Schneider, 1801)	3	0,29
Lutjanidae	*Lutjanus vivanus* (Cuvier, 1828)	2	0,19
Malacanthidae	*Lopholatilus villarii* (Miranda Ribeiro, 1915)	2	0,19
Moridae	*Physiculus* sp.	2	0,19
	Physiculus kaupi (Poye, 1865)	58	5,52
Muraenidae	*Gymnothorax conspersus* (Poye, 1867)	6	0,57
	Gymnothorax maderensis (Johnson, 1862)	3	0,29
	Gymnothorax polygonius (Poye, 1875)	12	1,14
Scorpanidae	*Pontinus rathbuni* (Goode & Bean, 1896)	6	0,57
Total Teleosts		**99**	9,43
	Elasmobranchs		
Carcharhinidae	*Carcharhinus signatus* (Poey, 1868)	2	0,19
Hexanchidae	*Heptranchias perlo* (Bonnaterre, 1788)	1	0,10
Scyliorhinidae	*Cirrhigaleus asper* (Merrett, 1973)	24	2,29
	Scyliorhinus sp. (Blainville, 1816)	52	4,95
Squalidae	*Squalus sp.* (Linnaeus, 1758)	1	0,10
	Squalus albicaudus (Viana, Carvalho & Gomes, 2016)	124	11,81
	*Squalus mitsukurii (*Jordan & Snyder, 1903)	52	4,95
Triakidae	*Mustelus canis* (Mitchill, 1815)	5	0,48
Total Elasmobranchs		**261**	24,86
Grand Total		**1050**	100,00

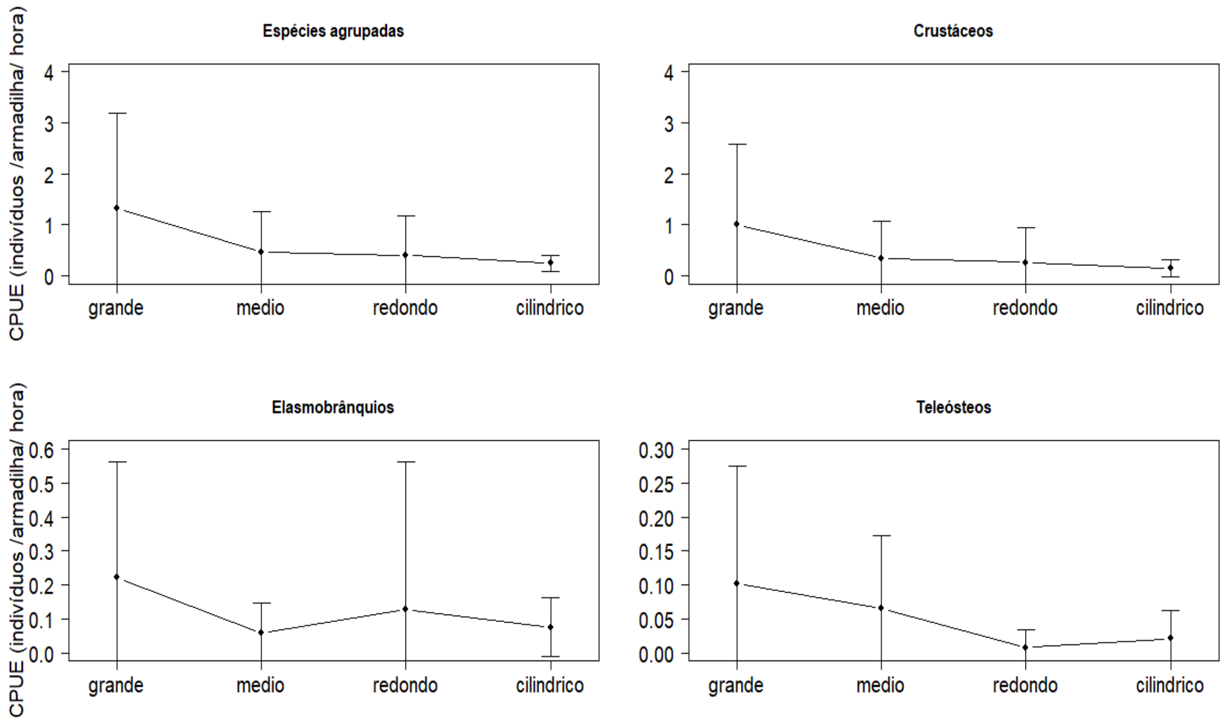

Figure 5. CPUE mean and standard deviation, for the different trap models used, for the grouped species, crustaceans, teleosts and elasmobranchs, on the upper slope of Pernambuco.

Table 2. Mean of CPUE of the main species, by trap model, by collection season and results of Kruskall-Wallis test (significance level of 95%), where GL are the degrees of freedom and X^2 is the Chi-square.

Collection season	CPUE *P. edwardsii*		CPUE *B. miyarei*		CPUE *P. kaupi*		CPUE *S. albicaudus*	
Model	Antigo	Cilíndrico	Antigo	Cilíndrico	Antigo	Cilíndrico	Antigo	Cilíndrico
North	0,07	0,13	0,24	0,01	0,06	0,02	0,07	0,05
South	0,43		0,18		0,03		0,10	
GL	1,00	-	1,00	-	1,00	-	1,00	-
x^2	0,57	-	0,05	-	0,73	-	0,0037707*	-
p-value	0,45	-	0,82	-	0,39	-	0,95	-

Table 3. Mean of CPUE of the main species, by trap model, per month and results of Kruskall-Wallis test (95% level of significance), where GL are the degrees of freedom and X² is the Chi-square.

Month	CPUE *P. edwardsii*		CPUE *B. miyarei*		CPUE *P. kaupi*		CPUE *S. albicaudus*	
Model	Antigo	Cilíndrico	Antigo	Cilíndrico	Antigo	Cilíndrico	Antigo	Cilíndrico
January	0,00		0,18		0,00		0,00	
February		0,11		0,00		0,01		0,09
March	0,00	0,15	0,07	0,01	0,00	0,00	0,00	0,03
April	0,00		2,24		0,22		0,00	
May	0,00		0,00		0,00		0,20	
June	1,81		0,09		0,03		0,08	
July	0,43		0,54		0,14		0,06	
August	0,30		0,14		0,05		0,20	
September		0,13		0,01		0,06		0,00
October	0,02		0,03		0,00		0,04	
November	0,00		0,22		0,10		0,00	
December	0,00		0,00		0,01		0,05	
GL	9,00	2,00	9,00	2,00	9,00	2,00	9,00	2,00
x^2	14,21	0,16	14,10	1,83	10,91	1,88	9,65	1,66
p-value	0,11	0,92	0,12	0,40	0,28	0,39	0,38	0,44

Table 4. Mean of CPUE of the main species, by trap model, by depth strata and results of Kruskall-Wallis test (significance level of 95%), where GL are the degrees of freedom and X^2 is the Chi-square.

Depth strata (m)	CPUE *P. edwardsii*		CPUE *B. miyarei*		CPUE *P. kaupi*		CPUE *S. albicaudus*	
Model	Antigo	Cilíndrico	Antigo	Cilíndrico	Antigo	Cilíndrico	Antigo	Cilíndrico
200-|250	0,00	0,00	0,00	0,00	0,00	0,00	0,03	0,09
250-|300	0,09	0,15	0,00	0,00	0,00	0,01	0,00	0,09
300-|350	0,85	0,18	0,06	0,01	0,09	0,03	0,15	0,00
350-|400	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,08
400-|450	0,00		0,43		0,06		0,12	
450-|500								
500-|550	0,04		0,53		0,00		0,00	
550-600	0,00		0,33		0,00		0,00	
GL	6,00	3,00	6,00	3,00	6,00	3,00	6,00	3,00
x^2	12,40	2,37	12,56	2,81	7,38	0,65	11,92	4,20
p-value	0,05	0,50	0,05	0,42	0,29	0,89	0,06	0,24

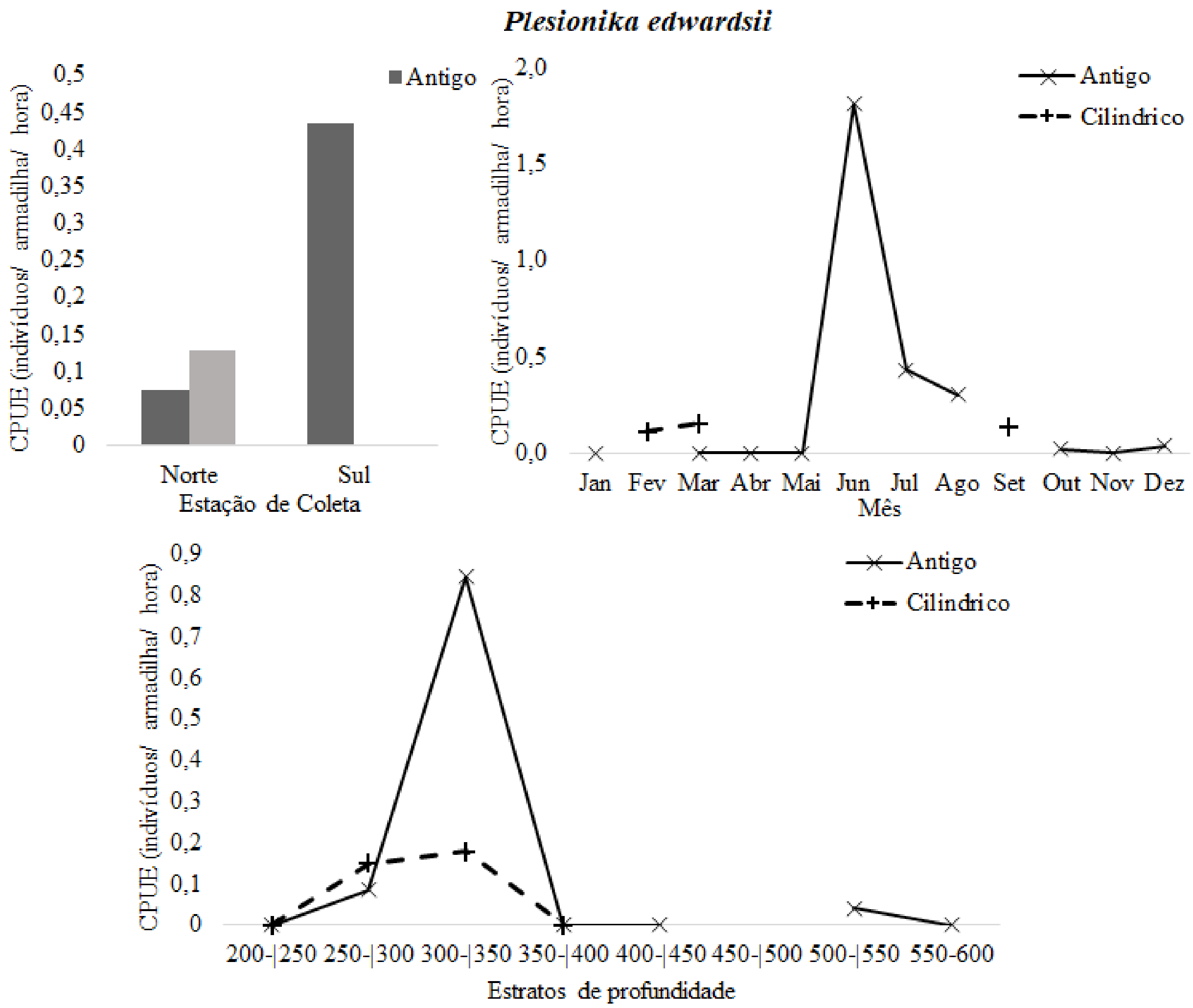

Figure 6. Distribution of *Plesionika edwardsii* CPUE (individuals / trap / hour), by trap model, for each factor separately, in experiments in the upper slope of Pernambuco, from October 2014 to March 2018.

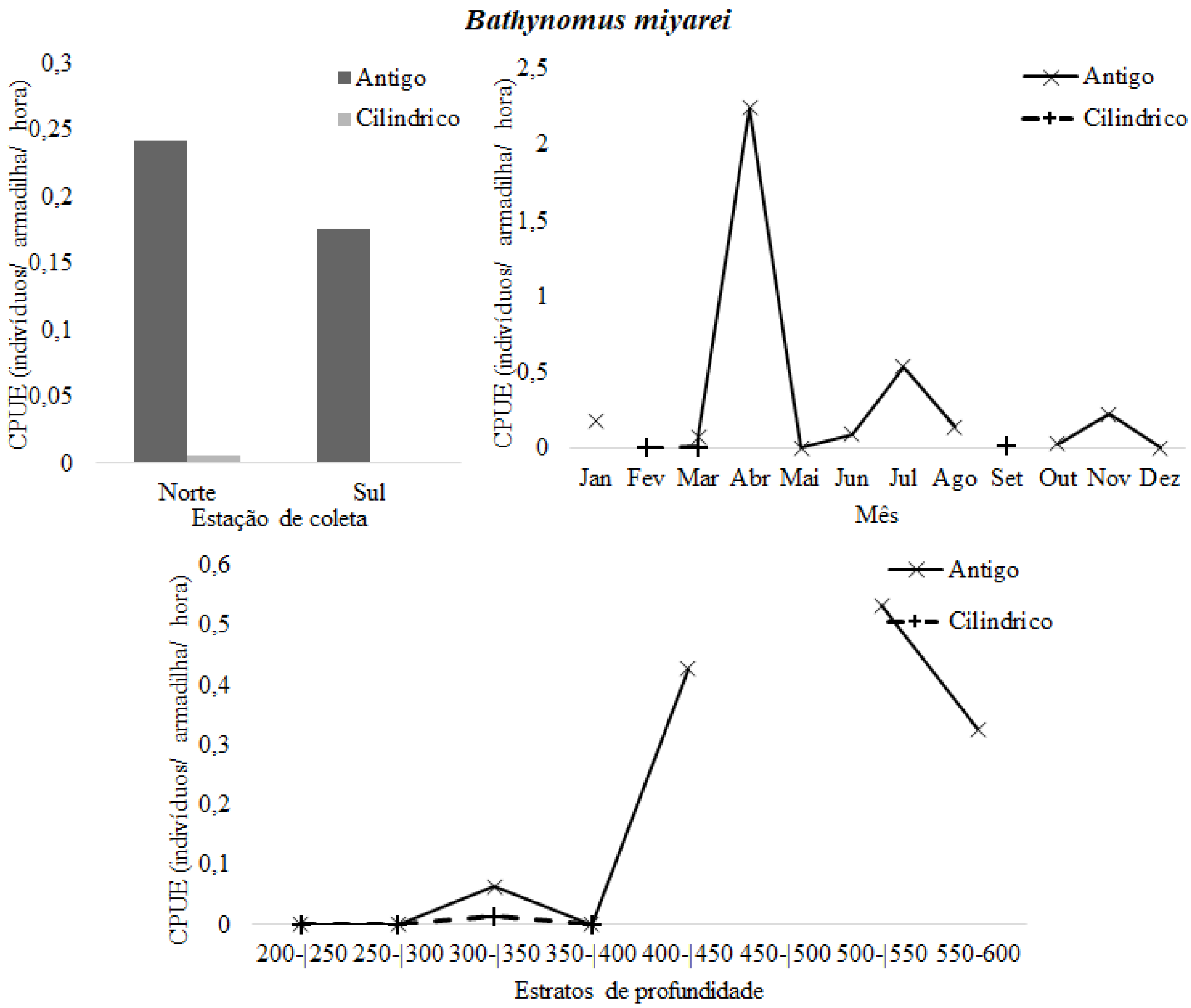

Figure 7. Distribution of the CPUE of *Bathynomus miyarei* (individuals / trap / hour), by trap model, for each factor separately, in experiments in the upper slope of Pernambuco, from October 2014 to March 2018.

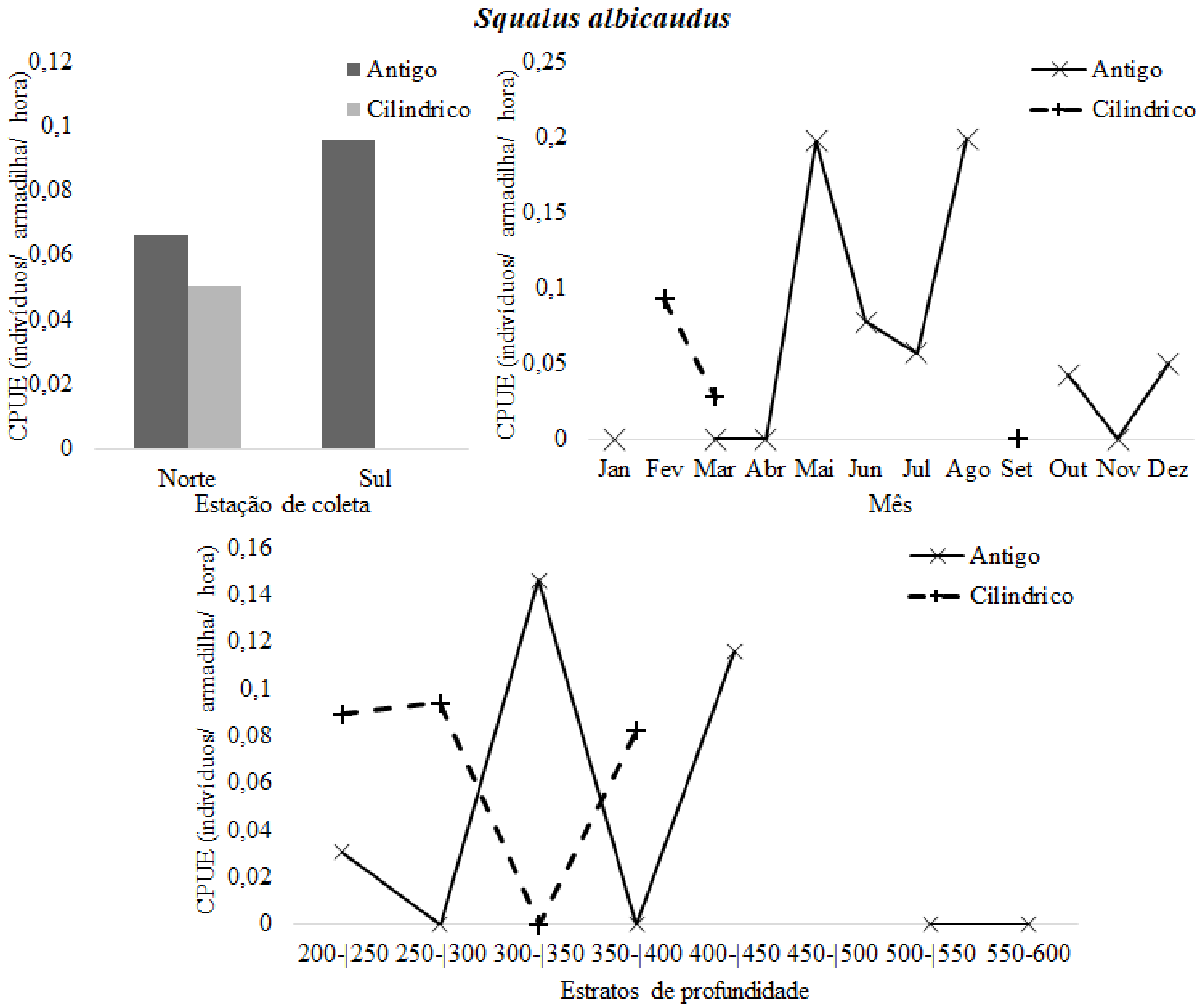

Figure 8. Distribution of CPUE of *Squalus albicaudus* (individuals / trap / hour), by trap model, for each factor separately, in experiments in the upper slope of Pernambuco, from October 2014 to March 2018.

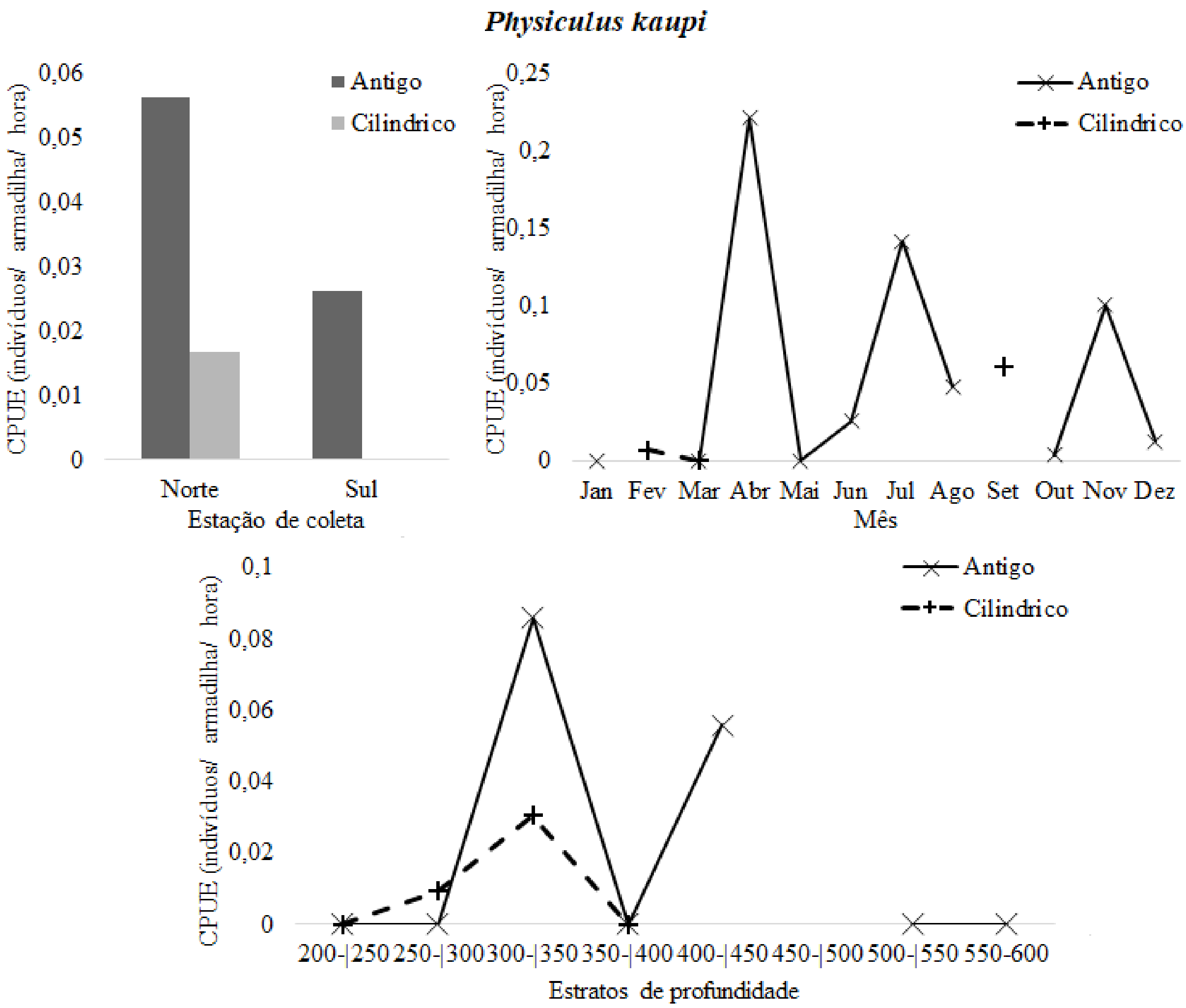

Figure 9. Distribution of the CPUE of the *Physiculus kaupi* (individuals / trap / hour), by trap model, for each factor separately, in experiments in the upper slope of Pernambuco, from October 2014 to March 2018.

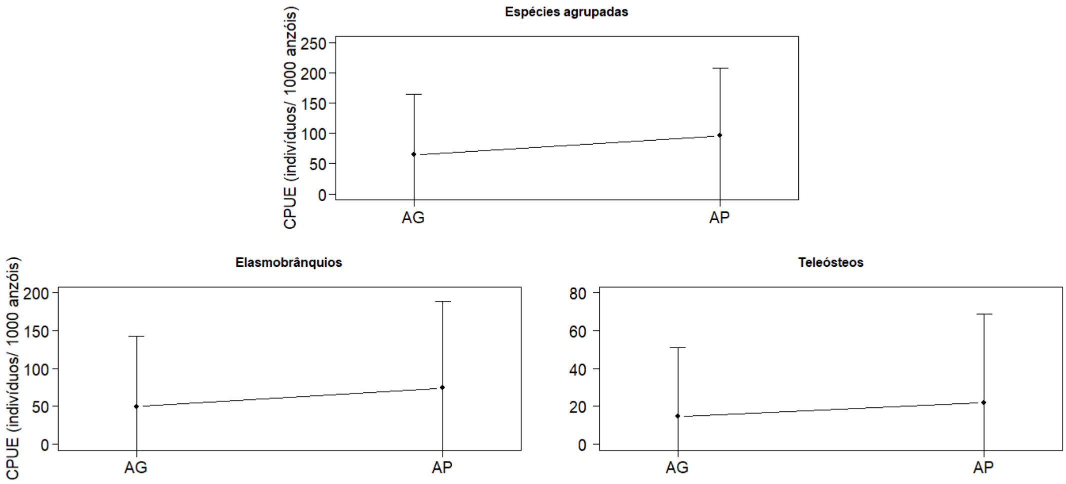

Figure 10. CPUE mean and standard deviation, among the hooks used, for the grouped species, teleosts and elasmobranchs. In samples obtained in depth surveys, in the upper slope of Pernambuco, from October 2014 to March 2018.

Table 5. Mean of CPUE (individuals / 1,000 hooks) of the total, teleosts and elasmobranchs, between the types of hooks used and the results of the statistical analyzes using the Kruskall-Wallis test (95% level of significance), where GL are the degrees of freedom and X² is the Chi-square.

Bottom long-line	Large hook	Small hook	Wilcoxon	
			W	P valor
CPUE Total	64,40318	96,49123	223	0,2445
CPUE Elasmobranchs	49,65517	74,5614	257	0,667
CPUE Teleosts	14,74801	21,92982	258	0,5986

Table 6. Mean of CPUE (individuals / 1,000 hooks) of the main species caught with the large hook by 2016, per collection season, and statistical analysis results for each factor separately by the Kruskall-Wallis test (95% significance level), where GL are the degrees of freedom and X^2 is the Chi-square.

Collection station	CPUE *S. mitsukurii*	CPUE *C. asper*
North	0,00	22,86
South	8,00	16,00
GL	1,00	1,00
x^2	1,40	0,56
p-value	0,24	0,45

Table 7. Mean of CPUE (individuals / 1,000 hooks) of the main species caught with the large hook by 2016, per month, and statistical analysis results for each factor separately using the Kruskall-Wallis test (95% level of significance), where GL are the degrees of freedom and X2 the Chi-square.

Month	CPUE *S. mitsukurii*	CPUE *C. asper*
January		
February		
March	0,00	0,00
April	0,00	0,00
May	0,00	0,00
June		
July	0,00	40,00
August	20,00	20,00
September		
October	0,00	0,00
November	0,00	53,33
December	0,00	0,00
GL	7,00	7,00
x^2	5,00	4,63
p valor	0,66	0,71

Table 8. Mean of CPUE (individuals / 1,000 hooks) of the main species caught with the large hook by 2016, by depth strata and statistical analysis results for each factor

separately using the Kruskall-Wallis test (95% significance level), where GL are the degrees of freedom and X^2 is the Chi-square.

Depth strata (m)	CPUE *S. mitsukurii*	CPUE *C. asper*
200-|250	0,00	0,00
250-|300		
300-|350	0,00	26,67
350-|400	0,00	0,00
400-|450	10,00	20,00
450-|500		
500-|550		
550-600		
GL	3,00	3,00
x^2	2,00	1,52
p valor	0,57	0,68

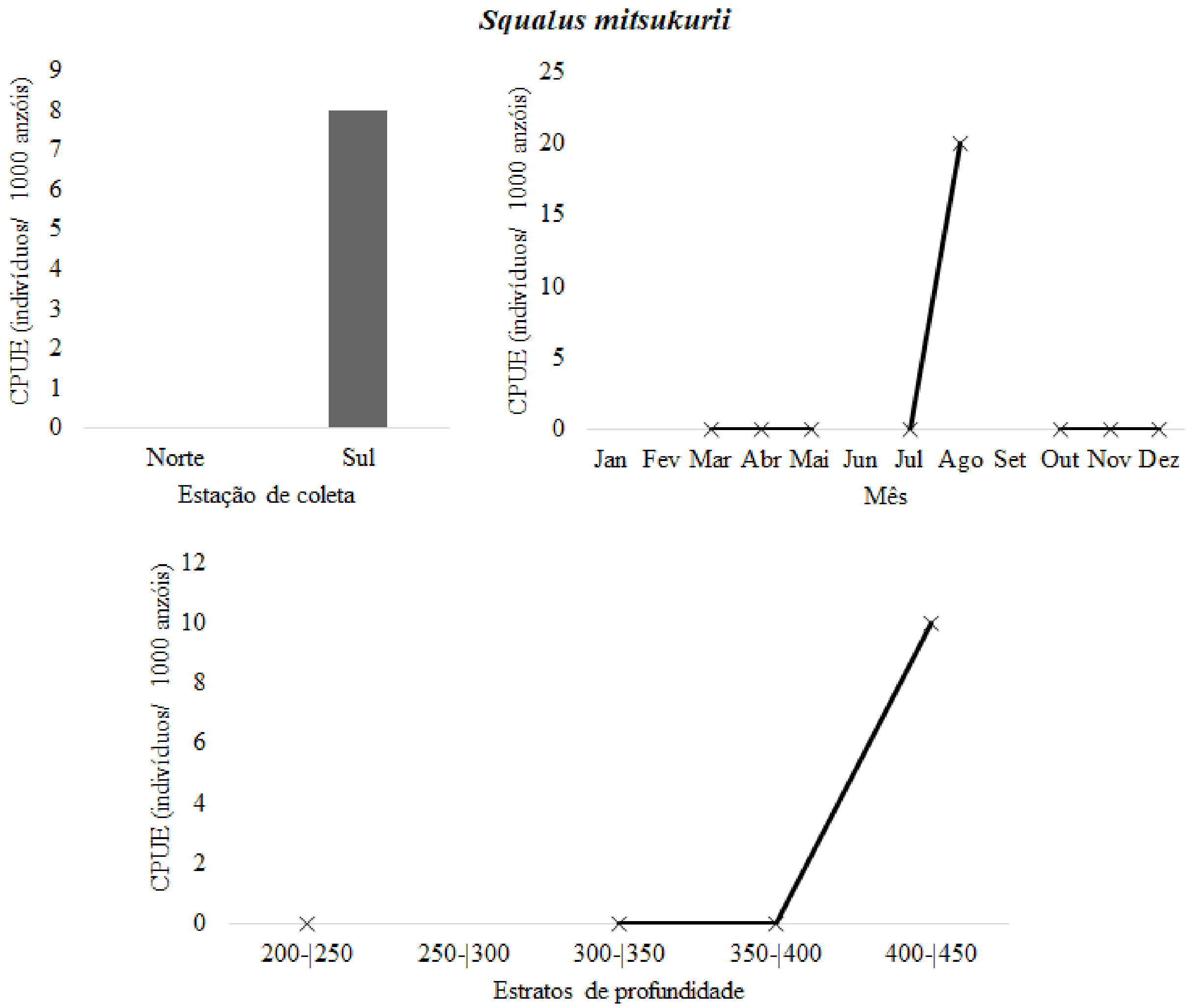

Figure 11. CPUE distribution of *Squalus mitsukurii* (individuals / 1000 hooks), for each factor separately, in experiments in the upper slope of Pernambuco, from October 2014 to March 2018.

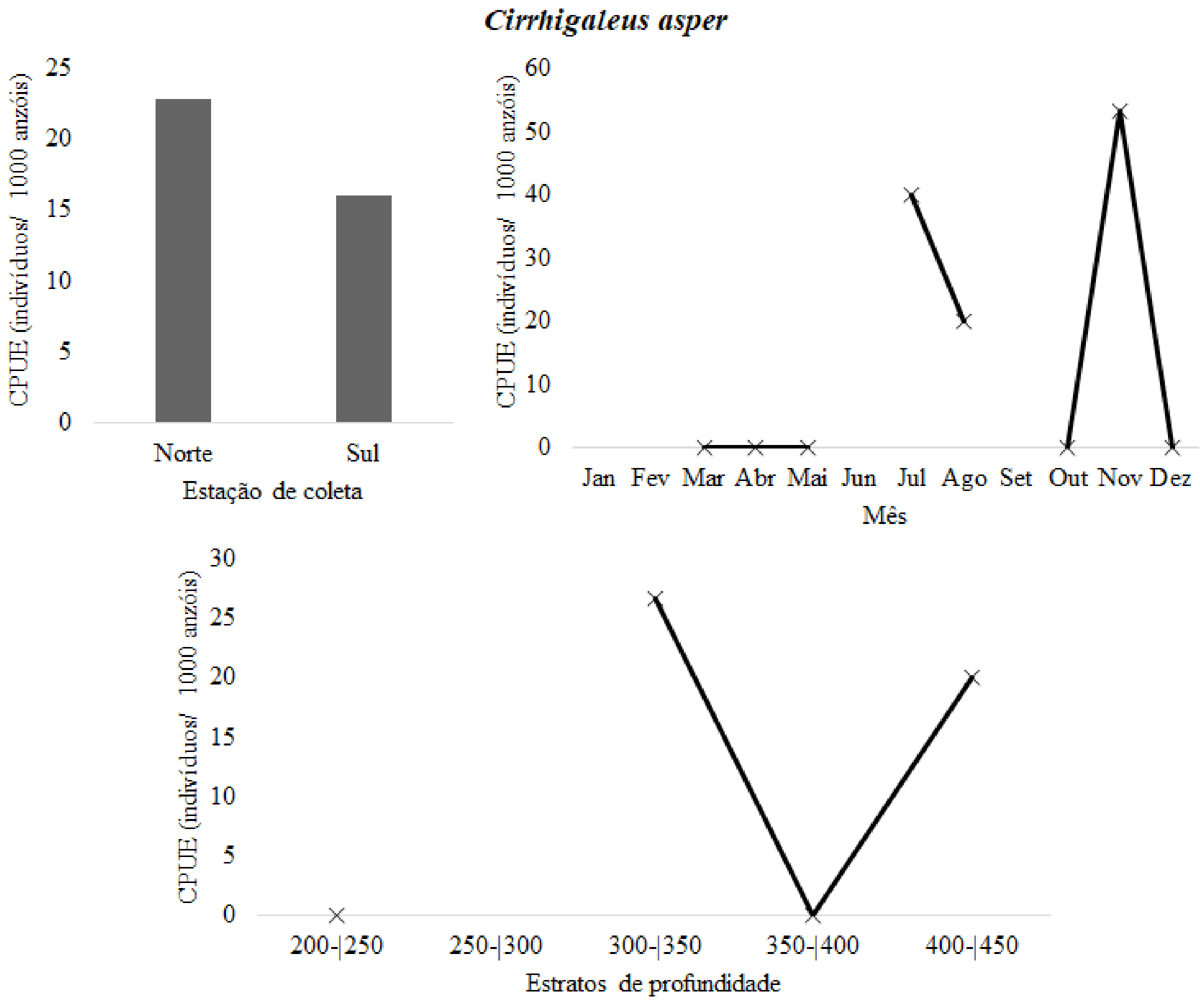

Figure 12. CPUE distribution of *Cirrhigaleus asper* (individuals / 1000 hooks), for each factor separately, in experiments in the upper slope of Pernambuco, from October 2014 to March 2018.

References

BELLWOOD D.R.; HUGHES T., 2001. Regional-assembly rules and biodiversity of coral reefs. Science, 292, 1532–1535.

BERNARDES, R.Á., J.L. DE FIGUEIREDO, A.R. RODRIGUES, L.G. FISCHER, C.M. VOOREN, M. HAIMOVICI E C.L.D.B. ROSSI-WONGTSCHOWSKI, 2005. Peixes de zona econômica exclusiva da região sudeste-sul do Brasil: Levantamento com armadilhas, pargueiras e rede de arrasto de fundo. São Paulo: Editora da Universidade de São Paulo. 295 p.

BRAGA, A. C.; COSTA, P. A. S.; NUNAN, G. W. 2008. First record of the firebrow lanternfish *Diaphus adenomus* (Myctophiformes: Myctophidae) from the South Atlantic. Journal of Fish Biology 73: 296–301.

CARNEY R.S., 2005. Zonation of deep biota on continental margins. Oceanography and Marine Biology: An Annual Review, 43, 211–278.

COSTA, P. A. S; BRAGA, A. C.; FRANCO, M. A. L. 2006. A ictiofauna profunda da Bacia de Campos-RJ In: I Congresso Brasileiro de Biologia Marinha, 2006, Niterói. Resumos, n° 109, PP .86.

FIGUEIREDO, J. L.; SANTOS, A. P.; YAMAGUTI, N.; BERNARDES, R. A.; ROSSI-WONGTSCHOWSKI, C. L. D. B. 2002. Peixes da Zona Econômica Exclusiva da região Sudeste-Sul do Brasil: levantamento com rede de meia água. São Paulo: Edusp. 242 p

FUJITA, T.; INADA, T.; ICHITO, Y. 1995. Density, biomass and Community structure of demersal fishes off the Pacific coast of northeastern Japan. Journal of Oceanography, 49: 211-229.

GARMAN, S. 1899. Reports on an exploration off the west coasts of Mexico Central and South America and off the Galapagos Islands in charge of Alexander Agassi, b the U.S. ish Commission steamer 'Albatross', during 1891, Lieut. Commander Z. L. Tanner, U.S.N., commanding XXVI. The Fishes. Memoirs of the Museum of Comparative Zoology, 24: 1-431.

GUNDERSON, D. R. 1993. Survey of Fisheries Resources. John Wiley & Sons,New York. 248 p.

GUNTHER, A. 1880. Report on the shore fishes procured during the voyage of H.M.S. Challenger in the years 1873–1876. Report on the scientific results of the voyage of H.M.S. Challenger during the years 1873-1876. Zoology, 1: 1-82.

HAIMOVICI, M. *et* al 2004. Prospecção pesqueira de espécies demersais com espinhel-de-fundo na Zona Econômica Exclusiva da Região Sudeste-Sul do Brasil / editores Manuel Haimovici, Antônio Olinto Ávila-da-Silva, Carmen L. D. B. Rossi-Wongtschowski. São Paulo: Instituto Oceanográfico — USP, 2004(Série Documentos REVIZEE, REVIZEE: Score Sul).

HARVEY, E. S.; NEWMAN, S. J.; MCLEAN, D. L.; CAPPO, M.; MEEUWIG, J. J.; SKEPPER, C L.; 2009. Comparation of the relative efficiencies of stereo-BRUVs and traps for sampling tropical continental shelf dermersal fishes. Fisheries Research 125/126: 108-120.

HAZIN, F. H. V. Prospecção Pesqueira Hidruacústica da região Nordeste. / Fabio H V Hazin; - Fortaleza: Editora Martin.s & Cordeiro, 2009. (Programa Revizee - Score Nordeste)116p.;

HOVGARD, H. & LASSEN, H. 2000. Manual on estimation of selectivity of gillnet and long-line gears in abundance surveys. FAO Fish.Tech. Paper, 397:84p.

JUCÁ-QUEIROZ, B., SILVA, A.C., NASCIMENTO, F.C.P. & FURTADO-NETO, M.A.A. Composição e abundância de elasmobrânquios capturados com espinhel de fundo no litoral oeste do estado do Ceará. Arq. Ciên. Mar, Fortaleza, 2011, 44(2): 5 – 11.

KITAHARA, M. V. 2009. A pesca demersal de profundidade nos bancos de corais azooxantelados do sul do Brasil. Biota Neotropica, 9(2): 35-43.

KINGSTON, D. S.; MANIKANDAVELU, D. 1998. Record of *Physiculus natalensis* Gilchrist (Fam: Moridae) from India waters. Indian Journal Fish, 45 (4): 447-449

MORA C., CHITTARO P. M., SALE P. F., KRITZER J., LUDSIN S. A., 2003. Patterns and processes in reef fish diversity. Nature, 421, 933–936.

NÓBREGA, *et al.*, 2009. Peixes Marinhos da Região Nordeste do Brasil. Ed. Martins & Cordeiro. Programa REVIZEE – Score Nordeste. 208 p.

NUNES, D. M. 2015. Pesca e biologia de espécies de águas profundas no Arquipélago de São Pedro e São Paulo, Atlântico Equatorial, Brasil (Tese de Doutoramento. Universidade Federal Rural de Pernambuco).

OLIVEIRA, I.M., HAZIN, F., OLIVEIRA, V.S., GEBER, F., OLIVEIRA, G.J. BARRADAS, R. Distribuição e Abundância Relativa de peixes capturados Com espinhel de fundo na costa de Pernambuco, Brasil. *B. Inst. Pesca*, São Paulo, *33*(2): 183-193, 2007.

OLIVEIRA, V.S. 2005. Distribuição e abundância relativa de crustáceos e peixes demersais capturados com espinhel de fundo na ZEE Nordeste do Brasil. Recife. 183p. (Tese de Doutoramento. Universidade Federal Rural de Pernambuco).

OLIVEIRA, V.S., RAMOS-PORTO, M., SANTOS, M.C.F. HAZIN, F.H.V. CABRAL, E. ACIOLE, F.D. Distribuição batimétrica e características populacionais do camarão *Heterocarpus ensifer* (caridea: pandalidae) capturado na plataforma externa e talude continental da costa nordeste do Brasil. Bol. Inst. Pesca, São Paulo, *37*(4): 375 – 382, 2011.

LORANCE, P., SOUISSI, S., UIBLEIN, F., EGUIA, R. C., 2001. Distribution and density of carnivorous fish species around Lanzarote and Fuerteventura, Canary Islands. In: Deep-sea Fisheries Symposium—Oral, NAFO SCR Doc. 01/168.

MELO, M.R.S.; BRAGA, A.C.; NUNAN, G.W.A.; COSTA, P.A.S. On new collections of deep-sea Gadiformes (Actinopterygii: Teleostei) from the Brazilian continental slope, between 11° and 23° S. Zootaxa, n. 2433, p. 25-46, 2010.

MENEZES, G. M., SIGLER, M. F., SILVA, H. M., PINHO, M. R., 2006. Structure and zonation of demersal fish assemblages off the Azores archipelago (mid-Atlantic). Mar. Ecol. Prog. Ser. 324, 241–260.

MINCARONE, M. M.; NIELSEN, J. G.; COSTA, P. A. S. 2008. Deep sea ophidiiform fishes collected on the Brazilian continental slope, between 11° and 23°S. Zootaxa, 1770: 41- 64.

MORA C., CHITTARO P. M., SALE P. F., KRITZER J., LUDSIN S. A., 2003. Patterns and processes in reef fish diversity. Nature, 421, 933–936.

NÓBREGA, *et al.*, 2009. Peixes Marinhos da Região Nordeste do Brasil. Ed. Martins & Cordeiro. Programa REVIZEE – Score Nordeste. 208 p.

NUNES, D. M. 2015. Pesca e biologia de espécies de águas profundas no Arquipélago de São Pedro e São Paulo, Atlântico Equatorial, Brasil (Tese de Doutoramento. Universidade Federal Rural de Pernambuco).

OLIVEIRA, I.M., HAZIN, F., OLIVEIRA, V.S., GEBER, F., OLIVEIRA, G.J. BARRADAS, R. Distribuição e Abundância Relativa de peixes capturados Com espinhel de fundo na costa de Pernambuco, Brasil. *B. Inst. Pesca*, São Paulo, *33*(2): 183-193, 2007.

OLIVEIRA, V.S. 2005. Distribuição e abundância relativa de crustáceos e peixes demersais capturados com espinhel de fundo na ZEE Nordeste do Brasil. Recife. 183p. (Tese de Doutoramento. Universidade Federal Rural de Pernambuco).

OLIVEIRA, V.S., RAMOS-PORTO, M., SANTOS, M.C.F. HAZIN, F.H.V. CABRAL, E. ACIOLE, F.D. Distribuição batimétrica e características populacionais do camarão *Heterocarpus ensifer* (caridea: pandalidae) capturado na plataforma externa e talude continental da costa nordeste do Brasil. Bol. Inst. Pesca, São Paulo, *37*(4): 375 – 382, 2011.

OLIVEIRA, V. D.; RAMOS-PORTO, M.; SANTOS, M. C. F.; HAZIN, F. H. V.; CABRAL, E.; ACIOLI, F. D. 2014. Características biométricas, distribuição e abundância relativa do camarão *Plesionika edwardsii* na costa Nordeste do Brasil. Bol. Inst. Pesca, São Paulo, 40(2): 215- 222.

OLIVEIRA, V.S., ANDRADE, H. A., HAZIN, F.H.V. & VIEIRA, A.C. Pesca da lagosta com covos na costa central de Pernambuco: taxas de captura da lagosta e fauna acompanhante. *Bol. Inst. Pesca*, São Paulo, *41*(2): 373 – 385, 2015.

PAIVA, C. C.; ARAÚJO, M. E.; CAÍRES, R. A.; SALLES, R.; MEDEIROS, R. S.; LOTUFO, T. M. C. 2011. Six new records of deep-sea fish off north-eastern Brazil. Marine Biodiversity Records,4: 1-5.

PAULMIER, G. and GERVAIN, P. 1994 Peches experimentales des crustaces profonds dans les eaux de la Martinique (Pandalidae, Nephropidae). Prospections, rendements et biologie des especes. 44p. 222 OLIVEIRA et al. Bol. Inst. Pesca, São Paulo, 40(2): 215 – 222, 2014.

PEREZ, J. A. A.; PEZZUTO, P. R.; WAHRLICH, R.; SOARES, A. L. S. 2009. Deep-water fisheries in Brazil: history, status and perspectives. Lat. Am. J. Aquat. Res., 37 (3): 513-541.

PEZZUTO, P. R.; PEREZ, J. A. A.; WAHRLICH, R. O ordenamento das pescarias de caranguejos-de-profundidade (chaceon spp.) (decapoda: geryonidae) no sul do Brasil. 2006 vol: 32 (2) pp: 229-24

PEREIRA, L. C. C.; JIMÉNEZ, J. A.; MEDEIROS, C., e COSTA, R. M. DA., 2003. The influence of the environmental status of Casa Caiada and Rio Doce beaches (NE-Brazil) on beaches users. Ocean & Coastal Management, 46(11-12), 1011–1030.

RAMOS-PORTO, M., SANTOS, M.C.F. HAZIN, F.H.V. CABRAL, E. ACIOLE, F.D. Características biométricas, distribuição e abundância relativa do camarão *Plesionika edwardsii* na costa nordeste do Brasil. Bol. Inst. Pesca, São Paulo, 40(2): 215 – 222, 2014.

RUDERSHAUSEN, P. J.; MITCHELL, W. A.; BUCKEL, J. A.; WILLIAMS, E. H.; HAZEN, E. 2010. Development a two-step fishery-independent design to estimate the relative abundance of deepwater reef fish: Application to a marine protected area off the southeastern United State coast. Fisheries Research, 105: 254-260.

SNELGROVE P. V. R., HAEDRICH R. L., 1985. Structure of the deep demersal fish fauna off Newfoundland. Marine Ecology Progress Series, 27, 99–107.

TAVARES, C. R. & SEREJO, C. S. 2007. Taxonomy of Aristeidae (Dendrobranchiata: Penaeoidea) from the central coast of Brazil, collected by the Revizee program, between 19o and 22oS. Zootaxa, 1585:1-44.

VAILLANT, L. 1888. Expéditions scientifiques du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883. Poissons. Paris, G. Masson.

VAN DOVER, C.; ARONSON, J.; PENDLETON, L.; SMITH, S.; ARNAUD-HAOND, S. 2014. Ecological restoration in the deep sea: Desiderata. Marine Policy, 44: 98-106.

ZAR, J. H., 1996. Biostatistical analysis. 3. ed. New Jersey: Prentice-Hall. 662p.

Considerações finais

O estudo realizado aporta informações importantes sobre o ecossistema de águas profundas na costa pernambucana e sobre as espécies demersais que nele habitam. Com poucos cruzeiros realizados, o estudo já demonstrou uma elevada diversidade de espécies, capturando indivíduos de diferentes grupos taxonômicos (crustáceos, elasmobrânquios e teleósteos). A segregação vertical das capturas mostrou a importância da profundidade para a distribuição das espécies, indicando as diferentes preferências batimétricas das diferentes comunidades ao longo dos estratos de profundidade.

As artes de pesca utilizadas se mostraram eficientes, capturando um grande número de espécies, sendo necessárias, porém, algumas adaptações no espinhel de fundo, como a utilização de um anzol menor, para a captura de indivíduos menores. A utilização desses aparelhos de pesca, de tamanho reduzido, permite a sua fácil utilização por embarcações de pequeno porte, de forma consorciada a outros aparelhos, com potencial, portanto, de contribuir para otimizar a produção e melhorar, consequentemente, a eficiência da atividade pesqueira e, assim, os níveis de emprego e renda gerados pelo setor.

Mesmo com todos os dados disponíveis, o ambiente alvo do estudo ainda é pouco acessível, sendo necessários maiores esforços de pesquisa para aprofundar os conhecimentos sobre as águas profundas e as espécies que aí habitam. Levando-se em consideração a fragilidade das espécies encontradas e sua reduzida distribuição, é importante a utilização de métodos não letais e não dependentes da pesca (RUDERSHAUSEN *et al*., 2010; BACHELER *et al*., 2013) para realização de prospecções, a exemplo de câmeras acopladas a estruturas rígidas (BRUV's - Baited Remote Underwater Video) (HARVEY *et al*., 2009), ou mesmo a utilização de veículos marinhos (ROV). Pela mesma razão, é necessário que qualquer desenvolvimento de um esforço de pesca direcionado a essas espécies seja acompanhado do devido controle e monitoramento científico, de forma a não resultar na sua rápida sobre-explotação, como já ocorreu em inúmeros casos, a exemplo do peixe-sapo, no sul do país.

Referências

ARANA, P.; PEREZ, J. A. A.; PEZZUTO, P. R. 2009. Deep-sea fisheries off Latin America: an introduction. Lat. Am. J. Aquat. Res., 37(3): 281-284

ÁVILA-DA-SILVA, A.O.; BASTOS, G.C.C.; TUTUI, S.L.S. 2001 A atividade pesqueira do Estado de São Paulo: Análise das capturas do biênio 1998-1999 com espinhel-de-fundo. *B. Inst. Pesca*, São Paulo, *27*(1): 33-38.

BARCELLOS, L.J.P.; PERES, M.B.; WARLICH, R. e BARISON, M.B. 1991 Relatório sobre otimização bioeconômica dos recursos pesqueiros marinhos do Rio Grande do Sul. Museu Oceanografico - Fundação Universidade do Rio Grande, Publicação Avula, 58p. 20:141-161.

BERNARDES, L. M. C. Pescadores da Ponta do Cajú: aspectos da contribuição de portugueses e espanhóis para o desenvolvimento da pesca na Guanabara. In: Revista Brasileira de Geografia, Rio de Janeiro, n.2, ano XX, 1958. LXVIII, julho, 1940.

BERNARDES, R.Á., J.L. DE FIGUEIREDO, A.R. RODRIGUES, L.G. FISCHER, C.M. VOOREN, M. HAIMOVICI E C.L.D.B. ROSSI-WONGTSCHOWSKI, 2005. Peixes de zona econômica exclusiva da região sudeste-sul do Brasil: Levantamento com armadilhas, pargueiras e rede de arrasto de fundo. São Paulo: Editora da Universidade de São Paulo. 295 p.

BOECKMAN, C.E., HAZIN, F.H.V. & HAZIN, H.G. 2001. Distribuição e abundância relativa de peixes demersais capturados na costa brasileira, entre São Luís (MA) e Cabo Frio (RJ). Bol. Tec. Cient. Cepene. 9(1):205-226.

BRAGA, A. C.; COSTA, P. A. S.; NUNAN, G. W. 2008. First record of the firebrow lanternfish *Diaphus adenomus* (Myctophiformes: Myctophidae) from the South Atlantic. Journal of Fish Biology 73: 296–301.

COSTA, P. A. S; BRAGA, A. C.; FRANCO, M. A. L. 2006. A ictiofauna profunda da Bacia de Campos-RJ In: I Congresso Brasileiro de Biologia Marinha, 2006, Niterói. Resumos, n˚ 109, PP .86.

DIEGUES, A. C. S. Pescadores, camponeses e trabalhadores do mar. São Paulo, Ed. Ática, 1983.

FIGUEIREDO, J. L.; SANTOS, A. P.; YAMAGUTI, N.; BERNARDES, R. A.; ROSSI-WONGTSCHOWSKI, C. L. D. B. 2002. Peixes da Zona Econômica Exclusiva da região Sudeste-Sul do Brasil: levantamento com rede de meia água. São Paulo: Edusp. 242 p

GARMAN, S. (1899) The Fishes. In: Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands in charge of Alexander Agassiz, by the the U.S. Fish Commission steamer "Albatross", during 1891, Lieut. Commander Z. L. Tanner, U.S.N., commanding. XXVI. Memoirs of the Museum of Comparative Zoology, 24, 1–431, Atlas: pls. 1–85 + A–M.

GORDON, J. D. M.; BERGSTAD, O. A.; FIGUEIREDO, I.; MENEZES, G. Deep-water fisheries of the Northeast Atlantic: Description and current trends. Journal of Northwest Atlantic Fisheries Science, vol.31, p.137–150, 2003.

GUNTHER, A. Report on the shore fishes procured during the voyage of H. M. S. Challenger 1837–1876. In: Report on the scientific results of the exploring voyage of H. M. S. Challenger 1873–1876, Zoology (Part. VI), 1880.

HAIMOVICI, M. *et* al 2004. Prospecção pesqueira de espécies demersais com espinhel-de-fundo na Zona Econômica Exclusiva da Região Sudeste-Sul do Brasil / editores Manuel Haimovici, Antônio Olinto Ávila-da-Silva, Carmen L. D. B. Rossi-Wongtschowski. São Paulo: Instituto Oceanográfico — USP, 2004(Série Documentos REVIZEE, REVIZEE: Score Sul).

MELO, M.R.S.; BRAGA, A.C.; NUNAN, G.W.A.; COSTA, P.A.S. On new collections of deep-sea Gadiformes (Actinopterygii: Teleostei) from the Brazilian continental slope, between 11° and 23° S. Zootaxa, n. 2433, p. 25-46, 2010.

MINCARONE, M. M.; NIELSEN, J. G.; COSTA, P. A. S. 2008. Deep sea ophidiiform fishes collected on the Brazilian continental slope, between 11° and 23°S. Zootaxa, 1770: 41- 64.

OLIVEIRA, V.S., ANDRADE, H. A., HAZIN, F.H.V. & VIEIRA, A.C. Pesca da lagosta com covos na costa central de Pernambuco: taxas de captura da lagosta e fauna acompanhante. *Bol. Inst. Pesca*, São Paulo, *41*(2): 373 – 385, 2015.

PAIVA, C. C.; ARAÚJO, M. E.; CAÍRES, R. A.; SALLES, R.; MEDEIROS, R. S.; LOTUFO, T. M. C. 2011. Six new records of deep-sea fish off north-eastern Brazil. Marine Biodiversity Records,4: 1-5.

PERES, M.B. & HAIMOVICI, M. 1998. A pesca dirigida ao cherne poveiro, *Polyprion americanus* (Polyprionidae, Teleostei) no sul do Brasil. Atlântica, 20:141-161.

PEREZ, J. A. A.; PEZZUTO, P. R.; WAHRLICH, R.; SOARES, A. L. S. Deep-water fisheries in Brazil: history, status and perspectives. Lat. Am. J. Aquat. Res., vol.37, n3, p.513-541, 2009. NÓBREGA, et al., 2009. Peixes Marinhos da Região Nordeste do Brasil. Ed. Martins & Cordeiro. Programa REVIZEE – Score Nordeste. 208 p.

PEREZ, J. A. A.; PEZZUTO, P. R.; WAHRLICH, R.; SOARES, A. L. S. 2009. Deep-water fisheries in Brazil: history, status and perspectives. Lat. Am. J. Aquat. Res., 37 (3): 513-541.

PEZZUTO, P. R.; PEREZ, J. A. A.; WAHRLICH, R. O ordenamento das pescarias de caranguejos-de-profundidade (chaceon spp.) (decapoda: geryonidae) no sul do Brasil. 2006 vol: 32 (2) pp: 229-24

TAVARES, C. R. & SEREJO, C. S. 2007. Taxonomy of Aristeidae (Dendrobranchiata: Penaeoidea) from the central coast of Brazil, collected by the Revizee program, between 19o and 22oS. Zootaxa, 1585:1-44.

TROYANOVSKY, F. M.; LISOVSKY, S. F. 1995. Russian (USSR) fisheries research in deep-waters (below 500 m) in the north Atlantic. In: A.G. Hooper (ed.) Deepwater fisheries of the north Atlantic oceanic slope. Kluwer Academic Publishers, Netherlands, pp. 357-365.

VAILLANT, L. (1888) Poissons. Expéditions Scientifiques du Travailleur et du Talisman pendant les années 1880, 1881, 1882, 1883. G. Masson, Paris, 406 pp, 28 pls.