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**Ocupação preferencial de áreas de concentração pela Baleia Franca Austral,
Eubalaena australis (Desmoulins, 1822), CETACEA, MYSTICETI,
no litoral sul do Brasil.**

Dissertação submetida ao Programa de Pós-Graduação
em Biologia Animal, Instituto de Biociências da
Universidade Federal do Rio Grande do Sul, como requisito
parcial à obtenção do título de Mestre em Biologia Animal.

Linha de Pesquisa: Estudos sobre a diversidade
de mamíferos no sul do Brasil

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UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL

PORTO ALEGRE

2000

**A todas as pessoas que têm a
coragem de lutar pelos seus ideais.**

AGRADECIMENTOS

Em especial à minha mãe Neiva, pela amizade, incentivo, coragem, carinho e compreensão.

Ao meu pai, Clóvis pelo apoio e incentivo.

Ao meu amor, Janir, por ter compreendido e suportado todas as minhas ausências.

A José Truda Palazzo Jr., por ter acreditado na minha capacidade, pelo estímulo, suporte e revisão dos artigos.

Ao Biól. Paulo A. C. Flores, pelo incentivo, amizade e suporte bibliográfico.

A Renato Sehn (Pousada Ilha do Papagaio, Palhoça, SC), Marcos Souza (Pousada Pinheira, Palhoça, SC), Enrique Litman (Pousada Vida, Sol e Mar, Imbituba, SC), Posto Amizade (Garopaba, SC) e Posto Irmãos Carvalho LTDA (Imbituba, SC) pelo valioso apoio logístico.

Ao meu orientador, Prof. Dr. Thales R. O. de Freitas, pela valiosa orientação à realização desta tese.

À CAPES, pelo suporte financeiro, sem o qual este trabalho não teria sido possível.

A todos que de alguma forma contribuíram para a realização deste trabalho.

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RESUMO

De Agosto a Outubro de 1998 e 1999, um estudo sobre os padrões de distribuição e ocupação sazonal, comportamento e composição dos grupos de baleias francas austrais foi realizado no litoral sul do Estado de Santa Catarina, Brasil. As baleias estavam presentes na área de estudo em todos os meses de observação, com uma maior frequência de avistagens no mês de Setembro em 1998 e Agosto em 1999. Uma aparente preferência por algumas enseadas ao longo da área de estudo foi observada. Nas enseadas, a maioria das avistagens ocorreu logo após a região da rebentação das ondas (a aproximadamente 500 m da costa) que corresponde à isóbata de 5 m de profundidade. Um tempo de permanência de 20 dias na mesma enseada foi observado, entretanto a maioria dos grupos, parecem se deslocar entre as enseadas ao longo da costa durante a maior parte do tempo em que permanecem na região.

A maioria dos grupo observados foram pares de mãe e filhote (100 % em 1998 e 79.4 % em 1999), com algumas avistagens de adultos solitários em 1999. Durante a maior parte das avistagens, somente um grupo foi observado na mesma enseada. Apesar de dois, três e quatro grupos ao mesmo tempo terem sido registrados, interações entre dois ou mais grupos não foram observadas.

Os pares de mãe e filhote observados em 1998 passaram a maior parte do tempo em atividades de descanso, seguido por natação. A categoria de comportamento menos freqüentemente observada foi outras atividades. A atividade predominante realizada pelos adultos foi natação, seguido por descanso. Estes indivíduos não demonstraram padrões comportamentais incluídos na categoria outras atividades. Eventos de interação de pares de mãe e filhote com embarcações e redes de pesca artesanal foram observadas, sendo verificadas reações negativas durante estes eventos.

Fatores antropogênicos podem alterar o comportamento das baleias francas e afetar a recuperação da espécie. Frente às potenciais fontes de perturbação, estudos sobre distribuição e comportamento podem ser uma ferramenta valiosa para o manejo e conservação adequados das populações de baleias francas.

ABSTRACT

A study on the patterns of distribution and seasonal occupation, behavior and group composition of the southern right whales from August to October in 1998 and 1999 was conducted in the southern coast of the Santa Catarina State, Brazil. Whales were present in the study area in all months of observation, with a higher frequency of sightings in September in 1998 and August in 1999. An apparent preference by some bays along the study area was observed. Inside the bays, most of the sightings occurred right after the breaking waves region (~500 m off the coast) around the 5 m deep isobath. A residence period of 20 days in the same bay was observed but most of the groups seem to move between bays along the coastline during most of their permanency in the region.

Mother and calf pairs were the predominant groups observed (100 % in 1998 and 79,4 % in 1999), with some lone adults being sighted in 1999. During most of the sightings only one group was observed in the same bay. Although sightings of two, three and four groups were registered, interactions between two or more groups were never observed.

Mother and calf pairs observed in 1998 spent most of their time resting, followed by swimming and in 1999 swimming, followed by resting. Other activities was the less frequent behavioral category observed in both years. The most common activity of adults was swimming, and the second one was resting. These individuals did not show the behavioral patterns included in the other activity category. Interaction events of mother and calf pairs with boats and artisanal fishery were observed with negative reactions been verified during these events.

Anthropogenic factors can disrupt the quiescent behavior of right whales and affect the recovery of the species. Faced to the potential sources of harassment, distribution and behavioral studies can be a valuable tool for the management and conservation of the right whales' populations.

CAPÍTULO I

INTRODUÇÃO

1. Caracterização da Ordem Cetacea

Os cetáceos são mamíferos aquáticos que realizam todas as suas funções vitais na água, e para isso desenvolveram uma série de adaptações. O corpo é fusiforme, para facilitar a natação, não possuem membros posteriores (há apenas alguns ossos vestigiais internos), os membros anteriores são transformados em nadadeiras, reduzidos e desprovidos de dígitos externos, garras ou unhas, e são usados para direcionamento e estabilidade. Apresentam uma cauda orientada horizontalmente a qual é responsável pela propulsão, e a maioria possui uma nadadeira dorsal. Não possuem pelos nem glândulas sebáceas (com raras exceções), mas possuem uma grossa camada de gordura abaixo da pele, o que lhes permite a manutenção da temperatura corporal. O crânio é bastante modificado pela migração dorsal das narinas facilitando a respiração durante o movimento, e não têm ouvido externo, apenas duas pequenas aberturas laterais na cabeça. Como a maioria dos mamíferos, os cetáceos possuem uma redução no número de vértebras cervicais, que são fusionadas, mas em algumas espécies estão separadas, permitindo grande flexibilidade do pescoço. Os órgãos sexuais externos estão completamente escondidos em camadas musculares logo abaixo da pele, estando aparente apenas fendas (aberturas) genitais, bem como as fendas mamárias e o ânus (Vaughan, 1986; Evans, 1987; Klinowska, 1991).

2. Classificação

A ordem Cetacea inclui duas subordens atuais: Mysticeti, as chamadas “baleias de barbatanas”, que inclui cerca de 10 espécies agrupadas em quatro famílias; e Odontoceti, as baleias com dentes, a subordem mais importante em termos de abundância, diversidade de espécies e distribuição, incluindo cerca de 70 espécies de golfinhos, botos e baleias, agrupados em nove famílias (Klinowska, 1991).

2.1 - Subordem Odontoceti

Os representantes da subordem Odontoceti caracterizam-se principalmente por possuírem dentes (em algumas espécies somente na fase adulta), crânio assimétrico, uma abertura nasal externa, e presença de um melão o qual se constitui em uma protuberância côncava gordurosa localizada na região frontal da cabeça (Evans, 1987) . Inclui desde indivíduos grandes com cerca de 18m de comprimento, como os cachalotes (*Physeter macrocephalus*, Physeteridae), até os pequenos golfinhos e botos com menos de 2 m. Ocorrem em todos os oceanos e mares, bem como estuários, alguns rios e lagos. Possuem hábitos bastante variados, incluindo desde espécies que viajam a longas distâncias entre áreas de alimentação e reprodução, até espécies relativamente sedentárias. Podem viver em grandes grupos sociais, com centenas de indivíduos, em pequenos grupos ou ainda solitários. Algumas espécies podem passar a vida inteira no grupo social em que nasceram, ou mover-se de um grupo a outro, sem um padrão aparente (Evans, 1987).

2.2 - Subordem Mysticeti

A subordem Mysticeti agrupa a maioria das grandes baleias, que diferenciam-se dos odontocetos principalmente pela presença de barbatanas no lugar dos dentes na maxila superior, nome dado a séries de lâminas transversas feitas de

um material semelhante à queratina, usadas para filtrar o alimento (Evans, 1987). Seu principal alimento consiste de grandes cardumes de plancton, “krill” e pequenos peixes. Outra particularidade é o método de alimentação por engolfamento, permitido pela livre articulação da mandíbula na sínfise proporcionando uma grande expansão da cavidade bucal. Alimento e água são armazenados brevemente numa bolsa formada pela expansão dos sulcos ventrais característicos da maioria dos indivíduos deste grupo, e posteriormente a água é expulsa pela contração da bolsa, ficando o alimento preso nas barbatanas. Possuem duas aberturas nasais e crânio simétrico. Os menores representantes possuem cerca de 7 m de comprimento, como a baleia franca pigméia (*Caperea marginata*, Neobalaenidae), até o maior animal já existente no planeta, a baleia azul (*Balaenoptera musculus*, Balaenopteridae), que pode atingir até 33 m de comprimento (Klinowska, 1991).

Estes animais habitam todos os oceanos, e quase todos os representantes realizam longas migrações sazonais entre áreas de alimentação nos pólos, e áreas de reprodução nos trópicos. Vivem em pequenos grupos sociais, podendo reunir-se em grandes grupos nas áreas de alimentação. Frequentemente se comunicam através de sons, desde os mais simples até os mais complexos como os das baleias jubarte (*Megaptera novaeangliae*, Balaenopteridae), compostos por seqüências que podem durar cerca de meia hora ou mais. Este grupo de baleias junto com o cachalote, *Physeter macrocephalus*, foi o mais afetado durante a época da caça devido ao seu grande tamanho corporal e às barbatanas, carne e óleo (Evans, 1987).

2.2.1 - Gênero *Eubalaena* – Aspectos gerais

As baleias francas são do gênero *Eubalaena*, pertencem à família Balaenidae, subordem Mysticeti. As fêmeas são maiores que os machos e podem atingir 18 m de comprimento e pesar de 50 a 56 toneladas. Possuem o corpo preto com manchas brancas no ventre e no mento; calosidades de pele características na região da cabeça, ao redor do orifício respiratório e da boca, infestadas por ciamídeos, *Cyamus* sp., responsáveis pela coloração branca ou amarelada (Payne *et*

al., 1983); numerosos pelos na região do queixo e maxila superior; cabeça grande; orifícios respiratórios bastante separados, originando um vapor em forma de “V” quando da respiração; nadadeiras peitorais curtas e largas, com formato de trapézio e ausência de nadadeira dorsal (Evans, 1987). A maturidade sexual parece ser atingida aos 6 anos (Payne, 1986) e a idade da primeira reprodução em torno de 9 anos (Payne *et al.*, 1990; Hamilton *et al.*, 1998). O período de gestação é de 11-12 meses (Payne, 1986; Best, 1994; Burnell & Bryden, 1997), e as fêmeas têm, em média, um filhote a cada 3 anos (Best, 1990; Payne *et al.*, 1990; Bannister, 1990; Hamilton & Mayo, 1990). O desmame parece ocorrer após o primeiro ano de idade (Thomas & Taber, 1984; Hamilton *et al.*, 1998).

Os padrões de calosidades existentes na região da cabeça das baleias francas são exclusivos para cada indivíduo. Após os primeiros meses de vida dos filhotes permanecem, em sua maior parte, inalterados, permitindo identificação individual do gênero *Eubalaena* (Payne *et al.*, 1983; Kraus *et al.*, 1986) e o monitoramento dos indivíduos ao longo do tempo.

Devido à sua localização geográfica e padrões de migração sazonal que as isolam reprodutivamente, a maioria dos autores reconhecem duas espécies do gênero *Eubalaena*: *E. glacialis* e *E. australis* (Evans, 1987). Além disso, baseado em dados de análise de DNA mitocondrial, Schaeff *et al.* (1991) apresentam evidências de que as duas espécies são isoladas geneticamente. A baleia franca glacial, *E. glacialis*, é a forma encontrada no Hemisfério Norte, nos oceanos Pacífico e Atlântico; a baleia franca austral, *E. australis*, habita o Hemisfério Sul, em todos os oceanos (Evans, 1987).

2.2.2 – *Eubalaena australis*, no Brasil

O litoral sul do Brasil representa uma importante área de concentração reprodutiva das baleias francas austrais, *Eubalaena australis*. Durante os meses de maio a dezembro (com pico de julho a outubro), diversos indivíduos são avistados principalmente ao longo da costa de Santa Catarina (~ 26°00' - 28°25' S) (Palazzo & Flores, 1998a).

Desde o século XVII tem-se registro de atividades de caça à baleia

franca no litoral do Brasil, desde a Bahia até Santa Catarina (Palazzo & Flores, 1999). A partir de meados daquele século, estações baleeiras chamadas “Armações” começaram a ser instaladas em diversos pontos do litoral de Santa Catarina. A baleia franca era considerada a “baleia certa” para caçar por sua docilidade e vulnerabilidade. Por isso, era o principal alvo das atenções dos baleeiros que utilizavam a sua espessa camada de gordura para a extração de óleo empregado na iluminação, lubrificação e fabricação de argamassa para construções, bem como as barbatanas para a fabricação de espartilhos.

Não se sabe ao certo quantas baleias francas foram mortas no litoral sul durante o período de caça mas estima-se que centenas delas possam ter sido dizimadas (Palazzo & Flores, 1999). O último registro de caça da baleia franca no litoral do Brasil data de 1973 na cidade de Imbituba, SC. Após esta data, a população parecia ter sido eliminada na região, e relatos sobre a presença destes animais eram considerados casos isolados e não confirmados pela comunidade científica (Palazzo & Carter, 1983). Somente a partir da década de 80 foram reavistados no litoral sul do país os primeiros indivíduos após o término das atividades de caça. A proibição oficial da caça comercial de baleias no Brasil ocorreu em 1987.

Desde 1981 esta população de baleias francas vem sendo monitorada pelo Projeto Baleia Franca - International Wildlife Coalition / Brasil. Através de avistagens a partir de terra e censos aéreos, foi possível estabelecer uma área principal de concentração destes animais em Santa Catarina entre o Cabo de Santa Marta, Laguna (28°36' S, 48°49' W) e Florianópolis (27°25' S, 48°30' W) (Simões-Lopes *et al.*, 1988). Esta região caracteriza-se por possuir a costa bastante recortada, com inúmeras enseadas e pequenas baías, oferecendo às baleias francas alguma proteção contra os fortes ventos característicos dos meses de inverno (Palazzo & Flores, 1998a). Nesta área, a maioria das avistagens consiste de pares de mãe/filhote, que são observadas por vários dias na mesma enseada próximo à arrebentação, ou ao longo de alguns quilômetros durante semanas, movendo-se lentamente de uma enseada para outra. Considerando-se que nos primeiros meses (maio a julho) da “estação reprodutiva” a maioria dos indivíduos avistados são adultos solitários, e que a partir de agosto começam as avistagens de pares de fêmeas com filhotes, presume-se que os nascimentos ocorram nesta região (Palazzo & Flores, 1998a). Grupos de acasalamento têm sido mais freqüentemente observados no litoral norte do Rio

Grande do Sul (29°19' S, 49°43' W a 31°15' S, 50°54' W) (Moreno *et al.*, 1996), que caracteriza-se por uma longa praia de mar aberto. Nesta região, pares de mãe/filhote também já foram observados, porém movendo-se para o norte (Palazzo & Flores, 1998a). No litoral de Santa Catarina, as avistagens mais recentes de grupos de acasalamento ocorreram ao norte da Ilha de Santa Catarina em 1994 e próximo ao Cabo de Santa Marta em 1997 (Palazzo & Flores, 1998a). Conforme estes autores, parece haver áreas definidas separadas para grupos de acasalamento e grupos de mãe/filhote porém um estudo mais aprofundado deve ser realizado para assegurar esta hipótese.

O número de avistagens de baleias francas no litoral Sul do Brasil, bem como em algumas regiões do Sudeste e Nordeste vem aumentando ano a ano. (Engel *et al.*, 1997; Moreno *et al.* 1996; Palazzo & Flores, 1998a; Santos *et al.*, 1998). Porém, em sua maioria, são observações casuais e pontuais, muitas provenientes de encalhes. Palazzo *et al.* (1999) relatam dados sobre a única reavistagem de fêmea com filhote ao longo da costa brasileira.

3. Informações prévias sobre a baleia franca austral, *Eubalaena australis*

3.1 - Distribuição e uso de habitat

As baleias francas passam o verão nos pólos onde se alimentam, e migram para águas tropicais mais quentes durante o inverno para acasalamento e procriação (Evans, 1987). Apesar da maioria dos autores considerarem este padrão de migração como regra geral para os misticetos, evidências diretas só foram obtidas recentemente, através de reavistagens de indivíduos fotoidentificados em algumas áreas de reprodução, em áreas de alimentação (Best *et al.*, 1993; Bannister *et al.*, 1997; Bannister *et al.*, 1999; Moore *et al.*, 1999).

As principais áreas de concentração reprodutiva no Hemisfério Sul são: Península Valdés, Argentina; Ilhas Tristan da Cunha; costa Ocidental da África do Sul; Ilhas Falkland, Malvinas; Ilhas Auckland e Campbell, Nova Zelândia; Austrália (Klinowska, 1991; Evans, 1987).; litoral Sul de Santa Catarina, Brasil.

Áreas de alimentação conhecidas são as regiões próximas à Convergência Antártica (Goodall & Galeazzi, 1986) e no entorno das Ilhas Geórgias do Sul (Moore *et al.*, 1999).

As áreas de alimentação dos mysticetos estão associadas a áreas de alta produtividade primária, onde há grandes concentrações de zooplâncton (Clapham, 1999; Evans, 1987; Laws, 1985; Moses & Finn, 1997).

Nas áreas de reprodução a distribuição das baleias francas é freqüentemente relacionada a águas calmas e rasas. Evans (1987) sugere a manutenção de determinadas áreas de reprodução simplesmente por tradição, como um reflexo da história evolutiva dos mysticetos, e menciona a preferência por regiões com águas calmas bem como regiões que ofereçam proteção contra predadores como orcas (*Orcinus orca*) e tubarões. Clapham (1999) relata haver uma maior freqüência de baleias francas em águas rasas com fundo relativamente plano, e com temperaturas entre 10° e 14° C, na única área de concentração reprodutiva conhecida para as baleias francas do Atlântico Norte. Porém, não deixa claro a existência de uma relação entre estes fatores e a preferência por esta área, mas menciona a predominância de águas calmas na região como provável fator determinante.

Estudos de fotoidentificação a longo prazo realizados em várias áreas de concentração das baleias francas no Hemisfério Sul demonstram haver uma certa fidelidade às áreas de reprodução. Pares de fêmea e filhote tendem a retornar à mesma região a cada 3 anos, em geral no mesmo local ou em áreas adjacentes ao local do primeiro ano de avistagem. Já os adultos não acompanhados por filhotes são reavistados a intervalos variados podendo ser avistados em anos subsequentes, seguindo o mesmo padrão de fidelidade por área (Bannister, 1990; Payne, 1986; Payne *et al.*, 1990).

Payne (1986), Best (1990), Bannister (1990) e Burnell & Bryden (1997) mencionam haver preferência por determinadas áreas de agregação dentro das áreas de concentração reprodutiva, bem como uma separação entre áreas de concentração de fêmeas com filhotes e grupos de acasalamento, porém sem associação direta com nenhum tipo de fator ambiental. Em geral, as baleias francas são encontradas próximas da costa. Adultos não acompanhados de filhotes permanecem um pouco afastados da região das ondas (em locais com profundidades de até 60-80 m) e fêmeas com filhotes são avistadas logo após a arrebenção em

profundidades em torno de 10 m (Payne, 1986; Thomas, 1986; Best, 1990).

Não se sabe ao certo se os acasalamentos observados em determinada região resultam nos filhotes observados no ano seguinte (Payne, 1986). Porém, a concepção ocorre na mesma região onde as fêmeas são avistadas com seus filhotes (Burnell & Bryden, 1997; Best, 1990; Payne, 1986). As fêmeas grávidas se aproximam da costa alguns dias antes do nascimento dos filhotes, e permanecem com os recém-nascidos em torno de 11 semanas na mesma área de concentração; o tempo de permanência observado para adultos sem filhotes varia bastante, mas em geral, pelo menos em algumas regiões, permanecem próximos à costa durante menos tempo que fêmeas com filhotes (em torno de 6 semanas) (Bannister, 1990; Burnell & Bryden, 1997). Fêmeas com filhotes apresentam menos movimentação ao longo da costa do que outros indivíduos (Bannister, 1990; Best, 1990). O período de duração da estação reprodutiva é em torno de 5 meses (Payne, 1986; Best, 1994; Bannister, 1990; Burnell & Bryden, 1997), ao término do qual os pares de fêmeas com filhote iniciam a migração para as áreas de alimentação (Taber & Thomas, 1982).

3.2 – Organização Social e Aspectos Comportamentais

As francas são animais pouco gregários tanto em áreas de alimentação, quanto em áreas de reprodução (Evans, 1987). Animais solitários ou grupos de dois indivíduos são os mais frequentemente observados, podendo vários grupos estarem distribuídos em pequenas áreas de agregação (Bannister, 1990; Best, 1990; Patenaude, *et al.*, 1998; Payne, 1986).

Grupos de baleias francas podem ser compostos por indivíduos solitários, pares de mãe e filhote ou grupos de adultos (Cassini & Vila, 1990; Payne, 1986). Interações sociais entre grupos e/ou indivíduos são observados, podendo ocorrer até durante horas (Patenaude, *et al.*, 1998; Payne, 1986). Porém, raramente são observadas interações entre pares de mãe e filhote, mesmo estando próximos uns dos outros (Thomas, 1986).

Os comportamentos mais frequentemente observados em grupos de baleias francas são: 1) natação, deslocamento aparente e em velocidade constante; 2)

descanso, sem movimento aparente, com a parte dorsal da cabeça e corpo acima da água; 3) atividade sexual, grupos com presença de machos e fêmeas, e observação de macho com pênis estendido; e 4) brincadeiras, diversas atividades realizadas entre fêmeas e filhotes. Atividades individuais observadas incluem: exposição caudal, batida da nadadeira caudal, exposição peitoral, batida de nadadeira peitoral, exposição da cabeça, salto, exposição ventral (Cassini & Vila, 1990; Clark, 1983; Payne, 1986; Thomas & Taber, 1984). Em pequenos cetáceos, comportamentos semelhantes a estes aparentam ter função comunicativa, mas não se tem informação conclusiva sobre tal relação nos mysticetos. Cada comportamento pode ter diferentes funções em diferentes espécies ou diferentes circunstâncias (Pryor, 1986).

Experimentos realizados por Clark & Clark (1980), demonstraram que as baleias francas reconhecem os sons produzidos por indivíduos da mesma espécie e diferenciam estes de outros sons do ambiente. Clark (1983) correlaciona algumas atividades comportamentais exibidas pelas baleias francas e seu contexto social com o tipo de som produzido pelos grupos observados. Oito padrões sonoros são descritos e, embora não se saiba ao certo sua função comunicativa, sabe-se que os diferentes padrões estão relacionados a diferentes níveis de interação entre os indivíduos e entre estes e seu habitat.

4. Conservação

As populações de baleias francas foram alvo da exploração comercial no mundo inteiro até o início deste século. Estima-se que a população original, antes das atividades de caça, era em torno de 80.000 indivíduos (Klinowska, 1991) e atualmente esteja em torno de 7000 indivíduos (Palazzo e Flores, 1998b). Proteção internacional teve início em 1935, mas mesmo depois desta data, atividades de exploração ilegais tiveram continuidade em diversas regiões (Klinowska, 1991). Segundo Best (1988) a maioria das populações de baleias francas no Hemisfério Sul foram reduzidas a níveis extremamente baixos até metade da década de 30, e aparentemente não demonstraram recuperação até cerca de 40 anos atrás. A única exceção é a população que frequenta Tristan da Cunha. Esta população teria

escapado da atenção dos baleeiros no final do século 19 e início do século 20, período de maior atividade de caça comercial, demonstrando sinais de recuperação há cerca de 60 anos atrás.

A baleia franca glacial, *Eubalaena glacialis*, considerada a espécie mais ameaçada de extinção dentre os grandes cetáceos, não tem demonstrado sinais de recuperação desde o término das atividades de caça. Atualmente, a população de baleias francas que vive no Norte do Oceano Atlântico está reduzida a cerca de 300 indivíduos, e a taxa de crescimento populacional estimada em 1994 é de 0,97% ao ano, 0,02 % menor do que a estimada em 1980 (Caswell *et al.*, 1999).

No Hemisfério Sul, a proteção contra a caça em áreas de reprodução parece estar surtindo efeito na recuperação populacional da espécie. Na Argentina, onde a população total estimada em 1997 é de 2500 indivíduos, e na África do Sul, onde a população estimada está em torno de 3000 indivíduos, acredita-se que a taxa de crescimento populacional seja de 7,8 % ao ano (Palazzo & Flores, 1998b).

Na região das Ilhas Geórgias do Sul, área de alimentação das baleias francas no Hemisfério Sul, a espécie mais avistada em um levantamento de dados feito por Moore, *et al.* (1999) desde 1979 foi *Eubalaena australis* (n=68). A partir da reavistagem entre indivíduos fotoidentificados nesta região e em outras áreas do Atlântico Sul (e.g. Argentina e África do Sul) e da similaridade genética entre estas populações, Moore *et al.* (1999) sugerem a mesma taxa de crescimento populacional estimada para estas áreas de concentração para a população das Geórgias do Sul.

Apesar das populações do Hemisfério Sul apresentarem sinais de recuperação, ainda são consideradas vulneráveis. Segundo Palazzo & Flores (1998b) vários fatores de ameaça à recuperação tanto das populações do Hemisfério Sul quanto do Hemisfério Norte são indicados, como: condição nutricional dos indivíduos, poluição química, emalhamento em equipamentos de pesca, interações com embarcações (e.g. colisões com navios e distúrbios sonoros) e perda e degradação de habitat.

Clapham *et al.* (1999) sugere que dentre os vários fatores que potencialmente afetam os misticetos, emalhamento em equipamentos de pesca e colisões com navios são os mais significantes a nível populacional. Segundo Caswell *et al.* (1999), a única chance da população de baleias francas glaciais que vivem no Norte do Oceano Atlântico se tornar viável é reduzir o risco de mortalidade causado

por estes dois fatores. E estimam, ainda, que, sob as condições atuais, esta população estará extinta em 191 anos.

OBJETIVOS

Apesar de monitoradas desde 1981, até o presente momento poucas informações pertinentes a biologia populacional e padrões de distribuição das baleias francas austrais, *Eubalaena australis* ao longo da costa brasileira são conhecidas. Estudos mais detalhados e precisos tornam-se imprescindíveis para se assegurar a adequada conservação da espécie, conforme enfatizado na última “Reunião Especial do Comitê Científico da Comissão Internacional da Baleia - CIB para avaliação do status mundial das baleias francas” realizada em Cape Town, África do Sul (Palazzo & Flores, 1998b). Dentre as recomendações de atividades de pesquisa prioritárias relevantes para o Brasil, está a necessidade de “conduzir investigações atinentes à melhor definição das características dos habitats das baleias francas”, tornando-se imprescindível o mapeamento destes habitats, os padrões de ocupação sazonal, bem como a caracterização da população que os frequenta.

Considerando-se as lacunas existentes no que diz respeito à biologia das baleias francas no sul do Brasil, e às atividades de pesquisa recomendadas, o presente trabalho tem os seguintes objetivos em relação a *Eubalaena australis*:

- a)** Determinar a distribuição espacial da espécie na área de estudo;
- b)** Analisar e determinar os padrões de ocupação sazonal;
- c)** Verificar a composição e a frequência dos grupos de baleia franca no sul do Brasil.
- d)** Determinar preliminarmente os padrões de comportamento entre os pares de mãe e filhote de baleia franca no sul do Brasil.

SÍNTESE DOS RESULTADOS

De agosto a outubro de 1998 e 1999, foram realizadas 353,5 horas de esforço amostral e 51,2 horas (14,5 %) de observações diretas (tempo despendido na presença de baleias), durante 83 dias, no litoral sul do Estado de Santa Catarina. Em cada ponto de observação (Apêndice 1) uma média de 18,7 dias (S.D. 2,74 dias) de observação foram realizados. Dos 81 grupos observados (incluindo contagens duplas), 91,1 % eram fêmeas com filhotes, e 8,9 % eram outros indivíduos.

As baleias estavam presentes na área de estudo em todos os meses de observação durante os dois anos de amostragem. O mês com o maior número de grupos avistados em 1998 foi setembro ($n = 16$), e em 1999 foi agosto ($n = 24$). Em ambos os anos, outubro foi o mês com o menor número de avistagens ($n = 3$ em 1998 e $n = 4$ em 1999). Com exceção de Laguna, onde 81% dos grupos avistados nos dois anos de observação estavam localizados na metade Sul da praia, em todos os outros pontos de observação onde ocorreu mais de uma avistagem, estas apresentaram distribuição homogênea por toda a enseada.

A distância da costa em que os grupos foram avistados, estimada a partir da plotagem das avistagens nas cartas náuticas (Apêndice 2), variou de ~100 m (região logo após à arrebentação) a 1500 m nos dois anos de observação, com uma maior frequência de avistagens no intervalo de até ~500 m da costa (73,8 %). A maioria das avistagens (61,4 %) ocorreu nas proximidades da região que corresponde à isóbata de 5 m de profundidade, 36,1 % das avistagens na isóbata de 10 m e 2,4 % na de 20 m.

Todos os grupos observados em 1998 eram fêmeas com filhote, e em 1999 84,8% dos grupos observados eram fêmeas com filhote e 15,2% eram adultos solitários.

Em 70,8% das avistagens realizadas em 1998 e 79,4% em 1999, apenas um grupo de baleias francas estava presente em um mesmo ponto de observação durante cada período de amostragem, e um número máximo de quatro grupos foram avistados simultaneamente. Não foram observadas interações entre dois ou mais grupos observados na mesma enseada.

Em 1998 a atividade predominante dos pares de mãe e filhote foi

descanso, seguido por natação e outras atividades. Em 1999, os pares de mãe e filhote passaram mais tempo nadando, seguido de descanso e outras atividades, e a atividade mais comum observada nos adultos foi natação, seguida por outras atividades, não tendo sido observado períodos de descanso nesta categoria.

As principais atividades individuais realizadas por mães e filhotes nos dois anos de observação, incluídas na categoria *brincadeiras*, foram: saltos, exposição de cabeça, exposição de cauda e batida de cauda (Apêndice 3). Atividades que incluíam contato físico entre mãe e filhote foram: filhote no dorso da mãe, filhote no ventre da mãe (esta com o ventre exposto fora da água) e batidas de cauda do filhote em cima do pedúnculo caudal da mãe. A distância máxima observada entre mãe e filhote em todos os pares observados foi $\frac{1}{2} WL$ em 88,6 % do tempo de observação em 1998 e 81,6 % em 1999.

Em duas ocasiões foram registradas interações de fêmeas com filhote com embarcações, e em outras duas foram observadas interações com redes de pesca artesanal.

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CAPÍTULO II

**PREFERENTIAL USE OF CONCENTRATION AREAS BY
SOUTHERN RIGHT WHALES, *EUBALAENA AUSTRALIS*,
IN THE SOUTHERN BRAZILIAN COAST**

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* Este artigo será submetido à publicação na Revista “Marine Mammal Science”, da “Society for Marine Mammalogy”.

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ABSTRACT

From August to October in 1998 and 1999, observations on the distribution, behavior and group composition of right whales in the southern coast of the Santa Catarina State, Brazil, were made. Whales were present in the study area in all months of observation, with a higher frequency of sightings in September in 1998 and August in 1999. An apparent preference by some bays along the study area was observed. Inside the bays, most of the sightings occurred right after the breaking waves region (~500 m off the coast), around the 5 m depth isobath. Groups can stay as well as 20 days in the same bay, but seem to move between bays during most of their residence period in the region.

The majority of the groups observed were mother and calf pairs (100 % in 1998 and 79,4 % in 1999), with some sightings of lone adults in 1999. During most of the sightings only one group was observed in the same bay. The predominant activity of the mother and calf pairs observed in 1998 was resting and in 1999 was swimming. Adults spent most of their time swimming. Interactions events of mother and calf pairs with boats and artisanal fishery were observed with negative reactions been verified.

Key words: *Eubalaena australis*, right whales, Brazil, distribution, seasonal occupation, preference by area, behavior.

INTRODUCTION

Southern right whale, *Eubalaena australis*, populations were severely depleted by commercial whaling until early in this century. Even after international protection in 1935, whaling activities had continued in some regions (Klinowska 1991). The southern hemisphere populations did not show signals of recovery until 30 to 40 years ago (Whitehead *et al.* 1986, Bannister 1990, Best 1990), apart from the Tristan da Cunha population (Best 1988) that escaped the pressures of commercial whaling in the end of the 19th century and the beginning of the 20th, and showed the first signals of recovery 60 years ago.

In Brazil, whaling activities targeting the species ceased only in 1973, when the population seemed to be extirpated from the region (Palazzo and Carter 1983). Only by the early 1980s the first individuals seen after the end of the whaling activities were 'rediscovered' along the Southern Brazilian coast (Palazzo and Flores 1999). Legal protection of cetaceans in Brazilian waters against commercial whaling was established from 1987 onwards.

Right whales spend summer and autumn months in feeding areas in high latitudes, and migrate to breeding areas in lower latitudes during winter and spring. In the breeding areas, right whales approach the coast to mate, give birth and nurse their calves. In the main breeding concentration areas of the species in the Southern hemisphere (e.g. Argentina, Australia and South Africa), there seem to occur greater preference towards some areas of the coast, as well as differentiated aggregation areas for mating and mother-calf groups (Payne 1986, Bannister 1990, Best 1990, Burnell in press).

The Southern Brazilian coast is an important breeding concentration area of Southern right whales from May to December. Opportunistic sightings since 1981 indicate to occur, apparently, a geographical segregation of mating groups and mother-calf pairs in this region (Palazzo and Flores, 1998a, 1999), though no systematic study on this matter was conducted until the present.

In this work data obtained from systematic observations on the distribution and patterns of seasonal occupation, group composition and behavior of the right whales in the Southern coast of Santa Catarina State, Brazil is presented.

MATERIALS AND METHODS

From August to October of 1998 and 1999, 353.5 hours of sampling effort, during 83 days, were undertaken in the southern coast of Santa Catarina State (27°52'43 S 48°34'33 W e 28°28'08 S 48°46'03 W), Brazil. This is the main breeding concentration area of right whales in Southern Brazil and the months chosen are of the highest frequency of sightings recorded in the region (Palazzo and Flores, 1999).

The study area is characterized by a number of embayments and small bays, due to the morphology of the Brazilian coastal Mountain Ridge. The bays have a maximum of 13 km in length, and most of them have coastal cliffs (at least in some section of the bay) and a sandy beach; some of it have high sand dunes in most of their extension. The observations were carried out from strategic points between 20 to 90 m above sea level, depending on the bay, allowing for a wide view of the study areas.

Ten observation points were chosen along the study area (Fig. 1). In each point, two observations by week in alternated turns, each with one hour of duration were made. The sampling timetable was systematically organized, in order to make the same observation period in each chosen point, in regular intervals, following the same geographic sequence, to optimize the validity of the conclusions.

In each observation point the date, time of the observation and environmental data (wind speed and direction, cloud cover, precipitation and Beaufort Sea State) were recorded. For each group sighted the following was recorded: time of sighting, number of individuals, group composition (adult, subadult or mother with calf), position of sighting (registered in detailed nautical charts in relation to buildings and distinct geographic features along the coast) and behavior. Except for two observation points (Silveira and Laguna), where the location of the observer was in the middle of the bay, in all others the observations were made from one edge of the bay. This permitted a triangulation of the position of individuals. The observations were made using 10 x 50 mm binoculars and a 22 x 60 mm scope, depending on the range of the individuals. Individual identification through the callosity patterns and other distinct body marks (Payne *et. al.* 1983), using a standard graphic card and/or photography, were made whenever possible. The photographs

were taken using a 35 mm camera with 80-300 mm lenses and 200 ISO colour print film.

The individuals observed were considered a group when two or more whales were seen in close proximity of one another, (no more than one whale length “WL” – the approximated length of an adult, used as reference for the distance between individuals) (Taber and Thomas 1982, Clark 1983). Groups were separated into two categories: mothers and calves (groups containing mothers with their calves) and adults (groups containing only adults or subadults, without calves) (Taber and Thomas 1982).

The Mann-Whitney *U* test was used to verify the difference in the distribution of the groups sighted in each observation point, between the two years of sampling.

For the register of the behavior of the groups the *Ad libitum* sampling method (Altmann, 1974) was used. The behavior was separated into three categories: swimming (directional forward movement in constant speed, that resulted in a change of location), resting (individuals remain motionless without any evidence of physical exertion, in general with the dorsal surface of the head and body above the water), other activity (activity not directly related to any of the above categories) (adapted of Clark 1983, Cassini and Vila 1990).

RESULTS

During 1998 and 1999, a mean of 18.7 days (S.D. 2.74 days) of observations in each observation point were made. Of the 353.5 hours of sampling effort, 51.2 hours of direct observations (time spent in the presence of whales) and 81 sightings (including double counting) were obtained. From the total, 91.1 % of the groups observed were mother and calves and 8.9 % were other individuals.

In 1998 18.52 hours of direct observations (11.8 % of the total sampling effort in this year) and 35 sightings (including double counting) were made, and in 1999 32.7 hours of direct observations (16.6 % of the total) and 46 sightings (including double counting) were obtained.

Distribution

The whales were present in the study area in all months of observation during the two sampling years. Figure 2 shows the distribution of sightings in each month during 1998 and 1999. Most of the sightings in 1998 occurred in September (n=16) and in 1999 was in August (n=24). In both years, October had the lower number of sightings (n=3 in 1998 and n=4 in 1999).

The sighting frequencies of the groups in each of the ten observation points, during the two years of sampling, are represented in Figure 3. In 1998 (Fig. 3a) the higher frequency of sightings was in Laguna, followed by Ribanceira and Ibiraquera. The lesser frequencies were observed in Imbituba, Rosa, Gamboa and Pinheira, and there were no sightings in Siriú, Garopaba and Silveira in this year. In 1999 (Fig. 3b) the Silveira bay had the higher frequency of sightings, with the second most used being Ribanceira, Imbituba and Rosa. In this year, Laguna, Ibiraquera, Siriú and Garopaba had the lesser frequencies, without sightings in Pinheira and Gamboa. The pattern of distribution of sightings between the two years of observation was not significantly different (Mann-Whitney *U*-Test, $U = 23$, $P > 0,05$).

Only one observation point showed an apparent preference by area inside the bay. In Laguna, 81 % of the groups, in both years of observation, were sighted in the southern half section of the bay (Fig. 3). In all other observation points with occurrence of more than one sighting, these had uniform distribution over the entire bay.

The distance of the coast at which groups were sighted, estimated through the plotting of sightings in the nautical charts, ranged from ~100 m (the region after the brake waves) to ~1500 m both in 1998 and 1999. To the analysis of the data, the sightings were grouped into three 500 m distance intervals. Most of the sightings occurred within the first 500 m off the coast (73.8 %), decreasing sharply at the two consecutive intervals (17.9 % between 500 and 1000 m, and 8.3 % between 1000 and 1500 m).

The plotting of the data in the nautical charts still permitted an estimation of the water depth at the location of the sightings. Three categories were considered according to the proximity to the 5, 10 and 20 m isobaths in the nautical charts. From

the totality of the groups sighted during the two years of observation, 61.4 % were sighted near the 5 m isobath, 36.1 % near the 10 m and 2.4 % at the 20 m isobath. The 5 m isobath corresponds to the breaking waves region, and the high frequency of sightings registered show a clear preference by this depth.

Excepting two mother and calf pairs sighted in August, one at Pinheira bay and the other at Laguna, any other group sighted in 1998 was photoidentified. In 1999, six mother and calf pairs were photoidentified and two of them resighted in other occasions. One of these two groups shown a coastal residence period of at least 20 days in the same observation point, the Silveira bay. The other one was sighted five times during 26 days at four different observation points. The minimum distance travelled by this group, according to the location and date of sightings, was 70 km.

Group structure and behavior

Figure 4 presents the composition and frequency of the groups sighted during the two sampling years. All of the groups observed in 1998 were mother and calf pairs, but the sightings of two adults were not considered in this analysis of the results due to the non-confirmation of the calf's presence. In 1999, 84.8 % of the groups observed were mother and calf pairs, and 15.2 % were lone adults.

In 70.8 % of the sightings in 1998 and 79.4 in 1999, only one right whale group was present in the same observation point during each sampling period. Two, three and four groups present simultaneously in the same bay was observed, but with a lesser frequency (Fig. 5).

No interaction between groups, when there was more than one group in the same bay, was observed both in 1998 and 1999, neither between different mother and calf pairs nor between these groups and lone adults and between adults. Even in the three times that two mother and calf pairs were observed passing one by another, interactions were not observed.

The mean probability of occurrence for each behavioral category during the observation of the groups is represented in Figure 6. In 1998, the predominant activity of mother and calf pairs was resting, followed by swimming and other activities. In 1999, mother and calf pairs spent most of their time swimming, and less time resting and in other activities. The most common activity observed in the adults

was swimming, followed by other activities. Resting behavior was not observed in this group category. In any moment during the two years of observation, indications of feeding behavior (when the whale is observed swimming at the surface with an opened mouth) were observed.

In two occasions during this study, interactions between mothers and calves and boats, were recorded, both in the vicinity of the Imbituba harbor. In the first event, one mother and calf pair was resting at the entrance of the harbor bay, when a harbor tug that was leaving the bay, approached the group. The group suddenly submerged and began to swim towards the open sea, far from the boat. The second event occurred during the approach of a small fishing boat that was navigating in a constant speed in the direction of a mother and calf pair which was swimming fast towards the North. When the boat approached the group, the animals submerged, emerging 3 minutes after the passing of the boat above them, when the boat was already far from the group. After this event, the group returned to their previous activity.

Interactions with the artisanal fishery were also observed. In one occasion a mother was observed with a piece of net on her head (leashed on the callosities of the bonnet). In the other, a mother and calf pair that were playing at the Southern edge of Ribanceira bay were observed pulling a gillnet floater during some minutes, then rapidly swimming offshore.

Environmental factors

The most frequently values for the Sea State during the sightings in 1998 were one and two, varying from one to five. In 1999 was two, ranging from two to six. The mean wind speed during the observations in 1998 was 14.7 ± 10.57 km/h and 9.9 ± 9.5 km/h in 1999. The predominant wind directions during the sighting periods in both years were South and Northeast.

DISCUSSION

Distribution

The distribution of the frequencies of sightings obtained during 1998 and 1999 show a higher concentration of sightings during August and September, and a sharp decrease in October. Although the peak of sightings in this region is considered to occur in July and October (Palazzo and Flores 1998a), October did not show the expected great number of sightings. July, that has yielded many sightings in previous years, and June, November and December with sporadic sightings, were not included in this study.

From personal observations and information of local residents during the two years of sampling, some sightings in the study area in June, July and November in 1998 and July and November in 1999 were recorded, though most of them were not confirmed. The results obtained in this study maintain that August and September are the months with the peak of sightings of right whales in this region.

In both years of sampling, sightings concentrated in the six Southern observation points. Due to the small number of groups photoidentified, it was not possible to establish the total number of right whales sighted in this region during the two years of observation. However, during aerial censuses (unpublished data), the maximum number of groups sighted in one day was 12 in 1998 and seven in 1999. The frequency of sightings obtained during the present study can represent the coastal residence periods of the groups in each bay. For example, the number of sightings of one of the groups photoidentified at Silveira bay in 1999 corresponds to 40 % of the total of sightings in this observation point. Thus, the distribution of the frequencies of right whale sightings in the region can indicate a preference by the observed areas with the higher frequencies (e.g. Silveira, Rosa, Ibiraquera, Ribanceira, Imbituba and Laguna).

In this study, no direct evidence on the preference by right whales of some of the observed areas was detected. Best (1990) reports the association between concentration areas and specific bays in South Africa, but does not attribute such association to any particular factor. According to Payne (1986), right whale groups at Península Valdés do not stay in the same place, but move along sections of the coast 30 to 40 km in length, apparently with no relation to natural features such as water temperature or food abundance. This is observed in some feeding areas of the northern right whales (*Eubalaena glacialis*) in the Northern Hemisphere (Moses and Finn 1997, Clapham 1999).

Feeding abundance estimates in this concentration area were not made until the present, and detailed data on water temperature in the region are not available, but the lack of observations indicating feeding activity during this study, and the apparent lack of great concentrations of the prey-species, does not allow to the conclusion of any relation between these aspects and the distribution in this region.

The physical features of some bays and the boat traffic in others can influence the distribution of the groups in the region. The Pinheira bay, with only one sighting (1.2 %) during the two years of observation, though being the bay which is most protected against the characteristic strong winds in the region included in this study, is an enclosed bay, has lots of sandbanks in its entrance and intensive traffic of small fishing boats. The same occurs at Garopaba bay, though this is a much wider bay. Gamboa and Siriú, with 1.2 % and 3.6 % of sightings, respectively, are more opened bays, and do not offer protection against the predominant winds in the region. The preference by area observed in Laguna could be related to the presence of a breakwater in the Southern edge of the bay, witch offers protection against the Southern winds. However, in only 21.4 % of the sightings in this section of the bay the predominant direction of the wind was South.

Although being a bay with traffic of large ships (mean length = 163.1 ± 4.7 m²) besides small fishing boats, the harbor Bay where the Imbituba harbor is located, had 9.6 % of the total sightings. The average ship traffic in the harbor during the observation period both in 1998 and 1999 was $16 \pm 2,8$ 'entering' and 'exiting' by month. These numbers are relatively low, when compared to other ports in Southern Brazil and ship collisions with right whales were never recorded in this region, but some deaths of right whales caused by ship collisions were documented in the nearby area of the Rio Grande Port, at Rio Grande do Sul State (Palazzo and Flores 1999). This is one of the principal threats for the recovery of the northern right whales in the North Atlantic (Caswell *et al.* 1999, Knowlton *et al.* 1997). Despite the numbers of these incidents observed here being so far from those recorded in the North Atlantic, the presence of four other ports, besides the Imbituba one, in the vicinity of the breeding concentration area of right whales in Southern

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Brazil and the probable growth showed by this population (Palazzo and Flores, 1998b), leads the ship traffic in the region be considered a potential threat.

Payne (1986) and Best (1990) reported the preference showed by mother and calf pairs by regions with waters with 5 m in deep at Península Valdés and South Africa, and few sightings at depths greater than 15 m. They also reported a preference by areas near the coast, right after the breaking waves. The same pattern of distribution seems to occur here for both the depth preference and the distance from shore.

The movement pattern presented by one of the groups identified in 1999 is probably the same as most of the right whales in this region. Other groups were not resighted but, analyzing separately the days of observation in each observation point (and considering that in only 50 % of locations the observations were made in consecutive days) in 43.6 % of subsequent observations to sightings, other sightings did occur. The hypothesis of the permanence in the same bay for some periods (which was observed in 1999 also) cannot be rejected, but some degree of movement between the bays in the region may occur. Similar patterns of movement were previously reported here twice (unpublished data) as well in other breeding concentration areas in the Southern Hemisphere (Payne 1986, Bannister 1990, Burnell in press).

Despite the evidences in some regions, it was not clear which features lead right whales to prefer certain aggregation sites inside breeding concentration areas. For example, even regions with heavy ship traffic, which is a potential threat to the survival of the individuals, are repeatedly visited by groups of right whales. According to Rowntree *et al.* (in press), right whales can be flexible in their choice of habitat, both on large scale (individuals photoidentified in different concentration areas in different years) and small scale (movements of individuals between different aggregation areas inside concentration areas). This flexibility have perhaps played a fundamental role in the species survival against coastal whaling impacts.

Structure and behavior of the groups

Despite some restrictions concerning the use of the *Ad libitum* sampling method (Altmann, 1974), it was considered appropriated to the study area, based on previous observations on the behavior of the right whales in this region, and on the number of groups sighted simultaneously in the same bay (one or two, in general, like observed in this study) (Palazzo Jr.³, pers. comm.).

The greater frequency of sightings of mother and calf pairs and the absence of sightings of mating groups during this study corroborate the status of this region as a nursery area. Mating groups are also observed in Southern Brazil (Palazzo and Flores 1998a) but sightings concentrate in adjacent areas North and South of the study area. The presence of only one group in each bay in most of the observations indicate mother and calf pairs segregation in this concentration area.

According to Watkins (1986) adverse reactions to human activities that change the behavior of the whales are classified as negative (*N*) reactions. In three of the four occasions in which the behavior of right whale groups in relation to human activities was observed, the reaction was *N*. Entanglement in fishing gear such as the observed here are common in the region, but today there is only one record of death of a right whale due to entanglement in fishing gear (Palazzo and Flores, 1999).

The first four months of lactation are an important period for the calves grow and development, as well as the energy conservation for the mother and calf pairs before the migration to feeding areas (Thomas and Taber, 1984). According to the size of the calves observed in relation to their mothers' length and according to Palazzo and Flores (1998a), the months with sightings of these groups in the study area are the first months of the calves' lives. Anthropogenic factors like these observed here can disrupt the behavior of the groups and compromise the success of their migration to feeding areas.

Best (1990) and Rowntree *et al.* (in press) reported changes in the patterns of distribution of right whale groups in South Africa and Península Valdés, along 20 years of research in these regions. Rowntree *et al.* (in press) attribute as possible causes for the changes to some factors such as kelp gull (*Larus dominicanus*) harassment and the increase of boat traffic due to the growing whale-watching industry. However, such relation was not confirmed.

³ Comunicação pessoal de José T. Palazzo Jr., Projeto Baleia Franca, IWC/Brasil, Caixa Postal 5087,

Only one case of kelp gull harassment in this study area was reported until the present (Groch and Palazzo in prep.) and, though the local whale-watching industry is still not established in great scale, with only one authorized boat operating in the region, this concentration area has a great potential for the development of this activity.

The results obtained in this work are not conclusive but patterns of distribution of the individuals in this region, as well as the structure and behavior of the groups are presented. The continuity of such studies in a long-term basis will contribute to assert the adequate conservation measures for the species in the region.

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**PRELIMINARY OBSERVATIONS ON THE MOTHER-CALF
BEHAVIOR OF THE SOUTHERN RIGHT WHALES, *EUBALAENA
AUSTRALIS*, IN THE SOUTHERN BRAZILIAN COAST**

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Page Headings: Mother-calf behavior in right whales

Key words: *Eubalaena australis*, Brazil, mother-calf behavior, management

* Este artigo será submetido à publicação na Revista “Journal of Zoology, London”, da “Zoological Society of London”.

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Abstract

Preliminary observations on the mother-calf behavior of right whales were conducted from August to October in 1998 and 1999, in the southern coast of the Santa Catarina State, Brazil. Mother-calf pairs spent most of their time resting and swimming near the coast, in close proximity of one another. Individual activities like breach, head up, belly up, tail up and tail slap on the water, as well as activities involving physical contact between mothers and calves were observed, though less frequently. Two stages of calves' development were recognized. The predominant number of mother-calf pairs observed in the same bay was one and interactions between two or more groups were never observed.

Studies on the behavioral patterns can be a valuable management tool in light to potential sources of harassment of right whale populations. Anthropogenic factors can disrupt the quiescent behavior of right whales, and affect the recovery of the species.

Introduction

The Southern Brazilian coast is an important breeding concentration area of southern right whales, *Eubalaena australis*. During the winter and spring, right whales approach the coast and use shallow and protected waters to mate, give birth and nurse their calves. Most of the groups observed in this region are mother-calf pairs (Groch & Freitas, in prep), with a few sightings of lone adults and mating groups (Palazzo & Flores, 1998a).

Even after being monitored since 1981, when the first individuals began to be observed after 10 years of disappearance due to commercial whaling in the region (Palazzo & Flores, 1999), little is known of the behavioral biology of the Southern right whales off the southern Brazilian coast. At this moment, a defined concentration area of mother-calf pairs is recognized in the Southern coast of Santa Catarina State (27°52' S 48°34' W - 28°28' S 48°46' W) (Palazzo & Flores, 1999). According to these authors, calves are probably born in this region, and are seen the whole time accompanied by their mothers.

Taber & Thomas (1982) and Thomas & Taber (1984) made a detailed study on the behavior of mother-calf pairs at Península Valdés, Argentina. In these studies, the authors describe stages of calf development since birth until the pre-migratory period to feeding areas; mother and calf relationship; and behavioral patterns. Interactions between mother and calf groups were rarely seen, but when it occurred it was often very active. According to Cassini & Vila (1990), the mother-calf pairs observed at Península Valdés may not socialize with other groups, and meeting with other pairs was probably a mere consequence of their constancy in a near-shore area.

Behavioral studies of right whales are valuable management tools in the light of the potential threats for the recovery of this species. Anthropogenic factors like ship noise can cause negative reactions on the individuals and disrupt their normal behavior. According to Pryor (1986), behavioral displays of cetaceans like breaching and tail slapping on the water can communicate internal states such as fear, aggressiveness and annoyance, and can be important tools on the management of cetaceans.

In this work, preliminary observations on the behavior of mother-calf

pairs of Southern right whales along the Southern coast of Santa Catarina State, Brazil are reported.

Materials and Methods

From August to October of 1998 and 1999, 90.5 hours of observations of mother-calf pairs and 73 sightings (including double countings) were undertaken in the breeding concentration area of right whales in the southern coast of Santa Catarina State (27°52'43 S 48°34'33 W e 28°28'08 S 48°46'03 W), Brazil (Fig. 1). This region is characterized by many headlands due to the morphology of the Brazilian coastal Mountain Ridge, with a number of embayments and small bays. Most of this have at least one high hillside location witch provides a good lookout of the area, and a sandy beach. The observations were made from 10 such strategic points along the coast, at a height of between 20 to 90 m above sea level, as part of a systematic study on the distribution and patterns of seasonal occupation of the right whales in this region (Groch & Freitas, in prep.).

With respect to each mother-calf pair sighted, time and location of the sighting (position registered on detailed nautical charts, in relation to buildings and distinct geographic features of the coast), and behavioral patterns and movements were recorded. The maximum sampling period for each sighting was one hour, due to the methodology applied in the distribution study (Groch & Freitas, in prep.). For the observations, 10 x 50 mm binoculars and a 22 x 60 scope were used. Whenever possible, individual identification through the callosity patterns and distinct body marks (Payne *et al.* 1983) were made, using a standard graphic card and/or photography. For the photographs a 35 mm camera, with 80-300 mm lenses and 200 ISO color print film was used.

The behavior of the mother-calf pair observed in each bay was registered using the *Ad libitum* sampling method (Altmann, 1974), and classified into three categories: swimming (directional forward movement that resulted in a change of location), resting (individuals remain motionless without any evidence of physical exertion, in general with the dorsal surface of the head and body above the water),

playing (activity not directly related to any of the above categories) (adapted from Clark, 1983; Thomas & Taber, 1984; Cassini & Vila, 1990). When observed, any indication of nursing behavior, according to the description of Thomas & Taber (1984), was registered.

To verify the level of interaction between calves and their mothers, the maximum distance between the individuals was recorded, and classified into three categories in increments of their mothers' lengths (adapted from Taber & Thomas, 1982): (1) when the distance was not outside $\frac{1}{2}$ whale length (WL), (2) within $\frac{1}{2}$ and 1 WL, and (3) outside 1 WL.

Results

The observation periods of a single mother-calf pair ranged from 10 to 60 min. The predominant activity of the mother-calf pairs observed in 1998 was resting (Fig. 2a). The second most common mother activity was swimming followed by playing. Playing was the second most common activity of the calves and swimming was the less frequent. In 1999, the predominant activity of both mothers and calves was swimming, followed by resting and playing (Fig. 2b). Direct evidence of nursing was not observed, but the most frequent behavior of the calves during nursing periods was observed in three times, one in 1998 and two in 1999.

The main individual activities showed by both mothers and calves in the two years of observation, including the playing category, were: breach, head up, tail up and tail slap on the water. When the calves were engaged in such activities, the mothers stayed resting and, most of the times, begun to swim, which resulted in the calf moving in parallel to the mother and travelling beside her. A number of consecutive breaching and tail slapping of the calves were observed many times. An activity observed only in mothers was belly up (in general with the two pectoral flippers out of the water). Some activities that included physical contact between mother and calf were observed, such as: the mother with the belly up and the calf being held on the mother's belly, between her pectoral flippers, and on the mother's back at the surface; the calf transversal to its mother's head, being pushed during

some minutes; several calves' head slapping onto the dorsal surface of the head and the caudal peduncle of the mother.

In 1998, two mother-calf pairs were photoidentified and one of them resighted in two other days. In 1999, six mother-calf pairs were photoidentified, two of them resighted in further occasions. The mean elapsed time between the first and last sightings of these pairs was 17.3 ± 2.5 days. Despite the small number of photoidentified and resighted individuals, and the length of time they were accompanied, two stages of calf development were observed in these pairs. Stage one, newborn travel stage, in which the calf spend most of his time swimming in close proximity to the mother, stage two, calf play stage, in witch the calf begun to play around the mother, alternating periods of resting and nursing, with less periods of swimming.

The maximum distance observed between all mother-calf pairs observed was $\frac{1}{2}$ WL in 88.6 % of the observation period in 1998 and 81.6 % in 1999. This distance fits the "stage two" of the calves' development.

Behavioral patterns of the "stage three" (pre-migratory stage) of the calf development were observed in some pairs. This stage is characterized by a decrease in playing and an increase in travelling in close contact with the mother. The occurrence of this stage was registered in late October, which coincide with the last weeks spent by the pairs in the region before the migration to the feeding areas.

During most of the observations (76.8 %) only one mother-calf pair was sighted in the same bay, and in any occasion more than three pairs were observed. Sightings of two pairs occurred in 14.3 % of the times and three in 8.9 %. In one occasion, one lonely adult was sighted in the same bay at the same time of three mother-calf pairs, and other two were sighted with two mother-calf pairs. Interactions between individuals present in the same bay (excluding the interactions between mother and calf), even when two groups passed one by another during a change of location inside the bay, were never observed. Excepting these occasions, a minimum distance of around 6 WL between the groups, during all of observation period, was kept.

Discussion

According to Taber & Thomas (1982) the first months of lactation are of great importance for the calves' growth and development. During the period spent in the breeding areas, females probably do not feed and channel most of their energy bearing and nursing their calves. In this period, calves have to develop motor skills, improve the level of competency in swimming, learn how to protect themselves and keep close to their mothers, essential tasks to the survival during migration to the feeding areas.

The predominance of the resting periods observed in 1998, both in the mothers and calves, fits the need for energy conservation by right whales in the breeding areas, but this was not observed in 1999. According to Taber & Thomas (1982), swimming, like observed in 1999, is the predominant activity of mothers with newborn calves, and during the period before migration. However, none of the mother-calf pairs were observed during all stages of development described by these authors, thus it was not possible to verify such statements. Since most of the births take place in August in many breeding areas of right whales in the Southern Hemisphere (Best, 1994; Burnell & Bryden, 1997; Taber & Thomas, 1982), including in Santa Catarina State, (Palazzo & Flores, 1998a), and that migration to feeding areas seems to begin in November (Taber & Thomas, 1982; Thomas, 1986), swimming could be the most frequent behavior during August and late October. But no evidence was found on the predominance of this behavioral pattern nor in the comparison of the behavior between the three sampling months of all groups observed.

The occurrence of the behaviors classified as playing by the calves can represent the learning and development of motor skill periods. However, in the attempts of energy conservation by the calves (since their nourishment during this period comes entirely from the mother), mothers often discourage calves' play by beginning to swim, leading the calf to move in parallel to the mother and travelling beside her (Taber & Thomas, 1982). This behavior was observed in the study area in some occasions.

According to Payne (1995) and Thomas & Taber (1984), mothers can interrupt nursing periods by beginning fast swim or suddenly submerging, or can avoid it in several ways like rolling belly-up so that their nipples stay out of the calf's reach. When mothers do this, calves may annoy them for hours, for example slapping their heads on the mothers' backs or slapping its tail on the water several times. If the bothering goes on too long, the mother can roll onto her back, holding the calf stranded on her belly between her pectoral flippers until it is calmed down. The small frequency of nursing bouts observed during this work is probably due to the short period of continuous observation for each mother-calf pair sighted. Nevertheless, the behaviors described above were observed in several occasions.

At Península Valdés, Argentina, right whales seem to be organized in a single unit centered on mothers with calves (Payne, 1995). Inside the same bay, many groups are distributed along the coast, rarely keeping physical contact with one another, probably using acoustic communication as a means of staying together in herds. According to Clark (1983), the sounds produced by right whales have communicative function and are correlated with the physical activities of the animals and their social context. Thomas (1986) suggests that the spacing of right whales in Golfo San Jose, at Península Valdés, is the required separation of mothers and calves from the other whales in the area.

When more than one mother-calf pair were observed in the same bay, they seemed to maintain a certain degree of spacing as observed at Península Valdés. If the groups need to communicate, due to the limitations on sound propagation, this is possible only through their movements between bays, passing by other groups in motion or stopped in other bays. However, no acoustic communication studies on the right whales in Brazil have been made until the present.

Many anthropogenic factors like chemical pollution, climate change, increasing ship traffic, whalewatching and entanglement in fishing gear can affect the recovery of the right whale populations (Palazzo & Flores, 1998b). Moreover, harassment like the kelp gulls feeding habit of gouging out peeling skin and flesh of the right whales, a growing problem at Península Valdés (Rowntree *et al.*, 1998), was first recorded in Santa Catarina in 1999 (Groch, in prep.).

Studies involving chemical pollutants analyses and climate change in relation to right whales in Brazil were still not conducted, but collisions with ships

near the Port of Rio Grande, Rio Grande do Sul State, and a number of entanglements in fishing gear (thought with only one confirmed case of death) were already recorded (Palazzo & Flores, 1999).

Ship collisions are one of the main causes of death of northern right whales, *Eubalaena glacialis*, of the Atlantic Ocean in the Northern Hemisphere, and one of the main threats to the recovery of this population (Caswell *et al*, 1999; Knowlton *et al.*, 1997).

The whale watching industry, though only in the early stages of its establishment in Santa Catarina and conducted in agreement to the international rules for the activity, can represent a factor of stress to this right whale population due to the great potential of this region for the development of this activity. In light of these factors, behavioral studies become a valuable tool for the management and implementation of the appropriate conservation measures for the species. The preliminary data presented here provide important information on the behavior of right whales in this breeding concentration region, but more detailed long term studies have to be conducted in the future.

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Figure 2 – Behavior of the mother and calf pairs of right whales observed from August to October in 1998 and 1999, in the southern coast of Santa Catarina State, Brazil.

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