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Interspecific cetacean interactions during the breeding season of humpback whale (*Megaptera novaeangliae*) on the north coast of Bahia State, Brazil

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The large majority of cetacean interspecific studies report only on dolphin interactions, while studies on interactions between odontocete and mysticete are less common. The present work aims to report on sightings of cetacean interactions, during the breeding season of humpback whales (Megaptera novaeangliae)*, along 370 km of the Bahia State, north-eastern Brazil, addressing aspects of cetacean distribution and behaviour. During 7 seasons (2000–2006), a total of 230 research cruises were performed, in which 38 events of interactions among humpback whales and other cetaceans* (Tursiops truncatus, Steno bredanensis, Peponocephala electra *and* Balaenoptera acutorostrata) *were observed, plus another 5 encounters without the whale's presence, including* T. truncatus, S. bredanensis, P. electra, Stenella clymene *and* Stenella attenuata. *Our results confirm the occurrence of multiple cetacean species in the Bahia State, being the first study in the world to report on a large range of interactions involving another 4 cetacean species, grouped with up to 3 mixed species per sighting, with humpback whales in their annual breeding ground.*

Keywords: *Megaptera novaeangliae*, cetacean interactions, Bahia, Brazil

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INTRODUCTION

Despite the increment of the field studies about cetacean diversity and distribution, in the south-western Atlantic Ocean, from the second half of the 1990s, based mainly on punctual sightings (for updated revision see Reyes, 2006), most of their natural habits, including the ecological interactions involving multiple cetacean species have been poorly addressed.

The large majority of interspecific studies report only on dolphin interactions (e.g. Frantzis & Herzing, 2002; Gannier, 2002; Herzing *et al.*, 2003; Psarakos *et al.*, 2003), while studies on interactions between odontocete and mysticete are less common, and bring information about species such as humpback whales (*Megaptera novaeangliae*) and pilot whales (*Globicephala melas*) (Ciano & Jorgensen, 2000), grey whales (*Eschrichtius robustus*) and Risso's dolphins (*Grampus griseus*) (Shelden *et al.*, 1995).

In the revision provided by Frantzis & Herzing (2002), the levels of dolphin interactions may vary from: (1) swim side-by-side while maintaining the borders of their own single-species sub-group; (2) mix in a way that yields no obvious, stable grouping of the different species; or (3) mix and also interact with individuals of other species in a complex way.

Interactions between mysticetes and odontocetes may include a prey/predator relation, as described in attack episodes to the humpback (e.g. Whitehead & Glass, 1985; Florez-Gonzales *et al.*, 1994), Bryde, *Balaenoptera edeni* (Silber *et al.*, 1990) and fin whale, *Balaenoptera physalus* (Vidal & Pechter, 1989). There are reports of dolphin attacks, including species such as killer whales (*Orcinus orca*), false killer whales (*Pseudorca crassidens*) to sperm whales (*Physeter macrocephalus*) (Arnbom *et al.*, 1987; Palacios & Mate, 1996). Killer whale attacks have been described involving many other cetacean species, as summarized in Jefferson *et al.* (1991). Also reported in the literature are non-aggressive interactions of sperm whales with pilot whales (*Globicephala melas*) (Weller *et al.*, 1996).

The present work aims to report on sightings of cetacean interactions, during the breeding season of humpback whales (July–November) from 2000 to 2006, along ~370 km of the north coast of Bahia State, addressing some aspects of cetacean distribution and describing the observed behaviours of the interaction events.

MATERIALS AND METHODS

Study site

The main characteristic of the north coast of Bahia State is the presence of a narrow continental shelf, with extension of about 15 km. The mean depth-range is 50 m and the tide amplitude varies between 0.1 and 2.6 m. This stretch of coast is characterized by sandy beaches, with some rocky substrate in the river mouths and fringed coral reefs, located from close to the shore up to 12 km (Marcovaldi & Laurent, 1996).

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The Praia do Forte is located at 55 km north from the capital, Salvador. The sampled area between 2000 and 2006 covered about 370 km of coast, from the northern limit, Subaúma (12°S 37°W) to the southern limit, Itacaré (14°S 38°W) (Figure 1).

Field procedures

Daily research cruises, with mean duration of 8 hours, departing from Praia do Forte (13°S 38°W) were conducted every week, during July to October, the breeding season of *M. novaeangliae* in the southern hemisphere. The main objectives of the cruises were to collect photoidentification, biopsy samples and behavioural data, including bioacoustics of the humpback whales. These cruises were performed in alternating routes for north and south, even including one specific expedition of about 10 days from Praia do Forte to the south, reaching Itacaré in three days. For more detailed information on cruise procedures see Martins *et al.* (2001) and Rossi-Santos *et al.* (2008).

Opportunistic data about other cetacean species were collected every time they could be sighted, then approached to register a more detailed observation as possible, including data such as time effort and observation, localization, composition and behaviour of cetacean groups, besides environmental parameters (wind direction and speed, visibility, sea state—Beaufort, depth) were also collected during the sampling. The sightings coordinates were plotted in a GIS chart, including coastline and isobaths for the study area, using Arcview 3.2 (ESRI, Headland, Califórnia).

A group was defined as either a lone animal or a group with members within 100 m of each other, engaged in the same activity and generally moving in a coordinated manner (Whitehead, 1983; Wilson, 2000).

The behavioural sampling followed the *ad libitum* method (Lehner, 1996), looking for describing the observation as much as possible. Humpback whale behaviours were adopted following previous works described in the literature wordwide (e.g. Clapham, 2000) and locally, for Brazil (Engel, 1996; Simões, 2005), through categories varying in time, such as states, continuous for a certain time (e.g. travelling, resting and singing) and events, or punctual activities (e.g. tail slaps, breaching and spy-hoping).

The main dolphin behavioural states adopted were: travelling, when a group is displacing without any evidence of subtle behaviour than just swimming; foraging, whenever a group is sighted showing any evidence of feeding, such as fish persecution, fish leaping, diving and coordinated movements; and resting, when the animals seem to be inactive, barely moving on the sea surface. All these definitions were adapted from the behavioural descriptions in the classic literature, such as Norris & Dohl (1980), Wells *et al.* (1980) and Shane *et al.* (1986).

Fig. 1. Study area map, between Subaúma and Itacaré, Bahia State, Brazil, where fieldwork took place, from July to November, between 2000 and 2006.

RESULTS

During seven seasons (2000–2006) a total of 230 research cruises were performed, covering about 9740 nautical miles, in 1645 hours of effort, in which 38 events of interactions among humpback whales and other cetaceans were observed (Table 1), plus another 5 encounters without the whale's presence (Table 2).

The encounter between dolphins and whales frequently expressed the idea of the dolphins disturbing whales. On some occasions it was possible to note the energetic behaviour of both dolphins, through leaps and surfacing very close to the whales, and producing highly audible whistles, that could be heard near to our research vessel. The whales presented a stressed-like behaviour, with short breath intervals and

Table 1. Cetacean species in interactions with humpback whales (*Megaptera novaeangliae*) on the north Coast of Bahia State, north-eastern Brazil, during July to November, between 2000 and 2006.

Species	Other cetacean's group size	Humpback whale's group size	Number of humpback's calf	Number of sightings	Depth (m)*	Direct observation (minutes)
T. truncatus	1–25	1–4	4	25	46.25	189
S. bredanensis	1–6	1–3	0	5	47.4	7
B. acutorostrata	1	1	0	1	47	50
T. truncatus + *S. bredanensis*	4–13	1–4	0	5	26.5	120
T. truncatus + *S. bredanensis* + *B. acutorostrata*	15	3	0	1	Not obtained	5
T. truncatus + *S. bredanensis* + *P. electra*	4	5	0	1	773	60
Total				38		431 (7.2 h)

*depth average for species with multiple sighting and absolute for species with only one sighting.

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Table 2. Cetacean species in interactions without humpback whales (*Megaptera novaeangliae*) on the north coast of Bahia State, north-eastern Brazil, during July to November, between 2000 and 2006.

Species	Number of dolphins	Number of sightings	Depth (m)*	Direct observation (minutes)
T. truncatus + *S. bredanensis*	38	3	30	15
T. truncatus + *P. electra*	6	1	36	5
S. clymene + *S. attenuata*	100	1	1832	85
Total		5		105

*depth average for species with multiple sighting and absolute for species with only one sighting.

trumpeting once on the surface. Many times the whales were observed swimming in zigzag.

During interaction events, humpbacks were often breaching and tail slapping very close to the dolphins, although no direct contact between the species was observed, nor obvious fresh scars, bite marks or even blood in the water.

Sightings and behaviour

The interactions between humpback whales and other cetacean species are represented in Figure 2, showing the single species in association (A—with bottlenose dolphins; B—with rough-toothed dolphins; and C—with northern minke whale) and the mixed groups, with more than one species in association with the humpbacks (D—represents interactions among bottlenose dolphin and rough-toothed dolphin; E—shows interactions among bottlenose dolphin, rough-toothed dolphin and northern minke whale; and F—represents interaction among bottlenose dolphin, rough-toothed dolphin (*Steno bredanensis*) and melon-headed dolphin (*Peponocephala electra*).

The majority of the sightings were around Praia do Forte, our departure point, which is characterized by its narrow continental shelf. *Tursiops truncatus* was the most sighted species (N = 25; Table 1) in interaction with the humpbacks and it is also the most common dolphin registered in our study area (Carvalho *et al.*, 2007). The sightings spread from the north of Praia do Forte to south, near to Camamú Bay, constituting the southern interaction sighting (Figure 2A).

Steno bredanensis was the second more frequent single species interacting with the whales (Figure 2B). Both the bottlenose and rough-toothed dolphins were also present in all other mixed groups engaged in interactions with the whales (Figure 2D, E, F).

We obtained a single register of an interaction between humpback and northern minke whales (Figure 2C). We were surveying from Praia do Forte to Salvador, when we sighted a group of probable humpbacks by their blowing. Then we proceeded to approach and could see that there were a humpback and a northern minke in travelling behaviour to the south, surfacing together and not exposing flukes. We stayed for 50 minutes and the whales kept the same behaviour, until we left them.

The episodes involving more than two species interacting with the humpbacks were rare, occurring just once for *T. truncatus, S. bredanensis, B. acutorostrata* and for *T. truncatus, S. bredanensis, P. electra* (Table 1; Figure 2E, F) in seven years of this study.

We sighted a whale blow and after approach we could see dolphins around, in their typical behaviour of swimming very close to the whale. We started to take photographs and suddenly a northern minke whale appeared at the side of the boat, blowing and diving towards the humpback. After that, the animals, gradually displaced, first the northern minke whale disappearing, then the dolphins and at last the humpback blows.

DISCUSSION

The information concerning cetacean interactions in the literature commonly states that the main behavioural aspect of one species gathering another would be foraging, being cooperative, as dolphin associations (e.g. Psarakos *et al.*, 2003) or even aggressive, such as those involving killer whale attacks (e.g. Jefferson *et al.*, 1991; Florez-Gonzáles *et al.*, 1994) and, also for reproductive concerns, as described by Herzing *et al.* (2003) and Psarakos *et al.* (2003).

According to our behavioural observations, we could suppose that the whales are very disturbed by dolphins. Similar observations were recorded in the Abrolhos Bank involving an interaction with humpback whales and rough-toothed dolphins, in which dolphins disturbed whales to prey on remoras attached to the whale's body (Wedekin *et al.*, 2004).

In the northern hemisphere, Ciano & Jorgensen (2000) also observed an evasive behaviour of the humpback whale towards a group of pilot whales. On that occasion the humpback was observed side-fluking in an attempt to disengage itself from the pilot whales, which were swimming beside and underneath the humpback, with some individuals often within 1–2 m of the humpback.

We believe that the interspecific interactions during the humpback whale breeding season, should be related to foraging behaviour, and the whale could act as a fauna attractor, breaking the habitat homogeneity and calling attention of the dolphins and smaller whale species. This hypothesis could be supported by some descriptions of dolphins preying on fish attached to the humpback whale's body (e.g. Wedekin *et al.*, 2004).

Herzing *et al.* (2003) reported on interspecific behaviours of spotted (*Stenella frontalis*) and bottlenose dolphins, over 6 years in the Bahamas, attributing to these behaviours some foraging and reproductive functions, such as cooperative feeding between these species and reproductive cohabitation, mostly from the bottlenose towards the spotted but also the inverse being registered.

For the Oahu Island, Hawaii, Psarakos *et al.* (2003) studied the mixed-species associations between pantropical spotted dolphins (*Stenella attenuata*) and spinner dolphins (*Stenella longirostris*) observed on 19 days between 1996 and 1998, describing behaviours such as aggression, copulation and travelling. These authors attribute a communication function through visual and acoustic signals between different dolphin species.

Gannier (2002) studied the distribution and abundance of cetaceans in the Marquesas Islands (French Polynesia), reporting on mixed groups involving two or three dolphin species. The most common association, sighted on 8 occasions was *S. attenuata* and *S. longirostris*. Associations including *P. electra*, *T. truncatus* and *S. longirostris* were observed twice and *T. truncatus*–*S. attenuata* once.

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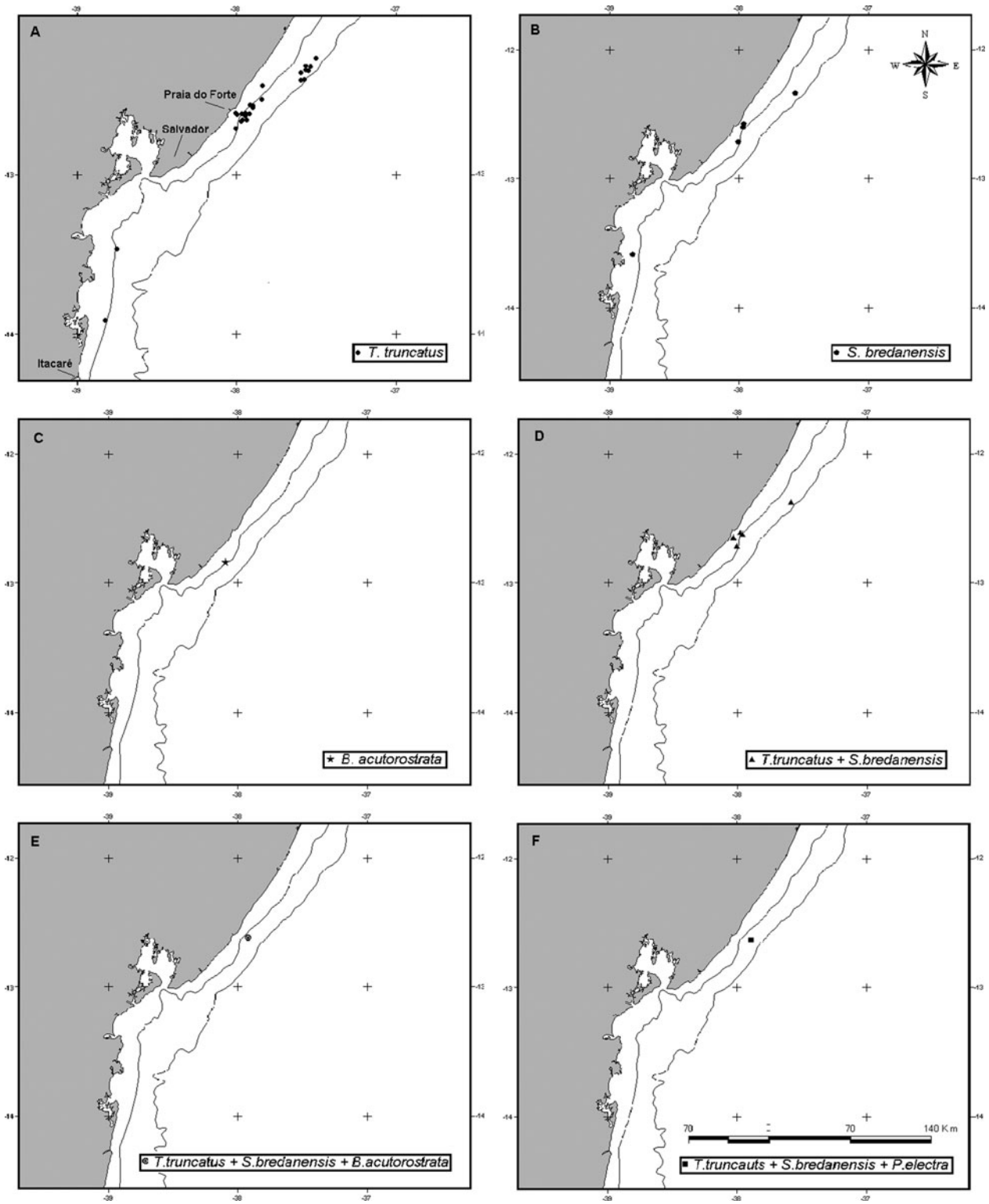

Fig. 2. Interactions between humpback whales (*Megaptera novaeangliae*) and other cetacean species, on the north coast of Bahia State, between 2000 and 2006.

Our results showed greater diversity of species during the 38 registered interaction events in a 7 year period, indicating that the region has strong importance to the scientific contribution of cetacean ecological aspects on the Brazilian coast. Due to the scarce information regarding whale species interactions, we bring the first information describing two sightings containing observations of a northern minke and humpback whales interacting, one of the sightings involving another two dolphin species (*Tursiops truncatus* and *Steno bredanensis*).

One fact that could be extremely related to such diversity on the observed cetacean species is the narrow continental shelf, which aggregates coastal and commonly sighted dolphin species, such as *T. truncatus*, *S. bredanensis* and *S. guianensis* with other oceanic species such as the mentioned *Stenella* species and the rare *P. electra*, bringing

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important behavioural observations to lesser studied dolphin species.

It is largely reported that cetacean distribution is related to environmental factors such as depth, slope, sea surface temperature and abundance of prey (e.g. Selzer & Payne, 1988; Baumgartner, 1997; Jaquet & Gendron, 2002; Rossi-Santos *et al.*, 2006). It is also known, for Brazilian waters that, at least for *T. truncatus*, the dolphins can move at distances up to 300 km, commonly attributed to the function of expanding their search for food and mate (e.g. Simões-Lopes & Fabian, 1999; Lodi *et al.*, 2008).

Previous studies on the Brazilian coast (e.g. Wedekin *et al.*, 2004, Baracho *et al.*, 2006) suggest that interactions among different cetacean species may be more common than generally suspected. Our results confirm the occurrence of a multiple cetacean species during the breeding season of humpback whales on the Brazilian coast, corroborating our attempt at a better understanding of ecological and behavioural aspects in an increased urban and exploited area in Brazil.

Despite the cetacean interaction not being an uncommon research subject, the only report about humpback whale and dolphin interaction is provided by Ciano & Jorgensen (2000) about an interaction event between *M. novaeangliae* and pilot whales (*Globicephala melas*). This is the first study in the world to report on a large range of interactions involving another four cetacean species, grouped with up to three mixed species per sighting, with humpback whales in their annual breeding ground.

Future investigation about photo-identification catalogues, mainly for bottlenose dolphins, along the Brazilian coast could bring more information about the origin of some dolphin populations, and initial registers for oceanic species, such as those herein reported.

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