

Preliminary observations on bottlenose dolphins, *Tursiops truncatus*, at Isla del Coco, Costa Rica

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It has been suggested from theoretical arguments that group structure traits of animals are influenced by the distribution of prey (Clark and Mangel 1986; Clark 1987). Feeding strategies of bottlenose dolphins, *Tursiops truncatus*, vary according to type and distribution of prey involved (Leatherwood 1975; Würsig 1986). We hypothesize that 1) variability in feeding group size will be higher in habitats where food items are different than in habitats where they are similar and 2) dolphin groups will have lower stability and more loose patterns of membership in habitats where variability in feeding group size is relatively high than groups in habitats where it is relatively low. However, no one has studied the influence of different feeding strategies on group structure of the bottlenose dolphin. Here, we report preliminary observations on the behaviour of this species around Isla del Coco. This study is part of a larger comparative study on feeding strategies and their influence on the group structure of bottlenose dolphins.

Isla del Coco is a small island (23.3 km in circumference) located in the eastern tropical Pacific Ocean (5°32'57"N, 86°59'17"W), approximately 500 km SW of Costa Rica (Hertlein 1963). The island is volcanic and depth increases rapidly with distance from shore (Fig. 1). The island is located in an area that has an intermediate level of biological productivity: 15-44 mgC/m³/day (Wooster and Hedgpeth 1966). Approximately 59 species of nearshore fishes have been reported for Isla del Coco (Hertlein 1963). Bottlenose dolphins are common around the island. Scott and Chivers (1990) reported that Isla del Coco is located in an area with the largest density of bottlenose dolphins in the eastern tropical Pacific Ocean, with two or more sightings per 1000 nautical miles searched.

Observations were conducted from June 29 to July 5, 1990 from two vessels. We used a 42 m ship, *Okeanos Aggressor*, to circumnavigate the island, and a small rubber boat (< 5 m) to approach dolphins to photoidentify individuals and record their behaviour. We also recorded the presence of seabirds and fishes.

When approaching dolphins, we used focal group sampling (Martin and Bateson 1986) to define group size, movement, and geometric formation (Shane 1990). Groups were defined as individuals swimming in a coordinated manner within 100 m of each other and performing the same behaviour. We continuously recorded all states of behaviour and defined three behavioural states: bow riding, travelling, and feeding.

Bottlenose dolphins were the only marine mammals observed around Isla del Coco. On the west side of the island they were seen 14 times on six days (Fig. 1). We identified 19 individuals from 6 photographic encounters. We resighted one dolphin on two occasions, each time with different individuals.

Feeding was observed on 3 different occasions. All feeding instances occurred at 500 m or more from shore in water deeper than 100 m. Group size ranged from 22 to 27 individuals. While feeding, dolphins simultaneously attacked the fish school at different sites, thereby reducing the number of potential escape routes for the fish. In all cases, dolphins were feeding on mackerel-type schooling fish, and seabirds fed with the dolphins. Brown boobies (*Sula leucogaster*), great frigate birds (*Fregata minor*), and red-footed boobies (*Sula sula*) comprised 69.7% of the feeding seabirds recorded; shearwaters (*Puffinus* s.p.), white terns (*Gygis alba*) and storm-petrels (*Oceanodroma* sp.) accounted for the rest. In all feeding instances, we also observed yellowfin tuna (*Thunnus albacares*) and Galapagos sharks (*Carcharhinus galapagensis*) in the area. Sharks were abundant and common around Isla del Coco; they usually came within a few metres of shore. We observed large aggregations (20-30 individuals) of hammerhead (*Sphyrna* sp.) and Galapagos sharks on a daily basis. We did not observe any aggressive interactions between sharks and dolphins.

Travelling was observed on seven different occasions. Group size ranged from 2 to 13 individuals. When travelling, bottlenose dolphins moved parallel to the coast; they did not enter bays. Dolphins were observed travelling close to shore (less than 500 m) on six different occasions in water deeper than 100 m. The geometric formation of the group was longer

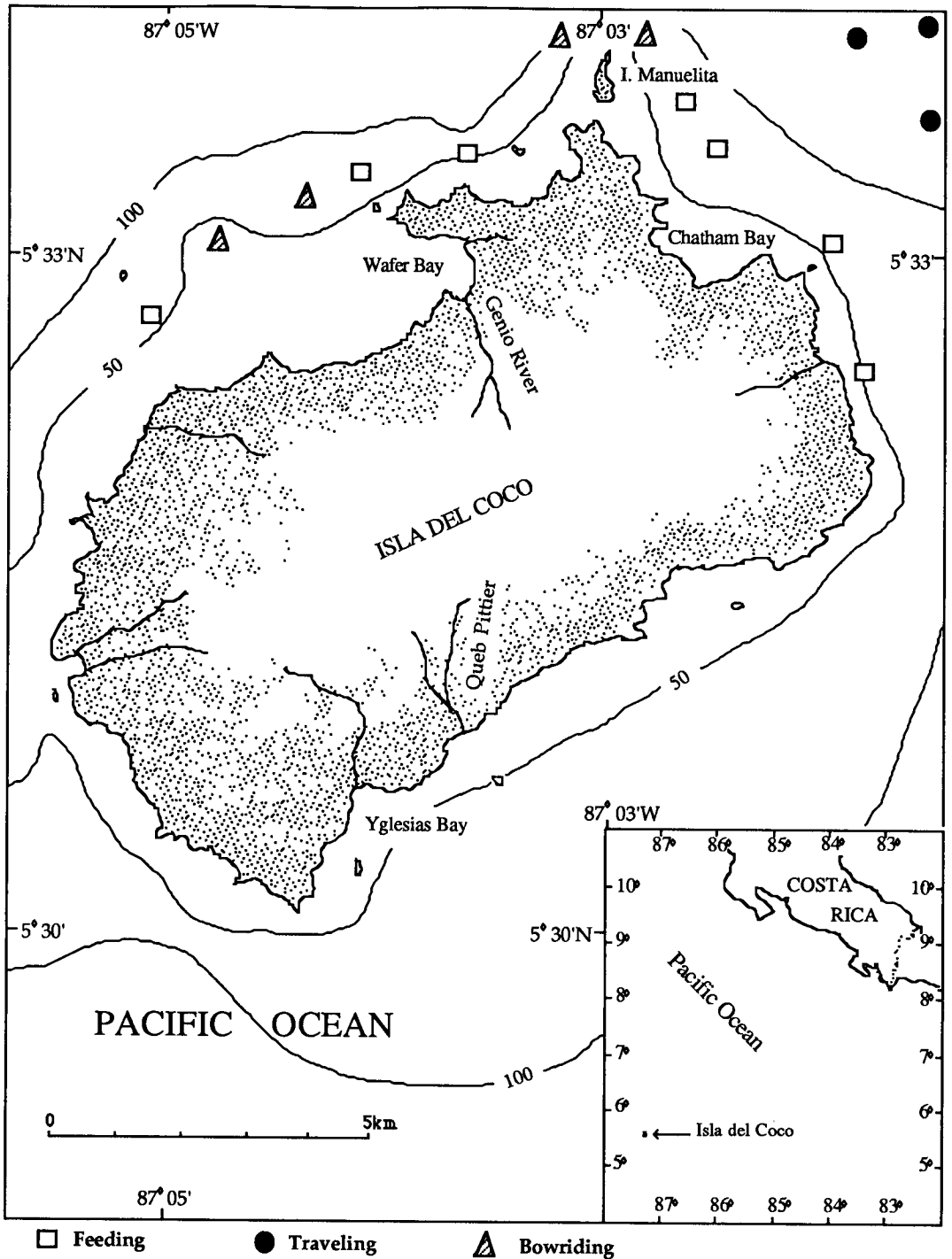


Figure 1. Location and bathymetry (in metres) of Isla del Coco. Sightings and behavioural states of bottlenose dolphins in the West side of Isla del Coco.

than broad relative to the direction of its movement. Bottlenose dolphins were observed travelling far from shore (more than 500 m) on one occasion in water deeper than 100 m. The geometric formation of the group was broader than long relative to the direction of its movement.

Bow riding was observed on four different occasions. Group size ranged between 5 and 7 individuals.

We never observed bottlenose dolphins feeding on nearshore fishes. Nonetheless, Walker (1981) reported that stomachs of bottlenose dolphins caught in the eastern tropical Pacific Ocean, including oceanic islands, contained remains of nearshore fish. The fish species belonged to the same families of fish regularly found at Isla del Coco (Snodgrass and Heller 1905).

Prey patches of schooling fish in the region of Isla del Coco are relatively large and diverse (Au and Pitman 1988). Association among seabirds (most commonly boobies), yellowfin tuna, and delphinids are common (Au and Pitman 1988). We believe that bottlenose dolphins at Isla del Coco at times move farther from shore, aggregating to feed on schooling fishes and later segregating when they move closer to shore, perhaps to feed on nearshore fishes. A similar pattern was detected on two days in 1979, 4 and 7 December, as one of us (Würsig) circumnavigated the island aboard the 44 m sailing vessel *Regina Maris*. He observed one dolphin group during 5–10 min, and after another 5–10 min a new group appeared. By the end of the circumnavigation, which took 1.5 hr, he had observed eight different groups, all less than 300 m from shore and each one numbering 5–7 individuals. Also during 1979, the largest group he recorded (15 bottlenose dolphins) was seen about 2 km from shore.

In estuarine systems, bottlenose dolphins feed predominantly on nearshore fishes (Gunter 1942; Leatherwood and Reeves 1982). If our hypotheses are correct, the similarity in food items might lead to stable social groups. For example, in the protected, inshore waters of Sarasota Bay, Florida, dolphins form a relatively closed community with stable groups and a well-defined distribution range (Wells *et al.* 1987). Dolphins living near oceanic islands and predominantly feeding on nearshore fishes might also be structured in stable social groups. Dolphins living near oceanic islands and feeding on both nearshore and offshore fishes, as we believe occurs at Isla del Coco, might be structured, due to the dissimilarity in food items, in unstable social groups.

We plan to test our hypotheses by studying bottlenose dolphins in an estuarine system of Costa Rica and at Isla del Coco. We will identify food items of dolphins, describe their feeding strategies, estimate their feeding group sizes, and describe their group structure while taking into account potentially confounding factors such as oceanographic features.

We expect to find relatively stable social groups in the estuarine system and relatively unstable social groups at Isla del Coco. Additional information from other studies will show if bottlenose dolphin group structure is flexible, as suggested by Würsig and Würsig (1977), and if this flexibility is related to prey type.

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Testosterone profiles in male grey seals (*Halichoerus grypus*)

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Summary

Peripheral plasma samples of eight male grey seals (*Halichoerus grypus*) were analysed for testosterone concentration by radioimmunoassay. Levels in six males captured from Amet Island, Nova Scotia, at the beginning of the sampling period were contrasted with levels measured in two males raised in captivity. The male seals were housed in pairs in Ontario, Canada, and were exposed to female seals during the breeding season or during the entire season. Both groups of males underwent reproductive cycles of testosterone levels in synchrony with the cycle of wild captured females. The two males raised in captivity had lower levels of testosterone for significantly longer periods than their wild conspecifics, but the timing was similar and baseline levels did not differ in non-breeding months. Captive rearing in an outdoor enclosure in Ontario did not prevent a cyclic pattern of testosterone secretion.

Key words: testosterone; grey seal; *Halichoerus grypus*

Introduction

Interest in the management of seal species has grown in recent years, particularly in two groups with opposing ideologies. Real or imagined competition with fisheries has promoted demands for population control of 'pest' species such as the grey seal (Royal Commission, 1986). In contrast, greatly reduced stocks of other phocine species survive in small mainly undefined numbers in the wild and in controlled zoos and aquaria. Information on the breeding biology of seals is needed both to implement successful breeding programmes for endangered groups while offering guidelines to evaluate the repercussions of population control.

The class Phocidae share similar breeding patterns, with all those examined being seasonal breeders and exhibiting a period of delayed implantation (King, 1964). Most information on the grey seal (*Halichoerus grypus*), has been furnished through lethal histological studies during the short breeding season lasting roughly one month (Backhouse, 1964; Boyd, 1983;

Hobson and Boyd, 1984; Mansfield, 1973; Ronald *et al.*, 1982), a pattern repeated in studies of other phocid species (e.g. Amoroso *et al.*, 1965, Craig, 1963; Daniel, 1981). Non invasive methods of evaluating reproductive condition are needed to supplement this anatomical detail for maintenance of captive populations.

Mating in grey seals follows the events of pupping and three weeks of lactation (Backhouse and Hower, 1964). The breeding season varies considerably between the three grey seal populations. In British waters, the breeding season ranges from September to November, in Eastern Canada the season occurs later in late December through February, and the Baltic population breeds in March (King, 1964). Individuals in each of these groups must be in synchrony with its conspecifics in order to successfully reproduce.

Histological studies demonstrate that males cycle annually, with testes regressing to half breeding size during most of the non-breeding year. In the British Isles, meiosis begins in May with spermatocytes becoming plentiful in the seminiferous tubules by July (Backhouse, 1964). In the Canadian population, sperm production is only evident by October (Mansfield, 1973). Androgens supporting spermatogenesis can be used as a non-intrusive method of evaluating reproductive condition. Sangalang and Freeman (1976) reported on levels of androgens in 3 male grey seal samples and found that testosterone may be elevated in January relative to July. Noonan (1989) found evidence of cycling testosterone levels in male hooded seals which corresponded to oestrus behaviour but reported no evidence of successful breeding in the captive animals.

Synchrony of male and female cycles is critical in seasonal breeders. Backhouse (1964) reports that males are incapable of breeding out of season. Of key concern to captive breeding of phocids is whether the animals remain fertile and cyclic in an artificial environment. This study examines whether male grey seals captured from the wild at the onset of the study and males reared in captivity undergo reproductive cycles of testosterone levels in synchrony with the reproductive cycle of wild captured females.

Materials and Methods

Experimental animals

Nineteen grey seals, six males and 13 females, were collected from the breeding ice surrounding Amet Island on the north-western shore of Nova Scotia (45°50'N; 63°10'W) between January 11–13, 1989. The ages of the seals were not known except that all were reproductively mature in the 1989 breeding season as the cows had all pupped and the bulls defended harems (3+ for females, 10+ for males). The males were numbered 89-1 through 89-6. These animals were transported to the Guelph holding facility within three days of capture.

An additional two males donated by the Rockton Lion Safari, Ontario, Canada, were also made available. The two males had been captive since birth and were aged 8 (89-22) and 9 years (89-23).

The animals were maintained in four cement outdoor tanks (10 × 7 × 1.5 deep) with haul out ledges. Three tanks each housed two male and four-five female seals, while the last tank held 89-22 and 89-23. The tank members varied through the year and all male seals were exposed to female seals during the breeding season. The seals were fed twice daily a diet of Atlantic herring (*Clupea harengus*) supplemented with Seatab® multi-vitamins and NaCl. Each animal received approximately 6–7 kg of fish per day.

Blood samples were taken weekly during November through May, and biweekly during the remainder of the year. The bulls were sampled between January 1989 and February 1990. Blood was collected by vacutainer method from the hind flipper plexus into heparinized tubes (Geraci, 1971) while the seal was restrained in a net. Samples were centrifuged at 3000 RPM for 10 minutes. The plasma was stored at -20°C until assayed.

Steroid radioimmunoassay

The concentrations of testosterone were determined by radioimmunoassay as described for hooded seals by Noonan (1989). Sensitivity of the antibody P4311 for testosterone is 10–25 pg and cross reacts (61.5% and 15.7%) with dihydrotestosterone and androstenedione respectively (Noonan, 1989). Intrassay variation was 4.6% (n = 10) and interassay variation was 15.0% (n = 10).

Statistical analysis

Data are expressed as mean ± standard error of the mean (s.e.m.) and n is the number of seals. The values for each month were computed as means of the weekly measurements in each seal. Statistical differences between monthly means were examined using one-tailed Student's t-test with Bonferroni's adjustment for repeated variables (Trippel and Hubert, 1990) to ensure that overall alpha level was not greater than 0.05. The corrected value for detection

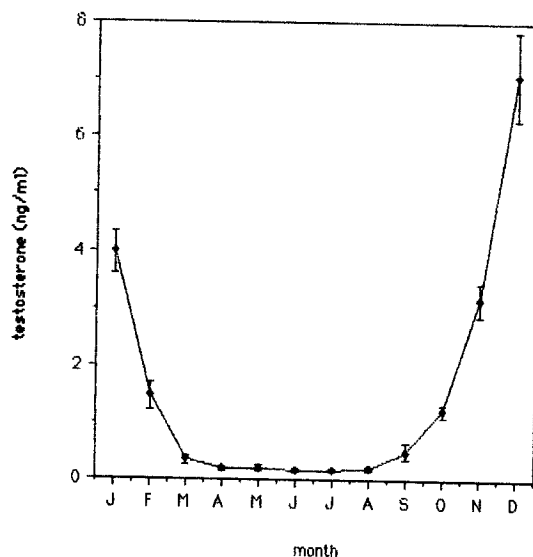


Figure 1. Monthly mean concentrations of plasma testosterone (\pm s.e.m.) in male grey seals. n = 8 male seals: January 1989–February 1990.

of significant difference was $p < 0.008$ when six months were considered (Fig. 2).

Results

Grey seals exhibited a definite seasonal pattern of androgen secretion. Mean monthly concentrations of testosterone \pm s.e.m. in peripheral plasma of male seals were plotted (Fig. 1). Values from the eight male seals were pooled for both years for each month in the calculation of monthly means. The plasma mean testosterone concentration was at baseline levels (<1 ng/ml) during March to September and then rose from October to January. The pattern was similar in all animals sampled.

The average monthly values of plasma testosterone \pm s.e.m. in the two captive-reared seals (89-22 and 89-23) and the six wild-captured males (89-1, -2, -3, -4, -5, and -6) during the breeding seasons in 1989 and 1990 were contrasted (Fig. 2). Only those six months where values rose above baseline were included. Mean plasma testosterone was higher in the wild seals than in the captive reared males in October to January, but the difference was not significant. The levels also declined more gradually in the latter group with significantly higher levels recorded in March in 89-22 and -23 than in the other 6 male grey seals.

Behavioural data parallels the testosterone level trend. Males became increasingly territorial and engaged in aggressive encounters with conspecific males in November and December. Copulations