# Aggression in bottlenose dolphins: evidence for sexual coercion, male-male competition, and female tolerance through analysis of tooth-rake marks and behaviour

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**Summary**

Aggressive behaviour is rarely observed, but may have a large impact on the social structure, relationships and interactions in animal societies. Long-term behavioural study of Indian Ocean bottlenose dolphins in Shark Bay, Australia, suggests that males are more aggressive than females, and use sexual coercion during the breeding season, but age and sex-specific patterns of aggression have not been well documented. We analyzed tooth rake marks, an indirect measure of received conspecific aggression, to determine such patterns by age, sex, and adult female reproductive state. Photographs of 224 Shark Bay bottlenose dolphins were examined for tooth rakes and each rake was categorized as new (broken skin), obvious (white rake lines that are clearly visible) or faint (faint evidence of rakes). Rake lines were also coded by each body section visible in the photograph. Cycling females (those that became pregnant within 6 mos. of the photograph date) were significantly more likely to have new tooth rakes than non-cycling females (pregnant or with a dependent calf $<$20 mos.). Adult males were significantly more likely to have tooth rake marks than adult females, with the same tendency for juveniles. Calves, with far fewer rakes than any age class, showed no significant sex difference. Body coverage of tooth rakes was significantly more extensive for adult males than for adult females, but there were no sex differences on coverage for juveniles or calves. Comparison of tooth rakes at two periods during adulthood ($>$2 years apart) suggests that the marks are not cumulative. Overall, 83% of the population has tooth rake marks, suggesting that agonistic interactions occur for most individuals at least every two years. Analysis of agonistic interactions for 55 adult focal females (observed for 1960 h) and their 88 calves

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(observed for 1876 h) show that female aggression is extremely rare (occurring every 490 h), but females receive aggression more often (every 61 h), and 84% of received aggression was from juvenile and adult males. Focal adult females were never observed acting aggressively towards juveniles or adults of either sex, suggesting that female bottlenose dolphins are highly tolerant. Of the four observed instances of adult female aggression, all were directed at their dependent offspring. Male calves are significantly more aggressive than female calves, and calves had higher rates of agonistic interactions than their mothers (every 18 h), even though calves had fewer tooth rakes than all other age classes. The patterns of tooth rake presence and prevalence likely result from sexual coercion of adult females by adult males and intra-sexual male competition.

*Keywords*: intra-specific aggression, female tolerance, sexual coercion, tooth rakes, bottlenose dolphins, *Tursiops* sp.

## Introduction

For over three decades, scars and natural markings have been used for photo-identification of cetaceans (Würsig & Würsig, 1977; Hammond et al., 1990; Würsig & Jefferson, 1990). The marks used to distinguish individuals include tears, nicks, tooth rakes, pigmentation patterns, and other marks located on the dorsal fin, flukes, and back (Gill & Fairbairns, 1995). In long-term studies of cetaceans, photo-identification helps researchers obtain information on group structure, life history parameters, site fidelity, movement patterns, and population size in, for example, sperm whales (*Physeter macrocephalus*; Whitehead, 1990; Childerhouse & Dawson, 1996), blue whales (*Balaenoptera musculus*; Sears et al., 1990), minke whales (*Balaenoptera acutorostrata*; Gill & Fairbairns, 1995), bowhead whales (*Balaena mysticetus*; George et al., 1994), bottlenose whales (*Hyperoodon ampullatus*; Gowans & Whitehead, 2001), humpback whales (*Megaptera novaeangliae*; Carlson & Mayo, 1990), humpback dolphins (*Sousa chinensis*; Karczmarski, 1999) and bottlenose dolphins (*Tursiops* sp.; Smolker et al., 1992; Wilson et al., 1997; Durban et al., 2000; Grellier et al., 2003).

However, only a few studies have used conspecific marks or scarring (tooth rakes) in cetaceans to examine relative rates of received aggression according to age and sex, and no studies have examined rake patterns by female reproductive state. Fresh or recent wounds may be used to indicate vulnerability to attacks by season or reproductive status. These measures are important given that, like predation events, agonistic interactions are rarely observed in wild animals, although indirect evidence of predation