Tattoo disease of odontocetes as a potential indicator of a degrading or stressful environment: a preliminary report

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ABSTRACT

We examined the presence of tattoo lesions in 613 small cetaceans belonging to nine species and originating from the Southeast Pacific Ocean, the Southwest and Northeast Atlantic Ocean as well as from the North, Baltic and Mediterranean Seas. Most of the specimens had been caught in nets or were found stranded in the period 1988-2002. Thirty-five bottlenose dolphins from the Sado estuary, Portugal were photographed alive in 1994-1997. Tattoo lesions were detected in 68 of 196 *Lagenorhynchus obscurus*, 33 of 54 *Delphinus capensis*, five of 12 *Tursiops truncatus*, 57 of 95 *Phocoena spinipinnis* from Peru as well as in 17 of 35 *T. truncatus* from the Sado estuary, in two of 10 *Stenella coeruleoalba* and one of four *T. truncatus* from the Mediterranean Sea. Prevalence of the disease varied significantly between species in mature specimens but not among immatures. It also varied very significantly between inshore (*P. spinipinnis* and Sado *T. truncatus*) and offshore or offshore-neritic (*S. coeruleoalba*, *L. obscurus*, *D. capensis* and Peruvian *T. truncatus)* odontocetes, being higher in adult specimens of inshore (53.5%) than of offshore (29.7%) taxa. This variation may be caused by immunotoxic environmental pollutants of continental origin like organochlorines. The coastal waters of Peru and the Sado estuary suffer from eutrophication and pollution from various origins. Direct correlation with pollutant loads needs to be investigated.

INTRODUCTION

Tattoo disease is characterised by very typical, irregular, slightly in relief, grey, black or yellowish skin lesions known as "tattoos" that may occur on any part of the body in toothed whales. With some practice, tattoos are easily distinguished visually from other types of integument blemishes and scars. This skin disease has been observed in several species of free-ranging odontocetes from the North Atlantic and East Pacific Oceans and in the Mediterranean Sea, as well as in captive bottlenose dolphins (*Tursiops truncatus*) (for a review see Van Bressem *et al*., 1999).

In the bottlenose dolphin, Atlantic white-sided dolphin (*Lagenorhynchus acutus*), dusky dolphin (*Lagenorhynchus obscurus*), long-beaked common dolphin (*Delphinus capensis*), killer whale (*Orcinus orca*) and Burmeister's porpoise (*Phocoena spinipinnis*) the disease is caused by uncharacterised poxviruses (Family *Poxviridae*) that are possibly antigenically related to cowpox virus, a member of the *Orthopoxvirus* genus (Geraci *et al.*, 1979; Van Bressem *et al*., 1993, 1998; Van Bressem and Van Waerebeek, 1996). It is thought to be endemic in the long-beaked common dolphin, dusky dolphin, bottlenose dolphin and Burmeister's porpoise from Peruvian waters as well as in bottlenose dolphin from the Sado estuary, Portugal (Van Bressem and Van Waerebeek, 1996; Van Bressem and Gaspar, 2003). In the dusky dolphin and Burmeister’s porpoise young calves seem to be protected from the disease by maternal immunity (Van Bressem and Van Waerebeek, 1996). In the four species from Peru

as well as in the Sado bottlenose dolphins the highest prevalence was observed in juveniles, presumably after they had lost passive immunity (Van Bressem and Van Waerebeek, 1996; Van Bressem and Gaspar, 2003). Though the affliction may last for months and even years in individual Sado bottlenose dolphins (and probably in other species), the prevalence of tattoo marks eventually decreases in adult Peruvian Delphinidae and apparently in Sado bottlenose dolphins, likely with a gradual development of immunity against the poxvirus.

There are no epidemiological studies available of tattoo disease at a global scale and none on the possible influence of the environment on its prevalence. However, unpublished results of own research and personal communications to the authors suggested prevalence to vary widely between species and locations. In search of the causes of such variability, in 1995 we started a worldwide survey on the epidemiology and ecology of tattoo disease. Here we present some preliminary results and evaluate the potential for the state of the aquatic environment to influence the prevalence of tattoo disease.

MATERIAL AND METHODS

With the exception of 35 bottlenose dolphins from the Sado estuary which were not captured, the whole body surface of 578 small cetaceans was examined for the presence of tattoo lesions. The odontocetes belonged to nine species and originated from the Southeast Pacific Ocean, Southwest and Northeast Atlantic Ocean as well as from the North, Baltic and Mediterranean Seas. Most had been caught in nets or were found stranded in the period 1988-2002 (Table 1). Condition thus varied from alive to early decomposed (but with intact skin) and several were frozen before examination. Detection of tattoos in free-ranging Sado dolphins was done by examining 586 photographic records taken during small-boat surveys. Considering that in these animals generally only upper body parts were visible, the reported prevalence should be considered a minimum value.

As prevalence of the disease varies with age, species were divided into sexually immature (calves and juveniles) and mature individuals. In the Burmeister's porpoise and dusky dolphin the immature category does not include neonates nor very young calves that do not have tattoo lesions (Van Bressem and Van Waerebeek, 1996). Sexual maturity was determined directly from an examination of gonads and lactation or was inferred from standard body length and known life history parameters for these populations. Maturity in Sado bottlenose dolphins was estimated from size and other external features (Van Waerebeek, 1992; Calzada, 1995; Reyes and Van Waerebeek, 1995; Wilson *et al.*, 1999). We examined interspecific variation in species with a sufficiently large sample size: Peruvian dusky dolphins, long-beaked common dolphins, Burmeister's porpoises and Sado bottlenose dolphins. We further examined variation in prevalence between odontocetes occupying an explicit inshore habitat (Burmeister's porpoises and Sado bottlenose dolphins) versus, combined (further referred to as 'offshore'), offshore-neritic (dusky and long-beaked common dolphins) and offshore-oceanic cetaceans (Peruvian offshore bottlenose dolphins and Mediterranean striped dolphins (*Stenella coeruleoalba*)). Significance of differences in prevalence ($\alpha = 0.05$) was verified with chi-square tests.

RESULTS

Tattoo lesions were detected in 68 of 196 dusky dolphins, 33 of 54 long-beaked common dolphins, five of 12 bottlenose dolphins, 57 of 95 Burmeister's porpoises from Peru (Van Bressem and Van Waerebeek, 1996; unpublished data) as well as in 17 of 35 bottlenose dolphins from the Sado estuary, in two of 10 striped dolphins and one of four bottlenose dolphins from the Mediterranean Sea (Table 1). They were not observed in five species of small cetaceans from the Southwest Atlantic Ocean and the North and Baltic Seas (Table 1).

Prevalence of the disease (Table 2) varied significantly between species in mature specimens ($\chi^2 = 14.35$, df= 3, P= 0.0024) but not among immatures ($\chi^2 = 5.56$, df= 3, P= 0.14). Prevalence of the disease varied very significantly ($\chi^2 = 11.56$, df= 1, P= 0.0007) between inshore and offshore odontocetes (Table 2), being higher in adult specimens of inshore (53.5%) than of offshore (29.7%) taxa. Prevalence was also higher in inshore (81.8%) than in offshore immatures (66%; Table 2) but statistical significance was borderline ($\chi^2 = 3.69$, df= 1, P= 0.055).

DISCUSSION

The interspecific variation in prevalence of tattoo disease observed among mature dolphins and porpoises may be caused in part by a different susceptibility to the poxvirus particular to each species but likely reflects also their ability to clear the disease, thus the efficiency of their immune response. The significantly higher prevalence in mature specimens of inshore taxa suggests a relatively deficient immune function that may be caused by environmental contaminants of continental origin. Organochlorines could represent some of these as they are well known to depress the immune system and contribute to the severity of diseases (Aguilar and Borrell, 1994; Ross *et al*., 1996). They may also accumulate at higher concentrations in inshore than in offshore species (Smyth *et al*., 2000). Similarly, the significantly higher prevalence of tattoos observed in male Burmeister's porpoises (Van Bressem and Van Waerebeek, 1996) could reflect a higher load of organochlorine pollutants in males than in females which has been observed in other species of cetaceans (Aguilar *et al*., 1999). Agricultural, mining and industrial activities in South America are thought to have released vast amounts of contaminants into the marine environment (Borrell and Aguilar, 1999). Sewage of various origins is still discharged, mostly untreated, in the coastal waters of Peru (own observations). The Sado estuary suffers from eutrophication and pollution from mining, industrial and agricultural activities as well as from domestic sewage (Harzen, 1995; Ferreira *et al*., 1989; Bruxelas *et al*., 1992). Interestingly, no tattoo lesions have been noted so far in a resident population of bottlenose dolphins occupying the estuary of the Gambia river in The Gambia, West Africa (Van Waerebeek *et al*., 2002). In the absence of industrial activity and large-scale agriculture along the river, contaminant levels are expected to be low. However, tattoo disease seems to be entirely absent in several species of odontocetes from other areas as well, including the highly-polluted North and Baltic Seas (see Table 1). In both cases, a zero prevalence can be easily explained if local populations of odontocetes have not yet been exposed to the virus.

Though preliminary, these results suggest that prevalence of tattoo disease may be an indicator of a degrading or stressful aquatic environment, which begs further research. Other infectious diseases (*e.g*. bacterial and parasitic pneumonia and generalised bacterial infection) have been shown to be significantly associated with chronic exposure to polychlorinated biphenyls in harbour porpoises (*Phocoena phocoena*) from England and Wales (Jepson *et al*., 1999). High levels of mercury were also associated with a significantly higher prevalence of lung lesions in harbour porpoises from German waters (North and Baltic Seas) (Siebert *et al*., 1999).

Further studies will cover more populations, larger samples and also examine variation in the size, density and corporeal distribution of the lesions in inshore versus offshore species. Where possible the incidence of tattoo disease will be correlated to quantifiable data for organochlorine and heavy metal contaminants both in the environment and the tissues of the animals examined.

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Species	N spec examined	Ocean province	Sampling period	Habitat	Prevalence % tattoo disease
Sotalia fluviatilis	80	SW Atlantic	1988-2001	inshore/neritic & estuarine	0
Pontoporia blainvillei	94	SW Atlantic	1989-2001	inshore/estuarine	0
Stenella frontalis	8	SW Atlantic	1992-1999	offshore/oceanic	0
Tursiops truncatus	5	SW Atlantic	1991-1996	offshore/oceanic	0
Lagenorhynchus obscurus [1]	196	SE Pacific	1993-1994	offshore/neritic	34.7
Delphinus capensis [1]	54	SE Pacific	1993-1994	offshore/neritic	61.1
Tursiops truncatus [1]	12	SE Pacific	1993-1994	offshore/oceanic	41.7
Phocoena spinipinnis [1, 2]	95	SE Pacific	1993-1994	inshore/neritic	60
Phocoena phocoena	8	Baltic Sea	1991-1995	inshore/neritic	0
Phocoena phocoena	12	North Sea	1991-1995	inshore/neritic	0
Tursiops truncatus	35	NE Atlantic	1994-1997	inshore/estuarine	48.6.
Stenella coeruleoalba	10	Mediterranean	2000-2002	offshore/oceanic	20
Tursiops truncatus	4	Mediterranean	2000-2002	probably inshore	25

Table 1. Characteristics of samples of 13 odontocete populations examined for tattoo skin lesions.
Source: [1] Van Bressem and Van Waerebeek (1996), [2] Van Bressem and Van Waerebeek, unpublished data.

Species	Ocean Province	Sexually mature			Sexually immature [3]		
		N examined	N positive	Prevalence	N examined	N positive	Prevalence
Offshore or offshore-neritic							
Stenella coeruleoalba	Mediterranean	4	0	0%	6	2	33.3%
Lagenorhynchus obscurus [1]	SE Pacific	128	43	33.6%	41	25	61%
Delphinus capensis [1]	SE Pacific	10	1	10%	44	32	72.7%
Tursiops truncatus [1]	SE Pacific	6	0	0%	6	5	83.3%
Inshore							
Phocoena spinipinnis[1,2]	SE Pacific	46	28	60.9%	34	29	85.3%
Tursiops truncatus	NE Atlantic (Sado estuary)	25	10	40%	10	7	70%

Table 2. Prevalence of tattoo disease according to sexual maturity in samples of six odontocete populations.

[1] Van Bressem and Van Waerebeek (1996); [2] unpublished data ; [3] in *P.spinipinnis* and *L.obscurus* the immature category does not include neonates nor very young calves.