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Long-term recording of gastric ulcers in cetaceans stranded on the Galician (NW Spain) coast

E. Abollo¹, A. López², C. Gestal¹, P. Benavente³, S. Pascual^{1,*}

¹Laboratorio de Parasitología, Facultad de Ciencias del Mar, Universidad de Vigo, Apdo. 874, E-36200 Vigo, Spain

²C.E.M.MA Anxeriz, 19, 5^oD. Milladoiro, E-15895 Ames, A Coruña, Spain

³C.E.S., Apto. 100, O Grove, E-36980 Pontevedra, Spain

ABSTRACT: Long-term (1990–1996) results of recording gastric ulcers in the common dolphin are presented for the NW Spanish Atlantic coast. The occurrence and abundance of cetacean carcasses (belonging to 10 species) with gastric ulcers are also given and discussed. Ulcerations were detected in 17.2% of the animals examined, with 15% for common dolphins and 0 to 29.4% in other cetacean species. A positive relation was noted between ulcer counts and length and maturity of *Delphinus delphis*. Clusters of the nematode *Anisakis simplex* could be seen embedded in the gastric ulcers of 3 common dolphins. It could be concluded that gastric ulcers are non-fatal lesions in cetaceans stranded in NW Spain.

KEY WORDS: Gastric ulcers · *Anisakis simplex* · Cetacean carcasses · NW Spain

The Galician coast with an length of 1720 km is an important area for cetacean strandings. In the past few years, unusual strandings and an increased number of dead marine mammals have been reported along the shores of N and NW Spain (López et al. 1996). Various causes of mortality have been suggested, such as toxic pollutants, bioaggressors, and accidental catches by fishermen (López et al. 1996).

Research interest in long-term studies has significantly increased in the last decade (Van Banning 1987, Malmer 1994). To obtain base-line data providing better insights into long-term disease prevalence fluctuations in wild cetacean stocks, a gross-lesion recording programme was carried out for 6 consecutive years.

Material and methods. Stomachs of 263 cetacean carcasses stranded on the NW Spanish coast were necropsied for macroscopic lesions during 1991–1996. The necropsies were carried out according to standard protocols specific for dissection techniques and tissue

sampling in cetacean pathology (Borgsteede 1991). A few stomachs were examined fresh, but most were examined after preservation in buffered formol 10%, 70% ethyl alcohol plus 5% glycerine, or after being frozen and stored at –20°C before preservation in alcohol. The date, location, total body length (BL) and sex of each animal were recorded. The reproductive status of cetaceans was roughly assessed on the basis of the estimated length at sexual maturity (Perrin & Reilly 1984, Bloch et al. 1993, Cordeiro de Almeida e Silva 1996). Stomachs dissected from each carcass were cut open, cleaned and the stomach wall examined under stereomicroscopy. The presence or absence of ulcerative lesions in the 3 stomach chambers (cardiac, fundic and pyloric) was noted.

Stomach contents were washed into a series of sieves (mesh sizes 2.0 mm and 850, 500, 250, and 100 µm). Parasites were removed from semidigested food items and those associated with ulcerations recovered from the gastric mucosa with forceps for later light (LM) and scanning electron microscopy (SEM) taxonomic identification.

The significance of differences between number of ulcers per animal (UC) and sex, length and maturity of common dolphins *Delphinus delphis* was tested by Mann Whitney *U*-test, correlation analysis and generalized linear models (GLMs). Because of the highly aggregated distribution of stomach ulcers within the cetacean population, GLMs were used as a current statistical method without recourse to writing specific macros or functions to define the appropriate error structure (Wilson & Grenfell 1997). Differences with $p < 0.05$ were accepted as statistically significant. The data were processed using the SPSS-PC(+) 6.1.2. statistical software. Because of the small sample size and the fact that an interspecific association between frequency and sample size can arise as an artefact

* Addressee for correspondence.
E-mail: spascual@setei.uvigo.es

(Gregory & Blackburn 1991), no comparative studies were carried out between different cetacean species.

Results. During the period 1991 to 1996 gastric ulcers were detected in 15% of the *Delphinus delphis* and in from 0 to 29.4% of other cetacean species examined (Table 1). Ulcers were only detected in the wall of the fundic part of the stomach, and had a size ranging from 0.5 cm diameter to 5 × 3 cm. A total of 23 common dolphin carcasses had from 1 to 5 ulcers. Clusters of *Anisakis simplex* (Rudolphi, 1809, det. Krabbe, 1878) at various stages of development (L₃, L₄ and adult forms) were found partially embedded in the stomach wall ulcerations of 3 common dolphins. Nine *D. delphis* had scars in the stomach and a single common dolphin presented scars and anisakids attached to ulcers. Although interannual variability was noted (Table 2), ranging from 0% (1992) to 19.6% (1996), no trends could be observed.

When UC was analysed according to the sex of *Delphinus delphis* carcasses, no significant differences could be established ($U = 1033.5$; $p > 0.05$). Nevertheless, a positive relation could be noted between UC and host length [(correlation coefficient $r = 0.205$; $p < 0.05$); $UC = -0.687BL^{0.005}$; $r^2 = 0.034$; $p < 0.05$, $N = 148$] and between UC and maturity ($U = 1349$; $p < 0.01$) of the common dolphins.

Discussion. This study has established that a single anisakid nematode species, *Anisakis simplex*, is associated with stomach wall ulcerations in cetaceans stranded in NW Spain. It could be concluded that in the sampling area, several species of small cetaceans are important final hosts for this nematode, as has been previously suggested by other eco-parasitological studies (Pascual et al. 1996).

Table 1. Distribution of ulcers within cetacean populations stranded on the coast of NW Spain. Abundance is expressed as total number of ulcers in a sample of hosts divided by total number of individuals examined for ulcerations. N: total number of stranded animals found on the Galician coast; No. ex.: number of individuals examined; No. ulc.: number of individuals ulcerated; % Ulc.: percentage of individuals examined with ulcers

Host	N	No. ex.	No. ulc.	% Ulc.	Abundance (mean ± SD)
<i>Delphinus delphis</i>	420	153	23	15	0.22 ± 0.67
<i>Stenella coeruleoalba</i>	52	20	4	20	0.50 ± 1.23
<i>Tursiops truncatus</i>	95	35	10	28.6	0.69 ± 1.37
<i>Grampus griseus</i>	27	13	0	0	0
<i>Globicephala melas</i>	44	16	3	18.7	0.53 ± 1.36
<i>Phocoena phocoena</i>	64	17	5	29.4	0.29 ± 0.47
<i>Kogia breviceps</i>	2	2	0	0	0
<i>Lagenorhynchus acutus</i>	2	2	0	0	0
<i>Physeter macrocephalus</i>	8	1	0	0	0
<i>Ziphius cavirostris</i>	4	3	0	0	0
Total	716	262	45	17.2	

Table 2. *Delphinus delphis*. Incidence of ulcers in stranded common dolphins during the period 1991 to 1996. N.: number of stranded animals; No. ex.: number of individuals examined; No. ulc.: number of individuals ulcerated; % Ulc.: percentage of individuals examined with ulcers

Year	N	No. ex.	No. ulc.	% Ulc.
1991	43	10	1	10
1992	33	13	0	0
1993	61	20	3	15
1994	45	24	3	12.5
1995	77	35	6	17.1
1996	137	51	10	19.6
Total	420	153	23	15

Stomach wall ulcerations in marine mammals have been reported associated with the presence of different anisakid genera. Nematodes of the genus *Contra-caecum* were reported in cetaceans and pinnipeds by Young & Lowe (1969), Wilson & Stockdale (1970), Liu & Edward (1971), Griner (1974) and Bratney & Ni (1992), and the genus *Phocascaris* in *Phoca groenlandica* in Newfoundland and Labrador by Bratney & Ni (1992). In porpoises, gastric lesions associated with *Anisakis simplex* have been reported by Young & Lowe (1969) and Smith (1989) in Scottish waters, by Baker (1992) and Baker & Martin (1992) in British waters, by Brosens et al. (1996) in Belgian and German waters and by Clausen & Andersen (1988) and Herreras et al. (1997) in Danish waters. These lesions have also been reported in bottle-nosed dolphins, pilot whales and common dolphins by Cowan et al. (1986), Baker (1992) and Kuiken et al. (1994). The frequency of the ulcers ranged from 8% recorded by Clausen & Andersen (1988) to 67% recorded by Kuiken et al. (1994). Interspecific and interannual variability in the observed frequencies recorded in this paper lie between the above published values, and may be due to differences in the feeding patterns and the abundance of intermediate hosts for *A. simplex* in the different sampling areas (Baker & Martin 1992).

The stomach contents of odontocetes stranded on the NW Spanish coast have provided evidence that they take prey which they encounter rather than being selective for particular prey items (González et al. 1994). This may well explain that no sex-related differences in ulcers counts on the stomach wall were found between male and female carcasses.

The lesions did not appear to stop the passage of ingesta and no haemorrhages from these ulcerations or perforations into the

abdominal cavity were observed; it could be concluded that gastric ulcers were non-fatal conditions. Moreover, the scars on the stomachs of *Delphinus delphis* were probably healed ulcers (Baker & Martin 1992).

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