

## CETACEANS STRANDED IN THE AZORES DURING 1992-96

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Forty nine strandings of 13 species of cetaceans were recorded in the archipelago of the Azores from 1992 to 1996. The common dolphin (*Delphinus delphis*) was the most frequent stranded cetacean. For the first time in this region of the Atlantic, a stranded fin whale (*Balaenoptera physalus*) was recorded. An unusual occurrence of a live stranding, apparently successfully rescued, of a dwarf sperm whale (*Kogia simus*) constitutes a new record for the Azores, increasing the number of cetacean species in the region to 24. Most of the strandings (32 out of 38 animals) of 1996 were recorded from 7 February to 12 April. The majority of these strandings were of *D. delphis* and took place mainly on S. Miguel and Terceira islands. The calculation of a stranding index (No. of annual strandings per 100 km of coastline) enabled us to compare the number of strandings in the Azores with those from nearby areas. The Azorean indices were found to be within the range of values calculated for these other areas. Several circumstances that might have been partly responsible for the strandings are discussed. The results of the analyses done (necropsies, and chemical analyses: PSP, DSP, PCB's, DDT, zinc, cadmium, lead and mercury) were lower or within normal limits. It seems reasonable to believe that natural mortality was the main cause of the strandings.

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Registaram-se no arquipélago dos Açores, de 1992 a 1996, 49 arrojamentos de 13 espécies de cetáceos. Os golfinhos-comuns (*Delphinus delphis*) constituíram a espécie que mais frequentemente arrojou. O arrojamento de um rorqual-comum (*Balaenoptera physalus*) foi registado pela primeira vez nesta região do Atlântico. O invulgar arrojamento de um cachalote anão (*Kogia simus*), que foi reconduzido aparentemente com sucesso para o mar, representa a ocorrência de uma nova espécie para os Açores, aumentando o número de espécies de cetáceos na região para 24. A maioria dos arrojamentos (32 dos 38 animais) em 1996 foi registado no período de 7 de Fevereiro a 12 de Abril. A maioria destes arrojamentos foi devida a *D. delphis*, sobretudo nas ilhas de S. Miguel e Terceira. O cálculo de um índice de arrojamentos (nº de arrojamentos anuais por 100 km de linha de costa) permitiu comparar os arrojamentos verificados nos Açores com os calculados para outras áreas próximas existentes na literatura e mostrou que os índices calculados para os Açores estão dentro dos limites calculados para essas áreas. Discutem-se vários factores que podem ter contribuído para os arrojamentos observados. Os resultados das análises efectuadas (necrópsias e análises químicas: PSP, DSP, PCB's, DDT, zinco, cádmio, chumbo e mercúrio) estão abaixo ou dentro dos limites normais. É assim razoável acreditar que a mortalidade natural tenha sido a causa principal dos arrojamentos.

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## INTRODUCTION

Cetacean strandings are dramatic events, that often attract public curiosity. They are also an important source of material for scientific studies, especially those concerned with pathology, anatomy, toxicology and ecology.

In most of the cases when dead animals appear stranded, they died at sea and drifted ashore afterwards. Some of the factors that contribute to the observed patterns of strandings are: coastline topography; species abundance and habitat; natural mortality; weather and oceanographic conditions; and the impact of human activities. Thus, strandings do not simply reflect the population abundance and distribution, and great care should be taken when using them to infer such information.

The archipelago of the Azores, located on the Atlantic Ridge (37°- 40°N; 25°-32°W), comprises 9 volcanic islands, with a coastline of about 700 km. A total of 23 species of cetaceans have been recorded for the Azores region, 4 of which need further confirmation (REINER et al. 1993; STEINER 1995).

In the past, there has not been a regular and systematic effort to report cetacean strandings in the Azores. The last publication on this subject was made by GONÇALVES et al. (1992), who reported the strandings occurred during 1990-91.

## METHODS

Information on cetacean strandings in the Azores was obtained from the reports and/or observations made by local authorities and the public.

The species observed were identified using standard cetacean guides (e.g. WATSON 1981; LEATHERWOOD & REEVES 1983; DUGUY & ROBINEAU 1987; EVANS 1987; JEFFERSON et al. 1993; CARWARDINE 1995). Measurements of stranded animals were taken according to NORRIS (1961). The body condition of the strandings was classified using the following categories (ECS 1991): 1 - live (becomes code 2 at death); 2 - extremely fresh (as if just died, no bloating, meat is considered by most to be edible); 3 - moderate

decomposition (bloating, skin peeling, penis may be extended, organs still intact excluding post-mortem damage); 4 - advanced decomposition (major bloating, skin peeling, penis extended in males, organs beyond recognition, bones exposed due to decomposition); 5 - indeterminate (mummified carcass or skeletal remains, no organs present). Carcasses that were strongly decomposed, that were stranded in inaccessible points or were floating offshore, were not studied. Necropsies were performed when possible, but only those performed at the Department of Agricultural Sciences (DCA, Terceira) were carried out by veterinarians. Whenever possible, samples of tissues (dorsal muscle, blubber, liver, and kidney) were taken for chemical analysis. The total mercury (Hg) levels were determined by a standard method (cold vapour atomic absorption spectrophotometry) at the Department of Oceanography and Fisheries (DOP, Horta). Tissue samples of 4 dolphins (Nos. 15, 18, 19, and 21 - Table 1) were sent to the Portuguese Institute for Marine Research (IPIMAR, Lisbon) for: biotoxin analyses (PSP, DSP by HPLC and mouse bioassay); organochlorine compounds (PCB's, ppDDT by HPLC); and heavy metals (zinc-Zn, chromium-Cr, and lead-Pb by atomic absorption spectrometry). The stomachs, when possible, were removed for identification of contents and some skulls were also removed for museum collections and morphometric measurement.

In order to compare the number of strandings in the Azores with those from nearby areas, a stranding index (number of annual strandings per 100 km of coastline) was calculated.

## RESULTS

### GENERAL

A total of 49 cetacean strandings comprising 13 different species was recorded for the Azorean islands between 1992 and 1996 (Table 1). Toothed whales represented the largest portion of the strandings in this period (91.8%) of which the majority were delphinids (71.4%).

Table 1

List of the cetaceans stranded in the Azores from 1992 to 1996.

Species	Date	Island/Locality	Condition stage	TL (cm)	Sex	Notes
<b>ODONTOCETI</b>						
<b>Kogiidae</b>						
1- <i>Kogia simus</i>	14/vi/96	FA - Porto Pim	1	ca. 260-280	?	Rescued
<b>Physeteridae</b>						
2- <i>Physeter macrocephalus</i>	29/i/92	FA - Praia do Norte	4-5	ca. 900-1100	?	
3- " "	10/viii/94	TR - Quatro Ribeiras	4	ca. 1500	M?	
4- " "	31/vi/95	TR - Baía da Salga	5	ca. 900	?	
5- " "	23/ii/96	TR - Negroito, Chanoca	5	ca. 800-900	?	
6- " "	25/ii/96	TR - Farol Contendas	3-4	ca. 900-1100	?	Distant observation
<b>Ziphiidae</b>						
7- <i>Mesoplodon bidens</i>	30/viii/94	FA - Praia do Norte	4	430	?	2nd local stranding
8- " "	4/viii/95	FA - Praia Ingleses	3-4	530	F-a	3rd local stranding
9- <i>Ziphius cavirostris</i>	19, 24/ix/95	FA - Ribeirinha	1; 3-4	546	F-a	2nd local stranding
<b>Delphinidae</b>						
10- <i>Pseudorca crassidens</i>	8/iii/96	TR - Porto Martins	2-3	ca. 500-600	M-a	Observed in sea
11- <i>Globicephala</i> sp.	26/ix/95	FA - Porto Pim	5	?	?	
12- <i>Delphinus delphis</i>	13/iii/94	TR - Angra Heroísmo	2	180	M-a	Nec
13- " "	7/ii/96	SM - Ribeira Grande	4	?	?	No direct observation
14- " "	7/ii/96	SM - Pópulo	3-4	200	F-a	
15- " "	12/ii/96	FA - Porto Pim	3-4	220	M-a	Nec
16- " "	21/ii/96	SM - Povoação	3	ca. 230	M-a	
17- " "	21/ii/96	SM - Fajã do Calhau	3	ca. 190	M-a	
18- " "	26/ii/96	SM - Ponta Delgada	2	200	M-a	Nec
19- " "	26/ii/96	SM - Ribeira Grande	3	ca. 200	F-a	
20- " "	28/ii/96	SM - V. Franca Campo	3	200	F-a	
21- " "	1/iii/96	SM - Sto. António	2-3	ca. 160	F-j	
22- " "	1/iii/96	TR - Porto Martins	2	201	F-p	Nec <sup>1</sup>
23- " "	16/iii/96	SM - Ribeira Quente	2	212	M-a	
24- " "	17/iii/96	SM - Mosteiros	2-3	140	M-j	
25- " "	7/iv/96	SM - Água d'Alto	3	190	?	
26- " "	11/iv/96	SM - Lagoa, Atalhada	2	180	M	
27- " "	22/iv/96	SM - Rabo de Peixe	2	223	M	
28- " "	13/viii/96	TR - Fanal	3	213	M-a	Nec <sup>12</sup>
29- <i>Stenella coeruleoalba</i>	10/iii/96	SM - R. Peixe, Calhetas	2-3	200	F-a	
30- " "	31/iii/96	FA - Porto Pim	3	187	M-a	Body perforations
31- " "	10/iv/96	TR - Vila Maria	2	205	M-a	Nec <sup>3</sup>
32- " "	11/vi/96	SM - Ilhéu S. Roque	2	115	F-c	
33- <i>Stenella frontalis</i>	21/ii/96	TR - Praia, Riviera	?	210	F	Nec
34- " "	26/viii/96	FA - Porto Pim	2-3	101	M-j	Body perforation, Nec
35- <i>Tursiops truncatus</i>	1/vi/94	TR - Biseoitos	3	215	M-j	Nec
36- " "	1/iii/96	TR - Serretinha	2	ca. 300-350		Not ashore
37- " "	12/ix/96	SM - S. Roque	1	ca. 200-250	F	Rescued
38- Unidentified delphinidae	28/vii/92	FA - Horta	4	210	?	
39- " "	1/iii/96	FA - Horta	4	?	M	
40- " "	5/iii/96	SM - Ribeira Grande	4	ca. 200	?	
41- " "	7/iii/96	TR - Ponta Mã Merenda	4	ca. 250-300	?	Distant observation
42- " "	21/iii/96	SM - Lagoa	4	?	F	
43- " "	2/iv/96	SM - Nordeste	3	120	M	
44- " "	25/ix/96	PI - Lajes do Pico	4	ca. 50	M-c	
45- Unidentified Odontoceti.	6/iii/96	TR - Vila Nova	4-5	ca. 600-700	?	
<b>MYSTICETI</b>						
<b>Balaenopteridae</b>						
46- <i>Balaenoptera acutorostrata</i>	20/ii/96	SM - Ribeira Grande	2	ca. 260-300	?-c	Not directly observed
47- <i>Balaenoptera borealis</i>	24/ii/96	SM - Fajã do Calhau	4	ca. 1200	?	
48- <i>Balaenoptera physalus</i>	2/iii/96	TR - Vila Nova	2-3	ca. 2000-2400	?	Distant observation
49- <i>Balaenoptera</i> sp. (unident.)	25/ii/94	SA - West coast	3	ca. 600-700	?-c	Distant observation

Notes: FA-Faial; TR- Terceira; SM- São Miguel; SA- Santa Maria; PI- Pico. F- female; M- male; c- calf; j- juvenile; a- adult; Nec.- necropsy performed; TL - total length. 1- Female with a foetus with a TL of 75 cm. Skull and foetus deposited at the Department of Agricultural Sciences (DCA) collection (#2/96); 2- Skull deposited at the DCA collection (#4/96); 3- Skull deposited at the DCA collection (#3/96).

Unidentified toothed whales accounted for 16.3% of the strandings, while baleen whales were rare (8.2%) during 1992 to 1996. The most frequent species stranded during those years was the common dolphin (*Delphinus delphis*) comprising 34.7%, followed by the sperm whale (*Physeter macrocephalus*), 10.2%. During 1996, strandings of *D. delphis* were very frequent (42.1%) (Table 1).

Records of cetacean strandings were obtained from 5 Azorean islands (Table 2). The largest number was observed in the islands of S. Miguel (42.9%), Terceira (30.6%) and Faial (22.4%). In 1996, the majority of the strandings (32 animals or 84.2%) occurred during a two months period (February 7 to April 12; with 13 strandings in February, 14 in March, and 5 in April). Of these, 50.0% occurred in S. Miguel, 26.0% in Terceira, and 46.9% were common dolphins. This unusual number of strandings attracted substantial media interest and lead to some speculation about the probable cause of this mortality.

Remarkably, no strandings had been reported in S. Miguel in the previous years (1992-95), despite the fact that this island offers the most extensive coastline of the 9 Azorean islands.

Similarly, in the second largest island (Pico) we have no records for the years of 1992 to 1995 and only one in 1996.

The stranding index was highest in the islands of Terceira and S. Miguel (Table 2). The number of strandings were much higher in 1996 than in previous years (Table 2). The number observed in 1996 (38 cetaceans) is the highest ever recorded in the Azores.

#### HUMAN RELATED MORTALITY

From the period 1992-96, only 2 dolphins (Table 1 - Nos. 30 and 34), presented injuries (body perforations) that may have resulted from direct human action (e.g. fishing related mortality). However, the majority of the strandings (62.5%) reported for these years were classified as in moderate or advanced state of decay (stages 3-5), which may conceal evidences of fishing related mortality.

In the particular case of the 1996 peak of strandings, 64.5% of the animals were classified in stages 1 to 3, without signs of injuries, with the exception of a single animal (Table 1 - No. 30) that presented evident injuries.

Table 2

Summary of the total number of strandings recorded for the Azores from 1992 to 1996. The stranding index (SI = No. of annual strandings per 100 km of coastline) for 1996 is also given.

Islands	Coastline (km)	No. of strandings per year					Total	1996 SI
		1992	1993	1994	1995	1996		
Faial (FA)	80	2	-	1	3	5	11	6.3
Pico	110	-	-	-	-	1	1	0.9
Santa Maria	46	-	-	1	-	-	1	-
São Miguel (SM)	155	-	-	-	-	21	21	11.6
Terceira (TR)	85	-	-	3	1	11	15	12.9
FA+SM+TR	320	2	-	4	4	37	47	10.6
Azores total	691*	2	0	5	4	38	49	5.5

Note: \* - Total coastline extension for the 9 Azorean islands (source: ANON. 1981).

## NECROPSIES

Necropsies were performed on 9 animals. Of these, 6 were performed at the DCA - Terceira. The following probable causes of death were reported: 3 animals showed evidence of a natural death due to illness or starvation; 2 presented evidences of heart attack (thrombosis); and one had died of acute pneumonia and encephalitis.

No anomalous stomach contents were found. The detailed results from the analysis of the stomachs contents will be presented in a future publication.

## CHEMICAL ANALYSES

The tissue samples from the 3 dolphins that were examined for the existence of biotoxins (DSP and PSP) gave negative results (Table 3). The PCB's and DDT values found, follow the general bioaccumulation rule in tissues (blubber>liver>muscle) and were lower or within the values reported in the literature for cetaceans (e.g. GASKIN 1982; HENRY & BEST 1982; EVANS, 1987). Also the levels of heavy metals (zinc, chromium, lead, and mercury) recorded, were lower or within the figures found in the literature (e.g. GASKIN 1982; GLÉMOT 1986; THOMPSON

1990; GONÇALVES et al. 1992; PALMISANO et al. 1995; WOOD & VAN VLEET 1996).

## LIVE STRANDINGS

Only three animals (*Kogia*, *Ziphius*, and *Tursiops*) came ashore alive (strandings No. 1, 9, and 37). In two cases (Nos. 1 and 37) rescue was apparently successful as the animals were not found stranded again. The *Ziphius cavirostris* was found alive swimming inside Horta harbour on 19 September 1995. The animal presented several scratches, mainly around the mouth, and it swam out to sea during the rescue attempt. Underwater video images of this event were recorded. Probably, the animal stranded during the afternoon of the same day at Ribeirinha (Faial island), as a result of the bad weather, but was found dead 5 days later (Table 1 - No. 9).

Another interesting event (stranding No. 1) took place on the afternoon of June 14, 1996, at the Porto Pim beach (Faial). A cetacean was observed swimming actively in calm sea near the coast. It seemed to chase small jumping fishes. Shortly afterwards it was found stranded alive on a rocky zone that formed a gentle slope towards the water. The animal was able to go back to the

Table 3  
Chemical analyses performed on dolphin samples (wet weight)  
(B- blubber; K- kidney; L- liver; M- anterior dorsal muscle tissue; - negative analysis).

No. in Table 1	Species	Tissue	DSP	PSP	PCB* (ng/g)	Σ DDT** (ng/g)	Zn (µg/g)	Cr (µg/g)	Pb (µg/g)	Total Hg (µg/g)
15	<i>D. delphis</i>	M		-						0.98
18	<i>D. delphis</i>	M					116.0	0.31	0.29	0.55
"	"	L					98.0	0.28	2.13	
"	"	K					107.0	0.21	0.03	
"	"	B					21.0	0.43	0.60	
19	<i>D. delphis</i>	M	-							2.43
20	<i>D. delphis</i>	M								2.47
21	<i>D. delphis</i>	M			3.6-114.8	411.3				0.42
"	"	L			3.0-230.3	900.9				7.39
"	"	B			8.7-551.4	1 878.6				
33	<i>S. frontalis</i>	L	-							
"	"	M		-						
34	<i>S. frontalis</i>	M								0.50
"	"	L								4.71

Note: \*- range of PCB values from 18 PCB congeners (18, 26, 44, 49, 52, 101, 105, 118, 128, 138, 149, 151, 153, 170, 180, 183, 187, and 194); \*\* The DDT values represent the sum of pp'DDE, pp'DDD, and pp'DDT.

sea unaided. Later the animal was found stranded again on the beach of this small bay. Two rescue attempts were made by DOP's staff. Finally, the animal was able to find deeper water and disappeared. While the whale was stranded on the beach it was observed and some rough measurements were taken. The animal presented several fresh scratches on the belly, fluke, pectorals and snout and it seemed that it was stranded accidentally when chasing a school of fish and had been scratched by the rocks in the process. The animal was positively identified as a *Kogia*. The measurements of the dorsal fin (ca. 20 cm), represent 7% of the total length (2.6-2.8 m), indicating that this animal was a *K. simus*.

#### UNUSUAL DEAD STRANDINGS

A TV report on the minke whale (*Balaenoptera acutorostrata*) stranded in the 20th February, 1996 (Table 1 - No. 46), was presented the following day by the regional TV news. The images showed the corpse being burned by firemen, reportedly for public health reasons. By chance, a University biologist was present on the same news and made an appeal for people to report any cetacean strandings they might

observe, explaining their scientific importance. More TV interviews on this subject followed in the subsequent days. It is interesting to note that the majority of the strandings in 1996 (81.6%) was reported after those TV news.

The strandings of *Mesoplodon bidens* (Table 1 - No. 7 and 8) are the second and third in the Azores. The first stranding was reported by REINER (1986).

A floating carcass of *Balaenoptera physalus*, (Table 1 - No. 48), although distant, could be positively identified by the asymmetric coloration of the head.

#### COMPARISONS WITH NEARBY AREAS

The total stranding index of 5.5 calculated for the Azores in 1996 (Table 2) is within the range of values found in other areas of Portugal and Spain (Table 4). However, when one considers separately the islands where strandings occurred more frequently (Table 2 - Faial-FA, São Miguel-SM and Terceira-TR), or when one considers the pooled data from those islands (Table 2 - FA+SM+TR), the indices are higher, but still within the values from other regions (Table 4).

Table 4

Summary of the stranding calculations carried out for some regions nearby the Azores.  
Stranding Index (SI - No. of annual strandings per 100 km of coastline).

Location and years	Authors	Coastline (km)	No. strandings (N)	No. years (y)	SI (N/y/100 km)
Mainland Portugal 1978-1988	SEQUEIRA et al. (1992)	832	384	11	4.2
	1980 - Maximum*	"	68	1	8.2
	<i>Delphinus delphis</i> **	"	57		6.9
	1984 - Minimum*	"	12	1	1.4
1989-1994	SEQUEIRA et al. (1996)	832	387	6	7.8
	1993 - Maximum*	"	119	1	14.3
	<i>Delphinus delphis</i> **	"	49		5.9
	1991 - Minimum*	"	35	1	4.2
NW Spain	1990 LÓPEZ et al. (1991)	1720	48	1	2.8
	1991 LENS & LÓPEZ (1992)	"	88	1	5.1
N & NW Spain	1992 GARCÍA-CASTRILLO et al. (1993)	2 750	92	1	3.3
	1993 GARCÍA-CASTRILLO et al. (1994)	"	161	1	5.9
	1994 LENS et al. (1995)	"	157	1	5.7
	1995 LÓPEZ et al. (1996a)	"	149	1	5.4
Canary Islands, Spain	MARTIN et al. 1995	1 500	45	3	1.0

Note: \*- years with the highest and the lowest number of strandings, respectively, for all the years reported by the author. \*\*- Contribution of the strandings of *D. delphis* for the total number of strandings in that year.

A similar high stranding index was found in Galicia for 1996 (A. Lopez, pers. commn). Also in Madeira archipelago an abnormal number of strandings was recorded during 1996 mainly during a peak period early that year, affecting common dolphins (L. Freitas, pers. commn). However, in mainland Portugal no abnormal numbers of cetacean strandings were recorded during 1996 (M. Sequeira, pers. commn). The higher numbers of strandings recorded during some years in mainland Portugal, which are very variable from year to year, are essentially a result of the occurrence of the peaks in the frequency of strandings of *Delphinus delphis* (Table 4).

## DISCUSSION

With the exception of the strandings of the fin whale (*Balaenoptera physalus*), and the dwarf sperm whale (*Kogia simus*), all the other cetaceans have been previously reported for the Azores (see REINER et al. 1993). The fin whale represents the first stranding for the region and the dwarf sperm whale is a new species record for the region, increasing the total number of cetacean species recorded on the Azores to 24. Only individual strandings occurred and two of the three live strandings seemed to be successfully rescued.

Although it is likely that unreported strandings have occurred during previous years, the number of strandings observed in 1996 certainly seems abnormal when compared with those from other years (Table 2; cf. GONÇALVES et al. 1992). Several questions can be raised in relation to these high occurrences in 1996: Are these numbers really high and/or unusual? Do they result from an increase in cetacean mortality or do they simply result from an increase in public awareness to report strandings? And what are the causes of this strandings, natural or abnormal ones?

In spite of the number of strandings reported in the Azores in 1996 (the highest ever recorded in the region), the comparison between the stranding indices obtained for the Azores (Table 2) and for other nearby areas (Table 4) shows that the Azorean figures are neither unreasonable nor unusual. Even considering the general natural

mortality rates found in the literature (e.g.: EVANS 1987 - ca. 4% a year), the number of strandings recorded in 1996 in the Azores is not exaggerated.

The media interest in the stranding incidents in 1996 lead inevitably to a raise in public awareness and probably to an increased rate of reporting. Coincidence or not, it demonstrates the importance of the media in public education and awareness. It should also be stressed that almost all the strandings were reported on the 3 most populated islands (S. Miguel, Terceira and Faial), with University Departments, where there are more people interested in these subjects.

It is commonly accepted that there is a direct relation (not a cause) between strandings and adverse weather conditions (e.g. LÓPEZ et al. 1996b). Increase of strandings related to storms (strong winds) has been reported in the French coast (DUGUY & WISDORFF 1988). It has been also observed that in some years, the increase of strandings related to winter storms affects more some species than others. DUGUY (1989) reported an increase of strandings of *D. delphis* on the French coasts as a result of winter storms. A similar situation could have occurred in the Azores in 1996, mainly in S. Miguel island where more common dolphins were recorded. The rigorous weather conditions in early 1996 may have contributed to this, bringing ashore a larger number of animals. This phenomenon could also have affected some other nearby areas. Also, the major occurrence of strandings during the winter and the beginning of spring is a common pattern found in nearby areas (e.g. LENS & LÓPEZ 1992; CENDRERO 1993; GARCÍA-CASTRILLO et al. 1993, 1994; SEQUEIRA et al. 1992; 1996; LÓPEZ et al. 1996b), and for this reason should not be regarded as abnormal. A direct correlation between sightings and strandings of common dolphins in the French coast has been described by COLLET (1980), supporting the hypothesis that strandings can sometimes reflect local abundance (cf. LEATHERWOOD & REEVES 1983).

Concerning the abnormal causes that were invoked by the media to explain these occurrences in the Azores (e.g. seismic activity, explosions, biotoxins, pollutants), the necropsies performed and the chemical analyses available (biotoxins -

DSP, PSP; organochlorine compounds - PCB's, DDT; and heavy metals - Zn, Cr, Pb, and total Hg) do not support any of them. It seems, however, reasonable to believe that natural mortality was the main cause for these strandings. We found little evidence that fishing related mortality could be the cause.

The data available does not permit to conclude with certainty whether the event in early 1996 was a result of increased mortality, severe weather conditions, or both of these combined. It is reasonable to believe that it was a natural but unusual occurrence amplified by the media.

We would like to stress as well that it is very important to use a correct scientific approach before drawing alarming conclusions based upon preliminary or scarce data.

It is crucial, therefore, that an organised stranding network be implemented in the Azores in order to co-ordinate and standardise the collection of stranding data for all the Azorean islands. Only in this way, will it be possible to compare objectively inter-annual variations in cetacean strandings and explain any anomalies that eventually may occur.

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#### REFERENCES

- ANON. 1981. *Roteiro do Arquipélago dos Açores*. PUB (N). IH-128-SN, Instituto Hidrográfico (IH), Lisboa. xviii+219 pp.
- CARWARDINE, M. 1995. *Whales, Dolphins and Porpoises*. Dorling Kindersley, London. 256 pp.
- CENDRERO, O. 1993. Nota sobre los hallazgos de cetáceos en el norte de España. *Boletim del Instituto Español de Oceanografía* 9(1): 251-255.
- COLLET, A. 1980. New data on small Delphinidae species, and particularly *Delphinus delphis* in the North-east Atlantic Ocean. *International Council for the Exploitation of the Sea*, CM 1980/N: 6. 4 pp.
- DUGUY, R. 1989. Annual report about the cetaceans and Pinnipedia stranded on the French coast in 1988. *International Council for the Exploitation of the Sea*, CM 1989/N: 4. 4 pp.
- DUGUY, R. & D. ROBINEAU 1987. *Guía de los Mamíferos Marinos de Europa*. Ediciones Omega, Barcelona. 198 pp.
- DUGUY, R. & D. WISDORFF 1988. Strandings of Cetacea and meteorological data on the Atlantic coast (from the Loire Estuary to Gironde). *International Council for the Exploitation of the Sea*, CM 1988/N: 3. 6 pp.
- EUROPEAN CETACEAN SOCIETY (ECS) 1991. Standard protocol for the basic post-mortem examination and tissue sampling of small cetaceans.

- Proceedings of the 1991 ECS Workshop on Cetacean Pathology*: 26-34.
- EVANS, P.G.H. 1987. *The Natural History of Whales and Dolphins*. Oxford University Press. 343 pp.
- GARCÍA-CASTRILLO, G., O. CENDRERO, C. PÉREZ & A. LÓPEZ 1993. Les mammifères marins du nord et du nord-ouest de l'Espagne en 1992. *International Council for the Exploitation of the Sea*, C.M. 1993/N: 14. 11 pp.
- GARCÍA-CASTRILLO, G., O. CENDRERO, C. PÉREZ & A. LÓPEZ 1994. Les mammifères marins du nord et du nord-ouest de l'Espagne en 1993. *International Council for the Exploitation of the Sea*, C.M. 1994/N: 10. 17 pp.
- GASKIN, D.E. 1982. Environmental contaminants and trace elements: their occurrence and possible significance in Cetacea (chapter 10). Pp. 393-433, in: *The Ecology of Whales and Dolphins*. Heinemann Educational Books, Ltd. London. 459 pp.
- GLÉMOT, J.-M. 1986. *Le Mercure Chez les Cétacés: Intoxication et Detoxication par le Sélénium*. Thèse Doctorat en Pharmacie. Université de Poitiers, France. 97 pp.
- GONÇALVES, J., M.L. GALHARDO & J. BRUM 1992. Marine mammals stranded in the Azores during 1990-91. *Arquipélago*. Life and Earth Sciences 10: 113-118.
- HENRY, J. & P.R. BEST 1982. Organochlorine residues in whales landed at Durban, South Africa. *International Council for the Exploitation of the Sea*, C.M. 1982/N: 21. 12 pp.
- JEFFERSON, T.A., S. LEATHERWOOD & M.A. WEBBER 1993. *Marine Mammals of the World*. FAO Species Identification Guide. FAO, U.N. Environment Program, Rome. 320 pp.
- LEATHERWOOD, S. & R.R. REEVES 1983. *The Sierra Club Handbook of Whales and Dolphins*. Sierra Club Books, San Francisco. 302 pp.
- LENS, S. & A. LÓPEZ 1992. Marine Mammals stranded on the Galician coast (NW Spain) in 1991. *International Council for the Exploitation of the Sea*, C.M. 1992/N: 6. 9 pp.
- LENS, S., A. LÓPEZ, O. CENDRERO & C. PEREZ 1995. Marine mammals stranded on the North and Northwest Spain in 1994. *International Council for the Exploitation of the Sea*, C.M. 1995/N: 3. 6 pp.
- LÓPEZ, A., S. LENS & J. SÁNCHEZ 1991. Cetaceans stranded on the Galician coast (Northwest Spain) in 1990. *International Council for the Exploitation of the Sea*, C.M. 1991/N: 25. 4 pp.
- LÓPEZ, A., O. CENDRERO, C. PÉREZ & G.G. CASTRILLO 1996a. Marine mammals stranded on the North and Northwest Spain in 1995. *International Council for the Exploitation of the Sea*, C.M. 1996/N: 9. 3 pp.
- LÓPEZ, A., A. BARREIRO & P. BENAVENTE 1996b. Varamientos de cetáceos en las costas occidentales del sur de Europa. *Quercus* 135: 34-37.
- MARTIN, V., M. CARRILO, M. ANDRÉ & V. HÉRNANDEZ-GARCIA 1995. Records of cetaceans stranded on the Canary Islands coast from 1992 to 1994. *International Council for the Exploitation of the Sea*, C.M. 1995/N: 9. 5 pp.
- NORRIS, K. 1961. Standardized methods for measuring and recording data on the smaller cetaceans. *Journal of Mammalogy* 42 (2): 471-476.
- PALMISANO, F., N. CARDELLICCHIO & P.G. ZAMBONIN 1995. Speciation of mercury in dolphin liver: a two-stage mechanism for the demethylation accumulation process and role of Selenium. *Marine Environmental Research* 40 (2): 109-121.
- REINER, F. 1986. First record of Sowerby's beaked whale from the Azores. *The Scientific Reports of the Whale Research Institute* 37: 103-107.
- REINER, F., J.M. GONÇALVES & R.S. SANTOS, 1993. Two new records of Ziphiidae (Cetacea) for the Azores with an updated checklist of cetacean species. *Arquipélago*. Life and Marine Sciences 11A: 113-118.
- SEQUEIRA, M.L., A.M. INÁCIO & F. REINER, 1992. Arrojamentos de mamíferos marinhos na costa continental portuguesa entre 1978 e 1988. *Estudos de Biologia e Conservação da Natureza* (Instituto de Conservação da Natureza, Lisboa) 7: 48 pp.
- SEQUEIRA, M.L., A.M. INÁCIO, M.A. SILVA & F. REINER 1996. Arrojamentos de mamíferos marinhos na costa continental portuguesa entre 1989 e 1994. *Estudos de Biologia e Conservação da Natureza* (Instituto de Conservação da Natureza, Lisboa) 19: 52 pp.
- STEINER, L. 1995. Rough-toothed dolphin, *Steno bredanensis*: a new species record for the Azores, with some notes on behaviour. *Arquipélago*. Life and Marine Sciences 13A: 125-127.
- THOMPSON, D.R. 1990. Metal levels in Marine Vertebrates. Pp. 143-182 in: *Heavy Metals in the Marine Environment* (R.W. Furness & P.S. Rainbow, Eds.). CRC Press, USA. 256 pp.
- WATSON, L. 1981. *Whales of the World: a complete guide to the world's living whales, dolphins and porpoises*. Hutchinson, London. 302 pp.
- WOOD, C.M. & E.S. VAN VLEET 1996. Copper, Cadmium and Zinc in liver, kidney and muscle tissues of bottlenose dolphins (*Tursiops truncatus*) stranded in Florida. *Marine Pollution Bulletin* 32 (12): 886-889.

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