EUROPEAN RESEARCH ON CETACEANS - 5

PROCEEDINGS OF THE FIFTH CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY, SANDEFJORD, NORWAY

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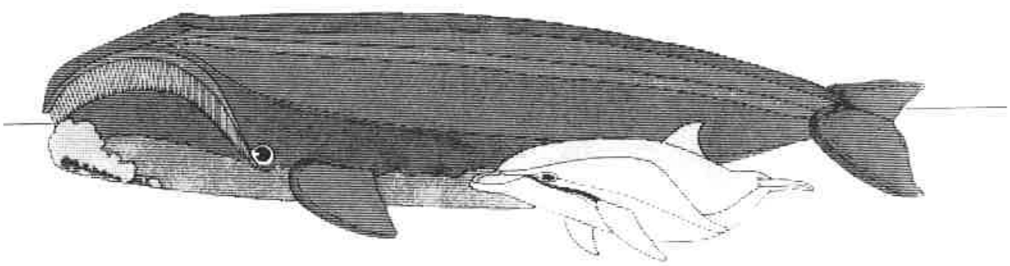

EDITOR: P.G.H. EVANS

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Proceedings of the Fifth Annual Conference
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INTRODUCTION

The fifth annual conference of the European Cetacean Society was held in Sandefjord, Norway between 21st and 23rd February 1991. Around one hundred persons from fourteen countries attended the conference and we particularly thank Arne Bjørge for all his efforts in organising a most successful and enjoyable meeting. Although attendance was lower than in previous years, presumably because of the relatively high costs of travel, this did not affect people's general enjoyment of the conference and the standard of talks was considered to be the highest of any we have had so far. We are particularly grateful to Sidsel Hansen of Sandefjord Travel Association for all the help she gave in the organisation of the conference.

The proceedings that follow are abstracts of the talks and posters presented at the conference. As for previous proceedings, the contributions have been edited only to improve clarity and maintain a uniformity of presentation. No external refereeing has taken place and much of the material presented here I hope will eventually be formally published in greater detail in scientific journals. I have tried to arrange the abstracts broadly by subject, and for this reason, the invited key note lectures are slotted into appropriate spots through the volume. I would like to take this opportunity to offer warm thanks to the invited speakers who came often great distances to address the society: David St Aubin, Mads Peter Heide-Jørgensen, Nils Øien, Ilona Visser, and Bernd Würsig. Prof. Wexelsen from Sandefjord Whaling Museum also provided a both entertaining and educational account of Sandefjord's history in whaling.

Finally, I thank Clare Hawkins for typing much of the proceedings.

Peter Evans

ADVICE TO DOLPHINS: AVOID THE NETS AND PCB'S UNDERWATER, AND DON'T BREATHE THE AIR

Bernd Würsig

Marine Mammal Research Program,
Texas A & M University,
4700 Avenue U, Building 303,
Galveston, TX 77551, U.S.A.

Large whales are no longer hunted for commercial purposes, at least on a large scale. There are still attempts at a relatively small hunt for minke *Balaenoptera acutorostrata* and fin *B. physalus* whales, disguised as "scientific whaling", and bowhead *Balaena mysticetus* and gray *Eschrichtius robustus* whales are taken for consumption by eskimos. At least for the time being, no large whale is in imminent danger of extinction (Perrin, 1989; Klinowska, 1991; several populations of large whales are endangered, however), a situation much better than twenty years ago, when it appeared probable that upcoming generations of humans might never have the chance to experience the glory of seeing a blue whale *Balaenoptera musculus.*

But a new problem is being acknowledged (Brownell *et al.*, 1989; Northridge, 1991). This is a danger to many of the smaller whales, dolphins and porpoises. The danger has been present for some time, but it is insidious and difficult to recognise, for it does not come from world-wide and forceful extermination. It results from local hunts affecting local populations, from incidental entanglement in fishing gear, and from pollution and other forms of habitat degradation.

The purposeful hunting of dolphins and porpoises occurs in many parts of the world, and is responsible for decimating populations of Dall's porpoises *Phocoenoides dalli* off Japan, Burmeister's porpoises *Phocoena spinipinnis* off Chile, and harbour porpoises *Phocoena phocoena* in the Black Sea. But incidental takes - the killing of cetaceans in fisheries for other animals - is even more devastating (Jefferson *et al.*, 1991). Spinner *Stenella longirostris*, spotted *S. attenuata* , and common *Delphinus delphis* dolphins have died in purse seines set for yellowfin tuna *Thunnus albacares* for 30 years now (Perrin, 1969). The tuna and dolphins associate together for not totally understood reasons, and it is thus logical to set nets around the more surface-visible dolphins in order to catch the fish below. Unfortunately, dolphins at times drown in the one kilometre long, 100 metre deep nets, and well over 100,000 dolphins perish per year in purse seines set in the eastern tropical Pacific (Perrin, 1989). Harbour porpoises of the northeastern coast of the United States and Canada are dying in large numbers in nearshore and shallow water gillnets; Hector's dolphins *Cephalorhynchus hectori* are similarly affected off New Zealand and the tip of South America, respectively; and the Gulf of California harbour porpoise *Phocoena sinus*, the vaquita, and Yangtze River dolphin *Lipotes vexillifer*, the baiji, are almost gone due in part to entanglement in gillnets and hook lines (Perrin, 1989; Perrin *et al.*, 1989). These latter two species present particularly bleak examples of human decimation, for it is unlikely that they will survive far into the twenty-first century.

As dramatic as these examples are, the third major threat, that of habitat degradation, may be the most important. After all, whaling for large whales has been strongly curtailed by public pressure and political action, and small whale decimation by purposeful hunting may follow a similar course. Furthermore, incidental catches can be controlled, and an forthcoming moratorium on setting of drift nets will make inroads into the marine mammal bycatch problem. Although huge difficulties remain, I am generally optimistic that we humans, once confronted with a serious problem, can be forced into corrective action. However, habitat degradation by low level chronic pollution and by catastrophic events such as oil spills have impacts or potential impacts which are difficult to grasp and evaluate even by rational beings. The data points are simply not there, even though we know, for example, that organochlorine pollutants such as polychlorinated biphenyls and DDE accumulate in long-lived cetaceans (Aguilar, 1984; Subramanian *et al.*, 1987), and that there is a direct link between raised DDE concentrations and lowered testosterone levels in Dall's porpoises (Subramanian *et al.*, 1987). We do not know to what extent proliferation of viral infections, such as a recent epizootic in striped dolphins *S. coeruleoalba* of the western Mediterranean, is spurred on by debilitation due to increased toxin levels (Borrell and Aguilar, this volume). We do not know the severity of toxin buildup in any but a few isolated marine mammal populations; and because of the nature of pollutant dispersion, we often do not know specifically who is responsible for certain acts of environmental degradation.

Catastrophic pollution by oil spills is different. We usually do know who is responsible, and we can map the progression and many of the effects of oil pollution. But catastrophic oil spills are Poisson-distributed events, striking somewhere with certainty, but without our knowledge of when and where (Neff, 1990). Oil spills have taken their unnatural place with earthquakes, floods, hurricanes and other natural disasters. It is a type of disruption our ecosystems do not need.

Oil spills are known to have serious effects on especially nearshore environments; and until recently I was under the impression that toothed whales, including the dolphins, could get out of harm's way from all but oil spills in confined near-shore waters (Würsig, 1990). It had been demonstrated that bottle-nosed dolphins in captivity detect and avoid even very light surface layers of oil (Smith *et al.*, 1983), and one could imagine that dolphins would rapidly swim away from a spreading oil sheen, and would thus minimise contact with the highly volatile toxic gases produced at the surface of fresh oil.

This is not the case. Our analysis of the behaviour of bottle-nosed dolphins *Tursiops truncatus* in two oil spills in Texas waters, the *Mega Borg* and *Apex* spills, taught us that dolphins can detect oil but generally do not avoid it, except for heavy weathered "mousse" (Henningsen and Würsig, this volume; Smultea and Würsig, 1991). We observed dolphins from an airplane and a small surface vessel; and described orientations, inter-individual spacings, respirations, and general movement patterns in oil-free waters, light sheen oil, heavier slick oil, and the globular non-toxic weathered mousse.

We observed high rates of reorientations, or changes in direction per time, at interfaces between oil types. This indicated that the dolphins could detect oil, and were reacting to its presence. By far the highest reorientations occurred between slick/mousse interfaces, and resulted in dolphins moving around or under, not through, patches of thick weathered oil. Very few reorientations occurred at clear/sheen oil interfaces, indicating that thin layers of fresh volatile oil were not as detectable, or not cause for concern by the dolphins.

Dolphin inter-individual spacings were greatest in oil-free areas (mean = 2.6 body lengths between nearest neighbours); reduced to 0.8-1.7 body lengths in sheen areas; and reduced further, to 0.4-0.6 body lengths, in slick and sheen/slick interfaces. These observations suggest that bottle-nosed dolphins may respond to certain detectable stimuli by decreasing inter-animal spacing, and it may indicate a "worry factor" which is known to create huddling behavior by many social animals when confronted with disturbing stimuli.

Respirations, calculated as blows per minute, decreased between clear and sheen oil, and showed a rise after dolphins which had been in slick for over 17 minutes returned to sheen oil. These data indicate that dolphins stay below the surface longer, and thereby decrease blow rates, when in slick rather than sheen oil. Gray whales also tended to decrease time at the surface when swimming through natural oil seeps; they also tended to respire less frequently, and to modify swim speeds (Kent *et al.*, 1982; Evans, 1982).

The most disturbing results of our opportunistic studies of dolphins in oil were that dolphins did not avoid clear/sheen oil interfaces, and were just as likely to travel into as out of oil interfaces (Figure 1). This undetectability of, or indifference to, volatile surface oil surely increases dolphin vulnerability to potentially harmful exposure to oil chemicals. Little is known about the effects of exposure to oil on marine mammals. Studies by Williams *et al.* (1990) indicated that sea otters *Enhydra lutris* exposed to the *Exxon Valdez* oil spill in 1989 experienced high incidences of emphysema, petroleum hydrocarbon toxicosis, abortion and stillbirths. Less is known about the potential impacts of oil exposure on dolphins and other cetaceans. Inhalation of toxic fumes may cause inflammation of mucous membranes, lung congestion and pneumonia (Hansen, 1985; Geraci, 1990). Inhaled volatile hydrocarbons are certain to accumulate in the blood and tissues, potentially inducing liver damage and neurological disorders (Geraci and St. Aubin, 1982). The fact that in our study, oil fumes permeated the air inside our observation airplane, at an altitude of 500 metres, seven to ten days after the initial spill, suggests that bottle-nosed dolphins travelling in the oil spill were exposed to considerable amounts of toxic vapours. We do not know what effect this exposure had on their health, longevity, and reproductive potential. We know even less about the impact of habitat destruction, including poisoning of prey species, on the health and well being of marine mammals.

Dolphins are in trouble in many parts of the world, from (1) intentional hunting, (2) incidental catches, and (3) habitat degradation. We must not ignore the first two problems, for they are rapidly causing the decline of a handful of species, and of several dozen populations (Klinowska, 1991). But my point here is to dramatise the third problem, that of habitat degradation, including both low level chronic problems and catastrophic pollution events, exemplified by oil spills. It is insidious habitat destruction which is the greatest threat to ecosystems, and which therefore is of direct but presently incalculable threat to cetaceans. Directed research efforts, strong public awareness, and intensive political-environmental lobbying are needed to begin to assess and eventually rectify problems of pollution. Western Europeans have made significant inroads to this problem in the past ten years, and I encourage my colleagues in North America and elsewhere to follow suit.

ACKNOWLEDGEMENTS I thank Mari Smultea and Thomas Henningsen for data on oil spills and dolphins; Spencer Lynn for the computer-drawing of Figure 1; and Claire Graham, Spencer Lynn, and Erica Lundin for typing and bibliographic help.

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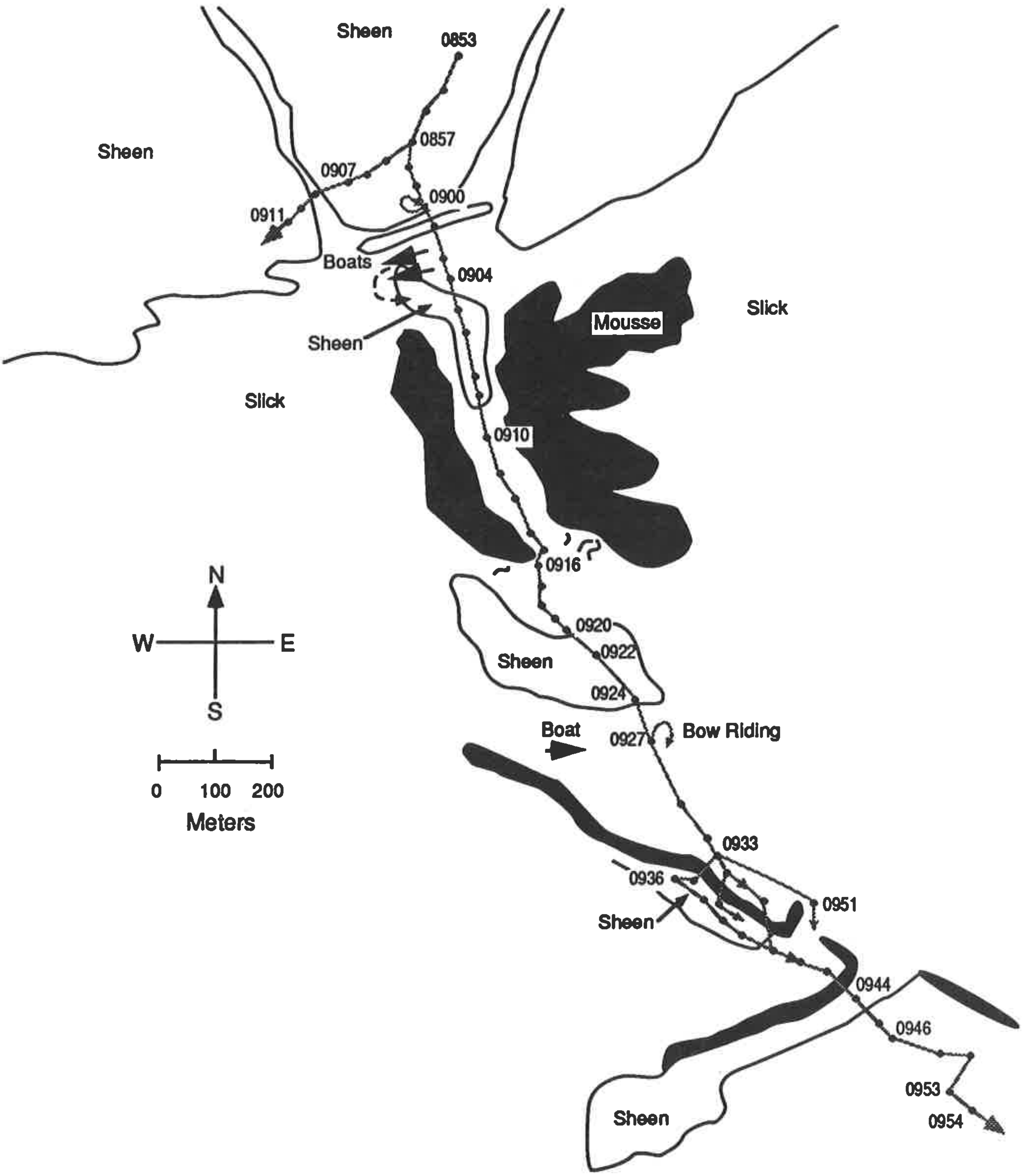


Fig. 1. A group of 17 bottlenose dolphins which split and aggregated in various ways in oil from the tanker *Mega Borg*, Gulf of Mexico. 18 June, 1990; 0853-0954 hr. Initial position: 29°18.6'N, 94°08.9'W. For details of subgroup numbers and behaviours, see Smultea and Würsig (1991).

NORTH ATLANTIC SIGHTINGS SURVEYS. WHAT DO THEY TELL ABOUT THE LARGE WHALES?

Nils Øien

Institute of Marine Research
P.O. Box 1870 Nordnes, N-5024 Bergen, Norway

Our knowledge of whales in the Northeast Atlantic has mostly relied on catch related information, incidental sightings and tagging experiments with Discovery marks. The implication has been that we have learnt a lot about the target species of whaling; that is mainly minke *Balaenoptera acutorostrata*, fin *B. physalus*, sperm *Physeter macrocephalus*, bottlenose *Hyperoodon ampullatus* and killer *Orcinus orca* whales, while we have had a rather superficial knowledge of the other species, mostly the small toothed whales. In recent years we have conducted sightings surveys, which especially in the case of the smaller whales, but also for the larger whales, have given us a better picture of whale distribution and abundance in general.

Our first attempts at conducting sightings surveys were made in 1984 and 1985, but it was readily recognised that much more effort had to be put into such studies if we were to get significant results. In 1987, a cooperative North Atlantic Sightings Survey was conducted with the participation of several countries, with the aim of mapping the simultaneous distribution of whales in the North Atlantic and to provide data for estimation of their abundance. A similar exercise was conducted in 1989. In addition, Norway conducted a survey in 1988, primarily to investigate the main concentrations of minke whales as revealed by the 1987 survey. This presentation is restricted to the Norwegian parts of these efforts, and I will concentrate on the larger baleen whales: fin, sei *B. borealis*, blue *B. musculus*, humpback *Megaptera novaeangliae* and bowhead *Balaena mysticetus*, in addition to the sperm whale.

The Norwegian surveys have been run with former whaling vessels as the main sightings platforms, although we have also tried to use other platforms such as fixed wing aircraft and helicopters, but without too much success. The surveys have been conducted with the vessels running along transects designed by following certain rules to ensure a representative coverage of the areas we wished to cover. When whales were observed, information necessary for the line transect analysis (angle and distance to the observation, group size, etc.) were collected.

In 1987, the Northeast Atlantic north of approximately 66° N was covered by Norway with three ships and one aircraft. In 1988, this area (with the exception of the Greenland Sea and the Northeastern Barents Sea) was covered by six ships and a helicopter. And finally, in 1989, the summer distributional area of the Northeastern stock of minke whales from the North Sea and northwards (Fig. 1) was covered by nine vessels.

Summaries of abundance estimates of large whales are given in Table 1. These estimates refer to summer distribution only since the surveys have been conducted mainly in July. The respective distributions may be summarised as follows: most fin whales were found in the Norwegian Sea and off Lofoten at this time of the year, with some stragglers along the Finnmark and Kola coasts. Humpbacks concentrated around the Bear Island area and in the northern part of the Norwegian Sea west of the continental slope in the Lofoten area, but there was also one individual northwest of Møre in southern Norway. Only one bowhead whale has been recorded during the sightings surveys, in the eastern Barents Sea.

Blue whales have been recorded in the Jan Mayen area, west of Lofoten, and west of Spitsbergen. There was only one observation of a sei whale, from the Norwegian sea. However, the sei whale is a species that has shown large fluctuations in numbers, as revealed by its previous catch history.

Table 1. Abundances of large whales as estimated from recent sightings surveys conducted by Norway. For each species, the total estimate for the total survey area in a given year is shown, as well as estimates broken down into comparable areas (the total areas covered were different in each year). 'Northeast' indicates the areas north of 66°N and east of 3°E. Coefficients of variation (c.v.) in parentheses.

SPECIES	ABUNDANCE (C.V.) 1989	1988	1987
FIN	2,245 (0.33)	2,309 (0.31)	-
... North Norway	1,906 (0.37)	1,045 (0.41)	-
... West Norway-Faroe Islands	340 (0.69)	-	-
... East Greenland-Iceland	-	1,265 (0.46)	5,806 (0.50)
HUMPBACK	698 (0.59)	1,126 (0.31)	-
... Northeast	698 (0.59)	1,067	-
SPERM	5,231 (0.31)	2,548 (0.27)	-
... Northeast	4,240	2,250	-
GREENLAND RIGHT	In the tens?		
BLUE	A few hundreds?		
SEI	???		

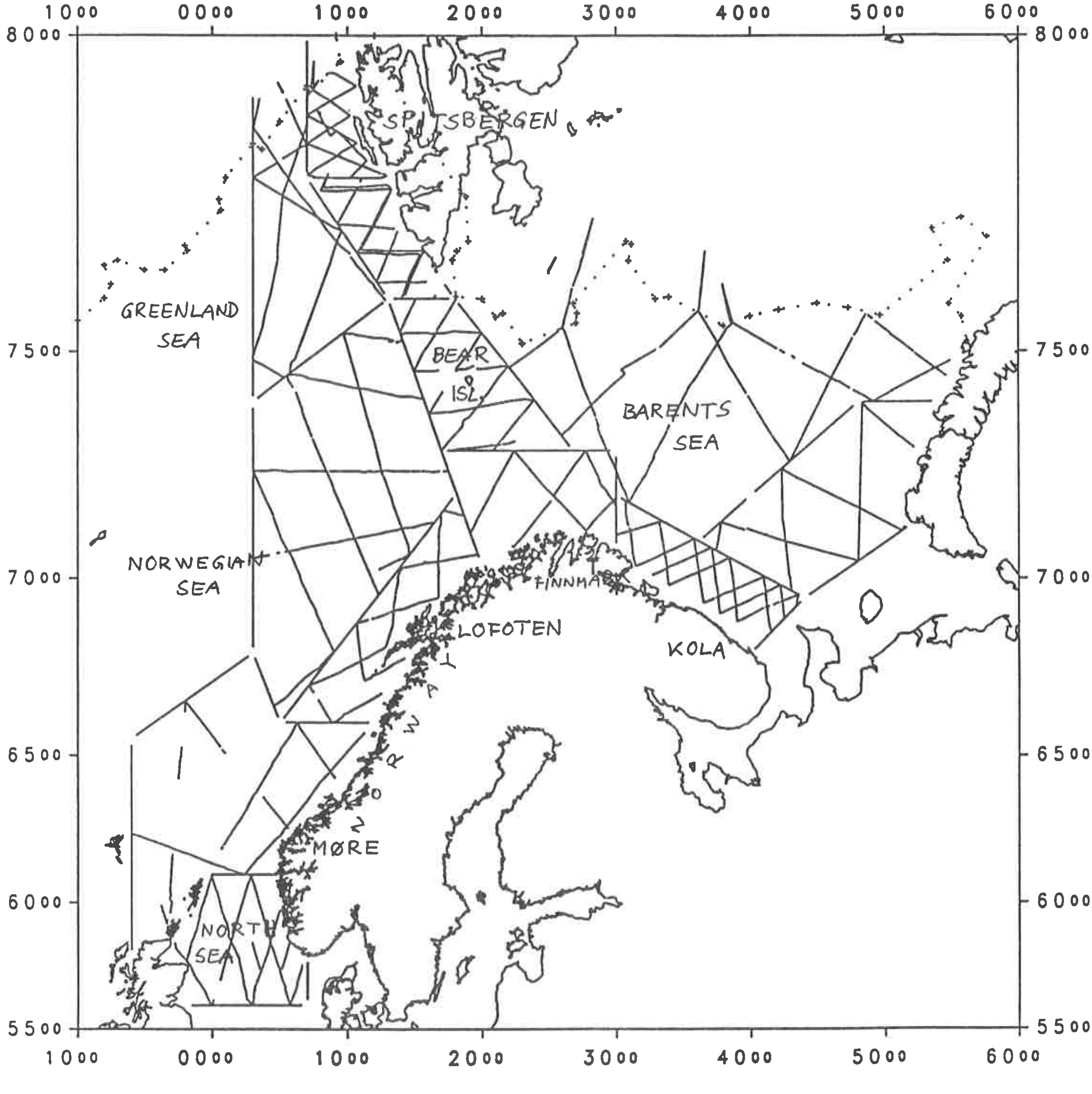


Fig. 1. Areas covered and transects run with primary search effort in the July 1989 survey.

SEA MAMMALS IN THE POLISH ZONE

Michal Malinga and Krzysztof E. Skóra

Hel Marine Laboratory, University of Gdansk,
B4-150 Hel, P.O. Box 37, Poland

Among sea mammals, the harbour porpoise *Phocoena phocoena* and seals *Halichoerus grypus*, *Phoca hispida* and *Phoca vitulina* are regular in the Baltic fauna. Other species occur only occasionally in the Baltic.

Data on cetaceans have been collected from 1979 to 1990 with the majority of observations being made in the Gdansk Bay. The harbour porpoise was observed 12 times while the beluga whale *Delphinapterus leucas* was recorded twice, and the humpback whale *Megaptera novaeangliae* only once. Finally, in the central part of the coastal waters, near Kolobrzeg, two white-beaked dolphins *Lagenorhynchus albirostris* were also caught.

The data on seals are only those which have been collected by Hel Marine Laboratory, University of Gdansk, since 1980. All observations were made in the region of Gdansk Bay, and, unfortunately, on the majority (six) of occasions, specific identification could not be made. The grey seal was definitely observed four times whilst the ringed seal was seen only once. There are no confirmed records of harbour seal between 1980 and 1990.

SURFACE FREQUENCY OF CETACEANS IN THE STRAIT OF GIBRALTAR

Dean D.K. Hashmi* and Boris B. Adloff**

*Zoological State Collection, Department of Ecology, Münchhausenstr. 21, D-8000 München 60, Germany
**Institut für Meereskunde, Abteilung Meereszoologie, Universität Kiel, Düsternbrooker Weg 20, D-2300 Kiel 1, Germany

INTRODUCTION Although the Strait of Gibraltar, as the only natural opening of the Mediterranean Sea, lies in a key position for migratory cetaceans which enter or leave Mediterranean waters, the occurrence and abundance of different species so far has been examined only superficially. In this study we present systematic data relating to about 38,600 cetaceans which were cumulatively counted (probably including multiple sightings of many individuals) along 11,370 km of trackline.

METHODS Almost daily crossings of the Strait were conducted from 18 September to 13 November 1987 (188 crossings covering 5510 km and 211 hours of observation), 29 March to 13 April 1989 (36 crossings, 1050 km, 39 h) and 6 August to 2 October 1990 (164 crossings, 4805 km, 178 h) along the 29.3 km between Algeciras (Spain) and Ceuta (Spanish North Africa).

The survey platforms (car ferries) had a height between 5 and 8 metres above sea-level and a steady speed of about 27 km/h. On either side of the vessel, within a sector of 180°, the sea was continuously surveyed with 10x40 binoculars by one observer.

RESULTS The most common of the 11 positively identified species were common dolphins *Delphinus delphis* and striped dolphins *Stenella coeruleoalba*, which together made up 95.4% of all cetaceans. During autumn 1987 and spring 1989 common dolphins were clearly more abundant than striped dolphins, but the opposite was the case during autumn 1990. Bottle-nosed dolphins *Tursiops truncatus* and pilot whales (probably exclusively *Globicephala melas*) were regularly present in small numbers. False killer whales *Pseudorca crassidens*, rough-toothed dolphins *Steno bredanensis*, Atlantic white-sided dolphins *Lagenorhynchus acutus* and killer whales *Orcinus orca* were rarely sighted, but their presence indicates that species of both warm and cold temperate waters enter the Mediterranean. White-sided dolphins, white-beaked dolphins and rough-toothed dolphins, which have been considered to be only rare visitors to the Mediterranean, may actually be regular components of the Mediterranean fauna. With respect to large whales, there were six sightings of sperm whales *Physeter macrocephalus*, two sightings of fin whales *Balaenoptera physalus* and two sightings of unidentified baleen whales *Balaenoptera* sp.. Although the data are probably biased by individuals not sighted due to submergence, encounters with large whales were surprisingly scarce.

ACKNOWLEDGEMENTS We would like to thank the Greenpeace Mediterranean Sea Project for their financial support for the 1990 field work.

Table 1. Cetaceans counted per km trackline during three transect series in the Strait of Gibraltar.

Species	29.3.-13.4.1989 1055 km		18.9.-13.11.1987 5508 km		6.8.-1.10.1990 4805 km		Total 11368 km	
	N	N/km	N	N/km	N	N/km	N	N/km
Delphinus delphis	690	0.654	11122	2.019	4521	0.941	16333	1.4367
Delphinus/Stenella * (unid.)	147	0.139	2006	0.364	3365	0.700	5518	0.4854
Stenella coeruleoalba	409	0.388	7079	1.285	7540	1.569	15028	1.3219
Tursiops truncatus	215	0.204	554	0.101	196	0.041	965	0.0849
Globicephala	37	0.035	272	0.049	149	0.031	458	0.0403
Lagenorhynchus albirostris			180	0.033			180	0.0158
Lagenorhynchus (unid.)					22	0.005	22	0.0019
Lagenorhynchus acutus					7	0.002	7	0.0006
Pseudorca crassidens	32	0.030	5	0.001	48	0.010	85	0.0075
Steno bredanensis	18	0.017			1	0.000	19	0.0017
Orcinus orca					6	0.001	6	0.0005
Physeter macrocephalus			3	0.001	4	0.001	7	0.0006
Balaenoptera physalus			5	0.001			5	0.0004
Balaenoptera (unid.)			2	0.000			2	0.0002
Total	1548	1.468	21228	3.854	15859	3.300	38635	3.3985

*may include a small proportion of other species

RESULTS OF THE GREENPEACE CETACEAN SURVEY CRUISES DURING THE WESTERN MEDITERRANEAN STRIPED DOLPHIN EPIZOOTIC.

Ricardo Aguilar *, Xavier Pastor ** and Jaume Forcada***

* Greenpeace Spain, Rodriguez San Pedro 58, 28015 Madrid, Spain
** Greenpeace International, Mediterranean Sea Project,
Ses Rafaletes, 16, 9J, 07015 Palma de Mallorca, Spain
*** Department of Animal Biology (Vertebrates), Faculty of Biology,
University of Barcelona, 08071 Barcelona, Spain

INTRODUCTION In mid-July 1990, a mass mortality affected the striped dolphin *Stenella coeruleoalba* population in the western Mediterranean Sea. The striped dolphin is a common species in this area, occurring mostly in deep waters. Because of this distribution, the number of animals washed ashore during the epizootic are believed to represent a small proportion of those actually killed. In order to gather data about the patterns of distribution, abundance and behaviour of striped dolphins in the area during the event, two sighting cruises were carried out on board the Greenpeace ship "Sirius". Survey One took place in an area known to have been affected by the die-off (Gulf of Lyons and western Ligurian Sea), while Survey Two covered an apparently unaffected region (south of the Balearic islands and north of Algeria).

Although the main purpose of the surveys was to collect information on the striped dolphin populations, data on distribution of other cetacean species were also collected.

MATERIALS AND METHODS Survey One (5-11 October 1990) cruised 656 nautical miles across the Gulf of Lyons and the western Ligurian Sea, covering an area of approx. 16,000 nm^2, and totalling 64.5 hours of effective searching time. Survey Two (7-9 December 1990) covered the waters south of the Balearic Islands and north of Algeria, totalling 306 nm over an area of 4,000 nm^2 during 28.5 hours of effective searching.

Both cruises were carried out with the MV "Sirius", a former Dutch pilot boat, 46 m long. Cruise speed during the survey was 10 knots. Track design and data collection followed standard line-transect methodologies.

Sightings were made by teams of two trained observers permanently placed above the vessel's bridge, 9 m above sea level. Observers were replaced every two hours.

Observations were carried out during 12 hours a day (05.30 to 17.30 h. GMT) during Survey One, and 10/11 hours a day (06.30 to 17.30 h. GMT) during Survey Two. The "Sirius" interrupted the cruise during night hours returning to position in the morning. Positions were determined by a satellite navigation system Magellan GPS NAV 1000. Water temperatures were measured with a digital thermometer Elektron, which ranges from -25°C to 120°C.

For every sighting, the following data were recorded: species, group size, direction of swimming, date, hour, position, surface water temperature, chart depth, duration of sighting, angle and distance of sighting, and weather conditions. Observations on behaviour and associated fauna were also recorded.

The data on school size obtained were compared between surveys and also with those available in the data base of the Department of Animal Biology of the Faculty of Biology, University of Barcelona (covering the period 1982 to 1989).

Indices of relative abundance of striped dolphins in each of the surveys were calculated as number of individuals and number of schools per hour of searching, and number of individuals and number of schools per nautical mile searched.

RESULTS Figures 1 and 2 show the survey tracks and the distribution of sightings. In total, 45 sightings of cetaceans were made (32 in Survey One and 13 in Survey Two). This included 25 sightings of striped dolphins (19 in Survey One and 6 in Survey Two). Of those, two sightings were of dead individuals found in open waters of the Gulf of Lyons. Other species occasionally sighted included fin whales *Balaenoptera physalus*, Risso's dolphins *Grampus griseus* , and common dolphins *Delphinus delphis*.

DISCUSSION In the area surveyed, striped dolphins were distributed in a similar pattern to that commonly observed for the species in the western Mediterranean. Thus, most observations were recorded in waters deeper than 100 m and at temperatures ranging from 16.2 - 22.6°C.

The number of schools observed was fairly high in both surveys and, when calculated relative to the time searched, were similar between the two areas (Table 2). However, substantial differences appear when school sizes are compared between surveys and with data obtained previously to the die-off with those carried out during Surveys One and Two.

At the time that the cruises were carried out, the epizootic had affected severely the area covered by Survey One (two dolphins were found floating dead during that cruise) while it had not reached the southern fringe or, if it had, its effects were less intense. Therefore, the low school size observed in Survey One probably reflected the high mortality suffered by the population during the episode. Coupled with the relatively high number of schools observed, these findings suggest that the population had seriously declined in this area and that, at the time of the surveys, the survivors had not come together to form new groups but, instead, still maintained their original school sizes.

Furthermore, reflecting this severe reduction in school size, the relative abundance of the striped dolphin in Survey One was substantially lower than in Survey Two, as indicated by the various indices depicted in Table 2.

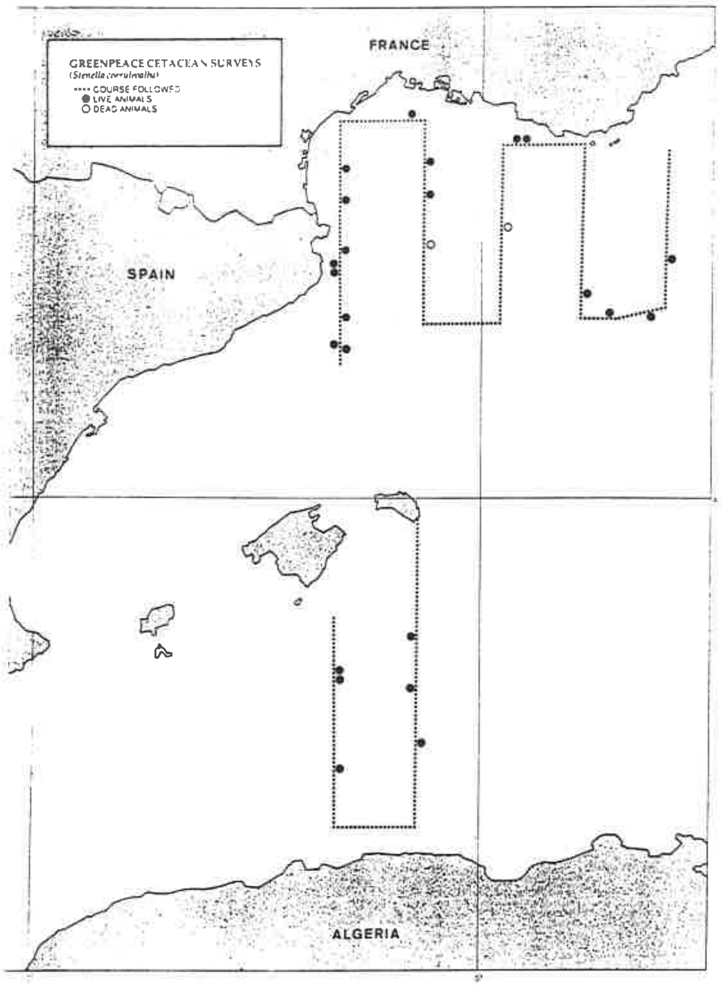


Fig. 1 Survey track and distribution of sightings of *Stenella coeruleoalba* from transects in Western Mediterranean Sea

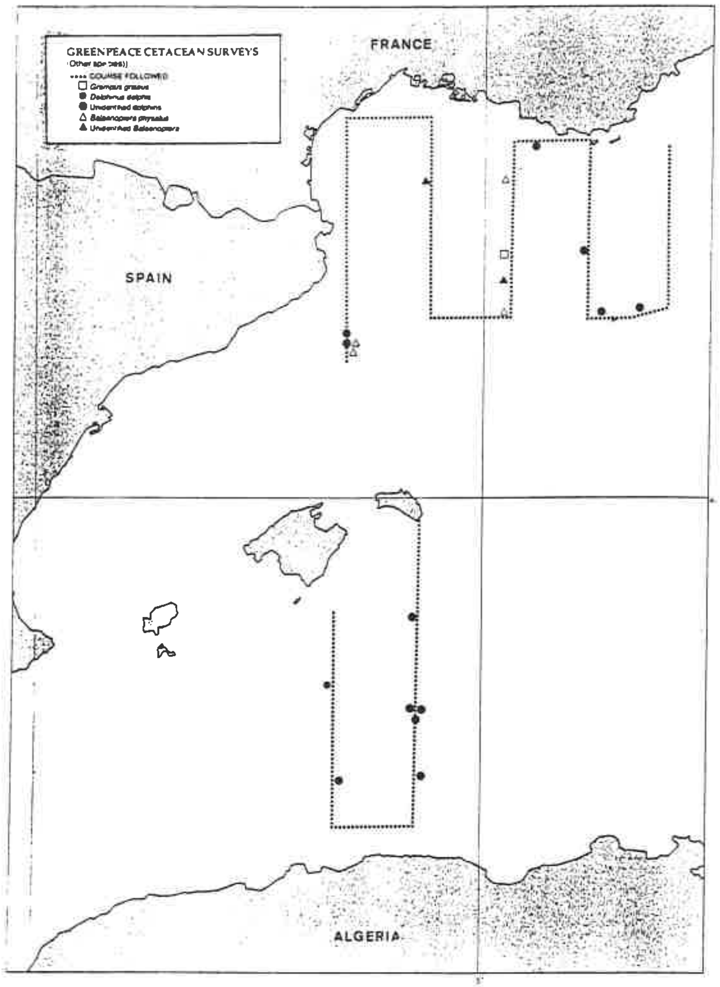


Fig. 2 Survey track and distribution of other cetaceans from transects i Western Mediterranean Sea

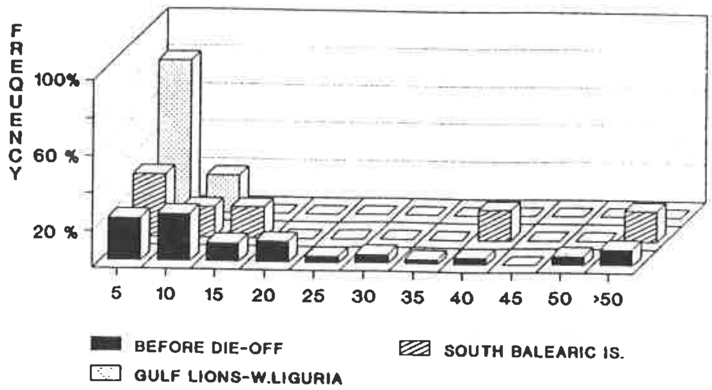


Fig.3 School sizes of striped dolphin *Stenella coeruleoalba*

Table 1 Mean school sizes of striped dolphins

Database 1982-89	*Sirius* Survey One	*Sirius* Survey Two
24.9	3.48	19.17

Table 2 Frequency and relative abundance indices for striped dolphin schools and individuals

	Survey One	Survey Two
Individuals/hour searched	0.93	4.02
Individuals/mile searched	0.09	0.38
Schools/hour searched	0.26	0.21
Schools/mile searched	0.03	0.02

PRELIMINARY RESULTS OF THE FIRST YEAR OF A SIGHTINGS SURVEY OF CETACEANS IN THE CENTRAL TYRRHENIAN SEA

Luca Marini, Carlo Consiglio, Anna Maria Angradi and Andrea Sanna

Dipartimento di Biologia Animale e dell 'Uomo,
Università "La Sapienza", Viale dell 'Università 85,
Roma, Italy

Up until now, the cetacean sighting cruises in the Mediterranean Sea have concentrated upon the summer and spring months, due to the high costs of equipping the boats that would have to face adverse weather and sea conditions. Therefore, we decided to utilize the ferry-boats of the National Railway that sail between the ports of Civitavecchia near Rome, and Golfo Aranci in the North-Eastern Sardinia, a distance of about 120 nm; this ferry service operates daily throughout the year, whatever the weather conditions.

The area is also an interesting bottleneck between the Ligurian Sea and the Southern Tyrrhenian Sea. From September 1989 to October 1990, 102 weekly trips were made by teams of skilled researchers, with a total of over 700 observation hours per person.

The results presented here concern only the first year of this research, since the second year is still in progress. Moreover, some of the data of the first year are still being analysed.

From over 400 sightings reported, the striped dolphin, *Stenella coeruleoalba* is the most common cetacean in this area in all seasons (see figure 1). The species is concentrated towards the centre of the channel, particularly beyond the western slope of a submerged ridge that runs in a north-south direction. The extremely confiding behaviour of this species prevented the possibility of doing an evaluation of the density of the population by the "line transect" method, since this condition would have surely led to an over-estimation. No significant seasonal differences in group size were noted, although average group sizes were higher in May and December. An analysis of the behaviour of striped dolphins in the presence of boats is still in progress (see figure 2).

The frequency of sightings of sightings of *Balaenoptera* species was of particular interest. Rorquals were present in the Tyrrhenian Sea throughout the year, including the winter months, when, in the past, strandings were only rarely recorded. The geographical distribution of rorquals was similar to that of the striped dolphin but was more extended above the submerged ridge; anyway, it was also recorded over the continental shelf. School sizes appeared to be greater in the winter months; in summer, only isolated individuals or pairs were seen. Isolated breaching animals were recorded twice, in January and in June.

A density estimate, calculated by the "line transect" method, is currently being developed. Sighting comparisons in different sea conditions suggest that those trips made when the sea state was above 3 should be omitted, in order to avoid under-estimating sightings.

Sightings of common dolphins *Delphinus delphis*, were rare, confirming the negative trend shown by other researchers. However, surprisingly in some aspects was the absence of both sperm whales *Physeter macrocephalus*, whose distribution is considered more southern, and long-finned pilot whales *Globicephala melas*, which have been frequently sighted by other authors both in the Southern Tyrrhenian Sea and in the Ligurian Sea.

Also interesting was an encounter with Cuvier's beaked whale *Ziphius cavirostris*, considered rare in the Tyrrhenian Sea; it was also photographed. As expected, Risso's dolphin *Grampus griseus* was sighted very rarely. The limited number of sightings of bottle-nosed dolphins *Tursiops truncatus* can be related to its coastal habit.

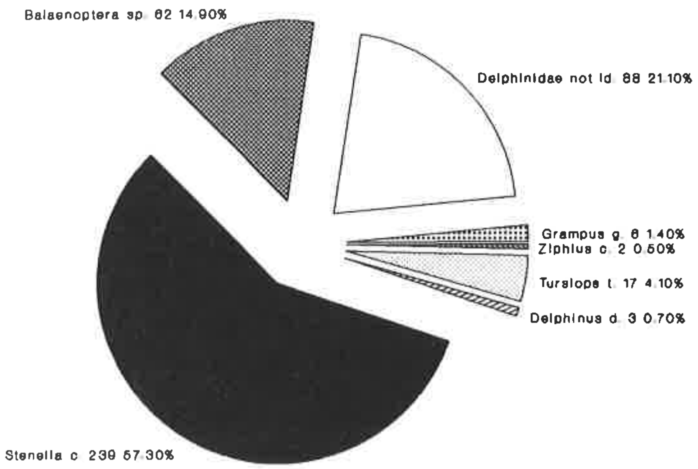
Although by using ferry-boats as "platforms of opportunity", some problems arise relating to the impossibility of stopping or altering course to approach the animals, the method appears to be very useful with respect to the large quantity of data collected on the ecology of cetacean populations.

ACKNOWLEDGEMENTS We owe much gratitude to all the people that took an active part in this research as observers (particularly to S. Sarmati and T. Valentini), to the officers and crews of the ferry-boats, to the staff of the National Railway Board and to the Environmental Bureau of the Provincial Administration of Rome, which sponsored the research. A special thanks goes to J. Gordon and P. Hammond for their kind advice, and to M.G. Finoia for her assistance in statistical work.

We show our gratitude to Germana Villetti, in recognition of her bright suggestion.

Table 1 Cetacean sightings in the central Tyrrhenian Sea

	1989				1990									
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	TOTAL
Stenella coeruleoalba	6	15	25	14	25	12	18	15	26	28	21	25	7	237
Tursiops truncatus		2	1	1				3	4		3	2	1	17
Delphinus delphis			1	1							1			3
Grampus griseus		3			1				1					5
Ziphius cavirostris										1		1		2
small whale sp.		1	2	2		4	4	4	9	2	7	8	1	44
medium whale sp.					1		1		1	1			1	5
Balaenoptera sp.		4	1	1	4	4	2	5	12	7	9	6	7	62
large whale sp.			1			1	1	1	1		1	1		7
unidentified cetaceans		2	1	2	2	4	2	5	4	5	6	3	1	37
total	6	27	32	21	33	25	28	33	58	44	48	46	18	419
no. of trips	2	8	10	7	9	7	8	8	10	8	10	8	7	102



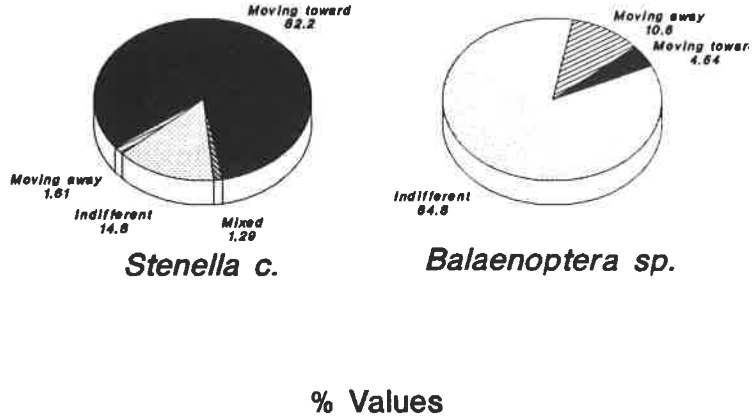


Figure 1 Sightings per species (%)

Figure 2 Comparative Behaviour of Schools

AN ANALYSIS OF SPERM WHALE *Physeter macrocephalus* L. STRANDING AND SIGHTING RECORDS FROM BRITAIN AND IRELAND

Simon D. Berrow*, Peter G.H. Evans** and Martin C. Sheldrick***

*Zoology Department, University College, Cork, Ireland
**Zoology Department, University of Oxford, Oxford, England
***Zoology Department, British Museum (Natural History), London, England

During 1990, there were many reports of relatively large numbers of sperm whales *Physeter macrocephalus* being washed ashore along the coasts of Britain and Ireland. This caused considerable speculation in the media concerning their potential causes of death. Stranding records from Britain and Ireland were analysed in order to determine whether the number of recent strandings were exceptional. This analysis was complemented with sightings data from weatherships operating approximately 700 km west of the Hebrides, Scotland.

RESULTS Most of the recent sperm whale strandings occurred on the western seaboard of the British Isles, especially on the north-west coasts. All stranding records from the east coast of England, except one, occurred during the period 1626-1825 so the distribution of the recent strandings was consistent with most of the previous records from the present century (Fig. 1). Records of stranded sperm whales have been made in all months although there was a slight increase in frequency during the winter (Fig. 2). The seasonal distribution of the present strandings is also consistent with previous records. Whenever the sex and length of the recent strandings were recorded, the whale was male and usually measured between 35'-60' in length. All animals except one, which was unreliably reported as 'alive this week but died within a few hours of arrival' were in poor condition after having been dead for some time. These data are consistent with previous records.

The number of sperm whales recorded stranded on the coasts of Britain and Ireland has increased this century and the rate has increased since the 1950's. This increase has occurred concurrently on both the British and Irish coasts (Fig. 3). During the last decade there was a significant increase (using Yates correction) in the number recorded stranded in 1987 (X^2_1= 5.46, P<0.05) but no significant difference between the years 1988 and 1989 (X^2_1= 1.37, n.s.) or 1989 and 1990 (X^2_1= 2.38, n.s.). The numbers of sperm whale sightings have increased since the 1960's, reaching a maximum in the late 1970's (Fig. 4) which was associated with an increase in the number of small groups and females with calves sighted. The number sighted since this maximum has been reasonably constant. Sightings were made throughout the year with a maximum recorded in the summer and autumn (Fig. 5).

DISCUSSION Implicit in the analysis of stranding data for monitoring both population status and distribution is the need for constant effort in obtaining records. An increase in the number of reported strandings may be due to an increase in observer effort (Fairley, 1979). Records identifiable as sperm whales date back to the 9th or 10th century as the distinctive features of sperm whales and their large size probably make them one of the best reported whale species (Evans and Scanlan, 1989). The number of reported strandings increased in Ireland and Britain concurrently, suggesting a real increase has occurred. The number of strandings reported during 1990 was not significantly greater than reported during the previous two years but does reflect the increase in strandings that has been occurring since the 1960's. This is also reflected by the sightings data. This analysis suggests that sperm whales off the coast of the British Isles are predominantly adult males, confirming previous work. There is no evidence that sperm whales were overfished off the British Isles (Brown, 1976) but this increase, especially with the frequent sightings of mother-calf pairs during the late 1970's, may indicate an increase in numbers further south or may perhaps be associated with the distribution of squid, their principal food. It is interesting to note that there has been a general increase, in recent years, of the number of reported strandings of squid-eating whale species on the coasts of Britain and Ireland.

However, with the stranding of over twenty sperm whales on the Norwegian coast during 1990, caution must be expressed in relating the increase in the number of reported strandings as merely reflecting an increase in the number of whales occurring in the Northeast Atlantic. Unfortunately, stranded animals were usually in too poor a condition for post-mortem analysis and careful monitoring of strandings and sightings will be required in the future to monitor this situation.

ACKNOWLEDGEMENTS Simon Berrow would like to acknowledge Joe Gatins, D.O. Wildlife Service (Ireland) and Kevin Flannery for unpublished stranding records and Penn Chemicals, Cork and Greenpeace for funding.

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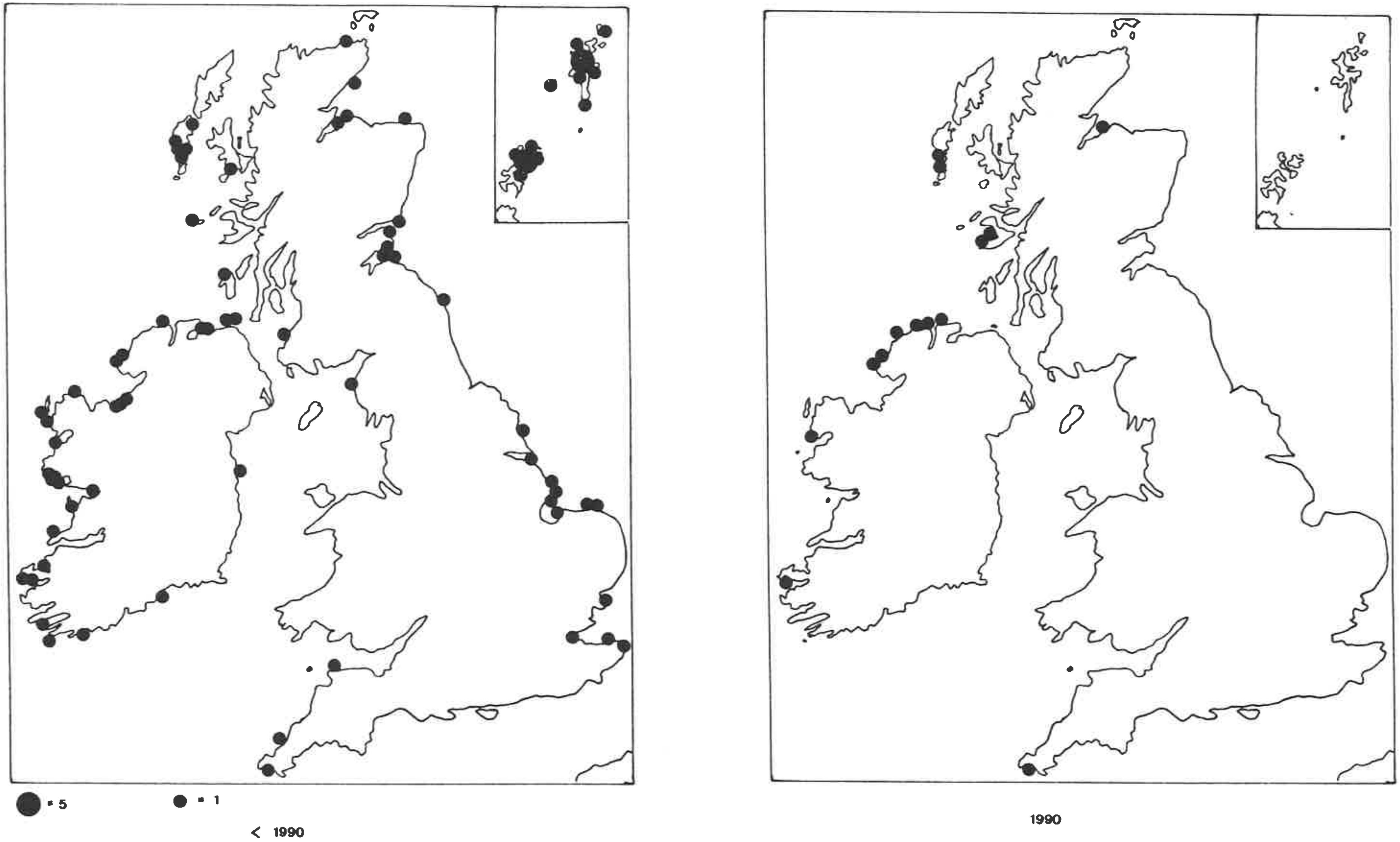

Fig. 1. Location of reported sperm whale strandings on the coasts of Britain and Ireland.

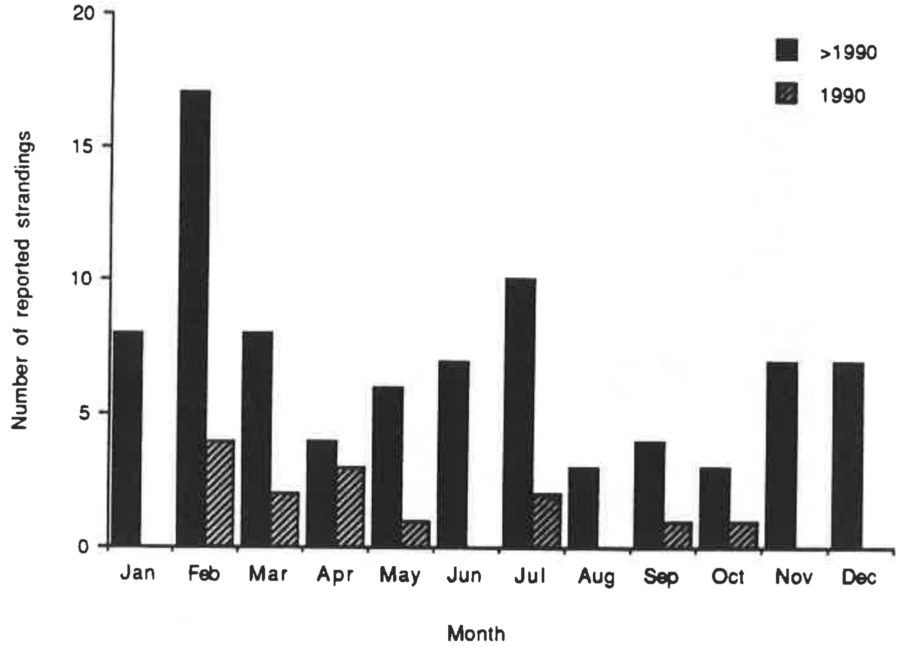

Fig. 2. Seasonal distribution of reported sperm whale strandings on the British and Irish coasts.

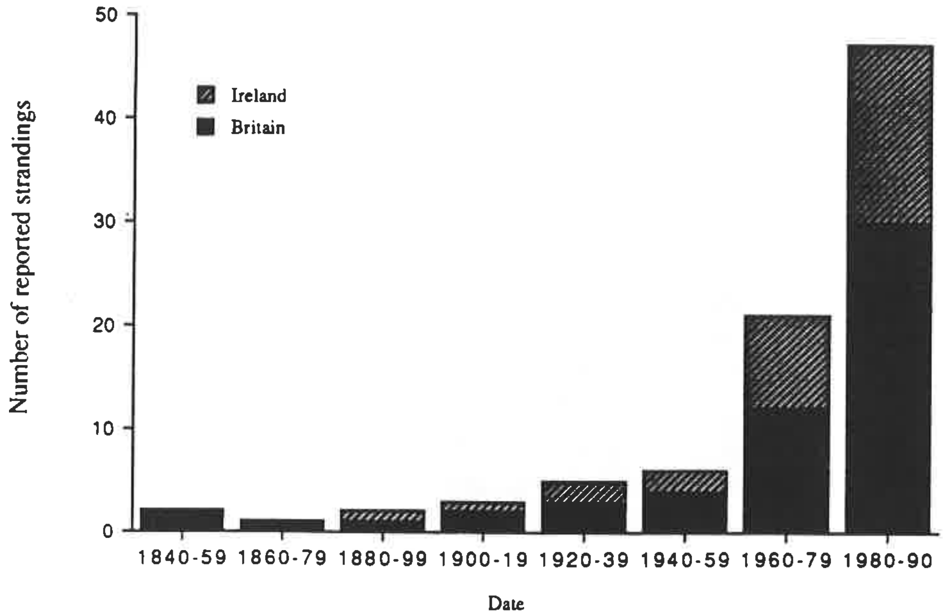

Fig. 3. Number of reported sperm whale strandings on the coasts of Britain and Ireland over the period 1840-1990.

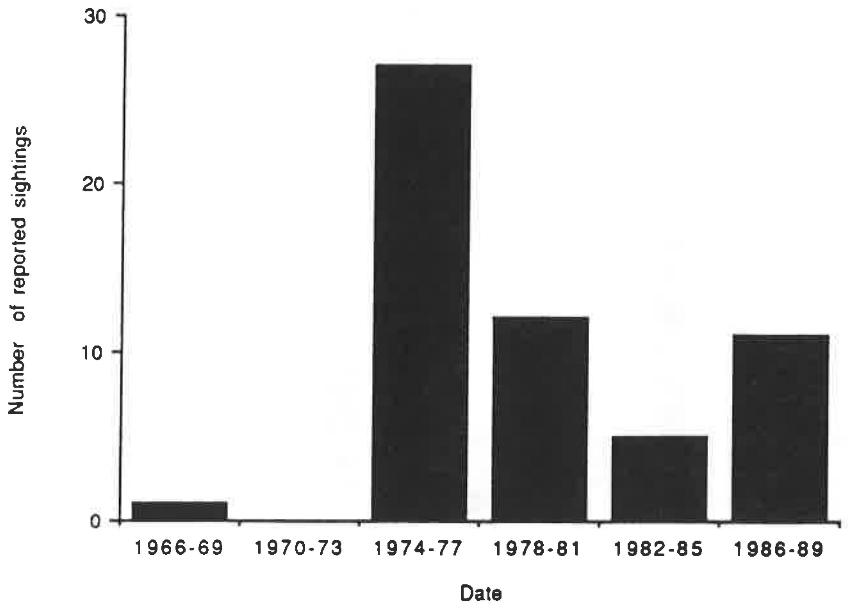

Fig. 4. The number of reported sperm whale sightings off the coasts of Britain and Ireland over the period 1966-1989.

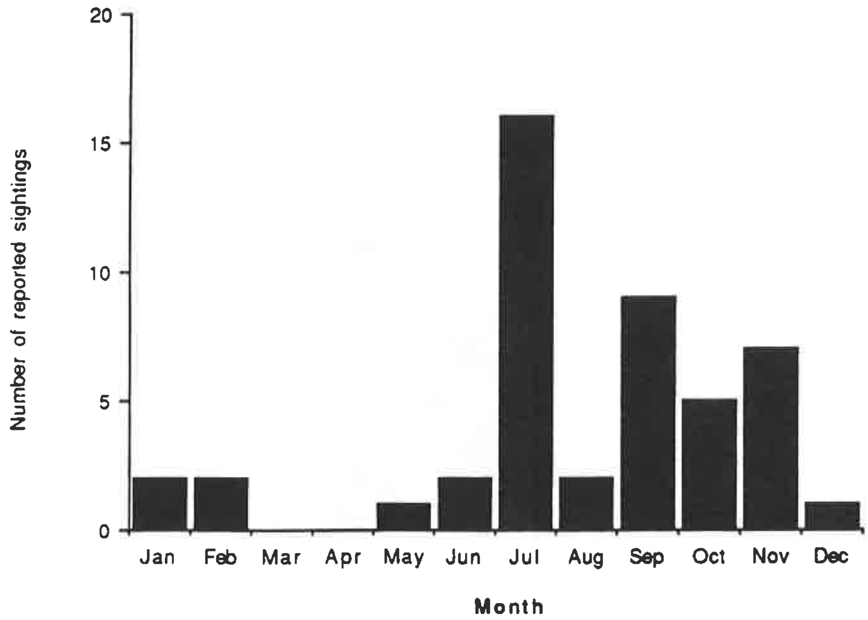

Figure 5. Seasonal distribution of sperm whale sightings.

RESEARCH AND MANAGEMENT OF BELUGAS AND NARWHALS IN GREENLAND

M.P. Heide-Jørgensen and J. Teilmann

Marine Mammal Section,
Greenland Fisheries Research Institute,
Tagensvej 135, DK-200 Copenhagen K, Denmark

Belugas *Delpinapterus leucas* and narwhals *Monodon monoceros* are amongst the most important of marine mammals for the Inuit subsistence exploitation of marine wildlife in Greenland. Harvest levels have increased since the 1950's and present catches amount to about 500 narwhals and 1,000 belugas per year. Both species are considered to be harvested at levels at or above Maximum Sustainable Yield, and both are subject to mass mortalities in ice entrapments.

Distribution of belugas in southwest Greenland has changed dramatically during this century and several neighbouring stocks are now considered depleted. The present status of the populations is uncertain and warrants more thorough assessment.

Samples from the Inuit harvest of the whales are collected routinely, and methods for monitoring movements and trends in abundance are being developed. Preliminary results from studies of changes in distribution and abundance, and estimation of reproductive parameters are presented.

LONG-TERM STUDIES OF KILLER WHALES *Orcinus orca* OFF THE MIDCOAST OF NORWAY

Anna Bisther and Dag Vongraven

Department of Zoology,
University of Trondheim-AVH,
7055 Dragvoll, Norway

Thirty-two individual killer whales from six groups have been photographically identified in the area around Kristiansund during the period January 1988 to November 1990. All fieldwork has been carried in the period October to April, peaking in January, coinciding with the occurrence of herring *Clupea harengus* in the fjords.

The same two adult males occurred together in two different groups consisting of 11 and 12 individuals respectively, males included. This could indicate the presence of a mating system with males migrating between groups. Newborns have been observed in November and February.

One group of four whales has been observed hunting seals, and eating on a seal carcass twice in areas known for their status as breeding and haul-out sites for grey and harbour seals. Between these observations, there was an interval of more than three years.

Acoustic investigations have revealed a stability in vocal repertoires over time, an acoustic variability within the pod depending upon its activity and the occurrence of identical types of pulsed calls in recordings made off the midcoast (Møre) and in the north (Lofoten). These two areas have been considered to be the most important for killer whales in Norway. Positive matches of individuals have now been made between the two areas.

KILLER WHALES *Orcinus orca* IN NORTHERN NORWAY

Tiu Simila* and Fernando Ugarte**

*Tromsø University, 9000 Tromsø, Norway
**Whale Center, P.O. Box 58, 8480 Andenes, Norway.

INTRODUCTION Killer whales *Orcinus orca* are distributed along the entire coast of Norway, with main concentrations in the Lofoten and Vesterålen islands (the present study area), off the coast of Møre and in Finnmark. In our study area the abundance of herring seems to be the main factor affecting the numbers and distribution of killer whales.

Benign research on Norwegian killer whales was started by a Nordic network group, the Centre for Studies of Whales and Dolphins. The group has photo-identified killer whales in Lofoten and Vesterålen islands since 1983. In 1983-88 this work was done mainly in late autumn in Lofoten. The establishment of a Whale Centre in Andenes, Vesterålen, forms a permanent base for research and, since 1989, field work has been done throughout the year. In summer field work is done outside the Vesterålen islands and in winter mainly in Tysfjorden in the Lofoten islands.

RESEARCH AIMS

1. To identify killer whale individuals and groups encountered in the study area. The structure and size of the groups are studied to see if the killer whales form groups with stable membership. The social organisation of age groups is analysed.

2. To study the seasonal distribution and abundance of killer whales around Lofoten and Vesterålen islands. The sightings are compared to the abundance of herring to find out to what extent the movements of the whales follow those of herring. Of special interest are possible group specific or seasonal differences in the diet of killer whales. This information, together with the knowledge about the number and size of groups observed in the study area, provides information on the role the whales play in the local marine ecosystem.

3. To study the behaviour of killer whales. The different types of surface behaviour are observed during each encounter and the data analysed to determine possible diurnal/seasonal patterns, the behaviour of different age/sex classes and possible differences between groups. Of special interest is the feeding behaviour: the manner in which killer whales hunt for herring and at what times. In addition to surface observations, this work includes underwater observations.

4. To study vocalisations of killer whales. Calls of different groups are analysed to determine whether the groups differ in their calls, as occurs for example amongst killer whale groups in the Pacific Northwest. The vocalisations accompanying different types of behaviour are also analysed. Sound recordings made during hunting and feeding are analysed to determine how the sounds are used in catching prey.

METHODS

1. Searches are made for whales using a combination of different methods. In the winter season, when whales are observed close to land, whales are searched from look-out points. In addition, a "Whale Hotline" has been established to get information on sightings from passenger boats, fisheries protection boasts, fishing boats and local people. Both in winter

and summer seasons, sighting surveys are made using both boat and aeroplane to estimate the distribution of whales.

2. Whales are photo-identified using 35 mm SLR cameras with 300 mm lenses, and black and white film. The negatives are analysed with a dissection microscope.

3. During each encounter, whales are video filmed in order to record the size of the groups, and for behavioural studies. Together with the identification pictures, the films can be used for analysing the structure and organisation of the groups.

4. In addition to using the video camera, the size of the groups and the behaviour of the whales is observed visually. When feeding is observed, a diver will aid in underwater documentation of the event.

5. Sounds are recorded during each encounter. The vocal activity level is studied with the aid of a towed hydrophone that allows listening also while the boat engine is running.

RESULTS Herring enter the fjords (especially Tysfjord and Ofotfjord) of Lofoten in September-October, followed by an estimated minimum of 500 killer whales. During this time, large numbers of whales can be seen in a relatively small area, making this the ideal field season. In early February the herring move to the spawning grounds further south and at least some of the pods follow. Between April and July, herring are scattered over a large area stretching from Lofoten to Møre. During this time, killer whales are mainly observed around the outermost islands of Lofoten and in continental shelf waters. In August, herring start to congregate around the Vesterålen islands, and killer whales are regularly observed in inshore waters.

So far, 270 individuals have been identified. 80% of the identifications are from the last two years, the result of a more extended field season and the establishment of the "Whale Hotline". The number of resightings in relation to the number of new individuals is increasing yearly. So far, 16 pods have been resighted often enough to be called pods and not temporary groupings. None of the pods has been completely identified so it is not possible to analyse their structure or stability yet, but certain individuals have been sighted together over periods of several years, indicating that there are long-lasting bonds at least between some individuals.

Our behavioural studies are still in the initial phase. Whilst individuals and groups remain poorly documented, photo-identification has the main priority. The behaviour of whales has been divided into four different categories: resting, travelling, playing and feeding. Most of the behaviour observed has been either resting or travelling, but much of the travelling behaviour may be related to searching for food. The play behaviour observed include spyhopping, breaching, cartwheeling, headstands, surfing, wave-riding, playing in the tidal currents and sexual playing. Most of the play behaviour is performed by calves and juveniles.

We have restricted the use of the term "feeding behaviour" to those observations where we have found fish scales, pieces of fish, or floating or stunned fish in the middle of milling whales. In the future we hope that our data gathering will be more precise with the aid of a fish finder and acoustic observations. The most obvious feeding behaviour which engages a lot of surface activity can be described as following: the whales form a large circle around a school of herring and start swimming around it in ever-decreasing circles. This behaviour is accompanied by high vocal activity, tail slaps and splashing. When the herring have been herded to a tight column, the fish are apparently kept together using vocalisations, by showing the white parts of the body, by emitting underwater bubbles, and by tail slaps.

THE CONFLICT BETWEEN KILLER WHALES AND FISHERMEN The North Atlantic stock of spring spawning herring collapsed due to overfishing around 1970, and this led to a change in the migration pattern of herring. Herring started to overwinter in northern Norway instead of Iceland. This led to a considerable increase in the number of sightings of killer whales in the study area, which was interpreted as a sign of increase in the whale population. Fishermen claimed that killer whales were preventing the recovery of herring, and 369 killer whales were killed in Lofoten and Vesterålen between 1971-81, until the International Whaling Commission stopped this hunt. During recent years, killer whales have concentrated in the innermost parts of the Lofoten area and it is not unusual to see 40-60 whales within a few square kilometres. This has caused an uproar and fishermen are annually demanding for the restart of hunting of killer whales. These claims are based on incorrect ideas on the number and biology of killer whales. We hope that the continuation of our study will help to spread correct information about killer whales in Lofoten and Vesterålen islands and thus solve the unnecessary conflict.

BOTTLE-NOSED DOLPHINS IN GALVESTON BAY, TEXAS: NUMBERS AND ACTIVITIES

Thomas Henningsen* and Bernd Würsig**

*Institut für Polarökologie der Christian-Albrechts-Universität zu Kiel, Ohlshausenstraße 40, 2300 Kiel, Germany
**Marine Mammal Research Program, Texas A&M University at Galveston, 4700 Avenue U, Galveston, Texas 77551 U.S.A.

The bottle-nosed dolphin *Tursiops truncatus* is the most common cetacean species found along Texan shores. Between April and October 1990, we investigated bottle-nosed dolphin occurrence and activity patterns in Galveston Bay, and adjacent waters of the Gulf of Mexico. Our main focus was on a comparison of residency patterns, group sizes, activities and interactions with human use of bays and open ocean waters. We conducted the study from a small motor vessel and from a helicopter. We identified dolphins by photography and high resolution videography by distinguishing marks on their backs (Defran *et al.*, 1990; Würsig and Jefferson, 1990).

The study area is 2,100 square kilometres including Galveston Bay, a bay system of four neighbouring bays which total approximately 1,550 square kilometres, and the adjacent waters of the gulf of Mexico which total approximately 550 square kilometres. There are only three small entrances to the bay system. The bays have mainly a muddy or fine sand bottom and are on average only 240 cm deep, whereas the adjacent waters have a middle-sized sand bottom and are about 10 m deep. There are about 400 km of 13 m deep dredged channels for shipping traffic inside the bay systems.

The Galveston Bay area is a centre of the petrochemical industry and is one of the most industrialised and polluted large bays in the United States. More than 50% of all chemical products manufactured in the United States are produced in this area, as well as 17% of the refinery of all oil produced in the entire Gulf of Mexico.

More than 3 million people live around Galveston Bay. There is a high amount of vessel traffic due to industrial, fishing and private utilisation (more than 120,000 private boats are registered in the four states surrounding Galveston Bay). It is also one of the main areas in the United States for the shrimp and oyster fishery.

Every sighting of single or groups of dolphins was registered, along with oceanographic and biological data. The location of each sighting was marked on a map.

During the study period we had 412 sightings totalling approximately 2,991 dolphins. We had more sightings in the last 3 months than in the first four months of the study. In May, June and July we had an average of 1.2 sightings, in August and September about 1.8, and in October 2.2 sightings per boat survey hour. This shows a tendency for increasing numbers of dolphins in the area from spring to autumn.

Of all dolphins sighted, we identified 1,002 different individuals by photographs. Of these 1,002 individuals we saw 867 dolphins only once during the study period, which means that only 135 dolphins were resighted, 32 dolphins more than once.

We spent almost the same amount of time in the bays as in the adjacent waters of the Gulf and we had approximately the same number of sightings in both habitats. The number of newly identified animals was 276 in the bays compared with 726 in the Gulf waters, but the number of resightings in the bays was 280 compared to 103 in the Gulf area.

There was a difference in group size between the bays and the Gulf area. We had more lone animals and small group sightings in the bays than in the Gulf, and there were more sightings of larger groups in the Gulf than in the bays. Lone animals in the bay constituted 13% of all sightings, but in the Gulf only 4%. Groups of more than 20 animals constituted 9% of sightings in the Gulf, and in the bays only 0.3% of sightings. The largest group sighted in the bays was 23 animals, whereas in the Gulf we had sightings of up to 100 animals in a group.

We found an unexpectedly high number of bottle-nosed dolphins using an area of high human impact. One reason could be that bottle-nosed dolphins may migrate to the Gulf of Mexico and therefore pass through this area, staying there only for a short period of time. This is indicated by the fact that 86% of the dolphins here were seen only once. Dolphins are also attracted to shrimp fishing vessels and to human made structures such as dredged channels and jetties, since prey are often concentrated in these areas. Of all sighted animals, 42% were swimming behind shrimping boats. These animals follow the fishing boats and feed on discarded fish, but their main food source is from fish and crustaceans disturbed by the bottom trawling nets. This had already been observed in various other places, such as California (Leatherwood, 1975) and Australia (Corkeron *et al.*, 1990).

The fact that most resightings of animals occurred inside the bays indicates that the bays may be a home range for some of the observed animals but the open waters more likely were not. The difference in group sizes between the bays and the Gulf might also be related to the shrimping activity. In the Gulf, there are many larger boats operating with two trawling nets, whereas the shrimping boats in the bays use only one net. This means that a larger group of animals can feed behind the Gulf operating boats. In the Gulf we saw 24 big groups consisting of more than 20 animals; 18 of them were seen behind shrimping vessels and we observed that in some cases these big groups split off into smaller groups. This might be a form of fusion-fission behaviour whereby social animals congregate for a short period of time in places of good supply and split off after they have eaten. This behaviour is known also in chimpanzees, for example (Ghiglieri, 1988).

There are many threats facing the dolphin population in this region. Shark predation and human activities are two of the most obvious. Of all observed dolphins, 5% had scars or wounds on their backs directly related to shark attacks. Since sharks normally attack their prey from below, the number of casualties is likely to be higher than this.

Bottle-nosed dolphins in Galveston tolerate the disadvantage of disturbance and noise pollution from small boats and big ships, and also from industrial and harbour activities, for the advantage of a good food supply.

Pollution and the toxic components contained within their environment are no doubt the biggest threats facing the health and future survival of these animals. There is a high concentration of heavy metals in the sediments (White *et al.*, 1985) as well as a high level of toxic hydrocarbons which are directly related to oil industry operations in the Galveston Bay area.

The fact that bottle-nosed dolphins do not avoid oil and its vapours was observed by us when two major oil spills occurred during the study period. Oil vapours are known to be very harmful for marine mammals, as was found for sea otters after the Exxon Valdez oil spill in Alaska (Osborne and Williams, 1990). We observed that the dolphins did not leave oil slicks for hours even when clean water was close by (Smultea, Würsig & Henningsen, unpubl.; Smultea and Würsig, 1990).

An exceptionally high mortality which occurred in the area in 1990 awaits necropsy and body tissue analysis and has not yet been explained.

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DIFFERENTIAL SITE USE AND DIVING BEHAVIOUR OF BOTTLE-NOSED DOLPHINS IN THE MORAY FIRTH, SCOTLAND

Frithjof Praetsch

Department of Biology and Preclinical Medicine, Bute Medical Building, University of St Andrews, St Andrews, Fife KY16 9TS, Scotland, UK

INTRODUCTION Over the last 25 years, free-ranging bottle-nosed dolphins (*Tursiops truncatus*) have been extensively studied in many parts of the world. The picture that has emerged from these studies is one of a highly polymorphic species that has successfully adapted to a wide variety of different habitats (Leatherwood & Reeves, 1990). In addition to various seasonal movements, both tidal and diurnal rhythms have been found in the behaviour of this species, probably reflecting the movements of the dolphin's main prey species (Shane *et al.*, 1986).

The Moray Firth (Fig. 1), off northeast Scotland, contains one of the best-known groups of bottle-nosed dolphins in British waters (Hammond & Thompson, 1991). Compared with most other populations of this species that have been studied to date, the bottle-nosed dolphins living in these relatively cold waters tend to be considerably larger and have a thicker layer of blubber, thus making a study of their ecology and behaviour particularly interesting. Nevertheless, this study was one of the first attempts to investigate the short-term movements and behaviour of Moray Firth bottlenose dolphins during the colder months of the year.

METHODS During winter and spring 1990, the behaviour of these dolphins was studied in the course of 370 hours of land-based observations, which were scheduled to cover all daylight hours. The study concentrated on three study areas (1 km radius) near the mouths of the Beauly, Inverness and Cromarty Firths (South Kessock, Chanonry Point and South Sutor respectively; see Fig. 1). Data on the size and composition of groups, general behaviour, the direction of movements, and the duration of submergences of identifiable dolphins were recorded using a portable tape recorder.

RESULTS AND DISCUSSION Mean daily group size was similar at 2.1 to 3.2 indviduals in the three study areas throughout this study. However, the mean daily group sizes recorded in the two more sheltered study areas (South Kessock, Chanonry Point) were significantly smaller than those recorded off South Sutor and off Tarbat Ness, areas closer to the open sea. The likely reason for this was a well-documented lack of prey in the inner Firths at the time. In agreement with earlier work, the maximum daily numbers of dolphins sighted off Chanonry Point was significantly greater during May than during March. During the warmer months of the year, Moray Firth bottle-nosed dolphins feed extensively on salmon *Salmo salar*, and the above-mentioned increase in the number of dolphins corresponds well with the onset of the annual return of large numbers of salmon to this area during late spring. The findings of this study lend support to the hypothesis that, compared with summer 1989, fewer bottlenose dolphins frequented the study areas during winter and spring 1990.

Both off South Kessock in January (Fig. 2) and off Chanonry Point in May, the presence of dolphins followed a statistically significant tidal rhythm, with animals being sighted more often during a rising tide. Off South Kessock, this possibly reflected the short-term movements of flatfish which, at this time of the year, have been found to move out onto mudflats with the rising tide to feed there. The prey species responsible for the rhythm observed off Chanonry Point was almost certainly salmon. During their return migration through estuaries, salmon tend to get carried along by tidal currents, and therefore relatively high numbers can be encountered in tidal rapids. Moray Firth bottle-nosed dolphins take advantage of this phenomenon, and were found to stay significantly longer in the area when tidal rapids were present. Interestingly, the presence of dolphins observed near Chanonry Point during winter 1991 followed a clear diurnal rhythm, with most animals being sighted around midday. Fish surveys and studies of Moray Firth common seals *Phoca vitulina* suggest that these dolphins were probably feeding on young herring *Clupea harengus* or sprats *Sprattus sprattus*.

There were significant differences, both between the three areas and seasonally, in the percentage of time spent by dolphins in different activities. Although all three study areas are quite similar with respect to their underwater topography, the dolphins observed off South Kessock spent most of their time travelling or resting whilst dolphins in the two other areas were presumed to be feeding for most of the time (Fig. 3). The reason behind this was probably that in the Beauly Firth, dolphins fed extensively in shallows just outside the study area but had to pass through it to reach and leave the shallows. It appears, therefore, that the small number of animals involved not only favoured particular areas for feeding but also certain other areas for resting. Off Chanonry Point, dolphins observed in May spent more time feeding and less time resting than dolphins observed there two months earlier. Again, this appears to reflect the changes in the abundance of salmon in the area.

Using watches which ranged in length from just under 3 to more than 38 minutes, 1259 submergences of bottle-nosed dolphins were analysed. The duration of submergences ranged from 3 seconds to 4 minutes and 43 seconds, the median duration being 20 seconds (Fig. 4). There were significant differences between the durations of submergences recorded in the three study areas, but since depth did not appear to have a strong influence on the duration of submergences, these differences were probably due to differences in the dolphins' behaviour. It was impossible to classify sequences of submergences into discrete categories, although two patterns were apparent: (a) distinct blow periods separated by long dives (50 seconds or longer), typical of dolphins presumed to be feeding at or near the sea-bed; and (b) more or less uniformly spaced surfacings of typically less than 50 seconds duration (Fig. 5).

Defining a dive as lasting 50 seconds or longer, correlation analyses were carried out using the duration of dives and blow periods, the number of blows between dives, and the mean interval between blows of a single blow period. These analyses revealed a number of significant correlations. After long dives, dolphins tended to come up for air more often, whilst spending less time underwater between blows. Furthermore, the longer the blow period, the more often dolphins tended to come up for air and the longer they stayed submerged between blows. There was, however, no correlation between the number of blows between two dives and the mean interval between those blows.

A study of this kind can obviously only be a first step towards a better understanding of the ecology and behaviour of this apparently resident group of bottle-nosed dolphins. This study has nevertheless highlighted areas in need of further investigation and raised questions that may be more satisfactorily answered by the now on-going long-term study of bottle-nosed dolphins in the Moray Firth.

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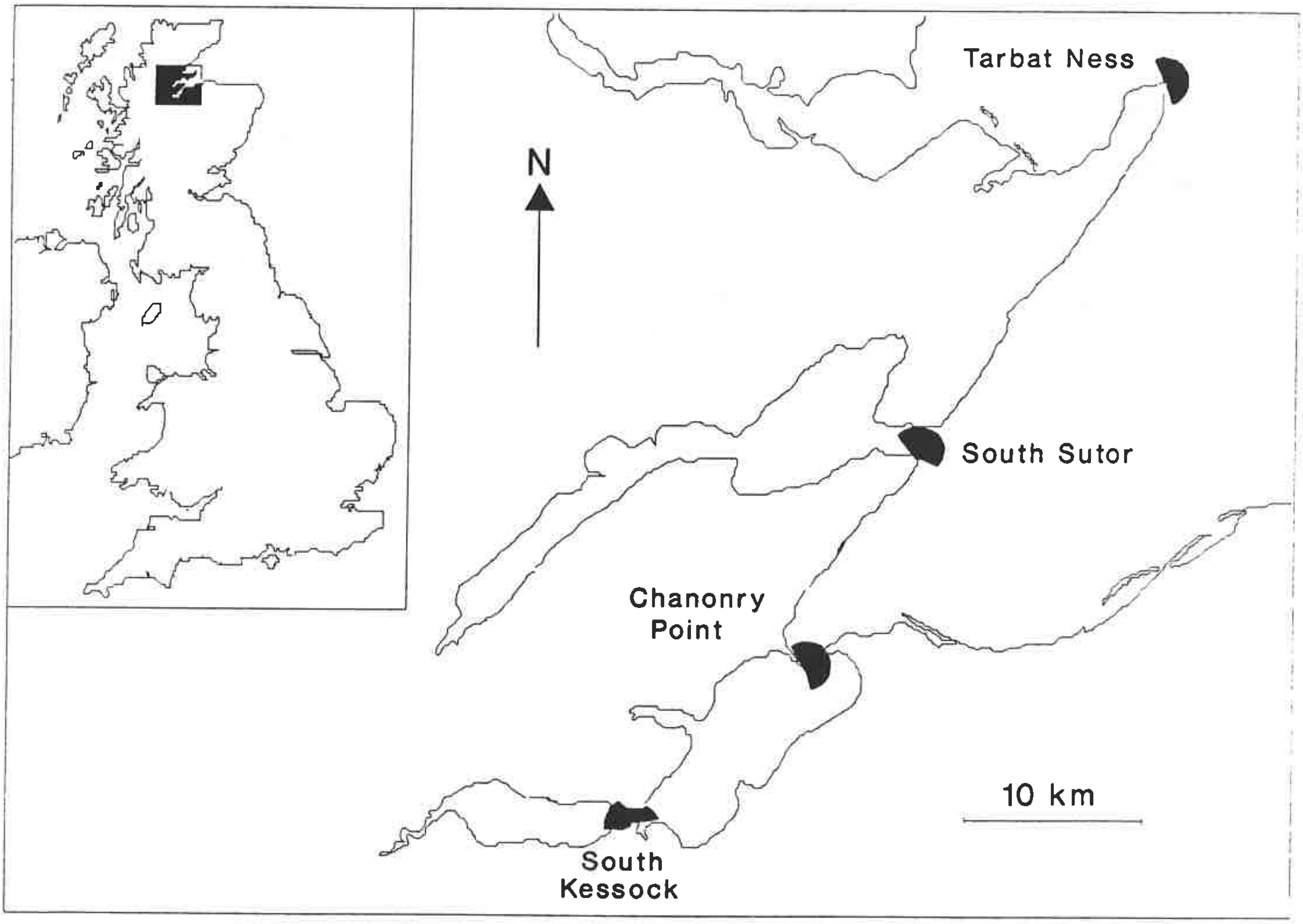

Fig. 1 Map of Study Area

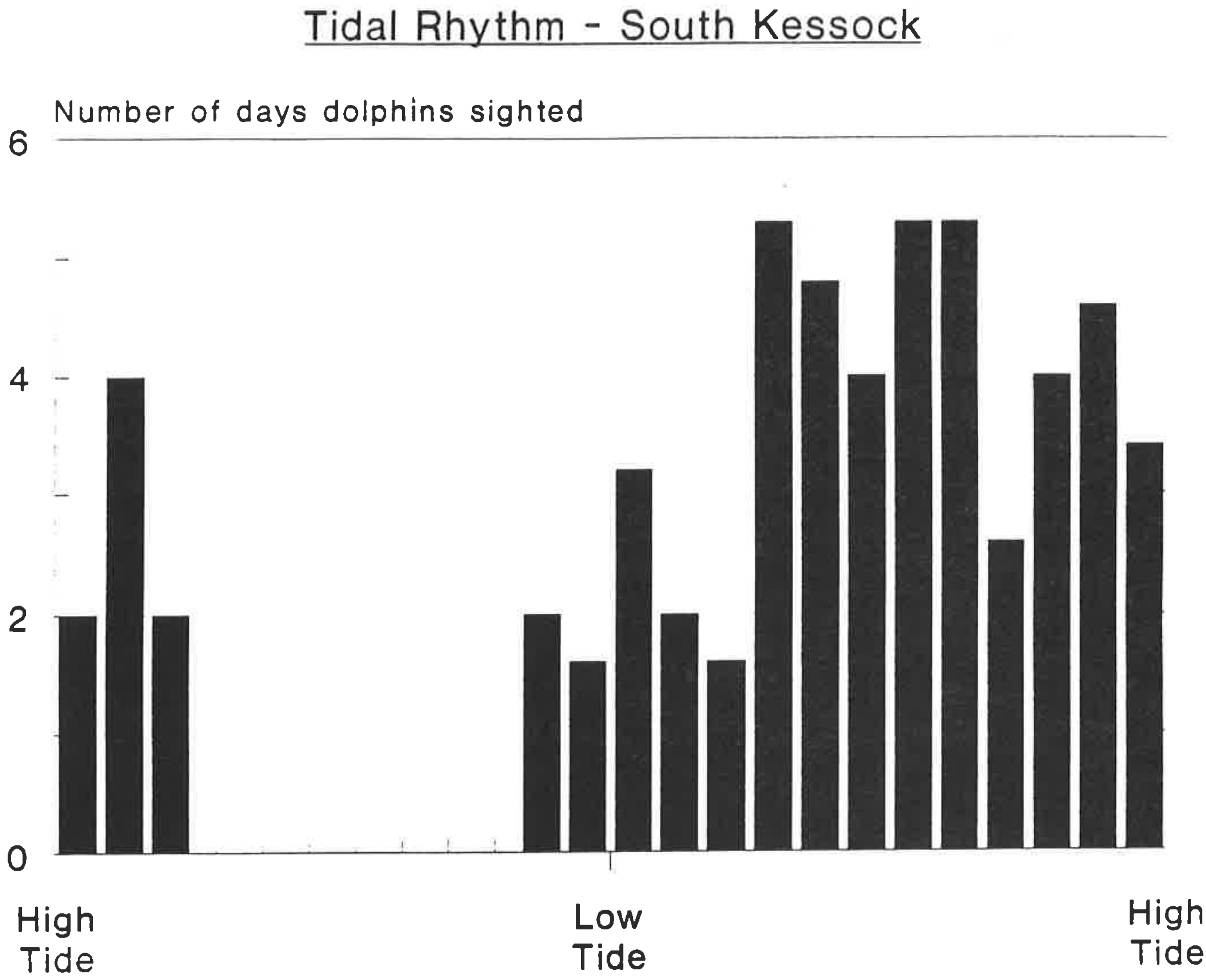

Fig. 2 Tidal rhythm of bottle-nosed dolphins at South Kessock

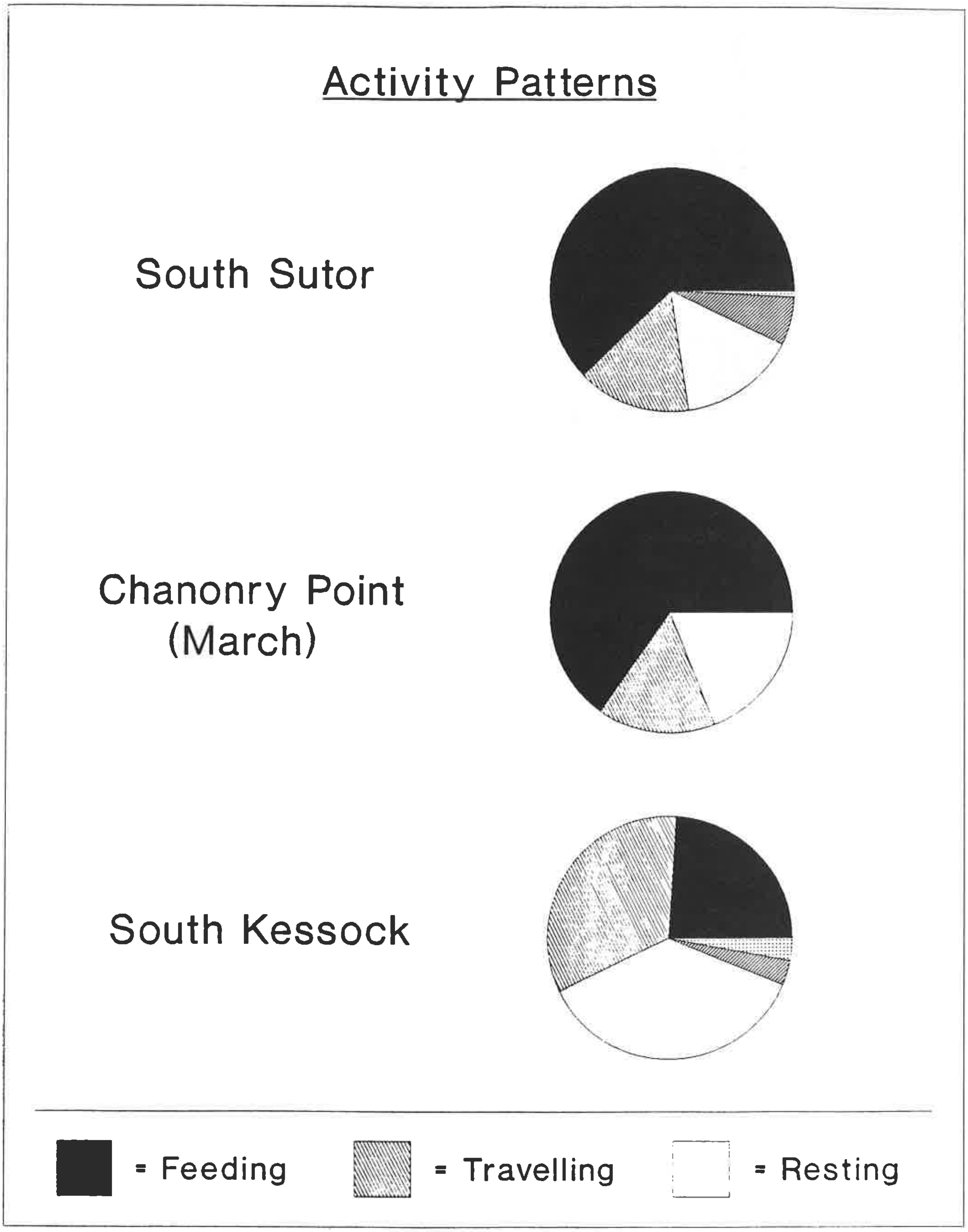

Fig. 3 Bottle-nosed dolphin activity patterns at three study sites in the Moray Firth

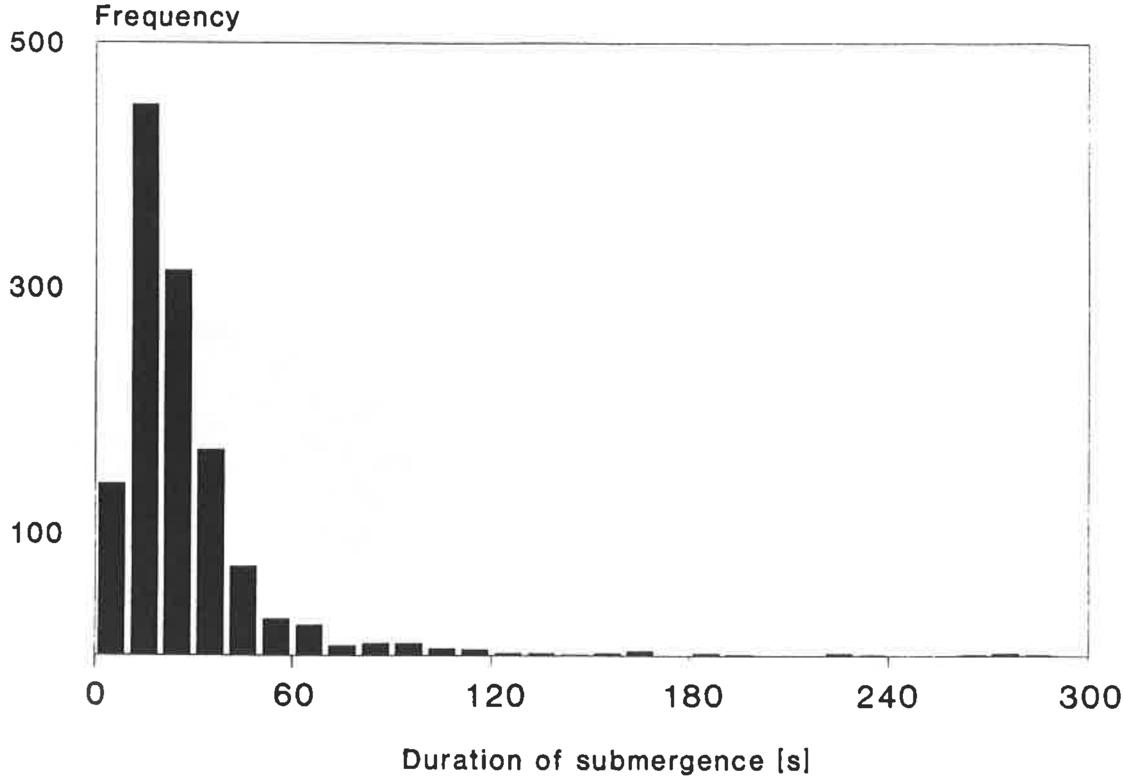

Fig. 4 Frequency distribution of pooled submergences

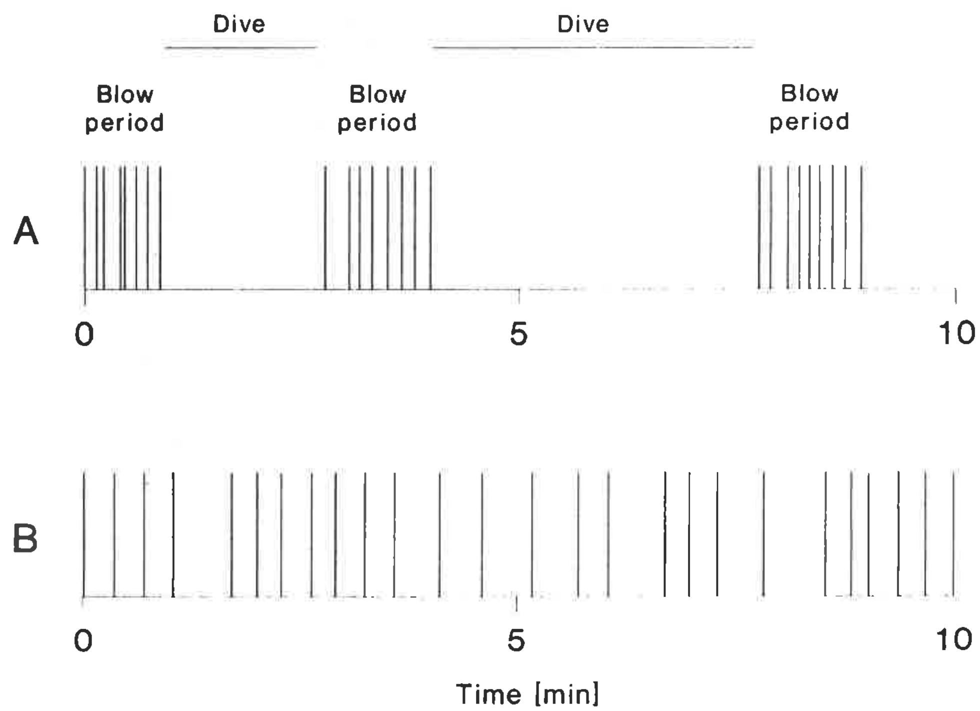

Fig. 5 Typical dive profiles for bottle-nosed dolphins in Moray Firth

PRELIMINARY FINDINGS FROM A PHOTO-IDENTIFICATION STUDY OF BOTTLE-NOSED DOLPHINS (*Tursiops truncatus*) IN CARDIGAN BAY, WALES, DURING 1990

Sue J. Mayer*, Holly C. Arnold* and Peter G.H. Evans**

* Greenpeace, Canonbury Villas, London, N1 2PN, UK
** Dept. of Zoology, University of Oxford, South Parks Road, Oxford 0X1 3PS, UK

INTRODUCTION There are two known resident populations of bottle-nosed dolphins *Tursiops truncatus* in British waters, one in the Moray Firth in Scotland, the other in Cardigan Bay on the west coast of Wales. In contrast to the enclosed nature of the Moray Firth, Cardigan Bay is a large bay approximately 120 km in length which is open to the Irish Sea. Little detailed knowledge exists of the size of this dolphin population, its dynamics or the size of the range over which the dolphins extend.

We describe here the results of a pilot study of photo-identification of bottle-nosed dolphins in Cardigan Bay during two periods in 1990.

The study had the following aims:
(1) To establish the feasibility of using photo-identification to study this group of animals;
(2) To establish a catalogue of individual animals; and
(3) To identify critical areas for future investigation.

METHODS A 30 foot fishing boat was used for searches. During the first period (24th July - 3rd August), searches were made north and south of Aberystwyth. In the second period (29th September - 1st October), three location were used to enable a better coverage of the bay. These were Pwllheli, Aberystwyth and New Quay. However, effort was not evenly distributed and the data can only be considered suggestive.

Most photographs were taken using a Canon EOS or T90 camera with a 75-300 mm zoom lens. A variety of colour slide film was used including Kodachrome 200, Ektachrome 100, 200 and 400, and Fujichrome 400. The best results were obtained using 400 ASA at least during the autumn period when light levels were low.

Shutter speeds faster than 1/250th of a second were needed for sharply focused pictures. There was often a compromise between shutter speed and depth of focus in poor light conditions.

When groups of dolphins were encountered, as well as attempting to take photographs of each animal, information was also collected on group size and behaviour. Sightings of harbour porpoises *Phocoena phocoena* were also recorded. No other cetacean species was sighted.

RESULTS

Natural markings were used to individually identify animals. These included a variety of tears or nicks on the caudal edge of the fin as well as rake and scar marks both on the fin itself and on the back of the animal. Only photographs of good quality were selected for mounting and identification of individual animals.

Numbers of animals identified A total of 60 animals have been individually identified - of these, 25 have both right and left sides catalogued, 19 right side only and 16 left side only. Calves (animals consistently seen with an adult and up to one third of adult length) have not been included in the catalogue at this stage. However, four calves were seen, three in summer and four in autumn.

Nine animals which were seen during the summer period were re-sighted during the autumn period. Of these, four were females with calves, one of which apparently calved between the two observation periods since she had not been seen with a calf in the summer. One other re-sighting was of a juvenile.

Average group size of bottle-nosed dolphins was 9.25 (range 4-31) and 11.5 (range 1-19) in the summer and autumn respectively. Between 0 and 100% of animals seen at each encounter were subsequently individually identified by photographs.

Average group size of harbour porpoises was 2.6 (range 1-5) and 1.6 (range 1-2) in the summer and autumn respectively.

LOCATIONS OF SIGHTINGS

Bottle-nosed dolphins There was a concentration of sightings in the region between New Quay and Cardigan Island in both the summer and autumn periods. Of the total of 17 encounters with dolphins, 12 occurred between New Quay and Cardigan Island.

Harbour porpoises The pattern of sightings was spread more evenly throughout the bay although there is a suggestion that sightings were more common in the southerly part of the bay particularly during the autumn period.

CONCLUSIONS Photo-identification proved to be a useful technique for studying bottle-nosed dolphins in Cardigan Bay. A total of 60 individual animals were identified.

Bottle-nosed dolphins were seen more frequently in the area between New Quay and Cardigan Island but no information is yet available on the true range or occupancy time of the dolphins in that region.

The area between New Quay and Cardigan Island has been identified for further study during 1991. Observations will be made throughout the year to begin to collect data on residency, behaviour and population parameters.

It is hoped that such information will contribute to our understanding of bottle-nosed dolphins and their long term conservation. These two groups of bottle-nosed dolphins are of considerable significance in British waters, being at the northernmost limits of the species distribution.

ACKNOWLEDGEMENTS We are grateful to the many people who made this study possible. In particular, thanks are due to the members of Friends of Cardigan Bay and Dyfed Wildlife Trust, Emily Lewis and Romy O'Driscoll, and the skippers of the boats, Nick Hughes, Steve Hartley, George Povey and Winston Evans.

DISTRIBUTIONAL ECOLOGY OF HARBOUR PORPOISES IN THE SHETLAND ISLANDS, NORTH SCOTLAND

Peter G.H. Evans and Lucy Gilbert

Department of Zoology,
University of Oxford,
South Parks Road,
Oxford 0X1 3PS, UK

INTRODUCTION Systematic boat transects over the last ten years indicate a substantial decline in the numbers of harbour porpoises *Phocoena phocoena* occupying inshore waters of the Shetland Islands, North Scotland, in summer. Causes of this decline are unknown but may relate to changes in food availability or mortality due to bycatches in gill nets. Following widespread declines in herring *Clupea harengus* stocks in the North Sea, local stocks of whiting *Merlangius merlangus* and, most recently, sandeel *Ammodytes* spp., several seabird species (notably arctic tern *Sterna paradisaea* and kittiwake *Rissa tridactyla*) have undergone repeated breeding failure with mass starvation of chicks (Heubeck, 1989).

The purpose of this study was to determine some of the ecological factors influencing the present distribution of porpoises in summer in Shetland coastal waters. Fieldwork was carried out between August and September, 1990.

Porpoise distribution in Shetland Systematic land-based watches of 100 minutes duration were carried out at fifty sites distributed around the coasts of mainland Shetland, supplemented by five boat transects (Figure 1). All watches were started only when sea states were less than 3.

Porpoises were recorded in small numbers throughout Shetland (av. no. = 1.36 indivs. per 100 min. +/- SE 0.3), but with local concentrations particularly along the east coast (av. no. in Mousa Sound = 9.5 indivs. per 100 min. +/- SE 1.6), generally coinciding with those identified in a previous study (Evans and Lane, 1989).

Porpoise occurrence in relation to time of day, tidal state, and current strength Three sites (Sumburgh Head Voe, Quendale Bay and Mousa Sound) were selected for more detailed observations to determine spatial and temporal variation in porpoise distribution. For each site, five watches of 3 hours duration were conducted for each of four tidal states, giving a total of 60 hours observation per site. Watches were initiated only when sea states were less than 3. However, an analysis of porpoise numbers against sea state showed that even at sea states of 1 or 2, a decline in sightings occurred at two of the three sites, suggesting that unless sea conditions are absolutely calm, detectability is affected.

Observations of the use made by porpoises of each site suggested that they avoided sea areas of depth less than 25 metres, most sightings occurring in water of depths of 25-40 metres (Figure 2). Some differences existed between the three sites, and the depths preferred could be related to gradient - differences in undersea topography and the manner in which the coastal shelf slopes away. For Mousa Sound and Sumburgh Head Voe, the shallowest gradients were at the greatest depths (c. 20-40 metres). For Quendale Bay, no such relationship exists because of a much more uneven sea bottom. An analysis of porpoise numbers against both gradient and water depth showed different relationships at different sites, reflecting their undersea topography. For Mousa, there were significant linear relationships between porpoise numbers and both depth and gradient. For Sumburgh and Quendale Bay, low numbers occurred at shallow depths and gradients. Numbers increased only at the greatest depths and gradients. For all sites, porpoises concentrated in particular areas, usually within or on the edge of basins.

Diurnal patterns of occurrence also varied between sites (Figure 3). In Mousa Sound, porpoises were scarce before 1200h BST, but then increased sharply and remained high thereafter. In contrast, porpoise numbers in Quendale Bay were highest before 1100h, declining during the middle of the day and were lowest in the afternoon. At Sumburgh Head Voe, where numbers were generally low anyway, peaks occurred at the start and end of the day. In Mousa Sound, comparative data from 1988 also indicated low porpoise numbers throughout morning hours, increasing sharply in late afternoon.

A comparison was made of porpoise numbers at different states of the tide in Mousa Sound and Sumburgh Head Voe/Quendale Bay (the latter two sites were combined because of their close proximity to one another, receiving essentially the same current). For both sites, porpoises came in mainly around low tide or soon after as the tide starts to run (Figure 4a). Lowest numbers occurred around or soon after high tide. However, a relationship exists between tidal state and current strength which is unique to a particular site (see Figure 4b). Evans and Lane (1989) found that porpoises in the North Minch, Northwest Scotland, concentrate in slack water at the head of a strong current. In this way, we presume that the porpoises are not wasting energy by swimming against a current, whilst food is being pushed towards them. A very similar situation may exist at Quendale Bay and Sumburgh Head Voe: the bays themselves cannot have strong currents flowing through them because they are only open on one side, so the current strengths calculated were those flowing past the bays and the porpoises themselves occurred in the slack water of the bay. Porpoises in those areas were most common when adjacent currents were relatively strong (1.5 knots and above). In Mousa Sound, there is never a time when there is an area of slack water in front of a strong current. Peak numbers in this region occurred between 1.2 and 1.4 knots, declining sharply thereafter.

In conclusion, we attribute differences between sites to the pattern of currents and their relative strengths in the locality. We are still some way from understanding the precise relationship between porpoise movements and environmental factors such as physical oceanography, and tides. Future work will concentrate upon studies of the dynamics of porpoise distribution and how this relates to prey distribution and ecology.

ACKNOWLEDGEMENTS We thank the Whale and Dolphin Conservation Society for funding this project, and both Ronnie Gallagher and Martin Heubeck for their invaluable logistical support.

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(FROM LAND-BASED WATCHES AND BOAT TRANSECTS)

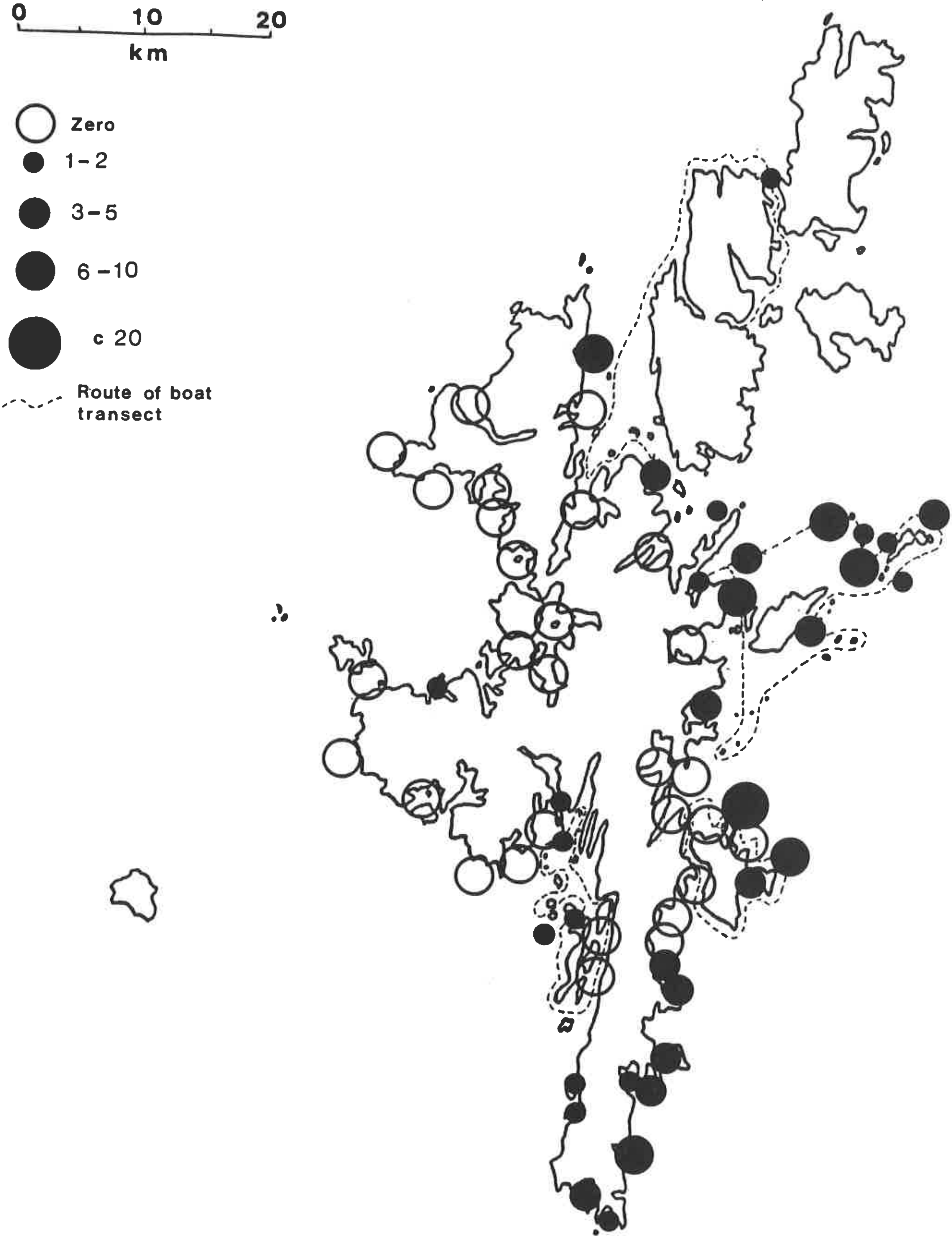

Fig. 1 Distribution of harbour porpoises in Shetland from timed watches

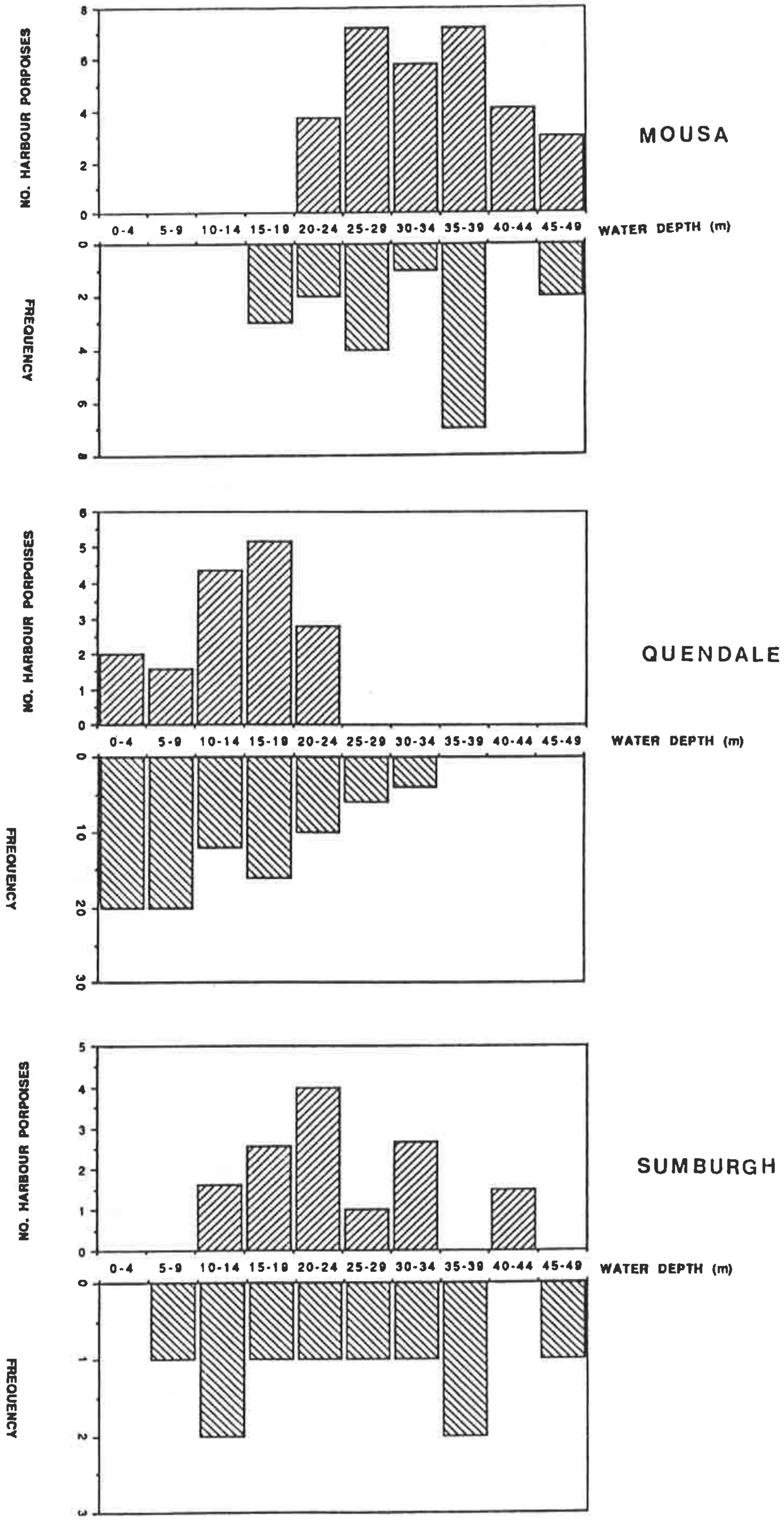

Fig. 2 The relationship between harbour porpoise numbers and water depth

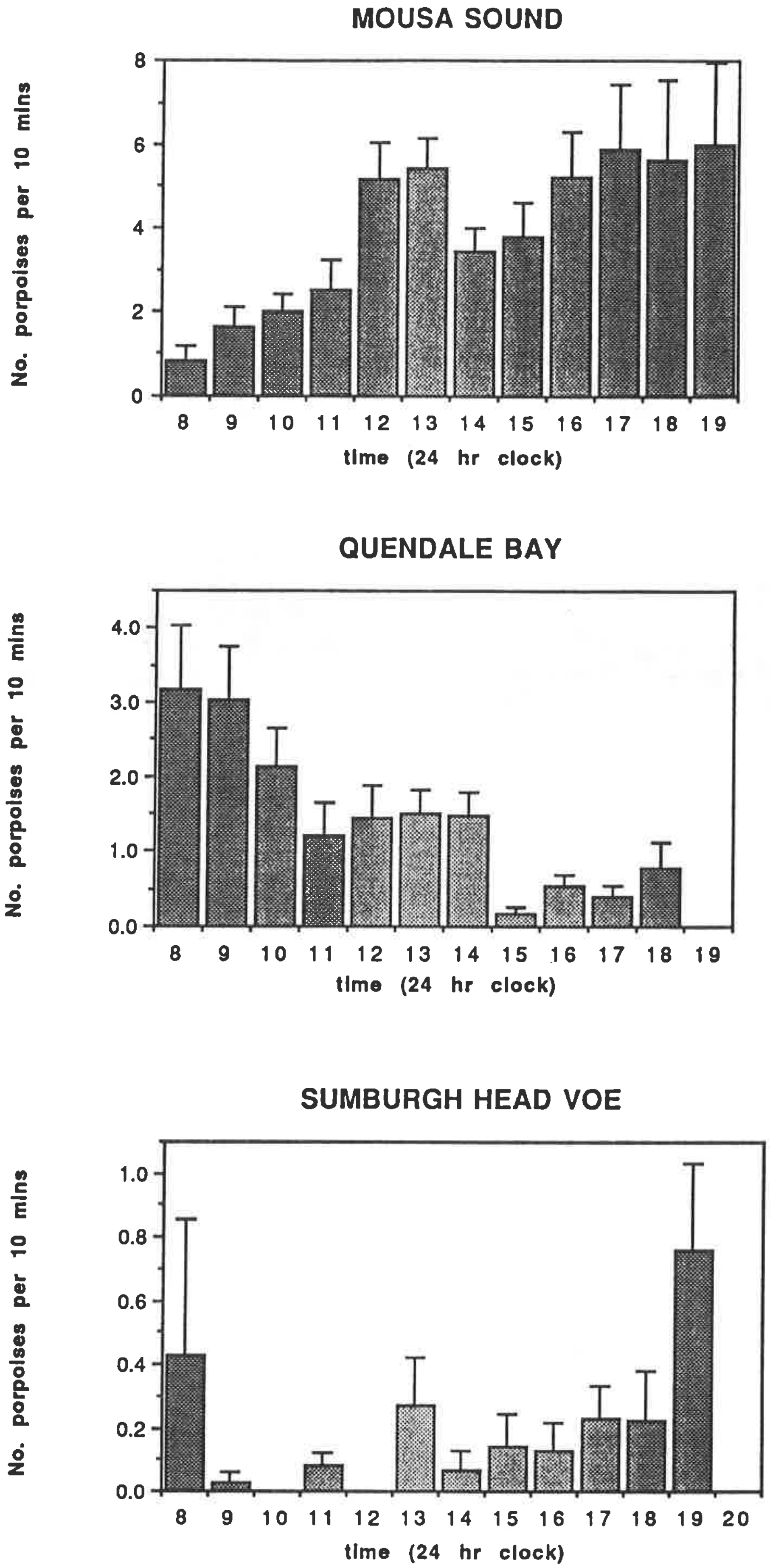

Fig. 3 Diurnal pattern of harbour porpoise inshore distribution at three study sites (standard error bars shown)

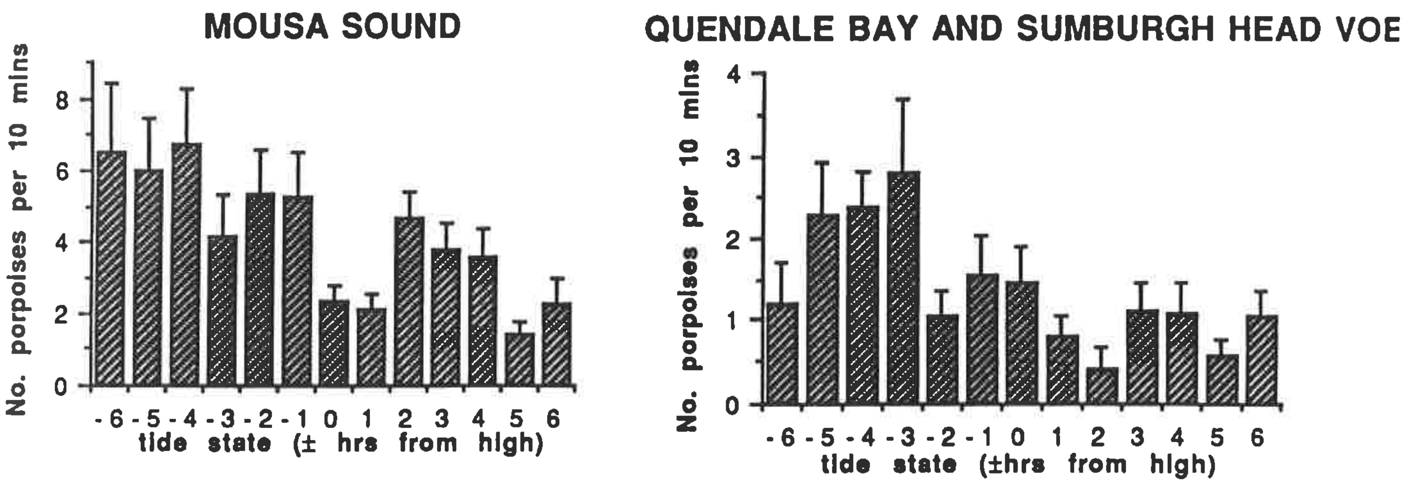

Fig. 4a Effect of tidal state on harbour porpoise numbers (standard error bars shown)

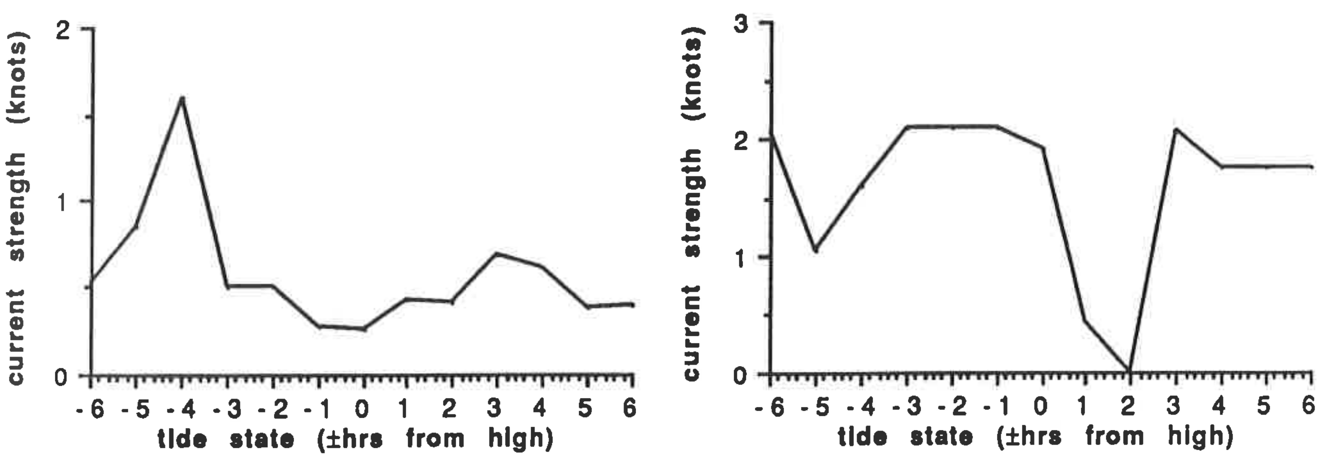

Fig. 4b Effect of tidal state on current strength

HARBOUR PORPOISES FOUND DEAD IN SWEDEN, 1988-90

Ingalill Lindstedt

Institute of Marine Research,
P.O. Box 4, S-453 00 Lysekil, Sweden

Since June 1988, the findings of dead harbour porpoises (*Phocoena phocoena* L. 1758) in Sweden are collected to the Museum of Natural History in Göteborg. The work is motivated by the need to develop methods to follow the population status and the geographical and seasonal distribution of the species in Swedish waters. There is also a wish to determine and follow the magnitude of the bycatch of harbour porpoises in the fisheries. Some results of the collection during two successive years are presented and discussed.

In Sweden, it is prescribed by law that findings of dead cetaceans should be reported to the authorities. To further increase the motivation to report such findings, a small economic compensation is currently offered for findings that are collected to the museum. There has also been information about the project to the public, to the fishermen, etc..

From June 1988 to the middle of December 1990, 349 harbour porpoises were collected. Of these animals, 51% were found in fishing gear, mostly in gill nets, the remainder were usually found dead on beaches or drifting in the water.

The project has led to an increased number of collected animals. A clearer picture of the bycatch situation has been obtained. The seasonal changes in the number of catches in fishing gear yields information about the migratory behaviour of the species. The collection of bycatch data during several successive years shows promise as a method to monitor population status.

INCIDENTAL CATCHES OF HARBOUR PORPOISE (*Phocoena phocoena* LINNAEUS 1758) IN THE COASTAL WATERS OF ANGELN AND SCHWANSEN (SCHLESWIG-HOLSTEIN, FRG) FROM 1987 TO 1990

Harald Benke*, Hartwig Kremer** and Andreas Pfander***

*Institut für Haustierkunde, University of Kiel,
Am Botanischen Garten 9, 2300 Kiel, FRG
**Institut für Meereskunde, Abt. Meereszoologie,
Düsternbrooker Weg 20, 2300 Kiel, FRG
***Ludwig-Hinrichsenstrasse 1, 2340 Kappeln/Schlei, FRG

Gaskin (1984) pointed out that worldwide the bycatch of harbour porpoises *Phocoena phocoena* in monofilament fishing nets is a serious problem. The reasons and circumstances of such incidental catches are more or less unknown and therefore effective protection is still very difficult.

Based on findings of net lesions, Kinze (1986) estimates that in Denmark, 99% of all strandings are previously bycaught animals, which have been discarded by fishermen. More than 3000 harbour porpoises have been estimated to be killed annually by the activities of the Danish wreck fishery alone, which is mainly located in the south western parts of the North Sea and the Channel (Clausen and Andersen, 1988). In German waters, bycatches have been recorded mainly in the nearshore set net fishery in the Baltic (Kremer and Schulze, 1990). Only very few records have been reported to date from the German North Sea coast. Even Schulze (1970) in a review of the different cetacean species in our coastal waters did not mention harbour porpoise bycatches. Here we consider particular aspects of the bycatch in the German Baltic. In due course, it may be useful to get a more detailed view of the situation in this region.

MATERIALS AND METHODS Prompted by the international meeting "The Harbour Porpoise in the Baltic and North Sea" at the Alfred-Wegener-Institute for Polar and Marine Research, Bremerhaven, in 1986, activities were focused on establishing a close cooperation with local fishermen, fisheries associations and the fishery authority at Kappeln. A recording scheme for harbour porpoise bycatches was also initiated. Before transportation to the University of Kiel for further investigations, it was therefore possible to take measurements, photographs etc. of several bycatches. These data were collected from 1987 to 1990, and special attention was paid to details such as location, fishing gear, phases of the moon, sex ration, length and weight distribution.

RESULTS The area of investigation is located between 54°32'N and 54°50'N and 9°52'E and 10°10'E (Fig. 8), and is highly preferred by the German set net fishery for cod. Between 1987 and 1990, a total of 41 bycaught harbour porpoises were recorded, 31 of which were delivered with precise information about the location of bycatch. Only one catch was made in waters deeper than 15 m, whereas the bulk of the monofilament nets are set between 7 m and 13 m depth. A typical set net is characterised by a length of up to 600 m and a height of 1.2 m. These typical tripple nets have an outer mesh size of 300 mm and an inner mesh size of 65-75 mm. Thirty-seven harbour porpoises (90.2%) were trapped in set nets. Otherwise, one porpoise was caught in a trawl during the morning hours, one entangled in a fish basket, one found in a pond net, and one in an unknown type of gear. The latter two specimens were found alive and were successfully released.

Comparing the number of bycatches in different years, there was an apparent decrease from 1987 to 1989, but then in 1990, ten porpoises were recorded, a similar number as in 1988 (Fig. 1). The seasonal distribution of incidental catches clearly reveals a peak in late summer and autumn, coinciding with the main season of the cod fishery from August to March (Fig. 2). As with the Danish findings (Clausen and Andersen, 1988), most bycatches were recorded between September and November. In 1990, the last record in the investigated area was registered in late September and no further porpoise bycatches had been recorded up to the beginning of February 1991.

Most porpoises caught were young animals. Seventeen specimens (46%) belonged to the smallest size class with a maximum length of 1.2 m (Fig. 3). Nine porpoises were between 1.21 m and 1.35 m, and nine porpoises had a body length between 1.36 and 1.5 m. Only two porpoises (5%) had a body length of greater than 1.5 m. Similarly, 67% of bycaught animals (i.e. 26 individuals) weighed less than 36 kg (Fig. 4). The sex of 36 individuals was determined and revealed a predominance of females (Fig. 5).

The set net fishery in this area is mainly performed during night time. Therefore, most of the bycatches were recorded to occur at night and especially in the early morning hours. In one case, the accurate time of bycatch was reported to have been between 04.30 and 06.30h. Correlating the incidental catches with the phases of the moon, indicated that in 14 cases they occurred at full moon, in three cases during the new moon, 12 cases during the wane and 11 cases whilst as a crescent (Fig. 6). Thus 27 bycatches occurred during nights which were probably light, whereas in only 11 cases did they occur during dark nights (Fig. 7).

DISCUSSION Summarising the results of the last four years' data sampling, we conclude that significant bycatches of harbour porpoises occur in the German Baltic. Time and location of bycatches in this coastal region closely reflect human fishing activities. For example, in the area around the "Geltinger Bucht" and "Kalkgrund", three animals were taken in 1987, none in 1988 and 1989 and just one in 1990. The absence of fish, especially cod, in the Western Baltic caused a sharp decline of fishing activities in this area.

Regarding the circumstances of bycatches, the following conclusions are of interest. There seems to be a negative correlation between presence of a new moon and incidental bycatches. Combining the phases of the moon with respect to the amount of light they are likely to provide, we conclude that there is a trend towards more bycatches in light rather than in dark nights. This finding possibly confirms the hypothesis of Gaskin (1984) that harbour porpoises could be visually attracted by the silver flashes of fish struggling in the set nets.

Comparing the length and weight distribution among bycaught harbour porpoises with data from the Danish fishery (Clausen and Andersen, 1988), our data show somewhat similar results. The findings of Clausen and Andersen (1988) regarding the pregnancy status of the porpoises confirm our conclusion that the bulk of the German bycatches comprises juvenile and subadult animals (see also Kremer and Schulze, 1990). Finally of note is the probably exceptional lack of bycatches in this area since September 1990. This does not correlate with any pattern of fishery activities and no explanation can be given at present. Since February 1991, there has been some ice in the Baltic due to the sharp decline in temperature but it is highly speculative to think that this might have had any influence on the porpoises' behaviour.

ACKNOWLEDGEMENTS We are grateful to local fishermen for their useful advice and their confident cooperation. We also wish to thank the fishery association at Masholm and the fishery authority, Kappeln, namely Mr. Grunau. Special thanks are also dedicated to Mrs.Havenstein for her patient cooperation and Mr. Boris Pfander who provided significant help during the sampling and processing of data.

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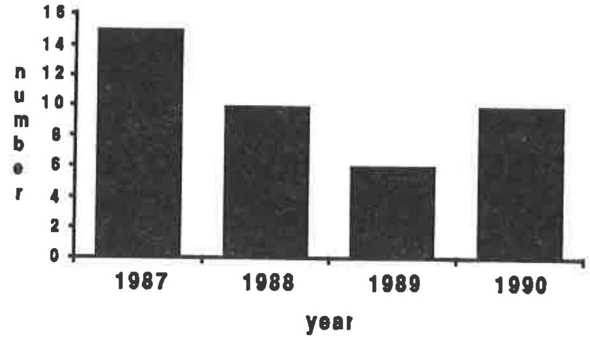

Fig. 1. Number of incidental catches of harbour porpoises in the years 1987 to 1990.

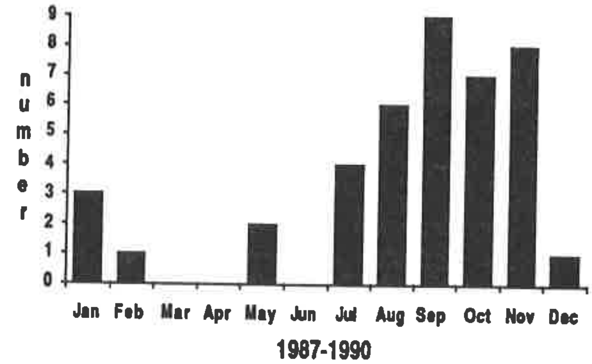

Fig. 2. Number of incidental catches of harbour porpoises in the different months from 1987 to 1990.

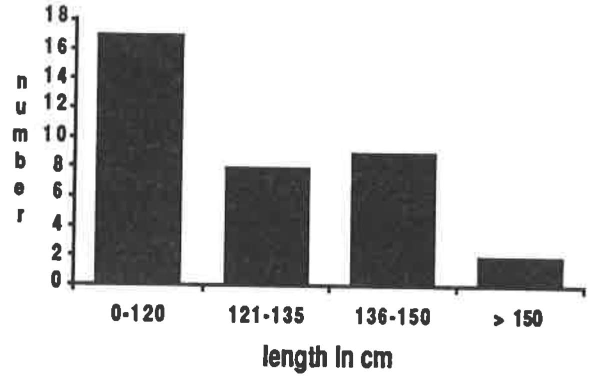

Fig. 3. Length distribution of the harbour porpoises.

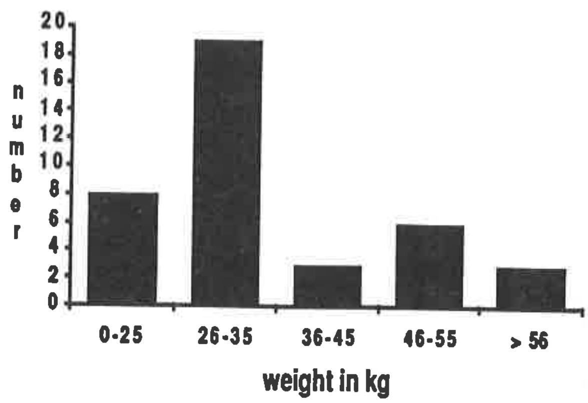

Fig. 4. Weight distribution of the harbour porpoises.

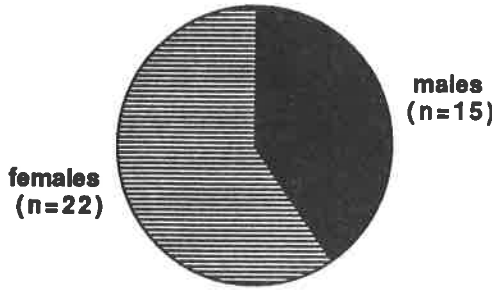

Fig. 5. Sex ratio of the harbour porpoises.

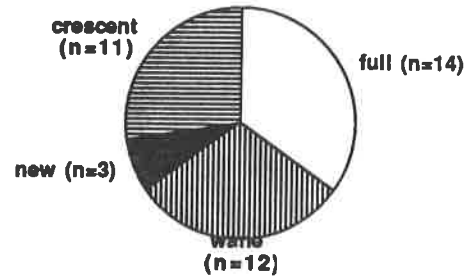

Fig. 6. Catches of harbour porpoises with regard to the phases of the moon.

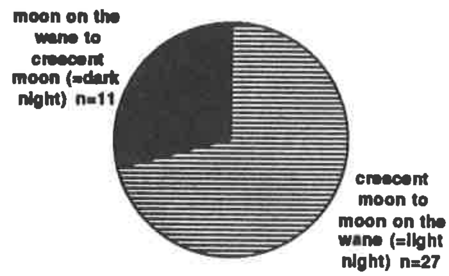

Fig. 7. Catches of harbour porpoises with regard to the moonlight.

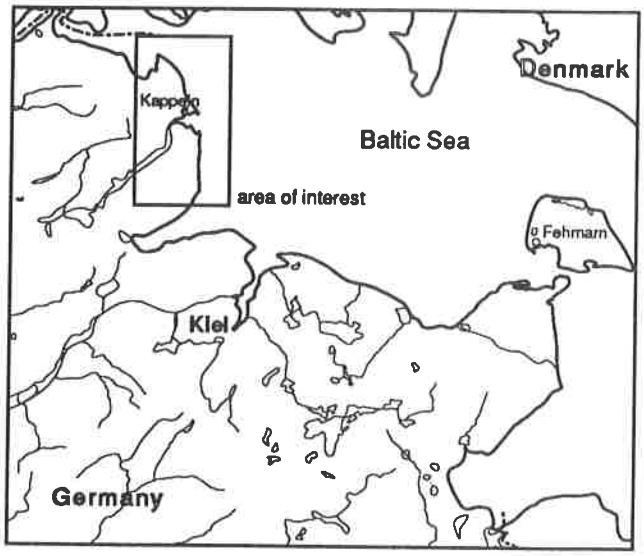

Fig. 8. Area of interest.

THE STOMACH CONTENTS OF A CUVIER'S BEAKED WHALE *Ziphius cavirostris*, AND A RISSO'S DOLPHIN *Grampus griseus*, STRANDED IN ITALY

Michela Podestà and Cristina Meotti

Museo di Storia Naturale di Milano,
Corso Venezia 55, 20121 Milano, Italy

INTRODUCTION Cuvier's beaked whale *Ziphius cavirostris* is an uncommon species of the Italian marine fauna. From strandings data, it appears to be most frequent in the Ligurian and Tyrrhenian waters (Tortonese, 1963; Cagnolaro, 1965, 1983; Cagnolaro *et al.*, 1986; Centro Studi Cetacei, 1987, 1988, 1990).

Risso's dolphin *Grampus griseus* is probably a little more common, but is nevertheless patchily distributed. Stranded specimens are found along the Ligurian, Tyrrhenian and Ionian coasts (Duguy *et al.*, 1978; Cagnolaro *et al.*, 1983; Cagnolaro *et al.*, 1986; Centro Studi Cetacei, 1987, 1988, 1990; Di Natale, 1982).

Although in the literature it is stated that both species are squid eaters, few studies have been carried out on the analysis of their stomach contents. Since we had the opportunity to examine specimens of both species during the activities of the Natural History Museum of Milan, we hope this short note will contribute to our knowledge concerning the diet of both these species, for which in Italy there is an almost total lack of information.

MATERIALS AND METHODS The Cuvier's beaked whale stranded dead on the beach of Foxi Lioni (Nuoro, Sardinia) on 10 February 1987 together with another specimen still alive, a female about 6 m long, which after being refloated, started to swim away by itself and was not seen again. The dead specimen, a female with a total length of 3.3 m, was buried near Cagliari in order to be recovered in the future; it was then disinterred and analysed. Although the specimen was in an advanced state of decay, the stomachs were still recognisable. They were opened up and found to contain 151 cephalopod beaks, one cephalopod buccal mass, a few pieces of unidentifiable cephalopod flesh, many eye lenses and a small piece of plastic material.

The Risso's dolphin was found floating dead in the Ligurian Sea one mile off the coast from San Remo on 26 May 1990. It was recovered by a fisherman, and taken to the San Remo harbour where it was collected and transported to the Museum of Milan for the dissection. The specimen was a female, 3 m long; neither external nor internal macroscopic injuries were observed. The stomachs contained 260 cephalopod beaks, 13 cephalopod buccal masses, many pieces of unidentifiable cephalopod soft parts and many eye lenses.

The lower beaks of the two specimens were identified using the methods described by Clarke (1986a).

RESULTS The 151 isolated beaks of the Cuvier's beaked whale were subdivided as follows: 73 upper and 78 lower beaks. We identified 73 lower beaks of the 79 found (78 isolated and one from the buccal mass); 6 were not identifiable. Table 1 summarises the data and indicates four species represented by beaks. The squid *Histioteuthis reversa* was the most abundant species represented, contributing 65.8% of the total numbers of lower beaks. The second most abundant species was *Ancistroteuthis lichtensteinii*, contributing

22.7% of the total. The other two squids, *Octopoteuthis sicula* and *Onychoteuthis banksii*, contributed 2.5% and 1.3% respectively.

Of the 260 isolated beaks found in the stomachs of Risso's dolphin, we separated 116 upper and 144 lower beaks. We also extracted beaks from the buccal masses, finding only eight lower beaks. We classified a total of 151 lower beaks, with one other unidentified. Table 2 lists the identified species and their relative percentages. The genus *Histioteuthis* was represented by 115 lower beaks of which 111 were classified as *H. bonnellii* species, the other four remaining unidentified. This genus constituted 75.6% of the lower beaks. Also of significance was *Ancistroteuthis lichtensteinii*, represented by 27 beaks. Finally we identified two octopods (*Eledone* sp.) whose lower beaks were still linked with their upper parts, and seven lower beaks belonging to the family Cranchiidae. We were unable to identify one beak since its very small size made it extremely difficult to classify.

DISCUSSION Information on the biology of Cuvier's beaked whale and Risso's dolphin are extremely poor and scattered. In particular, the food items of both species are scarcely known and we have very little information on Mediterranean specimens. The results presented here are in agreement with the diet being based almost exclusively on cephalopods, as described by several authors (Tomilin, 1967; Clarke, 1986b; Evans, 1987). The cephalopod species that we found are known to be present in Italian waters (Bello, 1986), although their distribution and abundance need further investigation.

For both cetacean species, the significant abundance of the genus *Histioteuthis* in the stomachs examined suggests that they feed mainly in deep waters. It is interesting to note the high quantity of *Histioteuthis bonnellii*, a particularly deep water species, found in the Risso's dolphin.

The presence in both cetacean species of *Ancistroteuthis lichtensteinii*, a pelagic species associated with the sea bottom during spring and summer (Roper *et al.*, 1984), confirms the deep diving behaviour of these cetaceans.

The areas of the two strandings are characterised by deep waters, and are probably related to the feeding requirements of these cetaceans which may therefore regularly frequent these waters, as confirmed also by the Italian strandings data.

Our data are partially in agreement with information provided by Bello and Pastore (in press) concerning a Risso's dolphin stranded on the coast of the Gulf of Taranto. They found a majority of *Histioteuthidae*, followed by Ommastrephidae and *Ancistroteuthis lichtensteinii.*

We identified only two *Eledone* while Clarke and Pascoe (1985) found a higher percentage of octopods in a Risso's dolphin stranded on the British coast. This may indicate an opportunistic feeding behaviour for this species, which varies its diet depending on local availability.

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Table 1. *Ziphius cavirostris.* Identity, number and percentage of lower beaks

SPECIES	No.	%
Histioteuthis reversa	52	65.8
Ancistroteuthis lichtensteinii	18	22.7
Octopoteuthis sicula	2	2.5
Onychoteuthis banksii	1	1.3
Unidentified	6	7.6
TOTAL	79	

Table 2. *Grampus griseus* . Identity, number and percentage of lower beaks

SPECIES	No.	%
Histioteuthis bonnelli	111	73.0
Histioteuthis sp.	4	2.6
Ancistroteuthis lichtensteinii	27	17.6
Cranchiidae	7	4.6
Eledone sp.	2	1.3
Unidentified	6	7.6
TOTAL	152	

ON THE STOMACH CONTENTS OF STRIPED DOLPHINS (*Stenella coeruleoalba,* Meyen 1933) FROM THE LIGURIAN COAST, CENTRAL MEDITERRANEAN SEA.

Maurizio Wurtz and Daniela Marrale

Istituto di Anatomia Comparata, Università di Genova.
Viale Benedetto XV,5 16126 Genova, Italy.

INTRODUCTION The striped dolphin *Stenella coeruleoalba* Meyen 1933) is the most abundant odontocete in the Ligurian Sea. An increasing number of strandings and sightings have been recorded from 1981 up to the present day (Cagnolaro *et al* 1986). Nevertheless the biology of striped dolphins is poorly known for this area.

This preliminary study is a first attempt at describing their feeding behaviour to interpret the reasons for striped dolphins concentrating in the Ligurian Sea.

MATERIALS AND METHODS Stomach contents have been analyzed from 19 specimens of striped dolphins stranded along the Ligurian coast (Central Mediterranean Sea) during the period 1983 to 1990.

The specimens have been measured and dissected by the scientific staff of the Museum of Natural History of Genoa (Italy), who also provided the stomach contents.

Twelve males and seven females were examined, with total lengths ranging between 110 and 201 cm. Strandings occurred all year around, but with a maximum during the summer.

The prey were identified by the following methods: cephalopods by beaks (Clarke, 1986); bony fishes by otoliths and dental bones, crustaceans by carapace, telson and mandibles.

In this preliminary study, stomach content analysis was carried out on the basis of prey composition by number. The estimation of prey biomass is still in progress.

RESULTS Results are summarized in Table 1. For each prey type, the total number (N) and the number of striped dolphins with that prey (frequency F) , are reported.

The prey number in the stomach was found to be extremely variable, ranging between one and 623 specimens per stomach. Bony fishes were the main food item: 1018 specimens were counted in 11 stomachs; cephalopod species were represented by 128 specimens in 18 stomachs; decapod crustacea numbered 44 in two stomachs.

The same data expressed as percentage of the total prey number (1190), are: bony fishes 85.6%; cephalopods 10.6%; and crustaceans 3.8%.

CONCLUSIONS The occurrence (F) of a particular prey was never frequent, no bony fish or crustacean species being found in more than five stomachs. On the other hand, some cephalopod species, such as *Todarodes sagittatus*, were in the diet of ten out of the 19 striped dolphins examined.

We suppose that cephalopod species represent a regular source of food. Fishes and crustaceans are eaten more occasionally, but some times in very large quantities.

The prey of striped dolphins are mainly benthopelagic and pelagic organisms living along the continental slope or in the corresponding water column. Many of them are capable of large vertical migrations from deep water to the surface.

It is likely that striped dolphins catch most of their prey in the upper levels during night movements, although they may dive down to 500 - 700 m. depth, to reach *Histioteuthis reversa, Histioteuthis bonnellii* and other luminescent organisms present in the diet.

The spatial concentration of high level consumers such as cetaceans in the region seems to confirm the trophic potential of the Ligurian sea (Boucher *et al.* 1987; Jacques 1989), where the physical structure and the particular circulation patterns affect the phytoplankton and zooplankton biomass.

In this pattern a significant role is played by those organisms capable of accelerating the energy turnover. Mesopelagic cephalopods seem to be eligible for this process; they present a relatively short food chain, fast growth and are strong vertical migrators.

The limitations of our sampling techniques result in us underestimating their biomass in the Mediterranean. Studies on their role in the bathyal food webs (Wurtz and Palumbo, 1985), as well as their frequency in the stomach contents of some abundant odontocetes have led us to the conclusion that the Ligurian continental slope and the corresponding water column are densely inhabited by strange luminous and hooked cephalopods

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Table 1 Stomach contents composition of 19 striped dolphin stranded along the Ligurian coast in the period 1983 - 1990.

N = prey number
F = frequency of occurrence

	N	%	F	%
CEPHALOPODA				
Histioteuthis reversa	23	18	2	10.5
Histioteuthis bonnellii	19	14.8	5	26.3
Illex coindetii	5	4	3	15.8
Todaropsis eblanae	2	1.6	2	10.5
Todarodes sagittatus	23	18	10	52.6
Ancistroteuthis lichtensteini	22	17	8	42.1
Loligo vulgaris	1	0.8	1	5.3
Heteroteuthis dispar	9	7	5	26.3
Sepietta oweniana	11	8.6	4	21
Not identified	13	10.2	7	36.8
Total	128	100		
CRUSTACEA				
Pasifaea multidentata	39	88.6	2	10.5
Acanthephyra pelagica	4	9.1	1	5.3
Sergestes sp.	1	2.3	1	5.3
Total	44	100		
OSTEICHTHYES				
Boops boops	71	7	3	15.8
Engraulis encrasicholus	73	7.1	3	15.8
Chauliodus sloanei	11	1.1	1	5.3
Belone belone	62	6.1	1	5.3
Micromesistius poutassou	698	68.6	4	21.0
Merluccius merluccius	19	1.9	5	26.3
Not identified	84	8.2	8	42.1
Total	1018	100		

PARASITES FROM THE DIGESTIVE TRACT AND FOOD ANALYSIS OF HARBOUR PORPOISE *Phocoena phocoena* FROM GERMAN COASTAL WATERS

Roland R. Lick

Institut für Meereskunde an der Universität Kiel,
Düsternbrooker Weg 20,
D-2300 Kiel 1, Germany

INTRODUCTION So far, only one reference (Schmidt-Ries, 1940) deals with parasites of harbour porpoises in German coastal waters. This author gives only scant information on anisakine nematodes. No food analysis on cetaceans has been carried out so far in the investigated area. This paper for the first time gives information concerning the food of harbour porpoises from the German coast of the North and the Baltic Sea.

MATERIALS AND METHODS In total, 102 stomachs and 45 intestines of harbour porpoises, stranded or bycaught along the German coasts of the North Sea and the Baltic Sea, were analysed for parasites and food remains (54 from the North Sea, 48 from the Baltic). The porpoises were collected from 1985 to 1990.

RESULTS

Parasites 28% of the 102 harbour porpoises were infected with stomach nematodes. The prevalence of infection was correlated with the age of the final host. Animals older than 1 year showed a higher prevalence of infection (52%) in the Baltic Sea than in the North Sea (23%). The infestation in porpoises younger than 1 year was 21% in the Baltic Sea and 15% in the North Sea. The mean intensity of infection in the North Sea was 12.5 nematodes (range 1-23) in young harbour porpoises and 32.2 nematodes (range 1-136) in older ones. In the Baltic Sea, the mean intensity was 4.5 nematodes in young whales and 131.1 nematodes in old final hosts.

A total of 1,907 nematodes were counted in all investigated harbour porpoises. Two species of nematodes have been identified: 84% belonged to *Anisakis simplex*, 16% to *Pseudoterranova decipiens*. The latter species was found only as larval stages and confined to the North Sea. The harbour porpoise does not seems to be a suitable host for *P. decipiens*.

Most of the nematodes were found in the first chamber of the stomach. Only in two cases were they also detected in the second chamber or the intestine, respectively. Most nematodes were lying free in the lumen of the stomach, in some cases fixed to the stomach wall.

Ulcers of the stomach wall, caused by the nematodes, occurred in 11 of the 52 harbour porpoises (21%) from the North Sea, and in 10 of 36 individuals (28%) in the Baltic Sea. The size of ulcers ranged from small holes, 1 mm in diameter, which were caused by single nematodes, up to big "cauliflower-like" ulcers with an inner diameter of 1.5 cm and an outer one of about 5 cm. Most frequently the ulcers were located in the first chamber of the stomach, but in two cases they also occurred in the second chamber.

Other parasites (Trematoda, Cestoda, Acanthocephala) were found only exceptionally in the intestine.

Food analysis Food remnants were found in 78 of the 102 investigated stomachs. Thirty-six porpoises in the North Sea, and 42 in the Baltic Sea had food remnants in their stomachs. More than 10,000 fish otoliths were sampled and identified. In four young harbour porpoises, the contents of the stomach consisted of milk.

The food of the harbour porpoise consisted of 17 different fish species belonging to 10 or 11 fish families (Table 1). In the North Sea, diversity of food was higher (15 fish species) than in the Baltic Sea (8 fish species). Flatfish had been eaten only in the North Sea, whilst herring in the diet was restricted to the Baltic Sea.

In some of the stomachs, small amounts of invertebrates were detected. Most of them, however, are supposed to be secondary food, which had been eaten by the fish.

The fish species which had been eaten with the highest frequency were sole, goby, cod, dab and whiting in the North Sea, and cod, herring and goby in the Baltic Sea.

The highest relative number of individual fish was represented by flatfish (dab, sole, flounder) and gobies in the North Sea. In the Baltic Sea, 96% of all fish consumed were gobies (Fig. 1).

Expressed as biomass of fish, sole (41%) and cod (25%) were the most important in the North Sea. In the Baltic Sea, cod (70%), goby (19%) and herring (11%) dominated (Fig. 2).

The maximum fish size found was an undigested sole of 42 cm length and a cod of 55 cm length. However, from otolith measurements, the maximum size calculated was a sole of 46 cm and a cod of 62 cm.

DISCUSSION AND CONCLUSIONS In the region, the only nematode species maturing in the digestive tract of harbour porpoise is *Anisakis simplex*. Schmidt-Ries (1940) described also *A. typica* and *Pseudoterranova decipiens* in the harbour porpoises of the Baltic Sea, and, according to van Thiel (1976), all records of *A. typica* from the North Sea are incorrect and belong instead to *A. simplex*. Smith & Wootten (1978) have also drawn attention to the unclear taxonomic distinction between *A. simplex* and *A. typica*.

Concerning the energy budget of harbour porpoises, flatfish (sole, dab) and gadids (cod, whiting) in the North Sea only, and cod and herring in the Baltic Sea are important in older animals. In young porpoises, gobies are the main prey both by number and by weight. However, for transmission of *Anisakis* to marine mammals, only cod and herring are known to be infected with this nematode species in the region (Grabda, 1976; Lang *et al.*, 1990; Lick, 1991).

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Tab. 1: Food of harbour porpoise in German coastal waters, 1985-1990.

	FISH-FAMILY	FISH SPECIES		NORTH SEA	BALTIC SEA
1	Ammodytidae	Sandeel	*Ammodytes lanceolatus*	+	+
2	Carangidae	Horse mackerel	*Trachurus trachurus*	+	-
3	Clupeidae	Herring	*Clupea harengus*	-	+
4		Sprat	*Sprattus sprattus*	+	+
5	Cottidae	Sea scorpion	*Myoxocephalus scorpius*	+	-
6	Gadidae	Cod	*Gadus morhua*	+	+
7		Whiting	*Merlangius merlangus*	+	+
8		Poor cod	*Trisopterus minutus*	+	-
9	Gobiidae	Goby	*Pomatoschistus spec.*	+	+
10		Black goby	*Gobius niger*	-	+
11	Osmeridae	Smelt	*Osmerus eperlanus*	+	-
12	Pleuronectidae	Flounder	*Platichthys flesus*	+	-
13		Dab	*Limanda limanda*	+	-
14		Plaice	*Pleuronectes platessa*	+	-
15	Soleidae	Sole	*Solea solea*	+	-
16	Zoarcidae	Eel mother	*Zoarces viviparus*	+	-
17	?	Unidentified species		-	+
	OTHER REMNANTS in the stomach, probably secondary food				
	Crustacea	*Crangon, Mysis (mixta?)*		-	+
	Mollusca	Molluscan shellfish and shellfish		+	+
	Polychaeta	Claws of polychaets		+	+
	Copepoda	*Lernaeocera sp.*	(parasite of gadids)	+	+
	Sand			+	-

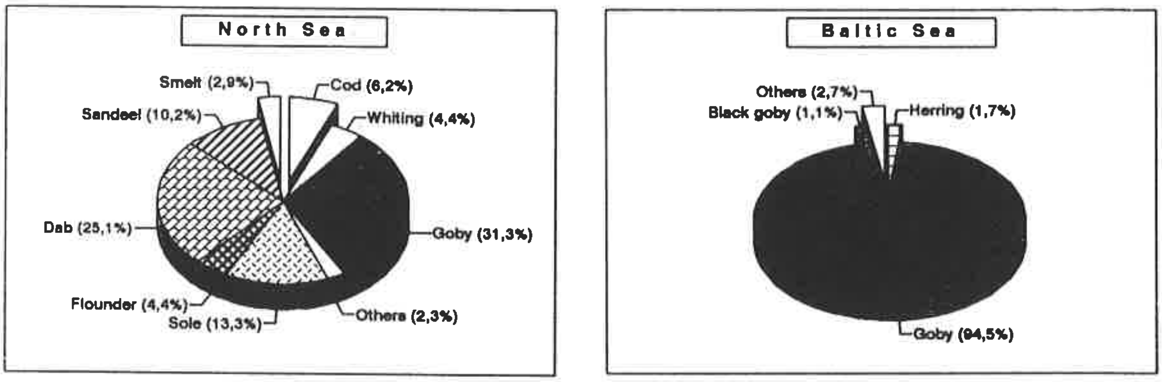

Fig. 1: Relative number (%) of different fish species found in the stomach of 102 investigated harbour porpoises, 1985-1990.

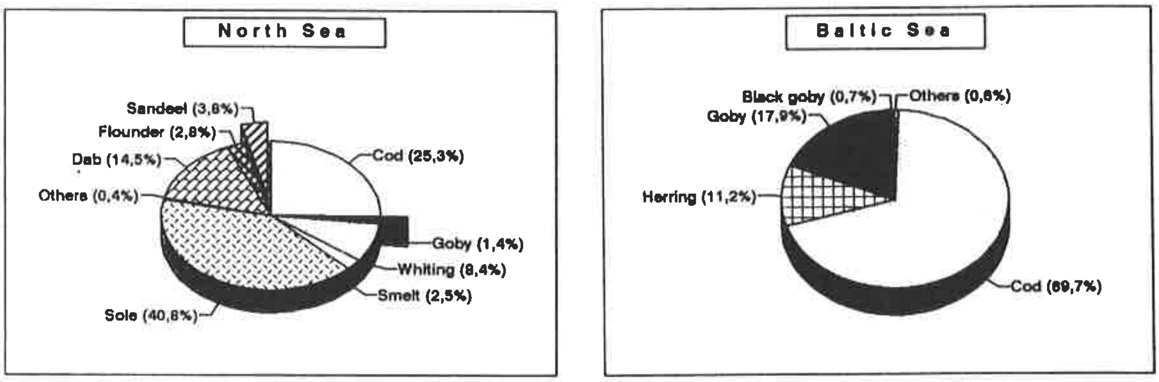

Fig. 2: Relative weight (%) of different fish species found in the stomach of 102 investigated harbour porpoises, 1985-1990.

REVIEW OF RECENT MASS MORTALITIES OF MARINE MAMMALS IN NORTH AMERICA

David J. St. Aubin

Department of Pathology,
Ontario Veterinary College, University of Guelph,
Guelph, Ontario, Canada

The past 10-12 years has seen an apparent increase in the number of unusual mass mortalities of marine mammals in North American waters. Of the six events identified in the 1990 Annual Report of the United States Marine Mammal Commission (Anon, 1991), four have been linked to biological toxins, one to a virus, and one remains unsolved. A review of the nature and pattern of these events reveals some similarities and differences with recent disease outbreaks in the Mediterranean and North Seas.

Between December 1979, and October 1980, at least 445 harbour seals *Phoca vitulina*, along the New England coast died of acute pneumonia associated with influenza virus (Geraci *et al.*, 1982). The virus had avian characteristics, and was the first of its kind to be associated with severe disease in wild mammals. Population density and environmental factors may have promoted the epizootic. At the time of the outbreak, there were unusually large numbers of seals hauled out in the area where the disease first appeared. These large aggregations reflected the increased number of seals along the New England coast, and unseasonably warm temperatures which can induce seals to spend more time ashore. The striking similarities between this event and previous accounts of mass mortalities of seals in Iceland and the Antarctic raised the possibility of a common etiological agent, though in the light of recent events in European seal populations (Kennedy, 1990), the latter occurrences might have been associated with a morbillivirus (Bengston *et al.*, 1991).

The possibility that biological toxins pose a threat to marine mammals was recognised over 25 years ago (Keyes, 1965), though in many instances it has been difficult to establish the link between mortality and exposure to the toxins. Such was the case in September, 1962, when approximately 275 dead northern fur seals *Callorhinus ursinus* were found on the shores of St. George Island (Keyes, 1965). Seabirds feeding on the same fish as the seals were also affected, as were foxes scavenging on the carcasses. However, tests to confirm the presence of a toxin proved negative, perhaps because the substance(s) were inactivated as a result of the less than ideal conditions under which the specimens were collected and stored.

In 1978, a more definitive case was made for ciguatoxin poisoning in the deaths of 50 or more Hawaiian monk seals *Monachus schauinslandi*, on Laysan Island (Gilmartin *et al.*, 1980). Affected animals apparently did not die acutely, but showed progressive debilitation and the effects of concurrent parasitic and microbial disease.

During a three-month period beginning in February, 1982, more than 30 manatees *Trichechus manatus* along the Gulf of Mexico coast of Florida died from eating tunicates that contained brevetoxin, the substance produced by the dinoflagellate *Ptychodiscus brevis* which is responsible for "red tide" (O'Shea *et al.*, 1991). Clinical signs in affected animals were indicative of neurotoxicity. Manatees were observed swimming in circles or unable to maintain themselves at the surface to breathe. A few individuals recovered after being supported at the surface for several hours by investigators.

Saxitoxin (STX), the compound responsible for paralytic shellfish poisoning in humans, was implicated in the deaths of 14 humpback whales *Megaptera novaeangliae*, in the region of Cape Cod Bay (Geraci *et al*., 1989). The carcasses came ashore during a six week period, but most were decomposed, suggesting that they had been dead for some time and were redistributed by wind and tide. The deaths likely occurred during a much shorter time interval than the recovery period would indicate. The whales were in good flesh, and had partly digested fish, including mackerel *Scomber scombrus* in their stomachs. One individual, observed close to shore, was apparently behaving normally, but 90 minutes later was dead. Bioassays of stomach contents and tissues collected from the whales revealed an acutely toxic substance, and chemical analysis showed that mackerel caught in the vicinity of where the whales were feeding contained STX. The vulnerability of the whales to such compounds is likely enhanced by physiological factors associated with diving and the fact that a water soluble toxin such as STX would bypass the blubber and be delivered to more sensitive tissues.

The acute deaths of the manatees and humpback whales contrasted with the condition of most of the 750 bottle-nosed dolphins *Tursiops truncatus* that came ashore along the central and south Atlantic coasts of the United States between June 1987 and March 1988 (Geraci, 1989). Many were emaciated and showed a broad spectrum of bacterial and viral diseases, possibly exacerbated by high concentrations of chlorinated hydrocarbons in their tissues. The animals appeared to have become ill after consuming fish containing brevetoxin, which rendered them more susceptible to a variety of pathogens. The toxin was isolated from the liver of some of the affected animals, from fish taken from the stomach of one of the dolphins, and from the same species of fish collected along the coast of Florida during the latter stages of the die-off. The toxin-producing organisms, which are typically restricted to the Gulf of Mexico, were apparently transported into Gulf Stream waters along the Atlantic coast, where they were consumed by planktivorous fishes such as menhaden *Brevoortia smithii*. These co-migrated northward with the dolphins during the spring of 1987, exposing a large segment of the population and setting the stage for mortalities which were first observed in the early summer. The algal bloom, which persisted along the mid-Atlantic coast and forced the closure of shellfish beds there in the fall of 1987, was encountered again by southerly migrating dolphins, and resulted in a second wave of mortalities along the coast of Florida during the winter of 1987-88.

The most recent event in North American waters involved bottle-nosed dolphins in the Gulf of Mexico. Unseasonably cold temperatures were implicated in the deaths of 23 animals washed up in Matagorda Bay, Texas, in January 1990. However, the cause of death of the more than 250 dolphins that were subsequently found along the shores of Florida, Alabama, Mississippi, Louisiana, and Texas during the following three months has not yet been established. It is also uncertain whether this event was linked to the deaths of 13 more dolphins near Galveston, Texas, during the first three weeks of November 1990. The investigation continues.

Unexpected die-offs of marine mammals continue to present a perplexing and often inconsistent picture which can confound investigators. In North America, we have seen viral infection causing relatively acute disease and death of otherwise healthy animals, and poisoning from biotoxins that in some instances was acutely fatal while in others appeared to be only the trigger that precipitated a long course of multi-systemic disease exacerbated by viruses, bacteria, parasites and organochlorines. Continued surveillance for these and other causes of natural mortality is essential as part of our ongoing efforts to understand and manage the dynamics of marine mammal populations.

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VIRUS INFECTIONS OF MARINE MAMMALS: AN OVERVIEW

I.K.G. Visser*,** and A.D.M.E. Osterhaus**,***

* Seal Rehabilitation and research Centre, Hoofdstraat 94a,
9968 AG Pieterburen, The Netherlands
** Laboratory of Immunobiology, National Institute of Public Health and Environmental Protection, P.O. Box 1, 3720 BA Bilthoven, The Netherlands
*** Division of Virology, Institute of Infectious Diseases and Immunology,
Veterinary Faculty, State University of Utrecht,
Yalelaan 1, 3508 TD Utrecht, The Netherlands

INTRODUCTION Epidemics or epizootics, occurring in humans and animals respectively, are outbreaks of disease or mortality, caused by an infectious agent, which is transmissable from one individual to one or several others, thus having an effect on a whole population.

During this century, several infectious diseases, not necessarily resulting in epizootics, have been described among pinnipeds and cetaceans. The first report of an epizootic dates from 1918 (Dietz *et al.*, 1989), when about 1,000 adult harbour seals *Phoca vitulina* died with signs of pneumonia in Icelandic waters. In 1955, about 3,000 animals (about 85%) of the crabeater seal *Lobodon carcinophagus* population in the Antarctic were killed by an agent inducing severe pneumonia (Laws, 1959). Although these outbreaks were probably caused by viruses, it was not until 1968 that a virus, in this case a picornavirus, was isolated from a marine mammal (California grey whale *Eschrichtius robustus*) (Watkins *et al.*, 1969). Since then, viruses of ten different families have been described as pathogens of different marine mammals, not all of them causing epizootics. This review reports incidental cases of identification of virus infections and die-offs associated with viral infections in aquatic mammals, which are summarised in a taxonomic order of the causative agents (for review, see Visser *et al.*, 1991).

VIRUS INFECTIONS OF MARINE MAMMALS

Adenovirus Infections Although in small numbers, California sea lions (*Zalophus californianus*) have been suspected to die from infection with an adenovirus. In 1978 and 1980, five and one animals of this species respectively died within 20-25 days after infection with an adenovirus that seemed associated with symptoms of severe infectious hepatitis (Dierauf *et al*, 1981; Osterhaus *et al.*, 1985). In contrast to these pinnipeds, an adenovirus which was most probably not associated with any disease, was isolated from a stranded sei whale *Balaenoptera borealis* caught by a whaling ship in Antarctic waters in 1977 (for review, see Kennedy-Stoskopf, 1991). Since then, no more cases of adenoviral hepatitis have been reported to occur in marine mammals, and due to lack of appropriate serological assays and available samples, there is no knowledge about the spread of adenoviruses among California sea lions or other marine mammal species.

Herpesvirus Infections In 1984, an apparently infectious disease characterised by vomiting, diarrhoea, nasal discharge, inflammation of the oral mucosa and fever, which affected all the harbour seal *Phoca vitulina* pups nursed in a Dutch seal sanctuary, was shown to be caused by a newly recognised alphaherpesvirus: phocid herpesvirus 1. During this outbreak, 11 of the 23 pups present at that time died (Osterhaus *et al.*, 1985). In 1986, a herpesvirus was also isolated from lung material of a California sea lion that had died from a pericarditis (Kennedy-Stoskopf *et al.*, 1986). During a serious outbreak of morbillivirus infection among seals in Northwest Europe in 1988, a herpesvirus was also isolated from several harbour seals (Frey *et al.*, 1989).

Among cetaceans, a herpes-like virus was isolated from a skin lesion of a beluga whale *Delphinapterus leucas* with a generalised dermatitis in 1989. It has been speculated that, apart from focal dermatitis, this virus does not cause severe disease (Barr *et al.*, 1989).

A worldwide survey of serum samples from pinnipeds sampled up to 1984 revealed that antibodies with neutralising capacity for phocid herpesvirus 1, or a closely related seal herpesvirus (SeHV) could be demonstrated in most of the populations screened (Vedder *et al.*, 1988). No data on the distribution of herpesvirus infections among cetaceans and no investigations on the relationship between the different herpesvirus isolated from marine mammal species have been reported.

Poxvirus Infections Since 1969, (California sea lion) skin disease associated with a parapoxvirus infection has been reported in a variety of marine mammal species. In pinniped species, the lesions have been described among harbour seals, California sea lions, northern fur seals *Callorhinus ursinus*, grey seals *Halichoerus grypus*, and South American sealions *Otaria byronia*. The disease is characterised by nodular proliferative cutaneous lesions, in which parapoxvirus particles can be demonstrated by electron microscopy. Although nothing is known about its aetiology, an orthopoxvirus was isolated from a biopsy of a pox-like skin lesion observed in a grey seal suffering from phocid distemper during an outbreak in 1988. In this lesion, parapoxvirus particles were also present (Osterhaus *et al.*, 1990). Although animals can be badly affected by cutaneous parapoxvirus infection, no serious illness or death seems to be related to this infection.

Among cetacean species, the bottle-nosed dolphin *Tursiops truncatus*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, and harbour porpoise *Phocoena phocoena* have been shown to be susceptible to a parapoxvirus infection. In these marine mammal species, the parapoxvirus infections are manifested in a different way. They are characterised by tattoo-like skin lesions formed by ring-like hyperpigmented areas in the epidermis. These infections are generally more severe than those observed in pinnipeds, and may even result in the death of affected animals (Geraci *et al.*, 1979).

The most likely mode of transmission of these parapoxvirus infections to other marine mammals, and even humans, is direct skin contact, although transfer may also result from arthropod bites and aerosol formation. Information about the spread of parapoxvirus infection among, and the impact upon, pinniped and cetacean populations is not available.

Picornavirus Infections Picornavirus infections have been observed in pinnipeds and cetaceans. After the first isolation of a picornavirus from an apparently healthy California grey whale in 1968 (Watkins *et al.*, 1969), no more reports on picornavirus infections in aquatic mammals have appeared until 1988. Then, during an outbreak of phocid distemper in Northwest European seals, a picornavirus was isolated from many seals (Dietz *et al.*, 1989). No clear association with the severity of the disease induced by the morbillivirus has been reported. From the present knowledge, it may be concluded that subclinical picornavirus infections occur in marine mammals and that they are not likely to be a major threat to these animals (Osterhaus and Vedder, 1988).

Calicivirus Infections A high incidence of abortions among California sea lions was observed from 1969 to 1971. A calicivirus indistinguishable from vesicular exanthema of swine virus (VESV) was isolated from affected mothers and aborted pups on San Miguel Island, and the virus was named san miguel sea lion virus (SMSV) (Smith *et al.*, 1973).

The abortions could not be directly linked to SMSV infection. However, vesicle formation observed on the skin of the flippers of affected animals was shown to be associated with the presence of calicivirus infection.

Since then, 14 different serotypes of calicivirus have been identified in several marine mammal species. Most of these strains seem to be non-host-specific. In California sea lions at least eight different caliciviruses have been demonstrated. The other strains have been identified in northern fur seal, northern elephant seal *Mirounga angustirostris*), Stellar sea lion *Eumetopias jubatus* and Pacific walrus *Odobenus rosmarus*. The Pacific walrus seems to carry a distinct serotype, besides the more common types (Smith *et al.*, 1983).

Of the cetacean species, calicivirus could be isolated from the Atlantic bottle-nosed dolphin (Geraci, 1989). Serological evidence for calicivirus infection was obtained from the California grey whale, the bowhead whale *Balaena mysticetus*, and the sperm whale *Physeter macrorhynchus* (Smith and Latham, 1978).

The caliciviruses isolated from marine mammals could not be distinguished from VESV and were shown to induce signs of vesicular exanthema in pigs (Gelberg and Lewis, 1982). In the Pacific basin, outbreaks regularly occur among aquatic mammals. As the same serotypes could be isolated from both California sea lions and opaleye perches *Girella nigricans*, this fish species was thought to be the reservoir for maintenance of the enzootic cycle (Smith *et al.*, 1978b). Three laboratory workers, working with two different marine calicivirus isolates developed type-specific antibodies without showing clinical signs. This indicates that these viruses also replicate in humans (Smith *et al.*, 1978a).

Influenza virus Infections In 1979, off the coast of New England, USA, several hundreds of harbour seals (about 20% of the total population) died with signs of respiratory illness resulting in severe pneumonia. From brain and lung material of clinically healthy and diseased seals, an influenza virus A/Seal/Mass/1/80 typed H7N7 could be isolated. In 1982, a second influenza virus A/Seal/Mass/133/82 typed H4N5 was isolated from animals dying from a similar disease in the same area. Although there is no evidence of influenza virus transfer from birds to seals, the viruses isolated in 1980 and 1982 seemed to be of avian origin (Webster *et al.*, 1981; Hinshaw *et al.*, 1984).

Experimental infection of a harbour seal, two ringed seals *Pusa hispida* and three harp seals *Phoca groenlandica* caused mild respiratory disease with mild cough and mucopurulent discharge from eye and nose, but was not shown to be lethal (Geraci *et al.*, 1984).

Besides these epizootic periods, no further outbreaks among pinniped or cetacean species could be attributed to influenzavirus infections.

Morbillivirus Infections In 1987, several thousands of Baikal seals *Phoca sibirica* died with signs of severe pneumonia and neurological symptoms, resembling distemper in dogs, at Lake Baikal in Siberia. The causative agent proved to be a morbillivirus very closely related if not identical to canine distemper virus (Osterhaus *et al.*, 1989). In 1988, a massive epizootic with a similar pattern affecting harbour seals started in the Danish Kattegat area and spread to harbour seal populations throughout Northwest Europe, killing more than half of the total population. Besides severe respiratory disease, observed in almost all affected animals, central nervous symptoms and more generalised illness with gastrointestinal involvement and signs of severe immunosuppression were observed in a majority of the animals. Secondary bacterial infections, causing conjunctivitis and cutaneous lesions, and secondary infections with other viruses, such as for example herpes-, picorna- and influenza viruses, were frequently observed (Visser *et al.*, 1989).

Specific pathogen free (SPF) dogs, experimentally infected with organ material from affected seals developed mild respiratory disease, similar to the respiratory symptoms of canne distemper (Osterhaus *et al.*, 1988). Experimentally infected harbour seals, however, died within 18 days after inoculation. Although grey seals, ringed seals and harp seals were shown to be susceptible to this infection, mortality seemed relatively low in these cases. The virus isolated from this outbreak proved to be a newly recognised member of the genus Morbillivirus and was named phocid distemper virus-1 (PDV-1) (Visser *et al.*, 1990). During this outbreak among seals, the presence of a similar virus was demonstrated in harbour porpoises that had stranded on the Northern Irish coast (Kennedy *et al.*, 1988). However, it was not until 1990 that a morbillivirus-induced epizootic was observed among cetacean species. During the summer of that year, several hundreds of Mediterranean striped dolphins *Stenella coeruleoalba* died in Spanish and adjacent waters. The epizootic spread to the Gibraltar strait, to France and Italy (Osterhaus *et al.*, in press). Affected animals showed serious respiratory disease and a morbillivirus could be demonstrated in several organs of affected animals. The virus has still to be characterised, and possible relationships to the seal viruses have to be evaluated as well as the virus responsible for the induction of morbillivirus-specific antibodies observed in serum samples obtained from dolphins along the Canadian coast in 1989 (Geraci, 1989).

Coronavirus Infection The only report on a presumed coronavirus infection in marine mammals dates from 1987 when three harbour seals of the Miami Seaquarium died within a short period, only one of them displaying signs of disease before death. Histopathology revealed intestinal disease, respiratory disease and depletion of lymphoid tissue. No virus could be isolated, but on the basis of histopathology and immunofluorescence, it was presumed that the animals had been infected with a coronavirus (Bossart and Schwartz, 1990).

Rabies Virus Infection During an outbreak of rabies among arctic foxes *Alopex lagopus* in 1980, a ringed seal, probably bitten by a rabid fox, displayed signs of rabies including signs of severe encephalitis. The skin on the head was oedematous and exudate ran from both eyes and mouth. Passaging of brain material into mice combined with immunofluorescence analysis confirmed the clinical diagnosis of rabies (Ødegaard *et al.*, 1981).

Retrovirus Infections In 1986, biopsies of recurrent ulcerative skin lesions of a captive California sea lion were shown to contain a foamy virus characterised as a member of the subfamily Spumavirinae. Besides this report, so far no other marine mammal species has been shown to harbour retroviruses (Kennedy-Stoskopf *et al.*, 1986).

CONCLUSIONS Fourteen different viruses representing ten different families have been shown to infect different marine mammal species. Most of these viruses induce disease in their respective host species, especially when they are introduced into hitherto unexposed populations, leading to serious epizootics. This has recently been observed during outbreaks of morbillivirus infections among different pinniped and cetacean species.

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THE STRIPED DOLPHIN DIE-OFF IN SPANISH MEDITERRANEAN WATERS

A. Aguilar* and A.J. Raga**

* Department of Animal Biology (Vertebrates), Faculty of Biology, University of Barcelona, 08071 Barcelona, Spain.
** Department of Animal Biology (Zoology), Faculty of Biological Sciences, University of Valencia, Dr. Moliner 50, 46100 Burjasot, Valencia, Spain.

During the summer and autumn of 1990, hundreds of carcasses of dolphins appeared stranded on the coasts of most countries bordering the western Mediterranean basin. The die-off first started in Spain, but soon extended to France, Italy, Morocco and Algeria.

The only species that is known with certainty to have been affected by the epizootic was the striped dolphin *Stenella coeruleoalba*. This is the most abundant cetacean in the Mediterranean, where it typically forms schools of some dozens of animals. It feeds mostly on squid and fish, and has an offshore distribution. Its calving period takes place mainly at the end of summer or early autumn, that is, precisely at the time the epizootic started, and this coincidence explains the considerable number of deaths between neonates and lactating calves that occurred during the episode.

DEVELOPMENT OF THE EPIZOOTIC The first animals to be identified as having been affected by the epizootic appeared on the coasts of the region of Valencia and the Balearic Islands (Spain) in early July (Aguilar and Raga, 1990). Thereafter, the epizootic quickly moved north and south and, by early September, diseased dolphins had already begun to appear in the Alboran Sea and southern France. In October, the die-off reached the coasts of Italy, Morocco and Algeria while, at the same time, it decreased its virulence in the areas where it first started. In October, the number of carcasses of striped dolphins appearing on the beaches showed an understandable decrease in all areas, but some diseased animals still arrived in small numbers all over the region until the end of the year.

MORTALITY STATISTICS In Spain, the country where the epizootic started and where it appeared most virulent, a network was established to collect all stranded dolphins and to ensure their proper sampling. In total, about 450 carcasses of striped dolphins were examined in the Spanish Mediterranean coasts. Nearly 40% of these specimens were considered to be fresh enough to be sampled for a variety of studies, including (but not limited to): anatomopathology, parasitology, pollution, genetics, virology, bacteriology, blood chemistry, age determination, reproduction, feeding, and nutritive condition. Research on these material is underway (Aguilar and Raga, 1990).

In France, because no proper network had been established and the efforts for collecting diseased dolphins were dispersed and fragmentary, no precise statistics for the die-off could be produced, although it has been estimated that stranded dolphins numbered at least 200 over the whole period.

In northwestern Italy, it has been estimated that the epizootic was responsible for the appearance of some 80 carcasses of striped dolphins on the beaches, although some uncertainties also existed about this figure because fishing operations in the area were known to have produced some parallel mortality at the time the die-off broke out. The relative importance of the two mortality factors has been impossible to apportion.

With the exception of casual reports of apparently diseased dolphins entering the harbours of Morocco and Algeria, almost no information is available for northern Africa, for which the virulence of the epizootic of the epizootic cannot be established in this region. however, only in Ceuta and Melilla (Spanish properties on Morocco's eastern coast), nearly 30 carcasses of striped dolphins were washed ashore during the period, September to December.

However, because the striped dolphin has a pelagic distribution and its highest population densities are located far away from the coast (at least 10-15 miles distance from shore), it is unknown what fraction the above numbers represent of the total that actually died because of the epizootic. Reports from fishermen, yachtsmen, specially organised helicopter flights and offshore sighting cruises indicated the frequent occurrence of carcasses of striped dolphins floating in open waters, too far away from the coast to reach the shore. For this reason it is assumed that the toll of the die-off was much higher than the number of carcasses collected on the beaches, and probably numbered several thousands of individuals.

ACKNOWLEDGEMENTS The Autonomous Administrations of Catalonia, Valencia, the Balearic Islands, Murcia and Andalucia organised the networks for collecting and sampling the stranded dolphins in Spain. The Institute for Nature Conservation (ICONA) centralised the information and directly undertook part of the fieldwork, including the helicopter flights. Greenpeace contributed information and carried out a sightings survey with the M/V "Sirius" to estimate offshore mortality. Financial support was obtained from the Direction of Maritime Fisheries (Generalitat de Catalunya), the Conselleria de Medi Ambient (Generalitat de Valencia), the Institute for Nature Conservation (ICONA), and the National Fund for Scientific and Technological Research (DGICYT) of the Ministry of Education and Science of Spain (projects NAT90-1255-E and NAT90-1254-E). Thanks are due to J.M. Bompar, F. Poitevin, G. Notarbartolo di Sciara, M. Podestà, P. Reignaud, Asociación de Naturalistas del Sureste (ANSE), Barcelona Zoo, and Marineland S.A. for providing information and cooperation.

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AGE AND SEX COMPOSITION OF STRIPED DOLPHIN DIE-OFF IN THE WESTERN MEDITERRANEAN

Nuria Calzada*, Christina Lockyer**, Esteve Grau*
and Alex Aguilar*

*Department of Animal Biology (Vertebrates), Faculty of Biology,
University of Barcelona, Spain.
**Sea Mammal Research Unit, Madingley Road, Cambridge, United Kingdom.

INTRODUCTION During the striped dolphin (*Stenella coeruleoalba*) die-off in the Western Mediterranean in 1990, data and samples from dolphins that reached the coast were collected in order to investigate the contributing factors that led to the death of these animals. However, the precise role played by the different factors so far identified (viral infections, pollutants, nutritional condition, parasites, etc.) and the interrelationship between them still remains to be ascertained.

In an attempt to contribute to the epidemiological aspects of the die-off, the age and sex composition of the dolphins killed by the epizootic was studied. This aspect was considered relevant because some of the agents claimed to have been involved in the event are known to affect the various components of the population in a different manner. For example, viral infections are typically more severe in individuals with weak immune systems, such as very young or old animals, and pollutant levels are typically much higher in adult males than in adult females or young males.

MATERIALS AND METHODS Teeth from about 120 striped dolphins were collected and prepared for age determination. So far, however, age calculations have only been completed for 68 specimens, and for this reason the results presented here should be considered preliminary.

Age was calculated by counting growth layer groups in the dentine of teeth previously decalcified with RDO, cut in a freezing microtome, and stained with haematoxilin, following standard procedures (Myrick *et al.*, 1983).

The sex of the striped dolphins was determined by trained personnel and, in most cases, this could be checked against the collected gonad samples.

RESULTS Figure 1 shows the age frequency distribution in the teeth sample so far analysed, which corresponds mostly to the specimens found off northeastern Spain (Catalonia). As can be seen, the bulk of the animals affected (60% of the total) falls within the 11-20 year age range. Striped dolphins reach sexual maturity at the age of 9 years (Miyazaki, 1977), so this age range corresponds to fully mature individuals.

Assuming that the population was in equilibrium before the event, a typically negative exponential age distribution should be expected, as is usual in undisturbed mammal populations (Allen, 1980). Therefore, we may conclude that the younger age classes (<11 years) were under-represented in the sample. This effect is especially noteworthy if we take into account the fact that the numbers of neonates and calves actually would have been overestimated because many of these animals probably died, not because they were themselves affected by the epizootic, but because their mothers became diseased. This may have been very significant because the epizootic outbreak at the end of the summer coincided with the peak of the calving period (Aguilar, 1991).

When body length frequency is examined (figure 2), the sample size (n=173) is considerably larger than for the age distribution. Even so, the conclusions that can be drawn from the plot are essentially the same as with the age. However, it is interesting to note the peak that appears on the left hand side of the figure (length classes 90-140), which actually corresponds to neonates and calves (Aguilar, 1991), thus suggesting an over-representation of these population components.

With regard to the sex composition of the dolphins affected by the epizootic, and according to X^2 tests, the male:female sex ration observed (0.98) did not differ from the value of 1 that should be expected if we assume an equal distribution of sexes, nor from the 1.06 estimated for this population in a previous study (Aguilar, 1991).

CONCLUSIONS The epizootic did not affect all age classes equally, but fully mature dolphins (11-20 years old) were the population component that displayed the highest mortality.

There was no apparent difference in the severity of the epizootic between sexes, and the sex ratio observed in the sample corresponds to the normal one for the population.

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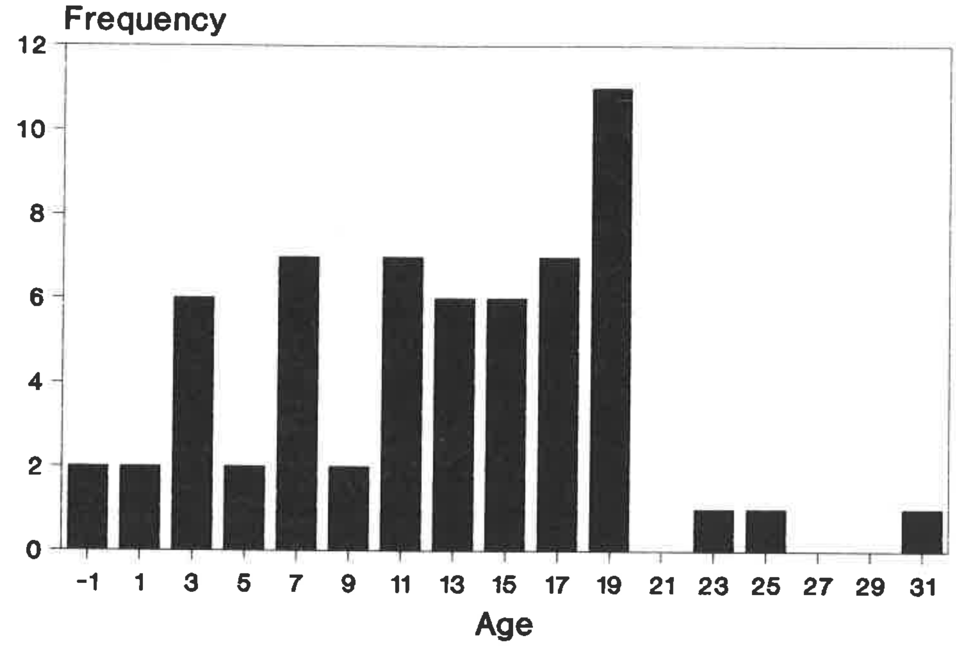

Fig. 1 Age frequency distribution of striped dolphins in epizootic

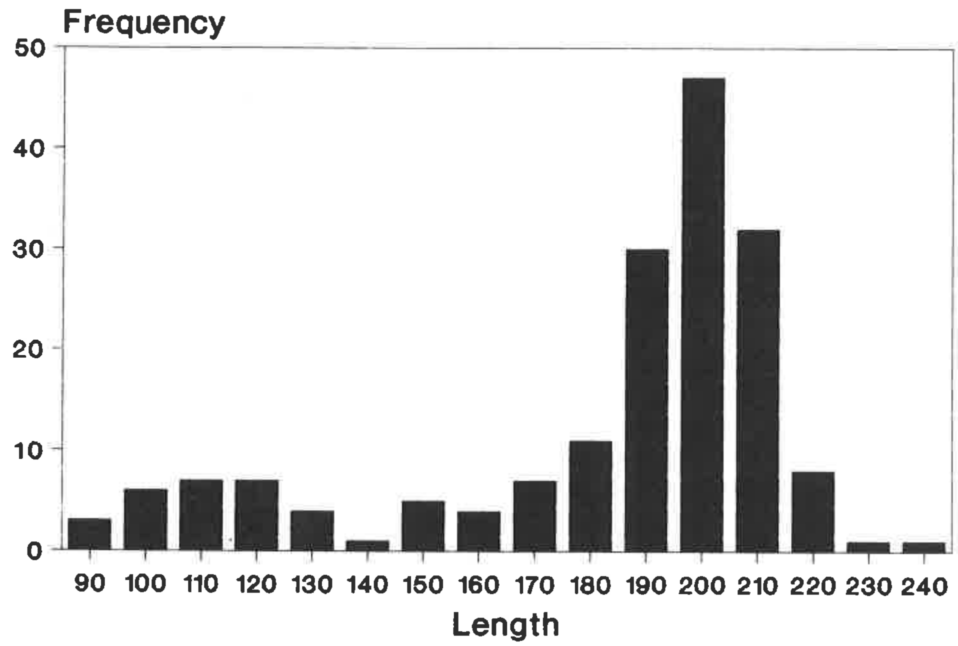

Fig. 2 Body length frequency of striped dolphins in epizootic

THE NUTRITIVE CONDITION OF STRIPED DOLPHINS (*Stenella coeruleoalba*) AFFECTED BY THE WESTERN MEDITERRANEAN EPIZOOTIC

A. Aguilar, A. Borrell, N. Calzada and E. Grau

Department of Animal Biology (Vertebrates),
Faculty of Biology, University of Barcelona,
08071 Barcelona, Spain.

The nutritive condition of the striped dolphins affected by the western Mediterranean die-off (Aguilar and Raga, 1990) was studied to better characterise the pattern of pathological and physiological changes produced by the epizootic, and to ascertain the involvement of environmental factors in its origin and development.

MATERIALS AND METHODS This study was carried out on 68 striped dolphins (35 males and 33 females) collected during the epizootic, and on blubber samples collected from 84 free-living dolphins of the same species, population and area during the summers of 1987, 1988 and 1989 with a butterfly-valve biopsy dart (Aguilar and Nadal, 1984). the variables used to measure the nutritive condition were the Trunk Blubber Weight (TBW), the Trunk Muscle Weight (TMW), and the Lipid Content of the Blubber (BLC).

TBW was considered to be the amount of blubber present in the trunk region defined as that comprised between two planes, one located just behind the eye and the other through the anus, as shown in figure 1. Previous studies have shown that the blubber from this region shows the greatest changes when dolphins grow thin or fat, while the blubber of the head, tail, and tailstock remains fairly insensitive to changes in body condition (Aguilar and Borrell, unpubl. data). TMW was calculated as the weight of the dorsal muscle from the same region, and BLC was determined from a sample of blubber excised from the region posterior to the dorsal fin, as shown with an arrow in figure 1. For the lipid analysis, the tissue sample was ground with anhydrous sodium sulphate and its lipid fraction extracted with n-hexane for 4 hours in a Soxhlet apparatus. The extract was concentrated, and the lipid content from an aliquot determined by evaporation under cold air stream and gravimetry (Aguilar and Borrell, 1990).

Body fat reserves were estimated for each individual by multiplying TBW by BLC and, by comparison to the "healthy" population, an estimate of the lipid deficit was obtained.

RESULTS AND DISCUSSION The three variables examined showed that condition of epizootic striped dolphins was poor and that, in any cases, body fat reserves had almost been depleted. BLC, considered to be the most reliable condition index for cetaceans (Aguilar and Borrell, 1990) was much lower in diseased dolphins than in the free-ranging individuals sampled by means of a biopsy dart during the summers of 1987-89.

These latter are assumed to be representative of the population in normal conditions. As can be seen in Figure 2, while most of the biopsy samples had lipid contents between 0.6 and 0.7, the epizootic dolphins had much lower values, usually in the range 0.4 to 0.6.

Comparatively, the index that reacted less to changes in condition was TBW. This was taken as an indication that when the dolphin grows thin, the blubber keeps freeing lipids without reducing its volume. Thus, lipid is substituted by water to keep blubber thickness constant and ensure appropriate thermal insulation. In contrast, TMW readily reacted to changes in body condition, indicating that muscle volume is considerably reduced when dolphins are deprived of adequate food supply.

Calculations of the lipid deficit showed that dolphins had on average 38.5% of their normal body fat reserves, with extreme lower values reaching 19% in females and 24% in males. Such extreme values are consistent with a considerably long period of fasting, and suggest that dolphins had been deprived of food for a period of at least several weeks before death. Using standard conversion factors for lipid caloric content and basal metabolic rates (Lockyer, 1981), it was estimated that, on average, complete fasting for at least 14 days was necessary to explain such a poor nutritive condition. This indicated that diseased dolphins suffered reduced feeding for a period of time much longer than would reasonably be expected to be the consequence of a fast-action virus such as a morbillivirus. Therefore, the present results suggest that the depletion of fat reserves was not a consequence of the viral disease but, rather, a condition preceding it.

ACKNOWLEDGEMENTS This research was funded by the Directorate of Maritime Fisheries (Generalitat de Catalunya), the Institute for Nature Conservation (ICONA), and the National Fund for Scientific and Technological Research (DGICYT) of the Ministry of Education and Science of Spain (project NAT90-1255-E). Thanks are due to all those that cooperated in the collection of dolphins and samples.

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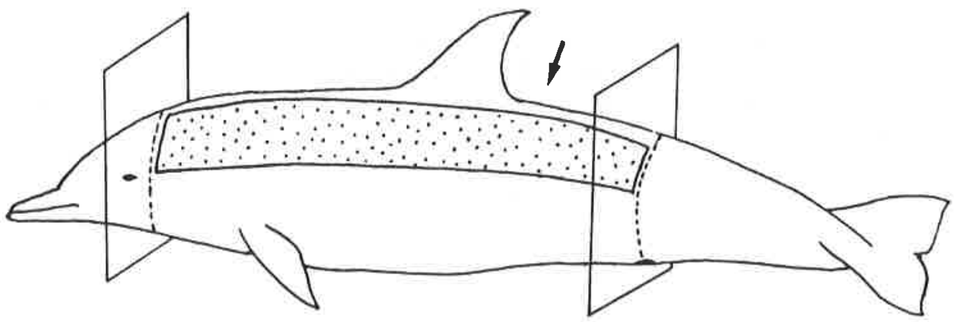

Fig. 1 Diagram showing the limits of the trunk region as defined to measure TBW (between the two planes, including dorsal fin and flippers), and TMW (shaded area). Blubber samples were collected in the location shown by the arrow.

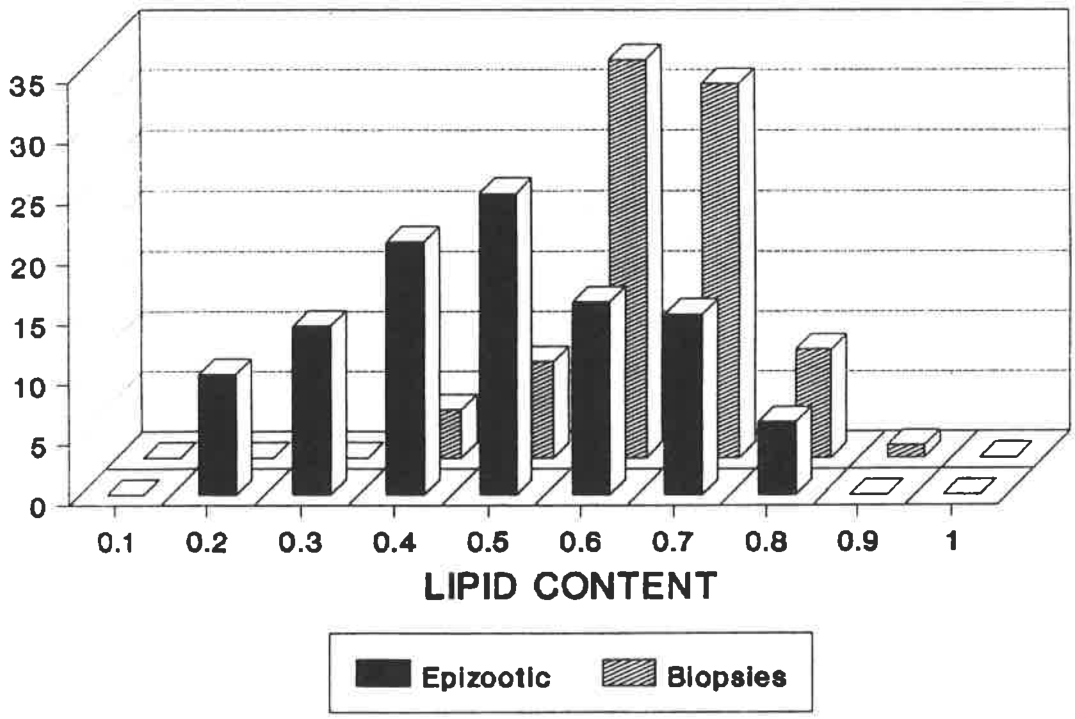

Fig. 2 Frequency distribution of Blubber Lipid Content (BLC) in striped dolphins sampled during the epizootic and by means of a biopsy dart during 1987-89.

ANALYSIS OF DIFFERENT ORGANOCHLORINES IN THE BLUBBER OF MALE HARBOUR PORPOISES FROM SCANDINAVIAN WATERS

Lars Kleivane

Avd. Marine Zoology and Chemistry, Institute of Biology, University of Oslo, 0374 Oslo, Norway

The ecological effects of organochlorines (OC) are not fully understood, but drastic impact on top predators and especially on their reproduction successes in certain marine food webs give alarming signals concerning the whole ecological system.

As a part of the Harbour Porpoise project in Norway "Prosjekt Nise", blubber samples of 23 male harbour porpoises *Phocoena phocoena* were selected for OC analysis. These were chosen from a number of bycaught animals all along the Norwegian coast in the years 1988/89. Additional 12 animals bycaught in Kattegat, were provided by the Danish Harbour Porpoise project "Prosjekt Marsvin". With this selection of animals, it is possible to compare the numbers and the levels of different organochlorines in porpoises from Kattegat, the west coast of Norway ("Vestlandet") and the northern coast of Norway ("Finnmarkskysten"), within an area range from 57°N to 71°N.

Analyses were done at the Research Institute for Nature Management (R.I.N.) in Holland, utilising a modified clean-up procedure described by Holden and Marsden (1969), and high resolution gas-liquid chromatography with an electron capture detector (GLC-ECD).

A total of 16 organochlorine chemicals or groups of chemicals were detected during the analysis. Of these chemicals only the polychlorinated biphenyls (the PCBs) and hexachlorobenzene (HCB) have been used in industry, while the rest, hexachloro-cyclohexanes (a-, b- and g-HCH), heptachlor epoxide, oxychlordane, trans-Nonachlor, Dieldrin, Endrin, DDT and metabolites (pp-DDE, op-DDD, pp-DDD, op-DDT, pp-DDT), are either pesticides or metabolites of these.

All these OCs were detected in all animals, except op-DDD which was not detected in five animals from "Vestlandet". The preliminary results indicate geographical and age related differences in the level of contamination for many of the organochlorines.

WERE PCB LEVELS ABNORMALLY HIGH IN STRIPED DOLPHINS AFFECTED BY THE WESTERN MEDITERRANEAN DIE-OFF?

Assumpció Borrell and Alex Aguilar

Department of Animal Biology (Vertebrates), Faculty of Biology,
University of Barcelona, 08071 Barcelona, Spain

Polychlorinated biphenyls, or PCBs, are a group of organochlorine pollutants which have a well-documented capacity for depressing the immune system of mammals (Loose *et al.*, 1977; Thomas and Hinsdill, 1978; Kunita *et al.*, 1985; Brouwer *et al.*, 1989). Because of this, and also because the striped dolphin population affected by the recent epizootic in the western Mediterranean is known to have been chronically exposed to high levels of PCBs during at least the last decade (Aguilar *et al.*, 1987), it has been suggested that these compounds may have triggered the development of the epizootic by weakening the ability of the dolphins to react to disease.

Moreover, preliminary analyses of diseased dolphins showed that blubber concentrations of PCBs were abnormally high in relation to typical values for the population, according to monitoring programs carried out in previous years using biopsy darts (Aguilar and Raga, 1990). However, this finding was concomitant to the one that epizootic dolphins were in a poor nutritional state, and for this reason it was suggested that the high PCB levels observed might be the consequence of intense lipid mobilisation from the blubber.

The aim of the present study was to estimate PCB levels in terms of total body load, in order to avoid the effect of differential nutritional condition. In addition, liver PCB concentrations were calculated and compared with those for blubber, with the aim of establishing whether mobilisation and re-distribution of PCBs in the body compartments had occurred.

MATERIALS AND METHODS Samples of liver and blubber from the region posterior to the dorsal fin were excised from dolphins collected during the epizootic in 1990. Biopsies of blubber were collected between 1987 and 1989 by means of a biopsy dart of the butterfly valve type, as designed by Aguilar and Nadal (1984)..

For the organochlorine analysis, the tissues were extracted in a Soxhlet apparatus with n-hexane and the resulting extract treated with sulphuric acid for the clean-up. An aliquot of the purified extract was then injected into a capillary gas chromatograph, following the procedures described by Borrell and Aguilar (1990). PCB concentrations in tissues are always expressed on an extractable lipid basis. Body loads were calculated as the total PCB load in the blubber, which from previous studies is known to represent up to 90% of the total body load in striped dolphins (Tanabe *et al.*, 1981). this variable was estimated as the product of the blubber weight, lipid content of the blubber and the PCB concentration in a sample from the dorsal region posterior to the dorsal fin.

RESULTS AND DISCUSSION Table 1 details the PCB concentrations detected in the blubber of epizootic dolphins. Males had substantially higher concentrations than females, as expected from the transfer of organochlorine pollutants that is known to occur during pregnancy and lactation.

Figure 1 compares the frequency distribution of PCB concentrations in the blubber obtained from biopsies and from epizootic dolphins. As can be seen, PCB levels in biopsies showed a very clear mode with a small coefficient of variation, while those from epizootic dolphins showed a much wider variation, in general reaching much higher concentrations than in the first group. Overall, blubber PCB concentrations were nearly three times higher in "diseased" dolphins than in "healthy" ones (Table 1).

When these levels are recalculated in terms of body loads (Figure 2), the frequency distribution pattern remains similar, but the difference between the two groups diminishes. However, the mean PCB loads in epizootic dolphins are still about twice as high as those sampled with the biopsy dart. This indicates that PCB levels were actually higher in the striped dolphins affected by the epizootic than in the "healthy" population sampled prior to the event, and that the difference between the two groups cannot be attributed to variations in nutritional condition.

Complementary to this conclusion is the finding that PCBs were indeed mobilised together with lipids during fat mobilisation, and that at least part of these compounds reached the liver. Figure 3 shows the relationship between PCB concentrations in liver and blubber of epizootic dolphins, and it can be seen that most individuals fall above the 1:1 line. This pattern suggests that large amounts of PCBs reached the liver in recent times, and that the body distribution had not reached an equilibrium between compartments at the time of death, in accordance with the simple mammalian model of distribution that organochlorines typically follow in the body of mammals.

CONCLUSIONS PCB levels in striped dolphins, affected by the western Mediterranean epizootic, were about twice as high as normal values for the population sampled prior to the event. This difference cannot be attributed to the dolphins' nutritional condition.

PCBs left the blubber during the mobilisation of fat reserves, and large quantities of this pollutant reached the liver. This happened shortly before the epizootic and, by the time of death, equilibrium had not been achieved.

ACKNOWLEDGEMENTS Funds for this research were provided by the Direcció General de Pesca Maritima of the Generalitat de Catalunya, the Instituto para la Conservación de la Naturaleza (ICONA) in Spain, and the Comisión Interministerial de Ciencia y Tecnología (project NAT90-1255-E).

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TABLE 1: Blubber concentrations and loads

CONC. (ppm)	Biopsies	Epizootic		
		Total	Males	Females
Average	309	886	1099	582
Number	86	46	19	27
St. deviation	145	648	695	414
Maximum	704	2965	2965	1687
Minimum	68	48	197	48

LOADS (g)	Biopsies	Epizootic
Average	1609	3258
Number	22	44
St. deviation	623	1608

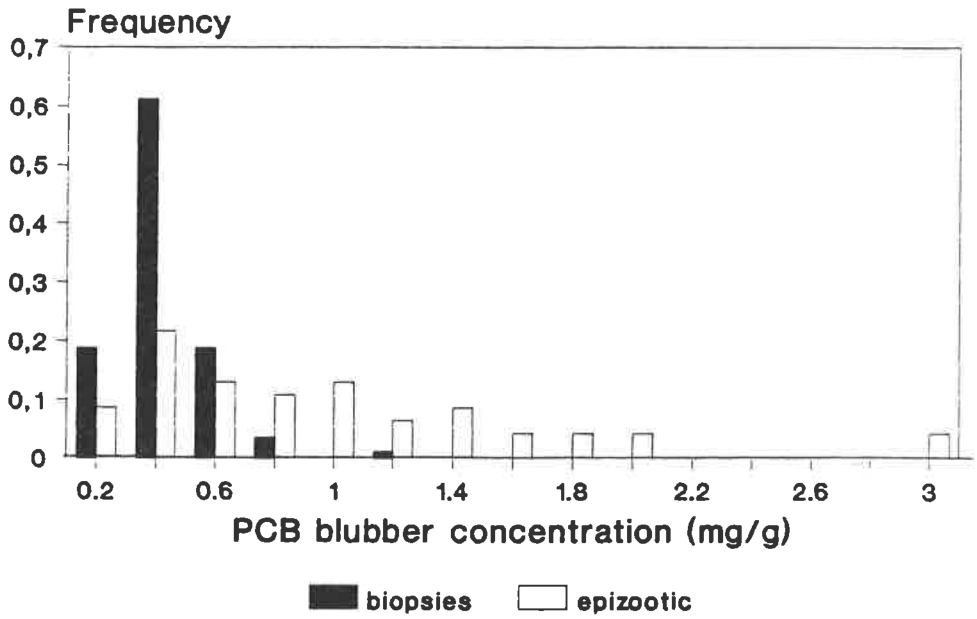

Fig. 1 Frequency distribution of PCB concentrations in blubber from biopsies and epizootic dolphins

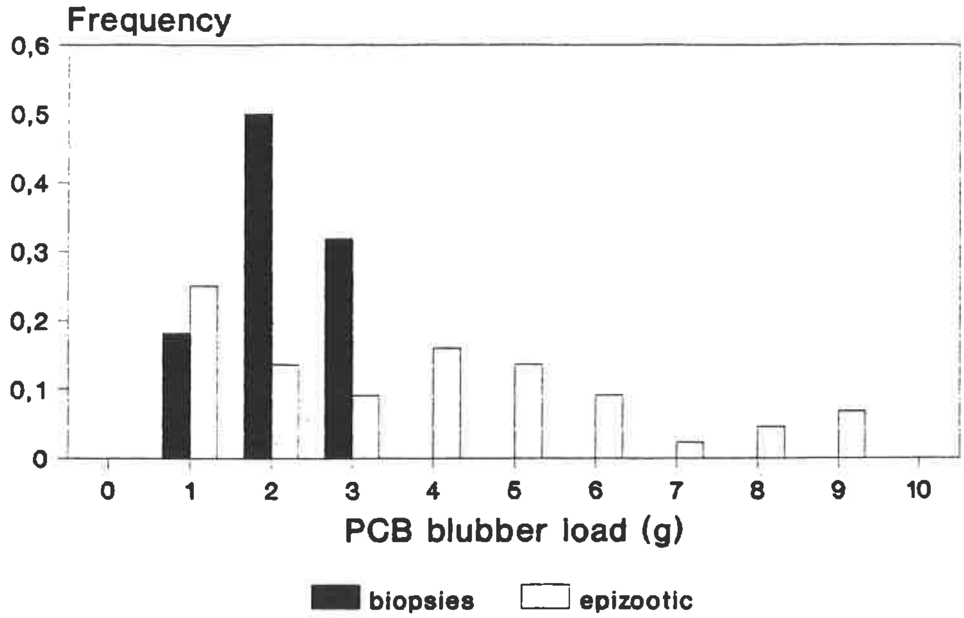

Fig. 2 PCB blubber loads from biopsies and epizootic dolphins

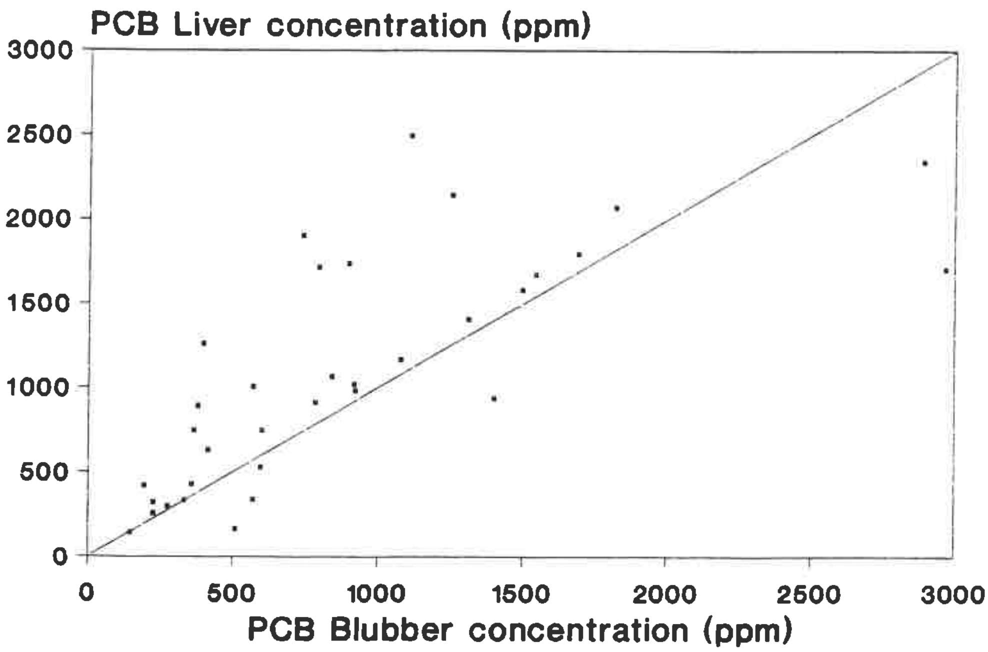

Fig. 3 Relationship between PCB concentrations in liver and blubber for epizootic dolphins

SUBCUTANEOUS ORGANOCHLORINE LEVELS IN FIN WHALES (*Balaenoptera physalus*) FROM THE LIGURIAN SEA

S. Focardi*, G. Notarbartolo di Sciara**, C. Venturino**, M. Zanardelli** and L. Marsili*

*Dipartimento di Biologia Ambientale, via delle Cerchia 3, 53100 Siena, Italy
**Tethys Research Institute, Piazza Duca d'Aosta 4, 20124 Milano, Italy

INTRODUCTION Organochlorine contaminants have penetrated all ecosystems, including those of "remote areas" such as the Arctic and Antarctic. In recent years the levels of these xenobiotics, especially polychlorinated biphenyls (PCBs), have shown a marked increase in oceanic waters, with the consequent phenomenon of biomagnification in the marine food chain. This can cause serious problems for Cetacea, since they are large, long-lived predators that are efficient biological accumulators of persistent environmental contaminants and are also known to be very sensitive to the toxic effects of these xenobiotics. Here we report the preliminary results of a study aimed at assessing the presence and levels of organochlorine compounds in a large Mediterranean cetacean; samples of subcutaneous tissue were remotely collected by biopsy darts from nine free-ranging fin whales *Balaenoptera physalus*, encountered in the Ligurian Sea during the summer of 1990.

MATERIALS AND METHODS Research cruises were conducted aboard a 15 metre yacht with auxiliary engine between 1 June and 20 September 1990. The study area included the waters off San Remo, in the western Ligurian Sea (Fig. 1, Table 1). All whales were sighted within a radius of approximately 30 km from San Remo (between 43°38.83' and 43°29.86'N, 07°51.90' and 07°27.72'E). Upon sighting, they were approached to within shooting range (6-25 m). The biopsy dart, a regular aluminium crossbow bolt with a modified stainless steel collecting tip and floater, was fired into the whale by means of a Barnett Wildcat II crossbow with a 150-pound test bow. To avoid the possibility of infection, the bolt tip was sterilised by rubbing alcohol before shooting. Biopsies were taken from a dorsal area in the vicinity of the dorsal fin and on the upper portion of the caudal peduncle. The whales' reaction to the biopsy varied from a slight start to no reaction at all. The subcutaneous tissue sample was immediately refrigerated aboard (approx. 3°C) and frozen a few hours later upon returning to shore. For the analysis, freeze dried material was extracted in Soxhlet with n-hexane; the extract was subjected to sulphuric acid clean-up, followed by Florisil chromatography. The analytical method used was high resolution capillary gas chromatography, with an electron capture detector (Ni63) and an SBP-5 (30 m) bonded phase capillary column. The carrier gas was argon/methane (95/5), 100 kPa; its split ratio being 100/1. The oven temperature was 100°C for 10 minutes, and this was then increased by 3°C/min to 280°C. The injector and detector temperatures were 200° and 280°C respectively. A mixture of specific isomers was used for instrumental calibration, recovery, evaluation and confirmation. The results are expressed in mg/kg on a lipid basis.

RESULTS AND DISCUSSION Capillary gas chromatography revealed the presence of op' and pp' isomers of DDT and its derivatives DDD and DDE, and about 25 PCB congeners in the subcutaneous tissue of all the fin whales analysed (Table 2; Fig. 2). The levels of DDTs varied between 5.5 and 24.6 mg/kg on a lipid basis; pp'DDE had the highest levels with an average of 6.5 mg/kg and a maximum of 14.9 mg/kg. The ratio pp'DDE/DDTs was similar in all samples (mean=0.65; SD=0.04), and was higher than that found by Aguilar and Borrell (1988) in the blubber of the same species. The total amount of polychlorinated biphenyls (PCBs) was calculated as the sum of the 24 congeners identified and quantified. As shown by the chromatogram, it constituted 90% of the total residues. PCBs ranged from 2.2 to 14.4 mg/kg, with an average of 6.1 ppm, and a standard deviation of 4.1. The ratio DDTs/PCBs was always greater than one, with a mean value of 1.71 (SD=0.52). Comparison with the literature is made difficult by the absence of biometric data (sex and age), important in order to understand the actual state of contamination of the species (Tanabe *et al.*, 1986; Aguilar and Borrell, 1988). Nevertheless, it is evident that in fin whales, the values we obtained were higher for DDT and its derivatives and also for PCBs, than those found by Aguilar and Borrell (1988) in fin whales from the North Eastern Atlantic. DDT and PCB levels were lower than those found in Mediterranean dolphins (Aguilar, 1985, Focardi *et al.*, 1990).

Detailed examination of PCB composition shows that the most frequent congeners were hexachlorobiphenyls and heptachlorobiphenyls. Among the latter, 22'44'55' (also known by IUPAC no. 153, Ballschmiter and Zell, 1980) predominated and was the most abundant component in all cases; the other abundant hexachlorobiphenyls were 22'344'5' and 22'33'44' (IUPAC no.s 138 and 128). Among the heptachlorobiphenyls, the most abundant were 22'33'44'5, 22'344'55' and 22'34'55'6 (IUPAC nos. 170, 180 and 187). No significant differences were found in the fingerprint of the PCBs in the different specimens, indicating a similar mode of intake and metabolism. This is certainly linked to the fact that these congeners are very persistent and resistant to metabolic breakdown.

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Tab. 1 - Place and date of the nine whales sampled.

sample	date	location
BP1	16.6.1990	43¯38.83' N, 007¯51.90' E
BP3	16.6.1990	43¯38.83' N, 007¯51.90' E
BP4	18.6.1990	43¯33.38' N, 007¯50.99' E
BP5	21.6.1990	43¯33.21' N, 007¯51.90' E
BP6	26.6.1990	43¯34.97' N, 007¯50.64' E
BP7	09.7.1990	43¯31.61' N, 007¯27.62' E
BP8	09.7.1990	43¯31.61' N, 007¯27.72' E
BP9	15.7.1990	43¯29.86' N, 007¯42.36' E
BP10	20.7.1990	43¯38.36' N, 007¯51.19' E

Tab. 2 - Chlorinated hydrocarbons (mg/kg fat basis) in *Balaenoptera physalus* (n=number of specimens; x=mean; SD=Standard Deviation).

Compounds	n	x	SD	range
op'DDE	9	0.07	0.06	0.02- 0.20
pp'DDE	9	6.52	4.32	3.19-14.93
op'DDD	9	0.11	0.10	0.03- 0.31
pp'DDD	9	0.90	0.78	0.39- 2.57
op'DDT	9	1.11	1.02	0.39- 3.44
pp'DDT	9	1.41	0.98	0.55- 3.21
DDTs	9	10.11	7.23	4.72-24.64
PCBs	9	6.14	4.18	2.25-14.39
DDTs/PCBs	9	1.71	0.52	1.07- 2.53

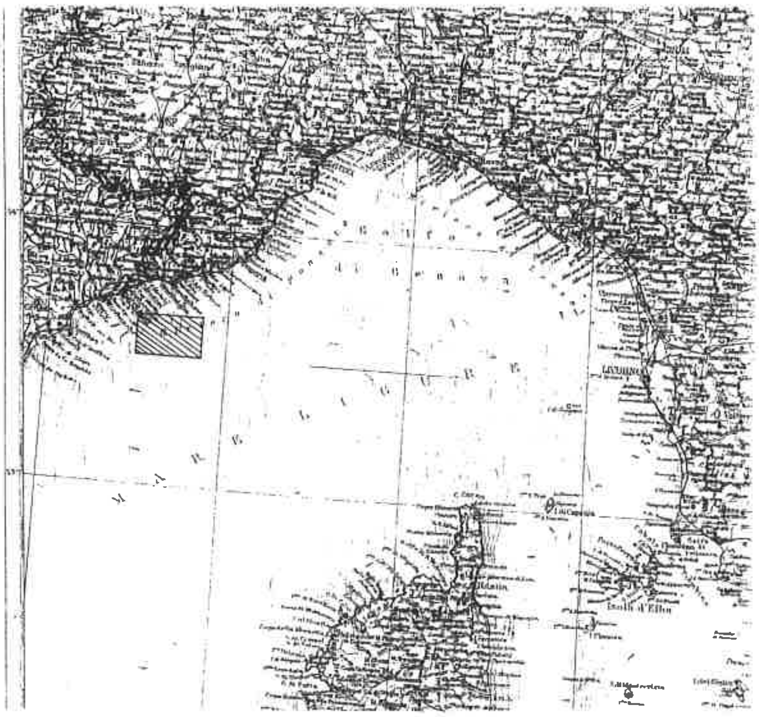

Fig. 1 - Sampling area.

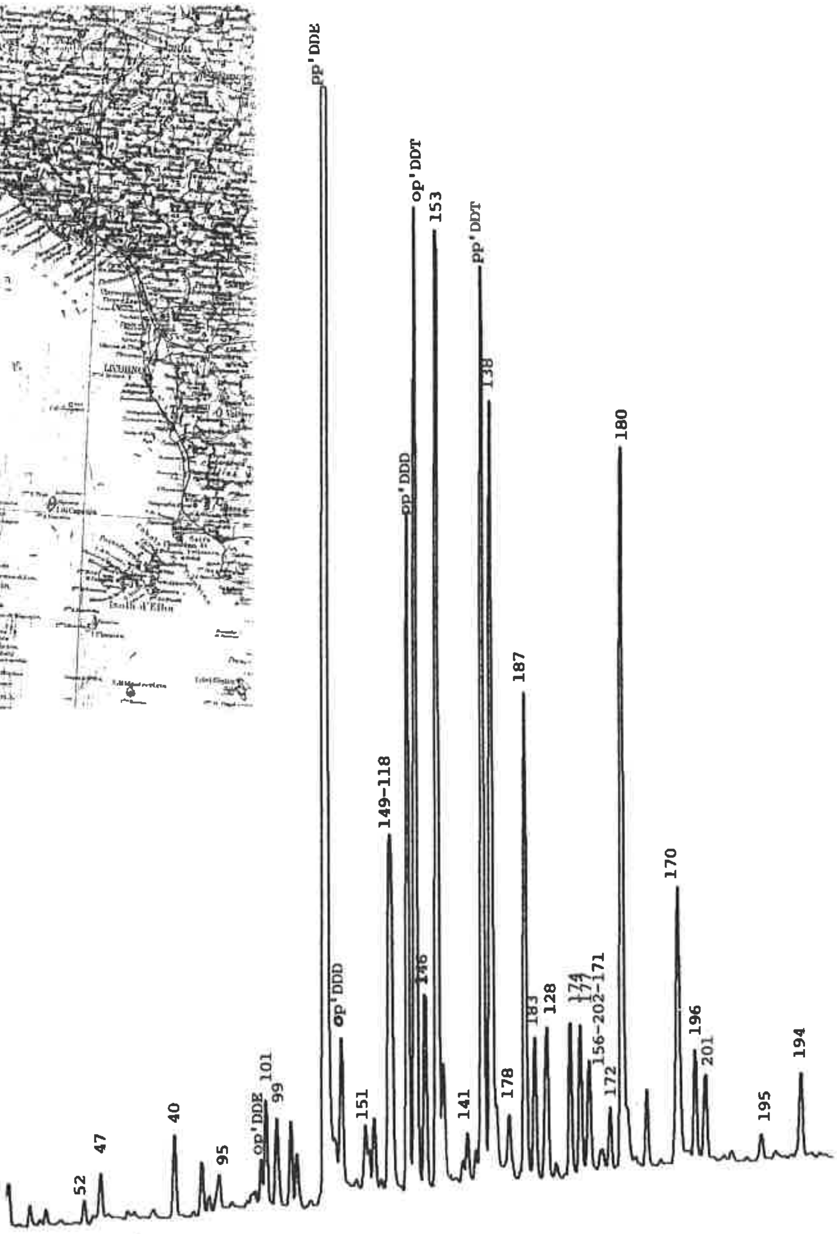

Fig. 2 Capillary column ECD chromatogram of subcutaneous tissue of *Balaenoptera physalus*

MORBILLIVIRUS INFECTION IN STRIPED DOLPHINS *Stenella coeruleoalba* IN THE MEDITERRANEAN SEA

M. Domingo*, M. Pumarola*, Joana Visa*, A. Marco*, L. Ferrer*, J. Plana** and S. Kennedy***

*Department of Veterinary Pathology, Autonomic University of Barcelona, 08193 Bellaterra, Spain
**Laboratorios Sobrino, 17813 Vall de Bianya (Olot, Gerona), Spain
***Veterinary Research Laboratories, Stormont, Belfast, Northern Ireland

Hundreds of striped dolphins, *Stenella coeruleoalba*, were killed in the Spanish Mediterranean Sea during the summer and autumn of 1990 by a major epizootic. Dolphins were found stranded, dead or moribund. Some of them showed diarrhoea or disorientation. No other clinical signs could be observed. Necropsy was done in 58 dolphins. Samples of organs were fixed in 40% neutral buffered formalin and embedded in paraffin for routine histopathologic and immunoperoxidase studies. The most significant pathologic findings were subacute to chronic pneumonia, encephalitis and lymphoid depletion. In the lungs, hyperplasia of type II pneumocytes was accompanied by exudation of large mononuclear cells into the alveolar and bronchiolar lumina. Many multinucleate syncytia were found in the inflammatory lesions. These cells frequently contained eosinophilic intranuclear and intracytoplasmic inclusion bodies. A severe lymphoid cell depletion of the cortical zone of the lymph nodes was regularly observed. Multinucleate syncytia in variable number were found scattered through the lymphoid tissue. Small foci of karyorhectic lymphoid cells were also evident. A non-suppurative encephalitis was frequently observed.

Inflammatory lesions consisted of multifocal or laminar degeneration and necrosis of neurons and glial cells in the cerebral cortex, with glial proliferation and neuronophagia. Pale eosinophilic intranuclear inclusion bodies were frequent in damaged and in apparently normal neurons. Edema of the neurophil and mild perivascular cuffing were found in these areas. One third of the dolphins showed a variable degree of acute or subacute liver cell dystrophy. This was manifested by the formation in some hepatocytes of a large central eosinophilic hyalinic vacuola, which displaced the nucleus of the cell. Necrosis of biliary duct epithelial cells, with disorganisation of the biliary ducts and a moderate pericolangitis was also found. A morbillivirus was isolated from tissues of dead dolphins, and morbillivirus antigen was detected in lesions by means of a monoclonal antibody raised against the phocine distemper virus (PDV).

The immunoperoxidase staining was seen as a diffuse or fine granular cytoplasmic reaction. Intranuclear and intracytoplasmic inclusion bodies were also heavily stained. Syncytial cells showed a prominent reaction.

These findings confirm a primary etiologic role of PDV or a closely related virus in this epizootic. This project was supported by the Catalonian Government.

TOXOPLASMOSIS IN STRIPED DOLPHINS *Stenella coeruleoalba*

M. Domingo, M. Pumarola, Joana Visa, A. Marco and L. Ferrer

Department of Veterinary Pathology,
Autonomic University of Barcelona, 08193 Bellaterra, Spain.

Infection by *Toxoplasma gondii* was observed in three striped dolphins *Stenella coeruleoalba*, found dead in the distemper epizootic in the Mediterranean Sea in 1990. Affected dolphins were all adult females. In one case, *Toxoplasma* oocysts were found in the brain. Some oocysts were in the nervous tissue without causing significant inflammatory changes, but some of them were also seen in zones of severe mononuclear encephalitis. In the second case, *Toxoplasma* endozooytes were found in high numbers in the lung-associated lymph nodes, causing a necrotizing lymphadenitis. A small number of endozooytes was observed in scattered inflammatory foci in the brain. In a third animal, a severe necrotizing lymphadenitis was associated with the presence of endozooytes in phagocytic cells. The brain of this dolphin could not be investigated. Cardiac and skeletal muscle showed no alterations. *Toxoplasma* oocysts and endozooytes were stained with a polyclonal antibody prepared in rabbit inoculated with *Toxoplasma gondii*.

One case of *Toxoplasma* infection has been already described in dolphins. The origin of the infection remains unclear, but residual waters and disposal of food wastes (swine and sheep meat) into the sea could be possible sources of infection. This project was supported by the Catalonian Government.

SYSTEMIC MYCOSIS CAUSED BY *Aspergillus fumigatus* IN STRIPED DOLPHINS *Stenella coeruleoalba*

M. Domingo*, M. Pumarola*, J. Visa*, L. Abarca** and M.R. Bragulat**

* Department of Veterinary Pathology, Autonomic University of Barcelona, 08193 Bellaterra, Spain
** Department of Microbiology, Autonomic University of Barcelona, 08193 Bellaterra, Spain

Mycotic lesions due to *Aspergillus fumigatus* occurred in the lungs and in the brain of two female dolphins found dead in the recent distemper epizootic in the Mediterranean Sea.

A severe multifocal granulomatous-necrotizing mycotic pneumonia was present in two dolphins. *Aspergillus* hyphae, grown in and around airways, easily infiltrated the lung parenchyma and penetrated large blood vessels.

A severe multifocal necrotizing encephalitis was also observable macroscopically in both cases. The large haemorrhagic foci of malacia were found mainly in the cerebral cortex. In these foci, hyphae were found infiltrating the nervous tissue. Mycotic growth was also frequent in the walls of large blood vessels. Thrombotic lesions were evident in the affected vessels. No other organs were affected.

The fungal species was isolated from lung tissues in both cases, and characterised morphologically as *Aspergillus fumigatus* . To our knowledge, this is the first report of infection by this mycotic agent in dolphins. The relationship of the infection with distemper or with other causes of immunosuppression is currently being investigated. This project was supported by the Catalonian Government.

THE USE OF PHOTOGRAPHY TO MONITOR DISEASES IN FREE-LIVING BOTTLE-NOSED DOLPHINS

Paul M. Thompson*, Philip S. Hammond** and Ben Wilson**

* Lighthouse Field Station, University of Aberdeen, George Street, Cromarty, Ross-shire, IV11 8YJ, UK
** Sea Mammal Research Unit, c/o British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, UK

There has been concern that some populations of small cetaceans have declined as a result of increased human activity in coastal areas. Pollution may, directly or indirectly, increase the vulnerability of these species to disease. However, to assess the extent of this problem, comparative data are required on mortality rates and disease prevalence in areas of differing water quality. It is not usually practical to capture cetaceans to assess their health, and the opportunities to examine stranded animals are often rare. Therefore, such studies require techniques which permit the prevalence of diseases to be assessed remotely.

This paper describes how conventional photo-identification techniques have been extended to record clinical signs of disease in wild *Tursiops* from the Moray Firth, northeast Scotland. Several types of skin lesion are described, and it is shown how systematic photographic surveys could be used to estimate the prevalence and development of these conditions. Used alongside more detailed pathological examinations of stranded animals, we suggest that these techniques could provide a useful tool for making comparative studies of disease in wild populations of small cetaceans.

PARASITES COLLECTED IN THE STRIPED DOLPHIN DIE-OFF IN THE SPANISH MEDITERRANEAN

M. Fernàndez, J. Aznar, J.A. Balbuena and J.A. Raga

Departamento de Biología Animal, Universidad de Valencia,
Dr. Moliner 50, 46100-Burjasot, Valencia, Spain

INTRODUCTION In July 1990, an abnormally high number of strandings and sightings of striped dolphin *Stenella coeruleoalba* occurred in the Spanish Mediterranean. Most animals washed ashore arrived dead. Those found still alive, died a few hours afterwards. Sightings were usually reported in shallow waters and the animals looked diseased or disoriented. This situation continued through August, September and October, but a substantial decrease in strandings and sightings was observed in November, December and January (1991). All carcasses fresh enough for sampling were processed following a standardised procedure set up by members of the Departments of Animal Biology of the Universities of Barcelona and Valencia. We present here preliminary results of parasitological analyses carried out on 53 animals. In future studies, one of our aims will be to assess the role of parasitism and its relationship with other agents as factors contributing to the die off.

MATERIALS AND METHODS Sampling of parasites included a review of the external surface of the animals in search for ectoparasites or epizoics. Blubber layer, mesenteries, kidneys and air sinuses were examined in the field. Digestive systems and lungs were collected and kept frozen. The intstines, stomach compartments, bile and pancreatic ducts, bronchi and bronchioles were split open and examined individually for helminths.

RESULTS AND DISCUSSION The parasite species detected are listed in Table 1. The ectoparasite and epizoic fauna formed by crustaceans is relatively rich. *Syncyamus aequus* occurred around the blowhole and mouth corners. *Xenobalanus globicipitis* appeared at different stages of development on the edges of the dorsal fin, flippers and flukes, occurring more frequently on the latter location. *Pennella* sp. was found attached to the skin and blubber layer on the flanks and belly. *X. globicipitis* and *Pennella* sp. were the commonest crustacean species detected, perhaps because both seem to be typical on cetaceans from warm and temperate waters. *Conchoderma virgatum* and *Lepas* sp. on the stripėd dolphin are new host records. Although there are a few records of *Lepas* spp. on seals, to our knowledge, this is the first report of such barnacles on a cetacean. Both *Conchoderma virgatum* and *Lepas* sp. were found still alive between the teeth of the same individual. However, the animal could not be surveyed for other parasites due to its bad conditon and, for this reason, prevalence figures for *C. virgatum* and *Lepas* sp. are not given.

Lesions due to epizoic or ectoparasite species were only observed in the case of *Pennella* sp. They consisted of local inflammatory reactions in blubber and muscle.

C. virgatum and the species of *Lepas* occur commonly on drifting objects or slow-swimming animals. Since the striped dolphin is a fast-swimming cetacean, the presence of these crustaceans might be indication of a period of restricted mobility of the dolphins. The relatively high prevalence of *X. globicipitis* is also consistent with this hypothesis. Similar features were also observed in 1987 mass dolphin deaths along the Atlantic US coasts (Brody, 1989).

The helminth fauna of the dolphins examined is also relatively rich. However, three cestode species, namely *Monorygma grimaldii, Phyllobothrium delphini* and Cestoda sp. larvae, appeared at larval stages. Since their adult forms are not known, their taxonomic status is unclear. *M. grimaldii* and *P. delphini* occurred as cysts in the mesenteries and blubber respectively, and may actually correspond to more than one species. It seems that these tapeworms parasitise sharks as final hosts. They both showed the highest prevalences in this survey, which is perhaps not surprising as they appear to occur commonly in cetaceans of warm and temperate waters all over the world. Cestoda sp. larvae occurred abundantly in the bile and pancreatic ducts and in the pyloric stomach. It has been proposed that these larvae may correspond to an earlier stage of development of *M. grimaldii, P. delphini* or both. If this hypothesis is correct, they might be ingested with food, passing from the stomach to the duodenum and hepatic and bile ducts. Then they would enter the blood stream through either mesenteric or hepatic vessels to reach the mesenteries and/or the blubber, encysting there.

Trematodes were represented by three species. *Pholeter gastrophilus* occurred within cysts in the stomach submucosa, showing a relatively high prevalence. Two Campulidae species, *Oschmarinella mascomai* and possibly *Zalophotrema* sp. were found in bile and hepatic ducts. Mixed infections with both species were common, but no interactions, such as site shifts, were apparent. However, this possibility will be rigorously tested in further studies.

Only one tapeworm species, *Tetrabothrium forsteri,* occurred at adult stage in the duodenal ampulla.

Three species of nematodes occurred: *Anisakis* sp., both as larvae and as adults in the stomach; *Skrjabinalius guevarai* in the bronchi; and *Crassicauda* sp. within the mammary glands and muscles and blubber on the ventral side.

Although some of these species are potentially pathogenic (for example *Anisakis* sp., *Crassicauda* sp. and the campulid trematodes), only a few, namely *Pholeter gastrophilus* and *Skrjabinalius guevarai,* were associated with gross pathologies and appeared frequently enough as to assume that they were having an effect on the health status of the striped dolphin population. According to the literature, *Pholeter gastrophilus* has no significant pathological effect (Woodard *et al*, 1969; Howard *et al.*, 1983). Only local reactions due to the presence of the parasites have been reported (i.e. Migaki *et al.*, 1971; Dailey, 1985), the largest cyst size recorded until the present study being only 3 to 4 cm (Raga *et al.*, 1985). However, a considerable proportion of the cysts found in the pyloric stomach were larger, weighing over 100 g. Our analyses indicate that such cysts may have an obstructive effect, particularly in the connecting channel, making either the passage of food or peristalsis difficult.

Skrjabinalius guevarai and other lungworm species have been related to obstruction of respiratory ducts and damage of lung parenchyma. In this case, they appeared to occur together with pulmonary lesions. In further studies, we shall evaluate the intensities of worm infections in relation to the total volume of lung damaged in an attempt to elucidate the effect of pulmonary nematodiasis in the health condition of the dolphins and its relation to other pathogenic agents.

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Table 1 Parasite and epizoic species collected during the striped dolphin die off in the Spanish western Mediterranean.

Parasite or epizoic species	site	prevalence (%)
AMPHIPODA		
Syncyamus equus	skin	17.0
COPEPODA		
Pennella sp.	flanks	34.0
CIRRIPEDIA		
Conchoderma virgatum	teeth	-
Lepas sp.	teeth	-
Xenobalanus globicipitis	flukes	49.1
DIGENEA		
Pholeter gastrophilus	stomach	81.0
Oschmarinella mascomai	bile ducts	53.3
	pancreatic ducts	57.6
Zalophotrema sp.	bile ducts	28.9
	pancreatic ducts	33.3
CESTODA		
Cestoda sp. larva	bile ducts	73.3
	pancreatic ducts	57.6
	pyloric stomach	31.0
Monorygma grimaldii	mesenteries	86.5
Phyllobothrium delphini	blubber	92.3
Tetrabothrium forsteri	duodenal ampulla	21.4
NEMATODA		
Anisakis sp.	stomach	16.7
Crassicauda sp.	ventral muscle & blubber	9.6
Skrjabinalius guevarai	lungs	77.1

FACTORS INFLUENCING INTESTINAL PARASITISM OF *Globicephala melas* OFF THE FAROE ISLANDS

J.A. Balbuena and J.A. Raga

Departamento de Biología Animal (Zoología), Universidad de Valencia, Dr Moliner 50, 46100-Burjasot, Valencia, Spain

INTRODUCTION The ecological aspects of parasitic infections of cetaceans, particularly those concerning host-parasite relationships, are poorly known. Helminthological studies of the long-finned pilot whale *Globicephala melas* , have been mostly based on occasional necropsies of one or few individuals stranded or by-caught at sea.

The International Research Programme on the pilot whale in the North-east Atlantic offered an unique opportunity for a study in depth of the helminth community of a comparatively large sample of animals. We focus here on the helminths from the intestine, presenting some preliminary results. We describe the intestinal helminth community, assess the effect of some biotic and abiotic factors on the abundance of the commonest parasite species, and give some zoogeographical data of the intestinal helminth fauna of the pilot whale.

MATERIALS AND METHODS We examined the intestines of 170 whales from 13 schools caught in the Faroese drive fishery between July 1987 and June 1988. The animals were sexed in the field and the ages of 147 animals were determined from dentinal growth layers by members of the Faroese Museum of Natural History. Whales were classified as less than ten years of age, which we shall refer to as 'young' individuals, and ten years of age or greater, which we shall refer to as 'old' individuals.

We attermpted total recovery of parasites and all individual helminths found in each intestine were counted.

RESULTS AND DISCUSSION

(a) The helminth community 9,977 individual helminths, representing eight species, were recovered. Sixty-seven animals were free of helminths, while 104 were infected with one to four species (mean 1.42). Four component species, *Hadwenius subtilus*, *H. delamurei*, *Bolbosoma capitatum* and *Trigonocotyle globicephalae*, accounted for 99.4% of all helminths and showed relatively low prevalences and abundances, and highly clumped distributions. This suggests overdispersed distributions of their larval stages in the intermediate hosts. In fact, simulation models demonstrated that a host-parasite system showing these features results if infective stages are supplied in single large waves rather than being continuously available to the hosts (Janovy and Kutish, 1988).

Considering the taxonomic groups, the community is dominated by digeneans: two species, *Hadwenius subtilus* and *H. delamurei*, accounted for 93.9% of all individual helminths. Acanthocephalans were represented by a single species, *Bolbosoma capitatum*, which showed the highest prevalence of all species and constituted 5.1% of all parasites. Cestodes belonging to the families Tetrabothriidae (one species) and Diphyllobothriidae (four species) represented in qualitative terms the bulk of the community (five out of eight species), but quantitatively they accounted for only 1.07% of all helminth specimens.

Diphyllobothriid tapeworms seemed to be occasional parasites of the pilot whale, as shown by their low prevalences. According to earlier observations (Delyamure, 1955), diphyllobothriids may not have met suitable conditions in cetaceans as they need to adapt themselves to complete their life cycles in oceanic waters.

It seems that environmental factors are more important than host phylogeny in determining parasite community patterns. Here, the number of component species is relatively high in line with those reported in other aquatic mammals (Bush *et al.*, 1990). Aquatic hosts encounter a greater helminth species richness since many helminth cycles are linked to aquatic systems. However, diversity indices indicated a depauperate community, resulting from both the low mean number of species per host and the dominance of the two digenean species. Mean diversities, even those of old animals, were low when compared with those of birds and terrestrial mammals available from previous studies, but were well within the range of those known for teleosts (Kennedy *et al.*, 1986). Further evidence in favour of the importance of environmental versus phylogenetic determinants comes from comparing the helminths present in Cetacea with those in marine birds. Both harbour many common taxa of helminths: diphyllobothriid and tetraothriid cestodes, polymorphid acanthocephalans and anisakid nematodes.

(b) Effects of host age and sex The mean abundance of the compound species both individually and collectively were significantly higher in old whales than in young ones. Likewise, mean ranked diversity was higher in old than in young hosts. These differences may be explained by (1) a higher exposure time to infective stages in old whales, i.e. the longer the whale has been preying, the higher the probability of becoming infected by helminths; and (2) a greater food intake in old individuals both in number and size of prey, also resulting in an increased chance of infection.

The average abundance of the collective four component species was also significantly higher in male than in female individuals. This seemed to be largely due to differences in ranked abundances of *H. subtilus*. Some analyses indicated that males become infected with *H. subtilus* before females, suggesting a higher resistance to the parasite among the latter. Differential stress between males and females related to polygyny might account for this (Zuk, 1990). Likewise, differences in daily food intake between adult male and female pilot whales, as a consequence of the sexual dimorphism in size of the species, may also contribute to the differences observed.

(c) School Effect The mean ranked abundance of the four component helminth species, considered collectively, varied significantly across schools. *B. capitatum* appeared to be responsible for most of this variation, being the only species showing significant differences in abundance across schools. A discriminant analysis revealed a pattern of dissimilarity between schools consistent with previous studies on organochlorine profiles carried out by Aguilar *et al.* (in press), suggesting a certain degree of isolation of the schools analysed (Balbuena, 1991).

(d) Zoogeographic Remarks The intestinal helminth community of the Faroese pilot whales appears to be composed not only of species whose range is restricted to relatively cold waters, such as *H. subtilus* and the diphyllobothrid tapeworms, and species occurring in both cold and temperate waters, such as *B. capitatum* and *T. globicephalae*. *H. delamurei* may also possess a wide geographical distribution since it was first reported parasitising Mediterranean pilot whales. The apparent richness of diphyllobothriid cestodes is noteworthy, representing as they do half the species recorded. This may be because these tapeworms appear to be endemic to high-latitude regions, and the Faroe Islands are well within the range proposed for these helminths in the Northern Hemisphere.

The breadth of the distribution of these helminth species probably reflects their degree of tolerance to variations in certain environmental factors, particularly water temperature. In the case of digenean trematodes, their distributions are also greatly influenced by the local molluscan fauna which determines which life-cycles are possible (Köie, 1983).

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ETHOGRAM OF BOTTLE-NOSED DOLPHIN *Tursiops truncatus*

Guido Gnone

Fondazione Cetacea, Viale Milano 63, 47036 Riccione FO, Italy

AIMS The main aim of this research has been to develop an ethogram of the bottle-nosed dolphin, *Tursiops truncatus*, in captivity, in other words to provide as comprehensive as possible a list of its various behaviours.

MATERIALS AND METHODS The research started on 11 December 1989 and was completed in June 1990.

During this period, the five dolphins at the Dolphinarium of Riccione were observed using a technique called 'ad libitum sampling' (Altman 1974), which consists of collecting data in abundance, without any selection, by simply describing everything that is seen.

We used a hand-recorder to note exactly what was going on in the pool. Afterwards we transferred all the data collected onto standardised recording sheets.

During every hour available, dolphins were observed for a total of 20 minutes, using the following procedure: 5 minutes watching and 10 minutes pause, repeated through the hour. This technique allowed us to cover a larger number of hours within a day and provided a more representative picture in quantitative terms of the behaviour of an animal, avoiding the watchers becoming too tired.

From 11 December 1989 to 8 April 1990, about 115 hours of observation were made, and these gave rise to about 380 standardised sheets.

After April 1990, the hand-recorder was no longer used, a video camera being used instead so as to provide a visual document of the behaviours observed. We continued watching but turned on the camera each time an interesting behaviour occurred. At the end of June 1990, we had completed about 17 hours of recordings.

At the start, we used to observe all the dolphins at the same time, trying to report everything that happened in the pool. But this technique turned out to be far too complicated. It was almost impossible to follow five different animals at the same time, besides which one risked missing those behaviours that lasted for some time.

We therefore decided to focus our attention upon one dolphin at a time, every 5 minutes, considering others only when they interacted with the protagonist of that moment.

This technique, which is not new, is called the "animal focal method" (Altman, 1974), and allows one to observe and describe every behaviour in a precise way.

During the first observation period, we developed a common vocabulary for descriptions of different behaviours, in order to avoid misunderstandings as much as possible.

In the description of the ethogram we tried to fit each different behaviour into a particular category of behaviours or motivational system.

The four basic motivational systems, which corresponded to the four "classic impulses", were: eating, reproduction, aggression and escape. However, there were some categories of behaviour which were hard to fit into any of the above mentioned motivational system: these were those impulses connected with sleep, migration, curiosity and, possibly, even with play and social interactions.

RESULTS AND CONCLUSIONS During the seven months of observation, we managed to identify and classify 70 different types of behaviour, assemble them to form the ethogram, illustrated with more than 83 drawings in sequence. The drawings were taken from the films shot at the Dolphinarium, using "freeze framing" from the video.

Although sometimes we tried to describe some of the categories of behaviour, our main objective was simply to write down in the clearest way the registrations and images of almost 200 hours of observation.

Table 1. The five bottle-nosed dolphins in the Dolphinarium of Riccione

NAME	SEX	DATE OF BIRTH	ARRIVAL	PLACE OF ORIGIN
Pelè	F	1964	1/06/70	Florida Keys Key largo
Bravo	M	1978	21/05/82	Tex, Rockport Mataborga Bay
Candy	F	1979	21/05/82	Tex, Rockport Mataborga Bay
Anay	F	1988	June 1989	Acquario nat. Cuba
Isa	F	1987	June 1989	Cuba

TARGET DETECTING STRATEGIES ADOPTED BY ONE CAPTIVE ECHOLOCATING SPECIMEN OF BOTTLE-NOSED DOLPHIN (*Tursiops truncatus*): PRELIMINARY OBSERVATIONS

Elena Valsecchi* and Massimo Azzali**

*Istituto di Fisiologia Generale, Università di Pavia,
Via Porlanini 6, Pavia, Italy
**I.R.Pe.M. (Istituto di Ricerca sulla Pesca Maritima),
C.N.R., Molo Mandracchio Ancona, Italy

Observations have been conducted, periodically, for more than two years, on one adult female bottle-nosed dolphin *Tursiops truncatus* at the Adriatic Sea World, Dolphinarium of Riccione (FO), Italy, in order to study the target detecting strategies adopted by the dolphin during echolocation tasks. All the instruments necessary for the study have been placed at the researchers' disposal by the Istituto di Ricerca sulla Pesca Marittima (I.R.Pe.M.), C.N.R. Ancona.

INSTRUMENTS A B&K Type 8103 hydrophone, capable of recording high frequency sounds, was arranged immediately above the target. With the help of an automatic underwater camera, that the experimenter could aim at the moving dolphin through a special console, the dolphin engaged in the task could be recorded continuously. Using both video and sound underwater recordings, and synchronising the two pieces of apparatus by a special circuit that produces an audible sound ("beep") on the audio channels of the video camera whenever a train of clicks hits the hydrophone, it was possible to observe the dolphin for the entire duration of the task. This included: (1) the swimming path followed by the dolphin during its approach to the target; and (2) the tri-dimensional position of its body during emission of the clicks in relation to the position of the target.

PROCEDURE The blind-held free swimming dolphin had to find the target (a copper sphere of 30 mm diameter) inside a circular concrete tank.

In correct trials, the dolphin located the target, approached it, made contact using its rostrum and, at the recall signal of the trainer, returned back to the station. Correct trials were reinforced with fish.

The target was placed in different areas of the tank at different depths. The dolphin did not show any difficulty in detecting the target wherever it was placed in the tank.

The tactical-acoustic behavior of the dolphin comprises three phases:

SEARCH PHASE As soon as the dolphin moves from the station, after the start signal of the trainer, it uses ultrasonic emissions to locate the approximate position of the target within the tank. During this phase, interest is concentrated upon a restricted area of the tank, up to five metres around the target.
APPROACH PHASE The dolphin, swimming at an approximately constant speed, moves towards the target, following particular trajectories (according to the adopted strategy) that had led it in the neighbourhood of the target. In this phase, the dolphin swims quite close to the surface of the water.
ATTACK PHASE When the dolphin gets quite close to the target (i.e. within a circle of 4-5 metres), it attacks it, moving along descending spiral-like trajectories. In this last phase, the behaviour of the dolphin seems to depend upon the depth of the target. When the target was close to the water surface or to the bottom of the tank, the dolphin seemed to hesitate

for a while. This is probably due to some form of 'acoustic mirage' caused by the reflective power of the water surface and of the bottom, that makes the dolphin see (or more correctly "hear") two targets instead of one.

In the case of the target being too close to the bottom of the tank, the dolphin rotated its body around its longitudinal axis up to 180°, echolocating the target by hitting it from below; in this way no ultrasonic waves could hit the bottom, since they were all aimed upwards to the surface.

STRATEGY ADOPTED WHEN APPROACHING THE TARGET At the beginning of the trials, during the training period (1987), the dolphin closely approached the target using a strategy very similar to the one used by artificial sonar systems. In the literature this is termed Track While Scan (T.W.S.). This means that the dolphin approaches the target by moving straight towards it, echolocating upon it continuously along its track.

The behaviour of the subject slowly evolved until the dolphin had adopted, in almost all trials (except some special ones), a strategy of approaching the target in a way described as unusual according to the literature on artificial sonar systems.

The target was illuminated by a number of clicks much lower than expected (two or three clicks in the approach phase instead of about thirty with the T.W.S. method). Furthermore, the path of approach was a polygonal-like curve up to the neighbourhood of the target, at which point the path assumed an arc of spiral shape and, just before contact, the target was illuminated again.

CONCLUSIONS AND FUTURE RESEARCH Since this strategy, which has been termed the "Triangulation Method", can work only if the target is not moving, a possible explanation for this unusual strategy is that, once it had learned the experimental procedure and that the target was generally not moving, the dolphin judged it much more convenient to estimate the position of the target through successive triangulations. This approach saved energy compared with detecting the target by going straight against it, which would have meant to echolocate it all along its track. We must stress that this is simply an interpretation of our observations collected over the first two years of experiment. In the future these hypotheses will require further verification.

Several limitations discovered daily during the development of the trials caused some problems (most yet unsolved). The following are just some examples: (a) would a conspecific inmate from another dolphinarium behave in the same way if asked to perform the same trial? (b) how much do the characteristics of the artificial environment (for example the particular shape of the tank) affect the dolphin's acoustical behaviour? (c) are the acoustic strategies adopted by the subject related to its temporary disposition (such as playing, feeding, etc.) (d) how would the dolphin react to a moving target? (e) why in general are dolphins unable to avoid some obstacles (such as nets), in spite of their extraordinary echolocating capabilities?

Some of these problems will probably be solved by use of the much more detailed information obtainable by use of a new system (TV-trackmeter), based on stereovision. This will allow us to analyse in 3D the motion strategy of the dolphin, driving itself only by its natural sonar. The use of the TV-trackmeter could also be of great help in studying the ability of dolphins to avoid obstacles (for example, nets), installed between the release station and the target (for much more detailed information about the new apparatus, contact Ing. Massimo Azzali).

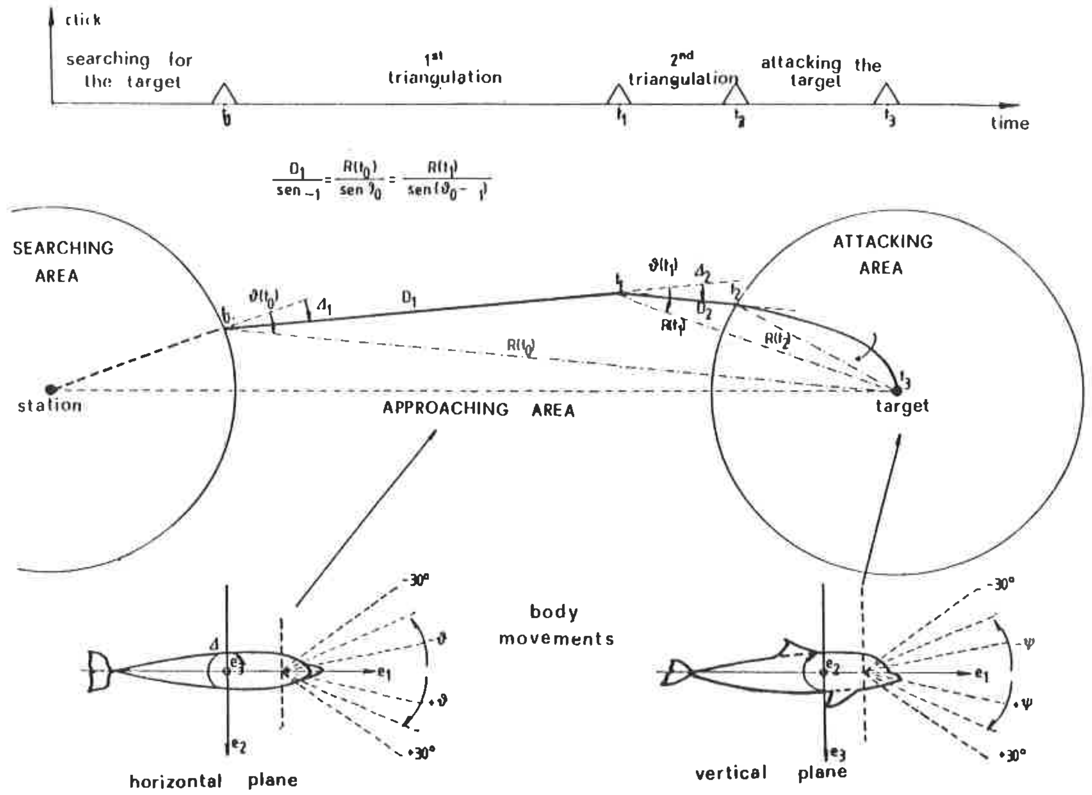

Fig. 1 TRIANGULATION DETECTING METHOD Instead of going straight to the target, the dolphin seemed to prefer to follow a polygonal-like path before reaching the target. Once it left the search area where the preliminary target location (estimation of the initial range $R(t_0)$ and of the bearing angle q (t_0)) occurs, the dolphin emits a click (time t_0); if the estimating bearing angle q (t_0) is on the left (right), then she turns her body to the left (right) through a free angle $D_1<q$ (t_0) around her vertical axis e_3. The dolphin swims along a line for a distance D_1 until time t_1 when she echolocates the target once more. Then the whole sequence starts again: the dolphin turns, through an angle D_2 around her vertical axis e_3, and swims until she echolocates the target once more (t_2). Once the attack area is reached, the dolphin dives against the target, following a sort of "cork-screw" path. However, the trajectories described by the dolphin depend strongly on the rostrum-to-target vector ($\underline{R}(t)$) at the moment of the last echolocation, and hence even on the depth at which the target has been placed.

SCANNING ELECTRON MICROSCOPIC STUDY IN THE DOLPHIN *Stenella coeruleoalba*

C. Vismara, V.G. Leone and G. Scari

Dipartimento di Biologia, Università degli Studi di Milano,
Via Celoria 26, 20133 Milano, Italy

INTRODUCTION In this study we report observations on the eye of a small cetacean, the striped dolphin *Stenella coeruleoalba*, to verify histological and morphological data on the visual system of ten specimens described elsewhere (Zaniboni *et al*., this volume) and to give further ultrastructural details concerning the eye of this species. The preliminary results, as obtained from just one well-preserved specimen, are compared with data on other small cetaceans published in the literature. In particular, we highlight the retinal and the retro-bulbar rete mirabile vascularisation, the morphology and arrangement of the outer retinal layer and the presence and dimensions of the "giant" ganglion cells and axons forming the optic nerve. Finally the structural organisation of the lens fibres were analysed.

MATERIALS AND METHODS After a preliminary histological examination performed on the retina, an eye of an adult animal was studied using scanning electron microscopy. Fixation was performed in 2.5% glutaraldehyde buffered in 0.1M sodium cacodylate (pH 7.4) for 1h at 4°C; post-fixation was made in 2% OsO_4 in 0.1M sodium cacodylate for 2h. After dehydration, cryosubstitution was made in liquid carbon oxide (CPD). The specimen was covered with Au by Sputter Coater (Nanotech). Observations were made by scanning electron microscope, Cambridge Stereoscan 250 MK2.

RESULTS We found a large rete mirabile near the optic nerve, with 90µm diameter vessels, *in anastomosis* with the wide choroid's vascular system and retinal blood vessels. The choroid's vascular system showed two blood vessel types: the first one, near the sclera, was 100µm in diameter; the other type, near the pigment epithelium, was 35µm in diameter. The retinal blood vessels beside the optic nerve papilla were about 150-200µm thick, while those beside the inner limiting membrane were about 75µm. The clearly visible outer limiting membrane bordered an odd arrangement between the outer segments of photoreceptors and the pigment epithelium. When separation occurs, the honeycomb like double layered cogging structure is visible. "Giant" ganglion cells of 120µm width were found only in the vertical focal axis region. Within the ganglion cell, nervous fibres ranged from 1 to 3µm diameter. The lens comprises a group of ribbon-shaped fibres, thin inside (0.6µm) but thicker in the outer sheaths (1µm).

CONCLUSIONS The slow accumulation of data on the ultrastructural study of the cetacean eye over the years is due in part to the limitation in availability of specimens, well-preserved tissue and a practical laboratory model. In our well-preserved specimen, the vascular system shows large dimensions compared with other mammals. This phenomenon is correlated with an increase in the external pressure during diving, also suggested by Nakajima (1966) for the rete mirabile in the eye of the bottle-nosed dolphin. The photoreceptor layer shows a honeycomb like structure, confirming histological data observed by Zaniboni (Zaniboni *et al*., this volume). This phenomenon is probably due to a different length of the outer photoreceptor layer overlying the pigment epithelium, which traces a typical profile. In the striped dolphin, as in other small dolphins (Dawson and Perez, 1973; Dawson *et al*., 1983; Dral, 1983; Mass *et al*., 1986), we found a region with "giant" ganglion cells. These cells were below the *ora serrata*. They may play a role in anaerobic metabolism, as required by long periods under water (Dawson and Perez, 1973). SEM studies of the organisation of the eye at both a general and specific level add new data in the still poorly described visual system of this small cetacean.

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ADAPTIVE RADIATION FEATURES IN THE EYE OF AN ODONTOCETE (*Stenella coeruleoalba*)

A. Zaniboni*, G. Scari*, V.G. Leone*, M. Podestá**, L. Cagnolaro** and C. Vismara*

*Dipartimento di Biologia, Universitá degli Studi di Milano,
Via Celoria 26, 20133 Milano, Italy
**Museo Civico di Storia Naturale, Corso Venezia 55,
20122 Milano, Italy

INTRODUCTION We have considered the visual system of one of the most representative odontocetes of Italian seas, the striped dolphin *Stenella coeruleoalba* (Cagnolaro *et al.*, 1983). Our study had three main goals: valuation of both inner and outer eye dimensions; microscopic study; and the possible adaptive radiation features for aquatic life of an eye ancestrally fitted to aerial vision. In this field, most research has been carried out on the bottle-nosed dolphin *Tursiops truncatus*, and we have therefore compared our results with those reported for that species.

MATERIALS AND METHODS We used the eyes of ten striped dolphins stranded along Italian Tyrrhenian coasts during the 1988-90 period (6 adult males, 3 adult and 1 young female), under the auspices of the Centro Studi Cetacei, in cooperation with the Museo Civico di Storia Naturale of Milan. Before removal of the eyeball, the mean body length of each animal was recorded. After marking at the dorsal and nasal poles, the specimens were fixed in modified Bouin's fluid. As a standard procedure, preliminary macroscopic observations were made, with a note of the outer eye dimensions (DV = Dorso-ventral / NT = Naso-temporal axes of the eyeball and cornea; AP = Antero-posterior eyeball axis); after a free-hand transverse cross-section was performed on the cornea, iris, ciliary body, choroid and retina, these being embedded both in paraffin and in polar resin and stained with H.-E. or Unna waserblau-orcein-eosin. Since no significant differences in measures between adult male and female specimens were found, all data, with mean values as a general representation of the population, were submitted to a corrected one-way analysis of variance. Statistically significant differences (at probability level of $P<0.005$) between measurements are indicated by two asterisks.

RESULTS (a) Morphological The mean body length was 195 cm (young female not included). The eyeball and corneal NT axes were longer than the DV ones, but not significantly different (NT=29, 16.5; DV=27.3, 4.5 mm). There was a striking shortening of the globe along the AP axis (AO=18.4 mm**). In transverse section, the inner DV and AP optic axes were 27.1 and 13.3 mm**. The sclera showed a different thickness from the limbus to the optic nerve (0.93 to 4.07 mm**); the cornea was thickest along its periphery (1.58 mm) and thinnest in the central area (0.56 mm); the optic disk and nerve were 1.76 and 2.77 mm** thick respectively. The mean lens weight was 0.61 ± 0.04 g; the AP and equatorial axis values were 0.9 and 1.0 mm** respectively. The presence of a retro-bulbar rete mirabile *in anastomosis* with the choroidal system and the peculiar pupillary opening, were constant in all specimens.

(b) Histological An indicative structure in the central district of the cornea was found: the epithelium several times interrupted the Bowmann's membrane, and was in touch with the layer of fibrocytes. The other layers (stromatic, the poorly observed Descèmet's membrane and endothelium) did not show any remarkable feature. The iris was more heavily pigmented in the inner surface and beside the pupillary opening; the anterior surface, where both the radial and circular vessels were huge in diameter (100-200μm), lacked a continuous epithelium in the proximal tract.

The ciliary body showed a bistratified epithelium with well articulated processes containing blood vessels. The two portions of the choroidal system, one with larger vessels near the sclera and the other with smaller ones by the choriocapillary, were clearly discriminated and continuous with the remarkably wide *sinus venosum.*

The overall thickness of the retina was 200μm, with the outer retina (pigment epithelium and photoreceptors) half as thick as the neural retina (from the inner to the outer limiting membrane). The retina showed a typical stratification, with a thin pigment epithelium and the cellular elements decreasing in number from the photoreceptor's layer to the ganglion cells.

The ganglion cell dimensions ranged from 35μm to 50 μm and some of these cells invaded the bipolar cell layer. Where separation between the pigment epithelium and the photoreceptors occurred, a honeycomb like double surface cogging structure was visible. The retinal vascularisation fits the holangiotic type cited by Prince (1956). The blood vessels were 200μm thick beside the optic disk; in the retina, a very thin capillary net reached the outer plexiform layer.

CONCLUSIONS We found that the nasal-temporal axis of the eye remains constant in value between specimens, leading to an inverse relationship with body length: the eye is therefore already morphologically "adult" shaped at birth. This ratio appears to be higher than in other mammal species (Dawson, 1980).

The difference between the DV and NT axes leads to a nearly ellipsoidal corneal and eyeball shape. The periphery of the cornea has a long radius, resulting in a slight curve: a large part of this feature, however, could be caused by a dramatic decrease in internal pressure subsequent to death.

The particular structure of the corneal epithelium described above has not been reported for any other species of odontocete. We hypothesise that it could improve the trophical supply hindered by the interposition of the thick Bowmann's membrane. As for other odontocetes (Dawson, 1980), the pupil forms an upward oriented crescent due to additional muscular fibres along the upper edge. The underlying lens is held in place by a strong ring of musculature at its equatorial region.

The retinal structure showed the typical mammalian arrangement for aerial vision (where the thickness of outer-neural retina ratio is 1:6). However, in our specimens the ratio was 1:2 tending to a 1:1 ratio; this is typical of diurnal good-sighted teleosts (Nicol, 1989; Vismara *et al.*, 1990). The organisation of the outer retina is characteristic, due to the interaction between the outer photoreceptor segments and the pigment epithelium, leading to the appearance of a honeycomb-like structure whenever retinal separation occurred. This is not reported for any other vertebrate retina, and requires further study before any hypothesis for its structure can be put forward.

The presence, dimensions and position of the "giant" ganglion cells are generally in accordance with the data reported for the bottle-nosed dolphin (Dawson *et al.*, 1973; Dawson *et al.*, 1982). The slight bending of the cornea, the shallowness of the anterior chamber and the round-shaped lens are the main adaptations for aquatic vision. The antero-posterior ocular flattening may be considered the result of an enhancement process of the visual capabilities of a round-shaped system (as the peculiar pupil) rather than as a response to external pressure. The large rete mirabile behind the sclera is anastomotic with the choroidal system. It is present in many mammals (notably the Artiodactyla) and its function is still uncertain (Barnet *et al.*, 1961; Nagel *et al.*, 1968). The presence of both the intraocular vascular systems, retinal and choroidal, is typical of aerial vision and optimal for the retinal metabolic needs. The evolutionary persistence of the rete mirabile in odontocetes ensures an ever perfect functionality of the ocular apparatus. It is analogous to the choroidal glands of the good-sighted bony fish.

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REPORT ON RESCUE TREATMENT OF TWO WHALES IN THE MEDITERRANEAN

Alessandro Benvenuti, Alessandro Bortoletto, Sabrina Gonnella, Antonella Odierna and Augusto Leandro Stanzani

Fondazione Cetacea, Via Milan, 63, 47037 Riccione (FO), Italy

INTRODUCTION Since 1985, the Centro Studi Cetacei (an operative branch of the Italian Society of Natural Sciences) has been coordinating the recovery of stranded cetacean carcasses both for study and exhibition in museums in home territory. In 1988, the Fondazione Cetacea was founded and since then it has been cooperating with the Centro Studi Cetacei. The aim of the Fondazione Cetacea is to study and protect marine mammals. To this end they work for the recovery of live cetaceans with the help of the Adriatic Sea World at Riccione which coordinates the first of the S.O.S. Rescue Team.

At present a national network of S.O.S. rescue is coordinated by the Centro Studi Cetacei.

The Cesenatico Whale

16 July, 1990 On this date, a large cetacean carcass was discovered a few miles off Cesenatico (Northern Adriatic Sea) by some craft. The masters informed Rimini Harbour Authority of the find and the Authority, considering the problems that could have been caused both to navigation and to the coast in case of stranding, alerted the Centro Studi Cetacei Operating Group. After an on-the-spot investigation, the animal turned out to be a fin whale, *Balaenoptera physalus* (L., 1758), a male, approximately 12 m long, weighing about 20 tonnes and in an advanced state of decomposition.

It was decided to anchor the carcass to an oil exploration platform in the sea offshore.

Different kinds of solution were then considered:

1) Blasting: to be avoided because of the risk that organic fragments could reach the coast with obvious negative consequences on tourism; also, because it would mean the loss of the skeleton.
2) Burying: prevented by local authorities for public health reason.
3) Incineration: to be avoided because of the loss of the skeleton; in any case, this was impossible because of the distance of the incinerator plant from the coast.
4) Setting the carcass adrift: to be avoided because of the loss of the skeleton, danger to navigation and the risk of stranding in case of bad weather.

Since none of the above possibilities was thoroughly satisfactory, members of Fondazione Cetacea suggested sinking the carcass: this solution would allow both the elimination of any risk and the recovery of the skeleton.

20 July, 1990 Once they had received permission from the competent authorities, the Fondazione Cetacea Operating Group started with the recovery of the skull using a craft put at their disposal by the Ministry of the Merchant Navy.

The skull, detached with the aid of a crane and some operators equipped with lances, was heaved aboard and the flesh partially removed. After this, the skull was completetly cleaned by means of a hot water polishing machine, and left exposed to the sun.

27 July 1990 Technicians of the Fondazione Cetacea Operating Group, with the support of the Harbour Authority, Castalia Company and Foschi Company, went to the place where the remaining part of the carcass was anchored and acted as follows:

1) The carcass was observed both from the surface and underwater in order to examine its condition and pick up the bare bones.
2) A net was placed around the carcass to hold the bones and avoid their loss once cleaned of soft tissue.
3) The carcass was sunk in a net with the aid of a large weight.
4) The coordinates of the site of sinking, in relation to the sea platform, were plotted.

Since then, the Fondazione Cetacea Operating Group has made periodic checks on the progress of the natural unfleshing process. At the end of summer, when the skeleton was completely bare, they started its recovery.

This operation has not yet been concluded because of bad weather conditions. The Fondazione Cetacea Operating Group expect in the future to recover the whole skeleton and rebuild it for an exhibition and for osteometric analyses.

This kind of rescue is desirable, being the quickest and the cheapest. Furthermore, it does not present any health risk. The recovery was not carried out, however, without some problems. The muddy sea bottom and poor visibility resulted in difficult working conditions.

The Calambrone whale

On Monday 15 October, 1990 at 1700 h, a call was received through the Europe Assistance switchboard, which maintains 24 hours a day contact with the Centro Studi Cetacei, informing them of the stranding of a large cetacean at Calambrone in the Leghorn area.

The area coordinator, Prof. T. Renieri of the University of Siena, and Dr. A. Roselli of the Natural History Museum of Leghorn were contacted and Dr. Roselli travelled immediately to the site where she began coordinating operations and providing the Adriatic Sea World with information on the precise condition of the whale which would then allow an efficient and suitable plan of intervention to be made.

In the meantime, at the Adriatic Sea World in Riccione, the Rescue Team, led by G. Caniglia and A.L. Stanzani, was being alerted. The team was composed of veterinary surgeons, biologists, divers, volunteers and photographers, all specialised in this type of operation, and who immediately began preparing the equipment and veterinary supplies for the rescue. Alongside the rescue team on Calambrone beach were members of the Italian Rescue Office, the Merchant Navy, the Marines, the Fire Brigade and Leghorn Harbour Authorities.

The whale was a fin whale which had run aground in the sand about 50 m from the beach in about 120 cm of water. The underside of the animal was almost completely stuck in the sand although the tail section was free and indeed the movements of the tail had resulted in the formation of two deep troughs in the sand along either side.

The animal was facing towards the beach and along most of its length protruded about 40 cm from the surface of the water. It was 19.2 m in length, its flukes 5.5 m wide, each flipper was 1.8 m long and it was estimated to weigh around 30 tonnes.

From a preliminary examination carried out by the veterinary surgeon, Dr. A. Benvenuti, it appeared that the animal was severely undernourished and subsequently in a general state of dehydration and muscular hypoptonicity which resulted in its skeletal structure being visible.

MATERIALS AND METHODS The skin of the animal had deep welts caused by skin parasites, copepoda (*Pennella balaenopterae*), which had burrowed under the skin, piercing the muscle in some places. The area around the blowhole appeared unharmed and the animal's breathing was only slightly affected.

Blood samples were taken from the dorsal fin in an attempt to diagnose the animal's illness and prescribe appropriate treatment, but operating conditions made it impossible to draw a sufficient amount of blood for total screening.

The results showed that the whale was slightly anaemic, a very common phenomenon in cetaceans requiring rescue operations. They also showed an increase in C.P.K. level, probably due to the extreme stress it was under, since stress causes the release of this enzyme from the muscle tissue. Samples of damaged skin and of the parasites were also taken. Sterile swabs were taken around the blowhole to check for respiratory infection, but the laboratory analyses were negative.

Cortisone treatment was immediately administered to relieve the animal's stress (Dexametazone in dosage 0.1 mg/Kg 1/M) and it was given antibiotics (Amoxicillin 5 mg/Kg 1/M). The welts on the skin of the whale were cleaned, disinfected and treated with antibiotic spray.

DISCUSSION The general condition of the whale was considered satisfactory and the possibility of euthanasia is therefore excluded. Instead, it was decided to organise the first attempt in Italy to tow an animal of this size out to sea.

The original idea came from an American Rescue Manual (North Wind Undersea Institute, 1985), but the technique had to be considerably altered to meet the team's technical and financial capacities. A harness had to be constructed which would be easy to apply and to remove but which, above all, would not injure the animal, either by cutting its skin or causing sprains, or pulling of the muscles in its tail section. A long belt of extremely resistant material, about 25 cm wide, was used. The belt did not cut into the skin during towing in the way that normal ropes would do. This belt had to be passed several times around the body of the whale, at the level of the centre of the dorsal fin. In order to do this, a high pressure water jet was used to excavate the sand and create a tunnel under the animal where the belt could be passed. The belt was passed around the animal on either side of the dorsal fin, forming a harness which criss-crossed the animal's flanks on either side (see fig. 5).

The harness was attached by rope to a tug and the towing operation began; the animal was constantly observed for the least sign of discomfort but it appeared extremely calm. The first stage of the towing operation was critical since the 30 tonne whale had to be pulled off the shallow bank upon which it was grounded. As soon as it reached open water, although still in the shallows, it took a deep breath, much deeper than any it had taken since the rescue operation began. This was because its great mass was now floating and its organs, particularly its respiratory system, were no longer being compressed. The danger that the animal would be "crushed" by its own weight, which often happens in the case of cetacean strandings, was now past.

The tug continued until it was just over a mile from the shore and during this journey the whale sometimes allowed itself to be towed, but sometimes began swimming, at times even pulling the tug along with it. Before removing the harness, which was not exactly an easy task, it was necessary to be relatively certain that the cetacean would not return towards the beach. For more than an hour, the tug followed the animal's lead, ascertaining the direction it took, which for a number of minutes appeared rather confused. When the experts considered that the whale's diving and surfacing intervals, breathing, behaviour and swimming direction were all sufficiently normal, it was released from the harness and all the boats involved in the operation spread out forming a barrier parallel to the coast to prevent the animal from returning towards the beach. As soon as the divers had finished removing the harness, the whale began moving rapidly out to sea.

CONCLUSIONS The entire operation lasted approximately 9 hours. A number of problems had to be faced, many of which were unexpected, but for each problem a suitable solution was found, thanks to the professionalism and cooperation of the team of people involved. The Calambrone fin whale was sighted nine days later (24 October) off S. Vincenzo (Leghorn) swimming close to the shore, but after a few hours it made its own way out to sea. On 26 October it was found in front of the industrial docks at Pontedoro Piombino, but this time it was dead.

The experts from the Natural History Museum in Leghorn now took charge of the huge cetacean's body, carrying out the appropriate examinations and recovering the skeleton.

The cause of the animal's death is not yet known. The data and the samples collected are being examined at the University of Siena and will certainly reveal if not the exact cause of death, at least a great deal of medical and biological information which will be of help in future rescue operations and for a better understanding of this cetacean species.

ACKNOWLEDGEMENTS We would like to thank Prof. Casarosa and Dr. Papini of Pisa University's Parasitology Department.

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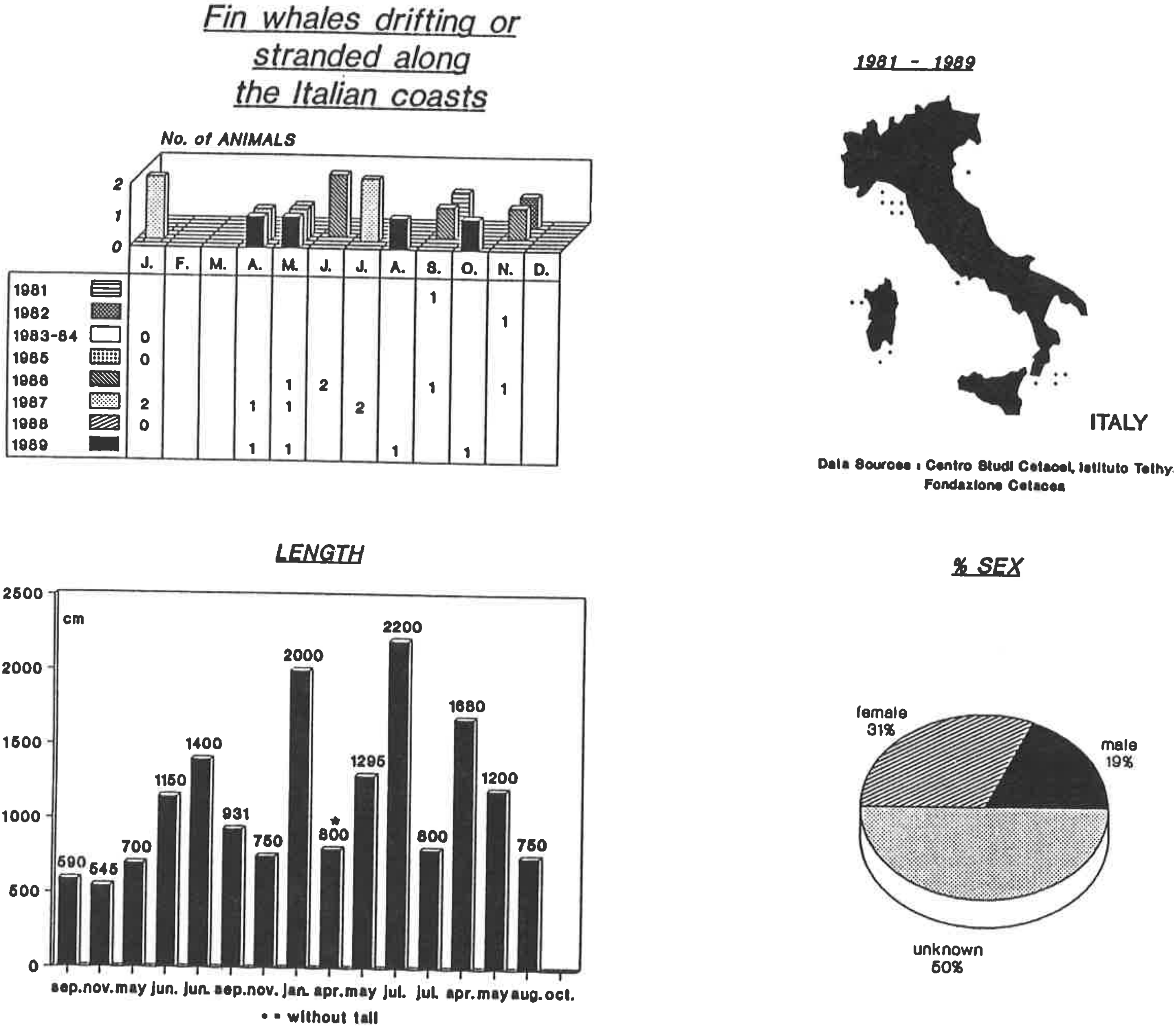

Fig. 1 Geographical and seasonal distribution, length frequencies, and sex ratios of fin whale strandings in Italy

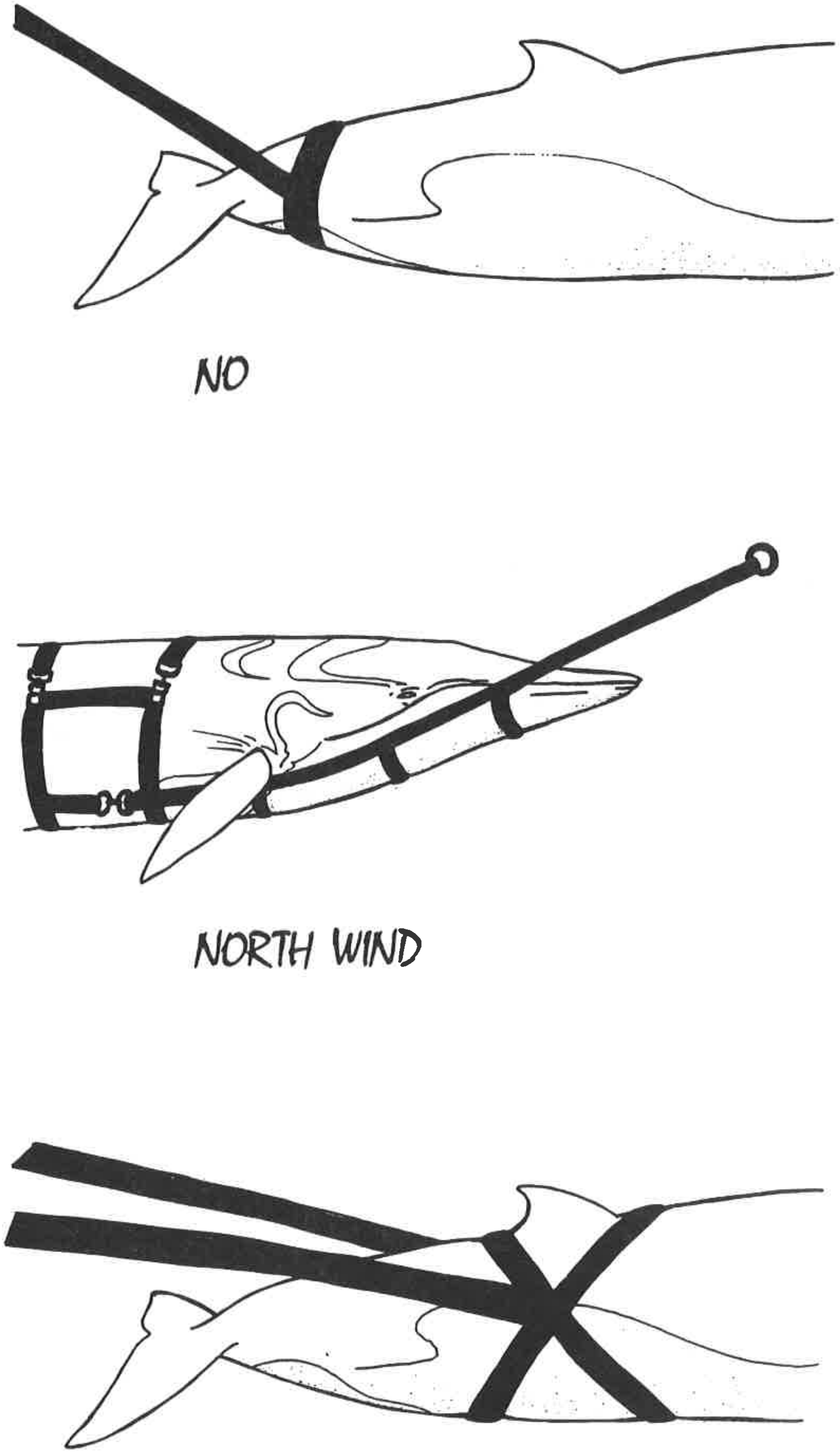

Fig. 2 Alternative methods for towing a whale

FEEDING ACTIVITY OF COMMON SEALS IN THE MORAY FIRTH

Paul M. Thompson

Lighthouse Field Station,
University of Aberdeen, George Street,
Cromarty, Ross-shire, IV11 8YJ, UK

Most studies of common seals *Phoca vitulina* have been based on observations of seals at their terrestrial haul-out sites. This study of common seals in Northeast Scotland aimed to relate seasonal changes in the size and distribution of haul-out groups to changes in the seals' feeding activity. Distribution and abundance of seals at haul-out sites were monitored by making weekly haul-out counts, and feeding patterns and locations determined using VHF radio-telemetry.

Maximum haul-out numbers were seen during the summer breeding season. Radio-tagged seals hauled out more frequently at this time of year, suggesting that such changes in abundance were the result of individual changes in behaviour. Seals regularly returned to favoured feeding sites, which were up to 50 km from haul-out sites. Feeding areas varied both seasonally and between years, with feeding occurring closer to the haul-out sites when overwintering clupeoids moved into inshore areas.

Annual and seasonal variations in the distribution of haul-out groups appeared to be related both to these changes in feeding movements and to the seals' reproductive activity.

FOURTH ANNUAL REPORT OF THE EUROPEAN CETACEAN SOCIETY: 1990

Membership of the European Cetacean Society numbers 270 persons from 31 countries (23 European). This number is lower than in previous years. It is expected to increase by next year since some who had not paid their subscription during the year did so subsequently on receiving a reminder. Fluctuations in membership between years also tend to reflect attendance at the annual conference since many persons join on a temporary basis in order to attend the meeting.

A successful conference was held in Palma de Mallorca, Balearic Islands between 2nd and 4th March, at which around 150 persons from 17 countries attended. The theme of the conference was "Population studies" and three speakers were invited to address aspects of this theme: Phillip Clapham and Mike Scott from the Unites States, and Rus Hoelzel from England. The abstracts of that meeting were published as proceedings under the title *European Research on Cetaceans - 4.*

Preceding the annual conference, on 1st March, a workshop on sightings methodology was held, organised jointly by Peter Evans and Phil Hammond. It was attended by 60 persons. The results of the workshop were published as a special issue of the newsletter. Three newsletters were produced reviewing recent research and news items in Europe and elsewhere in the world, conservation issues, cetacean meetings and publications, and with requests for information or biological material. We are very grateful to Marjan Addink and Joke Bakker for their unstinting support with the newsletter.

The Center for Coastal Studies, based in New England, U.S.A., kindly offered the society an internship for summer 1991 for a student member to learn large whale photo-ID techniques.

During the year, the European Cetacean Society continued to provide advice to the European Parliament, and government departments and non-governmental organisations in various European countries; it also provided specialist information to the media, and canvassed governments for action relating to specific conservation problems.

Peter G.H. Evans
Acting Hon. Secretary

FINANCIAL REPORT FOR 1990, UP TO 18 FEBRUARY 1991

	UK £	H Fl
Credit		
Balance from 1989		2,126.10
Conference fees and subscriptions from conference in Palma	3,752.08	
Subscriptions and donations	413.00	6,362.38
Sale of Proceedings		240.00
Sundry		120.00
Interest	2.21	129.53
Total Credit	**4,167.29**	**8,978.01**
Debit		
Newsletter production and postage		2,284.84
Secretarial/Proceedings production	300.00	2,153.40
Board expenses		336.00
Sundry		100.00
Bank charges		110.10
Total Debit	**300.00**	**4,984.34**
BALANCE	**UK £ 3,867.29**	**HFl 3,993.67**

REPORT OF THE ANNUAL GENERAL MEETING, 22nd FEBRUARY 1991, SANDEFJORD

1. Annual Report. The above report was presented, followed by a notice that it is hoped to hold the next annual conference of the Society in Italy.

2. Financial Report. The Treasurer presented the financial report for the year 1990 (see above). Credit amounted to just under Hfl 4,000 credit held at the end of 1990 in the Dutch account, and £3,867.29 in the newly formed UK account. Although this balance sounds very healthy, it should be pointed out that excluded from this is the cost of printing of the proceedings which have yet to be billed.

3. Membership of Council. With the birth of a child and a subsequent Antarctic whale cruise causing Genevieve Desportes to miss this annual conference, Peter Evans agreed to remain acting Hon. Secretary until 1991. No other changes to Council took place during the year.

4. Newsletter and Role of Contact Persons. A request was made by the Secretary for members to contribute cetacean news and reports of their work for circulation in the newsletter. The role that national contact persons could play in this procedure was emphasised. Council would prepare a sheet of guidelines to contact persons outlining their role, and the tasks we hope they could achieve. The treasurer would prepare for each a list of members and their addresses so that they can handle other routine society matters, recruit further members, and solicit local information for the newsletter.

5. Center for Coastal Studies Internship. Nine student members of the society applied for this. A shortlist of two persons (Giovanna Benazzo and Rikke Topholm) was put forward, and in the event, both were given the opportunity to take part.

6. Fleur de Lampaul voyage. Several persons also applied to participate in the Fleur de Lampaul voyage organised by Charlie Hervé-Gruyer. Their names were forwarded to him for selection.

7. Society remit and frequency of conferences. The results of postal ballots to all members were presented for two matters regarding the general organisation of the society. Sixty-six persons voted for the society remaining a cetacean society compared with 46 who favoured the inclusion of other marine mammals in its remit. On the second issue, there was no clear mandate for changing from holding conferences annually to biennial conferences, with an equal number (54) voting for each. Frithjof Praetsch asked whether by accepting talks on seals at our annual conference, we had in fact become a marine mammal society except by name. It was explained that the society would remain one concentrating upon cetacean interests but still welcome talks on other marine mammals when they have a bearing upon the study of cetaceans. Bernd Würsig added that he saw no conflict by taking this stance, and pointed out that the American Cetacean Society had a similar remit.

8. Future Conferences. The venue for the next annual conference was announced as Italy, in February 1992. Bids for a venue for future conferences were invited. Paul Thompson said he would like to organise one in Inverness for spring 1993; another possibility, raised by Dorete Bloch, was for the Faroe Islands. It was agreed that all bids for 1993 would be considered during the next Council meeting during the course of the year.

9. Any other business: Student prizes were awarded for "best talk" to two persons Tiu Simila and Frithjof Praetsch; and for "best poster" to Annemarie Zaniboni. The council congratulated these, and noted a continued improvement in the standard of presentations. A sum of money for travel grants was divided equally amongst thirteen students (eligible by having presented a paper or poster).

After an informal meeting of persons interested in post mortem studies of cetaceans, it was announced that a pathology working group would be set up, with Thijs Kuiken as contact person.

Peter G.H. Evans
Acting Hon. Secretary

EUROPEAN CETACEAN SOCIETY

The **European Cetacean Society** was formed in January 1987 at a meeting of eighty cetologists from ten European countries. A need was felt for a society that brought together people from European countries studying cetaceans in the wild, allowing collaborative projects with international funding.

AIMS (1) to promote and co-ordinate the scientific study and conservation of cetaceans;
(2) to gather and disseminate information to members of the society and the general public.

ACTIVITIES The Society has set up seven international working groups concerned with the following subject areas: sightings schemes; strandings schemes; cetacean pathology; bycatches of cetaceans in fishing gear; computer data bases that are compatible between countries; the harbour porpoise (a species in apparent decline in Europe, and at present causing serious concern); and a regional agreement for the protection of small cetaceans in Europe (in co-operation with the United Nations Environment Program/Convention on the Conservation of Migratory Species of Wild Animals, Secretariat in Bonn, Germany). The names and addresses of contact persons for all the working groups are given at the end.

Contact persons have been set up in each European member country, where appropriate, to facilitate the dissemination of ECS material to members, if necessary carrying out translations into the language of that country. Their names and addresses are also given at the end of this note.

A newsletter is produced three times a year for members, reporting current research in Europe, recent publications and abstracts, reports of working groups, conservation issues, legislation & regional agreements, local news, and cetacean news from other parts of the world.

There is an annual conference with talks and posters, and at which the annual general meeting is held. The results are published as annual proceedings, under the title *European Research on Cetaceans*. Besides the present volume, four others have been published for conferences held in Hirtshals (Denmark) in 1987, Tróia (Portugal) in 1988, La Rochelle (France) in 1989, and Palma de Mallorca (Spain) in 1990.

At intervals, workshops are also held on particular topics, and the results published as special issues of the newsletter. A workshop on the harbour porpoise, held in Cambridge (England) in 1988, was published as newsletter no. 6, whilst a sightings workshop held in Palma de Mallorca (Spain) in 1990 is published as newsletter no. 10.

Membership is open to *anyone* with an interest in cetaceans. The annual subscription is **£12.50** for full and institutional members, or **£7.50** for those who are 25 years of age or younger, full-time students or unwaged.

Payment may be made at the Annual Conference in pounds sterling or the currency of the host country. During the year, payment may be made by UK cheque, Eurocheque or bank draft in pounds sterling to *European Cetacean Society* ; if made by cheque in any other currency, £6 should be added to cover exchange charges. Please send subscriptions to the Treasurer, **Dr. P. Hammond, SMRU, c/o British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK.** Payment in excess of the membership fee will be gratefully received as a donation to the Society.

Officers & Members of Council

Chairman	Alex Aguilar
Secretary	Genevieve Desportes
Treasurer	Phil Hammond
Council	Arne Bjørge
	Harald Benke
	Peter Evans
	Giuseppe Notarbartolo di Sciara
	Chris Smeenk

Working Group Contact Persons

Strandings: Michela Podestà & Luca Magnaghi, Museo Civica di Storia Naturale, Corso Venezia 55, 20121 Milano, Italy.

Sightings: Peter Evans, Department of Zoology, University of Oxford, South Parks Road, Oxford 0X1 3PS, UK.

By-catches: Simon Northridge, Centre for Environmental Technology, Imperial College, 8 Prince's Gardens, London SW7 1NA, UK.

Harbour Porpoise: Carl Kinze, Zoologisk Museum, Universitetsparken, 2100 København Ø, Denmark.

Computers: Jan Willem Broekema, Klipperwerf 16, 2317 DZ Leiden, The Netherlands.

UNEP/CMS Agreement: Kees Lankester, 1e Helmersstraat 1183-III, 1054 DT Amsterdam, The Netherlands.

Pathology: Thijs Kuiken, Institute of Zoology, Zoological Society of London, Regent's Park, London NW1 4RY, UK.

National Contact Persons

Belgium Claude Joiris, Vrije Universiteit Brussel, Laboratorium voor Ecologie, Pleinlaan 2, 1050 Brussels.

Denmark Carl Kinze, Zoologisk Museum, Universitetsparken 15, 2100 København Ø.

Faroe Islands Généviève Desportes, Náttúrugripasavn, Natural History Museum, Fútalág 40,100 Tórshavn.

France Alexandre Gannier,14 Rue des Capucines, 33170 Gradignan.

Germany Harald Benke, Zoologisches Institut, Universität Bonn, Poppelsdorfer Schloss, 5300 Bonn 1.

Iceland Jóhann Sigurjónsson, Hafrannsóknastofnunin, Skúlagata 4, P.O. Box 1390,121 Reykjavik.

Italy Michela Podestà, Museo Civico di Storia Naturale, Corso Venezia 55, 20121 Milano.

The Netherlands Chris Smeenk, Rijksmuseum van Natuurlijke Historie, Postbus 9517, 2300 RA Leiden.

Norway Arne Björge, Norsk Institutt for Naturforskning, University of Oslo, PO Box 1037, Blindern, 1315 Oslo 3.

Portugal Marina L. de Sequeira, Serviço Nacional de Parques, Reservas e Conservação da Natureza, Rua Filipe Folque 46-5, 1000 Lisboa.

Russia M.V. Ivashin, All-Union Research Institute of Marine Fisheries & Oceanography (VNIRO),17, V. Krasnoselskaya, Moscow, B-140, 107140.

Spain Alex Aguilar, Catedra de Zoologia (Vertebrados),Facultad de Biologia, Universidad de Barcelona, Diagonal, 645, 08071 Barcelona.

Sweden Bernt Dybern, Institute of Marine Research, Box 4, 45300 Lysekil.

United Kingdom Peter Evans, Dept of Zoology, South Parks Road, Oxford OX1 3PS.