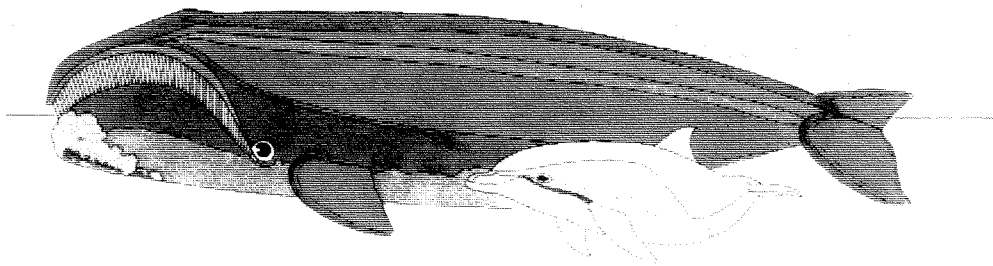


EUROPEAN RESEARCH ON
CETACEANS - 4

PROCEEDINGS OF THE FOURTH ANNUAL CONFERENCE OF
THE EUROPEAN CETACEAN SOCIETY,
PALMA DE MALLORCA,
2-4 MARCH 1990



EDITORS: P.G.H. EVANS, A. AGUILAR & C. SMEENK

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Proceedings of the Fourth Annual Conference
of the European Cetacean Society, Palma de Mallorca,
Spain, 2-4 March 1990

Editors: P.G.H. Evans, A. Aguilar & C. Smeenk

Date of Publication: December 1990

Place of Publication: Cambridge, England

CONTENTS

Introduction	6
Clapham, P.J. The identification of individual baleen whales in the North Atlantic: a selective review	8
Larsen, F. and Hammond, P.S. Photo-identification of West Greenland humpback whales, 1988-89	10
Hammond, P.S. Studying the movements and behaviour of marine mammals using telemetry	12
Martin, A.R. Satellite telemetry of cetaceans	14
Gordon, J. The use of acoustic techniques in studies of cetacean populations	15
Gordon, J., Gillespie, D., Goddard, A., Hiby, A., Leaper, R. and Lovell, P. Assessing sperm whale populations acoustically: theoretical considerations and some practical applications in the Azores	16
Scott, M.D. and Smith, K.L. Daily variations in pelagic dolphin herd sizes	17
Hoelzel, A.R. Darting for details about populations and behaviour	19
Evans, P.G.H. Stock identity in cetaceans: uses and abuses of population genetics	20
Palsbøll, P. Restriction fragment pattern analysis of mitochondrial DNA in minke whales (<i>Balaenoptera acutorostrata</i>) from the Davis Strait and the northeast Atlantic	25
Casinos, A., Viladiu, C. and Bisbal, F. A multivariate analysis of the skull of the genus <i>Sotalia</i>	26
Donovan, G. "...By 1990 at the latest": - the IWC, moratorium and the comprehensive assessment	27
Baptist, H., Camphuysen, C. and Leopold, M. Sea mammal sightings in the Netherlands	31
Castells, A. and Mayo, M. The seasonal distribution of odontocetes in Cantabrian, Atlantic and Mediterranean waters of Spain	34
Pérez, C. and Nores, C. Cetacean sightings on the central Cantabrian Sea, 1984 to 1987	35
Gannier, A. and Gannier, O. Cetacean sightings in the Mediterranean Sea: second report	39
Hashmi, D.D.K. Habitat selection of cetaceans in the Strait of Gibraltar	40
Notarbartolo di Sciara, G., Venturino, M.C., Zanardelli, M., Bearzi, G., Borsani, F., Cavalloni, B., Cussino, E., Jahoda, M. and Airoidi, S. Distribution and relative abundance of cetaceans in the central Mediterranean Sea	41
Consiglio, C., Marini, L., Angradi, A. and Sanna, A. A medium-term sighting scheme on cetaceans in the central Tyrrhenian Sea: work in progress	44
Danielsen, F., Christensen, K.D., Durinck, J. and Skov, H. Mortality of marine mammals in Denmark using activity-corrected stranding surveys, 1984-89	46

Bakker, J. and Smeenk, C. Dolphins on the Dutch coast: an analysis of stranding records	49
Bjørge, A. and Øien, N. Incidental catches and occurrence of harbour porpoises in Norwegian waters	53
Määttänen, K. Occurrence of harbour porpoises <i>Phocoena phocoena</i> in Finnish waters	55
Berggren, P. and Pettersson, F. Distribution and abundance of harbour porpoises <i>Phocoena phocoena</i> in Swedish waters	59
Kremer, H., Koch, L., Schneider, O., Adloff, B. and Fischer, W. Surprisingly high numbers of harbour porpoises <i>Phocoena phocoena</i> close to the Isle of Sylt	62
Forcada, J., Aguilar, A., Evans, P.G.H. and Perrin, W.F. Distribution of common and striped dolphins in the temperate waters of the eastern North Atlantic	64
Aguilar, A. Calving in the striped dolphin from the western Mediterranean Sea	67
Zanardelli, M., Notarbartolo de Sciara, G. and Pavan, G. Underwater acoustic signals by the striped dolphin <i>Stenella coeruleoalba</i>	69
Vonk, R. and Martel, V.M. Fraser's dolphin <i>Lagenodelphis hosei</i> Fraser, 1956: first record on the Canary Islands	70
Scott, M.D., Wells, R.S. and Irvine, A.B. A long-term study of bottle-nosed dolphins in Florida	73
Knowles, J., Hammond, P. and Thompson, P. Ecology of bottle-nosed dolphins <i>Tursiops truncatus</i> in the Moray Firth, Northeast Scotland	76
Sequeira, M.L. and Teixeira, A. On the distribution of the bottle-nosed dolphin <i>Tursiops truncatus</i> in Portugal	78
Harzen, S. Movement pattern of bottle-nosed dolphins <i>Tursiops truncatus</i> including the spatial structure and variability of subgroups	81
dos Santos, M.E., Xavier, P. and Lázaro, A. Measuring surfacing intervals in free-ranging bottle-nosed dolphins	82
Pizá, J. Pregnancy research in bottle-nosed dolphins <i>Tursiops truncatus</i>	86
Schneider, K. and Jurk, H. Vocal matching interactions in bottle-nosed dolphins	88
Sequeira, M.L. On the occurrence of Ziphiidae in Portuguese waters	91
Martin, V., Vonk, R., Escorza, S. and Montero, R. Records of Gervais' beaked whale <i>Mesoplodon europaeus</i> on the Canary Islands	95
Martin, V., Vonk, R., Montero, R. and Escorza, S. Pygmy sperm whales <i>Kogia breviceps</i> on the Canary Islands	96
Desportes, G., Saboureau, M. and Lacroix, A. Sexual activity of male long-finned pilot whales off the Faroe Islands	97
Andersen, L.W. Further studies on the population structure of the long-finned pilot whale <i>Globicephala melas</i> off the Faroe Islands	101
Heimlich-Boran, J.R. and Heimlich-Boran, S.L. Occurrence and group structure of short-finned pilot whales <i>Globicephala macrorhynchus</i> off the western coast of Tenerife, Canary Islands	102
Joiris, C.T., Bossicart, M. and Holsbeek, L. Mercury contamination of the harbour porpoise <i>Phocoena phocoena</i> and other cetaceans from the North Sea and the Kattegat	105

Forcadi, S., Marsili, L., Fabbri, F. and Carlini, R. Preliminary study of chlorinated hydrocarbon levels in Cetacea stranded along the Tyrrhenian coast of Latium (central Italy)	108
Borrell, A., Aguilar, A., Corcuera, J. and Monzon, F. Distribution of organochlorines in tissues and organs of the franciscana <i>Pontoporia blainvillei</i>	111
Calzada, N. and Domingo, M. Squamous cell carcinoma of the skin in a striped dolphin <i>Stenella coeruleoalba</i>	114
Silvani, L., Aguilar, A., Grau, E. and Sigurjónsson, J. Nutritional stress and adrenal gland weight in fin whales <i>Balaenoptera physalus</i>	116
Fernández, M., Kinze, C.C., Balbuena, J. and Raga, J.A. First record of <i>Crassicauda</i> sp. parasitising Atlantic harbour porpoises	117
Raga, J.A., Balbuena, J.A. and Aznar, J. Preliminary data on the parasite fauna of the franciscana in Argentinian waters	119
Rappé, G. <i>Isocyamus delphinii</i> (Crustacea, Amphipoda, Cyamidae), a possible biological indicator in the North Sea	121
Monzon, F., Corcuera, J., Aguilar, A. and Raga, J.A. Small cetaceans interacting with coastal fisheries in the area of Necochea (Argentina)	123
Schnapp, D. and Howroyd, J. Distribution and local range of the boto <i>Inia geoffrensis</i> in the Rio Apure, Venezuela	125
Lick, R.R. Stomach nematodes of harbour seal <i>Phoca vitulina</i> and harbour porpoise <i>Phocoena phocoena</i> from the German part of the North Sea and Baltic Sea	128
Laceck, A. and Adloff, B. Handling of healthy adult harbour seals <i>Phoca vitulina</i>	129
Thompson, P., Miller, D., Ross, H. and Cornwell, C. Impact of the 1988 phocine distemper outbreak on harbour seals <i>Phoca vitulina</i> in NE Scotland	130
De Groot, K. The history of Joc, a Californian sea lion <i>Zalophus californianus</i>	132
Corcuera, J., Aguilar, A., Lima, M. and Batallés, M. Reproductive parameters of the South American fur seal <i>Arctocephalus australis</i> in Uruguay	133
Third annual report of the European Cetacean Society: 1989	135
Report of the annual general meeting, 3rd March 1990, Palma de Mallorca	136
Financial report over 1989	137
European Cetacean Society	138

INTRODUCTION

The fourth annual conference of the European Cetacean Society was held in Palma de Mallorca in the Balearic Islands, Spain between 2nd and 4th March 1990. It was attended by around 150 persons from seventeen countries. The general theme of the conference was population studies and three speakers were invited to address aspects of this theme: Phillip Clapham (USA), Mike Scott (USA) and Rus Hoelzel (England). To these we owe a special thanks. On 1st March, a sightings workshop was held, attended by 41 persons from 14 countries. A summary of the workshop will appear in a special issue of the newsletter of the European Cetacean Society. The Council of the ECS are very grateful to Alex Aguilar for organizing a most enjoyable and successful conference.

The proceedings that follow are abstracts of the talks and posters presented at the conference. The contributions have been edited only to improve clarity and maintain a uniformity of presentation. No external refereeing has taken place and, as always, we hope that much of the material presented here will ultimately be formally published in greater detail in scientific journals. We have tried to arrange the abstracts broadly by subject.

Finally we are very grateful to Susanna Levy for her sterling efforts in typing the proceedings, often having to cope with deciphering tiny hand-written editorial changes.

Peter G.H. Evans
Alex Aguilar
Chris Smeenk

ABSTRACTS

THE IDENTIFICATION OF INDIVIDUAL BALEEN WHALES IN THE NORTH ATLANTIC: A SELECTIVE REVIEW

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INTRODUCTION This paper discusses methods and problems involved in the identification of individual baleen whales, and highlights the value of photo-ID studies by selectively summarising knowledge gained to date in the western North Atlantic. Particular attention is given to two species found in European waters: the humpback whale (*Megaptera novaeangliae*) and the fin whale (*Balaenoptera physalus*).

GENERAL METHODS

Equipment Any durable 35 mm camera with a shutter speed of at least 1/1000th of a second can be used, although one which permits manual metering is recommended. A gasketized camera body, while expensive, will last much longer in the often harsh field environment in which work is conducted. A telephoto lens with a minimum focal length of 200 mm should be used; 300 mm is ideal, while anything larger presents problems with handling and focusing. A power winder is essential (a motor drive is expensive and unnecessary).

Data recording Extreme care should be taken to accurately record photographic information and associated sighting data. While this may seem obvious, it is frequently not practised; as a result, analysis of photographs becomes difficult and the quality of data on individual whales suffers. A micro-cassette recorder is invaluable in situations where writing is impossible. Photographs of individual whales or associated groups of whales should be bracketed with neutral objects, and these brackets recorded on the data form; this should be done even if a recording databack is used with the camera.

HUMPBACK WHALE *Megaptera novaeangliae* The humpback is by far the easiest species to identify individually; consequently, it is the species about which we have learned the most. ISO 400 black and white print film is adequate and permits easy processing and printing. The ventral fluke pattern is the best identifying feature, and is particularly important in studies of the species at oceanic level. However, observers working on questions involving more restricted geographic scope will find that the dorsal fin exhibits considerable variation in shape, size and scarring; this makes it an equally important feature in the recognition of individual whales, and its use is highly recommended at all times. Problems in identifying humpbacks include: (1) changes in the ventral fluke pattern can occur in a few individuals in the first 2 years of life; (2) heavy diatom infestation can obscure the fluke pattern, especially in polar waters; (3) old scars can be lost, or new ones acquired, between years.

Results Intensive effort by several institutions over more than a decade has produced results that are exemplary of photo-ID studies. Re-sightings of identified individuals have demonstrated that: (1) the western North Atlantic humpback population appears to be made up of several distinct high-latitude feeding stocks; (2) animals from these stocks migrate to the West Indies each winter; (3) while the stocks appear to be relatively discrete in high latitudes, they mix spatially and probably genetically while in the West Indies; (4) fidelity to a given feeding stock is determined matrilineally; (5) at the level of specific habitats within a feeding stock, individual whales show a high degree of annual return (more than 80% observed one year will be re-sighted the next), although their occurrence within a season varies considerably, and data suggest that individuals exhibit regional preference; (6) detailed sighting histories of female humpbacks have shown that the mean calving interval is 2.4 years (range = 1 year to 6 years), and that most females attain sexual maturity by the age of 6.

Relevant questions Since the abundance, status, reproductive rate and migratory destinations of eastern North Atlantic humpback whales are unknown, photo-ID and genetic studies in European waters would be extremely valuable. In the light of the large data base which exists for western North Atlantic humpbacks (consisting of photographs and sighting histories of more than 4000 individuals), a relatively low level of effort in Europe should resolve the question of whether the remnant population in the eastern North Atlantic is spatially and genetically discrete.

FIN WHALE *Balaenoptera physalus* Because fin whales possess far less variation in natural markings, only high quality photographs taken from a narrow range of angles perpendicular to the whale will produce usable results. ISO 400 black and white print film is adequate, although some institutions prefer colour slide film (more difficult to work with in analysis). The features used are the blaze and chevron pattern, the shape of the dorsal fin (including any notches or nicks) and scars. Problems include the following: (1) it appears that some individuals do not possess discernible blaze and chevron patterns, and preliminary evidence suggests that this problem is particularly marked in some populations (e.g. West Greenland); (2) heavy diatom infestation can obscure natural markings; (3) photographs taken from an angle that varies significantly from the perpendicular will distort dorsal fin shape; (4) scars may be lost or acquired, but in any case are comparatively uncommon and should be used whenever present; (5) notches and nicks in the dorsal fin can be acquired. Because of the difficulties involved, individuals must be identified using a combination of features, and an extremely conservative approach must be taken towards matching.

Results Because of the lack of observer effort in other areas of the North Atlantic, virtually nothing is known from photo-ID studies about the migratory movement or extended ranges of individual fin whales. Studies conducted in the Gulf of Maine since 1979 suggest that the population characteristics of this species in high latitudes are similar in some respects to those of humpback whales, with individuals exhibiting fidelity to a specific feeding ground. However, data from radio telemetry and from whaling catches suggest fundamental differences between the two species. Data on reproductive rates are incomplete, but suggest a mean calving interval of 2 or 3 years.

Relevant questions Since so little is known concerning the population structure and migratory movement of North Atlantic fin whales, even small-scale photo-ID and genetic studies would be of value. Studies focused exclusively on this species would undoubtedly produce better data than those currently available. It remains to be demonstrated whether all fin whales are individually identifiable; comparison of the features of individuals from different areas would be useful. Furthermore, while the technique has worked extremely well in the Gulf of Maine, it is possible that it would be impractical in studies involving a much larger sample of individuals.

OTHER SPECIES: SEI WHALE *Balaenoptera borealis* Individual sei whales can be identified (perhaps more easily than fin whales) using dorsal fin shape and the often abundant scars. Very little is known about this whale; consequently, any study would be of value.

BLUE WHALE *Balaenoptera musculus* As demonstrated by Richard Sears and colleagues, individual blue whales can be easily identified by the pattern of mottling on their bodies. It is useful to include either the blowholes or the dorsal fin in any photograph as a reference point; good focus is essential. Little is known about the migratory movement of this species. Since a catalogue of more than 200 individuals exists, photographs of even a single animal would be useful, as demonstrated by a recent match between West Greenland and the Gulf of St Lawrence.

MINKE WHALE *Balaenoptera acutorostrata* Work by Eleanor Dorsey demonstrates that, with care, individual minke whales can be identified using the shape of the dorsal fin and any scars, although the technique is probably only valid for small populations.

PHOTO-IDENTIFICATION OF WEST GREENLAND HUMPBACK WHALES, 1988-89

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INTRODUCTION Photo-identification of humpback whales *Megaptera novaeangliae* in West Greenland was initiated in 1981. Surveys conducted during 1981-83 resulted in c. 110 different animals identified and provided the first evidence that West Greenland humpback whales form a separate feeding aggregation that migrates to the Caribbean breeding grounds (Perkins *et al.*, 1985).

Perkins *et al.* (1985) used Chapman's modification of the Petersen estimator to obtain an estimate of 271 animals with 95% confidence limits of 200-342 based on all 3 years of data. Hammond (1986a), using a log-linear capture-recapture model, arrived at a very similar estimate, but identified some problems relating to incomplete survey coverage in 1981 and 1982.

In 1988, Greenland Fisheries Research Institute initiated a 4 year photo-identification study of the West Greenland humpback feeding aggregation with the primary aim of obtaining a more reliable estimate of the size of this feeding aggregation. Results from the first 2 years are presented here.

METHODS The area surveyed extended from Narssalik Bank (61°45'N) up to Disko Island (69°15'N) in 1988 and up to Holsteinsborg (67°N) in 1989, and from the coastline out to a distance of approx. 40 nautical miles.

Most of the actual photography was carried out from an inflatable equipped with one or two 40-hp outboard engines. Photographs were taken using a 35 mm camera equipped with a 100-300 mm zoom lens, power winder and recording databack. Kodak Tmax 400 or Tmax 3200 black and white film was used. Individual humpback whales were identified through variation in ventral fluke pattern as described by Katona *et al.* (1980).

To estimate abundance from the photo-identification data, we used a modification of the Petersen two-sample mark-recapture model which minimises bias resulting from small sample sizes when sampling is with replacement (Bailey, 1951). Thus, if n_1 whales are identified in the first sample, n_2 whales are identified in the second sample and m_2 whales are identified in both samples, the estimate of abundance is:

$$N = n_1 (n_2 + 1) / (m_2 + 1)$$

with estimated variance, according to Seber (1982):

$$\text{var}(N) = n_1^2 (n_2 + 1) (n_2 - m_2) / (m_2 + 1)^2 (m_2 + 2)$$

This model assumes: (1) the population is closed to immigration and emigration; (2) the population is closed to births and deaths; (3) all animals are equally catchable - i.e. same probability of encountering, photographing and identifying each whale; and (4) markings do not change between samples. These assumptions have been addressed by Hammond (1986b) with respect to photo-identification data and are discussed further below.

RESULTS Sightings of c. 210 and c. 300 humpback whales were recorded during the surveys in 1988 and 1989, respectively.

Usable photographs were obtained of 87 and 196 flukes in 1988 and 1989, respectively. Deletion of within-year matches resulted in 72 and 131 individual whales identified in 1988 and 1989, respectively, from good quality photographs of whole flukes. Twenty-three were identified in both years.

The number of humpback whales summering off West Greenland in 1988/89 was estimated to be 396 with a standard error of 72, giving an approx. 95% confidence interval of 252-540 whales.

DISCUSSION In all capture-recapture studies it is important to assess whether the basic model assumptions are violated, as this will determine the reliability of the results.

In the present study, assumption (1) does not present a problem, since West Greenland humpback whales seem to form a more-or-less discrete unit (Katona and Beard, 1990).

Regarding assumption (2), we know that the population is not closed to births and deaths, but if we assume that births = deaths (i.e. stable population size in 1988-89) and assume that survival is 0.95/year (Buckland, 1990), then (after Hammond, 1986b) we have an overestimate of approx. 5%.

Assumption (3) appears to be more of a problem. We know that there are individual differences in the probability of being included in the sample, known as heterogeneity, and this causes a negative bias in the population estimate. Perkins *et al.* (1985) have shown that age-specific differences in the fluking rates can cause a negative bias of up to 10%. The best way to minimise bias due to heterogeneity is to ensure that capture probabilities are as high and as equal as possible (Hammond, 1986b). The latter is difficult but becomes less important if average probability of capture is high. In the present study, if population size is about 400, the mean capture probabilities in 1988 and 1989 were 0.18 and 0.33, respectively. These are higher than in earlier studies of West Greenland humpback whales, but it would be advantageous to get them even higher.

Regarding assumption (4), we know that markings can change in young animals (Carlson *et al.*, 1990) but as only one calf is included in our 1988 sample, this is not a major problem.

Perkins *et al.* (1985) estimated that there were 271 +/- 71 humpback whales off West Greenland. Our estimate of 396 +/- 144 is not significantly different from theirs, but we believe our estimate is better because of a more complete coverage in both sample years and because of the higher capture probabilities.

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STUDYING THE MOVEMENTS AND BEHAVIOUR OF MARINE MAMMALS USING TELEMETRY

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INTRODUCTION In the past, most of what we know about marine mammals was learnt from dead animals provided either opportunistically in the case of strandings or as a result of the industries for oil, fur and meat. It is only comparatively recently that the increased interest in cetaceans and pinnipeds as living creatures rather than as a commercial product has led to increased research on living animals in the wild. Many of the studies are still land-based, especially of seals which can spend much of their time hauled-out of the water, but there are a growing number of studies which involve collecting data at sea. Aspects of several such studies are described in other papers presented at this meeting. They mostly involve observations of animals at the surface. But whales and seals spend the majority of their lives underwater; it is there that they feed and interact with the marine environment. If we are to understand the processes which govern the lives of these animals we need to describe how they spend their time on a day-to-day basis. This paper describes some of the ways in which this can be done using telemetry.

METHODS Seals are easier than whales to study at sea using telemetry as they are more easily captured and as transmitters can be glued to their fur. For these reasons, studies of seals at sea are more widespread and will be used to illustrate the methods and type of information which can be collected. But the same principles apply to cetaceans.

Data can be transmitted and collected in three ways: using VHF radio, using UHF radio via a satellite link, and using ultrasonic transmission received underwater by a hydrophone. The transmitters must be small, robust, waterproof and able to withstand considerable pressure. They must also be able to be securely attached to the animal without altering its behaviour. Receiving equipment decodes the data and stores them. Data collected can be as simple as monitoring the presence or absence of an individual in a local area, or as complicated as the diving depth, swimming speed and heart rate of an animal at a particular location. The practicalities of collecting data can involve picking up VHF radio signals using a hand-held aerial and receiver, using an automatic receiving station to do the same job, following an individual in an ocean-going boat, or using a computer to access data collected by satellite.

RESULTS Results from some studies on seals around Britain are used as examples.

From 1986 to 1989, the Sea Mammal Research Unit (SMRU) conducted a study of grey seals around the Farne Islands off the northeast coast of England using VHF telemetry to monitor presence/absence in the area. Activity patterns over several months showed much variability among individual animals. Some seals spent prolonged periods either in the area or out of it. Other seals showed a cyclical pattern to their behaviour over periods of several days. For example, one adult male repeatedly spent 3-4 days out of the area and then spent part of the next 2-3 days in the area. Activity was loosely correlated to time of day in most animals. Typically, seals spent less time hauled out in late afternoon/early evening. A stronger and less variable relationship existed between activity and stage of the tidal cycle. Most seals hauled out of the water more often on a rising tide.

In a study currently being introduced by Paul Thompson of the University of Aberdeen on common seals *Phoca vitulina* in the Moray Firth in northeast Scotland, seals are located during each day using VHF radio by triangulating from more than one known position. The results show where each seal spends its time, either on land or in the water.

Three studies of grey seal behaviour at sea have been conducted around the coast of northern Britain by the SMRU using yachts to track and receive data from animals fitted with ultrasonic transmitters. Patterns of movement were very variable amongst individual animals. Diving behaviour could be identified into three type characteristics by the dive depth profile. When travelling, dives were characteristically V-shaped with very little time spent at maximum depth. When apparently feeding, dive profiles had a square-wave shape with about 60% of the dive spent at maximum depth. Resting dives were shallow, close to haul-out sites and variable in length. Swimming speeds were fastest during travelling and much slower when apparently

feeding. Heart rate was rapid at the surface at about 2 beats/sec and slower underwater at less than 1 beat/second.

CONCLUSIONS These and other studies are now beginning to give us a picture of how marine mammals spend their time at sea. Studies of dead animals still provide us with a lot of information which would be difficult or impossible to obtain in any other way and, through studies based on repeated observations of known individuals, we are learning more about many aspects of the behaviour of individuals and populations. To describe the way in which marine mammals interact with their marine environment, however, we must continue to find ways to monitor their daily lives.

SATELLITE TELEMETRY OF CETACEANS

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Our knowledge of the behaviour and migration of wild cetaceans is extremely poor, mostly because of the practical difficulties of locating, following and observing them. The recent introduction of satellite telemetry in wildlife studies, whereby a radio transmitter is attached to the animal and the signals are received by orbiting satellites, promised a means of gaining behavioural and locational information from cetaceans with minimum logistical requirements. Early enthusiasm for the techniques to be used on cetaceans, fuelled by spectacular successes on terrestrial animals, has been tempered by persistent technical problems. Nevertheless, signals have now been received from at least five species, ranging in size from bottle-nosed dolphin *Tursiops truncatus* to sperm whale *Physeter macrocephalus* and right whale *Eubalaena glacialis*, and significant behavioural information on such topics as dive profiles, surfacing schedules, habitat utilisation and diurnal and long-term movements has been gathered. The paper reviews progress to date and provides details of one particular study as an example, that of belugas *Delphinapterus leucas* in Arctic Canada.

Here, one female was tracked for 10.5 days, providing 88 locations accurate to about ± 2 km, during which time the animal moved a minimum of 487 km at sustained speeds of up to 4.8 km/hr. Another submerged to more than 300 m in a dive of at least 12 min, and returned to the surface at a steady 2.1 m/sec.

THE USE OF ACOUSTIC TECHNIQUES IN STUDIES OF CETACEAN POPULATIONS

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Sound propagates extremely well in the ocean and most cetaceans are highly vocal animals. These two facts alone indicate that passive acoustic techniques can be extremely useful when used in conjunction with, or as alternatives to, visual methods in many studies of cetacean biology including population assessment. Some additional advantages of acoustic techniques are that: the detectable range for a sound in the ocean is fairly predictable for any given condition; listening for sounds is typically less onerous than maintaining a high level of visual vigilance; there is good scope for automatic processing and logging of acoustic cues; and being independent of daylight acoustic studies can be continued for 24 hours a day. The equipment required is often moderately priced and is suitable for deployment from inexpensive platforms of opportunity.

Some information useful for population assessment can be relatively easy to obtain acoustically. Acoustic monitoring can provide an index of abundance to provide qualitative information on such things as geographical distribution and population trends over time. (As with any survey, the extent to which the production of the behavioural cues being scored varies diurnally, seasonally, geographically, between age classes or between the sexes, must be considered.) Obtaining a quantitative population estimate is more complicated, however. It will typically require a more complete knowledge of the patterns of production of the acoustic cues being scored and information on the range to vocalising animals. Even so, some encouraging attempts at obtaining quantitative population assessments acoustically have been made, notably with bowhead whales and sperm whales. This continues to be a most promising area for future development.

ASSESSING SPERM WHALE POPULATIONS ACOUSTICALLY: THEORETICAL CONSIDERATIONS AND SOME PRACTICAL APPLICATIONS IN THE AZORES

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Direct censuses of whale populations are normally attempted using visual surveys. Sperm whales, however, are less conspicuous at the surface than most of the great whales and make long dives which can last for over an hour, making them particularly difficult to count visually. By contrast they are relatively easy to detect acoustically, potentially at ranges of over 20 km, due to the low distinctive vocalisations (clicks) they make for most of the time that they are underwater. Acoustic surveys have several advantages over visual ones: they are less onerous for field workers, less susceptible to weather conditions, feasible from smaller, cheaper vessels and can be continued day and night.

Methodology and equipment for acoustic surveys have been developed for the International Fund for Animal Welfare's cetacean project in the Azores. In 1988 a stern-mounted directional hydrophone was used in three 500 mile surveys around the central Azores. During 1989 a new system has been developed consisting of four hydrophones towed in two streamlined bodies to form a horizontal square array. Signal processing techniques are used to compare the time of arrival of clicks at the different hydrophones and hence to calculate a horizontal bearing to each vocalising whale. This analysis can be carried out either at sea in near to real time or off-line from tape recordings. The change in the pattern of bearings to whales as the vessel moves through the area can be analysed using the "cartwheels" approach to estimate the effective range and population density. This new technique has several advantages: inter-observer error is eliminated, measurements can be made while the vessel is in motion, even while motoring, and the modestly priced equipment is easily fitted to any small platform of opportunity.

DAILY VARIATIONS IN PELAGIC DOLPHIN HERD SIZES

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It has been said that food and predation are the keys to understanding schooling behaviour. Teasing apart these factors has proven difficult, particularly given the dynamic nature of social groups. We thought, however, that by studying changes in group size in the light of what we know about daily behavioural cycles, it would be possible to examine how these factors influence schooling behavior.

We looked at data on a guild of predators that live in the eastern tropical Pacific: spotted dolphins *Stenella attenuata*, spinner dolphins *Stenella longirostris*, common dolphins *Delphinus delphis*, bottle-nosed dolphins *Tursiops truncatus*, and yellowfin tuna *Thunnus albacares*. We wanted to find out, first, if group sizes varied with time of day, and, if so, what do these patterns suggest about the influences of feeding and predation? Second, we wanted to know if mixed-species aggregations of dolphins and tuna also showed daily variation, and, if so, what does this suggest about inter-specific relationships? We analysed data gathered by Inter-American Tropical Tuna Commission (IATTC) and US National Marine Fisheries Service (NMFS) observers placed aboard tuna purse-seiners during over 200 cruises.

The mean herd size of several dolphin species increased significantly over the course of a day. This was seen in herds of spotted dolphins, spinner dolphins, common dolphins, and in mixed-species herds of spotted and spinner dolphins. Herds merged during the morning hours, and then fragmented in the late afternoon or at night. The average size of spotted dolphin herds, for example, increased from about 480 (08.00 hr) to about 670 (16.00 hr). Bottle-nosed dolphins, on the other hand, did not show this pattern.

In order to study the tuna-dolphin bond, the herd size of spotted dolphins and the catch of tuna were plotted by time of day. The catches of tuna were stratified by species and fishing mode: (a) "dolphinfish" - yellowfin tuna associated with dolphins (typically large tuna, longer than 90 cm), and (b) "logfish" or "schoolfish" - yellowfin or skipjack tuna not associated with dolphins (small tuna, typically less than 70 cm). The ratio of yellowfin tuna catch to the number of dolphins in the "dolphinfish" aggregations was examined for changes during the day to determine whether the tuna and dolphins join these aggregations at different rates.

The average catch of yellowfin tuna associated with dolphins increased in the morning, and levelled off in the afternoon. This pattern was not seen in smaller yellowfin tuna. Both large and small yellowfin tuna are generalists feeding on basically the same prey species, differing mainly in the size range that they take. This suggests that the daily increase in schools of large tuna may be a product of their association with spotted dolphins. As the spotted dolphin herds combine, the tuna associated with the herds are brought together as well.

The degree of association between different species also changed with time of day. The percentage of spotted dolphin herds that were associated with spinner dolphins increased from 38% in the morning to a peak of 47% in the early afternoon, and then declined in the late afternoon. Spinner dolphins showed a similar pattern, but the percentages were almost twice as high (increasing from 77% to a peak of 86%). Spinner dolphins are thought to seek out spotted dolphin herds in order to rest while in the company of spotted dolphins that are presumably more active and alert during the day. This suggests that the association is more important to the spinner dolphins. The association breaks up in late afternoon, presumably in preparation for night-time feeding.

The mean ratio of the catch of yellowfin tuna to the number of spotted dolphins in the same aggregation did not change significantly throughout most of the day, but increased markedly after 18.00 hr. The tuna schools remain cohesive at the same time that the spotted dolphin herds are fragmenting. This suggests that the tuna-dolphin bond weakens at night.

Because the same daily pattern in group size is seen in several members of the predator guild spotted dolphins, common dolphins, and yellowfin tuna, it is tempting to hypothesise that prey distribution is primarily responsible for daily group size variation. By adopting the daily schooling pattern of their prey, social predators can counter many of the protective advantages inherent in fish schools, particularly if they

feed cooperatively. There are problems with this hypothesis, however. Although these predator species overlap in their diets, it appears that they tend to concentrate on different prey species and feed at different times. Spotted dolphins and yellowfin tuna are considered to be primarily dawn-dusk or diurnal feeders on fish and squid that live near the surface, although radio-tracking data suggest that spotted dolphins also feed at night. Spinner dolphins are thought to feed deeper, primarily at night on fish and squid and to rest during the day. Common dolphins are thought to feed nocturnally on deep scattering layer organisms, although squid-feeding has been observed as well. Given the different feeding patterns of these predators, it seems unlikely that all are responding to daytime aggregation of their prey.

If the feeding hypothesis was true, one might expect that bottle-nosed dolphins would show this pattern as well because the few data that we have indicate that they have a similar diet to spotted dolphins. Bottle-nosed dolphins, however, did not show this daily pattern. Moreover, information collected by the NMFS and IATTC on the feeding habits of spotted dolphins indicated that virtually all of the stomachs collected from dolphins captured between 13.00 hr and 16.00 hr were essentially empty - precisely the time of day when the largest mean herd sizes were observed.

It has been suggested by Norris and Dohl (1980) that predation pressure is the primary advantage responsible for schooling in dolphins and fish. If predators of dolphins primarily locate their prey visually, then the daily pattern in herd size could be explained as a protective strategy. Spotted, spinner, and common dolphins, and large yellowfin tuna are all about the same size and presumably vulnerable to the same types of predators. Because the bottle-nosed dolphin is larger and therefore likely to have fewer predators, their herd sizes would not show this pattern.

A detailed explanation for the tuna-dolphin bond still remains elusive, and questions of whether one species seeks out the other, or what advantages each species gains have yet to be answered. A mathematical model proposed by Mullen (1984) indicated that the relationship must be advantageous to the shorter-lived species, the tuna, in order to be stable. The fact that the tuna stay with the dolphins even while the dolphins are being chased by a purse-seiner suggests a strong tendency for associating with dolphins. Tunas, on the other hand, are known to drive prey from deep water to the surface, and dolphins associated with the tuna would likely benefit from such behavior just as seabirds do. Au and Pitman (1988) have argued that spotted and spinner dolphins are ecologically more successful in the eastern tropical Pacific than other cetaceans due to the advantages they gain from associating with yellowfin tuna.

Observations of feeding aggregations of dolphins and tuna from the baitboat days of the fishery suggest that both species appear to benefit from the presence of the other. Once the tuna have driven the prey to the surface, the dolphins apparently disrupt the prey school and thus make it easier for the tuna to capture prey. Thus, the relationship may be mutualistic, with both species benefitting from foraging together. This scenario creates a bit of a paradox, however. If the relationship between spotted dolphins and yellowfin tuna is primarily a diurnal one based on feeding advantages, why are spotted dolphin stomachs empty in the afternoon? This suggests that the relationship is a complex one that may not be explicable based on solely one factor.

At the outset, we said that food and predation were the keys to understanding schooling behavior. Unfortunately, we still do not understand dolphin food habits and predation pressure very well. Using herd size as an indicator, however, we have begun to answer some of our questions about the relative importance of these factors, how they affect group cohesion, and the inter-specific relationships within this travelling circus of dolphins, tuna, sharks, and seabirds.

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DARTING FOR DETAILS ABOUT POPULATIONS AND BEHAVIOUR

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Over the last 10-20 years, observational studies of cetacean demographics and behaviour have come of age. In several cases, whole populations of individual whales have been photo-identified and their associations, movements and idiosyncratic behaviour documented for up to 20 years. Even so, there are some types of questions that remain intractable, and these are sometimes essential for the accurate interpretation of observational data. For example, the genetic structure of populations depends on the movement of individuals between populations, mating behaviour and the propensity of kin to travel in association with each other, among other factors. An observational assessment is difficult or impossible in these cases. However, especially with the background provided by longterm behavioural studies, many of these questions can now be addressed using a variety of genetic techniques that have been developed over the last 5-10 years. Tissue samples for analysis can be collected remotely using a small biopsy dart. In this paper I review the design and application of biopsy sampling systems, and the application of various genetic techniques to questions related to cetacean stock divisions and behavioural ecology.

STOCK IDENTITY IN CETACEANS: USES AND ABUSES OF POPULATION GENETICS

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Cetacean populations, like those of many other mammals, tend to show clumped geographical distributions associated with particular habitats or concentrations of food. Different populations may thus experience different selection pressures - human impacts, feeding conditions and predation all affecting survival and reproductive rates. Any conservation or management program needs to take account of the extent to which populations are separated either physically or in genetic terms. Because of difficulties in determining gene flow between populations, management of the whaling industry has traditionally relied upon "stock" divisions often described on the basis of phenotypic rather than genetic differences. As more sophisticated techniques develop, biologists and managers have sought to describe populations increasingly in genetic terms. However, movement patterns between individuals and genes have often been confused, as have the relationships between the two in population management considerations. Genetic differences between populations may exist despite those populations occurring together during part of their lifetime. Populations may have separate breeding grounds to which they traditionally return year after year, but during other times they may aggregate on common feeding grounds where they are susceptible to the same selection pressures (e.g. hunting, pollution or food shortage).

Various lines of evidence have been used to differentiate cetacean populations. These are reviewed under two main headings: those relying upon morphological differences, and those using genetic characters. In each case, any theoretical or practical deficiencies will be outlined, with emphasis upon the specific questions that the technique may be used to answer. In some cases, a method appropriate for population management may not be useful for studies of population genetics or behavioural ecology.

PHENETIC METHODS Ten methods have commonly been used to differentiate populations. The most approximate involves separation of different stocks on the basis of differences in their distributions (usually determined either from catch statistics or sightings during whaling activities). Mitchell and Chapman (1974), for example, distinguished two separate stocks of sei whale, one in the region of Nova Scotia and the other in the Labrador Sea, on the basis of discrete clumping of summer and winter sightings in these two regions. The drawback of this method is that it may simply reflect two separate areas of suitable habitat where food is concentrated, between which individuals may move either within a year or from year to year. It also tells us nothing about the movement of genes between populations.

Differences in parasite burdens have also been used in the recognition of separate populations. They are thought to reflect differences in food prey between populations which influence the transfer of parasites from the secondary host. This method has greater potential than the previous one since it is likely to require some time to develop, suggesting that those individuals are resident or returning repeatedly to a particular area. Again, it does not necessarily reflect population differentiation in genetic terms since individuals may not pick up parasites in the areas in which they breed. Individuals from different populations can have separate traditional feeding areas but a common breeding ground, or conversely, a common feeding area but be genetically independent. Using the same rationale, differences in pollutant burdens have also been proposed for stock identification. Similar limitations exist, however. Not only may there be no relationship to genetics, but several localities may have similar pollutant levels. Unless the species is largely sedentary, it is likely to be very difficult to identify a particular pollutant burden as being derived from a specific area.

The use of individual markings, either artificial tags or natural markings, has played an important role in determining the movements of individuals. Radio-tracking, particularly by satellite, has provided further information on individual movements, though usually only for short periods of their lives (when one cannot easily eliminate the possibility that the animal's movement is in response to the tagging). Since individuals may seasonally inhabit different areas during their lifetime, information should be obtained on movements of particular individuals over several years. Song dialects have also been used to distinguish populations. Humpbacks recorded in Hawaii and Mexico have similar songs (Payne and Guinee, 1983), and evidence that they are from the same population is supported by recognisable individuals moving between the two areas after sharing common wintering areas in Alaska (Darling and Jurasz, 1983). The evolution of song dialects is still poorly understood. It may reflect imitation of peers by younger animals and subsequent isolation between groups during periods of vocalisation. The regular temporal changes to the songs of humpbacks in an area may simply be due to temporal differences in settlement patterns by older males and imitation of

their songs by younger whales. Just as humans living in different localities may evolve their own dialects over time by cultural transmission, so may cetaceans develop dialects that are not necessarily the result of genetic segregation. Differences between populations in life history parameters such as growth rates, age of sexual maturity, reproductive and mortality rates may also indicate population segregation. They are most commonly observed in response to human exploitation, probably reflecting local selection pressures. However, these may be similar between areas where gene flow does not exist, and can also vary temporally, the consequences on the adult population only being felt several years later (through differential growth rates upon particular age cohorts, density-dependent effects, etc.).

The most common method used for population differentiation involves comparisons between a suite of metrical characters. In most cases, the differences observed are size-related, which may simply reflect fidelity to particular sites for these long-lived animals during critical periods (e.g. the first few months of life when growth is greatest). This could result in differential growth rates and subsequent differences in adult size. On the other hand, feeding conditions may be comparable between isolated areas with animals being of similar size despite never having contact with one another. Conditions may also vary both spatially and temporally making it difficult to interpret regional size differences, particularly when based upon small sample sizes of animals of varying age. Using multivariate statistics, it is possible to remove the effects of allometric growth upon metrical characters, and examine independent character variation. Another approach is to use non-metrical characters. Such variation appears to result mainly from genetic drift rather than local selection. The same applies to morphological variation such as colour pattern which is more complex than skeletal characters, often being controlled by several genes. They are best studied using principal components or principal coordinates analyses, which enable one to identify correlated variation in various characters. Populations geographically isolated from one another may diverge by random genetic drift, assisted further if assortative mating is occurring. Consistent differences in such characters may therefore suggest reduced gene flow between populations.

Each method described above only indirectly reflects population differentiation in genetic terms, and most have particular limitations. It is probably most useful to compare findings from a range of uncorrelated characters (e.g. colour pattern, vocal dialect, life history characteristics). If each gives similar results, this obviously lends weight to any theory of population segregation.

GENETIC METHODS Several genetic approaches are currently used in studies of population differentiation (see Table 1). For many years the main method was isozyme analysis, with a range of enzyme loci examined for genetically based polymorphisms using gel electrophoresis. Its main advantages are that it is relatively cheap and easy to use, and there is now a body of population genetic theory developed for use with such data. On the other hand, isozyme analysis typically reveals much less variation compared with that detected by DNA techniques. Much publicity has been given to DNA fingerprinting where use is made of the enormous range of base pair combinations potentially available within minisatellite regions of the DNA sequence. This method is particularly useful for individual identification and in studies of paternity amongst social groups, but has some limitations for population genetic studies. Not only is it relatively expensive and time-consuming, but there are also problems in the interpretation of multiple bands, requiring fairly complicated computing routines to perform segregation analyses and linkage studies that are advisable if haplotypes are to be detected. Those problems may be prevented if single locus probes are used (concentrating on probes for only moderately variable loci, say 3-10 well defined alleles); these are becoming increasingly straightforward to isolate although the technique remains relatively expensive and time-consuming. Alternative methods revealing a large amount of variation involve DNA sequencing, and most recently, DNA microsatellites, both using polymerase chain reaction (PCR) amplification. They also allow detection of moderately variable loci with associated low mutation rates, and so are more informative for determining genetic distances between populations.

The search for large amounts of individual variation may not be essential to identify separate populations; very many variable bands may lead to increased difficulties in interpretation. Indeed, if a few variable loci reflect overall genomic variation, it may be sufficient to examine just those loci. Further research is needed to elucidate these relationships. Several isozyme studies using a limited number of polymorphic loci have indicated similar patterns of population divergence to those predicted by other means. Since most published genetic studies of cetaceans have involved isozyme analysis, it is useful to evaluate their findings. It was originally thought that cetaceans possessed very low levels of variation at enzyme loci. However, this may have been due to the particular species and loci examined, as well as problems of protein denaturation caused by the difficulties of obtaining and adequately storing fresh samples of tissue or blood from dead whales. Wider sampling of cetacean species now indicates similar frequencies of polymorphic loci and levels of heterozygosity as found in a variety of other mammal groups (Fig. 1).

One of the most extensive population genetic studies was by Wada and Numachi (1979), who examined 3 polymorphic enzyme loci in the livers of c. 2,400 minke whales, and concluded that there were at least 4 populations in the S. Hemisphere, although allele frequency differences were generally quite small. Their analyses were criticised by Van Beek and Van Biezen (1982) on statistical grounds and because the small genetic differences were well within the range of several animal races. Although the last criticism is not necessarily valid (since different taxa exhibit different genetic distance characteristics - see Table 2), the grounds for making the population distinctions were certainly weak, and a further study by Wada (1983) using a larger sample failed to support earlier conclusions. A better approach for identifying separate populations might have been to plot genetic distance measures between samples against their geographical distances. The shape of the curve would reveal any discontinuity, suggesting a barrier to gene flow. Three genetic models have been proposed to describe the genetic structure of populations. The first, the continuous model, assumes that a population is more or less continuously distributed over a large area, geographical differentiation developing owing to the finite distances moved during dispersal. It may take many generations for genes to move across a species range. Possible cetacean candidates are the minke whale and common dolphin. In the stepping-stone model, populations are assumed to be "colonial", of roughly equal sizes, with gene flow predominantly to adjacent "colonies" either one-dimensionally with movement mainly along a river (river dolphins) or coastline (possibly porpoises); or two-dimensionally, with movement between discrete islands of suitable habitat (perhaps *Mesoplodon* whales living in ocean abysses). In the island model, gene flow among colonies is independent of the distance between them. It is equivalent to immigrants being drawn from a common gene pool comprising a mixture of all genotypes. A possible example is the humpback if individuals from separate breeding grounds share common summering areas, and choice of mate is influenced by associations developing in those areas.

The genetic structure of populations may be influenced by a variety of factors, and there is more than one route to genetic heterogeneity between social groups (Table 3). An examination of behavioural ecological characteristics may therefore throw further light upon how populations become differentiated genetically.

DISCUSSION AND CONCLUSIONS The choice of method for the study of population identity within a cetacean species depends greatly upon the specific questions being addressed. Some of the approaches may reveal differences between populations that have developed over very many generations. However, the population history may not be relevant if the question is "are those individuals experiencing different selection pressures (such as mortality from pollutants or human exploitation, or reduced reproductive rates due to food shortage resulting from overfishing) to those of this other group of individuals?" In such cases, it may not be relevant in the short term whether the populations are genetically isolated. The very presence of individuals during some part of their lifetime in an area exposed to particular selection pressures could be the critical factor in conservation or management considerations. Since various methods have their own particular limitations, it is probably wise to use a variety and compare the findings of each. Where possible, these should include independently derived phenetic and genetic methods. Whichever genetic method is used, attention should be given to the sampling procedure adopted. DNA studies have great potential for revealing individual variation but this may be limited if it is only feasible to sample a small number of individuals or cover the species range in an uneven fashion.

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Table 1. Genetic approaches to studies of population differentiation

ADVANTAGES	DISADVANTAGES
ISOZYME ANALYSIS	
Cheap, easy technique Genetic basis well understood Popn. genetic theory well dev.	Rel. few variable bands Samples preserve less well
FULL MITOCHONDRIAL DNA SEQUENCING	
Very many variable bands Haplotypes inherited from mother Variation by base substitutions	Rel. expensive technique Time-consuming Interspecific transfer of mtDNA in hybrid zones
MITOCHONDRIAL DNA SEQUENCING USING POLYMERASE CHAIN REACTION AMPLIFICATION	
Very many variable bands Locus-specific Good for popn. genetic studies	Rel. expensive technique Time-consuming
DNA RESTRICTION FRAGMENT LENGTH POLYMORPHISM ANALYSIS	
Many variable bands Locus-specific Good for popn. genetic studies	Probes difficult to isolate Expensive technique Time-consuming
DNA HYPERVARIABLE MINISATELLITES (DNA FINGERPRINTING) - a specialist class of RFLP	
- multiple locus probes Very many variable bands Avail. probes widely applic. Better for paternity studies, indiv. identification	Rel. expensive technique Time-consuming, q. diffic. Band interpretation - detection of haplotypes, linkage, compar. of genotypes
- single locus probes Many variable bands Locus-specific Better for popn. genetic studies	Rel. expensive technique Moderately time-consuming Probes mod. diffic. to isolate
DNA MICROSATELLITES [SIMPLE SEQUENCE REGIONS OF GENOME] USING PCR AMPLIFICATION	
Variable loci Modest numbers of alleles for easy typing Can use severely degraded DNA Good for popn. genetic studies	Moderately expensive technique Time-consuming

Table 2. Genetic distances (D) at different taxonomic levels

	Terrestr. mammals	Mysticetes	Odontocetes	Birds
Local popns.	0.06	0.003	0.0004	0.003
Subspecies	0.23		0.004	0.006
Sibling species	0.26			0.02
Species	0.56	0.047	0.026	0.10

Table 3. Genetic substructuring between social groups

Genetic heterogeneity is encouraged by:	Fruit bat	Marmot	Prairie dog	Badger
1. Mating within group	YES	YES	YES	YES
2. Mating by few indivs.	YES	YES	YES	YES
3. Low breeding dispersal	YES	YES	male NO female YES	male NO female YES
4. Low natal dispersal	NO	male NO female YES	male NO female YES	YES
Significant genetic heterogeneity	NO	YES	YES	YES

Sources: fruit bat *Phyllostomus hastatus* McCracken and Bradbury, 1977, Science, 198: 303-6;
 marmot *Marmota flaviventris* Schwartz and Armitage, 1980, Science, 207: 665-7;
 prairie dog *Cynomys ludovicianus* Chesser, 1983, Evolution, 37: 320-31;
 badger *Meles meles* Evans *et al.*, 1989, J. Zool., 218: 587-95.

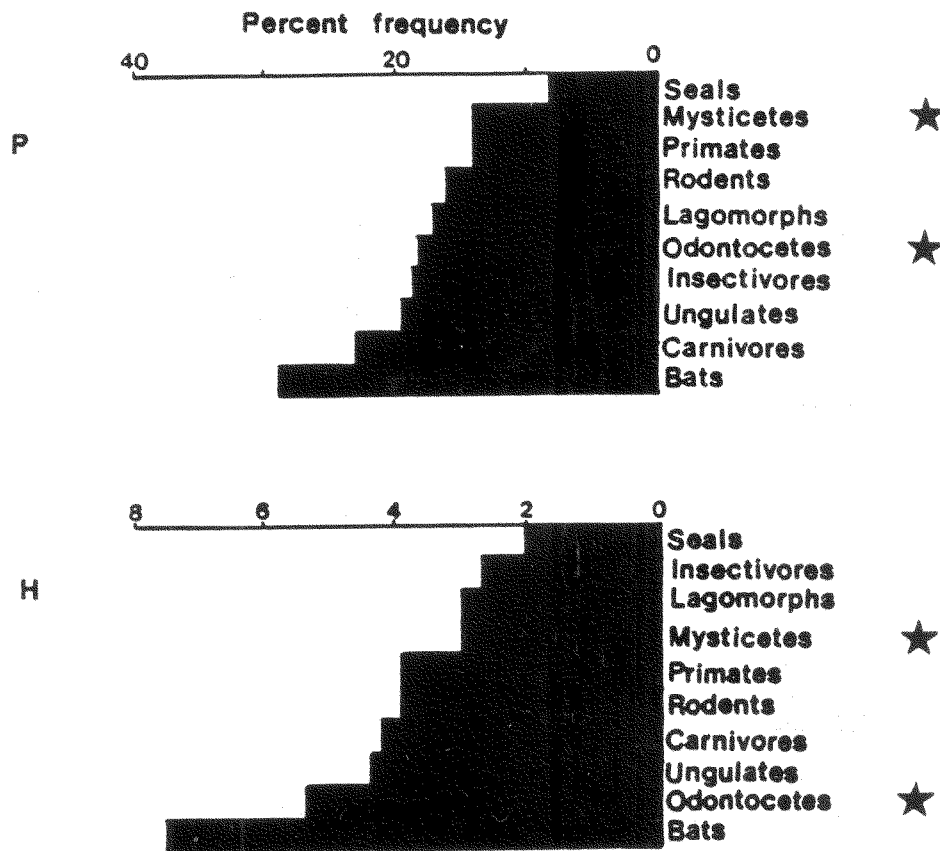


Fig. 1. The percent frequency of polymorphic loci (P) and heterozygosity (H) for various taxa of mammals

**RESTRICTION FRAGMENT PATTERN ANALYSIS OF MITOCHONDRIAL DNA IN
MINKE WHALES *Balaenoptera acutorostrata*, FROM THE DAVIS STRAIT AND
THE NORTHEAST ATLANTIC**

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Total DNA extracted from 89 minke whales *Balaenoptera acutorostrata*, from West Greenland (n=80) and the Northeast Atlantic (n=9) were digested with nine different restriction endonucleases, transferred to nylon membranes by alkaline Southern blotting and hybridized by three probes, each containing a different part of the mitochondrial (mt) genome, in all covering approx. 67% of the mt genome. In total 453 base pairs or 2.8% of the mtDNA were screened with the detection of 17 different mt haplotypes (p 0.02). No significant differences in the frequencies of the basic types were detected between different geographic areas, years, sex or length classes. Possible explanations for this apparent paradox may be either the coexistence of two maternal lineages within one random mating population or the existence of two distinct breeding populations within one common feeding aggregation.

A MULTIVARIATE ANALYSIS OF THE SKULL OF THE GENUS *Sotalia*

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Skulls from 30 different specimens of *Sotalia* sp. were measured. The description of each skull was made by means of 26 different measurements. The sample was divided into three populations: oceanic specimens, Maracaibo specimens, and Amazonian specimens. Measurements were grouped into three categories: those which described the length variability, those relative to width, and parameters describing the temporal fossa and the upper and lower jaw dentition. Discriminant analyses were carried out with these variable groups. The conclusion was that only the first two groups were useful for the statistical analysis. Results seem to agree with the current opinion that only one species should be considered within the genus *Sotalia*, taking into account that the oceanic and Amazonian populations show a high degree of overlap. In fact, the Maracaibo specimens are further from either the oceanic or the Amazonian populations than those two are from one another.

".....BY 1990 AT THE LATEST": - THE IWC, MORATORIUM AND THE
COMPREHENSIVE ASSESSMENT

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The story of the comprehensive assessment began in 1982 at the IWC meeting (International Whaling Commission, 1983). It was at that meeting that the pause or "moratorium" in commercial whaling was adopted which was to take effect in 1985/86. The initial proposal simply stated that "catch limits for the killing of whales for commercial purposes shall be zero" but before the vote was taken an amendment was made which was an attempt to indicate to the whaling countries that the Commission was not closing its door on the possibility of whaling resuming.

The actual wording was "This provision will be kept under review, based upon the best scientific advice, and by 1990 at the latest, the Commission will undertake a comprehensive assessment of the effects of this decision on whale stocks and consider modifications of this provision and the establishment of other catch limits".

However, there was no discussion at all at the meeting as to the meaning of "comprehensive assessment", even though the wording was adopted and became part of the Commission's Schedule to the Convention - essentially part of legal document.

At the 1983 IWC Meeting, the Commission added an extra piece to the puzzle by introducing a new management scheme for aboriginal subsistence whaling which again included the magic words "comprehensive assessment" and "by 1990 at the latest" (International Whaling Commission, 1984).

After vainly trying to get the Commission to explain what it meant by "comprehensive assessment", at the 1985 meeting the Scientific Committee was still in the position of having no Commission guidance. It therefore decided that if progress was to be made it would have to define what *it* thought was a comprehensive assessment and establish how one might be accomplished (International Whaling Commission, 1986). To this end it recommended, and the Commission agreed, to hold a special meeting on the subject.

That meeting was held in April 1986 and it was agreed that from a Scientific Committee viewpoint the Comprehensive Assessment¹ can be considered as an in-depth evaluation of the status of all whale stocks in the light of management objectives and procedures and that this would include the examination of current stock size, recent population trends, carrying capacity and productivity (International Whaling Commission, 1987). To achieve this, three major areas of work were required:

- (1) to review and revise current knowledge of methodology, stock identity and data availability;
- (2) to plan and conduct the collection of new data; and
- (3) to examine alternative management regimes.

These three areas of course are heavily interrelated and particularly important is the relationship between management regimes and data and methodology requirements. The Scientific Committee has had considerable trouble implementing the current management procedure. This is tied in to the concept of MSY and hence the need to have estimates of initial and current population size as well as a whole series of other parameters; most of these we have little hope of estimating with sufficient precision for management purposes in the near future. So, as an integral part of the Comprehensive Assessment, the IWC has funded and is funding a series of simulation studies of alternative feedback management procedures which have more realistic data requirements (Cooke, 1989; Magnússon and Stefánsson, 1989; de la Mare, 1989; Punt and Butterworth, 1989; Sakuramoto and Tanaka, 1989). I suppose the Holy Grail of these would be one which required no information but still enabled us to meet the Commission

¹Instant "tradition" has resulted in the Comprehensive Assessment, as defined by the Scientific Committee, to be given capital initials. It is broader in scope than the comprehensive assessments referred to in the Schedule but should, if and when completed, provide the information to carry out the review required by the Schedule.

guidelines of a stable catch regime giving a high continuing yield from the stock and with an acceptable risk level that the stock would not be depleted below some chosen level. Although the final procedure has not yet been developed, the results of the work so far are very encouraging and represent significant advances in the field of wildlife management. A recent workshop has shown that all five suggested alternatives are considerably more robust than the current procedure.

Another major area of concern is that of stock identity. Of course, if we want to assess the abundance and dynamics of a stock, it is clear we have to know what comprises that stock - in either geographical or even perhaps geographico-temporal terms. It has to be said that at the moment we do not have a good idea of the "biological" stock identity of many of what we term "management stocks". Methods to determine these have ranged from catch distributions, use of fisheries boundaries and "pure" guesses to movements of marked whales. There are two approaches to this problem. One is the "number cruncher" solution of saying "never mind, if we have data let's just stimulate the effects of possible boundary errors and see if they really are important". The other is to go out into the field and collect the relevant data. Of course, a combination of both methods is required and the IWC is encouraging both techniques. The simulation aspect is being incorporated into the testing of the alternative management procedures mentioned above. At the biological level the Commission has funded a considerable amount of work on the use and potential of molecular techniques to examine stock identity questions (see the excellent review by Hoelzel and Dover, 1989).

As part of its initial examination of methodology, the Scientific Committee examined the question of the estimation of current numbers (in particular, survey techniques) and the use of mark-recapture data. The major review of techniques (Hiby and Hammond, 1989) covered both practical and theoretical aspects of shipboard, aerial and land-based surveys. Large numbers of whales had been marked using Discovery marks (steel tags fired into a whale and recovered from the carcass) but no rigorous analyses of these data had been carried out. After a theoretical review (Pollock, 1987) an analysis of the best mark-recapture data available (that for the minke whales in the Southern Hemisphere) was undertaken (Buckland and Duff, 1989).

Of course, not all mark-recapture analyses require animals to be killed. An important factor in what might be termed pre- and post-moratorium whale science is that many of the "classical" methods of estimating abundance and biological parameters such as age at sexual maturity, mortality rates, etc. depended on information collected from dead whales. Irrespective of the value of the resultant estimates for management, the availability of samples is now clearly limited. Over the last 10 years several exciting non-lethal techniques have been developed which enable information required for management to be obtained for at least some species and populations. The commission recognised that these techniques must play a part in the Comprehensive Assessment programme and sponsored the symposium and workshop held in La Jolla in April 1988, which concentrated on the use of such techniques with regard to individual identification of whales (primarily by photo-identification) to obtain information needed for management. The fruits of this workshop are revealed in the latest volume in our special issue series (Hammond *et al.*, 1990).

The final methodology area addressed thus far is that of estimating trends in abundance. Classical fisheries theory has emphasised the use of CPUE (catch per unit effort) data and it has historically been a major element in the assessments of many whale stocks. However, surprisingly little attention had been paid, at least in the cetacean literature, to the key assumptions behind this, i.e. that CPUE is firstly a true index of abundance in the area where whaling has occurred and secondly that this can be extrapolated to the total stock area. A workshop held in Reykjavik in March 1987 (International Whaling Commission, 1988) found that there really are no models which suitably mimic the relationship of CPUE data and abundance. Indeed, given the high variation in operational factors, both with time within an operation and among operations, a detailed model needs to be developed for each particular fishery if CPUE data are to be used. Put another way, apart from giving a very gross picture where there is a major crash in a population, the inherent variability in CPUE data means that, at present, they are unlikely to be useful in assessing trends in population size - a conclusion which has ramifications in several other fisheries situations.

I hope this necessarily brief overview has shown that, although initially work on the Comprehensive Assessment began slowly (almost 4 years elapsed before its planning got underway), considerable progress has been made since; a pleasant surprise to many who thought it might become just another unfulfilled "initiative". Having said that, there is still much work to do and the fact that it will not be completed by 1990 for all stocks is apparent from the 1989 Report of the Scientific Committee (International Whaling Commission, 1990): by the end of the 1990 meeting, at best in-depth evaluations will only have been carried out for three groupings - the eastern North Pacific gray whales, the Southern Hemisphere minke whales and the North Atlantic minke whales. The present timetable for adopting a new management procedure does not envisage one before mid-1991.

It is clear that the "Comprehensive Assessment" in the grand sense, will not be ready for the Commission's meeting in July. Given that, what might happen? I should stress here that I am talking about what *might* happen, not what I think necessarily will happen and certainly not implying what I think *ought* to happen, which, as Thomas More said, is between me and my God! The first thing to say is that, given the wording in the present schedule, the "pause" in commercial whaling remains in force unless a 3/4 majority of those voting "yes" or "no" wish to change it for any or all stocks. The second thing to remember is the fact that the Scientific Committee will not be in a position to recommend a revised management procedure. So, if catch limits are to be set, it will have to be on an *ad-hoc* basis. If this is to be the case then it is likely that catch limits will only be considered for those groups being examined by the Scientific Committee, i.e. gray whales, North Atlantic minke and Southern Hemisphere minke whales. The situation is somewhat different for gray whales than for the others, since they are only subject to aboriginal subsistence whaling and a catch limit of 179 is in force until the 1991 season. However, for minke whales in the North Atlantic, apart from aboriginal subsistence catches by Greenlanders, it is possible that both Iceland and Norway would wish to resume commercial whaling. In the Southern Hemisphere, Japan is likely to wish to resume commercial whaling. It is not possible to predict in any detail the likely outcome of the Scientific Committee's deliberations, but one might guess that agreed estimates of current stock abundance will be available for some regions based on survey data. It is unlikely that all questions of stock identity will be resolved. It is possible that levels of depletion might be surmised from examination of catch data and a simple population model. In the absence of a management procedure the following might be suggested:

- (1) that no action be taken on changing catch limits from zero until a new procedure is agreed upon;
- (2) that the available data be "fed" to one or more of the potential new procedures, which while not perfect, have already shown themselves to be more robust than the current procedure;
- (3) that interim catch limits be set, based on a small percentage of estimated current abundance, until a new procedure is agreed.

The premise of anyone advocating either option (2) or (3) would be that they believed that a catch of a small percentage of current abundance for 1 year would be unlikely to irrevocably damage a "stock". Which, if any of these options is taken by the Commission, will in the end largely be a political decision.

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SEA MAMMAL SIGHTINGS IN THE NETHERLANDS

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Dutch research on cetaceans has been virtually confined to stranded specimens and captive animals in zoo exhibitions (Smeenk, 1987; Kastelein *et al.*, 1990) since bottle-nosed dolphins *Tursiops truncatus* disappeared and harbour porpoises *Phocoena phocoena* became rare in our inshore waters. Since 1973, living cetaceans have only been recorded occasionally during systematic seawatches at several sites along the Dutch coastline (Camphuysen, 1982).

Aerial surveys of seabirds, carried out since 1985 by the Tidal Waters Division in Middelburg on the Dutch sector of the North Sea, have shown that cetaceans occur in some numbers in the offshore zone (Baptist, 1987).

In 1987, Dutch seabird workers off the Netherlands Institute of Sea Research on Texel (M. Leopold) and Tidal Waters Division/Dutch Seabird Group (C. Camphuysen) started systematic ship-based surveys of seabirds and marine mammals in the entire North Sea.

Although slightly different, both mobile platforms use compatible methods, based on Tasker *et al.* (1984, 1987). This report is restricted to an overview of the sightings collected from 1985-1988 by plane and from 1987-1990 by ship.

From plane surveys, 4 species of cetaceans were positively identified: pilot whale *Globicephala melas* (2 individuals/1 sighting), white-beaked dolphin *Lagenorhynchus albirostris* (159/28), white-sided dolphin *Lagenorhynchus acutus* (3/3), and harbour porpoise (62/45). Seals were seen offshore (9/9), but only in the last days of May and the first days of June. Under the category "unidentified dolphins" (13/9) were probably some bottle-nosed dolphins.

Six species of cetaceans were positively identified during the ship-based surveys: minke whale *Balaenoptera acutorostrata* (10 individuals/10 sightings), sei whale *Balaenoptera borealis* (2/1), pilot whale (21/11), white-beaked dolphin (324/68), white-sided dolphin (34/11), common dolphin *Delphinus delphis* (50/1) and harbour porpoise (200/80). Of all cetaceans observed, c. 90% could be identified as to species.

WHALES Minke whales, sei whales and pilot whales were spotted in an area off eastern England to the Dogger Bank. Only one sighting of two pilot whales was made in the Dutch sector of the North Sea.

DOLPHINS Dolphins comprised the bulk of the sightings in offshore waters, with white-beaked dolphins predominating. White-sided dolphins were encountered mostly off the English east coast. In the same waters, one herd of 50 common dolphins was seen. White-beaked dolphins were observed throughout the year and were often attracted by the ship. Herds averaged 5.2 individuals. Close to the mainland shore, these dolphins were uncommon (Fig. 1).

Harbour porpoises Harbour porpoises were observed close to the coast, concentrated in a hydrographical frontal zone (Frisian Front) and scattered in offshore waters. Herds seen from the air averaged 1.4 individuals; herds seen from the ship averaged 2.5 individuals. Most remarkably, harbour porpoises and white-beaked dolphins were seen in separate areas offshore (compare Figs 1 and 2). In coastal zones where the water is not clear, harbour porpoises seem to be overlooked from the air.

ANALYSIS A full analysis of the sightings from these surveys is now under preparation. Data processing occurs at several places but in such a way that data-exchange is possible. Although observer effort is known, at this stage of our project calculations of densities (and population estimates) are not yet made. In our opinion the number of observations is still too small to produce statistically reliable figures.

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Postscript: During the first 2 days of aerial survey in June 1990, bottle-nosed dolphins (29/13) were seen all over the Dutch sector of the North Sea. Amongst the 29 individuals, there were 9 young animals.

LAGENORHYNCHUS - DOLPHINS

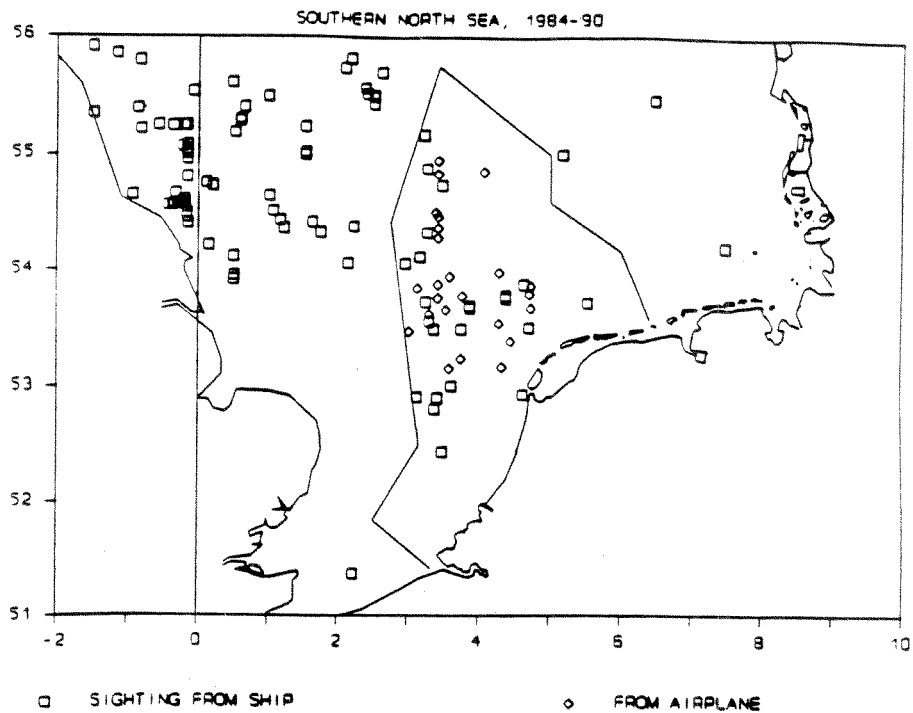


Fig. 1. Sightings of white-beaked dolphins (*Lagenorhynchus albirostris*), white-sided dolphins (*Lagenorhynchus acutus*) and unidentified patterned dolphins (*Lagenorhynchus* spp.) in the southern North Sea during 1984-90 from ship-based and aerial surveys (unpubl. data H.J.M. Baptist, C.J. Camphuysen, and M.F. Leopold)

HARBOUR PORPOISE PHOCOENA PHOCOENA

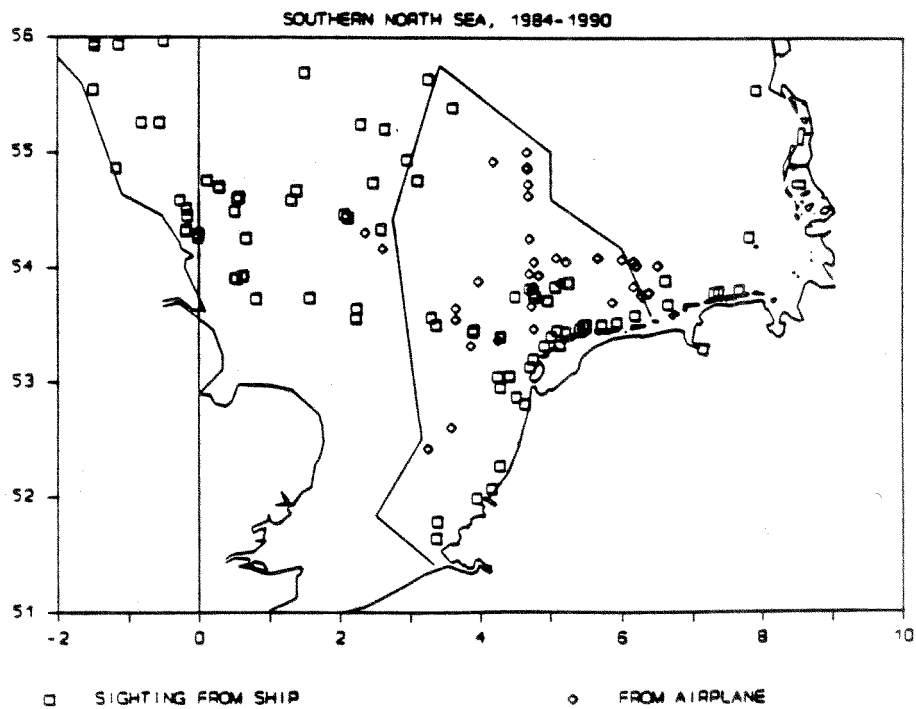


Fig. 2. Sightings of harbour porpoise (*Phocoena phocoena*) in the southern North Sea during 1984-90 from ship-based and aerial surveys (unpubl. data H.J.M. Baptist, C.J. Camphuysen and M.F. Leopold)

THE SEASONAL DISTRIBUTION OF ODONTOCETES IN CANTABRIAN, ATLANTIC AND MEDITERRANEAN WATERS OF SPAIN

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INTRODUCTION This study is based upon 719 references from the period 1900-1989; we studied the distribution of the species in the Iberian Peninsula waters and around the Balearic Islands for every month of the year.

RESULTS AND CONCLUSIONS For a comparison of the distribution of particular species in the three areas, we have used a Chi square test for nine species with sufficient records: striped dolphin *Stenella coeruleoalba*, common dolphin *Delphinus delphis*, bottle-nosed dolphin *Tursiops truncatus*, killer whale *Orcinus orca*, Risso's dolphin *Grampus griseus*, long-finned pilot whale *Globicephala melas*, harbour porpoise *Phocoena phocoena*, sperm whale *Physeter macrocephalus*, and Cuvier's beaked whale *Ziphius cavirostris*.

Nine of the 18 species apparently occur only accidentally. The area with the greatest diversity is the Cantabrian waters with 15 species, followed by Atlantic waters with 13 species, and finally, the Mediterranean with 11 species. From the chi square analysis, we conclude that the presence of common dolphin, Risso's dolphin, sperm whale and Cuvier's beaked whale is not associated with any of the three seas.

None of the species occurs primarily in the Mediterranean; killer whale and pilot whale are associated with Cantabrian waters, and the latter also with Mediterranean waters. The bottle-nosed dolphin is an Atlantic species with negative associations with Cantabrian and Mediterranean waters. Common dolphin and harbour porpoise show a mostly Cantabrian and Atlantic distribution, and the latter's absence in the Mediterranean is shown by a high chi square value.

Since this study is based upon those records we have been able to assemble, and clearly cannot take account of variations in coverage or gaps in our own coverage of the literature, there are several biases in the data. To solve this problem, we have taken into account the areas less prospected (325 km of Atlantic coast and 844 km of Mediterranean coast) in the Chi square tests.

In general the following results have remained the same, except that: the striped dolphin appears to be related to the Atlantic area; in the common dolphin and harbour porpoise we observed a strong association with Atlantic waters but no longer an association with Cantabrian waters; the bottle-nosed dolphin is even less frequent in Mediterranean waters whereas the long-finned pilot whale is relatively more common.

A comparison was made between the number of records from a particular area and its relative coverage. The area of better coverage was referred to as area A, and the area of less coverage as area B. Of the nine species studied, three were distributed at random between areas A and B and five were correlated with area A, suggesting that this may have been the result of a higher intensity of cetological investigation along the coast of the Iberian Peninsula and in the Balearic waters. Despite these, there was a negative correlation between the number of records of the long-finned pilot whale and area A.

The fact that the sperm whale shows no association with Cantabrian, Atlantic or Mediterranean waters but a positive relationship with area A, suggests that the increased presence of this species in a particular area is determined more by greater coverage of that area rather than any particular association with that region.

Seasonal distribution of odontocetes:

Striped dolphin Three peaks of abundance occur in Cantabrian, Atlantic and Mediterranean waters, one during the spring season, the second in summer and the third in winter. In the Mediterranean there is another peak in autumn. There is some variation in timing of the peaks between regions. However, there is a clear positive correlation in seasonal occurrence when populations from the three regions are compared.

Common dolphin The seasonal pattern of occurrence is similar for both Cantabrian and Atlantic waters, although peaks occur much later in the Atlantic. There is a peak at the end of winter - beginning of spring, with a gradual decline reaching a minimum at the end of autumn - beginning of winter. There is a positive correlation in the timing of seasonal peaks between populations from the three areas.

CETACEAN SIGHTINGS ON THE CENTRAL CANTABRIAN SEA, 1984 TO 1987

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INTRODUCTION Up to now, cetacean surveys off the Cantabrian coast have been based mainly on strandings (Nores and Pérez, 1983; Pérez and Nores, 1986-87; García-Castrillo, 1986). Sightings have assumed lower significance, being unsystematic and sporadic, with the exception of a general study in the Bay of Biscay (Duguy and Aloncle, 1974).

Cruises were carried out along the Spanish Atlantic seaboard, to determine whale stocks off the coast of Galicia, in which small cetaceans were also recorded (Aguilar *et al.*, 1983; Sanpera *et al.*, 1984). Other less complete cruises have also taken place (McBrearty, 1981; Raga *et al.*, 1985).

We have studied the relationship between the frequency of sightings of different species, as a reflection of natural abundance, and stranding frequencies, which can be explained by other factors.

MATERIALS AND METHODS In this study we used sightings recorded during activities which were not specifically dedicated to this purpose.

The first sighting set was collected by tuna fishermen in 1984 and 1985. These tuna fishing seasons took place between 43°N, 18°W and 45°N, 5°W from June to October, following migratory movements of *Thunnus alalunga*. Throughout the following season, the boats unload their catches at the nearest harbour and then return to fishing grounds.

Sightings information was collected during tuna unloads in Gijón and Avilés harbours and does not refer to all the fishing grounds, but only to those along the Asturian coast, from 46°30'N down to the Spanish coast and between 3°4'W and 8°W during the months of July, August and September. The results of the sighting record sheets were checked after an interview with the skippers on land to establish the certainty of sightings. The sighting effort (which includes fishing time and travel to harbours), amounted to 144 sea days in 1984 and 163 sea days in 1985.

The second set of sightings was made by the scientific staff of the 10 oceanographic cruises "COFACE" operating off the Asturian coast in the months of October 1986, and January, March, April, June, July, September, October and December 1987, in which a series of stations were sampled south of 44°N and between 5°40'W and 6°15'W, over 78 days.

Given the nature of the data, we have preferred to compare sets of sightings by means of non-parametric statistical tests. Within the sightings comparisons, we have used the number of schools because this is more precise: however, the numbers of individuals have also been included for comparisons between sightings and strandings.

RESULTS Tuna fishing seasons of 1984 and 1985 resulted in 49 and 52 sightings respectively, of which 30 and 34 were correctly identified (Table 1). This resulted in a detection rate of 0.34 sightings/day (1984) and 0.32 sightings/day (1985), and a species identification rate of 61.2 and 63.4%, respectively.

During the oceanographic cruises of 1986-87, 23 sightings were recorded (Table 1), almost all of them identified to species, because only those swimming near the boat were considered. Detection rate was 0.30 sightings/day.

The Spearman rank correlation coefficient between the two tuna season sightings was very highly significant ($r_s = 0.9515$, $p < 0.001$); for this reason both seasons were considered together in subsequent analyses.

For a closer comparison of these data with those from oceanographic cruises, we also compared records from the overlapping area of both activities. Correlation coefficients between sets of sightings and strandings data in almost all cases reached significant levels (Table 2).

Finally, frequencies of strandings were compared with two values obtained from sightings: frequency of number of individuals sighted and mean distance from the coast for each sighted species. A multiple regression analysis was made in which the number of cetaceans sighted explains more than 80% of the variance of strandings, distance being negligible.

DISCUSSION There does not seem to be any difference between sightings in the same areas, at least on a short-term basis and when the effort was high enough to avoid random errors. This could be the main cause of the lower correlation between coastal sightings and strandings, with only a small number of sightings compared with that over the total area surveyed. Seasonal trends could also affect number of individuals as well as school size (Evans, 1976).

The ranking of species for the entire tuna fishing seasons 1984-85 was very similar to the values obtained by "Ballena 1" (Aguilar *et al.*, 1983) and "Ballena 2" (Sanpera *et al.*, 1984) cruises, with highly significant correlation coefficients. The main difference is caused by the great whales. Firstly, whale concentrations off the coast of Galicia do not seem to continue eastwards, into the Bay of Biscay, where the sightings rate of fin and sperm whales is almost a third that of the Atlantic seaboard. Secondly, the greater variety of identified species of baleen whales in the Atlantic is probably due to more specialized watchers and the particular sighting aims of "Ballena" cruises.

Our results suggest that some species are under-represented due to mis-identification, i.e. striped dolphins instead of common dolphins. Nevertheless, several lines of evidence such as the similar abundance of various small cetacean species recorded in both the Atlantic and Cantabrian cruises, mixed species (pilot whales and bottle-nosed dolphins), and bathymetrical results, suggest that most sightings are correct.

Strandings may depend on an *a priori* analysis of different causes, such as species abundance, distance to the coast of dying animals, ability of carcasses to float, dominant wind or currents, etc. For these records we have considered data obtained from sightings such as species abundance at sea and mean distance from the coast. From these two values, abundance at sea is the factor which most closely explains the frequency of strandings, and the only really significant factor in a global sense. When comparing the rate of sightings and strandings of particular species, feasible interpretations can be made from strandings as an indicator of cetacean abundance.

The large number of stranded striped dolphins probably shows the under-estimation of this species in sightings, as on the Cantabrian coast where their stranding rate (15.4% of all species) is three times larger than sightings (5.5%), whereas in Galicia the values are closer, 17 strandings (Anon., 1986) versus 18.4% from "Ballena" sightings.

Up to now there have been no records of stranded bottle-nosed dolphins on the southern shores of the reviewed area, probably because this dolphin is common over the continental slope, but strands further eastwards, on the coast of Cantabria.

Two pelagic species, the fin whale *Balaenoptera physalus* and the sperm whale *Physeter macrocephalus*, are relatively uncommon. There has been a remarkable paucity of strandings of these whales on the entire Cantabrian coast during this century. Accordingly we know of only four whales stranded, all prior to 1933, and five sperm whales, all later than 1942, one of them with a whaling harpoon stuck in its back (Nores and Pérez, 1983).

A strictly coastal species, the harbour porpoise *Phocoena phocoena*, whose sightings do not extend beyond the continental shelf, seems to be over-represented in the strandings, probably due to its extreme coastal habitat.

We can also point out that the chance to detect small cetaceans at sea depends on school size and their conspicuous behaviour, thus hindering sightings of several sporadic species in the area, such as the pygmy sperm whale *Kogia breviceps*, which was never sighted in the Bay of Biscay or surrounding waters, but strands relatively frequently.

Acknowledgements We wish to thank tuna fishing boat skippers, tuna fisheries recorders and the crew of "COFACE" cruises for basic data and photographs, and for their interest in identifying cetaceans at sea.

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Table 1. Number of sightings and strandings for different cetacean species in Cantabrian waters

	1984		1985		1986-87		1984-87
	sight.	individ.	sight.	individ.	sight.	individ.	strandings
<i>Balaenoptera physalus</i>	3(1)	9-10(3)	3	4	1	3-4	-
<i>Balaenoptera acutorostrata</i>	1	1	-	-	-	-	+
<i>Balaenoptera</i> sp.	-	-	3	8-9	-	-	+
<i>Physeter macrocephalus</i>	3	9	3	5	-	-	+
<i>Kogia breviceps</i>	-	-	-	-	-	-	2
<i>Orcinus orca</i>	1(3)	2(9-10)	1	4-6	-	-	+
<i>Globicephala melas</i>	6	44-55	4	28-30	7	37-43	18
<i>Grampus griseus</i>	-	-	2	10-16	2	5-6	4
<i>Delphinus delphis</i>	6	320-340	11	30-200	10	150-220	32
<i>Stenella coeruleoalba</i>	2	20-30	2	12-20	-	-	12
<i>Tursiops truncatus</i>	3	19-21	3	22-31	3	24-26	6
<i>Phocoena phocoena</i>	1	4-6	2	26-33	-	-	4
Small unident. cetaceans	19		15		2		

In parentheses are cetaceans sighted out of the normal survey.

+ refers to species stranding on Cantabrian shores occasionally this century but not during the period 1984-87.

Table 2. Spearman rank correlation coefficients between sampling sets

		Coastal sightings 1984-85	COCAE sighting 1986-87	Strandings 1984-87
Total	1984-85	0.776**	0.787**	0.603*
Coastal	1984-85	1.000	0.779	0.527
COCAE	1986-87	0.501	1.000	0.732
Strandings	1984-87	0.714*	0.732*	1.000

The lower diagonal matrix refers to correlations between individuals; and upper half, between schools.

*p = 0.05; **p = 0.01.

CETACEAN SIGHTINGS IN THE MEDITERRANEAN SEA: SECOND REPORT

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This study started in March 1988 and has involved cruises made using a 30 foot yacht. The main aim has been to improve our knowledge of the seasonal distribution of the major cetacean species in the western Mediterranean Sea; a growing set of data should progressively lead to quantitative estimates of the populations, particularly in the northeast of the basin. The main results of 159 sightings include the winter presence of fin whales *Balaenoptera physalus* in the Corsican Sea and an important summer calving ground of striped dolphins *Stenella coeruleoalba* in the same area.

All major basins between the Strait of Gibraltar and the Strait of Sicily should be covered during the next few years; typically, one important area is covered each year during summertime, while the western Ligurian Sea is surveyed throughout the year, including winter, the ship being moored in the port of the city of Antibes. The basic crew of 2-3 people was involved in the 1988 and 1989 cruises, during which time the surroundings of Corsica and Sardinia were searched and the southern Tyrrhenian Sea covered.

The bulk of the sightings comprised striped dolphins (72% of all sightings) and fin whales (12% of all sightings), mainly occurring in pelagic waters, although it was very noticeable that the species remained frequent during winter in the Ligurian Sea. Bottle-nosed dolphins *Tursiops truncatus* were regular in coastal waters around Corsica and Sardinia, accounting for 10% of all records. Risso's dolphins *Grampus griseus* were seen on four occasions, long-finned pilot whales *Globicephala melas* and sperm whales *Physeter macrocephalus* twice each, and common dolphins *Delphinus delphis* were spotted once.

Striped dolphins were often met in small schools, typically between 10 and 20 animals, although in summer when numerous newborn calves were also observed, the groups tended to be larger though still rarely exceeding 100 individuals. Surprisingly, the calves may be left on their own in small groups for a few minutes, as was observed under excellent weather conditions. The western Ligurian Sea seems to be a very important calving ground for the striped dolphin, feeding favoured by good hydrobiological conditions, as was demonstrated in recent oceanographic studies.

Fin whales were seen in the western Ligurian Sea and northern Tyrrhenian Sea, the majority of sightings featuring single animals although pairs were not rare, and a group of three animals was recorded once. Pairs of fin whales always included a small-sized animal with a large one. Sightings occurred regularly in autumn and winter so that it appeared that the species may be resident in the western Ligurian Sea. Striped dolphins were often observed alongside fin whales, and sometimes the two species interacted.

Bottle-nosed dolphins have been sighted around Corsica and Sardinia, mostly over depths less than 200 metres. Schools usually numbered five to ten animals and included one or two calves, although no newborns were found during summer. Since bottle-nosed dolphins seemingly occur regularly in these coastal waters, an individual identification catalogue would be feasible and of some interest.

Risso's dolphins were observed twice each in the Tyrrhenian Sea and the Ligurian Sea each, with schools numbering less than 10 animals; sightings took place in summer and autumn in waters roughly 1000 m. deep. Young calves were recorded in the schools seen in the Ligurian Sea; in this area, Risso's dolphin does not appear to be very common, so that a photo-identification study could be initiated with a good prospect of success on the basis of characteristic dorsal fins, and perhaps the patterns of individual adults.

Long-finned pilot whales were sighted twice in late summer and autumn, and a school of 30 animals was observed for a period of 4 hours, some 20 miles off Cap d'Antibes. The pilot whales were apparently resting, being separated in three subgroups, each including two newborn calves and more than one male. Sperm whales were seen only twice, in both cases a single male breaching; sightings occurred in the southern Tyrrhenian Sea and the Ligurian Sea.

The results seem to be in accord with published work, with the exception of the winter presence of fin whales in the Ligurian Sea. This basin features a much higher rate of observation per unit time than other areas covered in summer, particularly the southern Tyrrhenian Sea. The Ligurian Sea is confirmed to be an important calving ground for striped dolphins in summer, and this emphasises the threat facing that population by the drift net fisheries.

HABITAT SELECTION OF CETACEANS IN THE STRAIT OF GIBRALTAR

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In the Strait of Gibraltar a high density of cetaceans and a change from neritic to oceanic waters is found within a small area. This situation offers an interesting basis for studies of habitat selection. For this purpose, 8100 km were covered along a transect line across the Strait during three expeditions (3-27 December 1986, 18 September-13 November and 29 March-13 April 1988).

An analysis of habitat selection was made for the four most regularly sighted species: common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba*, bottle-nosed dolphin *Tursiops truncatus* and long-finned pilot whale *Globicephala melas*, which together comprised 99% of all cetacean sightings in the Strait. Although every species was encountered in waters of widely varying depths, a comparison of the abundance with depth indicates that common dolphin and bottle-nosed dolphin prefer waters between 250 and 500 m deep, whereas the two other species mainly inhabit oceanic waters with a depth greater than 600 m. The species that, within the conditions in the Strait, showed greatest tolerance for changes from neritic to oceanic waters, was the striped dolphin. Pilot whales showed the least tolerance and were almost exclusively found above the African continental slope where they preferred waters of between 700 and 900 m. depth.

The major factors that may theoretically affect cetacean distributions, are the physiological tolerance to abiotic conditions, the availability of prey, interspecific competition and migration strategies.

There is some indication that the observed habitat selection follows from interspecific competition between similar species, or from evolutionary adaptations (e.g. specialisation on neritic and oceanic prey, respectively) that themselves are affected by interspecific competition.

In the case of pilot whales, migration strategies probably had an influence on the distribution. The direction of movement was quite uniform, with 98% of the animals observed leaving the Mediterranean during the surveys. The fact that long-finned pilot whales were only sighted in the area over the African continental slope and not over the European continental slope, indicates that the migration route presumably led the animals along the North African coast.

DISTRIBUTION AND RELATIVE ABUNDANCE OF CETACEANS IN THE CENTRAL MEDITERRANEAN SEA

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The species composition of the cetacean fauna occurring in the seas surrounding the Italian peninsula and islands (Ligurian, Corsican, Tyrrhenian and Sardinian Seas, Sardinia and Sicily Channels, Ionian and Adriatic Seas) is well known (Cagnolaro *et al.*, 1983). However, detailed knowledge of the distribution and of the relative abundance of each species in the different portions of the Italian seas is lacking. To bridge this gap, from 1986 to 1989 a series of summer cruises were conducted to acquire a better understanding of cetacean ecology in Italy.

METHODS Most observations were made from dedicated sailing vessels; a few observations were made from a research ship. The sample consisted of 305 uninterrupted observation bouts, totalling 2,432.7 h. The seas surrounding Italy were divided into seven areas (Fig. 1): 1) Ligurian and Corsican Seas (26 bouts); 2) Tyrrhenian Sea (109); 3) Sardinian Sea and Channel (13); 4) Sicily Channel (20); 5) Ionian Sea (37); 6) southern Adriatic Sea (9); and 7) northern Adriatic Sea (91). Observation start or finish times were determined, when applicable, by sunrise, sunset, departure or arrival time, deteriorating weather conditions and crossing the border between two areas. The presence of animals was assessed both visually and acoustically; relative sighting frequencies among species and among seas were calculated by dividing the number of sightings made during each bout by the duration of that bout. When possible, school size was determined for each sighting. From the sighting location, water depth and distance from the nearest coast was also calculated. Significance of all computed statistics was evaluated with the Kruskal-Wallis test, with the exception of depth statistics, on which an ANOVA could be performed.

RESULTS Cetaceans were sighted 246 times. Seven species were observed, including, in order of decreasing frequency: bottle-nosed dolphins *Tursiops truncatus* (0.032 sightings/hr), striped dolphins *Stenella coeruleoalba* (0.025), fin whales *Balaenoptera physalus* (0.0056), sperm whales *Physeter macrocephalus* (0.0051), Risso's dolphins *Grampus griseus* (0.0048), common dolphins *Delphinus delphis* (0.0018), and long-finned pilot whales *Globicephala melas* (0.0012) (Fig. 3).

Minke whales *Balaenoptera acutorostrata*, killer whales *Orcinus orca*, false killer whales *Pseudorca crassidens*, Cuvier's beaked whales *Ziphius cavirostris*, and rough-toothed dolphins *Steno bredanensis*, all of which are also known to occur in the central Mediterranean Sea (Cagnolaro *et al.*, 1983), were never observed.

Overall, the highest sighting frequencies occurred in the Ligurian-Corsican Seas; the lowest in the northern Adriatic. The very low sighting frequencies found in the Tyrrhenian Sea were surprising (Fig. 2.).

The bottle-nosed dolphin, the only cetacean found in all areas, was the only species observed in the northern Adriatic Sea, and predominated in the Sicily Channel and west and south of Sardinia. The striped dolphin was the most frequent species in the Ligurian-Corsican Seas, Tyrrhenian Sea, Ionian Sea and southern Adriatic Sea. Fin whales were most frequent in the Ligurian-Corsican Seas, but were also seen in the Ionian, Sardinian and Tyrrhenian Seas. Sperm whales were rare but found in all seas except the Adriatic Sea and the Sicily Channel. Risso's dolphins occurred in the Ligurian-Corsican, Tyrrhenian and Ionian Seas. The rarest species were common dolphin, seen in the Sardinia Sea, Ionian Sea and the Sicily Channel, and long-finned pilot whale, mostly found in the Ligurian-Corsican Seas, but observed also in the Tyrrhenian Sea (Fig. 1).

The largest observed schools were of common dolphins (mean group size = 76.8); however, sample size was very small. The striped dolphin had the second largest schools (26.5), but with a large variation in group size, probably because of the "fusion-fission" type of social organization of this species. The bottle-nosed dolphin occurred mostly in small schools (6.6); group sizes of Risso's dolphins (16.7) and pilot whales (10.1) were intermediate. Fin whales (1.5) and sperm whales (1.5) occurred singly or in small (4-7) groups.

Not surprisingly, bottle-nosed dolphins were the most coastal species, occurring at shallow depths and close (average 12 km) to the coast. Fin whales, sperm whales, pilot whales, and striped dolphins were pelagic,

being found in deep waters and far (average varying from 24 to 31 km) from the coast. Risso's dolphins were seen close to the coast (average 13 km) but in deep waters, possibly indicating their preference for steeply sloping bottoms near the coast.

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Cagnolaro, L., Di Natale, A. and Notarbartolo di Sciara, G. 1983. *Cetacei. Guide per il riconoscimento delle specie animali delle acque lagunari e costiere italiane*. Consiglio Nazionale delle Ricerche, Roma, 186 pp.

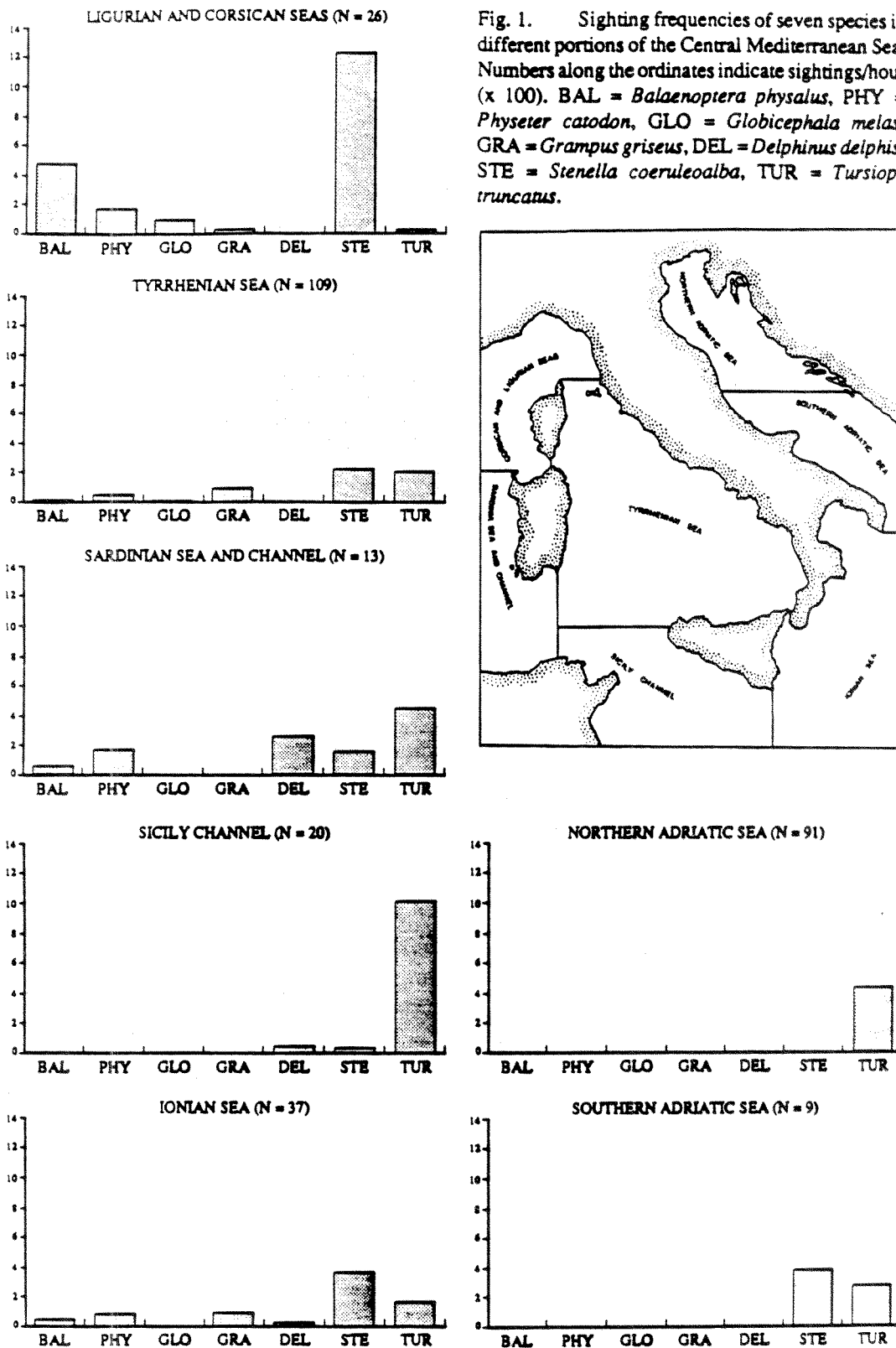
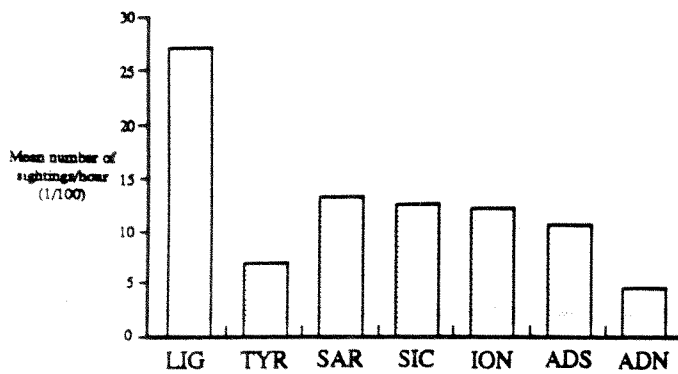


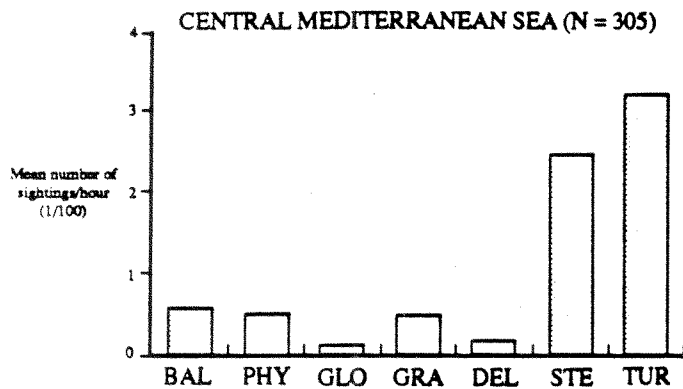
Fig. 1. Sighting frequencies of seven species in different portions of the Central Mediterranean Sea. Numbers along the ordinates indicate sightings/hour ($\times 100$). BAL = *Balaenoptera physalus*, PHY = *Physeter catodon*, GLO = *Globicephala melas*, GRA = *Grampus griseus*, DEL = *Delphinus delphis*, STE = *Stenella coeruleoalba*, TUR = *Tursiops truncatus*.



Seas	N	\bar{X}	SD	2SE	Range
Ligurian and Corsican Seas	26	27.05	22.95	9.00	0-86.37
Tyrrhenian Sea	109	7.01	10.31	1.98	0-52.17
Sardinia Sea	13	13.34	9.03	5.00	0-24.00
Sicily Channel	20	12.59	19.19	8.58	0-59.88
Ionian Sea	37	12.21	20.07	6.60	0-85.38
Southern Adriatic Sea	9	10.47	25.02	16.68	0-75.00
Northern Adriatic Sea	91	4.54	9.19	1.93	0-40.00

Kruskal-Wallis test: T = 51.215 P << 0.001

Fig. 2 Sighting frequencies for all cetacean species in different portions of the Central Mediterranean Sea.



Species	\bar{X}	SD	2SE	Range
<i>Balaenoptera physalus</i>	0.56	3.09	0.35	0-38.39
<i>Physeter catodon</i>	0.51	2.92	0.34	0-23.36
<i>Globicephala melas</i>	0.12	1.02	0.12	0-10.33
<i>Grampus griseus</i>	0.48	3.00	0.34	0-34.78
<i>Delphinus delphis</i>	0.18	1.48	0.17	0-17.64
<i>Stenella coeruleoalba</i>	2.48	7.47	0.86	0-53.36
<i>Tursiops truncatus</i>	3.21	8.30	0.95	0-59.88

Kruskal-Wallis test: T = 133.745 P << 0.001

Fig. 3 Sighting frequencies of seven cetacean species in the Central Mediterranean Sea.

A MEDIUM-TERM SIGHTING SCHEME ON CETACEANS IN THE CENTRAL TYRRHENIAN SEA: WORK IN PROGRESS

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Although the presence of some species of cetaceans in the Tyrrhenian Sea is known from chance encounters and from specific sighting cruises, the numbers of these animals in our Sea and their presence in particular seasons of the year are almost unknown.

The National Railway ferry line (FF.SS.) between Civitavecchia (Rome) and Golfo Aranci (Sardinia) runs throughout the year and offers the opportunity for a systematic sighting scheme, almost independent of meteorological conditions and at very low cost. The distance between the two harbours is about 120 nautical miles and the crossing lasts 7-8 hr.

METHODS With the collaboration of the National Railway Board, starting from September 1989 and lasting for 1 year, groups of between two and four University students and researchers travelled on the ferries once a week and recorded all cetaceans observed during both outward and return legs of the trip, for a total of c. 1600 hr of observation per year.

At each sighting, the following information was recorded:

- (1) Photographic documentation of the animal or of the groups;
- (2) Angles subtended from the transect line to the sighted group (or animal) and their estimated distance;
- (3) Identity;
- (4) Group size and presence of juveniles;
- (5) Particular observations about the behaviour or presence of other marine animals, such as seabirds; and
- (6) Nautical position of the ferry.

Sea state, visibility conditions, water temperature and their variation were also recorded. From the photographs, we are trying to determine the length of the animals and their distance from the ferry using J. Gordon's method and to identify individual specimens from their natural markings.

During the crossing, we also recorded personal observations from the ferry crews relating to their vernacular names, old fishery techniques, proverbs and legends concerning cetaceans in Italian seas.

At the end of the year we expect to have recorded sufficient data for hypotheses on the following points:

- (1) a check of techniques employed and research theories;
- (2) geographical and seasonal distributions for each species;
- (3) group size and composition; and
- (4) intra- and interspecific behaviour (reactions to the boat, mixed schools, correlation with seabirds, individual and social behaviour).

If the tested methods and data should prove to be effective, the research may be continued for further years on the same, or some other ferry lines.

The first, incomplete raw data obtained during the first 4 months are reported here: the methodologies have proved to be quite satisfactory, thanks to favourable weather conditions.

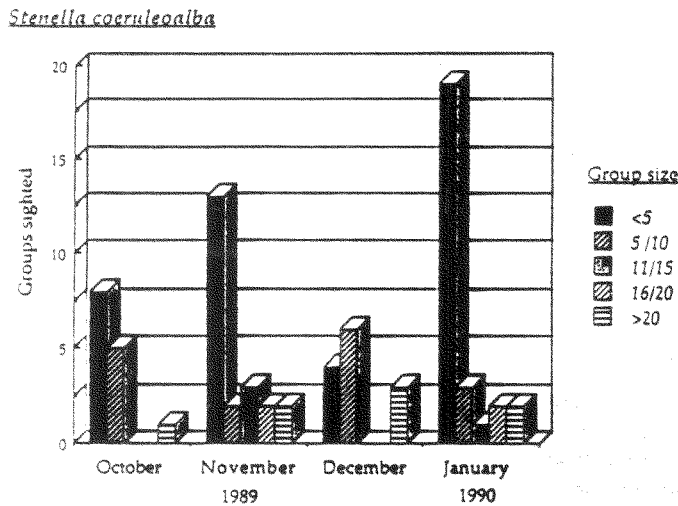
RESULTS Some difficulties in identifying different species of Delphinidae (striped dolphin *Stenella coeruleoalba*, common dolphin *Delphinus delphis*, bottle-nosed dolphin *Tursiops truncatus* and Risso's dolphin *Grampus griseus*) were sometimes due to bad sea conditions or, more frequently, to sightings being at distances over 1.5 nautical miles, although photographs can be very helpful: more than 500 photographs have been taken with 35 mm cameras using lenses of 50, 135 and 200 mm focal length.

This research was carried out with a grant from the Environment Bureau of the Provincial Administration of Rome.

Table 1. Number of groups encountered for various cetacean species

	October	1989 November	December	1990 January
<i>Stenella coeruleoalba</i>	14	22	13	27
<i>Tursiops truncatus</i>	1	1	1	
<i>Delphinus delphis</i>		1	1	
<i>Grampus griseus</i>	2			1
Delphinidae unident.		1	2	2
<i>Balaenoptera</i> sp.	4	1	1	4
Trips	8	10	7	9

Fig. 3. Seasonal variation in group sizes of *Stenella coeruleoalba*



In this analysis we have aggregated smaller groups encountered within a few minutes and considered them as larger groups.

Percentage of sighted groups

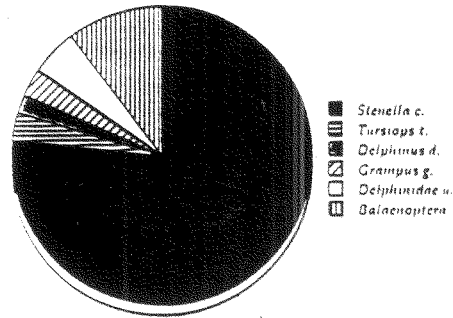


Fig. 2. Percentage of sighted groups of various cetacean species in Tyrrhenian Sea

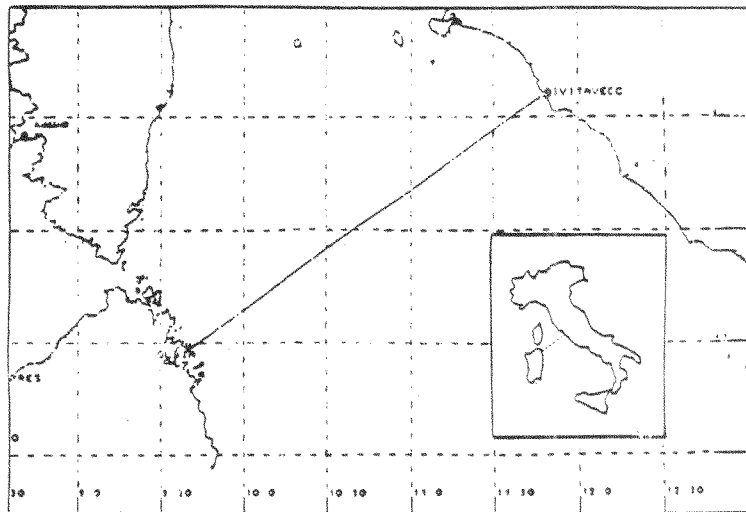


Fig. 1. Ferry route between Civitavecchia and Golfo Aranci, Tyrrhenian Sea

MORTALITY OF MARINE MAMMALS IN DENMARK USING ACTIVITY-CORRECTED STRANDING SURVEYS, 1984-89

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Since 1984, the Danish beaches have been surveyed every winter for stranded marine mammals and seabirds. This paper presents the results of these surveys for the harbour porpoise *Phocoena phocoena* and the harbour seal *Phoca vitulina*. The surveys have been coordinated by Ornis Consult and financed by the Commission of the European Communities, the scientific committee of the Danish Ornithological Society and private funds.

MATERIALS AND METHODS In the last weekends of February and March, exposed beaches have been surveyed for dead, stranded animals. The beaches were surveyed by 1-3 people on foot. The same people covered the same stretch of coastline every year. The number of dead animals found stranded has been divided by the distance of the coastline surveyed. This is used as an index for the mortality of the species.

RESULTS In the first two winters, 430 and 650 km of beaches were surveyed, while in the following years 1200 to 1500 km of beaches were surveyed every winter (Fig. 1).

During 1984-89 one dead harbour seal was found stranded for every 112 kms of surveyed coastline (see Table 1). Over this period there was a considerable change in the number of seals found per km of surveyed coastline (Fig. 2). In 1984-87, one dead seal was found for each 135 km of surveyed coastline. In 1988, however, one dead seal was found per 45 km of coastline surveyed, suggesting a considerable increase in the mortality of seals this winter. In 1989, one dead seal was found per 30 km of coastline surveyed. The majority of the dead seals this winter was found in the Danish part of the Wadden Sea, where one dead seal was recorded per 2 km of coastline. In the remaining areas this winter, one dead seal was found per 700 km of surveyed coastline.

One dead harbour porpoise was found stranded for each 123 km of surveyed coastline during 1984-89 (see Fig. 3). Since 1986 there has been a decrease in the number of dead porpoises found per km of surveyed coastline. The decrease, however, is not significant.

DISCUSSION In April 1988, a widespread mortality of seals was discovered at the breeding grounds, apparently caused by a phocine distemper virus infection (Osterhaus and Vedder, 1988). The relatively high number of dead seals found three months earlier suggests that, already during the preceding winter, there was an unusual high mortality of seals. Since no tissue samples were taken from the seals found during this study, it is not possible to say whether the high mortality in the 1988 winter was actually linked to the PDV infection. However, the high number of dead seals in the Wadden Sea in 1989 was most likely linked to the PDV infection. From 1988 to 1989 the Danish population of harbour seals decreased considerably. Therefore, it is not surprising that relatively low numbers of dead seals were found in other parts of Denmark this winter.

The number of stranded porpoises reported to the Zoological Museum of Copenhagen has decreased since 1986 (Kinze, in prep.), showing the same trend as found in this study (Fig. 4).

REFERENCE

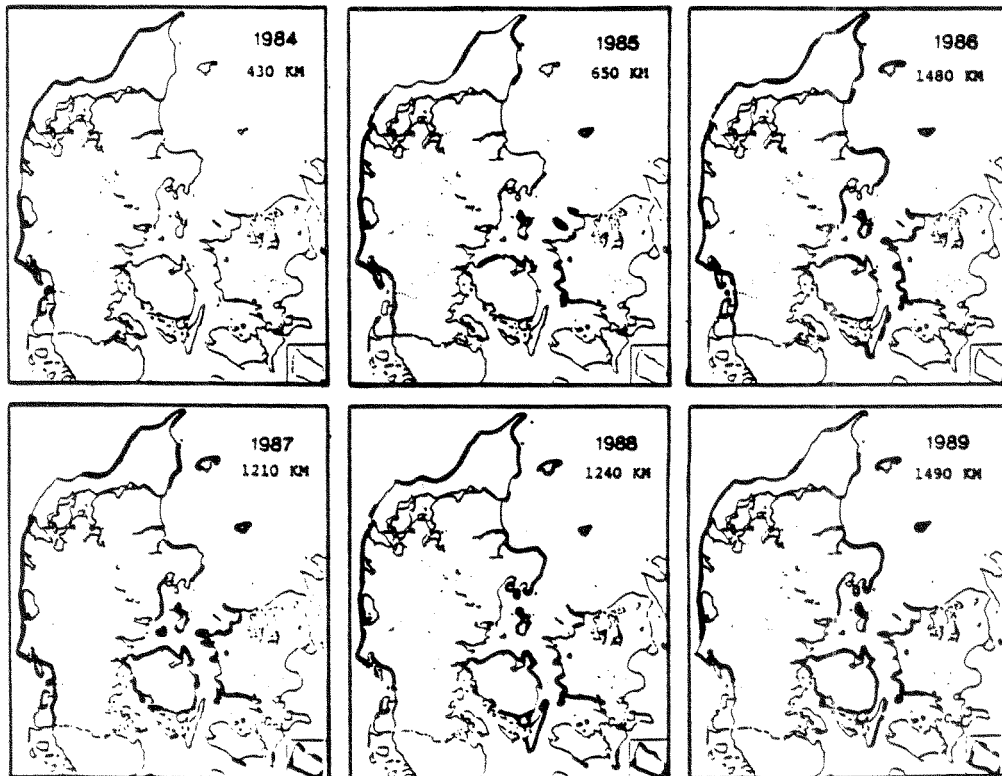
Osterhaus, A.D.M.E. and Vedder, E.J. 1988. Identification of virus causing recent seal deaths. *Nature*, Lond., 335: 19-20.

Table 1. Dead seals and porpoises found stranded per km of surveyed coastline in Denmark.
February - March 1984-89

	SEALS		PORPOISES		COVERAGE
	no.	no. per km surveyed (x 0.001)	no.	no. per km surveyed (x 0.001)	kms
1984	2	4.7	4	9.3	430
1985	6	9.2	5	7.7	650
1986	7	4.7	18	12.2	1480
1987	14	11.6	13	10.7	1210
1988	27	21.7	7	5.6	1240
1989	2*)	1.5*)	5	3.4	1490
Mean 1984-89		8.9*)		8.1	

*) Data from the Wadden Sea 1989 not included.

Fig.1. Coverage in Denmark, February - March 1984-89



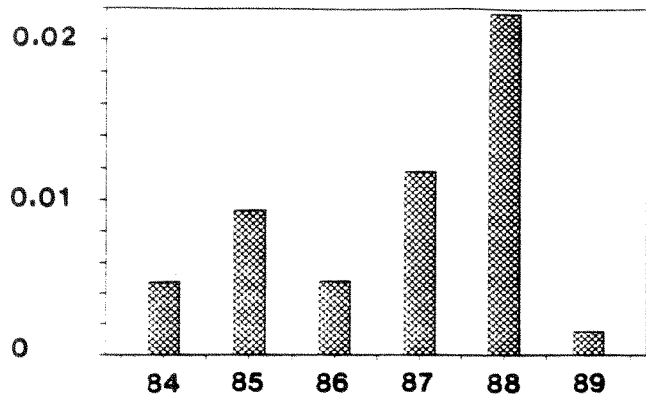


Fig. 2. Number of dead seals found per km of surveyed coastline in Denmark, February-March 1984-89

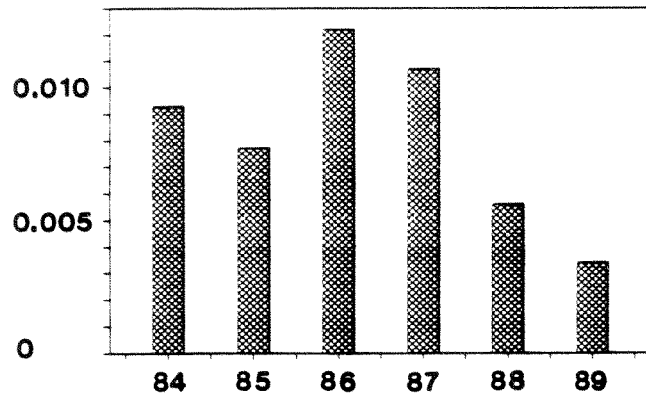


Fig. 3. Number of dead harbour porpoises found per km of surveyed coastline in Denmark, February-March 1984-89

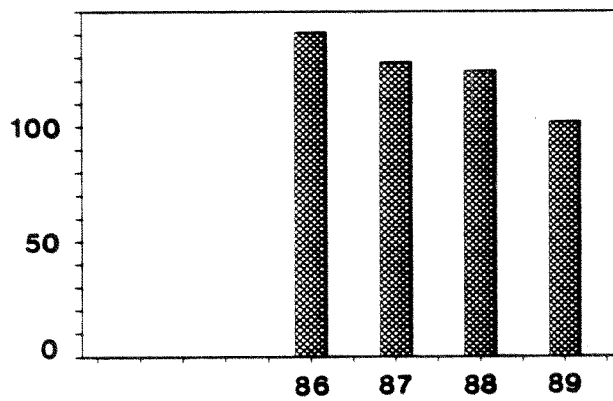


Fig. 4. Total number of dead harbour porpoises reported stranded by the Zoological Museum, 1986-89 (C. Kinze in prep.)

DOLPHINS ON THE DUTCH COAST: AN ANALYSIS OF STRANDING RECORDS

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INTRODUCTION In this study we have analysed the stranding records of bottle-nosed dolphin *Tursiops truncatus*, common dolphin *Delphinus delphis*, white-beaked dolphin *Lagenorhynchus albirostris* and white-sided dolphin *L. acutus* in The Netherlands for the period 1900-1988. An earlier, preliminary analysis was published by Bakker and Smeenk (1987).

Tursiops and *Delphinus* have a nearly cosmopolitan distribution, occurring in (sub)tropical and warmer temperate seas. The range of the bottle-nosed dolphin extends into slightly cooler areas than that of the common dolphin. The white-beaked and white-sided dolphin are restricted to the northern Atlantic Ocean and normally occur in subarctic and cold temperate zones. The North Sea is situated in the central part of the northern temperate zone and is a meeting area of the northern and southern species discussed here.

METHODS The stranding data of cetaceans in The Netherlands have been systematically collected since 1914. For a history of the Dutch recording scheme see Smeenk (1987). For our analysis, we have used a hypothetical outer coastline, divided into northern, central and southern sectors (Wadden, Central and Delta areas, respectively), with proportional lengths of 49: 29: 22 (Fig. 2).

The standard data recorded from a stranded animal are species, sex, length, and locality and date of stranding. However, not all these data could be retrieved for every case. Therefore, we had to use slightly different subtotals for the various analyses, depending on the available records in each category.

RESULTS AND DISCUSSION Temporal distribution (Fig. 1, bottom) - There has been an increase in strandings of bottle-nosed dolphins since the beginning of this century, with a peak between 1930 and 1965, followed by a sharp decline. Coinciding with this peak there has been a distinct peak in strandings of common dolphins (particularly in the 1940s), a species that had been absent from the stranding records before 1925. During the 1960s, the white-beaked dolphin appeared in increasing numbers, followed by the white-sided dolphin in the 1980s (not shown in Fig. 1 as there are still very few records).

Several factors appear to be correlated with these changes in stranding frequencies, and these include changes in sea surface temperature, food supply, and increasing pollution. For common and white-beaked dolphins, water temperatures seem to be of importance. Since 1920 these have increased slightly but significantly, to decrease again after 1960. During this warmer period, several species of marine organisms of southern origin entered the North Sea (Cushing, 1982). The availability of certain (as yet unknown) warm-water prey species may have caused the invasion of the common dolphin into the southern North Sea. Its disappearance may be related to the subsequent decline in temperature and a simultaneous decline in the - hypothetical - prey species of southern origin, along with a decline in certain resident North Sea species (notably herring *Clupea harengus*) due to overfishing. Unfortunately, we have no data on the food of the common dolphin in Dutch waters.

The increase in strandings of white-beaked dolphins during the 1960s could be the combined effect of favourable changes in water temperatures and currents, an increase of prey species such as gadoids as a result of several very good year-classes, as well as decreasing competition with other dolphin species, in particular the bottle-nosed dolphin.

For the bottle-nosed dolphin, changes in water temperature may have been less important, since its decline started only in the second half of the 1960s. Its virtual disappearance may be related to a decrease in prey (herring) and/or an increase in pollution. However, the initial increase in bottle-nosed dolphin strandings during the earlier part of the century may, after all, have some relationship with the temperature rise after 1920.

Seasonal distribution (Fig. 1, top) - The summer peak in strandings of common dolphins and the low in winter may be directly related to water temperature. The species' lower temperature limits appear to lie between 10° and 14°C (Sergeant, 1958; Gaskin, 1968; Leatherwood *et al.*, 1983; Evans, 1989). The average surface temperatures in the southern North Sea range between 5°C in winter and 16°C in summer.

Strandings of bottle-nosed dolphins also show a peak in summer and a low in winter. In the white-beaked dolphin, there is a slight low in summer.

Spatial distribution (Fig. 2) - the strandings of bottle-nosed dolphins are fairly evenly distributed along the Dutch coast, with a slight peak in the central sector. This indicates the existence of a resident population in Dutch waters till the mid-1960s. After that period relatively more animals became stranded in the southern sector, suggesting that in more recent years most bottle-nosed dolphins entered the area from the south. There is a resident population in the English Channel, of which animals may occasionally stray into the southern North Sea (Evans *et al.*, 1986; Evans and Scanlan, 1988).

The spatial distribution of strandings of the common dolphin shows a distinct peak in the central sector of the coast, and relatively few animals in the north. This indicates that this species invaded the southern North Sea through the English Channel.

The concentration of white-beaked dolphin strandings in the northern sector is indicative of the northern origin of the species. This corresponds well with field observations, which show that white-beaked dolphins occur mainly in the northern and central sector of the North Sea (Evans *et al.*, 1986). It is also consistent with the results of recent Dutch surveys, both from the air and from ships, during which most white-beaked dolphins are seen to the northwest of the Dutch Frisian Islands (Baptist, 1987; Baptist *et al.*, 1990).

CONCLUSIONS From the stranding patterns of dolphins on the Dutch coast it is evident that during this century marked changes have occurred in the dolphin fauna of the southern North Sea. These changes coincide with natural and/or man-induced changes in environmental conditions. At present, however, we are unable to draw firm conclusions as to the exact causes and effects in any particular case. To this end, a more detailed analysis of correlations between various environmental factors in the North Sea ecosystem is necessary.

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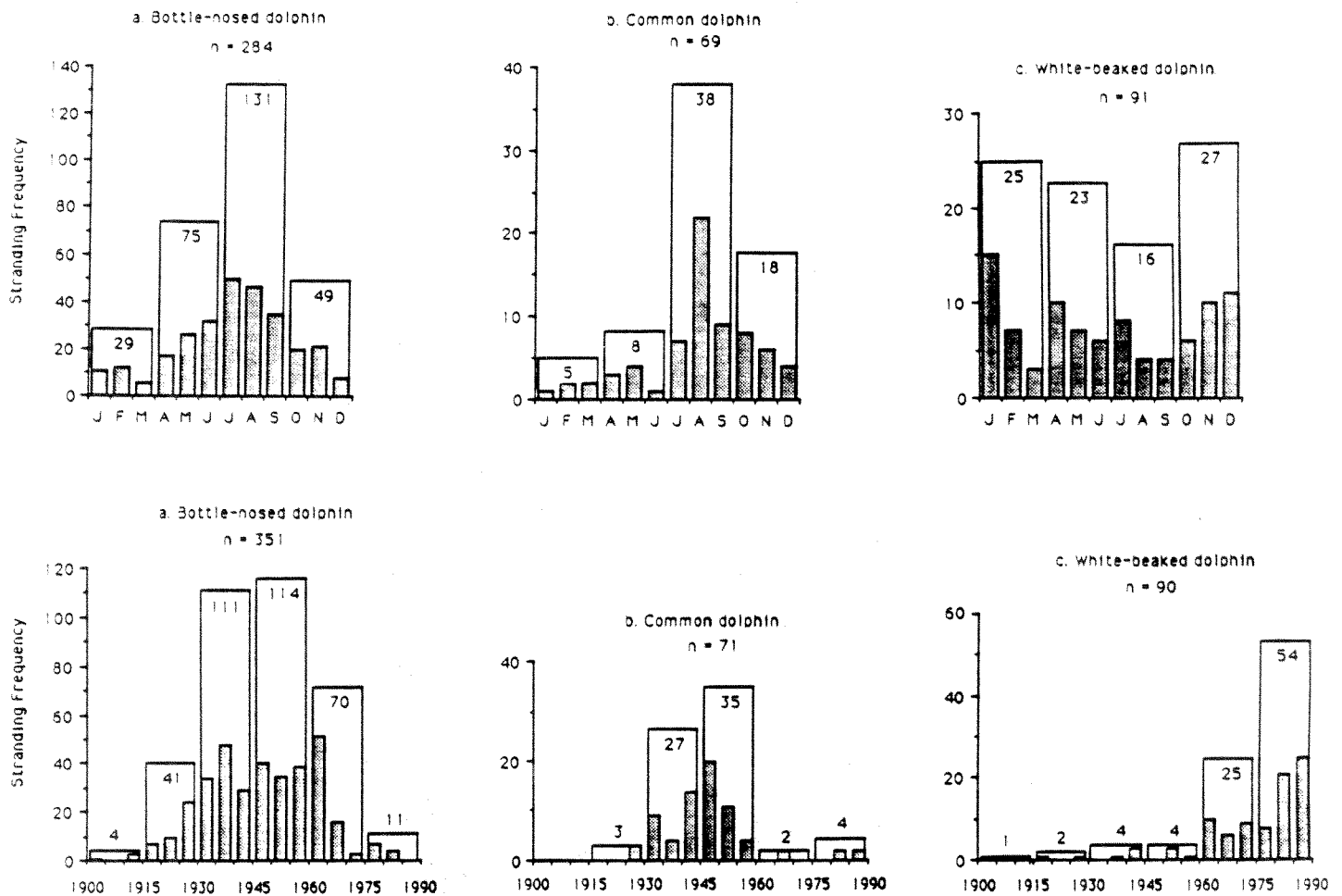


Fig. 1. Top: monthly distribution of (a) bottle-nosed dolphin, (b) common dolphin and (c) white-beaked dolphin stranded on the Dutch coast during the years 1850-1988 (dotted bars). The clear bars show the seasonal frequencies for winter, spring, summer and autumn respectively (n= sample size)

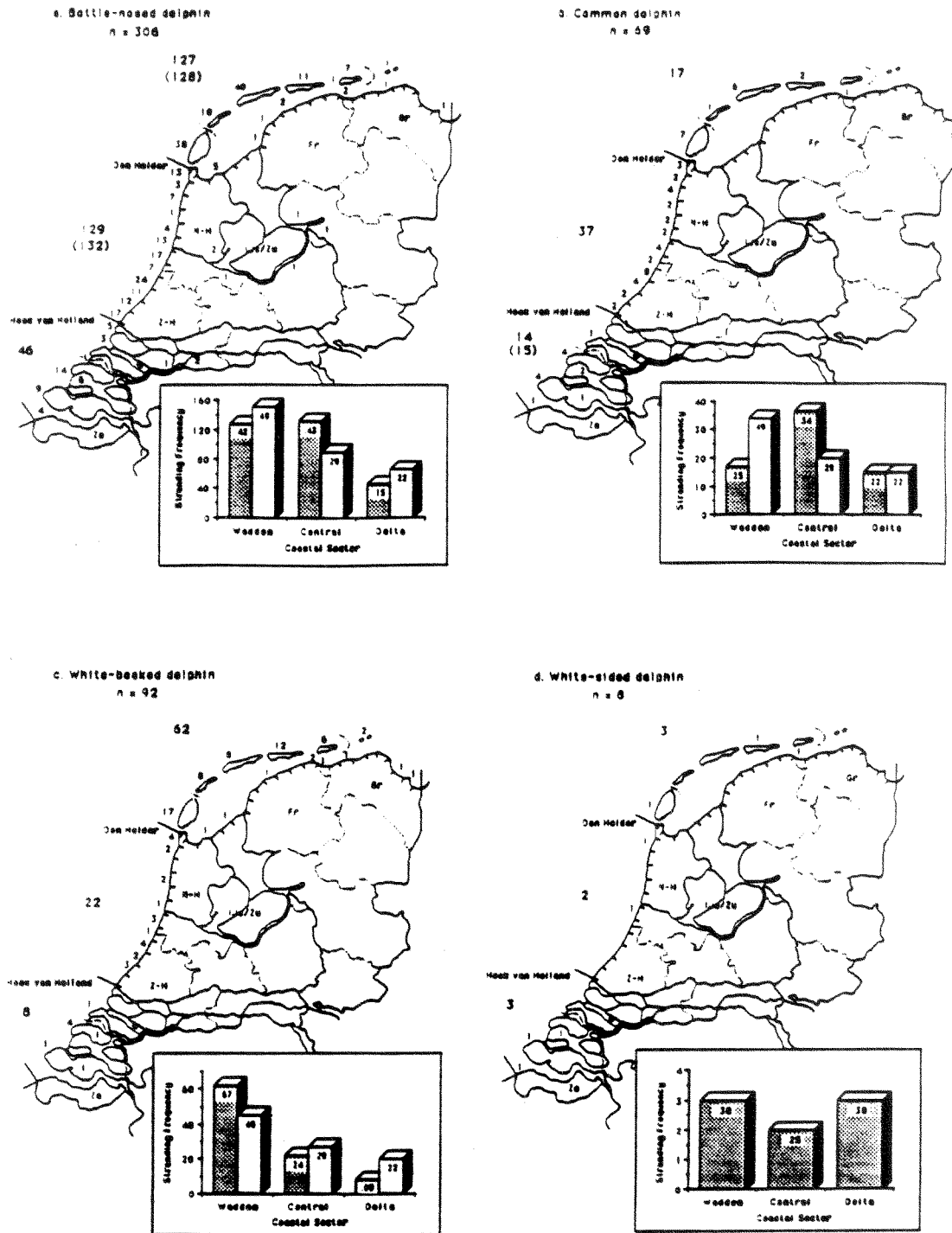


Fig. 2. Stranding localities of (a) bottle-nosed dolphin, (b) common dolphin, (c) white-beaked dolphin and (d) white-sided dolphin on the Dutch coast during the years 1850-1988. Stranded individuals are summarised per 10km zone, or per island. The totals for each of the 3 coastal sectors are given; figures in brackets include individuals for which the precise stranding location is not known (n= sample size). The histograms show the actual stranding frequencies (dotted bars) per sector and the expected frequencies based on the total coastal length of each sector (clear bars). Bottle-nosed dolphins strand significantly more often in the central sector ($\chi^2 = 31.5$, $df = 2$, $p < 0.001$), common dolphins strand significantly more often in the central sector and less often in the northern sector ($\chi^2 = 23.0$, $df = 2$, $p < 0.001$), and white-beaked dolphins strand significantly more often in the northern sector and less often in the southern sector ($\chi^2 = 14.4$, $df = 2$, $p < 0.001$)

INCIDENTAL CATCHES AND OCCURRENCE OF HARBOUR PORPOISES IN NORWEGIAN WATERS

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Porpoises are considered to occur regularly in Norwegian coastal waters, but the reported decline of porpoise abundance in the southern and eastern North Sea has led to concern about the future status of these animals. In this presentation we report on incidental catches in commercial fisheries, and give abundance estimates of porpoises in Norwegian and adjacent waters.

In 1988 we made personal contact with all fishermen licensed to catch salmon with drift nets, in order to examine the number of porpoises incidentally caught in that particular fishery. A total of 96 porpoises were reported caught during a 6-week period in June-July 1988, a figure we believe was very close to the true number of porpoises caught in this fishery during that period. The total drift-net fishing season was longer than the 6 weeks we carried out our investigation. After the 1988 fishing season the government imposed a ban on the use of drift nets for salmon fisheries in Norwegian waters.

In June 1989 a general inquiry was forwarded to all registered fishermen. By the end of December 1989 we received information on incidental catches of a total of 33 porpoises. Since the reported number of porpoises incidentally caught by our entire commercial fishing fleet during 6 months in 1989 was lower than the reported number caught in salmon drift nets alone during 6 weeks in 1988, we believe that porpoises are particularly vulnerable to those drift nets, and that the ban on the use of drift nets in salmon fisheries led to an improvement with regard to incidental mortality of porpoises in Norwegian fisheries.

A sighting survey designed primarily for sighting minke whales was carried out in July 1988 covering the Norwegian coastal waters north of 66°N and part of the Norwegian Sea and the southeastern Barents Sea. A total of 38 observations (79 individuals) of harbour porpoises were made. Abundance estimates have been calculated using a standard line transect theory and a hazard-rate detection function. The estimated total abundance in the surveyed area is 10,077 porpoises (c.v. 0.4463).

Geographical variation of incidental catches (corrected for fishing effort), and also the distribution of incidental sightings (sightings without any information on the effort), indicated a bimodal distribution of porpoises in Norwegian waters, with higher abundances in the North Sea and in the waters north of Lofoten compared with the intermediate waters off central Norway. This impression was further strengthened by the sightings made in July 1989 (Fig. 1), when both the southern and northern Norwegian waters were surveyed by a total of nine vessels. Abundance estimates were made, using the method as described above. In 1989 we arrived at an abundance estimate of about 11,000 porpoises (c.v. 0.4435) for the areas north of Lofoten (which is close to the estimate made in 1988), and a total abundance of 82,600 porpoises (c.v. 0.2381) for the central and northwestern North Sea area.

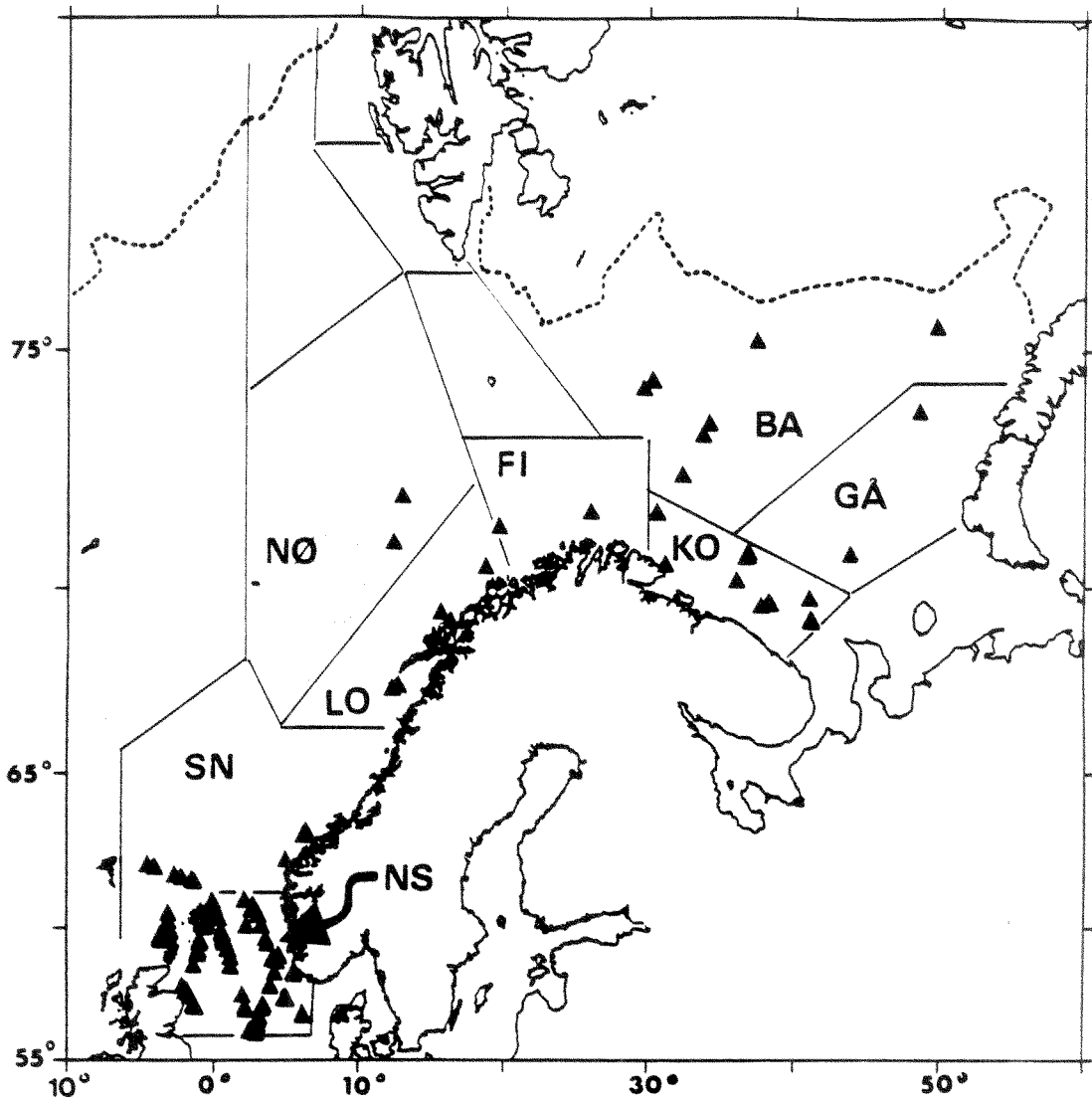


Fig. 1. Sightings of harbour porpoises and surveyed blocks by 9 Norwegian vessels in July 1989. The dotted line is the approximate ice edge

OCCURRENCE OF HARBOUR PORPOISES *Phocoena phocoena* IN FINNISH WATERS

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INTRODUCTION At present, there is no systematic recording scheme for harbour porpoise sightings, strandings or bycatches in Finland. Some short reviews exist in general literature and scientific publications from the 19th century and first half of the 20th century (Levander, 1906; Mela, 1909; Nordberd, 1939), and reports on encounters exist in magazines and newspapers. Until now no precise data on observations from recent decades have been published. The aim of this work has been to find old porpoise records, collect new data, look for the trend in the occurrence of porpoises and to find out the current status of the stock in Finland.

MATERIALS AND METHODS About half the data were obtained from the collections of the Zoological Museums of Helsinki and Oulu (including archives of J.A. Palmén and E. Merikallio - mainly clippings from magazines and newspapers), scientific publications and general literature. The other half was collected by means of a questionnaire sent to 715 professional fishermen in November 1989.

RESULTS 337 out of 715 fishermen (i.e. 47.1%) answered the questionnaire. Sixty-eight of these had porpoise records (20.2% of those who answered). Two non-fishermen also gave their records. The museum, literature and press data yielded 133 records and the questionnaires provided a further 122 records. The first records came from the 1870s and the latest from the 1980s.

Porpoises have been observed almost everywhere along the coast of Finland between the 1870s and 1980s (Fig. 1). The northernmost record was made near Tornio and the easternmost in Luokkala. In the beginning of the 20th century porpoises were still seen in the northernmost part of the Gulf of Bothnia (Kemi) and as far east as Säkkijärvi in the Gulf of Finland (Fig. 2). The eastern locations were part of Finland before the Second World War. Gradually over the decades the limit of their distribution moved southwards and westwards: in the 1960s the distributional limits were Kokkola and Sipoo (Fig. 3). During the 1970s, no more observations were made in the Gulf of Finland (Fig. 4) and the northernmost record was from Kaskinen. The only sighting from the 1980s was made near the edge of the Baltic proper, near Utö.

Over half of the records were during the summer months. This was not surprising since Finnish Baltic waters usually become frozen in winter. Less than 5% of the records were from December-March. The percentages of spring and autumn records were 22 and 19%, respectively (N = 209).

A minimum of 423 porpoises were observed in Finland between the 1870s and the 1980s: 199 animals from literature, museum and press data, and 224 from questionnaires. There were two peaks in the numbers of animals observed: 82 in the 1910s and 142 in the 1930s (Fig. 5). In the 1930s the two forms of data overlap, which partly causes this high value. On the other hand, data from the questionnaires alone, for this period, exceed the peak during the 1910s. The last drastic decline in animal numbers occurred between the 1960s and 1970s. From the 1980s there was only one sighting record, of two individuals.

Most of the records from this century have been sightings (Fig. 5). Absolute numbers of bycatches were also greatest in the 1910s (20 porpoises) and the 1930s (36 porpoises), which together comprise approx. 25% of total numbers. In the 1900s, less than 30% of the animals were recorded in fishing gear. The importance of the bycatches this century was greatest in the 1970s (60%, N = 10).

Groups of five or more animals were seen occasionally, and only between the 1910s and 1950s. Most records were of single individuals, but groups of two to four were next most common. In the 1970s, nearly all the records were of single animals.

DISCUSSION The results of this study show that numbers of harbour porpoises in Finnish Baltic waters have been low since the 1940s and that their visits essentially ceased after the 1970s. This reflects the situation for porpoises in the Baltic proper. According to Andersen (1982), their migration through Danish waters to and from the Baltic Sea stopped almost completely during the period 1940-50. A downward trend in the numbers of porpoises in the Baltic started at the end of the 1960s (Kinze, 1987). A

combination of several causes is thought to be responsible for this: bycatches, lack of food caused by overfishing, disturbance and pollution (e.g. Kinze, 1987). Apparently the porpoise population has been reduced so much that only a few individuals migrate as far as Finland. Bycatches in Finland make up only a small fraction of estimated bycatches of 3000 per year in Danish waters (Clausen and Andersen, 1988), and cannot have affected significantly the general situation in the Baltic. This does not negate the fact that many porpoises have died in fishing gear over a number of decades in Finland, whilst many by-catches will have gone unreported.

The trend of porpoises becoming rare in the Gulf of Finland was first noticed by Tomilin (1967), who stated that the reason was lack of food caused by low salinity. Low salinity does not cause lack of food except perhaps at the bottom of the Gulfs near estuaries. Elsewhere there should be sufficient food because the prey species of porpoises in the Baltic mentioned by Rae (1965) are all present in the Gulf of Finland (sprat *Clupea sprattus*, herring *Clupea harengus*, cod *Gadus morhua*, gobies *Gobius* spp., sandeels *Ammodytes* spp.), and most of them are common at least as far as Kotka (Koli, 1983; Sjöblom *et al.*, 1984). The same applies northward to the middle of the Gulf of Bothnia. Further north, lack of food could limit porpoise distribution. However, there were porpoises in the north from the 19th century until the 1930s. A reason for the distributional trend in Finnish waters could have been increased disturbance by marine traffic, or simply that with a general decline in numbers there are fewer animals travelling towards Finland, and hence it is less probable that they should disperse far to the east in the Gulf of Finland or to the northern Gulf of Bothnia.

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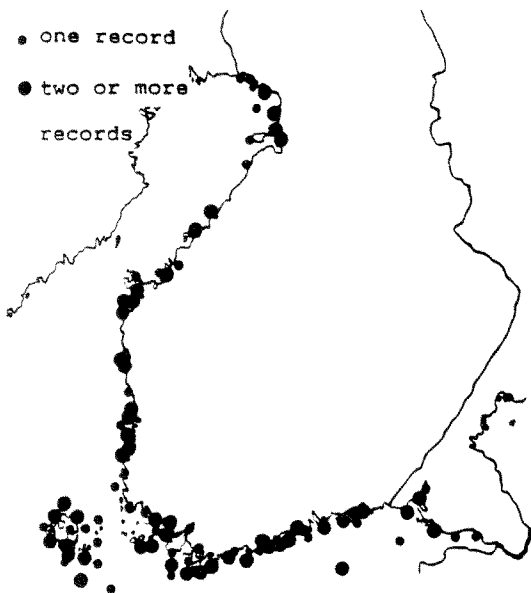


Fig. 1. Distribution of porpoise records between the 1870's and the 1980's (N=254).

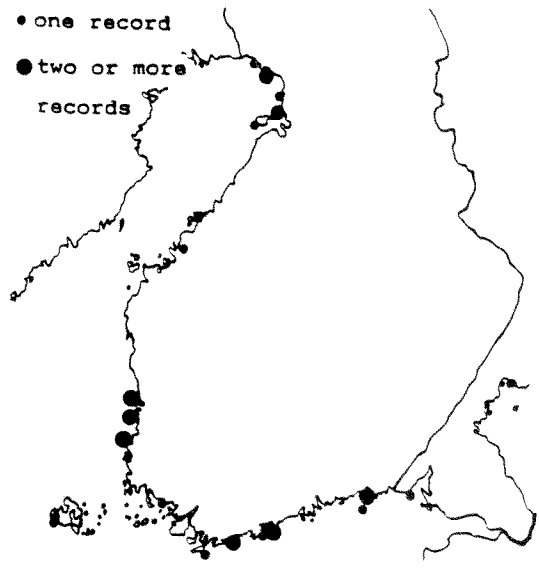


Fig. 2. Distribution of porpoise records in the 1910's (N=34).

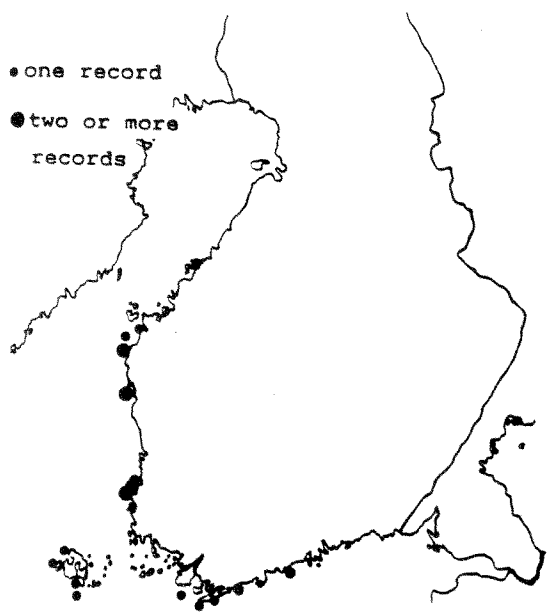


Fig. 3. Distribution of porpoise records in the 1960's (N=25).

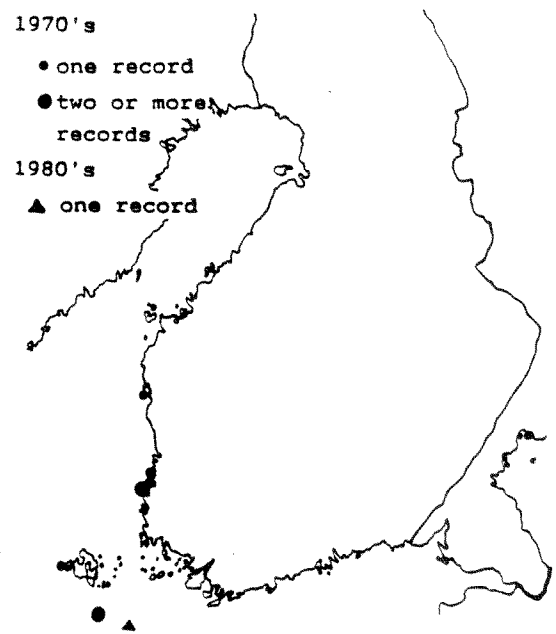


Fig. 4. Distribution of porpoise records in the 1970's and the 1980's (N=9, N=1).

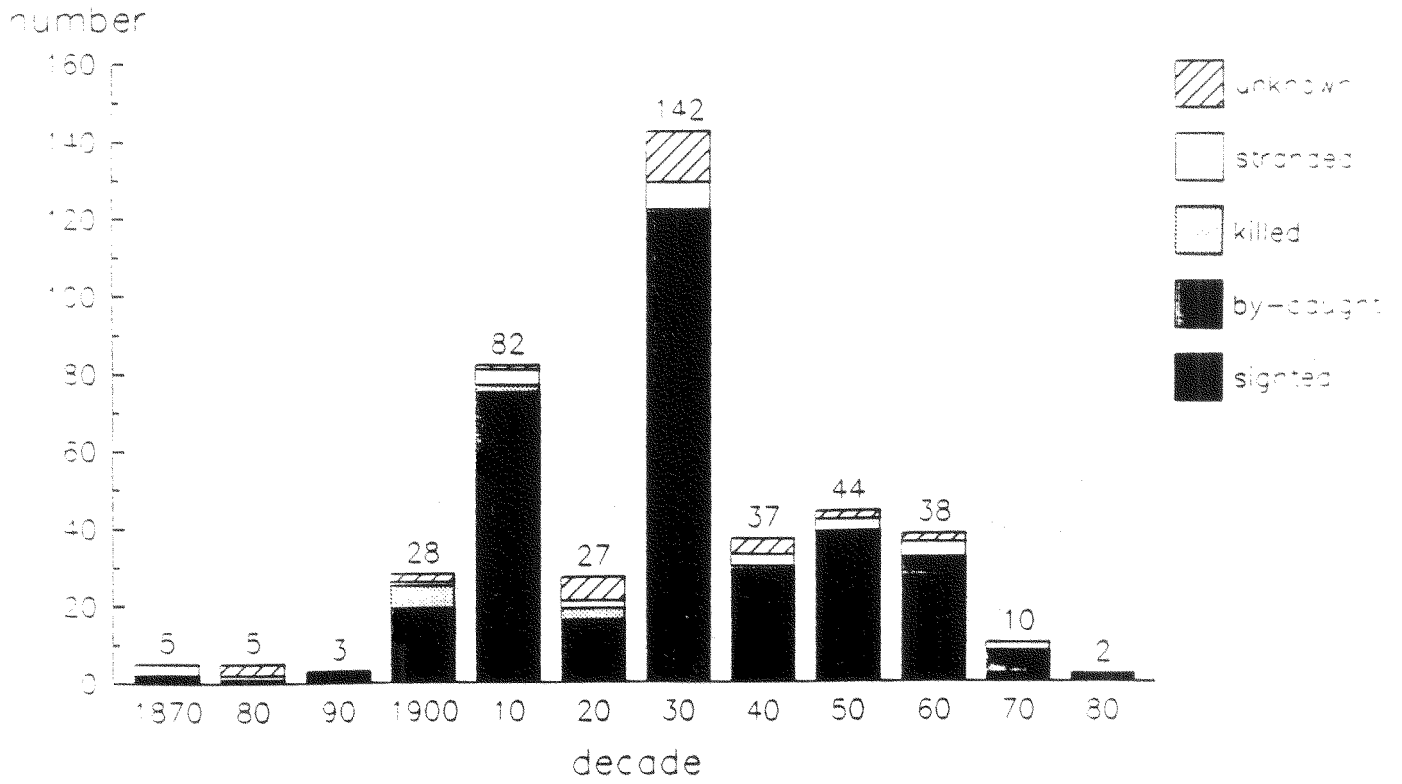


Fig. 5. Proportions of porpoises sighted, by-caught, killed or stranded in Finland between the 1870's and the 1980's

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DISTRIBUTION AND ABUNDANCE OF HARBOUR PORPOISES *Phocoena phocoena* IN SWEDISH WATERS

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INTRODUCTION

Trends in abundance To date there have been no population estimates of harbour porpoises in Swedish waters. From bycatch and stranding statistics it has been suggested that harbour porpoises in Swedish waters have declined in numbers during the 1960s and 70s and then increased during the 1980s. However, we feel that the use of bycatch and stranding statistics are inadequate for accurately assessing population trends because they do not account for: variation in fishing effort; changing fishing techniques; variation in prey abundance and distribution; increasing pollution; and increased disturbance by human activities.

All of these may influence rates of mortality without necessarily reflecting population status. In an attempt to accurately assess trends in population abundance, we have (A) circulated a sighting questionnaire; (B) organised a sighting network; and (C) undertaken dedicated sighting surveys. These methods suggest that the harbour porpoises in Swedish waters are still declining in numbers.

Distribution From reported sightings (method B) we have also been able to establish distribution and migration patterns of harbour porpoises in Swedish waters.

METHODS AND RESULTS

Trends in abundance estimated by each method A-C:

(A) A questionnaire was circulated in 1987 to fishermen, coastguards and ferry operators along the Swedish coast. For each of the last four decades participants provided estimates of the number of harbour porpoise sightings they made during the years they had been out at sea. The results from 194 replies indicated an almost ten-fold decline since the 1950s in the number of harbour porpoise sightings per year in Swedish waters, with no increase during the 1980s (Fig. 2).

(B) Questionnaire participants were also asked if they could report future observations. A network of 130 observers was organised, and has reported sightings on a regular basis since May 1988. The results in Table 1 show a 25% decrease in the number of sightings per observation day between 1988 and 1989. These data also indicate distribution and migration patterns of harbour porpoises in Swedish waters (Fig. 3).

(C) In 1988, a 6-week cruise was conducted on the west coast of Sweden. During 20 days, 731.5 km were sailed along transects and a total of eight porpoises were sighted on three occasions. In May 1989 a 3-week cruise was conducted in the same area. During 13 days, 772.6 km of transects were sailed, but no porpoises were sighted.

In 1989, 15.5 hours of aerial survey were conducted in the same area. During 2296 km of transects, 26 porpoises were sighted on 19 occasions. All field studies were performed in sea state 0-2 (Beaufort). The low numbers of sightings from both survey methods indicate that few harbour porpoises remain in Swedish waters. Again, fewer porpoises were seen in the 1989 boat survey than in 1988. Therefore, we stress the need for further studies to establish the trends in harbour porpoise abundance in Swedish waters.

Distribution We have divided Swedish coastal waters into five areas (Fig. 1) to compare the trends in distribution of harbour porpoises in Swedish waters. In Fig. 2, the different areas are compared by month and year. From November through January only one sighting was reported from all areas. No sightings in areas 3, 4 and 5 were recorded from November through April. In areas 1 and 2, sightings decreased in October, appeared again in February and March and increased in April. This suggests that migration occurs to the North Sea in November and then back to Swedish waters in February. Virtually no sightings have been made in the Baltic Sea.

CONCLUSIONS Method A confirms indications from bycatch and stranding data that harbour porpoises have declined in Swedish waters during the 1960s and 70s. All methods indicate that harbour porpoise abundance has not increased during the 1980s and suggest that harbour porpoises in Swedish waters are still declining in numbers. We believe four factors are responsible for the suggested decline: pollution, depletion of prey, bycatches and disturbance by human activities. In the future, aerial surveys will be maintained for population estimation and to further elucidate distribution patterns. We are also planning to radio-tag animals entangled in fishing gear to identify the migration patterns and habitat preferences of harbour porpoises in Swedish waters.

Table 1. A comparison of harbour porpoise observations made by the network from May - September 1988 and 1989

Year	No. porpoises sightings	No. sightings	No. observation days	No. sightings per observ. day
1988	328	97	4715	0.0206
1989	287	109	7007	0.0156

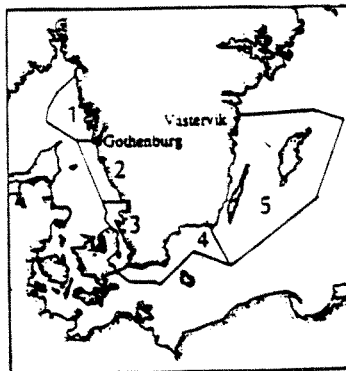


Fig. 1. Map showing study areas

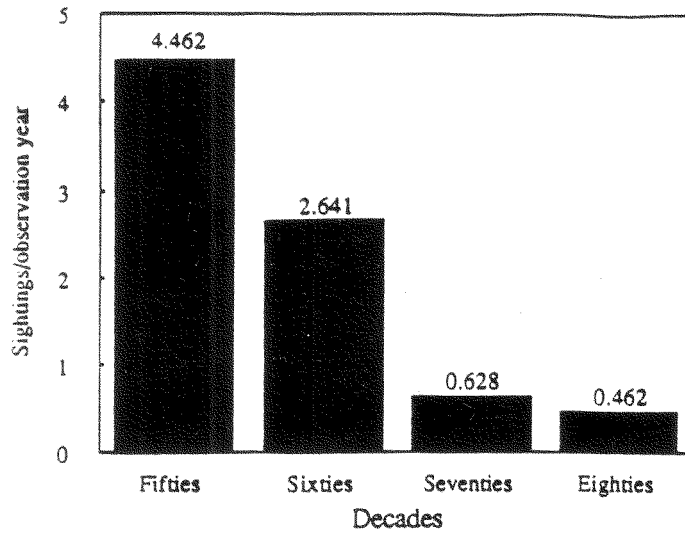


Fig. 2. Sightings of harbour porpoises in Swedish waters per observation year for each decade as determined from questionnaire

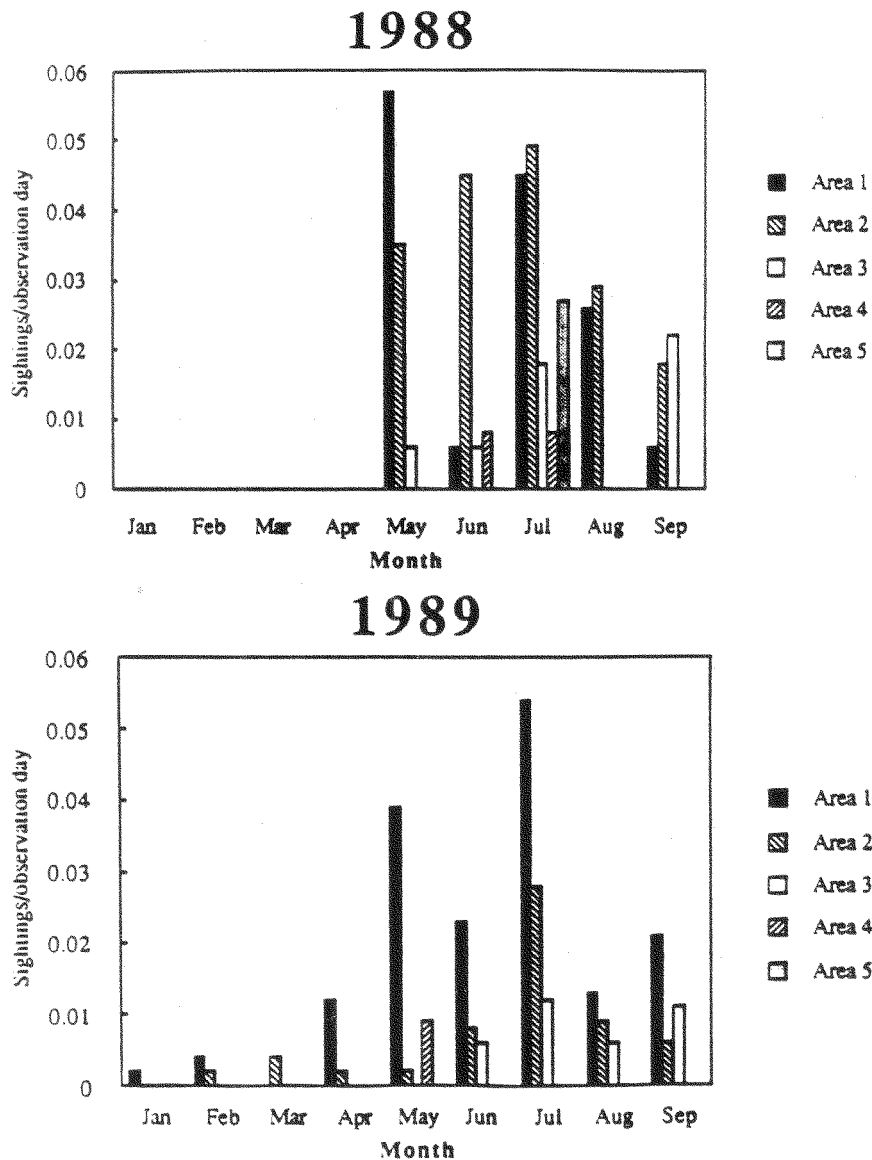


Fig. 3. Histograms showing sightings made by the network of harbour porpoises per observation day. The bars represent the different areas corresponding to the map, for each month of 1988 and 1989

SURPRISINGLY HIGH NUMBERS OF HARBOUR PORPOISES *Phocoena phocoena* CLOSE TO THE ISLE OF SYLT

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Since September 1988, the authors have been cooperating with the private conservation society "Schutzstation Wattenmeer", the German WWF and the authority of the National Park Schleswig-Holstein Wadden Sea in building up a sightings network for harbour porpoises *Phocoena phocoena* along the western coast of Schleswig-Holstein, FRG. More than 95% of the sightings reported came from the Isle of Sylt. So far, the study has yielded the following results.

During 17 months between September 1988 and January 1990, 165 sightings have been gathered, comprising a total of 406 individuals. Contrary to the expectations (inshore/offshore-model and biases created by variation in observer-effort), the sightings reached a peak during late autumn and winter. Group size varied between single individuals (40% of all sightings) and schools of up to 30 individuals. Thirty per cent of the reports comprised pairs of individuals and 17% groups of three. Mother-calf groups were sighted seven times. Four of these sightings on successive days in December were assumed to be the same mother-calf group.

Most movements of the animals were parallel to the shore. Observations were made in Beaufort sea states 0-2, with exceptional observations up to sea state 4, by skilled observers.

As yet, no seasonal trends in the preference of coastal sections could be found. There is a remarkable lack of observations of animals moving southwards into the stronger currents of the Hörnum Tief. Observations (n=20) could be accurately related to the tide. Seventy per cent of these were made shortly before the tide reached its peak. Amongst these, 19.2% were within 1 hour, 14.2% between 1-2 hours and 18.3% between 2-3 hours before high water. 72.5% of all sightings occurred 3 hours before or after high water.

The seasonal importance of the waters adjacent to the Wadden Sea should be reconsidered. The validity of the inshore/offshore-model, with inshore movements during summer and offshore movements during winter, was doubted for this region by Kremer (1990). Our study strongly supports that opinion. On the other hand, the possible effect of relatively high temperatures in the last two winters (with averages 3.6°C above the longterm mean winter temperature - Koch, 1989) should be taken into consideration.

The movements of harbour porpoises along the shores imply a potential for double-counting during the same day. A model to exclude such double-counts and give daily minimum numbers will be given in a later publication. The reasons for a peak in sightings just before high water are still unknown.

Although 12 information centres of the "Schutzstation Wattenmeer" distributed all along the coast are participating in this ongoing study, the feedback has concentrated on the Isle of Sylt. In this context, it may be interesting to note that Sylt is the most exposed of all the Wadden Sea Islands.

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Fig. 1. Map of Schleswig-Holstein showing study area

DISTRIBUTION OF COMMON AND STRIPED DOLPHINS IN THE TEMPERATE WATERS OF THE EASTERN NORTH ATLANTIC

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The striped dolphin *Stenella coeruleoalba* and common dolphin *Delphinus delphis* are probably the most common species of small cetaceans inhabiting the temperate waters of the eastern North Atlantic. The overall distribution of the two species grossly overlaps in a wide latitudinal area, and both of them share quite similar behavioural patterns and ecological traits. In spite of the apparent similarities when studying the distribution patterns on a smaller scale, the two species generally do not occupy precisely the same water masses, although it is possible to find mixed schools in certain areas. It was assumed, therefore, that the presence of a species in a given area depends on extrinsic factors, which differed between the two species.

In order to determine ecological aspects of the distribution of the two species, sightings data for the eastern North Atlantic were compiled from publications, together with unpublished data from the same area, obtained from our own sighting cruises or provided by qualified observers.

In most cases, the measure of sighting effort was not provided and so it was impossible to estimate density of dolphins for any area. Therefore, the results reflect presence or absence of a species in a locality, but not its abundance. All sightings studied belong to the summer period and for that reason the distribution patterns have been described for that season.

Alongside sightings data, environmental data such as water temperature and water depth were compiled, as well as behavioural data such as school size, presence of calves and time of observation. For all kinds of data, uncertain observations were omitted.

Altogether, 589 sighting records were assembled, and the sample sizes of each parameter are detailed in Table 1.

RESULTS AND CONCLUSIONS The overall pattern of geographical distribution differed for the two species. Striped dolphins occupied the entire latitudinal range considered in this study (30-50°N latitude), becoming rare north of the 50°N line. Most sightings were located in offshore waters at depths greater than 1000 m. This means that the striped dolphin is scarcely ever found over the continental shelf but becomes abundant from the continental slope to far oceanic waters. In high latitudes it is found far from the coast where the continental shelf extends some distance west of the British Isles and the Gulf of Biscay. Further south it is found close to the coast, where the continental shelf slopes steeply near the coasts of the Iberian Peninsula.

Common dolphins were also recorded throughout the study area, being more abundant than the striped dolphin in the northern and southern areas. Apart from that, two distribution patterns can be observed. In the northern region, common dolphin sightings were concentrated in both offshore and inshore waters, where the striped dolphin is very rare. In southern regions, common dolphins were found close to the coast over the continental shelf. A bimodal distribution suggested the existence of two populations, one inhabiting neritic waters and another living in more oceanic waters (Fig. 1).

This distribution suggests the mutual exclusion of the species, although both occupy an overlapping latitudinal range. The two species occupied different habitats, each with different oceanographic characteristics. Mixed schools of the two species were located in a narrow latitudinal band, between 48 and 52°N, according with the northerly limits of distribution of striped dolphins.

Surface water temperatures recorded for striped dolphin sightings showed a mode of 19°C, with a similar range of temperatures observed for the population inhabiting the waters off Japan (Miyazaki, 1978); the modal water temperature for common dolphins was 16°C. We conclude that striped dolphins are more frequent in warmer waters than those preferred by common dolphins. Considering the overlapping

latitudinal range of the two species, the surface water temperature cannot be said to preclude or determine the presence of either, but each is commonly found in waters with different surface temperatures (Fig. 2).

The results of analyses of behavioural data showed that striped dolphins form larger schools than common dolphins, with modal school sizes of 30 and 10 individuals, respectively. Large schools, numbering hundreds, are rare in either species, although large groups of more than 300 animals can sometimes be observed.

The presence of calves is not associated with any particular water depth, surface water temperature or school size, but more data are needed to investigate adequately any possible associations.

Sightings of the two species are distributed evenly throughout the day, and school size does not seem to be related to the hour of distribution, with individuals of both species recorded throughout daylight hours.

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Table 1. Sample sizes used in analyses of the relationship between the distribution of striped and common dolphins and various parameters

Sample size	<i>Stenella coeruleoalba</i>	<i>Delphinus delphis</i>
Surface water temperature (°C)	69	273
Water depth (m)	105	413
School size	90	111
Presence of calves	91	105
Hour of observations	91	105

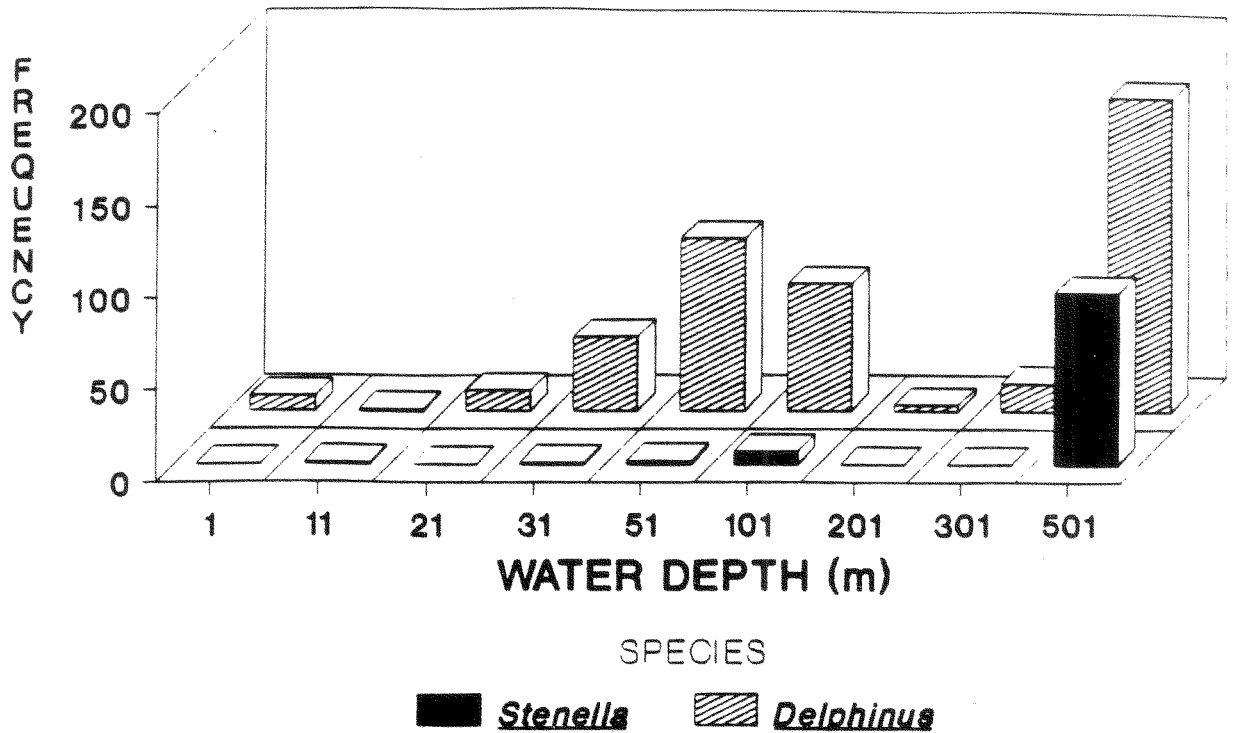


Fig. 1. Distribution of sightings of *Delphinus* and *Stenella* at different water depths in the temperate eastern North Atlantic

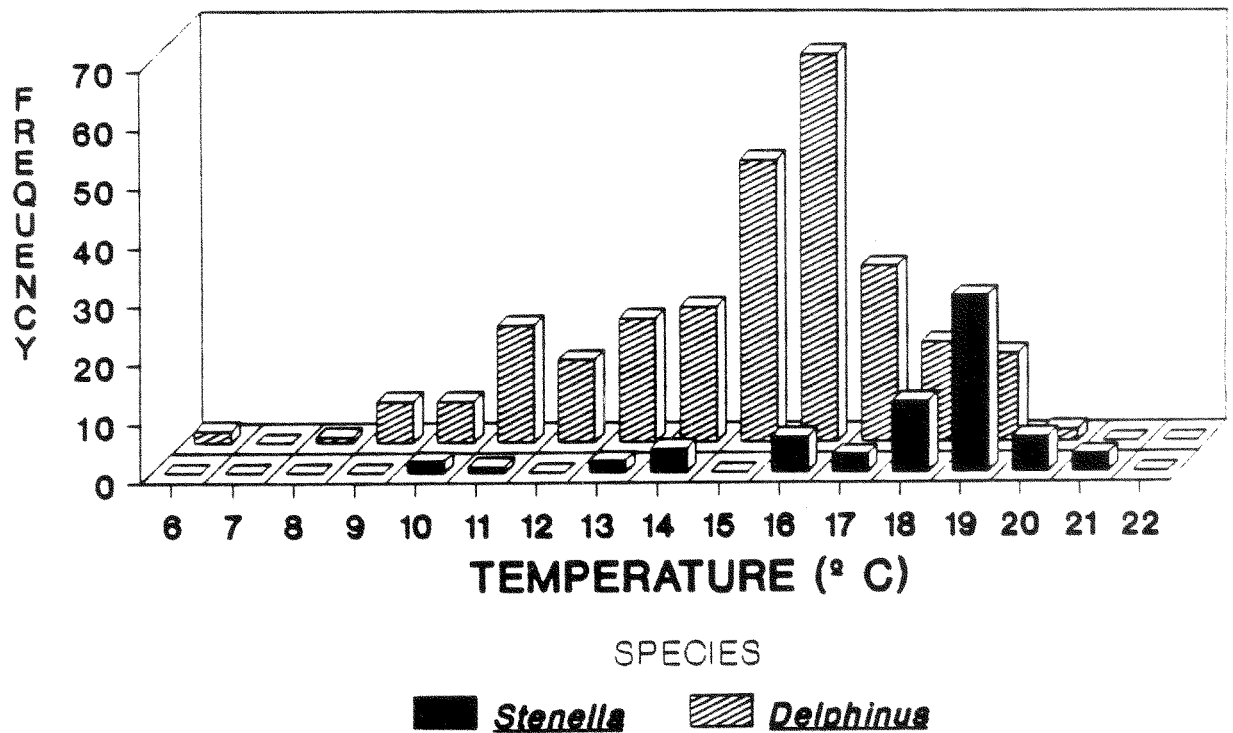


Fig. 2. Distribution of sightings of *Delphinus* and *Stenella* at different sea temperatures in the temperate eastern North Atlantic

CALVING IN THE STRIPED DOLPHIN FROM THE WESTERN MEDITERRANEAN SEA

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The striped dolphin *Stenella coeruleoalba*, is the most common cetacean in the northern waters of the western Mediterranean Sea. In northern Italy, southern France and northern Spain, this species typically represents about 60% of all cetaceans stranded or sighted (Duguy *et al.*, 1988). However, in spite of its abundance, our knowledge of the reproductive biology of Mediterranean striped dolphins is very limited. The present paper compiles the information available on body sizes of foetal, neonatal and juvenile striped dolphins from the western Mediterranean Sea and analyses the data to determine the calving period as well as body lengths and weights at birth for this population.

MATERIALS AND METHODS The data used for this study come from published records of stranded dolphins available in the literature and from the unpublished data base from the Universities of Barcelona and Valencia in Spain. In total, we were able to obtain information on 437 striped dolphins.

The calving period and birth lengths and weights were determined by studying the seasonal distribution of length of calves and by assessing foetal growth using the method of Huggett and Widdas modified by Laws. This method has been extensively used in studies of mammal gestation and was applied to several cetacean species in the past.

RESULTS AND DISCUSSION

Body length at birth There were several specimens in the data base considered to be neonates, some near-term foetuses, and other very young animals. From their lengths, we established the length at birth for this population at c. 90-95 cm, with a mean length close to 92.5 cm. This length corresponds to a body weight of about 11 kg.

Lengths at birth estimated for striped dolphin populations from Japan and the eastern tropical Pacific are somewhat greater, typically falling very close to 100 cm. However, striped dolphins in those areas are somewhat larger in size than in the Mediterranean. Thus, the maximum adult length for the western Mediterranean specimens is about 220 cm, for both males and females, whereas for the North Pacific populations it is about 245 cm for males and 230 cm for females. If length at birth is calculated as a percentage of mean adult body length, we obtain an almost identical value for the two areas (Table 1), indicating a similar growth pattern for all populations of the species.

Timing of reproduction Individuals larger than 120 cm were equally distributed throughout the year, but those of smaller size followed a pattern of distribution clearly indicating a single mating season per year, occurring in late summer to early autumn. In a previous study with limited data, Viale (1985) suggested a second peak of calving for this population in April-May, but the present results indicate that this possibility should be discarded.

From the fit of the Huggett and Widdas model to the data, of specimens of body size equal to or smaller than the estimated mean length at birth (93 cm), the mean birth date for the population is calculated as 11 October, with 95% of births occurring between 25 September and 27 October, i.e. during a period of about 1 month.

The existence in the Mediterranean population of a single calving season per year differs from that of the Japanese population which, according to the studies of Kasuya (1976) and Miyazaki (1977), has three mating seasons spread over the year. The reason for this apparent difference in mating seasonality between populations of the same species is unknown, although it is probably related either to differences in the pattern of availability of food resources or to seasonal variations in water temperature.

In the western Mediterranean, two distinct seasons of high productivity occur each year: one in late winter to early spring (January-March) and another in autumn (September-November). The first productivity peak, that of winter, is of relatively short duration and is probably unsuitable for calving because the surface water

temperature at this time of year is at its lowest level (usually in the range 13-18°C). These temperatures are amongst the lowest recorded in waters inhabited by striped dolphins, which typically range between 18-25°C. In contrast, the autumn peak of productivity lasts longer and, when it begins to develop, the total heat content in the water column is at its maximum level because surface temperature and depth of the upper warmer layer are the highest for the year (Flos, 1985).

It is therefore likely that the neonates are born in autumn, when waters are warmest and the nursing cow finds optimum conditions for feeding and coping with the energetic demands of lactation. Thus, calving in September-October would appear to offer the most advantageous conditions, both for the neonate and for the lactating cow.

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Table 1. Body length parameters in the Mediterranean and Japanese striped dolphins

	Length at birth	Adult body size	Percentage
W. Mediterranean	92.5	220	42.05
Japanese waters	100.0	male 245 female 230	42.10

UNDERWATER ACOUSTIC SIGNALS BY THE STRIPED DOLPHIN
Stenella coeruleoalba

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Very little is known about the acoustic capabilities of the striped dolphin *Stenella coeruleoalba*. A few whistles from this species were presented by Schevill and Watkins (1962) and Busnel *et al.* (1968). Underwater sounds produced by the striped dolphin, the commonest cetacean in the central Mediterranean Sea (Notarbartolo di Sciarra *et al.*, this vol.), were analysed from recordings collected on three occasions (1987-88) in the Ligurian and Tyrrhenian Seas. Sound types recorded included: (1) pure-tone, frequency modulated whistles; (2) burst-pulse sounds; and (3) echolocation clicks. Burst-pulse sounds appeared as variable pulse-rate click trains, reaching 900 clicks/sec. Emphasis of the analysis was based on whistles. In this preliminary study we propose an attempt of classification of several whistle types, based on general whistle contour and frequency and duration parameters.

MATERIALS AND METHODS Recordings were made (1) in the Gulf of Salerno on 6 July 1987, near a school of 40 dolphins; (2) off San Remo on 25 July 1988, near a school of 12 dolphins; and (3) off San Remo on 26 July 1988, in the vicinity of 2 individuals. For the recordings, a UHER 4400 Report Monitor recorder was used at a tape speed of 19 cm/sec, connected to an ITC-8073 hydrophone. A total of 136 different whistles were selected for the analysis. Tapes were analysed with a Kay Sonograph DSP 5500, frequency range 0-32 kHz, broad band 470 Hz and narrow band 235 Hz.

RESULTS Whistle type = A (24.2%) Rather short whistles, with small frequency modulations, and with initial or final frequencies generally corresponding to the maximum or minimum frequencies. The frequency is often only increasing or decreasing.

Whistle type = B (20.6%) Long duration whistle, moderately frequency-modulated. The maximum frequency, usually near the centre, is represented by a plateau. Initial rise and final fall are roughly symmetrical.

Whistle type = C (15.4%) Whistles of medium duration, with a sharp rise and one peak. The initial frequency is generally high, but lower than the maximum. The final frequency sometimes corresponds to the maximum frequency.

Whistle type = D (15.4%) Long duration whistles, with almost uniform frequency throughout. A small peak (maximum) is present around or after the centre. Initial and final frequencies are low and roughly symmetrical.

Whistle type = E (9.6%) Miscellaneous category including all whistles that did not fit in any other category.

Whistle type = F (8.8%) Whistles with at least two modulations and with very high peaks (up to 23.68 kHz). Initial frequency is generally lower than the final. The maximum frequency reached in this type is the highest of the entire sample.

Whistle type = G (5.9%) A medium-duration whistle, moderately modulated and generally low. The maximum frequency (a low peak) is reached soon after the beginning.

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FRASER'S DOLPHIN *Lagenodelphis hosei* FRASER, 1956: FIRST RECORD ON
THE CANARY ISLANDS

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INTRODUCTION Since Fraser described, in 1956, a skeleton collected by C. Hose at Sarawak as *Lagenodelphis hosei*, the only Fraser's dolphin stranding records on the Atlantic coasts were: three specimens in the Antilles (2.20.72, 15.5.76 and 18.5.76) (Caldwell *et al.*, 1976), two mass strandings at Florida (November 1981) and one on the northern coast of Brittany, France (30.5.84) (Van Bree *et al.*, 1986) (Fig. 1).

MATERIALS AND METHODS During August 1983, Pérez Coello reported the stranding of a small cetacean on a beach near Playa La Viuda (Candelaria), eastern Tenerife. On a first visit, we could hardly study the very decomposed odontocete, which was initially classified as undetermined, but several measurements and photographs were taken and some teeth collected. On a second visit a few hours later, specifically to collect the skeleton, we unfortunately found that it had been burnt. The only remains were a fragment of the base of the rostrum and several vertebrae. Measurements, photographs and remaining bones and fragments were used for the present study.

RESULTS AND DISCUSSION External morphology of the Canary Island's specimen corresponds to the description given by other authors (Perrin *et al.*, 1973; Miyazaki and Wada, 1978; Watson, 1981; Van Bree *et al.*, 1986): a rather robust body with comparatively small flippers, fluke and dorsal fin. Since the specimen had lost all of its characteristic coloration there was a possibility of confusion with the common dolphin *Delphinus delphis* or a *Stenella* sp., but its short beak, even shorter than *Lagenorhynchus* sp., makes its profile quite different from those species. On the other hand, although the number of teeth is not known exactly due to a partial loss during the stranding, those remaining on each side of the upper jaw numbered at least 28 and on the lower jaw at least 26. This means that there is no possible confusion with the bottle-nosed dolphin *Tursiops truncatus*, which has usually 24 or 25 teeth on each side of both jaws.

Comparing the external measurements taken from the Canary Islands' specimen with the mean values of the percentages of the same measurements from strandings in the Pacific, South Africa and the Atlantic Ocean (Table 1, Fig. 2), they are all within this range, with the exception of the distance between the tip of the upper jaw and the blowhole, which had possibly changed due to the specimen's condition. Examinations of the cranial fragment shows that it fits the characteristics for this species of maxillae and premaxillae at the base of the rostrum.

In conclusion, the identification of the odontocete stranded in August 1983 as *Lagenodelphis hosei* has been based on its external morphology and characteristics by comparing them with previous strandings, as well as the number of teeth, and on the study of the cranial fragment.

Finally, the presence of *L. hosei* in the Caribbean, Brittany and the Canary Islands (cf. the presence of Gervais' beaked whale *Mesoplodon ceropaeus* (Vonk and Martin, 1988), seems to be closely related to the Gulf Stream Current in the North Atlantic.

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Table 1. Measurements of Fraser's dolphin *Lagenodelphis hosei*

	Mean values expressed as percentages of LT (= 140 cm)			
	Canary Is.	Pacific*	Brittany**	S. Africa†
Tip of upper jaw to centre of eye	14.0	14.0	12.6	13.7
Length of gape	9.0	11.0	10.6	11.4
Tip of upper jaw to blowhole	20.3	13.9	13.2	12.8
Length of flipper to axilla	7.8	8.5		
Width of flipper	3.6	3.8	3.4	3.6

* Western and Eastern Pacific and Australia

** Northern coast of Brittany, France

† Strandings on S. African coast

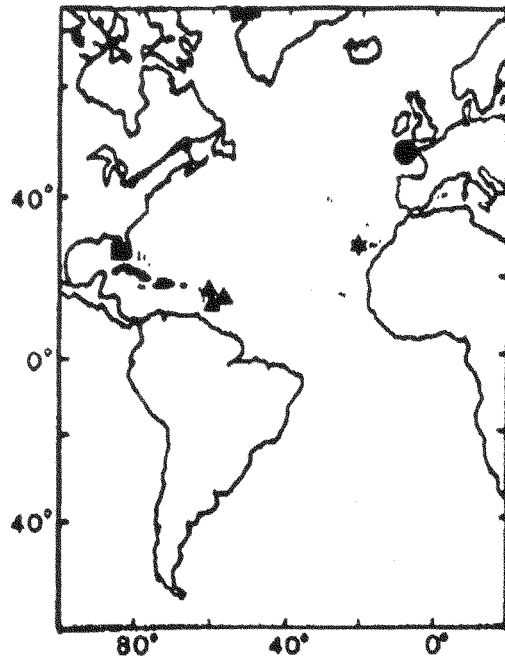


Fig. 1. Map of strandings of Fraser's dolphin in the Atlantic Ocean (triangle = Antilles, West Indies; square = Florida, USA; circle = Brittany, France; star = Canary Islands)

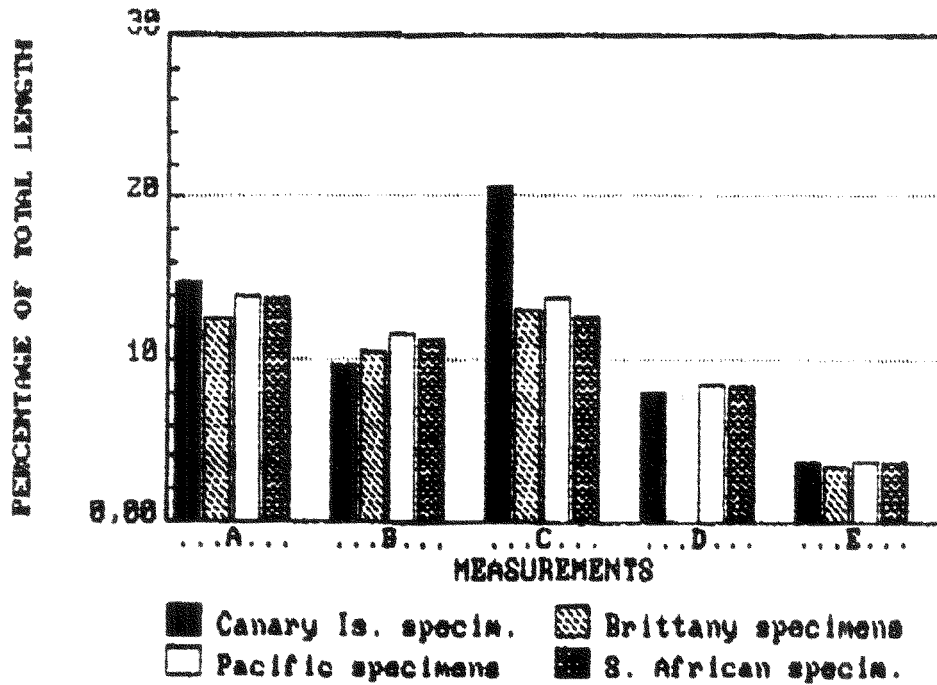


Fig. 2. Percentages of total length of five measurements, in four specimens of Fraser's dolphin (A = tip of upper jaw to centre of eye; B = length of gape; C = tip of upper jaw to blowhole; D = length of flipper to axilla; E = width of flipper)

A LONG-TERM STUDY OF BOTTLE-NOSED DOLPHINS IN FLORIDA

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Researchers have been able to solve many of the obstacles to studying dolphins. The uses of radio and theodolite tracking, photo-identification of naturally-marked individuals, tagging, and detailed observations of captive dolphins have given us more than just glimpses into the lives of bottle-nosed dolphins. However, while dealing with such day-to-day problems as salt-air corrosion of equipment and temperamental boat engines, researchers must continue to grapple with a fundamental dilemma: How can one study the social structure of an animal which lives for several decades - essentially the time span of a researcher's working career? Deciphering the patterns of social relationships of a long-lived animal requires a longterm approach. Such a longterm study ideally involves the monitoring of recognisable individuals throughout their lifetimes, tracking their reproductive success, and investigating how that success is influenced by their feeding strategies and social roles and by the pressures of predation.

For the past 20 years, we have been studying bottle-nosed dolphins near Sarasota, Florida. We have gathered information using a variety of techniques: captures for tagging and sampling, boat surveys for photo-identification and behavioural observations, genetic and reproductive analyses of blood samples, age estimation from tooth samples, measurement of indices of body condition, and acoustic recording. The long time-span of these studies has allowed us to address a wide range of biological problems. Details of the results can be found in a series of published works. Initial tagging results and conclusions were reported by Irvine and Wells (1972). The second round of tagging resulted in evaluations of tagging and photo-identification techniques (Irvine *et al.*, 1982; Scott *et al.*, 1990), a more detailed study of movements and behaviour (Irvine *et al.*, 1981), and an examination of social associations and home-range patterns (Wells *et al.*, 1980). More recent studies have focused on social structure (Wells, 1986; Wells *et al.*, 1987), and population biology and mark-recapture analyses (Wells, 1986; Wells and Scott, 1990). We also have embarked upon cooperative studies with other researchers on age estimation (Hohn *et al.*, 1989), acoustics (Sayigh *et al.*, 1990), seasonal body condition (with Dan Costa and Graham Worthy, University of California at Santa Cruz, and Andy Read, University of Guelph), reproductive hormone levels (with Vicky Kirby, University of California at Santa Cruz), and genetic relationships (with Deborah Duffield, Portland State University). The 20-year history of the project has been reviewed by Scott *et al.* (1990) and Wells (in press), and these reviews form the basis of this talk.

One important feature of long-term studies is that they build upon themselves. As the original questions are answered, new questions elbow their way forward. Thus, our objectives and methods have changed over time. We began with basic descriptive questions: can home ranges be defined for coastal bottle-nosed dolphins? If so, how extensive are these ranges? What constitutes a population? With answers to these questions presumably in hand, we could ask broader questions: What social units make up the population and how do the ecological strategies of these social units differ? How do reproductive parameters, such as the calving interval and age of sexual maturity, vary among individual females? What interactions occur between dolphins in neighbouring areas?

The range of the Sarasota community encompasses a 50-km stretch of coastline that includes a system of bays protected by a series of barrier islands and the waters of the Gulf of Mexico up to about 1 km offshore of the islands. The area is well-suited for studying dolphins, for typically the waters are calm and the climate mild. The shallow depth (<1.5 m) in many places allows for relatively safe captures. Large numbers of small powerboats frequent the area, so the dolphins are acclimated to the presence of boats, making them easier to approach and observe. We have not noted any anomalous behaviour of the dolphins caused by the cautious approach of observation boats. The relatively small population size of about 100 dolphins also makes the community favourable for study. The dolphins are abundant enough to be sighted frequently, yet few enough to allow a large proportion of the community to be readily identified.

Some marked dolphins have maintained fidelity to the Sarasota Bay area over the 20-year period that we have been studying them. Most individuals utilise particular core areas within the home range. Females appear to occupy relatively limited home ranges centred around productive seagrass meadows. Adult females

form bands that we believe comprise the stable core of the Sarasota community. The female band members appear to be linked by genetic ties and by longterm associations stretching over decades. The oldest known female is estimated from tooth layers to be 49 years old. Males range more widely, with the adults travelling from one female group to the next. The adult males also appear to be the vectors for genetic exchange because they occasionally travel through the home range of adjacent communities. We have observed little association between subadult males and adult males, which, combined with the spatial difference in home ranges between the two classes, indicates that segregation of subadult males occurs.

The differences between the sexes in their breeding strategies appear to have profound effects on virtually all aspects of their life histories. The reproductive success of the females is likely to depend primarily on their procuring enough food to support the heavy investment of energy in raising and protecting their calves, while the success of the males probably depends on their gaining access to the females. Differences between the sexes in movement patterns, associations, mortality, and longevity all appear to be tied to their basic differences in reproductive strategies.

One of the lessons that we have learned during this study is that conclusions based on short-term data tend to be simplistic and transitory. Collecting data for only 2 or 3 years is unlikely to give a complete picture of a complex society of long-lived animals, and we have been forced to revise our ideas with disconcerting regularity. We have also learned the value of simultaneously pursuing multiple lines of investigation. One way that we have been able to broaden the scope of our study has been by conscripting biologists with different areas of expertise into the project. The explosive growth of the scientific literature has meant that scientists can keep abreast of only a tiny fraction of the information available, but by employing a team approach, the disadvantages of this tendency towards parochialism can be diminished. The study has become increasingly a corporate affair, uniting biologists interested in behaviour, life history, genetics, physiology, veterinary medicine, acoustics, and population biology.

At the outset of the project, we were concerned mostly with the fates of individual dolphins - their movements, behaviours, and associations with other individuals. Now, we have expanded our interest to questions about higher levels of organization: What role do population subunits, such as the female groups, have in the population as a whole? How do different populations interact? How is this community of dolphins interwoven into its greater community of predators, prey, and non-combatants? In addition, we are exploring physiological questions, such as those concerning reproductive cycles and seasonal body condition. A longterm study provides an opportunity to study organisms with reference to both higher and lower integrative levels - a process that Bartholomew (1985) advocated for promoting both an analytical approach for dealing with mechanism and a synthetic approach for appreciating biological significance.

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ECOLOGY OF BOTTLE-NOSED DOLPHINS *Tursiops truncatus* IN THE MORAY FIRTH, NORTHEAST SCOTLAND

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INTRODUCTION It is widely believed that populations of small cetaceans, such as bottle-nosed dolphins *Tursiops truncatus*, have declined in some areas of Britain in recent years. However, little is known of the past or present status of these species, and there is almost no information on their ecology in North Sea areas.

The Moray Firth contains one of the few resident groups of bottle-nosed dolphins known to occur in British waters. It has been suggested that around 25-30 individuals frequent the area, but no detailed research has been carried out on this population. This project aimed at providing a minimum estimate for the size of the the Moray Firth population and assessing the potential for longer-term studies of bottle-nosed dolphins using direct observational and photo-identification techniques.

METHODS In order to assess changes in dolphin abundance and activity in inshore waters, land-based observations were made over three areas during June and July 1989. The areas were all natural constrictions at the mouths of the Beaully, Inverness and Cromarty Firths (Fig. 1), where dolphins have been recorded frequently during other studies. Two- to nine-hour watches were made between 08.00 and 20.00 hr BST and the size and movements of all dolphin groups were plotted on charts of the area.

To obtain a minimum estimate of population size, a 6-hour coordinated survey was carried out on 4 August 1989. Observations were made from 15 sites between Spey Bay and Tarbat Ness (Fig. 2) and covered most of the areas from which we had sightings records of dolphins. Throughout the watch, observers recorded the composition and minimum size of all groups of dolphins in their field of view. The locations and movements of all groups were also plotted on charts to assess the extent of overlap between adjacent sites.

The potential for further population studies based on naturally marked individuals was assessed by making weekly boat trips into the three observation areas and photographing any dolphins that we encountered. Pictures were taken using colour transparency film and an autofocus camera system with a 75-300 mm lens.

RESULTS Dolphins were seen regularly in all three observation sites, but were particularly predictable at the mouth of the Inverness Firth where they were present for more than 60% of the time (Fig. 1). Group sizes varied considerably, with between 2 and 22 individuals present in an area at the same time. The results of the coordinated watch confirmed that the three main observation areas were key areas for bottle-nosed dolphins in the Moray Firth. However, groups were also seen in other areas, particularly in the waters between the mouth of the Inverness and Cromarty Firths and in the Spey Bay area to the east of the study area (Fig. 2). The survey produced a minimum population estimate of 62, including seven calves.

Photographs were obtained of at least 44 recognisable individuals. Identifications were based on a variety of marks including nicks in their dorsal fins, tooth-rake marks their fins or bodies and natural variations in skin pigmentation. Eighteen of these individuals were photographed on more than one day and eight were recorded in at least two of the three observation areas. Five dolphins were known to have used all three areas.

CONCLUSIONS The coordinated survey results suggest that the Moray Firth dolphin population is larger than had previously been believed. Furthermore, because the survey covered only coastal areas, and observers were asked to make conservative estimates of group size, the real population size is likely to be even greater. The presence of many individually recognisable dolphins in the area suggests that, in future, it may be possible to produce better estimates of population size using capture-recapture techniques.

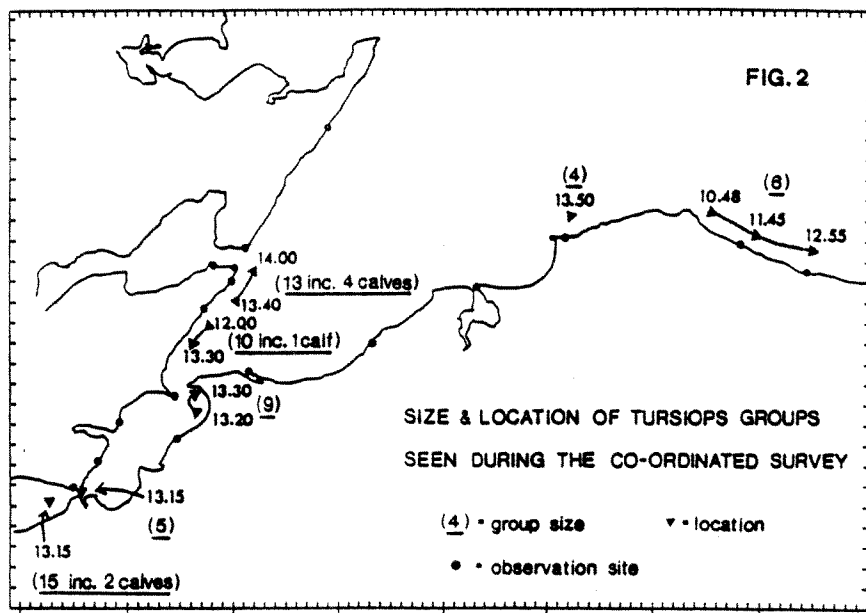
The predictability with which dolphin groups were seen to use certain inshore areas shows that the area provides a rare opportunity for the study of this species in British waters. Preliminary results from the photo-identification work suggest that these techniques could be used successfully, in conjunction with

observations made from the shore, to provide more detailed information on the activity and movements of dolphins within the Firth.

Acknowledgement We would like to thank the British Ecological Society for their financial support for its study.

FIG. 1

SITE	NO. OF DAYS OBSERVATIONS	PROP. OF TIME DOLPHINS PRESENT	DAILY PEAK COUNT - X (RANGE)
1	8	0.29	9.6 (5 - 22)
2	12	0.61	9.3 (2 - 20)
3	8	0.19	7.7 (4 - 14)



ON THE DISTRIBUTION OF THE BOTTLE-NOSED DOLPHIN *Tursiops truncatus* IN PORTUGAL

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INTRODUCTION Sightings of the bottle-nosed dolphin *Tursiops truncatus* have been regularly reported along the Portuguese coast at least since the 19th century (Bocage, 1863; Teixeira, 1979; Hussenot, 1982; Santos, 1985; Sequeira and Teixeira, 1987). Despite this fact, the number of strandings recorded up to 1977 was relatively low, and the sightings at sea obtained along the continental shelf also suggested comparatively low levels of abundance for this species. In fact, most of the sightings have been obtained in the Sado estuary, where *Tursiops truncatus* is known to occur regularly throughout the year.

Systematic surveys for cetaceans stranded on the shore were initiated in 1976, followed in 1986 by oceanographic transects at sea over most of the Portuguese continental shelf. From these transects very useful information on the distribution of bottle-nosed dolphins has been obtained.

RESULTS

Strandings Since the systematic surveys were initiated in 1976, 18 strandings of bottle-nosed dolphins have been recorded. However, the comparatively small sample size and its distribution throughout the year do not allow the detection of any regular patterns in the frequency of strandings. Nevertheless, it may be noted that many strandings did occur during the winter months, when adverse weather conditions can be fatal to weak or diseased animals.

The geographical distribution of strandings revealed a very regular pattern, with 75% of the observations between Cabo da Roca (38°47'N 09°30'W) and Sines (37°57'N 08°53'W) (Fig.1). Very high values for primary productivity have been recorded for this area, related to the concentrations of nutrients from the Tejo and Sado river systems, thus allowing a rich marine fauna. Another aspect to be considered is the presence of one resident population of bottle-nosed dolphins in the Sado estuary. Therefore, we may assume that a significant proportion of the strandings recorded in this sector of the coastline involves animals using the Sado estuary and adjacent areas.

Sightings Groups of bottle-nosed dolphins may be regularly observed along the continental shelf, and certainly not confined to the areas adjacent to the Sado estuary. The results obtained so far suggest that most sightings occur either in shallow waters up to 50 m deep or in depths greater than 200 m (Table 2). It is worth pointing out that many of the sightings recorded in waters deeper than 200 m are located close to deep underwater canyons, particularly those of Nazaré, Lisboa and Setúbal (Fig. 1). These areas are of considerable importance for the richness of their marine fauna: the area of Lisboa-Setúbal is greatly influenced by the concentrations of nutrients coming from the Tejo and Sado river systems and is also known as one of the most important upwelling zones on the Portuguese coast; the underwater canyon at Nazaré is the deepest along the Portuguese continental shelf, thus allowing for the presence of a rich abyssal marine fauna quite close to the shore.

Average group size was larger for groups sighted in offshore zones, suggesting the importance of gregarious behaviour in these areas. However, these results need more investigation, and more surveys at sea in offshore zones must be planned for the future.

CONCLUSIONS The distribution of bottle-nosed dolphins in Portugal appears to be related to areas of richer marine fauna, either associated with high levels of primary productivity (Tejo and Sado estuaries and the adjacent oceanic zones) or close to deep underwater canyons (Nazaré). Less information is available for the southern part of the Portuguese coast, thus highlighting the need for accurate surveys if we are to assess the patterns of distribution for the bottle-nosed dolphin in Portuguese waters.

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Table 1. Monthly distribution of strandings for *T. truncatus* (updated to February 1990)

Month	Number of strandings	Site (see map)
January	3	a,b,c
February	5	d,e,f,g,h
March	1	i
April	3	j,k,m
May	0	-
June	1	n
July	0	-
August	2	o,p
September	1	q
October	0	-
November	2	r,s
December	2	t,u
TOTAL	18	

Table 2. Bathymetric distribution of sightings (six transects along the Portuguese continental shelf)

Depths (m)	Number of sightings	Number of animals
0-50	9	c. 50
51-200	3	c. 40
> - 200	9	c. 110

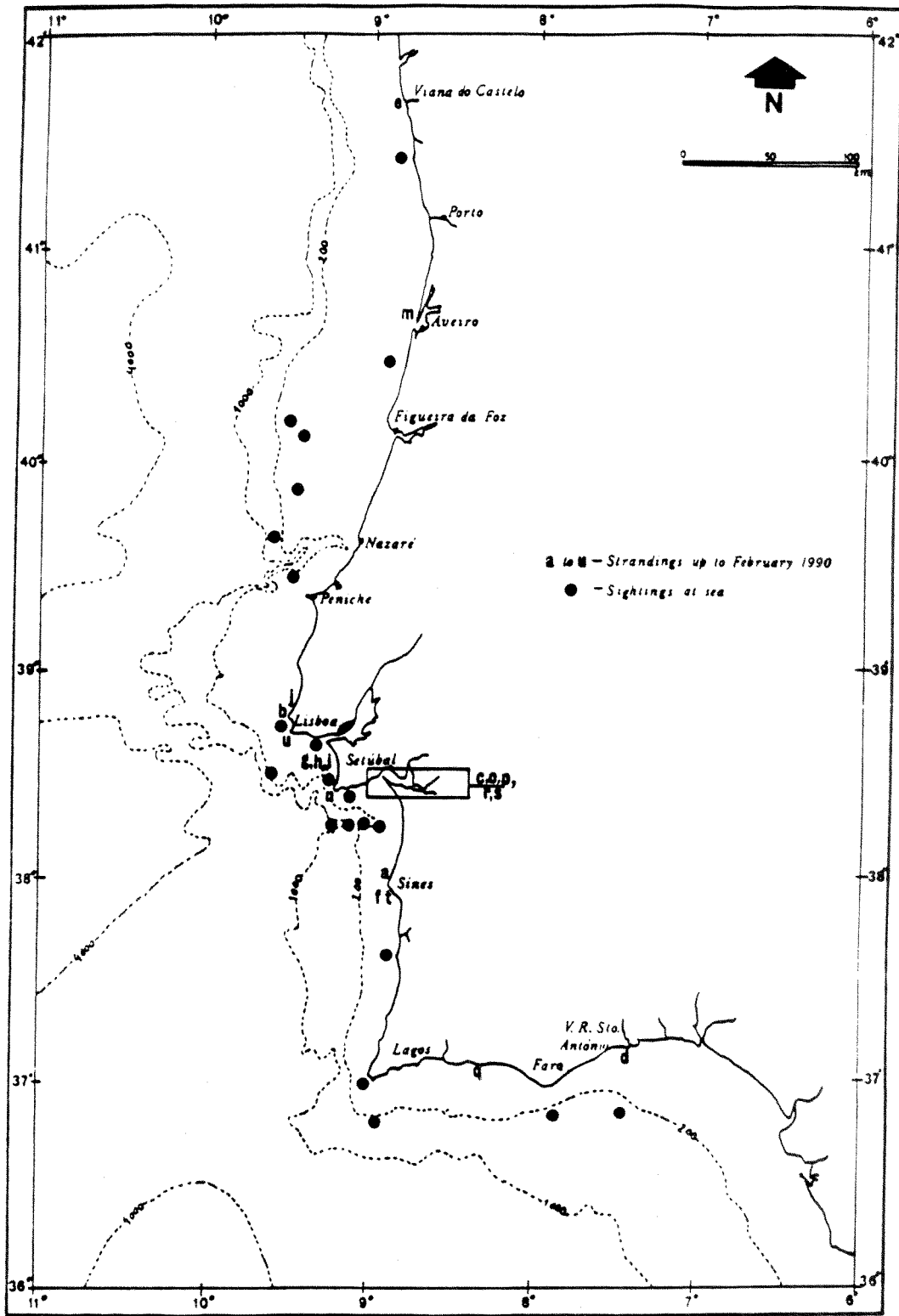


Fig. 1. Map of Portuguese coast showing location of bottle-nosed dolphin records

MOVEMENT PATTERN OF BOTTLE-NOSED DOLPHINS *Tursiops truncatus*
INCLUDING THE SPATIAL STRUCTURE AND VARIABILITY OF SUBGROUPS

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Bottle-nosed dolphins *Tursiops truncatus* in the Sado estuary, Portugal, have been monitored from a vantage point using a computerised theodolite. Most frequently the dolphins passed through waters 10 to 20 m deep, close to the shore, with a marked preference for the least disturbed habitat subareas. The average speed was 4.3 km/hr. They moved faster in deeper waters and when travelling upstream.

The theodolite tracking also gave insights into the dynamics of the spatial structure of subgroups, rejoining and splitting again. The area covered varied from 660 to 480,000 m² and was related to group size and water depth, and might also have been a function of different activities.

Between June and August 1986 and 1987, bottle-nosed dolphins were systematically observed from the shore and small boats, for a total of 231 hr of direct observation. Photographs were taken during the boat surveys.

The occurrence of animals was influenced by time of day and tides, with peaks in the morning and early afternoon, and the first hour after low tide. On average the dolphins spent 56 min per sighting within the standard study area. They swam more often with than against the tide.

During the boat surveys photographs were taken, which allowed us to identify 42 individuals by natural markings of the dorsal fin. The average group size ranged from 9 to 11 animals. High association values were detected for 13 pairs, including 14 animals.

There seems to be a core group of 17 animals within the estimated population of about 60 animals, which are probably year-round residents in the estuary. The estuary may be a core area within a larger home range, and seems to be especially used as a feeding area.

MEASURING SURFACING INTERVALS IN FREE-RANGING BOTTLE-NOSED DOLPHINS

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INTRODUCTION Surfacing intervals have been measured in many cetaceans, from the great whales to the smaller odontocetes, and these studies have inspired considerations on the animals' anatomy, physiology and underwater behaviour. The diving capacities and breathing rates of different species have been compared, and in some species breathing patterns have been proposed, sometimes in relation to general activity patterns. For example, Watson and Gaskin (1983) found two different patterns of breathing intervals in the harbour porpoise *Phocoena phocoena*, one related to travelling, in which all submergences were relatively short, and another related to foraging, in which long dives were separated by a ventilation sequence consisting of several short submergences.

Breathing intervals of bottle-nosed dolphins *Tursiops truncatus* have also been measured both in captivity and in the wild, stimulating discussions about diving strategies and physiological constraints to their behaviour (e.g. Ridgway *et al.*, 1969; Verwey, 1975), and also relating breathing intervals to activity patterns (Lockyer and Morris, 1986, 1987).

Groups of bottle-nosed dolphins resident in the Sado estuary and adjacent coastal waters (near Setúbal, Portugal) have been observed since 1984, and various aspects of their activities are being studied (dos Santos and Lacerda, 1987; dos Santos *et al.*, 1990; Harzen, this volume). In 1988, we initiated a program of measurements of their surfacing intervals, which are also quite variable but far from random. Here we present some preliminary data.

METHODS Measurements were made by two observers either in a 5.5-m long boat following the dolphins or from the top of a high building overlooking the mouth of the river, using 10 x 50 binoculars. Measurements were made either by reading stopwatch times to a tape recorder or by using a Psion Organiser II LZ hand-held computer, with a custom-built program for breathing interval data inputs.

We tried to follow the movements of particular focal animals, because some animals are easily recognisable due to natural marks on their bodies or fins, but our data are most often estimates for a whole group or subgroup. The animals' activity patterns and movements were also recorded throughout each measuring sequence.

RESULTS In 16 different days, we measured 858 surfacing intervals in 63 sequences, which lasted a total of 6.57 hours. These surfacing intervals varied between 2 and 453 sec (mean, 27.5 sec; s.d., 49.2 sec). We considered all the surfacing events to last 1 sec, as did Watson and Gaskin (1983) for the harbour porpoise. The term "surfacing" was preferred to "breathing", because we could not be sure that the animals were blowing every time they broke the surface.

In order to identify surfacing patterns, we selected those measured sequences that were longer than 180 sec or included at least 10 measured submergences. Basically three types of surfacing patterns (Fig. 1) were visible in the data and are described as follows:

(A) Surfacing intervals are variable, usually not exceeding 30 sec.

(B) There is a clear distinction between submergences longer than 30 sec (arbitrarily called "dives") and sequences of short submergences (called "ventilation periods"). This pattern can perhaps be divided into three subpatterns: (B1) dives alternate with sequences of several short submergences; (B2) dives alternate with ventilation periods in which submergences are relatively long; and (B3) dives alternate with one single surfacing (there is really no ventilation sequence).

(C) Surfacing intervals are very irregular, but dives do occur. (The patterns are illustrated in Fig. 1.)

After defining these surfacing patterns, we calculated several parameters for all the sequences in each pattern, excepting pattern B3 for which we have too few data. These calculations are presented in Table 1. In all the selected sequences (N=40), regardless of surfacing patterns, we measured 149 dives, with a mean duration of 97.8 sec (s.d., 66.9). Derived parameters used by other authors were also calculated, namely the "maximum to mean dive period ratio" and the "mean ventilation period to mean dive ratio", and these are presented in Table 2.

DISCUSSION - We must begin by noting some biases that may have affected our data. Many of our measurements were estimates for a whole group or subgroup, and so it is possible that we were timing different animals. Sometimes it is impossible to keep track of a focal animal (especially in the shore observations), and there are differences in the surfacing times of the various animals in the same group. Actually, some of our very short surfacing intervals may result from considering two different subgroups as one. Also, it is possible that during our boat measurements the animals were influenced by our proximity.

Although a quantitative description is not presented here, we found that, contrary to some other studies, there is no rigid relationship between surfacing and activity patterns. This point will have to be investigated with more data, and it may also be necessary to redefine our surfacing patterns.

Some of our results are comparable to those of other authors. Our surfacing patterns (A) and (B) are basically similar to those of Watson and Gaskin (1983), although the activities of the bottle-nosed dolphins in the Sado are not so clear-cut. A few remarks are worth making: our overall mean duration of ventilation periods is similar to that found by Watson and Gaskin (1983) in the harbour porpoise, although it is much longer than that found by Lockyer and Morris (1987) for a juvenile bottle-nosed dolphin; also, the mean dive of this latter animal was much shorter than the mean dive for dolphins in our study. Finally, Watson and Gaskin (1983) found that harbour porpoises showed very similar surfacing rates regardless of activity, and our data, as can be judged from Table 1, show a marked difference between the surfacing rate in pattern (A) and other patterns.

Acknowledgements We are grateful to TORRALTA for logistical support. Giorgio Caporin, António J. Ferreira and Mimi Mendonça have helped us during the boat trips.

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TABLE 1. Submergence parameters

Surfacing patterns	Total number of sequences	Total duration of sequences	Number of submergences	Duration of submergences	Number of dives	Mean duration of dives	No. of vent. sequences	Mean No. of surfacings per vent. sequence	Mean duration of vent. sequences	Surfacing rate
A	5	19.2 min.	96	$\bar{x} = 11.92''$ (s.d., 6.6) [3"-35"]	-	-	-	-	-	5.27
B ₁	24	209.2	313	$\bar{x} = 38.01''$ (s.d. 53.8) [3"-258"]	89	107.36 " (s.d. 58.6)	64	4.56 (s.d. 2.7)	38.81 " (s.d. 29.4)	2.29
B ₂	3	16.6	28	$\bar{x} = 35.46''$ (s.d. 30.6) [13"-138"]	6	83.5 " (s.d. 37.5)	5	4.4 (s.d. 2.7)	73.8 " (s.d. 63.8)	1.87
C	5	39.84	103	$\bar{x} = 23.15''$ (s.d. 21.15) [4"-128"]	25	51.0 " (s.d. 27.2)	20	3.8 (s.d. 3.3)	40.37 " (s.d. 45.3)	2.72

- Notes: i) Total durations of measured sequences are in minutes.
 ii) Other temporal parameters are in seconds (").
 iii) Surfacing rates represent "number of surfacings per minute".

	Overall	B ₁	B ₂	C
$\frac{\text{Maximum dive}}{\text{Mean dive}}$	4.63	2.4	1.65	3.1
$\frac{\text{Mean vent. period}}{\text{Mean dive}}$	0.33	0.36	0.74	0.65

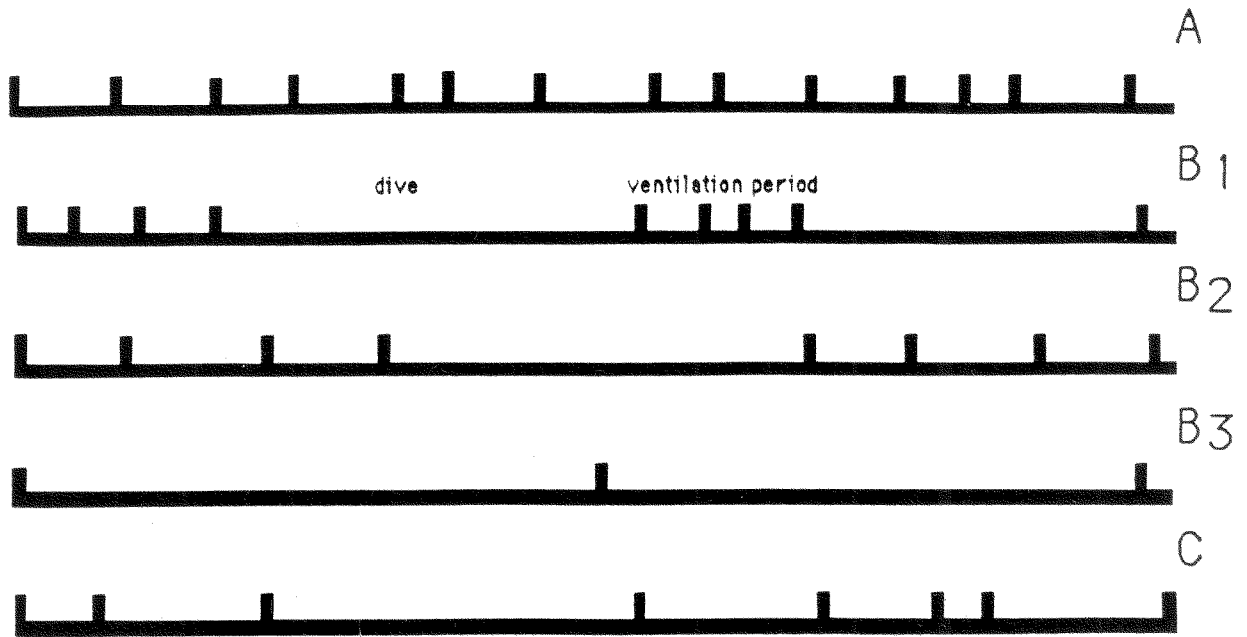


Fig. 1. Illustration of typical surfacing patterns of bottle-nosed dolphins

PREGNANCY RESEARCH IN BOTTLE-NOSED DOLPHINS *Tursiops truncatus*

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The reproductive system of cetaceans closely follows the basic mammalian pattern. But it is necessary that we make a very important division when introducing this principle. Firstly, we should mention the different organs, ovaries and uterus; and then there is the hormonal system. Between these there is a very complicated and close relationship; and finally, there is the central nervous system, which regulates and coordinates activities involving all these parts.

The anatomy of the ovaries resembles the typical mammalian pattern. The eggs pass to the fallopian tube through a large funnel. Each fallopian tube merges with a uterine horn and the two horns unite to form the body of the uterus. The cervix separates the uterus from the vagina. The thick walls of the vagina have a very good blood supply. The vagina opens to the exterior at the vulva, which is situated in a shared recess along with the urethra, the clitoris and the anus. The mammary glands are situated below the blubber on either side of the genital/anal recess. During lactation the elongated nipples can be seen protruding from the sides of the animals.

The hormonal system is much more complicated, since it can undergo changes from one moment to the next, so that it is not a static system. Also we find many relationships between this and the reeveille organs, but above all we must remember that the central nervous system is in control, like a director. However, there are some mechanisms to control this and here we introduce the term feed-back systems.

Progesterone can also be produced in the ovary and super-renal gland, but for us it is the excretion from the ovary's progesterone that is important. When we measure serum progesterone levels for pregnancy, we do not take the super-renal progesterone into consideration due to its low level.

Progesterone is not the only hormone that will participate in the pregnancy process: we may find various levels in estradiol and pituitary luteinizing hormone (L-H), to mention only the most common ones and those which we can determine easily, e.g. by blood sampling.

The earliest and most successful way to detect pregnancy in the bottle-nosed dolphin *Tursiops truncatus* is by the serum progesterone level. There are other methods: ultrasound exploration, detection of foetal heartbeat by the Doppler effect, and physical changes in the appearance of the female.

But we must reaffirm that the earliest method of detecting pregnancy in the bottle-nosed dolphin is by monitoring changes in serum progesterone. Serum progesterone levels higher than 6,000 pg/ml, maintained over a 4-6-week period, are considered an indication of pregnancy. During gestation, they vary from less than 10,000 pg/ml to over 50,000 pg/ml, averaging 25,000 pg/ml. Serum progesterone levels are determined by radioimmunoassay (RIA). The difference between plasma progesterone concentrations in a pregnant and a non-pregnant *Tursiops* is highly significant.

An incorrect positive test can be avoided by repeating the test 1-2 months later, to confirm that the high level persists and is caused by pregnancy and not by an ovulation or cystic corpus luteum. Ovulation is characterised by a dramatic change in plasma progesterone from normal to more than 3,000 pg/ml, then returning to normal within 1 month.

No one has detected different levels of progesterone due to the changing of seasons. Calves are born all year round, with a slight peak in spring and autumn. Progesterone levels should be monitored in all females of reproductive age if they are in contact with adult males. It can also be used to test adult females showing important changes in behaviour, but which have not yet been in contact with adult males.

If progesterone levels are not monitored, then it will take longer to detect pregnant females, because changes in weight, body shape or behaviour are factors that appear only from the sixth month onward. In this paper, we do not discuss, on knowing that a female is pregnant, when one should introduce changes in her life style or diet, special exercises, or forbid certain situations. However, there can surely be no objection to obtaining early knowledge of when a female is pregnant.

Ultrasound exploration is a test that gives us complete information without any risk to the animal. The Doppler effect, phonocardiography or detection of foetal heart beat, can only be carried out after 4-5 months of gestation, whereas ultrasound exploration can be used after the first month.

Whenever it is necessary to handle a pregnant female (for example if there is any doubt about foetal viability), it is monitored by the Doppler effect. This shows the different heart beat rate between mother and foetus. Adult female heart rate, measured approximately in the middle of a respiration cycle, ranges from 60-74 beats per min, compared to the foetus with 130-140 beats per min. This method is used if we need a strict daily or weekly control, since it is much simpler.

PREGNANCY LOSS On a particular occasion during the second echo, we took a blood sample; progesterone levels were down to normal. We began to consider pregnancy loss, but to our surprise we found no foetal material in the pool or in the filtration system. We have studied this in other animals (pigs, cows, domestic animals and also humans) and have found that "resorption" may take place.

When speaking about embryonic loss and early pregnancy loss, we must remember that, although many factors have been related to these, evidence is limited and frequently conflicting. The proposed causes of embryonic and early pregnancy losses can be divided into intrinsic, extrinsic and embryonic factors. Intrinsic factors include progesterone deficiency, maternal age and endometrial disease. Extrinsic factors include nutrition, season and climatic factors, stress and side effects. Embryonic factors include chromosomal abnormalities and immunogenetic tendencies.

Intrinsic factors:

Progesterone deficiency Low levels of progesterone have been associated with embryonic loss, and occurs in premature luteolysis or luteal deficiency.

Maternal age Increased maternal age has been associated with a higher incidence of pregnancy loss in young animals related to immaturity, nutritional upsets, physical stress and inadequate plasma progesterone.

Endometrial disease The endometritis has a variety of mechanisms which can produce the loss: (a) it can start from premature luteolysis; (b) the inflammatory response caused by the infection may lead to embryonic loss; and (c) the pathogen can directly affect the embryo.

Extrinsic factors:

Nutrition Poor nutrition has been associated with pregnancy loss.

Seasonal and climatic factors The seasonal influence on pregnancy loss is undetermined, but we know that heat stress exists in pigs and cattle; high environmental temperatures have an adverse effect, both on the embryo and the endocrine environment.

Stress Maternal stress has been shown to reduce plasma progesterone levels in pregnant mares (and other animals) and has been proposed as a factor in pregnancy loss. There are many different situations where the animal may find itself in stress: severe pain, infectious disease, transport, changes in group situations, poor nutrition caused by a new situation, and poor nutritional quality of the fish (every new delivery of fish needs checking).

Side effects The problems do not always derive from the mother; they can be caused by the father or by genetic factors, or infections such as non-specific bacterial diseases (we have never found venereal disease in the bottle-nosed dolphin).

Embryonic factors:

Chromosomal abnormalities In humans these are estimated to occur in 50% of all conceptions, and in 66% of spontaneous pregnancy losses between 3 and 7 weeks. The loss of embryos with chromosomal abnormalities is a means to eliminate them at a "low biological cost".

VOCAL MATCHING INTERACTIONS IN BOTTLE-NOSED DOLPHINS

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The subject of this study were three bottle-nosed dolphins *Tursiops truncatus* in the dolphinarium "Marineland" on Mallorca, Spain.

Our investigation focused on the question whether during communication of bottle-nosed dolphins, vocal matching is used as a means of interacting. Vocal matching is a common form of communicative interaction via animals. It means that one interacting member of a communicative system selectively responds to a signal (S) heard from another individual by replying with a signal of the same or similar pattern from its own repertoire (S*). Vocal matching is a multifunctional form of behaviour which, nevertheless, in most cases serves specifically to convey a particular message (Todt, 1981; Hultsch and Todt, 1986). Briefly, vocal matching requires the following prerequisites:

- (1) It is characterised by a short temporal latency between the signals exchanged by the partners. Therefore, vocal matching occurs in real interactions only; and
- (2) It requires a shared signal repertoire of the interacting partners.

According to these characteristics, vocal matching should be differentiated from vocal mimicry, a term which is often used synonymously, but does not necessarily fulfil these criteria.

Since cetaceans show strong reactions to playbacks of species-specific vocal patterns (e.g. Dreher, 1966; Fish and Lingle, 1977; Tyack, 1983), we confronted our subjects with playbacks of their own vocalisations (whistles) in a pilot study. In fact, we found indications for matching responses by the dolphins since several of the replies resembled our stimuli.

Hence the question was raised whether vocal matching is a typical form of interaction in this species. Considering the crucial influence of time structures in communication, we extended the playback set: instead of arbitrary stimuli randomly presented in the lapse of time, we played back the signal that the dolphin had uttered just before, so our experimental setting referred closely to the animal's behaviour.

The experimental setting comprised two tape recorders connected via a tape loop. The time interval between the animal's signal and the experimental response was defined and could be varied by changing the distance between the tape recorders. The delay was adjusted between 0.9 and 12.4 sec in different sessions, but was always kept constant during each session. This experimental set (called replicator: Todt, 1970) specifically simulated matching responses.

As a result of the well-known difficulty in assigning whistles emitted underwater to individual dolphins, we could not analyse individual responses, since we did not want to isolate the subjects during the experiments. Therefore, we compared recordings of non-influenced behaviour (controls) with our experimental sessions and examined them for modifications of signalling behaviour due to the experimental circumstances.

According to our matching definition, the data evaluation followed two steps:

- (1) We had to prove the dolphins' reaction to be responses to our stimuli;
- (2) A categorisation of whistles was necessary to judge similarities of the vocal patterns.

To prove that the dolphins' vocalisations were responses, we measured the time the subjects spent in front of the loudspeaker. In all experiments we found an increase of more than 100% compared with controls.

Additionally, we studied the time structure of whistle vocalisations. Because the time delay between signals during mutual signalling is generally short, if a whistle was performed simultaneously or within a period of 0-0.5 sec after the stimulus, it was labelled a response.

We found statistically significant results in the responses to the speaker in sessions with short delays of 0.9 or 1.6 sec (0.9s: $\chi^2 = 62.4$; 1.6s: $\chi^2 = 86.8$; $df = 1$, $P < 0.001$). Hence short delayed stimuli which correspond fairly well to natural response latencies (common dolphin *Delphinus delphis*: Caldwell and Caldwell, 1968), induced a substantial stronger response than stimuli with longer delays.

The second prerequisite which is required for matching is the categorisation of the whistles in order to check for similarities of response patterns.

Nine whistle types and one class comprising the remainder ("rest") were defined by modulations in the dominant frequency of the contours. The four most common categories together comprised more than 70% of all recorded whistles. They were called "A", "M", "Up" and "Rest". Whereas "Up" and "Rest" represented more than 50% of the whistles made by the controls, "A" and "M" were much less frequent in the controls. For short delays, the proportion showed an opposite pattern. "A" and "M" comprised more than 50% of the whistles whereas "Up" and "Rest" contributed only about 10%, respectively.

Long delay showed a similar proportion, but the difference between the categories decreased. However, the comparison of whistle types in the experimental animals versus controls showed statistically significant differences ($\chi^2 = 342.5$; $df = 9$, $P < 0.001$).

Then an obvious change in the choice of whistle types was evident in the experiment. We may now ask whether vocal matching is a significant feature in the vocal interaction of bottle-nosed dolphins: approximately 40% of the responses to our stimuli were responses of the respective stimulus type. The expected random frequency would only be approximately 20%. This result is highly significant ($\chi^2 = 61.8$; $df = 3$, $P < 0.001$). Therefore, matching responses can be assumed. Interestingly, 60% of these matching responses were responses using whistle type "A".

To conclude, by experimental influence we could induce a change in vocal behaviour of bottle-nosed dolphins that can be regarded as vocal matching. We can only assume that dolphins use the concept of vocal matching also in natural interactions with conspecifics.

Finally, we have to consider an open question: how can the change of whistle type performance during our experiment be explained?

One explanation relates to the signature hypothesis of Caldwell and Caldwell (1965), following the idea that each individual uses its own whistle designating itself. With this in mind, whistle type "A" could be the signature whistle of one individual which had been rarely emitted during control, perhaps due to the social status of the animal. Possibly the respective individual was addressed by the experimental matching of its signature whistle and thus stimulated to increase its response.

The results of Tyack (1988) suggest that conspecifics also "imitate" signature whistles of other individuals. This may indicate that matching is used in natural contexts as well, and serves an addressing function in bottle-nosed dolphins in the same way as it does in several terrestrial species.

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ON THE OCCURRENCE OF ZIPHIIDAE IN PORTUGUESE WATERS

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INTRODUCTION Contrary to the situation with some delphinids, which are fairly abundant (Teixeira, 1979; Reiner, 1985; Sequeira, 1988; Sequeira and Teixeira, 1988), the occurrence of ziphiids along the Portuguese continental coast seems to be relatively scarce and, in the case of the genus *Mesoplodon*, may be considered exceptional.

RESULTS & DISCUSSION From a total number of 395 odontocetes stranded on the shore or caught accidentally by the national fishing fleet up to June 1988 (Sequeira, 1988), only 12 were ziphiids and two of these belonged to the genus *Mesoplodon* (Table 1). The small size of this sample does not allow detection of any regular trends in the monthly occurrence of strandings, although several strandings occurred in the vicinity of Peniche (Fig. 1).

Since ziphiids tend to be associated with deep waters, one might expect the number of strandings to be small along the Portuguese coast since it possesses an extended continental shelf. However, the presence of a deep underwater canyon north of Peniche (Nazaré canyon) probably explains the comparatively high numbers of strandings observed in that area. Abyssal depths (2,000-5,000 m) are attained quite near the coast here, thus allowing the presence of a special fauna that may result in a closer approach of ziphiids to the shore. The preference of ziphiids for deep waters is also implied by the fact that most of the stranded animals (except the two *Mesoplodon* - see Table 1) were found in an advanced state of decomposition. In those cases, death probably occurred in deep water away from the coast, the carcasses then drifting for some time before being eventually washed ashore.

Data available from the Azores and Madeira are still scarce and seem to be rather inconclusive. Besides a recent sighting of the northern bottlenose whale *Hyperoodon ampullatus* in the Azores, most of the information currently available refers to quite old observations (Maul and Sergeant, 1977; Allen et al., 1979).

To date, five ziphiid species have been identified in Portuguese waters (including the Azores and Madeira). These identifications were based almost exclusively on stranded specimens. So far, the number of sightings at sea is extremely low and refers only to deep-water areas (seas around Azores and Madeira). Contrary to what has been found in the Canary Islands (Vonk and Martel, 1988), the occurrence of Cuvier's beaked whale *Ziphius cavirostris* in the waters around the Azores and Madeira may well prove to be quite exceptional (Table 2), despite the bathymetric characteristics being rather similar in all three zones (abyssal depths extending close to the insular coast). However, this may also result from insufficient observation effort in the two Portuguese archipelagoes, a situation we hope to improve in the near future.

Also important is the fact that no Cuvier's beaked whales have been confirmed in the Portuguese archipelagoes in the Atlantic, despite the vast distribution area known for that species (Duguy and Robineau, 1982; Leatherwood and Reeves, 1983; Evans, 1987) and the confirmation of its regular presence around the Canary Islands (Table 2). The proximity between these islands and the Madeira group calls for further careful investigation. We cannot exclude the possibility that the abundance of ziphiids in Portuguese waters has been grossly underestimated, due to the current shortage of observers, and particularly, trained cetologists.

These aspects should be studied in more detail soon, and shipbound surveys in deep-water zones along the Portuguese continental shelf are being planned, together with regular monitoring of the seas around the Azores and Madeira.

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Table 1. Monthly distribution of Ziphiidae strandings along the Portuguese continental coast, 1917-88

Species	J	F	M	A	M	J	J	A	S	O	N	D	?	Total
<i>Ziphius cavirostris</i>		1		2		2		1	1	1			2	10
<i>Mesoplodon densirostris</i>		1												1
<i>Mesoplodon europaeus</i>											1			1

Table 2. Ziphiidae strandings along the Portuguese Atlantic coasts (up to 1988) and in the Canary Islands (1980-87)

Location	Period	Total No. odontocetes	Ziphiidae	References
Portugal	up to 1988	395	<i>Z. cavirostris</i> - 10 <i>M. densirostris</i> - 1 <i>M. europaeus</i> - 1	Teixeira, 1979; Reiner, 1985; Sequeira, 1988; Sequeira and Teixeira, 1988
Azores	up to 1988	?	<i>H. ampullatus</i> (at sea) <i>M. densirostris</i> (at sea) <i>M. bidens</i> - 1	Allen <i>et al.</i> , 1979; Reiner, 1985; Santos, pers. comm.
Madeira	up to 1988	?	<i>M. densirostris</i> - 1 <i>M. bidens</i> - 1	Maul and Sergeant, 1977
Canary Islands	1980-87	60	<i>Z. cavirostris</i> - 26 <i>M. densirostris</i> - 2 <i>M. europaeus</i> - 4 <i>M. mirus</i> - 1	Vonk and Martel, 1988

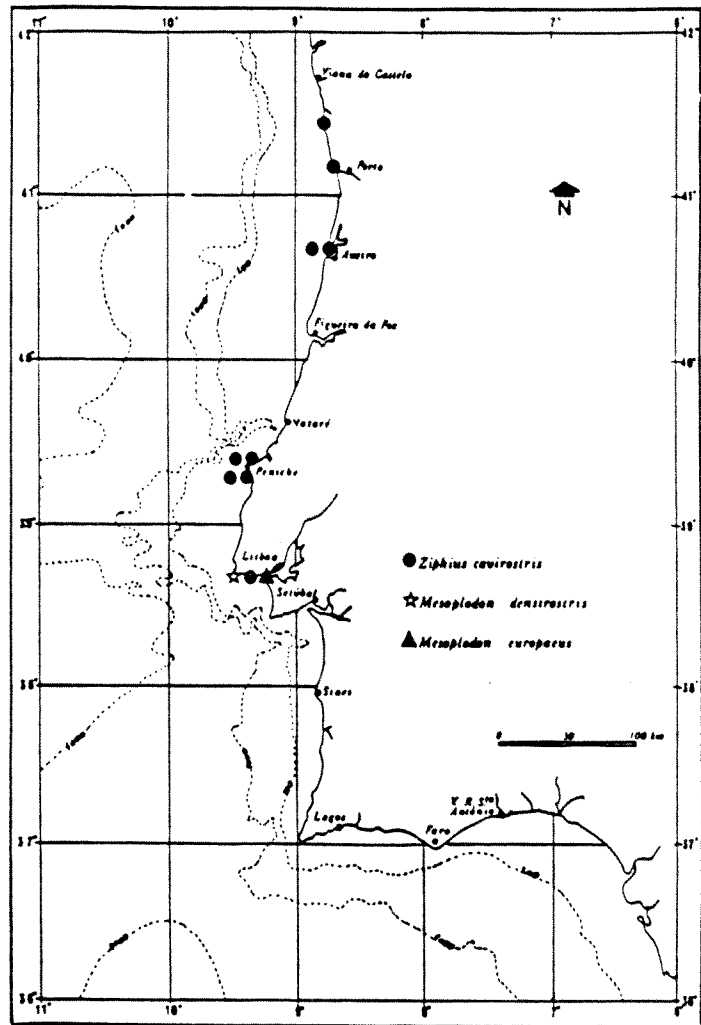


Fig. 1. Strandings of Ziphiidae on the Portuguese coast. From a total of ten *Ziphius cavirostris* stranded (see Table 1), only 9 cases could be accurately located

RECORDS OF GERVAIS' BEAKED WHALE *Mesoplodon europaeus* ON THE CANARY ISLANDS

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Gervais' or Gulf Stream beaked whale *Mesoplodon europaeus* is traditionally associated with Northwest Atlantic coasts where it is relatively frequent. On the contrary, until now the species was known on the eastern Atlantic coasts from only three records: the holotype which was found in the English Channel in 1848 (Gervais, 1855), a skull from Guinea-Bissau (Reiner, 1987), and a specimen stranded on the Portuguese coast in 1986 (Sequeira, pers. comm.).

Recently, seven individuals of *M. europaeus* have stranded on different occasions in the Canary Islands. Chronologically, the strandings were as follows:

- On 8 February 1985, a 430 cm male stranded at Giniginamar (Southeast coast of Fuerteventura island);
- On 8 June 1986, a 457 cm male was found dead on the coast of Maia (Northeast coast of Lanzarote island);
- On 4 July 1987, two males of 410 and 424 cm length were found at Punta Mujeres and Los Jameos del Agua, respectively (northeast coast of Lanzarote island);
- On 18 October 1989, three females of 462, 425 and 424 cm body length, stranded near Puerto Lajas (northeast coast of Fuerteventura island). The first and third females were pregnant, with 87 and 55 cm foetuses, respectively.

All strandings occurred along with individuals of Cuvier's beaked whale *Ziphius cavirostris* (Vonk and Martin, 1989) and Blainville's beaked whale *Mesoplodon densirostris*. All specimens were photographed and measured according to Norris (1961).

Stomach contents were composed of mandibles of the fish *Chauliodus sloani* and cephalopod beaks, which are at present being identified. Several nematodes of the genus *Anisakis* were found in the stomach, as well as *Phyllobothrium delphini* in the blubber (Raga, pers. comm.).

Acknowledgements We are particularly grateful to Dr. James G. Mead for confirming the species identification.

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PYGMY SPERM WHALES *Kogia breviceps* ON THE CANARY ISLANDS

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The pygmy sperm whale *Kogia breviceps* (De Blainville, 1838) was only known from the Canary Islands after a stranding on the north coast of Gran Canaria in February 1973 (Casinos, 1973). Since then, pygmy sperm whales have been recorded on the islands of Lanzarote and Fuerteventura. Chronologically, these strandings have occurred as follows:

- In April 1986, the remains of post-cranial bones were found on the coast of Cofete (southwest Fuerteventura) by Dr. J.A. Alcover;
- On 6 March 1987, a partial skull and skeleton was collected by Dr. R. Hutterer from the beach, 2 km west of Cofete (southeast Fuerteventura);
- On 6 October 1987, a 311 cm male stranded at Guacimeta beach (southeast Lanzarote) (Vonk and Martin, 1988);
- During summer 1988, one stranded alive at Gran Larajal (southeast Fuerteventura), but was finally refloated (Pizarro, pers. comm.);
- In November 1988, two females stranded at Orzola (northeast Lanzarote) (Vonk and Martin, 1989). Their total lengths were 250 and 163 cm, respectively.

All the animals were photographed and measured following Norris (1961), and autopsies were carried out, paying special attention to the key biological features of the species.

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SEXUAL ACTIVITY OF MALE LONG-FINNED PILOT WHALES OFF THE FAROE ISLANDS

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Age at sexual maturity and knowledge of reproductive cycles are needed for understanding the reproductive strategy of a species and for comparative and management studies.

The opportunistic Faroese catch of long-finned pilot whales *Globicephala melas* offers a good opportunity to study reproductive patterns and seasonality since entire pods, of a natural composition, are driven ashore all year round. A thorough study of the male reproductive pattern was undertaken by the authors (Desportes *et al.*, unpubl. manuscript). Determination of sexual maturity was based on histological examination of the testis (more accurate than gross observation), and stages of maturity were then correlated with life history data such as testis weight, body length, body weight, and age. Seasonal trends were investigated by looking at changes in testis weight, histological appearance of testicular tissue, (spermatogenesis, seminiferous tubule diameter), sperm density on smears and plasma testosterone levels; they were then compared with results from females and foetus data investigation. This presentation focuses only upon some of the main results of this work.

MATERIALS AND METHODS Sampling was made in connection with the large-scale international study on the status and ecology of the pilot whale off the Faroe Islands (for details on the fishery and the project, see Bloch *et al.*, 1990; Desportes, 1988; Desportes, 1990). Data were collected on 1,147 males from 39 schools caught between July 1986 and December 1989. Testis material was obtained from 656 males, and blood plasma from 218 males.

The maturity of testicular tissue was assessed by histological examination of testis samples taken on the same area of the testis (at the mid-length cross section on the side opposite to the epididymis). The stages were defined according to the proportion of seminiferous tubules being mature (0%, immature; between 0 and 50%, early maturing; between 50 and 100%, late maturing; 100%, mature). The weight of the fresh testis, without epididymis, was used. Plasma testosterone levels were measured by radio-immunoassay.

RESULTS AND DISCUSSION The growth pattern of the testis in pilot whales off the Faroes is similar to that previously described by Sergeant (1962) off Newfoundland, and by Kasuya and Marsh (1984) and Kasuya (1990) for two forms of the related species, the short-finned pilot whale *Globicephala macrorhynchus*. Testis weight increases linearly with body length and body weight in young animals, from 10 g to c. 200 g at c. 460 cm length, or a rate close to 0.7 g per cm of body length. Between approximately 460 cm and c. 510 cm body length, the rate of increase is about 50 g per cm, and a testis can weigh up to 3.5 kg at this size. After this spurt, the increase in testis weight continues at a lower rate as body length/weight increases, and a testis can reach over 6 kg in weight. The relationship between testis weight and age is similar with a linear growth between 0 and c. 13 years, then a spurt between c. 13 years and 20 years. But from this age, testis growth is no longer correlated with age, and individual variations are very important. Thus, for any given age-class, adult males of larger body size tend to have heavier testes than smaller ones. The sharp increase in testis weight is related to the maturation of the testis and concerns mainly testes classified histologically as maturing.

Plasma testosterone concentration varies from 0.01 ng/ml to 29 ng/ml. Testosterone levels are positively correlated with age, body length and testis weight in immature animals. In maturing ones there is no correlation, and levels vary from 0.5 to 11.2 ng/ml. In mature males, testosterone levels are correlated with testis weight and seminiferous tubule diameter, but not with age or body length.

Table 1 summarises the characteristics of age, body length, testis weight, and testosterone level at each stage of histological maturity. Males can produce spermatozoa when as small as 438 cm and when eight years of age. However, sperm density examination, together with analysis of testis weight and testosterone level, indicates that the functional maturity, defined as the possibility of successful breeding, is certainly reached some years later, the males belonging then to the late maturing and mature stages.

The reproductive activity of mature males is clearly seasonal, as shown by the changes observed in testis weight and testosterone level (Figs 1 and 2), with a period of high activity from March through September. Changes exist also in the histological appearance of the testis, with spermatogenesis showing peak activity in May and June and a very low profile in December - January. The primary season of conception, with 58% of all conceptions occurring from April through July, is within the period of elevated testis weight and testosterone level. However, this seasonality is diffuse and a not insignificant proportion of males are capable of reproducing outside the main mating season, since conceptions appear in any month of the year. This corresponds to the very important individual variations observed, particularly from September through March, in testis weight, testosterone level, sperm production and testis histological appearance. Kasuya and Marsh (1984) report also a diffuse seasonality in the short-finned pilot whale.

The analysis of the pod structure in terms of male sexual activity can throw some light on two difficult questions: (1) Which males are socially mature? and (2) Since reproductively active males have been shown to move between pods (Amos *et al.*, 1989), which factors control the movements of these males?

No pod contains maturing males without any fully mature ones. All pods contain at least one mature male. Thus maturing males seem unable to replace mature ones, and social maturity may only be reached some years after functional maturity. Testis weight, body weight and sperm density increase after the attainment of histological maturity, thereby suggesting that successful mating may appear even later than histological maturity. This hypothesis is supported by the fact that in schools, mature males younger than 22 years are always in the company of older mature males.

The important variation in the proportion of mature males per pod (from 1 to 20%) suggests that they move away from some schools and aggregate in others. On the other hand, mature males apparently do not aggregate around mating females (females which are probably close to, or just past ovulation) since their proportion in schools does not correlate with the proportion of mating females, nor does it increase significantly during the main mating season. This movement of mature males seems therefore to be controlled by other factors than the female reproductive cycle.

ACKNOWLEDGEMENTS We would like to thank all those involved in field sampling and laboratory processing, especially the staff of the Faroese Natural History Museum and the Centre d'Etudes Biologiques des Animaux Sauvages. Age determination was kindly conducted by D. Bloch and Dr. C. Lockyer. Thanks also go to A. Aguilar for his comments on the manuscript.

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Table 1. Range of data and mean for each stage of sexual maturity in male long-finned pilot whales *Globicephala melas* (The mean is the 50% point on the linear regression when the percentage of individuals at or beyond a stage is plotted against a parameter)

Stages of sexual maturity		Immature	Early maturing	Late maturing	
Mature					
Age (years)	min.	0	8	11	14
	max.	16	18	26	46
	mean	-	13.3	14.6	16.6
	n	305	23	32	222
Body length (cm)	min.	188	458	464	475
	max.	508	545	565	625
	mean	-	480.1	501.6	512.8
	n	351	26	36	240
Testis weight (g)	min.	9	248	575	807
	max.	346	760	2081	6150
	mean	-	313.0	653.3	1087.1
	n	352	26	36	242
Testosterone (ng/ml)	min.	0.1	0.5	1.1	1.1
	max.	1.8	2.7	11.7	22.7
	mean	-	1.3	1.6	1.9
	n	114	9	8	67

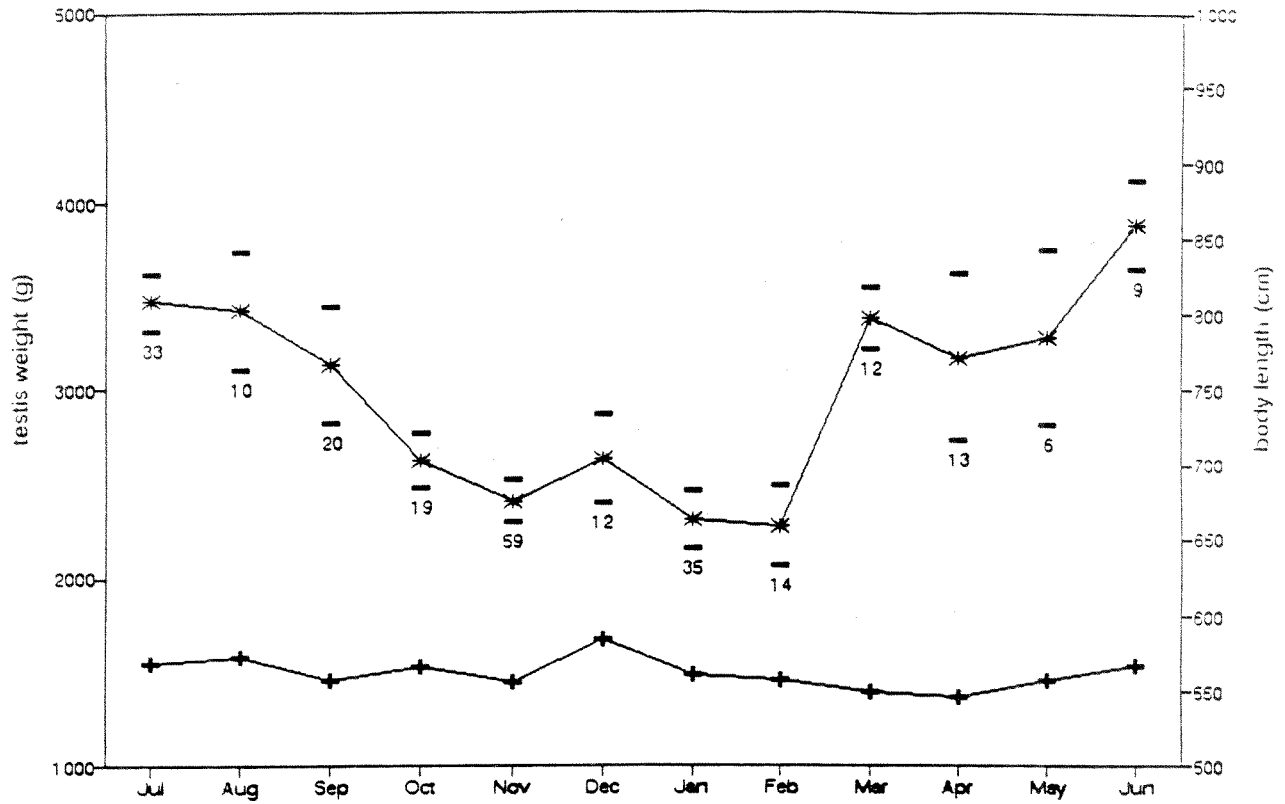


Fig. 1. Seasonal variations in mean testis weight for mature specimens of *G. melas* (n=242). Sample sizes are above the error bars which represent one standard error from the mean (star = mean testis weight; cross = mean body length)

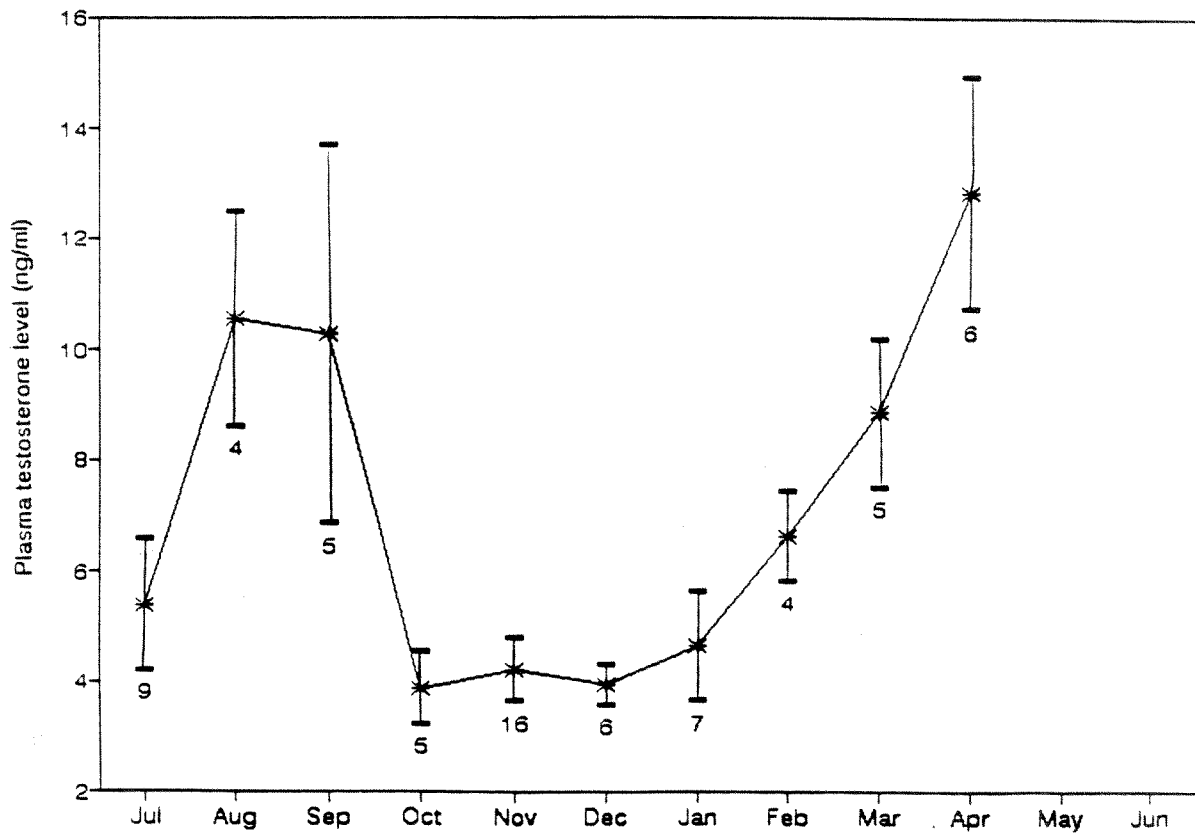


Fig. 2. Seasonal variations of plasma testosterone concentration for mature specimens of *G. melas* (n=67). Sample sizes are above the error bars which represent one standard error from the mean

FURTHER STUDIES ON THE POPULATION STRUCTURE OF THE LONG-FINNED
PILOT WHALE *Globicephala melas* OFF THE FAROE ISLANDS

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A genetic investigation of 31 schools of long-finned pilot whales *Globicephala melas* off the Faroe Islands was performed using isozyme electrophoresis to test the hypothesis of the existence of one or more stocks in the Northeast Atlantic.

The effect of age-structure and sex on the genotypic composition was examined to test if it was permissible to use a common gene frequency when comparing the 31 schools.

One school differed significantly from the rest, but no geographical origin could explain this observation.

The heterogeneity found between the schools could imply a strong maternal family structure, with mature males migrating between the schools.

OCCURRENCE AND GROUP STRUCTURE OF SHORT-FINNED PILOT WHALES
Globicephala macrorhynchus OFF THE WESTERN COAST OF TENERIFE,
CANARY ISLANDS

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INTRODUCTION Many intriguing questions relating to the group structure of large vertebrates have been raised by recent information on pilot whales *Globicephala* spp.: relatively large, sexually dimorphic dolphins living in highly cohesive, female-biased social groups. Data from shore fisheries for short-finned pilot whales *G. macrorhynchus* off Japan have recorded males up to age 50 years and females up to age 70 (Kasuya and Marsh, 1984). One-quarter of the females more than 36 years old showed no recent ovarian activity, suggesting an extended post-reproductive period, which is uncommon in mammals (Marsh and Kasuya, 1986; Hrdy and Whitten, 1987). Additionally, one-sixth of these post-reproductive females were still lactating (Kasuya and Marsh, 1984), probably due to the extended suckling of the last calf (Kasuya and Marsh, 1989). Thus, maternal investment continues with age, even as the females' potential for future reproduction decreases. It is also possible that these females may assist related females through the communal suckling of calves. However, there have been no detailed field studies of free-ranging pilot whales to examine the roles of these individuals.

This is a preliminary report of a 2-year study of a free-ranging group of short-finned pilot whales off the western coast of Tenerife in the Canary Island archipelago. This paper reports on the initial findings of occurrence and group structure which will form the basis for an on-going study of the behavioural ecology of this species.

METHODS Whales were observed primarily from a 4.9 m Zodiac inflatable boat and secondarily from shore stations. The primary method for assessing population identity, abundance and social structure has been the photographic identification of individual animals. Whales were identified on the basis of nicks and scars on the dorsal fin. Additionally, scars along the fin and back as well as pigmentation patterns have been used as identifying characteristics. Black and white photographs and colour slides were taken with a 35 mm Nikon FE-2 camera equipped with a 70-210 mm zoom lens and data-back for imprinting date and time on each frame of film. Negatives were examined under a 20x microscope and composite drawings were made from film sequences to compile identifying characteristics of the whales observed. Prints were made for a photographic catalogue. The drawings and prints were then compared with subsequent identifications in order to locate repeat sightings. Identifications from all frames of film were entered onto computer to aid in cross-referencing multiple sightings of the same individuals.

RESULTS Short-finned pilot whales were located on 21 of 34 boat days (from 25 September 1989 to 11 February 1990) and were observed for 56.1 hrs (49% of 114.9 hrs sighting effort). Whales were observed from shore on an additional 20 days. All whale observations occurred within a 130 km² area, between 28°00'N and 28°07'N latitude, and 16°42'W and 16°50'W longitude. Whales were consistently observed in the vicinity of the 1000 m depth contour, located approximately 4-5 km west of the port of Los Cristianos. There were some indications of diurnal activity during October through December. The majority of early morning observations were in the southern part of the study area, with whales first moving north and then turning south at mid-day, returning along the 1000 m contour. However, during January and February, the pattern changed and whales were most frequently observed travelling south from the northern part of the study area and arriving in the southern portion in the early afternoon. This is also the period when tuna begin to move into the region and this apparent shift in habitat use patterns may be based on a shift in food resources.

Individual short-finned pilot whales (187) were identified from over 3000 frames of film collected over 21 days (Fig. 1). Fifty-seven of these whales (30%) were seen on multiple days, some as many as 5 days. Maximum time between sightings was 127 days of the 131-day study period. A few small groups were consistently seen together on multiple days. However, many new individuals are still being encountered.

The whales have been tolerant of longterm observation, including underwater sessions. The sex of a few individuals has been postulated, although they have not been verified. Adult males were noticeably larger, with large, broad-based, hooked dorsal fins and melons which project noticeably beyond the tip of the upper jaw (a character discussed by Yonekura *et al.*, 1980). Young calves were obvious by their small relative size in comparison to adults, greyish colouration, and the occasional presence of fetal folds. Groups tended to be composed of small subgroups of mixed sex and age, and had up to 30 whales per group. Calves of several size classes were common and frequently found in subgroups with one or two attending adults of either sex. Pairs of adult males were also observed, often travelling separately from other group members.

Behavioural categories have not been thoroughly quantified. However, these pilot whale groups appear to have a limited behavioural repertoire. The most common behaviour has been slow travel, interspersed with stationary resting bouts at the surface. Animals respire synchronously, occasionally diving slowly just below the surface, and then surfacing again to hover for up to 2 min. They were always silent during this apparent resting behaviour. Feeding has been tentatively characterised by long dive times (average of 4 min) with little progression from the initial location. Fresh squid tentacles have been found in the vicinity of these groups, indicating recent feeding. On one occasion, a male was observed underwater with a tentacle hanging from the corner of his mouth. On a few occasions, directional high-speed travel has been observed, with animals "porpoising" high out of the water (to the midline of the body). Breaching was observed on only one occasion, when two groups were oriented towards each other, separated by approx. 25 m. Acoustic recordings during this period were the most complex recorded to date, comprising a variety of screeches and guttural bursts of rapid clicks and screeches. This could have been some sort of coordinated feeding activity, or perhaps a social interaction between the two groups. Subsequently, the two groups joined and travelled off together, never exhibiting the same behaviour for the rest of the day.

A number of other dolphin species were also observed in association with pilot whale groups. Bottle-nosed dolphins *Tursiops truncatus* have been most frequent, seen with pilot whales on 10 of the 21 days. Striped dolphins *Stenella coeruleoalba*, Risso's dolphins *Grampus griseus* and common dolphins *Delphinus delphis* have also been observed, each of on one occasion. Three fin whales *Balaenoptera physalus* were also observed in the study area, although not in association with pilot whales.

CONCLUSIONS Although these results are preliminary, they suggest that short-finned pilot whales off Tenerife exist in somewhat stable subgroups. At this point, the degree of mixing between groups appears to be high, superficially more similar to the semi-fluid groups observed in bottle-nosed dolphins (Wells *et al.*, 1987) than to highly stable killer whale groups (Heimlich-Boran, 1986). The large number of new animals observed indicates either a very large population of pilot whales in the region or a fluid and more open population with a cycling of temporary membership. It will be critical to identify the distribution range of specific groups.

Future research will focus on the examination of social dynamics within groups. A number of questions will be addressed. For example, how important are the roles of specific individuals (e.g. dominant males, matriarchal females, etc.) in determining group composition and stability? What ecological factors affect the relative stability of a social group? The answers to these questions will begin to aid in understanding the behavioural ecology of these whales, as well as other mammals.

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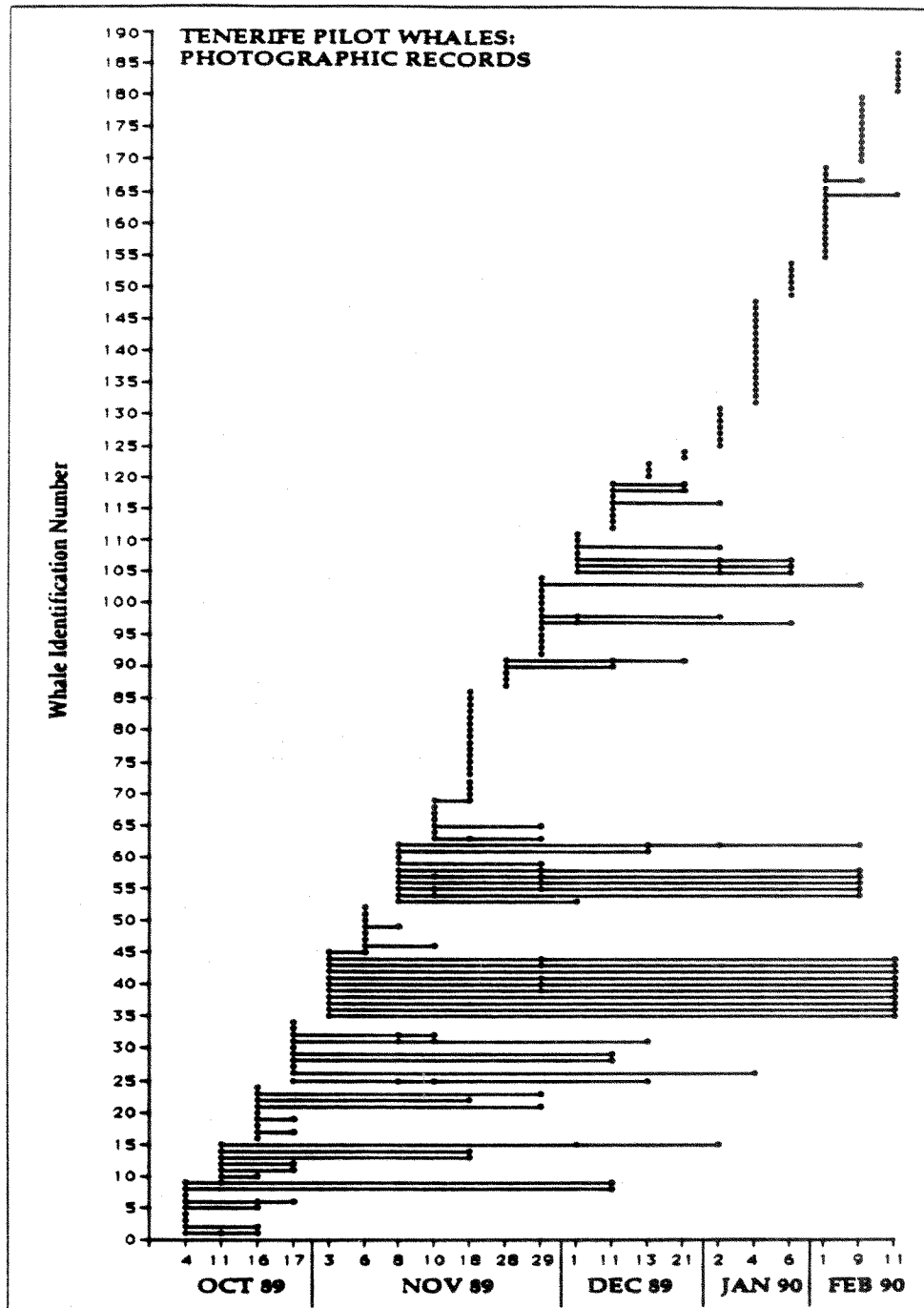


Fig. 1. Sighting histories of short-finned pilot whales identified off Tenerife. Each dot indicates a photographic identification. Horizontal lines connect multiple sightings of the same individual

MERCURY CONTAMINATION OF THE HARBOUR PORPOISE *Phocoena phocoena* AND OTHER CETACEANS FROM THE NORTH SEA AND THE KATTEGAT

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The following cetaceans were collected in the North Sea and the Kattegat over the period 1987-90: four harbour porpoises *Phocoena phocoena* from the bycatch in the central North Sea (origin: about 54°N, 2°E) and two porpoises, an adult male sperm whale *Physeter macrocephalus* and a common dolphin *Delphinus delphis* stranded in Belgium (samples provided by J. Van Gompel and F. Coignoul); 10 porpoises from the bycatch in the Danish waters of the Kattegat (C. Kinze); and two bottle-nosed dolphins *Tursiops truncatus* from the Brugge dolphinarium. All were analysed for their total mercury contamination in muscle, liver, kidney and blubber.

No geographical differences were observed between North Sea and Kattegat animals. In general, mercury levels which were relatively "normal" for marine mammals were found, both when expressed as a concentration (less than 10 µg/g dry weight in the different tissues) and as liver/muscle ratio of mercury concentrations (approx. 2).

The notable exceptions were three porpoises, the sperm whale and the common dolphin; they showed high concentrations of 40 to 50 µg/g dry weight, as well as a very high liver/muscle ratio (up to 20). This might be an indication of acute intoxication, and may possibly even be responsible for the death of the animals. The animals did not show any high parasitic infection, their stomachs were empty and bleeding and bleeding within the intestines was detected (F. Coignoul and M. Borrens, pers. comm.). Their lipid content was very low, suggesting that they were in poor physiological condition and that consumption of their own fat reserves might have caused a remobilisation of lipo-soluble xenobiotics, and provoking an acute intoxication.

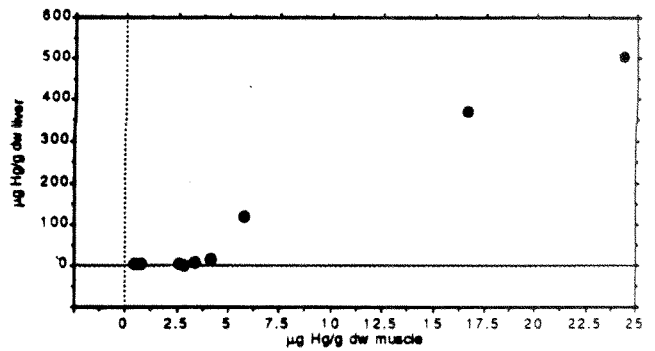
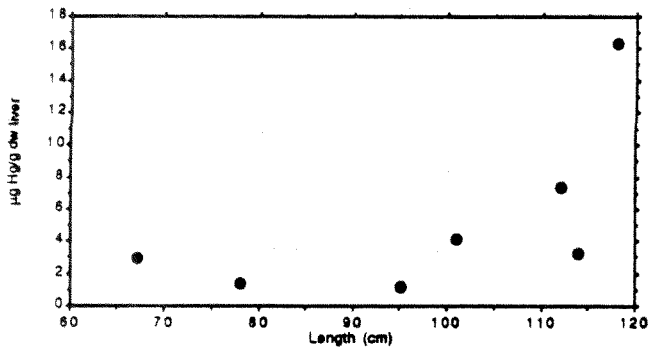
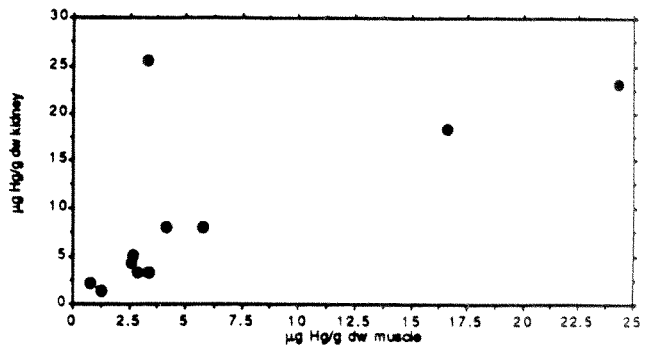
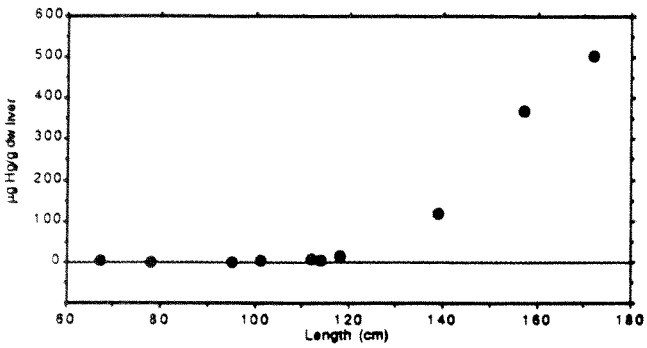
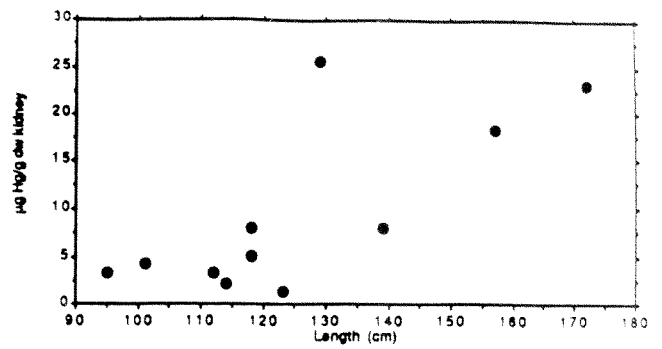
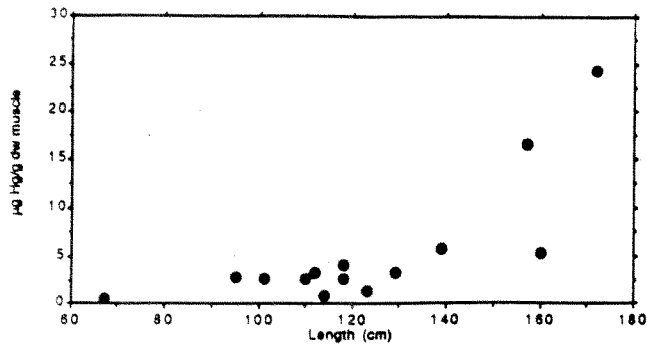
A separate determination of organic mercury was already performed in the case of the sperm whale and a bottle-nosed dolphin ('Laboratoire Intercommunal', Brussels), and revealed that all the mercury was present in methyl form, an observation entirely compatible with our interpretation.

Table 1: Total mercury contamination of North Sea cetacea.

	Species	Length cm	Tissue	$\mu\text{g Hg/g}$ fresh weight	$\mu\text{g Hg/g}$ dry weight	$\mu\text{g Hg/g}$ lipid weight
1	<i>Phocoena phocoena</i> Belgium, 04-05-1987 (juv. female, bycatch)	67	muscle liver	0,3 0,8	0,9 2,9	2,3 38,3
2	<i>Phocoena phocoena</i> Belgium, 26-06-1988 (juv. fem., found dead at sea)	78	blubber liver	0,5 0,4	1,1 1,4	2,3 16,4
3	<i>Phocoena phocoena</i> Belgium, 02-07-1988 (juv., bycatch)		liver	1,0	5,0	110,5
4	<i>Phocoena phocoena</i> Belgium, 08-07-1988 (ad fem., bycatch)	160	muscle	1,5	5,2	
5	<i>Phocoena phocoena</i> Belgium, 15-08-1988 (sub ad male, stranded)	110	muscle	1,0	2,6	12,5
6	<i>Phocoena phocoena</i> Belgium, 31-01-1990 (old female, stranded)	172	muscle liver kidney	6,5 131,7 4,8	24,3 504,0 23,2	
7	<i>Phocoena phocoena</i> Denmark, 01-1988 (female, bycatch)	157	muscle liver kidney	4,1 117,4 4,3	18,6 369,1 18,3	
8	<i>Phocoena phocoena</i> Denmark, 03-1988 (female, bycatch)	123	muscle kidney	0,4 0,4	1,3 1,3	
9	<i>Phocoena phocoena</i> Denmark, 04-1988 (female, bycatch)	118	muscle kidney	0,7 1,2	2,6 5,0	
10	<i>Phocoena phocoena</i> Denmark, 04-1988 (female, bycatch)	101	muscle liver kidney	0,7 1,1 1,3	2,6 4,2 4,3	
11	<i>Phocoena phocoena</i> Denmark, 04-1988 (female, bycatch)	118	muscle liver kidney	1,2 5,6 1,7	4,2 16,3 8,0	
12	<i>Phocoena phocoena</i> Denmark, 08-1987 (male, bycatch)	95	muscle liver kidney	0,8 0,2 0,9	2,9 1,2 3,3	
13	<i>Phocoena phocoena</i> Denmark, 01-1988 (male, bycatch)	112	muscle liver kidney	0,9 2,8 1,1	3,3 7,3 3,3	
14	<i>Phocoena phocoena</i> Denmark, 07-1987 (male, bycatch)	139	muscle liver kidney	1,7 43,8 2,0	5,8 118,9 8,0	
15	<i>Phocoena phocoena</i> Denmark, 04-1988 (male, bycatch)	114	muscle liver kidney	0,3 1,2 0,5	0,8 3,3 2,1	
16	<i>Phocoena phocoena</i> Denmark, 05-1988 (male, bycatch)	129	muscle kidney	0,9 8,3	3,3 25,6	
17	<i>Physeter macrocephalus</i> Belgium, 12-02-1989 (ad male, stranded alive)		muscle liver	0,9 18,9	2,7 50,3	10,6 4598,8
18	<i>Delphinus delphis</i> (*) Belgium, 10-01-1986 (ad male, stranded alive)	205	muscle liver blubber	5,7 30,6 0,8	8,2 41,6	7,6 1207,7
19	<i>Tursiops truncatus</i> "KIM" Brugge, Belgium, 01-05-1989 (female, dead in dolphinarium)	240	muscle liver kidney	1,1 18,6 1,3	4,0 83,6 6,8	
20	<i>Tursiops truncatus</i> Brugge, Belgium, 20-04-1989 (male, still born in dolphinarium) (son of preceeding)	111	muscle liver kidney	0,1 0,5 0,1	0,2 2,2 0,6	

(*) Joiris, C., J.M. Bouquegneau, K. Delbeke and W. Overloop. 1987. Contamination by stable pollutants (organochlorines and heavy metals) of a common dolphin *Delphinus delphis* found dying in Belgium. Eur. Cetacean Soc. Newsletter, 1: 30-31.

Phocoena



All Cetaceans

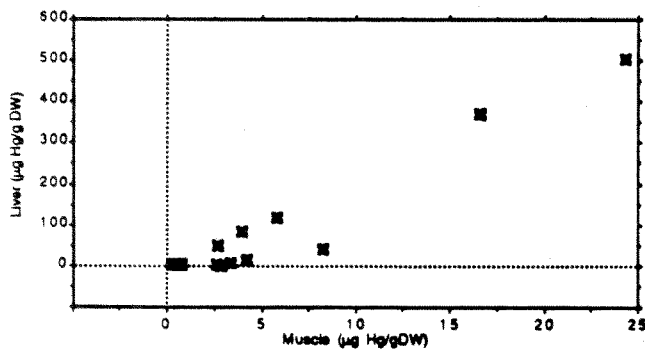


Fig. 1. Mercury concentrations ($\mu\text{g/g dry weight}$) in different tissues for *Phocoena phocoena* and all cetaceans combined

PRELIMINARY STUDY OF CHLORINATED HYDROCARBON LEVELS IN
CETACEA STRANDED ALONG THE TYRRHENIAN COAST OF LATIUM
(CENTRAL ITALY)

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INTRODUCTION Chlorinated hydrocarbons are a group of contaminants which have penetrated all ecosystems, including those of "remote areas" such as the Arctic and Antarctic. In recent years, the levels of these compounds, 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 animals at the top of the food chain such as marine mammals. It is particularly serious for Cetacea since, besides having very high concentrations of these persistent contaminants in their tissues, they are known to be very sensitive to the toxic effects of such xenobiotics (Aguilar, 1985).

The aim of the present paper is to report the first results of an investigation into the concentrations of chlorinated hydrocarbons in the tissues of cetaceans stranded along the Tyrrhenian coast. The present data refer in particular to two species common in the Mediterranean: the striped dolphin *Stenella coeruleoalba* and the bottle-nosed dolphin *Tursiops truncatus*, many specimens of which are found dead along the Italian coasts each year. The present samples come mainly from the central Tyrrhenian coast (Latinum coast). The congeners of PCBs were analysed in order to evaluate their actual toxicity.

METHODS For the analysis, freeze-dried material was extracted by 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 electron capture detector (Ni63) and an SBP-5 (30 m) bonded phase capillary column. The analytical details are reported elsewhere (Focardi *et al.*, 1988). In view of the variable water content of stranded material, the results are expressed in mg/kg dry weight.

RESULTS AND DISCUSSION The results (Tables 1-4) reveal the presence of hexachlorobenzene (HCB), pp' isomers of DDT and its derivatives DDD and DDE, op'DDT and many PCB congeners in all the cetaceans analysed. The data for the striped dolphin apply to a sufficiently large number of specimens for statistical analysis. Organochlorine concentrations are listed in decreasing order: blubber, liver, kidney, brain, heart, lung and muscle. This order is closely correlated with the lipid content of the tissues and confirms previous findings in the literature (Aguilar, 1985).

HCB levels were low in all samples; the levels of DDT and its derivatives, especially pp'DDE, were much higher. The pp'DDE/pp'DDT ratio was always greater than one, ranging from a mean of 2 in blubber to more than 10 in lean tissues. Capillary gas chromatography revealed about 25 PCB congeners in the two species (Fig. 1); the majority consisted of hexachlorobiphenyls 22'344'5' and 22'44'55', also known by IUPAC nos 138 and 153 (Ballschmitter and Zell, 1980), heptachlorobiphenyls 22'33'44'5, 22'344'55' and 22'34'55'6 (IUPAC nos 170, 180 and 187, respectively) and 22'33'44'5'6 (IUPAC no. 196). No significant differences were found in the fingerprint of the PCBs in the different tissues of either species: the correlation between the main congeners was with few exceptions quite high. Apart from 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.

These first results are not sufficient to show any differences between the two species, which are known to have different habits. As regards the relationships between contaminant levels, sex and age, the figures for muscle of striped dolphin clearly show an increase in all contaminants with body length in males. In females, contaminant levels remain stable or decrease from 170-180 cm body length, which presumably corresponds to sexual maturation. This has also been found in other species of cetaceans (Tanabe *et al.*, 1987; Aguilar and Borrell, 1988).

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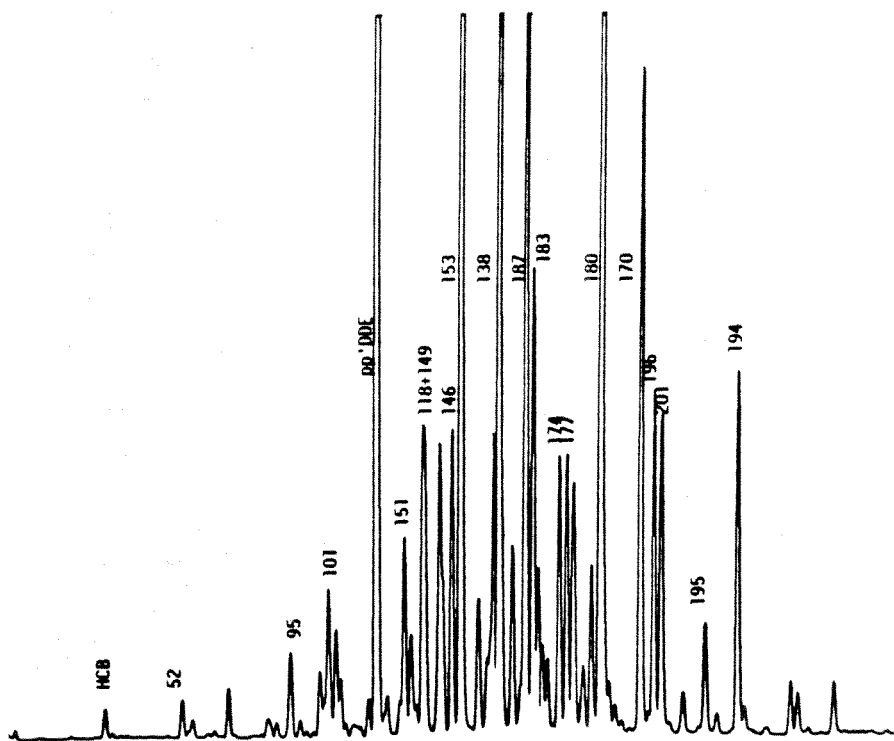


Fig. 1. Capillary column ECD chromatogram of the muscle of *S. coeruleoalba*. IUPAC numbers are indicated

Tab. 1 - Average concentrations (mg/kg dry weight) of HCB, DDT and derivatives, in *S. coeruleoalba* (EOM% = % of extracted organic matter d.w.).

tissues	n	EOM%	HCB	pp'DDE	pp'DDD	pp'DDT	op'DDT
muscle	20	16.2	0.004	1.577	0.078	0.143	0.134
liver	14	19.0	0.026	12.657	1.465	2.447	1.436
blubber	5	93.4	0.176	61.333	5.386	30.893	16.501
heart	10	15.3	0.004	2.415	0.288	0.435	0.168
kidney	7	12.1	0.011	4.726	0.500	1.058	0.414
lung	4	14.0	0.003	2.049	0.273	1.188	0.187
brain	5	27.5	0.010	3.901	0.253	0.397	0.321

Tab. 2 - Average concentrations of the main PCBcongeners (mg/kg dry weight) in *S. coeruleoalba* (IUPAC numbers).

tissues	n	138	153	170	180	187	196
muscle	20	0.622	1.193	0.496	0.868	0.537	0.550
liver	14	5.902	11.147	4.303	8.920	4.595	4.667
blubber	5	27.500	47.944	17.974	37.034	18.172	17.828
heart	10	1.445	3.016	1.241	2.223	1.351	1.453
kidney	7	1.931	3.568	1.507	2.744	1.647	1.787
lung	4	1.762	3.722	1.407	2.572	1.550	1.465
brain	5	1.970	3.566	1.316	2.564	1.586	0.874

Tab. 3 - Average concentrations (mg/kg dry weight) of HCB, DDT and derivatives in *Tursiops truncatus*.

tissues	n	EOM%	HCB	pp'DDE	pp'DDD	pp'DDT	op'DDT
muscle	6	24.3	0.143	4.583	0.388	0.460	0.656
liver	5	28.9	0.204	10.927	1.021	1.344	1.740
blubber	2	84.7	0.547	44.201	4.336	9.055	9.075
heart	3	43.0	0.013	10.375	1.569	1.722	0.496
kidney	1	31.3	0.096	13.202	1.881	2.286	0.720
brain	1	55.2	0.080	1.518	0.105	0.173	0.453

Tab. 4 - Average concentrations of the main PCBcongeners (mg/kg dry weight) in *T. truncatus*.

tissues	n	138	153	170	180	187	196
muscle	6	4.213	9.211	2.981	5.464	2.737	2.928
liver	5	7.270	13.214	4.094	7.600	3.790	3.818
blubber	2	30.835	55.095	18.060	36.850	14.910	16.440
heart	3	7.513	16.126	4.443	7.686	3.920	3.110
kidney	1	9.440	18.790	6.800	16.940	6.540	10.150
brain	1	1.560	3.482	1.410	2.800	0.830	0.880

DISTRIBUTION OF ORGANOCHLORINES IN TISSUES AND ORGANS OF THE FRANCISCANA *Pontoporia blainvillei*

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INTRODUCTION There has been a lack of standardisation as to which organ or tissue is representative for the calculation of residue levels of organochlorine compounds in marine mammals.

Biochemical composition and physiological function determine the concentration of pollutants present in a tissue, for which reason they may be substantially different in the various body organs of a given individual. Moreover, blubber and muscle, the tissues most often used in organochlorine surveys of marine mammals, are highly heterogeneous both in biochemical composition and histological structure. As a consequence of these heterogeneities, no reliable estimates of pollutant load can be obtained from a given species unless the pattern of variation of organochlorines within and between organs is determined. We present here the results of a study to determine this pattern of variation in the franciscana *Pontoporia blainvillei*.

MATERIALS AND METHODS Tissues from eight franciscanas caught in gill nets off Necochea (Argentina) in September 1988, were collected and analysed for organochlorines. Tissues sampled were: blubber (five locations), muscle (two locations), kidney and liver. Samples were preserved in deep freeze and analysed for organochlorines using a high resolution capillary gas chromatograph with electron capture detector following procedures described by Aguilar and Borrell (1988).

Because pollutant loads were somewhat different between individuals, tissue concentrations were standardised in relation to the mean pollutant content of the blubber of each individual. Results were analysed by a one-way ANOVA to detect differences between tissues or between locations within a tissue.

RESULTS AND DISCUSSION

Variation within blubber No statistical differences were found either in pollutant concentrations or in ratios between pollutants between the five locations sampled. The coefficients of variation of organochlorine concentrations for the five locations sampled were relatively small (usually ranging 0.1-0.25) and probably reflect more analytical variation than tissue heterogeneities. This suggests that any body site of blubber tissue can be taken as representative of the whole blubber compartment.

Variation within muscle Significant differences were found in the concentration of pp'DDT ($p < 0.05$) and in the ratio tDDT/PCB ($p < 0.01$) between the two locations of muscle sampled. While the other pollutants and ratios appeared to be similar all over the tissue, the differences found, especially in the case of the tDDT/PCB ratio, indicate the need for careful site selection in muscle when collecting samples for organochlorine analysis.

Variation between tissues Fig. 1 shows organochlorine concentrations for the different tissues expressed on a fresh weight basis and on a lipid basis (ng/g). Because of the much higher lipid contents of blubber in relation to the other organs, this tissue carried significantly ($p < 0.001$) higher concentrations of organochlorines, compounds which are highly lipophilic and tend to concentrate in lipid-rich layers (Fig. 1).

However, the magnitude of this difference diminishes when pollutant concentrations are calculated on a lipid basis, that is, in relation to the tissue's fat content. This can be clearly seen in Fig. 1, where the mean level of organochlorines in the different tissues expressed on a lipid basis are displayed. Nevertheless, even though variation between tissues has been much reduced, the ANOVA showed that some differences between tissues still persisted. Liver was the organ that was most clearly differentiated from the rest: its pollutant concentrations were significantly lower (except for pp'TDE), and the relative proportion of degraded forms of DDTs was much higher in this tissue than in the remaining ones. This difference should be attributed to the particular physiological function and structure of the liver. Thus, the lipids composing its cellular structure are mostly phospholipids, with a relatively high molecular polarity and low capacity for retention

of organochlorines. Moreover, the liver is the centre for enzymatic metabolism of organochlorines and the compounds reaching this organ are transformed into degraded forms more readily than in other, less physiologically active tissues.

CONCLUSIONS Organochlorine pollutants distribute homogeneously in the blubber of the franciscana, for which reason any body site (in the trunk) of this tissue can be taken as representative for the whole blubber layer.

Organochlorine pollutants distribute heterogeneously in the muscle, so there is a need for careful and consistent site selection when collecting samples from this tissue in the franciscana.

On a fresh weight basis, blubber is the compartment carrying the greatest proportion of the organochlorines present in the body. This is explained by the much higher lipid contents of this tissue.

When organochlorine concentrations are expressed on a lipid basis, it appears that liver carries significantly lower quantities of pollutants but proportionally more degraded forms than the other body organs. The reason for this seems to be the biochemical composition and enzymatic activity of liver.

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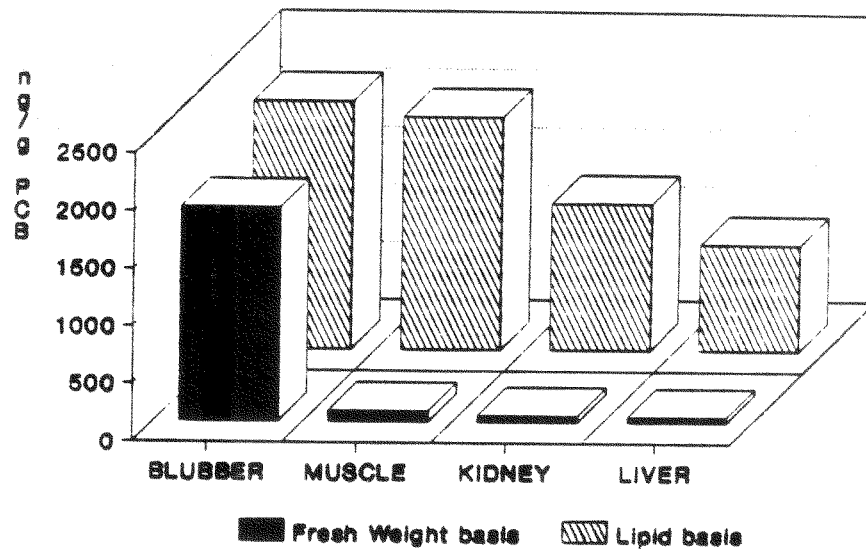
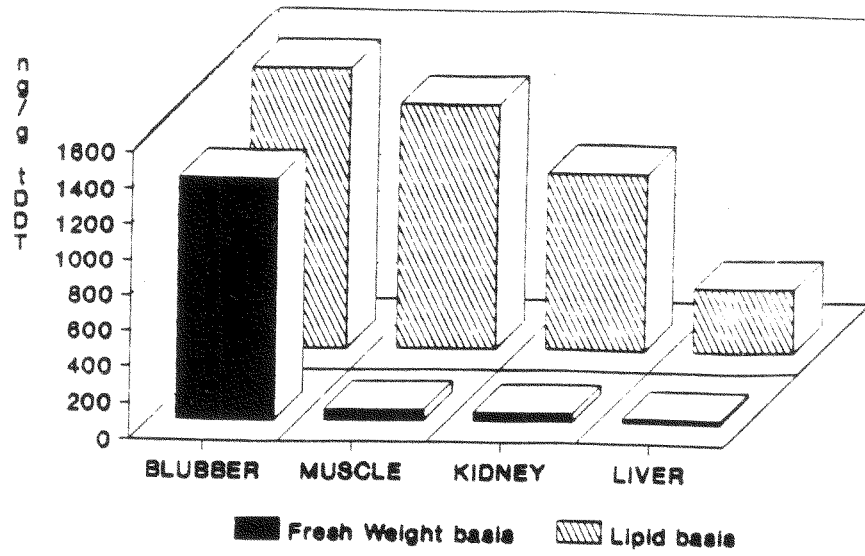


Fig. 1. tDDT and PCB concentrations (ng/g) expressed on a fresh weight and lipid basis for blubber, muscle, kidney and liver of the franciscana

SQUAMOUS CELL CARCINOMA OF THE SKIN IN A STRIPED DOLPHIN *Stenella coeruleoalba*

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During an autopsy of a striped dolphin *Stenella coeruleoalba* found stranded on a beach in Tarragona (Spanish Mediterranean Sea) on 4 April 1989, the presence of a squamous cell carcinoma was observed in its sternal region. The animal was a 182 cm long, sexually mature female. The animal's weight was 63 kg, a value which falls within the normal range of variation for this body size in striped dolphin. The dolphin showed no other signs of infection, with the exception of the presence of larvae of cestodes in the region around the anus and genitalia, some cirripedia (*Xenobalanus globicipitis*) attached to the tail, and a few cyamids in the blowhole. This paper describes the macroscopic and histological appearance of the carcinoma.

GROSS AND HISTOLOGICAL DESCRIPTION The squamous cell carcinoma found in the dolphin was a single, well circumscribed, mass of approx. 7 cm diameter, located in the sternal region of the trunk.

Histologically, the tumour was locally invasive and composed of masses or cords of epidermal cells that proliferated downward and invaded the dermis. Fibrosis was observed surrounding these neoplastic epithelial cords. Some cells had separated from the cords and remained as isolated islands forming focal, more or less circular, concentric layers of stratified epithelium. In these islands, the basal layer remained in the external region, and there was a progressive keratinisation from this region towards the centre of the nodule. Because of the high differentiation and poor anaplasia observed, this lesion is considered to be a squamous cell carcinoma of low grade malignancy.

CIRCUMSTANCES LEADING TO CARCINOMAS Compared with humans and domestic animals, the frequency of occurrence of neoplasia in wild terrestrial species is low. In aquatic mammals, even fewer neoplasias have been found. However, the lack of observations may be explained by the limited number of animals examined. Moreover, the few cases reported to date have been published in the last 20 years. According to Geraci *et al.* (1987), there have been 41 confirmed documented tumours in cetaceans, 24% of which have been recorded in the skin. The high percentage of skin tumours can be explained because of their superficial occurrence, that makes them easy to detect and identify.

Squamous cell carcinomas are the commonest form of carcinoma in most domestic animals, and they have also been reported in wild animals. These tumours derive from squamous epithelial cells and are in most cases of low-grade malignancy. They are locally invasive but slow to metastasise. When occurring, metastasis is mainly regional via the lymphatic system, but systemic hematogeneous spread does occur. The predominant anatomical location of squamous cell carcinoma varies between species. It has predilection for mucocutaneous areas, but can be found in all corporal regions. It has been observed in animals of any age, but it occurs more often in those of advanced age. In cetaceans, only two squamous cell carcinomas have been reported: one in the skin of a captive Pacific white-sided dolphin *Lagenorhynchus obliquidens*, and another one in the lung of an Amazon river dolphin *Inia geoffrensis* (Geraci *et al.*, 1987). In the first case, the tumour was treated with cryosurgery, apparently obtaining positive results.

CAUSATIVE AGENTS In most cases, the cause of the squamous cell carcinoma is not clear. In domestic species, it is strongly related to chronic exposure of poorly pigmented skin to ultraviolet light. It has also been reported to arise from scars of burns produced by heat or by chemical products. However, exposure to other agents, including hydrocarbons, arsenical compounds, or chemicals such as methylcholanthrene or benzopyrene are also known etiologic factors. In some animals, papillomas may also sometimes transform into squamous cell carcinomas.

Skin covers the largest area of the body and it is constantly exposed to factors that may cause cancer. The initiation of cutaneous neoplasms may result from multiple complex causes rather than from a single factor. The area where the dolphin was found is heavily polluted by a variety of chemicals released from

neighbouring industries and from oil drilling operations. However, no direct cause-effect relationship can be established.

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NUTRITIONAL STRESS AND ADRENAL GLAND WEIGHT IN FIN WHALES.
Balaenoptera physalus

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With the objective of ascertaining whether natural stress produced by variation in nutritive condition occurs in baleen whales, the pattern of variation of adrenal gland weight and energetic reserves in fin whales has been studied. Adrenal glands and samples of dorsal blubber were collected from fin whales *Balaenoptera physalus* of known reproductive condition, length and age, caught off Spain (N = 32) and Iceland (N = 28).

An ANOVA performed on the lipid content of blubber of the different specimens showed that lactating and resting (mostly post-hatching) females had significantly lower nutritive reserves than males and pregnant and sexually immature females. An ANCOVA (with body mass as covariate) made on the weights of the adrenal glands of the same specimens showed that lactating females, subject to the stringent energetic demands of nursing, suffer stress caused by depletion of nutritive reserves during at least the final period of their reproductive cycle.

FIRST RECORD OF *Crassicauda* sp. PARASITISING ATLANTIC HARBOUR PORPOISES

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INTRODUCTION The harbour porpoise *Phocoena phocoena* is one of the cetacean species currently in decline in European waters. The reasons for this marked decline in populations may be found in environmental deterioration involving accumulation of pollutants (organochlorines and heavy metals), weakening of the immunological response to bio-aggressors (viruses, bacteria and parasites), as well as an increase in human direct activities such as overfishing, bycatches and boat disturbance.

The parasite fauna composition of the harbour porpoise has been well studied from a qualitative point of view, but until now no quantitative parasitological study has been carried out.

In all, 23 parasites or phoront species have been reported from the harbour porpoises throughout its distribution area. Five of these species belong to Trematoda, four to Cestoda, nine to Nematoda, three to Acanthocephala, one to Cirripectida and one to Amphipoda (Raga, in press). One of the species of Nematoda, *Contracaecum aduncum*, is more likely to be a case of accidental parasitism due to the infected fish having been porpoise food (Young and Lowe, 1969).

MATERIALS AND METHODS In the course of multidisciplinary investigations of harbour porpoises in North Atlantic waters, 50 specimens shot in aboriginal hunting in Sukkertopen and Qasigiannuguit (Greenland) during 1988-89 were made available for parasitological studies.

Examination of skin, blubber, stomach, intestine, liver, heart, lungs and air sinuses of the porpoises resulted in the finding of several trematode, cestode and nematode species. Parasites collected are in the process of taxonomic and statistical studies.

RESULTS AND DISCUSSION The air sinuses of 47 porpoises were examined for parasites. Two ear-worm (Nematoda) species were detected. Small, brown-reddish nematodes identified as *Stenurus minor* (Kühn, 1829) (Pseudaliidae) were found in 40 porpoises (85.1%). Only very young animals were free of this parasite.

Large, whitish nematodes occurred in two hosts (4.2%) in mixed infections with *S. minor*. Only two male caudal fragments could be recovered since the worms appeared with their bodies deeply embedded in the surrounding tissues and bones. The morphology of these nematodes clearly conforms with that of the genus *Crassicauda* (Crassicaudidae). However, the low number of worms recovered and the poor condition of the material prevented identification at specific level, especially when taking into account the rather controversial taxonomy of this genus (Raga and Balbuena, in press).

Lesions caused by *Crassicauda* sp. were observed in one of the porpoises. These lesions involved damage of bones surrounding the air sinuses which attained the dorsal surface of the skull, with maxillary perforation in the vicinity of the nasal bones.

These pathologies are very similar to those described in skulls of Risso's dolphin *Grampus griseus* (Raga, 1987), bottle-nosed dolphin *Tursiops truncatus* (Robineau, 1975), spotted dolphin *Stenella attenuata*, spinner dolphin *S. longirostris* (Dailey and Perrin, 1973) and common dolphin *Delphinus delphis* (Walker et al., 1984).

Dailey (1985) pointed out that lesions related to *Crassicauda* sp. have been detected in a great number of odontocete species. Perrin and Powers (1980) considered that this nematode could play an important role in natural mortality of *Stenella* spp. in Pacific waters.

To our knowledge, the only previous report of *Crassicauda* sp. in the harbour porpoise was recorded by Dailey and Stroud (1978). These authors detected specimens of *Crassicauda* sp. in the mammary glands of a harbour porpoise stranded on the Pacific coast of North America. This is, therefore, the first record of a

member of the genus *Crassicauda* parasitising harbour porpoises in the Atlantic Basin. The worm is reported for the first time in the air sinuses of this host.

CONCLUSIONS The *Crassicauda* sp. was detected in mixed infections with *Stenurus minor* in two of 47 harbour porpoises shot in Greenlandic waters. Lesions caused by *Crassicauda* sp. detected in one animal represent the first record of a specimen of this genus parasitising the harbour porpoise in Atlantic waters. The air sinuses are a new location for the parasite in this host.

Acknowledgments This study was partially supported by the DGICYT of the Spanish Government (project no. PB87-997). M. Fernández and J.A. Balbuena received grants from the Danish Ministry of Education and the Conselleria de Cultura, Educació i Ciència de la Generalitat Valenciana.

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PRELIMINARY DATA ON THE PARASITE FAUNA OF THE FRANCISCANA IN ARGENTINIAN WATERS

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INTRODUCTION The franciscana or La Plata dolphin *Pontoporia blainvillei*, classically considered as the only platanistid living in marine waters, is currently regarded as a representative of the family Pontoporiidae. Its distribution area is limited to the South American coastal waters of the Atlantic Ocean, from the Doce River, in the Espiritu Santo Region in Brazil, to Valdez Peninsula in Argentina. It seems that this species is more common in the La Plata river mouth and neighbouring waters (Brownell, 1989).

The franciscana population is undergoing great human pressure, involving numerous bycatches in the shark fishery in Brazilian, Uruguayan and Argentinian waters (Praderi *et al.*, 1989; Pérez-Marcí and Crespo, 1989), so much so that the IUCN has proposed several plans to assess the impact of fishing activities upon this cetacean population (Perrin, 1988).

The biology of the franciscana dolphin is poorly known, most of the information coming from animals in Uruguayan waters (Brownell, 1989; Pinedo *et al.*, 1989). There are also data of its parasites from bycatches in the same area (Kagei *et al.*, 1976; Brownell, 1981).

MATERIALS AND METHODS A parasitological survey is being conducted as part of a research programme on factors limiting the population of the franciscana in Argentinian waters. So far, 17 franciscanas caught in shark fishing nets off Necochea and Claromecó (Buenos Aires Province) between 1988 and 1989 have been examined.

Necropsies included examination of skin and natural openings, lungs, heart, kidneys, muscle tissue, blubber, liver, pancreas, stomach and intestine. All worms collected were fixed and preserved in 70% ethanol. Nematodes and acanthocephalans were cleared in lactophenol, trematodes were stained in aluminic carmine and mounted in Canada Balsam for study of their internal structures.

RESULTS AND DISCUSSION Four parasite species were detected: *Polymorphus* (*Polymorphus*) *cetaceum* (Johnston and Best, 1942) (Acanthocephala: Polymorphidae) was found attached to the walls of the stomach and duodenal ampulla of all franciscanas examined. Although Kagei *et al.* (1976) reported this worm in franciscana as *Corynosoma cetaceum*, it was later transferred to the genus *Polymorphus* after re-examination of the helminths by Schmidt and Dailey (1971).

Anisakis simplex (Rudolphi, 1809) (Nematoda: Anisakidae) occurred in nine of the 17 animals (52.9%). Worms were found freely in the stomach compartments, showing a preference for the main (fundic) stomach.

Brownell (1972, 1989) noted the frequent occurrence of *Contracaecum* sp. (51%) in franciscanas off Uruguay. Kagei *et al.* (1976) considered, however, that these nematodes belonged to the species *Anisakis typica* (Diesing, 1860). Our helminths clearly correspond to the genus *Anisakis* because of the oesophagus, oesophageal ventriculum and intestine characteristics but, more precisely, must be ascribed to *A. simplex* because of the spicular ratio in the male (Davey, 1971).

Pholeter gastrophilus (Kossack, 1910) (Digenea: Pholeteridae) appeared within cysts in the submucosa of the main stomach and duodenal ampulla of a single specimen (5.9%).

Digenean trematodes of the family Campulidae were detected in the intestine of all franciscanas surveyed. Generally, these worms occurred in the anterior half of the intestine, particularly in the first 3 metres. The taxonomy of these helminths will be clarified in further studies.

Comparison of these results with those available from previous surveys in Uruguayan waters (Kagei *et al.*, 1976; Brownell, 1981, 1989) revealed qualitative differences. Unlike the franciscanas studied in Punta del Diablo (Uruguay), no parasitic (*Nerocila* sp.) or phoront (*Xenobalanus globicipitis*) crustacean species was

found on our specimens. By contrast, the discovery of members of the families Pholeteridae and Campulidae parasitising franciscanas off Argentina represents new host records.

These preliminary discrepancies between Argentinian and Uruguayan waters must be assessed with caution. Differences in numbers of hosts examined (193 in Uruguay vs 17 in Argentina), may account for the differences observed between the two geographical regions. Different feeding habits of franciscana between both areas studied, Punta del Diablo (Uruguay) and Necochea-Claromecó (Argentina), may also explain such qualitative variations.

CONCLUSIONS Preliminary results from a parasitological survey of 17 franciscanas bycaught off Argentina revealed four helminth species (prevalence is shown in parenthesis): *Polymorphus* (*Polymorphus*) *cetaceum* (100%) (Acanthocephala), *Anisakis simplex* (52.9%) (Nematoda), *Pholeter gastrophilus* (5.9%) (Digenea) and Campulidae sp. (100%) (Digenea). Comparison with previous studies carried out in Uruguay indicates qualitative differences in the parasite fauna composition. Differences in sampling effort, methodology and feeding habits between franciscanas of Argentina and Uruguay may account for such discrepancies.

Acknowledgements This study was financed by the DGICYT of the Spanish Government (Project No. PB87-146-C2-2). J.A. Balbuena and J.Azar received grants from the Conselleria de Cultura, Educació i Ciència de la Generalitat Valenciana.

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Isocyamus delphinii (CRUSTACEA, AMPHIPODA, CYAMIDAE), A POSSIBLE
BIOLOGICAL INDICATOR IN THE NORTH SEA

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The North Sea is a shallow sea with a wide oceanic connection in the north and a very small one in the south, through the Channel. It is basically funnel-shaped, getting narrower and shallower to the south. The main area concerned here is the southernmost part, called the Southern Bight. It has particular characteristics compared to the rest of the North Sea - very shallow, lower salinity, high level of pollution, much traffic etc. In the North Sea, this water mass (and fauna and flora) is most isolated from the ocean. In some periods the oceanic influence, based on the occurrence of unusual fishes, turtles, cetaceans, and a number of invertebrates, is more important. This is most clearly illustrated by species with a more southerly distribution moving in. From the Southern Bight viewpoint this can occur equally from the north or south. The reasons are not always very clear, but involve strong favourable winds pushing oceanic water masses into the North Sea and/or the Channel, or a (temporary) warming (either because of a hot summer or perhaps a more general trend of global warming) drawing certain prey species (and their predators) into the area, or a combination of these and other factors. Such "oceanic years" in recent times seem to have been 1966, 1970, 1972, 1976, 1979, 1981, 1984 and 1988.

The cyamid *Isocyamus delphinii* may belong to this group of oceanic indicator species. It is recorded from a variety of host species like common dolphin *Delphinus delphis*, long-finned pilot whale *Globicephala melas*, short-finned pilot whale *Globicephala macrorhynchus*, false killer whale *Pseudorca crassidens*, Risso's dolphin *Grampus griseus*, rough-toothed dolphin *Steno bredanensis*, bottle-nosed dolphin *Tursiops gilli*, Blainville's beaked whale *Mesoplodon densirostris*, Gervais' beaked whale *Mesoplodon europaeus*, and a variety of places like the Mediterranean, Azores, Cape Verde Islands, Far East, Gulf of Mexico, South Africa, Australia and Japan. These are always oceanic or warm temperate areas.

Isocyamus delphinii was first recorded in the North Sea in 1972, on the harbour porpoise *Phocoena phocoena*. Since then it has been found sporadically on this species. Analysing the strandings of harbour porpoise on the continental coast of the Southern Bight (Netherlands and Belgium), the occurrence of the cyamid always coincides with a peak (or its second half) in the 3-year running means (see Table 1). These peaks clearly show some affinity with "oceanic years" (which may show a prolonged effect). There is one other record of the parasite in the Southern Bight: in 1976 on a white-beaked dolphin *Lagenorhynchus albirostris*, also a new host species. Other records of *Isocyamus delphinii* elsewhere in northwestern Europe are: 1972 (in Wales, on a "porpoise"), 1979 (Scotland, host unknown), 1984 (in the French Atlantic, on a pilot whale), 1985 (in Ireland, on a common dolphin *Delphinus delphis*).

My hypothesis is that *Isocyamus delphinii* is an indicator of temporarily increased oceanic influence in the southern North Sea, and perhaps elsewhere in cold temperate waters on the continental northwest European shelf. Since the countries bordering the North Sea have produced some famous cetologists, both in the 19th and 20th centuries, *Isocyamus* would surely have been noticed earlier if it had been present before 1972. This raises the question "Why since 1972?" The following points may be pertinent to the discussion:

- *Isocyamus* prefers "oceanic" host species/populations in tropical and warm temperate waters.
- North Sea cetacean populations were/are free of cyamids.
- By the late 1960s, several cetacean populations in the Southern Bight were severely depleted.
- Since then, spasmodic incursions of partly infested groups of oceanic animals into the North Sea may occur more easily.
- Infested animals found in the southern North Sea could be originally oceanic stragglers or secondarily infested North Sea animals, after intra- or interspecific contact with oceanic animals.

The same may be true for other, even more rarely recorded cyamids in the area, such as *Scutocyamus parvus*.

Table 1. Number of strandings (and 3-year running means) of the harbour porpoise *Phocoena phocoena* on the Dutch and Belgian coast and occurrence of the cyamid *Isocyamus delphinii* on this host species

Year	Strandings	Mean	<i>Isocyamus</i>
1970	24	(17)	
1971	10	18	
1972	20	18.3	1
1973	25	17.7	2
1974	8	16.3	
1975	16	13	
1976	15	18	
1977	23	21.7	
1978	27	22	2
1979	16	21	2
1980	20	23.3	
1981	34	25.3	
1982	22	27.7	
1983	27	23.7	
1984	22	25.7	1
1985	28	23.7	
1986	20	(24)	

SMALL CETACEANS INTERACTING WITH COASTAL FISHERIES IN THE AREA OF NECOCHEA (ARGENTINA)

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INTRODUCTION Interactions of small cetaceans with fisheries have been recorded for several types of fishing operations and areas off the Atlantic coast of South America (Northridge, 1985). Pérez Macri and Crespo (1989) carried out a preliminary survey in central Argentina in 1986 to estimate incidental mortality of the franciscana *Pontoporia blainvillei*, one of the species most frequently affected by coastal fisheries. From information provided by fishermen, they suggested that the potential mortality of dolphins of this species in the harbour of Necochea might be as high as 260 individuals per year. Other small cetacean species are also known to be abundant in the region and it was expected that they might also be subject to incidental mortality.

Given the potential magnitude of the conflict in Necochea, in 1988 we started a survey to ascertain the nature of the interaction and to determine the composition and extent of the incidental catch in the area.

METHODS Fishing activities (coastal and pelagic) were monitored in the area of Necochea from 15 September to 17 October 1988, and from 29 October to 12 January 1989. Data collected included number of boats operating each day, type of fishing, type and length of nets employed, distance to the coast, and number and species of dolphins caught. Several boats in the area cooperated with the survey and brought dolphins incidentally killed to port, where biological samples were collected for studies on age determination, reproduction, feeding, parasites, pollutants and nutrition.

NATURE OF FISHING OPERATIONS Three types of fishing activities are carried out in the Necochea area: bottom trawling, purse-seining for anchovy *Engraulis anchovita* and mackerel *Scomber japonicus*, and gill nets fixed to the bottom for sharks.

The first type, bottom-trawling, does not seem to lead to dolphin mortality and was, therefore, not surveyed. The other two kinds of fishing gear, potentially dangerous for small cetaceans, are alternately used by the fishermen, depending on the season and the changing availability of each type of fish throughout the year.

Purse-seining is carried out by two cooperating vessels, which often set their nets in a strip of water ranging from 0.5 to 30 nautical miles from the coast. Anchovies and mackerel, the two main species exploited, are highly seasonal and the peak of their abundance usually occurs around October-November. Nets used in this fishery are about 150 m long and are often set around dolphin schools, both because the cetaceans are indicative of the presence of anchovy and because feeding dolphins often herd the fish, concentrating the school and bringing it to the surface. The killing of dolphins occurs when they become entangled, not in the bottom of the purse-seine, but at the sides of the net, where mesh size is around 30-60 cm.

Bottom-fixed gill nets are set in pieces (postas), each measuring 3.8 m deep and about 535 m long (range: 384-576 m). The number of "postas" used differs between boats (2-5 postas), and so does the total length of the gear set. The nets are placed on the sea bottom at a depth ranging from 15-60 m, usually at a distance of 1 to 20 nautical miles from the coast. The season for sharks, the main target of this fishing gear, lasts from September to January. Dolphins get entangled in any part of the net, which typically has a mesh size of 20 cm.

DOLPHIN MORTALITY Up to now, four species have been recorded as killed by fishing nets in the Necochea area: the franciscana *Pontoporia blainvillei*, Burmeister's porpoise *Phocoena spinipinnis*, dusky dolphin *Lagenorhynchus obscurus*, and common dolphin *Delphinus delphis*.

Franciscanas were always caught in shark nets, usually set in shallow waters (20-60 m deep). The number of individuals killed in the whole area surveyed was estimated at 80-100 dolphins per year, a substantially lower figure than that of 260 dolphins proposed by Pérez Macri and Crespo (1989). Among the 24 franciscanas recovered, no apparent bias in favour of sex, size, or reproductive status was observed. In most cases, individuals were caught alone but, on three occasions, they were found in pairs.

Burmeister's porpoises were also caught in shark nets, although the depth at which they became entangled (usually about 50 m) was somewhat greater than that observed for franciscanas. This species had previously been recorded as a bycatch in shark gill nets in Uruguay by Brownell and Praderi (1982), although their frequency there appeared to be much smaller. It is estimated that about 10-15 specimens are caught per season in the Necochea area.

Common and dusky dolphins are frequent in the waters off Necochea, where they are sometimes seen in mixed schools. These species are mostly caught in purse-seining, where "catastrophic" sets may lead to the killing of 50 or more individuals at a time. Also, they may exceptionally become entangled in shark nets. From information given by the fishermen, the total kill for the two species can be roughly estimated at 50-100 individuals per season.

CONCLUSIONS The conflict between small cetaceans and fisheries in the Necochea area is not restricted to the franciscana, as was once thought, but also affects three other species: Burmeister's porpoises, common dolphins and dusky dolphins. The total number of small cetaceans killed is roughly estimated at about 150-200 individuals per season, the toll appearing to be similar for the shark gill nets and the purse-seine fishing operations.

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DISTRIBUTION AND LOCAL RANGE OF THE BOTO *Inia geoffrensis* IN THE RIO APURE, VENEZUELA

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The boto, the Amazon or Orinoco river dolphin *Inia geoffrensis* (in Venezuela known as tonina), occurs in the Orinoco, Rio Negro and tributaries in Venezuela (Trebbau, 1975). It has been reported to be abundant in the Apure river and some of its tributaries in Estado Apure, northern Venezuela (Trebbau and Van Bree, 1974; Trebbau, 1975).

We conducted a survey of the distribution of the boto in the Rio Apure (202 km), the Orinoco (27 km) and the Apurito (27 km) followed by observations of dolphin groups around San Fernando de Apure (see Fig. 1).

THE SURVEY

Methods We used two different boats for the survey. Both boats were powered by the same 6.5 hp engine. Observations were carried out at different speeds, to investigate the effect of speed on the results.

For each observation, weather conditions and the size of ripples of the water surface were noted. In general, conditions were found to be fairly constant. Because sudden rainfall tended to interrupt the survey work, no attempt was made to standardise the daily observation time.

The distribution of individuals and groups within each 3 km interval was compared to a poisson distribution of equal mean (for methods and comparison, see Magnusson *et al.*, 1980). Since habitat factors such as stream velocity and depth of the river could not be monitored constantly, they cannot be compared with the overall density of the dolphins but were regressed against group size.

Distribution Groups within the surveyed area show a poisson distribution whereas the distribution of individuals was patchy (mean smaller than variance and significant values for chi square, calculated as the sum-of-squares divided by mean with d.f. = n-1). This implies that most individuals were encountered within groups. The distribution of individuals is shown in Fig. 2.

Density The average density of individuals per km was 0.02 in the Apure, 0.37 in the Orinoco and entrances of its tributaries, and 1.15 in the Apurito. The overall density of dolphins was 0.35 per km.

Habitat factors The relationship between group size and stream velocity was found to be significant. Most large groups were found in slow running rivers or parts of the river, such as in the vicinity of flooded banks or in blackwater tributaries.

As already reported by Best and da Silva (1989), the animals were found to occur mostly near the banks. With the exception of the Orinoco, the stretches of river covered during the survey were narrow enough to permit assessment of the position of the animals within the river. While the animals crossed rivers such as the Apure (300 m wide at that point), they were not found to remain far from the banks for long periods. The average position of the animals was 46 m from the bank.

DISCUSSION

The frequency distribution Contrary to the findings of Magnusson *et al.* (1980), 58% of *Inia* occurred in groups of two or more. The great difference between the frequency of single individuals and couples reported by Magnusson *et al.* (1980) and by us (80% vs 42%) is unlikely to be explained by observational error alone and may be due to the respective seasons in which each study was carried out. Many of the groups seemed to consist of subadult animals, 150-180 cm length.

Density and habitat factors We encountered a high density of dolphins in the slow flowing Apurito as compared to the Apure. Best and da Silva (1989) do not recognise any seasonal trends in their data, but it may well be that the dolphins tend to aggregate in the tributaries and floodplains during the rainy season.

Although our depth measurements failed to produce quantitative data on the tendency to aggregate on or near to the flooded bank, dolphins could usually be observed on floodplains. Both on the floodplains and in the Apurito, we observed high densities of young catfish skimming the surface. In the fast flowing Apure, young catfish could only be observed in the direct vicinity of the banks (max. 3 m away). Seasonal aggregations of fish may influence dolphin densities.

Problems Problems consisted of possible observer fatigue, variations in boat speed and disturbance of the dolphins by the boat. On several occasions, we observed longer dive intervals and shallower surfacing of *Inia* when 10-12 dugouts with 40-60 hp engines passed by.

LOCAL RANGES AND MOVEMENTS

Methods In an attempt to estimate the range of local groups, a 5-day survey was carried out over a stretch of 3.5 km of the Apure by San Fernando de Apure. About eight groups of *Inia* were resident within this stretch of river. The same area was covered each day except on the first day, and subsequent sightings of recognisable groups or individuals were noted on a 1 km scale map.

Results and Discussion The animals followed our boat on several occasions but would usually remain behind at some fixed point, possibly indicating a local range boundary. Occasionally, *Inia* could be observed to interact with neighbouring groups. Aggressive interactions were never observed. Thus, although most groups seemed to be sedentary, no evidence for territoriality was detected. The estimated minimum ranges were found to be overlapping.

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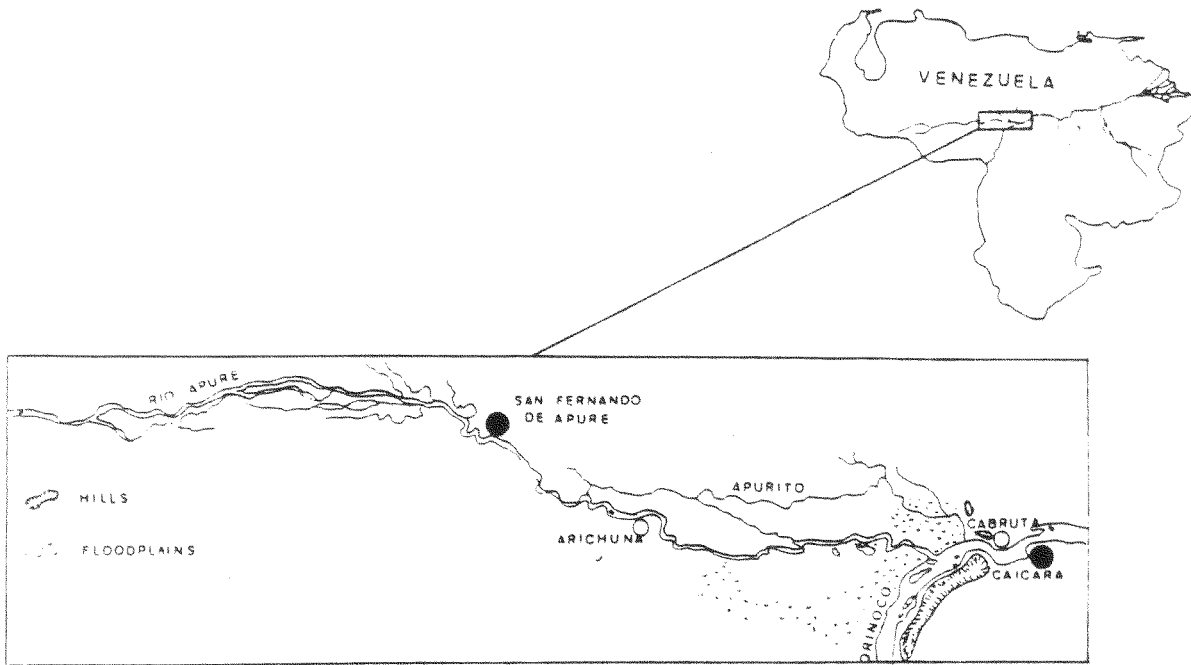


Fig. 1. Map of Rio Apure, Venezuela, showing study area

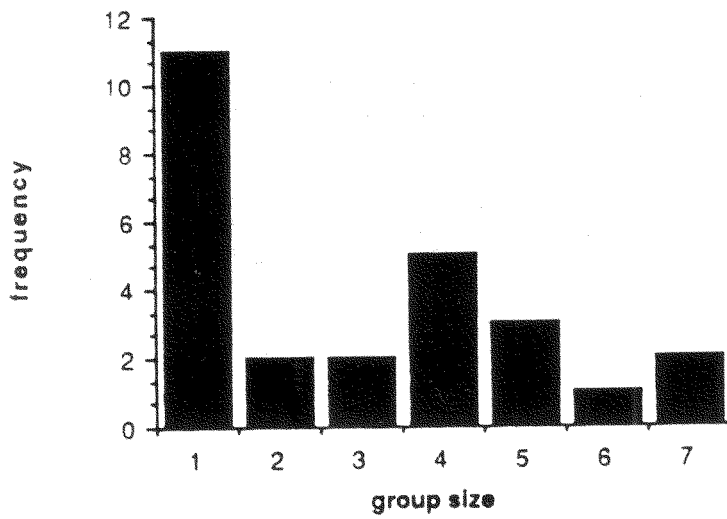


Fig. 2. Frequency distribution of group sizes of *Inia geoffrensis*

STOMACH NEMATODES OF HARBOUR SEAL *Phoca vitulina* AND
HARBOUR PORPOISE *Phocoena phocoena* FROM THE GERMAN PART
OF THE NORTH SEA AND BALTIC SEA

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SEALS Prevalence of infection with stomach nematodes of 184 harbour seals *Phoca vitulina* from the Schleswig-Holstein part of the German Wadden Sea and of 90 harbour seals from the Danish west coast were collected from March to October 1988 during the seal epidemic in the North Sea.

The total prevalence of infection was clearly correlated with the age of the seals. It increased from 28% in animals younger than 1 year up to 95% in animals older than 2 years.

In hosts older than 2 years, 95% of all seals investigated were infected by *Pseudoterranova decipiens*, 28% by *Contracaecum osculatum* and 13% by *Anisakis simplex*.

About 95% of all 4953 nematodes found were *P. decipiens*, about 3% were *C. osculatum* and about 1% were *A. simplex*. There was no significant difference in the relative abundance of the three nematode species between the two sexes of seals.

The mean number of nematodes per infected seal also increased with the age of the hosts. In specimens younger than 1 year the average number of nematodes per infected seal was nine; in specimens older than 2 years, the value was 36. The individual range was 1 to 159 nematodes per seal. An exceptional high number of 719 nematodes found in one seal from Schleswig-Holstein was not included in the calculation of the mean number.

PORPOISES The digestive tracts of 39 harbour porpoises *Phocoena phocoena* from the Schleswig-Holstein part of the North Sea and of 24 harbour porpoises from the German part of the Baltic were examined. The specimens were collected between 1986 and 1989.

The prevalence of infection in animals younger than 1 year (0-group) was 13% in the North Sea and 0% in the Baltic. In porpoises of 1 year and older, the prevalence of infection was 25% in specimens from the North Sea and 67% in those from the Baltic.

The most frequently occurring nematode species was *Anisakis simplex*. Only larval stages of *Pseudoterranova decipiens* were found. The intensity of infection ranged from 1 to 136 nematodes per porpoise in the North Sea and from 1 to 462 nematodes in the Baltic.

HANDLING OF HEALTHY ADULT HARBOUR SEALS *Phoca vitulina*

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Contrary to seal pups or weakened animals, healthy adult seals are often difficult to handle. This may become a problem when direct manipulations, such as blood-sampling or the attachment of transmitters, with a minimum crew of two people, are necessary.

In a pilot radio telemetry study at the Institute for Marine Research, University of Kiel, a safe method for handling adult harbour seals *Phoca vitulina* was required.

Blood-sampling from the flippers can be very difficult, because the selective vaso-constriction will close off the blood flow. To avoid this, samples were taken from the extradural vein in the pelvic region. It is obligatory that the animal is sufficiently immobilised during this procedure.

In dolphinarium, stretchers are used to transport or immobilise dolphins. The authors tested the feasibility of this method on harbour seals. Testing showed that the seals could easily be caught and transported, but were not immobilised.

Instead, a wooden cage, originally built for weighing the animals, was employed. Additional fixation was required. In the cage, eight belts with self-cleating locks were installed.

With both ends of the box open, the animal was chased into it. To the seal, the passage through the cage seems free. Being chased, it will try to make its way through the box. At this moment both ends are closed. The cage is then tilted to move the animal into the lower corner. The belts, previously boot-strapped to the cage's inner walls, are released and pulled tight.

Blood samples can be taken from the extradural vein in the pelvic region. This crescentic vein is as large as 3 x 1 cm in a juvenile specimen (King, 1983). The sampling point can be found behind the pelvis, which can be felt along the median line by hand. In a subadult animal, this point was 33 cm from the tip of the tail. The injection needle has to go in quite deep to meet the vessel. In one specimen, it had to penetrate approx. 8 cm.

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IMPACT OF THE 1988 PHOCINE DISTEMPER OUTBREAK ON HARBOUR SEALS
Phoca vitulina IN NE SCOTLAND

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In 1988, an estimated 17,000 harbour seals *Phoca vitulina* in the North Sea died during an epizootic caused by the phocine distemper virus (PDV). Although seals throughout Europe were affected to some extent, mortality rates appeared to differ between populations. This paper describes the nature of the epizootic in a population of harbour seals in the Moray Firth, NE Scotland, where low mortality was observed.

Levels of mortality were assessed in two ways. Firstly, by collating data on the number of dead seals recovered and secondly by following changes in the number of seals at haul-out sites. Between June 1988 and January 1989, 116 dead seals were reported from the study area, with 80% of these found in August, September and October 1988 (Fig. 1). A maximum of only four seals were reported each month during the subsequent summer and autumn of 1989. Regular haul-out counts were made throughout 1988 and 1989 in each of the four haul-out areas within the Moray Firth. Comparison of data from June/July 1988 and 1989 showed a significant decrease in mean haul-out counts in only one area, the Dornoch Firth. However, maximum counts showed a 12-17% decrease in all areas (Fig. 2).

The low mortality observed in this population could have resulted from (1) a lack of contact with the virus; (2) higher resistance to the virus; or (3) the virus mutating and becoming less virulent before it reached this area.

In order to assess whether survivors from this population had come into contact with the virus, changes in the incidence of PDV antibodies were followed by carrying out virus neutralisation tests (for the closely related canine distemper virus) on blood samples taken from seals captured for radio-tracking and marking studies. Titres for blood samples taken before the epizootic were all low and, given the likelihood of group cross-reactions, we assume that these animals were seronegative. Titres from samples taken after August 1988 were frequently higher and all seals with titres of >90 were considered seropositive. 52% of seals caught after 1 August were seropositive, with significantly more seropositive adults than juveniles (Fig. 3).

CONCLUSIONS Changes in numbers at haul-out sites suggest that the PDV epizootic resulted in approx. 10-20% mortality in the Moray Firth. The impact on this population was therefore much smaller than that seen in the eastern North Sea, where mortality rates of 30-60% were recorded.

Analyses of blood samples taken during and after the epizootic show that a high proportion of the population were exposed to PDV during 1988. Therefore, the low mortality observed in this population does not appear to have resulted from a lack of contact with PDV. The causes behind such variations in mortality are not yet understood.

Fig. 1. Temporal distribution of common seal deaths

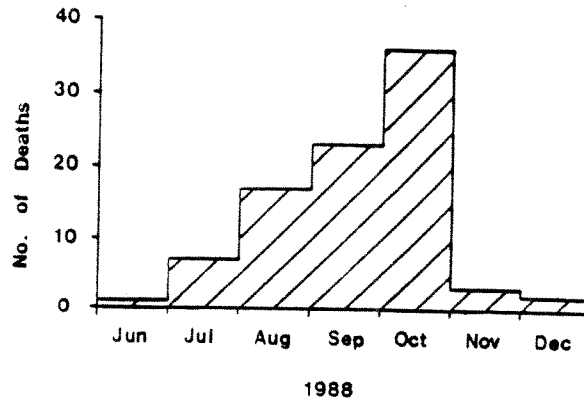


Fig. 2. Changes in common seal population size in the Moray Firth, 1988-89

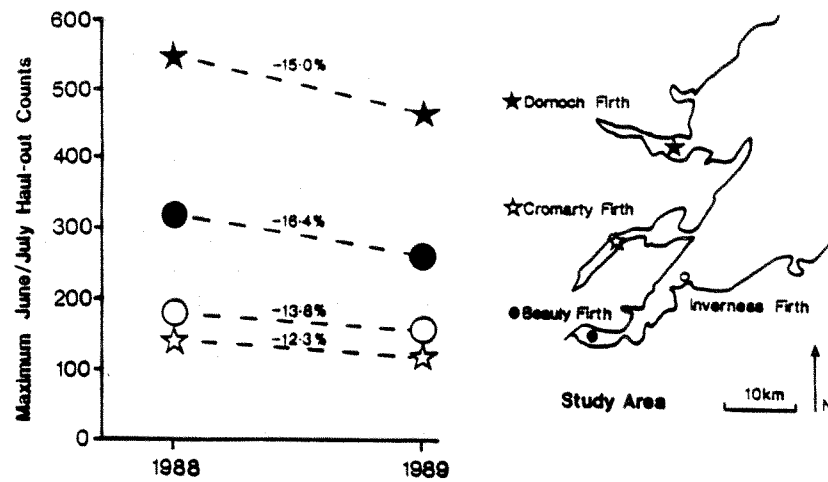
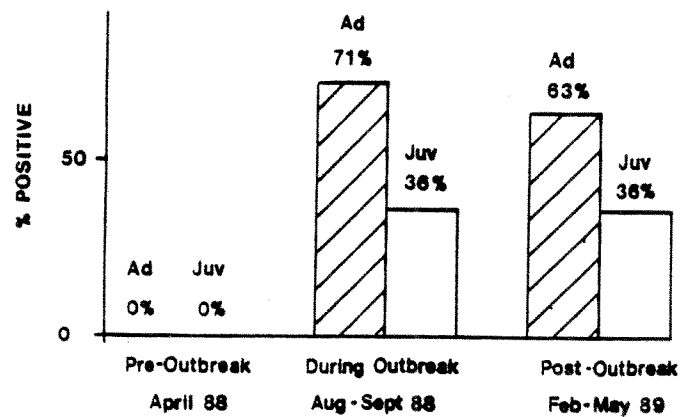


Fig. 3. Changes in the percentage of common seals seropositive for PDV



THE HISTORY OF JOC, A CALIFORNIAN SEA LION *Zalophus californianus*

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Joc was born in Marineland Mallorca on 1 June 1983. As his mother rejected him, he was bottle-fed. The formula was composed by the International Zoovet Group and consisted of herring *Clupea harengus*, water, cream, vitamins and minerals, all mixed in a liquidizer.

Joc was raised in a very human environment in the house of his adopted parents. He did not have any contact with other sea lions until he was 6 months old. He started eating fish when he was 11 months old. The first signs of cataracts were observed when he was completely blind. Although with the help of voice training, we were able to achieve amazing things with Joc, his blindness made him very nervous and anti-social towards other sea lions and towards people that he did not know.

Since cataracts are very common in wild sea lions, in the United States several sea lions with cataracts were operated with success. However, in Europe we had no experience with this type of operation. We decided to operate on both eyes simultaneously to minimise the risk with the anaesthesia.

Joc was transported to our park in Catalunya as this was better equipped, especially in respect of the post-operative phase. Voice training was used to prepare the animal for the operation, such as eye drop administration, blood sampling and breathing into a mask.

The operation took place in March 1988 and was performed by Dr K.C. Barnett, a surgeon from the Animal Health Trust, and the anaesthesia was performed by Dr A. Greenwood from the International Zoovet Group.

During the recovery period, Joc's eyesight gradually improved and it is now at approx. 80% of that of a normal sea lion. His behaviour towards the other members of our sea lion colony changed, and a little over a year after his recuperation, his first daughter, Cuca, was born.

REPRODUCTIVE PARAMETERS OF THE SOUTH AMERICAN FUR SEAL *Arctocephalus australis* IN URUGUAY

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INTRODUCTION The importance of estimating reproductive parameters such as age at sexual maturity (ASM), length at sexual maturity (LSM), and age at first pregnancy (AFP) has long been recognised in studies of population dynamics of mammals, and monitoring annual pregnancy rates (APR) is essential to ensure sensible management of the longterm exploitation of populations.

The South American fur seal has been exploited in Uruguayan and Argentinian waters since 1515. However, little is known about its reproductive parameters. The objective of the present survey is to assess ASM, LSM, AFP and APR in the Uruguayan population of this species.

MATERIALS AND METHODS Samples for age determination and analysis of the reproductive status of female fur seals were collected during the annual harvest in 1988 in Isla de Lobos (35° 01' 38"S, 54° 52' 55"W), the main Uruguayan rookery, 3 months after the estimated mean date of implantation. Thus, reproductive data were collected in the middle of a pregnancy cycle. A total of 168 females were taken for the APR study, 113 of which were analysed for ASM, LSM and AFP calculations.

Age was determined from canine teeth taken from the maxillae. Age of females up to 4 years old was estimated by means of external ring counts. The teeth of older females were sectioned longitudinally and polished, and age was determined by counting growth layers with the aid of a microscope, according to Payne (1978).

Standard body length was measured as a line parallel to the body axis, from the nostrils to the tip of the tail, between the hind flippers.

RESULTS

Pregnancy rates: 1988 Apparent annual pregnancy rate (APRa) is defined as the ratio of pregnant/total females (mature + immature); and true annual pregnancy rate (APTt) as pregnant/mature females. Both are calculated for each age class from 2-3 years onwards. Because of the reduced sample size in animals of over 11-12 years, a single pooled value for the proportion of mature animals and APRA was obtained from this age onwards. The APRA obtained for the overall population was 0.82, a significantly greater figure than an APRA estimation (0.68) obtained for 1987 (Batallés and Lima, 1988). Overall APTt for the population was 0.87.

The pregnancy rates of young age classes are higher than those found in other fur seal species such as Antarctic fur seal *Arctocephalus gazella* (Payne, 1978) and northern fur seal *Callorhinus ursinus* (York and Hartley, 1981). The structure of the pregnancy rate-age curve seems not to decrease with age. This suggests that this population may not display reproductive senescence as found in *A. gazella* and *C. ursinus*.

Age and length at sexual maturity (ASM, LSM) Three methods based on ovarian analysis were used to evaluate ASM: the first involves fitting a curve to the percentage distribution of sexually mature females at different ages, and subsequent interpolation in the model for that age which is associated with 50% sexual maturity. This method yielded an estimate of 2.42 years.

The second method involves the calculation of the accumulated probabilities of mature and immature females in each age class. The point at which the mature cumulative probabilities meet with that of the immature probabilities is the ASM estimation. This method corrects any possible bias caused by an asymmetrical distribution of the ovulation frequencies. Since our sample of mature ratios presented an almost symmetrical distribution, the ASM obtained by this second method (2.42 years) is identical to the first one.

The third method is the non-parametric Cooke estimator, which is insensitive to changes in the age composition of the population. The mean ASM obtained is 2.36 years with an associated variance of 0.0704.

Sexual maturity in this population is reached at a considerably younger age than any other fur seal, with the exception of *A. gazella*, a species which is experiencing rapid recovery from past exploitation. This similarity between the two species may indicate that *A. australis* is subject to a similar population process, more or less affected by the current reduction in exploitation.

The LSM obtained by using the method of the 50% mature point is 102.9 cm. This length is 71.1% of the asymptotic length of the species (Batallés *et al.*, unpubl. data), a value considerably lower than those proposed by Laws (1956) for twelve species of Pinnipedia.

Age at first pregnancy (AFP) Age at first pregnancy is a better estimator of age at first reproduction than age at first birth, because it is not affected by intra-uterine mortality. AFP involves the computation of the ratio of parous (pregnant at least once) females for each age class and the use of the 50% mature curve and the Cooke method.

In our sample, the 50% mature curve indicated an AFP of 2.67 years and the Cooke method one of 2.66 years (with a variance of 0.044). These ages are considerably lower than those proposed by Vaz-Ferreira and Ponce de León (1987), who suggested that most females became pregnant at the age of 4 years. They also noted, however, that some females were pregnant when 3 years old and, therefore, it would be possible for some individuals to ovulate at the age of 2 years.

The difference found between ASM and AFP estimates is very small. This reflects the high proportion of females that are successfully fertilised at their first ovulation.

CONCLUSIONS We provide evidence for the existence of an average ASM of between 2 and 3 years, but not 4, as some authors have previously proposed. LSM, AFP and pregnancy rates in 1988 indicate the present strength of population recruitment. An abrupt increase in 1988 pregnancy rates could be caused by changes in food availability, by an intrinsic instability of the population growth rate after a period of high exploitation rates from 1968 to 1980 (Lima, unpubl. data), or by biases in the ratio of reproductive females captured from one year to another. The estimated reproductive parameters may indicate a positive population trend, after a decade of high harvest. Whether or not these are density-dependent mechanisms remains unclear, and needs more investigation.

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THIRD ANNUAL REPORT
OF THE EUROPEAN CETACEAN SOCIETY: 1989

Membership of the European Cetacean Society is reaching a plateau at around 350 members, representing 32 countries (24 European). We are particularly pleased to welcome new members from a number of Eastern European countries including the Soviet Union. The membership list and details of members' interests have been ably managed by Jan-Willem Broekema, and will be made generally available in due course.

A successful conference was held in La Rochelle, France between 24th and 26th February 1989, at which 178 persons from 14 countries attended. The theme of the conference was "Pollution and pollutants" with three invited speakers, Drs Alex Aguilar, Daniel Osborn and Peter Reijnders. The abstracts from that meeting, together with a report of the Sightings Working Group, were published as proceedings under the title *European Research on Cetaceans - 3*.

Three newsletters were produced which reviewed recent research in various member countries including bibliographies, and reported the activities of the different working groups, conservation issues and local news, cetacean publications, and requests for information or biological material. We are very grateful to Marjan Addink and Joke Bakker for support in the editing and distribution of the newsletter.

The European Cetacean Society continued to provide advice to government departments and non-governmental organisations in various European countries; it also provided specialist information to a number of public enquiries and canvassed governments for action relating to particular conservation problems.

Peter G.H. Evans
Hon. Secretary

REPORT OF THE ANNUAL GENERAL MEETING,

3RD MARCH 1990,

PALMA DE MALLORCA

1. Annual Report. The above report was outlined, followed by a notice that it was hoped to hold the next annual conference in Norway.
2. Financial Report. The Treasurer presented the financial report for the year 1989 (see over). Credit amounted to c. Hfl 18,900. Debits totalled c. Hfl 16,800, leaving a credit balance of little more than Hfl 2,000. However, this included an advance payment of over Hfl 5,000 for the Palma conference so that the balance in effect is little different to that of the previous year. Nevertheless, this was still considered too small a reserve for the effective running of the society.
3. Changes to Council. In order to ease the retirement of officers after four years of serving, the Secretary (Peter Evans) and Treasurer (Chris Smeenk) stepped down, their positions to be taken by Geneviève Desportes and Phil Hammond respectively. Michela Podestà retired from the Council, her place being taken by Giuseppe Notarbartolo di Sciarra; and Anne Collet retired, her place being taken by Arne Bjørge.
4. Newsletter. As the major means of communication for ECS members, the newsletter received special consideration. The Secretary reiterated previous requests for contributions from members, emphasising that without the support of members, it could not flourish. As a means to increase regional input, a meeting was arranged with National Contact Persons, during the conference.
5. Other Matters. Two recurrent issues were discussed at great length. The first related to the question of whether the society should confine itself to cetaceans or be extended to include other marine mammals such as seals. The second considered whether the society's conference should be held annually or biennially. Since only a portion of the membership was present at the annual general meeting, it was decided that both issues should be voted on by the membership at large through a postal ballot. The results would then be announced at the 1991 AGM in Norway, and in a subsequent newsletter. Finally it was suggested that the society should make a formal statement expressing concern about the impact of bycatches in the driftnet fishery upon small cetaceans in the Mediterranean. Giuseppe Notarbartolo di Sciarra volunteered to make the society's concern known to the relevant authorities.

Peter G.H. Evans
Hon. Secretary

ECS - FINANCIAL REPORT OVER 1989

Credit

Credit balance 1988	Hfl 7,937.92	
Subscriptions	7,706.37	
Conference fees La Rochelle	2,908.89	
Sale proceedings 1988	110.00	
Credit interest	249.82	
Various		9.00
		Hfl 18,922.00

Debit

Board expenses	1,685.38	
Typing & printing proceedings	5,818.48	
Postage newsletters & proceedings	2,998.61	
Printing newsletters	556.01	
Conference expenses La Rochelle	509.00	
Advance payment conference Palma	5,105.25	
Bank charges	114.17	
Various	9.00	
		Hfl 16,795.90
 Credit balance 1989		 Hfl 2,126.10

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 set up six international working groups concerned with the following subject areas: sightings schemes; strandings schemes; 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, Federal Republic of Germany). The names and addresses of chairpersons for all the working groups are given at the end of this notice.

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 and regional agreements, local news, and cetacean news from other parts of the world.

There is an annual conference with talks, posters and discussion sessions on various projects, 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, three others have been published for conferences held in Hirtshals (Denmark) in 1987, Tróia (Portugal) in 1988, and La Rochelle (France) in 1989.

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*. Payment can be made by cheque in any other currency, but £6 should be added to cover exchange charges. Subscriptions should be sent to the Treasurer, Dr. P. Hammond, Sea Mammal Research Unit, 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	Peter Evans/Geneviève Desportes
Treasurer	Phil Hammond
Council	Harald Benke
	Arne Bjørge
	Giuseppe Notarbartolo di Sciara
	Chris Smeenk

Working Group Chairpersons

Strandings Michela Podestà and Luca Magnaghi, Museo Civico de Storia Naturale, Corso Venezia 55, 20121 Milano, Italy.

Sightings Peter Evans, Department of Zoology, University of Oxford, South Parks Road, Oxford OX1 3PS, UK.

Bycatches Simon Northridge, Imperial College, Centre for Environmental Technology, 48 Princes Gardens, London SW7 1NA, UK.

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

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

UNEP/CMS Agreement Kees Lankester, 1e Helmersstraat 183-III, 1054 DT Amsterdam, The Netherlands.

National Contact Persons

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

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

Faroe Islands Geneviève Desportes, Náttúrugripasavn, Fútalág 40, FR-100 Tórshavn.

Federal Republic of Germany Harald Benke, Forschungs- und Technologiezentrum, Universität Kiel, Werfstrasse 10, D-2242 Büsum.

France Alexandre Gannier, Domaine de Mauvin, F-33760 Targon.

Iceland Jóhann Sigurjónsson, Hafrannsóknastofnunin, Skúlagata 4, P.O. Box 1390, IS-121 Reykjavík.

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

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

Norway Arne Bjørge, Gjønnesskogen 1, N-1340 Bekkestua.

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

Spain Alex Aguilar, Catedra de Zoología (Vertebrados), Facultad de Biología, Universidad de Barcelona, Diagonal 645, E-08071 Barcelona.

Sweden Bernt Dybern, Institute of Marine Research, Box 4, S-453 00 Lysekil.

United Kingdom Peter Evans, Department of Zoology, University of Oxford, South Parks Road, GB-Oxford OX1 3PS.

USSR M.V. Ivashin, All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), 17, V. Krasnoselskaya, Moskva B-140, 107140.