Spatial and temporal distribution of the minke whale, *Balaenoptera acutorostrata* (Lacépède, 1804), in the southern northeast Atlantic Ocean and the Mediterranean Sea, with reference to stock identity

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ABSTRACT

New strandings, bycatch and sightings data for minke whales in the northeast Atlantic Ocean south of Cape Finisterre (Galicia) and the Mediterranean Sea were combined with earlier authenticated records, in order to re-assess spatial and temporal distribution, and provide clues to breeding areas and stock identity. The southern range of IWC-defined Northeastern Atlantic and Central North Atlantic stocks with no explicit, but a *de facto*, boundary of the Equator, was explored in particular. Senegal (6 records), Mauritania (1) and Western Sahara/Southern Morocco (3) are new West African Range States for the North Atlantic minke whale. Morocco and The Gambia are likely Range States. Specimens stranded or captured in Senegal and Mauritania were either calves ($n = 6$) or neonate ($n = 1$), a strong indication for a near-by calving ground. Juveniles and calves (median SL:418cm, $n = 6$) commonly occur off the Canary Islands, without apparent seasonality. Two strandings, one of which was a neonate (in February), were documented in the Azores. Evidence of minke whales is lacking for Madeira and the Cape Verde Islands. The temporal distribution of 33 records from the western coasts of the Iberian Peninsula in the period 1905-1998 included all seasons, but 76% were registered in spring and summer (March-August). The majority of animals were juveniles (mean SL:537.5cm, $n = 26$); none were neonates. Minke whales were encountered in low numbers in the western and central Mediterranean Sea mostly from March to November, although documented strandings in December and February argue for a year-round presence. The Ligurian and Tyrrhenian Seas and the Gulf of Lion are concentration areas, presumably (cf. fin whales) linked to the abundance of euphausiids. Small calves (SL:300-360cm) suggest that at least some females give birth in the Mediterranean. An unusual stranding in the eastern Black Sea (Georgia) may be related to migration of schooling fish. The southernmost specimen known from the North Atlantic is a calf captured near Hann (14°41'N, 17°27'W), Senegal, in May. Southernmost sightings include: (a) inshore: a foraging individual at Garnet's Bay (24°51'N,15°05'W) in November; (b) offshore: three minke whales at 10°40'N, 22°00'W in December. While small, the sample from West Africa does not seem to support a restricted, seasonal presence. Most likely, these individuals constitute the offspring and juveniles from the Northeastern Atlantic and/or Central North Atlantic populations, but an unrecognised local population cannot be discounted. Preliminary cladistic analysis of the mtDNA control region of one Senegal minke whale yielded equivocal results depending on the fragment sequenced. Field research in the region should be continued to provide the necessary samples to resolve the question of stock identity.

KEYWORDS: MINKE WHALE; ATLANTIC OCEAN; AFRICA; DISTRIBUTION; BREEDING GROUNDS; MIGRATION; GENETICS; INCIDENTAL CATCHES; STRANDINGS

INTRODUCTION

Donovan (1991) reported that the International Whaling Commission (IWC) currently recognises four management stocks for minke whale *Balaenoptera acutorostrata* (Lacépède, 1804) in the North Atlantic Ocean: Canadian East Coast; West Greenland; Central North Atlantic (CNA: East Greenland, Jan Mayen, Iceland); and Northeastern Atlantic (NEA: British Isles, Norway, Svalbard). The IWC Schedule (e.g. IWC, 1999b) does not specify a southern boundary for either the CNA or NEA stocks of minke whale, which begs the question: where are those boundaries situated? Currently, by definition of the North Atlantic, the Equator is the *de facto* southern boundary, but this may have little biological meaning.

Since 1993, Norwegian whalers resumed taking several hundred minke whales annually in the Northeastern Atlantic from an estimated population of 112,000 (95% CI 91,000-137,000; Schweder *et al.*, 1997; IWC, 1999c) under objection (Donovan, 1992) both to the IWC 1982 moratorium on commercial whaling (which entered into effect in 1986) and the IWC classification of the NEA minke whale as a Protection Stock. For decades very little was known about biological population structure in that region (Jonsgård, 1966; Mitchell, 1974; Rorvik and Jonsgård, 1981) while recent isozyme, mitochondrial and nuclear DNA variability studies continue to deliver contradictory results on stock identity. It is unclear what level of genetic exchange exists between CNA and NEA stocks (see Palsbøl, 1989; Daníelsdóttir *et al.*, 1992; 1995; Bakke *et al.*, 1996; Palsbøl

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et al., 1997; Martinez *et al.*, 1999). A morphometric comparison gave no firm conclusion (Christensen *et al.*, 1990). The sampling area is likely inappropriate: if two breeding stocks of minke whale intermix while feeding in the Northeast and Central Atlantic (Martinez *et al.*, 1999) the lack of genetic and morphological variability between such small areas is to be expected.

Continuing uncertainty of population structure is also partly rooted in our poor understanding of the paths and timing of long-distance movements and the location of pairing and calving areas for North Atlantic (NA) minke whales (see Mitchell, 1991). There may be little evidence for substantial latitudinal migrations (Evans, 1991), but neither is there evidence to the contrary. Overall the species appears to be widely distributed in all seasons and to migrate in a manner hard to predict (Klinowska, 1991).

Stephenson (1951) concluded, based on records from 1800-1950, that most strandings in Europe occur from July-November and that 'this supports the general impression that there are few lesser rorquals in European waters in winter'. From foetal growth data, it is known that pairing takes place from December to May, with calving predominantly from October to March, and that this coincides with minimum minke whale abundance in northern NE Atlantic waters (Jonsgård, 1951; 1966; Stephenson, 1951; Schultz, 1970; Mitchell, 1975; Evans, 1980; Klinowska, 1991; Northridge *et al.*, 1995). NA minke whales are thought to migrate north in spring passing west of the British Isles in search of feeding grounds in the North, Norwegian and Barents Seas, and return in the autumn possibly following a similar route back towards 'warmer waters' (Jonsgård, 1951; Matthews, 1978; Evans, 1980). Where those southerly waters are, and whether CNA and NEA stocks mix on these presumed breeding grounds, has not been investigated (see Folkow and Blix, 1991; Klinowska, 1991; Mitchell, 1991).

Some scientists have suggested that NA minke whale stocks are mainly limited to the continental shelf (Schultz, 1970; Mitchell, 1974). However, they have also been found in the deep pelagic waters of the mid-Atlantic (e.g. Van Beneden, 1889; Slijper *et al.*, 1964; Leatherwood *et al.*, 1976; Winn and Perkins, 1976; Folkow and Blix, 1991; Mitchell, 1991). Evans takes the view that there appears to be some offshore movement in autumn, possibly also associated with breeding (Evans, 1991; Evans *et al.*, 1993). Sexual and age segregation occurs at least during summer, with males moving further north in the open seas, females remaining in more southern areas closer to shore, and immatures occurring slightly further south (Jonsgård, 1951; Klinowska, 1991), but no specific areas have been mentioned. In apparent contrast, recently weaned minke whales have been taken in the early spring as far north as the Barents Sea and may spend the winter in high northern latitudes (Jonsgård, 1951; 1966; Slijper, 1979).

The long-held idea that minke whales (in taxonomic *sensu lato*) are scarce in warm waters and avoid the tropics (Norman and Fraser, 1948; Jonsgård, 1951; Clarke, 1957; Tomilin, 1967; Leatherwood *et al.*, 1976; Slijper, 1979; Dupuy, 1983) is not supported by solid evidence and is being increasingly contradicted by well-documented records from tropical latitudes in all oceans (Deraniyagala, 1963; Arnold *et al.*, 1987; Mitchell, 1991; Salm, 1992; Baldwin and Salm, 1994; Van Waerebeek and Reyes, 1994; Tan, 1995; Davis and Fargion, 1996; Zerbini *et al.*, 1996; Arnold, 1997). However, we emphasise that at least some of these whales may belong to the subspecifically separate (but unnamed) dwarf minke whale (Best, 1985; Arnold *et al.*, 1987; Pastene *et al.*, 1994; Arnold, 1997) or, as in Peru, to the Southern Hemisphere minke whale (*Balaenoptera bonaerensis*, Burmeister, 1867; Van Waerebeek and Reyes, 1994). While rare in the pelagic habitat of the eastern tropical Pacific (Jefferson *et al.*, 1993; Lee, 1993a; b; KVW, pers. obs.), there have been numerous sightings of an undefined (possibly diminutive) form in the eastern tropical Indian Ocean, especially between Java-Sumatra and northwestern Australia, in October-November of 1966/67 and 1984/85 (Kasuya and Wada, 1991). A form, probably 'dwarf', with white-banded flippers regularly occurs off the Sultanate of Oman (Baldwin and Salm, 1994, photos pp.17, 46) and off Palawan and Cavite, Philippines (Tan, 1995). Although unsubstantiated, Slijper *et al.* (1964) also reported sightings in the Indonesian Archipelago and off Madagascar. Neither absolute nor satisfactory relative abundance data are available for most tropical regions, with the exception of an index for 'minke whales sighted per 10,000 nm' in the eastern tropical Indian Ocean (Kasuya and Wada, 1991).

Minke whales in the NE Atlantic are commonly not thought to occur farther south than Cabo San Vicente on the Iberian Peninsula, or the Mediterranean Sea (Collett, 1911, not seen, in Jonsgård, 1951; Rorvik and Jonsgård, 1981; Stewart and Leatherwood, 1985; Lens and Rey, 1987; Klinowska, 1991; Mitchell, 1991), which is disproved by new evidence. The distribution of the minke whale in its southern range in the Northeast Atlantic including the Mediterranean Sea is reassessed here. All relevant published literature is critically reviewed and many new records are documented which demonstrate the frequent occurrence of juvenile and neonate individuals off West Africa, as well as juveniles off the Canary islands. Possible implications for the recognition of populations in the NE Atlantic are discussed.

MATERIAL AND METHODS

Strandings, bycatch, catch and sightings information was extracted from the primary literature and combined with original records collected by the authors or provided by colleagues (see Acknowledgements). Whether a particular published record is partly or fully supported, or is undocumented, was examined. Conclusions were based exclusively on authenticated records. Slijper *et al.* (1964) graphically presented an important number of minke whale sightings, by 10° latitude and longitude squares, reported from Dutch ships in the period 1954-56. Individual sightings in Slijper *et al.* (1964), made mostly by lay observers, are questionable and insufficiently documented and hence cannot be considered as evidence. Nonetheless, their general findings are indicative since it would be highly unlikely for all purported minke whale sightings to prove erroneous.

Sexual maturity in North Atlantic minke whales is attained on average at 730cm in females and 700cm in males (Jonsgård, 1951; Mitchell and Kozicki, 1975), lengths which were used here to distinguish juveniles from adults in the absence of ovaries and testes for examination. Neonatal length is 2.4-2.8m (Jonsgård, 1951; Sergeant, 1963; Mitchell, 1975). Length at weaning seems to be variable, Jonsgård (1951) reported a 513cm 'calf' with a stomach content consisting of milk, but on the other hand examined smaller individuals which had fed on copepods or fish and were evidently weaned. He added 'the calves seem to be weaned before they appear in Norwegian coastal waters and as a rule at lengths less than 15 feet [457cm]'. Hence, in the

present study animals >450cm (but less than the average length at sexual maturity) are defined as 'juveniles' and the ones ≤450cm as 'calves'.

The study area is defined as NE Atlantic waters south of the Cape Finisterre (42°53'N, 09°16'W), Galicia, which is the northern limit of the upwelling associated with the Canary current system (Wooster *et al.*, 1976), south to the Equator off Gabon and west to 30°W. For reasons of clarity, records are divided into seven sub-areas: western coasts of Iberian Peninsula; western and central Mediterranean; eastern Mediterranean; Black, Marmara and Azov Seas; subtropical archipelagos in the Northeast Atlantic; West Africa; offshore tropical Northeast Atlantic. This subdivision is, however, artificial and does not imply any suggestion of (sub)stocks or separate habitats.

RESULTS

Western coasts of Iberian Peninsula

This subarea includes the west coast of Spanish Galicia, Portugal and the (Spanish) coasts of the Gulf of Cádiz, i.e. from Cape Finisterre south to Gibraltar. Nobre (1935) catalogued the minke whale as a 'frequently sighted species' off Portugal in the winter, but Teixeira (1979) did not believe the species to be common. We identified 33 documented stranding and sighting records from western Iberia between 1905-1998, for all months of the year except January (see Table 1), 17 of which occurred after 1989 (Sequeira *et al.*, 1996). The details of seven formerly unpublished strandings (1995-97) from Portugal are given in Table 1. While all length classes except neonates were represented in the sample, most were juveniles. The mean standard length ($n=26$) was 537.5cm (SD = 185.0cm); three out of seven males, but only one out of 13 females, were inferred to be adult.

Sequeira *et al.* (1992) and Sequeira and Ferreira (1994) reported four minke whales bycaught off mainland Portugal in the period 1977-90; three were killed in fishing traps and one in undetermined fishing gear. From 1981-85 minke whales were sighted on three sighting/marking cruises west and northwest of the Iberian Peninsula (Aguilar *et al.*, 1983; Sanpera *et al.*, 1985).

Western and central Mediterranean

The species is considered rare in the Mediterranean (Fischer, 1881; Van Beneden, 1889; Duguy and Robineau, 1982; Duguy *et al.*, 1983). Nevertheless, as in many other areas, with augmented search effort, records have been accumulating in the past few decades. Minke whales were encountered especially in the Ligurian and Tyrrhenian Seas and in the Gulf of Lion (Di Natale, 1983; Duguy, 1989; and see below).

Spanish Mediterranean

Casinos and Vericad (1976) did not indicate any supported records for the Spanish Mediterranean Sea and coasts. They cited Yáñez (1842) who referred to a 'balenóptero picudo' (piked rorqual) stranded in Barcelona on 17 August 1839, but also pointed out that this reference is not verifiable. There were no minke whales among the cetaceans stranded on the Mediterranean coast of Spain from 1982-88 (Raga *et al.*, 1991). Recently, in October 1996, a 4.5m minke

Table 1

Confirmed stranding and sighting records (n=33) of minke whales, chronologically ordered for the period 1905-1998 off the western Iberian Peninsula, including western Galicia (Gal), Portugal (Por) and Gulf of Cadiz (no records). SL = standard length in cm.

Locality	Region	Date	Sex	SL	Comments	Source
Setubal	Por	1905	F	317	Unspecified circumstances	Cabrera, 1914
Setubal	Por	1951	-	-	Taken in whaling operations	Jonsgard, 1977
Peniche	Por	1967	-	400	Stranding	Teixeira, 1979
O Grove, Ria Arousa, Pontevedra	Gal	10 Jul. 1980	F	500	Dead floating (VABACU7)	Univ. Barcelona, 1997
Sines	Por	30 Jul. 1980	F	330	Stranding; photos in Sequeira *et al.*,1992. White flipper patch.	Reiner, 1980
Porto do Son, Ria de Noya	Gal	2 Apr. 1981	M	330	Playa de Coveiro	Duran *et al.*, 1981
42°35'N,10°20'W	Gal	Apr. 1981	-	-	Shipboard sighting	Duran, 1980
41°59'N,10°53'W	Gal	3 Sep. 1981	-	-	Shipboard sighting	Aguilar *et al.*, 1983
Lourinha, Torres Vedras	Por	27 Apr. 1981	M	450	-	Inacio, 1987
Peniche	Por	26 Jul. 1982	-	*ca* 900	Stranding	Sequeira *et al.*, 1992
Viana do Castelo	Por	4 Jul. 1983	-	400	Stranding	Inacio, 1987
Bueu, Illa de Ons (Ria Pontevedra)	Gal	22 Aug. 1984	F	430	Stranding, skeleton (VABACU11)	Univ. Barcelona, 1997
Praia da Vagueira, Aveiro	Por	23 Nov. 1986	-	-	Stranding	Sequeira *et al.*, 1992
O Grove, Pontevedra	Gal	10 Jul. 1988	F	500	Stranding, showed several cuts (VABACU12)	Univ. Barcelona, 1997
Peniche	Por	30 May 1989	F	630	Complete skeleton at Museu Bocage 1 May. 1989	Sequeira *et al.*, 1996
Peniche	Por	9 Jun. 1989	-	-	Stranding	Sequeira *et al.*, 1996
Sesimbra	Por	25 Jun. 1990	F	530	Skeleton buried; baleen in Aquarium Vasco da Gama	Sequeira *et al.*, 1996
Pl. Moana, Moana, Pontevedra	Gal	4 Oct. 1990	-	-	Live stranding (VABACU16)	Univ. Barcelona, 1997
Fonte da Telha, Almada	Por	7 Dec. 1990	F	434	Stranding	Sequeira *et al.*, 1996
Barra da Futeza, Olhao	Por	12 Jun. 1992	-	*ca* 450	Stranding	Sequeira *et al.*, 1996
Praia Vale Figueira, Aljezur	Por	21 Aug. 1992	-	860	Some baleen kept at ICN/DHE	Sequeira *et al.*, 1996
Leixoes, Porto	Por	4 Feb. 1993	F	374	Stranding	Sequeira *et al.*, 1996
Leixoes, Porto	Por	9 Aug. 1993	M	750	Stranding	Sequeira *et al.*, 1996
Ria Noia, Murosa, La Coruna	Gal	23 Sep. 1993	F	820	Carcass floating 2 n.miles offshore (VABACU21)	Univ. Barcelona, 1997
Praia da Torreira, Murtosa	Por	6 Jun. 1994	M	840	Stranding	Sequeira *et al.*, 1996
Praia da Torreira, Murtosa	Por	15 Jun. 1994	M	495	Stranding	Sequeira *et al.*, 1996
Sines	Por	21 Apr. 1995	-	450	Stranding, cause unknown	This paper
Setubal	Por	4 Mar. 1996	M	-	Stranding, cause unknown	This paper
V.R. Santo Antonio, Tavira	Por	6 Mar. 1996	F	560	Stranding, cause unknown	This paper
Peniche	Por	21 Nov. 1996	M	870	Stranding, cause unknown	This paper
Fonte da Telha, Almada	Por	15 Apr. 1996	M	545	Stranding, cause unknown	This paper
Ovar	Por	17 Apr. 1997	F	400	Stranding, cause unknown	This paper
Esposende	Por	11 May 1997	F	410	Stranding, cause unknown	This paper

stranded on Casares beach, Malaga. Evidenced by photos (Rueda-Ruiz, 1997) it is the first confirmed specimen for the Spanish Mediterranean.

French Mediterranean

Three confirmed cases of net entanglements are known from the French section of the Mediterranean Sea in the 1972-1998 period (Duguy, 1983b). According to Duguy (1983a) a total of six strandings and bycatch records are available for the French Mediterranean coast between the Bouches du Rhône Department (Gulf of Lion) and Nice (Ligurian Sea) since the 19th century. Gannier *et al.* (1994) reported, without providing details, a minke whale sighting in the Gulf of Lion for the period 1990-93. Based on 350 observer-days from a boat, Gannier (1995) classified the minke whale among the non-resident or rare species of the northwest Mediterranean Sea. The following five records from the French Mediterranean are documented and all originate from the Côte d'Azur coast of the Ligurian Sea:

(1) Van Beneden (1878) reported that a minke whale was taken at Villefranche-sur-Mer, département du Var, on 18 February 1878. The individual of unknown sex measured some 300cm, the small size lending credibility to the identification. Newborn calves of the next smallest balaenopterid, the Bryde's whale *Balaenoptera edeni*, measure about 340cm in length (Cummings, 1985; Klinowska, 1991); moreover it is unknown from the Mediterranean Sea (e.g. Notarbartolo di Sciara *et al.*, 1993). Nothing suggests that voucher material was collected. Van Beneden (1878) considered this to be the second case for the Mediterranean, the first being a 1771 record from Italy (Capellini, 1877; see below) for what was then considered a distinct species ('baleine de Méditerranée') by G. Cuvier.

(2) On 9 June 1977, J. Besson found a 375cm female stranded at Bandol, département du Var, which had been caught in an unspecified net (A. Collet, files Centre de Recherches des Mammifères Marins - CRMM, La Rochelle). The skeleton was preserved (Duguy, 1978).

(3) On 20 April 1982, a 360cm female (about 300kg) stranded at Saint-Raphaël, département du Var, and was reported by J. Besson (Duguy, 1983b). Skin marks suggested a net capture. An incomplete ovary is deposited at CRMM (MOLR 1548). Results of cytopathological analysis are available for the liver, kidney and spleen (A. Collet, CRMM files).

(4) Yachtsman G. Chapelle (in litt. to KVW, 11 August 1997) related a sighting at less than 10m distance from a sailing boat 5-6 n.miles south of Porquerolles Island (43°00'N, 06°10'E), Iles d'Hyères, on 16 July 1997 as follows: 'alerted by a different [from fin whales] "jizz" as it approached: tall fin, different shape of head, nearly invisible blow. And when really close, then appeared the white patch on the upper side of the pectoral fins. ... we have three pictures where the patch is clear, and one where the dorsal fin is just appearing with the nostrils just in the water.'

(5) A 340cm male minke stranded, after been caught in a gillnet off the Presqu'ile de Giens (département du Var) on 24 April 1998 (A. Collet, CRMM files, La Rochelle).

Italy

Four documented historical records are available. One juvenile specimen, of which the skeleton was initially deposited at the Natural History Museum of Bologna and in 1848 transferred to the collection of Comparative Anatomy at the University of Bologna, was captured in 1771 in the Italian Mediterranean, possibly in the Adriatic Sea (Carlo Mondini[1] in Capellini, 1877). Van Beneden examined the specimen in 1874 and explicitly recognised it (Van Beneden and Gervais, 1880) as *Balaenoptera rostrata* (Fabricius, 1780), synonym for *B. acutorostrata*.

Capellini (1877) described it as a new species *Sibbaldius mondini* but his fine drawings and description of the skull confirm Van Beneden's identification. One adequately described and two probable (but unconfirmed) specimens are known from the Tyrrhenian Sea: a minke whale of some 5.5-6m died on the rocky shore at Castel Fusano, near Ostia (41°44'N, 12°14'E) on 15 December 1911 (Carruccio, 1913); a presumed minke whale of an unknown size was by-caught in a net near Porto Santo Stefano (42°26'N, 11°07'E) on 6 October 1899, the skeleton of which was gathered for the University of Rome collection (Carrucio, 1899); and a ca. 6m individual was netted near Lacco Ameno, Ischia island (40°43'N, 13°54'E) off Naples (Monticelli, 1926).

During ten summer seasons (four months each) of dedicated cetacean surveys in the Ligurian Sea, G. Notarbartolo di Sciara and colleagues did not once sight a minke whale (in litt. to KVW, 15 February 1997).

Giordano (1988) observed, without providing much detail, two animals in August 1986 and one specimen in April 1987 in the Ligurian Sea; sightings locations were plotted on a map. His claim that seasonal migrations occur is unsupported.

A calf 3.5m in length was found stranded on the eastern coast of Sardinia on 17 May 1991 (Centro Studi Cetacei, 1994). Di Guardo *et al.* (1995a; b) took samples for pathological studies from an adult male minke whale which stranded on the coast of Tuscany (Ligurian Sea) on an unspecified date in 1993.

Di Natale (1983) briefly referred to eight sightings totalling 20 specimens (until 1982), from the central Tyrrhenian and Ligurian Seas and from south of Sardinia, but did not further authenticate these claims. He stated 'a calf has been reported during January, but no data are still available about reproduction in the Italian Seas' (Di Natale, 1983).

In all, only two minke whales were recognised out of a total of 2,142 identified cetaceans found stranded along the Italian coasts in 11 years (1986-1996) (G. Notarbartolo di Sciara, pers. comm. to KVW, 1 March 1998), suggesting the species to be fairly rare off Italy. Notarbartolo di Sciara *et al.* (1993) reached the same conclusion from 2,433 hours of boat-based observation in the central Mediterranean Sea from 1986 to 1989.

North Africa

In May 1976 a minke whale was caught alive, and was subsequently killed, in a tuna trap in the Gulf of Tunis, Tunisia (Ktari-Chakroun, 1980, not seen, in Di Natale and Notarbartolo di Sciara, 1994).

Notarbartolo di Sciara (in litt. to KVW, 15 February 1997) holds documentary film footage of a full-size minke whale sighted off Lampedusa (35°31'N, 12°35'E), a small Italian island situated between the eastern Tunisian coast and Malta (Notarbartolo di Sciara and Demma, 1994). The animal was filmed from the island's cliffs on 11 March 1991 and showed obvious white pectoral fins. Rueda-Ruiz (1997) stated that an individual was seen off Melilla, a small Spanish-owned

[1] Mondini, C. 1772. De capite balaenae. Unpublished memoria of 26 March 1772 presented to the Accademia delle Scienze dell'Istituto di Bologna, Italy (not seen).

enclave on the Moroccan coast, but no voucher data supports the claim. Recent inventories for cetaceans from Algeria do not include the minke whale (Boutiba, 1992; 1994). We were unable to find any published information on cetaceans from Libya and Egypt despite the fact that these countries have vast stretches of beaches and a concomitant great potential for strandings.

Eastern Mediterranean

Minke whales are extremely rare, perhaps even absent, in the eastern Mediterranean basin (Marchessaux, 1980). There are no documented records for the Adriatic, Ionian (despite claims by Toschi, 1965) or Aegean Seas. An alleged sighting off Santorini Island in May 1992 was never confirmed; it could have been a small fin whale (A. Frantzis, Dept. Biology, University of Athens, in litt. to KVW, 17 February 1997). Frantzis added that the only minke whale skeleton present in the Zoological Museum of the University of Athens was bought in London in 1880. With Frantzis (1997) we conclude that so far no authenticated records exist from Greece; the same is true for Mediterranean Turkey, Cyprus, Syria, Lebanon and Israel (Goffman *et al.*, In press).

Black, Marmara and Azov Seas

Tomilin (1967) claimed a minke whale entered the Black Sea on at least two occasions, in 1880 and 1926. Radde (1899, not seen, in Kleinenberg, 1956) writes in the Kavkaz museum catalogue 'No.158. Balaenoptera rostrata Fabr. This whale was washed up onto shore near Batumi [41°38'N, 41°38'E; presently Georgia] in May of 1880'. He added

> '... missing many vertebrae and several ribs, and a portion of the mandible was sawn off ... I measured: length of cranium from foramen occipt. to the end of the nose - 2 mtr., the greatest breadth between the orbits - 1.2mtr.'

Alexei Birkun, Brema Laboratory, Crimea, Ukraina (in litt. to KVW, 4 April 1997) confirmed the Batumi specimen and provided the following additional information. The minke whale stranded alive and died within a few hours on the shore of Zelonys Mys village, near Batumi, Georgia. The lower jaw is at the Krasnodar Museum of Nature, Russian Federation, but most of the skeleton is now in the Georgian State Museum of Natural History, Tbilisi. Since 1880 up to 1926 there were 1-2 more cases where single individuals of 'big whale', possibly minke whale, were observed in the Black Sea near the Georgian coast (Kleinenberg, 1956), however this is not verifiable. Interestingly, the migration route of European anchovy from the mouth of the Donau veers east at the Bosporus entrance to the Black Sea and progresses towards the Georgian coast. Several other fish species move in and out the Bosporus (Çelikkale, 1990). The rare occurrence of the minke whale in the Black Sea may be linked to fish migration.

Subtropical archipelagos in the northeast Atlantic

Azores

The minke whale is included in checklists for Azorean cetaceans (Reiner, 1988; Reiner *et al.*, 1993) but verifiable records are still few. Clarke (1981), who spent considerable time studying sperm whales in the Azores, thought that it was a rare species there. J.M. Gonçalves of the Departamento de Oceanografia e Pescas at the Universidade dos Açores points to five records, three of which (1,4,5) are unsubstantiated (Gonçalves *et al.*, 1996; and pers. comm. to KVW, 8 September 1999):

(1) Chaves (1924) reportedly found a minke whale of undetermined sex and size in advanced decay at Rosto de Cao, San Miguel Island.
(2) Reiner (1988) encountered a moribund individual of 485cm that ran aground at Porto Pim beach, Faial Island, on 3 May 1983. Rescue was attempted unsuccessfully. The published photograph shows a white flipper patch.
(3) A newborn calf of an estimated 2.6-3m (sex undetermined) was stranded, and filmed, at Ribeira Grande, São Miguel Island, on 20 February 1996 (Gonçalves *et al.*, 1996).
(4) A 'feeding group' (some 2-3 individuals) of alleged minke whales was filmed south of Pico island in the summer of 1996 by Serge Vialelle (Gonçalves, in litt. to KVW). However, until the footage can be viewed this record is unconfirmed.
(5) A specimen, apparently a gillnet victim, was found dead on 5 April 1997 near Maia, São Miguel island (Gonçalves, in litt. to KVW, 8 September 1999).

From 1987-1991, Steiner and Gordon (1993) spent 2,227 dedicated observation hours in the waters of the Azorean archipelago from mid-May to September, and while they sighted fin whales *B. physalus* and sei whales *B. borealis*, no minke whales were encountered. However, J.M. Gonçalves (in litt. to KVW, 8 September 1999) stated that sightings are becoming more common as whale watching tourism is increasing and more people are searching for cetaceans in the sea and from land look-outs.

Madeira

No minke whales have so far been reported from Madeira (see Maul and Sergeant, 1977) but until an update becomes available on recent research activities off the Madeira coast, little can be concluded about the occurrence of this balaenopterid in this area.

Canary Islands

Hervé-Gruyer (1989) first reported minke whales from the Canary Islands. Long-term investigations by two authors (MA and VM) revealed that it is fairly frequently seen and occurs year-round. Ten sightings and nine stranding records are registered to date (Table 2) and photographs are available for most of the strandings. Of the Los Gigantes specimen (Fig. 1), the skull, reproductive tract, stomach contents and parasites were collected and deposited at SECAC. The stomach was filled with small, so far unidentified, fishes. Continued work is expected to shed more light on the seasonality and feeding habits of minke whales in the archipelago. Most animals measured were calves according our body length criteria (median SL = 418cm, $n = 6$); all specimens ($n = 8$) were shorter than 6m, so none were adult.

West Africa

Atlantic Morocco and Western Sahara/Southern Morocco[2]

The minke whale has not yet been reliably reported from Morocco (Aloncle, 1964; Bayed and Beaubrun, 1987) while search effort has been limited. A 750km boat survey by Notarbartolo di Sciara *et al.* (1998) in coastal waters from the Bay of Dakhla south to the Bay of Cintra, Rio de Oro, from 20 January-14 February did not encounter minke whales.

[2] Legal status of territory, comprehending Saguia el Hamara and Rio de Oro, and question of sovereignty unresolved. Presently under de facto control of Morocco, but contested by Polisario Front.

Table 2

Confirmed stranding and sighting records 1986-97, chronologically ordered, of minke whales in the Canary Islands. All specimen records are supported by photographs deposited in the files of the Sociedad para el Estudio de los Cetaceos en el Archipielago Canario (SECAC), Santa Cruz de Tenerife.

Locality	Date	Size	Comments	Source
SPECIMEN RECORDS				
Puerto Lajas, Pto del Rosario, NE Fuerteventura	July 1986	-	Skull in SECAC collection; CBL <75cm; juvenile	SECAC files (unpublished)
Los Pocillos, SE coast Lanzarote	7 Dec. 1987	~5m	Carcass	SECAC files (unpublished)
Playa Blanca, south Lanzarote	1988	5m	Fresh carcass, poor condition	SECAC files (unpublished)
Los Gigantes, SW coast Tenerife	6 Jun. 1991	436	Female, dead floating, big shark bite laterally (Fig.1). Skull, stomach contents (small unidentified fishes), reproductive tract, parasites, and pectoral fin radiograph in SECAC collection.	SECAC files (unpublished)
Canary Islands	Sep. 1993	< 5m	Young animal stranded alive and released	SECAC files (unpublished)
Playa Banaderos, north coast Gran Canaria	Oct. 1993	< 6m	Carcass in advanced decomposition	MA personal files (unpublished)
Morro Jable, Pajara, SE coast Fuerteventura	winter 1993	~4m	Advanced decomposition; rostrum entangled in net; sex unknown	SECAC files (unpublished); photos
Playa del Cotillo, Carralejo, NW Fuerteventura	15 Jun. 1994	360	Carcass in advanced decomposition. Juvenile, sex unknown	SECAC files (unpublished)
Caleta del Sebo, Isla de La Graciosa, N. Lanzarote	Apr. 1997	3.5m	Live stranding and refloated by locals; sex unknown	SECAC files (unpublished)
SIGHTING RECORDS				
La Graciosa, from beach	29 Jan. 1988	-	3 minke whales spending min.50 minutes inshore (15m depth)	Herve-Gruyer, 1989
28°13'29"N, 15°51'49"W	-	-	2 minke whale sighted	Observers: MA, VM (this paper)
28°15'31"N, 15°59'16"W	15 Dec. 1992	-	2 minke whales, fast surface swim towards 2 fin whales 100m ahead	Observers: MA, VM (this paper)
27°53'58"N, 14°33'25"W	11 Oct. 1993	<5m	2 minke whales fast swimming side by side, heading NW	Observers: MA, VM (this paper)
27°57'23"N, 14°47'06"W	13 Feb. 1994	~4m	1 minke whale, fast swim before diving, heading NE	Observers: MA, VM (this paper)
27°59'06"N, 14°47'06"W	22 Sep. 1995	*ca* 4.5m	1 minke whale, fast surface swim and dive direction N	Observers: MA, VM (this paper)
27°49'58"N, 17°45'30"W	25 Apr. 1995	<5m	2 minke whales, 1 dove upon approach, other fled NE without diving	Observers: MA, VM (this paper)
27°58'32"N, 16°28'40"W	30 Apr. 1996	<6m	1 minke whale sighted	Observers: MA, VM (this paper)

Slijper *et al.* (1964), however, listed a few unsubstantiated sightings (reported by laymen) from off Atlantic Morocco, in March and September. It seems probable that it is only a matter of time before the species will be confirmed.

Martín observed opportunistic feeding behaviour of a minke whale in association with sardine purse-seine fishery operations in Garnet's Bay (24º51'38'N, 15º05'31'W), northwestern Sahara. On 12 November 1994, a solitary animal approached a stationary purse-seiner at less than 10m and began diving and moving quickly around the vessel (Fig. 2), showing evidence of sub-surface feeding. It displayed a distinct repertoire of feeding behaviours, including plunges, bubble clouds, lateral, ventral, oblique and ventral lunges. At the end of the seine set, the whale was seen eating dead sardines discarded from the vessel. Photographs taken are kept in VM's personal files. Similar approaches, without surface-feeding, were observed during the following three days (Martín, 1997).

Another two animals were recently seen off Rio de Oro by experienced cetologists, one specimen at 21°49'N, 17°09'W on 23 March 1997 and another at 23°20'N, 16°41'W on 28 March 1997 (A. Monna and A. Aguilar, pers. comm. to KVW, 16 April 1997).

Mauritania

Until recently the minke whale was unknown from the coastal waters of Mauritania (Vely, 1991; Robineau and Vely, 1998). In June 1994, Robineau found the rather fresh (condition 3), complete carcass of a 430cm calf (BLM3-94) stranded on the Great Mauritanian beach at 18º58'N 16º32'W, just north of Nouakchott (Fig. 3a). In November 1994, DR collected the skull (CBL = 110cm; Fig. 3b) and baleen and deposited these at the Centre National de Recherche Vétérinaire (CNRV) in Nouakchott. The baleen plates were ivory colour with some grey near the gums.

Senegal and The Gambia

Six records are documented:

(1) A 376cm female balaenopterid was found stranded on 21 September 1977 at Mbao village, Parc National de la Langue de Barbarie (centred at 15º50'N, 16º30'W) in northern Senegal. The whale calf had an estimated 64 ventral grooves, extrapolated from a left side groove count on a photo by J. Maigret (in Dupuy and Maigret, 1978). Small size, colouration and the number of ventral grooves combined readily excludes all rorquals except minke and Bryde's whale. A series of *ca*.12 small, brown-grey baleen plates (8.5-9.0cm long) with fine, yellow-brown bristles, referred to this stranding and curated in the collection of the Institut Fondamental d'Afrique Noir (IFAN), Université Cheikh Anta Diop, in Dakar (Van Waerebeek, 1999), positively identifies the calf as a minke whale. Maigret's photo shows a white (left) throat contrasting sharply with a dark mandibular lip, a feature common in NA minke whales (e.g. Mitchell and Kozicki, 1975, fig. 9, p.993; Kinze, 1995, fig.10, p.180); in Bryde's whales, dark lips and a lightly coloured throat are usually not that sharply divided.

(2) Dupuy and Maigret (1980) reported a 255cm rorqual that stranded in the Parc National de la Langue de Barbarie on 13 March 1979; no further voucher data are available. The small size agrees with the 2.4-2.8m neonatal length of North Atlantic minke whales (Jonsgård, 1951; Sergeant, 1963; Mitchell, 1975) and

Fig. 1. Ventral and lateral view of a 436cm, fresh minke whale calf found dead floating off Los Gigantes on the SW coast of Tenerife, Canary Islands, on 6 June 1991. [Photos by V. Martín].

Fig. 2. A solitary minke whale surfacing and feeding near a purse-seiner setting on sardines in Garnet's Bay (24°51'38"N, 15°05'31"W), northwestern Sahara, on 12 November 1994. The location is less than 3 n.miles from shore in shallow water (20m depth). Note the discriminatory white patch on the flipper (right). [Photo by V. Martín].

falls significantly short of the 3.4m neonatal length in Bryde's whale (Klinowska, 1991). The probability of the stranding being an intact aborted foetus of a larger balaenopterid (unreported to date) but not recognised as such (cf. umbilical cord) is negligible, so we are confident in assigning this specimen to the minke whale due to its size.

(3) A 380cm balaenopterid calf of unknown sex, in early decomposition, stranded on Mboro beach (15°10'S,16°55'W), between Dakar and Saint-Louis, northern Senegal, on an unspecified date in 1982 (Maigret, 1986). The very short, markedly triangular rostrum, characteristic of minke whales, is clearly discernible from a published photograph (Maigret, 1986) and two others (Fig. 4; courtesy J. Maigret, personal files, Muséum d'Histoire Naturelle de Paris) focusing on the dorsal aspect of the rostrum. The carcass (condition 4), was photographed by biologist Abdoulaye Djiba of IFAN on 8 May 1982, presumably shortly after the stranding. Flipper colouration cannot been determined due to post-mortem skin peeling. Nothing was collected.

(4) A small, immature calvaria (estimated CBL = ~85cm), collected by Abdoulaye Djiba from a beach near Mbao, Parc National de la Langue de Barbarie, on 15 July 1986, is kept (incomplete) at the IFAN museum, Dakar, under number 93-17. Small size, short nasofrontal maxillary processi (versus long in Bryde's whale, e.g. Omura

Fig. 3(a). The carcass (CBL = 110cm) of a 430cm minke whale calf stranded in June 1994 on the Great Mauritanian beach, just north of Nouakchott at 18°58'N,16°32'W. Baleen and skull are deposited (specimen BLM3-94) at the Centre National de Recherche Vétérinaire in Nouakchott, Mauritania. Note the short, broad nasal bones; the short maxillar and praemaxillar bones, and the very wide prenarial basin. [Photo by D. Robineau].

et al., 1981) and a wide peri-nasal basin between these processi (which are relatively narrow in Bryde's whale) indicate minke whale. The nasals were lost but their shape and relative position was obvious from the mark left in the frontal bone. Length of the bullae tympanicae: left, 80mm; right, 79mm.

(5) Mamadou Faye from the Centre National de Formation de Techniciens des Pêches Maritimes in Dakar conserves the almost complete skeleton (left mandible and some ribs are missing) of a calf (Fig. 5) for educational purposes. Fishermen of Thiaroye recovered the reportedly injured minke whale from a gillnet set 'some 50m from shore' in Anse de Hann (14°41'S,17°27'W), Cap Vert Peninsula, on 14 May 1993 (Ibrahima Sakho in daily newspaper *Le Soleil*, unknown date, photocopy in CEPEC files, showing photo of butchered carcass). The whale, which measured more than 4m, was landed and cut up for its meat. KVW and END studied and photographed the skeleton (assigned no. KVW-3036) on 20 May 1998. None of the vertebral epiphyses were fused to the centra. A sample of dried muscle tissue was taken which yielded usuable mtDNA (discussed below). No photos exist of the animal in the flesh, so the presence of white flipper patches could not be verified.

(6) The left mandibular ramus (KVW-3021) of a small balaenopterid whale was sold to KVW on 23 November 1996 by fisherman Mamadou Seck from Djiffer (13°48'N, 16°55'W), an artisanal fishing community on the southern tip of the west bank of the Saloum delta. The sun-bleached ramus was retrieved on a near-by beach 'some years earlier'. Its small length in a straight line (91cm) combined with the absence of a groove between the angular and articular parts of the lingual side of the mandible (present in Bryde's whale; see Junge, 1950) is congruent only with a minke whale calf. The smallest mandibular ramus from 33 Bryde's whales of all age classes and pooled stocks, including the diminutive form, exceeded 120cm (Perrin *et al.*, 1996). The ramus was accidentally destroyed in a fire, but voucher photos are in CEPEC files.

The minke whale has possibly been sighted in Gambia coastal waters (Murphy *et al.*, 1997). Dolphin watch operator Mr Mervyn Baldwin sees with regularity small whales he believes are minkes off Gambia's south coast (Kartong). In January 1998, two cetaceans identified as minkes (one estimated at ~6m) were spotted from the Dutch yacht *Schuttevaer* near buoy no.6 in the Gambia River mouth (Milko Berben, in litt. to KVW, 8 June 1999). The geography of The Gambia, i.e. surrounded by Senegalese territory, implies that most cetacean species encountered in Senegal are likely to be present in Gambian EEZ waters. The wide Gambia River estuary may represent a suitable habitat, as minke whales are known to enter river mouths and estuaries (Leatherwood *et al.*, 1976; Klinowska, 1991).

Cape Verde

No supported minke whale records exist from the Cape Verde islands (Reiner *et al.*, 1996), a nation archipelago of nine larger and several smaller islands centred around 16°N, 24°W. Lagendijk (1984) reported the live stranding of a 4.5m baleen whale weighing an estimated 600/700kg near Cidade Velha on the south coast of Santiago island on 5 November 1983, which he thought was most likely a minke whale 'but photographs in the local newspaper could not be examined'. Reiner *et al.* (1996) misidentified this specimen (and erroneously cited the stranding date as 2 November 1993) as a juvenile fin whale, but this has a neonate size of 6.4m (Laws, 1959), 2m larger than the Cidade Velha whale. C. Hazevoet and Fred Wenzel (in litt. to KVW, 7 September 1999)[3] kindly provided a copy of two Voz di Povo newspaper photos which showed a freshly stranded balaenopterid with a rounded, arched rostrum (contra sharp, V-shaped in minke), a largely dark coloured chin and ventral side, and apparently dark baleen plates with lighter bristles. The combination of these characters contradicts a minke whale identification and suggests a probable neonate sei whale, without excluding Bryde's whale with certainty.

Lagendijk (1984) did not sight minke whales on a short sailing vessel survey in the archipelago from 13 March-5 April 1984. Fred Wenzel (NEFSC, Woods Hole) who studied humpback whales and other cetaceans for four winter seasons (1990-91 and 1995-96) in the Cape Verde

[3] Based on: Hazevoet, C.J. and Wenzel, F.W. 1999. Whales and dolphins (Mammalia, Cetacea) of the Cape Verde Islands, with special reference to the humpback whale (*Megaptera novaeangliae*). Unpublished manuscript.

Fig. 3(b). The skull of a 430cm minke whale calf which stranded on the Great Mauritanian beach in June 1994. See Fig. 3(a) for details. [Photo by D. Robineau].

Fig. 4. A 380cm minke whale calf stranded at Mboro (15°10'N,16°55'W) in northern Senegal, photographed by biologist Abdoulaye Djiba on 8 May 1982 (courtesy Dr. Jacques Maigret, personal files, Muséum d'Histoire Naturelle de Paris). The very small body size and the short, triangular rostrum are discriminatory for the minke whale.

Islands also did not encounter minke whales (in litt. to KVW, 9 April 1997). Effort is however still too fragmentary to allow any conclusions on occurrence.

Offshore tropical Northeast Atlantic

Surprisingly few minke records are available in the literature from offshore tropical waters in the NE Atlantic, probably due in part to low survey effort (see Northridge *et al.*, 1995). Two reliable observations made by Folkow and Blix (1991) on an Oslo-Montevideo research cruise in December 1989 are as follows:

(1) one minke whale sighted at 19°35'N, 20°05'W on 10 December in clear weather, location was about 400km west of northern Mauritania, in waters of 2,000-4,000m depth;

(2) three animals were sighted, in clear weather, above an undersea ridge at 10°40'N, 22°00'W on 12 December 1989.

Seamen made several alleged minke whale sightings in the tropical Atlantic off West Africa from March-May and August-November (Slijper *et al.*, 1964).

DISCUSSION

Southern range boundary

The southernmost fully documented minke whale specimen registered in the Northeast Atlantic is a calf (KVW-3036) incidentally captured at Anse de Hann (14°41'N,17°27'W), near Dakar, Senegal. The mandibular ramus found at Djiffer (13°48'N, 16°55'W) may have been carried by currents over a significant distance. The most southerly reliable sighting in the offshore NE Atlantic is from 10°40'N, 22°00'W (Folkow and Blix, 1991), some 650km west of Guinea-Bissau. This suggests that at least some of the nine unconfirmed observations (most in April) by laymen in the area square 10°-20°N, 10°-20°W off West Africa and five in the square 0°-10°N, 30°-40°W (Slijper *et al.*, 1964) may be valid.

In the western North Atlantic, by comparison, minke whales do not range that far south: they have been sighted in southern Florida at 25°S (Moore, 1953; Moore and Palmer, 1955), the Gulf of Mexico (Davis and Fargion, 1996), Anguilla at 18°20'S (Leatherwood *et al.*, 1976) and the

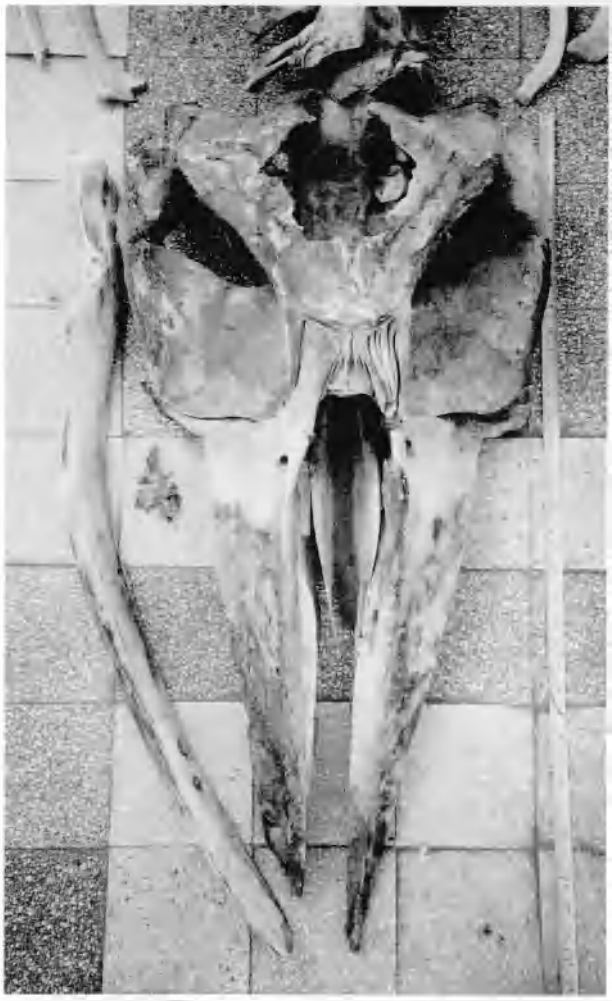

Fig. 5. Skull of a minke whale calf (KVW-3036) accidentally taken in a gillnet near Hann (14°41'S,17°27'W), Cap Vert Peninsula, Senegal, on 14 May 1993. It stands as the southernmost documented specimen from the North Atlantic Ocean. Its skeleton is at the Centre National de Formation de Techniciens des Peches Maritimes in Dakar. The animal measured somewhat more than 4m. [Photo by KVW].

Dominican Republic at 18°08'N, 67°50'W (Winn and Perkins, 1976). Mitchell (1991) found calves and adults sighted in winter in the western parts of an area bounded by 16°-33°N and 54°-80°W.

The Northwest African coasts south to the Cap Vert Peninsula are influenced by the cold Canary current system (Cushing, 1971; Mann and Lazier, 1996). Nine of ten West African coastal records were situated in this high-productivity, upwelling-modified habitat; one was in the border zone. The unconfirmed sightings off The Gambia suggest that distribution may extend south of Cap Vert Peninsula into waters governed by the warm Guinea Current. No cases exist for the continental shelf off Casamance, southern Senegal, southeast to Liberia and east in the Gulf of Guinea towards the equator. Admittedly, dedicated cetacean research in this huge area has only just started (Van Waerebeek and Ofori-Danson, 1999). From 1922-1959 intense whaling activity for Bryde's, humpback, fin and sperm whales, and possibly some blue and sei whales, operated in equatorial waters off Gabon and Sao Tome, north into southern Cameroon. Accounts of these whaling operations (Budker, 1952; 1953; 1954; Wells, 1984; Best, 1994) do not mention the minke whale, but whalers typically lack interest for species without commercial value and probably would not have reported it to the scientists. For example, despite two centuries of intensive whaling off Peru (Clarke, 1962), minke whales were first documented after whaling had ceased (Van Waerebeek and Reyes, 1994).

The northern range of Southeast Atlantic minke whales therefore seems to be Angola (Mörzer-Bruyns, 1971; Stewart and Leatherwood, 1985).

Migration, seasonality and segregation

In British and Irish waters minke whales are observed mainly between May and October (Evans *et al.*, 1993) but strandings in January and February (e.g. Fraser, 1953; 1974) suggest that at least certain individuals remain all winter or move in from more boreal areas. A study by Northridge *et al.* (1995) confirmed that minke whales are rare during the first quarter of the year, but during the second quarter move into coastal waters off northeast England and the Hebrides, and are subsequently augmented by more animals during the third quarter in the Hebrides and off the east coast of Scotland. In the last quarter of the year there are still some minke whales present in the Hebrides, and a few off the east coast of Scotland (Northridge *et al.*, 1995). They rarely go up the English Channel (Matthews, 1978) but several have stranded, mostly in autumn, on the sandy shores of Belgium, the Netherlands, Germany and Denmark (e.g. van Deinse, 1931; Schultz, 1970; Kinze, 1995), probably entering the North Sea from the north.

From the regular strandings (11 since 1980) on French shores of the Bay of Biscay (=Golfe de Gascogne), it is apparent that minke whales are present year round: January (1), February (1), March (1), June (3), July (2), August (1), September (1), December (1) (CRMM files, La Rochelle, France).

Temporal distribution along the western coasts of the Iberian Peninsula is similar to that from the British Isles and the Bay of Biscay (see also Lens and Rey, 1987). Although found in all months (minus January, so far), 76% of cases ($n=25$) were reported in March-August. Considering there are twice as many records in spring than in summer suggests that stranding frequencies may not be significantly distorted by higher observer effort in summer due to the greater use of beaches by the public. Both sexes and all length classes, but no neonates, were represented.

Positive sightings and strandings of minke whales in the Canary Islands have sharply increased since 1991 in conjunction with increased observer effort. Animals have been reported in each season and from all the major islands (Table 2). Interestingly, of the 12 animals for which total length was estimated or measured, all were smaller than 6m and therefore almost certainly sexually immature, but to date no neonates have been encountered. In the Azores, one neonate was reported in February, which agrees with the theoretically deduced November-March calving period for the NE Atlantic (Jonsgård, 1951; Sergeant, 1963; Mitchell, 1975). The seven specimens from Mauritania and Senegal were either calves (6) or neonate (1) which is a strong indication for these or nearby waters being a calving ground. Plausibly these are the undefined 'warmer waters' of other authors to which the NEA population migrates for reproduction, but a conclusive answer is premature.

Minke whales are distributed in the western and central Mediterranean Sea, except for an enigmatic but substantiated case from the eastern Black Sea. There is one possible record for the Adriatic Sea. The majority of records originate from

the Gulf of Lion and the Ligurian and Tyrrhenian Seas. No abundance estimates are available, but the species is clearly uncommon.

The apparent concentration in the Ligurian-Provincal basin requires further study, but may be linked to the local abundance of the euphausiid *Meganyctiphanes norvegica* as has been established for summering Mediterranean fin whales (Relini *et al.*, 1999). Euphausiids are part of the normal diet of NA minke whales (Jonsgård, 1951; Haug *et al.*, 1996).

While most sightings, strandings and bycatches in the Mediterranean Sea occurred in the warmer months of the year (April-October), confirmed winter strandings exist for December (Carruccio, 1913) and February (Van Beneden, 1878). Slijper *et al.* (1964) noted a second, unsubstantiated, sighting in December from the western Mediterranean north of 40°N. Low observer density in winter may account for the few encounters and a year-round resident population may exist. Four calves ranging from 300-360cm, incidentally caught in the French Ligurian Sea (off the département du Var), suggest they were born here.

Poor information permits no conclusions on the migratory movements of minke whale out or towards the Mediterranean Sea, despite Marchessaux's (1980) belief that 'it seemingly follows a summer migration from the Atlantic to the western Mediterranean, reaching as far as Tunisia'.

Stock identity and status

Not only is the relationship unclear between CNA and NEA populations, but how these relate to animals from coastal West Africa and the Mediterranean Sea needs to be elucidated. Where flipper colouration was noted (few animals), the prominent white flipper patch confirmed *B. acutorostrata* (Lacépède, 1804) as opposed to Southern Hemisphere (Antarctic) ordinary minke whale *B. bonaerensis* (Burmeister, 1867). Most probably the small specimens found off West Africa constitute offspring of breeding adults belonging to the NEA and/or CNA stocks. Less likely, but theoretically possible, is that they are an unrecognised, discrete local population, a form of dwarf minke whale (Best, 1985; Arnold *et al.*, 1987), or some heterogeneous sympatric mix. The same uncertainties shroud Mediterranean minke whales. Preliminary cladistic analysis of a 178bp segment of the mtDNA control region of KVW-3036 from Dakar suggests that it is an individual more closely related to the North Atlantic minke whale than to the Antarctic dwarf and ordinary types (M. Goto and L. Pastene, in litt., 1 Oct 1998). However, cladistic analysis of another, 355bp, portion of the control region (although hampered by a number of uncertain readings of bases) located KVW-3036 in a cluster related to, but independent from, a cluster containing NA minke whale plus Antarctic dwarf. Future samples will be needed to help resolve the question of stock identity.

A foraging minke whale off Rio de Oro and another with a full stomach in the Canary islands, in November and June respectively, show that the species at least occasionally feeds successfully in lower latitudes in summer and autumn. Such individuals may not need to migrate to boreal feeding grounds. Semi-residency and feeding in low latitudes is recognised in humpback whales occupying areas of strong coastal upwelling, apparently linked to the relatively predictable presence of prey (Mikhalev, 1997; Papastavrou and Van Waerebeek, 1997). The upwelling ecosystem off northwest Africa and Canary Current may provide both suitable breeding and opportunistic feeding habitat for minke whales. There is as yet no answer though to the general question (*re* balaenopterids) Mackintosh (Mackintosh, 1966) raised: whether the breeding community in low latitudes is concentrated or dispersed, possibly extending offshore. Mitchell (Mitchell, 1991) recommended shipboard transects between Dakar and Puerto Rico to establish whether winter distribution of minke whale is disjunct or continuous across the southern North Atlantic.

It was demonstrated that Senegal, Mauritania and Western Sahara/Southern Morocco (Rio de Oro) qualify as newly confirmed Range States for minke whale. It seems only a matter of time before adjacent nations like The Gambia and Morocco will join this group. In addition, minke whales were found to be common around the Canary Islands (Spain) and present off the Azores, but so far were not recorded off the Cape Verde Islands, nor Madeira.

If breeding areas are confirmed on the West African continental shelf, measures to safeguard the coastal ecosystem against excessive human disturbance may become essential to ensure calving success. The coastal habits of the minke whale renders it particularly vulnerable to a wide range of fishing activities (Sequeira *et al.*, 1992; Tobayama *et al.*, 1992). Despite the apparently small size of the Mediterranean 'population', eight animals are known to have died from human interactions in the western Mediterranean in 1973-1983 (Duguy, 1983b). Five (4 from Italy; 1 from France) were incidentally caught in pelagic gillnets, two became entangled in undetermined nets off France, and one was killed by a ship collision in Spain (Duguy, 1983b). The fraction of lethal encounters that remained undetected is unknown but may be significant. Of the 17 specimens recorded stranded in Portugal in 1989-1997, four showed marks of entanglement in cables from fishing traps, i.e. wire baskets or pots set for crustaceans and octopus (Sequeira *et al.*, 1996; Table 1).

Although incidental mortality of minke whale in fish traps, drift gillnets, purse-seines and from ship collisions is a worldwide problem (e.g. Lien, 1980; Northridge, 1984; Guerra *et al.*, 1987; Salm, 1992; Tobayama *et al.*, 1992; Todd *et al.*, 1992; Van Waerebeek and Reyes, 1994; Kim, 1999; this paper) it has received little attention and both its true extent and the impact on populations remains unassessed. The authors strongly recommend that efforts be made to estimate incidental takes. Indeed the IWC resolved (IWC, 1999a) that in setting catch limits the Commission should 'take account of all known human-induced mortalities including aboriginal subsistence whaling, scientific whaling, whaling outside the IWC, bycatches, ship strikes and other non-natural removals (*Rep.int.Whal.Commn.*49:35)'. One natural (but least recognised) threat that should be considered because of potentially devastating consequences at the population level, is the possibility of a lethal morbillivirus epizootic (Van Bressem *et al.*, In press). Di Guardo *et al.* (1995a; b) detected antibodies against canine distemper virus (a morbillivirus) in an adult minke whale, stranded in Italy, which suffered viral encephalitis. Cetacean morbillivirus would not be incompatible with the findings due to cross reactions between morbilliviruses in serum neutralisation tests as used by Di Guardo *et al.* (1995a; b). Dolphin morbillivirus-like infections have recently been found in 13 out of 48 samples from North Atlantic fin whales (Blixenkrone-Moller *et al.*, 1996), but clinical effects are unknown and unstudied.

Continued field research in West Africa under auspices of UNEP/CMS, including increased monitoring of bycatches and strandings (Van Waerebeek, 1999), is designed to further improve our understanding of distribution parameters and population composition. Larger sample sizes will permit rigorous statistical analysis and additional tissue samples

will shed light on genetic stock affinities. Screening of local or obscure literature may uncover other valuable historical records, especially for the Mediterranean where older accounts of small baleen whales were lumped under one species *Balaenoptera musculus,* Van Beneden and Gervais (=*B. physalus*, Linnaeus) (Fischer, 1881).

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