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Skulls of the harbour porpoise *Phocoena phocoena* (Mammalia: Cetacea, Odonticeti) from Mauritania and Morocco, West Africa

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Two skulls of harbour porpoises *Phocoena phocoena* from Mauritania and five from Morocco are described and their measurements compared with data from the literature. The condylobasal length (CBL) of one of the skulls from Mauritania (NMR 9990-00167) is 301 mm and the rostrum length is 135 mm and of one of the skulls from Morocco (NMR 9990-01498) 297 mm and 134,2 mm respectively. These dimensions are exceptionally large compared to skulls of harbour porpoises from northern regions in the Eastern North Atlantic (ENA). The size of NMR 9990-00167 and the reconstructed total body length (TBL) of 177.7 cm are also extraordinary with respect to its young age (2 years, not yet sexually mature). Compared to other harbour porpoises in the ENA, the length and diameter of the teeth of NMR 9990-00167 are unusually large as well, and are more in line with those of specimens from southern European countries (Spain, Portugal) rather than those from more northerly populations. Based on the two skulls described here, it is apparent that harbour porpoises from West Africa are significantly larger than those from the more northern waters of the ENA and belong to a separate, isolated population. In addition, both skulls from Mauritania show features of a chronic pyogenic osteomyelitis.

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INTRODUCTION

In February 1995 the second author collected the skulls of two dead harbour porpoises *Phocoena phocoena* (Linnaeus, 1758) on the beach near Nouakchott, capital of the Islamic Republic of Mauritania, West Africa. In addition, in March 1997 he collected the incomplete skulls of five harbour porpoises near Port of Tan Tan, Morocco, West Africa. The material was deposited in the Natural History Museum Rotterdam, the Netherlands.

Since skeletal material of this species from West Africa is scarce in museum collections and field observations from the area are rare too, the skulls were examined in detail. The dimensions of one of the skulls from Mauritania are exceptionally large, and both skulls from Mauritania show intriguing pathology. Therefore the specimens are described here and compared with harbour porpoises from more northerly populations in the Eastern North Atlantic. The data will add to the small body of knowledge about West African harbour porpoises.

PHOCOENA PHOCOENA IN WEST-AFRICA

The West African coast is the southernmost area of distribution of the harbour porpoise in the Eastern North-Atlantic. Smeenk *et al.* (1992) summarized the scarce records of sightings, strandings and catches of this species in West Africa (finds of skulls and skeletons not included), with records from Morocco, Mauritania and Senegal. Robineau & Vely (1998) mentioned 51 known strandings from the coastline of Mauritania. In Mauritania the harbour porpoise is most frequently observed in Baie du Lévrier, east of Cap Blanc, near Nouadhibou (Cadenat 1949; Duguy, 1975; Maigret *et al*. 1976; Dupuy & Maigret 1979; Smeenk *et al.* 1992). Sightings, strandings and catches south of this area are rare, despite intense observations (Smeenk *et al.* 1992; Robineau & Vely 1998). There are some records from Banc d'Arguin and some from near Nouakchott (Maigret *et al.* 1976).

MATERIAL AND METHODS

In February 1995, the second author found the decomposed remains of three harbour porpoises on the beach near Nouakchott; one other on the island of Nair, Parc National du Banc d'Arguin and three others in Morocco, near Port of Tan Tan (near Chebeiha and near Agfennir) (Fig. 1). In March 1997 the decomposed remains of five additional harbour porpoises were found on the beach north of Port of Tan Tan (Tan Tan Plage), Morocco. The cadavers were not measured, not sexed and not photographed, but the complete skulls of two of the three porpoises found near Nouakchott in 1995, and five incomplete skulls found near Port of Tan Tan in 1997 were collected and subsequently deposited in the collection of the Natural History Museum Rotterdam, the Netherlands, where they bear the catalogue numbers NMR 9990-00167, NMR 9990-00168, NMR 9990-02847, NMR 9990-01498, NMR 9990-02848, NMR 9990-02849 and NMR 9990-02850. Biometric data of four skulls are given in Table 1 and they are depicted in Figures 2-7.

Twenty-five skull characters were measured to nearest 0.1 mm. One tooth was extracted from the middle part of the mandible of NMR 9990-00167 and NMR 9990-00168 and was prepared into a thin longitudinal section. For the age determination, growth layers were counted (dr Christina Lockyer, Sea Mammal Research Unit, Cambridge, United Kingdom). Chronological age is estimated from the number of completed growth layers.

Abbreviations used: NMR - Natural History Museum Rotterdam; ZMA - Zoological Museum Amsterdam; TBL - Total Body Length; CBL - Condylobasal length; RL - Rostrum length; ENP - Eastern North Pacific; ENA - Eastern North Atlantic; WNP - Western North Pacific; WNA - Western North Atlantic.

The skulls

NMR 9990-00167 Collected in February 1995, on the beach near Nouakchott, Mauretania.

Figure 1 The beach of Tan Tan, Morocco. [photo's M.C.J. van Leeuwen]

Figure 2 *Phocoena phocoena* NMR 9990-00167, skull, dorsal view. [photo Rob 't Hart] (scale bar = 4 cm)

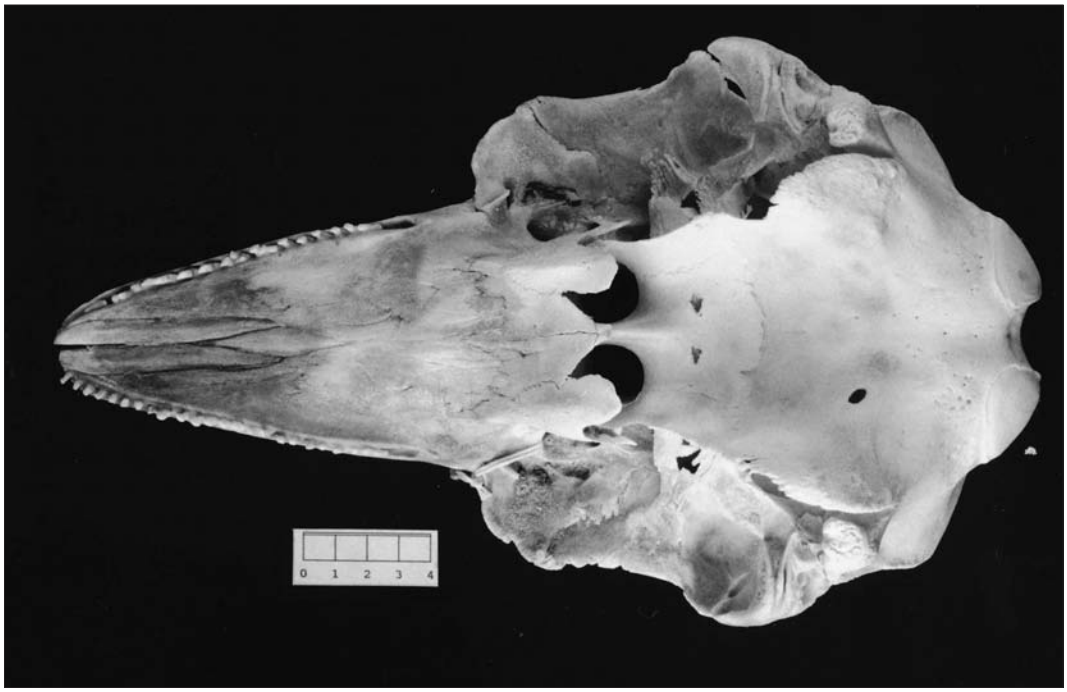

Figure 3 *Phocoena phocoena* NMR 9990-00167, skull, ventral view. [photo Rob 't Hart] (scale bar = 4 cm)

On first inspection the skull appears to be large and robust for this species (Figs. 2, 3). A longitudinal section of one of the teeth shows two dentinal growth layer groups, so it will be aged two years old. The frontal crest is not well developed and the teeth show no wear, indicating a young, not yet sexually mature, animal. The sex is unknown, although the measurements (Table 1) and the physical appearance of the skull point towards a female.

The left mandible shows severe pathological changes (Fig. 4). Large pieces of bone (sequestra) can be seen trapped in irregular new bone formation on the lateral side. Irregular larger and smaller holes can be seen on the lateral as well on the lingual side of the mandible. This jaw must have been fractured on the mid-lateral side and subsequently infected. A diagnosis of chronic pyogenic osteomyelitis seems to be adequate. The irregular holes in the bone can be interpreted as holes for pus drainage (cloacae). Apart from this pathology, the skull and right mandible are completely normal.

NMR 9990-00168 Collected in February 1995, on the beach near Nouakchott, Mauretania.

This skull also belongs to a young individual. It appears to be more juvenile than NMR 9990-00167. The longitudinal section of one of the teeth shows only the beginning of one dentinal layer group, so it will be aged younger than one year. The sex is unknown.
Given the relative shortness of the rostrum (Table 1), this skull is abnormal. The lower jaw protrudes more than normal in the species (Figs. 5, 6). The rostrum shows several abnormalities on the ventral side (Fig. 7). The distal part of the vomer is absent between both premaxillae. A pathological process widens the meso-rostral groove. The maxillae and premaxillae are irregular on the place of the distal part of the vomer and some new bone formation is visible. The palatine is severely deformed on both sides. The left palatine shows a large hole, through which one could look into the proximal part of the mesorostral groove. The

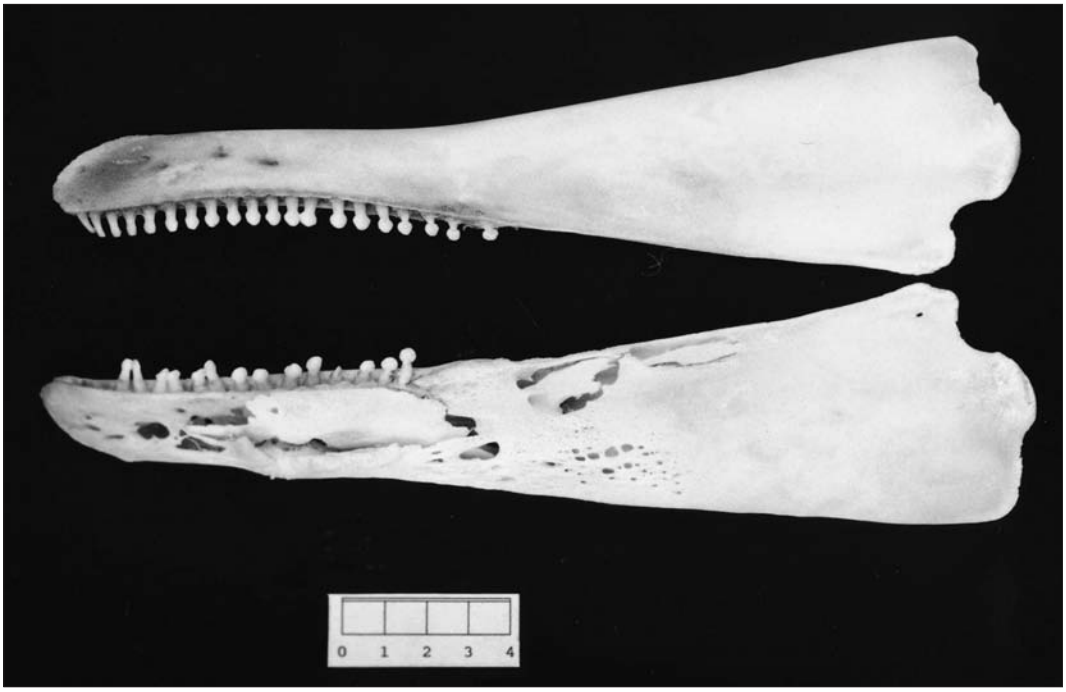

Figure 4 *Phocoena phocoena* NMR 9990-00167, mandibles. [photo Rob 't Hart] (scale bar = 4 cm)

Table 1 Measurements of *Phocoena phocoena* NMR 9990-00167, NMR 9990-00168, NMR 9990-01498 * = aberrant measurements due to pathology.

	NMR 9990-00167	**NMR 9990-00168**	**NMR 9990-01498**	**NMR 9990-02847**
condylo basal length (Total length of the skull)	301,0 mm	243,0 mm *	297,0 mm	--
rostrum length	135,0 mm	100,0 mm *	134,2 mm	134,0 mm
rostrum basal width	89,5 mm	85,5 mm	88,4 mm	81,0 mm
rostrum width 60 mm anterior to base	61,5 mm	--	58,2 mm	59,2 mm
rostrum width at its middle	57,0 mm	59,0 mm	57,0 mm	57,0 mm
breadth across postorbital angles of the supra-orbital processes	171,5 mm	154,0 mm	--	--
breadth across preorbital angles of supraorbital processes	143,5 mm	136,1 mm	139,2 mm	--
zygomatic width	173,5 mm	163,0 mm	168,0 mm	--
width of the braincase across parietals	135,2 mm	127,1 mm	136,0 mm	--
length of the temporal fossa	54,5 mm	49,0 mm	61,0 mm	--
height of the temporal fossa	39,0 mm	39,0 mm	48,0 mm	--
tip rostrum-nares	164,0 mm	132,0 mm *	--	--
length upper toothrow (right side)	122,0 mm	97,0 mm *	117,0 mm	--
length upper toothrow (left side)	124,0 mm	98,0 mm *	118,0 mm	--
tip rostrum-pterygoid	181,0 mm	139,0 mm	--	--
length mandible	235,0 mm	204,0 mm	--	--
height mandible at coronoid	59,0 mm	55,3 mm	--	--
symphysis mandibles (length)	27,8 mm	24,0 mm	--	--
length lower toothrow (right side)	118,0 mm	104,0 mm	--	--
length lower toothrow (left side)	--	101,0 mm	--	--
length 14th tooth mandible	15,5 mm	11,8 mm	--	14.0
diameter of the root 14th tooth	3,3 mm	2,6 mm	--	2,6 mm
width of the crown 14th tooth	4,5 mm	3,3 mm	--	--

(-- = not measured)

pathological process also affects the most proximal part of the vomer and the left pterygoid. There is an open connection between the mesorostral groove and the left narial opening. At the dorsal side of the skull, the maxilla and premaxilla are fused, showing irregular new bone formation (Fig. 5). These deformations are most likely the result of a chronic pyogenic osteomyelitis. This infection must have started at a rather young age, given its profound effect on the osteogenesis. The mandibles are normally developed. A large number of the parasitic nematode *Stenurus minor* was found around both tympanic bullae.

NMR 9990-01498 Collected in March 1997, on the beach near Port of Tan Tan, Morocco.

Only the upper skull collected. The mandibles, both tympano-periotics and almost all teeth are missing. On first inspection the skull appears to be large and robust for this species, which is reflected in the CBL (297,0 mm) and RL (134,2 mm).

NMR 9990-02847 Collected in March 1997, on the beach near Port of Tan Tan, Morocco.

Damaged skull, on the left side the whole maxilla, premaxilla, partial right maxilla, nasal, frontal and parts of the palatum and on the right side the whole premaxilla and parts of the maxilla, nasal, frontal and palatum are present, as the vomer and parts of the parietal. Both mandibles are severely fractured. Twenty-eight teeth from the lower jaws and thirty-six from the upper jaws are present. Sex unknown, judged from the overall appearance and wear from the teeth, this porpoise was not yet sexually mature. Only a few measurements could be taken (Table 1).

NMR 9990-02848 Collected in March 1997, on the beach near Port of Tan Tan, Morocco.

Neonate, sex unknown. Complete mummified head. Occipital, left temporal, basioccipital and one tympano-periotic detached. Sex unknown. No measurements taken.

Figure 5 *Phocoena phocoena* NMR 9990-00168, skull, dorsal view. [photo Rob 't Hart] (scale bar = 4 cm)

Figure 6 *Phocoena phocoena* NMR 9990-00168, skull, lateral view. [photo Rob 't Hart]

Figure 7 *Phocoena phocoena* NMR 9990-00168, skull, ventral view. [photo Rob 't Hart] (scale bar = 4 cm)

NMR 9990-02849 Collected in March 1997, on the beach near Port of Tan Tan, Morocco.

Immature, sex unknown. Mummified upper skull. Thirty-seven teeth present. Right squamosal and occipital detached. One tympano-periotic present. Sex unknown. No measurements taken.

NMR 9990-02850 Collected in March 1997, on the beach near Port of Tan Tan, Morocco.

Immature, sex unknown. Mummified upper snout. Incomplete right and left maxilla and premaxilla, vomer, occipital, basioccipital and both tympano-periotic. Thirty-six teeth in upper jaw.

ANALYSIS

Fraser (1958) was the first to describe the skull-dimensions and measurements of harbour porpoises from West Africa. He compared the measurements and morphological features of twenty skulls from porpoises from British waters with those of five skulls from West Africa. He only found an obvious difference in absolute size.

Condylobasal length and rostrum length

The CBL and RL of NMR 9990-00167 and NMR 9990-01498 are exceptionally large, but equal to the largest skull described by Fraser (1958) from West-Africa (Table 2). The skulls of harbour porpoises from Mauritania measured by Van Bree (unpublished data, see Table 2) have smaller CBL and RL, but they could represent either more immature or male specimens.

Amano & Miyasaki (1992) only found skulls with CBL >300 mm and RL >130 mm in porpoises from the ENP and WNP, but not in porpoises from the ENA (Table 2). Van Bree et al. (1977) and Stuart & Morejohn (1980) found such features only in skulls from the ENP. Only three skulls of porpoises from the ENA with a CBL larger than 300 mm and RL larger than 130 mm were traced in the literature: one skull from Denmark (Kinze 1994), one from Portugal (Reiner 1985) and one from West Africa (Fraser 1958). A CBL larger than 290 mm is only found in female harbour porpoises.

Relation between Condylobasal length and age

Miyasaki *et al.* (1987) found a relation between CBL and age. They recorded a female harbour porpoise from the ENP with a CBL of 300 mm and an age of ten years. A two year old female from the ENP had a CBL of 260 mm. They also found a two year old female and a nine year old female with a CBL of 285 mm. Stuart & Morejohn (1980) found a CBL between 290 and 311 mm only in female porpoises from the ENP (California) in which they counted between 5,5 and 7,0 dentinal growth layer groups.

Length and diameter of teeth

The teeth of *Phocoena phocoena* are small, the crown spade-shaped and vulnerable to wear. The length is about 10 mm, the diameter about 3 mm (Schulze 1987; Stuart & Morejohn 1980). The tooth length and diameter of the root of NMR 9990-00167 are larger compared with tooth of porpoises from the Netherlands (northern ENA) and Senegal (southern ENA) (Table 3). The largest female (TBL 186 cm) from the series of Van Utrecht (1978) has a tooth length of 12,6 mm and a root diameter of 2,7 mm.

Relation between total body length and condylobasal length

Harbour porpoises from West Africa have a larger TBL than porpoises from other areas (Cadenat 1949; Duguy 1975; Maigret *et al.* 1976; Dupuy & Maigret 1979). Fraser (1958) described a female porpoise from West Africa with a TBL of 177 cm (CBL 295 mm, RL 134 mm). The relationship between TBL and CBL is given by Miyasaki *et al.* (1987). They indicate that a female porpoise (from ENP) with a CBL of around 300 mm, will have a TBL of around 180 cm. Stuart & Morejohn (1980) described two female porpoises from the ENP with an CBL of 303 and 311 mm. The porpoise with the CBL of 311 mm has a TBL of 167-cm.

Table 2 Condylobasal length (CBL) and Rostrum length (RL) in *Phocoena phocoena* from different regions and countries.

region	country	reference	n =	CBL	RL
ENA	United Kingdom	Fraser 1958	20	178-279	
ENA	Netherlands, United Kingdom	Amano & Miyasaki 1992	39	221-283	89=123
ENA	Netherlands	Noldus & De Klerk 1984	61	m: 182-280 f: 207-283	
ENA	Denmark	Kinze 1994	10	m: 214-285 f: 205-304	m: 89-126 f: 82-142
ENA	Portugal	Reiner 1985	7	190-312	
ENA	West Africa	Fraser 1958	5	280-300	120-135
ENA	West Africa	Van Bree (unpublished)	6	281-289	117-130
WNA	USA, Canada	Amano & Miyasaki 1992	12	255-281	101-122
ENP	USA [California]	Norris & McFarland 1958	1	290	
ENP	USA [Alaska]	Van Bree *et al.* 1977	3	261-302	114-131
ENP	USA [California]	Stuart & Morejohn 1980	84	m: 234-278 f: 179-311	m:103-128 f: 76-141
ENP	USA [Pacific coast]	Amano & Miyasaki 1992	22	266-315	108-145
WNP	Japan	Miyasaki *et al.* 1987	15	m: 246-286	f: 255-288
WNP	Japan	Amano & Miyasaki 1992	31	246-303	105-138

(= male; f = female)

Van Utrecht (1978) made a correlation between age and body length. Female porpoises from Dutch waters (ENA) of two years of age have a body length between 116,5 and 127 cm. He found one female of 8 years old with a TBL of 186 cm. Addink & Smeenk (1999) found that animals up to puberty (older than one year but not sexually mature) have a TBL between 117 and 148 cm. Maigret *et al.* (1976) described a male porpoise with a TBL of 200 cm This latter observation should be judged with reserve. It probably concerns a female porpoise or the

Table 3 Tooth length en diameter of root in *Phoena phocoena*.

	tooth length	**diameter of root**
Van Utrecht (1978), Netherlands	male 11,4 (9.0-12,8 mm) [n=19] female 11,8 (8,6-14,4 mm) [n=32]	male 2,4 mm [n=19] female 2,3 mm [n=32]
NMR 9990-00167	15,5 mm	3,3 mm
NMR 9990-00168	11,8 mm	2,6 mm
ZMA 13.257 Dakar, Senegal	11,4 mm	3,2 mm

TBL was not measured correctly.

Galatius (2005) stated that in female harbour porpoises from Danish and German waters the CBL represents 16.93% of the TBL and that female harbour porpoises have a prolonged period of growth, reaching 95% of their predicted asymptotic length at an age of 4.9 years. Following this the TBL of NMR 9990-00167 is 177.7 cm, and has at the age of 2 years not reached full body length at the time of death.

If we hypothetically suppose that NMR 9990-00167 had a TBL of about 180 cm (based on a CBL of 301 mm), then it can be placed among the six out of twelve porpoises from West Africa with a TBL of 170 cm or more (Smeenk *et al.* 1992). With some caution, this conclusion seems justified, as the female porpoise described by Fraser (1958) had a TBL of 177 cm and a CBL of 295 mm.

Table 4 *Phocoena phocoena* in random series from the Eastern North Atlantic with a TBL of 170 cm or more.

location	**number of porpoises with TBL of 170 cm or more**	**percentage of total number**
Begium coast (n=30) (De Smet 1974,1981; Van Gompel 1991)	0	0%
Dutch waters (n=295) (Van Utrecht 1978; Smeenk *et al.* 1992)	3	1%
Danish waters (n=392) (Mohl-Hansen 1954)	10	2,5%
French coast (n=60) (Duguy 1973, 1978, 1981, 1982, 1983, 1984, 985, 1986a, 1986b, 1988, 1990)	15	25%
Spanish and Portugese coast (n=65)(n=Sequeira *et al.* 1992; Castellis & Mayo 1992)	14	21,5%
West Africa (n=11)(Cadenat 1949, 1957, 1959; Dupuy & Maigret 1979,1980; Fraser 1958; Duguy 1975; Aloncle 1964; Maigret *et al.* 1976)	5	45%

Isolated population?

Since the harbour porpoise is not a migrating species (Neave & Wright 1968; Gaskin & Watson 1985; Amano & Miyasaki 1992), the population in West Africa can be seen as an isolated one. Several other isolated populations have been recognized. The populations of the North Atlantic, North Pacific and Black Sea differ significantly in dimensions. Gene flow between the different populations appears to be very limited or even absent. Gaskin (1984) recognizes nine different populations in European waters. Kinze (1985) stated the harbour porpoises from the North Sea and those from the Baltic Sea to be different populations, but this conclusion is contradicted by the genetic study of Tiedemann *et al*. (1996).

Pathological changes

The pathology found in both skulls is not exceptional for harbour porpoises. Kompanje (1993) described pyogenic osteomyelitis of the mandible in five cases from the Dutch coast. The first author knew several unpublished cases since then. Pyogenic osteomyelitis of the rostrum or mandible is also known to occur in other odonticeti (e.g. Harmer 1927; Coyler 1938). The aetiology in the two skulls described in this article is most probably a posttraumatic pyogenic infection.

CONCLUSIONS

NMR 9990-00167 and NMR 9990-01498 belong to female individuals. The CBL and RL are exceptionally large compared to skulls of harbour porpoises from other regions in the ENA. NMR 9990-00167 has an unusual CBL (301 mm) in relation to its age of 2 years (not yet sexually mature). The length and diameter of the teeth of NMR 9990-00167 is uncommon compared to other harbour porpoises in the ENA. The reconstructed TBL is exceptionally long for a two year old porpoise from the northern waters in the ENA, but seems to be more common in southern coastal waters of the ENA (Table 4). NMR 9990-00167 was, at the age of two years, and with a TBL of 177.7 cm not yet fully grown. Most probably, harbour porpoises from West African waters belong to an apparently isolated population that occurs along the West African coast from Agadir, Morocco, south to Dakar, Senegal. This population is characterized by a greater body length than porpoises from northern waters in the ENA. This is also reflected by a large CBL and RL at a younger age (not sexually mature).

Further study on the dimensions and analysis of DNA of harbour porpoises from West Africa can give more inside in geographic variation and provenance of this species in West Africa. It also seems useful to compare porpoises from French, Spanish and Portuguese waters with those from Dutch, Belgian, Danish and British waters and those from West Africa.

REFERENCES

Addink, M.J., Smeenk, C., 1999 - The harbour porpoise *Phocoena phocoena* in Dutch coastal waters: analysis of stranding records for the period 1920-1994 - Lutra 41: 55-80

Aloncle, H., 1964 - Premières observations sur les petits cétacés des côtes marocaines - Bulletin de l'Institut des Pêches maritimes du Maroc 12: 21-42

Amano, M., Miyasaki, N, 1992 - Geographic variation in skulls of the harbor porpoise, *Phocoena phocoena* - Mammalia 56: 133-144

Cadenat, J., 1949 - Notes sur les cétacés observés sur les côtes du Sénégal - Bulletin de l'Institut Français d'Afrique Noire 11: 1-15

Cadenat, J., 1957 - Observations de cétacés, siréniens, chéloniens et sauriens en 1955-1956 - Bulletin de l'Institut Français d'Afrique Noire 19: 1358-1375

Cadenat, J., 1959 - Rapport sur les petits cétacés ouest-Africaines. Résultats des recherches entreprises sur ces animaux jusqu'au mois de mars 1959 - Bulletin de l'Institut Français d'Afrique Noire 21: 1367-1409

Castellis, A., Mayo, M., 1992 - Relacion de citas de cetaceos (Mammalia, Cetacea): España y Portugal, numero 1 volumen 2 - Centro de estudios de mammíferos marinos

Coyler, J.F., 1938 - Dento-alveolar abcess in a Grampus

(*Orca gladiator*, Bonn) - Scottish Naturalist no. 230: 53-57

De Smet, W.M.A., 1974 - Inventaris van de walvisachtigen (Cetacea) van de Vlaamse kust en Schelde - Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Biologie 50(1): 1-156

De Smet, W.M.A., 1974 - Gegevens over de walvisachtigen (Cetacea) van de Vlaamse kust en Schelde uit de periode 1969-1975 - Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Biologie 53(4): 1-34

Duguy, R., 1973 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France II. année 1972 - Mammalia 37: 669-677

Duguy, R., 1975 - Contribution à l'étude des mammifères marins de la côte nord-ouest Afrique - Revue des Travaux de l'Institut des Pêches maritimes 39: 321-332

Duguy, R., 1978 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France VII. année 1977 - Annales de la société des Sciences naturelles de la Charente-maritime 6: 333-344

Duguy, R., 1981 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France X. année 1980 - Annales de la société des Sciences naturelles de la Charente-maritime 6: 803-818

Duguy, R., 1982 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France XI. année 1981 - Annales de la société des Sciences naturelles de la Charente-maritime 6: 969-984

Duguy, R., 1983 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France XII. année 1982 - Annales de la société des Sciences naturelles de la Charente-maritime 7: 121-135

Duguy, R., 1984 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France XIII. année 1983 - Annales de la société des Sciences naturelles de la Charente-maritime 7: 189-205

Duguy, R., 1985 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France XIV. année 1984 - Annales de la société des Sciences naturelles de la Charente-maritime 7: 349-364

Duguy, R., 1986a - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France XV. année 1985 - Annales de la société des Sciences naturelles de la Charente-maritime 7: 507-522

Duguy, R., 1986b - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France XVI. année 1986 - Annales de la société des Sciences naturelles de la Charente-maritime 7: 617-639

Duguy, R., 1988 - Rapport annuel sur les cétacés et pinnipèdes trouvés sur les côtes de France XVII. année 1987 - Annales de la société des Sciences naturelles de la Charente-maritime 7: 753-769

Dupuy, A.R., Maigret, J., 1979 - Les mammifères marins des côtes du Sénégal. 3. Observations signalées en 1978 - Bulletin de l'Institut Fondamental d'Afrique Noire 41: 429-439

Dupuy, A.R., Maigret, J., 1980 - Les mammifères marins des côtes du Sénégal. 4. Observations signalées en 1979 - Bulletin de l'Institut Fondamental d'Afrique Noire 42: 401-409

Fraser, F.C., 1958 - Common or harbour porpoises from French West Africa - Bulletin de l'institut Français d'Afrique Noire série A: 276-285

Galatius, A., 2005 - Sexually dimorphic proportions of the harbour porpoise (*Phocoena phocoena*) skeleton - Journal of Anatomy 206: 141-154

Gaskin, D.E., 1984 - The harbour porpoise *Phocoena phocoena* (L.): regional population, status, and information on the direct and indirect catches - Report of the International Whaling Commission 34: 569-586

Gaskin, D.E., Watson, A.P., 1985 - The harbour porpoise, *Phocoena phocoena* in Fish harbor, New Brunswick, Canada: occupancy, distribution and movements - Fishery Bulletin 83: 427-442

Harmer, S.F., 1927 - Report on Cetacea stranded on he British coasts from 1913 to 1926 - Trustees of the British Museum, London: 1-91

Kinze, C.C., 1985 - Intraspecific variation in Baltic and North sea harbour porpoises (*Phocoena phocoena* (L., 1758)) - Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening 146: 63-74

Kinze, C.C., 1994 - *Phocoena phocoena* (Linnaeus, 1758) - Schweinswal oder Kleintümmler (auch Braunfish) - In, Niethammer, J., Krapp, F. (eds), Handbuch der Säugetiere Europas. Band 6, Meeressäuger I, Aula Verlag, Wiesbaden: 242-264

Kompanje, E.J.O., 1993. Osteomyelitis of the mandible in harbour porpoises *Phocoena phocoena* from the Netherlands - Lutra 36: 39-45

Maigret, J., Trotignon, J., Duguy, R., 1976 - Observations de cétacés sur les côtes de Mauritanie (1971-1975) - Conseil International pour l'Exploration de la Mer, Comité des Mammifères Marins C.M. 1976/N, 4: 1-6

Miyasaki, N., Amano, M., Fujise, Y, 1987 - Growth and skull morphology of he harbour porpoises in the

Japanese waters - Memoirs of the National Science Museum 20: 137-146

Mohl-Hansen, U., 1954 - Investigations on reproduction and growth of the porpoise (*Phocoena phocoen*a (L.)) from the Baltic. Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening 116: 369-396

Neave, D.J., Wright, B.S., 1968 - Seasonal migrations of the harbour porpoise (Phocoena phocoena) and other Cetacea in he Bay of Fundy - Journal of Mammalogy 49: 259-264

Noldus, L.P.J.J., De Klerk, R.J.J., 1984 - Growth of the skull of the harbour porpoise, *Phocoena phocoena* (Linnaeus, 1758), in the North Sea, after age determination based on dental growth layer groups - Zoologische mededelingen Leiden 58(14): 213-239

Norris, K.S., McFarland, N., 1958 - A new harbour porpoise of the genus *Phocoena* from the Golf of California - Journal of Mammalogy 39: 22-39

Reiner, F., 1985 - Mammifères de l'Atlantique Portugais et le phoque moine de Madère - Thèse presentée à L'Université d'Aix-Marseille III pour obtenir le Diplôme d'Etudes Doctorales de l'Université

Robineau, D., Vely, M., 1998 - Les cétacés des côtes de Mauritanie (Afrique du nord ouest). Particularités et variations spatio-temporelles de repartition: rôle des facteurs océanographiques - Revue Ecol (Terre Vie) 53: 123-152

Sequeira, M.L., Inacio, A., Reiner, F., 1992 - Arrojamentos de Mamíferos Marinhos na Costa Portuguesa entre 1978 e 1988 - Estudos de Biolia e Conservaçao de Natureza 7. Serviço Nacional de Parques, Reservas e Conservaçao da Natureza, Lisboa

Schulze, G., 1987 - Die Schweinswale - A.Ziemsen Verlag, Wittenberg, Lutherstadt

Smeenk, C., Leopold, M.F., Addink, M.J., 1992 - Note on the harbour porpoise *Phocoena phocoena* in Mauritania, West Africa - Lutra 35: 98-104

Stuart, L.J., Morejohn, G.V., 1980 - Developmental patterns in osteology and external morphology in *Phocoena phocoena* - Reports of the International Whaling Commission (Special Issue 3): 133-142

Tiedemann, R., Harder, J., Gmeiner, C., Haase, E., 1996 - Mitochondrial DNA sequence patterns of harbour porpoises (*Phocoena phocoena*) from the North and the Baltic Sea - Zeitschrift für Säugetierkunde 61: 104-111

Van Bree, P.J.H., Sergeant, D.E., Hoek, W., 1977 - A harbour porpoise, *Phocoena phocoena* (Linnaeus, 1758), from the Mackenzie River delta, Northwest Territories, Canada (Notes on Cetacea, Delphinoidea VIII) - Beaufortia 26: 99-105

Van Gompel, J., 1991 - Cetacea aan de Belgische kust, 1975-1989 - Lutra 34: 27-36

Van Utrecht, W.L. 1978 - Age and growth in *Phocoena phocoena* Linnaeus, 1758 (Cetacea, Odontoceti) from the North Sea - Bijdragen tot de Dierkunde 48: 16-28

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