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Occurrence of Cuvier's beaked whales in the southern Adriatic Sea: evidence of an important Mediterranean habitat

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The intent of this work is to summarize the available knowledge on the appearance, identification and distribution of Cuvier's beaked whales (*Ziphius cavirostris*) in the Adriatic Sea through a review of historical data, inspection of natural history collections and collection of original data. In total, eleven occurrences are documented of Cuvier's beaked whale along the Adriatic coast with all records originating from the deep southern Adriatic basin. The number of recorded stranded Cuvier's beaked whales in the southern Adriatic represents about 3% of the recorded specimens in the entire Mediterranean. This percentage increases up to about 5% when considering only data collected after the first recorded stranding of the recent era in 1975. Comparing these percentages to the extent of the area relative to the Mediterranean, the proportion of occurrence of the total stranded Cuvier's beaked whales in the southern Adriatic ranged between the same to double of that of the entire Mediterranean Sea. Therefore, the southern Adriatic Sea should be considered as a potentially relevant habitat of the Cuvier's beaked whale. This hypothesis has clear conservation implications particularly in view of the adverse impact of sonar experiments, carried out by navies from several countries, on this species and should be further investigated. Finally, there is no evidence of the northern bottlenose whale (*Hyperoodon ampullatus*) ever having occurred in this part of the Mediterranean region.

INTRODUCTION

Within the beaked whale family, Cuvier's beaked whale (*Ziphius cavirostris* G. Cuvier, 1823) is the only species known to regularly occur throughout the entire Mediterranean Sea (Notarbartolo di Sciara & Demma, 1997; Notarbartolo di Sciara, 2002). Information regarding the species' distribution and occurrence in the Adriatic Sea is scarce, with most reports and papers written in local languages or presented in non peer-reviewed publications. The intent of this work is to summarize the available knowledge on the appearance, identification and distribution of Cuvier's beaked whales in the Adriatic Sea and suggest that the southern Adriatic basin should be regarded as a regular habitat of this species.

The Adriatic Sea is the northernmost part of the Mediterranean basin (Figure 1). It is a small, semi-enclosed sea with a surface area of around 138,600 km^2, connected to the Mediterranean through the narrow (72 km wide) but deep (780 m) Strait of Otranto (Cushman-Rosin et al., 2001). The bathymetry of the Adriatic Sea is characterized by strong latitudinal and longitudinal asymmetries. The 170 m deep Palagruža (Pelagosa) sill separates the shallow northern and central sub-basins (maximum depth of 273 m), from the much deeper southern basin reaching depths of 1330 m. This southern basin consists of around 55% of the surface area (76,230 km^2) and about 80% of the total volume of the Adriatic Sea (Cushman-Rosin et al., 2001). It also represents about 3% of the total surface of the Mediterranean Sea (about 2.5 million km^2). According to the documented information on the preferred habitat of the Cuvier's beaked whale it would be expected to be absent from the shallow northern and central Adriatic Sea (Notarbartolo di Sciara, 2002; Podestà et al., 2006). *Ziphius cavirostris* has, however, been noted in the deeper southern basin, where all the stranded specimens have been found, but considered as an occasional visitor (Lamani et al., 1976; Centro Studi Cetacei, 1987; Notarbartolo di Sciara et al., 1994; Centro Studi Cetacei, 1995; Storelli et al., 1999; Holcer et al., 2002; Holcer et al., 2003; Gomerčić et al., 2006; Podestà et al., 2006).

Ziphius cavirostris *records in the Adriatic Sea*

Inspection of natural history museum collections in Croatia (Zagreb, Rijeka, Zadar and Dubrovnik) found no records or material that would refer to the occurrence of Cuvier's beaked whale in the eastern Adriatic waters. Cagnolaro (1996), in his comprehensive survey of cetaceans in Italian collections, also found no evidence of specimens from the western shores of the Adriatic Sea.

A review of older literature found one description of the occurrence of Cuvier's beaked whale in the Adriatic Sea (Hirtz, 1940). This specimen, however, was mistakenly identified as a northern bottlenose whale, *Hyperoodon ampullatus* (Forster, 1770). Based on this record the northern bottlenose whale appeared listed as part of the fauna of the Adriatic Sea (Gomerčić et al., 1998; Gomerčić et al., 1999; Anonymous, 2001; Gomerčić et al., 2002; Gomerčić et al., 2003). In his short report 'Northern bottlenose whale (*Hyperoodon ampullatus*

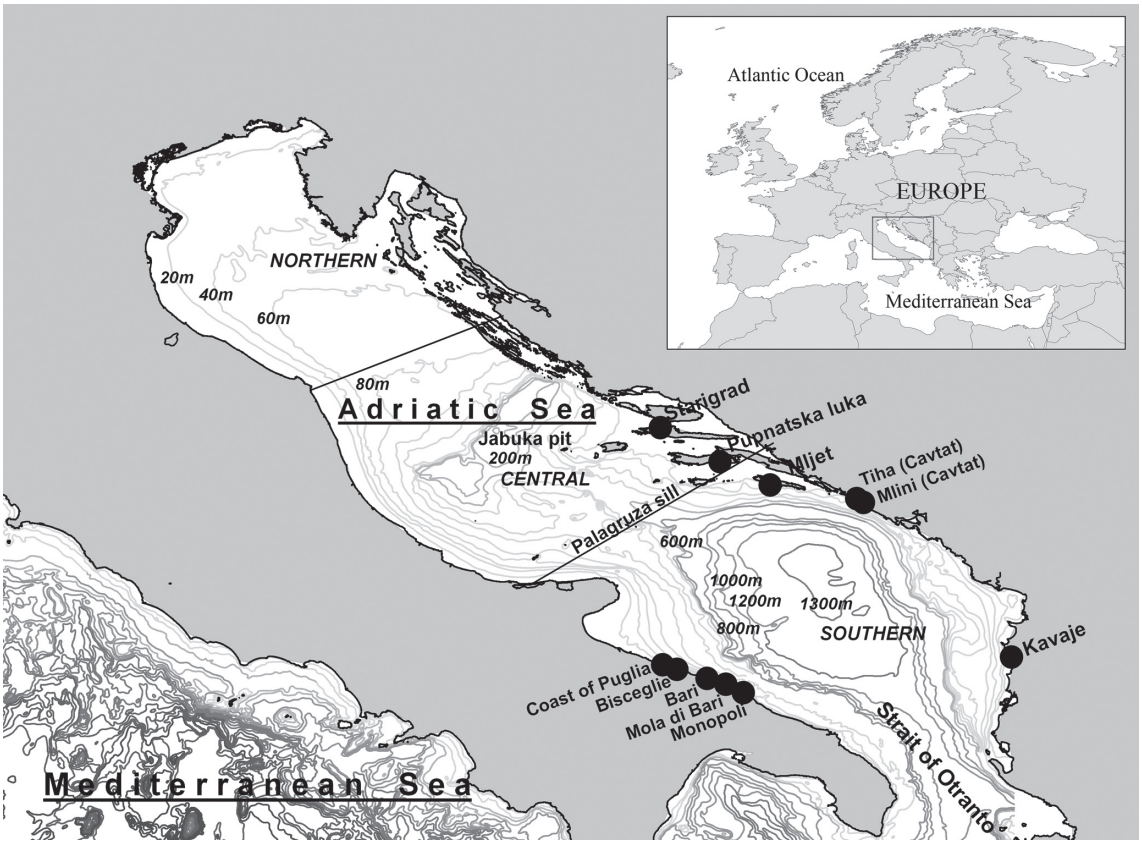

Figure 1. Locations of strandings of *Ziphius cavirostris* in the Adriatic Sea with bathymetric contour lines.

Forst.) in the Adriatic waters' Hirtz (1940) stated that the animal was found stranded alive on 8 October 1939 in the vicinity of the town of Cavtat. It was subsequently examined in Zagreb, and identified as a northern bottlenose whale. The animal was 5.35 m long and weighed approximately 2 tons. The specimen was dark in colour, very likely due to a combination of post-mortem and preservation processes, and as Hirtz (1940) describes, 'it had a particularly shaped beak, similar to duck's beak'. Unfortunately, no osteological material was preserved to confirm the identification; however, pictures, a description and measurements of the animal were published (Figure 2). Based on this material, we concluded that the specimen was, in fact, a Cuvier's beaked whale (also known as goose-beaked whale).

Since this first record was made in the Adriatic Sea, ten other stranded specimens of Cuvier's beaked whales have been documented (Table 1). Five of these were recorded along the Apulian coast in Italy, one in Albania and four along the Croatian Adriatic shore. Podestà et al. (2006) quote eight of these records (including Hirtz, 1940): three stranded animals remain unrecorded. One such record is of an adult male, five metres long, stranded in Monopoli (Bari) in June 1980 (L. Cagnolaro, personal communication). Bello (1990) also mentions a specimen stranded in Monopoli in 1980, possibly the same individual, although in Bello's account the animal was found in the 'Fall 1980'. Due to the uncertainty of the date Bello's record is not listed as a separate stranded animal.

Table 1. *Locations, dates, specimen data and sources of information for strandings of Cuvier's beaked whale,* Ziphius cavirostris, *along the coasts of the Adriatic Sea.*

Location	Date stranded	Sex	Size	Source
Tiha bay (Cavtat)	8 October 1939	-	5.35 m	Hirtz, 1940
Near Kavaje (Albania)	23 October 1975	-	5.75 m	Lamani et al., 1976
Monopoli (Bari)	6 June 1980	M	5 m	Cagnolaro, pers. comm, Bello, 1990
Bari	15 February 1982	-	5.8 m	Podestà et al., 2006
Mola di Bari (Bari)	22 May 1986	F	3.3 m	Centro Studi Cetacei, 1987
Bisceglie (Bari)	12 October 1992	F	5.3 m	Centro Studi Cetacei, 1995
Apulian coast	between June and September 1996	F	5.3 m	Storelli et al., 1999
Starigrad, Hvar Island	February 2001	M	–	Original data
Mlini (Cavtat)	12 April 2001	F	4.3 m	Holcer et al., 2003; Gomerčić et al., 2006
Pupnatska luka (Korčula Island)	7 February 2002	M	5.1 m	Holcer et al., 2003; Gomerčić et al., 2006
South coast (Mljet Island)	17 April 2004	M	~5 m	Original data

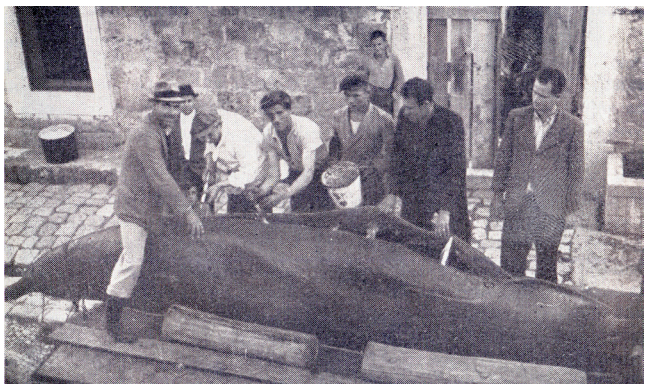

Figure 2. The first recorded specimen of *Ziphius cavirostris* in the Adriatic Sea, wrongly identified as *Hyperoodon ampullatus* by Hirtz 1939. Photograph taken from the original article.

The most recent strandings have all occurred along the Croatian Adriatic shore. The first whale was sighted on 3 March 2001 swimming in the same area where Hirtz's specimen was caught in 1939 (Holcer et al., 2003). Based on the original Hirtz (1940) paper, the whale was initially misidentified as *H. ampullatus* (Anonymous, 2001; Đuras et al., 2001), but our field observation clearly identified the animal as Cuvier's beaked whale. The whale remained in the shallow waters of Župski bay for over a month, emaciated and in poor physical condition. Finally the animal was found dead on 12 April 2001 near the village of Mlini (Cavtat) (Figure 3). It was a female less than 5 m in length. Information on its morphology and molecular identification can be found in Gomerčić et al. (2006).

In February 2001 we received a tooth (Figure 4) of an animal whose remains were found on the seabed of Starigrad bay, Hvar Island. A tooth was extracted from the remains of a skull buried within a seagrass meadow. The carcass itself was highly decomposed consisting of skeletal remains with only connective tissue. The tooth was inspected and confirmed to belong to a male *Z. cavirostris*. The location of this find is further north than expected and in a deep bay facing north-west. It is possible that its presence may be due to the dominant winter sea currents pushing the remains into the bay. The carcass may have lain in the bay undiscovered in the quiet winter season which would be consistent with the state of decomposition of the specimen.

The remains of another *Z. cavirostris* specimen were found washed ashore on the beach in Pupnatska Luka bay, on the island of Korčula, on 7 February 2002 (Holcer et al., 2003; Gomerčić et al., 2006). The carcass was in an advanced state of decomposition, but the external morphology and a total body length of about 5 m, allowed the unambiguous determination of the species. The presence of the two teeth in the lower jaw, a secondary male characteristic, enabled swift determination of the sex of the animal.

The most recent specimen of Cuvier's beaked whale was found stranded on the southern shore of Mljet island, on 17 April 2004. Once again this specimen was in an advanced state of decomposition. The body length of about 5 m

Figure 3. *Ziphius cavirostris* found dead in the vicinity of Cavtat on 12 April 2001 and wrongly identified as *Hyperoodon ampullatus*.

Figure 4. *Ziphius cavirostris* tooth found on the seabed in Starigrad bay, Hvar Island in February 2001.

suggests that the animal was an adult. The sex of the animal was again identified as male, as the teeth alveoli were present and visible in the lower jaw.

CONCLUSIONS

The information presented in this paper confirms that *Ziphius cavirostris*, a well-known beaked whale from the Mediterranean, does occur in the Adriatic Sea. In fact, even though the known occurrences of Cuvier's beaked whale strandings in the southern Adriatic could appear small, they represent approximately 3% of the entire Mediterranean stranding record (Podestà et al., 2006). This percentage increases up to about 5% if considering only data collected after 1975 (Podestà et al., 2006), when the first stranding of the recent era was inspected. Considering that the southern Adriatic represents approximately 3% of the Mediterranean surface, the proportion of occurrences of the total number of stranded Cuvier's beaked whales in this small area ranges from average to almost double of that of the entire Mediterranean Sea. Therefore, the southern Adriatic Sea should be considered as a potentially relevant habitat of Cuvier's beaked whale, in agreement with the present knowledge on its habitat preferences (Notarbartolo di Sciara & Demma, 1997). This has clear conservation implications, particularly in view of recent mass strandings related to the adverse impact of sonar experiments, carried out by navies from several countries (Frantzis, 1998; Jepson et al., 2003) and hence should be further investigated. Finally, there is no evidence of the northern bottlenose whale (*Hyperoodon ampullatus*) ever occurring in this part of the Mediterranean region.

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