

Photo-identification of *Physeter macrocephalus* in the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea)

Stefano Bellomo¹, Francesca Cornelia Santacesaria¹, Carmelo Fanizza¹, Giulia Cipriano², Vito Renò³, Roberto Carlucci², Rosalia Maglietta³

¹ *Jonian Dolphin Conservation, Viale Virgilio 102, Taranto, Italy, e-mail: stefano@joniandolphin.it; lia@joniandolphin.it; carmelo@joniandolphin.it*

² *Department of Biology, University of Bari, Via Orabona 4, Bari, Italy, e-mail: giulia.cipriano@uniba.it; roberto.carlucci@uniba.it*

³ *Institute of Intelligent Industrial Systems and Technologies for Advanced Manufacturing, National Research Council, Via Amendola 122 D/O, Bari, Italy e-mail: vito.reno@cnr.it; rosalia.maglietta@cnr.it*

Abstract – A photo-identification study of *P. macrocephalus* was carried out from 2016 to 2018 in the Gulf of Taranto, providing information on its distribution. Photographs of flank and flukes of individuals were collected to identify their natural marking pattern. In addition, a catalogue of photo-identified individuals was stored and embedded in the digital DolFin platform. During the study period, 13 sightings were recorded in the Gulf of Taranto in a depth range between 550 and 1200 m with a mean value of 853 ± 193 m. The group size ranged from 1 to 7 specimens and calves were noted. Twelve sperm whales were photo-identified, showing a prevalence of marks on their flanks than flukes. The occurrence of sperm whale on the continental slope grounds suggests that the northernmost portion of the Taranto Valley canyon system can be a suitable habitat to this species as well as for other 4 cetacean species that, here, regularly perform essential tasks for their survival.

I. INTRODUCTION

The sperm whale *Physeter macrocephalus* is widely distributed at Mediterranean scale, from the Strait of Gibraltar to Levantine basin [1], inhabiting offshore and continental slope waters, especially those characterized by a high primary production [2] and oceanographic frontal systems with marked temperature discontinuities [3]. In addition, a strong correlation can be found between sperm whale distribution and areas characterized by the presence of mesopelagic cephalopods [4] [5].

In the Mediterranean Sea the distribution of sperm whales seems varies depending on sex and on the number of individuals forming the group, similarly to that observed in ocean [6] [1]. In general, males seem to stay north of the 41° parallel without forming cohesive groups at the surface, performing seasonal migration in the southern part of

Mediterranean basin also for the breeding purpose [6] [7] [8]. On the contrary, females and their offspring seem to remain south of the 41° parallel forming clusters of up seven animals, at the surface. However, both single animals and groups of females with calves might co-habit as reported in waters surrounding Balearic Islands, Tyrrhenian Sea and in the northern part of the Hellenic Trench (Greece) [6] [7] [8].

Regarding the inter-basin movements of sperm whale, even if they are poorly documented they seem to be able to sustain the gene flow within the Mediterranean subpopulation, that is considered separate from the Atlantic ones [6] [8] [9].

Unfortunately, a wide range of threats including habitat fragmentation, resources depletion, entanglement in driftnets, ship collisions, noise pollution and plastic debris ingestion, affects the Mediterranean subpopulation of *P. macrocephalus* that is assessed Endangered by IUCN Red List [5]. In this light, an increase in monitoring effort is required to rise knowledge regarding sperm whale's distribution, behaviour and habitat use, helpful to suggest indications and practices for its conservation.

This study provides the first data on the photo-identification of sperm whale in the Gulf of Taranto and update information about its distribution. In addition, the catalogue of geo-referred images of *P. macrocephalus* acquired in the study area from 2016 to 2018, were provided and stored in the digital platform DolFin.

II. MATERIALS AND METHODS

A. Study area

The Gulf of Taranto extends from Santa Maria di Leuca to Punta Alice covering an area of about 14000 km² (Fig. 1). It shows a complex geomorphology with narrow continental shelf and steep slope cut by several channels in

the western sector and descending terraces in eastern one. The central sector is characterized by the submarine Taranto Valley canyon system. This peculiar morphology involves a complex distribution of water masses and the occurrence of upwelling phenomenon with high seasonal variability [11] [12].

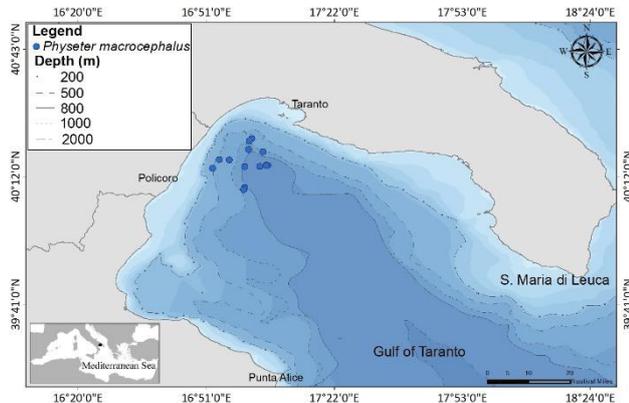


Fig. 1. Map of the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea) with indication of sightings of *P. macrocephalus* occurred from 2016 to 2018.

B. Data collection and analysis

Photo-identification data of sperm whale were collected from 2016 to 2018 during surveys targeting small odontocetes carried out only in favourable weather conditions (Douglas scale ≤ 3 and Beaufort scale ≤ 4). The sampling effort was set to approximately 5 h/day along 35 nautical miles (nm) and to survey speed of about 7.5 knots. Once an individual or a group of sperm whales have been sighted, they were followed switching to off-effort and they were approached from behind at very low speed minimizing the risk of disturbance [12] [13].

Photographs were collected by two photographers placed on the bow of vessel with a Nikon D3300 digital camera with Nikon AF-P Nikkor 70-300 mm, f4,5-6,3G ED lens. They were taken as consecutive shots in order to capture the entire emerged body from the blowhole to the caudal peduncle (flank), the dorsal fin and whenever possible, both ventral and dorsal side of fluke, when it was raised in the air before a deep dive [14]. In addition, date, time of sighting, sea weather conditions, geographic coordinates, group size (number of individuals), depth (m) were recorded.

A manual photo-identification was performed by two expert biologists, employing as skilful markers the shape of dorsal fin as well as the occurrence of pigmentation, the shape and colour of patches and other mark types according to [15]. An individual has been defined photo-identified only if there was the availability of photographs of his flukes (used as main feature for the photo-identification analysis) and his right and/or left flank. Exception is made for calves due to their different surface behaviour, with no deep diving and emersion of their flukes. Finally, photographs of each photo-identified individual was stored and embedded in the digital DolFin

platform [16].

III. RESULTS

From 2016 to 2018, 13 sightings of *P. macrocephalus* were recorded applying 843 km of survey effort, 65 hours of observation. Sightings occurred in a depth range between 550 and 1200 m with a mean value equal to 853 ± 193 m (Table 1). Moreover, the distance from the nearest coast ranged between 11 and 27 km with a mean value of 22 ± 4 km. The group size ranged from 1 to 7 specimens and the occurrence of two calves were noted. Through the study period, 12 sperm whales were successfully photo-identified thanks to the presence of marks on their flukes and flanks. Among those 12 individuals, 9 were observed only once; 2 adult individuals and 1 calf were re-sighted twice in the same year, within 3 months. Ten different mark types were observed in photo-identified sperm whales (Fig. 2), of which 8 were present on the flanks, 6 on the flukes and 4 mark types were common to the both areas (Table 2). Non-circular light patch, knobs and white area resulted types of marks with the highest frequency of occurrence on flanks whereas the most frequent marks on the fluke were notch, peak and non-circular light patch (Fig. 3).

Table 1. Date, depth and number of individuals of sperm whales observed in the Gulf of Taranto, from 2016 to 2018.

Date of sighting	Depth (m)	N. individuals
10/07/2016	940	7
11/07/2016	1000	7
03/10/2016	1000	2
06/10/2016	1000	7
05/07/2017	900	1
05/07/2017	950	1
06/07/2017	1200	2
04/07/2018	550	1
05/07/2018	650	3
21/07/2018	800	2
22/07/2018	600	1
06/08/2018	850	1
14/09/2018	650	7



Fig. 2. Mark types observed in photo-identified sperm whales.

Table 2. Mark types observed in the photographs analyzed.

Mark type	Flank	Fluke
Pigmentation		
White area (WA)	x	
Light area (LA)	x	x
Patch		
Non-circular light patch (NCP)	x	x
Circular light patch (CLP)	x	x
Circular dark patch (CDP)	x	
Other		
Knobs (KN)	x	
Scar (SC)	x	
Disease (DI)	x	x
Notch (NO)		x
Peak (PE)		x

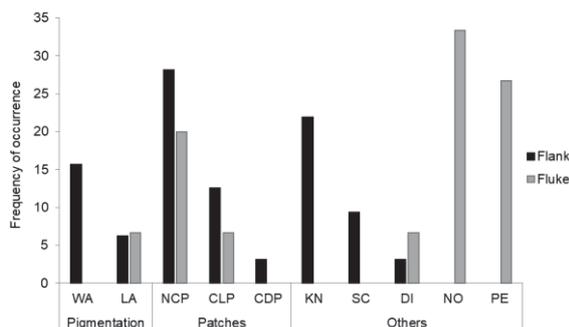


Fig.3. Frequency of occurrence of different mark types on flank and fluke of photo-identified individuals.

IV. CONCLUSION

This study corroborates information on the distribution of *P. macrocephalus* in the Gulf of Taranto through a photo-identification study carried out from 2016 to 2018. The occurrence of sperm whales on the continental slope

grounds and at a relatively brief distance from the coast resulted similar to that observed in other Mediterranean areas [17] [18], suggesting the northernmost portion of the Taranto Valley canyon system as a possible suitable habitat to this species. The observation of groups of 7 individuals, including calves, seems to confirm the occurrence of larger groups in the southern Mediterranean Sea [19] [6] [20]. Nevertheless, the sightings of single individuals and of aggregation of 2-3 sperm whales result more frequent than larger aggregation similar to observations made in the western Mediterranean basin [21] [6] [22] [23] and along the Hellenic Trench [20].

Concerning the photo-identification of sperm whales, the use of flank photographs, supporting those of flukes, resulted advantageous because this body zone resulted the most marked as for sperm whales observed in the Pelagos Sanctuary [15]. In effect, the reduced occurrence of sperm whales' predators in the Mediterranean Sea compared to open ocean, seems to cause a low degree of marks on their flukes, thus making them not very useful to the photo-identification process in this area [24] [15]. Moreover, the presence of non-circular light patch, white area and knobs with a high frequency on flanks resulted useful marks in the photo-identification of *P. macrocephalus* [15] as well as of the pink river dolphins *Inia geoffrensis* [25], the common bottlenose dolphin *Tursiops truncatus* [26] and the humpback whale *Megaptera novaeangliae* [27].

Although further investigation on the habitat use, site fidelity of *P. macrocephalus* in the Gulf of Taranto are necessary, the results highlight the importance of the Taranto Valley canyon system for this endangered odontocete as well as other cetacean species using the Gulf of Taranto as an area regularly used to perform essential tasks for survival [28] [29] [30] [31]. Likewise, the implementation of the catalogue of images of photo-identified sperm whales in the study area and the desirable data sharing with other institutions could provide helpful indication on its movements within the Mediterranean basin.

V. REFERENCES

- [1] L.Rendell, S.Simião, J.M.Brotons, S.Airoldi, D.Fasano, A.Gannier, "Abundance and movements of sperm whales in the western Mediterranean basin", *Aquatic Conserv: Mar. Freshw. Ecosyst.* Vol.24, (Suppl. 1), 2014, pp. 31–40.
- [2] N.Jaquet, H.Whitehead, "Scale-dependent correlation of sperm whale distribution with environmental features and productivity in the South Pacific", *Mar. Ecol. Prog. Ser.*, vol. 135, 1996, pp. 1–9.
- [3] A.Gannier, E.Praca, "SST fronts and the summer sperm whale distribution in the north-west Mediterranean Sea," *J. Mar. Biol.Assoc. UK*, vol.87, 2007, pp. 187–193.
- [4] E.Praca, A.Gannier, "Ecological niches of three teuthophageous odontocetes in the northwestern Mediterranean Sea," *Ocean Science*, vol.4, 2008, pp.

- 49–59.
- [5] G.Notarbartolo di Sciarra, A.Frantzis, G.Bearzi, R.Reeves, “*Physeter macrocephalus* (Mediterranean subpopulation),” IUCN Red List of Threatened Species. Version 2013.1, 2012, downloaded on 04 February 2013 from www.iucnredlist.org.
- [6] V.Drouot, A.Gannier, J.C.Goold, “Summer social distribution of sperm whales (*Physeter macrocephalus*) in the Mediterranean Sea”, *J. Mar. Biol. Ass. U.K.*, vol.84, 2004, pp. 675-680.
- [7] V.Drouot-Dulau, A.Gannier, “Movements of sperm whale in the western Mediterranean Sea: Preliminary photo-identification results”, *J. Mar. Biol. Assoc. U.K.*, vol. 87, 2007, pp. 195–200.
- [8] A.Frantzis, S.Airoldi, G.Notarbartolo di Sciarra, C.Johnson, S.Mazzariol, “Inter-basin movements of Mediterranean sperm whales provide insight into their population structure and conservation”, *Deep Sea Res. Part 1*, vol. 58, 2011, pp. 454–459.
- [9] D.Engelhaupt, A.Rus Hoelzel, C. Nicholson, A. Frantzis, S. Mesnick, Gero S, Whitehead H, Rendell L, Miller P, De Stefanis R, et al. 2009. Female philopatry in coastal basins and male dispersion across the North Atlantic in a highly mobile marine species, the sperm whale (*Physeter macrocephalus*). *Molecular Ecology* 18: 4193–4205.
- [10] R.Matarrese, M.T.Chiaradia, K.Tijani, A.Morea, R.Carlucci, “Chlorophyll a multi-temporal analysis in coastal waters with MODIS data”, *Ital. J. Remote Sens.*, vol. 43, 2011, pp. 39–48.
- [11] R.Carlucci, D.Battista, F.Capezzuto, F.Serena, L.Sion, “Occurrence of the basking shark *Cetorhinus maximus* (Gunnerus, 1765) in the Central-eastern Mediterranean Sea”, *Ital. J. Zool.*, vol. 81, 2014, pp. 280–286.
- [12] International Fund for Animal Welfare, “Report of the International Whorkshop on the special aspects of watching sperm whales” Roseau, Commonwealth of Dominica, East Caribbean, Yarmouth Port, 1996.
- [13] A.Frantzis, P.Alexiadou, “Male sperm whale (*Physeter macrocephalus*) coda production and codatype usage depend on the presence of conspecifics and the behavioural context”, *Can. J. Zool.*, vol. 86, 2008, pp. 62-75.
- [14] T.Arnbohm, “Individual identification of sperm whales”, *Rep. Int. Whal. Commn.*, vol. 37, 1987, pp. 201–204.
- [15] J.Alessi, M. Aïssi, C.Fiori, “Photo-identification of sperm whales in the north-western Mediterranean Sea: an assessment of natural markings”, *Aquatic Conserv: Mar. Freshw. Ecosyst.*, vol. 24(Suppl. 1), 2014, pp. 11–22.
- [16] R.Maglietta, V.Renò, G.Cipriano, C.Fanizza, A.Milella, E.Stella, R.Carlucci, “DolFin: an innovative digital platform for studying Risso’s dolphins in the Northern Ionian Sea (North-eastern Central Mediterranean)”, *Sci. Rep.*, vol. 8, 2018, DOI: 10.1038/s41598-018-35492-3.
- [17] A.Azzellino, S.Gaspari, S.Airoldi, B.Nani. ”Habitat use and preferences of cetaceans along the continental slope and adjacent pelagic waters in the weatern Ligurian Sea”, *Deep Sea Res. Part 1*, vol. 55, 2008, pp. 296-323.
- [18] B.Mussi, A.Miragliuolo, A.Zucchini, D.S.Pace, “Occurrence an spatio-temporal distribution of sperm whale (*Physeter macrocephalus*) in the submarine canyon of Cuma (Tyrrhenian Sea, Italy)”, *Aquatic Conserv: Mar. Freshw. Ecosyst.*, vol. 24(Suppl. 1), 2014, pp. 59–70.
- [19] A.Gannier, V.Drouot, J.C.Goold, “Distribution and relative abundance of sperm whales in the Mediterranean Sea”, *Mar. Ecol. Prog. Ser.*, vol. 243, 2002, pp. 281-293.
- [20] A.Frantzis, P. Alexiadou, K.C. Gkikopoulou, “Sperm whale occurrence, site fidelity and population structure along the Hellenic Trench (Greece, Mediterranean Sea)”, *Aquatic Conserv. Mar. Freshw. Ecosyst.*, vol. 24 (Suppl. 1), 2014, pp. 83–102.
- [21] G.Pavan, T.J.Hayward, J.F.Borsani, M.Priano, M.Manghi, C.Fossati, J.Gordon, “Time patterns of sperm whale codas recorded in the Mediterranean Sea 1985–1996”, *J. Acoust. Soc. Am.*, vol. 107, 2000, pp. 3487–3495.
- [22] G.Notarbartolo di Sciarra, A.Frantzis, G.Bearzi, R.R.Reeves, “Sperm whale *Physeter macrocephalus* (Mediterranean subpopulation)”. In R.Reeves G.Notarartolo di Sciarra (Eds.), “The Status and Distribution of Cetaceans in the Black Sea and Mediterranean Sea”, IUCN Centre for Mediterranean Cooperation: Malaga, Spain, 2006, pp. 45–56.
- [23] R.de Stephanis, T.Cornulier, P.Verborgh, J.Salazar Sierra, N.Perez Gimeno, C.Guinet, “Summer spatial distribution of cetaceans in the Strait of Gibraltar in relation to the oceanographic context”, *Mar. Ecol. Prog. Ser.*, vol. 353, 2008, pp. 275–288.
- [24] S.Dufault, H.Whitehead, “An assessment of changes with time in the marking patterns used for photoidentification of individual sperm whales, *Physeter macrocephalus*. *Mar. Mam. Sci.*, vol. 11, 1995, pp. 335–343.
- [25] C.Gomez-Salazar, F.Trujillo, H.Whitehead, “Photo-identification: a reliable and non-invasive tool for studying pink river dolphins (*Inia geoffrensis*)”, *Aquat. Mam.* vol. 37, 2011, pp. 472–485.
- [26] B.Wilson, P.M.Thompson, P.S.Hammond, “Skin lesions and physical deformities in bottlenose dolphins in the Moray Firth: population prevalence and age-sex differences”, *Ambio*, vol. 26, 1997, pp. 243–247.
- [27] A.L.Blackmer, S.K.Anderson, M.T.Weinrich, “Temporal variability in features used to photo-identify humpback whales (*Megaptera novaeangliae*)”, *Mar. Mam. Sci.*, vol. 16, 2000, pp. 338–354.
- [28] R.Carlucci, C.Fanizza, G.Cipriano, C.Paoli, T.Russo, P.Vassallo, “Modeling the spatial distribution of the striped dolphin (*Stenella coeruleoalba*) and common bottlenose dolphin (*Tursiops truncatus*) in the Gulf of

- Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea),” *Ecol. Indic.*, vol. 69, 2016, pp. 707-721.
- [29] R. Carlucci, P. Ricci, G. Cipriano and C. Fanizza, “Abundance, activity and critical habitat of the striped dolphin *Stenella coeruleoalba* in the Gulf of Taranto (Northern Ionian Sea, Central Mediterranean Sea),” *Aquatic Conservation: Marine and Freshwater Ecosystems*, 28, 324-336, 2018a.
- [30] R. Carlucci, G. Cipriano, C. Paoli, P. Ricci, C. Fanizza, F. Capezzuto and P. Vassallo “Random Forest population modelling of striped and common-bottlenose dolphins in the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea),” *Estuarine, Coastal and Shelf Science*, 204, 177-192, 2018b.
- [31] R. Carlucci, A. Akkaya Bas, R. Maglietta, V. Renò, C. Fanizza, A. Rizzo, R. Crugliano, G. Cipriano, “Site fidelity, residency and habitat use of the Risso’s dolphin *Grampus griseus* in the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea) by photo-identification. 2018 IEEE International Workshop on Metrology for the Sea; Learning to Measure Sea Health Parameters (MetroSea), Bari, Italy, 2018, pp. 173-177.