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First photo-ID catalogue of killer whales (*Orcinus orca*) in Terre Adélie

MAGALY CHAMBELLANT¹, CLAIRE GARRIGUE¹, HELENE PELTIER², VINCENT RIDOUX², JEAN-BENOIT CHARRASSIN³

¹ Opération Cétacés, BP 12827, 98802 Nouméa, New Caledonia

² Littoral, Environnement et Sociétés (LIENSSES), UMR 6250 - Centre de Recherche sur les mammifères marins, Université de La Rochelle, Avenue Michel Crépeau F-17042, 17000 La Rochelle, France

³ LOCEAN, UMR 7159, Muséum National d'Histoire Naturelle, Université Pierre et Marie Curie, Tour 45-55, 4 place Jussieu, BP 100, 75252 Paris Cedex 05, Paris, France

Contact author: mchambellant@yahoo.fr

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ABSTRACT

We present the first photo-ID catalogue of killer whales (*Orcinus orca*) in Terre Adélie, Antarctica. Pictures were taken over a two-year period (December 2008-January 2011) either opportunistically from land or ship, or systematically from the R/V L'Astrolabe as part of the CETA (CÉtacés de Terre Adélie) project. Twenty five encounters with killer whales were reported. Fifteen of them were documented with a total of 611 pictures and one video were obtained and examined. Shape, size and characteristics of the dorsal fin as well as shape, color and marks of the saddle patch were the two most important features retained to identify individuals, but eye patches were also examined to help identification. Thirty-five individuals were identified, including nine adult males and thirteen females with calf. Two individuals were seen on multiple occasions over the study period. A total of twenty-five mother/calf pairs were established. The biggest group was observed in January 2011 with 26 identified individuals. The three ecotypes recognized in Antarctic waters were present in our study. Ecotype B was seen mostly around the French Antarctic base (Dumont D'Urville) whereas ecotype A and C were seen exclusively offshore. Presence of cookie-cutter shark (*Isistius* spp.) scars on type B and C killer whales may indicate migration to warmer waters. This catalogue is the baseline to which pictures from future CETA projects will be compared and added. It will be used to evaluate the distribution of the different ecotypes of killer whales in East Antarctica.

INTRODUCTION

In 2010, as part of the Southern Ocean Research Partnership (SORP), the French Polar Institute (IPEV) launched a new 4-year research program CETA (Cétacés en Terre Adélie) to assess distribution and relative abundance of cetaceans off Adélie Land (IWC Area V, 65-66°S and 140-145°E; Garrigue et al. 2010). Photo-identification and/or biopsy of four targeted species, including killer whales (*Orcinus orca*), was also part of the program to identify stocks.

Killer whales are circumpolar in Antarctic waters (Kasamatsu & Joyce 1995) and three different types have been recognized so far (Pitman & Ensor 2003). Types A, B and C are different in morphology, habitat and feeding habits (Pitman & Ensor 2003) and type A is also genetically different from the two other forms (LeDuc et al. 2008, Morin et al. 2010). Little is known about the abundance, distribution and movement pattern, at either local or larger scale, of each type. This information is critically needed to understand the role of killer whales in the Antarctic ecosystem in the current context of climate change and be able to take appropriate conservation measures, should they be needed.

So far, reports of killer whales off Adélie Land were mostly anecdotic and CETA represents the first effort to systematically record killer whale sightings in this region over a planned 4-year period. In this study, we combined anecdotic and systematic photographic data collected from December 2008 to January 2011 to create the first photo-identification (photo-ID) catalogue of killer whales in waters of Adélie Land. Our objective was to provide a baseline and comparative tool for other and future research efforts around Antarctica that may help deepen our understanding of killer whale ecology.

MATERIALS AND METHODS

Data collection

Anecdotic photographs of killer whales were obtained from people on board the R/V L' Astrolabe during transits between Hobart, Tasmania, and the French Antarctic base Dumont d'Urville (DDU) and from people spending a summer or overwintering at DDU from December 2008 to December 2010.

Killer whale photo-IDs were collected during CETA campaigns 2010 and 2011. CETA 2010 started on 31 December 2009 when R/V L' Astrolabe left Hobart, Tasmania, to reach DDU, and ended on 28 January 2010, upon R/V L' Astrolabe return to Hobart, for a total of 115.53 hours of effort. CETA 2011 spanned from 29 December 2010 to 31 January 2011 for a total of 165.07 hours of effort. Two dedicated and trained observers applied line-transect sampling on a constant basis while the ship was transiting from Tasmania to Antarctica and on the continental shelf and slope off Adélie Land (Figure 1), daylight and weather permitting. Observations took place mostly from the bridge but were also occasionally conducted from the "crow nest", a higher platform. Line-transects were stopped when a group of killer whales was spotted and the R/V L' Astrolabe tried to approach whales to a distance allowing photo-IDs.

Photographs were taken using DSLR Canon 40D and 50D cameras with a 100x400mm lenses and 70x200mm lenses equipped with x1.4 or x2.0 extender.

Data analysis

All pictures were cropped so that each killer whale present on a picture was isolated on a 1x0.5 frame for photo-ID. We tried to use as many pictures as possible but had to discard those with the poorest quality. Pictures were corrected for contrast and luminosity when needed.

Individual identification and comparison among individuals were based primarily on the shape, size and characteristics of the dorsal fin, along with the shape, coloration and scars of the saddle patch. Eye patch were used secondarily to help identification if needed. Due to logistical constraints, it was not always possible to follow the protocol for killer whale photo-ID (see Ford et al. 1994) and particularly, to take pictures of whale left sides. Right and left sides of the same individual were associated when possible. Calves were designated as such from their size, coloration and/or close association with an adult-size whale (presumably their mother).

An individual was classified as identified (ID) if there was enough information on the picture to be able to compare it unequivocally with other whales. It was classified as non-identified (non-ID) otherwise. All calves were classified as “non-identified” because their identification characteristics are likely to change significantly as they grow.

RESULTS

Killer whales were observed on twenty-five occasions over the study period (Table 1; Figure 1). Pictures were available for fifteen of these observations but only eleven had suitable photo-ID pictures for a total of 611 pictures and one video included in the analysis (Table 1). Generally, pictures were of poor quality due to large distances between animals and the ship, a poor luminosity and/or the angle from which the ship approached killer whales. From December 2008 to January 2011, fifteen sightings were recorded, including eight during CETA, but only eleven had pictures allowing photo-ID analysis (Table 1).

Over all years and all sightings, thirty-five killer whales have been identified, including nine adult males and thirteen mother/calf pairs (Table 2). Two identified killer whales, an adult male and a female or juvenile, were seen together on four occasions over a two-month period (December 2008-January 2009) around DDU. The same adult male was also seen two years after (December 2010) with another individual that could not be identified from the poor quality picture, around the French base (Table 2). These sightings constitute the only recaptures so far.

Sixty-five killer whales were classified as “non-identified” (NI), including 26 calves, seven adults males and twelve mother/calf pairs. A total of 26 calves have been observed and 25 mother/calf pairs were established (Table 3).

The biggest group sighted (sighting 12; Table 1) consisted of twenty-six identified and 44 “non-identified” individuals (although some “non-identified” whales could be the other side of

identified animals). At least, twenty mother/calf pairs were established, which represents 47.6% of the group once adult males were excluded.

DISCUSSION

Pitman and Ensor (2003) described three types of killer whales in Antarctic waters. Type A, the biggest form, inhabits open waters, feeds preferentially on Antarctic minke whales (*Balaenoptera bonaerensis*) and is thought to follow their prey in their summer/winter migrations. Its color pattern is black and white as the typical killer whale, with an oval, medium sized eye-patch oriented along the body axis and no dorsal cape. Type B can be smaller than type A, is pagophilic and usually occurs in loose ice field near shore, and feeds preferentially on pinnipeds. Type B has been seen at lower latitudes as well as in the Antarctic pack ice during winter, and was found to make short round trips to warmer waters (Durban and Pitman 2012). Its color pattern is a two-toned grey, instead of black, and white with a marked darker dorsal cape. Eye-patched are very large and oriented along the body axis. Type C is the smaller form, inhabits dense pack ice, feeds preferentially on fish and has been seen both in lower latitudes and in Antarctic ice over winter. Group size is usually large and up to 150 individuals. Its color pattern is similar to type B but eye-patches are small and slanted approximately 45° relative to the body axis, the front facing downward.

From these descriptions and after confirmation by R. Pitman (pers com), it seems that killer whales encountered off Adélie Land belong to the three ecotypes.

Killer whales seen around DDU are likely from type B (Figure 1), presenting the typical large eye-patch, dorsal cape and grey and/or yellowish coloration (Figure 2). They were always seen very close to shore and usually around ice sheets. Group size ranged from two to seven. The same adult male was seen around DDU on multiple occasions and over 2 years, indicating that it might be a “resident” or at least a regular visitor of waters around the French base. One sighting of a group of seven type B whales was of particular interest. An individual that, by its size, seemed to be a young whale (Oor_TA_08_005) followed a mother/calf pair closely. Considering what is currently known of some killer whale social structure (Ford et al. 1994), this young whale could be speculated to be a previous offspring of the female Oor_TA_08_001 (Figure 3). In the same group, on two occasions, adult whales accompanied by calves were seen approaching an ice sheet synchronously and in a side-by-side formation (Figure 4). Type B killer whales feed mostly on pinnipeds and hunting techniques involved washing off seals hauled-out on ice floes by either moving the floes or making a strong wave next to it (Pitman & Ensor 2003, Pitman & Durban 2012). Thus, the observed behavior could likely be interpreted as a hunting training session.

Killer whales seen offshore were distributed all over the continental shelf and up to the continental slope. They were seen in open water, surrounded by big icebergs or in loose ice fields. Group size, as determined through photo-ID or number of whales present simultaneously on one picture, ranged from 2 to >46 individuals. Most killer whales encountered offshore were

type C killer whales (Figures 1 and 5). On one encounter on the slope of the continental shelf, sighting 50, the two individuals present likely belonged to type A killer whales (Figure 6).

Cookie-cutter shark (*Isistius* spp.) scars were present on at least four type B (Figure 7) and several type C killer whales (Figure 8). Since cookie-cutter sharks inhabit tropical to subtropical waters, their scars on killer whales may be an indication that type Bs and Cs migrate to warmer waters (Pitman 2011).

Despite pictures of poor quality, it was possible to create the first photo-ID catalogue of killer whales off Adélie Land. Photo-ID from future CETA campaigns and anecdotic sightings could be compared and added to this catalogue. We hope the Adélie catalogue will contribute to a better understanding of the distribution and ecology of the different ecotypes of killer whale in this region.

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Table 1: Sighting date and type, sighting (sight.) used for photo-ID analysis, number (#) of pictures taken, minimum (min.) number of individuals (ind.) in the group present simultaneously on one picture (pict.), number of identified (ID) and non-identified (NI) killer whales (*Orcinus orca*) in the group, minimum number of mother/calf pairs and of adult males for each sighting made off Adélie Land for the period December 2008-January 2011. CETA= CÉtacés de Terre Adélie campaign; AN = anecdotic sighting; DDU = French Antarctic base Dumont D'Urville; incl. = included; excl. = excluded.

sighting	date	type	sigth. used	# pictures	min. # ind. calf incl. (pict.)	min. # ind. calf excl. (pict.)	# ID ind.	min. # mom/calf	# ind. NI calf incl.	# ind. NI calf excl.	min. # adult male
55	17-Jan-11	CETA	*	41	4	4	2	2	10	8	2
50	16-Jan-11	CETA	*	12	2	2	1	0	1	1	1
33	14-Jan-11	CETA		0	-	-	-	-	5	-	-
21	13-Jan-11	CETA		0	-	-	-	-	1	-	-
16	12-Jan-11	CETA		50	12	-	-	-	12	-	-
14	12-Jan-11	CETA		4	5	-	-	-	-	-	2
13	12-Jan-11	CETA	*	70	7	4	1	1	10	9	3
12	12-Jan-11	CETA	*	380	13	9	26	20	44	23	5
DDU	25-Dec-10	AN		0	-	-	-	1	2	1	0
DDU	11-Dec-10	AN	*	2	2	2	1	1	5	4	1
DDU	9-Dec-10	AN		0	-	-	-	-	6	-	-
	24-Jan-10	CETA		0	-	-	-	-	5	-	-
	16-Jan-10	CETA	*	2	2	1	0	1	10	9	-
	11-Jan-10	CETA		0	-	-	-	-	5	-	-
	5-Jan-10	CETA		0	-	-	-	-	3	-	-
pod#1	5-Jan-10	CETA	*	17	6	4	0	1?	-	4	2
	4-Jan-10	CETA		0	-	-	-	-	5	-	-
	3-Jan-10	CETA		0	-	-	-	-	1	-	-
DDU	30-Dec-09	AN		4	2	2	0	0	0	0	2
R/V L'Astrolabe	27-Oct-09	AN		2	1	1	0	0	0	0	-
DDU	16-Jan-09	AN	*	4	2	2	2	0	0	0	1
DDU	6-Jan-09	AN	*	video	2	2	2	0	0	0	1

DDU	5-Jan-09	AN		0	-	-	-	0	2	2	1
DDU	2-Jan-09	AN	*	1	2	2	2	0	0	0	1
DDU	24-Dec-08	AN	*	22	5	3	5	2	2	0	1
total				611	67	38	42	28	127	59	22

Table 2: List and information on photo-identified killer whales (*Orcinus orca*) off Adélie Land for the period December 2008-January 2011. CETA= CÉtacés de Terre Adélie campaign; AN = anecdotic sighting; DDU = French Antarctic base Dumont D'Urville.

identification	status/sex	sighting	year	type	comments
Oor_TA_11_ 001	male	12	2011	CETA	
Oor_TA_11_ 002		12	2011	CETA	
Oor_TA_11_ 003		12	2011	CETA	
Oor_TA_11_ 004	male	12	2011	CETA	
Oor_TA_11_ 005	mom	12	2011	CETA	
Oor_TA_11_ 006		12	2011	CETA	
Oor_TA_11_ 007	mom	12	2011	CETA	
Oor_TA_11_ 008		12	2011	CETA	
Oor_TA_11_ 009	mom	12	2011	CETA	
Oor_TA_11_ 011	male	12	2011	CETA	
Oor_TA_11_ 012		12	2011	CETA	
Oor_TA_11_ 013		12	2011	CETA	
Oor_TA_11_ 014	mom	12	2011	CETA	
Oor_TA_11_ 015		12	2011	CETA	
Oor_TA_11_ 016		12	2011	CETA	
Oor_TA_11_ 017	mom	12	2011	CETA	
Oor_TA_11_ 018	mom	12	2011	CETA	
Oor_TA_11_ 019	mom	12	2011	CETA	
Oor_TA_11_ 020	male	12	2011	CETA	
Oor_TA_11_ 021	male	12	2011	CETA	
Oor_TA_11_ 022		12	2011	CETA	
Oor_TA_11_ 023	mom	12	2011	CETA	
Oor_TA_11_ 024	mom	12	2011	CETA	
Oor_TA_11_ 025	mom	12	2011	CETA	
Oor_TA_11_ 026		12	2011	CETA	
Oor_TA_11_ 010	mom	12	2011	CETA	
Oor_TA_11_ 027		13	2011	CETA	
Oor_TA_11_ 028	male	50	2011	CETA	
Oor_TA_11_ 029	male	55	2011	CETA	
Oor_TA_11_ 030	male	55	2011	CETA	
Oor_TA_10_ 001	male	DDU	2010	AN	
Oor_TA_09_ 001	male	DDU	2009	AN	= TA_10_001 3 resights in 2009
Oor_TA_09_ 002		DDU	2009	AN	3 resights in 2009
Oor_TA_08_ 001	mom	DDU	2008	AN	
Oor_TA_08_ 002	male	DDU	2008	AN	= TA_10_001
Oor_TA_08_ 003		DDU	2008	AN	= TA_09_002
Oor_TA_08_ 004	mom	DDU	2008	AN	
Oor_TA_08_ 005		DDU	2008	AN	

Table 3: List of killer whale (*Orcinus orca*) mother/calf pairs sighted off Adélie Land between December 2008 and January 2011.

mom		calf		Comments
Oor_TA_11_	NI018	Oor_TA_11_	NI001	
Oor_TA_11_	NI022	Oor_TA_11_	NI002	
Oor_TA_11_	NI006	Oor_TA_11_	NI007	
Oor_TA_11_	014	Oor_TA_11_	NI008	
Oor_TA_11_	007	Oor_TA_11_	NI009	
Oor_TA_11_	009?	Oor_TA_11_	NI011	female alone on several pictures
Oor_TA_11_	023	Oor_TA_11_	NI013	
Oor_TA_11_	NI029	Oor_TA_11_	NI016	
Oor_TA_11_	024	Oor_TA_11_	NI017	
Oor_TA_11_	019	Oor_TA_11_	NI024	
Oor_TA_11_	005	Oor_TA_11_	NI025	
Oor_TA_11_	NI026	Oor_TA_11_	NI027	
Oor_TA_11_	010	Oor_TA_11_	NI030	
Oor_TA_11_	NI003	Oor_TA_11_	NI031	
Oor_TA_11_	018	Oor_TA_11_	NI033	
Oor_TA_11_	017?	Oor_TA_11_	NI034	not sure about this pair
Oor_TA_11_	NI023	Oor_TA_11_	NI035	
Oor_TA_11_	025	Oor_TA_11_	NI036	
Oor_TA_11_	?	Oor_TA_11_	NI040	
Oor_TA_11_	NI037	Oor_TA_11_	NI042	
Oor_TA_11_	NI043	Oor_TA_11_	NI044	
Oor_TA_11_	NI055	Oor_TA_11_	NI049	
Oor_TA_11_	NI051	Oor_TA_11_	NI050	
Oor_TA_10_	NI005	Oor_TA_10_	NI006	
Oor_TA_08_	004	Oor_TA_08_	NI001	
Oor_TA_08_	001	Oor_TA_08_	NI002	female may also be the mom of juvenile Oor_TA_08_005

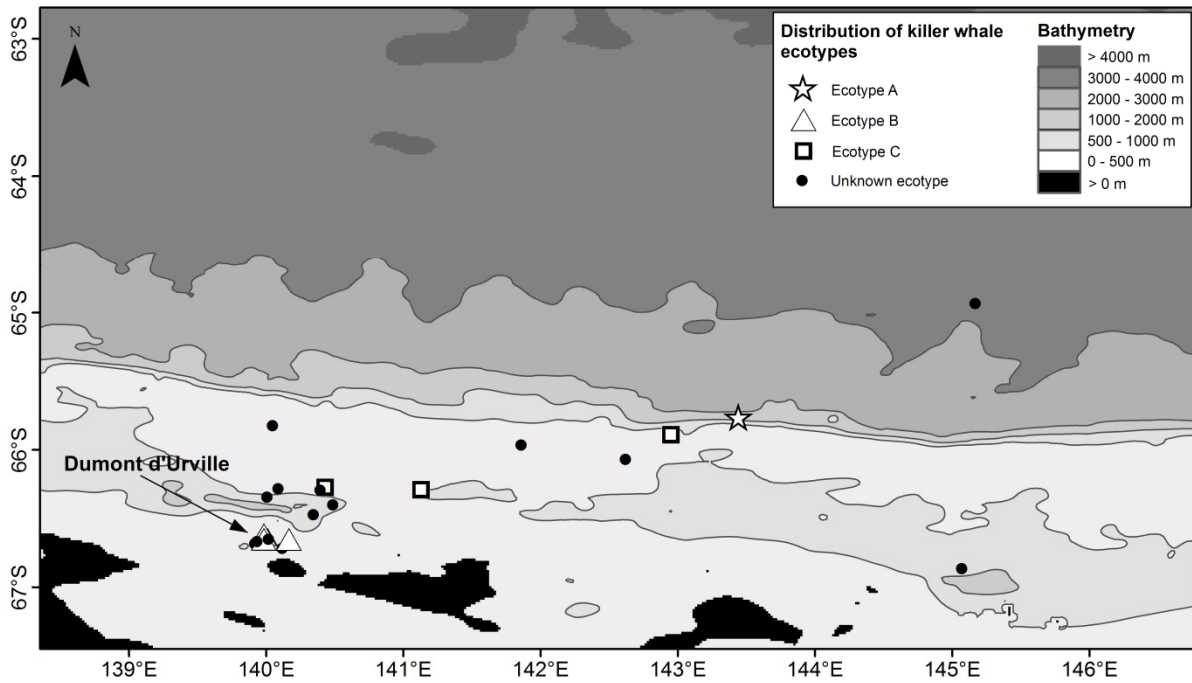


Figure 1: Study site and distribution of the different killer whale (*Orcinus orca*) ecotypes observed on the continental shelf and slope off Adélie Land, Antarctica, over the period December 2008-January 2011.



Figure 2: Type B killer whales (*Orcinus orca*) photographed around the French Antarctic base Dumont D'Urville in December 2008, showing typical large eye-patch, dorsal cape and greyish color pattern.

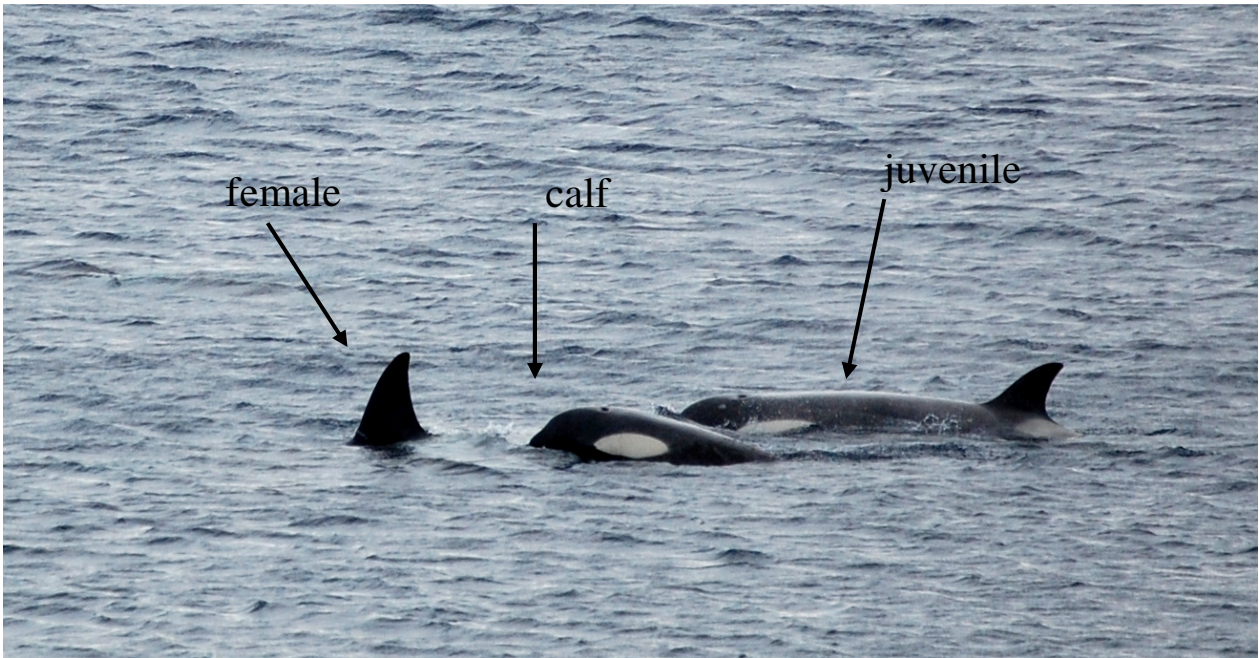


Figure 3: Possible association of a type B female killer whale (*Orcinus orca*) with its calf and its juvenile offspring photographed around the French Antarctic base Dumont D'Urville in December 2008.



Figure 4: Possible hunting training session for type B killer whales (*Orcinus orca*) photographed around the French Antarctic base Dumont D'Urville in December 2008.



Figure 5: Killer whales (*Orcinus orca*) photographed off Adélie Land in January 2011 showing type C slanted eye-patches, dorsal cape and greyish tones.



Figure 6: Type A killer whale (*Orcinus orca*) male (a and b) and female/juvenile (c and d) photographed off Adélie Land in January 2011.



Figure 7: Type B killer whales (*Orcinus orca*) observed around the French Antarctic base Dumont D'Urville in December 2008 showed round scars likely due to cookie-cutter shark (*Isistius* spp.) bites.



Figure 8: Type C killer whales (*Orcinus orca*) observed off Adélie Land in January 2011 showed round scars likely due to cookie-cutter shark (*Isistius* spp.) bites.