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Short Note

White Killer Whales (*Orcinus orca*) in the Western North Pacific

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Cetaceans with anomalously white coloration have been observed in a number of species, including killer whales (*Orcinus orca*) (Hain & Leatherwood, 1982; Fertl et al., 1999, 2004). The oldest published reports of white killer whales date back to the early 20th century (e.g., Moran, 1924). A summary of published sightings of white killer whales in the North Pacific is shown in Table 1. Comparatively fewer reports of white killer whales have been made from other oceans, including accounts from around New Zealand in 1977 and the Azores in 1985 (cited in Fertl et al., 1999). Herein, we report the recent sightings of white killer whales in the western North Pacific and discuss the possible implications of their occurrence.

From 2008 through 2015, three different white killer whales, all of the resident ecotype, were encountered in the waters around the Commander Islands (Russia) during a long-term study conducted by the Far East Russia Orca Project (FEROP) since 1999 in which the authors (except B. Siviour) are involved (Table 2):

1. A small calf, CO065 in the FEROP catalog, was sighted in a large group of normally pigmented whales on 21 May 2008. This animal was resighted as a juvenile in August and September 2011 (Figure 1).

Table 1. Published sightings of white killer whales (*Orcinus orca*) in the North Pacific

Observations	Location	Date	References
White individual	Chatham Sound, BC, Canada	August 1923	Moran, 1924
White male	Anadyr Gulf, Chukotka, Russia	Mid-1930s	Zenkovich, 1952
White individual	Vancouver Island, BC, Canada	Starting in the mid-1940s; multiple observations	Carl, 1959
White juvenile	Pedder Bay, Vancouver Island, BC, Canada	March 1970	Ridgway, 1979
White male	St. Lawrence Island, Bering Sea, USA	August 1993	Speckman & Sheffield, 2001
White male	Adak Island, central Aleutian Islands, USA	August 2000	Renner & Bell, 2008
White male (the same individual as in August 2000)	Adak Island, central Aleutian Islands, USA	February 2008	Fearnbach et al., 2014
Several white individuals depredating longlines	Okhotsk Sea, Russia	2001-2005	Karyakin, 2006
White transient calf	Near Victoria, BC, Canada	December 2009	Vancouver Aquarium, 2012

Table 2. Sightings of white killer whales in the western North Pacific in 2008 through 2015; all sightings were confirmed by photographs.

Regions	Latitude/Longitude	Date	Age/sex	ID
Commander Islands	N54° 59.0' E166° 07.1'	21/05/2008	Calf	CO065
	N54° 58.2' E166° 08.7'	21/08/2011	Juvenile	
	N54° 49.9' E166° 16.4'	15/09/2011		
	N54° 58.7' E166° 05.2'	17/08/2009	Other* (probably female)	CO210
	N54° 57.8' E166° 07.9'	13/07/2010		
	N54° 57.7' E166° 07.2'	19/07/2010		
	N54° 51.1' E166° 16.6'	13/08/2010		
	N55° 00.2' E166° 02.2'	14/09/2010		
	N55° 00.7' E166° 01.3'	15/09/2010		
	N54°58.6' E166° 01.1'	11/08/2010	Adult male	CO539
	N54°50.9' E166° 17.1'	13/08/2010		
	N54°55.2' E166° 08.2'	14/07/2015		
Kuril Islands	N50° 03.8' E155° 03.4'	28/08/2014	Juvenile	
Sakhalin Island	N48° 23.1' E145° 28.0'	29/08/2014	Female, juvenile	

*This category includes all whales except adult males, confirmed females, calves. and juveniles.

2. The white whale CO210 (Figure 2), classified as "other" in the first encounter (this category includes all whales except adult males, confirmed females, calves, and juveniles), was first sighted on 17 August 2009. In July through September 2010, the group that included this whale was re-sighted five times. On several occasions, this whale was accompanied by a normally pigmented juvenile, suggesting that the individual was an adult female with her offspring. However, this group was generally difficult to approach; we could not reliably identify the relationships of animals within the group.

3. The white adult male CO539 called "Iceberg" (Figure 3) was sighted on 11 and 13 August 2010 and re-sighted on 14 July 2015. It is notable that during the 13 August 2010 encounter, the white male CO539 and white presumed female CO210 were encountered in the same multi-pod aggregation but in different groups. No further connection between these animals has been identified, so this joint sighting was apparently casual.

We compared our photographs of the white adult male CO539, Iceberg, with the photograph published in Renner & Bell (2008) that was taken near Adak Island in 2000, and with the 2008 photographs of the same male published online. Though CO539 had a similar semi-open saddle patch on the left side, the shape differed from that of the Adak Island male from Renner & Bell. The photographs from 2008 show that the saddle patch of the Adak Island male was closed on the right side, while the saddle patch of CO539 was semi-open on both sides (Figure 3). Thus, we conclude that CO539 is a different individual than the male reported in Renner & Bell (2008) and in Fearnbach et al. (2014). This means that there were at least four white killer whales in the Commander and Aleutian Islands region in the 2008-2011 time period.

Another area of occurrence of white killer whales is the Okhotsk Sea (Table 2). A juvenile white killer whale was spotted in August 2014 south of Paramushir Island (northern Kuril Islands) as a part of a wide-area FEROP survey. This juvenile was briefly encountered in a large multi-pod aggregation of resident killer whales; almost immediately, we lost this animal due to the fog, so the only photos obtained were taken of the right side at an oblique angle (Figure 4). The quality of the photos was not sufficient to either confirm a match with CO065 or classify the animal as a unique individual.

A group with two white killer whales, apparently female and juvenile, was encountered by the cruise ship *Silver Discoverer* in August 2014 in the western Okhotsk Sea about 60 km southeast of Terpenija Cape, Sakhalin Island (Figure 5). The female is different from CO210, based on the shape of the dorsal fin and a small nick near the top of the fin of CO210 that is not visible on the female encountered by the cruise ship. The quality of the photographs of the juvenile was not sufficient to confirm through photo-identification matching if it was the same or a different animal from the two white juveniles mentioned above. However, the observation occurred only a

Figure 1. White juvenile killer whale (*Orcinus orca*) CO065 in the waters of Bering Island, Commander Islands (photo by Olga Filatova)

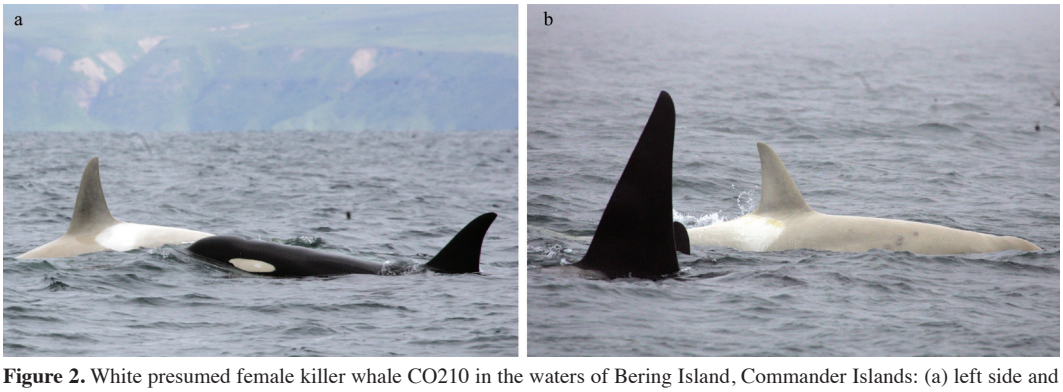

Figure 2. White presumed female killer whale CO210 in the waters of Bering Island, Commander Islands: (a) left side and (b) right side (photos by Evgenya Lazareva)

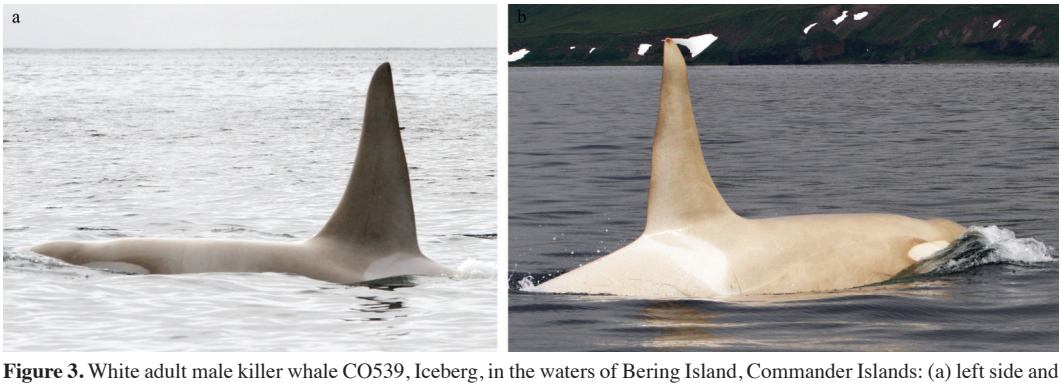

Figure 3. White adult male killer whale CO539, Iceberg, in the waters of Bering Island, Commander Islands: (a) left side and (b) right side (photos by Olga Filatova)

Figure 4. White juvenile killer whale in the waters of the 4th Kuril Strait, Northern Kuril Islands (photo by Olga Filatova)

Figure 5. White female and juvenile killer whale pair off Sakhalin Island: (a) white female from the left side and (b) white female and juvenile from the right side (photos by Brad Siviour)

day before and at a distance of 700 km from the sighting near Paramushir Island. This is too far for killer whales to travel in 1 d; the maximum travel distance for killer whales is about 250 to 290 km/d (Matthews et al., 2011; Durban & Pitman, 2012). Also, CO065 had a normally pigmented mother, so this juvenile must be a different individual.

Karyakin (2006) reported several encounters with multiple white killer whales depredating longlines from 2001 to 2005 in the Okhotsk Sea, but some of these sightings might be of the same individuals. In July 2001, a group consisting of three white animals—one adult male, one female, and one "other" (sex unknown)—was observed in the northern part of Lebed Trench (approximately N55° E154°). A white male was also sighted a week later, 83 km to the south. In August 2001, apparently the same group of white killer whales, together with other groups of normally pigmented animals, was sighted over the western slope of the TINRO depression (approximately N56.5° E152.5°). In May 2002, a group that included three white killer whales—one adult male and two animals recorded as females—was sighted in the central Okhotsk Sea from a ship fishing Greenland halibut (*Reinhardtius hippoglossoides*). Karyakin does not explain how the sex of "females" was determined. Female and young male killer whales are indistinguishable if the genital area is not visible, so a female can be reliably identified in the field only by the presence of an accompanying calf. Therefore, the whales identified as "females" in Karyakin's report could be classified as "others." Thus, the group consisting of "male, female and other" in 2001 and "male and two females" in 2002 could be, in fact, the same group (p. 239). In April

and June 2005, one white "other" was sighted in a group of normally pigmented killer whales.

At least three animals reported by Karyakin (2006) were sighted simultaneously in the Okhotsk Sea region—one adult male and two "others." Either of the white killer whales reported above—the juvenile from Paramushir Island and the female with a juvenile from the western Okhotsk Sea—could be from the same group of three white whales described by Karyakin (2006) because, in both cases, we could not ensure that we had photographed the whole group, so other white whales could have been missed. Therefore, the minimum total number of white killer whales in the Okhotsk Sea is four—the group with a white male, two white "others" (who could be the female and juvenile), and at least one separate white animal. The white male could be the same animal as either Iceberg (CO539) or the Adak Island male reported in Renner & Bell (2008) and in Fearnbach et al. (2014). We can neither confirm nor reject this possibility because no photos of the white male from the Okhotsk Sea are available. The white juvenile sighted near Paramushir Island could be the same animal as CO065 from the Commander Islands. However, the white "other" CO210 is different from the white female with the white juvenile, which were sighted off Terpenija Cape.

Therefore, there are at least five white killer whales in the western North Pacific—four animals from the Okhotsk Sea plus CO210. However, given the distance between the Commander Islands and the Okhotsk Sea (about 800 km to Paramushir Island and about 1,300 km to the central Okhotsk Sea), it is quite possible that killer whales from these areas represent different communities. No matches have been found so far between the whales identified in the northern Kuril Islands and areas off eastern Kamchatka, including the Commander Islands (FEROP, unpub. data). If this is the case, then the total number of white killer whales is eight—four in the Okhotsk Sea and four in the Commander-Aleutian area.

The white killer whales described herein belong to the *resident* (fish-eating) ecotype (Filatova et al., 2015). This was determined by the shape of the dorsal fin and saddle patch in the photographs of these whales and their group members as well as from their behavior. Animals reported by Karyakin (2006) were observed depredating longlines, so they were apparently fish-eating, too. However, in the eastern North Pacific, white killer whales have been reported as killer whales belonging to the *transient* (mammal-eating) ecotype. The white killer whale from Vancouver Island described by Carl (1959) traveled with a group of whales later photographically identified as transients (Ford & Ellis, 1999). The white juvenile female "Chimo," captured in British Columbia in 1970, also belonged to the transient ecotype (Ridgway, 1979). More recently, in 2009, the white calf sighted near Victoria, British Columbia, was accompanied by a transient female (Vancouver Aquarium, 2012). Therefore, the mutation leading to the anomalously white pigmentation has apparently appeared independently in at least two reproductively isolated ecotypes of killer whales in the North Pacific.

For those whales with a detailed description, the coloration of all reported white killer whales from the resident ecotype was described as "creamy yellowish." The transient killer whales were pale grey rather than yellowish, supporting the different nature of mutations, causing the white coloration in the two ecotypes. Both ecotypes retained the visible white patches of normal killer whale pigmentation.

It is not known if white killer whales are true albinos or leucistic. The only white killer whale in captivity—the transient juvenile Chimo—has been confirmed to be a true albino (Taylor & Farrell, 1973; Ridgway, 1979), but no close-up photos of the eyes and no biopsy samples have been obtained for the free-ranging white killer whales, so the nature of their anomalously white coloration remains unknown. However, the yellowish coloration is a likely indication of albinism rather than leucism. Albinism is caused by defects of melanin production and equally affects the whole skin, fur, and eyes; while leucism results from defects in pigment cells and can be patchy. Homogenous creamy yellowish coloration in killer whales is similar in appearance to type 2 albinism in humans expressed as yellow hair, lightly pigmented skin, and reduced iris pigmentation (Manga & Orlow, 1999). Similar mutation in mice produces pink eyes and light gray or cream-colored fur (Brilliant, 2001).

Albinos often have a reduced life span and are prone to skin and eye diseases. The captive white juvenile, Chimo, was diagnosed with Chédiak-Higashi syndrome, a type of albinism associated with deteriorating health and a reduced lifespan (Taylor & Farrell, 1973; Ridgway, 1979). The albino allele is usually recessive, so it remains in the population even though it is selected against; but the prevalence of albinos is often related to the level of inbreeding. In mammals, albinos on average occur in ~1 in 10,000 births (Miller, 2005).

There are no reliable abundance estimates for western North Pacific killer whales. Photo-identification catalogs include about 550 resident killer whales off Eastern Kamchatka and about 800 residents around the Commander Islands (Shabalina et al., 2015). Estimates for the Okhotsk Sea (both ecotypes pooled) vary from 500 (Berzin & Vladimirov, 1989) to 3,130 (VNIRO, 2015).

In any case, the total abundance of resident killer whales in the western North Pacific is on the order of several thousand animals, which means that the incidence of white killer whales is ~1 in 1,000—a rather high occurrence for a mammalian species.

In human populations, inbreeding has been recognized as a major factor when there is a high incidence of albinism (Okoro, 1975). The rate of albinos varies from 1 in 20,000 in Europe to 1 in 1,000 in some African communities (Lund et al. 1997). The highest incidence of human albinism in the world—one in 200—was found in the Cuna tribe on the San Blas Islands in Panama, which is considered the result of inbreeding in isolation (Keeler, 1970). The only known albino gorilla was also reported to be the result of inbreeding (Prado-Martinez et al. 2013).

Anomalously white individuals have been observed in other cetacean species (reviewed in Fertl et al., 1999, 2004); many whales and dolphin species are more numerous than killer whales, but white individuals are generally observed less often in other species. For example, only one case of an all-white individual was published for the humpback whale (*Megaptera novaeangliae*), which is one of the most frequently sighted species of large whales (Polanowski et al., 2012).

Killer whale populations are often relatively small and have low genetic diversity (Hoelzel et al., 2002), so the high occurrence of anomalously pigmented individuals is unsurprising. The management implications of this finding is that killer whales are vulnerable not only to environmental and anthropogenic factors but also to the internal mutation load, which can become a significant threat in small inbred populations.

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