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Chapter 8

AN INFREQUENTLY-OCCURRING ANOMALOUS COLOR PATTERN ON PACIFIC WHITE-SIDED DOLPHINS, *LAGENORHYNCHUS OBLIQUIDENS*

***Keiko Sekiguchi*[*1], *Thomas A. Jefferson*[2], *Yuka Iwahara*[3], *Motoi Yoshioka*[4], *Kyoichi Mori*[5], *John K. B. Ford*[6], *Yoko Mitani*[3] and *Uko Gorter*[7]**

[1]International Christian University, Mitaka City, Tokyo, Japan
[2]Clymene Enterprises, Lakeside, CA, US
[3]Hokkaido University, Hakodate, Hokkaido, Japan
[4]Mie University, Tsu, Mie, Japan
[5]Teikyo University of Science, Uenohara, Yamanashi, Japan
[6]Pacific Biological Station, Fisheries and Ocean Canada, Nanaimo, British Columbia, Canada
[7]Natural History Illustration, Kirkland, WA, US

ABSTRACT

Anomalous body coloration often appears on many mammal species. In the case of cetaceans, coloration patterns may be particularly important

[*] Corresponding author: Keiko Sekiguchi, e-mail address: ksekiguc@hawaii.edu

and have functional and adaptive value. However, white animals for many cetacean species have been sighted world-wide, and also some anomalous color patterns have been reported. Anomalous, albinistic and leucistic coloration has been reported for the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), distributed in the cold temperate waters of the North Pacific. One pattern first reported by Brownell (1965) has been seen infrequently, but 19 more sighting/capture records are restricted to nearshore regions in the eastern North Pacific (*e.g.*, southern California, Monterey Bay, off San Francisco, Washington, and Alaska). We added seven sightings of these anomalous-colored animals over the wide range of the mid-western and central North Pacific in different years; five in 1987 and two in 2012. Color patterns for these animals were very similar, despite occurrence at different times and in widely separated locations. Although variable, animals with this anomalous coloration had darker thoracic patches often completely bordered dorsally and laterally by an extensive, white stripe. However, for some animals this white stripe was distinguished strongly only above the eyes. We compiled 27 records of this anomalous form, over a wide range in the North Pacific. The distribution of these records suggests genetic restriction in the sighting region (*i.e.*, the mid-western to eastern North Pacific). This type of anomalous color pattern has not been reported around Japanese coasts. Hayano et al., (2004) concluded that there are genetically-distinct populations around Japan. Anomalous animals observed in the mid-western, central and eastern North Pacific, but not off Japan, appear to support their conclusion.

INTRODUCTION

Characteristic fur/skin color is important as a key for species identification, and also has functions for concealment, communication and physiological process regulation (Caro, 2005). Yet, anomalous pigmentation often appears on many mammal species, as a result of disorder of pigmentation presence and distribution. Abrew et al., (2013) reviewed anomalous coloration in neotropical mammals, and categorized it into four types: albinism, leucism, piebaldism and undetermined. Anomalous color patterns they described were mostly caused by lack/excess of pigmentation; however, there is another case (it could be categorized into "undetermined"). The king cheetah, animals with longtidudinal black stripes instead of regular black spots, was first reported as a distinct species, *Acinonys rex* (Pocock, 1927). Wild king cheetahs were caught in a very restricted area - Zimbabwe, eastern Botswana and northern South Africa (Lindburg, 1989). Later, normal

captive cheetahs (*A. jubatus*), which originated from those areas, gave birth to king cheetahs, and then it was found that it was actually an abnormal colored cheetah carrying an autosomal recessive trait (van Aarde and van Dyk, 1986).

In the case of cetaceans, coloration is very much species specific, although virtually all species have variation in the color pattern according to age, sex, habitat, and geographical regions (Perrin, 2002). Albino and leucistic-type white animals have been reported often in a variety of cetacean species. Hain and Leatherwood (1982) and Fertl et al., (1999) reviewed records of anomalously white animals and found them in 20 cetacean species, including many published records in the southern right whale (*Eubalaena australis*), gray whale (*Eschrichtius robustus*), sperm whale (*Physeter macrocephalus*), killer whale (*Orcinus orca*), long-finned pilot whale (*Globicephala melas*), common dolphins (*Delphinus* spp.), spinner dolphin (*Stenella longirostris*), common bottlenose dolphin (*Tursiops truncatus*), harbor porpoise (*Phocoena phocoena*) and Dall's porpoise (*Phocoenoides dalli*). Melanistic-type anomalies (*e.g.*, southern right whale dolphin *Lissodelphis peronii*; Visser et al., 2004) have also been reported. Unusual color variants can also be caused by hybridization events (*e.g.*, Berube and Aguilar 1998, Yazdi 2002).

AN ANOMALOUS COLOR PATTERN ON PACIFIC WHITE-SIDED DOLPHINS

The Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) is a dolphin species widely distributed in cold temperate waters of the North Pacific and adjacent seas from near shore to deep oceanic waters (Brownell et al., 1999, Jefferson et al., 2008, Walker et al., 1986). Figure 1 shows the typical color pattern of this species (top); a dark gray/black dorsal surface, light gray sides (a light gray large thoracic patch from melon to a center of body, and a light gray flank patch from the mid body toward the flukes with dorsal and ventral blazes pointing forward, with the dorsal blaze arcing over the sides to the back and almost reaching the blowhole area), and a white ventrum with a black stripe from eye to flipper to anus forming a border line (for schematic interpretation, see also Figure 1 in Tsutui et al., 2001). Albino-type or other white body color anomalies have been reported widely among its distribution range (Black 1994, Brown and Norris 1956, Stacey and Baird 1991, Tsutsui et al., 2001). Brownell (1965) first reported a sighting of an anomalous-colored individual of this species off San Francisco in a school of

15 dolphins. Its pigmentation was totally different from the "regular color pattern". This animal had a large lateral thoracic black area, and a distinct, wide white line between a black thoracic and a dorsal back (Figure 2-a). This animal was not an albino, but it looked like a totally different species, as in the case of the king cheetah.

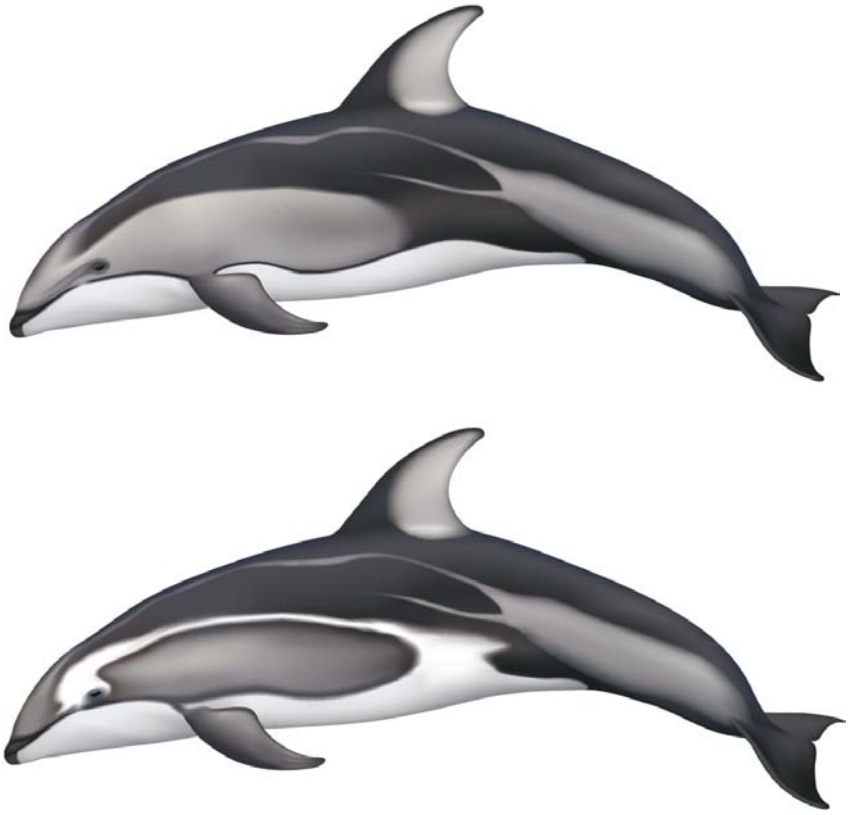

Figure 1. A "normal-colored" Pacific white-sided dolphin, *Lagenorhynchus obliquidens*, (top) and a composite sketch of the "Brownell-type" anomalous-colored dolphin (bottom) (illustrations by UG).

In this study, we collected and summarized sighting/capture records of this "Brownell-type" anomalous-colored Pacific white-sided dolphin, from all available sources, both published and unpublished. We found a total of 20 records, possibly representing 23 individuals, of the "Brownell-type" anomalous-colored Pacific white-sided dolphins along coasts of the eastern North Pacific Ocean (Table 1). Walker et al., (1986) reported the second

specimen of this "Brownell-type" dolphin, which was collected off central California, 37°46'N 124°30'W, on 25 February 1966 (Record no. 2 in Table 1, Figure 2-b). They also mentioned another three sightings by Leatherwood: off Washington in April 1971, off Southern California in February 1974 and February 1976 (Record no. 3, 4, 5 in Table 1). Black (1994) conducted vessel

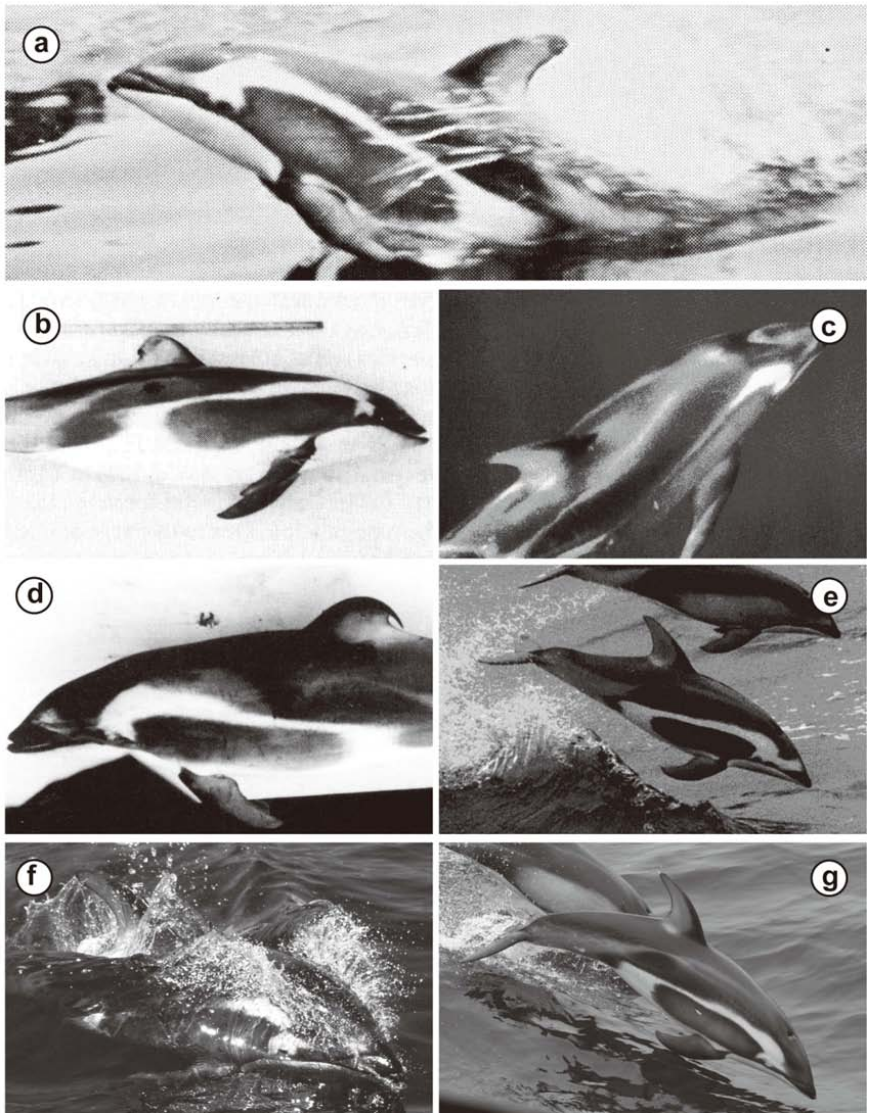

Figure 2. (Continued).

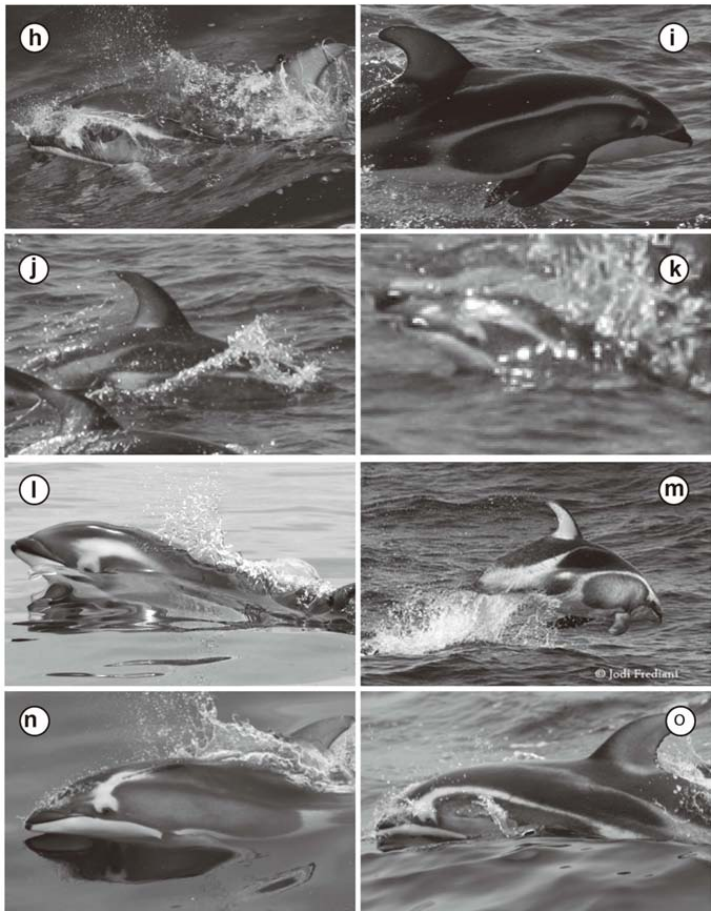

Figure 2. Photographs of anomalous-colored Pacific white-sided dolphins captured or sighted along the eastern North Pacific. Photograph letters refer to records in Table 1. (a) the first recorded anomalous-colored dolphin by Brownell (Fig. 1 in 1965); (b) a captured animal off San Francisco reported by Walker et al. (Fig. 21-7 in 1986); (c) one of sightings by Black (1994) (photo by TAJ); (d) an animal reported by Stacy and Baird (Fig. 3 in 1991); (e) a sighting along Aleutian Island by S. Webb (p. 197 in Jefferson et al. 2008); (f) an unpublished sighting in Monterey Bay, CA by Marine Life Studies in 2001 (photo by P. Stap); (g) an unpublished sighting in southern California by K. Whitaker in 2011 (photo by Whitaker); (h, i) two sightings in Monterey Bay, CA by Monterey Bay Whale Watch in 2012 (photo by M. Merlo and K. Spencer); (j, k) two animals sighted in one school, southern California by K. Whitaker in 2013 (photo by Whitaker); (l) a sighting in Monterey Bay, CA by Marine Life Studies in 2013 (photo by P. Stap); (m) a sighting in Monterey Bay, CA by Monterey Bay Whale Watch in 2013 (photo by J. Frediani); (n, o) two sightings southwest of Vancouver Island in 2013 (photo by B. Gisborne).

Table 1. Sighting records of anomalous-colored Pacific white-sighted dolphins in the eastern North Pacific. Star marks (*) indicate a mixed school with northern right whale dolphins.

Record No.	Date	Type	Location	School size	Source	Photo No.
1	4 July 1963	Sighting	37°41'N 123°45'W Off Farallon Islands	15	Brownell 1965	a
2	25 February 1966	Capture	37°46'N, 124°30'W		Walker et al., 1986	b
3	April 1971	Sighting	Washington State		Leatherwood in Walker et al. 1986	
4	February 1974	Sighting	Southern California		Leatherwood in Walker et al. 1986	
5	February 1976	Sighting	Southern California		Leatherwood in Walker et al. 1986	
6	12 December 1988	Sighting	Monterey Bay, CA	800	Black 1994	c
7	19 April 1990	Sighting	Monterey Bay, CA	500	Black 1994	
8	23 February 1991	Sighting	Monterey Bay, CA	1100	Black 1994	
9	?	Capture	Unknown		Stacey and Baird 1991	d
10	?	Sighting	Along Aleutian Islands		S. Webb in Jefferson et al., 2008	e
11	2001	Sighting	Monterey Bay, CA		Marine Life Studies	f
12	23 April 2011	Sighting	33º54.23'N, 121º39.64'W, S. California		K. Whitaker, pers. comm.	g
13	3 June 2012	Sighting	Monterey Bay, CA		Monterey Bay Whale Watch	h
14	23 June 2012	Sighting	Monterey Bay, CA		Monterey Bay Whale Watch	i
15	8 October 2012	Sighting	NW of Vancouver Island, Canada	~155*	J. Ford, unpublished data	
16	25 April 2013	Sighting	35º09.97'N, 123º52.86'W, S. California		K. Whitaker, pers. comm.	j, k
17	10 June 2013	Sighting	Monterey Bay, CA	~200	Marine Life Studies	l
18	27 June 2013	Sighting	Monterey Bay, CA		Monterey Bay Whale Watch	m
19	13 September 2013	Sighting	SW of Vancouver Island, Canada	~220*	J. Ford, unpublished data	n
20	17 October 2013	Sighting	SW of Vancouver Island, Canada	~300	J. Ford, unpublished data	o

Table 2. Sighting records of anomalous-colored Pacific white-sighted dolphins in the western and central North Pacific.

Record No.	Date	Time	Location		SST	School size	Source	Photo No.
			Latitude	Longitude				
21	6 August 1987	13:50	43º18.5'N	156º09.4'E	13.9	?	Yoshioka 1988	p
22	21 August 1987	2:58	49º58.3'N	136º00.5'W	13.8	70	Yoshioka 1988	
23	21 August 1987	7:33	49º11.3'N	136º01.4'W	14.3	8	Yoshioka 1988	q
24	21 September 1987	7:47	44º16.1'N	160º45.2'E	12.7	>3	Yoshioka 1988	r
25	21 September 1987	9:00	44º07.5'N	160º34.8'E	13.5	8	Yoshioka 1988	s
26	12 July 2012	15:46	44º34.52'N	150º0.09'W	12.1	4	Sekiguchi pers. obs.	t
27	13 October 2012	15:22	43º15.08'N	154º36.05'E	12.1	50	Iwahara pers. obs.	u

surveys in Monterey Bay, California from 1987 to 1991 and encountered "Brownell-type" dolphins on three occasions; 12 December 1988 (Record no. 6 in Table 1, Figure 2-c), 19 April 1990 and 23 February 1991 (Record no. 7, 8 in Table 1). Although she wrote that all three sightings were the same animal, we report them here as separate sightings. The next specimen was a possible captured animal shown in the photograph, but unfortunately no data are mentioned in Stacey and Baird (1991; Record no. 9 in Table 1, Figure 2-d). An animal in the photograph on page 197 of Jefferson et al., (2008) was taken by S. Webb along the Aleutian Islands, but with no data attached (Record no. 10 in Table 1, Figure 2-e). Marine Life Studies made two sightings of “Brownell-type” dolphins in Monterey Bay in 2001 (unpublished data, Record no. 11 in Table 1, Figure 2-f) and 10 June 2013 (http://www.youtube.com/watch?v=qjqpmpPBlhM; Record no. 17 in Table 1, Figure 2-l) . K. Whitaker had three unpublished sightings of "Brownell-type" dolphins off southern California. The first one was sighted at 33°54.23'N 121°39.64'W on 23 April 2011 (Record no. 12 in Table 1, Figure 2-g), and the second and third sightings were in the same school at 35°09.97'N 123°52.86'W on 25 April 2013 (Record no. 16 in Table 1, Figure 2-j, k) (K. Whitaker, pers. comm.). Three more sightings were from Monterey Bay by Monterey Bay Whale Watch on 3rd and 23 June 2012 (https://www.facebook.com/media/set/?set=a.277107862386956.57066.170012223096521&type=1 and https://www.facebook.com/media/set/?set= a.286916834739392.59063.170012223096521&type=1; Record no. 13, 14 in Table 1, Figure 2-h, i), and 27 June 2013 (https://www.facebook.com/media/set/?set=a.432385626859178.1073741951.170012223096521&type=3; Record no. 19 in Table 1, Figure 2-m). The last three sightings were off Vancouver Island (JKBF, unpublished data); at 50°12.42'N 128°20.4'W on 08 October 2012 (Record no. 15, no photograph), at 49°04.46'N 127°28.0'W on 13 September 2013 and at 48°11.6'N 126°56.1'W on 17 October 2013 (Record no. 19, 20 in Table 1, Figure 2-n, o). Record no. 15 and 19 were in a mixed school of Pacific white-sided and northern right whale dolphins, *Lissodelphis borealis* (~100 and ~55 dolphins, and ~130 and ~90 dolphins respectively). Record no. 20 had three "Brownell-type" dolphins in a school of about 300 Pacific white-sided dolphins.

Data collection in the western and central parts of the North Pacific is difficult because its vast area far away from population centers results in less frequent encounter opportunities; however, we managed to collect seven sightings of "Brownell-type" dolphins (Table 2). Yoshioka (1988) had five "Brownell-type" dolphin sightings during their 52-day trans-Pacific research

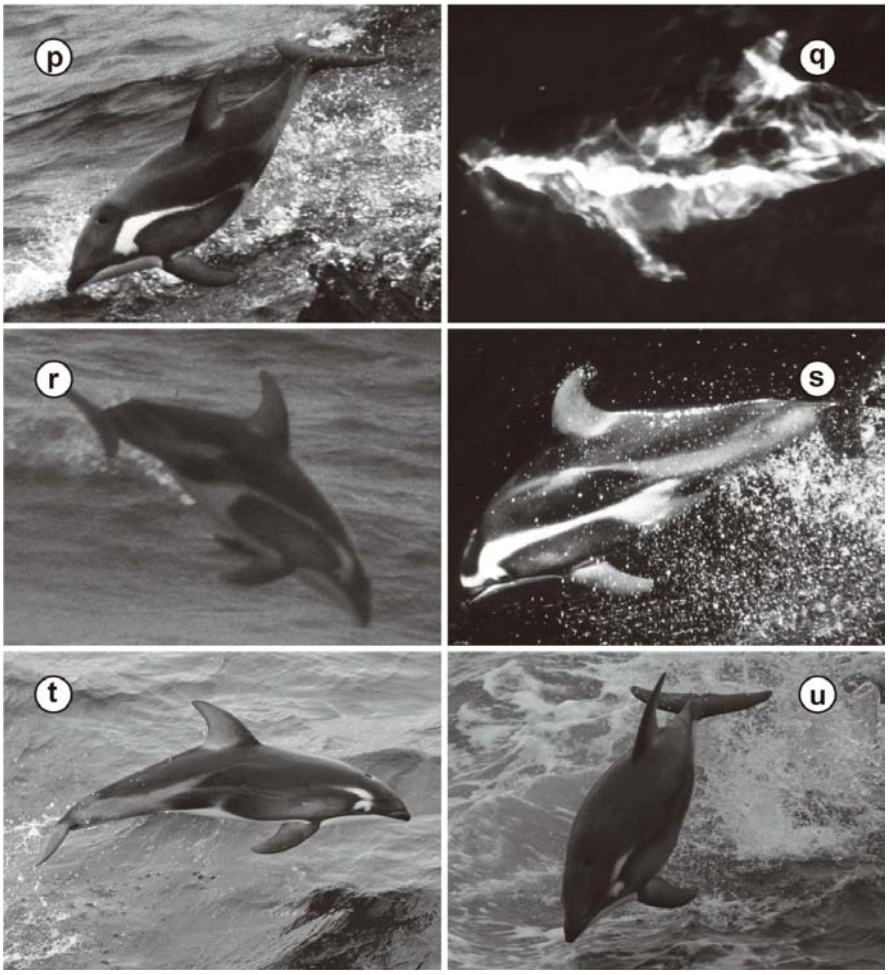

Figure 3. Photographs of anomalous-colored Pacific white-sided dolphins sighted in the western and central North Pacific. Photograph letters refer to records in Table 2. (p) a sighting at 43°18.5'N 156°09.4'E in 1987 (photo by KM); (q) a sighting at 49°11.3'N 136°01.4'W in 1987 (photo by KM); (r) a sighting at 44°16.1'N 160°45.2'E in 1987 (photo by MY); (s) a sighting at 44°07.5'N 160°34.8'E in 1987 (photo by KM); (t) a sighting at 44°34.5'N 150°0.1'E in 2012 (photo by KS); (u) a sighting at 43°15.1'N 154°36.1'E in 2012 (photo by B. Nishizawa).

cruise from August to September 1987. The first animal was sighted at 43°18.5'N 156°09.4'E, 13:50, 06 August 1987 (Sea Surface Temperature (SST)=13.9°C; Record no. 21 in Table 2, Figure 3-p). The second sighting was among a large school of 70 animals, at 49°58.3'N 136°00.5'W, 02:58, 21

August 1987 (SST=13.8°C; Record no. 22 in Table 2, no photo). The third one was sighted on the same day as one of eight animals, at 49°11.3'N 136°01.4'W, 07:33 (SST=14.3°C; Record no. 23 in Table 2, Figure 3-q). The fourth and fifth sightings were on the same day, 21 September 1987, at 44°16.1'N 160°45.2'E, 07:47 (SST=12.7°C, school size >3; Record no. 24 in Table 2, Figure 3-r), and at 44°07.5'N 160°34.8'E, 09:00 (SST=13.5°C, school size=8; Record no. 25 in Table 2, Figure 3-s). The first author had one sighting in a group of four animals at 44°34.52'N 150°00.09'W, 15:46, 12 July 2012 (SST=12.1°C) (unpublished data; Record no. 26 in Table 2, Figure 3-t). The last sighting was made by the third author among about 50 Pacific white-sided dolphins at 43°15.08'N 154°36.05'E, 15:22, 13 October 2012 (SST=12.1°C) (unpublished data; Record no.27 in Table 2, Figure 3-u).

DISCUSSION

This study shows that "Brownell-type" anomalous-colored Pacific white-sided dolphins are distributed in a wide area of the North Pacific Ocean (Figure 4). Monterey Bay has a concentration of sightings, but this may be caused by the large amount of effort in the area, including many whale-watching businesses. Color patterns for these animals were all very similar (Figures 2 and 3), despite occurrence at different times and locations. At a minimum, all animals had dark thoracic patches with a white blaze rising dorsally and extending at least somewhat posteriorly as a border around the thoracic patch (Figure 1). In extreme cases, the white blaze originating at the eye also extended anteriorly and was present above the beak encircling the melon (Figures 2-a, e, m, Figure 3-s). Also, when present to the maximum extent, the white stripe connected with the white ventral field through a break in the black eye to flipper to anal stripe. This further enhances its thoracic patch, which is darker and more distinct than on a normal-colored dolphin. Although it seems there is some variation in specific elements of the anomalous animals, we illustrate a dolphin in Figure 1 (bottom) that shows a "composite" sketch of the color pattern representative of the most frequently occurring "Brownell-type" dolphin based on all the available photographs. These anomalous color patterns somewhat resembled the pattern of hourglass dolphins (*Lagenorhynchus cruciger*), as Mitchell (1970) pointed out. Anomalous-colored animals have been found among "normal" colored dolphins with a school size from three up to 1,100, and thus those anomalous

animals seem to have no problem associating with "normal" individuals. Although there is no evidence for reproductive condition for these "Brownell" type animals, these anomalous genes must be carried to the next generation of Pacific white-sided dolphins, as in the case of king cheetahs. The distribution of this anomalous form may suggest genetic restriction in the sighting region (*i.e.*, mid-western to eastern N. Pacific).

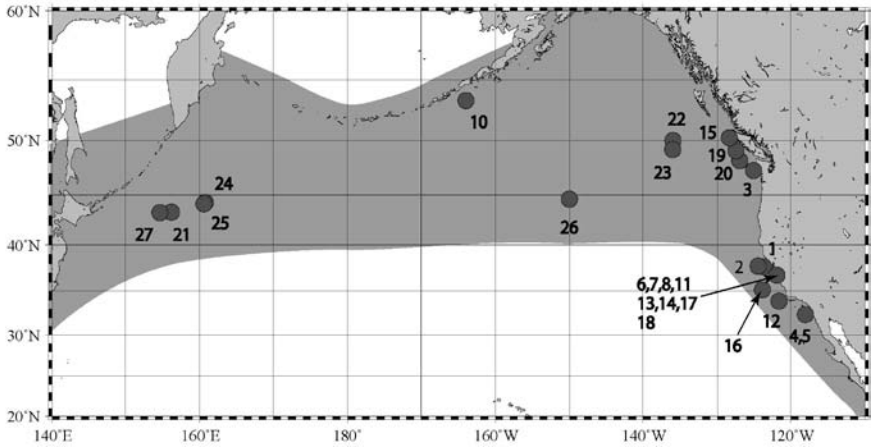

Figure 4. Sighting/capture locations of anomalous-colored Pacific white-sided dolphins (gray circles). The numbers on the map refer to the record numbers on Tables 1 and 2. The gray section over the North Pacific indicates the distribution range of the Pacific white-sided dolphin.

The anomalously-colored “Brownell type” Pacific white-sided dolphin has not been reported from around Japan, despite high levels of marine mammal survey (Kato 2006) and capture effort (Kasuya 2011, Kishiro 2012) in Japanese coastal waters. However, albino-type and other anomalously-white Pacific white-sided dolphins have been reported from the entire species' distribution range, including Japan (*e.g.*, Walker et al., 1986, Black 1994, Tsutsui et al., 2001). From results of marine mammal surveys conducted across the North Pacific, Miyashita (1993) found a gap of Pacific white-sided dolphin sightings at around 150°E. Hayano et al., (2004) concluded that there are genetically-distinct populations around Japan, and suggested the area around 145-150°E was a boundary between Japanese coastal and offshore North Pacific populations. Anomalous "Brownell-type" animals observed only in the mid-western to eastern North Pacific appear to support their conclusion. Lux et al., (1997) found genetic divisions among their samples of Pacific

white-side dolphins from the central and eastern North Pacific; however, the presence of "Brownell-type" genes in the entire central and eastern North Pacific suggest these populations may have evolved from a common ancestor after isolation from the Japanese coastal population.

In the genus *Lagenorhynchus*, six species are currently recognized, although taxonomic revisions are needed and more than one genus is probably involved (Cipriano and Webber 2010). Among these currently-recognized species, Fertl et al., (1999) summarized unpublished records of albino-type dusky dolphins *L. obscurus* and Atlantic white-sided dolphins *L. acutus*. Yazdi (2002) and Bastida and Rodríguez (2005) reported a possible hybrid anomalous-colored dusky dolphin. A heavily-melanized dusky dolphin has also been reported (Cipriano and Webber 2010). However, no "Brownell-type" anomaly has yet been reported for these other *Lagenorhynchus* species. Further studies will be needed to determine whether the "Brownell-type" anomaly is indeed species specific.

Although there is variation in the extent and intensity of some elements of the "Brownell-type" color pattern, it exists in the same basic form throughout a large part of the range of the species from the mid-western to the eastern Pacific (but so far, not in far-western Japanese waters). The basic, common elements are a darkened thoracic patch, and a sometimes-wide white stripe surrounding the thoracic patch from the eye to the white ventral field (Figure 1). A similar situation exists in several other small cetacean species, in which a recurring anomalous color pattern occurs infrequently among some individuals of an otherwise-normally colored school, throughout much of the known range of the species. Well-known examples include the anomalous pattern found on some short-beaked common dolphins (*Delphinus delphis*), in which the cape extends down to obscure the light thoracic patch (Perrin et al., 1995). Another example is the pattern that has been called “swirled” found on some northern right whale dolphins (*Lissodelphis borealis*), in which the white ventral pattern extends up much further onto the sides and even on the dorsal surfaces of the flippers (often in a swirled pattern) (Tobayama et al., 1969; Leatherwood et al., 1979; Jefferson et al., 2008; TAJ unpublished). All of these may be examples of anomalous patterns caused by infrequently-occurring or recessive genetic conditions, similar to that in the king cheetah. Biopsy sampling of such individuals may be necessary to clarify the specific genetic causes of these anomalous coloration patterns.

CONCLUSION

Since Brownell (1965) first reported an anomalous-colored Pacific white-sided dolphin sighted off San Francisco, we collected a total of 20 sighting and capture reports in nearshore regions in the eastern North Pacific. We also found seven sightings over the wide range of the mid-western and central North Pacific. Despite being seen at different times and locations, these animals all had very similar anomalous color patterns: dark thoracic patches surrounded by an extensive, white stripe going occasionally forward to the melon and connecting with the flank patch, but for some animals this white stripe was distinguished strongly only above the eyes. The absence of reports of this anomalous-colored dolphin in Japanese waters may support the hypothesis of genetic division of this species between Japanese waters and further east in the central and eastern North Pacific.

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Reviewed by Drs. Robert L. Brownell Jr. (Southwest Fisheries Science Center, USA) and Marc Webber (Alaska Maritime NWR, USA)