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Movement of a humpback whale (*Megaptera novaeangliae*) between the Revillagigedo and Hawaiian Archipelagos within a winter breeding season

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Abstract: On 5 February 1986 a humpback whale was photographed near Isla Clarión, in the Revillagigedo Archipelago, Mexico, and again 51 days later near the island of Kauai in the Hawaiian Archipelago. The straight-line distance between the two sightings is approximately 4700km. This resighting constitutes the only known instance in which the same humpback whale has been documented in two discretely different breeding areas within the same season. This finding reinforces the conclusion from other studies that the humpback whale aggregation of the Revillagigedo Archipelago constitutes a separate sub-population from mainland Mexico.

Resumen: En 1986 una ballena jorobada fue fotografiada en la costa de Isla Clarión, del Archipiélago de Revillagigedo, México, y 51 días después se fotografió cerca de isla Kauai, del Archipiélago de Hawaii. La distancia en línea directa entre los dos lugares donde so observó es de aproximadamente 4700 kilómetros. Éste es el único caso conocido en el cual la misma ballena jorobada se ha observado en dos áreas de crianza diferentes en la misma temporada. Esta observación refuerza la conclusión de otros estudios de que las ballenas que se congregan en el Archipiélago de Revillagigedo constituyen a subpoblación diferente a las de la costa continental de México.

Key words: Humpback whale, *Megaptera novaeangliae*, migration, photo-identification, Hawaii, Mexico, North Pacific.

Introduction

Humpback whales are found throughout the world's oceans, and engage in one of the longest-known migrations of any mammal (Stone *et al.*, 1990; Darling *et al.*, 1996; Calambokidis *et al.*, 2001). Whaling records (Townsend, 1935) and recovery of Discovery marks (Omura and Ohsumi, 1964; Dawbin, 1966; Ivashin, 1973) provided limited information on the general distribution and movement of humpback whales in both the Northern and Southern Hemispheres. Since the 1980's more detailed knowledge has resulted from the recognition of individual animals from photographs of unique markings on the ventral surface of the tail flukes (Katona *et al.*, 1979), the flanks (Kaufman *et al.*, 1987), and around the mouth (Glockner and Venus, 1983). Comparison among photographs from different study areas in the North Pacific has resulted in documentation of migratory movement across broad areas. While a number of multi-site analyses of fluke identifications of North Pacific humpback whales have been reported since 1980, the most comprehensive assessment to date was undertaken by Calambokidis *et al.* (2001). Further analyses, involving systematic effort in all known humpback whale feeding and wintering areas of the North Pacific during five field seasons from 2004 - 2006, are currently underway (Cascadia Research, 2007). Distribution and movement patterns of North Pacific humpback whales have also been studied through satellite telemetry (Mate *et al.*, 1998), acoustic recordings (Helweg *et al.*, 1990; Norris *et al.*, 1999), and genetic analysis (Baker *et al.*, 1998).

Humpback whales typically feed in temperate waters during the summer, and move to tropical areas during the winter, where mating and calving occur (Mackintosh, 1965; Clapham, 2000; Silvers *et al.*, 2002). In the North Pacific, humpback whales feed in near-shore temperate waters along the entire western coast of North America, through the Aleutian Islands, north and westerly into the Bering and Chukchi Seas, and down into the Sea of Okhotsk and off the coast of northern Japan (Tomilin, 1957; Rice, 1978; Calambokidis *et al.*, 2001). In winter they migrate to three relatively discrete areas: in the western North Pacific from Japan to the Philippines; in the Central Pacific around the main Hawaiian Islands; and in the eastern North Pacific off the coasts of Mexico and Central America (Herman *et al.*, 1980; Urbán *et al.*, 1987; Darling and Mori, 1993; Acevedo and Smultea, 1995).

On 5 February 1986 a humpback whale was photographed near Isla Clarión in the Revillagigedo Islands off the western coast of Mexico (approx. 115°W, 18°N). On 28 March, 51 days later, the same whale was photographed near Kauai, Hawaii (approx. 160°W, 22°N). The whale was photographed again on 29 March in the same vicinity. The direct travel distance between the Mexico and Hawaii sightings is approximately 4700km. The match between the photographs of the Hawaii and Mexico sightings was initially documented by staff of the National Marine Mammal Laboratory (NMML), Seattle, using their computer photographic identification system (Mizroch *et al.*, 1990). Figure 1 shows images of the underside of the tail flukes obtained in 1986 near Isla Clarión (Figure 1*a*) and Kauai (Figure 1*b*).

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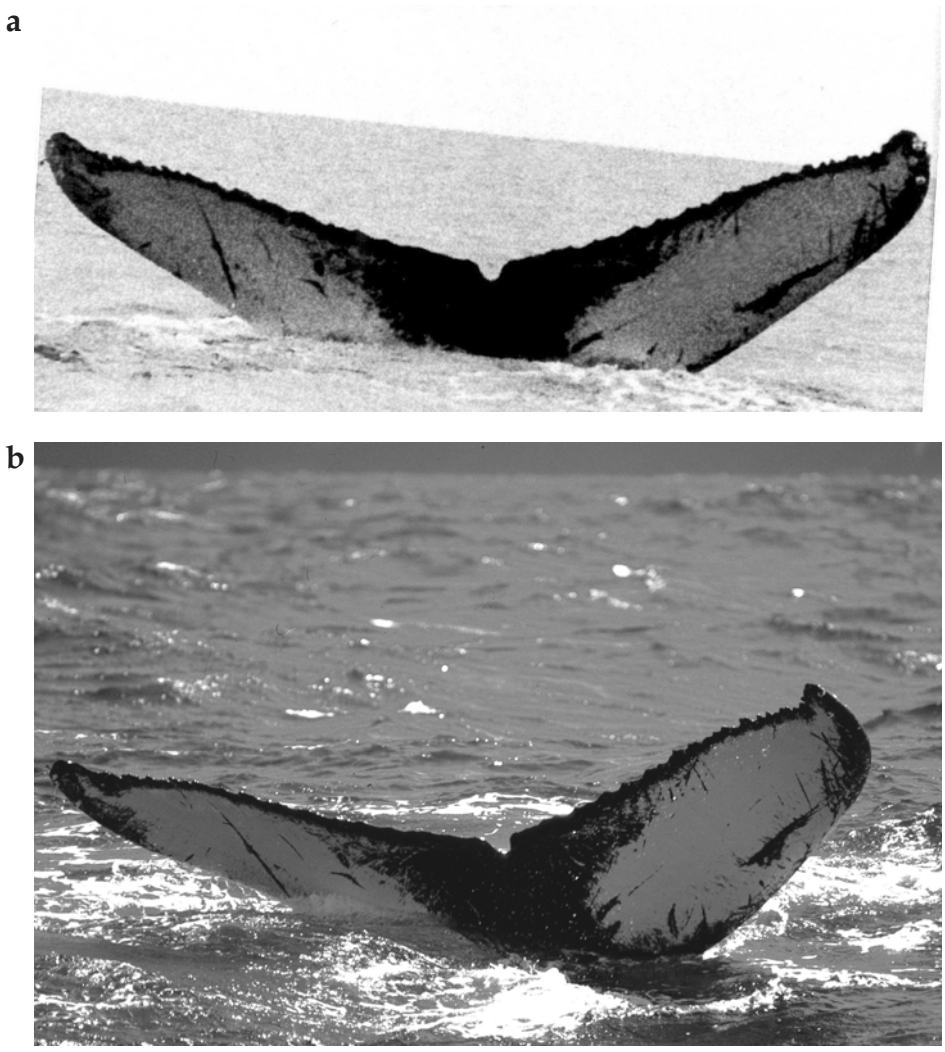

Figure 1*a*. Fluke of animal 089 photographed off Mexico on 5 February 1986. (Photo: Jorge Urbán: 2M-86-R003); **figure 1*b*.** Fluke of animal 089 photographed off Hawaii on 29 March 1986. (Photo: Rob Slade/Pacific Whale Foundation: KA-86-045-20)

This same whale was photographed by the Pacific Whale Foundation (PWF) on six occasions before and after the 1986 sightings, as shown in Table 1. All observations of this animal (identified as animal 089 by the PWF), with the exception of the first observation in 1984, indicate that it was either an escort in mother-calf pods or a competitive adult in large, surface active groups. Such behavior has been generally associated with males (Glockner, 1983; Baker and Herman, 1984; Clapham, 2000; Clambokidis *et al.*, 2001). In each of the five wintering seasons during which it was observed, animal 089 spent at least a portion of the winter in Hawaii. It has been documented in Mexico on only one occasion to date.

The 1986 match between Revillagigedo and Hawaii constitutes the only known movement of an identified whale between discrete wintering grounds within a given season anywhere in the world, despite nearly 20 years of marking with Discovery-type tags by the commercial whaling industry, and a further 30 years of photographic identification field studies. Although there is no direct way to determine what line of travel animal 089 took between Mexico and Hawaii, a straight-line crossing of 4700km in 51 days (the most time it could have taken between sightings) would require an average speed of 3.8km/h. A report based on photo-identification records by Gabriele *et al.* (1996) documented a 39-day transit of a humpback whale between Southeast Alaska and Hawaii, a distance of 4440km requiring an average speed of 4.7km/h. Mate *et al.* (1998) placed satellite tags on six humpback whales in Hawaii, and tracked three of them (one mother with a calf and two of unidentified sex) heading almost due north to Alaska. The female was tracked over 670km moving at an average speed of 6.2km/h. The other two whales were tracked for 14.7 and 17 days traveling at an average sped of 4.5km/h. Zerbini *et al.* (2006) tracked two whales by satellite in the southwest Atlantic Ocean that traveled in excess of 3500km at mean speeds of 2.6km/h and 3.8km/h. Chittleborough (1953) reported a mean speed of 4.3knots

(7.96km/h) during humpback whale migration along the east coast of Australia, based on aerial observations. More recently, Noad and Cato (2007) tracked humpback whales along the east coast of Australia by shore-based observer and hydrophone, and reported that singing whales move significantly slower than non-singing whales, with the latter traveling at an average speed of 4.0km/h. The somewhat slower migratory speed shown by the animal reported here might indicate that the actual transit from Mexico to Hawaii was less than the 51 days between photo-identification events.

Calambokidis *et al.* (2001) carried out an extensive analysis of 3650 suitable-quality photographic images of humpback whale flukes obtained by 16 independent research groups throughout the North Pacific between 1990 and 1993. Of 1056 individual animals identified in the Hawaiian wintering area (central stock), three were also documented near the Ogasawara Islands off Japan (western stock) and five were identified in the Revillagigedo Islands off Mexico (eastern stock). None of the eight resightings were within the same season. Overall, Calambokidis *et al.* (2001) concluded that humpback whales in the North Pacific are most likely to return to the same general feeding and breeding areas from year to year. More recent photo-identification results summarized by Cascadia Research (2007) were based on identifications of more than 10000 individuals throughout the North Pacific between 2004 and 2006. Whales identified in Hawaii were resighted primarily in the Gulf of Alaska, Southeast Alaska and northern British Columbia. Humpback whales found in the eastern North Pacific wintering areas showed two primary patterns. Those from the Revillagigedo Islands were resighted primarily in the Gulf of Alaska. Those observed off mainland Mexico and Central America were resighted in California and Oregon. An additional group of animals photographed off Baja California, Mexico were found widely distributed across all known feeding areas between California and the Aleutians. The relationship between the group of humpback whales in the Revillagigedo Archipelago (which stretches from 528km off the Baja California Peninsula to 615km off the mainland coast of Mexico) and groups of whales elsewhere in the North Pacific has yet to be established.

Urbán *et al.* (2000) carried out an extensive resighting analysis of 1304 photographic images of humpback whales from mainland Mexico, Baja Mexico, and the Revillagigedo Islands. The images were compared with those obtained from a number of known feeding areas from the coast of California all the way north and northwest through the western Gulf of Alaska. Based on the patterns of resightings between breeding and feeding areas, Urbán *et al.* (2000) concluded that the Revillagigedo Islands constitute a separate sub-population from the mainland Mexico and Baja animals. Calambokidis *et al.* (2001) found a higher number of matches between Hawaii and Revillagigedo than between Hawaii and mainland Mexico or Baja. Further effort to understand the migratory connections between the Revillagigedo Islands and other areas of the Pacific has recently been carried out using satellite telemetry (Lagerquist *et al.*, in press).

Despite the evidence that humpback whales tend to return to the same general breeding and feeding areas, a number of exceptions have been documented in the North Pacific. These include observations of whales moving between Mexico and Hawaii (Darling and Jurasz, 1983), Japan and Hawaii (Darling and Cerchio, 1993; Salden *et al.*, 1999), California and Hawaii (Perry *et al.*, 1990), and British Columbia and Japan (Darling *et al.*, 1996). All of these observations documented interchange between areas across seasons or years. The overall pattern of a small number of dominant migratory connections, with evidence of occasional exchange taking place through anomalous movements is consistent with what has so far been documented for humpback whales in the western North Atlantic (Katona and Beard, 1991, based on photo-identification studies) and in the South Pacific (Dawbin, 1966, based on Discovery-type dart recapture studies; Garrigue *et al.*, 2000 and Rock *et al.*, 2006, based on photo-identification). None of the movements reported to date have occurred within the same season.

Table 1. Sighting records of animal 089 documented by photograph.

DATE	LOCATION	POD TYPE*	ACTIVITY	PHOTOGRAPHER
12/2/84	Maui, Hawaii	2A	medium swim	Carol Hart (PWF)
5/2/86	Revillagigedo, Mex	no info	no info	J. Urbán (UNAM)
28/3/86	Kauai, Hawaii	Mo/Ca, 2E	no info	R. Slade (PWF)
29/3/86	Kauai, Hawaii	5A	no info	R. Slade (PWF)
11/3/87	Maui, Hawaii	4A, 2S	surface active	Mari Smultea (PWF)
30/3/89	Maui, Hawaii	3A, 1S	milling	Barb Lagerquist (PWF)
13/3/90	Maui, Hawaii	11A	surface active	Barb Lagerquist (PWF)
20/3/90	Maui, Hawaii	Mo/Ca, 2E, 1S	surface active	Curt Jenner (PWF)
20/3/90	Maui, Hawaii	Mo/Ca, 2E, 2S	surface active	Curt Jenner (PWF)

*Mo=Mother, Ca=Calf, A=Adult, E=Escort, S=Subadult.

Chittleborough (1955), Dawbin (1966), Darling *et al.* (1996) and Baker *et al.* (1998) have all suggested that movement between breeding grounds may provide an opportunity for gene flow between otherwise separate populations. In the North Atlantic, humpback whales from virtually all of the feeding areas migrate to a single known breeding area in the West Indies (Mattila *et al.*, 1994). In the Southern Hemisphere Noad *et al.* (2000) analyzed vocalization patterns of whales in two discrete breeding areas off the east and west coasts of Australia. They found incorporation of unique west coast patterns into the east coast song over a two-year period, and concluded that one or a few individual whales must have moved between the two breeding stocks. This suggestion is reinforced by historical Discovery tag results (Dawbin, 1966) and more recent photographic evidence (Cochrane and Kaufman, *pers. com.*). In the North Pacific, there is genetic (Baker *et al.*, 1998), acoustic (Helweg *et al.*, 1990) and photographic (Calambokidis *et al.*, 2001) evidence of exchange among the western, central and eastern stocks. In none of the movements documented to date has there been evidence of movement between breeding areas within a single season.

Baker and Herman (1984) and Mobley and Herman (1985) have shown that movement patterns and associations between identified whales during the winter are extremely fluid and highly transient. Mobley and Herman (1985) related these factors to the likely tendency for males to prospect widely for females. The observation reported here appears to be of a male, and extends the possible extent of prospecting to include, on at least this occasion, different wintering grounds within the same season.

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