REMOVAL RATES OF EPIZOIC BARNACLES DUE TO THE SURFACE ACTIVITY OF HUMPBACK WHALES IN A LOW-LATITUDE GROUND

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Figure 1

Photos of the right side of the head taken at 1547 (left), 1608 (center) and 1642 (right) hours. White arrows in the left and center photos show the barnacle prior to removal and the white arrow in the right photo the site where it was removed.

Abstract

On 13 August, 2004 a solitary humpback whale (*Megaptera novaeangliae*) exhibiting a high level of surface activity, was approached and observed for 65 minutes off the coast of Salinas, Ecuador (2º10'S, 81º00'W). Throughout this observation the animal breached 80 times and flipper-slapped 78 times. Although there are a number of possible reasons for this surface activity, dislodging epizoonts and ectoparasites has been proposed to explain such active behavior in this species. During the observation 63 high resolution digital photographs were taken and used to determine the number of epizoic barnacles (*Coronula* sp) that were removed from the whales head and pectoral fins or flippers. The photographs of the whale's head (right and left side) show that 1 barnacle was removed after 69 breaches (17 backward and 52 forward breaches). Three barnacles were removed from the inner side of the right flipper and the outer side of the left flipper after 62 flipper-slaps. The global removal rate of barnacles from the whales head and flippers during this activity was 0.052. With these results it is not possible to establish whether or not the surface activity was the primary cause of the barnacles removal. However, if it was this activity that caused the barnacles to dislodge the loss of barnacles was so minimal that it would be difficult to justify as the primary reason for the whale to carry out such vigorous surface activity.

Figure 2

Photos of the outer side of the left flipper taken at 1554 (left), 1631 (center) and 16:40 (right) hours. White arrows in the left photo indicate the barnacles prior to removal, white arrows in center show the sites where two barnacles were removed and the arrow in the right photo the site where a third barnacle was removed.

1 Introduction

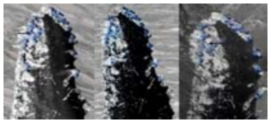
Humpback whales (*Megaptera novaeangliae*) are commonly infested with various epizoonts and ectoparasites (Fertl 2002). Humpbacks are particularly prone to infestation by two species of sessile crustaceans (Cirripedia): the acorn barnacles *Coronula diadema* and *C. reginae* and the stalked barnacles *Conchoderma auritum* and *C. virgatum* (Clarke 1966; Dawbin 1988; Fertl 2002). Although none of these barnacles are true ectoparasites as they do not feed on whale skin or body fluids, they could become abundant enough to increase drag and affect hydrodynamics.

Conchoderma auritum on *Coronula diadema*

Acorn barnacles attach to humpback whales as cyprid larvae by means of their cement glands (Schmitt 1965). On humpback whales these barnacles occur most commonly in clusters on the tip of the lower jaw, the middle line of the ventral grooves region, the knobs on the front forward edge of the flippers, and around the genital slit (Clarke 1966; Slijper 1979; Fertl 2002).

Humpback whales are also known for their intense and varied surface behaviors such as breaching, flipper-slapping and fluke-slapping. Such displays are carried out to produce percussion sounds, which may travel several kilometers through air and underwater, that are used as a form of communication or to maintain acoustic contact (Herman and Tavolga 1980; Tyack and Whitehead 1983). Scientists have long speculated that breaches also help to dislodge barnacles from humpback whales, but so far no studies have been conducted to determine whether this really occurs.

2 Materials and Methods



Negative image of Figure 2, created by Microsoft Photo Editor to help identify barnacles for an accurate count.

On 13 August 2004, while aboard a whale watching yacht near Salinas, Ecuador (2º10'S, 81º00'W), a highly active solitary humpback whale was approached and followed for a continuous 65 minute period. The photograph records provided an opportunity to document the short-term loss of barnacles from four areas on the body of the whale: the right side of the head, left side of the head, inner side of the right flipper tip, and external side of the left flipper tip. Photographs were taken with a Canon Digital Rebel at maximum resolution (6.3 megapixels) equipped with a 70-300mm zoom lens, then analyzed to look for differences in the number of barnacles attached. Microsoft Photo Editor was used to improve the contrast and clarity of the photographs and to create negatives for the images used in the comparison.

3 Results

The observation started at 1540 hrs and ended at 1645 hrs, during which 63 photographs were taken. Data were recorded continuously through two 15-minute intervals and one 35-minute interval.

Three specific displays were used in the assessment: backward breaches, forward breaches and flipper-slaps. The types of displays and their frequency in each interval is showed in Table 1. Backward breaches occurred with similar frequency during the first and third intervals but decreased significantly during the second interval (X^2_2=4.25, p<0.05). Contrarily, the frequency of forward breaches was lower in the first and third intervals and significantly higher in the second interval (X^2_2=34.04, p<0.01). Flipper slaps were executed with a low frequency during the first two intervals but increased significantly in the third interval (X^2_2=41.96, p <0.01).

Table 1. Frequency of displays executed in each interval and rates (*n*/minute).

Display	Interval I (1540-1555)		Interval II (1555-1610)		Interval III (1610-1645)	
	n	rate	*n*	rate	*n*	rate
Backward breach	5	0.33	1	0.07	15	0.43
Forward breach	12	0.8	32	2.13	15	0.43
Flipper-slap	3	0.2	2	0.13	73	2.08

Table 2 shows the number of barnacles recorded at the time of the first and last photograph and their removal rates for each part of the whale. Losses were noticed on the right side of the head (*n*=1) (Figure 1) and on the left flipper tip (*n*=3) (figure 2). The barnacle removed from the right side of the head fell off sometime after the beginning of the second 15-minutes interval, when the rate of forward breached increased, and the three barnacles removed from the left flipper tip occurred during the third interval, when the rate of flipper slaps increased significantly (see table 1). This suggests a relationship between barnacle detachment and these particular surface displays, but without control groups it is not possible to establish how many barnacles dislodged naturally or due to whale behavior. We discard, however, that all removed barnacles detached spontaneously, i.e. without help of the surface activity; otherwise all barnacles would have detached from the assessed parts (and from other parts with similar removal rate) in 1,251 minutes (20.8hrs). If the global rate showed in Table 2 is extrapolated to the whole whale a considerable amount of barnacles could have been detached during the sighting period.

Table 2. Initial and final accounts of barnacles on four parts of the whale and their removal rates.

Body part	Initial account		Final account		Removal rate
	n	time	*n*	time	
Left side of the head	10	1547	9	1642	0.10
Right side of the head	2	1552	2	1640	0
Right tip of the flipper	19	1554	19	1640	0
Left tip of the flipper	46	1554	43	1640	0.065
Global rate					0.052

4 Discussion

The removal rate of head barnacles was 70% higher than pectoral flippers', which does not necessarily means that barnacles are more frequently removed from this part of the whale. Contrarily, the bigger size of the barnacles on the head indicates they are older and therefore less frequently removed than those attached to the flippers. It must be noted that in addition to slaps, barnacles on the flippers receive abrasion during breaching, which would weaken the barnacles' attachment. Rubbing during male competition (see Tyack and Whitehead, 1983; Baker and Herman, 1983) would also reduce barnacle resistance in breeding animals, especially those located on appendages. Big barnacles and scars on the head of the whale left from previously detached barnacles (see figure 1) suggest either that barnacles stop growing or that they are removed at a similar and particular size. Larger and massive barnacles would be more easily removed as they grow taller and heavier, increasing drag and surpassing the force of adherence of the barnacle to the whale.

Forward Breach
Humpback

Therefore, barnacles indeed drop off in tropical waters as proposed by Kaufman and Forestell (1986) and Dawbin (1988), but instead to be a process caused by the change of water temperature it would occur as a result of the loss of attachment as barnacles grow, whale skin aging, or any other natural process that would be accelerated by whale surface activity. Alternatively, surface activity would work as a selection mechanism for barnacles, those with a stronger attachment and/or located on more appropriated sites would stay on the whale. Multiple photographs focusing on barnacle abundance on the same individual throughout the season may lead to a better understanding of this issue.

Backwards Breach
Humpback whale

From this opportunistic sighting it is not possible to establish with certainty that surface activity was the primary cause of barnacle removal or whether it just accelerated the natural detachment process. Nor can it be discarded that dislodging barnacles was the main reason to carry out such vigorous surface activity, despite the low removal rate found. Not much can be added with respect to the behavior of the whale in a social context, since no whales were interacting with this individual nor was any other group of whales around. If any information or signal was sent through the whale behavior it was not evident to us, but the lack of response from conspecifics could have been a reason to continue the activity. Observations made during our long-term humpback whale study in Ecuador suggest that solitary sub-adults and adult males that are forming competitive groups have the highest level of surface activity (Félix 2004). But such continued activity is rather atypical and has been recorded in only 8 of 136 (6%) solitary animals observed in 15 years.

Flipper Slap
Humpback whale

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