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Surface and dive times of the Blue Whale (*Balaenoptera musculus*) in Trincomalee Bay of Sri Lanka

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ABSTRACT

Dive times of a single Blue Whale observed in Trincomalee Bay, Sri Lanka, in relation to the abiotic parameters of the bay's waters and its ability to support large densities of krill from May 2011 to July 2011. Thirty five total dives were observed and its mean dive time was 9.6 ± 0.31 min. The observed whale's feeding dives lasted longer than what has been previously recorded for blue whales in the Pacific Ocean. The mean salinity, Mean Total Suspended Solids (TSS) and mean temperature of Trincomalee Bay was respectively 28.1± 4.8 ppt, 9.92 ± 0.3 mg/L and 28.81 ± 0.96 ^{o}C. All studied abiotic parameters of Trincomalee Bay show that it is able to support large concentrations of krill. Trincomalee Bay thus seems to serve as a highly productive hunting ground for Blue Whales in the northern Indian Ocean.

KEYWORDS
Krill, TADL, Hunting ground, Abiotic parameters, oxygen demand, Resident population

Introduction

The Blue Whale (*Balaenoptera musculus*) is the largest animal ever to have lived on earth. An adult averages 24.7m in length and can weigh up to 92.6 metric tonnes (Nishiwaki, 1950). The Pygmy Blue Whale (*B. m. brevicauda*) has been reported from Sri Lankan waters (Alling *et al*., 1991; Branch *et al.*, 2007). The Sri Lankan population of blue whales is thought to be resident because the animals are encountered throughout the year. This population, like that of humpback whales in the northern Indian Ocean, is presumed to have a restricted range and breed six months out of phase with the pygmy blue whales of the southern Indian Ocean (Mikhalev, 2000).

Blue whales feed almost exclusively on small crustaceans of the Order Euphausiacea (commonly known as 'krill') (Kawamura, 1980) and require large concentrations of food due to their large body size. Therefore, it is logical to reason that these whales prefer seas where krill densities are high. Krill can survive in a variety of marine habitats with different biological and abiotic conditions. They have been known to survive in waters where the temperatures were as low as -4^{0}C and salinity ranged between 25-45 ppt (Aarset and Torres, 1989). Krill feed on a variety of microscopic food items and most are considered omnivorous (Cripps and Atkinson, 2000).

In order to hunt krill, blue whales dive under the surface of the water and swim rapidly towards the krill mass engulfing large quantities of water and aggregated krill (Kawamura, 1980). These feeding dives have been found to be longer than travelling dives and also to be deeper (Croll *et al.*, 2001). When diving for relatively long periods of time the Theoretical Abiotic Dive Limit (TADL) is an important parameter. It delineates the theoretical diving time for a given species (Kooyman, 1989). This is calculated by estimating oxygen stores and diving metabolic rates of a species and is usually based upon body mass. For the Blue Whale TADL has been calculated to be 31.2 min (Croll *et al.*, 2001). However, whales are known to dive for periods well short of their TADL (Schreer and Kovacs, 1997) and this is attributed to the high dispersal rate of krill (Croll *et al*., 2001).

Materials and Methods

In this paper we discuss the dive times of a single Blue Whale observed in Trincomalee Bay, Sri Lanka, in relation to the abiotic parameters of the bay's waters and its ability to support large densities of krill — thereby acting as an ideal hunting ground for filter feeders such as blue whales. Trincomalee Bay is located on the east coast of Sri Lanka. It is consisting 1630 hectares of water area and it lying between geographic coordinates of 08^{0} 42' 3" N and 081^{0} 21' 00" E. Trincomalee bay is the largest bay in Sri Lanka that harbouring many marine mammals (Sri Lanka Ports Authority, 2013).

Figure 1. Blue Whale at Trincomalee Bay.

The individual Blue Whale in question was observed from May 2011 to July 2011 during a survey of cetacean communities in Trincomalee Bay. The individual was readily identifiable because of its distinctive dorsal fin and mottling on the dorsal flank (Fig. 1). This whale was photographed using a Nikon 5000D camera fitted with a 300mm Nikon lens. Observations were made while sailing

in a 13m fishing vessel with four observers (one at the bow, one aft, one at port, and one at starboard). Observations were made using Bushnell Sportview 8x21 field binoculars. The notes on behaviours including dive times were recorded using a Dictaphone machine (Sony M-727V). Whenever the whale was observed it was followed and surface and dive times, as well as behaviour, recorded. Abiotic parameters such as mean salinity, temperature, and total suspended solids of Trincomalee Bay were recorded each month, from June 2010 to January 2012 using a YSI 6820 CTD Profiler.

Results and Discussion

During the study period thirty five total dives were observed and its mean dive time was 9.6 ± 0.31 min. The longest observed dive time was 10 min and this longest dive time observed for 10 times. Observed shortest dive time was 9.2 min and it observed for six times. Our results indicate that the observed whale's feeding dives lasted longer than what has been previously recorded for blue whales in the Pacific Ocean (Croll *et al.*, 2001; Lagerquist *et al.*, 2000). This indicates that the oxygen demand of the whale's muscle tissue per dive is less than in individuals inhabiting the Pacific Ocean and that the whale is able to use the oxygen it stores before a dive for a longer time period. One possible explanation for this would be that the individual in question had the unique ability to store more oxygen in its muscle tissues due to a higher concentration of myoglobin, analogous to the exploits of an elite athlete amongst humans.

Research has shown that the lunging behaviour practiced by blue whales while foraging is energetically costly when compared to the more passive techniques practiced by species such as bowhead whales (Acevedo-Guitierrez *et al.*, 2002). This, when coupled with highly dispersed krill in low concentrations, means that a Blue Whale sometimes (as in the Pacific) has to engage in a high number of lunges per feeding dive in order to obtain sufficient sustenance. However, if krill were available in high enough concentrations, lunge-feeders like blue whales could minimize their feeding lunges per dive thereby decreasing oxygen demand and allowing submergence for longer time periods.

The mean salinity of Trincomalee Bay was 28.1± 4.8 ppt with the lowest values being recorded during February 2011 (15 ppt) and the highest (33 ppt) recorded in July, 2010 and September, 2011 (Fig. 4). Mean Total Suspended Solids (TSS) of Trincomalee Bay was 9.92 ± 0.3 mg/L with the highest values (highest, 13.8 mg/L) being recorded between October 2010 and February 2011 (Fig. 3). The mean temperature of sea water recorded during the study period in Trincomalee Bay was 28.81 ± 0.96 ^{0}C. Lowest temperature of the sea water was recorded in September 2011 and highest temperature was recorded in November 2011 from Trincomalee Bay (Fig. 2). The results of the investigation of abiotic parameters of Trincomalee Bay show that it is able to support large concentrations of krill. The mean salinity of the bay is within a range reported as the optimum condition for the survival of krill (Aarset and Torres, 1989). The month of May during which our study on the Blue Whale was observed follows the southwest monsoon rains (May to September) of Sri Lanka (Department of Meteorology - Sri Lanka, 2013). This is when large quantities of nutrients are washed down from the central highlands of Sri Lanka by the Mahaweli River (335 km) which drains into Trincomalee Bay. Evidently, the egress of nutrients optimises the environmental conditions for krill (Morris *et al*., 1984; Nicol, 2006).

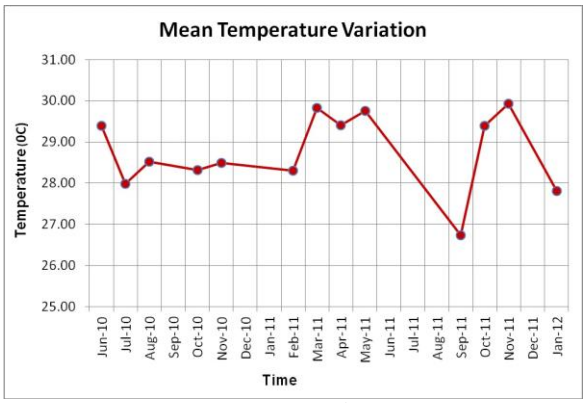

Figure 2. Mean Temperature variation from June 2010 to Jan. 2012.

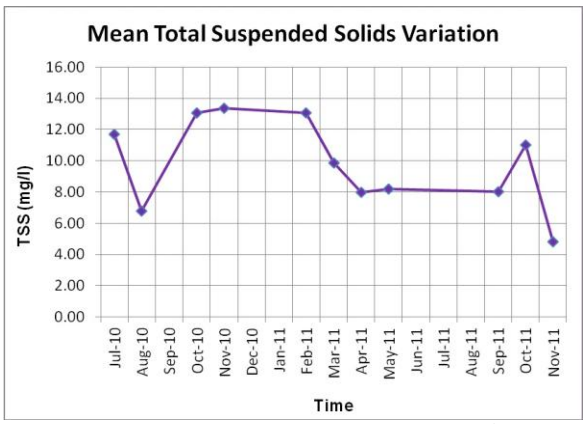

Figure 3. Mean Total Suspended Solids (TSS) variation from July 2010 to Nov. 2011.

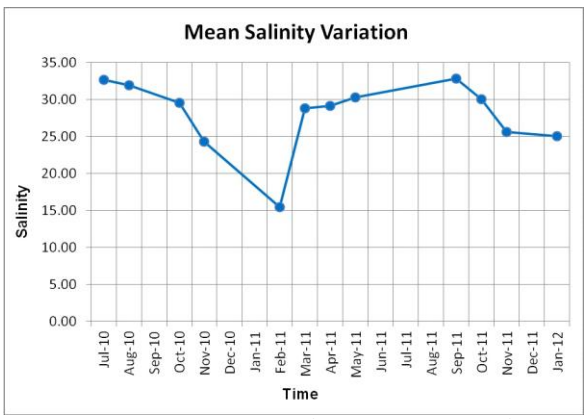

Figure 4. Mean Salinity variation of the Trincomalee Bay from July 2010 to Jan. 2012.

Moreover, the mean temperature of Trincomalee Bay is close to the temperatures reported by Farber-Lorda *et al.*, (1994) as optimal in parts of the Gulf of Tehuantepec that supported the largest krill densities. It is entirely possible, then, that the Blue Whale we observed was not exceptional athletically but was simply taking advantage of the high krill abundance in Trincomalee Bay.

Trincomalee Bay thus seems to serve as a highly productive hunting ground for Blue Whales in the northern Indian Ocean. It is clear from our investigations that responsible stewardship of the bay is critical for the conservation of the Sri Lankan population of Blue Whales.

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