Re-examination of mandible accelerometer data obtained from Weddell seals in the Antarctic Ocean

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INTRODUCTION

Bio-logging system is useful tool for understanding behavior of marine mammals and their environmental condition. Especially, the minimized mandible accelerometers (MACs) having no-invasive and less effect on animal health is useful for measuring underwater behavior of wild animals. Naito et al. (2010) reported fine-scale behavior of Weddell seals in Antarctic Ocean with MACs and documented two kinds of typical signals in these seals, feeding signals for iceberg associated dives (<60m, 11.3 signals/dive) and for midwater depth dives (>60m, 0.5 signals/dive). During processing these data, we found other signals: (1) high frequency jaw movement signals and (2) respiration signals. In the present study, we aim to re-examine these two kinds of signals from free-ranging adult female Weddell seals in the Antarctic Ocean.

MATERIALS & METHODS

The experiments were conducted in Atka Bay, near Neumayer Station (70º39'S, 08º15'W), in early December 2008. Water depth in Atka Bay ranges from <80m to 250m. The sea ice in the bay provides a birth site for many Weddell seals that gain access to the water via breathing holes, and tidal cracks at the base of the icebergs located within the bay. We used two non-lactating female Weddell seals from a tidal crack (Wed 06) and from vicinity of an iceberg (Wed 16). The seals were anesthetized and the MAC (15 mm diameter, 53 mm length, 18 g in air; Little Leonard Co., Tokyo, Japan) was then glued to the hair below the center of the lower jaws using Araldite epoxy resin and nylon mesh. In addition, we attached a digital still image logger (DSL: 22mm diameter, 132 mm length, 82 g in air; Little Leonard Co., Tokyo, Japan) to the head of each individual. We obtained depth and environmental temperature data at 1 HZ and two way accelerations, heave (*x*) and surge (*y*) data at 32HZ over three consecutive days from all seals. We excluded data from dives that were <0.5 m in depth as the majority of jaw activity in this layer is likely related to the animals reaming the sides of their breathing holes (Liebsch et al., 2007). The acceleration data were processed and analyzed using the Ethographer package (Sakamoto et al., 2009) and Igor Filtering Design Laboratory (IFDL: ver. 4, WaveMetrics) with Igor Pro software (6.30 J; Wave Matris, OR, United States). Based on these observations, assuming that feeding behavior occurs underwater in quick motions that defined the periodicity, duration, and the level of acceleration (Suzuki et al., 2009), we attempted to extract various events by filtering the depth and acceleration data with the mask manipulation function in the Ethographer.

RESULTS & DISCUSSION

We obtained jaw movement acceleration data from two Weddell seals (Wed-06 and Wed-16) (Figs. 1 & 3) . We isolated 135 events in the 269 dives of the seal (Wed-06) and 29 events in the 167 dives of the seal (Wed-16). The average cycle, average duration , and average depth of high-frequency signals of these two seals were showed in Table 1. These high frequency jaw movements were absolutely different from feeding events having shorter un-attenuated pattern (Fig.2). As Weddell seals produce a number of vocalizations at shallow depths during the breeding season, these vocalizations are assumed to be related to mating. Thus, we hypothesize that these high frequency jaw movements with attenuating pattern in shallow water might be related to mating behavior.

Respiration data were recorded in rhythmical interval after diving behavior of the seal (Wed-16)(Fig. 4). The data logger measured breathing behavior of the seal after diving at various depth. These signals were observed from the experimental study of Hooded seals in captivity (Suzuki et al., 2009). Average duration (s), average numbers of breath, and average respiration cycle were showed in Table 2. Comparing these factors between after shallow dive (<60m in depth) and after mid water dive (>60m in depth), it appears to be shorter in duration and less number of breath after shallow dive rather than those after mid water dive, but average duration per one breath (respiration cycle) showed almost same value in both dives, indicating respiration cycle is almost same in both dives.

Table 1. High frequency jaw movement of two female Weddell seals.

Individual	No. of records	Ave. duration (s)	Ave. depth (m)	Ave. cycle (Hz)
Weddell-06	135	4.43±0.23	2.06±0.42	0.22±0.007
Weddell-16	29	4.08±0.68	6.21±1.9	0.16±0.008

Table 2. Respiration cycle of the Weddell seals (Wed-16).

	No. of records	Ave. Duration (s)	No. of breath	Respiration cycle (s)
After shallow dive (<60m)	4	5.7±0.7	3.0±0.8	1.98±0.5
After mid water dive (>60m)	9	8.6±5.2	4.3±2.3	1.98±0.5
Total	13	7.7±4.5	3.9±2.0	1.98±0.5

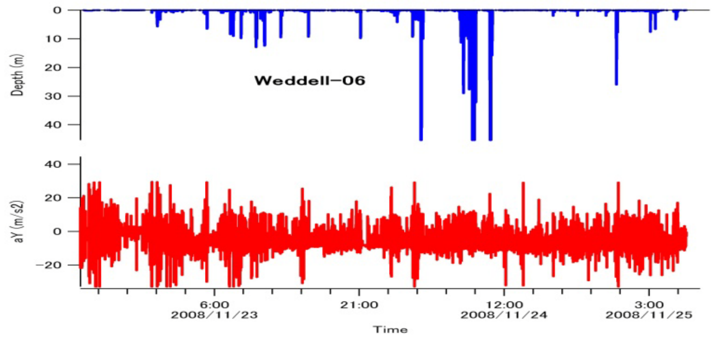

Fig.1. Depth and mandible acceleration data from free-ranging Weddell seal (Wed-06) using acceleration meter in Atka Bay, in early December 2008 (Naito et al., 2010).

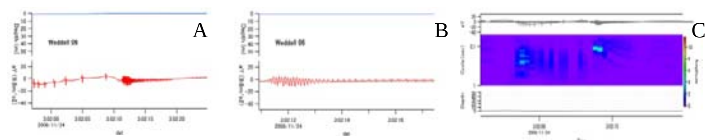

Fig.2. Signals associated with vocalization in Weddell seal (Wed-06) . A:Mandibale acceleration pattern, B:Enlarged acceleration pattern, C: Ethographer pattern.

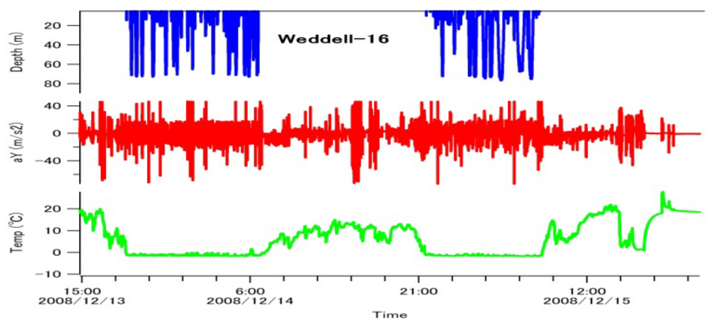

Fig.3. Depth and mandible acceleration data from free-ranging Weddell seal (Wed-16) using acceleration meter.

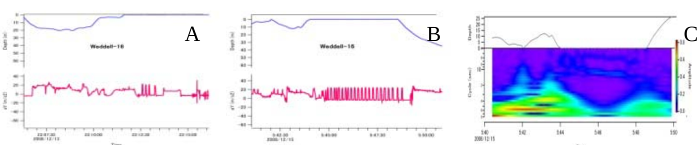

Fig.4 Respiration cycle from free-ranging Weddell seal (Wed-16) using acceleration meter. A: Typical mandible acceleration pattern, B: Long-term respiration pattern, C: Ethographer pattern.

CONCLUSION

We detected low frequency cycle in y-axis with attenuating pattern from the seals, and isolated 135 events in the 269 dives of the seal (Wed-06) and 29 events in the 167 dives of the seal (Wed-16). These signals are considered to relate with mating vocalization, but not feeding events. Comparing respiration cycle between after shallow dive (<60m in depth) and after mid water dive (>60m in depth), it is shorter in duration and less number of breath after shallow dive rather than those after mid water dive, but average respiration cycle is almost same in both dives.

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