

Unique calls of the pygmy blue whale (*Balaenoptera musculus brevicauda*) recorded off the coast of Chile during the SOWER 1997/98 programme

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ABSTRACT

The 1997/98 International Whaling Commission Southern Ocean Whale and Ecosystem Research (IWC-SOWER) cruise was the third in a series of cruises undertaken to evaluate scientific techniques for differentiating between ‘true’ blue whales (*Balaenoptera musculus*) and pygmy blue whales (*B. m. brevicauda*). Data were collected from skin tissue samples, acoustic recordings and behavioural observations. The cruise was supported by two vessels, the *Shonan Maru No. 1* (SM-1) and *Shonan Maru No. 2* (SM-2), provided by the Government of Japan. The research was conducted from 12 December 1997 through 9 January 1998 in an area off the west coast of Chile bounded by 18–40°S and 70–77°W. All whales studied on this cruise were visually identified by observers as pygmy blue whales. Sound recordings were obtained during 13 occasions when the SM-1 vessel approached pygmy blue whales to obtain biopsy samples and identify the sounds produced. On eight of these approaches, a total of 20 calls were recorded, and these are unlike any calls previously recorded from pygmy blue whales off Chile. Call durations were between 2 and 60 s, and all calls had a fundamental frequency around 11 Hz and contained 2–5 harmonics. These results suggest that pygmy blue whales might respond acoustically by producing distress or alarm calls when approached by vessels, a novel acoustic behaviour observed for a mysticete. This study underscores the need for further acoustic research to better understand this phenomenon beyond this blue whale population.

KEYWORDS: IWC-SOWER; PYGYMY BLUE WHALE; ACOUSTICS; BIOPSY SAMPLING; CHILE

INTRODUCTION

Blue whales (*Balaenoptera musculus*) worldwide produce patterned, rhythmic sequences of low frequency, long duration sounds that are repeated regularly to form songs that are unique to each population (Ljungblad *et al.*, 1998; McDonald *et al.*, 2006; Širović & Oleson, 2022; Branch *et al.*, 2025). Additionally, blue whales emit a non-song social sound (frequency range: 20–106 Hz; duration: 2–6 s), the D-call (Rankin *et al.*, 2005; Oleson *et al.*, 2007), which is detected across all blue whale populations. Songs are believed to be produced by males only as long-range sexual advertisement and communication sounds (e.g., McDonald *et al.*, 2001, 2009), whereas non-song sounds are produced as short-range social contact calls by both males and females (e.g., Oleson *et al.*, 2007). Several non-song vocalisations (frequency range: 10–750 Hz; duration range: 0.92–16 s) have been associated with pygmy blue whales in Australia (Recalde-Salas *et al.*, 2014; Jolliffe *et al.*, 2025). To date, about

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11 blue whale songs have been identified across different oceans (e.g., Širović & Oleson, 2022), but none in the Arctic. Spectrograms of different blue whale songs are summarised in Shabangu (2026) for easier comparison. Buchan *et al.* (2014) detected two southeast Pacific (SEP) blue whale song types off Chile: SEP1 and SEP2. SEP1 was first described by Cummings & Thompson (1971) and is still detected today (e.g., Buchan *et al.* 2019). The SEP2 song was initially described by Stafford *et al.* (1999) in the eastern tropical Pacific and then detected in Chilean waters by Buchan *et al.* (2014). Malige *et al.* (2020) observed a decline in the pulse rate and peak frequency of these songs over time, similar to those of other blue whales globally (McDonald *et al.*, 2009). The seasonality of these blue whale songs and non-song sounds varies with changes in environmental conditions and prey abundance (e.g., Buchan *et al.*, 2021).

The 1997/98 International Whaling Commission Southern Ocean Whale and Ecosystem Research (IWC-SOWER) Blue Whale cruise was carried out in the eastern South Pacific Ocean off the coast of Chile during December 1997 and January 1998. This was the third cruise of the IWC's research programme on Southern Hemisphere blue whales and the second to be undertaken under the IWC-SOWER programme. The overall objective of this programme was to assess the status of 'true' blue whales (*B. musculus*) in the Southern Hemisphere. The immediate research objective was to evaluate and develop scientific techniques for distinguishing between 'true' blue whales and pygmy blue whales (*B. m. breviceauda*). Data collection methods included acoustic sampling, biopsy sampling, photo-ID and visual observations of whale behaviour. The initial two cruises were in Australian waters (Kato *et al.*, 1996) and south of Madagascar (Best *et al.*, 1997). The Japan/IWC Blue Whale Cruise in 1995/96 off Australia recorded some sounds in the presence of pygmy blue whales, while the IWC-SOWER cruise in 1996/97 successfully collected acoustic recordings of southwest Indian Ocean pygmy whales off Madagascar and 'true' blue whales off Antarctica (Ljungblad *et al.*, 1998). Over 700 sonobuoys were deployed in the Southern Ocean between 1996 and 2010 to collect acoustic data during SOWER cruises to detect and characterise Antarctic blue whale sounds (Rankin *et al.*, 2005; Shabangu *et al.*, 2017, 2024). Here, we describe the sounds recorded from SEP pygmy blue whales during the passive acoustic sampling effort conducted off the west coast of South America, Chile (Findlay *et al.*, 1998), prior to the 1998 Antarctic IWC-SOWER cruise to Area II (Shabangu *et al.*, 2024).

METHODS

The passive acoustic monitoring research was conducted from 12 December 1997 through 9 January 1998 in an area off the west coast of Chile bounded by 18–40°S and 70–77°W (Table 1). The daily survey began at 06h00 local time each day and continued until 18h00 local time, under good to moderate sea conditions (Beaufort sea state scale from 0 to 5 characterised by wind speed < 25 knots). The SOWER line-transect visual sighting surveys began off the northwest coast of Chile and moved south, working from the 12 nautical mile nearshore limit to approximately 200 nautical miles offshore (Findlay *et al.*, 1998).

The passive acoustic equipment used to record low frequency whale sounds included expendable AN/SSQ-53B sonobuoys for transducing underwater sounds and transmitting signals over a radio frequency channel, an AN/SSQ-42A Very High Frequency (VHF) radio for receiving the signals from the sonobuoy, and a Sony TCD-D7 Digital Audio Tape (DAT) recorder for archiving the underwater sounds. The acoustic system's frequency response was flat over the 5–2400 Hz frequency band. The radio receiver output was also linked to the audio input of a Macintosh 5300 computer running the SoundView software (Peabody Digital SoundWork, Baltimore, MD, USA). This software was configured to display a continuous, real-time spectrogram in the 1–300 Hz frequency band, ensuring the display of sounds below the human hearing range (i.e., 20 Hz). This setup allowed personnel to visually monitor the recordings for possible whale sounds in order to associate sounds with the presence of whales and evaluate the circumstances under which calls were detected. The SoundView software also allowed personnel to measure features of the whale signals (e.g., fundamental frequency, duration and number of harmonics) to describe the characteristics of the SEP pygmy blue whale sounds.

On occasion, the intensity of a whale call was so high, due to the proximity of the sonobuoy to the vocalising animal, that the sound overloaded the DAT recorder (e.g., Electronic Supplementary Material Figures 1 and 2 of Shabangu & Rogers [2021]). This artefact caused the signal to be distorted on the recorder but not on the

computer display. Under these circumstances, the call's frequency and duration could be measured from the call's spectrographic computer image, and these measurements were written into an acoustic logbook. This combination of DAT recordings and visually displayed data that could be measured and logged in real-time increased the chances that few, if any, calls were missed.

Passive acoustic recordings were collected whenever a biopsy sample was attempted from a pygmy blue whale. Once a pygmy blue whale was sighted, as confirmed by the visual observers, acoustic personnel deployed a sonobuoy. Each deployment and recording effort was referred to as a station. The first hour at a station was spent making behavioural observations and collecting data on surface and dive times, while the acoustic personnel monitored and recorded the acoustic environment via the sonobuoy system. During the behavioural observation period, the vessel was generally drifting, but it would occasionally move slowly towards the whale to keep within a range of approximately one nautical mile (nm). When the behavioural observation period was completed, the vessel began an approach towards the whale to obtain a biopsy sample. During this approach, signals from the sonobuoy, which had a life of eight hours, continued to be received aboard the vessel, provided that the vessel remained within five nm of the sonobuoy. An effort was made to record during the entire biopsy chase. When tapes were being changed or other events caused the DAT recorder to be briefly shut down, the spectrographic display permitted uninterrupted detection of sounds of interest. Whenever calls were detected, basic contextual information (e.g., vessel's position and distance from the animal, vessel's speed) and acoustic data (e.g., number of calls, fundamental frequency, call duration, number of harmonics) were noted in the acoustic logbook.

After the cruise, all sections of tapes known to contain whale sounds were digitised and transferred to computer files. These data segments were analysed on a computer-based sound analysis workstation (Canary), which provided spectrographic and spectral displays of signals of interest (Charif *et al.*, 1995). The basic analysis followed that used for the IWC-SOWER 1996/97 acoustic recordings (Ljungblad *et al.*, 1998).

RESULTS

During the process of collecting a biopsy sample, the research vessel pursued a whale which often attempted to avoid the vessel by swimming faster and moving to the right or left of the approaching vessel. This is referred to as a biopsy approach. Experiences over the previous two cruises, when biopsy samples were also being collected, showed that, while the whale being pursued might travel for considerable distances, it generally travelled in circles. This behaviour meant that the vessel could usually remain within the approximately five nm transmission range of the sonobuoy while staying close to the whale. This permitted passive acoustic recording and monitoring to continue throughout the biopsy approach.

For the 13 biopsy approaches that were acoustically and visually monitored, 20 very low frequency calls (Table 1) were detected, measured, logged and/or recorded during eight biopsy approaches. The timing of these calls was unpredictable. Some occurred at the very beginning of the biopsy and others late in the approach. The

Table 1

Details of passive acoustic stations and characteristics of calls recorded from pygmy blue whales during biopsy approaches. 'Distance' refers to the estimated distance between the whale and the sonobuoy in nautical miles (nm). 'Vessel speed' refers to the speed of the research vessel as it approached the whale. 'No. of calls' refers to the number of calls in the sample. 'Call time' refers to the time of the call(s) relative to the start time of the approach in minutes (mins). 'Call duration' refers to the duration of the call(s). 'FF' refers to the fundamental frequency averaged over the duration of the call(s). The calls recorded for the two biopsy chases on 29 December 1997 at station 20 are from two different whales.

Date (mm/dd/yyyy)	Latitude (S)	Longitude (W)	Station no.	Distance (nm)	Vessel speed (kts)	No. of calls	Call time (mins)	Call duration (s)	FF (Hz)
12/28/1997	30° 48.45'	72° 31.03'	18	1	12	5	2	29, 3, 10, 5, 22	11
12/29/1997	30° 36.87'	72° 16.87'	20	1.2	12	1	27	45	11
12/29/1997	30° 38.07'	72° 18.27'	20	0.5	12	4	3, 13, 93	60, 19, 7, 50	11
12/30/1997	30° 46.28'	72° 49.97'	22	3.7	12	8	30	4. 6	11
12/31/1997	30° 24.81'	73° 28.17'	25	1	12	1	2	9	11
01/01/1998	29° 51.41'	72° 02.64'	27	2.1	9	4	25	56, 14, 5, 5	11
01/02/1998	29° 47.90'	71° 52.16'	28	1.2	11	1	8	16	11
01/05/1998	39° 59.63'	74° 07.59'	29	1.8	12	2	115	50, 2	11

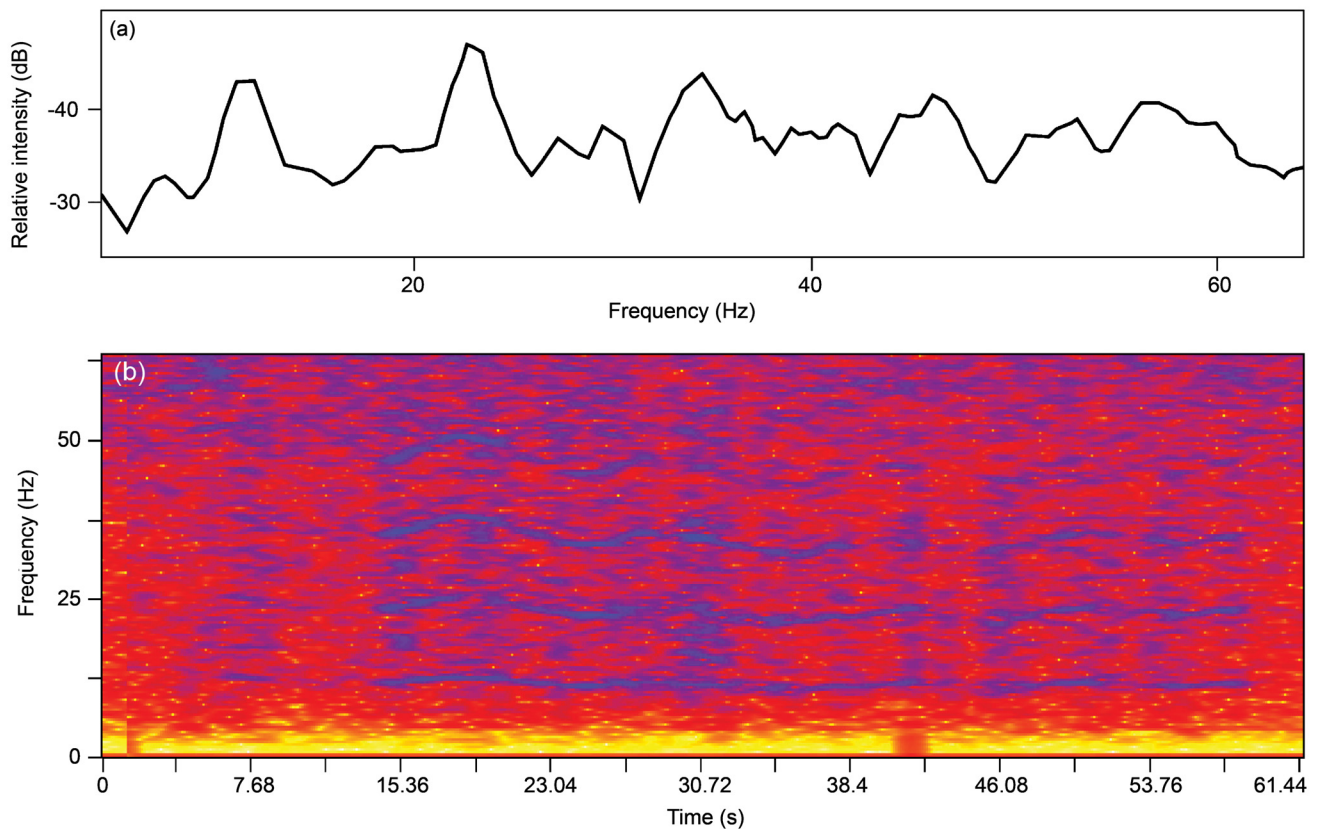


Figure 1. Spectrum (top) and spectrogram (bottom) illustrating the frequency distribution of energy and time varying features of a call recorded from a pygmy blue whale as identified by visual observers during the first biopsy approach on 29 December 1997 off Chile. Spectrum analysis parameters: 6,400 Hz sampling rate, Hanning window, fast Fourier transform (FFT) size of 16,384 points, 95.31% overlap, 0.78 Hz frequency and 1.28 s time resolution.

common denominator was that all the calls were recorded when the vessel was moving rapidly towards the whale to obtain a biopsy sample, and no calls were detected during the period of behavioural observations prior to direct approaches. After two early biopsy approaches during which these calls were first noted, particular attention was directed at monitoring, detecting and recording these specific calls during the vessel's approach. All recorded or noted calls in the acoustic logbook had a fundamental frequency of approximately 11 Hz, up to 5 harmonics, and a duration of 2–60 s (Fig. 1; Table 1).

Figure 1 presents a spectrum and spectrogram of the Chilean pygmy blue whale call as recorded during the first biopsy approach at station 20 (whale no. 1). The average fundamental frequency of the call was 11.3 Hz, and three harmonics were evident. The vessel had been trying to approach the whale for 27 minutes when the call was detected and recorded at approximately 1.2 nm from the sonobuoy. The vessel's speed at the time of the call was approximately 12 knots. Another example came from station 20, where the third whale biopsy was sampled that day (see Table 1, second whale at station 20). The first call began 3 minutes into the approach (11 Hz fundamental, 60 s duration), a second pair of calls occurred 13 minutes into the approach (11 Hz, 19 s; 11 Hz, 7 s), and the fourth and final call was detected 93 minutes into the approach (11 Hz, 50 s). The whale and vessel distances during this approach were not far from the sonobuoy (1.1, 1.1 and 0.52 nm, respectively). The final call was of very high intensity, causing the DAT recorder to overload and distort the signal. However, the call was clearly visible on the computer monitor, thereby allowing its frequency and duration to be measured.

DISCUSSION

Calls recorded in close proximity to pygmy blue whales off Chile had low fundamental frequencies, were harmonically rich, and lasted 2–60 s. This sound type differs from those previously reported for this blue whale

population, suggesting that the vocal repertoire of this population has not yet been fully studied. Additionally, this result suggests that pygmy blue whales might produce distress or alarm calls when threatened or disturbed by vessel presence. None of the calls previously reported for blue whales off Chile is similar to the calls reported in this study. Nonetheless, the sound type reported here is identical to the EIO6-8 non-song sounds (frequency range: 15–166 Hz; duration: 5–16 s) recently detected off Australia, which are attributed to east Indian Ocean pygmy blue whales (Jolliffe *et al.*, 2025). The spectral similarity of these sound types produced by allopatric blue whale populations confirms that blue whale social sounds might be more multifaceted and diverse than previously conceived, and that these sounds might be innate. In our recordings, the fundamental frequency of calls is consistently in the 10–12 Hz band, and the duration is often quite long. The durations of calls noted in Table 1 should be considered minimum durations as duration was a difficult parameter to measure. For example, in cases where a sequence of calls occurred, the start and end of the calls were not abrupt, suggesting that the sequence was actually one very long call broken in appearance by either changes in the source intensity or transmission loss. A change in transmission loss could easily occur with changes in the whale's depth. Sound intensity is strongly influenced by the depth of the source or receiver (Jensen, 1981), a phenomenon used by humpback whale (*Megaptera novaeangliae*) researchers when using song intensity to anticipate when a male singer is about to surface (Tyack, 1981). For the blue whales recorded as part of this research, if a whale was near the surface and breathing relatively often due to the physiological demands of trying to outrun the approaching vessel, the intensity of its sounds received at the sonobuoy would increase and decrease as its depth changed (Jensen, 1981).

The consistent production of harmonics was an interesting feature of these sounds. The two other blue whale sounds off Chile also contained harmonics, but the fundamental frequency was not at 11 Hz (Cummings & Thompson, 1971; Buchan *et al.*, 2014). The consistent acoustic features of multiple harmonics (an acoustic feature that imparts a growly, harsh quality to a sound), very low frequency, and long duration are common acoustic characteristics produced by animals in an agonistic or threatening context (Morton, 1977; Byrkjedal *et al.*, 1989). No calls of this type were ever detected during the pre-biopsy behavioural observation period or in the other 146 hours of acoustic monitoring and/or recording that took place during this cruise. Instead, these calls were only detected once the biopsy approach was underway, sometimes within several minutes after the start of the biopsy chase. The unusual combination of acoustic features and the particular context of an animal being pursued and chased by a large, noisy vessel suggests that the call is associated with a sudden change or disturbance in the whale's environment, namely the persistent, rapid approach of a vessel and an increase in underwater noise. The acoustic detectability of Antarctic blue whales off the west coast of South Africa increased with the low frequency underwater noise that was highly predicted by vessel presence (Shabangu *et al.*, 2022). However, Antarctic blue whale acoustic detectability decreased with increasing low frequency underwater noise in a soundscape dominated by wind speed (i.e., geophonic source) in the sub-Antarctic region (Shabangu *et al.*, 2025). As such, observations from this study further confirm that blue whales could be responding adversely to vessel noise more than noise from natural sources.

Whether or not 'true' and other pygmy blue whale subspecies produce a unique call type in a similar context remains to be determined. Therefore, we strongly recommend that existing archived data, such as data from other IWC-SOWER Antarctic cruises, collected in similar circumstances, be examined for this or a similar call type(s). The novel acoustic results presented here support the view that passive acoustic efforts should be prioritised in future research (preferably in conjunction with acoustic tags that include an integrated video camera system and kinematic and motion sensors) to understand blue whale ecology and their responses to stressful situations.

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