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The song of the Brazilian population of Humpback Whale *Megaptera novaeangliae*, in the year 2000: individual song variations and possible implications

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ABSTRACT

The song of the Brazilian population of the Humpback Whale *Megaptera novaeangliae* was studied in its breeding and calving ground, the Abrolhos Bank, Bahia, Brazil, from July to November 2000. Aural and spectral analyses of digital recordings were completed for approximately 20 song cycles, totaling 5 hours of song from 10 different recording events. We identified 24 note types, organized in five themes. All songs presented the same themes and the order in which they were sung did not vary. We registered the appearance of a note type and the disappearance of a phrase ending, which indicate that the song changed as the season progressed. Moreover, we detected individual variation in the way singers performed certain complex note types. As songs are transmitted culturally, it is likely that singers have different abilities to compose and/or learn new notes. If, as it has been previously suggested, 'new' songs are preferred to 'old' ones, these more able singers will be sending out information about their learning abilities that could be used by other whales to decide whether or not to interact with them.

Key words: Humpback Whale, *Megaptera novaeangliae*, song, Brazilian population, 2000, individual song variation.

INTRODUCTION

The Humpback Whale *Megaptera novaeangliae* sings long and complex songs (Payne and McVay 1971) that change, at a non-uniform rate, with time (Payne et al. 1983, Cato 1991). To date, singers have been found to be males (Darling and Berube 2001), which sing predominantly on their breeding and calving grounds (Payne and McVay 1971). One song cycle typically lasts from 6 to 35 minutes and singers usually repeat various cycles continuously to the point that a song session has been observed to last 22 hours (Winn and Winn 1978). The function of the song seems to be related to mating behavior – possibly to attract females (Winn and Winn 1978, Tyack 1981, Clapham 1996) and to signal status to other males (Darling and Berube 2001). The vocal repertoire of the species also includes calls, either by competitive groups formed in winter breeding grounds (Tyack 1983, Silber 1986, pers. obs.) or by whales involved in group feeding in summer grounds (Mattila et al. 1987).

There are Humpback Whale populations in all oceans of the world, each one possessing its own characteristic song. In contrast, individuals of the same population generally sing a similar song (Winn and Winn 1978).

Studies carried out in the northern hemi-

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sphere, such as that of Payne and Payne (1985), have established certain patterns in the song structure that also seem to be true for the Australian populations (Cato 1991). The results of the study reported here show that the song of the Brazilian population in the year 2000 conforms to these same patterns. Moreover, we detected individual variations in the song, for which we suggest possible implications.

MATERIALS AND METHODS

This study was carried out at the Abrolhos Bank (17°S and 38°W), an enlargement of the Brazilian continental shelf situated on the southern part of the State of Bahia, Northeastern Brazil (Fig. 1), the only known winter breeding and calving ground of the Humpback Whale in the Western South Atlantic Ocean.

Songs were recorded using Sony TCD D-10 and D-8 digital tape-recorders, and a home-mounted omni-directional hydrophone. Subsequent recordings were generally temporally segregated by more than one day, sometimes a week, and recording sites were randomly (although not intentionally so) spaced across the Abrolhos Bank.

Aural and spectral analyses were carried out for 10 different recording sessions (apparently 10 different singers), adding to a total of 5 hours of songs and 20 song cycles. The Spectrogram (version 5.1.7) software was used for a real-time check of the recordings and Cool Edit Pro to produce sonograms and to measure note parameters, namely: duration of the note, duration of the interval in between subsequent notes, minimum and maximum frequencies. A total of 4474 notes were measured.

For the analysis regarding the individual variation, we divided the note types that occupy the second part of the phrases of theme 5 into two categories: note types W and X form the first and S, T and U the second, more elaborate ones. We then counted the total number of notes belonging to each of the two categories per song session and calculated the average number of elaborate and non-elaborate notes in each singer's song cycle.

RESULTS AND DISCUSSION

The song of the Brazilian population of Humpback Whale in the year 2000 is composed of 24 note types, organized in 5 themes (Fig. 2). This repertoire is somewhat larger than the 12 to 15 note types that Cato (1991) considered to be typical for the song of the East Australian population, and there are three possible explanations: we have established narrower limits for the note character variation, the greater number of note types is characteristic of the Brazilian population or 2000 was not a typical year.

All songs are constituted of the same five themes. No theme was left out of any song cycle and there was no variation in the order that themes were sung. This uniformity corroborates current knowledge that individuals within a population sing a similar song (Cato 1991).

When we compared songs of different individuals or different songs in the same song session, we observed that the quantity of notes per song cycle varied considerably both between individuals and between successive song cycles (Fig. 3). This variation is the result of the different number of phrases repeated in each theme. Payne and Payne (1985), studying the alterations of the song throughout 19 years, concluded that songs in a population are similar with regard to phrase and theme structure, as well as in their sequences, although the number of phrases in any particular theme is unpredictable either within a song session or between them. The same observations have been made in the present study.

We also observed that some note types seem to emerge from the modification of others. This progressive change of the characteristics of a certain note type into a new one has been observed by Winn and Winn (1978) and Cato (1991).

Our observations of the behavior of the singers, together with data on the behavior and sex of singers and joiners obtained from other studies, suggest that the Humpback Whale's mating system has strong similarities with what is called a 'lek'. We observed males singing while submerged and surfacing to breathe approximately at the same location, stand-

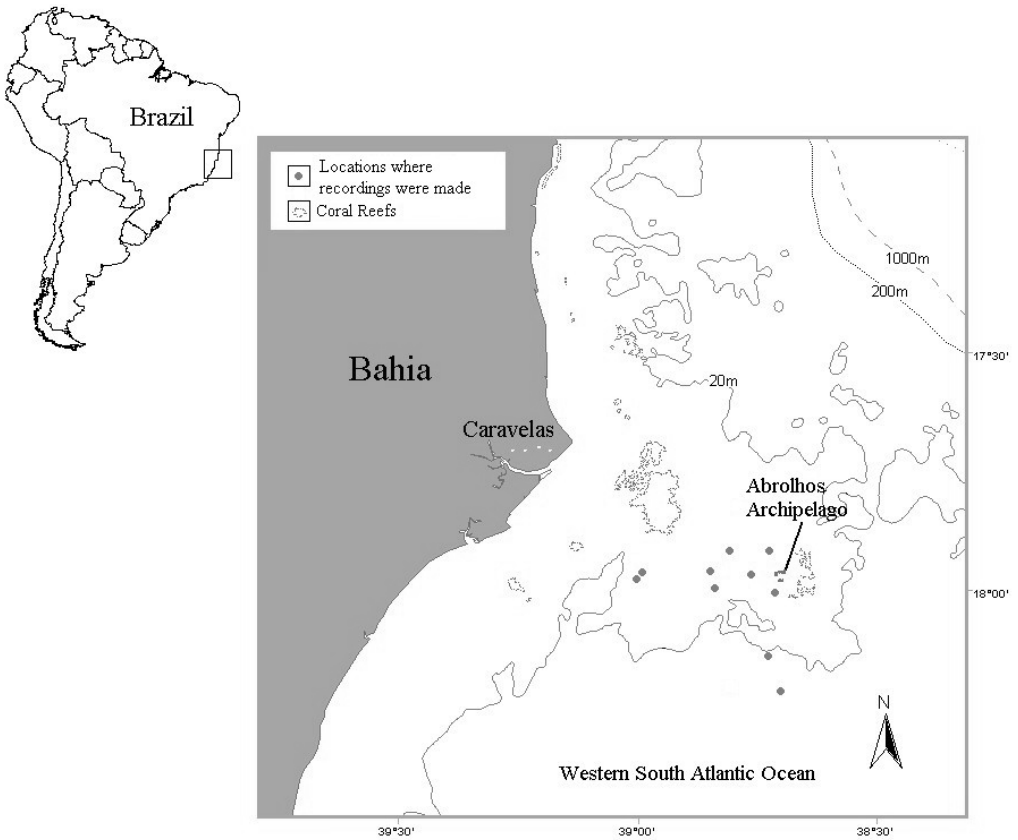

Fig. 1 – Study region on the Western South Atlantic Ocean indicating the Abrolhos Archipelago and the locations where recordings were made.

ing with the 'tail up' or in slow, non-directional swimming. These singers are generally lone whales spaced a few kilometers apart. As in breeding areas there seems to be no food, females tend to be very mobile, avoid each other mutually and distribute themselves irregularly in space (Clapham 1996). All these spatial and behavioral traits are typical of a lek, and Clapham (1996) suggested the term 'floating lek' for the Humpback Whale's mating system, stressing the singer mobility displayed by the species, in contrast to traditional, spatially fixed leks.

Song Alterations Related to the Progression of the Breeding Season

Two inter-individual variations seem to be related to the progression of the breeding season. The first one was the disappearance of the ending made of the notes H and M, which was present in all phrases of theme 3 of singer I (13 July, beginning of the season) and gradually became less frequent until it disappeared from singer VII (30 September) on (Fig. 4). The second was the appearance of note type J, which was detected for the first time in theme 3 of singer IV and occurred in all songs recorded thereafter (Fig. 5).

The fact that the song of this species changes with time has been observed by several authors (Winn and Winn 1978, Payne et al. 1983, Payne and Payne 1985, Mattila et al. 1987, Guinee and Payne 1988, Cato 1991, Dawbin and Eyre 1991, Noad et al. 2000, Cerchio et al. 2001). Moreover, it has been established that the greatest change in the song occurs during the winter breeding and not during the non-singing summer feeding season (Payne et al.

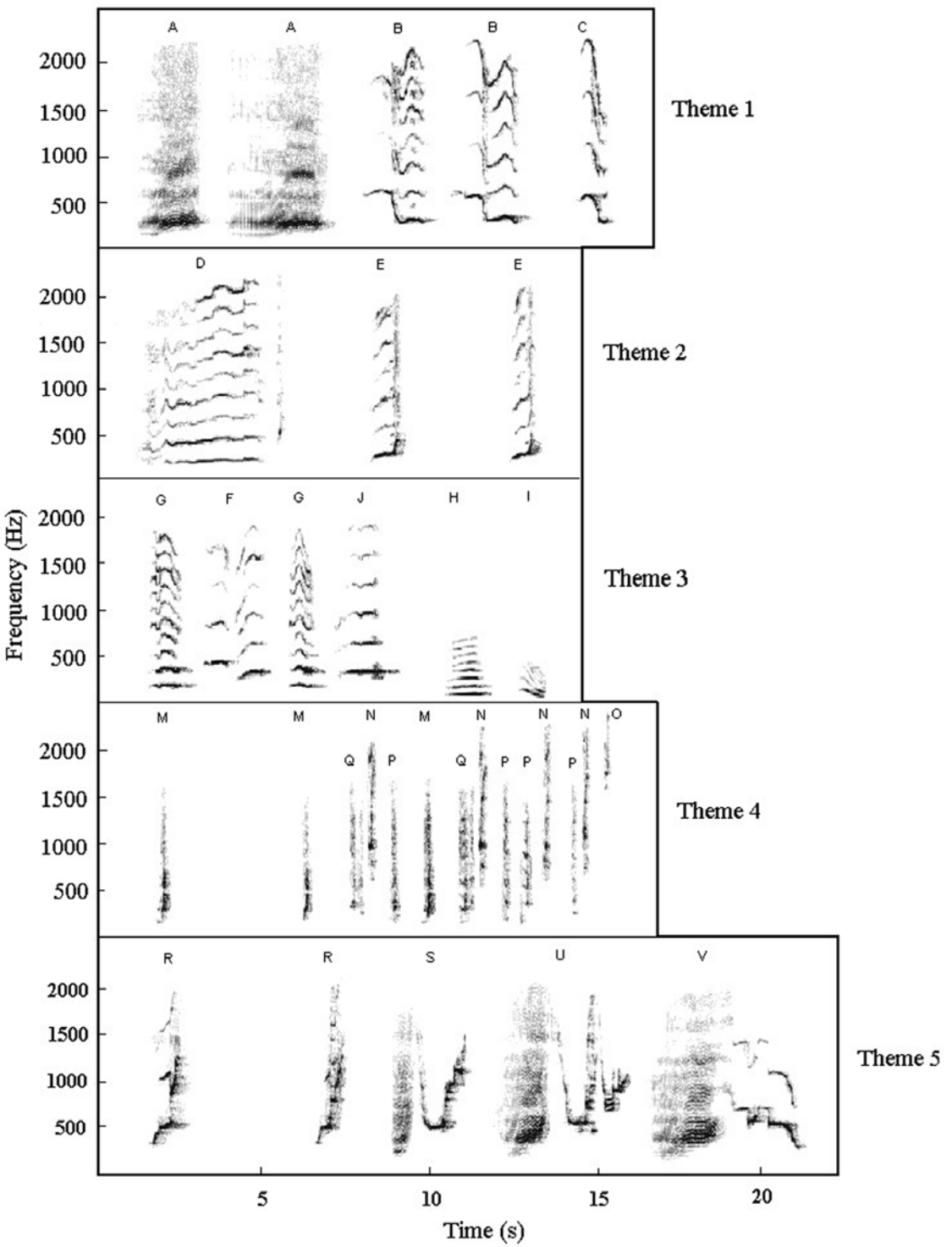

Fig. 2 – Song of the Humpback Whale Brazilian population in the year 2000. Phrases representing each of the five themes are shown. Scales are: vertical = frequency (0–2500Hz), horizontal = time (0–20s).

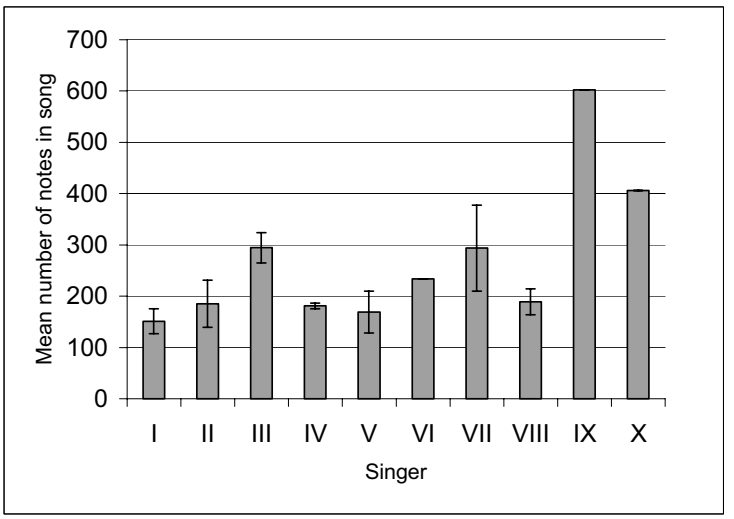

Fig. 3 – Mean number of notes per song cycle of each singer. Bars with no SD indicate that only one song cycle was analyzed.

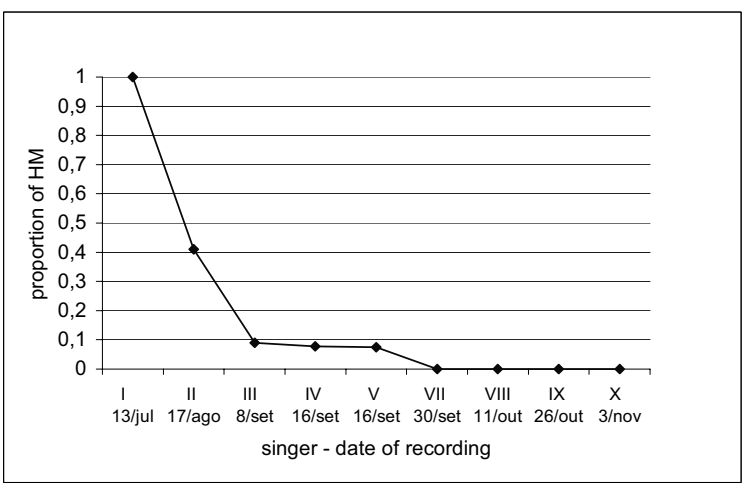

Fig. 4 – Proportion of phrases ending in HM in each singer's song session. This proportion is the number of phrases ending in HM divided by the total number of phrases present in the theme (phrases ending in HH + HI + II + HM). Singers (I to X, less singer VI for which the recording was too short for calculation) are presented in chronological order.

1983). Among the several forms of song alteration observed by Payne et al. (1983), one of them was the replacement of a certain note type by another. In our study, the appearance of note type J seems to have been through the modification of another note type F, though the latter did not disappear.

The disappearance of the ending HM was a different phenomenon. In this case, no new note type was created or lost (no change in the repertoire), but, rather, the note types H and M ceased to occur in the same place of the song. It was thus an organizational change.

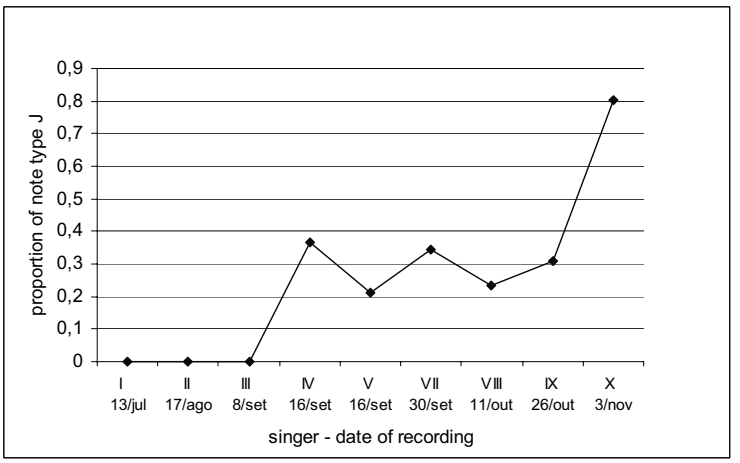

Fig. 5 – Proportion of phrases containing note type J, calculated as the number of notes J divided by the sum of notes F, L and J (these three note types occupy the same relative position in the phrases of theme 3: third and/or fifth notes of every phrase). Singers as on figure 4.

Possible Individual Variation in Song Learning

We detected individual variation in the way singers performed certain complex note types. In theme 5, the note types following notes R are of two structural categories, a relatively simple (note types X and W) and a more complex one (note types S, T and U), as illustrated in part on figure 6. The proportion of notes of these two categories varies from one singer to another. In figure 7, the six singers for which we have enough recording are ordered according to the decreasing proportion of simpler notes uttered. This order, to the contrary of the changes related before, does not represent the progression of the breeding season. Thus, if we admit that the song is transmitted through learning (Payne et al. 1983, Noad et al. 2000), these individual differences suggest that singers have different abilities to compose and/or to learn their song. If this is true, singers that compose and singers that learn the changes faster and better sing a novel song earlier on in the breeding season. Furthermore, if, as suggested by Noad et al. 2000, novelty drives song change – which implies that novel songs are more attractive to other whales than 'old' ones – individuals that compose and/or learn faster send out information about their differential learning abilities that could be used by other whales to decide whether or not interact with them. Therefore, sexual selection in the Humpback Whale would be made through the ability to acquire quickly and perform properly new sound structures in the song.

As our data are too limited for further development of such assumptions, we can only stress here the necessity to gather enough recordings to document better and through a longer time the intra- and inter-individual variations in the song. It would also be necessary, in order to test our hypothesis on the species mating system, to identify the sex of the singers, monitor the interactions of these known singers with other whales of known sex, and determine the reproductive success of each one of the singers by genetic analyses.

CONCLUSION

Although various studies have stressed the fact that all males of the same population tend to sing the current version of the song, thus emphasizing the aspect of uniformity, focus should also be directed to studying the ability singers have to compose and/or

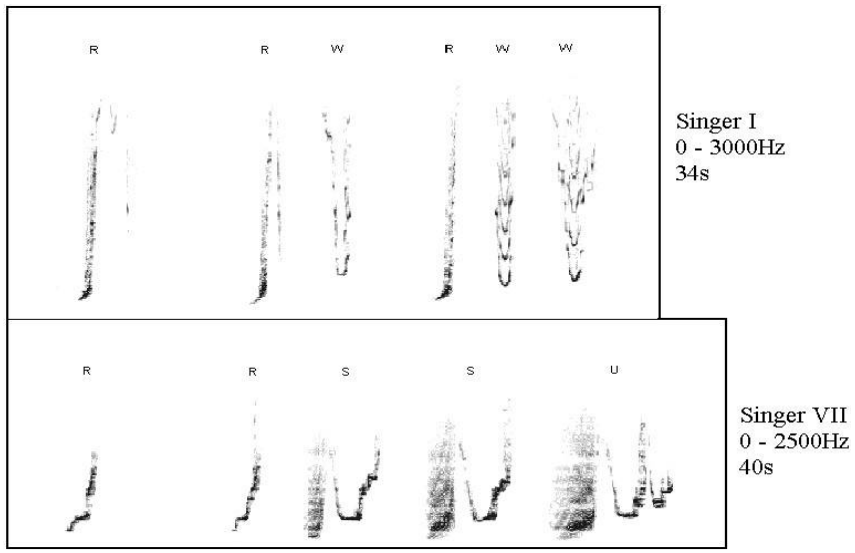

Fig. 6 – Sonograms of phrases containing note types of the two categories that we established for theme 5: simpler on upper row (singer I), more complex on lower row (singer VII). Scales as in figure 2.

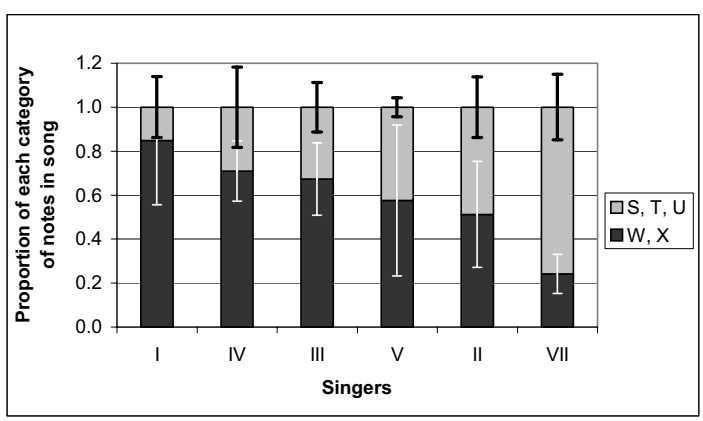

Fig. 7 – Proportion of each of the two categories of note types in theme 5 (see figure 6). The proportions shown are the average (with standard deviation) for all song cycles of each singer.

learn the changes, as this would probably improve our understanding of the song's behavioral function.

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RESUMO

Estudamos o canto da população brasileira de Baleia-jubarte *Megaptera novaeangliae* em sua área de reprodução – a região do Banco dos Abrolhos, Bahia – de julho a novembro do ano 2000. Completamos análises auditiva e espectral de aproximadamente 20 ciclos de canto, em um total de 5 horas de gravações provenientes de 10 ocasiões diferentes. Identificamos 24 tipos de notas, organizadas em cinco temas. Todos os cantos são formados pelos mesmos temas e não houve variação na ordem na qual foram cantados. Registramos o aparecimento de um tipo de nota e o desaparecimento de uma terminação de frase, o que indica que o canto mudou ao longo da temporada de reprodução. Mais ainda, detectamos variação individual na forma como os cantores emitiam certos tipos de notas mais complexos. Uma vez que o canto é transmitido culturalmente, é provável que os cantores tenham habilidades diferentes para compor e aprender novas notas. Se, como já foi sugerido anteriormente, cantos 'novos' são preferidos a cantos 'antigos', cantores mais capazes estariam mandando informação sobre suas habilidades de compor e aprender que pode ser usada por outros indivíduos para decidir quanto a interagir ou não com eles.

Palavras-chave: Baleia-jubarte, *Megaptera novaeangliae*, canto, população brasileira, ano 2000, variação individual no canto.

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