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SONGS INDICATE INTERACTION BETWEEN HUMPBACK
WHALE (*MEGAPTERA NOVAEANGLIAE*) POPULATIONS
IN THE WESTERN AND EASTERN SOUTH ATLANTIC OCEAN

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The purpose of this study was to investigate the relationship of humpback whale (*Megaptera novaeangliae*) populations off Gabon and Brazil through song comparisons. The characteristics of humpback whale singing behavior, specifically that the composition of the complex song continuously changes yet all the singers in a breeding area sing very similar songs at any one time, allow an indirect test of whether seasonally isolated populations are in acoustic contact (Payne and McVay 1971, Winn *et al.* 1981, Payne *et al.* 1983, Payne and Guinee 1983, Payne and Payne 1985, Noad *et al.* 2000, Cerchio *et al.* 2001). Our working assumption is that, for different humpback whale populations to sing the same version of a continually evolving song there must be some acoustic overlap in their annual cycles. A preliminary comparison of songs from the Cape Lopez region of Gabon (0°40'S, 8°30'E) and the Abrolhos Archipelago off northeastern Brazil (18°S, 39°40'W), separated by more than 5,500 km, revealed striking similarities and strongly suggests that whales from these major breeding areas come into some form of contact at some time during the year.

The Brazilian humpback whale population is distributed along the coast of the country from approximately 5° to 24°S (Zerbini *et al.* 2004).¹ Occasional offshore sightings go as far North as the Archipelago of Fernando de Noronha (3°51'S) and as South as Trindade and Martins Vaz (20°30'S) (Lodi 1994).¹ Recent observations indicate that humpback whale calving grounds in Brazil range between 5° and 20°S (Zerbini *et al.* 2004). The highest densities of individuals, as well as the highest percentage of groups with newborn calves are found on the Abrolhos Bank (16°40'–19°30'S, 37°25'–39°45'W). The whales occupy this region from May to December with peak abundance between late August and early September (Siciliano 1997, Martins *et al.* 2001, Morete *et al.* 2003, Zerbini *et al.* 2004). Recent population estimates suggest upwards of 3,200 individuals in the wintering grounds, the

majority (2,500), found on the Abrolhos Bank (Freitas *et al.*, in press).² Behavioral patterns associated with breeding, such as active competitive groups and singing are observed throughout the season in this area (Martins *et al.* 2001; Projeto Baleia Jubarte, unpublished data).

The central African humpback whale population is trans-equatorial, currently ranging approximately from Equatorial Guinea (2°N)³ southward through Gabon, Congo and possibly Angola (9°S), although the southern boundary or breeding ground is unclear.⁴ The highest density of whales is near shore, however sightings also occur offshore near the islands of Príncipe⁵ and São Tomé (1°30'N, 7°30'E).⁶ There are no recent estimates of the central African humpback whale population size. However, whaling records suggest a very large prewhaling population. During 13 whaling seasons between 1912 and 1937 over 11,000 humpbacks were taken off Cape Lopez (Mackintosh 1942). After World War II, in five seasons between 1949 and 1959, another 4,000 humpbacks were killed there (Budker and Collingnon 1952). Surveys off Gabon since 1999 revealed a high density of whales in the region from June through September, with peak abundance likely in July-August⁷ (JDD 1999, 2002 unpublished reports). Occasional sightings have been documented as late as December (JDD, unpublished data). Breeding activities, such as cows nursing young calves, group competition, and singing, were predominant from June through September (JDD, unpublished data).

Song comparisons were made using samples from two singers from Gabon in 1999, and one singer from each location in 2001 and in 2002. The 2001 Gabon sample did not include a full song. Comparisons with the 1999 Gabon song were made to evaluate the degree of change in the song over time within that location and compare it to the song samples from Brazil. The song recordings used in this analysis are listed in Table 1. The recordings from Brazil were made by RSSL from a small inflatable boat on the Abrolhos Bank, using a DAT portable recorder (Sony DAT D8) connected to a hydrophone (HTI-90-min). Songs from Gabon in 1999 and 2002 were recorded in the vicinity of Cape Lopez by JDD using a portable tape deck (Marantz PMD430) connected to a hydrophone (HTI-96-min) from a small local craft. The 2001 Gabon recording in the Cape Lopez region was made by S. Gulick using a hydrophone (HTI-94-SSQ) trailing behind a sailboat.

Spectrographs were made from all of the recordings by JDD using Avisoft-Saslab software. Different song themes are coded with numbers and were defined by the unique patterns (phrases) of repeated sounds (units) (Payne and McVay 1971). The composition and presentation of songs between locations and years were qualitatively compared.

In 2002 the "same" five specific themes, constructed from similar units and phrases were found in songs from both locations. These themes were referred to as Themes 1–5. A combination Theme 1&4 segment (units from both themes 1 and

¹ SICILIANO, S., J. L. PIZZORNO AND P. BARATA. 1999. Distribution and possible migratory routes of humpback whales (*Megaptera novaeangliae*) in the Western South Atlantic. Paper SC/51/CAWS4, presented to the IWC Scientific Committee, May 1999, Grenada, WI (unpublished). 12 pp.

² ANDRIOLO, A. C., C. A. MARTINS, M. H., ENGEL, J. L. PIZZORNO, S. MÃS-ROSA, A. C. FREITAS, M. E. MORETE, P. G. KINAS. 2003. Second year of aerial survey of humpback whales (*Megaptera novaeangliae*) in the Brazilian breeding ground, 2002. Preliminary analysis. Working paper IWC/SC55SH1.

Table 1. Recordings used to compare songs from Gabon and Brazil.

Year	Date	Gabon				Brazil				
		Singer	# of songs	Length s/min	Grade ^a	Date	Singer	# of songs	Length s/min	Grade ^a
2002	27 Aug.	1	4+	3,965/66	A	5 Oct.	1	3+	2,700/45	B–C+
2001	3 Sept.	1	Part	5,60/9.3	C+	22 Oct.	1	1+	2,150/35.8	A
1999	29 July	1	1+	1,060/17.6	B					
	5 Aug.	1	1+	1,120/18.6	B					

^a A = all song units clear with minimal background noise; B = hear all song units but background noise significant; C+ = able to make out song units, but noise and/or distance a factor.

4) was also found in both locations. Figure 1 shows spectrographs of the phrases that were typical of each theme. The similarity of the composition between locations is clear; differences in the spectrographs of some units are largely due to differences in quality of recording.

There were small-scale exceptions to the overall similarity. For example, the second unit in Theme 5 had an upswing in frequency in Gabon and a downswing in Brazil (Fig. 1). In some cases differences within the song of an individual over several song cycles were as great as differences between the songs from the different breeding areas. For example, in 2002, in three of four songs of the Gabon singer Theme 3 included an additional repetitive unit not present in the Brazilian song. However, in the fourth song cycle of this Gabon singer the unit was not present, making the theme identical to its counterpart in the Brazilian song. This level of intra-individual variation is common in the humpback whale song and appears to be a characteristic of the species (Payne and Payne 1985, Frankel 1994, Cerchio *et al.* 2001).

Themes 1–5 were sung in the same order in both locations, with a tendency towards repetition of Themes 4 and 5 (*i.e.*, 1234545). The Theme 1 and 4 combination was interspersed within this repetition in both locations. The order of themes in all 2002 song cycles is shown in Figure 2. The repetition of specific themes within the overall order has been observed in other song studies in Hawaii.

³ CARROBLES N. A., R. P. VISO AND J. A. B. AQUIAR. 1999. Informe preliminar sobre la viabilidad del ecoturismo de observación de yubartas (*Megaptera novaeangliae*) en la Bahía de Bata, Guinea Ecuatorial. Parque Nacional de Monte Alén. ECOFAC. Guinea Ecuatorial (unpublished). 23 pp. Available from Ecofac, Quartier Batterie IV, BP 15115 – Libreville, Gabon.

⁴ Personal communication from Peter Best, Mammal Research Institute, University of Pretoria, % South African Museum, P. O. Box 61, Cape Town 8000 South Africa, December 2003.

⁵ Personal communication from Steve Gulick, Wildland Security, www.wildlandsecurity.com, September 2002.

⁶ Personal communication from Cristina Brito and Ines Carvalho, Project Delfim–Portuguese Center for the Study of Marine Mammals, Apartado 23051, 1147-601 Lisbon, Portugal, December 2003.

⁷ Personal communication from Tim Collins, International Conservation, Wildlife Conservation Society, 2300 Southern Blvd. Bronx, NY 10460-1099, December 2003.

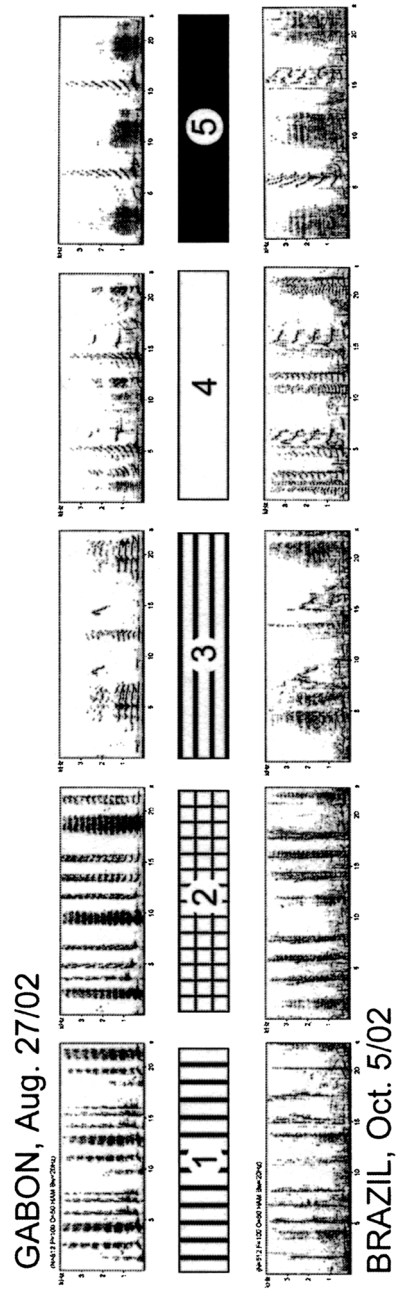


Figure 1. Spectrographs of phrases typical of Themes 1–5 in songs recorded in Brazil and Gabon in 2002. The corresponding patterned bars represent each theme in subsequent figures.

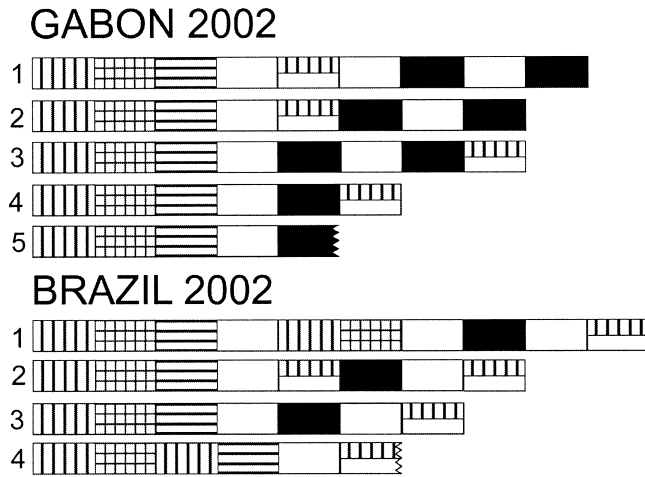


Figure 2. The order of themes in all 2002 song cycles. Themes same as in Figure 1. The numbers indicate each song cycle.

However, it is not generally the rule (JDD unpublished data), therefore, its occurrence in both locations represent notable song similarity.

All themes are not equally represented within a song cycle. The proportion of the song spent in each specific theme was virtually identical between locations. The pie charts in Figure 3 illustrate the mean time per theme in full song cycles from

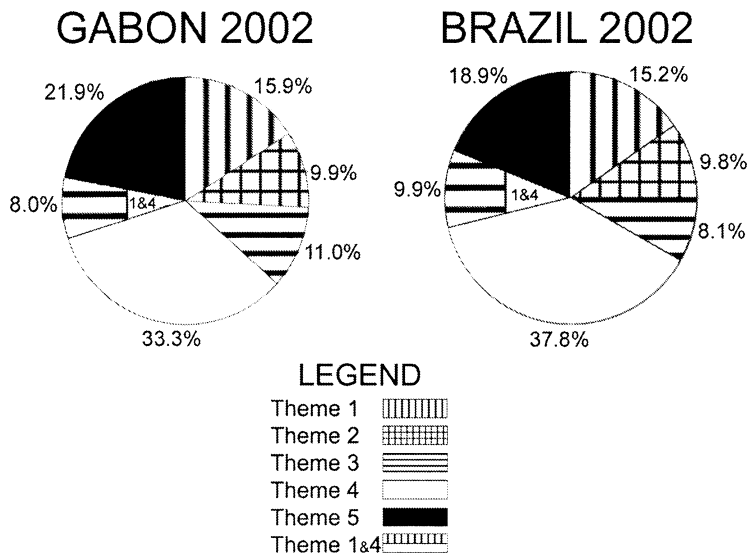


Figure 3. The percentage of the 2002 song dedicated to specific themes in each region. The charts reflect mean percent of song dedicated to each theme from all full song cycles (four from Gabon and three from Brazil).

GABON 2001



BRAZIL 2001



Figure 4. Theme composition of 2001 song recordings from Gabon and Brazil. The 2001 song samples from both locations did not include the 2002 Theme 4, yet both included a theme not present in 2002: Theme 0 (zero).

both locations. For example, over 50% of the song was spent in Themes 4 and 5 (Brazil 56.7%, Gabon 55.2%). The largest difference in time dedicated to a specific theme between the regions was only 4.5% in the use of Theme 4 (Brazil 37.8%, Gabon 33.3%).

The same changes occurred in the song from both regions. For example, the 2001 song samples in both locations did not include the 2002 Theme 4 (consequently also the combination Theme 1 and 4), yet both included a theme not present in 2002: Theme 0 (zero). Figure 4 illustrates the theme composition of the 2001 recordings from both locations. Theme 0, 2001, had a different composition than any of the themes in 2002, yet was identical in both locations in 2001. Also, in 2001, Theme 5 consisted of the repetition of the phrase ABABABCC, in both locations. In 2002 the CC was absent in both locations; Theme 5 consisted only of AB, AB. Figure 5 illustrates this change.

Song patterns from Brazil and Gabon in the same year (2002) qualitatively have more in common than songs from the same location, Gabon, in different years (1999 *vs.* 2002) (note: 2001 was not included due to the lack of a complete song cycle). Only one of the five themes in the 1999 Gabon song was recognizable (in terms of composition and arrangement of song units) in the 2002 Gabon song as shown in Figure 6. This comparison corroborates the general assumption that clear differences in humpback whale songs are the result of a collective change over time, rather than geographic separation (Payne and Payne 1985).

The similarity in structure and collective changes over time of the songs of Gabon and Brazil indicates some level of interaction between these two humpback whale assemblages. Examples from the North Pacific and Australia suggest that the occurrence of a common song display across an ocean basin, and even between southern oceans, is not unlikely and perhaps even the rule, with the movement of individual singers providing the most likely mechanism. The similarity of the continuously changing songs between breeding assemblages in Mexico and Hawaii, which are separated by approximately 4,000 km, has been well documented (Winn *et al.* 1981, Payne and Guinee 1983, Cerchio *et al.* 2001), as well as the interchange of individuals between these locations (Darling and Jurasz 1983, Darling and McSweeney 1985). One preliminary song comparison of breeding assemblages from Hawaii and Japan (6,000 km distant) indicated a high degree of similarity (Darling and Mori 1992). Furthermore, movements of individuals between these locations were later documented (Darling and Cerchio 1993, Salden

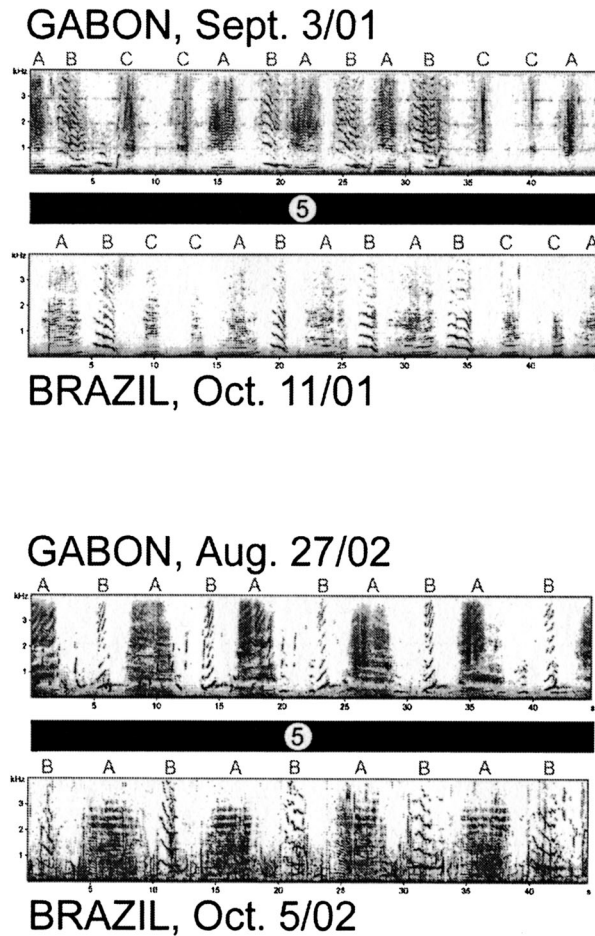


Figure 5. Comparison of Theme 5 between 2001 and 2002 in both Gabon and Brazil. Note that Theme 5 consisted of the repetition of the phrases ABABABCC in both locations; in 2002 the CC was absent in both locations.

et al. 1999). Perhaps the best documentation of such song transmission comes from observations of western Australian songs introduced into and adopted by eastern Australian humpbacks, apparently due to migration between locations (Noad *et al.* 2000).

The mechanism involved in the maintenance of similar songs between such widely separate assemblages (or for that matter even between whales in the same assemblage) is not understood. Apparently, singers within the same assemblage listen to one another and through some form of mimicry across a large percentage of the singers, a common song denominator results. Song similarity between different assemblages such as Gabon and Brazil might result from a few “wandering” males that carry the song between locations. This mobility, combined with the characteristic collective adoption of song novelty throughout

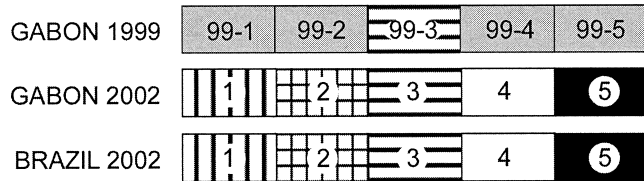


Figure 6. Comparison of themes in the 1999 Gabon song with the 2002 Gabon and Brazil songs. Only one of the five themes in the 1999 Gabon song was recognizable in the 2002 Gabon song.

the population, leads to the maintenance of song similarity across ocean basins. Current evidence from the Pacific suggests that while a majority of whales may show fidelity to a specific breeding ground, some interchange of individuals occurs between widely separated populations (Winn *et al.* 1981, Payne and Guinee 1983, Darling and McSweeney 1985, Darling and Mori 1992, Darling and Cerchio 1993, Noad *et al.* 2000, Calambokidis *et al.* 2001, Cerchio *et al.* 2001).

The Brazil and Gabon humpback whales may also share a common feeding ground, which allows regular interaction, and possible interchange of individuals and/or song (see Clark and Clapham 2004) between breeding areas and the maintenance of overall song similarity from year to year. Independent speculation from Gabon (Congo region) circa 1942 based on whaling statistics (Mackintosh 1942), and from Brazil since 2000 based on genetic data (Engel 2003), has suggested South Georgia as a possible common feeding ground for each assemblage. To date, the feeding grounds of neither assemblage have been definitively defined or linked.⁸

It is also possible that Gabon and Brazil are way-points of a single population on one migratory route. This idea is at odds with the traditional view of north-south migrations, instead suggesting a circular South Atlantic route where the same whales pass through both locations. There is no evidence that this occurs, however the current lack of any knowledge about migratory routes, the apparent offset of peak abundance in the regions (July–August in Gabon and late August–early September in Brazil), and the prevalent east-west patterns of winds and currents in the Southern Atlantic Ocean (Pinet 1992) leaves this possibility open to serious consideration. Previously documented east-west movement of a humpback whale across the North Pacific, from Japan to North America, indicates their transocean potential (Darling *et al.* 1996).

This preliminary song comparison suggests the occurrence of some level of interaction, at least acoustic, between individuals from the Gabon and Brazil humpback whale assemblages. Thus, management and conservation programs should take this potential connection between Gabon and Brazil into consideration.

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⁸ Recent satellite telemetry results included two humpback whales tagged in Brazil that migrated to the South Georgia–South Sandwich islands region; see Zerbini, A. N., A. Andriolo, M. P. Heide-Jørgenson, J. L. Pizzorno, Y. G. Maia, G. R. Van Blaricom, D. P. DeMaster, P. Simoes-Lopes, S. Moreira and C. Bethlem. 2004. Identification of summering ground of humpback whales from Brazil: Preliminary results from satellite telemetry. Paper SC/56/SH1 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 10 pp.

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