Behavior of southern right whales: R/V *Hero* cruise 72-3

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This was our third in a series of related cruises aboard R/V *Hero*. The main objective this time was to further investigate southern right whales, *Eubalaena glacialis australis,* in Golfo San José, Argentina. Our previous work along the temperate coasts of South America was described in four earlier reports (Cummings and Thompson, 1971a, 1971b; Cummings *et al.,* 1971; Cummings *et al.,* 1972). Because it is generally isolated from inhabited areas of the Valdés Peninsula, has clear and protected water, and possesses a natural attraction for breeding right whales, Golfo San José was an ideal location for studying underwater sound production and other behavior.

We boarded *Hero* at Puerto Madryn, Argentina, on August 3, 1972, a day's sail from Golfo San José. Between 15 and 20 whales were observed during our stay in the Golfo during August 4 to 20. Original plans called for ending the work and leaving the ship on August 24. Minor engine difficulties, however, prompted an earlier departure. We worked the ship northward on its way for repairs in Bahia Blanca, in the small likelihood of spotting other whales. The rare southern right whale had not been seen for many years by Argentine observers in the area north of the Valdés.

Much to our surprise we saw two humpback whales, *Megaptera novaeangliae,* and 25 to 30 southern right whales 13 kilometers from Punta Rasa and about 250 kilometers north of the Valdés Peninsula. The right whales outnumbered those in Golfo San José at the time of our trip. Assuming they did not later join those to the south, in the Valdés area (Golfo San José and Golfo Nuevo), the discovery of this northern group represented a substantial increase in the estimated right whale population of Argentina, as previously indicated by those whales known only to be in the Valdés region during the breeding season.

Southern right whales in Golfo San José generally frequented the east and northeast coasts while *Hero* was there in 1972. During our work the year before, however, the whales spent most of their time in the southeast corner, which we called "Whale Bay," and along the southern shore. The reasons for this change in orientation are unknown to us but probably were related indirectly to timing since cruise 72-3 was about a month later in the season than was 71-3. Other causes for the change in orientation may have been possible shifts in prevailing wind or current directions, small differences in temperature, changes in bottom characteristics, or other factors associated with seasonal or behavioral differences.

Another outstanding contrast to the previous year's observations was the absence of killer whales and the lack of porpoises in Golfo San José. Only three *Lagenorhynchus* sp. were found, rather than the hundreds of porpoises noted in 1971. Porpoises and killer whales apparently enter the gulf intermittently, as evidenced by Bernd G. Wuersig, State University of New York, Stony Brook, who reported (personal communication) that they were very common 2 months after we left in 1972.

The underwater sounds of southern right whales, many of which were described earlier (Cummings *et al.,* 1972), definitely were most numerous, diverse, and spectacular when the animals were courting or apparently copulating. Compared to our 1971 recordings, more of the sounds recorded in 1972 were bellowings and moans of rising pitch. Conversely, the belch-like sounds, so common in 1971, were less frequent in 1972. We recorded and analyzed 1,750 whale sounds from the 1972 cruise.

Right whales sometimes produced outstanding blow (respiration) sounds which were recorded simultaneously from above and below the water surface (fig. 1A to E). These blow sounds sometimes included moaning components that clearly were audible in the air and from the hydrophone (fig. 1A and B). The whales evidently could control the frequency independently of the main blow components (as illustrated by the downward frequency trend of the three lower components, fig. 1A, top). Arrival time differences between waterborne and airborne blow sounds allowed us to estimate the distance of the whales without relying upon visual methods. For example, the whale producing the sound shown in fig. 1A was 1,300 meters away; in the cases of fig. 1D and 1E, 310 meters. A mating whale often would roll on its side, producing loud slapping sounds as the upper flipper repeatedly beat the water's surface. These slaps could also be heard from the air and the water (fig. 1F).

Often we saw masses of bubbles rising from the tops of heads of submerged whales as they emitted sounds,

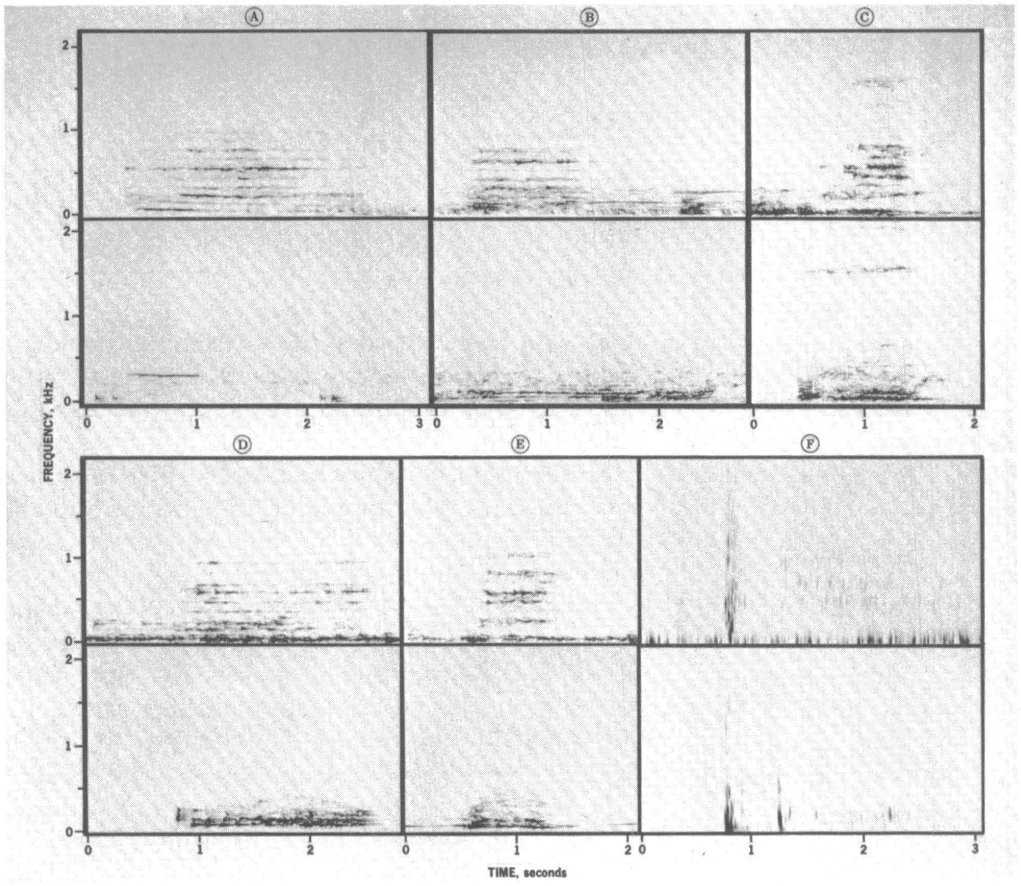

Figure 1. Sonograms of southern right whale sounds recorded in Golfo San Jose, Argentina. The grams are in pairs: upper ones were recorded from above the water, lower ones were recorded from below the water. Paired sounds are artificially alined with one another in time. Pairs A and B were distant blows with moaning components recorded in and above the water. Moaning components in pair A, only one of which was recorded underwater, mainly were below 350 hertz and swept downward in frequency. Pairs C to E were blows from nearby whales. Pair D has a fluttering pulsed characteristic. Pair F shows a flipper slap. Analysis filter band width in pair F was 100 hertz; for all other sonagrams it was 10 hertz.

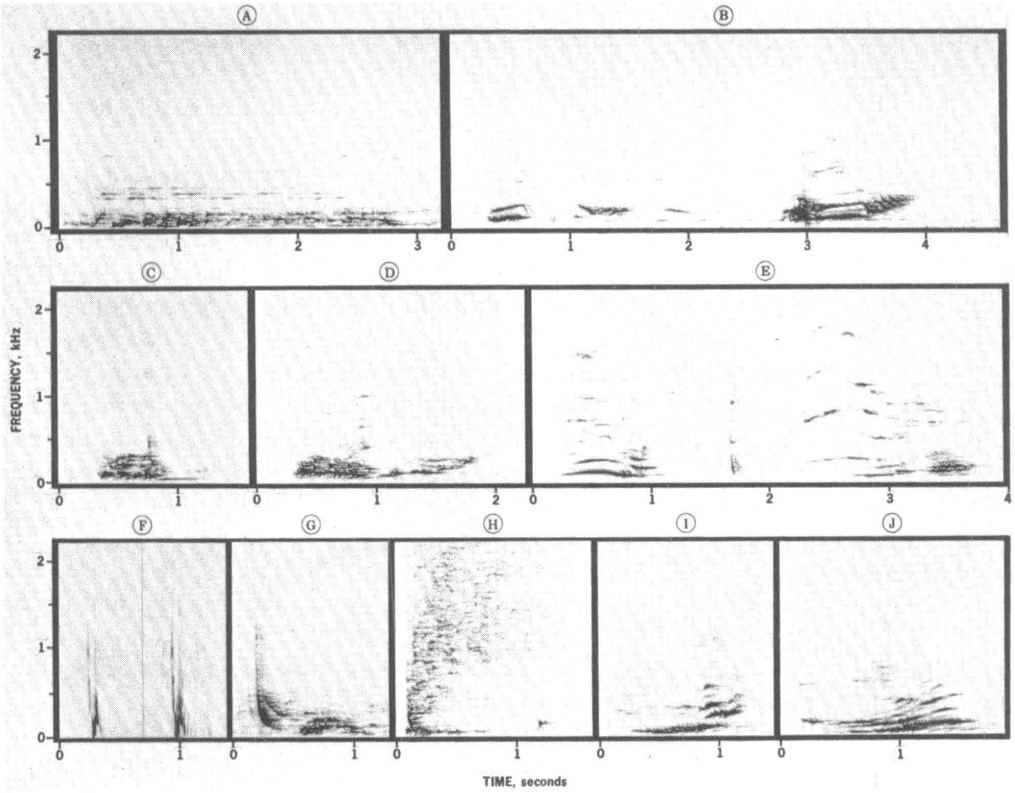

Figure 2. Sonograms of southern right whales' underwater sounds. Gram A shows a blow with flutter and pulsed characteristics. Grams B to D show underwater blows with weak single pulses. Gram E is a pulse between bellowing sounds; gram F is common pulses; gram G is an unusual pulsed moan; gram H is a pulse exhibiting the gun shot characteristic and a strong reverberation; grams I and J are moans with upward frequency shifts. Analyzing filter band width was 10 hertz for all grams except F (100 hertz).

indicating that the sounds' sources were subsurface exhalations (fig. 2A and C). The underwater blow sounds sometimes began with low frequency pulse trains with slow repetition rates (fig. 2A); at other times they simply had pulse components (fig. 2B to D). Similar pulses occurred independently of blows (fig. 2E to G).

Blow sounds did not propagate well in the water when nostrils were well above the surface (fig. 3) throughout exhalation. Evidently the mere coupling of the head with water was insufficient for good underwater conduction of this sound, as contrasted to the wheezing blow sounds noted from humpback whales (Watkins, 1967). Also noted by Watkins, and corroborated by our experiences, was the necessity of being very close to hear the inhalation of whales. Right whales normally produce a characteristic V-shaped blow (Cummings *et al.*, 1972). During this cruise and the previous one, however, we observed a whale that blew only out of one side, possibly indicating that the other nostril was congested.

One of the most spectacular sounds recorded in the presence of southern right whales was a very strong pulse resembling a gun shot, followed by a persistent reverberation lasting at least 5 seconds and ranging from 50 to above 2,200 hertz (fig. 2H). Its pulse length resembled that of flipper slaps, but we could not relate it to any particular behavior. Bellowings (fig. 2E) and moans of rising pitch (fig. 2I and J) were very common among mating whales and most likely a part of breeding behavior.

A scarcity of sounds at times other than during breeding suggests that phonations are significant in bringing and keeping the whales together, or perhaps as an auditory signal used as a social releaser for mating. Sound production is functional in the breeding behavior of other mammals and insects, frogs, toads, fishes, and birds (Marler and Hamilton, 1966).

We tried to determine the role of sound in the behavior of right whales by playing back various types of their sounds and even those of killer whales. Regardless of the right whales' social state preceding playback, however, no type of playback sound elicited decided changes in movement or sound production. Powerful equipment of good fidelity (modified from that of Cummings and Thompson, 1971c, and Fish and Vania, 1971) was used to project the sounds close to natural source levels. Playback sequences, each consisting of six of the most common right whale sounds recorded during cruise 71-3, were transmitted 25 times in the presence of the whales. When these failed to induce any obvious reaction we used a natural sequence of sounds recorded on the spot from a breeding pair of right whales during the second week of cruise 72-3. This playback often was used later in the cruise, but it similarly failed to bring about a notable change in the right whales' behavior.

Sound sequences previously recorded from killer whales in the northeast Pacific were played to the southern right whales 11 times without affecting their behavior. The same was true of the previous year's at-

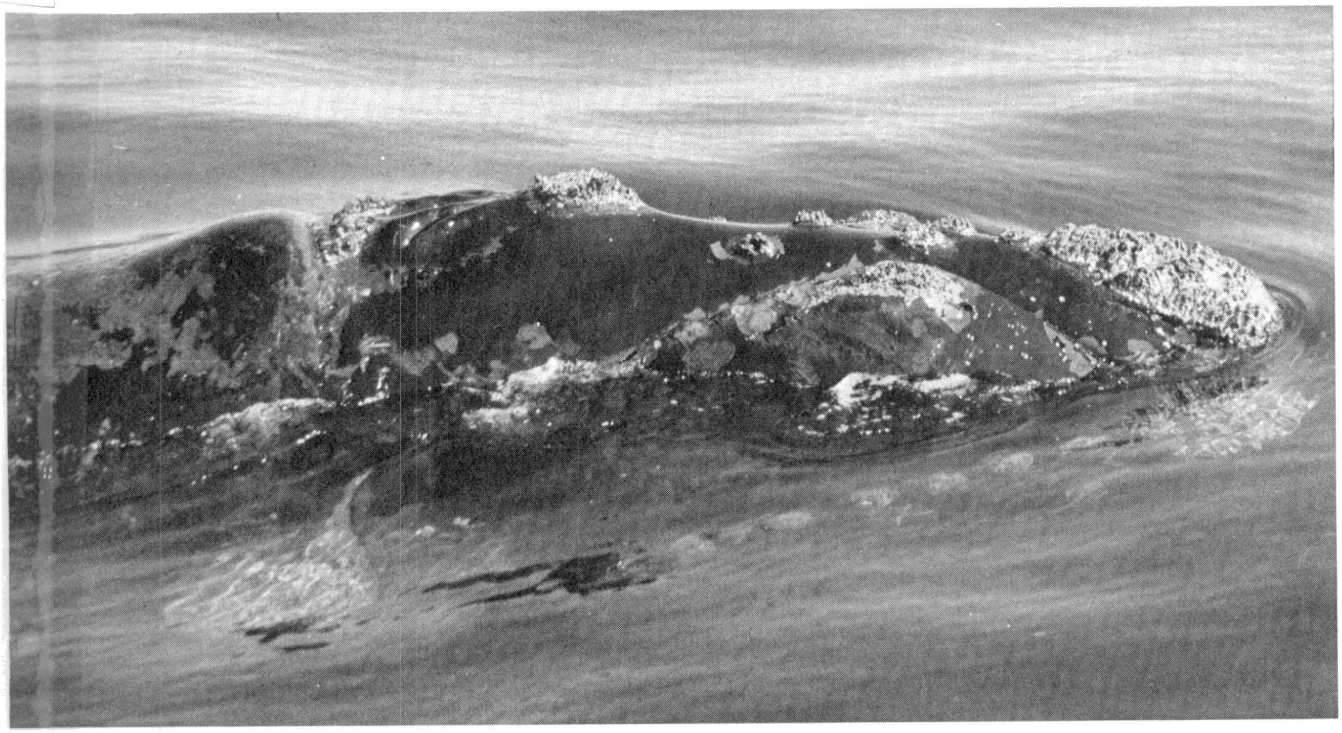

Figure 3. Southern right whale's head with its characteristic bonnet on the snout and other callosities along the upper and lower (underwater) edge of the lower jaw, the top of the head, and posterior to the blow holes. When blow holes were well out of the water, as shown here, blow sounds did not propagate well underwater.

tempt with less powerful instrumentation. We had expected the right whales to avoid the sounds of a potential enemy by rapidly swimming away, as gray whales and belugas did in past experiments (Cummings and Thompson, 1971c; Fish and Vania, 1971).

We are trying to determine if the sounds of killer whales off Argentina are different from killer whale sounds recorded in the northeastern Pacific. Cummings has several indications of regional dialects among large whales; the same could be true of killer whales. We are analyzing some sounds from killer whales in the antarctic region, recorded by Dr. Gerald S. Kooyman, Scripps Institution of Oceanography. So far the spectral and aural analyses show them to be different from recorded sounds of northern killer whales. Perhaps the sounds of northern killer whales used in this study were unfamiliar to southern right whales. During cruise 71-3 we tried to record sounds of five killer whales attacking two right whales; unfortunately these marauders were reticent.

In addition to employing killer whale sounds during this study, we also used five life-size, plywood models of killer whale dorsal fins. The fins were ballasted, keeping them upright and sailing downwind (fig. 4). On the first attempt the fins were released (without accompaniment of killer whale sound playback) about 45 meters upwind from a breeding pair of right whales that were rolling at the surface. Before releasing the models we observed the whales while the ship was anchored for about 30 minutes. Much to our surprise, upon release of the killer whale models the two whales stopped breeding and swam toward the models.

The two right whales then resumed their courtship in the midst of the killer whale models, and we replayed the killer whale sounds. Possibly the whales ignored the sounds and the model fins appeared more like the normally protruding appendages of breeding right whales, thus serving as a positive rather than a negative stimulus. Although the right whales slowly left the area after several minutes, it was doubtful that they did so in reaction to the sounds. We tried other experiments with the fins, setting them several hundred meters ahead of transiting whales. These whales also showed no sign of avoidance.

Following our recommendation, Mr. Philippe Cousteau and his party came to Golfo San José to film right whales after *Hero's* departure. We had the pleasure of reviewing their spectacular underwater photography that

Figure 4. Killer whale fin models being used during underwater sound playback experiments.

included a female accepting three males, each with the penis extruded. They noted that breeding groups generally consisted of one female and more than one male. We suspected such a sex ratio after we saw groups breeding during both years. For example, we saw four groups of three animals each on August 7, 1972.

Mr. Cousteau told us that when a female apparently was through mating she often rolled over on her back at the water's surface, a posture that moved her genitalia away from the male. The male frequently would position himself on his back under the "unwilling" female and grasp her with his flippers. When the female rolled over to breathe, she put the male in a favorable coital position and mating often resumed. Similar behavior was reported by Payne (1972). We often saw whales upside down at the surface (sometimes with a gull walking on the whale's belly), but lacked the opportunity for underwater observations. Once, during cruise 72-3, it appeared that a female was shunning her nursing calf by remaining upside down at the surface. Cousteau's observations agreed with ours in that he too never observed any animosity between suitors of the same female: an unusual behavior for animals.

Observers aboard *Hero* in 1972, who had been to the gulf the year before, unanimously agreed that mating and apparent copulations were much more frequent than during the previous year. In fact, we saw few isolated, single whales in 1972 as compared to 1971. There was about 1 month's difference in the dates of our visits of the 2 years. Assuming right whales first appeared in the gulf at about the same time during both years, they would have had more time to become involved with overt sexual behavior before our work began in 1972. Although not documented in the case of whales in the natural environment, many other animals require extended precoital rituals (Marler and Hamilton, 1966).

Other evidence for this year's cruise being later in the breeding season was the appearance of two baby whales with their mothers. In addition, a dead, newborn, 4.8-meter baby was beached on the eastern shore of Golfo San José. A complete set of measurements is being compiled by Cummings and Dr. Joseph R. Jehl, Jr., San Diego Natural History Museum. We did not witness parturition but evidently right whales do give birth in the gulf, an enigma during cruise 71-3. We saw no young offspring in the northern group off Punta Rasa, but right whales there apparently were mating and copulating. There was no difference in behavior between right whales of the open sea off Punta Rasa and those of Golfo San José.

Jumping or breaching, as it is often called, is common in whales. This spectacular burst from the water and the tumultuous splash upon re-entry frequently was observed among right whales in Golfo San José. One animal seen along the eastern shore jumped ten times: a series of eight consecutive jumps followed by two separate ones. As we have seen in other species (fin, humpback, gray, and Bryde's), large whales generally turn in mid air and fall on either the side or the back. Although there are many plausible theories connected with this behavior among whales, the sudden and repeated appearance of diving brown-hooded gulls, *Larus masculipinnis,* while right whales were jumping at Golfo San José, led us to believe that the whales perhaps were dislodging parasites or other debris in such a manner. The two ornithologists who called our attention to this were fellow scientists aboard *Hero:* Dr. Jehl and Mr. Maurice A. E. Rumboll, Argentine Museum of Natural Sciences, Buenos Aires. We tried unsuccessfully to collect some of these birds to determine their stomach contents. They obviously were feeding on something in the wake of the jumping whales. Birds were not always attracted to jumping whales; in one case we saw a baby whale, presumably free of parasites, jump without the presence of birds.

We have described a common behavior of southern right whales called "headstanding," a posture that consists of holding the flukes upright and out of the water for periods of from a few seconds to 2 minutes (Cummings *et al.,* 1972). Local fisherman suggested that this behavior perhaps was associated with bottom feeding. We concurred because the shallow depths in which headstanding took place at Golfo San José indicated that the whales' heads must have been on or very close to the bottom. During the present cruise, however, we noticed the same behavior off Punta Rasa where the depth exceeds 25 meters. We think that our original interpretation of headstanding was incorrect since the whales had to be well off the bottom in the deeper water near Punta Rasa. We have no satisfactory explanation for this remarkable behavior, but urge others to observe whether or not headstanding appears to be a sign stimulus for mating (as in courtship displays of other animals), a rest posture (as suspected by Payne, 1972), or some other behavioral significance.

Hero left Bahia Blanca, Argentina, on August 23 and proceeded on to Punta Arenas, Chile, investigating sea and shore birds along the way. We thank Dr. Jehl, Mr. Rumboll, Mr. Jon Winter (Sonoma State College), and Lieutenant Arturo Cancela (Argentine navy), for their assistance at sea; Commander Alfredo Yung, Argentine navy, for coordination; Captain P. J. Lenie and the crew of *Hero* for their helpful support and able skills at sea; and Ms. Charlotte Meinert for assistance with data analysis and preparing the manuscript. This work principally was supported by National Science Foundation grant AG-261 and partly by grant NR 104-123 of the Office of Naval Research, and task SF 221-005, Naval Ships Systems Command.

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