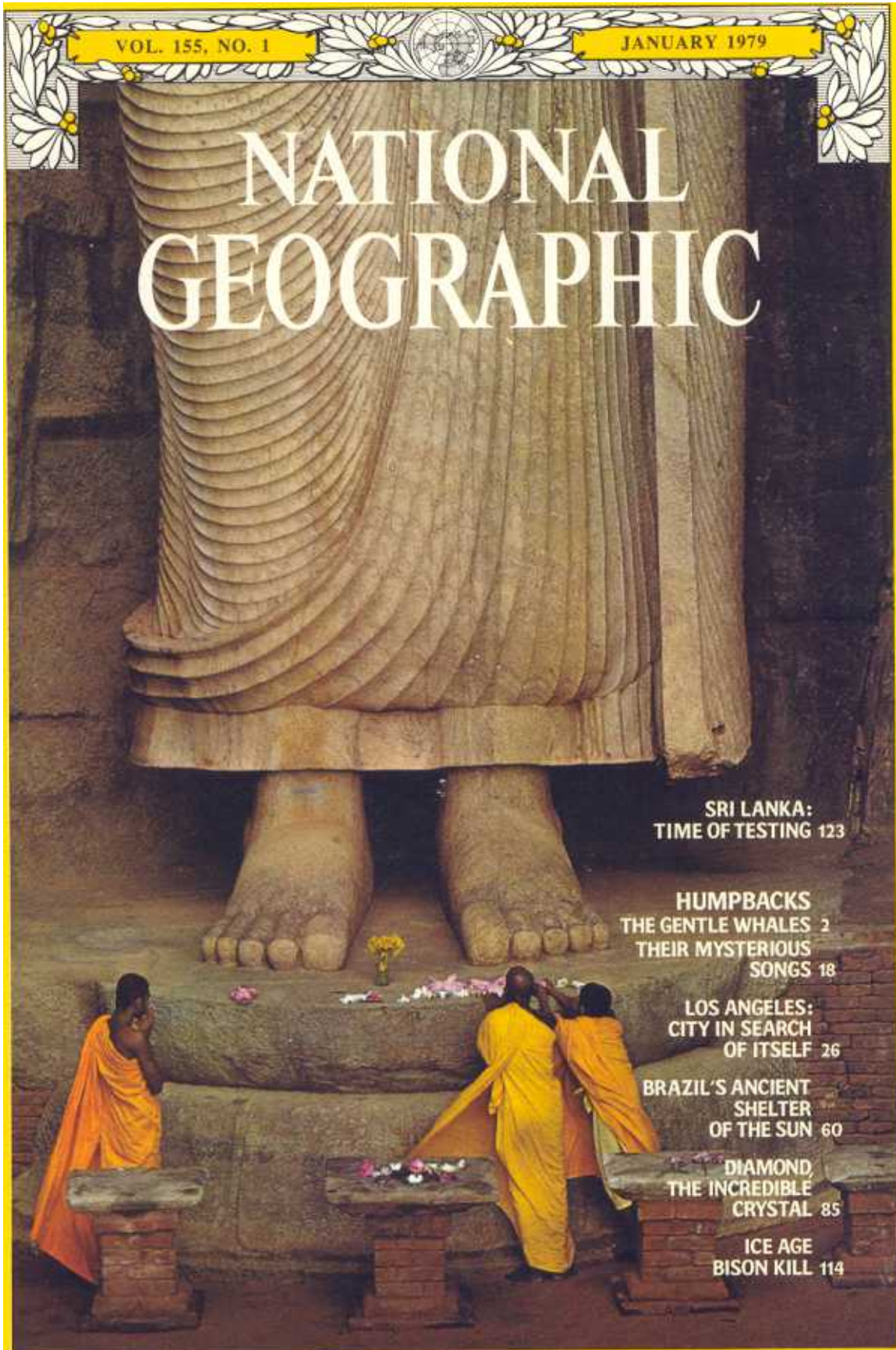


SPECIAL SOUND SHEET: "SONGS OF THE HUMPBACK WHALE" (page 24)



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SEE NATIONAL GEOGRAPHIC SPECIAL, "GOLD!" SUNDAY, JAN. 7, ON PBS TV

**O**N JANUARY 7, National Geographic Specials will begin a fourth season over television stations of the Public Broadcasting Service—an event that has become a happening. Last year, “The Great Whales” and “The Living Sands of Namib” drew the largest audiences of all PBS programs rated during the season, and “The Great Whales” went on to win a coveted Emmy award.

We rejoice in such success, not only for the men and women who work so hard to make good programs possible, but also because it means significant numbers of television viewers appreciate informative and interesting programming. We believe that the same standards we seek to maintain in our magazine and other publications can be maintained on television, and not only survive but be welcomed.

Our new season opens with “Gold!”—a report on the lure and beauty of the precious metal. A mine in South Africa, a treasure hunters’ excavation of an ancient Colombian grave, a gold-bedecked wedding in India, and the vault at Fort Knox are among the settings for the story.

On January 28, “Hong Kong: A Family Portrait” will show you the Crown Colony from a view seldom shared by the tourist. We come to know the members of a Chinese family and see through their eyes that remarkable Far Eastern economic machine.

The scene shifts to East Africa on March 4 and a drama of utmost importance to all those who revere the wildlife threatened by poachers and changing land use. “Last Stand in Eden” tells the story of elephants forced into a farm area, and the complexity of rights and wrongs that results.

The season concludes on April 1 with “The Tigris Expedition.” With Norwegian mariner-adventurer Thor Heyerdahl, we sail aboard the reed boat *Tigris* through waters traveled by the ancient Sumerians, along sea routes by which man’s earliest civilizations may have spread.

As in previous seasons, the Society and station WQED in Pittsburgh, our PBS associate, are indebted to Gulf Oil Corporation, whose generous grants make these programs possible. We are indebted most, however, to the millions of viewers who continue to approve of good programming.

*Silbert Browner*

# NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 155, NO. 1  
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January 1979

## HUMPBACK WHALES

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*Marine biologist Sylvia A. Earle and photographer Al Giddings swim confidently among those benign behemoths off Hawaii and Alaska.*

### II—Their Mysterious Songs 18

*A 12-year study by zoologist Roger Payne and his wife of the complex, ever changing sounds made by humpbacks suggests that the “songs” may relate to social behavior and possibly even intelligence. An accompanying sound sheet reproduces some of these haunting sequences, as yet unfathomed.*

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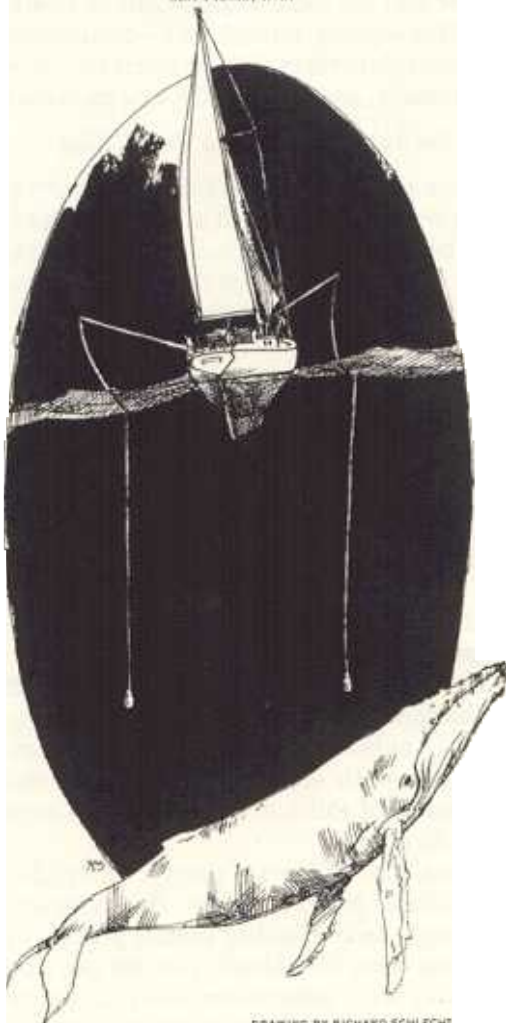
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*The Resplendent Land, long known as Ceylon, pushes ambitious plans for critically needed new jobs and farmlands. Story by Robert Paul Jordan, with photographs by Raghubir Singh.*

COVER: *Symbols of life’s frailty, flowers are laid at the feet of a colossal Buddha in Sri Lanka. Photograph by Raghubir Singh.*

# HUMPBACKS: Their Mysterious Songs

By ROGER PAYNE, Ph.D.  
Photographs by AL GIDDINGS  
SEA FILMS, INC.



DRAWING BY RICHARD SCHLECHT

**A**T DUSK I SAT in the stern sheets of our small sailboat, braced against a stanchion and using the last light of day to take a final sight on Bermuda's Gibbs Hill Lighthouse, 35 miles to the northeast.

We were too far from land to return that evening; my wife, Katy, and I would have to spend the night at sea. Bermuda's treacherous reefs are difficult enough to navigate in broad daylight. In darkness they are impossible.

As night deepened, a familiar feeling came over me, one of loneliness at sea. I felt at one with the other solitary watchers elsewhere on earth—the shepherds, sentinels, and herdsmen who huddled alone beneath these same stars, feeling the night close in around them.

To break the mood, Katy and I got down to work. We brought the boat about onto the other tack and pointed her as high into the wind as we could, so that she nodded gently with the waves. After lowering a pair of hydrophones into the sea, I switched on their amplifiers and listened in stereo through the headphones.

We were no longer alone! Instead, we were surrounded by a vast and joyous chorus of sounds that poured up out of the sea and overflowed its rim. The spaces and vaults of the ocean, like a festive palace hall, reverberated and thundered with the cries of whales—sounds that boomed, echoed, swelled, and vanished as they wove together like strands in some vast and tangled web of glorious sound.

I felt instantly at ease, all sense of desolation brushed aside by the sheer ebullience of it all. All that night we were borne along by those lovely, dancing, yodeling cries, sailing on a sea of unearthly music.

Often during that night off Bermuda I thought how the oceans had once heard these wild cries. How, once, the echo chamber of the sea had reverberated to the haunting "songs" of whales. Then I thought of what it is like today in many of the whales' former haunts—silent, lifeless, impressing one most with a sense of what has been lost.\*

\*The author's articles include "At Home With Right Whales" in the March 1976 NATIONAL GEOGRAPHIC and "Swimming With Patagonia's Right Whales" in the October 1972 issue.

Humpback whales pass Bermuda each spring on their way north from southern calving grounds near Puerto Rico. During this period the humpbacks fill the ocean with complex and beautiful sounds. Many hours of these sounds were recorded and later analyzed with the help of a friend, Scott McVay, at Princeton University. The analysis showed that humpback sounds are in fact long songs. I use the term song not in a sense of beauty, although humpback sounds are indeed beautiful. By song I mean a regular sequence of repeated sounds such as the calls made by birds, frogs, and crickets.

#### Humpbacks Change Their Tune

Most birdsongs are high pitched and last only a few seconds, while humpback songs vary widely in pitch and last between six and thirty minutes. Yet if you record a whale song and then speed it up about 14 times the normal rate, it sounds amazingly like the song of a bird. In the second selection on side one of the detachable sound sheet included with this article (pages 24A and 24B),\* you will hear that striking similarity.

When you go out to listen to a humpback sing, you may hear a whale soloist, or you may hear seeming duets, trios, or even choruses of dozens of interweaving voices. Each of those whales is singing the same song, yet none is actually in unison with the others—each is marching to its own drummer, so to speak.

The fact that whales in Bermuda waters are singing the same song at any given moment is not surprising when you think of how similar two robins or two cardinals sound. But if you collect humpback songs for many years and compare each yearly recording with the songs of earlier years, something astonishing comes to light that sets these whales apart from all other animals: Humpback whales are constantly changing their songs.

In other words, the whales don't just sing mechanically; rather, they compose as they go along, incorporating new elements into their old songs. We are aware of no other animal besides man in which this strange and complicated behavior occurs, and we have no idea of the reason behind it. If you listen to songs from two different years you

will be astonished to hear how different they are. For example the songs we taped in 1964 and 1969—both of which can be heard on the enclosed sound sheet—are as different as Beethoven from the Beatles.

By combining our own tapes with those of friends like Bermudian Frank Watlington, we now have a sample spanning twenty years in Bermuda.

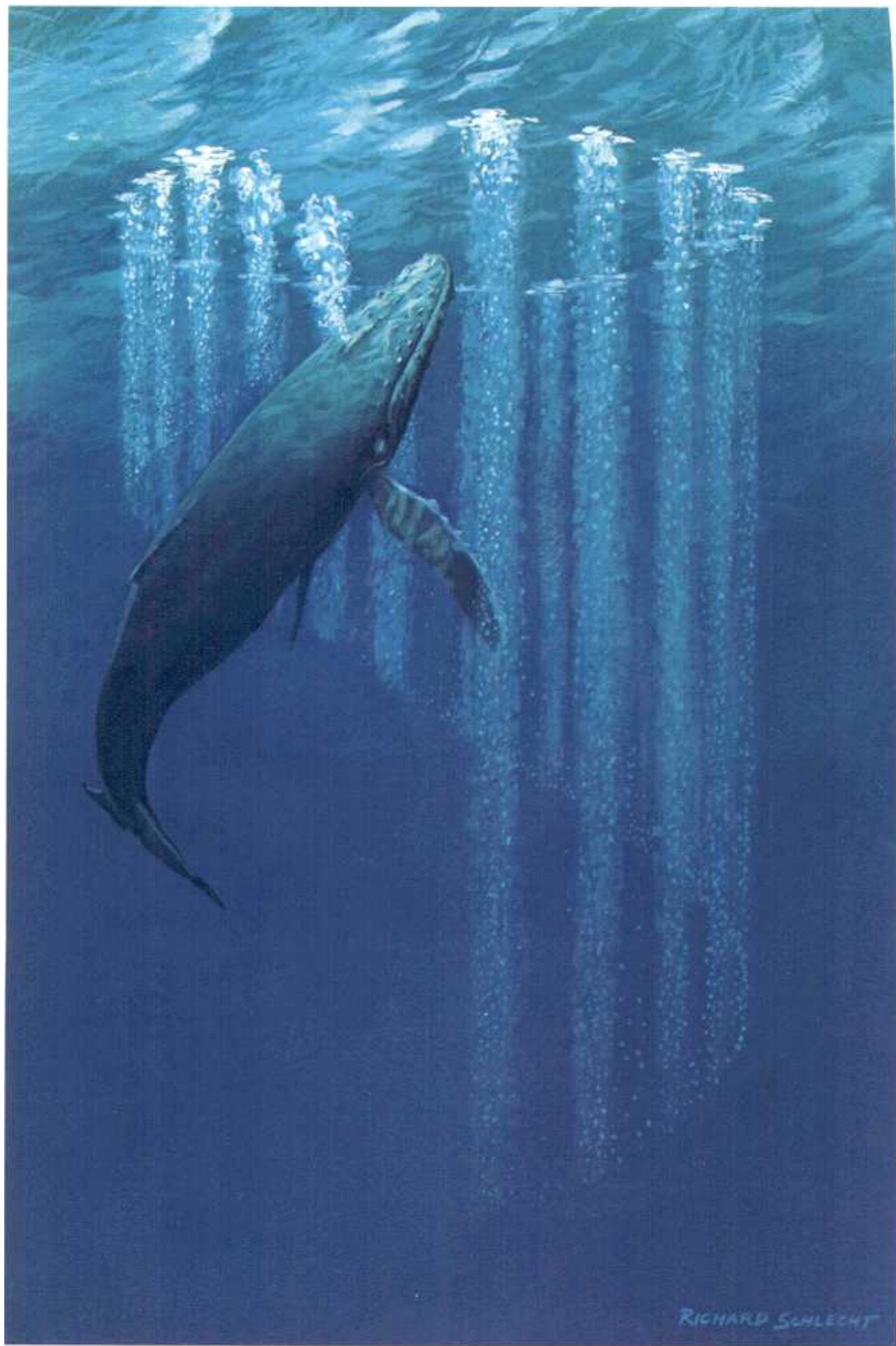
Katy and I have analyzed this data in detail. We find that the song has been constantly changing with time. All the whales are singing the same song one year, but the next year they will all be singing a new song. The yearly differences are not random, however. The songs of two consecutive years are more alike than two that are separated by several years. Thus, the song appears to be evolving, but regardless of how complex the changes are, each whale apparently keeps pace with the others, so that every year the new song is the only one that a listener hears.

#### Musical Talent May Be Inherited

We have also recorded and analyzed four years of humpback songs from Hawaii, a major wintering area for humpbacks. Although songs of the same year in Hawaii and Bermuda are different, it is intriguing that they obey the same laws of change, and have the same structure. Each song, for example, is composed of about six themes—passages with several identical or slowly changing phrases in them. Each phrase contains from two to five sounds. In any one song the themes always follow the same order, though one or more themes may be absent. The remaining ones are always given in predictable sequence.

The whale populations of Hawaii and Bermuda are almost certainly not in contact. Thus, the fact that the laws for composing the songs are the same in both places strongly suggests that the whales inherit a set of laws and then improvise within them. Whether these laws are transmitted from one generation to the next genetically or by learning remains to be seen. When Katy first

\*Longer samples of humpback whale songs can be heard on two albums produced by Capitol Records, Inc.: "Songs of the Humpback Whale" (SW-620), and "Deep Voices" (ST-11598). Artists' royalties go to the New York Zoological Society's Whale Fund.



RICHARD SCHLECHT



**Ingenious hunter** solves the problem of herding scattered morsels into a bite-size feast by blowing a bubble “net.” Like a giant undersea spider spinning its web, the humpback begins perhaps fifty feet deep, forcing bursts of air through its blowhole while swimming in an upward spiral (left). Big bubbles, followed by a mist of tiny ones, rise to create a cylindrical screen that concentrates krill and small fish. Bubbles and food pop to the surface (above), followed by the gaping mouth of the whale (right) as it emerges in the center of its net. Charles Jurasz, who discovered that Alaskan humpbacks make bubble nets, says that two animals sometimes collaborate on a net perhaps a hundred feet across.

Dr. Payne has spent 12 years studying the sound sequences in the humpbacks’ rhapsodies and has worked with Jurasz to analyze noise patterns produced as they blow bubble nets. “It appears that the whales can select the size of the bubbles; they can make their nets any size ‘mesh’ they want,” the author believes.

An alternate tactic called “flick feeding” has also been observed, during which the whales splash water over their heads with their flukes so that it lands in front of them as they swim. The impact of the water startles krill long enough for a quick gulp. Humpbacks may also use their flippers—longest of any whale species—to scoop their prey into the path of their mouths.



PAINTING (OPPOSITE) BY RICHARD SCHLECHT



*Flurry of flukes draws a surge of tourists to the rail of a cruise ship in*

discovered that the songs of humpbacks were changing from year to year, a simple explanation seemed likely: Since the whales do not sing at their summer feeding grounds, and since the song is complex, perhaps the humpbacks simply forget the song between seasons and improvise a new version from whatever fragments they can recall.

To test this theory, we organized a season-long study of humpbacks off the island of Maui in Hawaii.

The study had two objectives: to record a full season of songs and to make observations of the whales' behavior.

We were joined in the study by Al Giddings and Sylvia Earle, two of the most experienced divers in the world. Al, with

his unsurpassed ability as an underwater photographer, and Sylvia, with her background in both diving and science, were ideal partners, as were our two graduate students, Jim Darling and Peter Tyack.

**Songsters Pick Up Where They Left Off**

To me, the results of the study are fascinating. Over a six-month period we obtained samples of songs, coupled with unique observations of underwater behavior. The subsequent analysis of our tapes has revealed an intriguing fact: The whales had not forgotten the previous season's song, for they were singing it when they first returned to Maui. Only as the season progressed did the changes gradually take



*Glacier Bay. In small boats, whale-watchers can harass the creatures.*

place. Obviously, during the period between breeding seasons the song is kept in “cold storage,” without change.

Another fascinating thing we discovered is that the whales always sing new phrases faster than the old ones. We discovered, too, that new phrases are sometimes created by joining the beginning and end of consecutive phrases and omitting the middle part—just as we humans shorten “do not” to “don’t.” In many other ways the introduction of new material and the phasing out of old are similar to evolving language in humans.

So far, the study of humpback whale songs has provided our best insight into the mental capabilities of whales. Humpbacks are clearly intelligent enough to memorize

all the complicated sounds in their songs. They also memorize the order of those sounds, as well as the new modifications they hear going on around them. Moreover, they can store this information for at least six months as a basis for further improvisations. To me, this suggests an impressive mental ability and a possible route in the future to assess the intelligence of whales.

Songs are not the only vocalizations of humpbacks; we often hear grunts, roars, bellows, creaks, and whines. These sounds sometimes accompany particular types of behavior, suggesting that they may have specific social meaning.

One such association between sound and behavior has been documented by Charles



# Symphony of the Deep: “Songs of the Humpback Whale”

**T**HE SOUND SHEET facing this page contains a unique concert composed and orchestrated by one of earth's largest and most endangered creatures. The humpback is the only whale known to emit underwater sounds in the form of “songs”—long, complex sequences of repeated phrases.

Roger Payne, author of the accompanying article, has studied whale songs with his wife, Katy, for more than a decade. With support from the National Geographic Society and the New York Zoological Society, the Paynes recorded all but one of the songs on this sheet. Selection 3, side one, was recorded by

Frank Watlington, an acoustical engineer at Columbia University's Geophysical Field Station in Bermuda. Selection 2 is a speeded-up version of that song. The sound of a humpback blowing a “net” of underwater bubbles to trap food was recorded by Al Giddings for Survival Anglia, Ltd., of England.

The Paynes conduct their research in Bermuda and Hawaii, both singing grounds of the humpback. “The Bermuda and Hawaii songs are different,” Dr. Payne observes, “but all humpbacks in each area sing only the local song.”

To introduce these remarkable songs to its members, the Society ordered ten and a half million copies of the sound sheet, the largest pressing ever published. *Remove the sheet carefully by pulling straight out from the binding, and play it manually at 33 $\frac{1}{3}$  rpm. The sound sheet is in stereo but will play satisfactorily on any phonograph.*

Because humpback whale songs are among the loudest sounds made by any animal, you will experience the “presence” of the whale best by playing the sound sheet at louder than usual volume.

For Roger Payne the songs symbolize both the majesty and the fragility of the sea. “We have learned,” he says, “that all men are created equal, but the whales remind us that all *species* are created equal—that every organism on earth, whether large or small, has an inalienable right to life.

“Our belated concern for whales is helping to save them from extinction by commercial hunting, but how are they to survive if we destroy the oceans themselves? Pollution has replaced the harpoon as a mortal threat to whales, and in its way can be far more deadly. If we ignore the dangers of tanker spills, industrial contamination, and simple human carelessness, then nothing can save the whales. If that day ever comes, the exquisite songs you hear on this sound sheet will be voices not from the sea, but from the past.”

\*\*\*



NATIONAL GEOGRAPHIC PHOTOGRAPHER JOE BAILEY

Orchestrating a whale concert, Dr. Payne, left, and Jon Larimore, manager of the Geographic's Audiovisual Services Division, produce the master tape.

Jurasz, an independent researcher in Glacier Bay, Alaska, whose observations on “bubble netting” Sylvia Earle describes in the previous article. Chuck’s 12-year study has added significantly to our knowledge of whales. On a recent visit with Chuck I recorded the underwater sounds of a humpback in the act of “spinning its net.” Such sounds, which can be heard in the first selection of side two on the sound sheet, consist solely of expelled air. There are no accompanying social or vocal noises, which suggests to me that bubble netting is a deliberate act—that of a whale setting a trap.

#### Are We Killing Whales With Kindness?

Only a few years ago the chief threat to humpback whales was the men who hounded them dangerously close to extinction. Today international agreement forbids the killing of humpbacks, but in some areas man threatens to love them to death.

In Hawaii increasing numbers of well-meaning tourists now converge on the breeding grounds in small boats to observe and photograph the great creatures at close range. Observation can sometimes edge over into harassment, which is illegal under both the Marine Mammal Protection Act and the Endangered Species Act.

In 1976 I tackled the problem with Nixon Griffis, a longtime friend of humpbacks. Together we called on Elmer Cravalho, mayor of Maui County, who appointed Jim Luckey, manager of Maui’s Lahaina Restoration Foundation, to be chairman of a citizens’ committee to explore the problem. The result is an official organization to educate the public and so prevent harassment of the whales. Thus the citizens of Maui have taken a major initiative in generating local government and citizen concern for protecting a marine mammal on the endangered species list.

Plans are now under way to establish a Pacific Marine Research Center at Lahaina with support not only from Hawaiians but also from worldwide subscription.

Happily for whales, such efforts are on the increase. One recent development may have spread the songs of humpbacks not just from the oceans to the land, but throughout the galaxy. In late summer of 1977, Voyagers 1 and 2—spacecraft launched from Cape

Canaveral, Florida, toward other worlds in our galaxy—carried aboard unique recordings that included the works of Bach, Mozart, and a rock group, as well as a section entitled “The Sounds of Earth.”

In the latter section delegates from 60 member countries of the United Nations offered a greeting in 55 languages. The messages were followed by a somewhat longer “greeting” from a humpback whale, recorded by Katy and me off Bermuda in 1970. In some ways this constitutes a step beyond all my dreams, in seeing whales become a symbol for the hope that there is still intelligent life on earth.

The expected lifetime of the records is a billion years. Should they be encountered by some other space-faring civilization, they would bear a message that had lasted longer than perhaps any other human work.

Could it be that mankind is simply the humpbacks’ guarantee that its songs will be heard throughout the galaxy? □



Following humpback “scores” on charts called spectrograms, Katy Payne, the author’s wife, found that the whales compose new songs each year, improvising on their old ones—an indication of uncanny intelligence.

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JANUARY 1979 PAGE 24A



SONGS OF THE  
HUMPBACK  
WHALE

COMMENTARY BY  
ROGER PAYNE, Ph.D.  
RESEARCH ZOOLOGIST  
NEW YORK ZOOLOGICAL  
SOCIETY

SIDE 1  
33 1/3 RPM  
STEREO

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