

Whale talk: Song and dialect

Eavesdropping on whales, always a challenging enterprise, has now yielded family dialects as well as evolving songs. At the meeting in San Francisco of the AAAS, Roger and Catherine Payne and colleagues continued their description of humpback whale songs (SN: 1/13/79, p. 26). However, a researcher from the University of British Columbia reported on a quite different vocal repertoire recorded among killer whales.

Groups of killer whales, even those with overlapping ranges, call with distinct dialects, says John K. B. Ford. The social organization of the whale has been described by Michael Bigg and co-workers at the Pacific Biological Station who identify individual whales from photographs showing the color pattern, nicks and scars on the dorsal fin. They find that the killer whales maintain stable family groups, called pods, which contain up to 40 individuals.

Loud screams, peer-toned whistles and echolocation-type clicks are included in the abundant underwater vocalization of killer whales. Ford has recorded from 12 different pods the screams of rapidly generated pulses that he calls stereotype calls. These S-calls make up more than 85 percent of the sounds emitted by foraging whales, which scatter over an area of up to 10 square kilometers and move at the same pace and in the same direction and exchange 20 or more calls per minute.

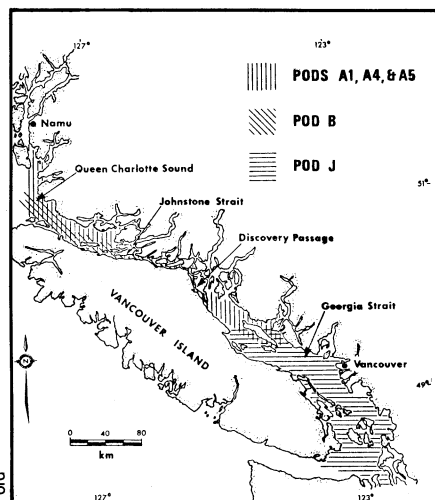
Each pod of killer whales has a repertoire of 10 to 15 different S-calls, Ford finds. Within each pod a few S-calls dominate, while others are emitted only sporadically. The calls often occur in series, as if the call of one animal triggers the same call from other whales in the pod.

Different pods call in distinct dialects. Three pods, called A1, A4 and A5, which often travel together and may represent one extended kinship group, share a repertoire of 13 S-calls. Another pod, called B, sometimes travels with one or more of the A pods and makes at least 9 S-calls, only one of which resembles an A-pod call. Even when the pods travel together, each adheres to its own stereotype repertoire.

Another pod of killer whales, pod J, has minimal contact with the A and B pods. "Pod J really does sound remarkably different," Ford says. It has 11 S-calls, none of which resemble those of the A or B pods.

The separate call repertoires, far more varied than those found between adjacent populations of birds, may permit members of a pod to maintain contact with each other while traveling with other pods and could help preserve group identity, Ford says. In eight years of observation, no whales have been seen to leave the pod into which they were born.

It is tempting to speculate that the calls communicate information to coordinate movement of the foraging whales, which



Kinship groups of killer whales use distinct repertoires of calls although some groups (such as the A pods and pod B) often travel together.

are often out of sight of one another yet change direction in unison. Only one S-call so far has been associated with a particular behavior; one call of the A pod is only given during "group-resting," when the animals form a tight group and make long, slow, synchronous dives.

Unlike the songs of the humpback whale, the killer whale calls do not vary over time. Ford says that recordings from 1964 of whales in the range now inhabited by the A pod contain the entire repertoire of the current A-pod whales and no other S-calls.

Continuing work on the much longer, more complicated and continually evolving songs of the humpback whale is focusing on the songs' relation to behavior. Mounting evidence indicates that only males sing. Photographs of patterns on the tails' underside has allowed the identification of more than 250 individual humpback whales, reports James D. Darling and Kenneth S. Norris of the University of California at Santa Cruz. By recording the activities of identified whales each time they are sighted, they deduced some sex roles for the whales. (Usually a whale's sex cannot be determined when the animal is observed in the ocean.) Most whale social roles, such as being alone or part of a trio or part of a larger group, are open to all individuals. However, in no case has Darling observed singing by any animal that was ever seen with a calf (and therefore known to be female). Similarly, Darling observes "escorting" of a cow and a calf only by animals (presumably male) never seen with a calf themselves.

Interactions of singing humpback whales and nearby animals are being described by Peter Tyack of Rockefeller University. He believes the song, as in other animals, acts to space males and to attract females for mating. Tyack and colleagues

developed a new technique to chart whale song and behavior. Observers in small boats follow the whales and record their songs, while observers on a coastal hilltop trace the whale and boat movements with surveyors' instruments.

Most singing whales appear to be lone males and the singers are evenly spaced. They often pursue nearby non-singing whales and when they join others they stop singing. The singing role is interchangeable; a non-singing animal joined by a singer, for instance, may begin singing itself when again alone. Tyack has observed behavior associated with courtship after a singer meets with a female, and also aggressive behavior between singing and non-singing whales. The duration of song bouts is shortest when the largest number of receptive females is present, again suggesting a relation to reproductive behaviors. During their next observation, the scientists plan to play recordings of the songs to the whales in an attempt to identify any reaction. □

'Safe' sedatives and pregnancy

A pregnant woman's heavy use of certain drugs, alcohol, tobacco or other substances can have noticeable, and at times severe, effects upon the unborn child. Perhaps the most disastrous example of this was thalidomide, a sedative that triggered unanticipated, grotesque anatomical defects in newborn children. Since then, it has become apparent that use of everyday substances such as alcohol and cigarettes can contribute to the birth of smaller babies as well as to other deficiencies.

But what of the user of small or moderate amounts of today's "acceptable" substances? Can two or three glasses of wine with dinner, an occasional cigarette or sleeping pill do any harm? The answers are not yet known, at least among human beings. Newly reported animal studies, however, show that even minimal, three-day doses of what is believed to be a safe sedative can produce "striking and permanent effects upon reproductive functions," says Sumner J. Yaffe of the University of Pennsylvania and Children's Hospital in Philadelphia.

Yaffe administered phenobarbital to female rats for three days late in their 21-day pregnancy periods. The drug doses were smaller than those required to actually cause the animals to sleep, he says. Yet, after following the injected rats' offspring for 90 days (into adulthood), Yaffe reports that "close to 100 percent" of the offspring suffered some type of delayed abnormality in their development. "Even though these are animal experiments... the implications are great," Yaffe says. "We think we've seen permanent effects by... a commonly used drug in our society—[one of] a vast number of psychotropic drugs

taken by many women during pregnancy."

In his report at the AAAS meeting, Yaffe described the drug's effects on the offspring of the phenobarbital treated rats:

- From the end of weaning to the maximum growth spurt in adulthood, the rats in the treatment group were significantly smaller than the control animals.

- A delay in vaginal opening times for female offspring occurred at the onset of puberty.

- In adulthood, just one-third of the female offspring had regular menstrual cycles, compared with 100 percent of the controls.

- Such abnormal cycles were associated with infertility in 60 percent of the females.

- Estrogen concentrations were higher before puberty and during adulthood in treated animals' offspring; progesterone concentrations were also higher before puberty.

While it is not known exactly how phenobarbital interacts with the fetus to produce such abnormalities in later life, Yaffe suggests that the drug somehow alters the "thermostatic setting" of the neuroendocrine system. "Something reaches the brain of the fetus," he says, producing a "permanent effect."

Phenobarbital, Yaffe notes, is an "old drug" that has been accepted and used for years as a sedative and anti-anxiety medication, although Valium (diazepam) has replaced it as the most widely used anti-anxiety drug. Although it was determined years ago that phenobarbital presented no apparent danger of gross anatomical malformation to most unborn babies, Yaffe suggests that few researchers have tested it or many other psychoactive drugs for more subtle, delayed effects from small dosages during pregnancy.

One study that has examined such possible effects of morphine and methadone was performed recently at the University of Vermont. Researchers there gave single doses of one of the drugs to male rats one day before mating them with female rats. Despite waiting one day — "when you think the drug is no longer present," Yaffe says — investigators found the offspring of the treated male rats had "markedly decreased survival rates," he says. Other, similar results have also been seen in animal experiments with caffeine, the painkiller Darvon and other substances, he says. Yaffe speculates that the morphine or methadone may still be present in the animal's seminal fluid one day later or may somehow alter the sperm.

He is cautious about directly applying such study results to human pregnancies, but at the same time suggests that his work and that of others could have human implications. "The rats were given the drug [phenobarbital] late in pregnancy, beyond the period when they could lead to malformations [in offspring]," he says. Extrapolated to the human pregnancy period, the dosage given to the rats would be approximately equivalent to a woman

taking very small doses of the drug for three to four weeks in her third trimester.

Yaffe is already planning a similar investigation of the possible long-term effects of Valium upon offspring. "Any psychoactive drug might have an effect," he says. "There are some grounds for concern. The task of assuring the public of [drug] safety is even more difficult than it was before." □

Now — asteroid-caused extinctions

By a process of elimination, a 10-kilometer-diameter asteroid has been chosen most likely to have caused the death of the dinosaurs and other organisms 65 million years ago. The Cretaceous-Tertiary extinction, which is believed to have wiped out 50 percent of the plant and animal genera on earth, is the most recent of five mass extinctions that can be detected in the sedimentary record. It has been attributed to everything from an ice age to a supernova.

Seven months ago, Luis Alvarez, Walter Alvarez and co-workers reported evidence that the cause of the mass extinction was "more extraterrestrial than terrestrial" (SN: 6/2/79, p. 356). Since then, they have ruled out the popular supernova theory and discarded most other extraterrestrial events. At the AAAS meeting, they reported their observations best fit the following scenario: A 10-kilometer-diameter asteroid hit the earth with the force of 100 megatons of TNT, producing a crater 175 km in diameter. Pulverized rock from the asteroid and the crater filled the stratosphere with dust and blocked sunlight from the planet for three to five years. Photosynthesis halted; land plants and marine plankton went dormant or died. With the base of their food chain gone, animals that could not adapt to a diet of nuts, seeds and decayed plants vanished.

Then, say the researchers, the asteroid dust settled to earth. Eons later, Alvarez and co-workers believe they have found that layer of dust. In a layer of clay found in limestones from Gubbio, Italy, and Stevns Klint, Denmark, Alvarez and co-workers found 30 and 160 times, respectively, the amount of the element iridium found in other layers. In both cases, the jump in iridium exactly coincides with the time of the extinctions. Iridium is an element that can only have an extraterrestrial origin because all the earth's iridium is concentrated at its core. Small amounts of the element drift in from space and some is added in large doses by meteors.

The most obvious explanation for the excess iridium is a supernova that destroyed life by a burst of cosmic radiation. Such an explosion should have left a predictable amount of plutonium 244, an isotope with a half-life of 83 million years, and a certain ratio of iridium 191 to iridium 193. But, as preliminary results suggested

last spring, the researchers found no evidence for either. In addition, the requisite supernova would have had to explode about one-tenth of a light year away, more than 40 times closer than the nearest star is today. That possibility, say the researchers, is "vanishingly small." The scientists similarly found problems with other extraterrestrial explanations, such as oxygen depletion by passage through a gaseous nebula or an encounter with Jupiter.

Though no appropriately sized crater has been found, the asteroid theory is supported by several lines of evidence. For example, the calculated number of times the earth might have encountered an asteroid of the proposed size is plausible — about every 100 million years. In addition, the debris from the impact should have deposited a clay layer in sedimentary rock that is chemically different from adjacent layers. Such a layer is found in their samples, the researchers say. It is the layer that contains the excess iridium. Confirmation of the theory, say the scientists, depends on finding iridium excesses that mark other mass extinctions. □

Chemical analogies between the stars

The chemistry of the interstellar molecular clouds, so far as it is known, does not include a large variety of elements. Most of the interstellar molecules are made of just four elements from the first two rows of the periodic table: hydrogen, carbon, nitrogen and oxygen. The most important exception to this rule is sulfur, according to R. A. Linke and M. A. Frerking of Bell Telephone Laboratories in Holmdel, N.J., and Patrick Thaddeus of the Goddard Institute for Space Studies in New York, writing in the *ASTROPHYSICAL JOURNAL* (Vol. 234, p. L139).

Sulfur is particularly interesting because sulfur compounds form analogs of oxygen compounds, one oxygen atom being replaced by a sulfur atom in the given structure. This characteristic fits the two newest interstellar sulfur compounds identified by these three astronomers in the cloud Sagittarius B2: methyl mercaptan (CH₃SH), the analog of methyl alcohol (CH₃OH), and isothiocyanic acid (HNCS), the analog of isocyanic acid (HNCO). With six atoms, methyl mercaptan is the "most complicated sulfur molecule yet detected in space." Linke, Frerking and Thaddeus also point out that methyl mercaptan is a malodorous gas familiar on earth as a product of organic metabolism and that sort of effluent. It is also used industrially in the manufacture of a number of organic compounds, "in particular the amino acid methionine."

The last remark is a reference to the sort of organic compounds every observer would dearly love to find in interstellar