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UNDERWATER SOUNDS FROM RIBBON SEAL, *PHOCA (HISTRIOPHOCA) FASCIATA*[1]

Intense downward frequency "sweeps" and broadband "puffing" sounds were recorded underwater in the presence of ribbon seal, *Phoca (Histriophoca) fasciata* Zimmerman 1783. The recordings were made in the waters off Savoonga, St. Lawrence Island, Alaska, on 16, 17, 18, and 23 May 1967.

The seals were encountered in the final ice of the spring made up of windrows of small to moderate floes mixed with brash ice, and with stretches of up to 1 km of open water between. On this ice typically occur adults and pups of a variety of other pinniped species (*Phoca largha, Erignathus barbatus, Pusa hispida,* and *Odobenus rosmarus*), but during the spring of 1967 there was a preponderance of *Histriophoca* in this area. This is reflected in the records of the pinniped harvest for this area (Alaska Department of Fish and Game) which show that *Histriophoca* usually composes less than 2% of the catch, but in 1967 it made up 60% of the harvest and most of the *Histriophoca* were caught during the last half of May. The 1967 underwater recordings showed similar differences, contrasting sharply with previous years when *Erignathus* dominated the underwater sound ambient (Ray et al. 1969).

Relatively little is known of the behavior of *Histriophoca* (cf. Scheffer 1958; King 1964). Breeding assemblages occur on ice that rarely approaches shore (Burns 1970) and other social behavior may mostly occur in the water.

Instruments and Methods

Underwater sounds were recorded with a Chesapeake Instrument Corp.[2] hydrophone system and a Nagra III B tape recorder whose combined response was 50 Hz to 18 kHz (±2 dB, decibels). The sounds were studied by means of a Kay Elemetrics 7029A spectrographic analyzer and time sequences were measured by a Tektronix 565 oscilloscope.

To make the recordings, appropriate *Histriophoca* habitat in the sea ice was located with the aid of Eskimo hunters, and their skin boat was allowed to drift with the ice while the hydrophone was in the water. Only a few of these seals were seen as we approached, and they always submerged and were difficult to find again. However, some of their underwater sweep sounds were loud enough to be audible in air, implying that these seals were not far away.

Taped sequences of 5 to 8 min duration were analyzed from each of nine locations over 4 days of field study. Higher level underwater sounds, presumably from nearby seals, were analyzed and compared with background lower level sounds. Sounds from distant animals were not used for detailed analysis.

As is usually the case with underwater record-

[1]Contribution No. 3753 from the Woods Hole Oceanographic Institution.

[2]Reference to manufacturers does not imply endorsement by the National Marine Fisheries Service, NOAA.

ings, the attribution of these sounds to *Histriophoca* is circumstantial since they are underwater sounds from animals out of sight below the surface. These sounds are unlike sounds attributed to any of the other animals known to inhabit the area: gray whales (Asa-Dorian and Perkins 1967; Cummings et al. 1968; Fish et al. 1974), walrus (Schevill et al. 1966; Ray and Watkins 1975), and the ringed seal and spotted seal (Schevill et al. 1963; Stirling 1973; Ray pers. obs.). The bearded seal, *Erignathus barbatus,* was seen at times in low numbers during May 1967; some of the recordings have a background that we recognize as from *Erignathus,* but we eliminate it because: 1) the *Histriophoca* sounds are very different from the *Erignathus* sounds heard at this season (Ray et al. 1969); 2) in previous years when only *Erignathus* was nearby, none of the *Histriophoca* sounds was heard; 3) *Histriophoca* sounds were heard in the presence of these seals whether *Erignathus* were audible or not; and 4) none of these sounds were heard unless *Histriophoca* were observed in the area.

The recordings were made in a variety of ice conditions and ice is known to produce sounds underwater (Schevill 1966; Watkins and Ray pers. obs.). The seal sounds did not vary with the ice and did not match the kinds of sound we associate with ice.

Underwater Sounds

Two types of underwater sounds were heard in the presence of *Histriophoca:* a relatively intense prolonged downward sweep in frequency and a broadband puffing sound. These calls were heard sporadically, with no obvious pattern to repeated sounds nor to any answering calls. Nearby seals could be heard at least once in 2 min and often there were enough seals in audible range so that when calling was most frequent we recorded 3 to 5 calls in 10 s. Since the seals were out of sight and probably underwater during the recordings, we could not correlate the sounds with behavior.

The sweep sound (Figure 1) varied in frequency from 7 to 0.1 kHz in downward sweeps of 2 to 5 kHz each. Of the 120 sweep sounds measured, all but one could be separated into three length categories (Figure 2), each with somewhat different starting and ending fundamental frequencies:

Short sweeps,	1 s or less,	sweeping from 2000-1750 Hz to 300 Hz.
Medium sweeps,	1.3 to 1.8 s,	sweeping from 5300-2000 Hz to 100 Hz.
Long sweeps,	4 to 4.7 s,	sweeping from 7100-3500 Hz to 2000 Hz.

Short sweeps were common in the background ambient sound, but only a few were heard from nearby seals (16 measured). Midlength sweeps were the ones most often heard from local seals (84 measured), and some of these began with a short segment of sound at constant frequency for the first 0.1 to 0.2 s before beginning the downward frequency sweep (Figure 1). The long sweeps were not particularly abundant but were conspicuous

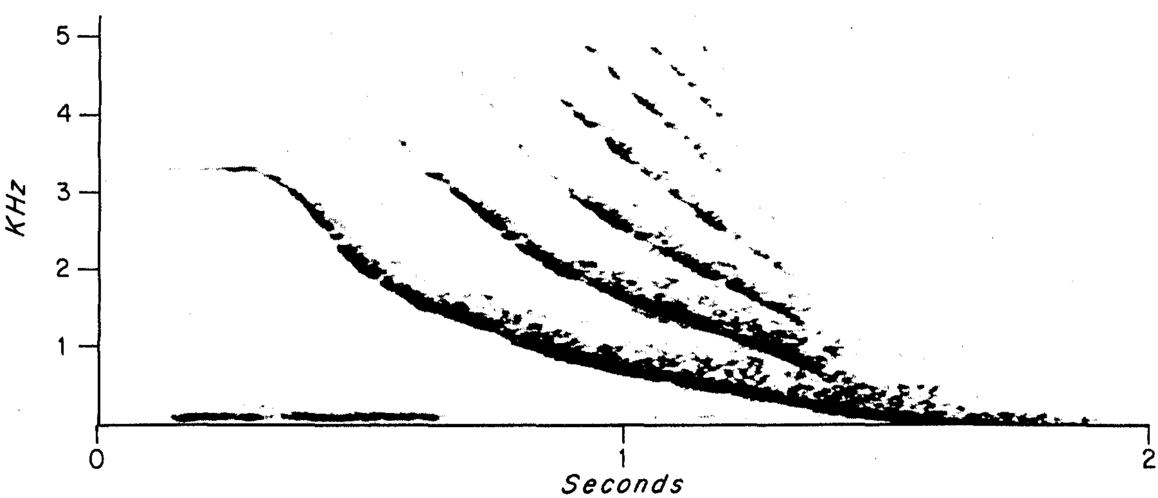

FIGURE 1.—The midlength sweep sound of *Histriophoca* often has a short portion of constant frequency before it begins to sweep downward in frequency. Analyzing filter bandwidth was 45 Hz. Analyses of short and long sweeps (not figured separately) were generally similar in character to the midlength sweep.

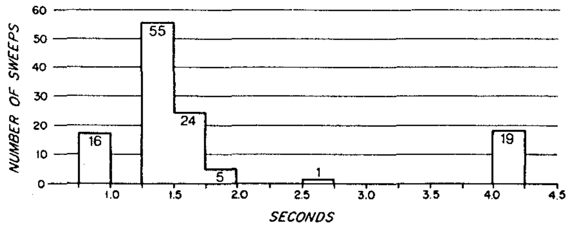

FIGURE 2.—Lengths of 120 sweep sounds from *Histriophoca* separate all but one (at 2.75 s) into three categories.

(19 measured) because of the higher frequency ending. Harmonics (up to 6 or more) were consistently present in the spectrographic analyses of even low-level sweep sounds, and appear to be a result of the pulsed character of the seal sounds (Watkins 1967).

Since we never knew the distance to calling seals, we did not have accurate acoustic source levels for these sounds. Some sweeps overloaded the recording system at the usual gain settings and therefore were received at levels estimated in excess of 40 dB (re 1 volt/dyne·cm^2). Assuming a 60-65 dB source level at 1 m and spherical spreading losses, these very loud sounds were sometimes from animals that were only 15 to 20 m from the hydrophone. Sounds of each type and length category were heard from distant as well as nearby seals so that none of these sounds were characteristic of a particular seal.

A second type of underwater sound which we associate with *Histriophoca* was a broadband puffing sound with frequencies below 5 kHz and lasting a little less than 1 s (Figure 3). This was somewhat reminiscent of some seal respiratory sounds, but it was not audible in air and we could not correlate them with respiratory activity. The puff sounds were 20 to 25 dB lower level than the sweeps.

Discussion

The downward sweeping frequency and pulsed quality of the sounds is characteristic of many underwater calls of other seals: *Erignathus barbatus* (Ray et al. 1969), *Leptonychotes weddelli* (Ray 1967; Schevill and Watkins 1965, 1971), *Pagophilus groenlandica* (Watkins and Schevill in prep.), *Pusa hispida* (Stirling 1973), *Arctocephalus philippii* (Norris and Watkins 1971). Coincident with spring reproductive activities, most of these pinnipeds produce striking underwater acoustic signals and greatly increase their calling. Ovulation normally occurs from mid-April to mid-May in *Histriophoca* and adult males remain sexually potent through early June (Burns[3]). Analogy to these other pinnipeds suggests similar social functions for the underwater sounds of *Histriophoca,* in reproductive and/or territorial behavior.

[3]Burns, J. J. 1969. Seal biology and harvest. Marine Mammal Investigations. Fed. Aid Completion Rep., Alaska Dep. Fish Game 10:1-25.

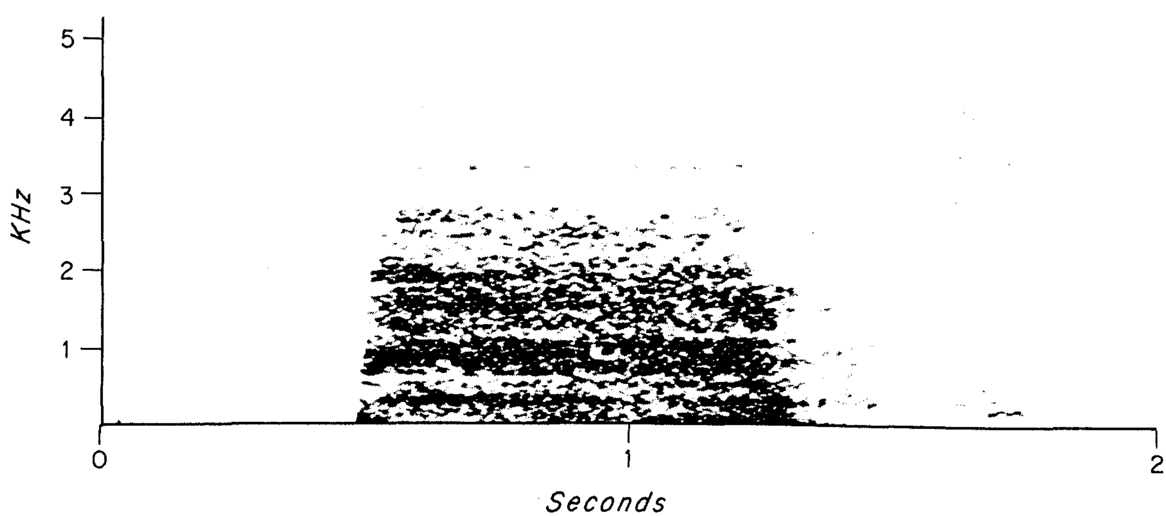

FIGURE 3.—The "puffing" sound of *Histriophoca* is not related to any respiratory activity but is an underwater sound with broadband characteristics that are quite variable. Analyzing filter was 45 Hz.

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OBSERVATIONS ON FEEDING, GROWTH, LOCOMOTOR BEHAVIOR, AND BUOYANCY OF A PELAGIC STROMATEOID FISH, *ICICHTHYS LOCKINGTONI*

Stromateoid fishes (Order Perciformes) occur in either coastal or oceanic regions of the sea. Inhabitants of the latter region are generally rare and sporadic in occurrence, especially as adults. Many of the oceanic species have particular adaptations for pelagic existence (Horn 1975) and their frequent association with floating objects, especially coelenterates (scyphomedusae and siphonophores), is well documented (e.g., Mansueti 1963; Haedrich 1967; Bone and Brook 1973; Horn 1975).

The live capture and successful laboratory maintenance of a juvenile *Icichthys lockingtoni* Jordan and Gilbert (family Centrolophidae), an oceanic fish of the North Pacific, provided the first opportunity to record the feeding, growth, and locomotor behavior of this pelagic stromateoid and, upon the death of the fish, to measure its buoyancy and lipid content (as a factor in buoyancy). In this paper, the laboratory rearing and maintenance of oceanic stromateoids are briefly reviewed, and the adaptive strategy of *I.*