Aquatic Mammals 1989, **15.3,** 87–88

Letters to the Editor

Sir,

The biological sonar system of odontocetes allows them to gather relevant information about their surroundings: obstacles, food and accompanying animals. Their sonar system can be either a passive one or can be actively used. In the latter case the animal is echolocating in its environment by means of a specifically structured acoustic signal. In this way it uses both its sound-producing capabilities and its auditory system to reveal acoustic features that are of prime interest.

Limitations on the performance of this active process of echolocation are determined not only by the perceptual faculty of the animal, but also by the specific emitted signal. The auditory sensitivity of odontocetes has been a subject of thorough investigation since 1966. It does appear that the established excellent auditory capabilities to perceive signals in the order of up to some 150 kHz give sound reasons to stipulate that the used echolocation frequencies are in the same frequency range (Dubrovskii *et al.*, 1971; Popper, 1980).

However, our knowledge and understanding of dolphin sonar is far less complete than our knowledge of dolphin hearing (Ridgway, 1982). Maybe the reason could be the lack of—expensive—equipment in the laboratory and in the field or maybe it is a different approach on the part of researchers to the understanding of sonar.

In any case, looking for an answer in literature, we note an extensive interest in theories about the mechanism of sound production and only minor attention to the sonar signal problems, although there should be a close relation between the two. We need to fill up the gaps in sonar descriptions, especially in the case of wild dolphins. Therefore, it is disappointing to have to state that several opportunities to obtain high quality recordings were missed. To cite one of them: Morris & Lockyer (1988), who studied a juvenile wild bottlenose dolphin SIMO, made 'a range of underwater recordings of the animal's underwater acoustic emissions'. These recordings were made with a NAGRA IVSJ, covering a recording bandwidth up to 35 kHz, whereas Morris on page 387 in Bryden & Harrison's *Research on Dolphins* (1986) indicates: 'dolphins emit up to 200 kHz'.

In fact, the 35 kHz bandwidth recording apparatus then causes the dolphin's high frequency sonar sound to be subjected to some kind of a low-pass filter with a grossly nonlinear amplitude response. Probably, the authors did not grasp the simple advice on underwater sound recording (as was already brought forward in 1973) in the articles of the JASA by Diercks, Trochta & Evans: 'Adequate bandwidth is the prime requisite for validity in (delphinid sonar) measurements' and, more recently, the self-evident remarks of Watkins & Wartzok (1985): 'good bioacoustic records need among other things the use of equipment suitable in bandwidth, dynamic range, sensitivity and cable impedance for the particular recording intended'.

Maybe we should not only complete the list as compiled by Watkins & Wartzok, but add to the

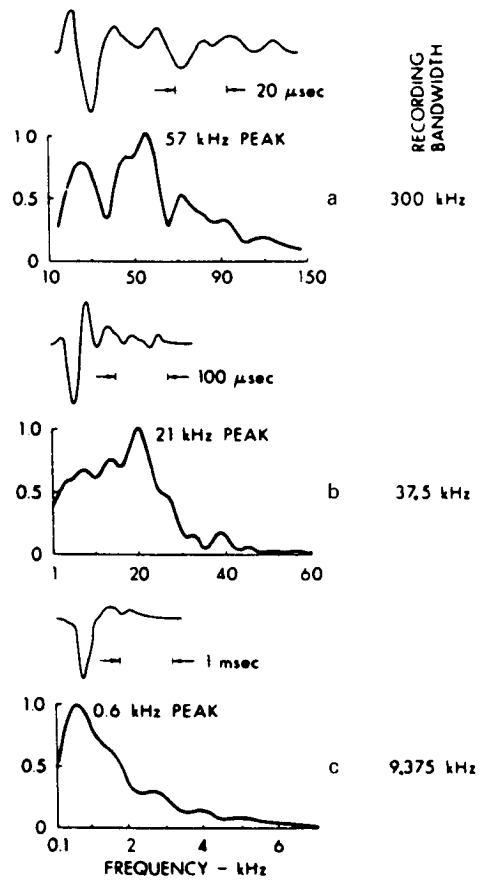

Figure 1. Demonstration of effects of inadequate bandwidth recording. Top: simulated dolphin-like click. (a) Nominal bandwidth; (b,c) Reduced bandwidth recording. Taken from *JASA* (1973), **54(1),** p. 202.

validity of the sound recordings with a note on the bandwidth.

The effects of recording with inadequate bandwidth are clearly illustrated in Figure 1, where a simulated dolphin-like click is submitted to recording at reduced bandwidth. Figure 1b would then easily lead to an explanation for the description of a click as: 'complex, structured, broad-band pulse containing most energy between 6–24 kHz' (Morris & Lockyer, 1988). Or perhaps, do we face here different acoustic behaviour from SIMO in British waters as opposed to that of Jeanne Louise along the coast of Brittany? (Kamminga, in press).

It is a pity to have to state that the cited example is not the only one, although it is the most recent one in quite a list. A hundred to one chance was missed in getting a perfect full bandwidth recording of *Lipotes vexillifer* (the Chinese river dolphin) when Jing Xianying *et al.* (1981) (p. 408) recorded underwater acoustic signals with a frequency bandwidth of up to 30 kHz. Let us hope that in the near future there will be an opportunity to register the entire acoustic spectral range of this rare dolphin species in a proper way.

The marvellously filmed Cousteau expedition to the Amazonas in 1982 illustrates how a special chance was missed in the full range recording of wild dolphins, held temporarily in captivity. Even in the eighties the audio bandwidth limited NAGRA still seems to be the ultimate in ultra-sonic sonar recording

In my opinion, the above-mentioned points illustrate that more cooperative interaction between different disciplines in delphinid research is needed; this type of research must be indeed multidisciplinary! Let us not deny that an adequate description of acoustic behaviour does not end with a qualitative description but also comprises biochemistry, psychophysics, biomathematics and much more.

C. KAMMINGA

References

Diercks, K. J., Trochta, R. T. & Evans, W. E. (1973). Delphinid sonar: measurement and analysis. *J. Acoust. Soc. Am.* **54(1),** 200–205.

Dubroviskii, N. A., Krasnow, P. S. & Titov, A. A. (1971). On the emission of echolocation signals by the Azov sea harbour porpoise. *Soviet Physics—Acoustics*, **16(4),** 444–448.

Jing Xianying, Xiao Youfo & Jing Rongcai (1981). Acoustic signals of the Chinese river dolphin (*Lipotes vexillifer*). *Scientia Sinica* **24(3),** 407–415.

Morris, R. J. (1985). The acoustic faculty of dolphins. In: M. M. Bryden & R. J. Harrison (eds), *Research on Dolphins.*

Morris, R. J. & Lockyer, C. (1988). A juvenile wild bottlenose dolphin. *Aq. Mamm.* **14(2),** 49–63.

Popper, A. N. (1980). Behavioural measures of odontocete hearing. In: R. G. Busnel & J. F. Fish (eds), *Animal Sonar Systems.* New York, Plenum Press, pp. 469–483.

Ridgway, S. H. (1983). Dolphin hearing and sound production in health and illness. In: R. R. Fay and G. Gourevitch (eds) *Hearing and other senses: Presentations in honour of E. G. Wever.* The Amphora Press, pp. 247–297.

Watkins, W. A. & Wartzok, D. (1985). Sensory biophysics of marine mammals. *Marine Mammal Science* **1(3),** 219–260.