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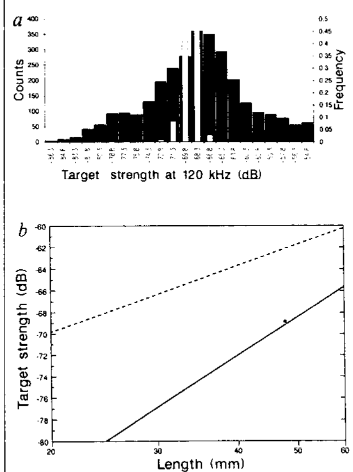
# Krill abundance

SIR — Antarctic krill (*Euphausia superba*) is the primary food source for many animals in the southern ocean and is also the basis of a large fishery. To manage this resource, krill abundance has been estimated directly with acoustics and indirectly with estimates of predator consumption rates. However, the abundance estimates using acoustics are often an order of magnitude less than those based on predator consumption rates[1]. The acoustic method converts echo energy to absolute biomass by assuming that the echo return is the sum of individual scatterers, and by assuming an empirical or modelled acoustic target strength (TS) for individual krill. Everson *et al.*[2] and Greene *et al.*[3] reported new TS measurements of experimentally constrained krill, but to date no corroborating field data have been published. We present new *in situ* TS measurements of krill obtained in March 1991 off Elephant Island, Antarctica.

Foote *et al.*[1] ensonified live krill aggregations in a cage at 120 kHz. The mean single-animal target strength of krill (lengths 30–39 mm) was inferred from the aggregation backscatter to range from −81 to −74 dB. Past acoustic surveys have typically used TS values calculated using the equations from the BIOMASS[4] program, but these equations lead to gross underestimates of krill abundance[2].




*a*, TS distribution for 2,957 individual krill detected with a Simrad EK500 echo sounder and a 120-kHz split-beam transducer off Elephant Island, Antarctica in March 1991. Solid bars, *in situ* measurements; open bars, distribution predicted from the sampled distribution of animal lengths. *b*, TS by length relationship at 120 kHz. Solid line reproduced from ref. 3. Also plotted are the median length and TS from the Foote *et al.* experiment (open circle)[1], the data reported here (solid circle), and the BIOMASS equation (dotted line).

Until recently, a fluid sphere model was thought to characterize adequately the acoustic TS of krill. Wiebe *et al.*[5] ensonified several species of live, but tethered, zooplankton at 420 KHz and concluded that sound scatter from elongated animals is better described by a bent cylinder model[6] and that TS is proportional to the volume of an animal rather than its cross-sectional area. Using these data, Greene *et al.*[3] predicted krill TS at several frequencies and over a range of animal lengths. The Foote *et al.* data agree with the TS prediction for a mean animal size of 33 mm. Because the bent cylinder model predicts that TS is much more sensitive to animal length than would be expected with the fluid sphere model, additional measurements of krill TS, particularly at different lengths, could provide strong corroboration of refs 1 and 3.

We present *in-situ* TS measurements of krill (mean length = 47.44 mm, $\sigma$ = 2.92), around Elephant Island (*a* in the figure). Zooplankton sound scattering depends upon the morphology of the animal as well as its size, shape and orientation[5]. The spread of the distribution is likely due to the size distribution and variable orientation of the ensonified krill. Some of the high TS observations may be from multiple krill erroneously identified as individual scatterers. Nonetheless, the distribution is centred on −69dB, within 1dB of the prediction by Greene *et al.* Furthermore, the slope between the Foote *et al.* data and the data presented here is in accordance with that predicted by the bent cylinder model.

The TS of 47.44-mm krill estimated from the BIOMASS equations is −62.3 dB, 6.7 dB above the modal value of the measurements reported here. Thus, for a population composed of 47.44-mm individuals, abundance estimates using the mean TS reported here would be 4.7 times higher than that estimated with the BIOMASS value.

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