

## Acoustic properties of *Salpa thompsoni*.

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### EXTENDED ABSTRACT

Salps are common members of the world oceans planktonic community (Madin, et.al., 2006). In the southern ocean, both krill (*Euphausia superba*) and salps (*Salpa thompsoni*) can occur in dense aggregations (Loeb et al, 2009, Atkinson et al. 2004, Woodd-Walker et al., 2003). Krill, an important part of pelagic food webs, are prey of many Antarctic marine mammal, sea bird, penguin, and fish species. They are also subject to a significant fishery. Each year there are krill surveys using high frequency acoustics scattering techniques supplemented by ground truthing with macrozooplankton nets and pelagic trawls to provide the data from which sound scientific advice about harvesting levels can be made (Madureira et al, 1993; Brierley and Waktins, 1996; SC-CAMLAR, 2000). While salps do not often form krill-like aggregations, they do aggregate and form dense layers like those that krill are also known to occur in. Recent studies suggest that the salps have an acoustic frequency response similar to that of krill and the ability to discriminate the two groups was a problem (Woodd-Walker et al., 2003). Our study was undertaken to understand how this might be possible.

Aggregations of the salp, *Salpa thompsoni*, were encountered in the vicinity of Bouvet Island (54° 26'S; 3° 24'E) during the Antarctic krill and ecosystem studies (AKES) cruise on the Norwegian research vessel G.O. SARS from 19 February to 27 March 2008. Individuals were collected with a "Krill Trawl" with the 5-net Multi-sampler (Engås et al. 1997; Skeide et al. 1997), with a "Macroplankton Trawl" with a single cod-end, or with smaller vertical net tows (Juday and WP2). A subsample of the salp catch from the trawl and net tows was taken for weight and length measurements.

The salp's in situ target strength (TS), size, number of individuals in aggregate chains, and chain angle of orientation were determined from acoustic and optical data collected with a submersible TS-sonde instrument. This instrument package carried an EK 60 down-looking echo sounder operating at three frequencies (38, 12-0, 200 kHz) and a pair of digital 12.1 megapixel Sony cameras, and was deployed to 20 to 50 meters depth.

Shipboard measurements were made of *Salpa thompsoni*'s material properties -sound speed contrast  $h$  and density contrast  $g$  - using the Acoustic Properties Of zooplankton (APOP) system to measure the sound speed contrast and the dual-density method to measure the density contrast (Chu and Wiebe, 2005).

An acoustic scattering model based on the Distorted Wave Born Approximation (DWBA) developed in Chu et al. (1993) and Stanton et al. (1993) was used to describe the backscattering of the aggregate salps and to compare the theoretical predictions with the observed backscattering from the TS-sonde.

*Salpa thompsoni* was abundant over a large ocean area around Bouvet Island and in the survey area further to the north. During the day acoustic layers in which trawl catches were dominated by salps ranged from 60 to 120 m. Aggregates of *Salpa thompsoni* occurred typically in chains of individuals that were mostly 45.5 to 60.6 mm in mean length and comprised most of the salp biomass; the relatively rare solitaries were about 100 mm. Chains ranged from 3 to at least 121 individuals and in the upper surface waters (<20 m) at night showed no preferred angle of orientation.

Salp sound speed contrast (h) ranged from 1.006 to 1.0201; the density contrast (g) estimates varied between 1.0 and 1.0039. The in situ TS-distributions peaked between -75 and -76 dB at 38 kHz, with a secondary peak of stronger targets at ~-65 dB. TS ranged between -85 and -65 dB at 120 kHz and 200 kHz, and peaked around -74 dB. The measured in situ TS of salps with TS-sonde at three frequencies match the Distorted Wave Born Approximation theoretical scattering model predictions reasonably well.

A primary conclusion is that the backscattering from salps when aggregates dominate the population is not from single individuals, but from the chains made up of multiple individuals. When this situation exists, salps can give rise to TS values that can be similar to krill and other zooplankton with higher density and sound speed contrasts.

Note: Complete details of the work described in this extended abstract are in a manuscript that has been submitted to the ICES Journal of Marine Science [Wiebe, P.H., D. Chu, S. Kaartvedt, A. (Hölter) Hundt, W. Melle, E. Ona, and P. Batta-Lona. Acoustic properties of *Salpa thompsoni*.]

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