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Correction of the estimation of the volume of copepods from 2-dimensional *in situ* images

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Abstract

Plankton images not only allow to classify organisms taxonomically but also to measure their size, which is then used to estimate their biomass. Accurate plankton biomass estimations are needed to quantify their role in ecological processes and biogeochemical cycles; this is particularly true for copepods, which dominate mesozooplankton.

However, imaging devices only provide a 2D projection of 3D ob-18 jects. The assumptions made to retrieve a 3D volume and the diverse 19 orientations of the organisms relative to the camera *jii* in situ*jii* in-20 duce a bias in our estimation of volume. Here we present a method 21 to correct this bias. The body of copepods is modeled as an ellipsoid 22 of known volume, whose projected silhouette is mathematically de-23 rived. Samples of copepod bodies are simulated with a realistic size 24 distribution and random orientations, their volume is estimated from 25 their silhouette using two classic methods (Equivalent Spherical Di-26 ameter and best-fitting ellipse), and a correction factor is computed 27 for each, by comparing with the actual, known, volume. On real data, 28 individual orientations and volumes are unknown but the correction 29 factors still hold for the jb¿totalj/b¿ volume of a jb¿largej/b¿ num-30 ber of organisms. The correction is -22% for the spherical diameter 31 method and +12% for the ellipse method. 32

When applied to a database of 150,000 real ji¿in situ;/i¿ images of
copepods captured by the Underwater Vision Profiler, the corrections
decreased the gap between the two methods by a factor of 20.

Incidentally, we also propose more accurate techniques for surface
estimation and ellipse fitting.

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