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

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Abstract

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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.

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However, imaging devices only provide a 2D projection of 3D objects. The assumptions made to retrieve a 3D volume and the diverse orientations of the organisms relative to the camera *in situ* induce a bias in our estimation of volume. Here we present a method to correct this bias. The body of copepods is modeled as an ellipsoid of known volume, whose projected silhouette is mathematically derived. Samples of copepod bodies are simulated with a realistic size distribution and random orientations, their volume is estimated from their silhouette using two classic methods (Equivalent Spherical Diameter and best-fitting ellipse), and a correction factor is computed for each, by comparing with the actual, known, volume. On real data, individual orientations and volumes are unknown but the correction factors still hold for the $\sum V_{\text{total}}$ volume of a N number of organisms. The correction is -22% for the spherical diameter method and +12% for the ellipse method.

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When applied to a database of 150,000 real *in situ* 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.