FlowCam®

FlowCam Macro Publications Demonstrate its Value for Zooplankton Characterization in Aquatic and Environmental Research

Since they are such good indicators of a waterbody's biological condition, Zooplankton have long been the focus of aquatic ecosystem research. These small, aquatic microorganisms are sensitive to nutrient changes and, over time, can reveal how environmental and anthropogenic challenges impact our water systems[1]. FlowCam Macro is designed to capture superior images of visible particles in the 150 µm – 5 mm size range. It is proving to be the instrument of choice for zooplankton research and a significant time saver over traditional microscopy.

Herein, we highlight a selection of recent peer-reviewed journal articles demonstrating FlowCam Macro's value in zooplankton research. With advanced VisualSpreadsheet particle imaging analysis software, FlowCam Macro optimizes the counting, sizing, and morphological characterization of zooplankton. These features are especially relevant for accurate taxonomic identification and subsequent design of eutrophication mitigation strategies.

1. https://www.epa.gov/national-aquatic-resource-surveys/indicators-zooplankton

Carbon Budgets of Scotia Sea Mesopelagic Zooplankton and Micronekton Communities During Austral Spring

Cook KB, Belcher A, Bondyale Juez D, Stowasser G, Fielding S, Saunders RA, Elsafi MA, Wolff GA, Blackbird SJ, Tarling GA, Mayor DJ. *Deep Sea Research Part II: Topical Studies in Oceanography*. August 2023; 210:105296. doi: 10.1016/j.

This study investigates how the daily migration patterns of zooplankton influence carbon cycling in the South Atlantic. Net samples were used to calculate mesozooplankton and micronekton biomass values and ingestion and respiration rates– all factors that influence ocean biogeochemistry. Using FlowCam Macro, preserved mesozooplankton were imaged and manually classified into broad taxonomic groups. VisualSpreadsheet software abundance data were then used to calculate biomass values. Using FlowCam 8400 in auto-image mode, preserved microplankton samples taken from controlled laboratory copepod grazing experiments were counted, and concentrations were calculated. VisualSpreadsheet was used to create libraries of cell types and automatically classify particles into broad taxonomic groups.

FlowCam analysis of the mesopelagic zooplankton and micronekton communities helped the researchers present vertical biomass profiles and estimates of daily ingestion and respiration rates – adding to the overall understanding of biologically-driven carbon sequestration in the epi- and mesopelagic zones open sea ecosystems.

Carbon and Lipid Contents of the Copepod *Calanus finmarchicus* Entering Diapause in the Fram Strait and Their Contribution to the Boreal and Arctic Lipid Pump

Tarling GA, Belcher A, Blackwell M, Castellani C, Cook KB, Cottier FR, Dewar-Fowler V, Freer JJ, Gerrish L, Johnson ML, Last KS, Lindeque PK, Mayor DJ, Parry HE, Stowasser G, Wootton M. *Frontiers in Marine Science*. June 2022; 9:926462. doi: 10.3389/fmars.2022.926462

This study is the first attempt to estimate the size of the lipid pump in the Fram Strait region between Greenland and Iceland. Specifically, it focuses on how climate change-induced shifts to the distributional range of the copepod species *Calanus finmarchicus* (Figure 1) impact the estimated magnitude of the lipid pump in the region.

As part of this effort, FlowCam Macro was used to analyze samples collected from Bongo nets deployed at 14 stations spread throughout the Fram Strait region. The instrument captured images of individual copepods, which were then classified into taxonomic groups using VisualSpreadsheet software, allowing researchers to quantify the number of *Calanus* individuals within all Bongo net samples and estimate the total abundance of taxa across sampling stations. According to the researchers, FlowCam Macro provided reliable estimates of population sizes of late-stage *C. finmarchicus* in the surface layers of all sampled locations.

Use of Imaging Particle Analyzer (FlowCam) for Characterizing Metrics for Zooplankton

Nelson H, Broadway K, Detmer T, Potter C, Buerkens K. *Illinois Natural History Survey, Prairie Research Institute*. 2019; 9:926462. https://experts.illinois.edu/en/publications/use-of-imaging-particle-analyzer-flowcam-for-characterizing-metri

Evaluations of zooplankton body size, biomass, density, and community composition are critical for understanding ecosystem structure and function. The process of enumerating, identifying, and measuring zooplankton has traditionally been accomplished through microscopy, which can be time intensive and accrue high costs over time. Semi-automated methods are becoming an increasingly viable and cost-effective alternative to historical approaches.

This study presents an approach to studying zooplankton using the imaging particle analyzer FlowCam and FlowCam Macro, along with portions of a study conducted by the Illinois Natural History Survey that compared FlowCam and microscopy for characterizing mesozooplankton body size, biomass, density, and community structure.

Zooplankton Size Structure in Relation to Environmental Factors in the Xiangxi Bay of Three Gorges Reservoir, China

Li H, Gu Y, Cai Q, Dong X, Ye L. *Frontiers in Ecology and Evolution*. February 2022; 10:800025. doi: 10.3389/fevo.2022.800025

Scientists from the Institute of Hydrobiology in Wuhan, China, used FlowCam Macro to investigate the size structure of zooplankton by measuring biovolume and abundance and their relationship to environmental conditions across nitrogen and phosphorus gradients in the Three Gorges Reservoir in the Yichang region of China. The authors reference previous studies showing global warming and nutrient eutrophication to impact zooplankton size structure. Warmer waters benefit smaller zooplankton, whereas nutrient enrichment caused by runoff (eutrophication) increases the presence of larger zooplankton. They hypothesize that nutrient levels affect zooplankton size indirectly by altering the trophic web and affecting the availability of their food source (phytoplankton) and that warmer waters will reduce size diversity.

On The Accuracy of Assessing Copepod Size and Biovolume Using FlowCam and Traditional Microscopy

Karnan C, Jyothibabu R, Manojkumar TM, Jagadeesan L, Arunpandi N. *Indian Journal of Geo-Marine Sciences*. July 2017; 46(07):1261-1264.

In this article, the authors compare FlowCam's ability to estimate length and biovolume to that of a traditional microscope. Microscopy has been considered the most accurate and globally accepted method to measure the size and biovolume of individual copepods. However, protruding body parts (i.e., appendages, cilia, etc.) are not easily accounted for in biovolume estimations using traditional microscopy and often result in inaccurate estimations. FlowCam provides digital images of each copepod.

The Area Based Diameter algorithm of FlowCam provides a better estimation of copepod biovolume than traditional microscopy. This method also incorporates the copepod's appendages and other extruded portions for biovolume estimation. ABD biovolume was found to be greater than biovolumes calculated using traditional microscopy due to the contribution of appendages and other extended body parts.