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Astract

he effects of turbulent motion on planktonic organisms hae mainly been studied in the laboratory with deices capable of generating controlled turbulent conditions. Owing to technical and logistical difficulties, thorough assessments of hydrodynamics in such eperiments are not routinely made. In this study, we eamined the suitability of two widely used systems to generate isotropic, homogeneous, and stationary turbulence in laboratory containers: oscillating grid deices with large stroke length and relatiely low freuencies of oscillation and orbital shaker tables. urbulent kinetic energy dissipation rates were estimated from elocity measurements made with acoustic oppler elocimeters. Both systems were shown to generate isotropic conditions in a relatiely broad range of dissipation rates. ridstirred tanks produce homogeneous turbulence in both the horiontal and ertical dimensions, as long as stroke length is comparable to the height of the container. urbulence in orbital shakers is not completely homogeneous, as it depends on the distance to the wall and to the surface. mpirical models are deried as a tool for the calculation of dissipation rates in the two systems within the ranges and conditions eamined in this study.

ntroduction

urbulent flow is ubiuitous in auatic systems and thus can potentially affect a wide range of planktonic organisms and processes. urbulence is still often referred to as one of the unsoled problems in physics, and there has been a strong interest in its effects on plankton, especially during the last 20 years, resulting in a growingly actie area of study (for a reiew, see eters and Marras 2000). ield studies on the effects of turbulence on plankton hae been hindered by the lack of turbulence measurements in biological studies and by the difficulty of discriminating these effects from those of other ariables, such as temperature, light, or nutrient concentration, which often coary. herefore, much of the current knowledge has been deried from laboratory or enclosed systems, with configurations to generate controlled turbulence conditions.

Ideally, the generation of smallscale turbulence in laboratory containers should conform to a few reuirements to correctly assess the response of plankton to a certain leel of turbulence in open water (i.e., not considering responses to turbulence close to bottom boundary layers). irst, turbulence should be constant, that is, stationary in time and homogeneous in space. Although plankton eperiences shifting turbulent conditions in nature, it is necessary to establish the responses to constant leels of turbulence before much more challenging nonstationary fields can be addressed. Second, the system should not induce changes in the behaior or distribution of the organisms other than those directly triggered by water motion. And finally, organisms must perceie turbulence as natural. his implies, for eample, that all releant scales influencing the inestigated process should be contained in the fully deeloped cascade of turbulent eddies (i.e., within the inertial subrange of the turbulent energy spectrum). his is difficult since the scales of generation of turbulent

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