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Marine diatoms change their gene expression profile when exposed to microscale turbulence under nutrient replete conditions

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Diatoms are a fundamental microalgal phylum that thrives in turbulent environments. Despite several experimental and numerical studies, if and how diatoms may profit from turbulence is still an open question. One of the leading arguments is that turbulence favours nutrient uptake. Morphological features, such as the absence of flagella, the presence of a rigid exoskeleton and the micrometre size would support the possible passive but beneficial role of turbulence on diatoms. We demonstrate that in fact diatoms actively respond to turbulence in non-limiting nutrient conditions. TURBOGEN, a prototypic instrument to generate natural levels of microscale turbulence, was used to expose diatoms to the mechanical stimulus. Differential expression analyses, coupled with microscopy inspections, enabled us to study the morphological and transcriptional response of *Chaetoceros decipiens* to turbulence. Our target species responds to turbulence by activating energy storage pathways like fatty acid biosynthesis and by modifying its cell chain spectrum. Two other ecologically important species were examined and the occurrence of a morphological response was confirmed. These results challenge the view of phytoplankton as unsophisticated passive organisms.

Oceanic plankton are characterised by a huge biodiversity spanning over many phyla. The different life strategies and behaviours displayed by such diverse organisms were selected also to cope with a patchy and variable 3D world driven by water motion[1]. Key factors for their survival, e.g., light availability, nutrient concentrations, prey abundance and water temperature, are all strongly tuned by the fluid motion at different scales. Fluid motion introduces kinetic energy in the system and turbulence is the way kinetic energy is transferred, through a dissipation cascade, over several eddy-like structures down to the smallest scale. Below this scale, energy is dissipated to heat via the friction of viscosity and water motion cannot prevail over molecular diffusion but can control it by changing local gradients[2,3]. This is particularly important for unicellular phytoplankton which are surrounded by a fluid boundary layer where molecular diffusion is the dominant process and only solute (nutrient) chemical gradients assure cell provisioning. A distortion of the boundary layer would change these gradients, hence nutrients would diffuse more rapidly, enhancing the uptake rate[4]. For non-motile cells, like diatoms, the distortion of the boundary layer can be produced only by sinking or by the shear generated by the decay of turbulent kinetic energy. Therefore there is no more turbulence, as a random motion of water parcels, but the effects of turbulence which dissipates though sheared flow. Shear stress is what cells below Kolmogorov scale would ultimately perceive

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