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New and Fast Method to Quantify Respiration Rates of Bacterial and Plankton Communities in Freshwater Ecosystems by Using Optical Oxygen Sensor Spots

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Abstract:

A new method of respiration rate measurement based on oxygen luminescence quenching in sensor spots was evaluated for the first time for aquatic bacterial communities. The commonly used Winkler and Clark electrode methods to quantify oxygen concentration both require long incubation times, and the latter additionally causes signal drift due to oxygen consumption at the cathode. The sensor spots proved to be advantageous over those methods in terms of precise and quick oxygen measurements in natural bacterial communities, guaranteeing a respiration rate estimate during a time interval short enough to neglect variations in organism composition, abundance, and activity. Furthermore, no signal drift occurs during measurements, and respiration rate measurements are reliable even at low temperatures and low oxygen consumption rates. Both a natural bacterioplankton sample and a bacterial isolate from a eutrophic river were evaluated in order to optimize the new method for aquatic microorganisms. A minimum abundance of 2.2×10^6 respiring cells ml^{-1} of a bacterial isolate was sufficient to obtain a distinct oxygen depletion signal within 20 min at 20°C with the new oxygen sensor spot method. Thus, a culture of a bacterial isolate from a eutrophic river (OW 144; 20 x 106 respiring bacteria ml^{-1}) decreased the oxygen saturation about 8% within 20 min. The natural bacterioplankton sample respired 2.8% from initially 94% oxygen-saturated water in 30 min. During the growth season in 2005, the planktonic community of a eutrophic river consumed between 0.7 and 15.6 µmol O_2 $liter^{-1}$ h^{-1}. The contribution of bacterial respiration to the total plankton community oxygen consumption varied seasonally between 11 and 100%.