Threshold of gross primary production for planktonic metabolic balance in the Southern Ocean: An experimental test

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ABSTRACT: The proposed threshold planktonic gross primary production (GPP) value for O_2 of 2.05 mmol m^{-3} d^{-1} separating net heterotrophic from net autotrophic communities in the Southern Ocean was tested experimentally using large mesocosms (20 m^3). A set of eight mesocosms was moored in Johnson□s Dock (62° 39.576'S, 60° 22.408'W, Livingston Island, Antarctica) and a gradient of GPP was experimentally generated by imposing four light levels (100%, 50%, 25%, and 10%) in the presence or absence of nutrient additions (0.1 mol NH_4Cl, 0.1 mol of F_6Na_2Si, and 0.01 mol KH_2PO_4 per mesocosm per day). The experimental treatments resulted in a broad range of chlorophyll *a* (Chl *a*) (0.31-93.5 mg m^{-3}) and GPP (O2, 0.17-16.7 mmol m^{-3} d^{-1}). Community respiration (R) increased with increasing GPP, but not proportionately, resulting in a range of P :R ratios ranging from 0.12 in intensely shaded communities to 1.3 in those receiving high irradiance and nutrient additions, with the compensation irradiance for community metabolism (i.e., percentage irradiance at P:R = 1) being reached at 83% of the ambient irradiance. The experimental estimate of the threshold GPP for metabolic balance of the community investigated (i.e., P :R = 1) was 2.2 (SE ± 0.016) mmol O_2 m^{-3} d^{-1}, thereby validating the estimate of 2.05 mmol O_2 m^{-3} d^{-1} derived in the past from comparative analyses of planktonic metabolism across the Southern Ocean. The validation of this threshold suggests that net heterotrophic planktonic communities may be more prevalent in the Southern Ocean than hitherto believed.

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