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Seabird guano enhances phytoplankton production in the Southern Ocean.

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Great congregations of seabirds in sub-Antarctic and Antarctic coastal areas result in delivery of nutrient-rich guano to marine ecosystems that potentially enhances productivity and supports biodiversity in the region. Guano-derived bio-available micronutrients and macronutrients might be utilized by marine phytoplankton for photosynthetic production, however, mechanisms and significance of guano fertilization in the Southern Ocean are largely understudied. Over austral summers of 2012 and 2013 we performed a series of guano-enrichment phytoplankton incubation experiments with water samples collected from three different water masses in the Southern Ocean: Antarctic waters of the Ross sea and sub-Antarctic waters offshore the Otago Peninsula, both showing iron limitation of phytoplankton productivity in summer, and in the subtropical frontal zone offshore from the Snares Islands, which is generally micronutrient-repleted. Samples were enriched with known concentrations of guano-derived nutrients. Phytoplankton biomass increased significantly in guano-treated samples during all three incubation experiments (7–10 fold increase), while remained low in control samples. This response indicates that seabird guano provides nutrients that limit primary production in the Southern Ocean and that these nutrients are readily taken up by phytoplankton. Guano additions were compared to Fe and Macronutrient treatments (both added in quantities similar to those in the guano treatment). Phytoplankton biomass increased significantly in response to the Macronutrient treatment in the subtropical frontal zone, however, the response had a smaller magnitude compared to the guano treatment (2.8 μgL-1 vs 5.2 μgL-1) ; there was no significant effect of Fe on phytoplankton growth. This suggests the potential importance of synergistic effects of nutrients in guano. Incubation with sub-Antarctic waters showed that Fe and Macronutrients might be equally important for enhancement of phytoplankton production. Analysis of phytoplankton community composition showed that Prymnesiophytes (in particular, Phaeocystis antarctica) dominated phytoplankton response in both sub-Antarctic waters and offshore the Snares islands. Simultaneously, significant increases in the number of diatoms and photosynthetic pico- and nanophytoplankton were observed. Our study elucidates the potential role of seabirds in supporting productivity in the Southern Ocean.