Synechococcus and Prochlorococcus: A tale of two cyanobacteria

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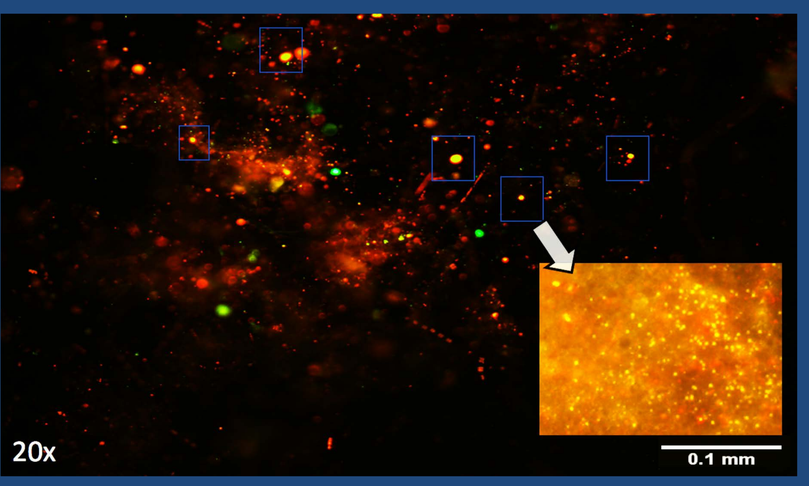


Synechococcus and likely also *Prochlorococcus* embedded in a a phytodetrital aggregate collected with Particle Interceptor Traps at BATS in Spring 2018 at 200m depth (Cruz et al. in prep.)

Introduction

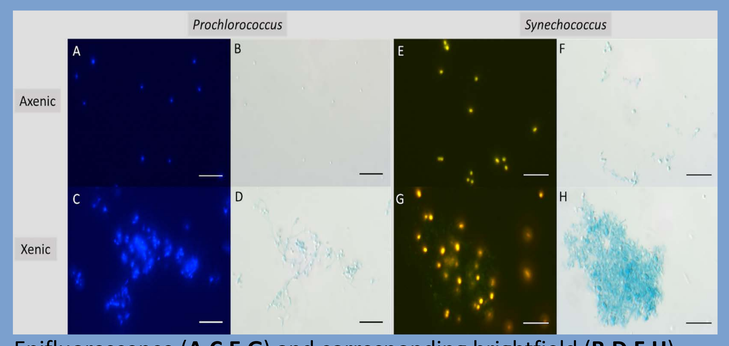
The picocyanobacteria *Synechococcus* and *Prochlorococcus* dominate phytoplankton communities in the subtropical North Atlantic.

Despite their similarities, observations from field studies indicate that *Synechococcus* is more closely associated with export flux compared to *Prochlorococcus*.

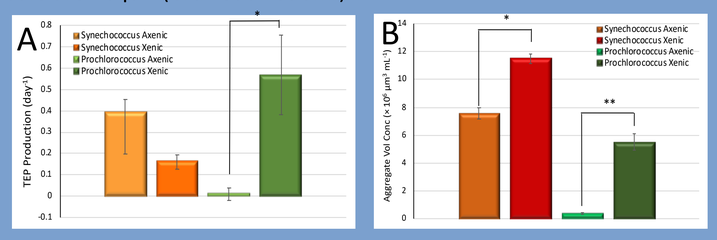
Insights from laboratory studies might shed light on what causes the difference in the biogeochemistry between these two picocyanobacteria.

Insight from laboratory experiments

Synechcococcus produce Transparent Exopolymeric Particles (TEP) and form suspended aggregates in axenic cultures, but *Prochlorococcus* does not.



Epifluorescence (**A**,**C**,**E**,**G**) and corresponding brightfield (**B**,**D**,**F**,**H**) photomicrographs of Alcian Blue stained cultures of *Prochlorococcus* in axenic (**A**,**B**), and xenic (**C**,**D**) conditions, as well as *Synechococcus* in axenic (**E**,**F**), and xenic (**G**,**H**) conditions. Scale bars are 10 µm (Cruz et al. subm.)

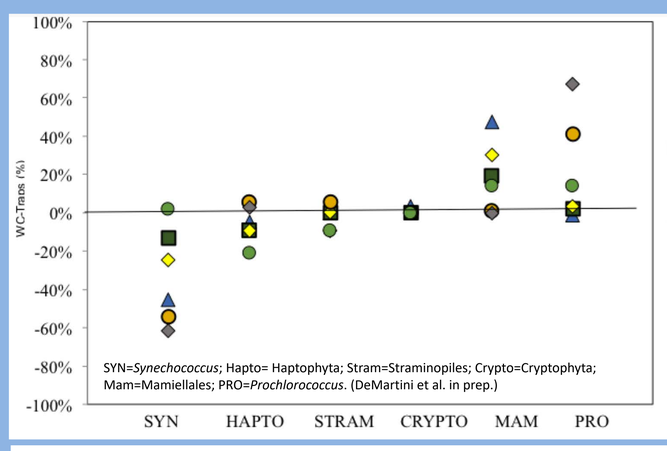


Heterotrophic bacteria enhanced TEP production (A) as well as suspended and visible aggregates (B) in *Prochlorococcus*, while in *Synechococcus*, aggregation was enhanced with no changes in TEP.

Furthermore, aggregation experiments using a natural plankton community dominated by picocyanobacteria resulted in aggregation only when *Synechococcus* were in their highest seasonal abundance (Cruz et al. subm.).

Insight from field studies

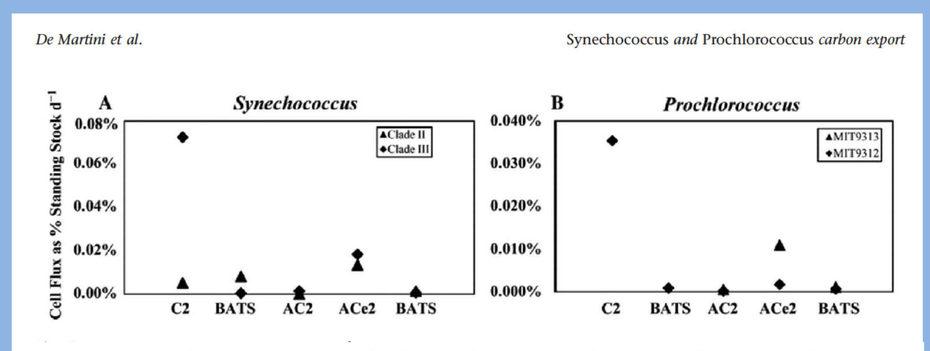
A. *Synechococcus* are overrepresented in particle trap material compared to *Prochlorococcus*



SYN=*Synechococcus*; Hapto= Haptophyta; Stram=Straminopiles; Crypto=Cryptophyta; Mam=Mamiellales; PRO=*Prochlorococcus*. (DeMartini et al. in prep.)

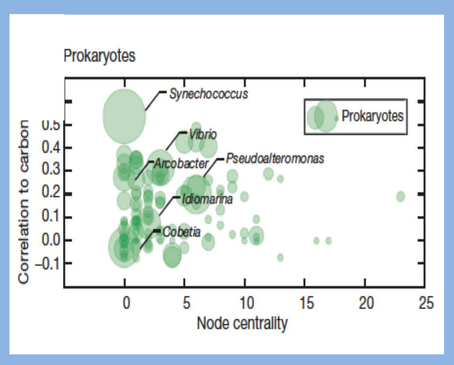
Difference of the relative abundance of cyanobacteria and phototrophic eukaryotes in the water column (20 &100 m) and trap material (150 m) from 4 cruises in spring and summer 2011 and 2012 at and around BATS, based on bacterial amplicons. Positive difference denotes an overrepresentation in the water column; negative difference an overrepresentation in the trap material. These results confirm earlier DNA-basd observations made at BATS in a 2-yr study by Amacher et al. (2013).

B. *Synechococcus* contribute more to POC flux and can have higher absolute flux events compared to *Prochlorococcus*



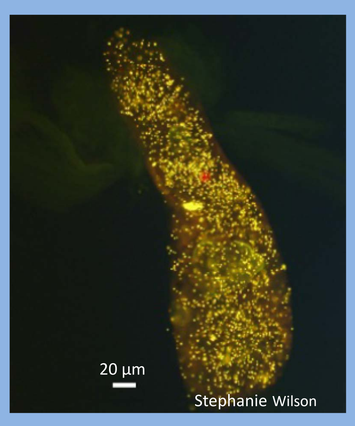
DeMartini et al. (2018) quantified absolute cyanobacteria flux at and around BATS using quantitative Polymerase Chain Reaction for specific clades and strains in winter (C2, BATS) and summer (AC2, ACe2, BATS) 2012. *Synechococcus* as a fraction of cell standing stock in the euphotic zone reaches higher values (A) compared to *Prochlorococcus* (B). Overall, *Synechococcus* contribute nearly 3% to the total winter POC flux, *Prochlorococcus* less than 0.2% (DeMartini et al. 2018).

C. *Synechococcus,* but not *Prochlorococcus,* are strongly correlated with carbon-export in a global regression analysis *(Guidi et al. 2015).*



D. *Synechococcus* are present in zooplankton fecal pellets, but not *Prochlorococcus*

- in a study investigating diet of different zooplankton groups at BATS, *Synechococcus* dominated cyanobacterial amplicons in guts or fecal pellets. *Prochlorococcus* was absent (Stephanie Wilson, unpublished).
- Gorsky et al. (1999) found *Synechococcus* present in appendicularian fecal pellets based on flow cytometry, but not *Prochlorococcus.*



Conclusion: What makes them different?

- Field observations show that the picocyanobacteria *Synechococcus* have a higher export potential compared to *Prochlorococcus*, despite similar abundance.
- *Synechococcus* appear to be preferentially ingested by zooplankton, or alternatively, *Prochlorococcus* may be preferentially digested.
- TEP production and suspended aggregated formation of *Synechococcus* is much greater than that of *Prochlorococcus,* which might make them more susceptible to sinking or ingestion by zooplankton.

References

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