Phosphorous utilization by microbial populations in the NW Mediterranean

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OBJECTIVE

Examine cell-specific phosphorous utilisation by dominant microbial populations in the North-West Mediterranean in response to inorganic phosphate limitation.

APPROACH

A 7-yr oceanographic time-series was combined with tag pyrosequencing of ribosomal RNA and radioactive tracer and cell-sorting experiments (1-yr).

MAIN FINDINGS

- **Bacterial and SAR11 diversity exhibit strong seasonal cycles.**

- **Physical mixing of the water column periodically resets a high diversity state and drives SAR11 ecotype distributions.**

- **Phosphate limitation appears to promote the development of low diversity states.**

- **Low diversity communities have significantly higher cell-specific uptake rates of inorganic and organic phosphorous substrates.**

Box 1: Seasonality of bacterial and SAR11 diversity in the North-West Mediterranean
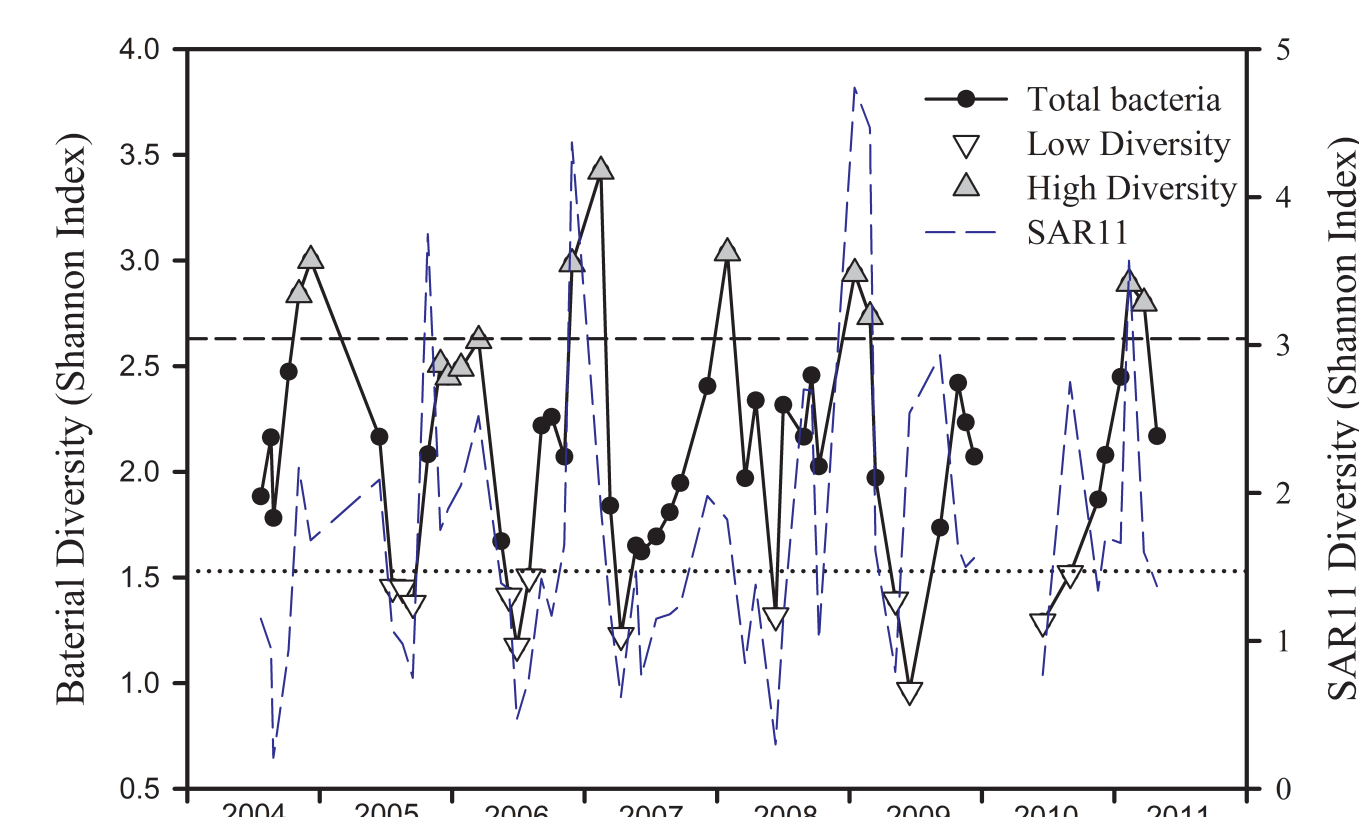
- Strong seasonal cycles in diversity are similar for total bacteria and SAR11.

- Categorical analysis shows high diversity states are associated with deep mixed layers (83 ± 31 m) compared to low diversity states (13 ± 9.1 m).

What is SAR11 ecotype diversity comprising high and low diversity regimes?
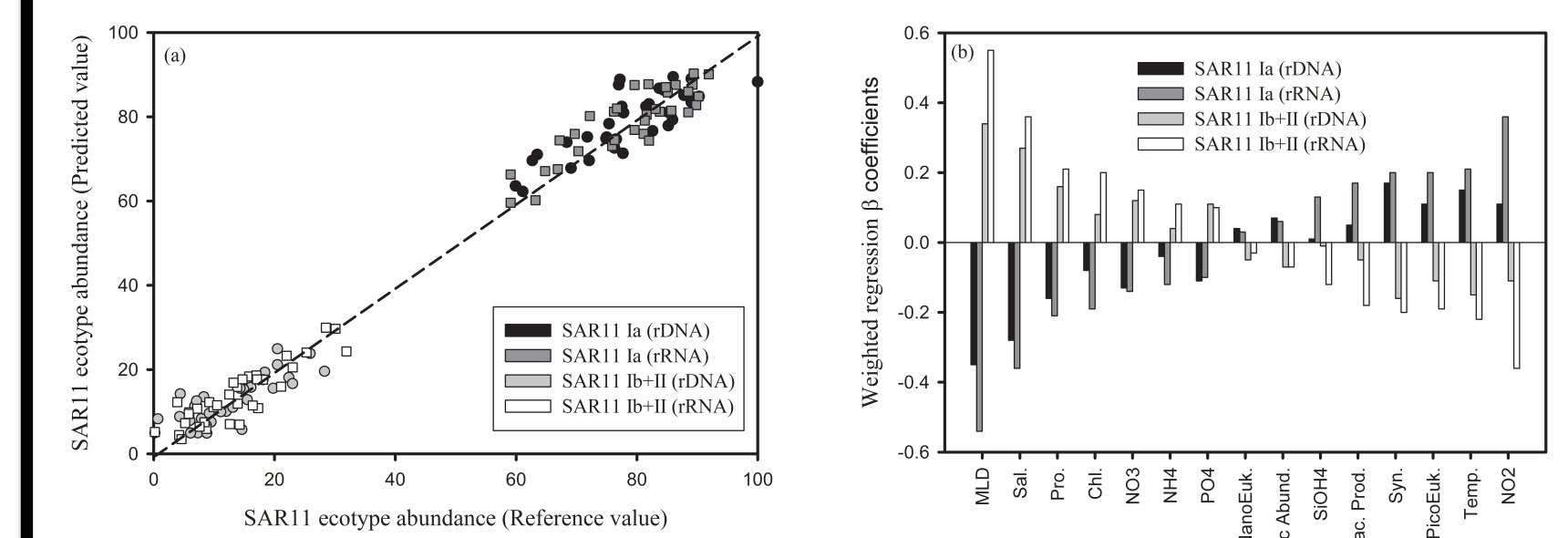➔ Box 2

Box 2: SAR11 ecotype diversity comprising high and low diversity states
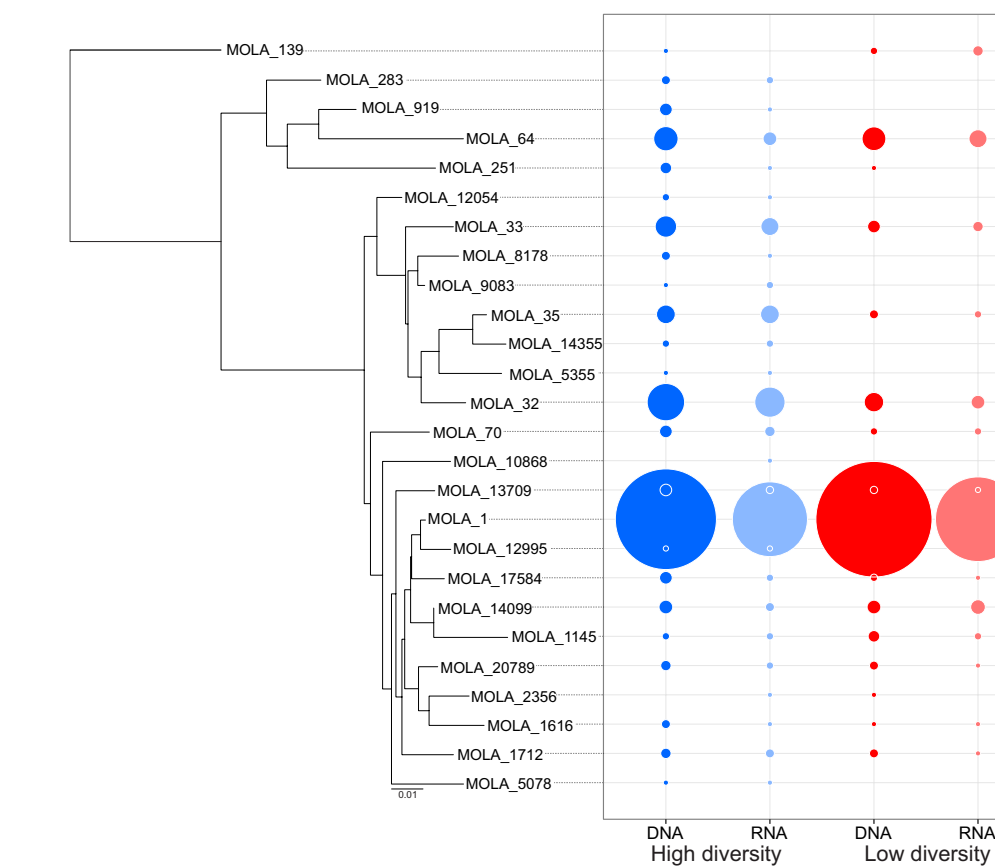
- Ecotype *Ia* (OTU-MOLA 1) dominates the SAR11 assemblage in high and low diversity states

- High diversity states show an increase in ecotypes *Ib* and *II*.

What are the important environmental factors shaping SAR11 ecotype dynamics? ➔ Box 3

Box 3: Predictive modeling of SAR11 ecotypes

- Partial least squares analysis was used to model SAR11 ecotype abundance from measured environmental data.

- The goodness of fit for individual ecotype groupings were 0.76-0.78 for rRNA and 0.63-0.66 rDNA abundances (0.63-0.66).

- Mixed layer depth was the most important environmental parameter.

Can we propose a conceptual framework for patterns of SAR11 diversity in the North-West Mediterranean? ➔ Centre Box

Physical mixing periodically resets SAR11 communities to a high diversity state and seasonal development of phosphate limitation drives evolution of a low diversity state

Box 4: Seasonal patterns in SAR11 ecotype dynamics and phosphate limitation
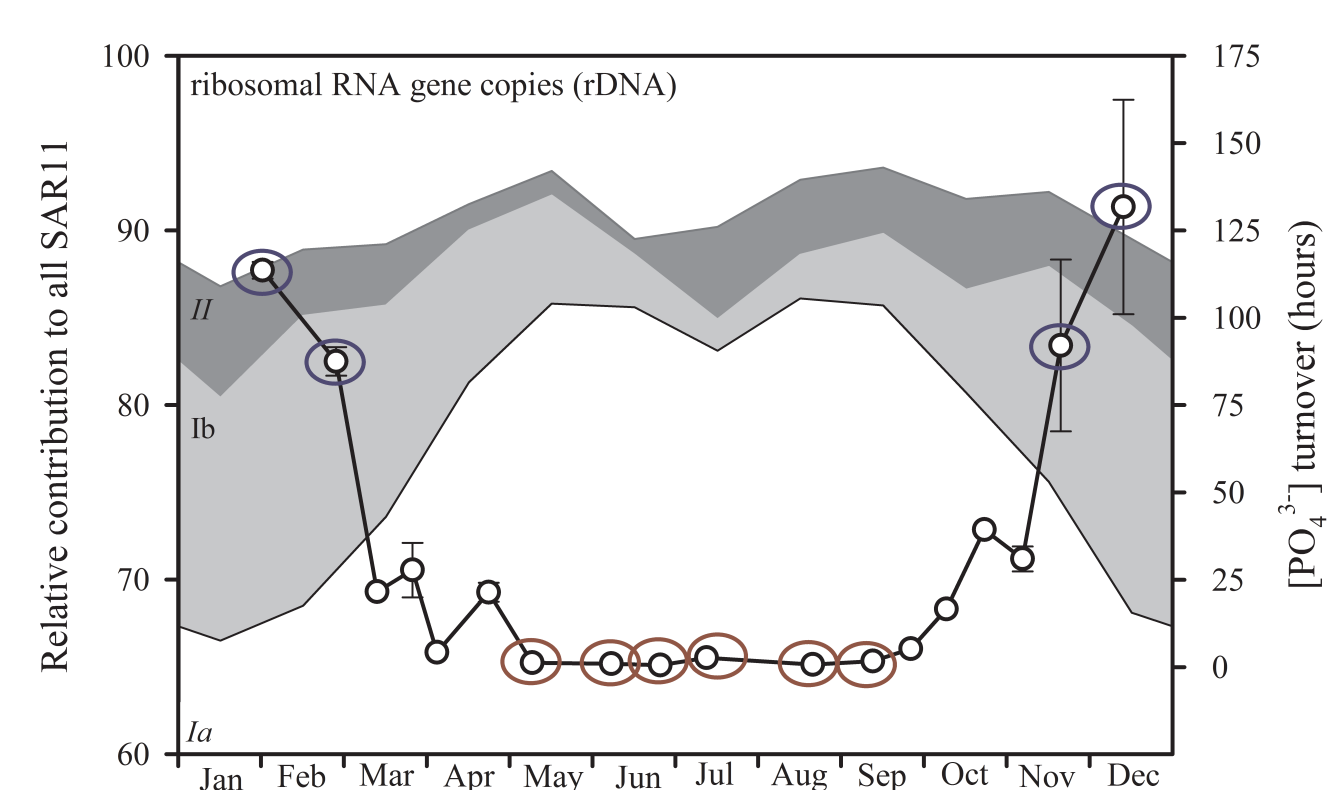
- In NW Mediterranean there is a strong seasonal trend in phosphate limitation

- Turnover times of < 5 hours in summer months correspond to low diversity communities dominated by SAR11 ecotype *Ia*

Do high and lowdiversity bacterial communities have different cell-specific uptake rates for phosphorous substrates ➔ Boxes 5 and 6

Box 5: Bacteria cell-specific uptake rates of inorganic and organic phosphorous nutrients
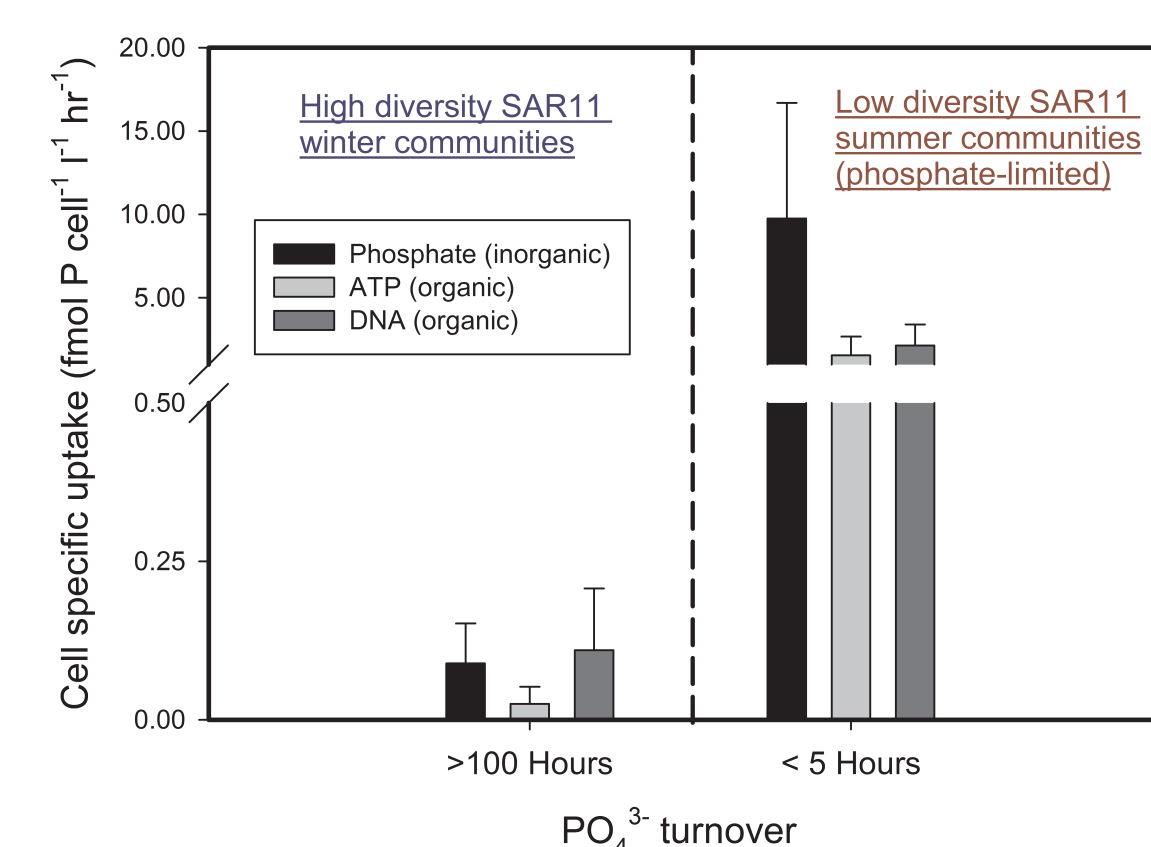
- Phosphate uptake rates are significantly higher during summer

- Uptake rates of organic P-esters (ATP and DNA) are also enhanced in summer

The metabolic adaptation of SAR11 Ia to extreme phosphate limitation may explain dominance in low diversity states.

Box 6: *Synechococcus* cell-specific uptake rates of inorganic and organic phosphorous nutrients

Synechococcus sequence abundance
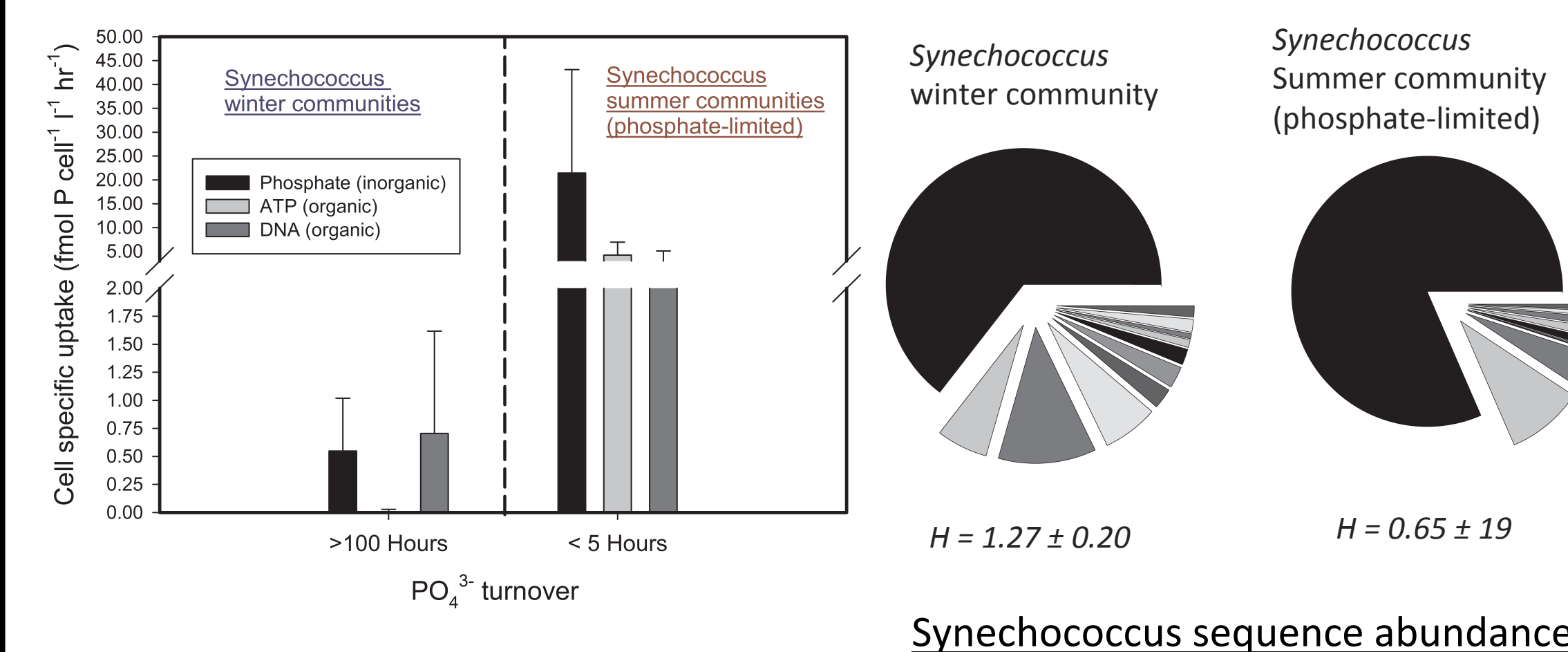
- *Synechococcus* diversity lower under extreme phosphate limitation (Turnover < 5 Hrs).

- Enhanced uptake rates of inorganic and organic P sources in .

Seasonal adaptation of phosphorous metabolism by dominant Synechococcus ecotypes under phosphate limitation.