Significance of Viral Lysis and Nanoflagellate Grazing as Factors Controlling Diel Variations of *Synechococcus* spp. abundance

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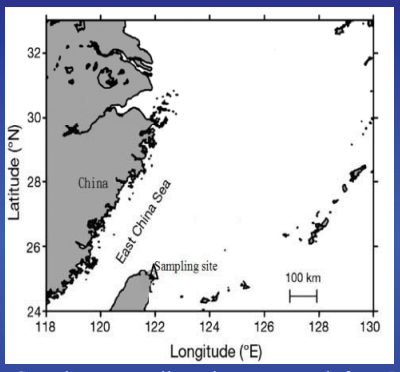
Abstract

Protozoan grazing and virally mediated mortality of diel variations in *Synechococcus* spp. abundance were investigated in the coastal waters of the western subtropical Pacific Ocean during summer 2011. In this study, a modified dilution method was designed to simultaneously estimate the effect of both viral lysis and protozoan grazing on the mortality of *Synechococcus* spp.. We report the results of 7 dilution experiments, *Synechococcus* spp. specific growth rates varied during the experimental period from 0.025 to 0.033 h^{-1} and 0.050 to 0.085 h^{-1} at daytime and nighttime, respectively. Rates of *Synechococcus* spp. mortality due to nanoflagellate grazing varied from 0.025 to 0.034 h^{-1} and 0.035 to 0.047 h^{-1} at daytime and nighttime, respectively (with average of 0.031 and 0.041 h^{-1}, respectively). Furthermore, for viral lysis, we could estimate 0.011 to 0.019 h^{-1} and 0.026 to 0.065 h^{-1} at daytime and nighttime, respectively. We determined that nanoflagellate grazing was a significant cause of *Synechococcus* spp. mortality (66% of total mortality) during daytime in summer, however, both viral lysis and nanoflagellate grazing can cause significant mortality at nighttime (51.2% vs. 48.8% of total mortality).

Materials and Methods



Samples were collected once a month from **May to August 2011 (30 May, 27 June, 21 July and 23 August)** at an established coastal station (25°09.4'N, 121°46.3'E) along a rocky shore in northeastern Taiwan.

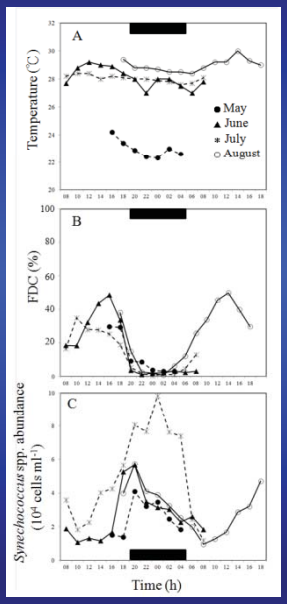
Modified Dilution experiments

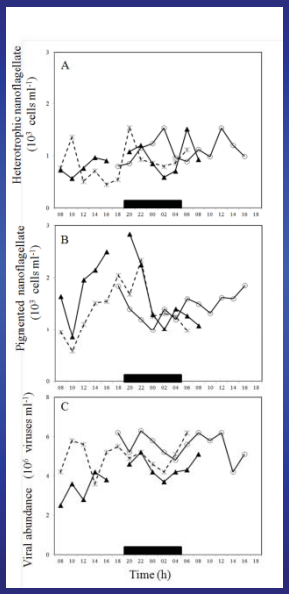
The regression coefficient resulting from the 0.2 µm dilution series represents only the nanoflagellate grazing rate (mg). Thus, the net growth rate of bacteria (k1) should be calculated as

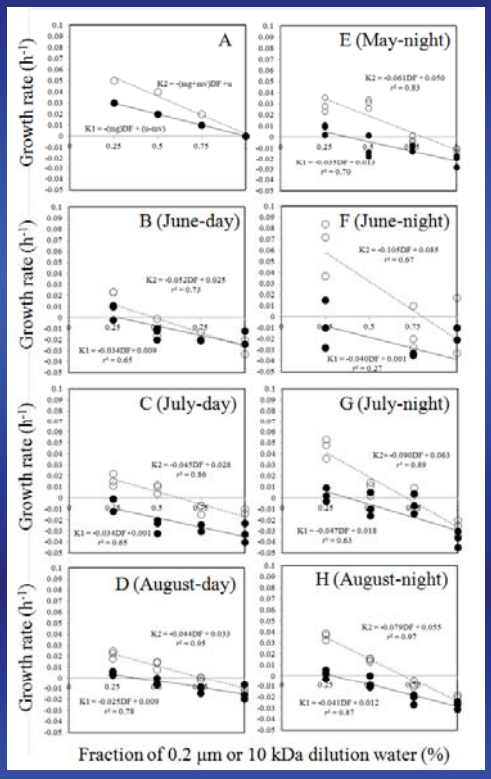
K1=(µ-mv)-(mg)×DF

If virus-free seawater is used as a diluent (10 kDa filters), the net growth rate of *Synechococcus* spp. (k2) should be calculated as the difference between growth rate (µ) and mortality due to lysis (mv) and grazing (mg)

K2=µ-(mv+mg)×DF







Results

Table 1. Diel variations in growth rate, grazing rate, lysis rate and ratio of lysis to total mortality during the study period.

Month	period	Growth rate (h^{-1})	Grazing rate (h^{-1})	Lysis rate (h^{-1})	Ratio of lysis (%)
May	Day	—	—	—	
	Night	0.050	0.035	0.026	42.6
June	Day	0.025	0.034	0.018	34.6
	Night	0.085	0.040	0.065	61.9
July	Day	0.028	0.034	0.011	24.4
	Night	0.063	0.047	0.043	47.8
August	Day	0.033	0.025	0.019	43.2
	Night	0.055	0.041	0.038	48.1
Mean	**Day**	**0.029**	**0.031**	**0.016**	**34.0**
	Night	**0.063**	**0.041**	**0.043**	**51.2**

In conclusion, the present study aimed to determine the diel variations in grazing versus virus-induced mortality of *Synechococcus* spp. at a coastal site in the western subtropical Pacific Ocean. Our data reinforce the view that the abundance of *Synechococcus* spp. was high (>10^4 cells ml^{-1}) and exhibited a clear diel pattern during summer. Using the modified dilution technique, we confirmed that nanoflagellate grazing was a significant cause of *Synechococcus* spp. mortality, but viral lysis was also an important source of mortality – especially at nighttime. Future study will evaluate the ecological importance of viral lysis and examine the cause for its diel periodicity in the marine environment.

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