The effect of light on N_2 fixation and net nitrogen release of field *Trichodesmium*

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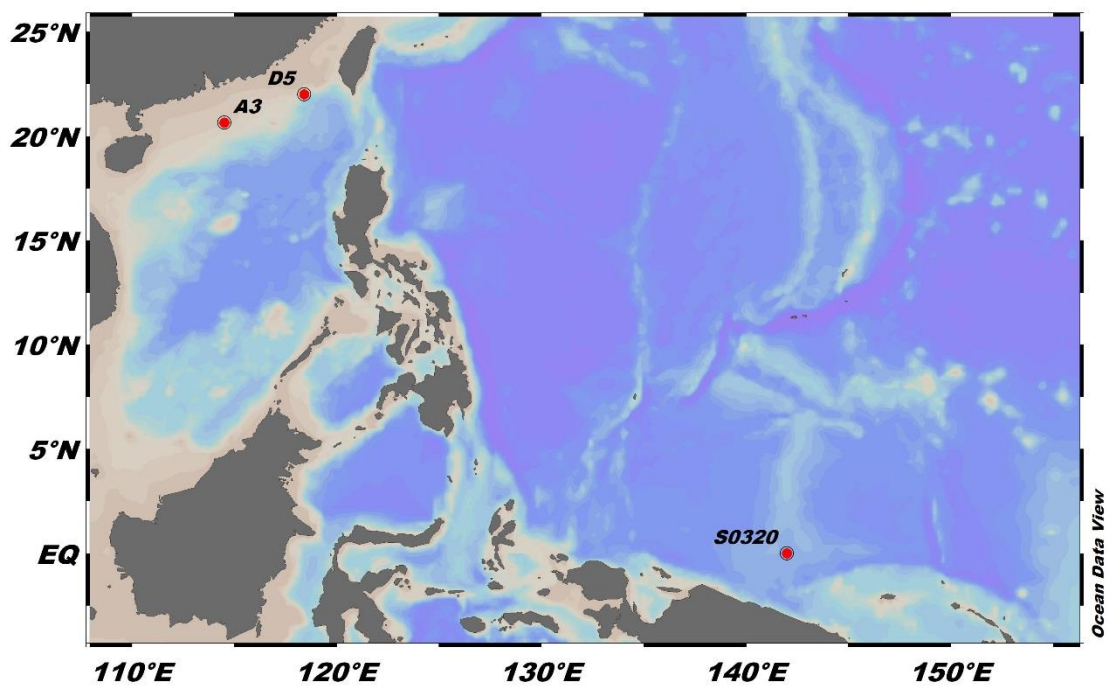
Figure 1. Sampling locations in the Western Pacific Ocean and the South China Sea

Table 1. Synthesis of PON/POC and DON isotopic value before and after 24h incubations at station S0320. Where the '<10 μm-a' represent NF rate of <10 μm community incubated with > 10 μm *Trichodesmium* colonies, '<10μm-b' represent the background NF rate of <10 μm community.

irradiance ($\mu E\ m^{-2}\ s^{-1}$)	PON $\delta^{15}N$ (‰)	DON $\delta^{15}N$ (‰)	POC $\delta^{13}C$ (‰)
Initial condition	-0.6 (0.1)	3.0 (0.4)	-18.1 (0.1)
2010	4050 (372)	78.8 (3.0)	708 (11.2)
2010 (<10μm-a)	1092 (215)	-	191(14.6)
2010 (<10μm-b)	314 (32.3)	-	-
1180	4621 (375)	115 (14.7)	692 (19.7)
612	4121 (352)	132 (18.6)	604 (1.7)
315	2488 (43.6)	123 (36.2)	440 (17.0)
192	913 (233)	35 (7.8)	217 (63.7)
22	301 (71.5)	21 (0.9)	93.6 (17.1)

Table 2. Synthesis of PON and DON concentration, isotope value before and after 24h incubations at different light intensity and corresponding NF in station D5.

Incubation irradiance ($\mu E\ m^{-2}\ s^{-1}$)	PON $\delta^{15}N$ (‰)	Particulate NF rate ($nM\ L^{-1}\ d^{-1}$)	DON $\delta^{15}N$ (‰)	Dissolved NF rate ($nM\ L^{-1}\ d^{-1}$)
Initial condition	2.0 (0.1)	-	5.8 (0.2)	-
1104	234 (1.1)	9.9 (0.4)	6.7 (0.7)	0.65 (0.65)
2010 (<10μm-a)	28.6 (5.7)	1.0 (0.3)	-	-
2010 (<10μm-b)	15.0 (3.5)	0.5 (0.1)	-	-
648	229 (9.2)	10.1 (1.1)	7.2 (0.2)	1.01 (0.11)
336	132 (34)	5.7 (1.5)	6.8 (0.3)	0.74 (0.26)
173	72. 8 (7.7)	2.9 (0.2)	7.1 (0.4)	0.98 (0.31)
106	26.8 (6.3)	1.0 (0.3)	7.0 (0.4)	0.86 (0.29)
12	21.9 (7.1)	0.9 (0.3)	6.7 (0.2)	0.68 (0.18)

Table 3. Synthesis of PON and DON concentration, isotope value before and after 24h incubations at different light intensity and corresponding NF in station A3.

Incubation irradiance ($\mu E\ m^{-2}\ s^{-1}$)	PON $\delta^{15}N$ (‰)	Particulate NF rate (nM L^{-1} d^{-1})	DON $\delta^{15}N$ (‰)	Dissolved NF rate (nM L^{-1} d^{-1})
Initial condition	2.3 (0.1)	-	1.2 (0.5)	-
2024	320 (57.5)	12.2 (1.8)	4.2 (2.3)	1.9 (1.5)
2010 (<10μm-a)	38.2 (11.5)	1.9 (0.3)	-	-
2010 (<10μm-b)	24.3 (5.9)	1.2 (0.4)	-	-
1188	465 (99.2)	19.6 (7.2)	7.3 (2.0)	3.1 (0.7)
616	452 (72.9)	17.4 (4.6)	8.2 (3.2)	5.0 (1.6)
317	258 (53.0)	9.9 (2.4)	7.6 (1.8)	4.5 (1.4)
194	162 (49.4)	7.1 (3.4)	8.6 (1.1)	4.0 (1.0)
22	135 (51)	5.3 (2.0)	7.0 (1.1)	4.2 (0.02)

Table 4. Recalculate the <10μm fraction (non-diazotrophic phytoplankton) CF rate by Eq. (1) based on $N_m = 0.28 \pm 0.03$ μM L^{-1} d^{-1}, I_k =50 μE m^{-2} s^{-1}, N_d = 0.05 μM L^{-1} d^{-1}, then get >10μm fraction (*Trichodesmium*) CF rate and corresponding *Trichodesmium* CF/NF at different light intensity in station S0320.

Incubation irradiance (μE m^{-2} s^{-1})	< 10 μm fraction CF rate (μM L^{-1} d^{-1})	>10μm fraction (*Trichodesmium*) CF rate (μM L^{-1} d^{-1})	*Trichodesmium* CF/NF
2010	0.33 (0.06)	3.3 (0.2)	8.4 (0.9)
1180	0.33 (0.06)	3.0 (0.1)	7.0 (0.6)
612	0.33 (0.06)	2.6 (0.08)	6.6 (0.5)
315	0.33 (0.06)	1.7 (0.07)	7.2 (0.5)
192	0.32 (0.06)	0.66 (0.26)	7.6 (1.3)
22	0.15 (0.06)	0.29 (0.08)	10.9 (1.8)

Table 5. Recalculate the <10μm fraction (non-diazotrophic phytoplankton) CF rate by Eq. (1) based on $N_m = 0.28 \pm 0.03$ μM L^{-1} d^{-1}, $I_k = 120$ μE m^{-2} s^{-1}, $N_d = 0.05$ μM L^{-1} d^{-1}, then get >10μm fraction (*Trichodesmium*) CF rate and corresponding *Trichodesmium* CF/NF at different light intensity in station S0320.

5   Although we did not perform size fractionated incubations at various light intensities, we may evaluate the contribution from non-diazaotrophic phytoplankton to the observed variation pattern. According to previous study, the CF ratio non-

Incubation irradiance (μE m^{-2} s^{-1})	< 10 μm fraction CF rate (μM L^{-1} d^{-1})	>10μm fraction (*Trichodesmium*) CF rate (μM L^{-1} d^{-1})	*Trichodesmium* CF/NF
2010	0.33 (0.06)	3.3 (0.2)	8.4 (0.9)
1180	0.33 (0.06)	3.0 (0.1)	7.0 (0.6)
612	0.33 (0.06)	2.6 (0.08)	6.6 (0.5)
315	0.31 (0.06)	1.7 (0.07)	7.3 (0.5)
192	0.27 (0.06)	0.71 (0.26)	8.2 (1.1)
22	0.10 (0.06)	0.34 (0.08)	13 (2.2)

diazotrophic would increase during low light condition (Harris 1980) due to its lower I_k value (50-120μE m^{-2} s^{-1}) relative to the apparent I_k value (455μE m^{-2} s^{-1}) for this station. Since we have the CF rate of <10μm fraction (0.28 ± 0.03 μM L^{-1} d^{-1}) for surface light, this value of approximate N_m of non-diazotrophic phytoplankton CF rate. Combined this N_m with reported I_k

10 value, the Eq. (1) (simulated PI curve) may allow us to assess the influence of non-diazotrophic phytoplankton (<10μm fraction) on bulk CF. By assuming the I_k value for non-diazotrophic phytoplankton CF to be 50-120 μE m^{-2} s^{-1}, we derived the non-diazotrophic phytoplankton CF rate for each light point and assess their interference on the *Trichodesmium* CF:NF ratio variation. Result showed that after eliminating the non-diazotrophic CF the bulk CF:NF ratio would be 6.6 ± 0.5 to 10.9 ± 1.8 ($I_k = 50$ μE m^{-2} s^{-1}) and 6.6 ± 0.5 to 13.0 ± 2.2 ($I_k = 120$ μE m^{-2} s^{-1}), still increasing significantly when light intensity dropped

15 from 600 to 20 μE m^{-2} s^{-1} (table 4-5). Taking into consideration of the high apparent I_k, I_c (455 μE m^{-2} s^{-1} and 315 μE m^{-2} s^{-1}) and high R square (0.92) of fitted light response curve of CF, we postulate the variation of CF rate and POC with different

light intensity mainly reflect the carbon metabolism of *Trichodesmium*. The CF by non-diazaotrophic phytoplankton cannot alter the existing pattern.

References

Harris, G.: The measurement of photosynthesis in natural populations of phytoplankton, in, 129-187, 1980.