Supplementary Material

Response of microbial community of surface and deep chlorophyll maximum to nutrients and light in South China Sea

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# Supplementary Figures and Tables

## Supplementary Figures

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**Supplementary Figure 1.** Time course of the concentrations of NO3−, NH4+, PO43− and SiO42− during the field incubation experiments.

## Supplementary Tables

**Supplementary Table 1.** Water quality parameters in the station B6.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Depth**  **(m)** | **Salinity** | **Temperature**  **(°C)** | **DO**  **(mg L−1)** | **pH** | **Chl a**  **(μg L−1)** | **NH4+**  **(µM)** | **PO43−**  **(µM)** | **NO2− (µM)** | **NO3− (µM)** | **SiO42− (µM)** | **DIN**  **(µM)** | **N: P** | **N: Si** |
| **2** | 34.02 | 29.05 | 6.54 | 8.17 | 0.06 | 1.54 | 0.32 | 0.01 | 0.18 | 5.71 | 1.74 | 5.40 | 0.30 |
| 10 | 34.03 | 29.03 | 6.49 | 8.19 | 0.07 | 1.25 | 0.08 | 0.04 | 0.71 | 6.65 | 1.99 | 24.62 | 0.30 |
| 20 | 34.30 | 28.22 | 6.49 | 8.19 | 0.07 | 1.18 | 0.11 | 0.00 | 0.10 | 5.93 | 1.29 | 11.62 | 0.22 |
| 30 | 34.42 | 26.66 | 6.26 | 8.17 | 0.09 | 0.94 | 0.12 | 0.01 | 0.24 | 4.02 | 1.18 | 9.50 | 0.29 |
| **50** | 34.55 | 22.21 | 5.96 | 8.09 | 0.13 | 1.26 | 0.62 | 0.17 | 5.30 | 4.90 | 6.73 | 10.84 | 1.37 |
| 60 | 34.58 | 21.54 | 5.69 | 8.07 | 0.08 | 1.08 | 0.31 | 0.31 | 5.58 | 10.22 | 6.96 | 22.53 | 0.68 |
| 70 | 34.62 | 20.01 | 5.48 | 8.05 | 0.09 | 0.99 | 0.34 | 0.40 | 5.58 | 7.36 | 6.97 | 20.44 | 0.95 |
| 80 | 34.61 | 19.75 | 5.48 | 8.04 | 0.01 | 0.90 | 0.36 | 0.21 | 6.15 | 8.21 | 7.26 | 20.39 | 0.88 |
| 100 | 34.63 | 19.19 | 5.31 | 8.03 | 0.05 | 0.95 | 0.32 | 0.12 | 7.13 | 9.52 | 8.20 | 25.74 | 0.86 |
| 150 | 34.60 | 16.81 | 5.27 | 7.97 | 0.06 | 0.87 | 0.55 | 0.02 | 9.01 | 14.54 | 9.90 | 18.12 | 0.68 |
| 180 | 34.56 | 15.81 | 5.23 | 7.96 | 0.03 | 1.44 | 0.61 | 0.03 | 9.80 | 16.43 | 11.26 | 18.39 | 0.69 |

**Supplementary Table 2.** Time course of the concentrations of NO3−, NH4+, PO43− and SiO42− during the field incubation experiments.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Groups** | **Time**  **(hours)** | **NH4+**  **(µM)** | **NO3− (µM)** | **PO43−**  **(µM)** | **SiO42− (µM)** |
| Surface layer water incubations | Light | 0 | 1.54±0.29 | 0.18±0.12 | 0.33±0.00 | 5.71±1.48 |
| 24 | 1.01±0.33 | 0.08±0.03 | 0.36±0.19 | 3.80±1.11 |
| 48 | 1.38±0.13 | 0.09±0.08 | 0.32±0.12 | 5.88±1.40 |
| 72 | 1.26±0.17 | 0.06±0.02 | 0.32±0.11 | 6.85±2.20 |
| Nutrients + Light | 0 | 1.54±0.32 | 41.4±3.15 | 1.67±0.20 | 7.33±1.33 |
| 24 | 1.45±0.24 | 39.6±3.63 | 1.56±0.30 | 8.66±1.81 |
| 48 | 1.52±0.39 | 36.14±3.35 | 1.48±0.21 | 7.93±1.57 |
| 72 | 2.00±0.33 | 30.67±3.20 | 0.98±0.24 | 7.35±2.72 |
| DCM layer water incubations | 10% Light | 0 | 1.26±0.28 | 5.30±1.06 | 0.63±0.15 | 10.62±2.52 |
| 24 | 1.81±0.51 | 5.29±1.04 | 0.63±0.13 | 10.58±3.30 |
| 48 | 1.50±0.23 | 5.01±1.08 | 0.63±0.21 | 11.98±1.89 |
| 72 | 1.30±0.38 | 3.50±0.68 | 0.51±0.14 | 11.92±1.06 |
| Light | 0 | 1.26±0.28 | 5.30±0.58 | 0.63±0.15 | 10.62±1.52 |
| 24 | 1.75±0.39 | 5.03±0.16 | 0.64±0.34 | 8.61±2.15 |
| 48 | 0.81±0.07 | 3.81±0.40 | 0.55±0.40 | 7.64±2.14 |
| 72 | 1.73±0.41 | 0.43±0.23 | 0.42±0.17 | 5.16±2.46 |
| Nutrients + Light | 0 | 2.86±0.41 | 39.25±4.07 | 2.58±0.29 | 12.82±1.02 |
| 24 | 1.92±0.35 | 41.72±3.28 | 2.73±0.45 | 9.18±3.35 |
| 48 | 1.33±0.31 | 40.91±2.09 | 2.68±0.47 | 7.1±2.55 |
| 72 | 0.97±0.30 | 37.33±3.22 | 1.94±0.30 | 7.28±3.70 |

**Supplementary Table 3.** Time course of cell abundance of heterotrophic bacteria, Cyanobacteria (*Prochlorococcus* and *Synechococcus*), PPE (photosynthetic pico-eukaryotes) and PNE (photosynthetic nano-eukaryotes) during the field incubation experiments.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Groups** | **Time course**  **(h)** | **Total**  **(×104 cell ml-1)** | ***Prochlorococcus* (×104 cell ml-1)** | ***Synechococcus***  **(×104 cell ml-1)** | **Heterotrophic bacteria**  **(×104 cell ml-1)** | **PPE**  **(×103 cell ml-1)** | **PNE**  **(×103 cell ml-1)** |
| Surface layer water incubations | Light | 0 | 1.04±0.25 | 0.34±0.05 | 0.04±0.05 | 0.65±0.16 | 0.69±0.07 | 0.52±0.06 |
| 24 | 0.72±0.14 | 0.28±0.05 | 0.02±0.05 | 0.41±0.05 | 1.72±0.89 | 0.20±0.10 |
| 48 | 0.68±0.14 | 0.26±0.03 | 0.02±0.04 | 0.40±0.06 | 1.70±0.63 | 0.10±0.07 |
| 72 | 0.35±0.20 | 0.08±0.09 | 0.03±0.06 | 0.24±0.05 | 1.40±0.91 | 0.80±0.04 |
| Nutrients + Light | 0 | 1.04±0.26 | 0.34±0.05 | 0.04±0.06 | 0.65±0.16 | 0.69±0.07 | 0.52±0.06 |
| 24 | 1.73±0.49 | 0.47±0.09 | 0.27±0.15 | 0.99±0.25 | 0.72±0.35 | 0.01±0.02 |
| 48 | 2.45±0.49 | 0.73±0.18 | 0.20±0.13 | 1.52±0.17 | 1.70±0.23 | 0.19±0.03 |
| 72 | 2.53±0.46 | 0.66±0.17 | 0.15±0.13 | 1.72±0.16 | 3.40±0.67 | 0.86±0.55 |
| DCM layer water incubations | 10% Light | 0 | 1.12±0.29 | 0.19±0.06 | 0.02±0.01 | 0.91±0.23 | 0.28±0.02 | 0.04±0.01 |
| 24 | 2.11±0.38 | 0.36±0.08 | 0.06±0.03 | 1.68±0.27 | 0.14±0.03 | 0.02±0.00 |
| 48 | 1.80±0.38 | 0.23±0.07 | 0.08±0.02 | 1.48±0.30 | 0.05±0.02 | 0.29±0.02 |
| 72 | 1.91±0.38 | 0.71±0.08 | 0.12±0.05 | 1.08±0.25 | 0.17±0.04 | 0.83±0.06 |
| Light | 0 | 1.12±0.30 | 0.19±0.06 | 0.02±0.01 | 0.91±0.23 | 0.28±0.02 | 0.04±0.01 |
| 24 | 2.35±0.46 | 0.32±0.09 | 0.44±0.09 | 1.59±0.28 | 1.18±0.54 | 0.16±0.01 |
| 48 | 3.06±0.49 | 0.54±0.09 | 0.60±0.14 | 1.92±0.26 | 3.08±0.47 | 1.50±0.01 |
| 72 | 3.30±0.86 | 0.82±0.47 | 0.68±0.11 | 1.79±0.28 | 3.47±0.47 | 2.31±0.12 |
| Nutrients + Light | 0 | 1.12±0.29 | 0.19±0.06 | 0.02±0.01 | 0.91±0.23 | 0.28±0.02 | 0.04±0.01 |
| 24 | 1.91±0.35 | 0.31±0.09 | 0.07±0.04 | 1.53±0.22 | 0.30±0.02 | 0.20±0.00 |
| 48 | 2.45±0.38 | 0.66±0.06 | 0.11±0.05 | 1.68±0.28 | 1.52±0.03 | 1.06±0.02 |
| 72 | 3.52±0.51 | 1.03±0.15 | 0.45±0.11 | 2.03±0.26 | 1.75±0.18 | 4.61±0.31 |

**Supplementary Table 4.** Time course of the alpha diversity indices of bacteria during the incubation experiments.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Groups** | **Time course**  **(h)** | **Observed\_OTU** | **Shannon** | **Simpson** | **Chao1** | **ACE** |
| Surface layer water incubations | Light | 0 | 1076 | 6.41 | 0.95 | 1441.35 | 1411.48 |
| 24 | 994 | 4.24 | 0.76 | 1347.27 | 1347.23 |
| 48 | 868 | 6.39 | 0.97 | 1151.04 | 1188.81 |
| 72 | 736 | 6.43 | 0.98 | 937.07 | 979.36 |
| Nutrients + Light | 0 | 1076 | 6.41 | 0.95 | 1441.35 | 1411.48 |
| 24 | 815 | 6.14 | 0.96 | 1076.36 | 1052.34 |
| 48 | 748 | 5.46 | 0.94 | 937.18 | 945.38 |
| 72 | 870 | 6.16 | 0.96 | 1204.20 | 1223.57 |
| DCM layer water incubations | 10% Light | 0 | 1212 | 7.11 | 0.98 | 1532.76 | 1539.53 |
| 24 | 1667 | 9.14 | 1.00 | 1671.64 | 1682.87 |
| 48 | 710 | 4.44 | 0.88 | 1015.36 | 1087.39 |
| 72 | 800 | 5.34 | 0.92 | 1065.00 | 1093.27 |
| Light | 0 | 1212 | 7.11 | 0.98 | 1532.76 | 1539.53 |
| 24 | 957 | 5.98 | 0.94 | 1235.20 | 1271.87 |
| 48 | 890 | 6.08 | 0.95 | 1135.16 | 1130.63 |
| 72 | 901 | 6.20 | 0.96 | 1182.30 | 1220.33 |
| Nutrients + Light | 0 | 1212 | 7.11 | 0.98 | 1532.76 | 1539.53 |
| 24 | 920 | 6.63 | 0.97 | 1181.07 | 1192.10 |
| 48 | 708 | 5.69 | 0.95 | 921.03 | 939.30 |
| 72 | 781 | 5.32 | 0.93 | 1012.66 | 1084.88 |

**Supplementary Table 5.** Time course of the alpha diversity indices of eukaryotes during the incubation experiments.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Groups** | **Time course**  **(h)** | **Observed\_OTU** | **Shannon** | **Simpson** | **Chao1** | **ACE** |
| Surface layer water incubations | Light | 0 | 1463 | 7.98 | 0.99 | 1575.73 | 1571.04 |
| 24 | 1095 | 7.38 | 0.98 | 1168.77 | 1166.01 |
| 48 | 976 | 7.22 | 0.97 | 1028.56 | 1027.92 |
| 72 | 602 | 4.25 | 0.84 | 667.06 | 677.64 |
| Nutrients + Light | 0 | 1463 | 7.98 | 0.99 | 1575.73 | 1571.04 |
| 24 | 1156 | 7.52 | 0.98 | 1229.51 | 1237.03 |
| 48 | 768 | 5.28 | 0.89 | 850.25 | 865.46 |
| 72 | 1135 | 7.69 | 0.99 | 1222.44 | 1233.30 |
| DCM layer water incubations | 10% Light | 0 | 1272 | 7.05 | 0.98 | 1345.10 | 1355.46 |
| 24 | 430 | 1.69 | 0.33 | 500.14 | 506.02 |
| 48 | 757 | 4.74 | 0.87 | 838.08 | 850.02 |
| 72 | 592 | 3.15 | 0.71 | 686.51 | 698.29 |
| Light | 0 | 1272 | 7.05 | 0.98 | 1345.10 | 1355.46 |
| 24 | 1191 | 7.35 | 0.98 | 1310.40 | 1307.34 |
| 48 | 784 | 5.72 | 0.94 | 856.66 | 870.26 |
| 72 | 975 | 5.72 | 0.94 | 1065.42 | 1078.85 |
| Nutrients + Light | 0 | 1272 | 7.05 | 0.98 | 1345.10 | 1355.46 |
| 24 | 1324 | 6.79 | 0.94 | 1403.57 | 1401.44 |
| 48 | 1031 | 5.44 | 0.90 | 1622.85 | 1248.52 |
| 72 | 463 | 3.55 | 0.80 | 524.32 | 531.57 |

**Supplementary Table 6.** Shifts in relative abundance (%) of major bacteria lineages during the incubation experiments.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Surface layer water incubations** | | | | | | | | **DCM layer water incubations** | | | | | | | | | | | |
|  | **Light** | | | | **Nutrients + Light** | | | | **10% Light** | | | | **Light** | | | | **Nutrients + Light** | | | |
|  | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** |
| Gammaproteobacteria | 24.14 | 52.88 | 40.33 | 20.91 | 24.14 | 32.83 | 41.1 | 18.82 | 17.89 | 30.53 | 57.59 | 21.16 | 17.89 | 19.65 | 32.5 | 15.15 | 17.89 | 27.53 | 30.46 | 18.48 |
| Alphaproteobacteria | 20.15 | 10.15 | 23.57 | 35.46 | 20.15 | 20.16 | 33.88 | 31.49 | 14.49 | 17.43 | 36.11 | 21.72 | 14.49 | 48.00 | 13.73 | 17.02 | 14.49 | 47.99 | 35.8 | 33.96 |
| Cyanobacteriia | 30.69 | 18.05 | 15.44 | 25.08 | 30.69 | 27.52 | 15.59 | 21.92 | 8.19 | 1.18 | 2.00 | 47.86 | 8.19 | 11.85 | 43.76 | 44.08 | 8.19 | 3.46 | 23.27 | 34.93 |
| Thermoplasmata | 7.53 | 1.45 | 1.32 | 0.09 | 7.53 | 2.45 | 0.01 | 4.30 | 24.45 | 0.10 | 0.03 | 0.02 | 24.45 | 7.54 | 1.83 | 6.38 | 24.45 | 1.13 | 0.37 | 0.01 |
| Nitrososphaeria | 0.03 | 0.05 | 0.03 | 0.01 | 0.03 | 0.02 | 0.02 | 0.02 | 7.66 | 5.38 | 0.57 | 1.54 | 7.66 | 2.85 | 0.95 | 0.45 | 7.66 | 6.42 | 3.83 | 3.42 |
| Clostridia | 0.15 | 0.07 | 0.13 | 0.12 | 0.15 | 0.71 | 1.59 | 0.16 | 0.14 | 7.55 | 0.14 | 0.11 | 0.14 | 0.19 | 0.08 | 0.04 | 0.14 | 0.18 | 0.10 | 0.08 |
| Bacteroidia | 1.81 | 3.22 | 4.13 | 3.74 | 1.81 | 2.95 | 1.91 | 5.79 | 1.47 | 7.10 | 0.42 | 0.53 | 1.47 | 1.03 | 0.92 | 1.38 | 1.47 | 2.34 | 0.62 | 0.63 |
| Acidimicrobiia | 3.94 | 3.59 | 3.05 | 3.50 | 3.94 | 2.96 | 0.66 | 6.43 | 4.50 | 1.09 | 0.31 | 0.42 | 4.50 | 1.98 | 1.15 | 0.71 | 4.50 | 2.01 | 0.97 | 0.30 |
| Bacilli | 0.19 | 0.07 | 0.09 | 0.06 | 0.19 | 0.10 | 0.12 | 0.08 | 0.17 | 5.16 | 0.09 | 0.09 | 0.17 | 0.08 | 0.11 | 0.05 | 0.17 | 0.04 | 0.03 | 0.09 |
| Actinobacteria | 0.41 | 0.13 | 0.07 | 0.04 | 0.41 | 0.09 | 0.22 | 0.09 | 0.48 | 2.51 | 0.07 | 0.11 | 0.48 | 0.06 | 0.07 | 0.15 | 0.48 | 0.04 | 0.02 | 0.12 |
| Others | 10.95 | 10.34 | 11.85 | 11.00 | 10.95 | 10.22 | 4.91 | 10.9 | 20.59 | 21.97 | 2.66 | 6.44 | 20.59 | 6.78 | 4.90 | 14.58 | 20.59 | 8.86 | 4.54 | 7.97 |

**Supplementary Table 7.** Shifts in relative abundance (%) of major planktonic eukaryotic lineages during the incubation experiments.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Surface layer water incubations** | | | | | | | | **DCM layer water incubations** | | | | | | | | | | | |
|  | **Light** | | | | **Nutrients + Light** | | | | **10% Light** | | | | **Light** | | | | **Nutrients + Light** | | | |
|  | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** | **0** | **24** | **48** | **72** |
| Dinophyceae | 34.36 | 10.05 | 18.61 | 1.07 | 34.36 | 21.81 | 22.61 | 5.27 | 30.29 | 3.00 | 1.71 | 0.14 | 30.29 | 8.29 | 1.55 | 3.31 | 30.29 | 22.77 | 5.84 | 0.30 |
| Mamiellophyceae | 7.59 | 1.53 | 0.8 | 68.64 | 7.59 | 0.30 | 10.61 | 50.27 | 15.59 | 2.67 | 0.98 | 0.26 | 15.59 | 15.12 | 13.31 | 25.80 | 15.59 | 3.82 | 1.02 | 6.29 |
| Bacillariophyceae | 1.46 | 4.86 | 2.16 | 14.73 | 1.46 | 2.34 | 7.59 | 8.39 | 2.68 | 10.04 | 5.6 | 10.80 | 2.68 | 10.20 | 34.55 | 25.06 | 2.68 | 4.18 | 16.78 | 8.99 |
| Mediophyceae; | 4.06 | 22.02 | 2.17 | 13.53 | 4.06 | 2.36 | 10.31 | 12.54 | 5.89 | 60.14 | 69.3 | 83.03 | 5.89 | 11.33 | 31.09 | 23.04 | 5.89 | 8.87 | 52.60 | 77.22 |
| MASTs | 3.82 | 4.41 | 9.67 | 2.94 | 3.82 | 11.37 | 5.17 | 1.14 | 1.90 | 1.95 | 0.94 | 0.43 | 1.90 | 2.09 | 1.29 | 2.37 | 1.90 | 2.89 | 0.84 | 0.31 |
| Dinoflagellata | 2.70 | 0.66 | 2.07 | 0.05 | 2.70 | 2.11 | 2.01 | 0.43 | 1.38 | 0.08 | 0.12 | 0.04 | 1.38 | 0.67 | 0.12 | 0.28 | 1.38 | 1.62 | 0.20 | 0.03 |
| Ciliophora | 2.36 | 3.62 | 1.81 | 0.21 | 2.36 | 1.83 | 2.87 | 0.28 | 1.01 | 0.41 | 0.41 | 0.14 | 1.01 | 1.10 | 0.88 | 0.39 | 1.01 | 2.56 | 0.70 | 0.07 |
| Retaria | 5.49 | 0.84 | 2.18 | 0.1 | 5.49 | 1.09 | 0.89 | 0.25 | 10.09 | 0.73 | 0.60 | 0.21 | 10.09 | 5.30 | 0.56 | 0.39 | 10.09 | 8.87 | 1.26 | 0.16 |
| fungi | 0.28 | 5.85 | 0.14 | 0.09 | 0.28 | 0.10 | 0.22 | 0.03 | 0.15 | 15.01 | 0.07 | 0.16 | 0.15 | 2.63 | 0.06 | 0.02 | 0.15 | 0.48 | 0.30 | 0.17 |
| Cercozoa | 0.05 | 0.03 | 0.18 | 0.02 | 0.05 | 0.05 | 0.14 | 0.04 | 0.05 | 0.07 | 0.01 | 0.00 | 0.05 | 0.07 | 0.03 | 0.02 | 0.05 | 0.14 | 0.25 | 0.02 |
| Haptophyta | 0.01 | 0.00 | 0.06 | 0.00 | 0.01 | 0.04 | 0.02 | 0.02 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 |