Additional file 1- Table 1 Lists of kea features and genomes information from cyanobacterial strains analyzed in this paper. Note: HL, high light adaptation; LL, low light adaptation; GS, genome size

| Species | Kea Features | | | GS (Mb) | Genes |
|---|---|---|---|---|---|
| *T. elongatus* BP-1 | unicellular | hot-spring | thermophile | 2.59 | 2,528 |
| *N. punctiforme* ATCC 29133 | filamentous | freshwater | nitrogen fixation | 9.06 | 6,794 |
| *A. variabilis* ATCC 29413 | filamentous | freshwater | nitrogen fixation | 7.07 | 5,724 |
| *A*. sp. PCC 7120 | filamentous | soil | nitrogen fixation | 7.21 | 6,223 |
| *A. platensis* NIES-39 | filamentous | | nitrogen fixation | 6.79 | 6,676 |
| *T. erythraeum* IMS101 | filamentous | marine | nitrogen fixation | 7.75 | 4,498 |
| *A. marina* MBIC11017 | unicellular | | | 8.36 | 8,462 |
| *C*. sp. PCC 7425 | unicellular | freshwater | nitrogen fixation | 5.79 | 5,380 |
| *C*. sp. ATCC 51142 | unicellular | freshwater | nitrogen fixation | 5.46 | 5,359 |
| *C*. sp. PCC 8801 | unicellular | freshwater | nitrogen fixation | 4.79 | 4,416 |
| *C*. sp. PCC 7424 | unicellular | freshwater | nitrogen fixation | 6.55 | 5,763 |
| *M. aeruginosa* NIES-843 | unicellular | freshwater | toxic bloom | 5.84 | 6,363 |
| *S*. sp. PCC 7002 | unicellular | marine | | 3.41 | 3,235 |
| *S. elongatus* PCC 6301 | unicellular | freshwater | | 2.75 | 2,580 |
| *S. elongatus* PCC 7942 | unicellular | freshwater | | 2.74 | 2,715 |
| *G. violaceus* PCC 7421 | unicellular | marine | | 4.66 | 4,484 |
| *S*. sp. PCC 6803 | unicellular | freshwater | | 3.96 | 3,725 |
| *S*. sp. RCC307 | unicellular | marine | | 2.22 | 2,583 |
| *S*. sp. CC9311 | unicellular | marine | | 2.61 | 2,944 |
| *S*. sp. WH 7803 | unicellular | marine | | 2.37 | 2,586 |
| *S*. sp. WH8102 | unicellular | marine | | 2.44 | 2,579 |
| *S*. sp. CC9605 | unicellular | marine | | 2.51 | 2,692 |
| *S*. sp. CC9902 | unicellular | marine | | 2.23 | 2,355 |
| *P. marinus* str. MIT 9303 | unicellular | marine | 100m, LL | 2.68 | 3,049 |
| *P. marinus* MIT9313 | unicellular | marine | 135m, LL | 2.41 | 2,326 |
| *P. marinus* SS120 | unicellular | marine | LL | 1.75 | 1,928 |
| *P. marinus* str. MIT 9211 | unicellular | marine | 83m, LL | 1.67 | 1,900 |
| *P. marinus* MED4 | unicellular | marine | 5m, HL | 1.66 | 1,756 |
| *P. marinus* MIT9312 | unicellular | marine | 132m, HL | 1.71 | 2,007 |
| *P. marinus* str. MIT 9215 | unicellular | marine | HL | 1.74 | 2,025 |
| *P. marinus* str. MIT 9301 | unicellular | marine | 90m, HL | 1.64 | 1,949 |
| *P. marinus* str. AS9601 | unicellular | marine | 50m, HL | 1.67 | 1,964 |
| *P. marinus* str. MIT 9515 | unicellular | marine | 15m, HL | 1.70 | 1,948 |
| *P. marinus* str. NATL1A | unicellular | marine | 30m, LL | 1.86 | 2,236 |
| *P. marinus* str. NATL2A | unicellular | marine | 10m, LL | 1.84 | 2,207 |
| *S*. sp. JA-3-3Ab | unicellular | hot-spring | | 2.93 | 2,815 |
| *S*. sp. JA-2-3B'a(2-13) | unicellular | hot-spring | | 3.05 | 2,914 |

Additional file 2 – Table 2 The percentage of amino acid sequence similarity for CCD7 proteins from *Synechococcus* and *Prochlorococcus*

| | PMM0280 | PMT9312_0282 | PMT1879 | Pro0312 | A9601_03031 | P9211_03071 | P9215_03051 | P9301_03041 | P9303_25111 | P9515_03131 | NATL1_03601 | PMN2A_1646 | Syncc9605_0221 | SYNW0227 | Syncc9902_0248 | SynRCC307_2292 | SynWH7803_0270 | sync_0261 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PMM0280 | 100 | 97 | 61 | 61 | 96 | 64 | 96 | 97 | 61 | 85 | 65 | 65 | 60 | 61 | 60 | 62 | 62 | 61 |
| PMT9312_0282 | | 100 | 60 | 61 | 97 | 64 | 96 | 97 | 60 | 86 | 65 | 65 | 60 | 61 | 60 | 62 | 61 | 60 |
| PMT1879 | | | 100 | 68 | 61 | 71 | 60 | 61 | 99 | 61 | 65 | 65 | 73 | 73 | 72 | 71 | 73 | 71 |
| Pro0312 | | | | 100 | 60 | 69 | 60 | 61 | 68 | 62 | 66 | 65 | 64 | 64 | 63 | 64 | 64 | 62 |
| A9601_03031 | | | | | 100 | 64 | 94 | 98 | 60 | 86 | 66 | 66 | 59 | 60 | 59 | 62 | 61 | 61 |
| P9211_03071 | | | | | | 100 | 64 | 64 | 71 | 65 | 69 | 69 | 69 | 68 | 69 | 66 | 70 | 68 |
| P9215_03051 | | | | | | | 100 | 95 | 60 | 85 | 65 | 65 | 60 | 61 | 60 | 62 | 61 | 61 |
| P9301_03041 | | | | | | | | 100 | 61 | 85 | 65 | 65 | 60 | 61 | 60 | 62 | 62 | 61 |
| P9303_25111 | | | | | | | | | 100 | 60 | 65 | 64 | 73 | 73 | 72 | 71 | 73 | 70 |
| P9515_03131 | | | | | | | | | | 100 | 65 | 65 | 60 | 60 | 60 | 61 | 61 | 60 |
| NATL1_03601 | | | | | | | | | | | 100 | 99 | 65 | 65 | 65 | 65 | 66 | 65 |
| PMN2A_1646 | | | | | | | | | | | | 100 | 65 | 65 | 65 | 64 | 66 | 65 |
| Syncc9605_0221 | | | | | | | | | | | | | 100 | 94 | 90 | 75 | 76 | 75 |
| SYNW0227 | | | | | | | | | | | | | | 100 | 90 | 75 | 75 | 76 |
| Syncc9902_0248 | | | | | | | | | | | | | | | 100 | 75 | 77 | 74 |
| SynRCC307_2292 | | | | | | | | | | | | | | | | 100 | 75 | 75 |
| SynWH7803_0270 | | | | | | | | | | | | | | | | | 100 | 82 |
| sync_0261 | | | | | | | | | | | | | | | | | | 100 |

Additional file 3 – Table 3 The percentage of amino acid sequence similarity for ACO proteins from distinct organisms

| | gll2774 | slr1648 | AM1_0925 | Cyan7425_3964 | AM1_1272 | SYNPCC7002_A2200 | all4895 | Npun_R0776 | PCC7424_5321 | MAE60600 | PCC8801_0015 | cce_2515 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| gll2774 | 100 | 48 | 50 | 50 | 52 | 48 | 53 | 55 | 53 | 51 | 53 | 53 |
| slr1648 | | 100 | 43 | 47 | 48 | 43 | 46 | 49 | 48 | 45 | 48 | 45 |
| AM1_0925 | | | 100 | 57 | 52 | 45 | 51 | 53 | 47 | 50 | 52 | 50 |
| Cyan7425_3964 | | | | 100 | 53 | 45 | 54 | 52 | 51 | 53 | 54 | 52 |
| AM1_1272 | | | | | 100 | 46 | 54 | 55 | 54 | 49 | 52 | 50 |
| SYNPCC7002_A2200 | | | | | | 100 | 50 | 52 | 52 | 48 | 53 | 50 |
| all4895 | | | | | | | 100 | 76 | 61 | 56 | 59 | 58 |
| Npun_R0776 | | | | | | | | 100 | 61 | 53 | 58 | 57 |
| PCC7424_5321 | | | | | | | | | 100 | 55 | 64 | 61 |
| MAE60600 | | | | | | | | | | 100 | 61 | 60 |
| PCC8801_0015 | | | | | | | | | | | 100 | 69 |
| cce_2515 | | | | | | | | | | | | 100 |

Additional file 4 – Table 4 The percentage of amino acid sequence similarity for CCD1, NCED, and CCD8 proteins from distinct organisms.

| | **CCD8** | PCC8801_0352 | cce_3977 | PCC7424_0935 | A. thaliana | C. reinhardtii | **NCED** | P. tricornutum | A. thaliana | S. lycopersicum | Tery_3212 | A. thaliana | Z. mays | **CCD1** | O. tauri | Ava_2047 | PCC7424_4841 | cce_2215 | Tery_3794 | Npun_F286 | all1106 | Ava_3710 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CCD8** | | | | | | | | | | | | | | | | | | | | | | |
| PCC8801_0352 | | 100 | 70 | 65 | 25 | 26 | | | | | | | | | | | | | | | | |
| cce_3977 | | | 100 | 64 | 23 | 24 | | | | | | | | | | | | | | | | |
| PCC7424_0935 | | | | 100 | 25 | 25 | | | | | | | | | | | | | | | | |
| A. thaliana | | | | | 100 | 33 | | | | | | | | | | | | | | | | |
| C. reinhardtii | | | | | | 100 | | | | | | | | | | | | | | | | |
| **NCED** | | | | | | | | | | | | | | | | | | | | | | |
| P. tricornutum | | | | | | | | 100 | 25 | 25 | 23 | 25 | 29 | | 25 | 26 | 26 | 27 | 25 | 27 | 26 | 26 |
| A. thaliana | | | | | | | | | 100 | 60 | 99 | 39 | 40 | | 29 | 34 | 32 | 33 | 34 | 34 | 32 | 33 |
| S. lycopersicum | | | | | | | | | | 100 | 48 | 37 | 40 | | 30 | 32 | 33 | 37 | 34 | 36 | 35 | 34 |
| Tery_3212 | | | | | | | | | | | 100 | 39 | 31 | | 27 | 32 | 29 | 29 | 28 | 29 | 27 | 29 |
| A. thaliana | | | | | | | | | | | | 100 | 37 | | 28 | 34 | 35 | 35 | 35 | 37 | 35 | 35 |
| **CCD1** | | | | | | | | | | | | | | | | | | | | | | |
| Z. mays | | | | | | | | | | | | | 100 | | 31 | 40 | 36 | 44 | 40 | 44 | 44 | 44 |
| O. tauri | | | | | | | | | | | | | | | 100 | 34 | 34 | 36 | 35 | 32 | 33 | 32 |
| Ava_2047 | | | | | | | | | | | | | | | | 100 | 50 | 52 | 50 | 55 | 53 | 53 |
| PCC7424_4841 | | | | | | | | | | | | | | | | | 100 | 59 | 52 | 55 | 54 | 54 |
| cce_2215 | | | | | | | | | | | | | | | | | | 100 | 56 | 64 | 59 | 59 |
| Tery_3794 | | | | | | | | | | | | | | | | | | | 100 | 60 | 57 | 58 |
| Npun_F286 | | | | | | | | | | | | | | | | | | | | 100 | 74 | 74 |
| all1106 | | | | | | | | | | | | | | | | | | | | | 100 | 96 |
| Ava_3710 | | | | | | | | | | | | | | | | | | | | | | 100 |

Additional file 5 – Table 5 the percentage of amino acid sequence similarity for CCD7 proteins from distinct organisms (except *Synechococcus* and *Prochlorococcus* )

| | AM1_3102 | Cyan7425_4222 | all4284 | Ava_1236 | Npun_F0298 | NIES39_D06860 | SYNPCC7002_A1425 | sll1541 | PCC8801_4340 | cce_2665 | PCC7424_0449 | MAE09040 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AM1_3102 | 100 | 62 | 58 | 58 | 60 | 57 | 56 | 54 | 54 | 58 | 57 | 57 |
| Cyan7425_4222 | | 100 | 60 | 61 | 61 | 59 | 54 | 54 | 54 | 54 | 55 | 56 |
| all4284 | | | 100 | 95 | 79 | 65 | 58 | 56 | 60 | 61 | 63 | 65 |
| Ava_1236 | | | | 100 | 79 | 65 | 59 | 56 | 60 | 61 | 63 | 64 |
| Npun_F0298 | | | | | 100 | 62 | 58 | 55 | 61 | 61 | 60 | 63 |
| NIES39_D06860 | | | | | | 100 | 62 | 60 | 59 | 60 | 58 | 63 |
| SYNPCC7002_A1425 | | | | | | | 100 | 59 | 57 | 62 | 62 | 62 |
| sll1541 | | | | | | | | 100 | 61 | 60 | 58 | 61 |
| PCC8801_4340 | | | | | | | | | 100 | 69 | 63 | 62 |
| cce_2665 | | | | | | | | | | 100 | 66 | 64 |
| PCC7424_0449 | | | | | | | | | | | 100 | 65 |
| MAE09040 | | | | | | | | | | | | 100 |