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CARBON AND NITROGEN PHYSIOLOGY OF SEAWEEDS ALONG A LIGHT GRADIENT

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It is hypothesised that under light limiting conditions, the ability of seaweeds to take up and assimilate 'energetically expensive' forms of nitrogen and carbon are reduced. For carbon, light-limited seaweeds may take up CO_2 in preference to bicarbonate and for nitrogen, ammonium is considered to be preferred over nitrate. This hypothesis was examined in Doubtful Sound, Fiordland, New Zealand, during a 10-day workshop in January 2008. 30 species of seaweed ($n = 3–5$) were collected from two depths (4 m and 10–15 m) at three sites with differing incident irradiances: high light (1000 $\mu mol\ m^{-2}\ s^{-1}$), medium light (200 $\mu mol\ m^{-2}\ s^{-1}$), and low light (50 $\mu mol\ m^{-2}\ s^{-1}$). Carbon stable isotopes (δ^{13} C) were determined to provide an indication of whether seaweeds were using CO_2 and/or bicarbonate. This was confirmed for some seaweeds by examining rates of photosynthesis at a range of dissolved inorganic carbon concentrations, their ability to raise the pH of culture medium (pH-drift experiments) and by measuring the activity of extracellular carbonic anhydrase. The nitrogen status of seaweeds was determined from the ratio of tissue carbon:nitrogen and soluble nitrate and ammonium pools. The effect of nitrate vs ammonium on photosynthesis was determined by culturing seaweeds with those nutrients present, and measuring 'rapid light curves' using a Pulse Amplitude Modulated chlorophyll fluorescence. Environmental data including underwater light levels and seawater nutrient concentrations were collected at each site so that physiological data could be related to the seaweeds' habitat.

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CYTOKININ PRODUCING CYANOBACTERIA INDUCE LOCALIZED RESISTANCE IN ARABIDOPSIS THALIANA AGAINST PSEUDOMONAS SYRINGAE PV. TOMATO DC3000

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Cyanobacterial species were screened for plant growth promotion using Arabidopsis thaliana model plants. Shoot length and root length was enhanced by *Synechosystis*, *Oscillatoria*, *Phomidium*, *Chroocidiopsis and Anabaena species*. Engogenous and exogenous cytokinin in axenic cyanobacterial culture was quantified by using Ultrapressure liquid chromatography (UPLC) coupled to a tandem quadrupole mass spectrometer (MS/MS) equipped with an electrospray interface (ESI) in MRM mode. Lyophilized biomass of cyanobacteria was extracted in Bielesky buffer, and purified by solid phase extraction (SPE). Stable isotope labelled standards were added to the samples to check recovery and validate method. CZ, TZ, ZR, ZOG and DHZ were detected and quantified. In-planta cytokinin secretion by cyanobacteria was followed by infiltrating Arabidopsis ARR5::GUS leaves or treating roots of ARR5::GUS seedlings with cyanobacterial suspension and gus induction. Localized gus staining was observed in areas infiltrated with cyanobacterial strain. Unicellular strains were used for therir biocontrol activity against *Pseudomonas syringae* tomato DC3000 in arabidopsis leaves. Synechosystis and *Chroocidiopsis* were able to restract growth in localized areas of the leaves however no systemic resistance was evidant. In another study we found that cytokinin confer localized resistance against Ps DC3000 in arabidopsis and Ps tabaci in *Nicotiana tobacum*. We tested cyanobacterial system for the same mechanism of resistance and found consistant results with the kinetine system including upregulation of PR1 protein, unaffected level of ROS, SA and JA. Extract from leaves infiltrated with the strains showed enhanced antimicrobial activity suggesting high camalexins accumulation.

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MORPHOLOGICAL CHARACTERISTICS OF THREE CRYPTIC SPECIES RELATED TO *PORPHYRA TENERA* KJELLMAN REVEALED BY MOLECULAR DATA

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In the previous study, three cryptic species were revealed by the analysis of molecular data (nuclear SSU rDNA, plastid *rbc*L and mitochondrial *cox*1 gene sequences) to find out the phylogenetic relationship of *Porphyra tenera* Kjellman and its related species from Korea and Japan: *P. kinositae* (Yamada et Tanaka) Fukuhara, *P. koreana* Hwang et Lee,

P. kuniedae Kurogi, *P. yezoensis* Ueda. The morphological characters discriminating the species but the cryptic ones are thickness of gametophytic thalli, shape of spermatangial sori, division pattern of spermatangia and zygotosporangia, and so on. However, the characters show the variation according to the environmental conditions so that the species discrimination has been problematic even to *Porphyra* taxonomists. The cryptic species are hardly distinguished from *P. yezoensis* by those characters, and only minute differences were observed in the length of trichogynes on carpogonia of gametophytic thalli and some characters of sporophytic thalli such as the length of vegetative cells of conchocelis filaments, the branching pattern of conchosporangial branches. Morphological characteristics of gametophytic and sporophytic thalli of each cryptic species will be presented and the incongruity of divergence degree between morphological and molecular characters in a group including *P. tenera* and its related species will be discussed.

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A NEW SPECIES OF *ULVA*, *ULVA LIMNETICA (ULVALES, ULVOPHYCEAE)* ADAPTED TO FRESHWATER

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The green macroalgal genus *Ulva* (Ulvales, Ulvophyceae, Chlorophyta) distribute from marine to brackish water all over the world. The genus *Ulva* includes approximately 100 species in the world, of which 18 species of *Ulva* are currently recognized in Japan. Freshwater ulvalean alga, *Ulva limnetica* Ichihara et Shimada, sp. nov. is described from the Ryukyu Islands, Japan and is characterized by the branched, tubular, fragile, wrinkled thalli, and the rhizoidal cells bearing tubular extensions on the outside of the cell layer in the stipe. *Ulva limnetica* is distinguished from similar species by its morphological features and sequences of the nuclear encoded 18S ribosomal RNA gene and the plastid encoded large subunit of ribulose-1,5-bisphosphate carboxylase/oxgenase gene. *Ulva limnetica* was also investigated to understand molecular mechanism of its tolerance or adaptation to freshwater. A 19 kDa protein was accumulated in freshwater-cultured samples than seawater-cultured samples. The protein showed 30% identity and 45% similarity to lectin isolated from *Ulva pertusa* Kjellman, and thus, this gene was named as *ULL* (*Ulva limnetica* lectin like protein). Northern blot analysis demonstrated that the expression level of the *ULL* in the freshwater-cultured sample was higher than in the seawater-cultured sample.

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CHARACTERIZATION OF PARMALES, A SILICEOUS PHYTOPLANKTON, ISOLATED FROM THE OYASHIO WATER NEAR JAPAN

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Parmales, an order of class Chrysophyceae, encompasses a group of tiny and solitary cells, generally 2 to 5 μm in diameter, with silicified cell wall composed of five to eight plates. Parmales has been reported to distribute widely in the world oceans, from polar to subtropical regions, and to be often abundant in polar and subpolar waters. The ecological role of Parmales is still unclear since it is difficult to estimate its abundance under a light microscope due to its small cell size. Additionally, their taxonomic position has not been ascertained since no observation of living cells or molecular studies have been done due to lack of culture. We established a crude culture of Parmales from the sea water in the Oyashio region, the western part of the subarctic Pacific Ocean, in summer, 2008. The culture was obtained by serial dilutions with filtered sea water and maintained in a modified f/2 medium at 5°C under with a 14 h light (100 μmol photons·m^{-2}·s^{-1})-10 h dark photoperiod. We will report the morphological features observed under SEM and TEM, phylogenetic data using 18SrRNA sequence and photosynthetic pigment composition of our isolate. From these data, the taxonomic position of Parmales will be discussed.

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MODELS FOR PS I SPECIAL PAIRS BASED ON THE ABSORPTION SPECTRA AND REDOX POTENTIALS

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P740 in Acaryochloris marina is a Chl *d*/*d*' heterodimer like the Chl *a*/*a*' for P700 in other cyanobacteria. The oxidation potential of Chl *d* was +0.88 V in acetonitrile, higer than that of Chl *a*(+0.81 V). The E_m of P740 was +430 mV, equal to that of P700. The difference in the oxidation potential shifts between Chl *a*/Chl $a^+ \rightarrow$ P700/P700$^+$ and Chl *d*/*d*$^+ \rightarrow$ P740/P740$^+$ suggests to us that the interaction between the