Pelagibacter metabolism of diatom-derived volatile organic compounds imposes an energetic tax on photosynthetic carbon fixation

PRESENTER:

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BACKGROUND: Photosynthetic diatoms and marine bacteria contribute about one third of the net primary production in marine environments. Understanding the interactions between these two organisms is potentially important to the over all flow of carbon in the marine ecosystem.

METHODS

1. Collected *T. pseudonana* and *Pelagibacter*
2. Create 3 tests: monoculture, co-culture, co-culture with no added metabolites.
3. Collect carbon fixation data using pH and a scintillation counter.
4. Measure culture growth data with Guava and Culture counter.
5. Measure VOC levels and types with PTR-TOF/MS

RESULTS

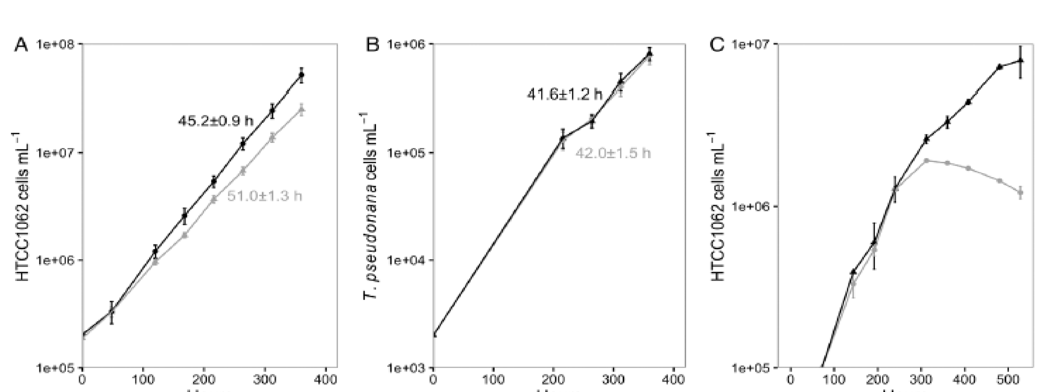


Fig. 1. HTCC1062 growth is enhanced by the presence of *Thalassiosira pseudonana*.
A. HTCC1062 generation times under carbon-replete conditions were nearly 6 h faster in co-culture (black) with the diatom compared with growth in monoculture (gray); $p = 1 \times 10^{-4}$, $n = 5$.
B. *T. pseudonana* growth rates were unchanged in the presence of the heterotroph (black = co-culture, gray = monoculture); $p = 0.67$, $n = 5$.
C. In medium lacking pyruvate, glycine and methionine, HTCC1062 was added to an exponentially growing *T. pseudonana* culture after 72 h (black) and reached a maximum density that was fourfold higher than the density reached by cells in monoculture also lacking pyruvate, glycine and methionine (gray) ($n = 3$). Error bars show SDs, *p*-values calculated using a student's *t* test.

1. Bacterial generation times were nearly 6h faster in co-culture
2. In metabolite deprived culture, addition of bacteria to diatom culture resulted in four-fold increase in density.

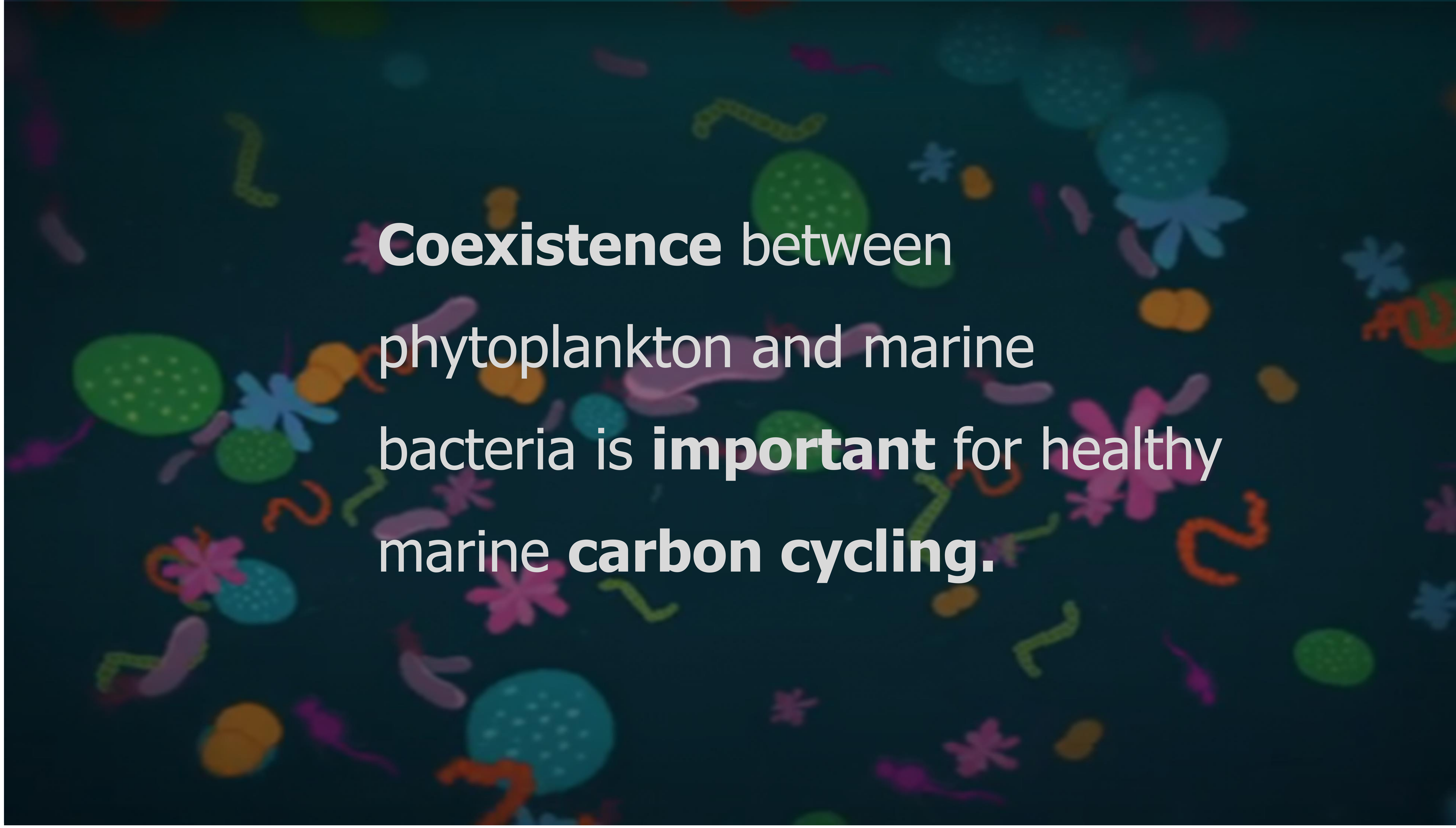


Table 2. Putative identification of *m/z* values that differed in concentration in the co-culture relative to the *T. pseudonana* monoculture.

m/z	Putative VOC	Log_2 fold change in co-culture	*Q*-value
42.034	Acetonitrile	−0.163	0.08
43.051	*Propene, cyclopropane*	−0.479	0.04
45.033	Acetaldehyde	−0.971	0.03
49.011	Methanethiol	+1.110	0.03
59.049	Acetone	−0.322	0.06
63.026	DMS	−0.269	0.12
69.070	Isoprene	−0.348	0.12
82.958	*Carbonyl chlorofluoride*	−0.971	0.01
84.940	*Dichloromethane*	−0.393	0.004
87.080	Cyclopentanol, pentanal	−0.555	0.02
101.096	Cyclohexanol, hexanal	−1.237	<0.001

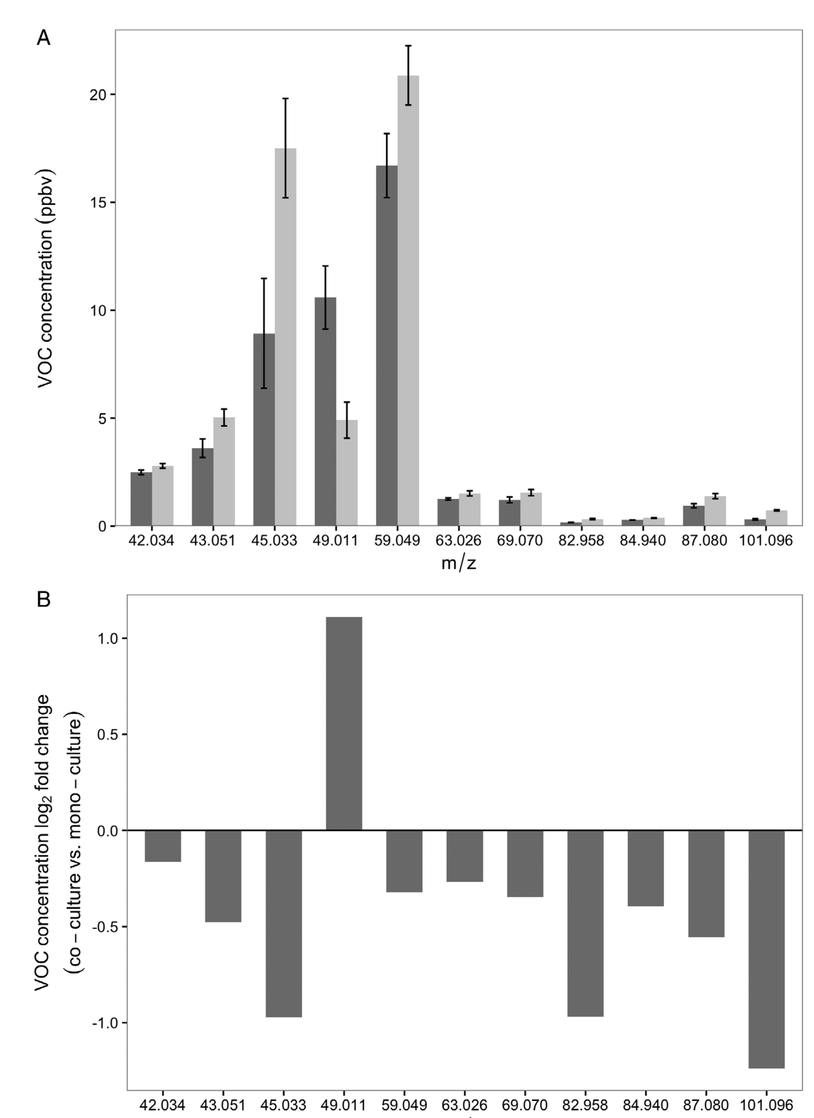
Table 3. VOCs were added to starved HTCC1062 (VOC added row) and cellular ATP content measured relative to negative controls (No VOC row).

	Isoprene[a]	Acetone[b]	Cyclohexanol[b]	Hexanal[c]	*Cis*-3-hexen-1-ol[c]	2-Hexanone[c]	Acetonitrile[d]	Toluene[d]
m/z	69.071	59.055	101.092	101.092	101.092	101.092	42.035	93.070
No VOC (– control)	2896 ± 247	3210 ± 172	3210 ± 172	3692 ± 108	3692 ± 108	3692 ± 108	4105 ± 2261	4105 ± 2261
VOC added	3318 ± 252	3631 ± 96	3845 ± 120	4185 ± 170	3739 ± 285	3501 ± 152	6167 ± 3114	6864 ± 1032
Pyruvate (+ control)	10,339 ± 1254	4533 ± 111	4533 ± 111	6629 ± 252	6629 ± 252	6629 ± 252	6707 ± 644	6707 ± 644
p-value	0.015	0.032	0.009	0.004	0.775	0.091	0.411	0.157

Table 4. Measurements of photo-physiological properties in *T. pseudonana* grown in monoculture or co-culture showed little detectable variation between conditions.

Parameter or pigment	*T. pseudonana* monoculture	Co-culture	Units	*p*-value
F_v/F_m	0.62 ± 0.00	0.61 ± 0.01	Unitless	0.05
Total absorbance	0.0116 ± 0.0012	0.0135 ± 0.0014	$m^2\ mg^{-1}$	0.13
Chlorophyll a	0.7247 ± 0.0209	0.7541 ± 0.0617	pg $cell^{-1}$	0.50
19′-Hexanoyloxyfucoxanthin	0.0018 ± 0.0003	0.0016 ± 0.0005	pg $cell^{-1}$	0.64
β-Carotene	0.0219 ± 0.0012	0.0193 ± 0.0019	pg $cell^{-1}$	0.13
Chlorophyll b	0.0100 ± 0.0014	0.0099 ± 0.0009	pg $cell^{-1}$	0.95
Chlorophyll c	0.0758 ± 0.0117	0.0688 ± 0.0043	pg $cell^{-1}$	0.41
Chlorophyllide	0.0222 ± 0.0046	0.0293 ± 0.0043	pg $cell^{-1}$	0.12
Diadinoxanthin	0.0420 ± 0.0023	0.0394 ± 0.0039	pg $cell^{-1}$	0.37
Fucoxanthin	0.2737 ± 0.0105	0.2603 ± 0.0181	pg $cell^{-1}$	0.34
Lutein	0.0010 ± 0.0006	0.0012 ± 0.0003	pg $cell^{-1}$	0.51
Violaxanthin	0.0031 ± 0.0003	0.0027 ± 0.0002	pg $cell^{-1}$	0.16
Zeaxanthin	0.0015 ± 0.0008	0.0010 ± 0.0002	pg $cell^{-1}$	0.42
Total carotenes	0.0219 ± 0.0012	0.0193 ± 0.0019	pg $cell^{-1}$	0.13

Values are the average of three biological replicates ± SD.



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