Potentials of Marine Fungal-like Protists in Production of Fatty Acids

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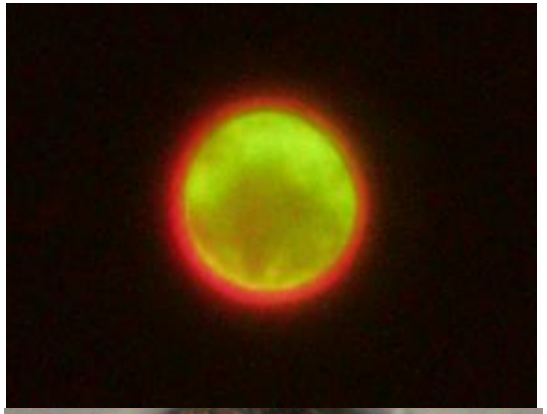
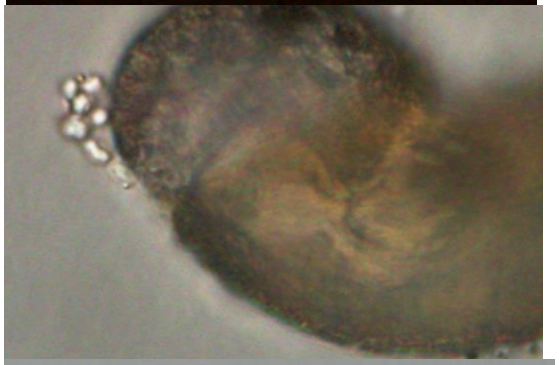
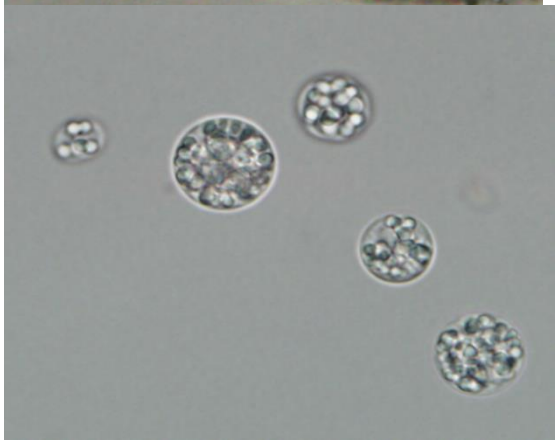
Marine Thraustochytrids

- heterotrophic, unicellular, marine (fungal-like) protists;
- play active role in decomposing detritus matters by produce diverse hydrolytic enzymes;
- Producing diverse hydrolytic enzymes and fatty acids.





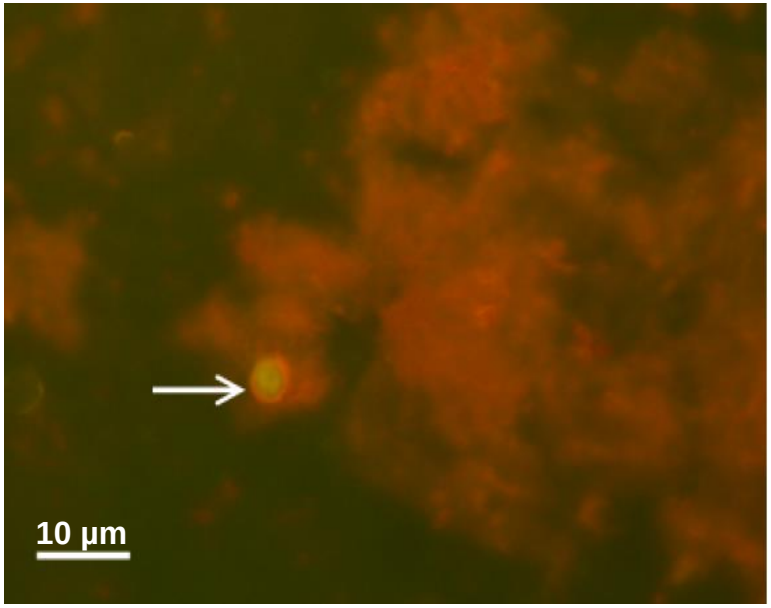


Marine *Labyrinthulomycetes*

Labyrinthulomycetes
(mainly marine)

- *Labyrinthulids*
- aplanochytrids
- *Thraustochytrids*

$$\frac{20.6\times10^{-12}\text{ g carbon/cell}}{3.02\times10^{-15}\text{ g carbon/cell (Bac)}} = 682$$



Photomicrograph of an acriflavine-stained thraustochytrid cell (marked by arrow) from a natural sample on a black filter membrane (Demare, 2008)

Biomass of thraustochytrids in marine habitats

Substrate	Parameter
Brown alga *Sargassum cinereum*; 21 days of decomposition; coastal waters of Goa, India	0.0007 g C per g detritus
Decaying mangrove leaves	0.0015–043% of detrital dry weight
Phytoplankton detritus; North Sea	0.111 mg C g^{-1} detritus, at 20.6 pg C per 5 µm cell (based on Kimura et al. 1999)
Faecal pellets of the salp, *Pegea confoederata*; Arabian Sea	12 mg C g^{-1} dry wt. faecal pellet, at 20.6 pg C per 5 µm cell (based on Kimura et al. 1999)
Coastal waters of the Japan Sea	0.0026 mg C L^{-1} seawater (at 165 pg C per 10 µm cell, Kimura et al. 1999)
Water column of the Arabian Sea	Up to 0.027 mg C L^{-1} seawater (at 20.6 pg C per 5 µm cell (based on Kimura et al. 1999)

2.6 µg C/ml

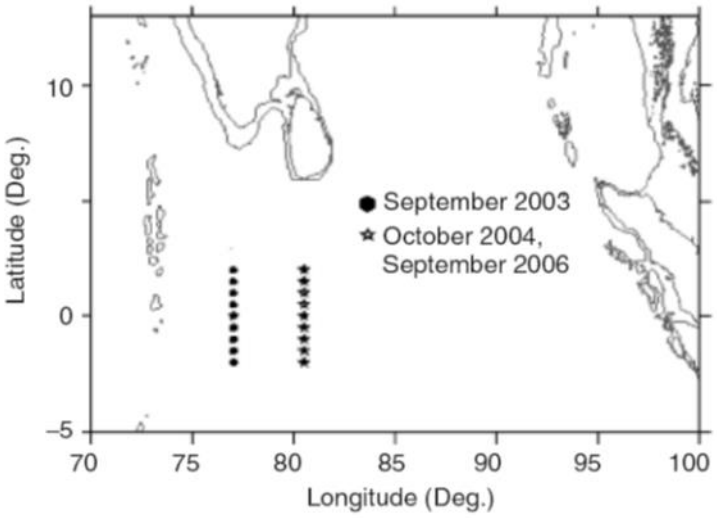
27 µg C/ml

Thraustochytrids Abundance

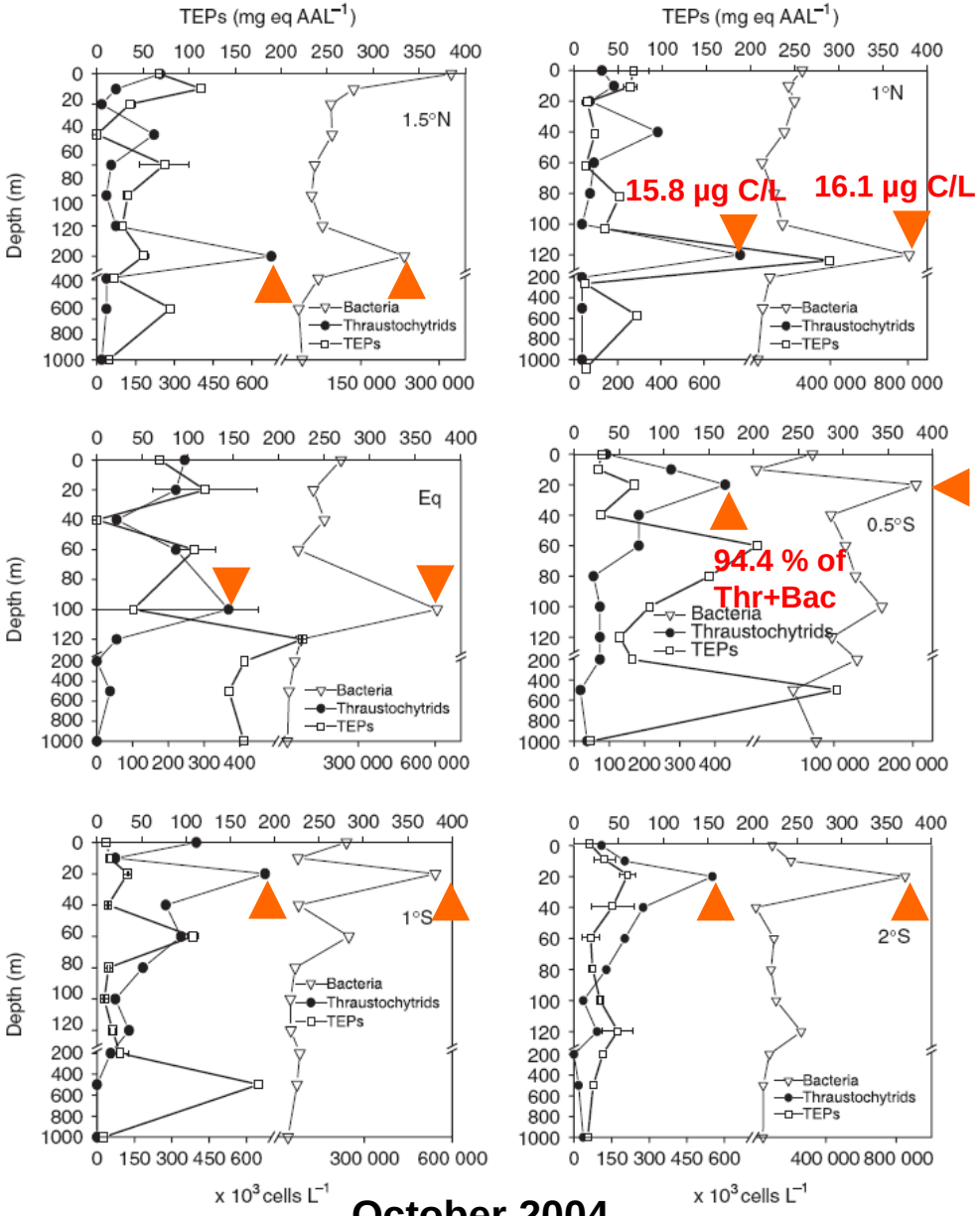
No. of cells (per litre)	Habitat	Reference
56 $X10^3$	Coastal Oceanic waters off Japan	Naganuma et al. (1998)
50 $X10^3$	Coastal Oceanic waters off Japan	Kimura et al. (1999)
21.4 $X10^3$	Coastal Oceanic waters off Japan	Kimura et al. (2001)
130 $X10^3$	Arabian Sea	Raghukumar et al. (2001)
42.3 $X10^3$	Sandy shores of Mediterranean Sea	Bongiorni et al. (2004)
230 $X10^3$	Greenland and Norwegian Seas	Naganuma et al. (2006)
674 $X10^3$	Equatorial Indian Ocean	Damare and Raghukumar (2008)
630$X10^3$	North Pacific subtropical Ocean off Hawaii	Li et al. (2013)
320 $X10^3$	Coastal Oceanic waters of Pearl River Delta	Liu et al. (2014a)

Thraustochytrids (cont'd)

Abundance in the equatorial Indian Ocean



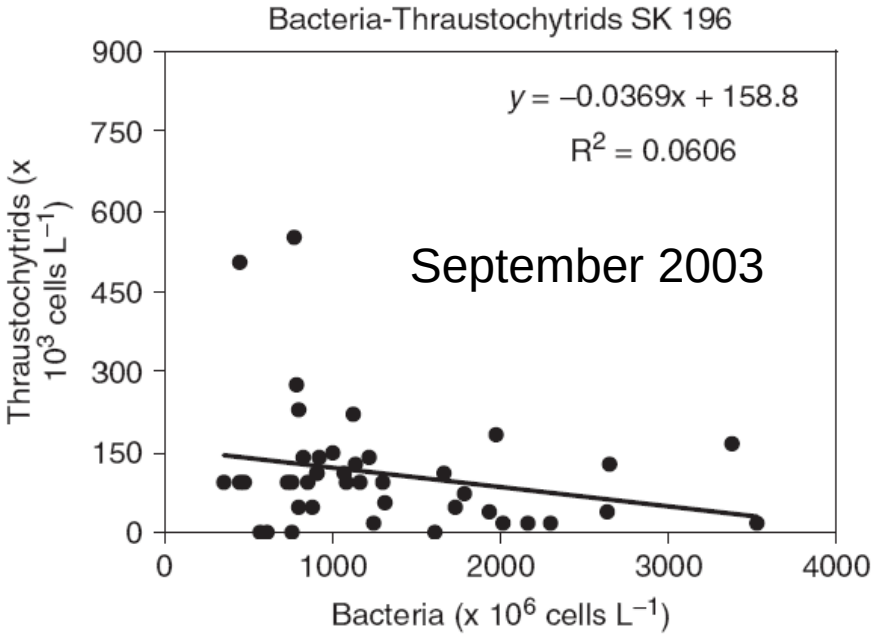
CTD stations in the equatorial Indian Ocean during the cruise of ORV Sagar Kanya.

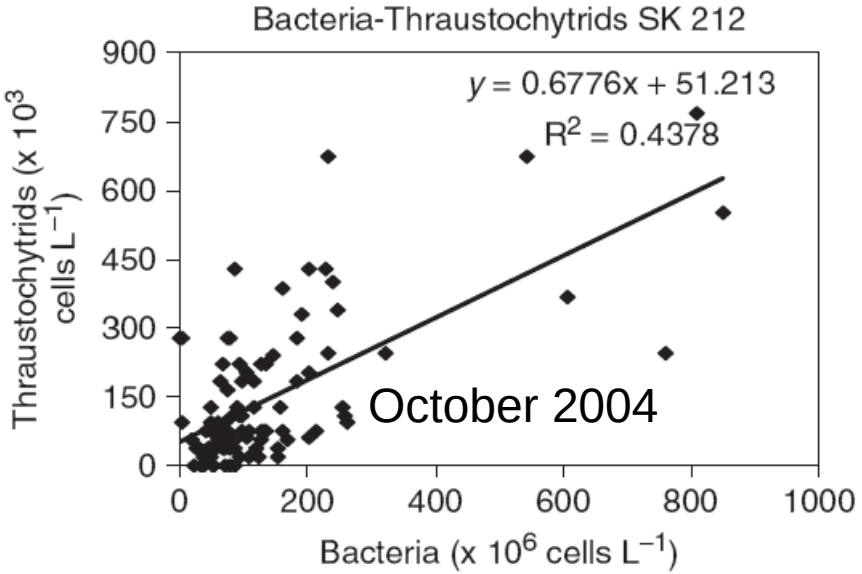


October 2004

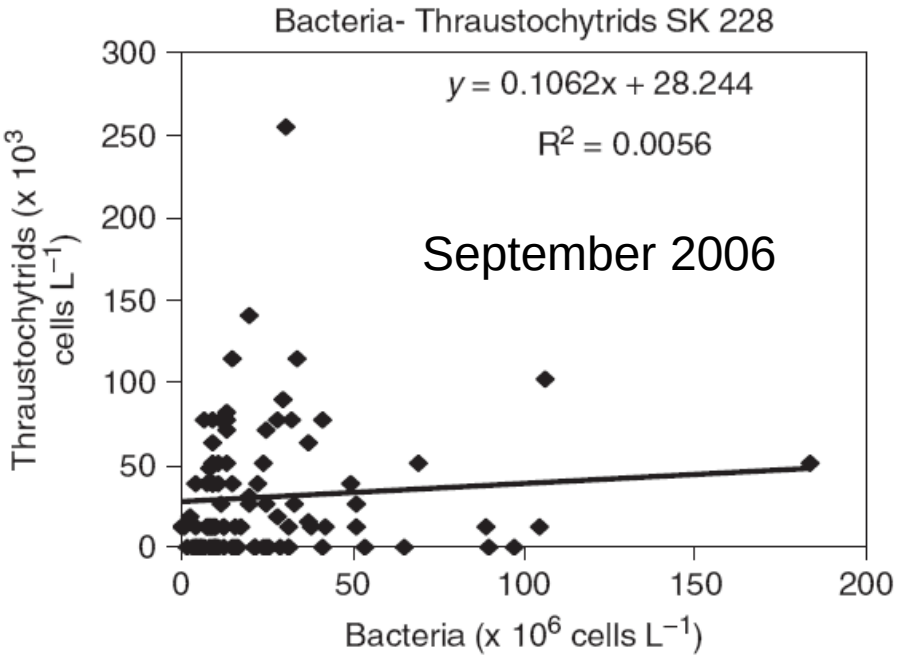
Damare & Raghukumar, 2008

Thraustochytrids (cont'd)

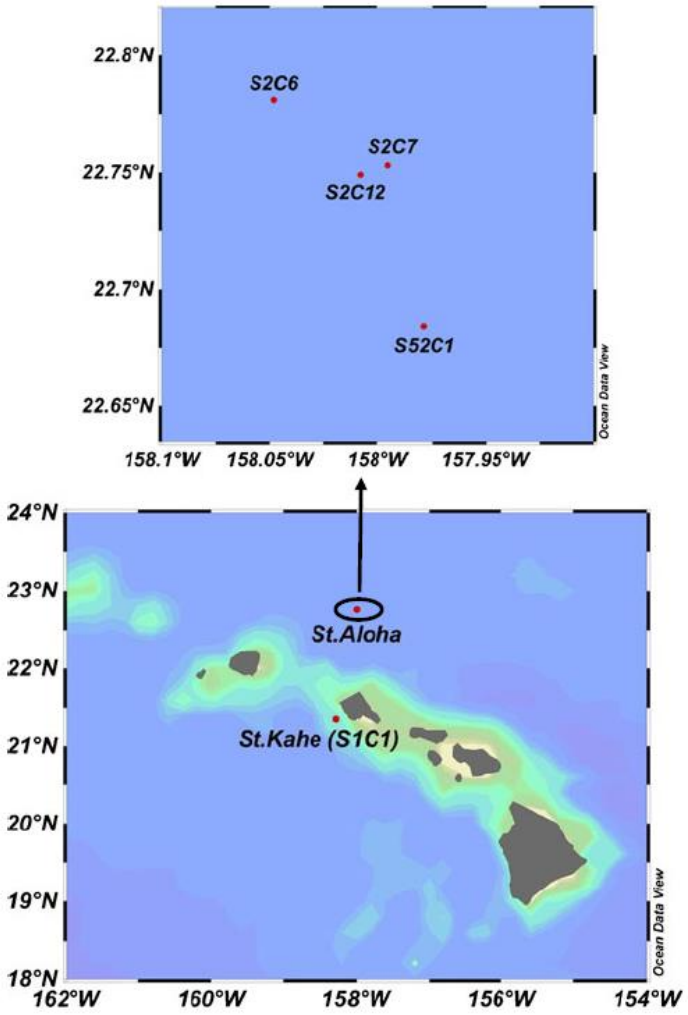




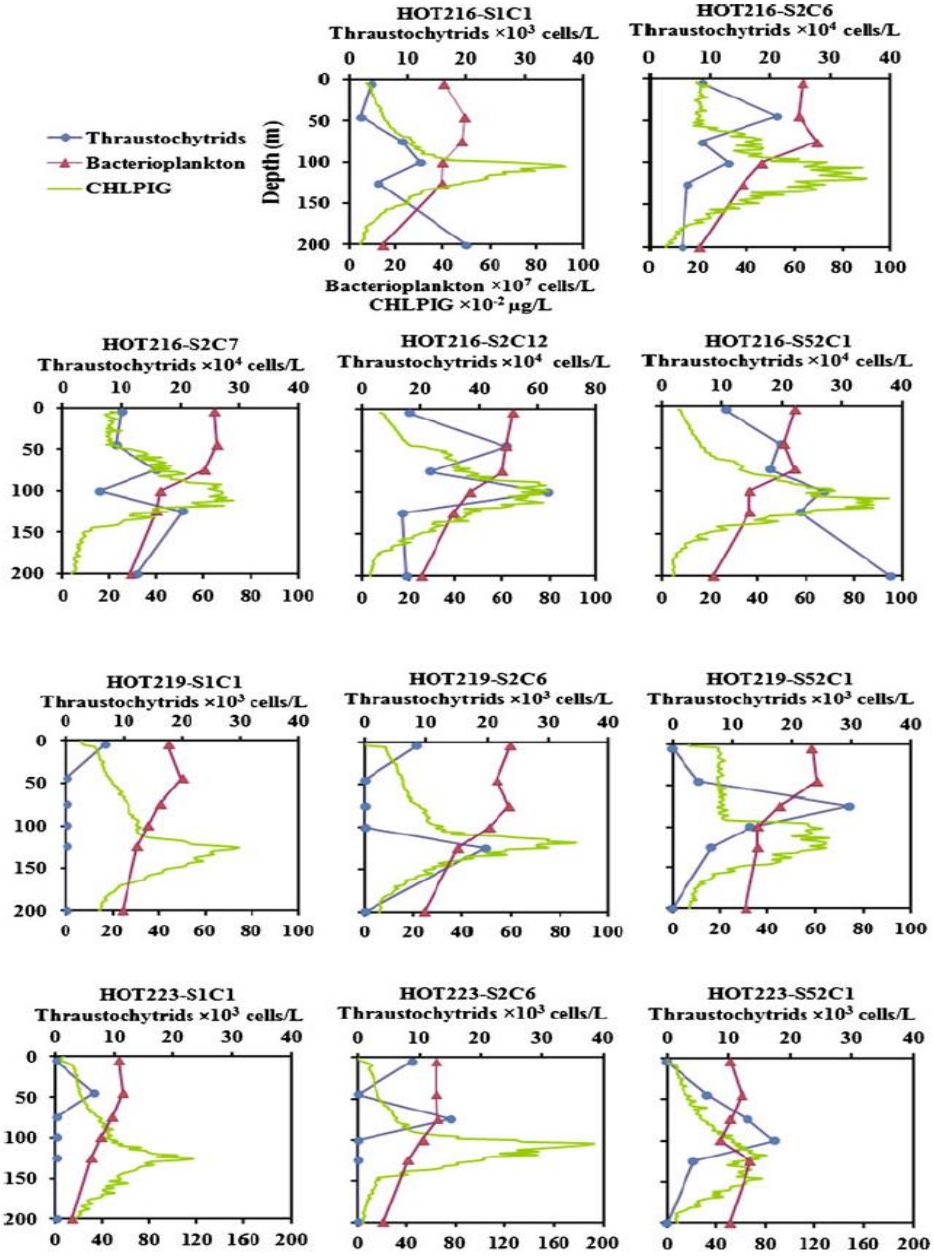
- **Relationship between thraustochytrids and bacteria varied with sampling time.**
- **Biotic and abiotic factors, which affect the abundance of thraustrochytrids, remain unknow.**



Thraustochytrids (cont'd)



Vertical distribution of thraustochytrids in Hawaiian waters (Li et al, 2013)

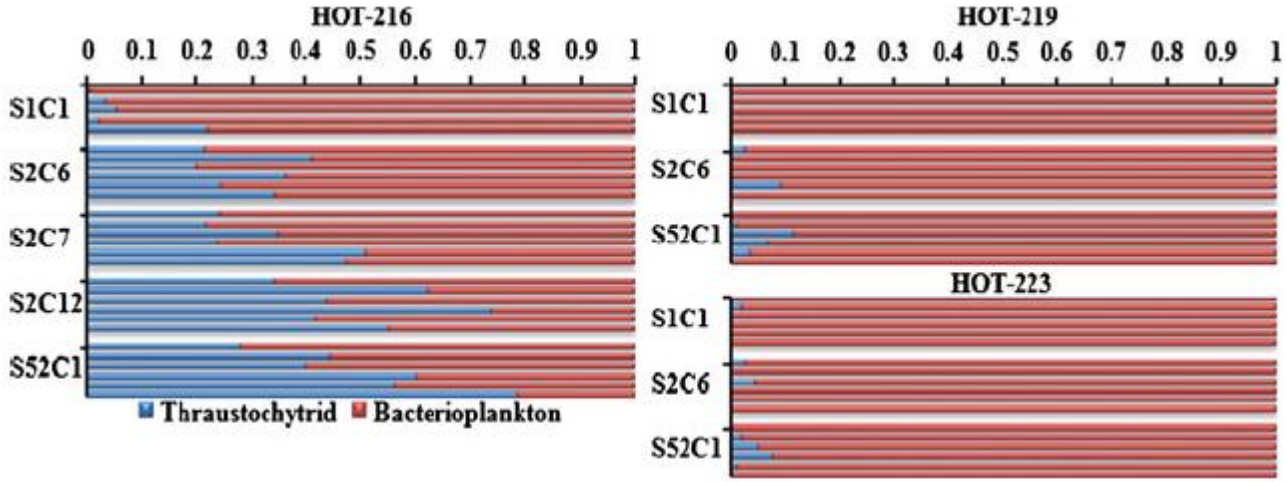


Thraustochytrids (cont'd)

Table 1 Extreme values occurrence of thraustochytrids abundance and biomass percentage during all three cruises (each cell displayed in value and location)

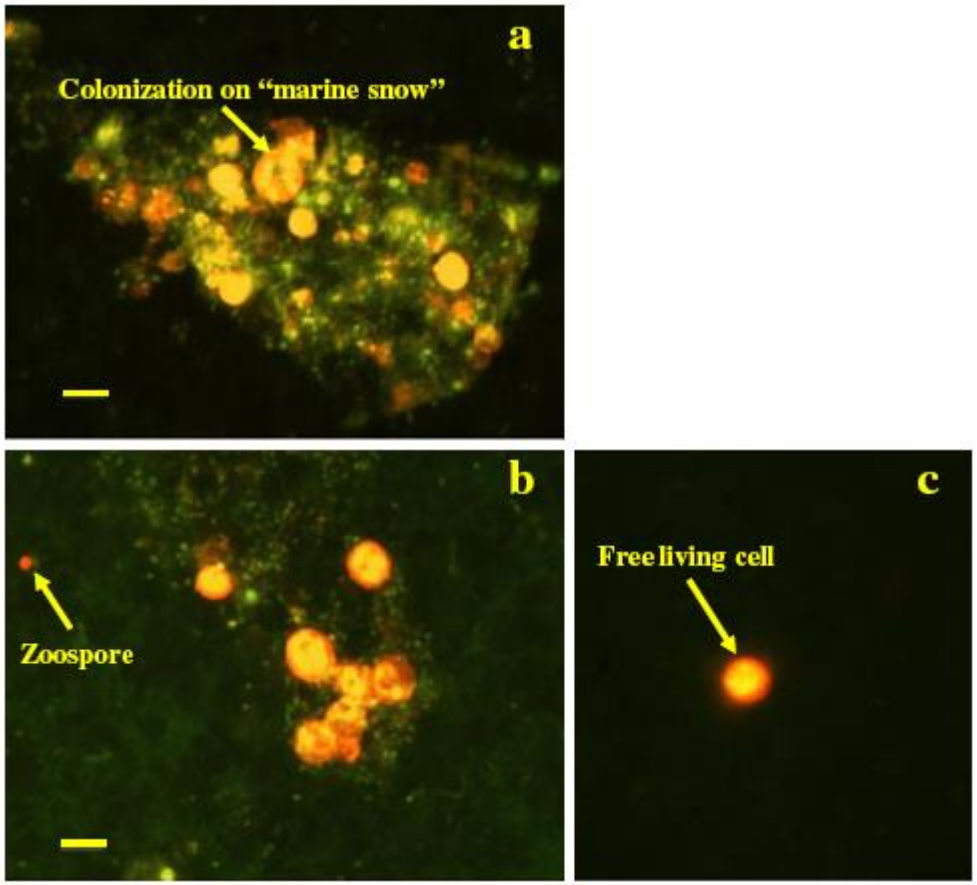
Features of Bacterioplankton and thraustochytrids	HOT-216 (November 2009)	HOT-219 (March 2010)	HOT-223 (July 2010)
Maximum thraustochytrid abundance (cells/L)	6.3×10^{5}, 100 m, S2C12	2.95×10^{3}, 75 m, S52C1	1.75×10^{3}, 100 m, S52C1
Minimum thraustochytrid abundance (cells/L)	1.89×10^{3}, 45 m, S1C1	UD	UD
Maximum bacterioplankton abundance (cells/L)	6.94×10^{8}, 75 m, S2C6	6.09×10^{8}, 45 m, S52C1	6.81×10^{8}, 125 m, S52C1
Minimum bacterioplankton abundance (cells/L)	1.45×10^{8}, 200 m, S1C1	2.41×10^{8}, 200 m, S1C1	1.41×10^{8}, 200 m, S1C1
Maximum thraustochytrid biomass percentage against bacterioplankton	365.1 %, 200 m, S52C1	13.49 %, 100 m, S2C12	8.36 %, 100 m, S2C12
Minimum thraustochytrid biomass percentage against bacterioplankton	0.79 %, 45 m, S1C1	UD	UD

UD undetectable

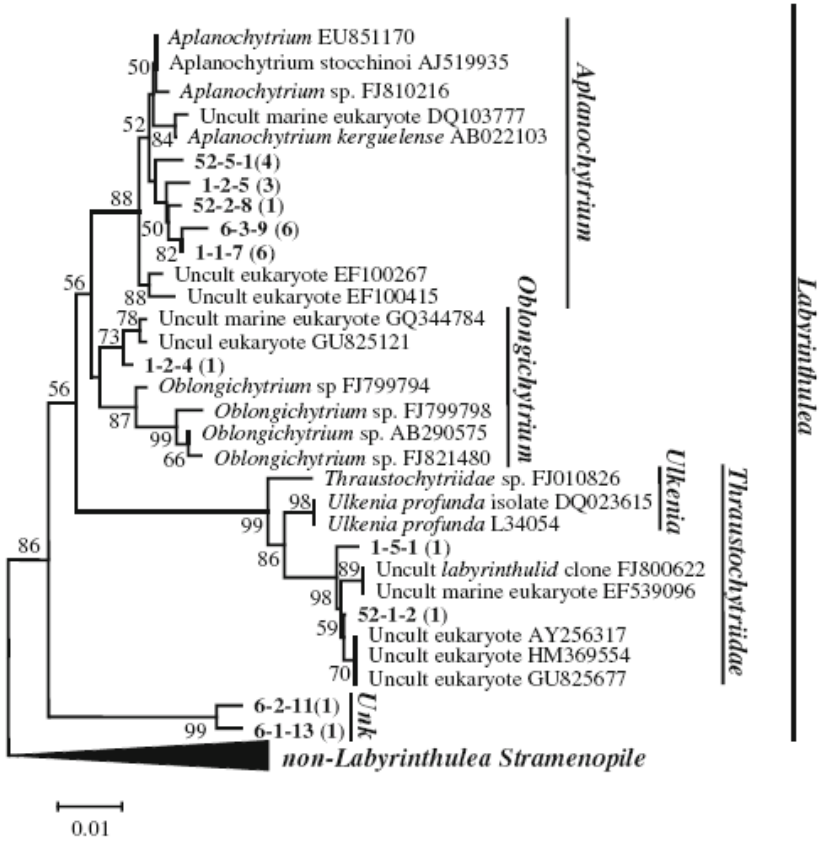


(Li et al, 2013)

Thraustochytrids (cont'd)



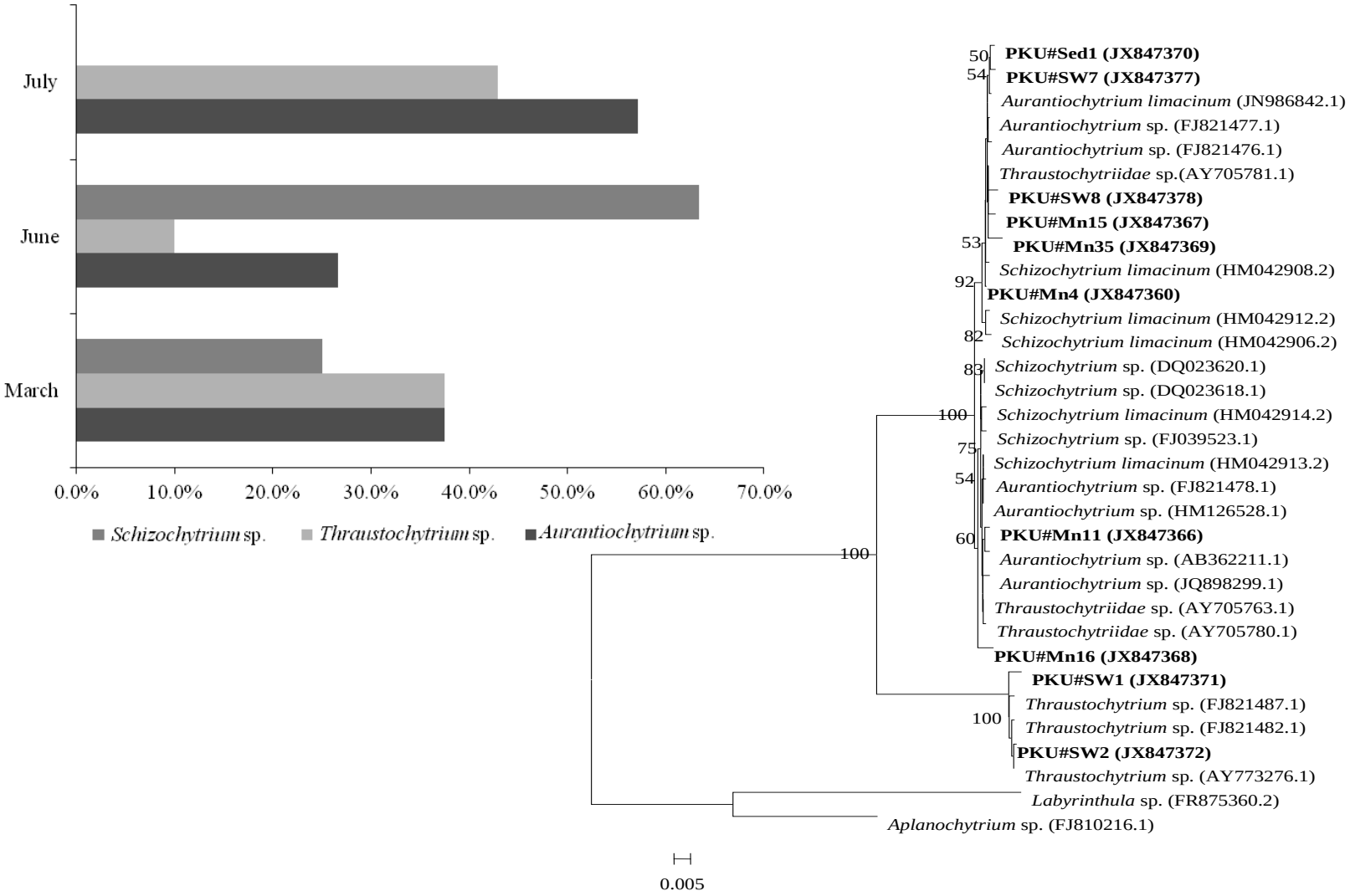
Living styles



Low diversity

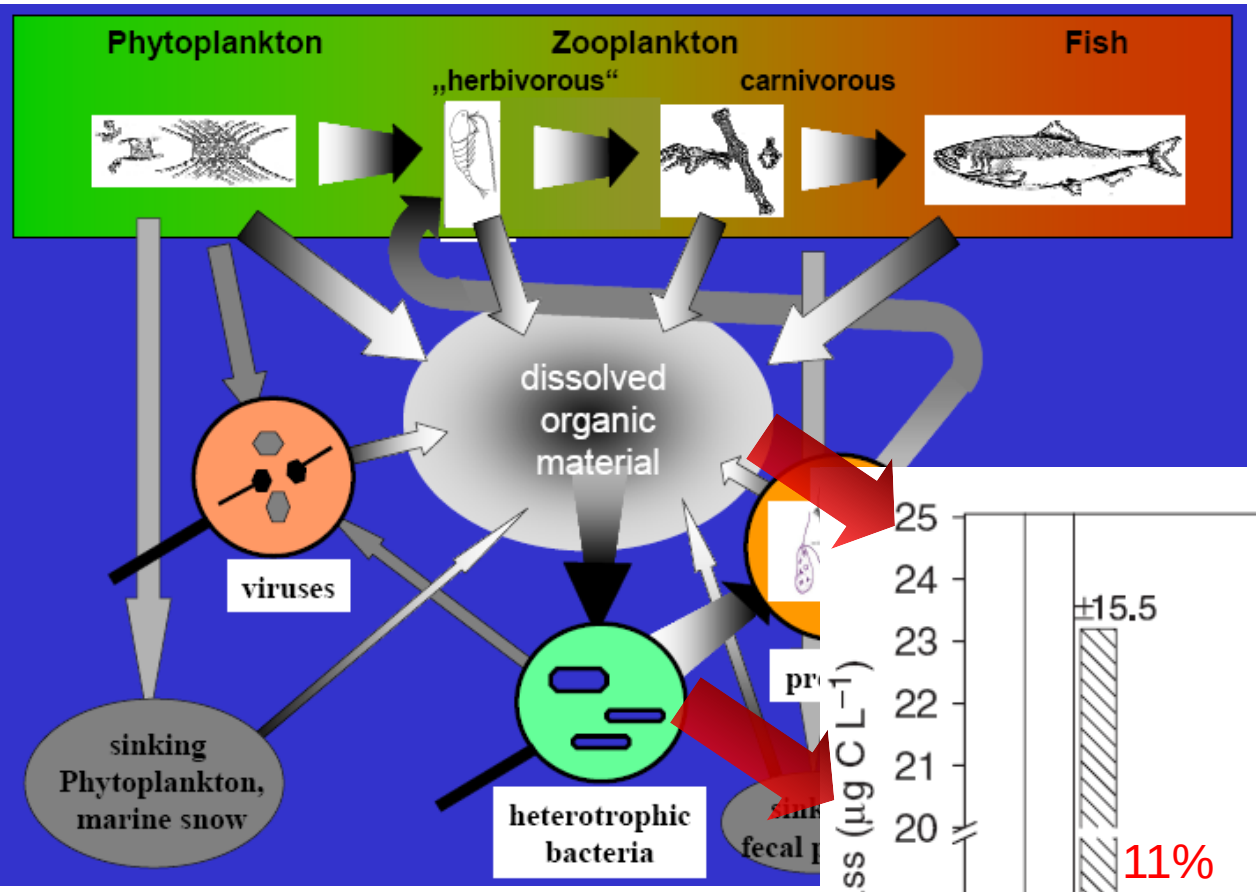
(Li et al, 2013)

Thraustochytrids (cont'd)

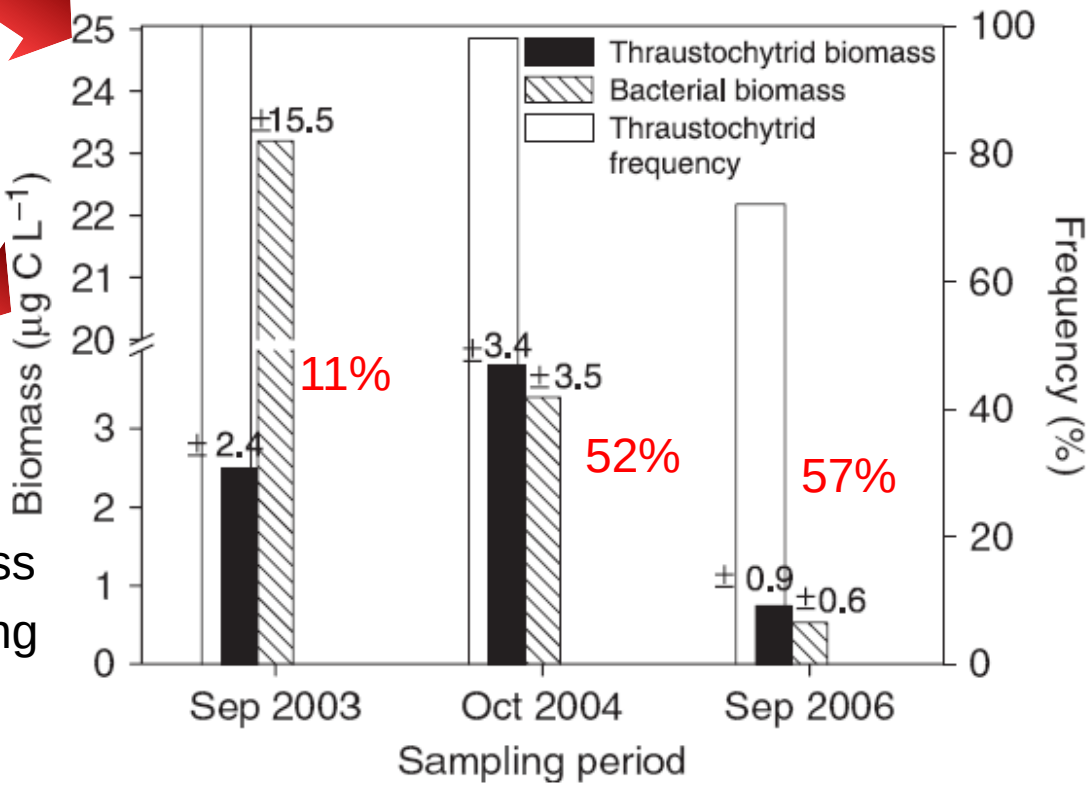


Dynamics and phylogenetic phylogenetic analysis of thraustochytrid isolates from China coastal waters.

Thraustochytrids (cont'd)

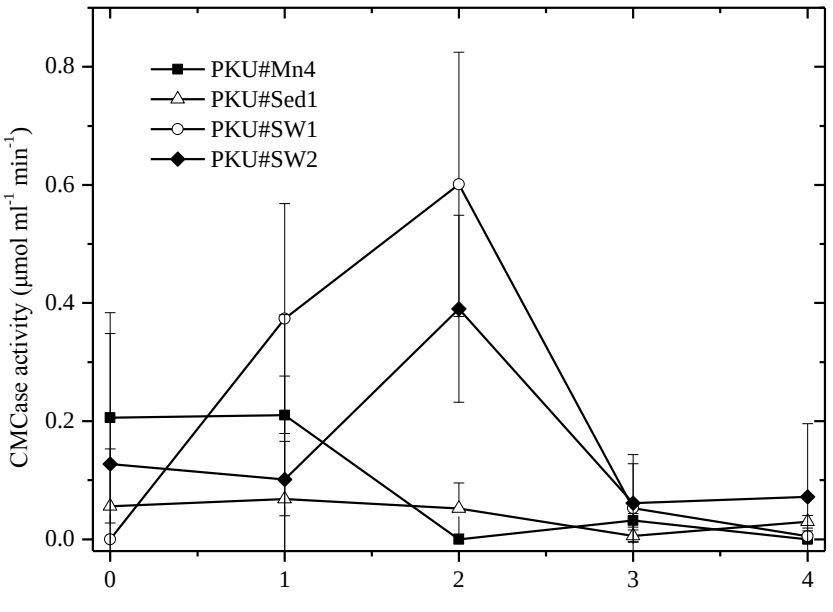


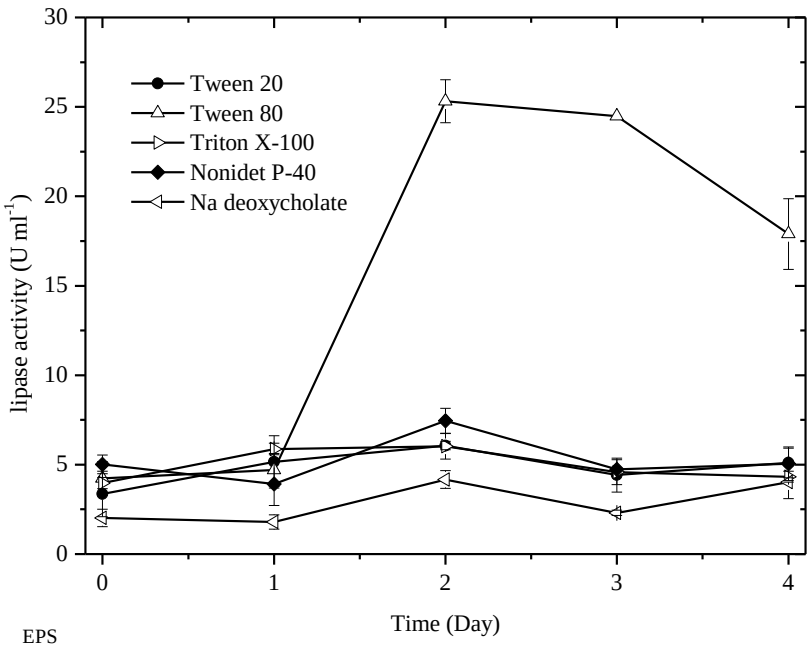
We are likely ignoring more than half of secondary production in the oceans!!!!

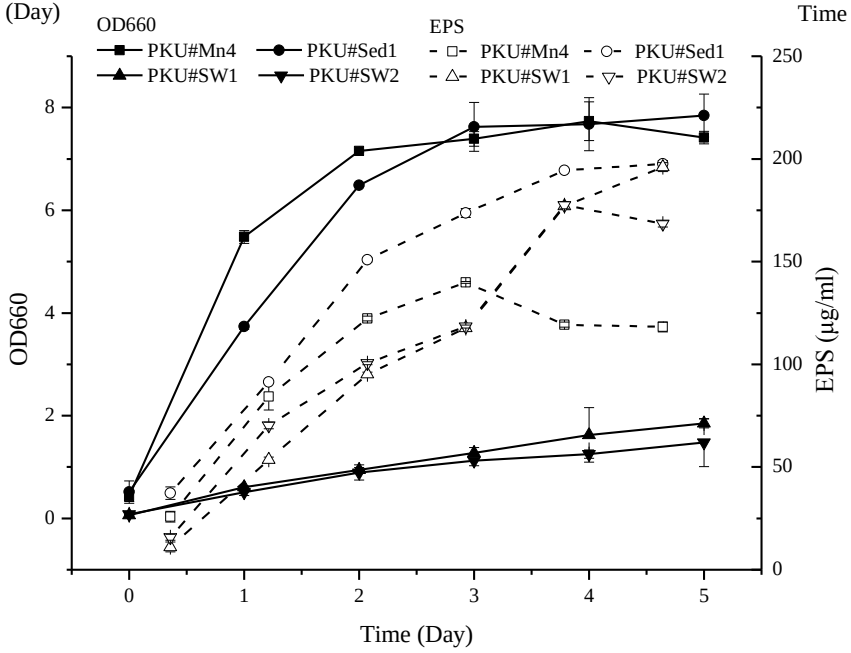


Thraustochytrid frequency and biomass with respect to bacterial biomass during three cruises (Damare 2008).

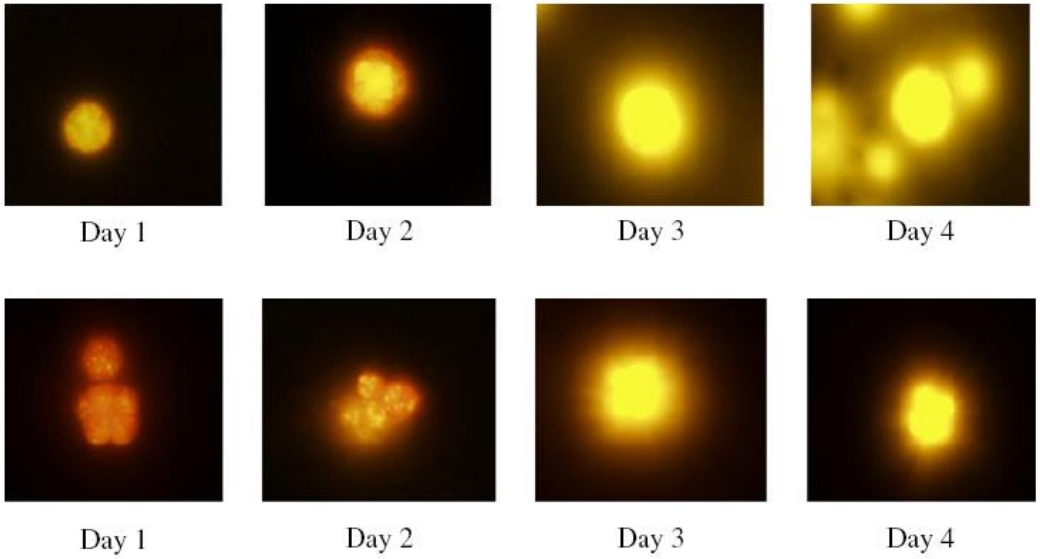
Thraustochytrids (cont'd)



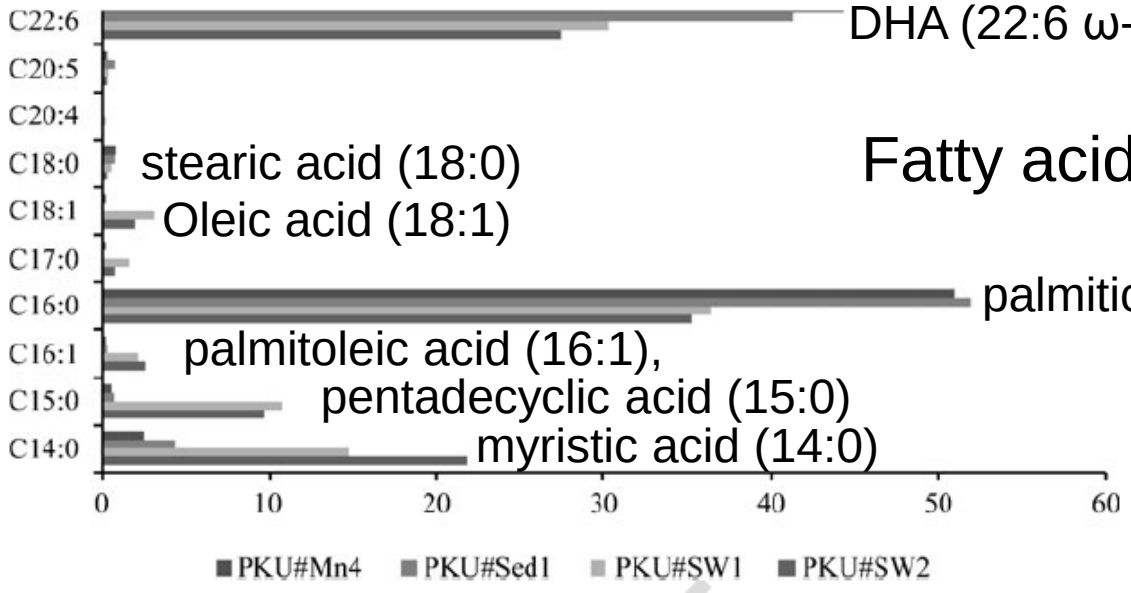




Thraustochytrids (cont'd)



Nile red staining



DHA (22:6 ω-3).

Fatty acid profile

stearic acid (18:0)

Oleic acid (18:1)

palmitic acid (16:0)

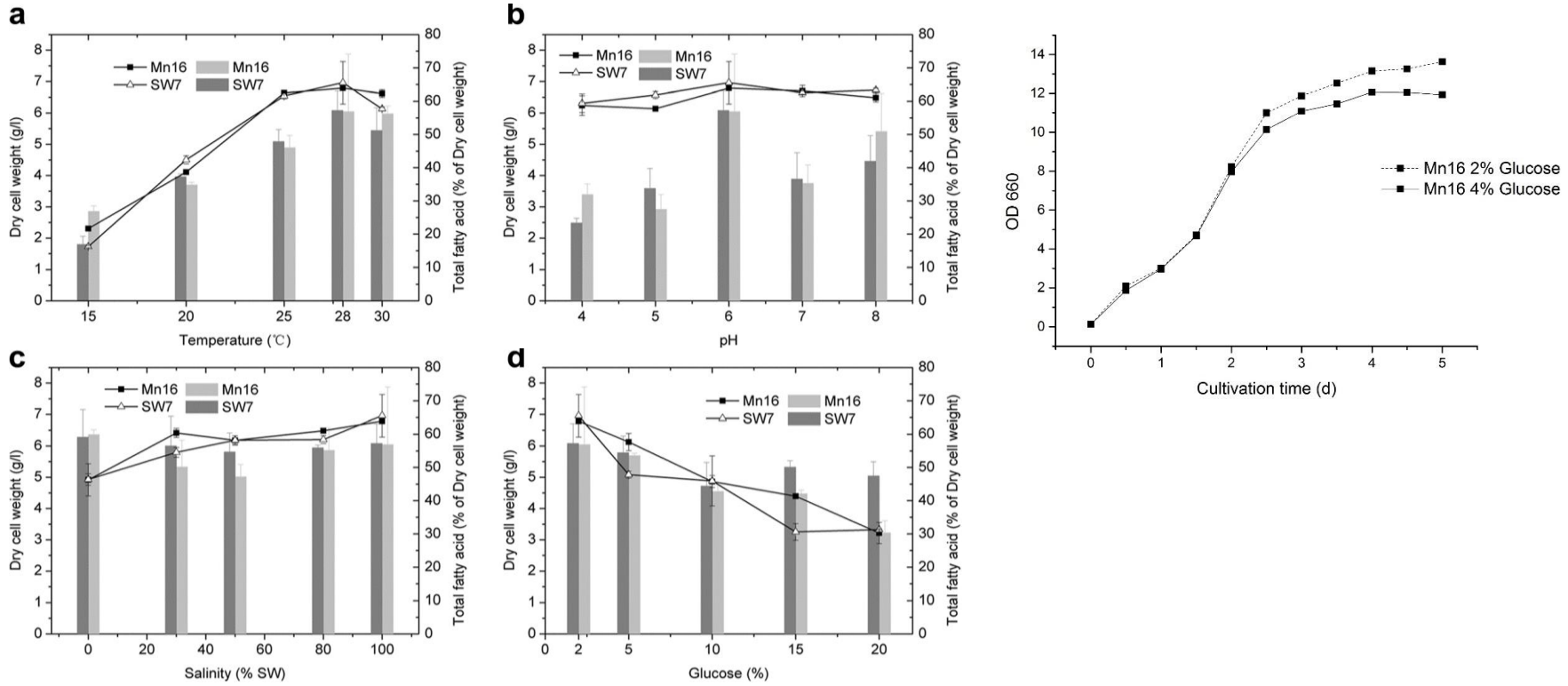
palmitoleic acid (16:1),

pentadecyclic acid (15:0)

myristic acid (14:0)

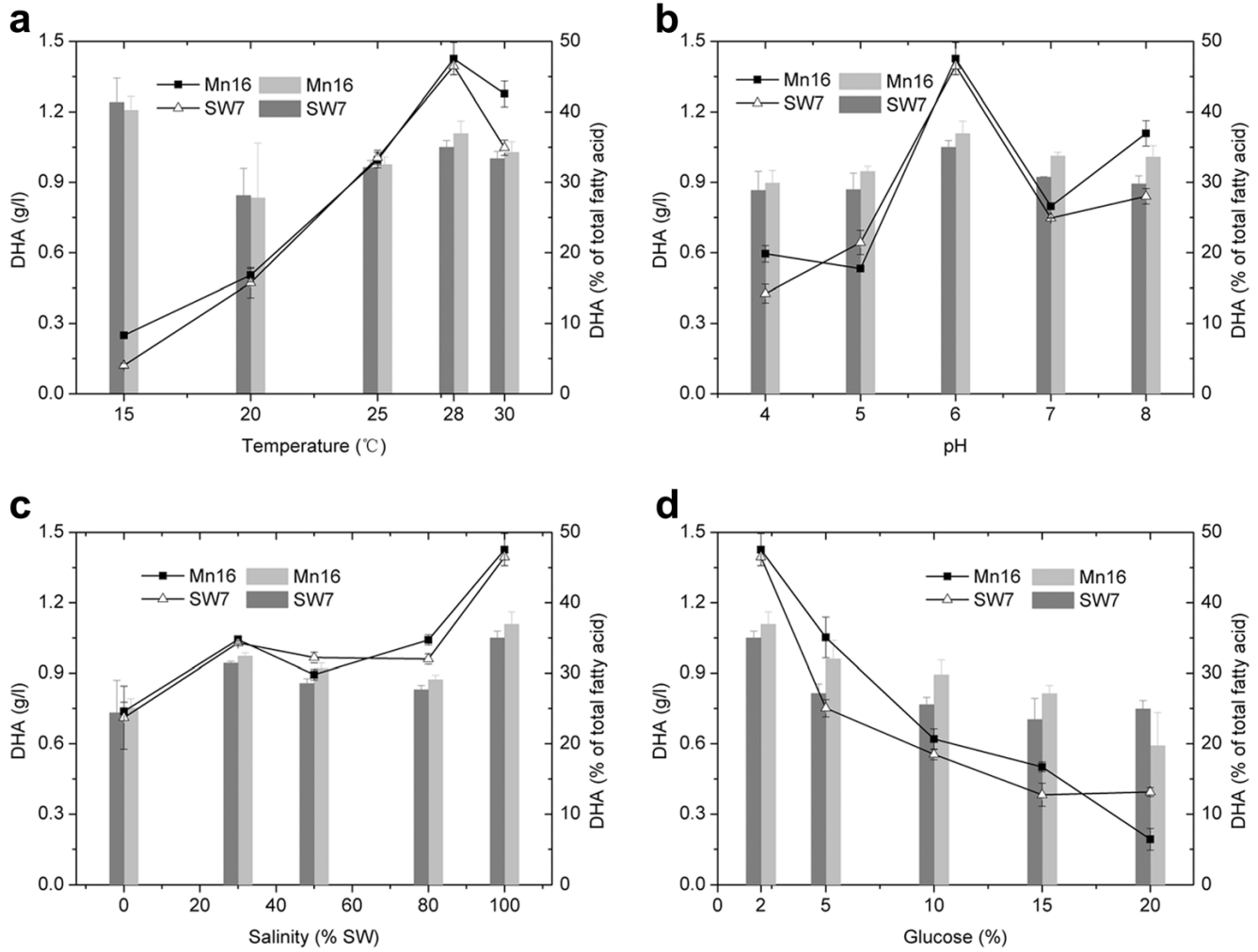
Liu et al, 2013

Thraustochytrids (cont'd)



The biomass accumulation (*represented by lines*) and total fatty acid content of dry cell weight (*represented by bars*) of *Aurantiochytrium* sp. SW7 and *Thraustochytriidae* sp. Mn16 in the presence of varying temperature (a), initial pH (b), salinity (c), and glucose concentration (d). (Liu *et al.* 2014)

Thraustochytrids (cont'd)



DHAyield (represented by lines) and DHA content in TFA (represented by bars) of Aurantiochytrium sp. PKU#SW7 and Thraustochytriidae sp. PKU#Mn16 in the presence of varying temperature (a), initial pH (b), salinity (c), and glucose concentration (d) (Liu et al).

Summary on Thraustochytrids

1. Significant role in ocean carbon cycling and seconday production (frequency and biomass), but with low diversity;
2. Rich in fatty acids and potential application in DHA and biodiesel production.

Acknowledgements

- Reform and Development Commission of Shenzhen Municipal Government (China);
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Thank You!