Response of algal holobionts towards environmental changes

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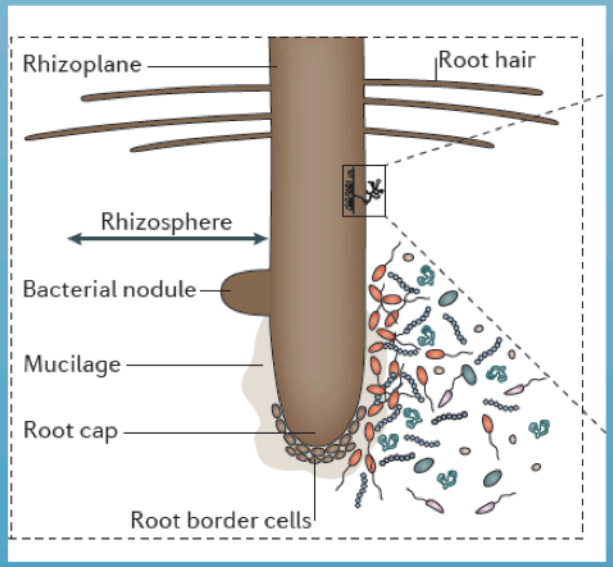
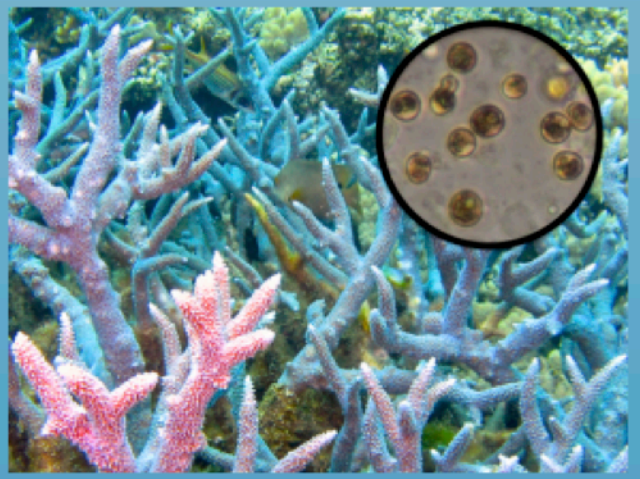
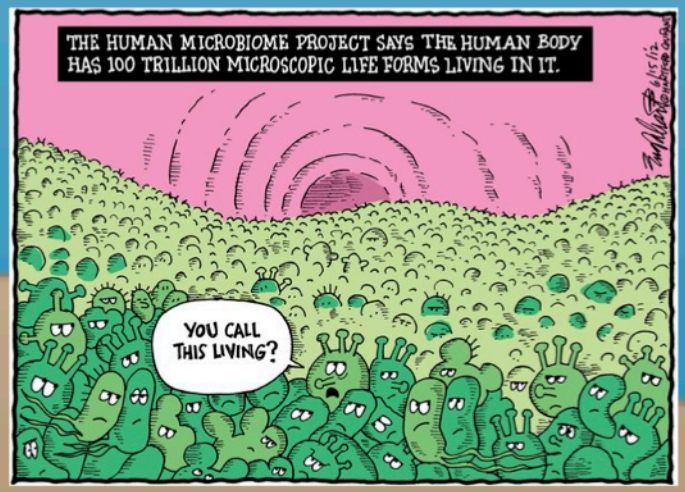
The holobiont concept: a « new » paradigm in biology



Philippot et al. Nature Rev Microbiol 11: 789-799, 2013





Macroalgal biofilms - a second skin

Brown macroalgae: Key components of marine coastal ecosystems that depend on their biofilm

Sugars, Amino acids

Egan et al. 2013

Vitamins, NH_4, hormones defense

Macroalgal biofilms - a second skin

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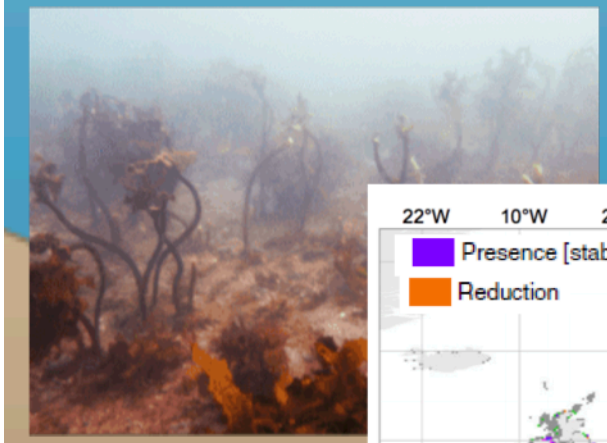
Global decline



Sugars, Amino acids

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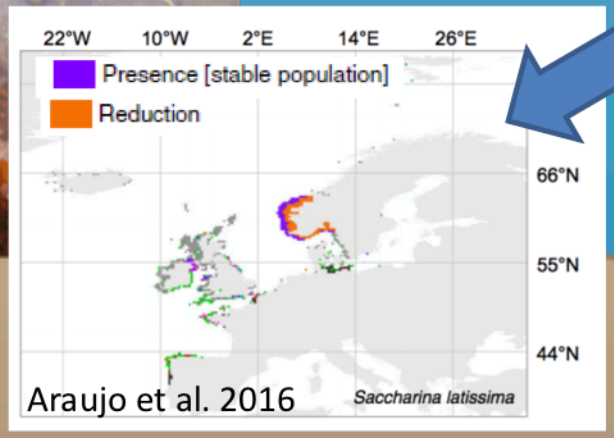


Araujo et al. 2016

What is the role of the biofilm in this?

Environmental changes cause impact holobiont systems

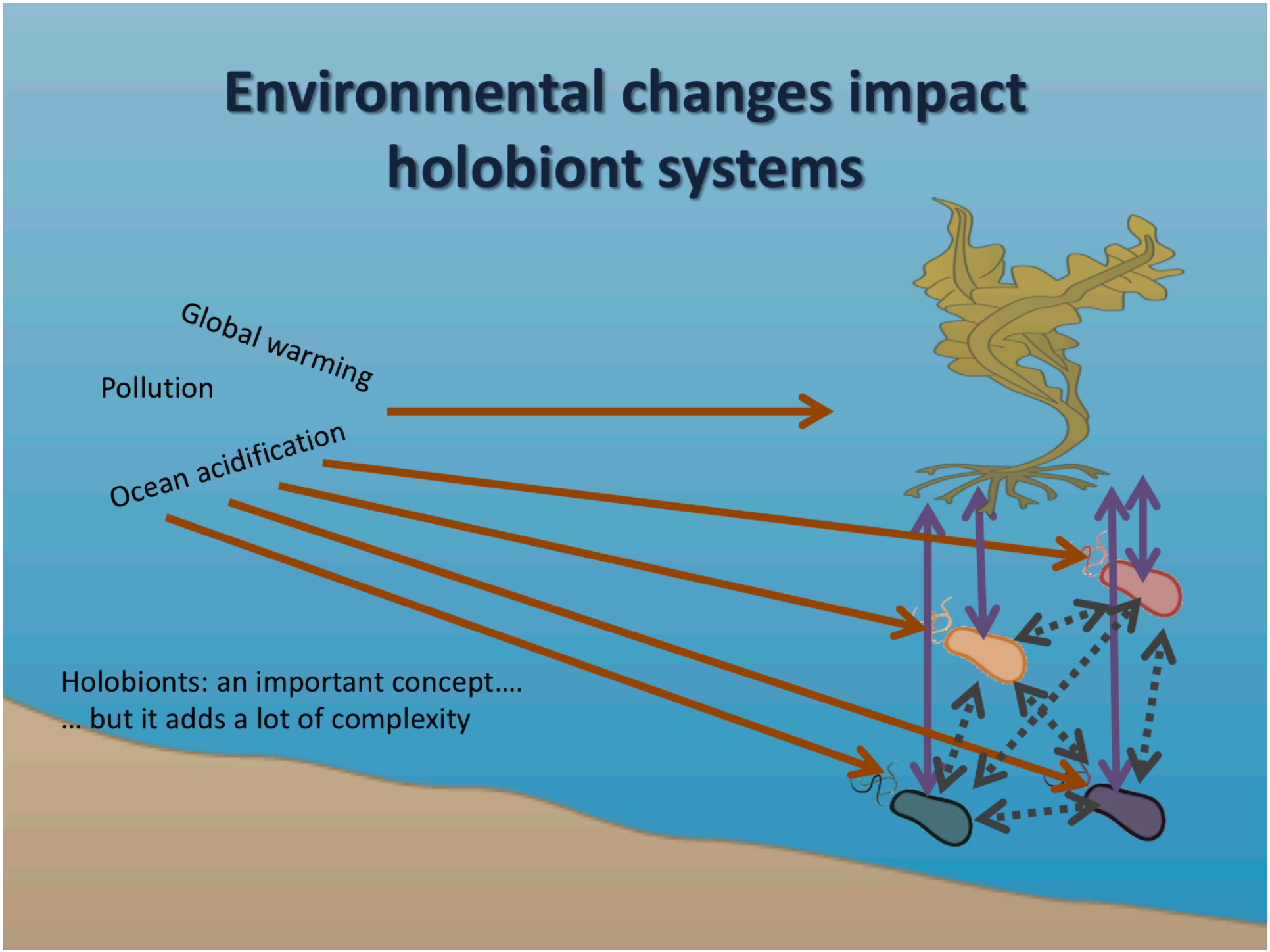
Global warming

Pollution

Ocean acidification

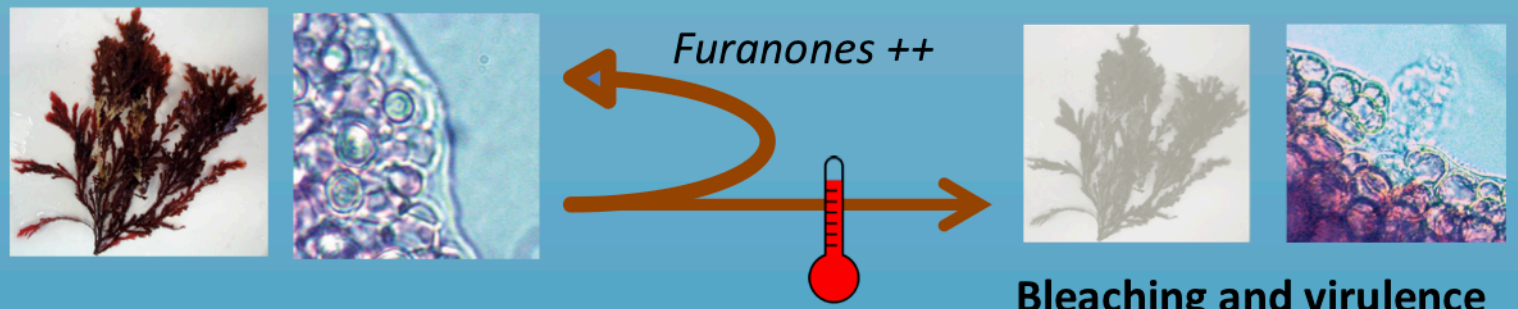
Holobionts: an important concept….

Environmental changes impact holobiont systems



Example: Temperature increase can induce virulence in symbiotic bacteria

Delisea pulchra + *Ruegeria* sp. R11



Case et al. 2011

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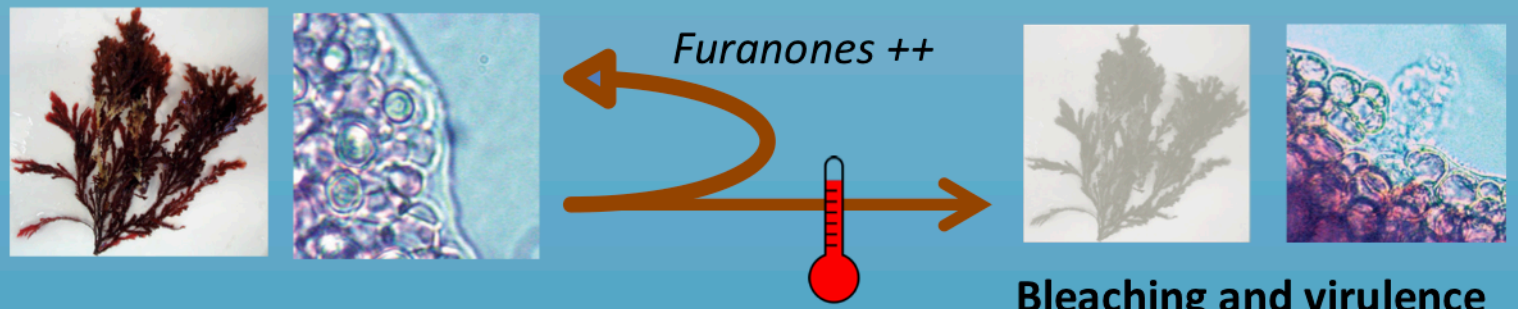


Case et al. 2011

The challenge:

1 bacterium → many bacteria

1 metabolite → many metabolites

A good laboratory model is required : *Ectocarpus*

- Sister group to Kelps (Silberfeld et al. 2010)

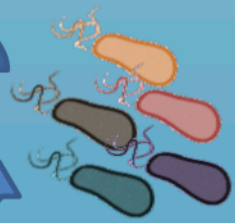
A small but active community and many tools (Cock et al. 2010, Prigent et al. 2015, …)

- Collection of > 500 *Ectocarpus*-derived bacteria (Tapia et al. 2016; KleinJan et al. in revision; Dittami et al. in prep.)

Question 1: Which bacteria are beneficial in stable conditions? **metabolic complementarities?**

Vitamins, NH_4, hormones, (defense compounds)

Sugars, Amino acids



Using metabolic networks to predict complementarities

Genome

encodes

Enzymes

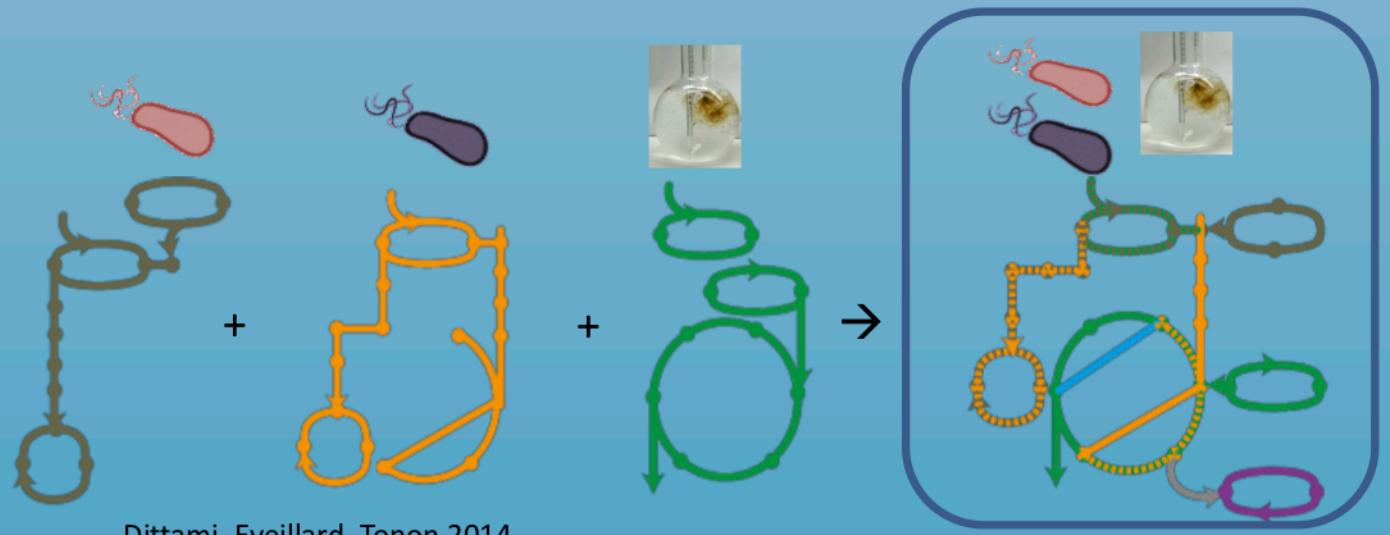
catalyzes

Reactions
A + B -> C

DyLiSS

Metabolic networks

From metabolic networks to metabolic complementarities



Dittami, Eveillard, Tonon 2014

Holobiont metabolism

β-alanine

Pantoate

Vitamin B5 (both)

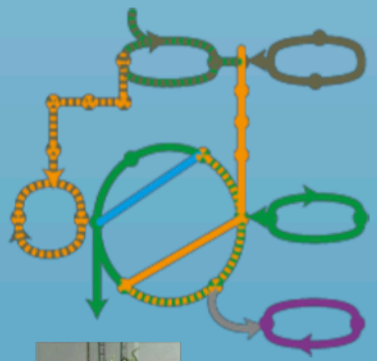
Coenzyme A (both)

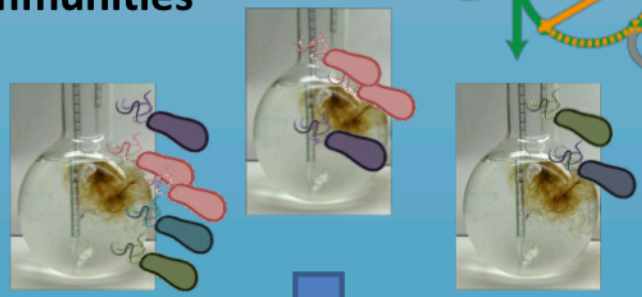
Enumerate complementarities / exchanges: Answer set programming-based approach

Defining complementary communities and testing predictions

bacterial isolates

Predict more or less beneficial holobiont communities





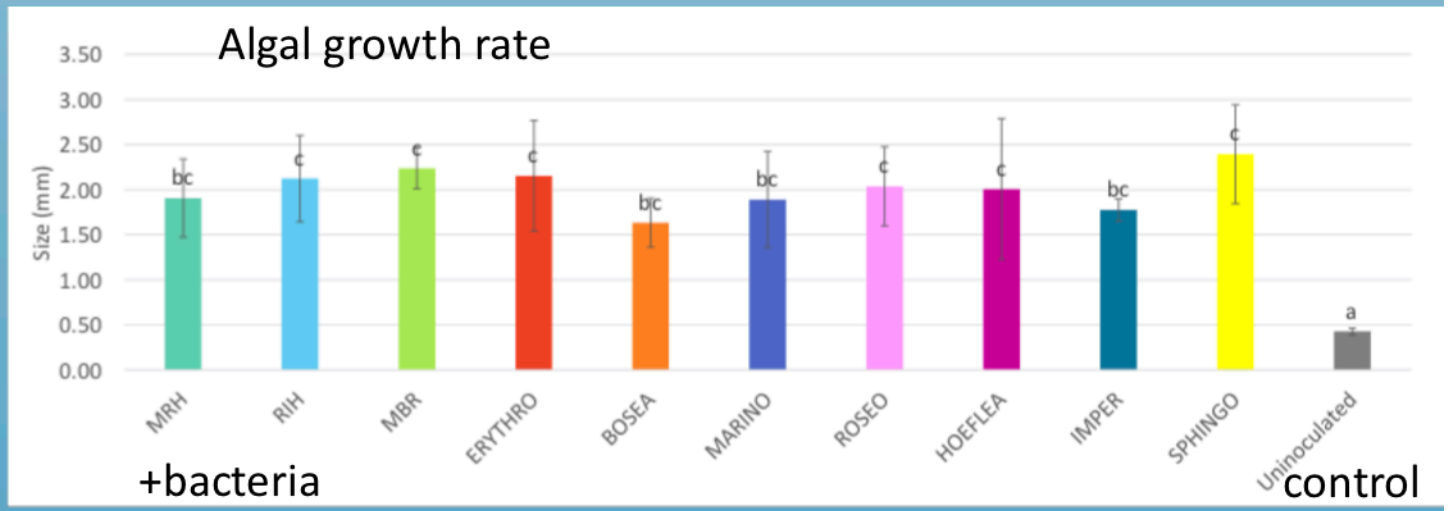
...

In vitro testing of predictions

Growth,
produced metabolites

Frioux et al. 2018

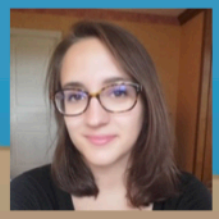
Promising preliminary results



Compounds characterized by UPC²-QTOF after 4 weeks of coculture. (-) : absence (+) : presence

	Spermidine	Putrescine	Nicotinic acid	Folic acid	Auxin	L-Histidine	β-Alanine	preQ1
MRH	-	-	-	-	+	-	-	+
RIH	-	+	+	-	+	-	+	+
MBR	-	-	+	+	-	-	-	+
Erythro	-	+	-	-	-	-	-	+
Bosea								
Marino	+	-	+	-	-	-	-	+
Roseo	-	+	-	-	-	-	-	-
Hoeflea	+	+	-	-	+	+	+	+
Imperiali	-	-	+	-	+	+	-	+
Sphingo	-	-	-	+	+	+	-	+
Uninoculated	-	-	-	-	-	-	-	+

M2 Bertille Burgunter-Delamare

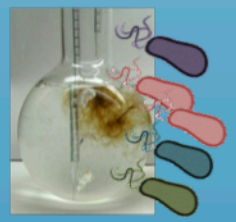


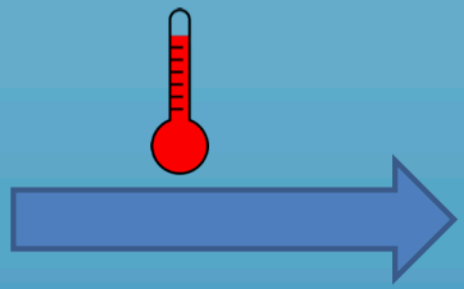
But: problems controlling the bacterial community

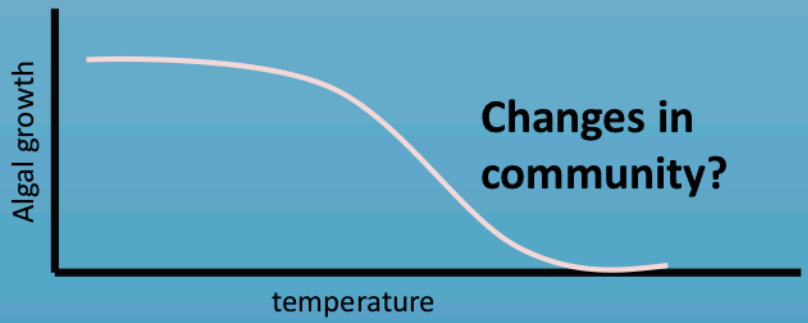
Question 2: Plasticity of metabolic interactions under environmental stress

Impact of microbiome on temperature tolerance?

Co-cultures







Changes in community?

Induction of virulence?

Impact on potentially beneficial exchanges?

Ongoing work: Elham Karimi

The role of the microbiome during low salinity acclimation

Hopkins River Falls, Victoria, Australia

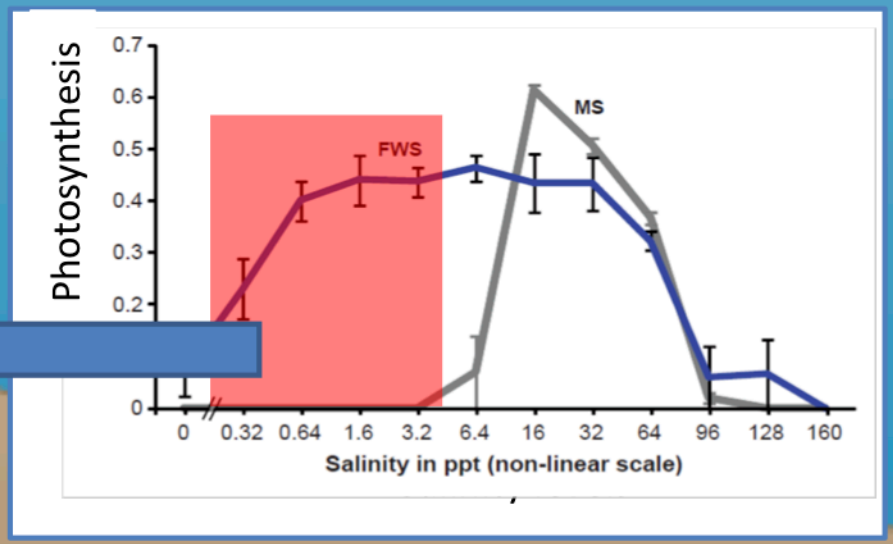
***Ectocarpus subulatus* freshwater strain:**

- The only known freshwater *Ectocarpus*
- One of only max. 8 brown algal species found in fresh water

Growth in freshwater depends on bacteria.

→ Despite extensive efforts and test with cultured bacteria the identity of the microbiome for fresh water tolerance remains unknown

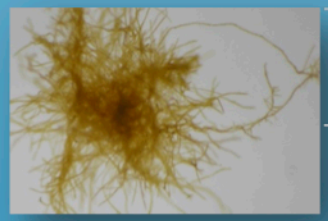
UNCULTIVABLE MICROBIOME!



Working with modified microbiomes

Bacterial community

«Full microbiome »



ATBmix

ATBmix 2

ATBmix3

Study response to freshwater with mutli « omics » apporach:

- Genome
- Transcriptome
- Metabolome)
- Metabolic networks for data integration

DyLiSS

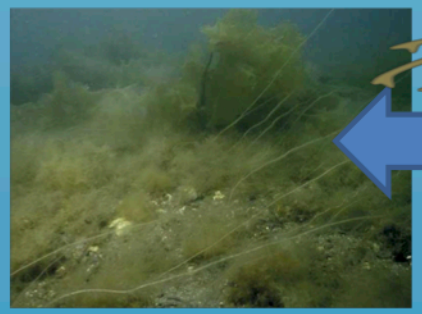
Generate hypotheses:

↓ Vitamin K1 synthesis
↓ Seleno-amino acid biosynthesis

↑ Autoinducer AI-1 biosynthesis
(Virulence?)

Question 3: Environmental relevance of laboratory results: the example of *Saccharina latissima*

interactions, markers
methodology



experimental system to test
new hypotheses

Thesis Bertille Burgunter-Delamare (2018-2021)

Conclusion: biology is messy and slow

- (and biologists too, sometimes)

But: don’t give up…

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Angélique Gobet

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Akira Peters

Cultivation bacteria
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Metabomer platform Roscoff

ALFF Consortium
Claire Gachon

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Thank you