

Impact of heavy metal and nutrient pollution on the microbiota of temperate corals from the Mediterranean Sea

Jeroen A.J.M. van de Water[§], Christian R. Voolstra[¥], Denis Allemand[§] & Christine Ferrier-Pagès[§]

[§] Centre Scientifique de Monaco, 8 Quai Antoine 1er, MC 98000, Principality of Monaco - Contact: jvdewater@centrescientifique.mc
[¥] Red Sea Research Center, King Abdullah University of Science and Technology (KAUST), Thuwal 23955-6900, Saudi Arabia

Introduction

- Gorgonians are key habitat-forming species of temperate benthic communities¹.
- Dramatic population declines due to local human impacts and mass mortality events caused by high temperatures and disease outbreaks².

Recently, we have shown^{3,4,5}:

- Ancient host-microbe associations conserved through evolutionary times.
- Divergence in microbiome composition clear along distant phylogenetic lines.
- Highly structured and relatively stable gorgonian-associated bacterial communities on both temporal and seasonal scales
- Unique composition of *Corallium rubrum* microbiota
- Microbiome impacted by / acclimated to local environmental conditions.

OBJECTIVES – Understand functional differences in the microbiota of gorgonians and how it is impacted by the most common pollutants in the Mediterranean Sea: copper and nutrients.

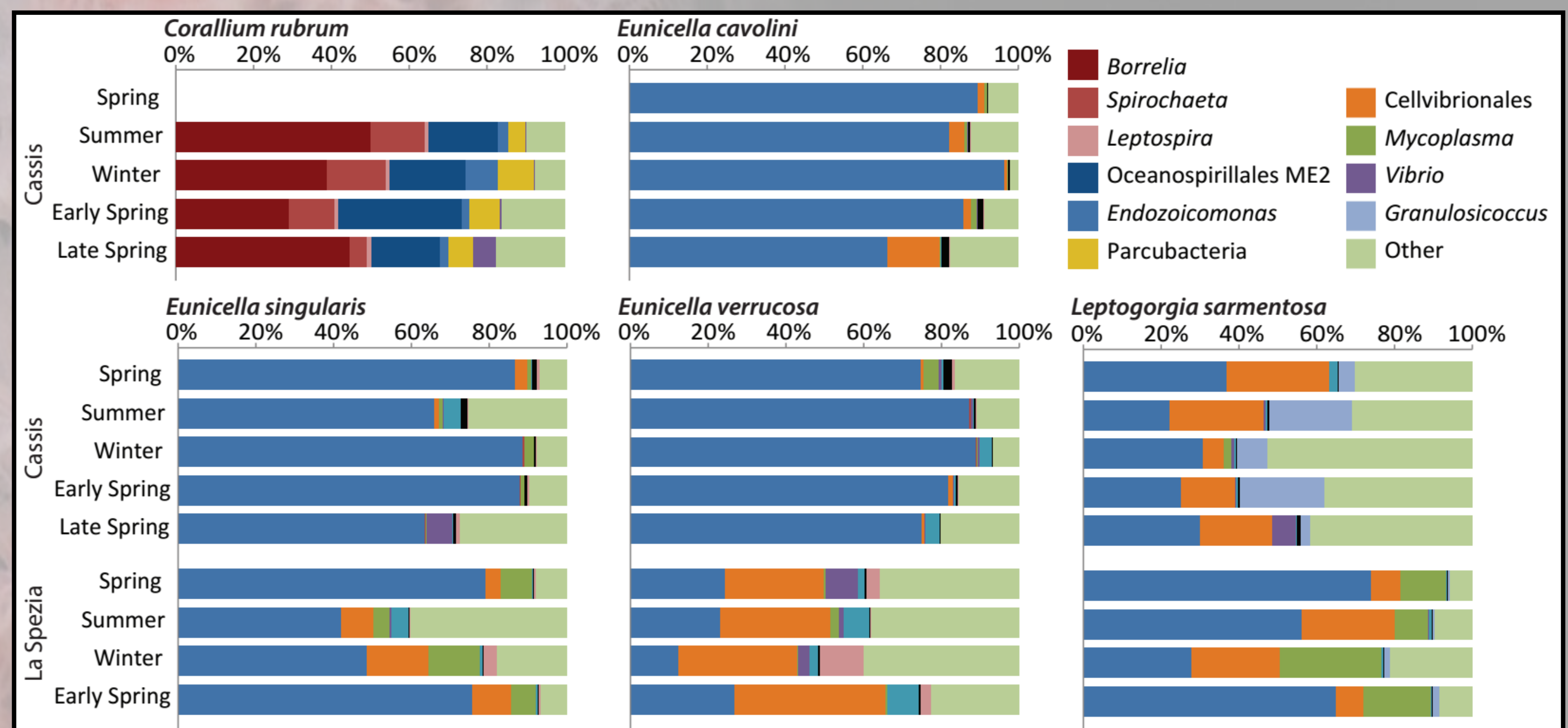
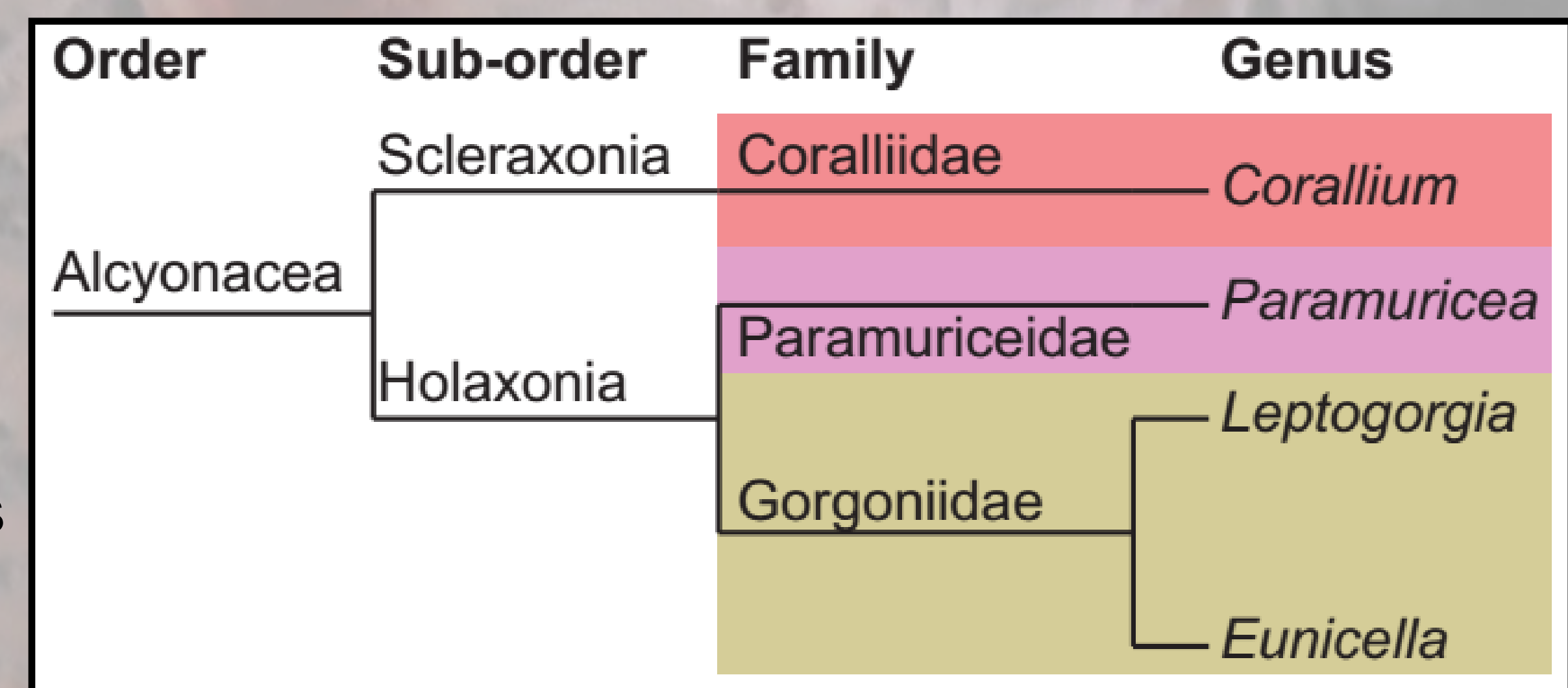


Figure 1 - Composition of the bacterial communities associated with five different gorgonians over time at two different locations – Cassis and La Spezia.

Figure 2 - Schematic overview of Mediterranean gorgonian taxonomy. The different colours identify taxa harbouring distinct core microbiomes.



Material & Methods

Study species (encompassing 3 families, 2 sub-orders)

Eunicella cavolini
Paramuricea clavata
Corallium rubrum

Experimentally exposed to copper pollution and eutrophication for 18 hours (n=6 per condition)

Metatranscriptomics analysis

Library preparation – rRNA and polyA mRNA-depleted
 Sequencing on Illumina HiSeq4000
 Data analysis: SAMSA2 pipeline⁶ and DESeq2⁷

Discussion & Conclusions

- Eutrophication has no effect on the microbiota of temperate gorgonians
- Bacteria limit toxicity of copper by upregulation of heavy metal transporters
- Copper may affect host health due to increased bacterial virulence and inactivation of phages⁸
 → Long term effect microbiota composition?
- Major functional differences in the microbiota of sympatric gorgonian species
 → *C. rubrum*: protection against bacteria and phages. Amino acid production. Iron uptake.

Results

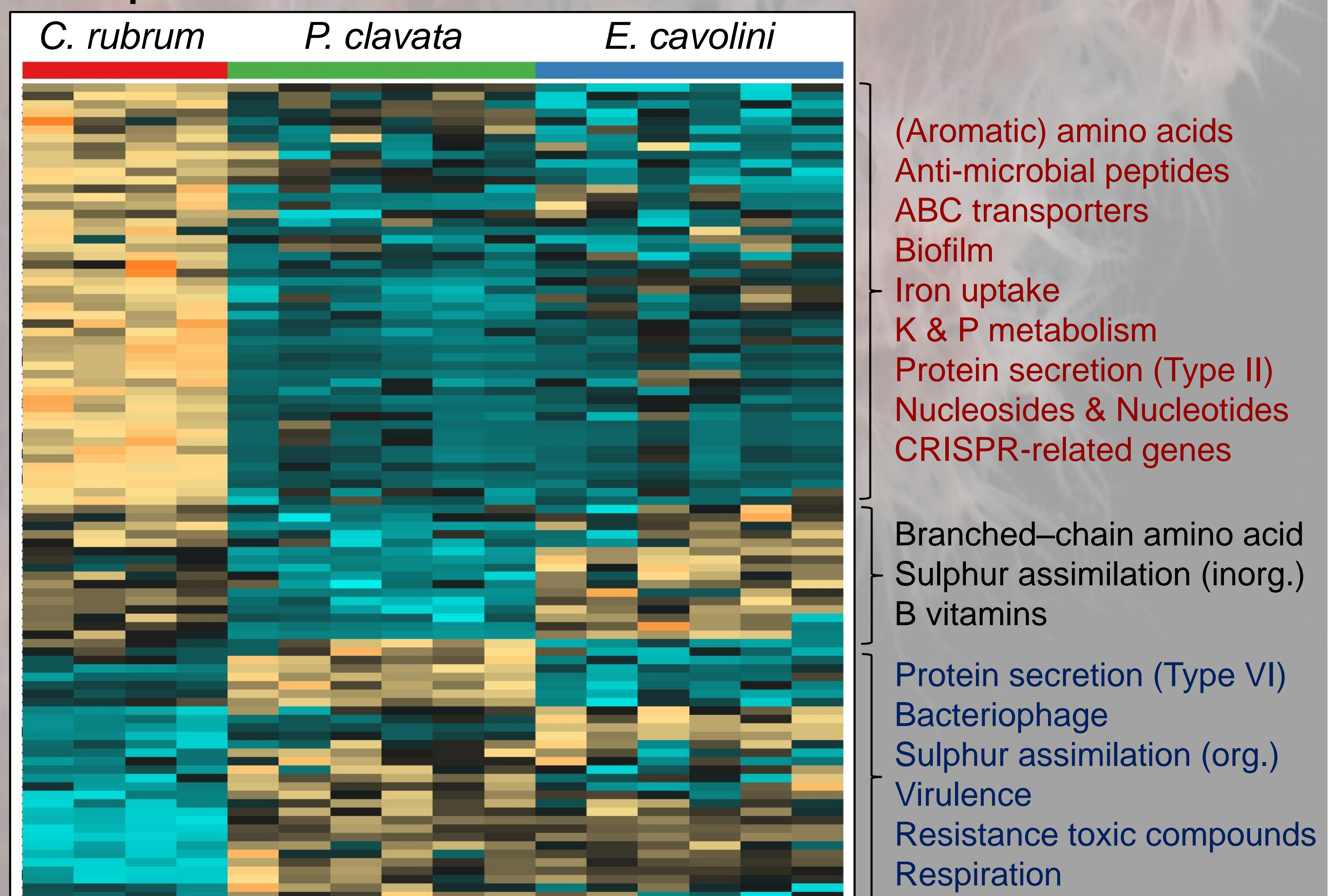
Eutrophication: No short-term effect

Copper pollution: No effect on *C. rubrum* microbiota

Similar effect on microbiota on *P. clavata* and *E. cavolini*

- > upregulation copper and heavy metal transporters, and chaperone DnaK
- > increased virulence and reduced phage-related processes

Inter-species differences:



References

- Ballesteros E. *Oceanography and Marine Biology - An Annual Review*. 2006; 123-195.
- Bally M & Garrabou J. *Global Change Biology* 2007, 13 (10):2078-2088.
- van de Water JAJM et al. *Scientific Reports*. 2016 June; 6: 27277
- van de Water JAJM et al. *Microbial Ecology*. 2016 October; 73(2): 466-478

References

- van de Water JAJM et al. *Microbial Ecology*. 2018 January; 75(1): 274-288
- Westreich ST et al. *BMC Bioinformatics*. 2018 May; 19:175
- Love MI et al. *Genome Biology*. 2014 December, 15(12): 550
- Li J & Dennehy JJ. *Applied & Environmental Microbiology*. 2011 October; 77(19)

Acknowledgements

- Eric Tambutti - background photo ©
- Funding provided by Fondation Paul Hamel & KAUST