



HAL
open science

Combined effect of time, temperature and light intensity on the metabolome of the model green microalgae (*Scenedesmus costatus*) in the global change context

Mélissa Eon, Mariem Fadhlou, Soizic Morin, Nicolas Creusot, Nicolas
Creusot

► To cite this version:

Mélissa Eon, Mariem Fadhlou, Soizic Morin, Nicolas Creusot, Nicolas Creusot. Combined effect of time, temperature and light intensity on the metabolome of the model green microalgae (*Scenedesmus costatus*) in the global change context. JS RFMF 2023, May 2023, Perpignan, France. hal-04172925

HAL Id: hal-04172925

<https://hal.science/hal-04172925>

Submitted on 28 Jul 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Combined effect of time, temperature and light intensity on the metabolome of the model green microalgae (*Scenedesmus costatus*) in the global change context

Mélissa EON 1,2
Mariem FADHLAOUI 3
Soizic MORIN 1
Nicolas CREUSOT 1,2

1 INRAE Nouvelle-Aquitaine Bordeaux, UR EABX, 50 avenue de Verdun, 33612 Cestas, France

2 Bordeaux Metabolome, MetaboHUB

3 INRS-ETE, 490 rue de la Couronne, Québec, QC G1K 9A9, Canada

Introduction

- Aquatic ecosystems undergo an increase of temperature and light intensity that can affect their functioning [1]
- Increasing evidence about the effect of light and temperature on the physiology of micro-algae that play a key role in the aquatic trophic chain of both freshwater and marine ecosystems [2].
- Need to gain understanding of the molecular/biochemical mechanisms underlying the acclimation and adaptation of these organisms towards their resilience in a multi-stress environment
- **Untargeted metabolomics is a cutting-edge approach to provide a comprehensive picture of the molecular phenotype in response to changing environmental conditions [3]**

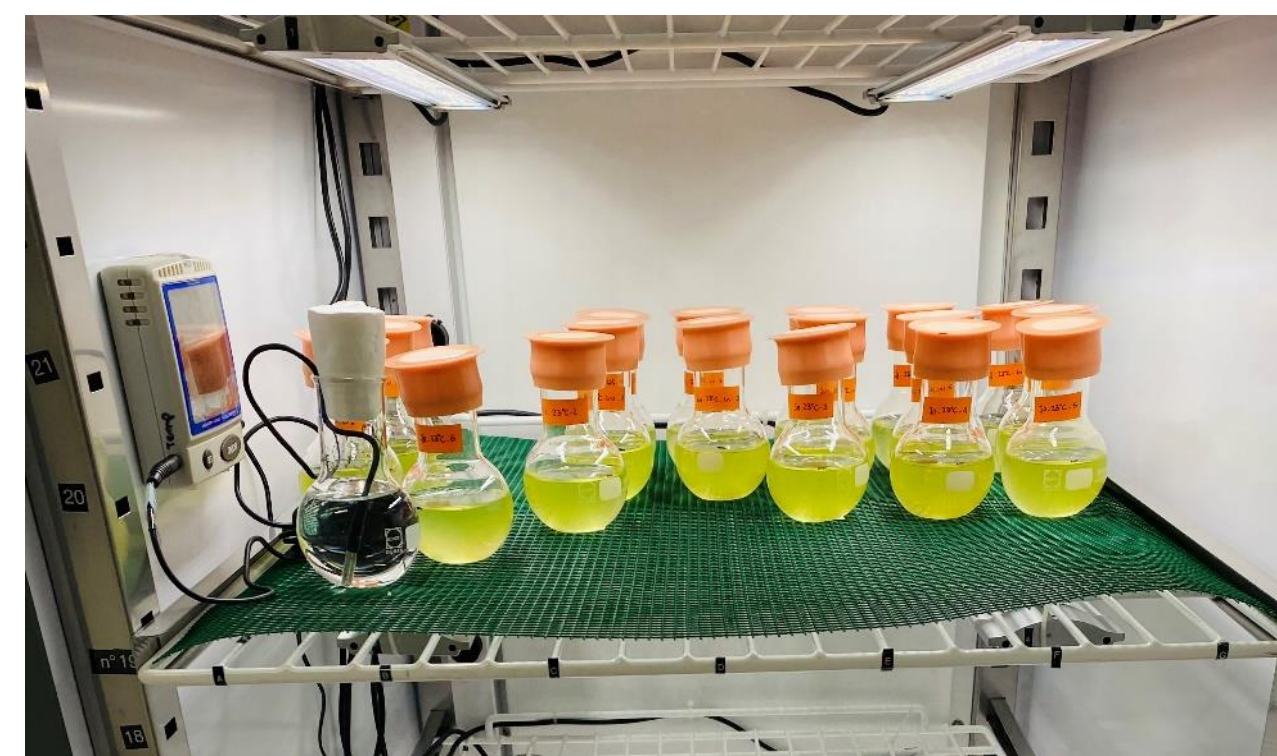
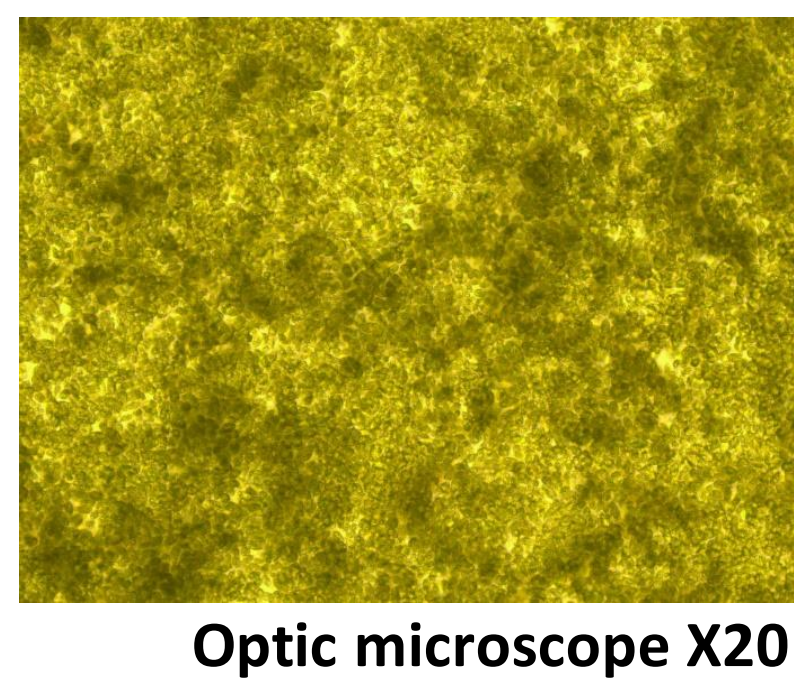
Aim: To unravel the molecular/biochemical responses of *Scenedesmus costatus* to increasing temperature and light intensity and their combination along the time through the implementation of untargeted metabolomics

Materials & Methods

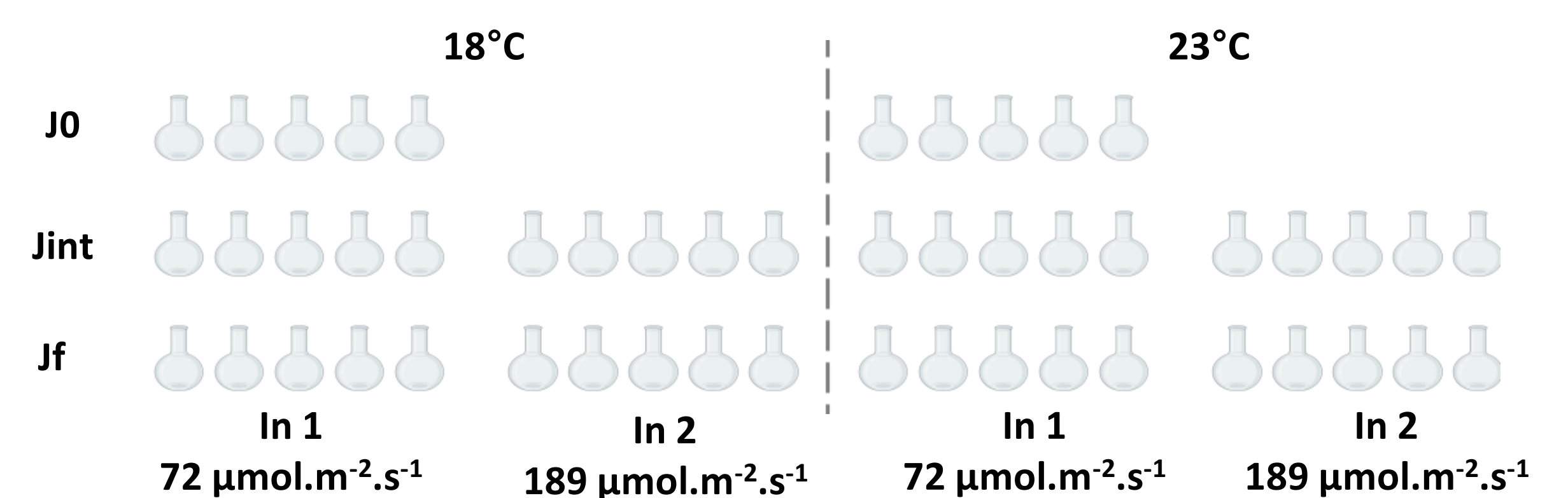
Biological model

freshwater chlorophyte

Scenedesmus costatus



Experimental design: 2 T°C vs 2 Light intensity (In) at 3 times

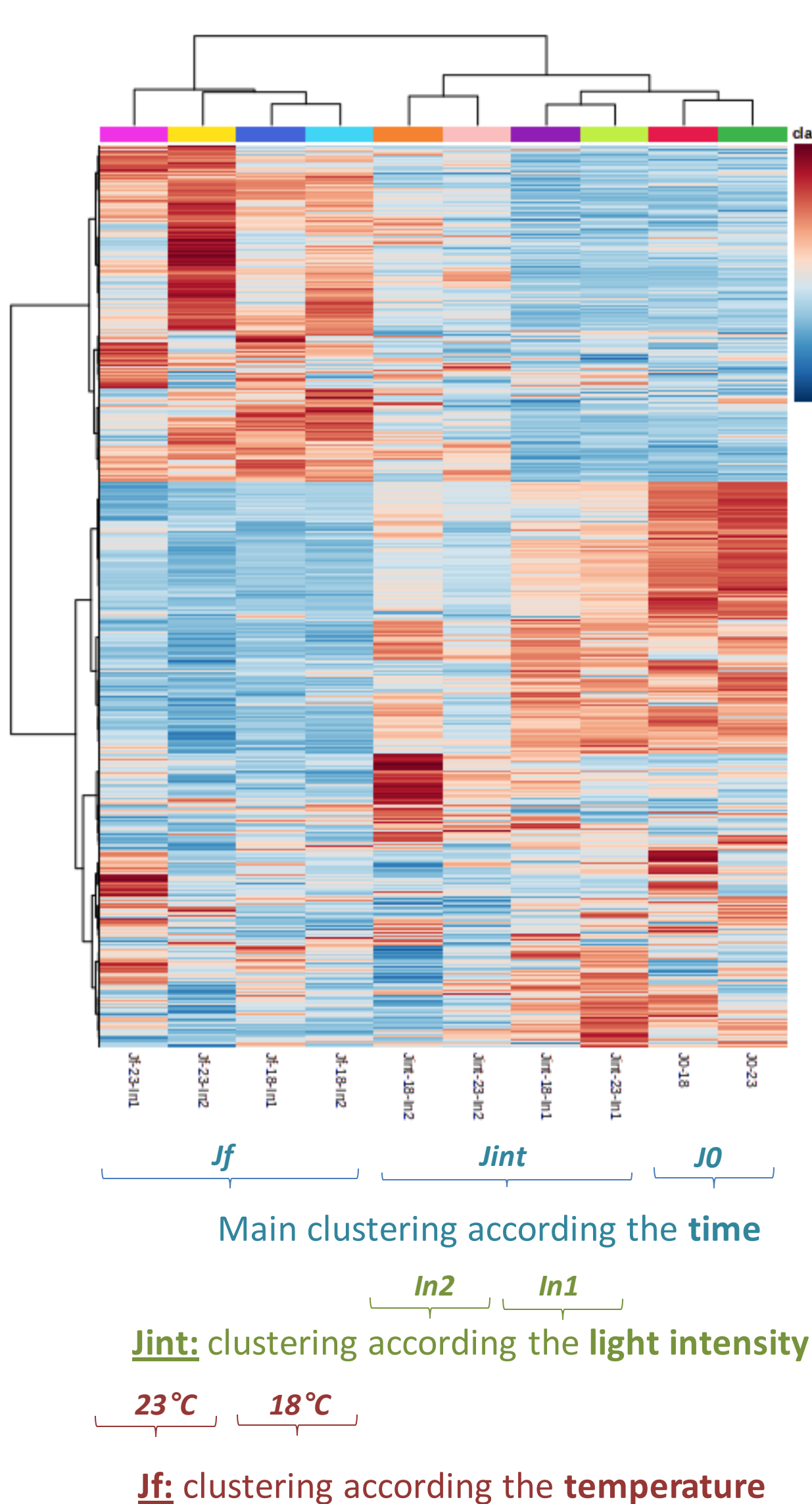


Metabolomics workflow

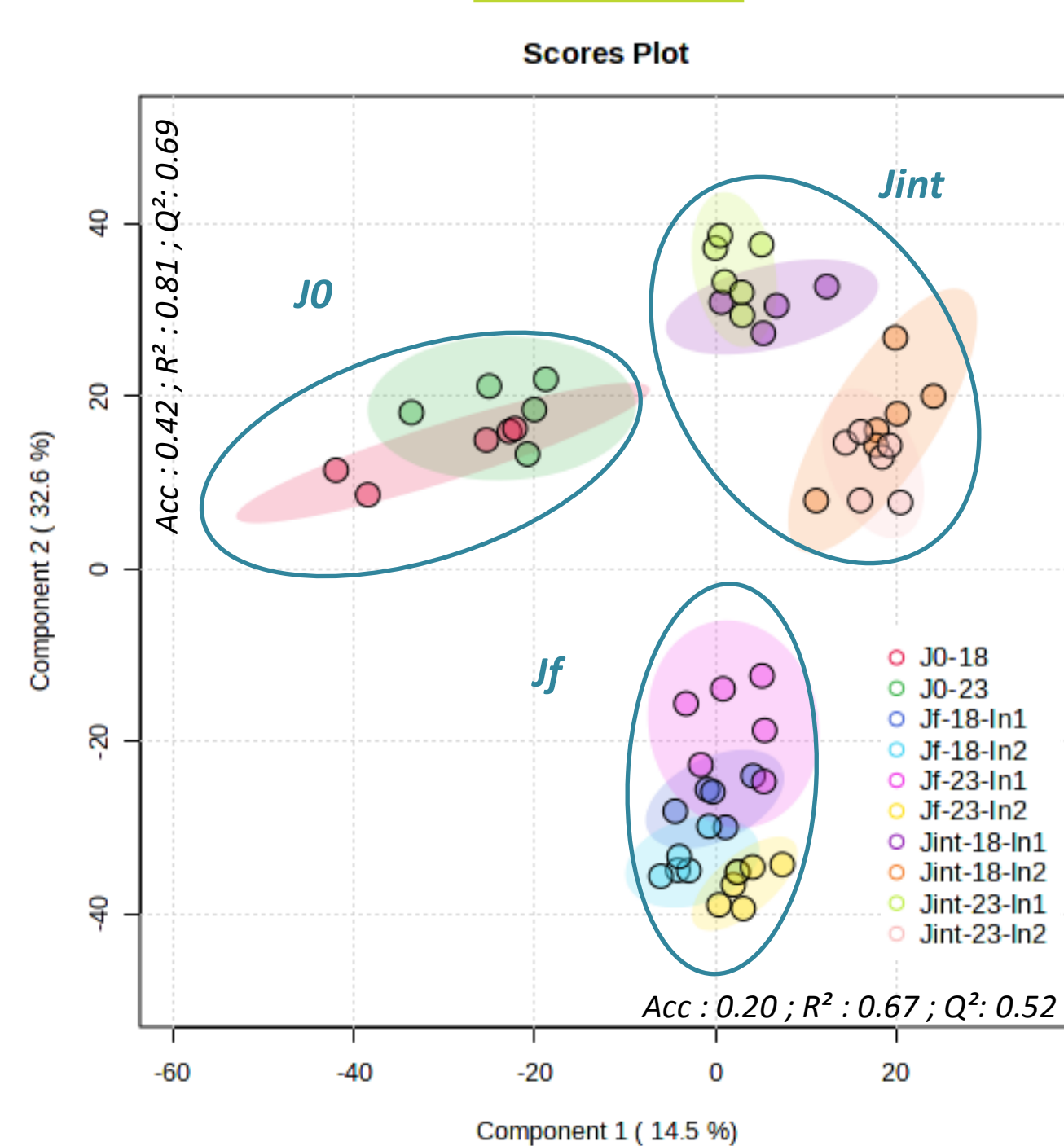


Results

HCA*



PLS-DA*



Discrimination mainly according to the time

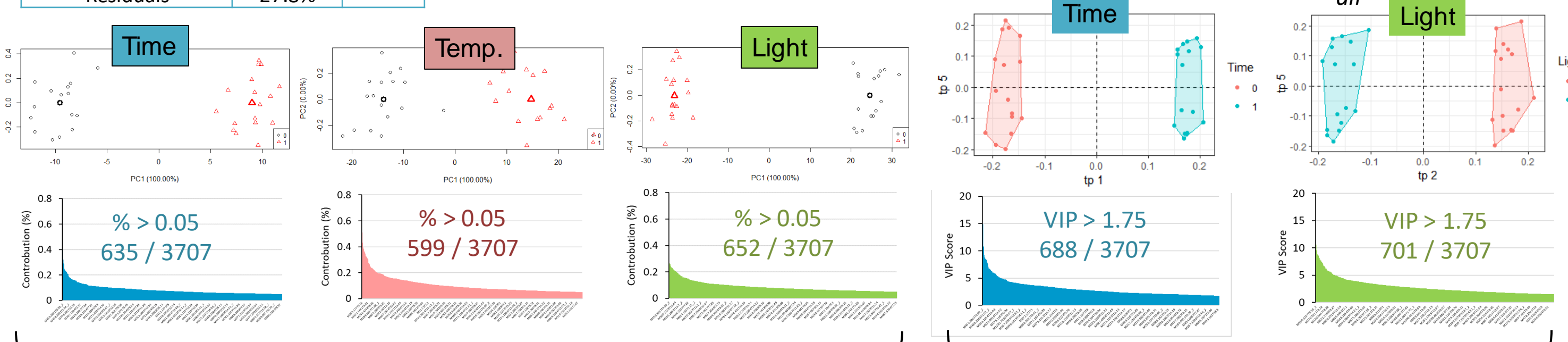
Difficulty to isolate the most contributing features to the discrimination of the various factors

ANOVA-simultaneous component analysis (ASCA) vs Analysis of Variance Multiblock Orthogonal Partial Least Squares (AMOPLS) [4]

ASCA*

Factor	% contrib.	p-val
Time	37.3%	0.001
Temp	5.2%	0.001
Light	13.7%	0.001
Time x Temp	4.5%	0.138
Time x Light	6.1%	0.077
Temp x Light	2.9%	0.115
Time x Temps x Light	2.50%	0.551
Residuals	27.8%	

- ✓ Significant effect of time > light > temperature
- ✓ No significant combined effect



AMOPLS*

Factor	RSS ^a	p-val	RSR ^b	p-val
Time	0.373	0.01	5.175	0.01
Temp	0.052	1.00	1.240	1.00
Light	0.137	1.00	2.273	0.05
Time x Temp	0.045	1.00	1.213	1.00
Time x Light	0.061	1.00	1.350	1.00
Temp x Light	0.029	1.00	1.104	1.00
Residuals	0.303	NA	1.000	NA

- ✓ Significant effect of time > light
- ✓ No significant combined effect

^aRelative Sum of Squares (RSS), ^bResidual Structure Ratio (RSR). Permutation = 100, R²Yp-val = 0.01 for all

Conclusions

- ✓ Strong effect of the time on the metabolome de *Scenedesmus costatus* compared to light intensity and temperature
- ✓ No significant combined effect of time, light intensity and temperature
- ✓ ASCA overestimates the significance of the temperature effect
- ✓ ASCA & AMOPLS prioritize the same features
- ✓ The most contributing features are factor specific:
 - Metabolite Class specific → Functional pathways specificity?
 - Relevant potential biomarkers ?

Next step :

- Identity of the metabolites and associated pathways?
- Natural fluctuation of *S. costatus* metabolome along its life cycle? Consequence on its « sensibility » to environmental stressors?
- Actual influence of temperature vs light following acclimation?

References :

- [1] Cavicchioli, R., Ripple, W.J., Timmis, K.N. *et al.* (2019) Scientists' warning to humanity: microorganisms and climate change. *Nat Rev Microbiol* 17, 569–586. <https://doi.org/10.1038/s41579-019-0222-5>
- [2] John Beardall & John A. Raven (2004) The potential effects of global climate change on microalgal photosynthesis, growth and ecology, *Phycologia*, 43:1, 26-40, DOI: [10.2216/00031-8884-43-1-26-1](https://doi.org/10.2216/00031-8884-43-1-26-1)
- [3] Bedia *et al.* (2018) Applications of Metabolomics Analysis in Environmental Research in *Comprehensive Analytical Chemistry* Volume 82, 2018, <https://doi.org/10.1016/bs.coac.2018.07.006>
- [4] Boccard J, Rudaz S. (2016) Exploring Omics data from designed experiments using analysis of variance multiblock Orthogonal Partial Least Squares. *Anal Chim Acta*. DOI: [10.1016/j.aca.2016.03.042](https://doi.org/10.1016/j.aca.2016.03.042)
- [5] Kim, Hyun Woo *et al.* (2021) NPClassifier: A Deep Neural Network-Based Structural Classification Tool for Natural Products. *Journal of Natural Products*, 84, 202 <https://doi.org/10.1021/acs.jnatprod.1c00399>

Acknowledgments: ISC XPO ; MetaboHUB (ANR-11-INBS-0010)

