WG1: Fertility induction

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Phycomorph

MORPHOGENESIS IN MACROALGAE

cost

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WG 1: Fertility induction

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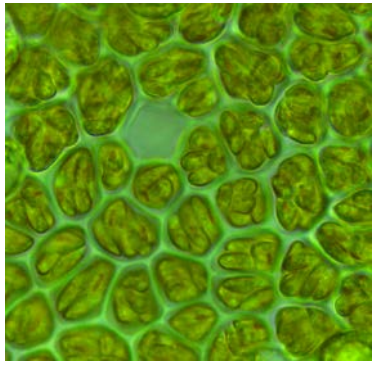
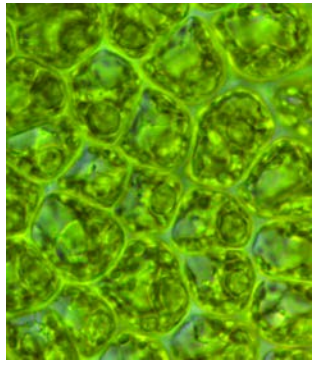
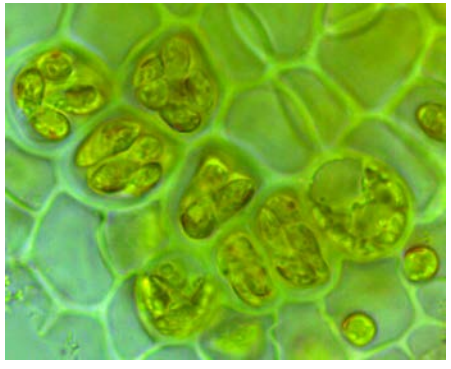
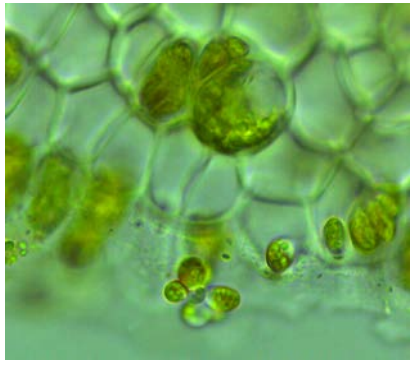
- Why is fertility induction important for aquaculture?
- How has Phycomorph advanced knowledge of the control of seaweed fertility?
  - Training schools
  - Phycomorph STSM
  - PEGASUS guidelines
  - Scientific progress & papers
  - Dissemination


Why is this important for aquaculture?

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Fertility induction - two ‘conflicting’ issues:

Controlling lifecycle & the formation of gametes & zygotes for:

- Avoiding biomass breakdown for maximal biomass production (spontaneous sporulations)

- Controlled seeding of cultures

Fatemeh Ghaderiardakani/AlgaPlus

WG 1: Training school

- First Workshop & Training School
- Seaweed Cultivation
- 2016
- Kavala, Greece
- Sotiris Orfanitis & Kristos Katsaros
- Avoiding spontaneous sporulation (Ulva)
- Controlling life-cycle and inducing fertility (Kelps)

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WG 1: 9 STSMs related to fertility induction

- **Neusa Martins**: Optimising Kelp Gametophyte culture to investigate transcriptional networks during gametogenesis: CCMAR, PT → AWI, DE
- **Patricia Oliviera**: Effects of temperature variation on the reproductive stages of *Fucus* sp: Uni Porto, PT → Uni Trieste, IT
- **Jessica Knoop**: *Porphyra*/cultivation of early life stage: Swansea Uni, UK → Algae+, PT
- **Marina Linardic**: Induction of fertility of *Dictyota*: Uni Cambridge, UK → Uni Ghent, BE
- **Xiaojie Liu**: Transcriptomics of Ulva fertility induction: Uni Ghent, BE → Uni Jena, DE
- **Yacine Badis**: Gamete production *Ectocarpus*: SAMS, UK → Algal Genetics group Roscoff, FR
- **Fatemeh Ghaderiardakani**: *Ulva* production: Uni Birmingham, UK → Algae+, PT
- **Daniele Grech**: Methyl Jasmonate-mediated conceptacle development in red corraline algae: Uni Trieste, IT → Uni Las Palmas, ES
- **Omri Nahor**: Starch production during gametogenesis in *Ulva:* Uni Tel Aviv, IL → Uni Jena, DE

WG 1: PEGASUS guidelines

Contributions from Phycomorphers from science and industry

- also on fertility induction

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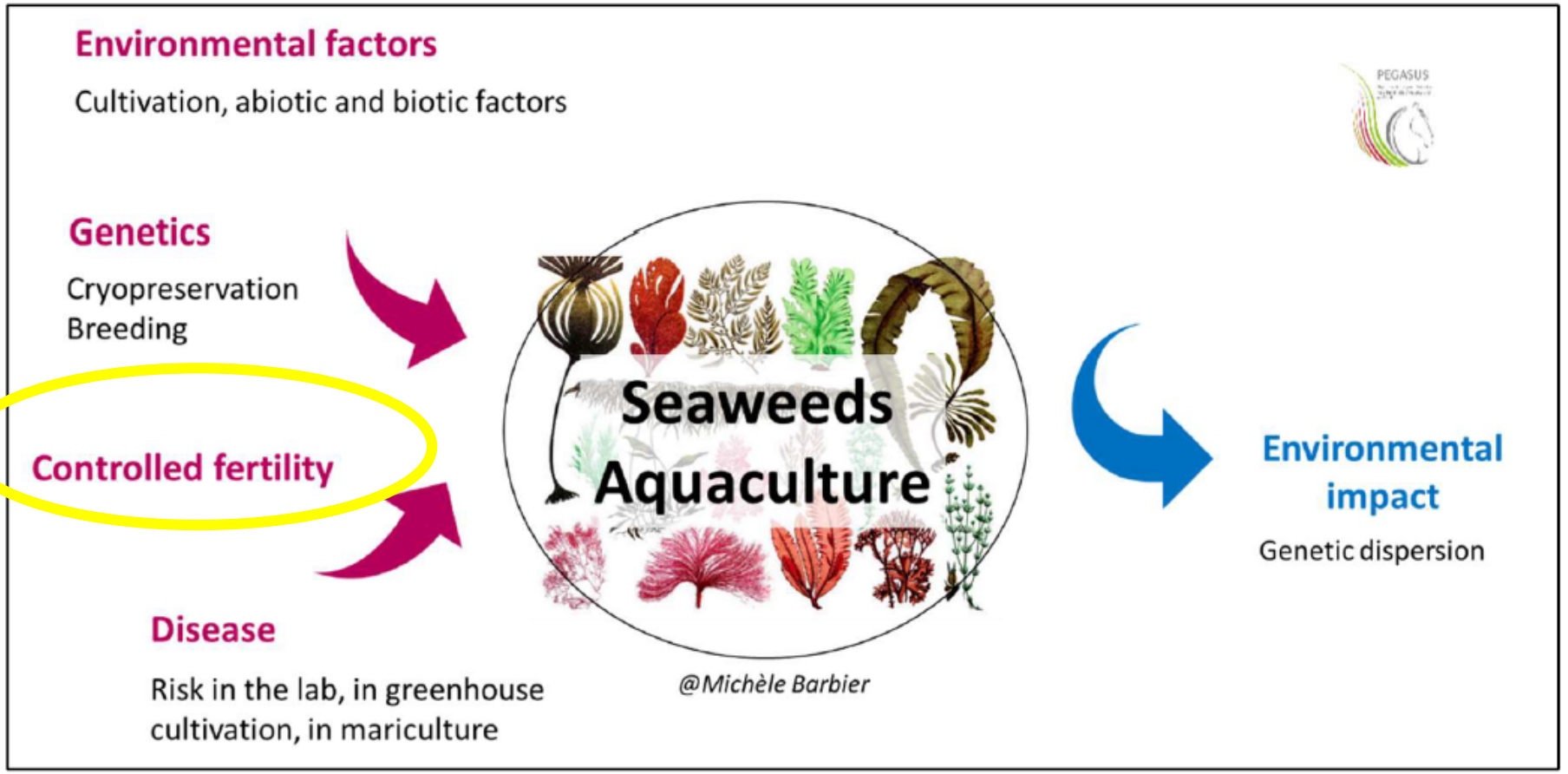
WG 1: PEGASUS guidelines

Controlling fertility
= major challenge:

- Cultivation of new species under artificial conditions
- Improve production of juvenile seaweeds

→ more R&D

in cooperation between fundamental seaweed biology and aquaculture



WG 1: Scientific progress & papers

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Joint reviews:

Controls of seaweed reproductive biology

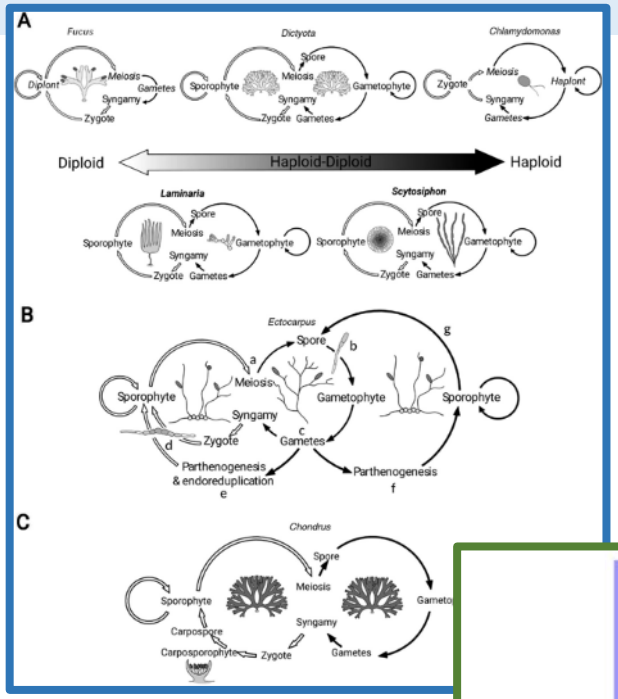
Liu *et al.* 2017 Botanica Marina

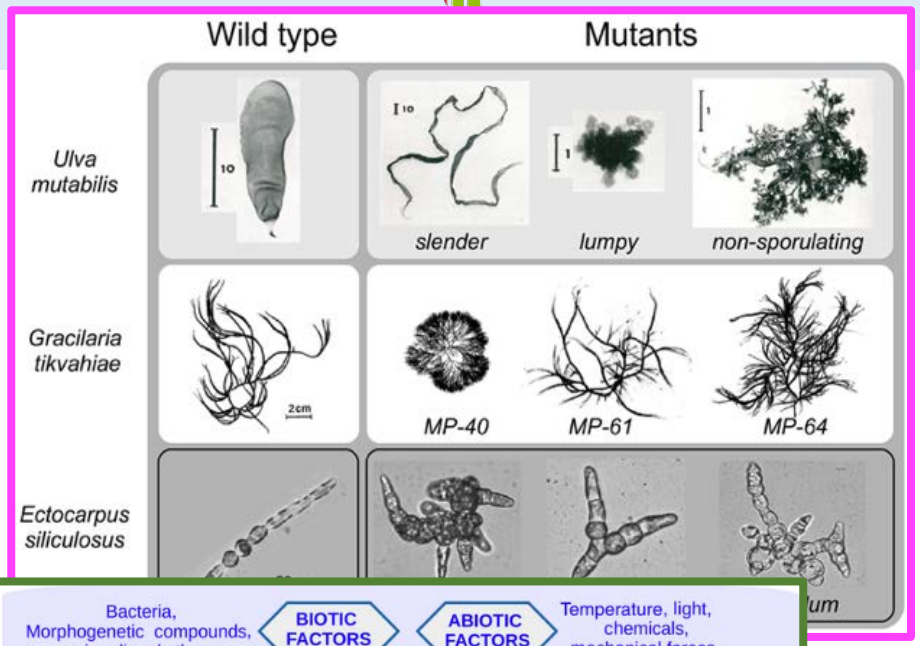
Morphological mutants including non-sporulating mutants

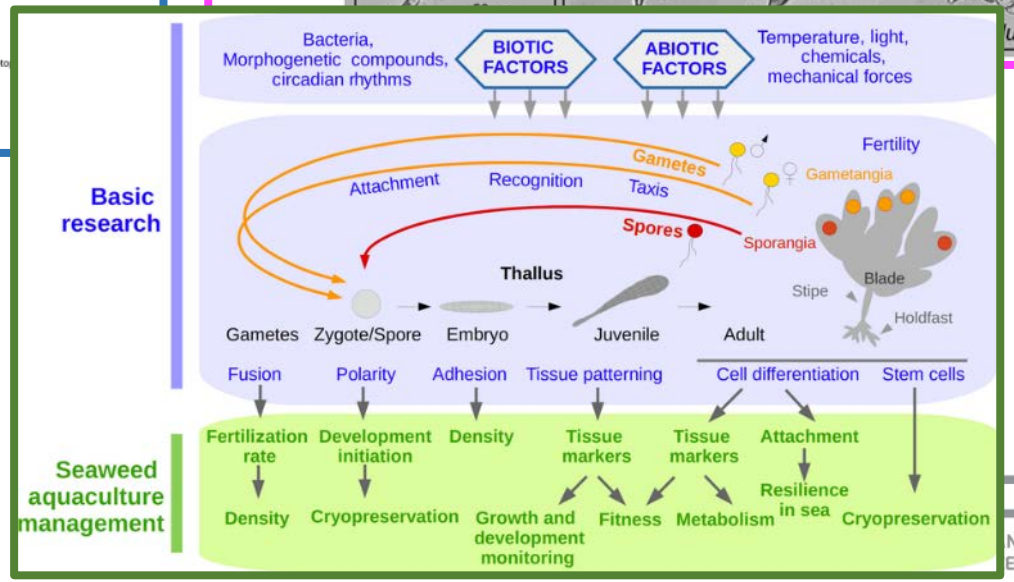
Charrier *et al.* 2017 Frontiers Plant Sci

Fertility bottlenecks (amongst other things)

Charrier *et al.* 2017 New Phytologist







D1.1: Identify the overall biological and environmental parameters triggering the shift to the reproductive phase (>7 papers)

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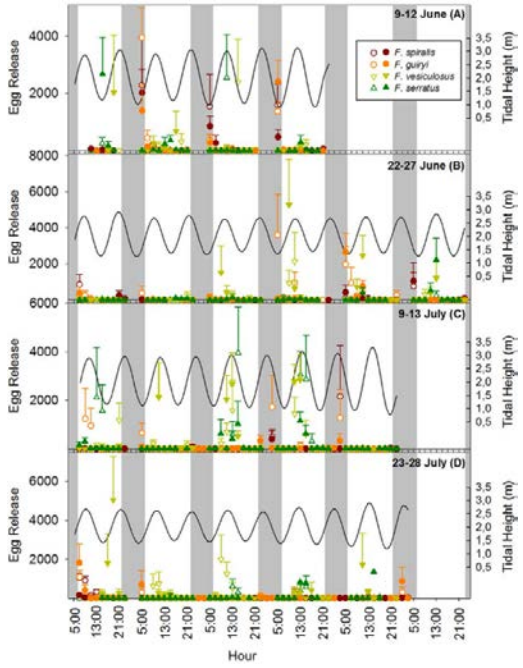
Pearson Group: brown algae

Timing of gamete (egg) release in co-existing *Fucus* species (in natural populations) leads to partial reproductive barriers between species.

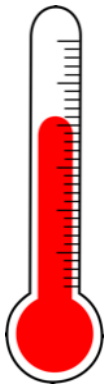
Monteiro *et al*. *Scientific Reports*



De Clerck group: brown algae

Regulation of gamete- and spore release by abiotic factors in *Dictyota*

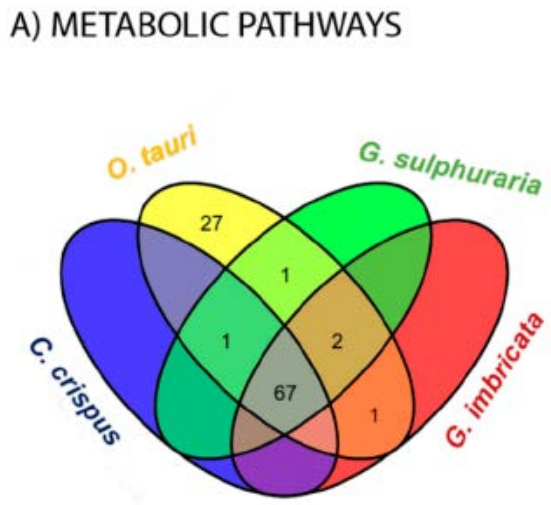
Bogaert et al 2016 J. Appl. Phycol.



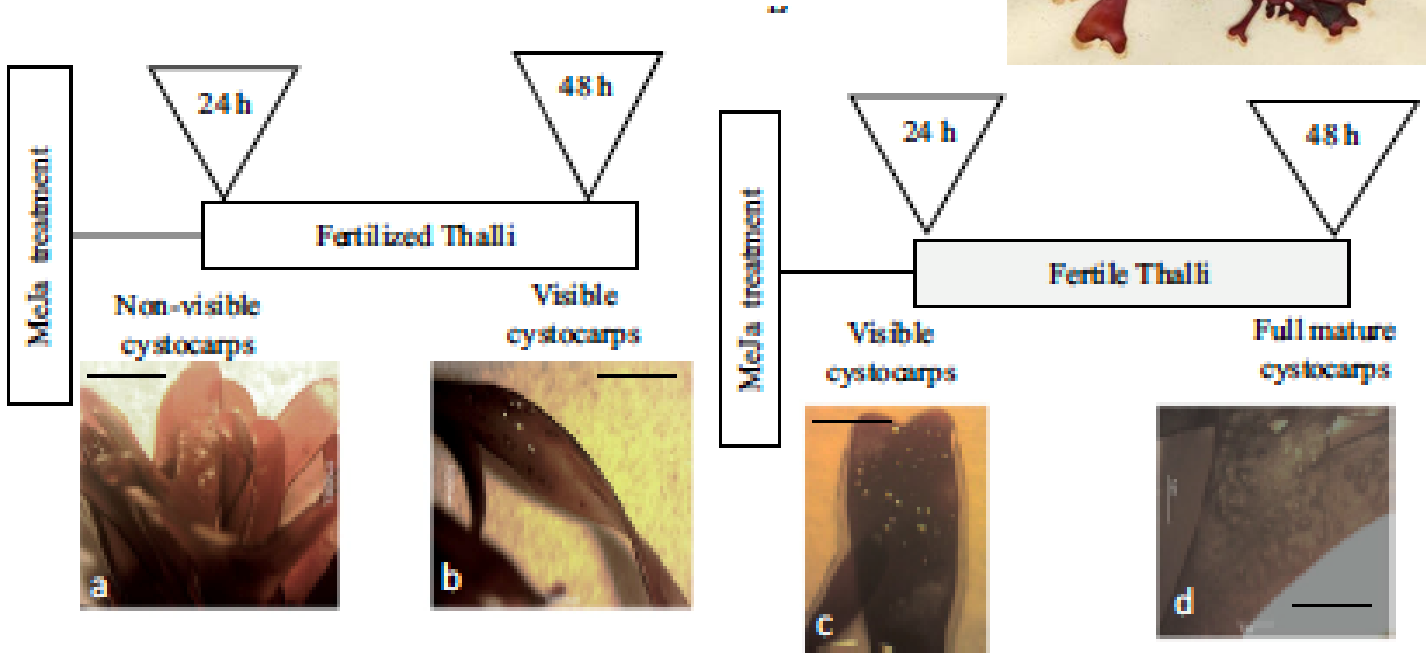
D1.2: Identify the chemical compounds and signalling molecules (morphogens) mediating the differentiation of the reproductive cells (gametes or spores) (>5 papers)

Robaina Group: *Grateloupia*

Taiju Kitayama



Transcriptome: Polyamines, ethylene, methyl jasmonate.
New ways to enhance reproduction. Garcia-Jiminez et al 2018, Marine Drugs.

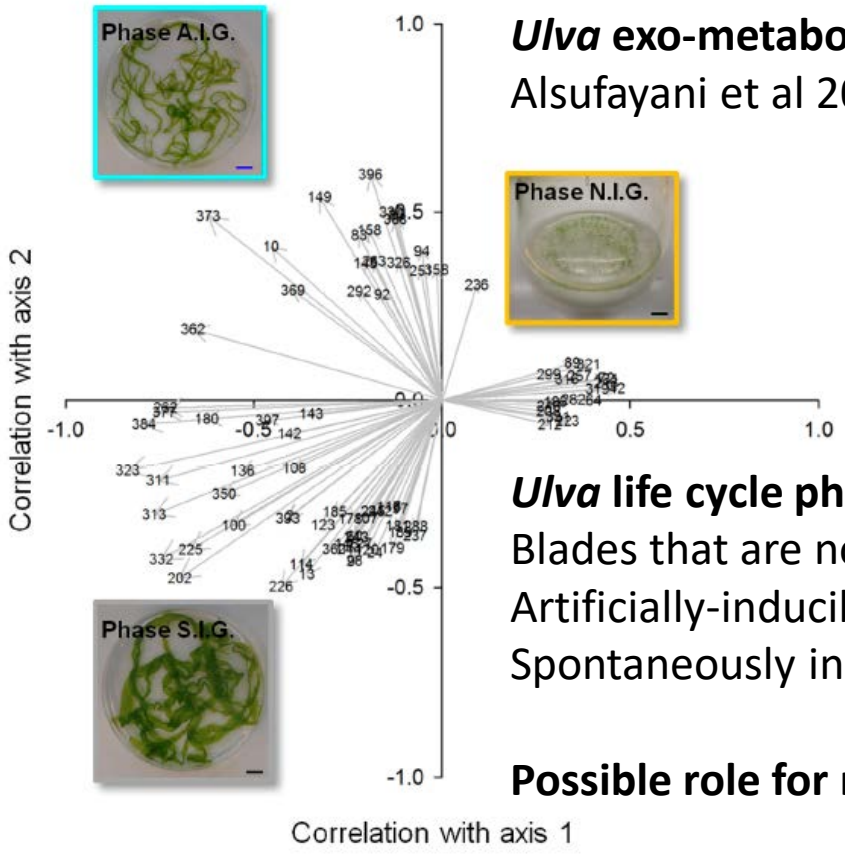


Methyl Jasmonate: Garcia-Jiminez et al 2017, J Phycol.

Ethylene-induced genes: Garcia-Jiminez et al 2018, J Phycol.

D1.3: Identify the mode of action of the signalling molecules within the whole seaweed tissue: localisation of biosynthesis, transport and receptors (>2 papers)

Wichard Group: *Ulva*



***Ulva* exo-metabolomic profiling**
Alsufayani et al 2017; Mar Drugs.

***Ulva* life cycle phases:**
Blades that are non-inducible for gametes (NIG)
Artificially-inducible (AIG)
Spontaneously inducible (SIG)

Possible role for nitrate in suppressing fertility?

D1.4: Characterize the cell differentiation steps leading to the development of reproductive organs, at both the cellular (microscopy) and the transcriptional level (microdissection followed by transcriptomics) (> 2 papers)

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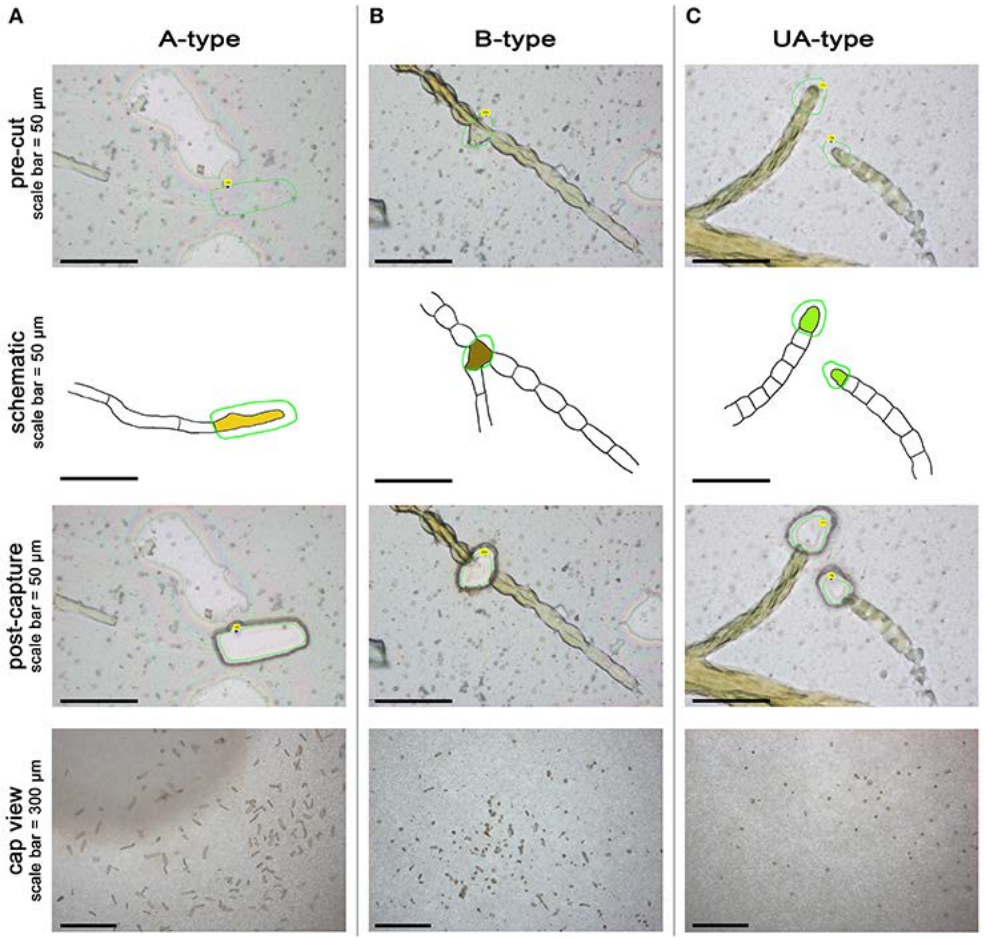
Charrier group: brown algae

First step – a PHYCOMORPH tool that can be applied to seaweed fertility?

Laser capture microdissection in *Ectocarpus siliculosus*: the pathway to cell-specific transcriptomics in brown algae.

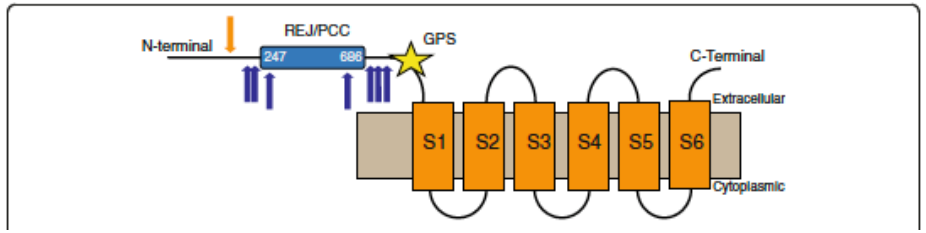
Saint-Marcoux *et al.* 2015 Frontiers Plant Sci



D1.5. Identify cell markers (transcripts and proteins) allowing early identification of reproductive cells prior to morphological differentiation (>2 papers)

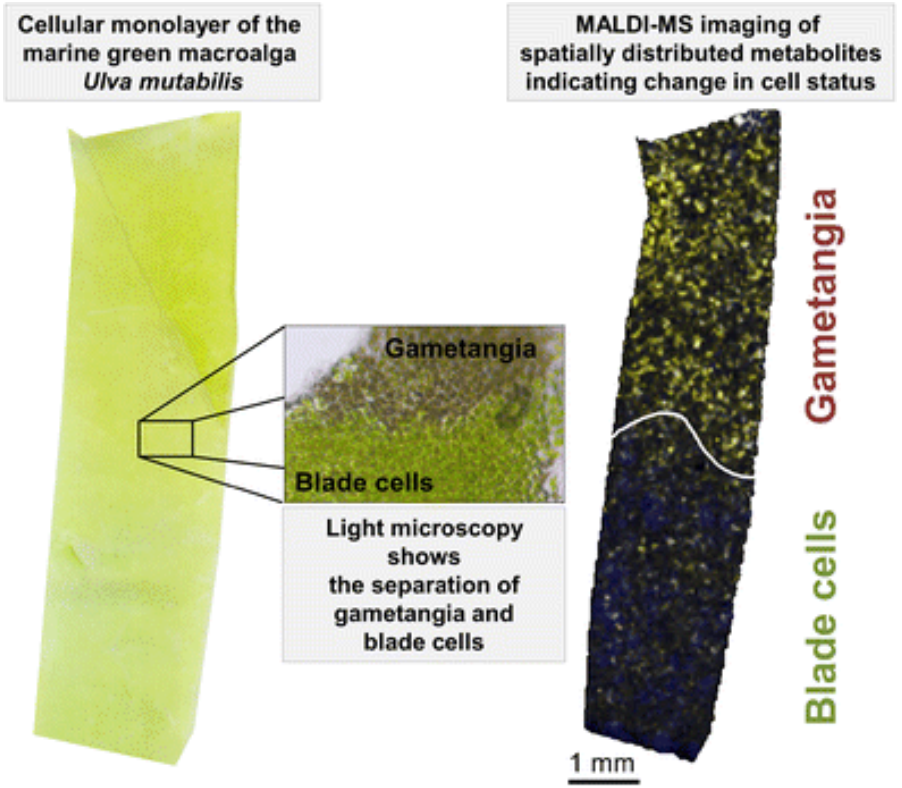
De Clerck group: brown algae

***Ectocarpus* male-specific gamete genes**
Lipinska et al 2016; BMC Evol Biol



Wichard Group: *Ulva*

Gametogenesis biomarkers identified:
Kessler et al 2017; Anal. Bioanal. Chem.



WG 1: Dissemination & outreach

Example:

4th WG meeting in Grenaa Denmark in connection with:

- 8th Nordic Seaweed Conference -“From research to industry”
- Regional industry network meeting

- Site visit at commercial IMTA site
- Participants from DK/EU industry at WG meeting
- PEGASUS promoted at conference
- Phycomorph MCs and IP = speakers at conference
- Two new spin-off companies benefitting from Phycomorph network

WG 1 Speakers: Early Carrier Investigators

1. Xiaojie Lui (Ghent University, Belgium): Gene expression analysis of gametogenesis in *Ulva mutabilis*

2. Peter Søndergaard Schmedes (DTU Aqua, Denmark): Fertility and the induction of tetraspores in *Palmaria palmata*