

# Trace element bioaccumulation and compartmentalization in the invasive algae *Caulerpa racemosa* var. *cylindracea* from the Calvi Bay, Corsica

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## Introduction and objectives

The algae *Caulerpa racemosa* var. *cylindracea* (Sonder) was first observed along Corsican coasts in 2002 (Ruitton et al., 2005 - Mar Pollut Bull), and more recently in the Calvi Bay in 2008 (northwestern Corsica, France; Fig. 1). Numerous works have studied the distribution of that invasive species, the factors driving its rapid expansion and the resulting ecological impacts on native communities (Klein and Verlaque, 2008 - Mar Pollut Bull). However, little is known regarding *C. racemosa* biochemistry and its ability to concentrate trace elements (TEs). This work thus aimed to study the accumulation and the compartmentalization of 19 TEs in this macroalgae.

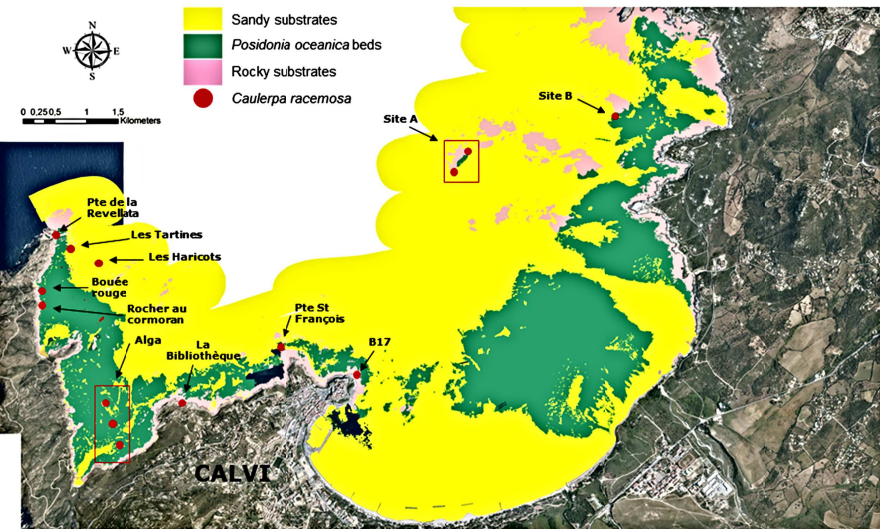


Fig. 1 - Map of the Calvi Bay (42°35'0"N, 8°46'0"E), northwestern Corsica (France), highlighting stations (red circles) where *Caulerpa racemosa* were observed in August 2011. The distribution of the 3 main substrates in the Bay (rock, sand, *Posidonia oceanica*) are also reported (STARESO, pers. comm.).

## Results and discussion

- This is the 1<sup>st</sup> study on the bioaccumulation of 19 TEs in the invasive algae *Caulerpa racemosa* var. *cylindracea* in the northwestern Mediterranean. TE concentrations ranged from  $10^{-3} \mu\text{g g}_{\text{DW}}^{-1}$  for Be and Bi in fronds and stolons to  $10^2 \mu\text{g g}_{\text{DW}}^{-1}$  for Al and Fe in rhizoids (Tab. 1; Fig. 3).
- In accordance with the algae physiology (coenocytic algae), similar TE levels were measured in fronds and stolons. However, since all TEs except Cd and As displayed higher concentrations in rhizoids (Fig. 3), this part of the algae could be regarded as the preferential route of TE uptake from the sediment or as a storage compartment (Richir et al., 2013 - Aquat Toxicol).
- Only Fe, used as a chemical reagent in the treatment of wastewater, and Bi, a urban sewage tracer (Fig. 3), showed in station B17 a clear increase of their concentrations with increasing depth in the algae 3 compartments. This could result from the discharge of Calvi city Fe-treated wastewater at 40 m depth in the vicinity of that station and to the presence of the wreckage of a B17 aircraft along that transect at 27 m depth (Fig. 4).

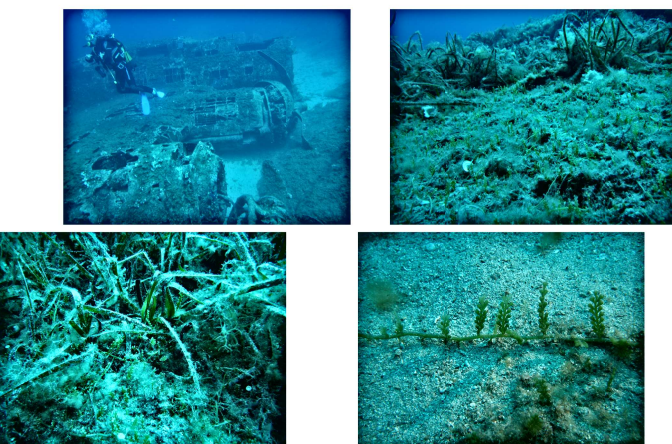


Fig. 4 - Pictures showing the wreckage of the B17 aircraft (upper left), fields of *Caulerpa racemosa* colonizing epiphyted *Posidonia oceanica* meadows (upper right and lower left) and zoom on an expanding thallus of the invasive algae (lower right).

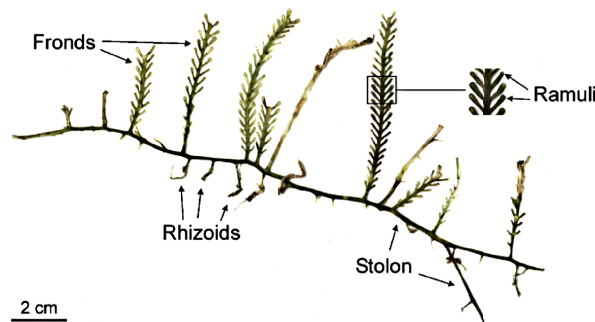


Fig. 2 - Thallus of the invasive algae *Caulerpa racemosa* from the Gulf of Marseille (France). Herbarium specimen, J. Klein (Klein and Verlaque, 2008 - Mar Pollut Bull).

## Material and methods

- Caulerpa racemosa* var. *cylindracea* were sampled by SCUBA diving in August 2011 along 2 depth gradients in the little anthropized Calvi Bay: station B17 (at 10, 15, 20, 22 and 28 m depth) near Calvi city and station Pointe de la Revellata (at 18 and 42 m depth) at the western limit of the Bay (Fig. 1).
- Collected algae were sorted in fronds, stolons and rhizoids for compartmentalization analysis (Fig. 2), lyophilised, and ground to powder.
- 19 TEs: Al, V, Fe, Cr, Mn, Co, Ni, Cu, Zn, Se, Ag, Cd, Sn, Sb, Mo, As, Be, Pb and Bi, were measured by DRC-ICP-MS in the algae compartments following acid digestion ( $\text{HNO}_3/\text{H}_2\text{O}_2$ ). Analytical accuracy was checked through the analysis of CRMs.

|          | Al  | V    | Fe  | Cr    | Mn   | Co    | Ni   | Cu   | Zn   | Se      |
|----------|-----|------|-----|-------|------|-------|------|------|------|---------|
| fronds   | 47  | 1.65 | 79  | 0.140 | 7.45 | 0.118 | 0.99 | 2.13 | 20.0 | 0.114** |
| stolons  | 75  | 2.32 | 91  | 0.184 | 6.68 | 0.105 | 1.20 | 2.49 | 25.2 | 0.135** |
| rhizoids | 479 | 3.20 | 354 | 0.910 | 8.85 | 0.131 | 1.58 | 4.26 | 28.5 | 0.187** |

|          | Ag    | Cd    | Sn    | Sb     | Mo    | As   | Be        | Pb   | Bi     |
|----------|-------|-------|-------|--------|-------|------|-----------|------|--------|
| fronds   | 0.158 | 0.151 | 0.058 | 0.0152 | 0.181 | 7.44 | 0.0049*** | 1.44 | 0.0054 |
| stolons  | 0.178 | 0.132 | 0.053 | 0.0166 | 0.222 | 6.29 | 0.0050**  | 1.77 | 0.0058 |
| rhizoids | 0.219 | 0.053 | 0.201 | 0.0421 | 0.560 | 3.63 | 0.0326*   | 4.76 | 0.0219 |

Tab. 1 - Trace element median concentrations ( $\mu\text{g g}_{\text{DW}}^{-1}$ ) in fronds (n = 3-10; N=38), stolons (n = 4-10; N = 44) and rhizoids (n = 1-4; N=20) of *Caulerpa racemosa* sampled in August 2011 along 2 depth gradients (total number of sampling depths = 7) in the Calvi Bay. \*, \*\* and \*\*\* represent Se and Be concentrations below the analytical quantification limit, detection limit or detection decision, respectively.

## Conclusion

This study showed that bioaccumulation processes in *Caulerpa racemosa* var. *cylindracea* are under the influence of natural and anthropogenic factors that require further investigations.

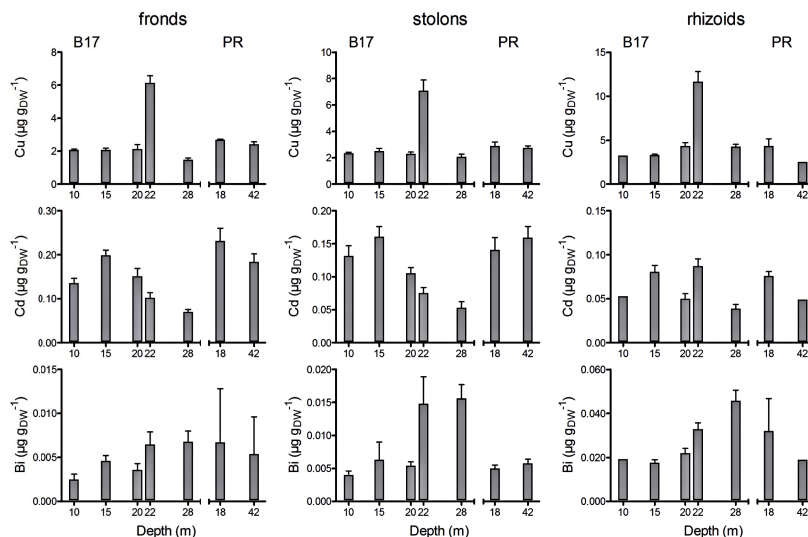


Fig. 3 - Cu, Cd and Bi concentrations ( $\mu\text{g g}_{\text{DW}}^{-1}$ ) in fronds, stolons and rhizoids of *Caulerpa racemosa* sampled in August 2011 along 2 depth gradients in the Calvi Bay: station B17 (at 10, 15, 20, 22 and 28 m depth) and station Pointe de la Revellata (PR; at 18 and 42 m depth).

## Acknowledgements

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