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Seasonal survey of gelatinous plankton within a harbour of the North Sea (Dunkirk, France): Assessing potential clogging risk for coastal industrial plants.

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Background

In the late 1980s high abundances of the sea gooseberry *Pleurobrachia pileus* (Ctenophora) in Dunkirk Harbour (North Sea, France) episodically caused problems to local industries by clogging water-intake systems. Efficient counter-measures were taken at the times and no further incident occurred since then.

However, with reports of a possible increase in gelatinous plankton abundance in response to climate change and other factors [1,2], recent cases of detrimental impacts of jellyfish on power plants in northern Europe [3,4], and the detection in 2013 of the potentially invasive and bloom-forming species *Mnemiopsis leidyi* in the harbour [5]; an updated evaluation of the risk related to gelatinous plankton in Dunkirk harbour was needed .

Pleurobrachia pileus

Methods

- Three points sampled twice a month from March to October, once a month from November to February, +/- 2h around slack waters.
- Gelatinous plankton sampled with a WP3 plankton net (1 m² opening, 1 mm mesh size) towed for 10 min in undulating movements from surface to near bottom. All ctenophores and medusae identified and measured alive.
- Mesozooplankton sampled by WP2 plankton net (0.25 m² opening, 200 µm mesh size) towed vertically between the surface and the sea bed. Preserved in 4% formalin.
- All nets equipped with mechanical flowmeter (KC Denmark).
- Temperature, Salinity, pH, turbidity, in-situ fluorescence profiles measured with multiparametric probes (YSI 6600V2).
- Chlorophyll *a* and phaeopigments measured by fluorometry [6].

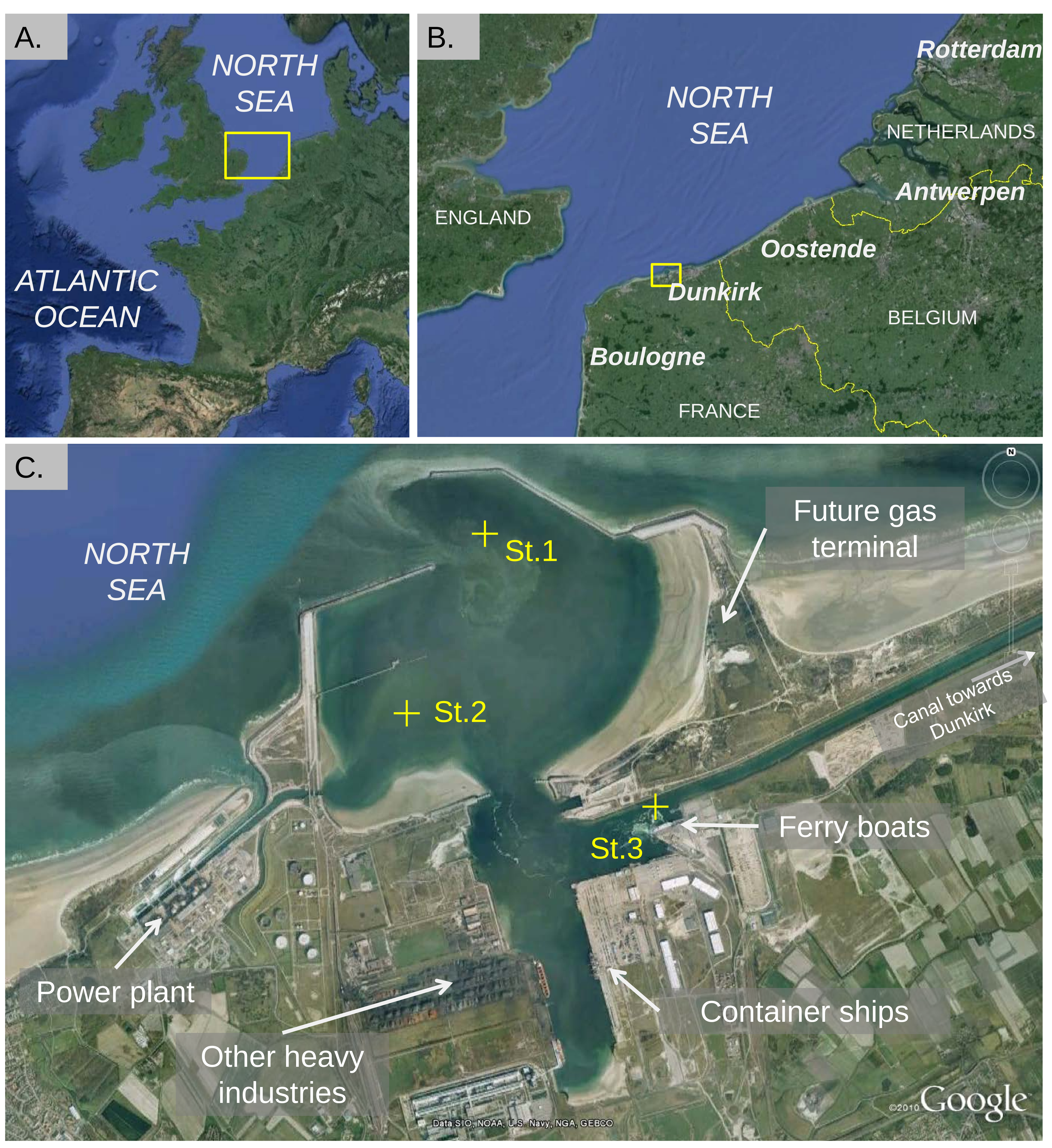

Fig. 1. Localisation of Dunkirk Harbour (A-B) and sampling locations from April 2013 to April 2014 within Dunkirk harbour (C) with indications on the main industries present in the area.

References

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Acknowlegments

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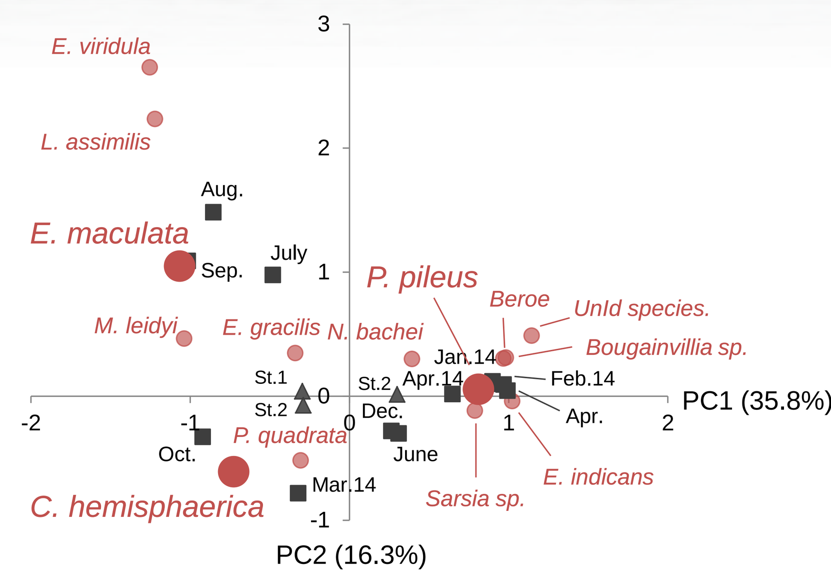
Results

- **3 ctenophores**, **>15 hydromedusae** and **4 scyphozoan** species were recorded, among which several are potentially problematic species.
- The ctenophore ***Pleurobrachia pileus*** and the hydromedusae ***Clytia hemisphaerica*** and ***Eucheilota maculata* were the most abundant species** (max 6.5, 1.7, and 0.9 ind. m^{-3} respectively). Variability of their abundances drove the main temporal variations observed in gelatinous plankton assemblages.

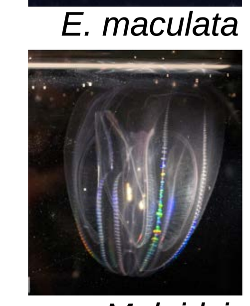


Only P. pileus, C. hemispherica and E. maculata contribute significantly to PC1 and 2. Illustrative variables (month and station number) are shown in black.

Fig. 2. Correspondance analysis on gelatinous plankton abundances (Ctenophora and Hydrozoa only)

- ***P. Pileus* present year-round, with peak abundance in April-June** (max 1.2 ind. m^{-3} in May 2013, but 6.5 ind. m^{-3} in April 2014).
- **Peak of hydromedusae in October** (4.0 ind. m^{-3}), largely dominated by *C. hemisphaerica* and *E. maculata*.
- Presence of the invasive ctenophore ***Mnemiopsis leidyi*** from September to December.
- Presence of ***Nemopsis bachei*** (Hydrozoa), which recently caused problems to industrial plants elsewhere (0.02 ind. m^{-3} in 2013).
- Presence of **several scyphomedusae** (*Cyanea lamarckii*, *Chrysoara hysoscella*, *Rhizostoma octopus*) from April to August.

E. maculata



M. leidyi

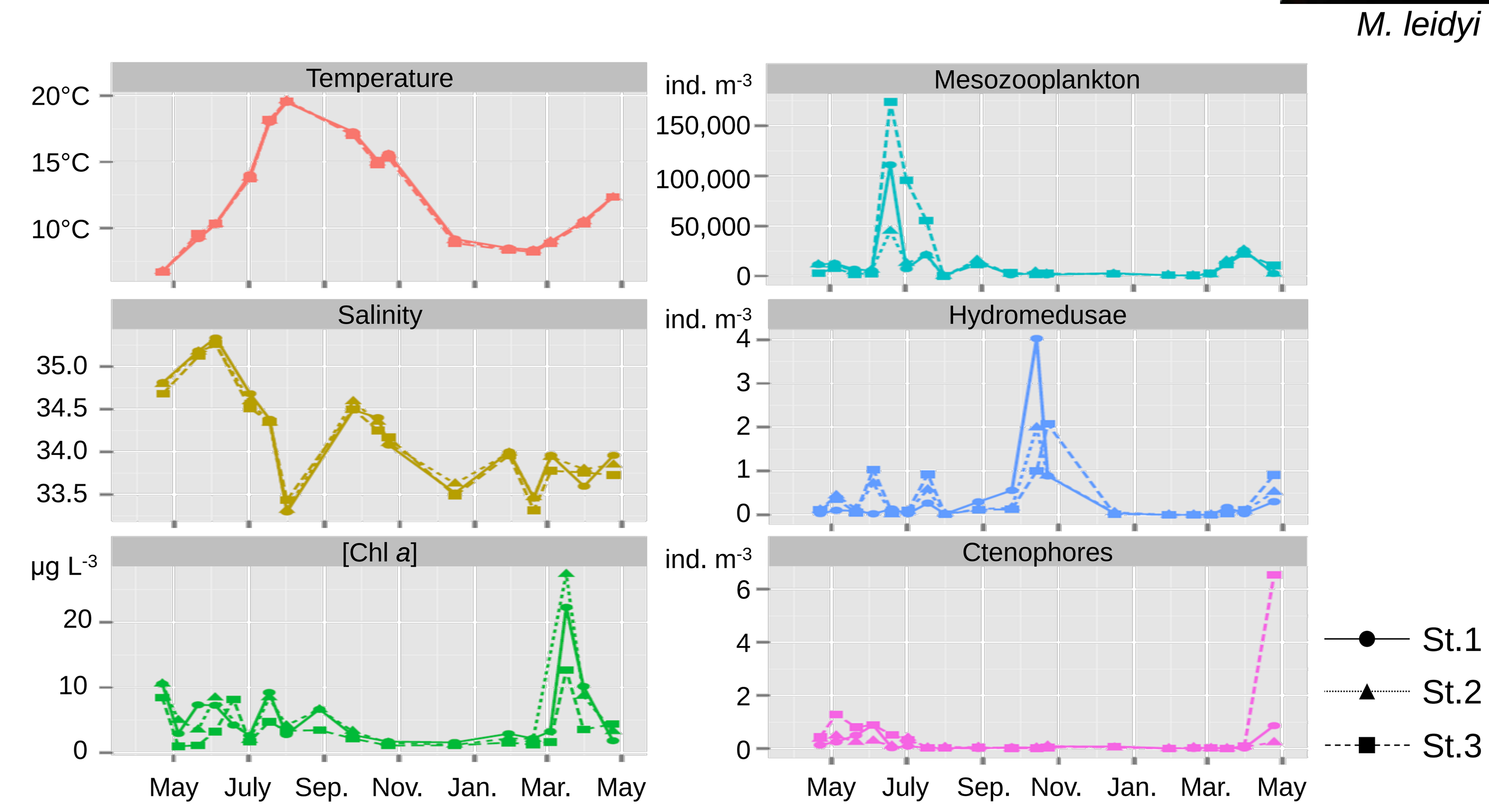


Fig. 3. Surface temperature, salinity, and chlorophyll a concentration; and abundance of meso-zooplankton, hydromedusae and ctenophores in Dunkirk harbour from April 2013 to May 2014.

- The analysis of size spectra suggests the existence of **retention zones in the inner harbour** favourable to the growth and/or accumulation of potentially problematic species
- Overall, most individuals measured < 1.5 cm (86% on average in the outer harbour, 85% in the inner harbour)

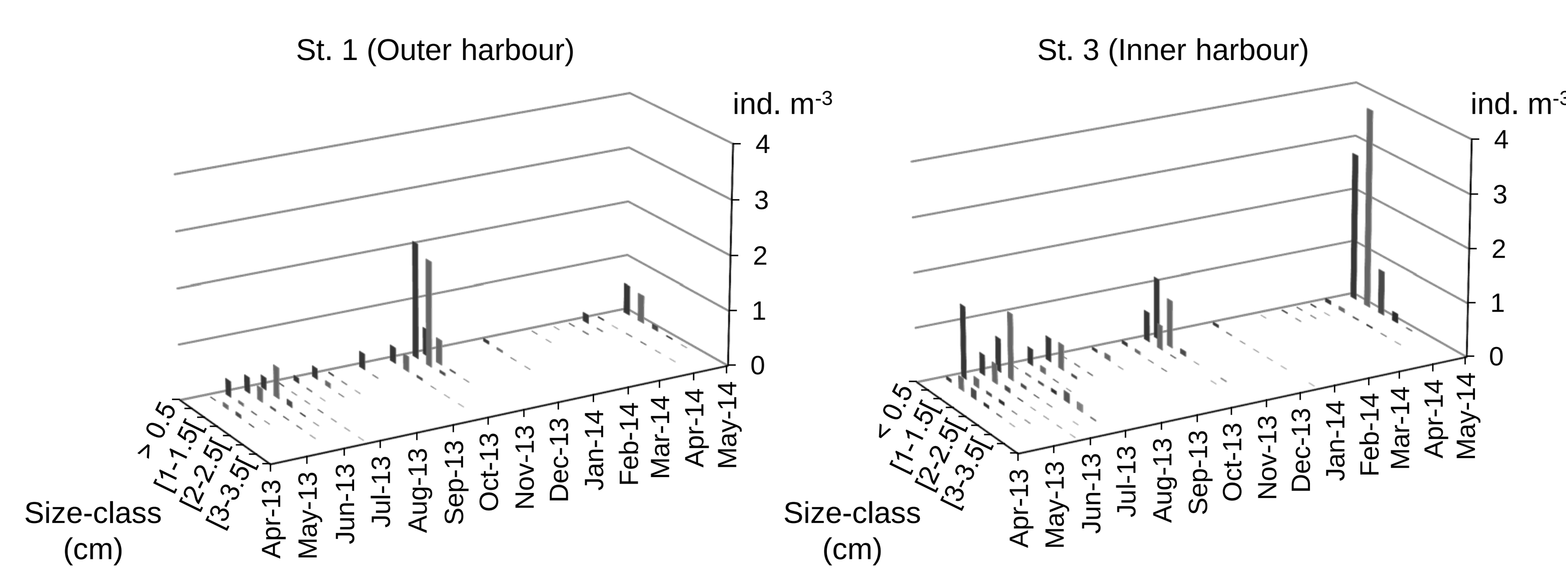


Fig. 4. Size-distribution of gelatinous plankton (hydrozoa and ctenophora only) in Dunkirk outer and inner harbour from April 2013 to May 2014.

Conclusion and perspectives

This first year of monitoring provided a first complete description of the gelatinous plankton community composition within Dunkirk harbour. It confirmed the presence of several potentially problematic species in the area, and in particular the potentially invasive and bloom-forming ctenophore *M. leidyi* [5].

Additionnal data will be necessary before changes in species assemblage can be linked to environmental conditions. In fact, monitoring in spring and summer 2014 already showed constrasting results and in particular much higher abundances of *P. pileus* (max. 53 ind. m^{-3} in May 2014), *N. bachei* and *C. hysoscella*.

Finally, sampling at higher frequency appears necessary to assess the risk of short-term dense aggregation (i.e. « apparent blooms » [7]) forming in response to transient specific conditions (wind, tide), in particular during the months of proliferation.