Dinophysis through good and lean times: exploring the phenology of a toxic marine dinoflagellate with a kleptoplastidic lifestyle

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Résumé

The planktonic dinoflagellate *Dinophysis* is a major source of concern in various coastal ecosystems worldwide, where it regularly contaminates edible shellfish with diarrhetic toxins. *Dinophysis* is also a peculiar biological model, that relies on specific kleptoplastidy (i.e. acquisition of plastids from a specific prey) for photosynthetic growth.

Using data from decades-long observation networks, we studied the phenology of *Dinophysis* in a diverse array of coastal sites along the French coastline, from the English Channel to the Mediterranean Sea. Based on cell counts from systematic microscope observation, we used Generalized Additive Models (GAMs) to model seasonal dynamics of *Dinophysis* and, when data was available, of its prey *Mesodinium rubrum* (a photosynthetic, kleptoplastidic ciliate). These analyses revealed that *Dinophysis* and *Mesodinium* abundances and growth exhibit clear, region-specific seasonal patterns. We compared these patterns to those of temperature and stratification of the water column, two hydrological parameters that shape the pelagic ecosystem. Moreover, in the two distinct regions for which *M. rubrum* observation data was available, we observed that periods of *Dinophysis* growth were concomitant with periods of high prey abundance, corroborated by the detection of high-biomass *M. rubrum* blooms on satellite images. This finding points towards a significant trophic link between *Dinophysis* and *M. rubrum* in the wild, for which concrete evidence is rather scarce in published research conducted in natural environments.

Finally, we focused on periods of low-to-no growth, when *Dinophysis* is hardly ever observed *in situ*. Starvation experiments on laboratory cultures of *Dinophysis*, combined with measurements of environmental DNA at several depths in one coastal site, help us draw hypotheses on the survival strategies of *Dinophysis* during the unfavourable winter period. Faced with the absence of prey, *Dinophysis* rapidly reduces its vegetative growth and photosynthetic activity. In accordance with previously published laboratory experiments, we

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observed that *Dinophysis* can survive long periods of starvation (> 30 days) and successfully resume growth upon the return of its prey. Overall, our work offers new knowledge about a toxic marine microorganism whose blooms strongly affect shellfish farming worldwide, as well as insights into the ecology of an intriguing planktonic protist.

Mots-Clés: harmful algal blooms, microbial predation, kleptoplastidy, plankton, phenology