Carbon assimilation by offshore wind farm fouling communities

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Offshore wind farms (OWFs) in the North Sea are continuously constructed, licensed or scheduled as a measure to meet green energy requirements. Offshore wind turbines add artificial hard substrates into naturally soft bottom areas, altering the natural biodiversity. Suspension feeding organisms are the main colonizers of the newly introduced habitats, reducing the local phyto- and zooplankton biomass. This could potentially lead to changes in the food web and the biogeochemical cycling in and around the OWFs. Thus, estimating the consumption of organic matter by the biofouling invertebrate organisms is crucial to understand the effects of OWFs on the pelagic ecosystem. Therefore, we investigated the carbon assimilation by fouling organisms of offshore wind turbines by performing a pulse-chase experiment. Our initial hypothesis was that the blue mussel (*Mytilus edulis*) would be a key player in the reduction of primary producer standing stock and would, therefore, reveal the highest carbon assimilation. To examine our hypothesis, we deployed a tripod with PVC panels in an OWF, in the Belgian part of the North Sea (BPNS). After one year, the fully colonized PVC panels were collected and transferred to the lab, where four of the panels were immediately scraped and used for collecting background data and another five were incubated in experimental tanks. After a day of acclimation, ^{13}C-labeled algal cells were added, corresponding to *in situ* algae concentration. Three days later, the organisms from all PVC panels were collected. For each species, a subsample for stable isotope analysis was taken and the remaining organisms were counted and weighed. *Mytilus edulis* indeed showed the highest total biomass-specific carbon assimilation, confirming its role as key fouling species affecting primary producer standing stock. However, the amphipod *Jassa herdmani* assimilated the highest total amount of carbon, which could be explained by its high abundance on the PVC panels. This high assimilation is an indication that this species is an opportunistic feeder, since it is known to exploit any food particle in suspension. The total faunal carbon assimilation in our study was estimated at 4 ± 3 % of the added algae. This relatively low value can be explained by the fact that the added food resource was possibly not highly favoured by the non-filter feeders and that the communities were not in an advanced successional stage. Finally, we scaled the results of this study up to estimate the percentage of the annual primary producer standing stock that is grazed by the fouling fauna of all the offshore wind turbines that have been installed in the BPNS. Our results indicated that 1.3 % of the annual primary producer standing stock in the BPNS can be grazed by *Jassa herdmani* and *Mytilus edulis*, which are, therefore, the main species influencing the carbon-flow in the area. This amount seems low, considering that ~ 30 % of the primary producer standing stock is exploited in the benthic food web of the BPNS. In natural permeable sediments, approximately 2.3 g C m^{-2} is assimilated by the macrobenthos. According to the results of our study, the introduction of offshore wind turbines increases this amount by 1.1, 2.5 and 4 times with the installation of a monopile, a gravity-based and a jacket foundation, respectively. Considering that the majority of the offshore wind turbines in the BPNS are monopiles (264 out of 318), the increased carbon assimilation is expected to remain low.

Keywords: Artificial hard substrates; Carbon assimilation; Fouling organisms; Offshore wind turbines; Primary producer standing stock; Pulse-chase experiment