



Continuity in the importance and mechanisms of photosynthetic production of dissolved organic carbon from eutrophic to oligotrophic waters

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Despite its wide ecological and biogeochemical significance, the photosynthetic production of dissolved organic carbon (DOCp) is not routinely measured in most surveys of marine primary productivity. We have studied the magnitude and mechanisms of DOCp during summer oligotrophic conditions in the Celtic Sea. The production rate of size-fractionated, particulate organic carbon (POCp) was also determined, as well as the relationship between irradiance and DOCp and the kinetics of DOCp during a 24-h light-dark cycle. Mean, euphotic layer-integrated POCp was $510 \pm 61 \text{ mg C m}^{-2} \text{ d}^{-1}$ and cells in the $< 5 \mu\text{m}$ size fraction accounted for around 60 % of total integrated chlorophyll *a* concentration and POCp. The mean, integrated percentage of extracellular release [PER, calculated as $\text{DOCp} / (\text{DOCp} + \text{POCp})$] was $22 \pm 2 \%$. The kinetics of DO^{14}C accumulation over 24 h showed that photosynthate release stops during the dark, indicating that direct exudation from intact cells is the main mechanism of DOCp and that indirect processes such as cell lysis or zooplankton grazing are not involved. Significant DOCp occurred throughout the euphotic layer and across a wide range of irradiances, which suggests that passive diffusion, rather than overflow, is the main physiological process responsible for the release of recent photosynthate. When comparing our measurements of DOCp in the Celtic Sea with previous observations in coastal, eutrophic waters, a remarkable continuity was evident both in the relative significance and the mechanisms of DOCp, despite the fact that phytoplankton biomass, production and size structure differed greatly between environments. Across a productivity range from < 100 to $> 15000 \text{ mg C m}^{-2} \text{ d}^{-1}$, PER is relatively constant at $\sim 20 \%$ and integrated DOCp can be predicted from integrated POCp with the equation: $\log(\text{DOCp}) = 0.96 * \log(\text{POCp}) - 0.51$ ($r^2 = 0.90$, $n = 35$, $p < 0.001$).