WINTER PELAGIC PHOTOSYNTHESIS IN THE NW MEDITERRANEAN. EVIDENCE OF HIGH PRIMARY PRODUCTION RATES

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Abstract

Primary production in the NW Mediterranean was estimated in two cruises (Mar'99 and Jan-Feb'00) by means of *in situ* incubations and photosynthesis-irradiance relationships. Both approaches showed a good agreement. Photosynthetic parameters displayed differences within the mixed layer, suggesting rapid photoacclimation. Phytoplankton assemblages were acclimated to lower irradiances during 2000. Although a high variability was found between years, stations and visits, chlorophyll *a*-normalized rates were ~1 mg C mg Chl a^{-1} h^{-1} in both cruises. Primary production rates were generally higher in 1999 than in 2000, ranging 326-1963 mg C m^{-2} d^{-1} and 124-868 mg C m^{-2} d^{-1}, respectively. These results support the hypothesis of a late winter, rather than spring, maximum of primary production in the NW Mediterranean.

Keywords: phytoplankton, primary production, photosynthetic parameters, NW Mediterranean, winter

The NW Mediterranean was sampled during the winters of 1999 (3-13 March) and 2000 (29 January-10 February) in the HIVERN cruises. We estimated primary production at 6 stations with the ^{14}C technique using two methods, short-term *in situ* incubations and photosynthesis-irradiance (*P-E*) relationships. *In situ* incubations were performed with water collected from 8 depths down to 60 m. For the *P-E* experiments, water was taken from 2 depths within the photic layer (mostly 5 and 30 m) and incubated under an irradiance gradient of ~2-2000 µmol photons m^{-2} s^{-1}. Photosynthetic parameters were obtained with the model of Platt et al. (1). The depth profiles of photosynthetically active radiation (PAR) and chlorophyll *a* together with the daily variation in surface PAR were used to estimate integrated rates of primary production from photosynthetic parameters.

Photosynthetic parameters (Table 1) indicated that phytoplankton assemblages were acclimated to lower irradiances in 2000, as expected from the earlier sampling. Photoinhibition was commonly observed in deep samples. Alhough the parameters were differentially affected in the two years most of them presented significant differences between surface and deep values within the well-mixed upper layer, suggesting that photoacclimation was faster than water column mixing rates, as previously observed in the Alboran Sea (2).

Table 1. Mean (± SD) photosynthetic parameters in surface (5 m) and deep (15-60 m) samples in the two cruises. P^B_m: maximum chlorophyll *a*-normalized photosynthetic rate (mg C mg Chl a^{-1} h^{-1}); α: initial slope of the *P-E* relationship [mg C mg Chl a^{-1} h^{-1} (µmol photons m^{-2} s^{-1})$^{-1}$]; ß: photoinhibition paramenter (same units as α). E_k: light saturation parameter (µmol photons m^{-2} s^{-1}).

	P^B_m	α	β	E_k
Mar 1999				
surface	2.32 ± 0.76	0.013 ± 0.005	0 ± 0.0001	204 ± 114
deep	1.77 ± 0.57	0.015 ± 0.007	0.0008 ± 0.0012	127 ± 48
Jan-Feb 2000				
surface	1.64 ± 0.55	0.012 ± 0.001	0.0002 ± 0.0003	154 ± 90
deep	1.56 ± 0.48	0.017 ± 0.006	0.0018 ± 0.0016	97 ± 35

A good agreement was found between both methods of estimating primary production. Fig. 1 shows the relationship between chlorophyll *a*-normalized hourly rates at the depths of the *P-E* experiments of all stations (n=35). The slope of the linear regression (*In situ* PP = -0.06 + 0.96 *P-E* PP, r^2=0.68, p<0.001) was not significantly different from 1.0 (*t*-test, p=0.28). Estimates of *in situ* and *P-E*-derived integrated primary production rates were also significantly correlated (r=0.85, p<0.001, n=16).

Surface phytoplankton biomass was a good estimate of integrated primary production rate (r^2=0.71). A high variability was found between years, stations and consecutive visits, with relative increases up to 9-fold, but integrated assimilation numbers were virtually the same in both periods (1.07 ± 0.37 and 0.99 ± 0.45 mg C mg Chl a^{-1} h^{-1}, respectively), suggesting similar phytoplankton assemblages and/or photoacclimation responses during the later winter months. Due to later sampling, values were generally higher in 1999 than in 2000, with respective ranges of 0.3-2 g C m^{-2} d^{-1} and 0.1-0.9 mg C m^{-2} d^{-1}. These values, particularly the 1999 ones, are considerably higher than those available from other more intensively sampled periods (3) and comparable to more productive systems, supporting the hypothesis of a late winter, rather than spring, maximum of primary production in the NW Mediterranean.

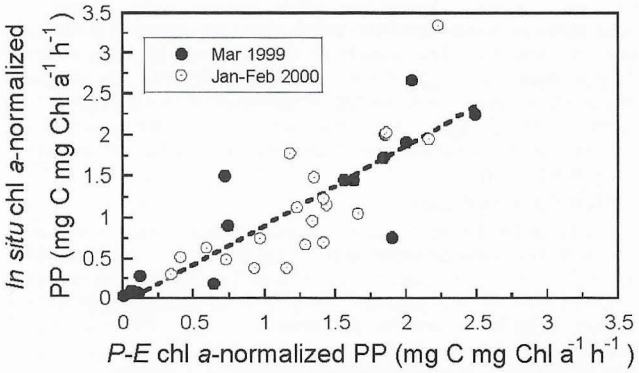

Fig. 1. Relationship between chlorophyll *a*-normalized primary production rates obtained in *in situ* and *P-E* experiments. Linear regression explained in the text.

References

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