Distribution of phytoplankton in the largest productive system of the world ocean: the Pacific equatorial upwelling

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At 165°E in April 1988, in the presence of a relatively low phytoplankton biomass (chlorophyll a = 14.5 mg m^{-2} in the euphotic zone), primary production of the equatorial upwelling was 1.6 gC m^{-2} day^{-1} on the average (8 days of intensive *in situ* measurements, "PROPPAC 2" cruise). This mean value was corroborated by other direct or indirect estimates of the production which were obtained in similar biological and environmental conditions. A crucial question is the following: is the situation described during "PROPPAC 2" representative of the whole Pacific equatorial upwelling? To answer this question a wide study of the distribution of phytoplankton and physical and chemical properties was performed during the "ALIZE II" cruise, stretching all along the equator from 95°W to 165°E (January and February 1991). As previously observed, the equatorial enrichment area covered a belt more than 11,000 km long, with surface nitrate concentration up to 11 μM near the Galapagos, decreasing westward and disappearing beyond 167°E. In spite of this zonal gradient, the amount of surface chlorophyll a (Chl a) did not change significantly from one end of the upwelling to the other, and was very low everywhere: Chl a = 0.22 mg m^{-3} in the east (n = 55 profiles) and Chl a = 0.22 mg m^{-3} in the west (n = 31). These values are similar to those observed at 165°E during the six transects of the "PROPPAC" and "SUBTROPAC" programmes which have crossed the equatorial upwelling since 1988: Chl a = 0.23 mg m^{-3} (n = 57). During the "ALIZE I" cruise in 1965, covering the same area as "ALIZE II", the equatorial upwelling presented nearly the same distribution. The mean surface Chl a was 0.19 mg m^{-3} in the east (n = 17) and 0.19 mg m^{-3} in the west (n = 13). Similar to surface Chl a, the mean Chl a content of the euphotic layer was respectively 13.1 and 13.8 mg m^{-2} in the eastern and western parts of the Pacific in 1991, and 14.3 mg m^{-2} at 165°E. More surprisingly, the size structure of chlorophyll a was also nearly constant from 95°W to 167°E. Chl a>3 μm represented 27% and 28% of total Chl a in the east and west respectively, and Chl a<1 μm = 39% on the average all along the equator. These size distributions are no different from those observed at 165°E in the western equatorial upwelling. Besides, counts of cells by epifluorescence microscopy performed by Jean Blanchot at 48 hydrocasts revealed that the euphotic zone contained on the average 4.2 × 10^{11} cyanobacteria per m^2 and 2.1 × 10^{11} eucaryotic microalgae per m^2, without any bloom anywhere. Schematically, in spite of the typical longitudinal gradients of temperature and nutrients shown by the equatorial transects of both the "ALIZE I" and "ALIZE II" cruises, all the biomass indexes available today clearly indicate that an extreme monotony characterizes the distribution of phytoplankton all along the enrichment area due to the equatorial upwelling, covering 11 million km^2 for mean conditions. Hence, primary production could also be extremely monotonous within the whole system.

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