

## Interval Nutrient Pulses Responses of Compaititive Culture Experiment: *Chaetoceros* Sp. *Thalassiosira allenii* (Takano), *Gomphosphaeria* Sp.

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**Abstract:** As phytoplankton are indisputably a major component of many food webs, estimating their abundance, biomass and growth rate has been an essential component of marine studies. The aim of this study is to establish the effects of different nutrient pulses on the cell size and biovolumes in competetive experiments of marine phytoplakton that was cultured from natural seawater. The growth of natural pytoplankton populations taken from Izmir bay (Aegean sea, Turkey) was observed for 6 different nutrient pulse periods (4, 8, 12, 24, 48 and 96 h) and determined Chl a, mean cell sizes and biovolumes. *Thalassiosira allenii* (Takano), *Chaetoceros* sp. and *Gomphosphaeria* sp. were dominated all pulse periods during the batch culture experiment. Nutrient pulses <2 days will be able to limit the exponential growth rate of community markedly. Although, *T. allenii* and *Chaetoceros* sp. cells enlarged their biovolumes with the extension of pulse period, *Gomphosphaeria* sp. cells was not.

**Key words:** Nutrient pulse, cell size, biovolume, growth, population, phytoplankton

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### INTRODUCTION

Izmir bay is the biggest natural bay in Turkey and one of major estuaries Aegean sea is formed by Aegean sea inserting 60 km in West Anatolia (Cirik *et al.*, 1990). It is naturally divided into three parts: outer, central and inner Izmir bays. Inshore of Izmir bay are subjected to episodic nutrient inputs, mainly by municipal wastewater treatment plant effluents, agricultural and industrial effluents during the all seasons. Its pollution is also reached by atmospheric deposition, shipping, rivers and streams, erosion (Filibeli *et al.*, 1995) National comitee reported that Izmir bay receives 60% of the urban and industrial waste water of Izmir.

Similar to the Eastern Mediterranean sea basin, Aegean sea shows more eutrophic characteristics than in other seas. In estuaries, combined Nitrogen (N) is typically the limiting nutrient for phytoplankton communities (Howarth, 1988; Nixon, 1995). The potential for nutrient limitation in both marine and freshwater ecosystems is usually governed by the concentration of nitrogen and phosphorus (Guildford and Hecky, 2000). In Izmir bay similar features was reported N limitation (Buyukisik and Erbil, 1987; Buyukisik, 1986). However, phosphorus limitation in the Eastern Mediterranean sea was demonstrated by several researchers (Krom *et al.*, 1991; 1992; Berland *et al.*, 1995; Ignatiades *et al.*, 2002). Nutrient availability is a major factor controlling phytoplankton growth (Estrada *et al.*, 2003). Intermittent

inputs of nutrients from various sources also effect the biological processes (Gentilhomme and Rich, 2001) and species diversity.

The importance of nutrient pulses to phytoplankton growth of aquatic systems was reported in the 1980s (Officer and Ryhter, 1980). Although, several papers have demonstrated the effects of pulsed nutrient supply on a single species (Sciandra, 1991; Grover, 1991; Yamamoto and Tsuchiya, 1995), there are few study showing that the dominant phytoplankton species is changeable depending on whether the nutrient supply is pulsed or continuous (Olsen *et al.*, 1989; Grover, 1991). The aim of this study is to establish the effects of different nutrient pulses on the marine phytoplankton that was cultured from natural seawater.

### MATERIALS AND METHODS

The seawater was taken from inner part of Izmir bay (38°26'36"N, 27°06'24"E) and was kept on f/2 (Guillard, 1975) enrichment medium and ‰ 33 salinity. Culture was maintained in an incubator (NUVE) at 11±0.5°C (natural sea water temperature) under continuous light regime and 38.7 µmol m<sup>-2</sup>sec<sup>-1</sup> (PAR) light intensity by using 40 Watt day light flouresans illumination. Algal biomass has been measured for each 4 h period as Chl a by using the Turner Designs 10-AU Field Floumeter (Brand and Guillard, 1981) and added nutrients for previously given each pulse period. The chlorophyll based exponential growth rates were calculated following Guillard (1973):

$$\mu = 1/(t_2 - t_1) \times \log_2 (N_2/N_1)$$

Where:

$\mu$  = Specific growth rate ( $\text{day}^{-1}$ )

$N_1$  = The Chl a measure at the beginning of the exponential growth phase  $\mu\text{g L}^{-1}$

$N_2$  = Chl a measure at the end of the exponential growth phase  $\mu\text{g L}^{-1}$

$t_1$  = The time period during which  $N_1$  was determined

$t_2$  = The time period during which  $N_2$  was determined

The data of exponential growth rates against pulse periods has been fitted to Monod curve. The kinetic parameters was calculated by statistically (Least Square Method). Cell counting were made by single drop technique. Olympus model BH2 research microscope were used for microscopical analysis. The arithmetic mean cell size of each pulse period was used as a standardized biovolume (Monas, 2005).

## RESULTS AND DISCUSSION

In this experiments, the maximum biomass that seawater can carry was estimated as  $5.51 \mu\text{g Chl a L}^{-1}$  for these species at the end of 96 h. The lag phase durations were decreased and maximum Chl a concentrations were increased with increasing pulse periods  $>12$  h (Fig. 1).

The other hand, the exponential growth rates were decreased at the greater pulse periods than 96 h and were limited for shorter pulse periods than 24 h. Relationship between maximum exponential specific growth rates ( $\mu_{\text{exp}}$ ) and pulse periods (T) was found  $\mu_{\text{exp}} = 0.046 \times [T / ((11.3833) + T)]$ , ( $p < 0.05$ ) (Fig. 2). Although, *T. allenii* cells enlarged its diameters and biovolumes with the extension of pulse period ( $p < 0.05$ ), *Gomphosphaeria* sp. and *Chaetoceros* sp. cells was not (Fig. 3). Thus, *T. allenii* cells raise their nutrient supply between two pulse periods. Cell length and biovolume of *T. allenii* and *Chaetoceros* sp. changed depending on pulse periods ( $p < 0.05$ ) and the relationships consistent with Monod equation.

Increasing cell numbers of all specieses associate with pulse periods (Fig. 4). This change of morphological parameter provides to maintain the cells aliveness during the pulse interval.

As pulse intervals becomes frequent, diameter of these diatom cells decreases because of the sufficient nutrient amounts in the medium. On the other hand *Gomphosphaeria* sp. increased only its cell number. When pulse period extended, *Gomphosphaeria* sp. cell abundances exponentially ( $p < 0.05$ ) (Fig. 4).

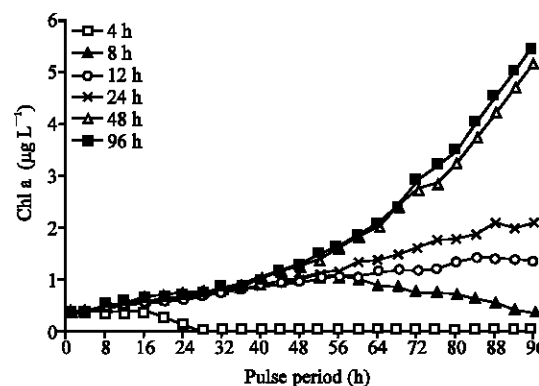


Fig. 1: The growth curve of competitive culture at different nutrient pulse periods

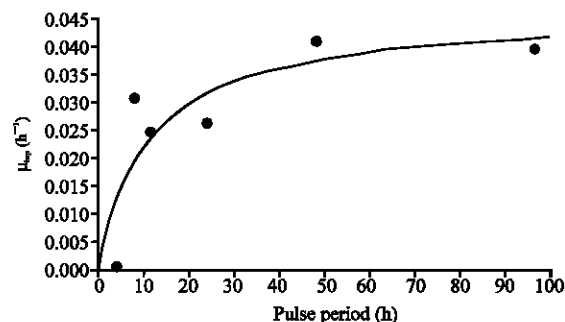


Fig. 2: Relationship between exponential growth rates ( $\mu_{\text{exp}}$ ) of community and pulse periods (T)

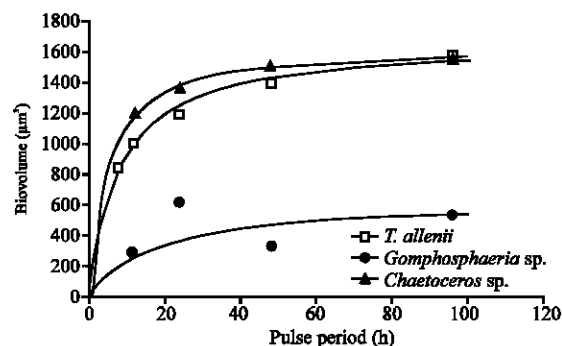


Fig. 3: Relationship pulse periods and biovolume of *Chaetoceros* sp. *T. allenii* and *Gomphosphaeria* sp.

Izmir bay receives approximately 60% of the urban and industrial waste water of Izmir. Generally in temperate ecosystems diatoms are dominant where nutrient and light intensities are high and reproduce relatively fast under these conditions compared to the other groups (Harrison *et al.*, 1993). In Izmir bay as all estuaries, phytoplankton are exposed to rapidly changing conditions that may have a great effects on community structure and function. Many papers demonstrating that

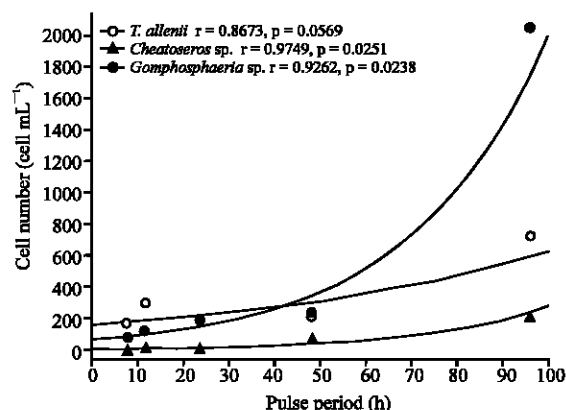


Fig. 4: Cell numbers of *Chaetoceros* sp. *T. allenii* and *Gomphosphaeria* sp. depends on pulse periods

the dominant phytoplankton species is changeable depending on whether the nutrient supply is pulsed or continuous (Olsen *et al.*, 1989; Grover, 1991). Although, phytoplankton responses to limiting nutrients may also involve changes in growth rates as well as shifts in community composition (Pinckney *et al.*, 1999). Theoretical and experimental studies suggest that variability in nutrient supply favors dominance by species with high maximum growth rates (Grover, 1989). In this study, *Thalassiosira allenii* (Takano), *Chaetoceros* sp. and *Gomphosphaeria* sp. were dominated all pulse periods during the batch culture experiment. If capacity to store P (is greater in large cells than large not small, cells may be favored by variability in P supply (Suttle *et al.* 1987)). In this study, algae from a natural community were grown under various nutrient pulse periods in batch cultures, designed so that Si and P would limit algal growth.

Pulses >12 h are typical for domestic waste water discharge and this will be able to increase these species cell volume to saturation value. In the same way, growth rates also increase (Aydin and Buyukisik, 2005). Small cells tend to have both rapid nutrient uptake rates (Smith and Kalff, 1982) and high maximal growth rates (Banse, 1982).

On the otherhands, competition fluctuated nutrient levels results with the dominance of large specieses in the coastal and tide areas (Turpin and Harrison, 1979). Because Large cells may also suffer lower respiratory losses than small cells during periods of depletion between nutrient pulses (Turpin and Harrison, 1980). In the fluctuating conditions, higher nutrient storage capacity of large specieses in intermittent inputs of nutrients becomes better competitor. Because of the small size and low nutrient storage capacity of these species will caused their population out of competition in nutrient pulse periods <2 days.

## CONCLUSION

As a result of this experiments, it can be concluded that nutrient pulses shorter than 2 days will be able to limit the exponential growth rate of phytoplankton community markedly. In estuaries, combined Nitrogen (N) is typically the limiting nutrient for phytoplankton communities (Pinckney *et al.*, 1999). If as a result of human activity, nutrient inputs into rivers increased interval nutrient pulses during discharge events may be a main nutrient source to sustain the growth inhibition of primary producers in Izmir bay.

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