SOME NOTES ON THE VERTICAL MIGRATION PATTERNS OF THE DINOFLAGELLATE *Prorocentrum micans* EHR. IN RELATION TO LIGHT AND NUTRIENT CONDITIONS

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Diurnal vertical migration of the dinoflagellate Prorocentrum micans was investigated under field conditions in Limski kanal (northern Adriatic) in relation to the underwater light field, and the vertical distribution of nutrients. The species exhibited a vertical migration patterns, and accumulated at the 5 meter depth during daylight, "avoiding" the highly lit surface layers. During night, the species migrated to the deeper portions of the water column, where higher concentrations of phosphates (considered limiting) were available. The calculated migration rates ranged from 75 to 200 cm h^{-1}. No apparent relationship with the nitrate concentration and water column stability structure was observed.

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Within the framework of recent phytoplankton investigation, there is a relative paucity of information concerning the diel vertical migration of dinoflagellates, as well as the possible reasons for these migrations. This is primarily due to the difficulties inevitably associated with the field studies. However, field data are useful (if not absolutely necessary) in order to understand the conditions necessary for the "bloom" development of vertically migrating dinoflagellates, as well as providing insights into possible "unfavorable" environmental conditions associated with nonmigrating species. In this study the vertical migration patterns of Prorocentrum micans were studied over a 48 hr period under field conditions in relation to the underwater light field and the vertical distribution of phosphates and nitrates. P. micans is the dominant microphytoplankton species in the northern Adriatic, and under the stratified water column conditions it can reach "bloom" densities.

The samples for measuring biological, and other oceanographic parameters, were taken throughout the water column at four hour intervals over a 48 hr period in September 1980, at a permanent station (14 meters deep), in the northern Adriatic Sea. Phytoplankton cell enumeration used the inverted microscope technique of "Lugol" preserved whole water samples. Nutrient analysis followed Strickland and Parsons (1972). The underwater light field was monitored with an underwater photometer as specified in Precali (1981).

The changes in the vertical distribution of P. micans cell densities (Tab. I) show a periodicity, indicating that the algae is able to undergo diel vertical migrations.

As evidenced by the vertical cell density distribution, in the morning the algae migrated upward in the water column and accumulated

TABLE I Vertical distribution of the P. micans cell density during the period of observation in Limski kanal, northern Adriatic.

	3 Sept.						4 Sept.						5 Sept.	
Hours	08	12	16	20	24	04	08	12	16	20	24	04	08	
Depth	Number of cells x 10^3 l^{-1}													
0 m	1.3	0.6	1.7	1.2	1.5	2.7	1.7	0.6	2.4	1.4	1.2	1.0	2.3	
2 m	1.6	0.9	2.0	1.4	0.4	0.7	1.9	1.6	2.0	1.7	0.2	1.2	3.2	
5 m	**9.4**	**9.4**	3.7	2.0	2.2	2.1	**10.3**	**9.8**	**4.2**	1.9	1.7	1.3	**5.0**	
7 m	1.9	2.8	3.7	1.1	4.8	2.9	0.7	2.9	3.5	2.0	1.3	3.1	1.3	
10 m	0.4	0.6	**5.9**	2.0	3.3	3.2	0.5	3.0	3.9	3.7	**2.4**	1.2	1.0	
13 m	1.7	0.1	4.8	**3.9**	**8.7**	**5.4**	0.4	6.3	1.0	**4.7**	**2.4**	**8.5**	1.6	

at about the 5 meter depth during the period of the high light intensity. At noon, a decrease of the Prorocentrum cell density at the surface and at the 2 meter depth occurred, suggesting that P. micans "avoids" the near surface layers during the period of the highest light intensities (when the light intensity values at the surface ranged between 208 and 216 Wm^{-2}), and accumulated at the 5 meter depth, where an "optimum" light intensity of about 50-75 Wm^{-2} existed. With the lowering of the light intensity at night, the algae migrated to the deeper portions of the water column (10-13 meters).

It is hypothesized that this downward movement is related to the availability of phosphate, the nutrient considered limiting phytoplankton production in the northern Adriatic (Pojed and Kveder, 1977). Higher concentrations of phosphates occurred toward the base of the water column (up to 0.11 μmol l^{-1}, in contrast to the upper layers, where the highest measured phosphate concentrations were about 0.02 μmol l^{-1}). A most important point is, that nitrates, usually found limiting in most of the world ocean, were non-limiting under existing conditions (with average concentration of 1.3 μmol l^{-1} throughout the water column), giving further evidence that downward vertical migration in dinoflagellates is nutrient driven.

In addition, the data establish that P. micans performed these migrations against the vertical density gradient, as evidenced by $\Delta\sigma_t$ values that ranged from 0.6 to 2.6 between the surface and bottom layers. The calculated rates of migration indicated that upward movements were approximately 200 cm h^{-1}, and downward ranged between 75-200 cm h^{-1}.

The ability of P. micans to capitalize upon the most favorable nutrient and light conditions in the water column is probably the reason for its frequent appearance in the relatively shallow northern Adriatic, reaching periodically "bloom" densities.

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Pojed, I. and S. Kveder. 1977. Investigation of nutrient limitation of phytoplankton in the northern Adriatic by enrichment experiments. Thalassia Jugosl. 13:13-24.

Precali, R. 1981. Light and primary production. Univ. Zagreb, Yugoslavia (M.Sc. thesis) : 88 pp.

Strickland, J.D.H. and T.R. Parsons. 1972. A practical handbook of sea water analysis. Fish. Res. Bd Can. Bull. 167:310 pp.