IMPROVEMENTS IN THE DIVERSITY OF SPECIES CAUSED BY A WASTE WATER TREATMENT FACILITY AS EVIDENCED BY DISCRIMINATION OF PHYTOPLANKTON POPULATIONS USING DISCRIMINATE ANALYSIS

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Abstract
In this study, the variations in the diversity of phytoplanktonic species (Shannon-Wiener) were investigated vertically and quantitatively in three stations located in the inner, middle and outer bay of Izmir over the years 1998 to 2001. Statistically significant positive increases in the diversity of species have occurred after the commencement of the wastewater treatment activities.
Keywords : Phytoplankton, Pollution, Aegean Sea.

Introduction
The Izmir Bay has been under constant pressure of ever-increasing household and industrial contamination since 1970's. Having been put in operation in 2000, the Cigli Wastewater Treatment Facility, with its nitrogen and phosphorus units, managed to achieve an apparent upgrading in the Izmir Bay within a year.This study aims at identifying phytoplankton species, their quantitative distributions and the variances in the diversity of species along a time vector of 1998 to 2001.

Materials and Methods
This study seasonally examines the population structure of the group in the Izmir Bay at 3 predetermined stations. The samples were taken from depths of 0.5 m, 5.0 m, 10.0 m and 15.0 m (Figure 1).

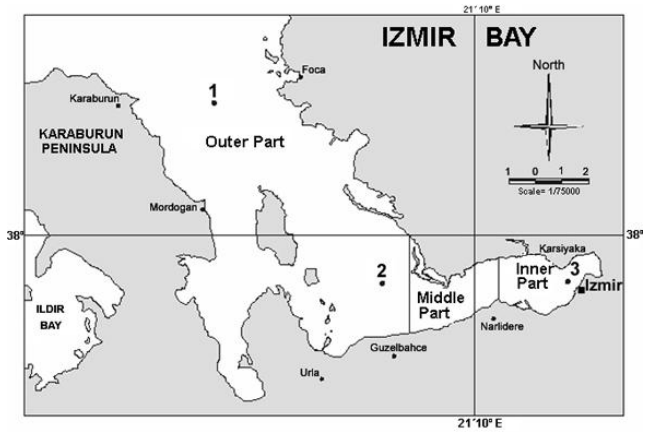

Fig. 1. Sampling stations

In order to determine the diversity of phytoplankton, the Shannon-Wiener diversity indexes were calculated. Variations within a year and between years were first tested using the Student's t-test. If any such variations were detected by the Student's t-test, a discriminate analysis was carried out to obtain discriminant functions at micro-algae class levels for different years.

Results and Discussion
Koray [1], in his studies on the Izmir Bay, reports that in case the selected organism group is phytoplankton, using the diversity index value to indicate a level in the eutrophication process may lead to erroneous results and that such indexes may only be used for the purposes of comparison in relation to time and region. Using diatoms as an indicator of eutrophication level will produce more accurate results than if dinoflagellate or total phytoplankton is used. Similarly in our study, variations in the diversity of diatom species were found to be more consistent than those in the diversity of dinoflagellate species. While the maximum value of the diatom population was 3.445 bits in 1998, it went up to 3.734 bits just after the treatment unit had been put in operation in 2000 and further to 3.782 bits in 2001. The results of the Student's t-test conducted to clarify the annual differences at the sampling stations. According to these results, the dinoflagellate populations did not display any annual differences, whereas the diatoms clearly showed a difference in their species composition from 1998 to 2000. This difference continued in 2001.

The results of the Student's t-test run following the $\log_{10}$transformation of the cell concentrations integrated into cm^2 surface along the vertical water column seem to exhibit a successful distinction. However, they were, in any case, tested by discriminate analyses as well.
Diatom populations appear to differ from each other on an annual basis at a level of p=0.00353. Figure 2 summarises the distribution diagram of these two components. As can be seen on the diagram, an increasingly evident distinction exists, moving from 1998 towards 2001 (Figure 2).

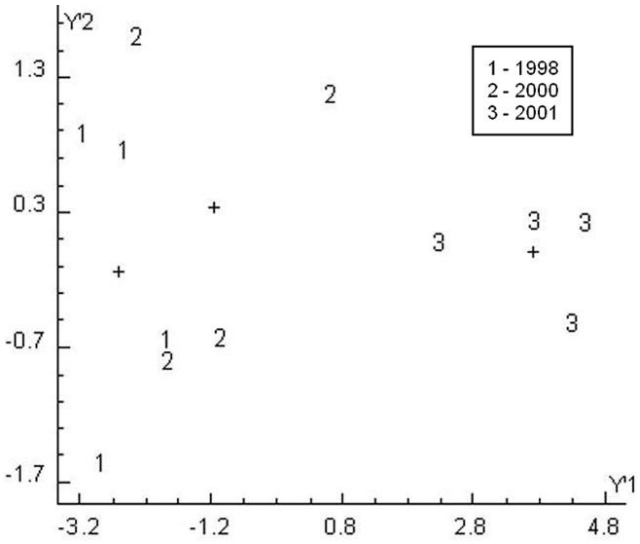

Fig. 2. Distribution diagram of the first two components

Having been put in operation, the Wastewater Treatment Facility of the Izmir Bay enhanced a positive increase in the diversity of species in phytoplankton populations especially in diatom populations.
In this study, the micro-plankton data pertaining to pre- and post-treatment facility periods in the Izmir Bay were, for the first time, successfully discriminated from each other by using discriminate analyses. The use of discriminate analyses to determine eutrophication is a relatively new area of research. By making use of discriminate analysis, Tsirtsis and Karydis [2] tried to determine the eutrophication of the Aegean Sea.This proves that the ecologic balance limits in the bay has not yet been surpassed. Therefore, the Izmir Bay may, with a high probability, re-establish itself in the first decade of the 21^{st} century.

References
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2 - Tsirtsis, G. and Karydis, M. (1999).Application of discriminant analysis for water quality assessment in the Aegean. *Marine Pollution Bulletin*, 24: 238-243.