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HYDROGRAPHIC INDICATIONS TO UNDERSTAND THE ABSENCE OF *POSIDONIA OCEANICA* IN THE LEVANT SEA (EASTERN MEDITERRANEAN)

Abstract

In the present study the three hydrological factors turbidity, salinity and temperature which may be possible reasons of the absence of Posidonia oceanica *in Levant Sea were investigated. The temperature has come out as the most remarkable factor between the two sides of the* Posidonia oceanica *boundary in the northeastern Mediterranean Sea. The observations suggested that the 28.4 ºC is a limit for the growth of the species.*

Key-words: Posidonia oceanica*, Levant Sea, temperature, salinity, turbidity*

Introduction

As an endemic seagrass species to the Mediterranean *Posidonia oceanica* (L.) Delile can be found in the littoral zones of the Mediterranean and Marmara Seas (Green and Short, 2003). There is little information about the distribution of *P. oceanica* in the eastern Mediterranean.

Along the eastern Mediterranean coast of Turkey there are only two records of the species, which are located in the bays of Iskenderun (Tutin, *et al*. 1964) and Mersin-Akkuyu (Cirik, 1991). However, recent field studies revealed that there are no meadows present in these given areas and the meadows end with a sharp border in the eastern Levant Sea, at 36º 09' N, 33º 26' E (Gucu and Gucu, 2002).

In this study, temperature which controls the geographical distribution of the meadows, and light penetration which determines the limits of its vertical distribution (Borum *et al.*, 2004), were compared to evaluate their significance in the distribution of the plant. The salinity, which is apparently an important factor limiting *P. oceanica* growth (Fernández-Torquemada and Sánchez-Lizaso, 2005) was also included in the evaluations.

Material and methods

The southern coast of Turkey, between Kizilliman/Mersin and Cevlik/Hatay were surveyed in the study. The 50 meter depth contour was taken as the lower depth limit for all the measurements. The eastern most boundary of the *P. oceanica* at 36º 09' N, 33º 26' E, which fell within the study area provided an opportunity for comparative measurements. The surveys took place inside the boundary, to the west, where there were healthy meadows, and outside this boundary, to the east, where meadows were absent.

Turbidity and Salinity measurements:

Turbidity was measured and quantified using a Secchi disk between 2000 and 2005 at 35 stations to the east and to the west of the *P. oceanica* boundary.

PAR/Irradiance profiles were measured at 69 stations for the calculation of

light penetration coefficients in the study area, between 2004 and 2005. Salinity profiles during the warmest periods (August) of the years 1990 and 1991 were used for the comparisons of salinity ranges on both sides of the boundary.

Temperature measurements:

Two types of temperature measurements were made; 1) warmest seasonal water column temperature of the previous years (1990 - 1991), and 2), continuous water temperature in the warmest period of 2005 at several fixed depths.

Temperature profiles were measured at 219 stations and using these profiles a general temperature limit for the growth of *P. oceanica* in the Levant Sea was estimated.

For continuous water temperature recordings 10 HOBO Pendent Temperature Data Loggers were deployed during the warmest period of the year 2005, from 12th of August to 11th of September. They were set to record seawater temperatures with 10 min intervals, at 5 different stations, at 2 different depths; St-1 was set as the reference station on a meadow located at 8.3 nm west of the *P. oceanica* boundary; St-2 was set on the meadow forming the eastern boundary of *P. oceanica*; the remaining three stations were all set to the east of this boundary with St-3 at 7.2 nm; St-4 at 46.5 nm; and St-5 at 121.1 nm.

The data loggers enabled to investigate a more precise temperature limit which may be affecting the growth of *P. oceanica*. The temperature recordings of St-1 were taken at 10 min intervals and were averaged over a day (00:00-24:00). The maximum daily average temperature measured at this reference station, with a representative healthy meadow, was set as the Maximum Tolerable Temperature Limit (MTTL). This limit provided the maximum temperature for *P. oceanica* growth in the Levant basin. For further analysis, numbers of warm pulses, which had higher temperatures than the MTTL, along with their duration, and frequency, were estimated for the rest of the stations.

Results

Turbidity and Salinity measurements:

The Secchi disk depths inside the *P. oceanica* covered zone ranged between 8 - 40 meters, which were wider than the depth ranges observed outside the zone. The Secchi depths measured east of the boundary were between 12 and 31 meters.

The depths of 10% surface irradiance, which was defined as the lower limit of *P. oceanica* growth (Duarte, 1991) were calculated using PAR/Irradiance profiles, at 69 stations. The results were mapped in Fig. 1. The areas near representing high light attenuation sites were found outside the *P. oceanica* boundary. But there is one area with low light attenuation site found outside the boundary where hypothetically light may be adequate for *P. oceanica* growth (e.g., north of the Iskenderun Bay).

The vertical salinity profiles in the warmest season of the years 1990 and 1991 inside and outside of the *P. oceanica* zone showed different ranges. The salinity profile measured outside, to the east of the *P. oceanica* boundary, during the warmest month of the year had a relatively narrow range, which was between 39.1‰ and 39.7 ‰. The salinity profile measured inside, to the west of the boundary, was between 38.7‰ and 39.9 ‰. The salinity range outside the boundary fell within the range inside the boundary.

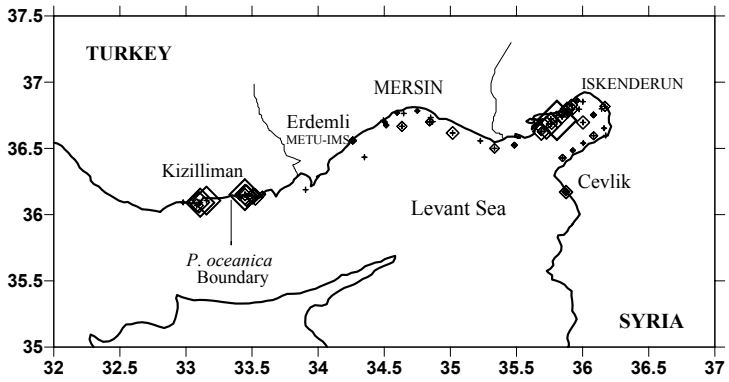


Fig. 1 - Map of Levant Sea where light penetration is adequate for growth of *P. oceanica* (squares indicate sutable areas)

Temperature measurements:

The vertical temperature profiles in the warmest season of the years 1990 and 1991 indicated distinctive ranges between the eastern and western sides of the border. The mean temperature of the eastern side was higher than the mean temperature of the western side in 1990 and 1991. Furthermore, the range of the eastern side for the water column up to 20 meter depth was narrower and closer to the maximum temperatures of the western range (27-29 ºC and 23-28 ºC, respectively). Considering these profiles the separation point of temperature ranges of western and eastern sides is found around 27.5ºC. Therefore, this temperature is presumed as the limit for the growth of the *P. oceanica* in the Levant Sea.

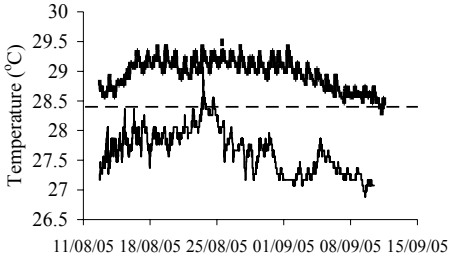


Fig. 2 - Continuous temperature recording data in 2005 (bold line: station in Cevlik, dashed line: MTTL and line: station in Kizilliman)

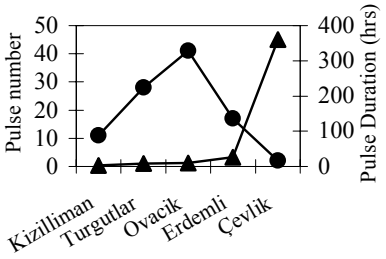


Fig. 3 - Pulse frequency and duration (● total number of pulses, ▲ mean pulse duration).

The continuous temperature measurements at fixed depths during the warmest season of 2005 represented an increasing trend from the west to the east (Fig. 2). From the continuous temperature recordings at the westernmost station, MTTL is calculated as 28.4 ºC. The total exposure time to warm pulses higher than MTTL showed same increasing trend from the west to the east.

Beside the mean pulse duration also the number of pulses higher than MTTL was found important for the growth and survival of the species on the western side of the border. Going eastwards the number of pulses increased in the first three stations paralleling the mean pulse duration, but it decreased sharply in the last two stations; while the mean pulse duration continued to increase (Fig. 3). This increase in the easternmost station reached 99 – 100 % of the entire recording period at each depth.

Discussion

The importance of temperature on the growth of *P. oceanica* in the western parts of the Mediterranean Sea has been highlighted by several studies (Zupo *et al*., 1997; Mayot *et al*., 2005). However, in the present investigation of the Levant Sea (Eastern Mediterranean), which encompasses the easternmost boundary of the species, temperature did not suggest such clear cut significance.

Nevertheless, the vertical temperature profiles inside and outside the boundary were distinctively separate and 27.5 °C seemed to be the highest temperature limit the meadows could survive. This analysis was done in the warmest month, August, and continuous data was necessary to further investigate the temperature limitations.

Therefore, continuous data loggers were deployed and the maximum daily average temperature measured at the reference station, representing a healthy meadow, was recorded as 28.4 °C. This temperature was set as the Maximum Tolerable Temperature Limit (MTTL) and it was assumed to be the maximum temperature for *P. oceanica* growth in the Levant basin (Fig. 2). For further analysis, numbers of warm pulses, which had higher temperatures than the MTTL, along with their duration, and frequency were estimated for the rest of the stations and the data suggested that the eastern side of the boundary had the highest exposure and the highest temperatures (Fig. 3).

Apart from temperature, the two other hydrological factors, turbidity (Fig. 1) and salinity profiles, revealed no differences between the two sides of the border. The matching profiles of these parameters on both sides may suggest that salinity and light availability were not the major factors hindering the growth of the species.

On the other hand, care should be taken when interpreting these results, because in this study each factor was evaluated individually for its separate effect, however their possible combined effects were disregarded. In literature, there are short term laboratory studies which investigate environmental factors and emphasize both antagonistic and synergistic impacts among factors, as well as projecting collective impacts on the growth of the species.

In conclusion, this preliminary study may provide the baseline information for future long-term studies from which models predicting the integrated effects of hydrological factors on seagrass distribution in the Levant Sea can be developed.

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