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RESEARCH ARTICLE

A Preliminary Survey on Settlement and Recruitment Patterns of Mediterranean Mussel *(Mytilus galloprovincialis)* in Dardanelles, Turkey

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Summary

In this study, the settlement and growth of the Mediterranean mussel, *Mytilus galloprovincialis*, was monitored from September 2002 to February 2004 in Kilya Bay, Dardanelles. Water temperature ranged between 8.3-25°C, the average chlorophyll-a was 0.70 μgL^{-1}. The mussel abundances on the ropes in Kilya Bay, indicated the highest density of mussels in November 2002 (14184 ind. 0.25 m^{-1}) and March 2003 (15485 ind. 0.25 m^{-1}) and lowest in February 2004 (3713 ind. 0.25 m^{-1}). Settlement was significantly different between samplings ($P<0.05$). At the end of 18 months, 91.36% of spat on rope was smaller than 2.8 mm. The highest percentage of length class was 1.5-2.79 mm with 40.26%. Even though mussel size reached a maximum of 55.7 mm, their density was very low, 0.20%.

Keywords: *Mediterranean mussel, Mytilus galloprovincialis, Spat, Settlement, Dardanelles*

Akdeniz Midyesinin *(Mytilus galloprovincialis)* Çanakkale Boğazı'nda Tutunma ve Stoğa Katılma Durumu Üzerine Bir Ön Çalışma

Özet

Çanakkale Boğazı'na bağlı Kilya Koyu'nda yapılan bu çalışmada, Eylül 2002 - Şubat 2004 tarihleri arasında Akdeniz midyelerinin (Mytilus galloprovincialis) yerleşimi ve büyümeleri takip edilmiştir. Su sıcaklıkları 8,3-25°C arasında değişirken, ortalama klorofil-a 0,70 μgL^{-1} olarak bulunmuştur. Kilya Koyu'ndaki iplerde en yüksek midye yoğunluğu Kasım 2002'de (14184 birey 0,25 m^{-1}) ve Mart 2003'de (15485 birey 0,25 m^{-1}) elde edilirken, en düşük miktar Şubat 2004'te (3713 birey 0,25 m^{-1}) tespit edilmiştir. Yerleşimde örneklemeler arasında önemli derecede farklılıklar bulunmuştur ($P<0,05$). 18 ayın sonunda, iplerde yerleşmiş olan spatların 91,36%'sının 2,8 mm'den daha küçük olduğu görülmüştür. Boy sınıfları arasında en yüksek oran 40,26% ile 1,5-2,79 mm boy aralığında belirlenmiştir. Midyeler maksimum 55,7 mm boya ulaşmasına rağmen, bu boy grubunda yoğunluğun çok düşük olduğu görülmüştür (0,20%).

Anahtar sözcükler: *Akdeniz midyesi, Mytilus galloprovincialis, Spat, Yerleşim, Çanakkale Boğazı*

INTRODUCTION

Marine mussels, perhaps of all the species of shellfish which are cultivated around the world, most readily demonstrate these characteristics that go to make up the 'ideal candidate for aquaculture'. The natural availability of seed sources without the need of hatchery production has been a significant positive factor in the development of mussel farming [1,2].

Mussel culture has a short history in Turkey. The Mediterranean mussel, *Mytilus galloprovincialis,* is an abundant species in the Marmara Sea in Dardanelles and there is only one mussel farm (longline). The long-line culture depends upon mussel seed collection from artificial collectors and intertidal zone.

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Colonization on natural and artificial substrates by mussels and oysters may occur by settlement of competent pediveliger larvae and/or by settlement of drifting postlarvae [3-7]. This settlement pattern could have practical importance for the mussel grower, because its knowledge in a given area may improve the chance of collecting mussel seed from nature [8].

The purpose of this study was to investigate the seasonal settlement differences and growth of mussels, *M. galloprovincialis,* on suspended ropes between September 2002 and February 2004 in Kilya Bay, Dardanelles.

MATERIAL and METHODS

The study was carried out between September 2002 and February 2004 in an area of the north-western of Turkey, Kilya Bay in Dardanelles (40° 12.01'N, 26° 21.30'E) *(Fig. 1).*

Surface water samples were collected monthly intervals from September 2002 to February 2004. Water temperature was measured to 0.1°C accuracy. Salinity was estimated by Mohr Knudsen method [9]. Seston and chlorophyll-a were determined by filtering over filter paper of 0.45 µm porosity [9].

Plaited rope collectors were homemade, prepared from old fishing nets for collecting of mussel spats. Old fishing nets were cut 3 equal lines. Then these lines were plaited like a pigtail to create a rope (4 cm in diameter) which was used as a mussel spat collector. Plastic pegs were used at the end of ropes to prevent mussel losses. Twenty four collectors in triplicate (8x3=24) were hung from a raft every 0.5 m in September, 2002. One month after placement (October 2002), an initial sampling was carried out to evaluate newly settled mussels. Following samplings took place in November 2002, December 2002, January 2003, March 2003, June 2003, October 2003 and February 2004 to observe the settlement and development of mussels on the ropes. Each sampling period, collectors (3 ropes) were taken out to cut 3 cm segments from three parts (upper, middle and down part of rope) of each rope at 0.35-0.45 m depth. Other parts of the ropes were not used to continue experiments.

Mussels were collected from the sampled parts of rope, washed with water under a sieve collecting all mussels smaller than 1 mm. Mussels were sorted into thirteen length classes with the help of a series of sieves with the following mesh size: <0.47, 0.48-0.99, 1.0-1.49, 1.5-2.79, 2.8-4.99, 5.9-9.99, 10-19.9, 20-29.9, 30-39.9, 40-49.9, 50-59.9 mm. Mussel yields were determined by count and measurement. Based on the sample counts the total number of individuals per rope was calculated. Mussels under 5 mm in length was measured under a microscope and the others with a caliper.

Differences in mean numbers of settled mussels were analyzed by using one-way ANOVA and Tukey's test as a post-hoc test. The length frequency distribution for each sampling was tested using χ^2 (Chi square) statistics. All data was carried out using the statistical package SPSS 11.0. Differences were considered significant when $P<0.05$.

RESULTS

Chlorophyll-a, seston, salinity, and temperature of sea water were recorded in Kilya Bay between

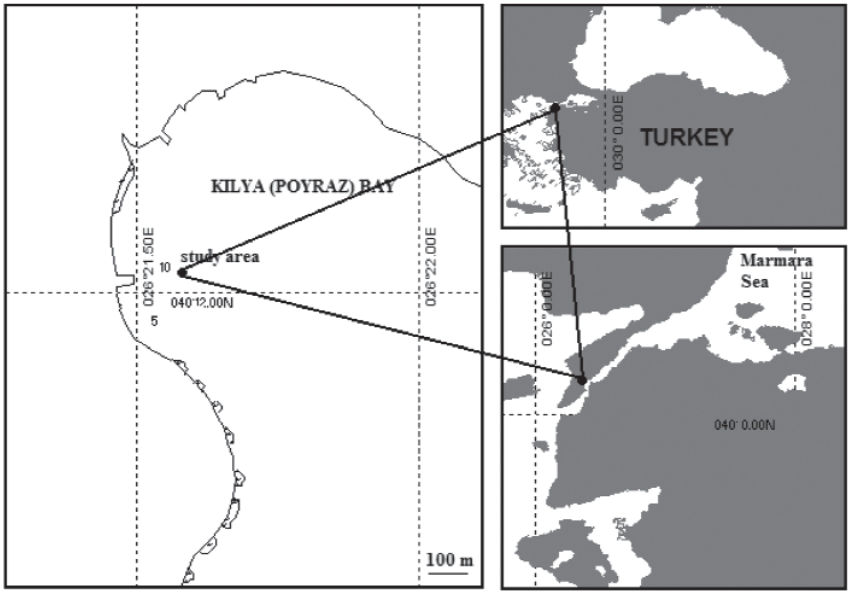

Fig 1. Map of research area in Dardanelles, North-Western Turkey

Şekil 1. Türkiye'nin Kuzeybatısında bulunan Çanakkale Boğazı'ndaki araştırma alanının haritası

Table 1. *Mussel numbers on rope during the experiment*
Tablo 1. *Deneme süresince iplerdeki midye sayıları*

Months	Total Number of Spat (ind. 0.25m^{-1})	Observed Maximum Length (mm)
October 2002	9765±1232	1.54
November 2002	14184±2580	2.02
December 2002	6414±1045	2.09
January 2003	7585±1120	5.9
March 2003	15485±2665	12.5
June 2003	10220±1323	30.4
October 2003	4245±965	48.9
February 2004	3713±528	55.7

September 2002 and February 2004. Minimum water temperature was 8.3°C in March 2003; maximum temperature was 25°C in August and September 2003. Salinity levels in the seawater ranged between 19-25.5 ‰ during the study *(Fig. 2)*.

Seston was minimum (6.2 mgL^{-1}) in December 2002 and maximum (17.5 mgL^{-1}) in April 2003 *(Fig. 3)*. The mean value of chlorophyll-a was 0.70 ±0.1 µgL^{-1} *(Fig. 4)*.

The mussel abundances on the ropes in Kilya Bay, indicated higher density of mussels in November 2002 and March 2003 (14184 and 15485 ind. 0.25 m^{-1}) and

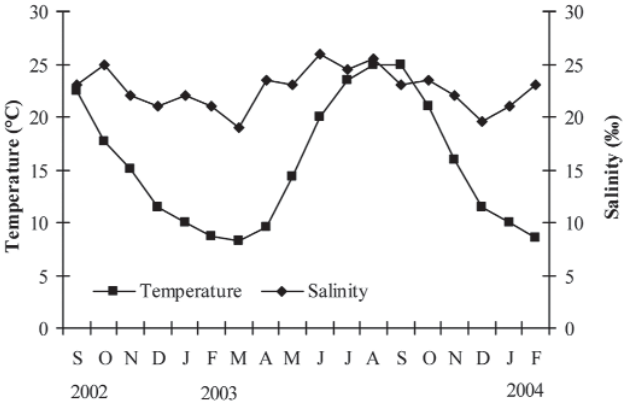

Fig 2. Temperature and salinity levels at the study area

Şekil 2. Çalışma alanında sıcaklık ve tuzluluk seviyeleri

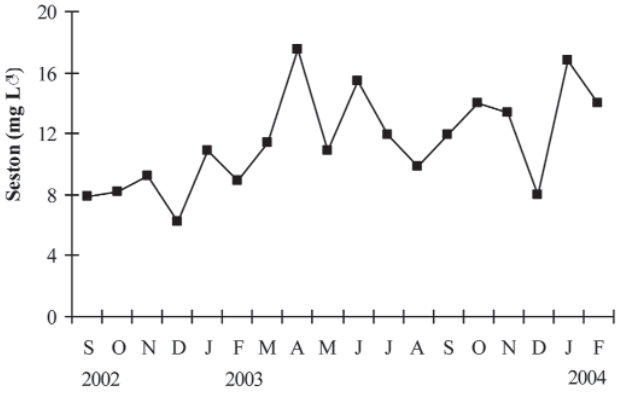

Fig 3. Seston changes in Kilya Bay

Şekil 3. Kilya Koyu'ndaki seston değişimleri

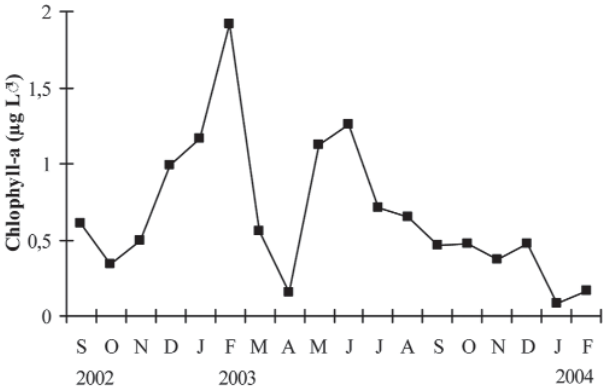

Fig 4. Chlorophyll-a values in Kilya Bay

Şekil 4. Kilya Koyu'ndaki klorofil-a değerleri

decreasing to February 2004 *(Table 1).* Settlement was significantly different between samplings (P<0.05).

Length frequencies of mussel seeds are shown in *Fig. 5.* With regard to the <0.47 mm length classes, first two months, October and November, showed significantly higher density (9765±1232ind. 0.25 m^{-1} and 14184±2580 ind. 0.25 m^{-1}) than other months. At the last sampling period, although the frequencies of the smallest (<0.47 mm) and the largest (50-59.9 mm) size classes showed 1.69% and 0.26%, the highest percentage (40.26%) was observed with the size class of 1.5-2.79 mm. Only 10 mussels were between 50-59.9 mm.

collector types and environmental conditions (water temperature, food availability, current, etc.) [11]. Based on the percentage of newly settled mussels smaller than 0.47 mm occurred mainly in October (65.48%), and then decreased to 27.49% in December. On collectors situated in Kilya. The following months were not up 10%. Generally attachment of new spat decreased after January 2003. It can be three reasons for decreasing of newly settled mussels. Either there were not enough larvae for settling, sweeping of larvae by water movements or larvae did not prefer to settle on the ropes covered with mussels. Peteiro et al.[12] remarked sub-

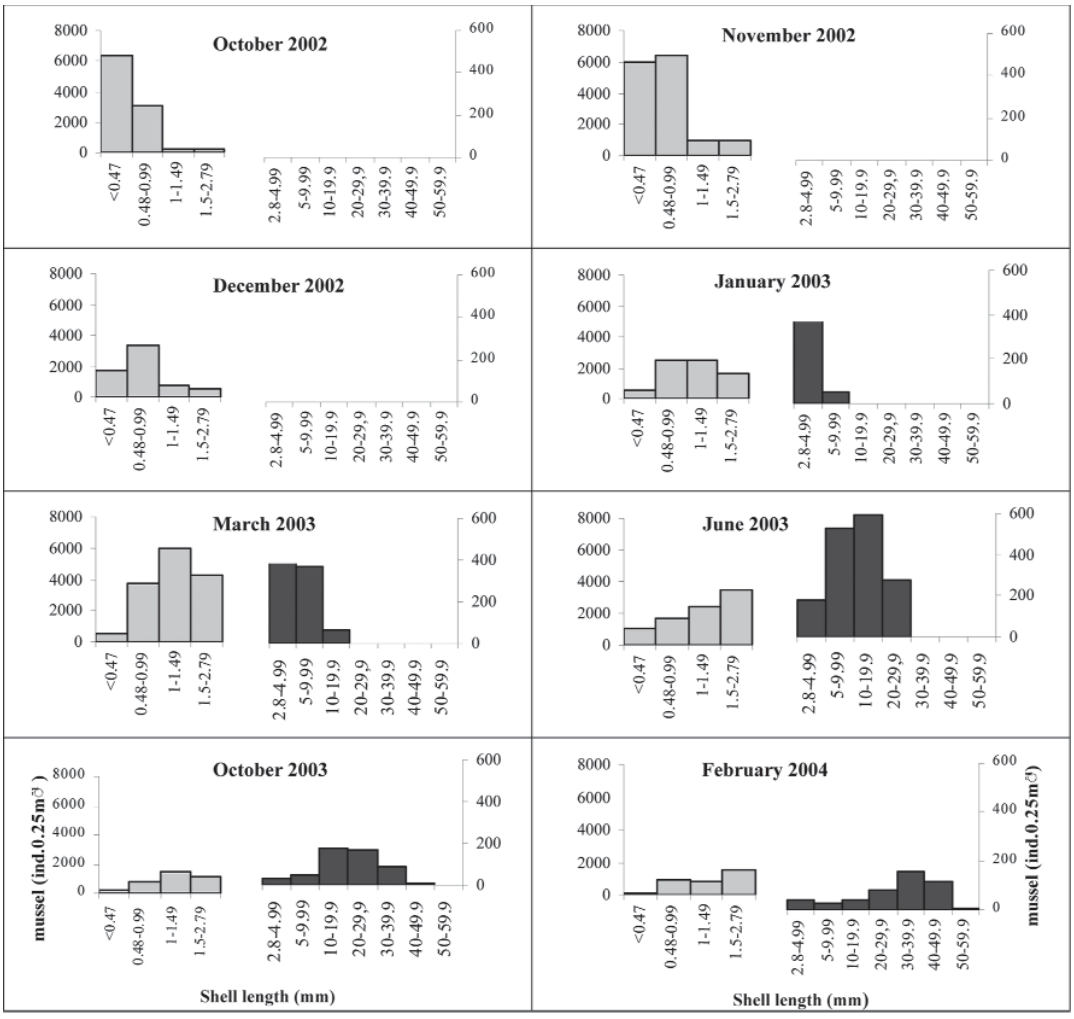

Fig 5. *The number of settled mussels on the ropes during the study*
Şekil 5. *Çalışma süresince iplerdeki yerleşmiş midyelerin sayısı*

DISCUSSION

Spat collecting plays an important part in the continuity of suspended mussel cultivation [10]. Efficiency of spat collection depends on density of pediveliger, merged time of collector ropes and advised minimum submersion time of 41 and 46 days for mussel spat settlement. However we observed employed ropes were not favourable for larval settlement for a long time.

Although Dardanelles has mainly rough weather

during winter, the highest density of mussels on March rope can explain with these ropes were not affected by wave and current and kept mainly all attached mussels on its body as extraordinary.

Adirect relationship between spawning periods and subsequent settlement of post larval juveniles has been shown for several mussel species [13,14]. But there is not any published data for reproductive and spawning period of *M. galloprovincialis* in Dardanelles to compare the settlement results.

The total number of spat was 9767 and 14184 ind. 0.25 m^{-1} in October and November. Yıldız [15] and Yıldız et al. [16] reported better settlement in winter months than summer months in Dardanelles. Prior studies [15-17] demonstrated that higher mussel (newly settled) settlement densities were obtained on ropes between February and March (53641 ind. 0.25 m^{-1}) in Kilya Bay. Karayücel et al. [5] observed 19760 spat m^{-1} at 3 m depth in May and 15187 spat m^{-1} in June in Black Sea. Alfaro and Jeffs [14] recorded that the higher mussel settlement (2028 spat 0.5 m^{-1}) in August and decreased through December (61 spat 0.5 m^{-1}) in Northern New Zealand. Okumus [18] suggested that the seed density is of over 1200 individuals m^{-1} is necessary to produce high yields of cultured mussels. Apparently, seed density of our ropes is very high and need thinning.

Growth of settled spat on ropes can be affected by heavy spat density as well as environmental conditions. Yıldız and Lök [19] reported that 10 mm in shell length of mussel spat reached 29.37 mm in net bags and 48.18 mm on rope without net in one year in Kilya Bay. However settled mussels in this study did not show similar growth pattern. Karayücel and Karayücel [20] indicated that shell and tissue growth in mussels is mainly affected by environmental factors although there is also slight genetic effect. The most important hydrological parameters for bivalve growth are water temperature and food availability [21]. Among the hydrological parameters, chlorophyll-a value was observed lesser amount (0.70±0.1 µg L^{-1}) than [19] reported for the same place (2.14±1.1 µgL^{-1}), while other parameters were acceptable for mussel growth. It seems to be chlorophyll value is not enough for mussel growth. The other important factor is heavy density of mussels on ropes. The abundances of attached mussels on ropes are also affecting their food intake and giving slow growth. For this reason, thinning out is necessary to obtain better growth in Kilya Bay. Extremely high densities may limit growth due to overcrowding and competition for available food [5].

The results of this study indicate that Kilya Bay have a high potential for the settlement of mussel seed. But further studies such as spawning period, different collector types, hydrological conditions (wave, current, plankton community, etc.) are necessary to understand Kilya Bay for successful mussel culture.

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