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Field Report

Impact of Planting Season on Growth and Survival of the Carpet Shell Clam (*Tapes decussatus*, Linnaeus 1758)

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Abstract

The growth and survival of juvenile carpet shell clams, *Tapes decussatus*, planted in autumn (October-April) and spring (April-October) in Sufa Lagoon near Izmir, Turkey, were compared. Clams of 20.39±0.24 mm were sown in October (Group I) and clams of 20.43±0.23 mm were sown in April (Group II). Seedlings were sown in plastic boxes at a density of 160 clam/m^2. Temperature ranged 8-32ºC, salinity 38-43‰, and chlorophyll *a* 4.04-30.93 µg/l. In six months, the clams in Group I reached 23.16 mm while the clams in Group II reached 24.02 mm ($p<0.05$). Survival was 80% in Group I and 77.5% in Group II ($p>0.05$).

Introduction

The carpet shell clam (*Tapes decussatus* L.; also known as *Venerupis* and *Ruditapes decussatus*) is a common infaunal bivalve native to Europe. It occurs along the Atlantic coast from the British Isles to Morocco and Senegal and into the Mediterranean (Tebble, 1960). The species is also distributed along the coasts of the Aegean and Marmara Seas. The suitability of many European coastal lagoons, especially in France, England, Portugal, Spain, and Italy (Vincenzi, et al., 2006), allowed the development of fisheries and mollusk farming. Carpet shell clams are eurythermal, euryhaline, and highly resistant to desiccation, making them suitable for aquaculture production (Christophersen, 1994). The carpet shell clam has been exploited in southern Europe (Italy, Spain, Portugal, and France) where consumption is high. The price of *T. decussatus* has remained high and there is good market demand for them (Breber, 1985).

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In the past, *T. decussatus* were collected traditionally from coastal areas of the Mediterranean. This kind of harvesting, however, ceased to satisfy the market and culture was recently expanded into Italian lagoons (Sorokin and Giovanardi, 1995). In 2003, about 19,700 tons of clams (mostly *Venus gallina* and *T. decussatus*) were harvested between September and May in Turkey (SIS, 2003). Izmir Bay is the most important area for collecting of *T. decussatus*.

Growth rate is an important consideration when selecting a site and season for commercial production of clams. Faster growth results in a higher and more rapid return of investment with less risk of loss. The purpose of the present study was to investigate the effects of planting season and environmental factors on the growth and survival rate of *T. decussatus* in Sufa Lagoon on the Aegean coast of Turkey.

Materials and Methods

The study was conducted in Sufa Lagoon, 35 km from Izmir, Turkey (38º31'10" N, 26º49'50" E). Carpet shell clam spat from Cakalburnu Lagoon in Izmir Bay were provided by fishermen. Group I was stocked in October 2001 and measured monthly until April, while Group II was stocked in April 2002 and measured monthly until October. Initial stocking density was 160 clams per m^2 for both groups with three replicates. Clams were stocked in commercial plastic boxes and placed at the sea bottom at a depth of 40-60 cm. The upper side of the box was covered with a 12 mm mesh net to prevent predation. The corners of the boxes were attached to stakes.

The initial mean shell length (anterior-posterior axis) and weight were 20.39±0.24 mm and 1.52±0.05 g for Group I and 20.43±0.23 mm and 1.66±0.06 g for Group II. Shell length, width, and height were measured with a caliper to an accuracy of 0.1 mm; weight was measured on a scale to 0.01 g.

Specific growth rate (SGR) was determined according to the following equation (Malouf and Bricelj, 1989): $SGR = (\ln Wt_2 - \ln Wt_1)/(t_2 - t_1)$ where Wt_1 = initial mean weight, Wt_2 = final weight, and t_2-t_1 = elapsed time. A similar equation was used to determine growth in length. Survival (S) was calculated as S (in %) = $100(N_t/N_0)$ where N_0 = initial number of clams and Nt = final number of clams.

Water temperature was measured with a thermometer to 0.1ºC and salinity with a hand refractometer to 1‰. Chlorophyll *a* was extracted with 90% acetone and assayed according to Strickland and Parsons (1972). To determine seston, a GF/C filter was dried and weighed. A water sample was filtered through the filter, then dried for 24 h at 60ºC until a constant weight was obtained. The filter was weighed again to calculate the total particulate material.

Student's *t* test was used to check differences in growth and survival between and within the groups. Percent survival was determined after arcsin transformation of data. Differences in environmental factors were tested by Student's *t* test. Statistical analyses of data were performed with the SPSS 11.0 Software Package.

Results

Temperature ranged 8-32ºC and salinity 38-43‰ (Fig. 1). Chlorophyll *a* ranged 4.04-30.93 µg/l with a mean of 15.66±3.71 µg/l in Group I and 15.57±3.92 µg/l in Group II (Fig. 2). Mean seston was 94.14±28.83 mg/l in Group I and 76.14±22.53 mg/l in Group II. At the end of the experiment, the shell length, width, and height of Group I reached 23.16, 16.87, and 10.1 mm, respectively, significantly differing ($p<0.05$) from Group II where they reached 24.02, 18.21, and 10.92 mm. Total weight (3.08 g in Group I; 3.68 g in Group II) also significantly differed between groups (Fig. 3). SGR in length and weight were 0.021 and 0.117 for Group I and 0.026 and 0.132 for Group II (Fig. 4). At the end of the study, survival was 80% for Group I and 77.5% for Group II (Fig. 5) with no significant difference between groups ($p>0.05$).

Discussion

Clam growth is dependent on temperature and food availability (Laing et al., 1987), factors that vary from location to location (Anderson et al., 1982). Since the study site was inside the lagoon near the lagoon

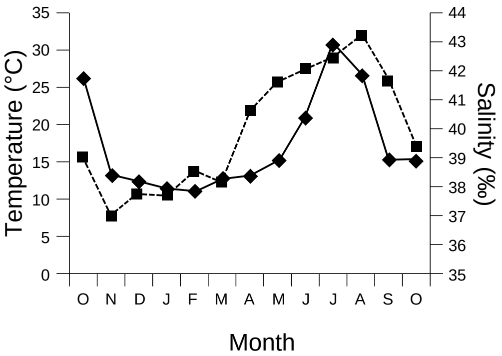

Fig. 1. Mean monthly temperature (■) and salinity (◆).

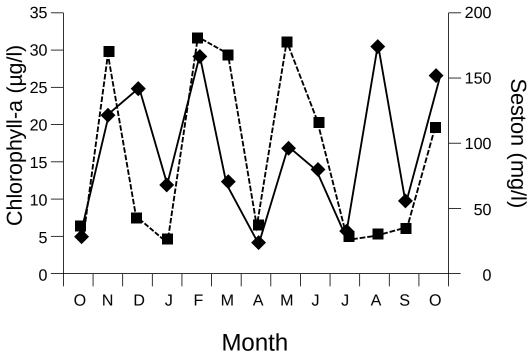

Fig. 2. Mean chlorophyll *a* (◆) and seston (■).

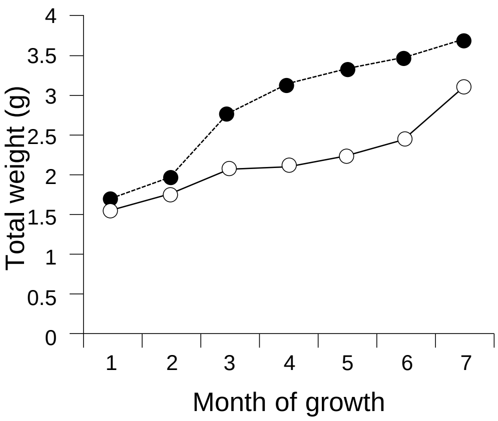

Fig. 3. Increase in weight of clams stocked in fall (Group I; ○) and clams stocked in spring (Group II; ●).

entrance, water conditions were affected by the exchange of water between the sea and the lagoon. Jara-Jara et al. (1997) reported that *Ruditapes decussatus* seed in Carril (Spain) were subject to tidal cycles as well as food fluctuations. Tides and the geographic position of filter feeders may result in low food usage (Grant, 1996). Although the chlorophyll *a* concentrations in Carril, Spain, were lower (2-5 µg/l; Jara-Jara et al., 1997) than in Sufa Lagoon, clam growth was higher; perhaps because the clams stocked in Carril were smaller than in Sufa and small individuals grow faster than larger ones (Viella, 1950). Water currents at the study site were high but we have no data on their speed. It is possible that the currents affected their growth. In Puigcerver's (1996) work, carpet shell clams in the delta of the Ebro river (Spain) grew -0.10 to 0.24 mm in 120 days for 6-12 mm clams in parc culture. In the present study, carpet clam stocked in October grew 2.77 mm (0.46 mm/month) whereas those stocked in April grew 3.59 mm (0.59 mm/month).

Orive et al. (1984) suggested that a spring peak could result from optimal nutritional conditions, indicated by high chlorophyll concentrations in March-May. As much as 50% of the annual clam growth in an estuary in Spain occurred in the spring whereas growth dropped in summer, maybe due to negative effects of the temperature (Urrutia et al., 1999), causing physiological stress (Shpigel and Fridman, 1990). This agrees with our results, where greater growth was obtained in the spring (Group II) while clam growth was lower in the winter due to the lower water temperature and poor nutrition. Walne (1976), Laing et al. (1987), Puigcerver (1996), and Soudant et al. (2004) also reported continuous but slower growth in clams during winter.

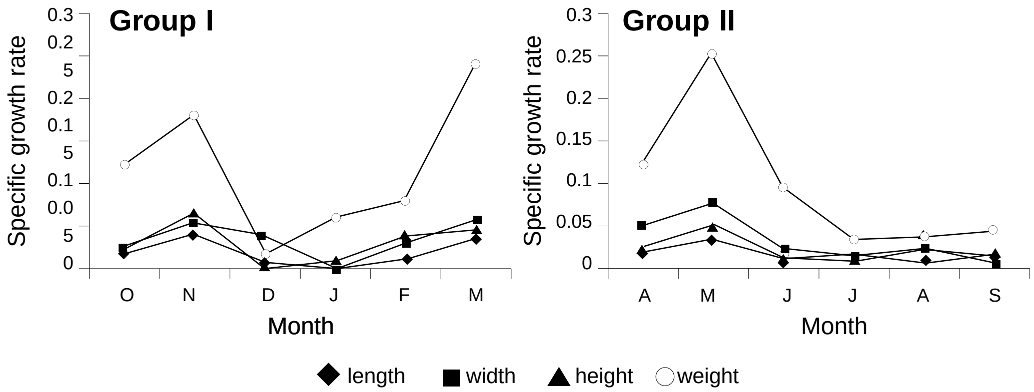

Fig. 4. Specific growth rate of clams stocked in fall (Group I) and clams stocked in spring (Group II).

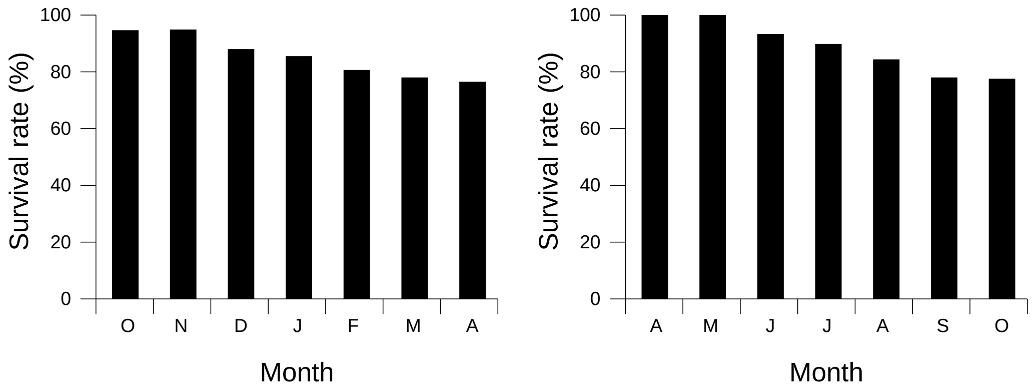

Fig. 5. Survival of clams stocked in October (Group I) and clams stocked in April (Group II).

Clam seedlings may be planted in spring or autumn, but spring planting is favored as it results in immediate growth, shortening time to harvest (Bardach et al., 1972). Clam farmers in Ireland agree, preferring that spat be available for ongrowing in April/May (Christophersen, 1994).

Survival of clams planted in the field depends on a number of variables including water quality, pollution, seed size, density, protection devices (Kraeuter and Castagna, 1989), and planting season (Anderson et al., 1982). Mortality was 20-22.5% in our study, much lower than the 35% obtained in Carril (Jara-Jara et al., 1997). Annual mortality of *Venerupis decussata* varied 10-40% in different populations with an average of 23% per year (Walne, 1976).

In conclusion, the present work shows that growth of *Tapes decussatus* in Sufa Lagoon is better from April to October than from October to April. That is, the spring is more suitable for planting clam seed. Spring plantings benefit from faster growth and more suitable water conditions (temperature, food). Results of this study demonstrate that Sufa Lagoon is favorable for clam culture. Further research is needed to characterize the effects of density and culture system on the growth of clam from spat to market size in this lagoon.

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