Research Article
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Body-Shell Dimension Relations and Growth Parameters of the Invasive Ark Clam (*Anadara inaequavalvis*) in Turkish Coast of the Black Sea

İşgalci *Anadara inaequivalvis*'in Vücut-Kabuk Boyutları İlişkileri ve Büyüme Parametreleri

Türk Denizcilik ve Deniz Bilimleri Dergisi Cilt: 4 Sayı: 1 (2018) 46-51

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ABSTRACT

In this paper, the relationship between body-shell dimensions and growth parameters of ark clam (*Anadara inaequavalvis* Bruguière, 1789) were estimated for the Black Sea. At the end of this research, there was a significant relationship between body size and shell dimensions. In addition to this, the Von Bertalanffy growth parameters were found as L_∞=8.61 mm, K= 0.25 and t_0= -0.43 yr^{-1}. Mortality rates were also analyzed for the ark clam as Z= 0.95 yr^{-1}, M= 0.77 yr^{-1}, F= 0.18 yr^{-1}. This research is important in terms of the first study of body-shell dimension relationships and mortality rates for *Anadara inaequavalvis* from the Black Sea. The ark clam can use a descriptor for the Good Environmental Status (GES) according to Marine Strategy Framework Directive (MSFD) 2th Task Group in European Commission.

Keywords: Black Sea, ark clam, body-shell dimensions

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ÖZET

Bu çalışmada Karadeniz'de *Anadara inaequavalvis* (Bruguière, 1789)'in vücut-kabuk boyu ilişkileri ve büyüme parametreleri tahmin edilmiştir. Sonuç olarak, vücut ölçüleri ile kabuk boyutları arasında önemli bir ilişki gözlenmiştir. Buna ek olarak, Von Bertalanffy büyüme parametreleri L_∞=8.61 mm, K= 0.25 and t_0= -0.43 yr^{-1} olarak bulunmuştur. Ayrıca, ölüm oranları Z= 0.95 yr^{-1}, M= 0.77 yr^{-1}, F= 0.18 yr^{-1} olarak hesaplanmıştır. Bu çalışma, *Anadara inaequavalvis*'in vücut-kabuk boyutları arasındaki ilişki ve ölüm oranlarının tahmin edildiği ilk çalışma olma özelliği taşımaktadır. Bu tür Avrupa Komisyonu'nun Deniz Stratejisi Çerçeve Direktifi 2. Grup'ta İyi Çevre Statüsü'nün bir tanımlayıcısı olarak da kullanılmaktadır.

Anahtar sözcükler: Karadeniz, vücut-kabuk boyutları

1. INTRODUCTION

Invasive species are defined as aquatic organisms threating biological diversity by introducing into natural ecosystems according to IUCN Guidelines for the Prevention of Biodiversity Loss caused by Alien Invasive Species (2000). The studies on invasive/non-native/alien/exotic/introduced/allochthonous or non-indigenous species have been available in aquatic environments since early 1980s. These species tend to survive and subsequently reproduce (Gosling, 2003). The invasive alien species (IAS) are introduction resulting from human activities. For example, since the increase in cargo transportation, a lot of invasive species have been transported by ballast water all around the world. Besides, natural phenomenons are effects of distribution of them such as climate change or dispersal by ocean currents. IAS have negative effects on biodiversity, ecosystem processing, socio-economic life and human health in invaded areas (Olenin *et al.*, 2010). The Black Sea has a fragile ecosystem and is threatened by a lot of invasive species day by day.

Ark clam or blood cockle (*Anadara inaequavalvis* Bruguière, 1789), originated from the Indian Ocean, with a blood red color due to a high consistent level of hemoglobin in their bodies. It was introduced to the Black Sea in 1981 (Zolotarev and Zolotarev, 1987) and since then it has been distributed along the coast. The reason for invasion success is that the heamolymph species which has ability of binding oxygen in the lack of oxygen (de Zwaan, Cortesi *et al.*, 1991; Holden and Pipe, 1994). Also, this species can tolerate salinity, hypoxic and anoxic water conditions just as veined whelk. It lives mostly in clay or sand substrata (Sahin *et al.*, 2009). This species is economically important in the Asian countries such as Malaysia, West India, China, Thailand, and Korea (Acarli *et al.*, 2012). This species replaced *Mytilus galloprovincialis* and it is under predation of *Rapana venosa* at present in the Black Sea (Erdogan Saglam *et al.*, 2010). The morphological characteristics changes of the individual *A. inaequivalvis* can use an indicator for the early determination of the effect of pollutants on benthic habitats (Kolyuchkina and Miljutin, 2013).

In this paper, we aimed to determine body-shell dimension relations of invasive ark clam and growth parameters for the Turkish Black Sea. This paper results can use to compare in future studies in order to the early pollution detection for Good Environmental Status (GES) in the Black Sea ecosystem. Besides, obtained data of the ark clam will enlighten and compare possibility for the future work.

2. MATERIAL AND METHODS

In this study, 313 specimens for *A. inaequivalvis* were obtained from Trabzon between September 2010 and May 2011 (Figure 1). Samples were caught as discard species by bottom trawls (40 mm mesh size in cod-end). The length, width and height of shell were measured with digital callipers which are the nearest 0.01 mm (Figure 1). The weight of shell and its body was weighted as nearly 0.01 g. The length-weight relationship was estimated by $W = aL^b$ where a and b are constant, W refers to weight of shell (g), and L refers to length of it (cm) (Ricker, 1975). The difference of the calculated and measured length was tested with student t test. *A. inaequivalvis* ageing is hard issue therefore age and growth and mortality parameters estimated by FISAT II® (FAO-ICLARM Stock Assessment Tool, 2006-2018)

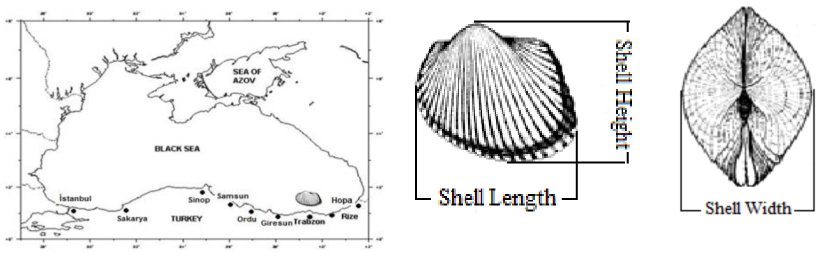

Figure 1. Sampling station and measurements of the samples (Measurement of the ark clam figure were modified from (Fischer and Bauchot, 1987)

3. RESULTS

The ark clam samples sizes were varied between 1.3-7.9 cm total lengths, 0.52-62.58 g total weight. The mean length and mean weight of ark clam were calculated as 4.23 cm and 20.05 g, respectively. The majority of the samples were detected in 3.0-4.0 cm (33.46%) size class (Figure 2). According to the regression analyses, there were strong relationship between total weight and shell height (R^2= 0.957), body weight and total weight (R^2= 0.938). The weak relationships were observed between bodyweight and shell height (R^2= 0.849) and followed by body weight and shell weight (R^2= 0.859). The relationships between body and shell dimensions were given in Figure 3.

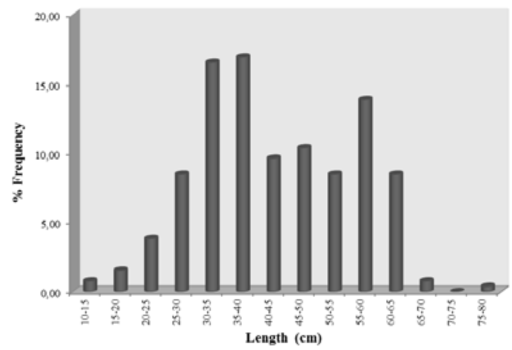

Figure 2. The length-frequency of ark clam

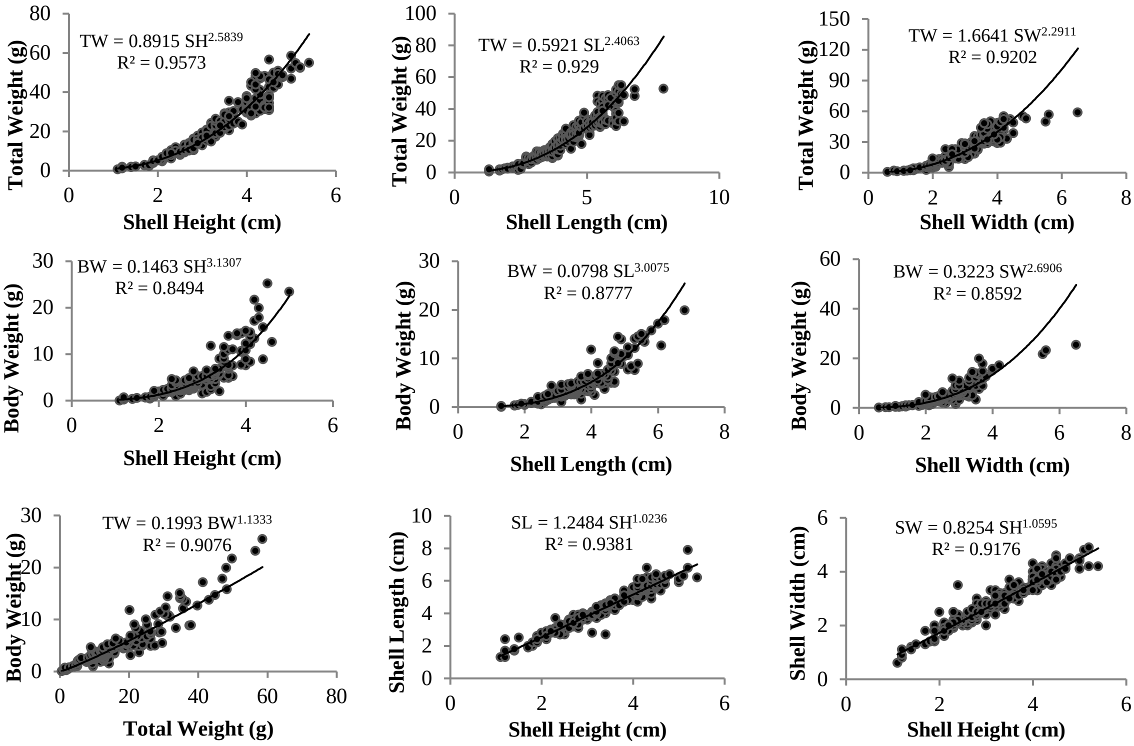

Figure 3. Relationships between body measurements and weights of ark clam

The ages of ark clam were determined as five-year class according to Bhattacharya's method using the length frequency data and shown in Figure 4.

The ages of ark clam were estimated between 1 and 5 according to length class from the Bhattacharya's method (Figure 4). The dominant age groups were observed as 2 (48.33%) and followed by the age groups 4 (19.70%), 3 (16.36%), 1 (8.55%) and 5 (7.06%). The mean measured length of the ages were with Bhattacharya method as 2.62±0.27 cm for 1 age group, 3.65±0.50 cm for 2 age group, 4.89±0.35 cm for 3 age group, 5.79±0.21 cm for 4 age group and 6.25±0.21 cm for 5 age group. The calculated ages were also determined as 2.59 cm for 1 age group, 3.92 cm for 2 age group, 4.96 cm for 3 age group, 5.77 cm for 4 age group, 6.40 cm for 5 age group. There was no difference of the measured and calculated length and shown in Figure 5 (P›0.05). The Von Bertalanffy growth parameters of the ark clam were calculated in ELEFAN I as $L_t=8.61\,(1-e^{-0.25(t+0.43)})$. Instantaneous total mortality rate (Z) of ark clam was calculated as 0.95 yr^{-1}, natural mortality rate (M) as 0.77 yr^{-1}, fishing mortality rate (F) as 0.18 yr^{-1} and exploitation rate as 0.19 yr^{-1} from the Length-Converted catch curve (Figure 6).

The recruitment pattern of ark clam *A. inaequivalvis* was demonstrated in Figure 7. When NORMSEP normal distribution procedure was applied, two peak recruitments were found in May and November.

The probability of capture was estimated of the ark clam as L_{25}=3.05 cm, L_{50}=3.53 cm, L_{75}= 4.00 cm (Figure 8).

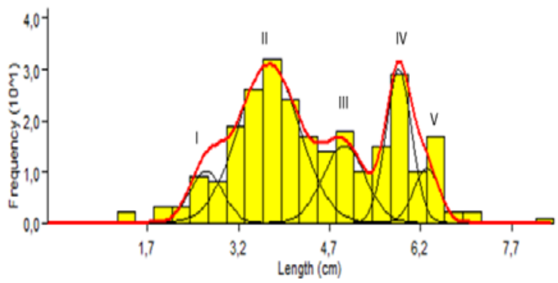

Figure 4. Age classes of ark clam

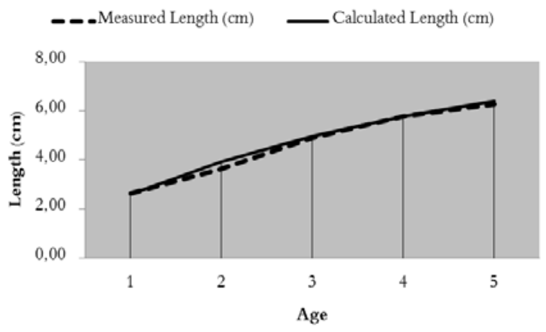

Figure 5. Differences calculated and measured length of ark clam

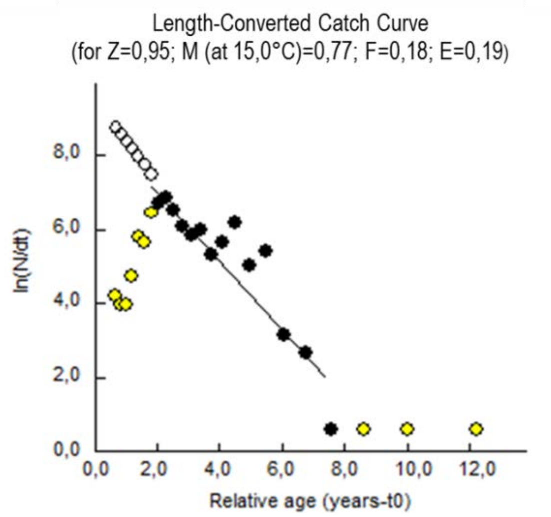

Figure 6. Catch curve for the mortality and exploitation rate of the ark clam

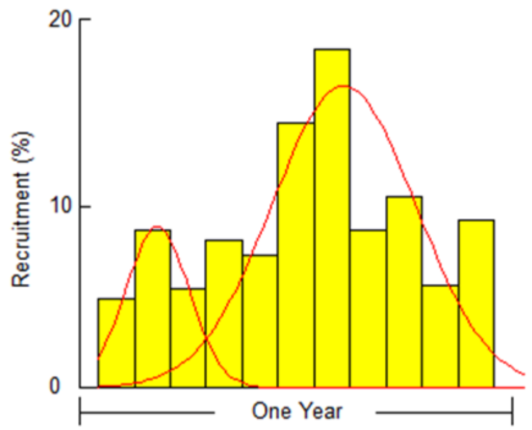

Figure 7. Recruitment pattern of ark clam

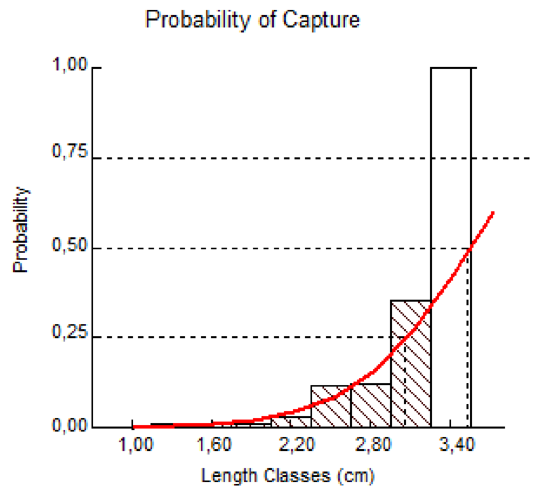

Figure 8. The probability of capture of ark clam

4. DISCUSSION

The body and shell dimension relations of the ark clam were calculated in this study. However, these results could not be but not compared with any study because of absence of the published scientific manuscript before. The same situation is also applicable for the mortality rates.

The ages and mean length of ark clam in this study were estimated as 1-5 years, these findings were also likewise with Sahin *et al.* (2009). Although, L_∞ of the ark clam is calculated higher than Sahin *et al*. (1999). This could be explained with obtaining of larger size samples in this study than the Sahin *et al*. (1999).

The mortality rates show that there is low fishing pressure for ark clam in the Black Sea. The exploitation rate (0.18 yr^{-1}) of the ark clam is also highly lower than optimum fishing level (0.5 yr^{-1}) in the Turkish coast.

There are two recruitment peaks (the strong peak and the slight one) in this study. The strong recruitment curve time might be in July and the slight curve time could be in November. These findings are same with the results of Sahin *et al*. (2006). The slight peak in autumn might be caused of low lipid content (lipid uses for the wintering) in the ark clam (Sahin *et al*., 2006). The reasons of the strong curve in the spring and summer of the ark clam might also be related with the high sea temperature-chlorophyll-a and low salinity conditions (Acarli *et al*., 2012).

5. CONCLUSION

The under controlling of invasive species is difficult in an ecosystem. In addition to, developing strategy provides bio-invasion impact/dimension or bio-pollution index in the invaded area for the GES according to Non-Indigenous Species-Marine Strategy Framework Directive Task Group 2. A monitoring strategy for the settled and incomer of the invaders especially toxic and harmful ones should be developed.

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