Allometric relationship and meat yield of *Chama pacifica* broderip, 1835 from the Gulf of Antalya, Turkey

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Abstract

In this study, the allometric relationship and the meat yield of the large Pacific jewel-box *Chama pacifica* Broderip, 1835 were investigated. *C. pacifica* samples were by scuba diving at depths of 3-8 m in the Gulf of Antalya. The relationship of total shell length and total shell weight was determined as TW = 2.2693*TSL* 2.5327 (R² = 0.69). The mean flesh weight and mean meat yield were determined to be 11,07±0.445 g and 6.84±0.18%, respectively. This research revealed the meat yield data of *C. pacifica* and its potential importance as a food source.

Keywords: *Chama pacifica*; Pacific jewel-box; flesh weight; meat yield; allometric relationship

1. Introduction

The Eastern Mediterranean Sea is prone to biological invasions because of its location between the Atlantic, Pontic and Erythrean regions, intensive marine traffic, and occurrence of abundant aquaculture activities in the coastal waters (Arvanitidis et al., 2006). The opening of the Suez Canal in 1869, allowing the introduction of the Indo-Pacific and the Red Sea originated species, was the main reason for biological invasion in the Mediterranean Sea (Galil, 2007; Zurel et al., 2011). A few of the Mediterranean species were partially or totally displaced by these invaders (Galil, 2007). One of these invaders was *Chama pacifica* Broderip, 1835 (Bivalvia: Chamidae), which was first recorded from Egypt in the Mediterranean Sea by Tillier and Bavay in 1905. This bivalve has settled in many locations of the south-eastern basin such as Israel, Lebanon, Turkey, Syria and Greece (Otero et al., 2013; Türkmen et al., 2005).

*C. pacifica* is a very peculiar species often taken into consideration as one of the most variable cosmopolitan chamics in the CIESM Atlas of Exotic Species in the Mediterranean Sea (Crocetta & Russo, 2013). *C. pacifica* was detected on the coast of Phalaselis Ancient City in the Gulf of Antalya, where exotic species have been generally recorded in Turkey (Gökoğlu et al., 2017).

* C. pacifica has separate sexes and fertilization is external (Otero et al., 2013). Spawning occurs once a year usually in spring and summer when the water temperature is more than 21 °C. This prolonged spawning period contributes in part to the...
settlement success in the new surroundings (Zurel et al., 2011; Otero et al., 2013).

Knowledge on the meat yield, biology and growth of *C. pacifica* in the Gulf of Antalya is limited. In our study, we aimed to determine the allometric relationship and the meat yield of *C. pacifica* from the Gulf of Antalya in order to examine its potential usage as an important source of food for humans.

2. **Materials and methods**

2.1. **Sampling**

A total of 92 *C. pacifica* samples were by scuba diving at depths of 3-8 m in the Gulf of Antalya (between 36°52′54.49″N 30°41′37.67″E) on April 21st of 2018 (Figure 1).

2.2. **Determination of allometric relationships**

Samples of *C. pacifica* were transported to the laboratory and fouling organisms attached to their shells were removed (Figure 2). Total shell length (TSL) (the maximum length along the anterior-posterior axis), total shell width (TSW) (maximum distance on the lateral axis) and total shell height (TSH) (from the umbone area to the opposing valve margin) of the *C. pacifica* were measured by a caliper to the nearest 0.1 mm. The total weight and flesh weight were determined by using a digital balance with an accuracy of 0.01g. For flesh weight measurements, all specimens were opened using a hammer and the flesh removed.

Shell length and weight relationship was calculated according to the allometric equation: Weight = a * size^b using the least square regression analysis of Microsoft Excel software. The exponential relationship can be shown by a linear equation as follows; log Weight = log a + b log size.

The term “weight” referred to the total weight (TW) and total flesh weight (FW). L was also related to size such as TSL, TSW and TSH where “a” is the intercept and “b” is the slope of the function. T-test was used to determine the significance of b values (Pauly, 1984; Berik et al., 2017).

2.3. **Sex ratio**

Sex of the samples was determined with naked eye and by stereo microscope. Total numbers of males and females were used to calculate the sex ratio (Zurel et al. 2011).

2.4. **Specifying of meat yield**

Parts of *C. pacifica* for meat yield calculation were shown in Figure 3. Meat yield was determined by the following equation; 

\[
\text{Meat Yield} = \left( \frac{\text{Meat weight (g)}}{\text{Total weight (g)}} \right) \times 100
\]

(Yıldız et al., 2011; Çelik et al., 2012; Berik et al., 2017).
3. Result and discussion

3.1. Shell dimensions and allometric relations

Total shell lengths of *C. pacifica* ranged from 3.2 to 6.7 cm and total weights from 42.99 to 323.75 g (Table 1).

### Table 1

| Measurements   | N  | Minimum | Maximum | Mean (SE) |
|----------------|----|---------|---------|-----------|
| TSL            | 92 | 3.2     | 6.7     | 5.31±0.71 |
| TW             | 92 | 42.99   | 323.75  | 164.51±6.251 |
| TSW            | 92 | 2.5     | 7.8     | 4.39±0.087 |
| TSH            | 92 | 4.2     | 8       | 6.51±0.085 |
| FW             | 92 | 2.45    | 22.04   | 11.07±0.445 |

TSL, Total Shell Length (cm); TW, Total Weight (g); TSW, Total Shell Width (cm); TSH, Total Shell Height (cm); FW, Flesh weight of *C. pacifica* (without shell) (g).

The TSL-TW relationship was calculated as TW = 2.2693*TSL^{2.527} (R²= 0.69) (Figure 4). The TSL frequency distribution was given in Figure 5.

![Figure 4. The TSL-TW relationship of *Chama pacifica* collected from the Gulf of Antalya.](image)

![Figure 5. TSL frequency distribution of *Chama pacifica* from the Gulf of Antalya.](image)

3.2. Meat yield

In this study, mean meat weight and mean meat yield of *C. pacifica* was determined to be 11,07±0.445 g and 6.84±0.18%, respectively. Unfortunately, no data is available in order to compare these results. But, according to Çelik *et al.* (2012), mean meat yield of *Mytilus galloprovincialis* in Sinop, South of the Black Sea (Turkey) was determined as 9.98±0.73%. Furthermore, mean meat yield of *Flexopecten glaber* caught from Çardak Lagoon in Çanakkale, Turkey was reported to be 34.14%, 37.63%, 39.69%, 29.96% in autumn, winter, spring and summer respectively, while mean meat weight of *F. glaber* was determined as 10.12 ±0.280 (g) (Berik *et al.*, 2017). These results show that mean meat weight of *C. pacifica* was higher than that of *F. glaber*. In bivalves, meat yield is dependent on the environment, breeding season, feeding regime and species (Çelik *et al.*, 2012; Lagade *et al.*, 2015; Berik *et al.*, 2017).

### Table 2

| Relationship  | a     | b     | R²   | p    |
|---------------|-------|-------|------|------|
| TSL on TW     | 2.27  | 2.53  | 0.69 | P ≤ 0.05 |
| TSL on TSW    | 0.84  | 0.99  | 0.48 | P ≤ 0.05 |
| TSL on TSH    | 1.77  | 0.78  | 0.61 | P ≤ 0.05 |
| TW on FW      | 0.12  | 2.69  | 0.62 | P ≤ 0.05 |
| TSW on FW     | 0.10  | 0.92  | 0.68 | P ≤ 0.05 |
| TSW on TSH    | 2.99  | 0.53  | 0.56 | P ≤ 0.05 |

TSL, Total shell length (cm); TW, total weight (g); TSW, Total shell width (cm); TSH, Total shell height (cm); FW, Flesh weight of *C. pacifica* (without shell) (g).

3.3. Sex ratio

While 45 individuals of *C. pacifica* were males, 44 of them were females and sex of 3 individuals couldn’t be assigned. The sex ratio was determined to be 51% to 49%. Zurel *et al.* (2011) notified the male/female ratio approximately 1:1.5. In bivalves, exogenous steroids, temperature, food availability and pollutants were reported to have influence on the sex ratio (Breton *et al.*, 2017).

4. Conclusion

*C. pacifica* is one of the highly effective alien and cryptogenic marine species reported on ecosystem services or biodiversity (Katsanevakis *et al.*, 2014). Scientific informations on the meat yield, biology and growth characteristics are missing for the surrounding waters of Turkey and Mediterranean. In our study, we examined the allometric relationship and the meat yield of *C. pacifica* from the Gulf of Antalya in order to determine its potential usage as an important food source for balanced nutrition. Moreover, intense population of *C. pacifica* in the Gulf of Antalya was observed on hard substrates (Figure 6). Although the species is not consumed as a food source in Turkey yet, the mean meat weight of *C. pacifica* was found to be higher than that of *F. glaber* in...
Mytilus galloprovincialis is one of the most high market valued species for the seafood sector in Mediterranean (Berik et al., 2017). The total marine catch was decreased in Turkey and the world (FAO, 2018; The Ministry of Agriculture and Forestry, 2019). These show that C. pacifica has an important potential not only to be a suitable food source, but also creates profit for fishermen.

Figure 6. Chama pacifica on the rock in the Gulf of Antalya.

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