Population dynamics of a conch, *Strombus persicus* in a coastal area of Levantine Basin in Mediterranean Sea

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Abstract- Size dynamics and annual production and mortality estimates of a non-indigenous marine shell species, *Strombus decorus persicus*, Swainson, 1821 were studied at 5 and 10 m depth contours of a Turkish coastal area in the Eastern Mediterranean Sea over monthly sampling from February to December, 2000. Mean wet weight and abundance varied between 19 (July) and 20 g/m^2 (October), and 0.02 (September) and 2.22 ind/m^2 (October) at 5 m depth and 0.01 (July) and 2.5 ind/m^2 (February), and 25 (May) and 28.5 g/m^2 (October) at 10 m. Minimum and maximum shell lengths were measured as 2.5 and 6.2 cm. Two cohorts due to reproduction of the animals were observed from July to September when the sea surface temperature ranged from 29-27 °C. The reproduction was less pronounced at 10 m depth. Most of small size individuals appeared at 5 m depth. Intercept values obtained from weight-length relationship of the 10 m depth were generally found to be greater than 1, which showed the occurrence of the larger organisms there. Growth in shell length as function of sampling days was 0.00051 cm/day/cm at 5 m depth and 0.000048 cm/day/cm at 10 m depth. Total specific production increment (ΔP) in wet weight was estimated as 6 g/m^2 at 5 m and 0.6 gr/m^2 at 10 m over a period of 7 months. Total of natural and fishing mortality increment (ΔM) was 11 gr/m^2 and 3 gr/m^2 as function of the depths, respectively.

Keywords- Population, dynamic, *Strombus*, Mediterranean Sea

Introduction

The Northeastern Mediterranean coast holds an important position with regard to introduction and new records of exotic marine species since the Sea has the natural connection with both Suez Canals to the Red Sea, hence Indian Ocean and Gibraltar Strait to Atlantic Ocean, and artificial connection with Ocean-crossing ships. Many exotic species were recorded in the Mediterranean Sea (CIESM). One of the exotic species is *Strombus persicus* Swainson 1821. Its first specimens as new subspecies (its relevant synonym; *S. decorus raybaudii* Nicolay and Manoja 1983) were recorded in the Mediterranean Sea (South-Turkish Coasts) in 1983 (Nicolay and Manoja, 1983). *S. persicus* is originally restricted to the South coast of Arabia and part of the Persian Gulf (Moolenbeck and Dekker, 1993), whereas the related species *S. decorus* (Röding, 1798) has a broader distribution in the other parts of the Indian Ocean. Swainson described *S. persicus* from the Persian (Arabian) Gulf in 1821. The Mediterranean records are from Israel (Mienis, 1984), Lebanon (Bogi and Kharallah, 1987), the southern coast of Turkey (Crucitti and Rotella, 1991; Engl, 1995), Rhodes (Nicolay, 1986), and Cyprus (Bazzocchi, 1985). The species invaded Turkish Coasts in the Mediterranean Sea. It was proposed that the introduction was made by ships coming from the Persian Gulf, a tenable scenario since (1) the species does not occur in the Red Sea and (2) the current Mediterranean area is close to Iskenderun, also a port of call for tankers that may proceed from the Persian Gulf. Further localities have been found shortly after but it is not known if this is due to rapid spreading or to an increase in the exploration effort during the 1980's; the species may have been established for many years when it was first noticed. Oliverio (1995) has presented this as an example of "non lessepsian" introduction. Although not currently a widely consumed species, it is potentially interesting as seafood. Mienis (1999) reports the occurrence on the fish market of Yafo, Israel, of *Strombus* caught by shrimp trawlers and sold for a price rounding 2-3 euros. This paper has held, at aim, investigation of population dynamics (biomass and abundance, length-width-weight relationship, growth parameters, annual production and mortality rates, cohorts denoting the reproduction and recruitment to the population) of the species over monthly samplings at two different depth contours (5 and 10 m).

Material and Methods

Temporal size dynamic of *Strombus persicus* Swainson 1821, was studied at 5 and 10 m depth contours in a small area of the Turkish coast of the Mediterranean Sea (Fig. 1a) with monthly sampling from February 2000 to April 2002 skipping March, April, June 2000 and December 2001 and January, March 2002. The samples were collected with a standard dredge that has a mouth width of 60 cm and a net meshed in 0.5 cm square sampling size. The dredge was trawled for 15 min at once at each station. Regarding to the sea, current and wind condition, towing speed was tried to keep at 2 knots. The Global Positioning System (GPS) was used to determine the position of the station. The Sea Surface Temperature (SST), salinity, density were measured using the SeaBird Oceanographic probe. Even though the dredge was towed for 15 min at each station, the distance dredged was calculated to be different for each time due to temporal and spatial change in the wind and current. Several dives were made to determine where the individuals disappeared to in winter around the study area. Some samples with tremendous individuals over 200-1000 inds were subjected to sub-sampling. Efficiency of sub-sampling was statistically tested using dispersion index (I). Five samples of the total sampling were tested for the efficiency of the subsampling with the Dispersion Index (I, Carr, 1991). The sample was randomly split into 3 or 5 subsamples. The I values were significant by showing that the sub-sampling was equally efficient. In the laboratory, shell lengths, width and weight of the individuals and number of individuals were determined. Monthly length-frequency distributions were sorted into 0.15 cm length classes. Parameters of length-weight relationship were calculated from curvelinear regression analysis. Annual growth rate (K) and asymptotic length (L∞) were estimated from regression technique (Beverton and Holt, 1957). Data for the technique were formed by estimating mode values of length distribution of a cohort recruited to the stock in April 2001. The estimates were followed from the length distribution by eye up to December 2001. Specific growth, K and asymptotic value in weight were calculated. Groups of age classes were estimated using Battacharya's method based on pooled data of L/F at both depth contours using ELEFAN I of FAO-ICLARM fish Stock Assessment Tools (FISAT II, ver. 0.4.1, Gayanilo and Pauly, 2001). The groups were decomposed with a method NORMSEP. Monthly L/F data of year 2001 was subjected to an analysis Recruitment Pattern. Production and mortality increments were calculated from method described by Holme and McIntyre (1971). Production has been estimated by stock with recruitment in April and May that was estimated from recruitment pattern.

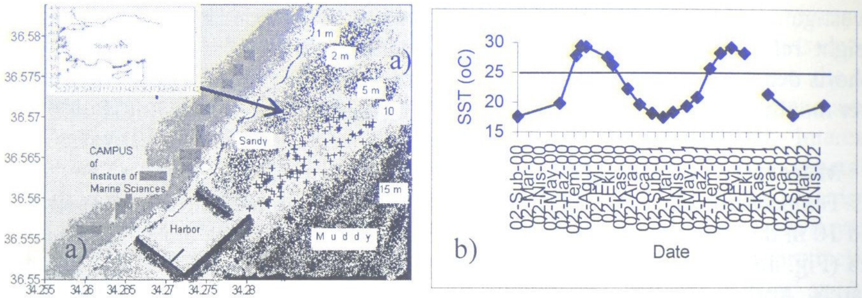

Fig. 1. Locations where *Strombus persicus* was observed and the study area where the dredge was deployed and line stations at 5 and 10 m depth contours and moles of the Institute of Marine Sciences' harbor (a). Sea Surface Temperature (SST) during the sampling times (b).

Results

Spatial distribution of *Strombus persicus* was restricted to a depth of 10 m as Ergev (2002) described the depth as end zone of sandy bottom. During the present study, dredge was trawled at 15 and 25 m depths and Ergev (2002) and Mutlu (2002) studied seasonal distribution of macrobenthic fauna in region including also the present study area between 5 m and 200 m depths (7 depths) using grab and dredge samples. No individuals of the species were found beyond 10 m depth seaward.

Sea Surface Temperature (SST)

The Sea Surface Temperature (SST) varied between 17.5 (February) and 29.3 °C (August) throughout year in the study area. SST was over 25 °C in summer and autumn (up to November). Winter and spring SST was below 25 °C. SST increased from 17.5 °C (winter) to 19 (spring), and reached a maximum value of 29.3 °C (summer), then turned down to decrease throughout autumn (Fig. 1b).

Biomass, abundance and mean individual weight

Overall, mean individual weight of *Strombus persicus* varied between 0.04 and 110 g wt w m^{-2} and population density was between 0.01 and 4.5 ind. m^{-2} (Fig. 2 a, c). The biomass and abundance peaked mainly in spring and summer, regardless of the sampling depth. Decrease in the biomass and abundance began through autumn and they reached minimum values in winter (Fig. 2a, c see plot of 5 + 10 m) when the SST trended dropping down to 25 °C (Fig. 1b). Individual mean weight of the species was below 20 g in April while it was over 25 g (Fig. 2 d). The species yielded seasonality in distribution of population density, standing crop and mean individual weight besides it showed also synchronization between 5 and 10 m depth contours in association with SST (Fig. 2). There were two peak seasons (autumn and spring), one minimum season (winter), and one stagnation period (summer) with regard to abundance and biomass at both two depths. Abundance and biomass peaked on 12 October and 20 March at 5 m depth while it was on 27 September and 23 May (Fig. 2a, c). Autumn peak in autumn at 5 m depth was a result of recruitment of the population at 10 m to population at 5 m with decreasing SST. These movements proceed inversely in spring. As the SST started to increase in March and thousands of adult specimens that disappeared moving to rocky shores of the harbor moles (pers com. Ergev, 2002, visual inspection from dives) and buried underneath sediment at 1-2 m depths in winter appeared at 5 m (visual inspection from dives), abundance peaked one month earlier at 5 m than peak at 10 m. Recruitment occurred from 5 to 10 m. In July the secondary peak of year 2001 occurred, which occurred in September in year 2000. The secondary peak was a consequence of recruitment and growth of new specimens to the stock in April, and then the population declined towards winter minimum phase with decreasing SST. Small sized specimens passed their certain period over the rocky shores until they had reached shell lengths up to 2.5 cm (visual inspection). There were two peaks a year in mean individual weight at 5 m depth; March and October. The weight reached a minimum value (12 g) in April when new small size individuals stocked to the population. March peak was due to return of winter population over rock shores and underneath sediment. October peak was due to movement of specimens from 10 m to 5 m depths with decreasing SST. Growth in weight continued from April to August. The 10 m depth was inhabited by relatively larger sized group of specimens throughout year (Fig. 2d).

Size composition and morphometric characters

The shell length was measured in a range of 2.4 to 6.1 cm at 5 m depth throughout the sampling period while it varied between 3.2 and 6.1 cm at 10 m. Mean shell length varied between 4.2 and 5.2 cm at 5 m while it rounded 5.2 and 5.3 cm at 10 m in a year. Mean length increased from spring (April) to late summer (August) with growth. Mean length decreased a lit bit in September, then inclined until December when the length started to decrease throughout winter. In winter the length unchanged at 5-1-5.2 cm. The same trend was observed for the mean and maximum shell length. This change was most pronounced at 5 m depth as compared with that of 10 m depth contour. Curvilinear fitting between shell length and wet weight estimated slope and intercept to be 3.371 and 0.0949 ($r=0.84$), respectively and 2.603 and 1.4323 ($r=0.86$) between shell width and wet weight. Linear relationship between shell length and width was significantly characterized with slope and intercept of 1.0528 and 2.0603 ($r=0.78$), respectively. In time when the reproduction occurred, the slopes of length-weight relationships at 5 m depth were found to be higher than 3 while it changed between 1.6 and 2.5 in the rest of the year. The intercept was less than 1 for the whole year. At 10 m depth, the slope increased during summer, then started to decrease after the early autumn, and remained unchanged at a level of 1.9 in autumn and winter. The intercept was generally over 1 throughout the whole year, resulting in that the large specimens were found at this depth. When the comparison was made for intercepts between 5 and 10 m depth, greater values of the intercept implied that larger individuals were settled at 10 m depth.

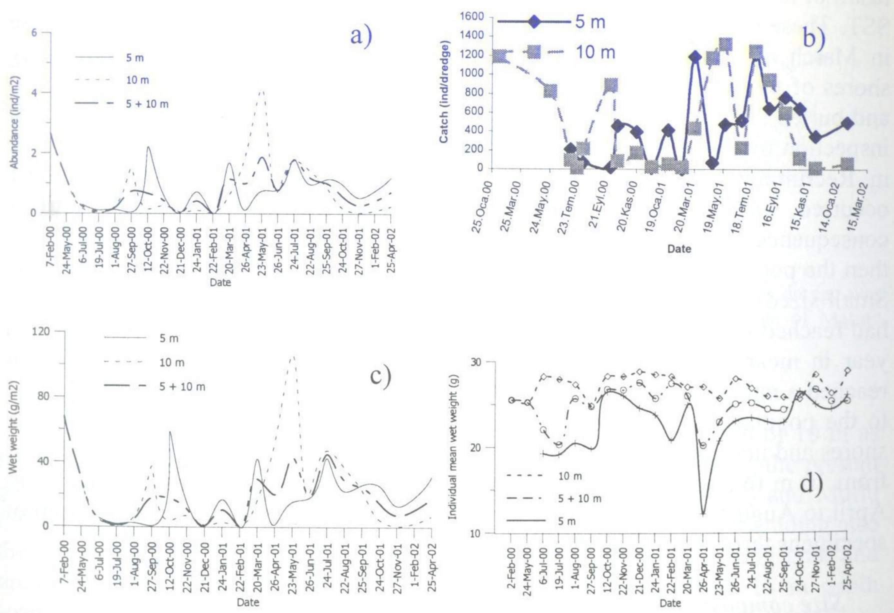

Fig. 2. Monthly abundance (ind. m^{-2}, a), catch (ind/dredge, b), biomass (wt w g m^{-2}, c) and individual mean wet weight (g/ind, d) of *Strombus persicus* from February 2000 to April 2002.

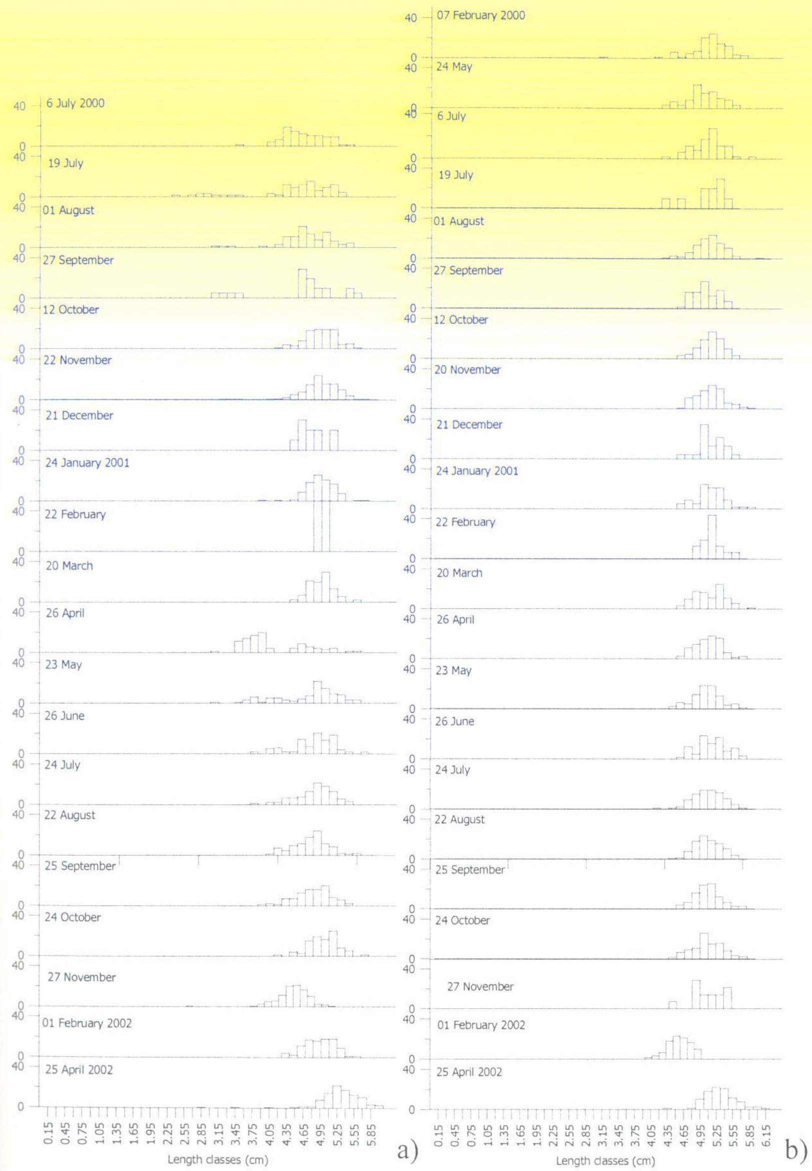

Fig. 3. Temporal change in shell length-frequency distribution at 5 m (a) and 10 m (b) depth contours

Length-frequency (L/F) distribution showed that there were two cohorts at 5 m while there was only one cohort characterized with unchanged unimodal distribution at 10 m (Fig. 3). At 5 m depth L/F showed bimodal distribution associated with reproduction in April when the SST started to increase (Fig.s 1b and 3) and growth continued until September in year 2001. Such growth parameters in length as asymptotic length, growth rate, t_0 (theoretical age when embryo is seeded) were calculated to be 5.646 cm, 0.360 and -0.247 in a period of April to November 2001, respectively. Specific growth was calculated to be 0.000994 cm d^{-1} cm^{-1}. Three age classes with mean values of 3.2, 3.8 and 5.2 cm were found using Battacharya's technique. Normalized means of age classes were 3.3, 3.9 and 5.1 cm. Last age class was significantly separated and fixed regarding separation indices over 2. However, there is one age group with length less than 2 cm, which was never observed in the samples. They were visually inspected over rocky shores covered with macrophytic algae by diving. So, there are three age groups of the species and maximum age was estimated to be 3 after the normalization. Maximum recruitment occurred in May with recruitment starting in April by occurrence of new specimens. Larger specimens moved from 5 m to 10 m depth one month after the reproduction.

Production and mortality

Production and mortality of the species were estimated to be 8.02 g m^{-2} and -3.90 g m^{-2} at the end of period of years 2000 and 2001 for the study area, respectively. Estimates of production and mortality displayed significantly difference between 5 m and 10 m depths. Mortality occurred at 5 m while no mortality was observed at 10 m depth. This could be due completely to recruitment of new specimens at 5 m in April and movements of the specimens with growth to 10 m dept in May. Production and mortality in years 2000 and 2001 were 6.9 g m^{-2} and –2.6 g m^{-2}, and 7.9 g m^{-2} and –3.8 g m^{-2}, respectively. Production and mortality at the end of these two years were 14.8 g m^{-2} and –6.4 g m^{-2} at 5 m depth, respectively. Insignificant production and mortality occurred at 10 m depth. Although monthly production and mortality increments showed fluctuations in a great range, best period for their estimates of the species between recruitment time (April) and movement time to rocky shores and burying time underneath the sediment (September-October when the SST dropped down to 25 °C). Estimates of total production showed that the production was over zero in the period while it dropped below zero in winter period.

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