

**SEASONAL VARIATIONS IN SIZE, WEIGHT AND BIOCHEMICAL
COMPOSITION OF DONAX TRUNCULUS L. (PELECYPODA,
MOLLUSCA) FROM ABU KIR BAY AND ROSETTA REGIONS**

NAIM M. DOWIDAR AND F. E. EL-NADY

Department of Oceanography, Faculty of Science, University of
Alexandria, Egypt

ABSTRACT

Seasonal variations in size, weight and biochemical fractions (total protein, lipid, carbohydrate and ash) of the edible clam *Donax trunculus* were studied in two ecologically different niches in the vicinity of Alexandria i.e Abu-Kir Bay and Rosetta estuary. The population of Rosetta was characterized by smaller size and smaller dry weight, high water content and larger wet weight compared to that of Abu Kir Bay. Rosetta animals reached maturity (maximum size and weight) in spring and probably breed during this season while those from Abu-Kir Bay breed in summer. The seasonal and regional variations in protein and lipid were also significant. The average protein content amounted to 65.3% and 61.0% of the dry body weight in Abu-Kir Bay and Rosetta estuary respectively. A significant inverse correlation between protein and lipid was demonstrated. The average lipid amounted to 17.1 % in Rosetta and 13.1 % in Abu Kir-Bay.

The seasonal and spatial variations in these parameters are discussed in relation to the prevailing environmental conditions.

INTRODUCTION

The pelecypod mollusc, *Donax (Serrula) trunculus trunculus* L., known locally as "Om El-Kholool" is the most popular edible clam along the Egyptian Mediterranean coasts. It is fished in comparatively large masses, being sieved from the sandy muddy bottom in the shallow waters, along the entire Delta coast particularly from Abu-Kir and Rosetta coasts. No particular work was done before on the biochemical composition of edible molluscs in the Egyptian waters.

This paper entails the results of biochemical analysis of the organic content of *Donax trunculus*. The components determined were: total protein, lipid, carbohydrate and ash content expressed as percentage of the dry body weight. Variations in size, weight and water content of the species were also studied. All parameters were traced seasonally on the populations of the species from Abu-Kir Bay and Rosetta estuary. These

two regions are usually considered the main fishery grounds of this species in Alexandria province and represent ecologically different niches.

MATERIAL and METHODS

Collection of Samples :

Samples were collected seasonally during spring (May), summer (August), autumn (November), 1974 and winter (January) 1975, from the southern part of Abu-Kir Bay near Idku city east of El-Maadiya channel as well as from the northwestern region of Rosetta estuary (Fig. 1). The bottom in the former site is sandy muddy while in Rosetta the bottom is predominantly covered with muddy sand deposits. Samples from each site were obtained from the commercial catch fished by shellfish fishermen in both localities.

Treatment of samples

In each season a reasonable number of animals (100 individuals) was randomly taken from the sample collected in each site. The total length and breadth of the shell was measured and the mean values recorded. The shell was carefully removed and the fleshy body of the mixed sample from each site was washed and prepared for further analysis as described in a previous paper (Dowidar and El-Nady, in press). Proteins were determined as total nitrogen using the micro-Kjeldahl method (Vogel, 1968; Raymont et al., 1964). The percentage of nitrogen obtained was multiplied by 6.25 to obtain the percentage of total protein in the sample. Lipids were determined using the method of Floch, Lees & Stonely (1956). Extraction of fat was achieved by using a soxhelt apparatus and a mixture of chloroform and methanol 2:1 v/v at 60-70°C for about 20 H. The carbohydrate content was determined spectrophotometrically following the procedure of Hemitt (1958). The results of the biochemical components were expressed in terms of percentage of the dry body weight. All the data were subjected to statistical treatment; analysis of variance and correlation coefficients were made for the different parameters.

RESULTS

1. Seasonal Variations in Size and Weight :

The seasonal variations in the size and weight of the populations of *Donax trunculus* in Abu-Kir Bay and Rosetta regions are shown in tables (1 & 2). On the whole, the population of Abu-Kir Bay was slightly larger in size (average length 24.75 mm) and greater in weight (average dry weight 36.4 mg/individual) than that of Rosetta region (average length and dry weight 23.25 mm and 31.14 mg respectively). However, these variations were statistically not significant. In both regions a significant correlation was found between the length and breadth of the shell ($r = 0.98$ and 0.94 for the population of Abu-Kir and Rosetta respectively). The ratio between length and breadth of the shell (L/B) varied between 1.82 to 1.92 in Abu-Kir & 1.45-1.93 in Rosetta region, minimum ratios were found in autumn in both regions. On the other hand, in both regions seasonal variations

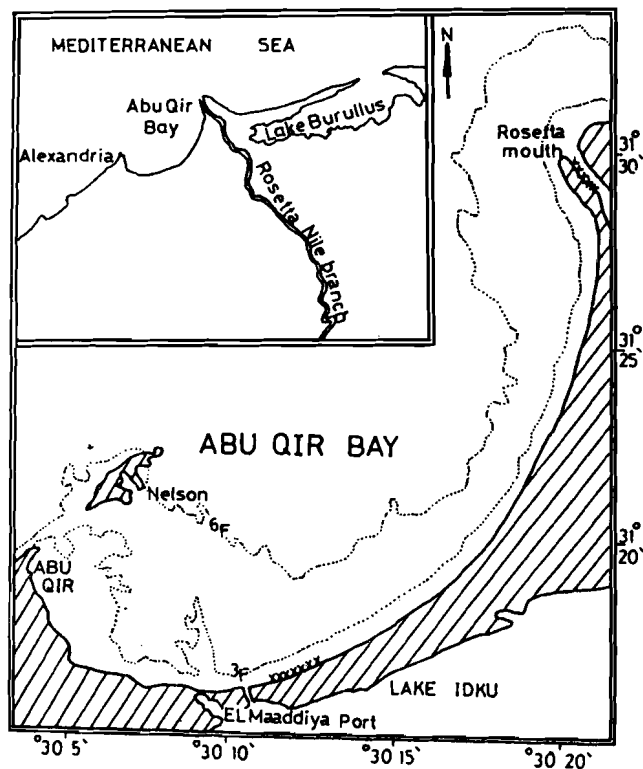


Figure 1: Showing the sites samples (X) in Abu Kir Bay and Rosetta estuary

in the dimensions of the shell were statistically significant. The population of Abu-Kir Bay reached maximum shell size in summer (Table 1) while that of Rosetta attained its largest size in spring (Table 2). It appears therefore, that in Abu-Kir Bay, the species reached maturity (maximum size and weight) during summer. It seems however, that breeding in these animals commences in spring and reaches its climax in summer. On the other hand, the population of *Donax* in Rosetta estuary reached maturity earlier i.e. during spring when it attained maximum size and weight. According to personal observations, animals from that region reach sexual maturity in early spring and breed throughout this season. During summer both the mean length and weight decreased remarkably, but the decrease in weight was more pronounced; the mean weight during summer was almost half that in spring indicating that most of the weight is due to that of the gonads.

The autumn populations in both regions were characterized by smaller size and lighter weight, and probably represent the immature individuals of the following adult generation. As a result of active feeding during

TABLE 1
 Donax FROM ABU_KIR BAY. MEAN SHELL DIMENSIONS, MEAN DRY WEIGHT PER INDIVIDUAL AND
 PERCENTAGE OF WATER CONTENT OF LIVE SPECIMENS, TOGETHER WITH WATER TEMPERATURE AND
 SALINITY RECORDED DURING THE PERIODS OF SAMPLING.

Season	Mean values							Salinity (‰)	
	Length mm	Breadth mm	L/B	Met wt. mg	Dry Wt. mg	% of water content	Surface water temperature °C	Surface	Sub-surface
Spring	26	14	1.86	175.4	37.7	78.50	22.2	38.06	38.31
Summer	30	16	1.87	176.3	48.3	72.60	29.0	28.09	38.09
Autumn	20	11	1.82	79.6	21.4	73.10	23.6	38.17	38.35
Winter	23	12	1.92	162.3	38.3	76.40	15.2	37.80	38.05

TABLE 2
 DONAX FROM ROSETTA ESTUARY. MEAN SHELL DIMENSIONS, MEAN DRY WEIGHT PER INDIVIDUAL AND
 PERCENTAGE OF WATER CONTENT OF LIVE SPECIMENS, TOGETHER WITH WATER TEMPERATURE AND
 SALINITY RECORDED DURING THE PERIODS OF SAMPLING.

Season	Mean values					Salinity (‰)			
	Length mm	Breadth mm	L/B	Wet wt. mg	Dry wt. mg	% of water content	Surface temperature °C	Surface	Sub-surface
Spring	29	15	1.93	254.6	50.15	80.3	21.5	25.12	36.81
Summer	25	13	1.92	127.0	26.03	79.5	28.9	25.34	37.35
Autumn	16	11	1.45	79.6	16.23	79.6	23.5	6.69	30.71
Winter	23	12	1.92	169.2	32.15	81.0	14.8	4.33	20.40

autumn the animals increased in both size and weight. During winter the populations of the species in both regions showed the same size.

2. Water Content :

The water content of the species varied also in both localities. The water content of the population from Abu-Kir Bay was remarkably low (average 75.15 %). The values varied between 78.5 % in spring and 72.6 % in summer (Table 1). On the other hand, the water content of the animals from Rosetta was comparatively high (average 80.1 %). The values varied between 81.0 % in winter and 79.5 % in summer. In both localities seasonal variations in the water content of the species were statistically not significant.

3. Protein Content :

The protein content of the species in Abu-Kir Bay varied widely between a minimum of 56.25 % in winter and a maximum of 69.0 % in autumn (Table 3). In Rosetta region, the values also varied within wide limits in different seasons; the maximum i.e. 71.5 % was recorded in spring while the minimum i.e. 50.0 % occurred in winter.

In both regions high protein coincided with the breeding seasons. The low protein content seems to be a general property of the immature animals.

4. Lipid Content :

The fat content of the species in Abu-Kir Bay was significantly, lower than that in Rosetta region. In the Bay region the values varied between 8.5 % in autumn and 20.3 % in winter (Table 3). In Rosetta region the lipid content varied between 8.8 % in summer and a maximum of 25.0 % in winter (Table 4). The lipid content of the mature animals was much lower than that of the immature individuals of the autumn and winter seasons.

TABLE 3
THE ORGANIC CONTENT OF *Donax trunculus* FROM ABU-KIR BAY
AS PERCENTAGE OF THE DRY BODY WEIGHT.

Season	Protein	Lipids	Carbohydrate	Ash
Spring	67.25	13.5	4.16	13.95
Summer	68.70	10.0	6.00	14.10
Autumn	69.00	8.5	5.58	17.70
Winter	56.25	20.3	5.18	18.20

5. Carbohydrate Content :

The carbohydrate content of the species was generally lower than the other components determined. The values varied between 4.16 % and 6.0 % in Abu-Kir Bay and 5.4 to 8.87 % in Rosetta. In both regions higher values were recorded in winter and summer i.e. following the seasons of active feeding on the abundant food developed during autumn and spring. On the whole the carbohydrate content of the species in Rosetta region was generally higher than in Abu-Kir Bay.

6. Ash Content :

The ash content of *Donax* showed considerable variations in different seasons (Table 3 & 4). In Abu-Kir Bay the lowest value (13.95 %) was recorded in spring and increased more or less gradually until it reached a maximum of 18.2 % in winter.

In Rosetta, the lowest value was likewise recorded in spring but the maximum i.e. 19.1 % occurred in autumn. On the whole, lower values occurred in spring and summer while higher values were recorded in autumn and winter in both regions. In other words the ash content of the immature individuals was higher than that of the mature animals.

TABLE 4
THE ORGANIC CONTENT OF *Donax trunculus* FROM ROSETTA REGION AS
PERCENTAGE OF THE DRY BODY WEIGHT.

Season	Protein	Lipids	Carbohydrate	Ash
Spring	71.5	11.4	5.80	10.5
Summer	70.0	8.6	6.30	14.0
Autumn	52.5	22.2	5.40	19.1
Winter	50.0	25.0	8.87	16.1

DISCUSSION

The populations of *Donax trunculus* dealt with in the present study from Abu-Kir Bay and Rosetta estuary are taxonomically identical. The environmental conditions in both habitats are however quite different. The area of Rosetta estuary receives continuous supply of variable amounts of fresh water through Edfena Barrage erected on Rosetta Nile Branch.

Consequently its salinity is always lower than that of the proper Mediterranean waters. Throughout the year the sub-surface salinity varied between a minimum of 20.4 ‰ in winter and a maximum of 37.4 ‰ in summer (Table 2). On the other hand the subsurface salinity of the area sampled in Abu-Kir was always above 38.0 ‰ with insignificant seasonal variations (Table 1). A number of authors have claimed salinity induced modifications of the structure and size of the shell, development, growth and maturity of various invertebrate animals including molluscs (Kinne, 1957; 1958; 1964; 1970; 1971; Raymont; 1963; Eisma, 1965; Lauckner, 1971). The average size of Rosetta animals was smaller than that in Abu-Kir Bay most probably because of the lower salinity in the former region. Reduction of the average size of certain molluscs as a result of lowered salinity have been reported by several authors (cf. Raymont, 1963; Kinne 1964, 1971). Nikitin and Turpaeve (1957) found that reduced salinity prolonged larval development of certain molluscs; low salinity also affects the rate of growth after metamorphoses in many marine invertebrates (cf. Raymont, 1963). In Rosetta region where the animals probably breed in spring, the average shell length of the autumn population was smaller than the corresponding value in Abu-Kir Bay where the animals probably breed in summer. It is most probable that the low salinity in Rosetta region prolongs larval development of the species and decreases the rate of growth directly after metamorphoses. In later stages however, the effect of nutrition on the growth of the animals was more pronounced. As a result of active feeding on the abundant phytoplankton crop developed in autumn, the rate of growth in Rosetta exceeded that in Abu-Kir Bay; so that in January the populations in both regions attained the same average shell size. The idea that maturation (maximum size and weight) of Rosetta animals was reached earlier than in Abu-Kir Bay is probably also related to the abundance of suitable food. In Rosetta region following the autumn bloom, the phytoplankton population maintained a high crop throughout winter and spring seasons (Dowidar, unpublished) thus allowing for a continuous and steady growth of both body and gonads. As pointed out by Kinne (1970) gonad growth is possible only in the presence of sufficient food. In Abu-Kir Bay growth was continued from autumn and reached its peak (maximum size and weight) in summer. However, the rate of increase during winter was comparatively lower due to the low phytoplankton crop.

The water content of Rosetta animals was significantly higher than in Abu-Kir Bay (Table 5). This again seems to be a direct consequence of the low salinity of the environment in Rosetta estuary (average 31.4‰). Temperature also appears to influence the water content of the animals as lower values were recorded during summer. However, seasonal variations in the water content of the species, in both regions, were statistically not significant. Seasonal and regional variations of the wet weight of the species described the same pattern as water content (Table 6). On the other hand seasonal variations in dry body weight in both regions were highly significant presumably reflecting the stages of growth and maturation

TABLE 5
Donax trunculus. BALANCE SHEET OF BIOCHEMICAL FRACTIONS (MEAN VALUES)
 AS PERCENTAGE OF THE DRY BODY WEIGHT, TOGETHER WITH MEAN VALUES OF WET WEIGHT,
 DRY WEIGHT (IN mg/INDIVIDUAL) AND PERCENTAGE WATER CONTENT OF THE SPECIES IN
 ABU-KIR BAY AND ROSETTA ESTUARY.

Fraction	Abu-Kir Bay	Rosetta estuary
Protein content %	65.3	61.0
Lipid	13.1	17.1
Carbohydrate	5.0	6.6
Ash	16.0	14.9
Water content	75.2	80.1
Wet weight,mg/individual	148.4	157.6
Dry weight,mg/individual	36.4	31.1

TABLE 6
Donax trunculus FROM ABU-KIR BAY AND ROSETTA ESTUARY. ANALYSIS OF
 VARIANCE OF THE DIFFERENT PARAMETERS STUDIED HS: HIGHLY SIGNIFICANT
 (P = 0.01); S: SIGNIFICANT (P = 0.05); NS: NOT SIGNIFICANT.

Breadth	Seasonal variations	Regional variations
Breadth	S	NS
Length	HS	NS
Dry weight	HS	NS
Wet weight	NS	HS
Water content	NS	HS
Protein	S	S
Lipid	S	S
Carbohydrate	NS	NS
Ash	NS	NS

of the species as well as changes in the biotic and abiotic environmental factors particularly abundance of food and variations in temperature and salinity.

The protein content of the species displayed significant seasonal and regional variations. The average value in Abu-Kir Bay was significantly higher than in Rosetta (Table 5). In both regions minimum values occurred in winter indicating that protein cannot be a useful energy source for the species. On the other hand, higher values occurred in spring and summer. In other words the protein content of the mature individuals was higher than that of the immature animals. On the whole, the average protein content of the species is nearly similar to that reported for other molluscs (Masumoto and Hibino, 1932; Walne, 1970; Gilles, 1972). The protein content determined for some molluscs from the Eastern Harbour of Alexandria was as follows: *Venerupis decussata*, 70.0 %, *Mytilus edulis*, 78.7 %; *Patella vulgata*, 67.2 % (Dowidar, unpublished).

The fat content of the species was relatively high varying on the average, between 17.1 % in Rosetta and 13.1 % in Abu-Kir Bay. The average lipid content of several molluscs from the Eastern Harbour was nearly of the same order : *Patella vulgata*, 16.8 %, *Venerupis decussata*, 12.0%, *Mytilus edulis*, 14.0 % and *Lithophaga lithophaga* 14.0 % (Dowidar, unpublished). The lipid content of *Donax* displayed interesting regional and seasonal variations during the period of study. The high lipid in Rosetta animals may be directly correlated with abundance of suitable food in that region. Many workers have shown that increase in the lipid content of various animals is mostly related to food abundance (cf. Orr, 1934; Raymont, 1963; Giese, 1966; Pandian, 1975). Lee and co-authors (1970) found that in *Calanus helgolandicus*, total lipid drops from 37% to 9% when the concentration of *Skeletonema costatum* is decreased from 800 to 100 $\mu\text{g C}^{-1}$. The seasonal variations of the lipid content of the species is also affected by both temperature and salinity of the environment. An inverse correlation between total lipid and salinity was demonstrated particularly in Rosetta region, where maximum lipid occurred in autumn (22.2%) and winter (25.0%); the substance salinity in both season represented the lowest recorded in all seasons, being 30.7% and 20.4% respectively.

Of the three main categories used as store of reserve energy by animals i.e fat, carbohydrate and protein, fat is the most ideal storage material as it contains less water than carbohydrate or protein; more important is that fat liberates twice as much energy as an equal weight unit of carbohydrate or of protein (Pandian, 1975). In *Donax trunculus* fat appears to be an important store of energy permitting survival and preparation for reproductive activity during winter. During that season (temperature Ca. 15°C) the lipid content of the species reached its peak i.e 25.0% in Rosetta and 20.3% in Abu Kir Bay. These results also demonstrate an inverse relation between temperature and lipid. In *Euphausia crystallophobia* and *Euchaeta antarctica* maximum lipid reserve is reached when the environmental temperature is the lowest (Littlepage, 1964). On the other

hand, the increased fat content during winter is probably associated with the reproductive activity of the species. Masumoto and Hibino (1932) found that the female oyster *Ostrea gigas* stores twice as much lipid as the male at the time of gametogenesis. A significant inverse correlation was found between lipid and protein, i.e. both components are complementary. Such a relation has been demonstrated in various invertebrate animals (Vinogradov, 1953; Nakai, 1955; Giese, 1966).

Carbohydrate while certainly the smallest of the organic fractions determined for the species (Table 5), was higher than in *Patella* (1.04%) and *Murex* (1.08%) from the Eastern Harbour of Alexandria (Dowidar, unpublished). Some bivalves store large amounts of glycogen (11 to 30%)(Giese, 1966). Unusual high values i.e about 60% were reported in *Mytilus edulis* (Dezwaan and Zandee, 1972) and in *Ostrea edulis* (Walne, 1970). The concentration of carbohydrates in *Donax* (average 6.6% in Rosetta and 5.0% in Abu Kir Bay) was rather constant with insignificant seasonal or regional variations (Table 6). The remarkable increase of carbohydrate observed in winter, particularly in Rosetta may indicate that these animals store glycogen as an energy reserve to be utilized in reproductive activities.

The average ash content of the species was relatively high i.e 16% in Abu Kir Bay and 15% in Rosetta. The ash content of immature individuals was higher than that of mature animals. However, these variations were statistically not significant.

SUMMARY AND CONCLUSIONS

Donax trunculus is the most popular edible clam along the Egyptian Mediterranean coast. Seasonal variations in size of the shell, weight of the fleshy body and biochemical fractions of the species including total protein, lipid, carbohydrate and ash were studied in two ecologically different niches in the vicinity of Alexandria i.e Abu Kir Bay and Rosetta estuary. These two region represent the main fishery grounds of the species. The salinity in Rosetta estuary is always lower (average 31.3‰ near the bottom) than in Abu Kir (corresponding average 38.2‰) and is subjected to wide seasonal variations reaching its minimum (20.4‰) in winter. Seasonal variations of temperature in both regions were almost identical. Maximum temperature (ca.29°C) usually occurs in August and minimum (ca. 15°C) in February . The standing phytoplankton crop in Rosetta is mostly higher than in Abu Kir particularly in winter. These differences in the biotic and abiotic environmental factors were reflected on the seasonal and spatial variations of the different parameters studied in the bivalve mollusc *Donax trunculus*.

In Rosetta region, both the maximum and average size of the shell were smaller than in Abu Kir Bay probably because of the low salinity in Rosetta estuary. The water content of the species showed a significant inverse correlation with the environmental salinity. being on the average 80.1%

in Rosetta and 75.2% in Abu Kir . The average dry weight per individual was larger in Abu Kir (36.4 mg) than in Rosetta (31.1 mg).

In Abu Kir Bay maturity (maximum size and weight) was reached in summer while the population in Rosetta reached maturity early in spring. The size of the autumn population in Rosetta was significantly smaller than in Abu Kir Bay. It appears, therefore that the low salinity in Rosetta prolongs larval development of the species and decrease the rate of growth directly after metamorphoses.

The protein content of the population of Abu Kir bay (average 65.3%) was significantly higher than in Rosetta (61.0%). In both regions minimum values occurred in winter showing that protein cannot be a useful energy store for the species.

A significant inverse correlation between the lipid and protein content of the species was demonstrated. In Rosetta animals the lipid was higher (average 17.1%) than in Abu Kir Bay (average 13.1%), probably because of the abundance of suitable food. In both regions, maximum concentrations were found in winter indicating that lipid is an important store of energy; besides it may be associated with the reproductive activity of the species in the following season. In Rosetta region seasonal variations in lipid showed an inverse relation to the corresponding salinity of the environment.

The concentration of carbohydrate in *Donax* was rather constant with insignificant variations in both regions being on the average 6.6% and 5.0% in Rosetta and Abu Kir Bay respectively.

Seasonal and spatial variations in the ash content of the species were not significant. The average values varied between 16% and 15% respectively in Abu Kir and Rosetta estuary.

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