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CHEMICAL COMPOSITION AND WALL STRUCTURE OF SOME GASTROPOD SHELLS FROM THE MEDITERRANEAN SEA, SUEZ-CANAL AND RED SEA, EGYPT.

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ABSTRACT

The present work deals with the chemical analyses of Mg, Sr and Mn contents in some shells of nine representative species of two gastropod families, Muricidae and Strombidae, collected from the Mediterranean Sea, Suze Canal and the Red Sea. The shells collected from the Suez Canal and the Red Sea contain higher Sr and Mn contents than those collected from the Mediterranean Sea. The Mg content is nearly equal in all the studied shells. The surface water temperature and salinity of the studied areas were measured during the four seasons of the year and compared with the results of the chemical analyses. The wall structure of the studied shells indicated that the shells of every species consists of two or three layers of the following aragonitic types: prismatic, composite prismatic and nacreous.

INTRODUCTION

The present study deals with the chemical composition and wall structure of some Recent marine gastropod shells collected from the following five localities (Fig. 1):

1-**Gulf of Abu Qir (Mediterranean Sea):** It is a semicircular bay, bordered at its eastern side by the Rosetta branch of the Nile and at its western side by the Abu Qir peninsula which lies at about 36 km to the east of Alexandria. Abu Qir Bay is characterized by the presence of different types of sediments, varying from consolidated coarse sand to clayey and silty grains.

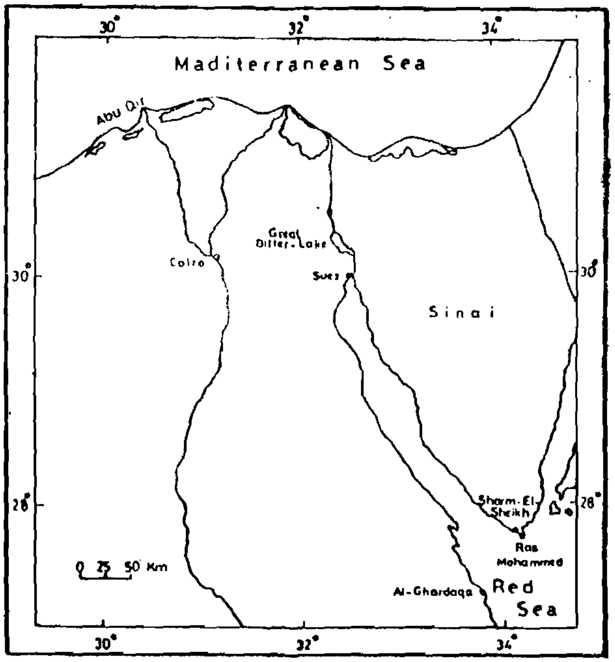


Fig. 1

Location at source areas

2- **Great Bitter-Lake (Suez Canal):** It extends about 20 km (from km 100 to 120) along the Suez-Canal which extends 162.5 km from Port Said at the northern entrance to Suez at the southern entrance. The Great Bitter Lake is characterized by sandy and muddy bottom, with scarce algal vegetation covering a layer of gelatinous black slimy mud. In some localities of the Lake there are enormous layers of salt beds.

3- **Sharm El-Sheikh, Ras Mohammed and Al-Ghardaqa (Red Sea):** The Red Sea regions are characterized by the presence of various associations of flora and fauna. Different types and several colonial coral reefs are irregularly scattered and interrupted with numerous patches of gravels, sands and shell remains.

a-**Sharm El-Sheikh:** It lies between the two arms of the Red Sea where both gulves meet together at their southern side.

b- **Ras-Mohammed:** A promontory at the southern tip of Sinia, at about 11 km from Sharm El-Sheikh.

c- **Al-Ghardaqa:** It lies at 400 km to the southeast of Suez, at the western coast of the Red Sea.

MATERIAL AND TECHINIQUE

Fourty one entire shells, among the whole collection, were selected to chemical analysis by means of a Carl Zeith spectrograph, using the method described by Abdel Aal and Frihy (1984).

Fifty thin sections were prepared through the different parts of the shells and studied under polarized light. The studid shells represent nine species belonging to two families as follows:

I- **Family Muricidae:**

1- **Murex brandaris** Linne: collected from Abu Qir Bay at different levels and different substrata, muddy sand (34m depth), silty sand (40-44m) sandy silt (52m), and rarely scattered on shallow depths of sandy and clayey silt grounds.

2- **Murex tribulus** Linne: collected from the shallow water sand of the Great Bitter Lake, Sharm El-Sheikh, Ras Mohammed and Al-Ghardaqa at a depth of 10-12m.

3- **Murex ramosus** Lamarck: collected from the shallow water sand of the three localities of the Red Sea at a depth of 10-20m.

4- **Trunculariopsis trunculus** Linne: collected from Abu Qir Bay on sandy bottom (6-16m), consolidated coarse sand (11-12m) and muddy bottom (48224m).

5- **Thias carinifera** Lamarck: few scattered specimens are collected from Abu Qir Bay on clayey silt (10-20m), muddy bottom (50m) and sandy mud (80-140m).

6- **Drupa albolabris** (Blainville): few individuals are recorded from the intertidal zone 10m seawardly at Al-Ghardaqa.

II- **Family Strombidae:**

1- **Strombus tricornis** Lamarck: collected from the shallow water sand of Sharm El-Sheikh, Ras-Mohammed and Al-Ghardaqa (10-12m).

2- **Strombus fasciatus** Born: collected from the shallow water sand of the Great Bitter Lake and the intertidal zones of Sharm El-Sheikh, RasMohammed and Al-Ghardaqa (10-12m).

3- **Strombus urceus** Linne: collected from the sandy bottom of Sharm El-Sheikh, Ras-Mohammed and Al-Ghardaqa at a depth of (10-12m).

CHEMICAL ANALYSES

The results of the chemical analyses of the selected intact gastropod shells are here recorded (Tables 1-5) and illustrated (Fig. 2).

Table 1
Values (%) of Mg , Sr and Mn contents of the shells collected from the Gulf of Abu Qir (Mediterranean Sea).

Species	Mg%	Sr%	Mn%
Murex brandaris	0.074	0.58	0.038
Murex brandaris	0.098	0.60	0.039
Murex brandaris	0.090	0.50	0.026
Murex brandaris	0.120	0.64	0.030
Murex brandaris	0.100	0.60	0.020
Thias carinifera	0.116	0.50	0.048
Thias carinifera	0.100	0.46	0.042
Trunculariopsis trunculus	0.082	0.60	0.024
Trunculariopsis trunculus	0.086	0.52	0.032
Trunculariopsis trunculus	0.140	0.50	0.038
Trunculariopsis trunculus	0.090	0.50	0.032
Trunculariopsis trunculus	0.100	0.44	0.034
Arithmetic mean =	0.100	0.54	0.034

Table 2

Values (%) of Mg, Sr and Mn contents of the shells collected from the Great Bitter-Lake (Suez-Canal).

Specis	Mg%	Sr%	Mn%
Murex tribulus	0.100	0.68	0.066
Murex tribulus	0.100	0.80	0.060
Murex tribulus	0.110	0.72	0.066
Murex tribulus	0.092	0.58	0.054
Strombus fasciatus	0.084	0.76	0.068
Strombus fasciatus	0.120	0.68	0.074
Arithmetic mean =	0.101	0.70	0.065

Table 3

Values (%) of Mg, Sr and Mn contents of the shells collected from Sharm el-Sheikh (Red Sea).

Species	Mg%	Sr%	Mn%
Murex tribulus	0.084	0.58	0.056
Murex ramosus	0.068	0.72	0.068
Murex ramosus	0.140	0.70	0.068
Strombus tricornis	0.090	0.72	0.072
Strombus fasciatus	0.160	0.68	0.062
Strombus fasciatus	0.120	0.62	0.060
Strombus urceus	0.060	0.70	0.074
Arithmetic mean=	0.103	0.67	0.066

Table 4

Values (%) of Mg, Sr and Mn contents of the shells collected from Ras Mohammed (Red Sea).

Species	Mg%	Sr%	Mn%
Murex tribulus	0.110	0.62	0.058
Murex tribulus	0.130	0.62	0.058
Murex ramosus	0.090	0.64	0.046
Strombus tricornis	0.080	0.64	0.066
Strombus fasciatus	0.140	0.80	0.062
Strombus fasciatus	0.120	0.80	0.070
Strombus urceus	0.084	0.72	0.076
Arithmetic mean =	0.108	0.70	0.062

Table 5

Values (%) of Mg, Sr and Mn contents of the shells collected from Al-Ghardaqa (Red Sea).

Species	Mg%	Sr%	Mn%
Murex tribulus	0.180	0.74	0.060
Murex tribulus	0.120	0.70	0.060
Murex ramosus	0.080	0.78	0.072
Murex ramosus	0.094	0.64	0.060
Drupa albolabris	0.090	0.82	0.050
Strombus tricornis	0.120	0.60	0.074
Strombus fasciatus	0.086	0.60	0.070
Strombus urceus	0.100	0.58	0.060
Strombus urceus	0.100	0.70	0.048
Arithmetic mean =	0.107	0.68	0.061

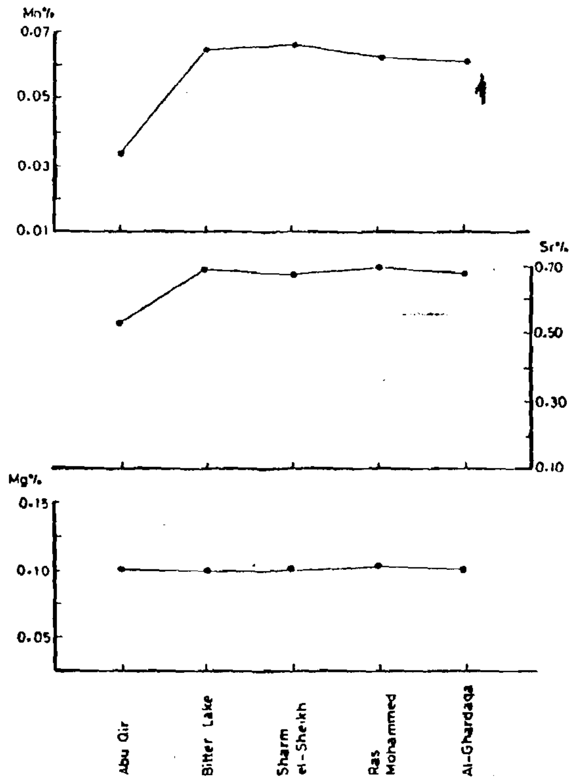


Fig. 2
Distribution of Mg, Sr and Mn throughout the studied shells.

WATER TEMPERATURE AND SALINITY

The mean of maximum values of surface water temperature and salinity of the investigated areas were measured by the present second author during the four seasons of the year. It is generally observed that August and January are the months of maximum and minimum values of both temperature and salinity (Table 6).

Table 6
Mean of maximum values of both temperature and salinity during the fore seasons and values (%) of Mg , Sr and Mn contents of the studied shells.

Area		Spring	Summer	Autumn	Winter	Mean content Mg%	Sr%	Mn%
Gulf of Abu Qir	Temperature	21.2°C	27.9°C	23.3°C	14.4°C	0.100	0.54	0.034
	Salinity	37.63%o	39.70%o	38.83%o	34.61%o			
Bitter-lake	Temperature	26.8°C	29.4°C	26.0°C	17.8°C	0.101	0.70	0.065
	Salinity	44.97%o	46.19%o	45.11%o	43.30%o			
Sharm el-Sheikh	Temperature	26.7°C	30.20°C	23.3°C	18.1°C	0.103	0.67	0.066
	Salinity	42.03%°	42.89%o	41.89%o	41.39%o			
RAS-Mohammed	Temperature	26.5°C	30.0°C	23.1°C	18.0°C	0.108	0.70	0.062
	Salinity	42.02%o	42.78%o	41.86%o	41.30%o			
Al-Ghardaqa	Temperature	27.2°C	31.1°C	24.0°C	18.7°C	0.107	0.68	0.061
	Salinity	41.90%o	42.85%o	41.72%o	41.72%o			

Wall Strcture

The wall structure of the studied shells (pls. I and II) revealed the following:

I- **The shells of family Muricidae:**

1- **Murex tribulus** (pl. I, Fig. 1): the shell wall is formed of three layers: an external thin aragonitic prismatic layer, a middle layer composed of nacreous aragonite and an internal layer formed of relatively thick aragonitic prisms, making an angle of 75°-85° with the shell surface.

2- **Murex ramosus** (pl. I, Fig. 2) the wall is composed of three layers. The external one is a thin aragonitic prismatic layer in which the prisms are arranged perpedicular to the shell surface. The middel layer is formed of fine-grained aragonitic nacreous structure. The internal layer is formed of relatively coarse prisms, making an angle of 70°-85° with the shell surface.

3- **Murex brandaris** (pl. I, Fig. 3): the shell wall consists of three layers, an external rather thick, relativel long aragonitic prismatic layer. The middle layer is composed of nacreous aragonite. The internal aragonitic layer is formed of short prisms, attaining about half (10/18mm) the length of those of the external layer.

4- **Drupa albolabris** (pl. I, Fig. 4): The wall is composed of two aragonitic layers. The external one is formed of composite prisms, making an angle of 80° with the shell surface, while the internal layer is formed of nacreous structure. The length of the internal layer is attaining about 0.63 the length of the external layer.

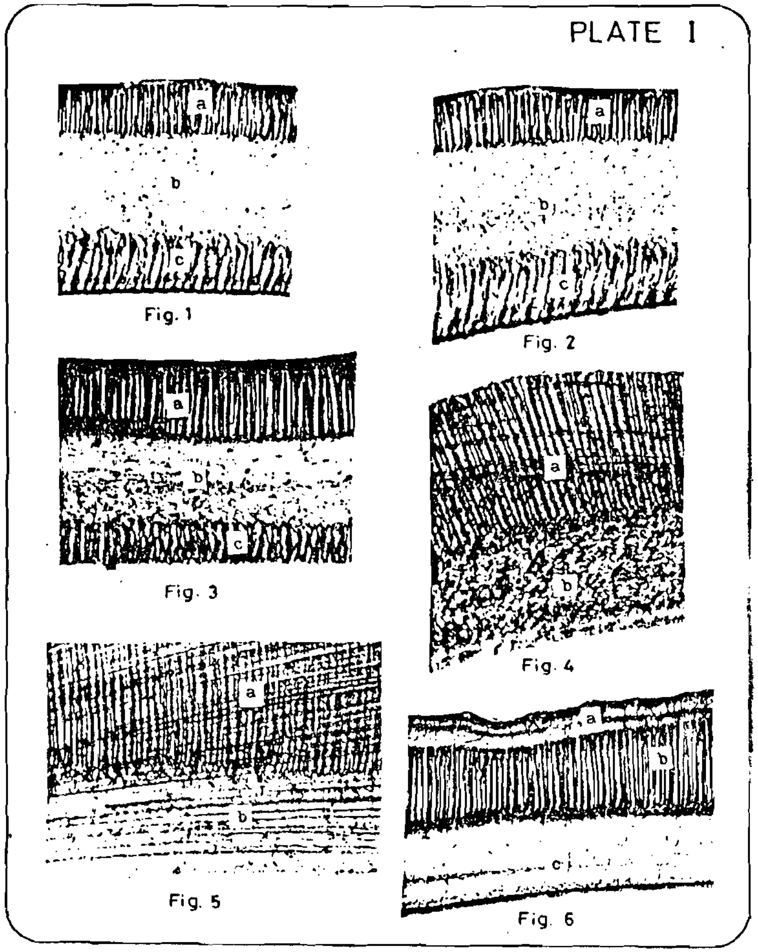
5- **Thias carinifera** (pi. I, Fig.5): The wall is composed of an external composite prismatic layer,and an internal nacreous layer.The nacreous layer consists of 10-12 lamellae,which are separated by many horizontal sheets of organic materials.

6-**Trunculariopsis trunculus** (PL.I,fig.6): the shell wall is formed of three layres composed of aragonite.Both the external and internal layers are composed of nacreous tablets. The external layer attains about 1/3 the thickness of the internal one. The middle layer is formed of simple prisms oriented perpendicular to the shell surface.

II- **The shells of family Strombidae:**

1- **Strompus tricornis** (pl. II, Fig. 1): The wall is formed of an external thick composite aragonitic prismatic layer, and an internal nacreous layer.

2- **Strombus urceus** (pl. II, Fig. 2): The wall is composed of two aragonitic layers. The external one is formed of composite prisms, sinuously arranged, while the internal layer is composed of three sublayers separated by organic sheets.



Explanation of Plates

Plate I :

Fig. 1. **Murex tribulus** (x25). a = external prismatic layer, b = middle nacreous layer and c = internal prismatic layer.

Fig. 2. **Murex ramosus** (x25). a = external prismatic layer, b = middle nacreous layer and c = internal prismatic layer.

Fig. 3. **Murex brandaris** (x25). a = external prismatic layer, b = middle nacreous and c = internal prismatic layer.

Fig. 4. **Drupa albolabris** (x40). a = composite prismatic layer and b = internal nacreous layer.

Fig. 5. **Thias carinifera** (x40). a = external composite prismatic layer and b = internal nacreous layer.

Fig. 6. **Trunculariopsis trunculus** (x25). a = external nacreous layer, b = middle prismatic layer and c = internal nacreous layer.

3- **Strombus fasciatus** (pl. II, Fig. 3): the shell wall is formed of three layers composed of aragonite. Both the external and internal layers are composed of composite prisms. The external layer is slightly wider than the internal one. The middle layer is thin, formed of very fine nacreous tablets.

PLATE II

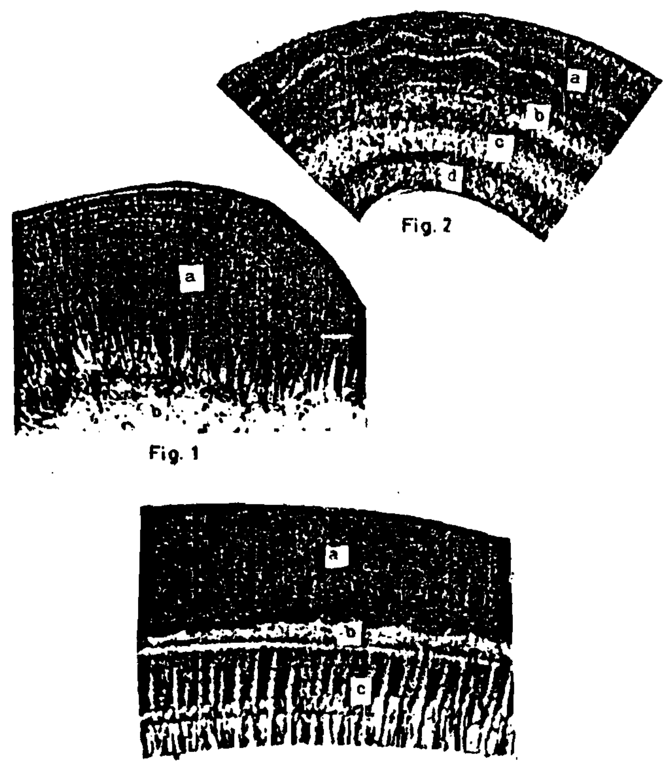


Plate II :

Fig. 1. **Strombus tricornis** (x25), a = external composite prismatic layer and b = internal nacreous layer.

Fig. 2. **Strombus urceus** (x25), a = external composite prismatic layer, b,c and d = internal nacreous sublayers.

Fig. 3. **Strombus fasciatus** (x25), a = external composite prismatic layer, b = middle nacreous layer and c = internal composite prismatic layer.

DISCUSSION AND CONCLUSION

The shells collected form the Suez Canal and Red Sea contain higher Sr concentrations than those collected from the Mediterranean Sea. According to the previous studies done by Dodd (963), Yasamanov (1977), Abdel Aal (1983) and the present measurements of water temperature (Table 6), the Sr content is an indicator for water temperature. Accordingly, the water temperature of the Suze Canal and Red Sea regions are higher than that of the Mediterranean Sea.

The studied Suez Canal and Red Sea shells contain higher Mn contents than those collected from the Mediterranean Sea. This indicates that the Mediterranean Sea is deeper than both the Suze Canal and Red Sea. The results arrived at agree with those obtained by Smislova (1973), Ismail and Abdel Aal (1986) and Abdel Aal et al. (1987) who concluded that the increasing amount of Mn indicates a deposition under comparatively shallow marine conditions.

The shells of **Murex tribulus, M. ramosus.** and **M. brandaris** are composed of an external and internal aragonitic prismatic layers and a middle layer of nacreous aragonite.

The shells of **Drupa albolabris, Thias carinifera, Strombus tricornis** and **S. urceus** are composed of an external composite prismatic layer and an internal aragonitic nacreous layer.

The shells of **Truncilariopsis trunculus** are composed of an aragonitic nacreous layers. The middle layer is formed of aragonitic prisms.

The shells of **Strombus fasciatus** are composed of an external and internal composite prismatic layers and a middle layer of nacreous aragonite.

Cox (1960) stated that the shell wall structure of the Prosobranchia, Opisthobranchia and Pulmonata has three or four layers of crossed-lamellar aragonite with alternating fabric orientation. Mac Clintock (1967) concluded that the shells of superfamily Bellerephontoidea are characterized by the following structural units: prismatic, foliated, crossed lamellar and nacreous, while the shells of the superfamily Patelloidea are characterized by the absence of the nacreous structure, though the inner layer may be iridescent. Wise (1969 and 1970) indicated that the growth surface of the nacreous layer of the gastropod shells is always covered by a tall conical stacks of aragonite crystals, in vertical cross-section these tablets are arranged in vertical columns. Erben (1972 and 1974) concluded that the nacreous layer in the gastropod shells consists of aragonitic lamellae which are composed of single units called tablets. The lamellae are separated by intercalated horizontal conchiolin sheets which form the organic basal and top covers of the tablets contained in the lamellae. Maslov (1973) mentioned that the Recent gastropod shells are characterized by the following aragonitic structural units: prismatic, crossed-lamellar and nacreous layers. Abdalla Hegab (1983) concluded that the shells of **Athleta** sp. are composed of simple and complex crossed-lamellar aragonitic structure, while the shells of **Nerita** sp. are composed of aragonitic complex crossed-lamellar structure.

From the above mentioned discussion we can conclude that there is a great relationship between shell wall structure and the systematic classification of the Gastropoda.

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