Bull. Inst. Oceanogr. & Fish., ARE, 14 (3) 1988. 167 - 176.

WALL STRUCTURE AND CHEMICAL COMPOSITION OF FRESH WATER BIVALVE SHELLS FROM LAKE IDKU AREA, EGYPT.

A. A. ABDEL AAL

Geology Department, Faculty of Science, Alexandria University.

ABSTRACT

The present work is a detailed structural and chemical composition of the freshwater bivalve shells from Lake Edku area. The majority of the bivalvian shells in the studied area represents only two species, **Unio pictorum** (Linne.) and **Corbicula (Corbiculina)** angasi Prime. The shell-wall of **U. pictorum** is composed of an external aragonitic prismatic layer and on iternal aragonitic nacreous layer, whereas that of **C. (corbiculina) angasi** is composed of an external aragonitic nacreous layer and an internal aragonitic prismatic layer. The chemical analysis of Mg and Sr contents in shells along of different ontogenetic stages of the two studied species revealed that the concentration of Mg shows a generally increasing trend from the neanic stage towards the adult stage, while the concentration of Sr varies irregularly during their life stages. The X-ray analysis of the two studied species indicated that they are mainly composed of aragonite.

INTRODUCTION

The wall structure and chemical composition of the Recent bivalvian shells were studied by several authors. Vinogradov (1953) pointed out that invertebrates with calcitic skeletons that contain large quantities of Mg CO^3 are typically marine and are not present in fresh water environments. Turekian and Armstrong (1960) stated that the Sr contents in aragonitic shells are higher than in calcitic shells. Maslov (1973) indicated that the shells of **Mytilus edulis** consists of two layers, an external prismatic calcite and an internal nacreous aragonite. Yasamanov (1977) mentioned that the modern fresh water molluscan shells are composed of aragonite and contain very little Mg, where the Sr content does not depend on the genus or species but varies with the temperature of environment both in the shells and in the river water. Abdalla Hegab (1982) indicated that the outer shell layer of the Recent shells of genus **Modiolus** from the Red Sea Coast consists of aragonitic nacreous structure and the internal shell layer consists of calcitic prismatic structure. Abdel Aal (1983 a) and Abdel Aal and Frihy (1984) concluded that the shells of Pinctada radiata from the Mediterranean Coast of Alexandria consist of two layers, the external one is calcitic prismatic layer, while the internal is aragonitic nacreous layer.

MATERIAL AND TECHNIQUE

One hundred and twenty shells of two Recent fresh-water species were collected from Lake Idku area (Fig. 1). Twenty intact valves, ten of every species, were selected and subjected to chemical analysis. The descriptive characteristics and size measures indicate that these valves represent different ontogenetic stages, beginning with the smallest specimen (No. 1) which represents the neanic stage and ending with the largest specimen (No. 10) that represents the adult stage (Tables 1 & 2). The aim of this analysis is to determine the distribution of Mg and Sr content through the different life stages of the two studied species (Figs. 2 & 3). The analysis was done by means of a Carl Zeiss spectrograph, using the method described by Abdel Aal and Frihy (1984).

Twenty four thin sections were prepared across the different parts of the valves and optically studied under polarized light.

The two studied species were subjected to X-ray analysis to determine the mineralogy of their shell wall by the X-ray diffractometer model (Shimadzu XD-3) using copper target tube and nickel filter. Specimens were scanned from $2\theta = 10°$ to about $2\theta = 55°$ and the counts were recorded automatically on a chart speed of 1 Dig/Min. The diffraction peaks were converted to d-spacing using $\lambda = + 1.54178$ A° (Cu k). The identification of the different minerals was done by using the ASTM cards. Taxonomically, the studied specimens represent two species, classified as follows :

Phylum Mollusca
Class BIVALVIA Linne, 1758 (Buonanni, 1681)
Subclass PALEOHETERODONTA Newell, 1965
Order UNIONOIDA Stoliczka, 1871
Superfamily UNIONACEA Fleming, 1828
Family UNIONIDAE Fleming, 1828
Genus Unio Philipsson, 1788
Unio pictorm (Linne), 1758

Subclass HETERODONTA Neumayr, 1884
Order VENEROIDA H. Adams & A. Adams, 1856
Superfamily CORBICULACEA Gray, 1847
Family CORBICULIDAE Gray, 1847
Genus Corbicula Mergele von Muhlfeld, 1811
Corbicula (Corbiculina) angasi Prime, 1864

TABLE (1)

Concentration of Mg and Sr in the studied shells of **Unio pictorum.**

Specimen No.	Valve dimensions in mm Length	Height	Thickness	Ratios H/L	T/L	Mg %	Sr %
1	16.2	9.4	1.0	0.58	0.06	0.060	0.190
2	22.6	13.7	1.2	0.61	0.05	0.050	0.090
3	27.3	16.8	1.5	0.62	0.05	0.060	0.110
4	31.3	18.8	1.5	0.60	0.05	0.080	0.110
5	36.0	25.1	2.0	0.70	0.06	0.080	0.060
6	40.2	25.2	2.1	0.63	0.05	0.095	0.080
7	48.7	27.3	2.1	0.56	0.04	0.110	0.095
8	56.2	32.8	2.3	0.58	0.04	0.120	0.100
9	61.3	31.9	2.3	0.52	0.04	0.110	0.090
10	66.6	33.9	2.4	0.51	0.04	0.120	0.090

TABLE (2)

Concentration of Mg and Sr in the studied shells of **Corbicula Corbiculina) angasi**

Specimen No.	Valve dimensions in mm Length	Height	Thickness	Ratios H/L	T/L	Mg %	Sr %
1	10.1	8.8	1.0	0.87	0.10	0.020	0.090
2	12.8	9.9	1.0	0.77	0.08	0.040	0.080
3	16.3	13.1	1.2	0.86	0.09	0.050	0.120
4	19.6	17.8	1.3	0.91	0.07	0.030	0.100
5	21.9	20.2	1.4	0.92	0.07	0.050	0.100
6	22.5	21.4	1.6	0.95	0.07	0.050	0.090
7	23.4	22.0	1.7	0.94	0.07	0.075	0.100
8	25.8	24.4	2.1	0.95	0.08	0.065	0.080
9	29.2	27.1	2.3	0.93	0.08	0.070	0.090
10	31.6	29.3	2.5	0.93	0.08	0.080	0.095

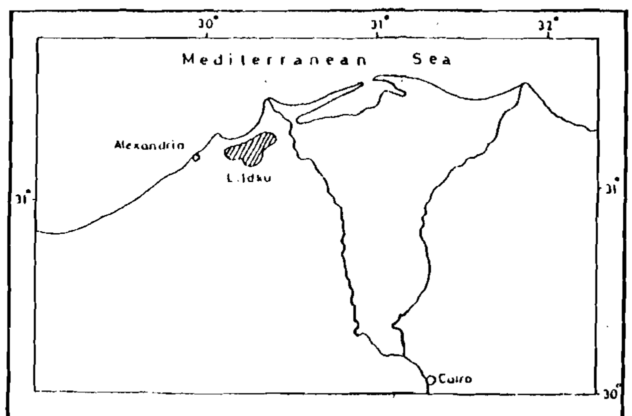

Fig. (1)
Location map.

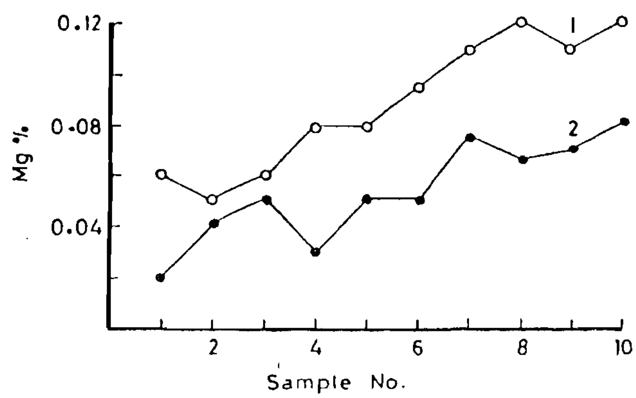

Fig. (2)
Distribution of Mg in the studied shells.
1 = **Unio pictorum.** 2 = **Corbicula (C.) angasi.**

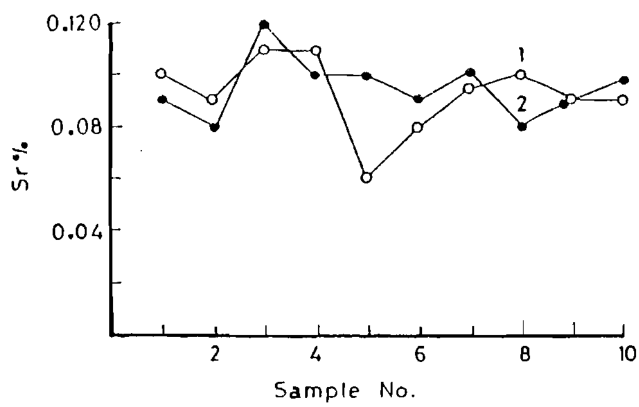

Fig. (3)
Distribution of Sr in the studied shells.
1 = **Unio pictorum** 2 = **Corbicula (C.) angasi.**

Shell wall structure

The valves of the studied shells are composed of two types of wall structure : aragonitic prisms and nacreous aragonite, as follows:

1- The beak area : The beak area of **Unio pictorum** (Linne) (Pl. I, Fig. 1) is composed of an external aragonitic prismatic layer and an internal aragonitic nacreous layer. The beak area of **Corbicula (Corbiculina) angasi** Prime (Pl. I , Fig. 2) is completely composed of aragonitic nacreous layer.

2- The dental plate : The thin sections across the dental plate exhibited that, in **Unio pectorum** (Pl. 1 , Fig. 3) it consists of an external aragonitic

PLATE I

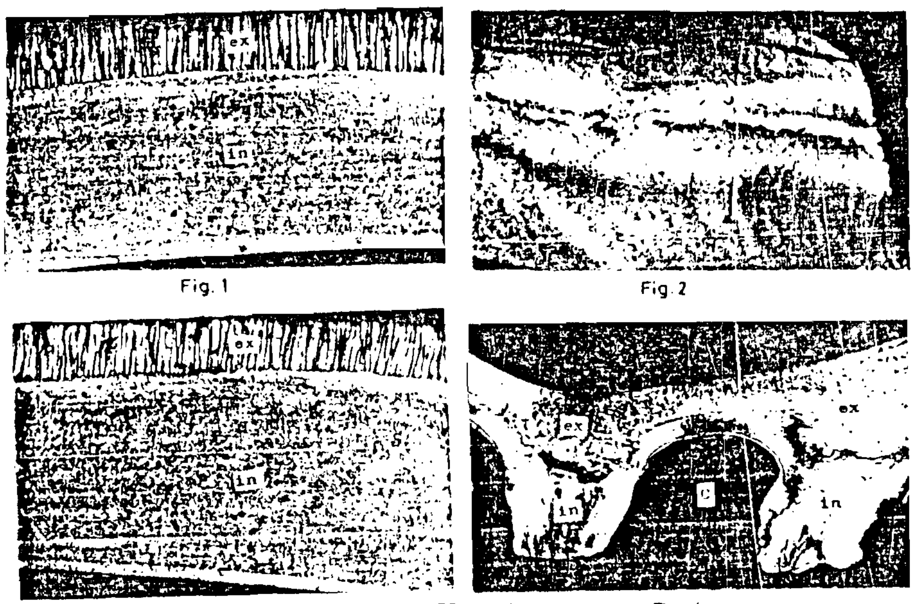

Fig. 1 Fig. 2

Fig. 3 Plate 1. Fig. 4

Fig. 1. **Unio pictorum** (Linne.) (X 30), section in the beak area of an adult specimen, right valve, ex = external aragonitic prismatic layer and in = internal aragonitic nacreous layer.
Fig. 2. **Corbicula (Corbiculina) angasi** Prim (X 40), section in the beak area of an adult right valve, formed of aragonitic nacreous layer.
Fig. 3. **Unio pictorum** (X 30), section across the dental plate of an adult right valve, ex = external aragonitic prismatic layer and in = internal aragonitic nacreous layer.
Fig. 4. **Corbicula (Corbiculina) angasi** (X 30), section across the cardinal teeth of an adult right valve, ex= external aragonitic nacreous layer, in = internal aragonitic nacreous layer and c = socket.

prismatic layer and an internal aragonitic nacreous layer, while in **Corbicula (Corbiculina) angasi** (Pl. I , Fig. 4) it is composed of two aragonitic nacreous layers.

3- <u>The adductor muscles</u> : The studied valves are of the dimyarian type, two scars on each valve, are composed of the following :

a- In **Unio pictorum** (Pl. II , Fig. 1) it consists of an external aragonitic prismatic layer and an internal aragonitic nacreous layer.

PLATE II

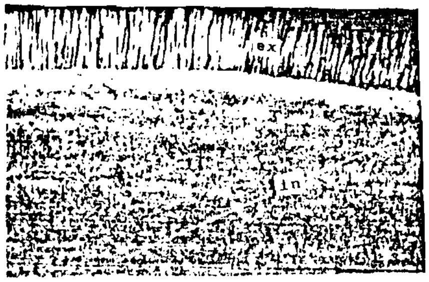

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Plate 2.

Fig. 1. **Unio pictorum** (X30), section across the adductor muscle scar of an adult valve, ex = external aragonitic prismatic layer and in = internal aragonitic nacreous layer.
Fig. 2. **Corbicula (Corbiculina) angasi**, (X25) section across the adductor muscle scar of an adult valve, ex = external aragonitic nacreous layer and in = internal aragonitic prismatic layer.
Fig. 3. **Unio pictorum** (X30), dorso-central section showing ex = external aragonitic prismatic layer and in = internal aragonitic nacreous layer.
Fig. 4. **Corbicula (Corbiculina) angasi** (X25), dorso-ventral section showing ex = external aragonitic nacreous layer and in = internal aragonitic prismatic layer.

b- In **Corbicula (Corbiculina) angasi** (Pl. II , Fig. 2) it consists of an external aragonitic nacreous layer and an internal aragonitic nacreous layer.

4- The main parts of the valves : Many thin sections were prepared parallel to and perpendicular to the ventral margin. These sections exhibited the following :

a- The valves of **Unio pictorum** (Pl. II , fig. 3) are composed of an external aragonitic prismatic layer and an internal aragonitic nacreous layer.

b The valves of **Corbicula (Corbiculina) angasi** (Pl. II , Fig. 4) are composed of an external aragonitic nacreous layer and an internal aragonitic prismatic layer.

Taylor et al (1969), in their study on shell structure of bivalves, distinguished between simple prisms which may be calcite or aragonite, and composite prisms which are only aragonite. The simple prisms usually lie with their long axes perpendicular to the shell surface, while the composite prisms usually lie with their long axes parallel to the shell surface and radiate from the umbo.

The nacreous structure is usually formed of aragonite and consists of very fine tabular crystals, their longer axes parallel to the contour of shell surface. According to Strachimirov (1972), Taylor et al (1969 and 1973), Carter and Tavez (1978 a & b) the nacreous structure is widely distributed among many ancient superfamilies (e.g. the Nuculacea, Cyrtodontacea, Ambonychiacea, Modiomorphacea, most Mytilacea, Trigonacea and Pholadomyacea).

Distribution of Mg and Sr in valves of different life stages

The concentration percent of Mg and Sr in the studied valves are recorded in (Tables 1 & 2). The contents of Mg % (Fig. 2) throughout the different life stages of **Unio pictorum** (linne) and **Corbicula (Corbiculina) angasi** Prime show a generally increasing trend starting from the smallest specimen (No. 1) that repressents the neanic stage and ending with the largest specimen (No. 10) that represents the adult stage. The contents of Mg % in the shells of **Unio pictorum** are higher than those of **Corbicula (Corbiculina) angasi.** The studied fresh-water bivalved shells are characterized by lower concentrations of Mg as compared with the marine forms studied by Chave (1954), Deer et al. (1962), Kokonko (1976) and Abdel Aal and Frihy (1984). This agress with the results achieved by Vinogradov (1953) who concluded that invertebrates with calcitic shells that contain large quantities $MgCO_3$ are typically marine and are not present in fresh-water environments.

The concentration percent of Sr (Fig. 3) in the valves of **Unio pictorum** and those of **Corbicula (Corbiculina) angasi** varies irregularlly in the different life stages. According to Yasamanov (1977) the Sr content in the shells does not depend on the genus or species but varies with the temperature of environment both in the shells and in the river water. Abdel Aal (1983 b) indicated that the Sr content in molluscan shells increases with increasing environmental temperature.

X-ray analysis

The two studied species were subjected to X-ray analysis to determine the mineralogy of their shell wall. The diffraction peaks (Fig. 4) indicated that the shells of **Unio pictorum** and **Corbicula (Corbiculina) angasi** are completely composed of aragonite. This agress with the results arrived at by the wall structure study which indicated that both the prismatic and nacreous layers are formed of aragonite.

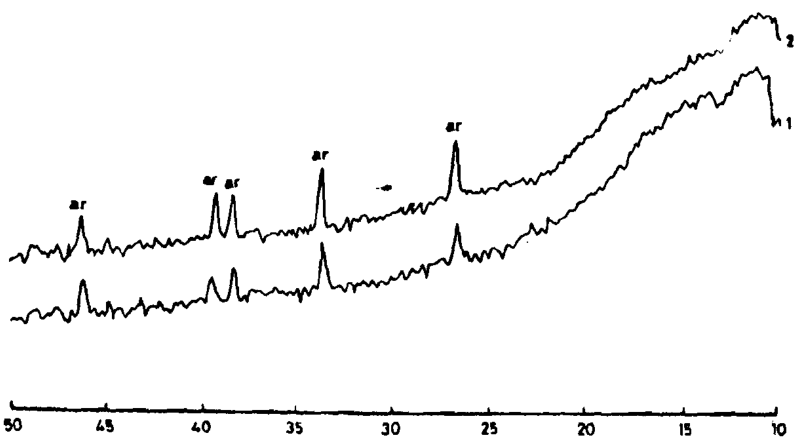

Fig. (4)
X - ray diffractograms of the studied species.
1 = **Unio pictorum.** 2 = **Corbicula (C.) angasi.**
ar = aragonite.

CONCLUSION

The shells **Unio pictorum** are composed of an external aragonitic prismatic layer and an internal aragonitic nacreous layer. The shells of **Corbicula (Corbiculina) angasi** are composed of an external aragonitic nacreous layer and an internal aragonitic prismatic layer.

The concentration of Mg throughout the different life stages of the two studied species shows a general increase starting from the life stage No. 1 that represent the neanic stage and ending with the life stage No. 10 that represents the adult stage.

The concentration of Sr in the shells of **Unio pictorum** and **Corbicula (Corbiculina) angasi** varies irregularly in all life stages. The irregular variation of the Sr content in the studied shells may be due to the variation of the water temperature during the four seasons of the year.

REFERENCES

Abdalla Hegab, A.A., 1982. Wall structure characteristics of Quaternary Bivalvia from the northern Red Sea coast. **Bull. Fac. Sci., Assiut Univ.**, 11 (2): 73-95.

Abdel Aal, A.A., 1983a. Structures and chemical composition of some Recent bivalvian shells from the coastal zone of Alexandria, Egypt. **Delta J. Sci.**, 7 (2): 463-489.

Abdel Aal, A.A., 1983b. The distribution of Mg and Sr within the Upper Jurassic-Upper Cretaceous molluscan shells from the North-eastern part of the Ukrainian Soviet Socialist Republic. **Delta J. Sci.**, 7 (1): 158-178.

Abdel Aal, A.A. and O. E. Frihy, 1984. Concentration of Mg and Sr in the internal and external shell layers of the Recent pelecypod species **Pinctada radiata** (Leach). **N. Jb. Geol. Palaont.**, 8: 449-454.

Carter, J.G. and M. J. S. Tavesz, 1978a. Shell microstructure of a Middle Devonian (Hamilton group) bivalve fauna from Central New York. **J. Paleont.**, 52: 859-880.

Carter, J.G. and M. J. S. Tavesz, 1978b. The shell structure of Ptychodesma (Crytodontidae Bivalvia) and its bearing on the evolution of the Pteriomorphia. **Philos. Trans. R. Soc. London Ser. B 284**. pp. 367-374.

Chave, K.E., 1954. Aspects of biogeochemistry of Mg of calcaeeous marine organisms. **J. Geol.**, 62: 266-283.

Deer, W.A.,R.A. Howie and J. Zussman, 1962. **Rock forming minerals. 5. nonsilicates.** London (Longmans). 317 p.

Kokonko, V.K., 1976. Concentration of trace elements in Danian shells of family Terebratulidae. **Bull. Kharkov Univ.**, 136: 3033 (In Russian).

Maslov, V.P., 1973. **Atlas of rock - building organisms (Calcareous and siliceous organisms).** Publishing office "Nauka", Moscow, 264 p.

Strachimirov, B., 1972. Recherches morphologiques et microstructural sur la coquille de **Corbula (Varicorbula) gibba** du Tortonien et du Tchokorakien en Bulgarie. **Proc. Int. Geol. Cong., 24th session, Montreal**, pp. 4147.

Taylor, J.D., W. J. Kennedy and A. Hall, 1969. The shell structure and mineralogy of the Bivalvia: Introduction: Nuculacea - Trigonacea. **Bull. Br. Mus. (Nat. Hist.) Zool**. Suppl., 3: 1-125.

Taylor, J.D., W. J. Kennedy, and A. Hall, 1973. The shell structure and mineralogy of the Bivalvia. I. Lucinacea-Calvagellacea. **Bull. Br. Mus. (Nat. Hist.) Zool**. Suppl., pp. 253-294.

Turekian, K.K. and R. L. Armstrong, 1960. Magnesium, strontium and barium concentrations and calcite/aragonite ratios of some Recent molluscan shells. **J. Marine Res.**, 18: 133151.

Vinogradov, A.P., 1953. **Elemental chemical composition of marine organisms.** Sears Foundation for marine research. Vol. II, New Haven, Yale Univ. Press.

Yasamanov, N.A., 1977. Strontium in the shells of modern freshwater mollusks and the possibility of determining the temperature of their habitat from Ca/Sr ratio. Trans. from **Geokhimiya**, 11: 1683-1690.