

## DISSOLUTION OF SOME TRACE ELEMENTS IN SOME ARAGONITE CORALS IN AN AQUEOUS SOLUTION

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### ABSTRACT

*Three different coral species have been geochemically analyzed. The mineralogical analysis indicates that they are composed principally of aragonite . It has been noted that no possible diagenetic alteration can be observed .Sr .Mg . and Ca are the more effective elements in both mineralogy and geochemical characters of the studied species. The dissolution experiment illustrates that no mineral transformation occurs indicating the stability of the studied aragonite coral species .*

### INTRODUCTION

Coral reefs accompany almost all coasts of the tropical seas such as the Red Sea which contains about 110 coral species<sup>1,2</sup>. Raised Pleistocene reefal limestones skirt the area of investigation (i.e, Hurgada). They resulted from a series of marine transgression which occurred in the Red Sea. The age of these formations dates back to 70,000-92,000 year B.C.<sup>3</sup>.

The biogenic skeletons of modern reef building corals are mostly composed of aragonite containing various minor elements. Many studies on the transformation of aragonite to calcite in an aqueous solution have reported that inorganic ions in aqueous solutions have a great influence on the transformation<sup>4-10</sup>.

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Kitano *et al.* (1980)<sup>11</sup> reported that : a) some coral pure aragonite transform in distilled water and some chloride solutions. However, the others never transform in any aqueous solution ; b) when powdered aragonite corals are suspended in an aqueous solution, two different types of suspension are observed; i) hydrophilic and ii) hydrophobic. The transformation rate of hydrophilic aragonite is higher than that of hydrophobic one . some aragonite corals are very stable but some others are fairly unstable.

#### MATERIAL AND METHODS OF ANALYSES

Three different coral species have been collected in February 1992 from Hurgada area. The taxonomy of the studied species can be summarized as follows :

|                                    |                           |
|------------------------------------|---------------------------|
| <b>Class :</b> Anthozoa;           |                           |
| <b>Subclass :</b> Hexacorallia     | Ehrenberg .1834           |
| <b>Order:</b> Scleractinia ;       | Haeckel. 1869             |
| 1) <b>Suborder :</b> Faviina;      | Bourne, 1900              |
| Family : Faviidae;                 | Vaughan and Wells. 1943 . |
| Genus : <i>Leptoria</i> ;          | Gregory 1900              |
| <i>Leptoria phrygia</i> ;          | Milne-Edwards , 1848 .    |
| 2) <b>suborder:</b> Astrocoeniina; | Ellis and Salander ,1785  |
| Family : Acroporidae;              | Vaughan and Wells .1943   |
| Genus : <i>Acropora</i> ;          | VeIll, 1902               |
| <i>Acropora sp.</i>                | Oken , 1815               |
| 3) Suborder ; Fungiina;            | Verill. 1965              |
| Family ; Fungiidae ;               | Dana , 1946               |
| Genus : <i>Fungia</i> ;            | Lamark, 1901              |

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*Fungia fungites*; Linnaeus, 1758

In the laboratory, the samples were washed in distilled water and left in air to dry. A portion of about 10 grams from the terminal part of each collected species was ground in an agate mortar. The powdered samples were preserved in labelled plastic bags for further chemical and mineralogical analyses. The studied species were chemically analysed for Ca, Mg, Sr, Mn, Zn, Cu, Pb, and Fe concentrations using Perkin-Elmer 2830 AAS. The mineralogical composition of the investigated species has been determined by X-ray diffraction analysis using Philips diffractogram.

Another portion of the studied coral species was used to illustrate the dissolution of some elements as a result of soaking in an aqueous solution for different time intervals ; whereas the studied species were cut with a diamond cutter to slices of 1 cm x 1 cm x 1 mm. The weight of each slice was about 100 mg, Two pieces of the sliced sample were suspended in 50 ml of 1% sodium chloride solution which was kept from evaporation. One piece was used for the determination of the change in the transformation and the other piece was used for studying the distribution of the elements in the sample.

In an experiment run, the solution was renewed every five days during the period the period of soaking suspension and in another run the solution was not renewed throughout the whole period. Each solution was stirred with a magnetic stirrer at 25°C .

## RESULTS AND DISCUSSION

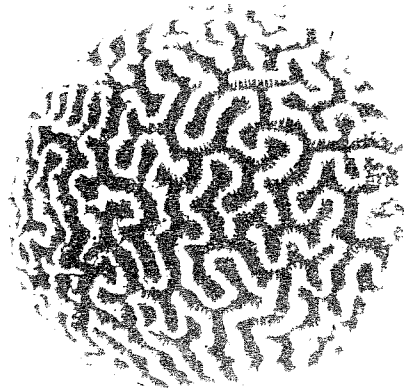
### I) Chemical and mineralogical compositions of the investigated species :

Table 1 illustrates the chemical composition of the studied species (Plates 1, 2, and 3). Ca% records its higher value (about 37.9 %) in *leptoria phrygia*. whereas its minimum value (36.9 %) was recorded in *Acropora* sp. The concentration of Ca in the Red Sea is relatively lower than its value in the Mediterranean. This can be interpreted on one hand on the basis of the absence of Ca supply by river water inflow, and on the other hand on the basis of its removal by corals and other marine organism. Mg attains its maximum value (860 ppm) in *Acropora* sp. and its lowest value (648 ppm) in *leptoria phrygia*. The differential variations of Mg<sup>++</sup> concentrations may be due to anionic substitution of Mg<sup>++</sup> in sites of Ca<sup>++</sup>. Magnesium is essential to the tissue and skeleton formation as well as to the body fluid chemistry of corals. The major factors controlling Mg concentration are ; skeletogenesis, mineralogy , water temperature and phylogenic level of the organisms<sup>12</sup>. Sr<sup>++</sup> concentraion records no much variations between the studies species whereas it records about 7600 ppm in *leptoria phrygia* and 7220 ppm in *Acropora* sp. Table 1 illustrates that Ca, M g, and Sr are the more effective elements in both the mineralogy and the geochemical characters of the studied species. According to El-Wakeel *et al.*<sup>13</sup>. Fe, Mn, Zn, and Cu are preesent in the coral skeleton and show variation between the different species indicating species- specific control.

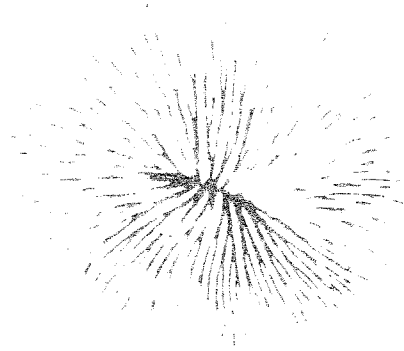
Mineralogically, all studied species are principally composed

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(1)



(2)



(3)

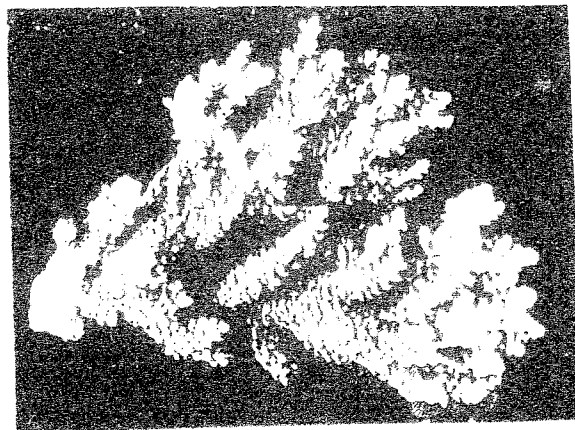


Fig.1: *Leptoria phrygia*.

Fig.2: *Fungia fungites*.

Fig.3: *Acropora* sp.

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Table (I): Chemical analysis of the studied coral reef species.

| Species                 | Ca   | ppm |      |     |     |     |     |     | Mg/Ca  | Sr/Ca |
|-------------------------|------|-----|------|-----|-----|-----|-----|-----|--------|-------|
|                         | %    | Mg  | Sr   | Mn  | Zn  | Cu  | Pb  | Fe  |        |       |
| <i>Leptoria phrygia</i> | 37.9 | 648 | 7600 | 4.2 | 4.9 | 4.7 | 145 | 155 | 0.0017 | 0.02  |
| <i>Fungia fungites</i>  | 37.4 | 753 | 7400 | 5.3 | 4.5 | 4.5 | 125 | 146 | 0.002  | 0.02  |
| <i>Acropora Sp.</i>     | 36.9 | 860 | 7220 | 4.2 | 4.2 | 4.2 | 102 | 89  | 0.0023 | 0.02  |

Table (II): Dissolution of the measured elements in *Leptoria phrygia* (F1), *Acropora sp.* (F2) and *Fungia fungites* (F3)

| Time interval                | Ca   | ppm |      |      |      |      |       |      | Mg/Ca   | Sr/Ca  |
|------------------------------|------|-----|------|------|------|------|-------|------|---------|--------|
|                              | %    | Mg  | Sr   | Mn   | Zn   | Cu   | Pb    | Fe   |         |        |
| <i>Leptoria phrygia</i> (F1) |      |     |      |      |      |      |       |      |         |        |
| 15 days                      | 37.0 | 637 | 7100 | 4.2  | 4.4  | 4.5  | 139   | 147  | 0.00172 | 0.0191 |
| 45 day unrenewed water       | 36.7 | 643 | 7080 | 4.08 | 4.65 | 4.3  | 130   | 140  | 0.00175 | 0.0193 |
| 45 day in renewed water      | 36.3 | 641 | 7050 | 3.99 | 4.55 | 3.9  | 127   | 138  | 0.0018  | 0.0194 |
| <i>Acropora sp.</i> (F2)     |      |     |      |      |      |      |       |      |         |        |
| 15 days                      | 36.8 | 739 | 7050 | 5.1  | 4.1  | 4.25 | 112.6 | 1402 | 0.0020  | 0.0191 |
| 45 day unrenewed water       | 36.5 | 747 | 7000 | 4.9  | 4.3  | 4.1  | 108.5 | 136  | 0.0020  | 0.0192 |
| 45 day in renewed water      | 36.2 | 754 | 6950 | 4.5  | 4.25 | 3.9  | 94    | 1315 | 0.0021  | 0.0192 |
| <i>Fungia fungites</i> (F3)  |      |     |      |      |      |      |       |      |         |        |
| 15 days                      | 36.4 | 845 | 7950 | 4.1  | 3.9  | 3.9  | 92    | 83   | 0.0023  | 0.022  |
| 45 day unrenewed water       | 36.2 | 853 | 6900 | 4.0  | 3.35 | 4.05 | 86    | 79   | 0.0024  | 0.019  |
| 45 day in renewed water      | 36.0 | 850 | 6850 | 3.9  | 3.05 | 4.0  | 75    | 37.5 | 0.0036  | 0.019  |

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of aragonite (Fig. 4). *Acropora* sp. shows traces of calcite and Mg-calcites. This can be interpreted on the basis of differential variations of both  $M^{++}$  and  $Sr^{++}$  in the studied coral species. The limited variation of  $Sr^{++}$  between the investigated species can be explained through the dominance of aragonite which constitutes the major part of the studied species. According to Milliman (1974)<sup>14</sup> and Folk (1974)<sup>15</sup>, the following parameters are important for the formation of aragonite;  $Mg^{++}$  in solution, high water temperature (between 20° and 30°C) high PH, presence of certain organic compounds, presence of  $Sr^{++}$  and possibly  $Ba^{++}$  and  $Pb^{++}$ .

In general, the skeleton of Hurgada corals are aragonitic. However, traces of Mg -calcite and calcite indicate that no possible diagenetic or alteration of the carbonate minerals occurs in this area, even in the exposed corals in the reef flat<sup>13</sup>.

The petrographic examination (Fig. 5 a, b, c) illustrates the needle structure of aragonite which constitutes the major part of the studied coral species.

Generally, the mineralogical and elemental variations in the corals of Hurgada is possibly a function of ; the rate of the coral metabolism, rate of skeletogenesis and biological contamination.

### **II) Dissolution of some elements in the studied species in an aqueous solution :**

The slices of the studied species were soaked in sodium chloride solution for different time intervals to observe the dissolution of the studied elements.

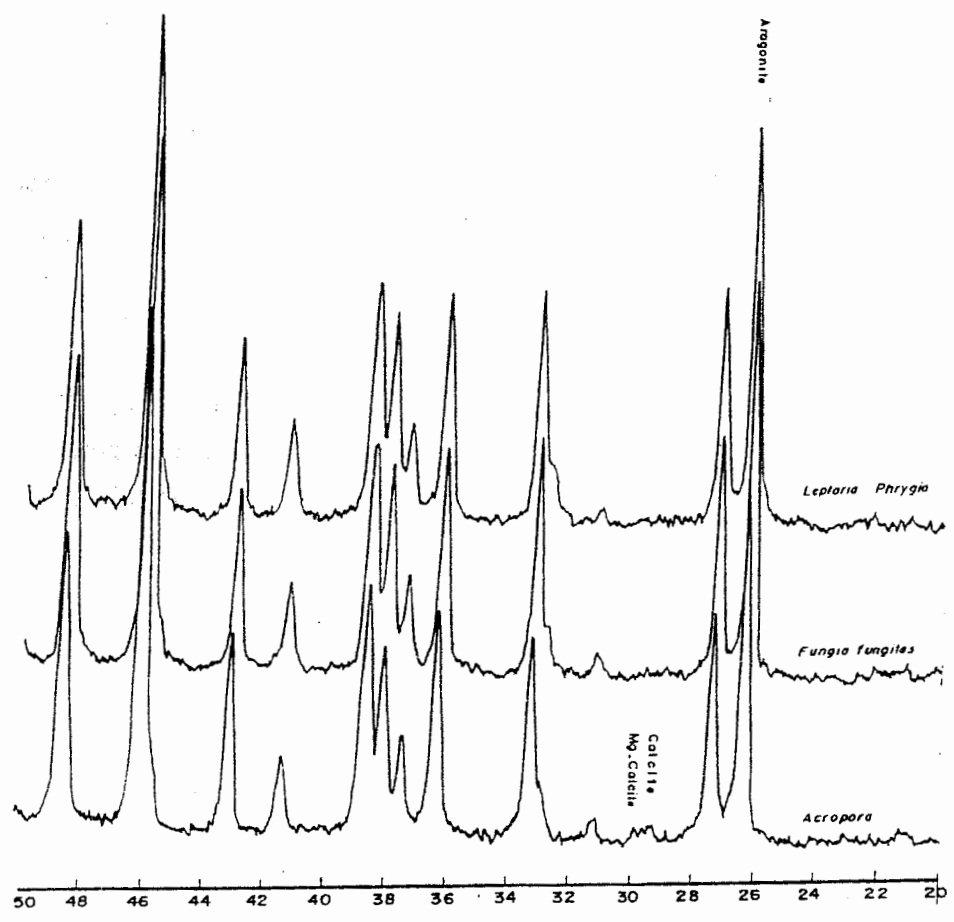


Fig 4 : X \_ray pattern of the studied coral reef species .



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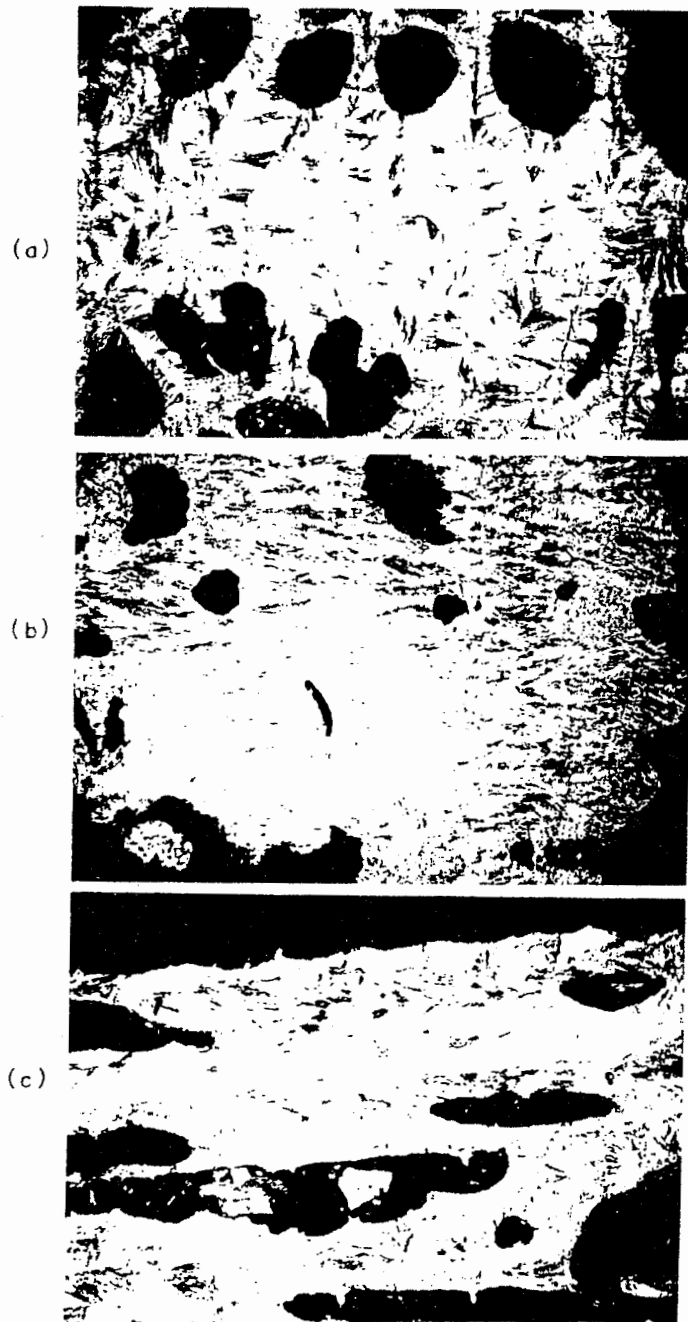


Fig. 5: Photomicrograph of (a) *Leptoria phrygia* (b) *Fungia fungites* (c) *Acropora*.

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Table II, shows the concentrations of the measured elements in the investigated species at different time intervals of soaking in sodium chloride solution.

In dissolution experiments, the studied coral species did not show mineral transformation i.e. aragonite to calcite. Kitano *et al.*<sup>11</sup> reported that some coral pure aragonites transform in distilled water and sodium chloride solution, whereas, some other coral pure aragonite, do never transform in any solution. Figures 6 a, 6 b and 6c respectively show the changes in the amount of Mg, Sr and Zn dissolved from the sliced aragonite samples into sodium chloride solutions which were renewed every five days. The amount of released Mg ions into the solution is large at the initial stage of suspension and then it reaches a constant value after 30 days. Contrary to that we find that the released Sr<sup>++</sup> is small at the initial stage of 5 days suspension and it reaches a constant value throughout the remaining periods of suspension. It was reported that the presence of Mg ions in a solution strongly inhibits the transformation of aragonite to calcite. Ameil *et al.*<sup>15</sup> mentioned that Mg is a major exchangeable cation adsorbed on the surface of aragonite inhibiting any calcite precipitation on the aragonite surface. Kitano *et al.*<sup>9</sup> reported that aragonite never transforms into calcite in an aqueous solution containing Mg and Zn ions. It is supposed that magnesium and zinc ions adsorbed on aragonite reduce the rate of transformation into calcite. However, it was noticed that the rate of transformation depends principally on the stability of biogenic aragonite crystals.

Figs. (7 a and 7 b ) show the concentration ratios of Mg<sup>++</sup>/Ca<sup>++</sup> and Sr<sup>++</sup>/Ca<sup>++</sup> dissolved from aragonite into sodium chloride during

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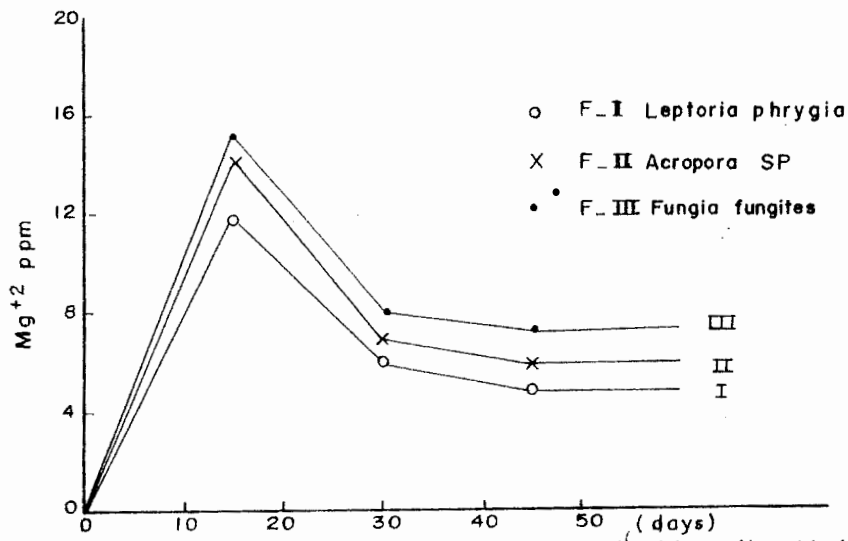


Fig. 6a: Amounts of Mg dissolved from coral aragonite into sodium chloride solution when renewed every five days.

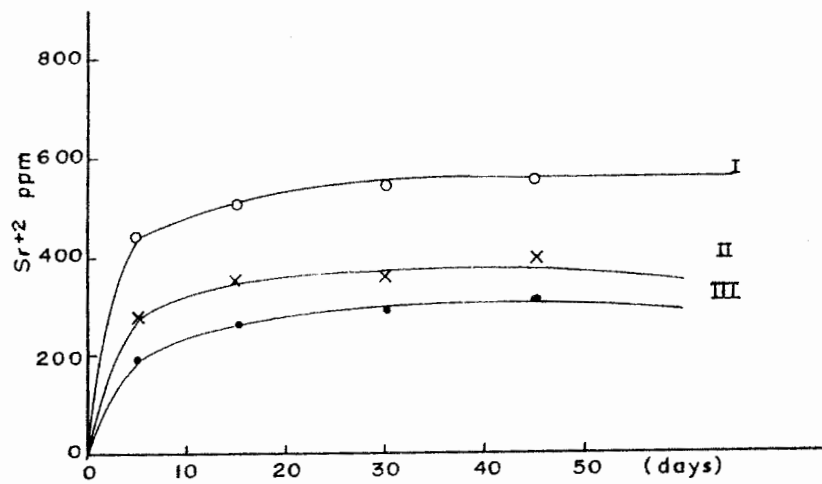


Fig. 6b: Amounts of Sr dissolved from coral aragonite into sodium chloride solution when renewed every five days.

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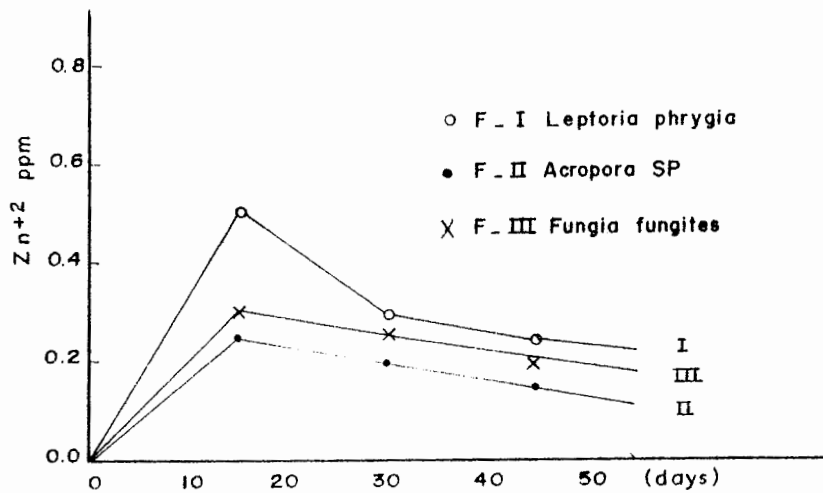


Fig.6c: Amounts of Zn dissolved from coral aragonite into sodium chloride solution when renewed every five days.

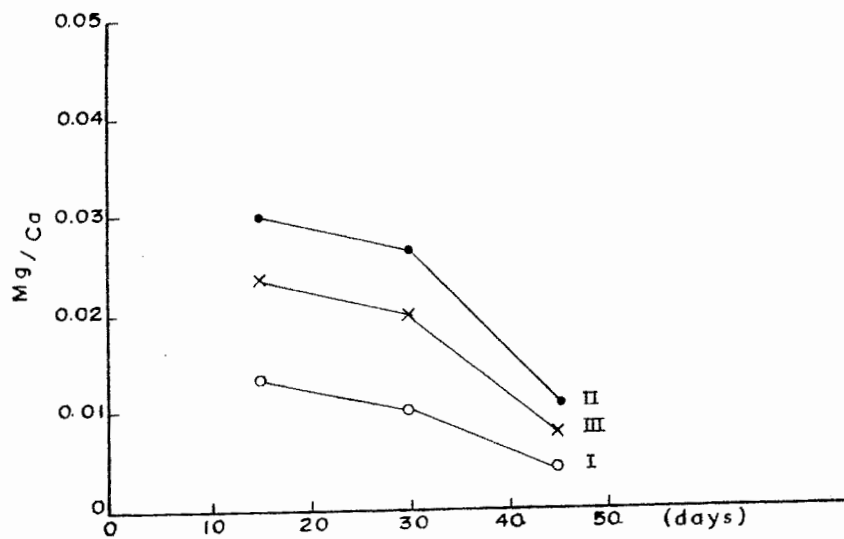


Fig.7a: Ratio of magnesium to calcium (Mg/Ca) ions dissolved into sodium chloride solution without renewing the solution.

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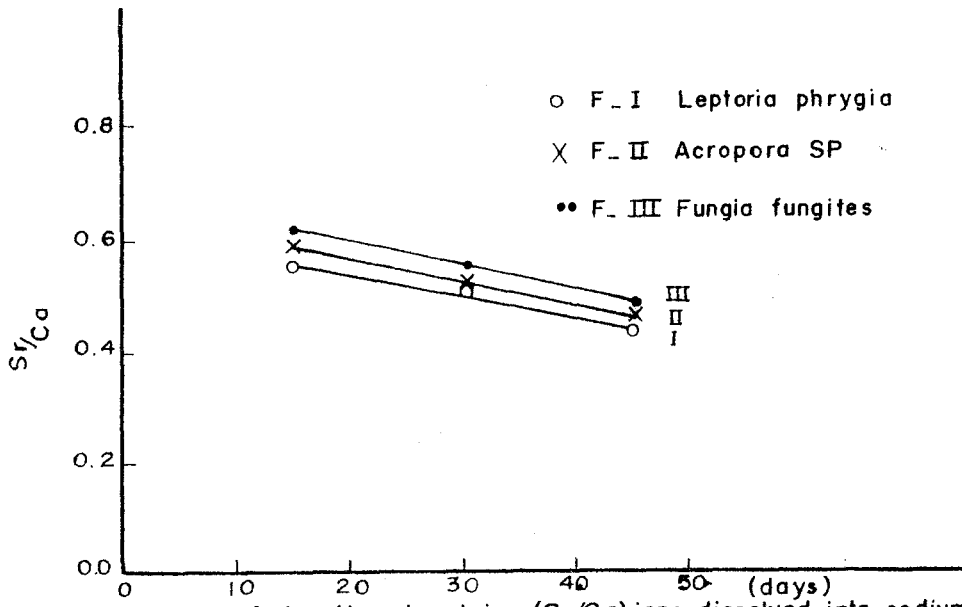


Fig. 7 b: Ratio of strontium to calcium (Sr/Ca) ions dissolved into sodium chloride solution.

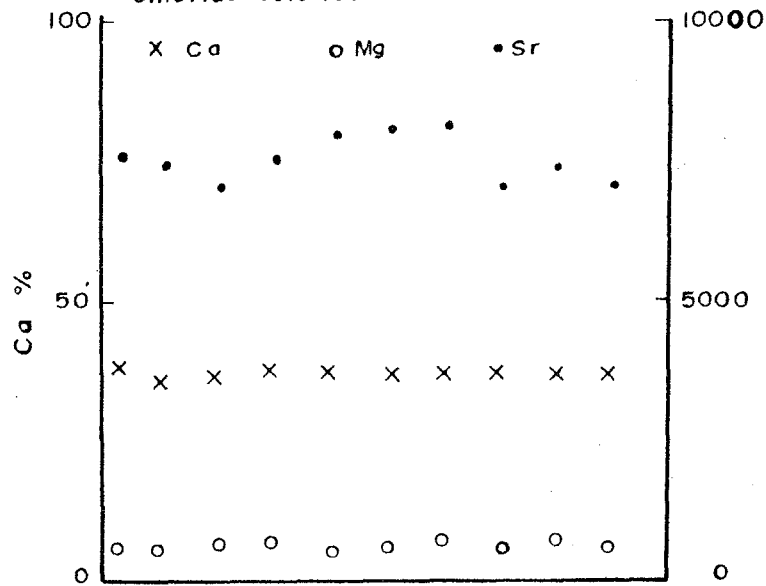


Fig.8 : Variation of Ca, Mg and Sr contents of coral reef species after soaking in sodium chloride solution for 45 days.

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the continuous soaking without renewing the solution. After soaking, it was noticed that there was no mineral transformation. Accordingly, the variations of both Ca and Mg after the soaking is very limited.

Ca, Mg and Sr contents in the studied coral skeletons are distributed homogeneously before soaking and their variations seem to be very limited after soaking (Fig , 8).

#### CONCLUSION

Owing to the stability of the aragonite of the studied coral species it is observed that there is no mineral transformation. Both Mg and Sr show very limited variations after suspension in sodium chloride solution. This can be interpreted on the basis of the stability of crystal lattice of aragonite in which the studied elements are incorporated .

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## الملخص العربى

### إذابة بعض العناصر من شعب مرجانية فى محلول مائى

محمد على محمد شطا ، ساميه خميس حمدونه  
المعهد القومى لعلوم البحار والمصايد - قايتباى - الإسكندرية

تمت دراسة جيوكيميائية لثلاثة أنواع من الشعب المرجانية تتكون أساساً من معدن الأراجونيت . فقد أوضحت الدراسة عدم وجود تغييرات أساسية فى التركيب المعدنى للعينات كما بينت الدراسة أن كل من السترونشيوم والماغنسيوم والكالسيوم تعتبر عناصر مؤثرة فى الصفات الجيوكيميائية ، ولقد لوحظ فى تجارب الإسالة عدم وجود تحول معدنى للعينات مما يؤكد ثبات هذه العينات التى خضعت للبحث .