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Study the Effect of Biological Activities in Deterioration of Archaeological Painted Pottery and its Treatment and Conservation with Application on Selected Object

Doaa Samir Ahmed Al-Nashar

Nagwa Sayed Abd Alrahim[1]

Ehab Moaz Abu Zaid[2]

Hamada Sadiq Ramadan[3]

Professor at the Department of Archeology Restoration, Faculty of Archeology, Fayoum University[1]

Professor at the Department of Zoology, Faculty of Science, Fayoum University[2]

Assistant Professor, Department of Archeology Restoration, Faculty of Archeology, Fayoum University[3]

Research Summary:

The research deals with the restoration of one of the colored pottery coffins, the identification of the biological injury scenario, the restoration and maintenance of the colored pottery coffin and the assembly of its parts.

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Introduction:

In a distinct study of a phenomenon that had never been experienced by an archaeological pottery sarcophagus extracted from excavations. The study dealt with the discovery of a colored pottery sarcophagus dating back to the Greco-Roman era containing some inscriptions, including the god Anubis, who was believed by the ancient Egyptians to protect the body from damage and theft, but was also found in this The coffin is a rare type of damage that has not dealt with archeology before this biological injury was identified, and this was rare because of the earthworm, and so this damage was examined through the historical study of this coffin, and then identifying the cause of this damage, which was not known before and is rare, which is Biological infestation by knowing the life cycle of the earthworm (2) and it was identified after conducting tests, analyzes and the pilot study. Matching models were made for the tests and analyzes. The earthworm was placed in this sample, so the tunnels in the experimental sample were matched with the coffin under study and also different measurements of the size of the worm were made and thus A statistical table was drawn up comparing each of the tunnels in the coffin under study, as well as the tunnels in the experimental sample, and the table proved the matching of the tunnels, thus we record the first reference in the Antiquities in particular and the first historical reference in general to record the phenomenon of biological damage due to earthworms.

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1- Damaged of sarcophagus:

Part of the pottery sarcophagus shows damage to the biological activity represented by the tunnels on the surface of the colored pottery sarcophagus with damage to the color layer.

Picture No. (1) shows the loss of the color layer with the appearance of tunnels in the hull layer below the color layer and the colors peeling off

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Picture No. (2,3) represents some tunnels and pits as a result of the biological activity processes in the impact

Analytical study:

The analytical and applied study in this research was conducted on a colored pottery sarcophagus dating back to the Greco-Roman era.

a. **Various examinations and analyzes:**
   Examinations and analyzes helped to identify the organic materials entering the industry, through which the causes of biological injury were known and the different degrees of burning were identified. The composition of each of its basic components and colors was also identified.

   B. Impact Assessment (Photography):
   All parts of the sarcophagus, inside and out, were photographed and recorded, and the pieces were numbered.

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C. Recording the general condition of the coffin and the extent of damage suffered by the coffin:

It also appears from the general pictures that the coffin suffers from severe damage, both externally and internally, and we note that the number of parts of the coffin reached 119 pieces before the restoration, treatment and maintenance.

Picture (4,5) of the apparent damage to the coffin before starting the restoration process

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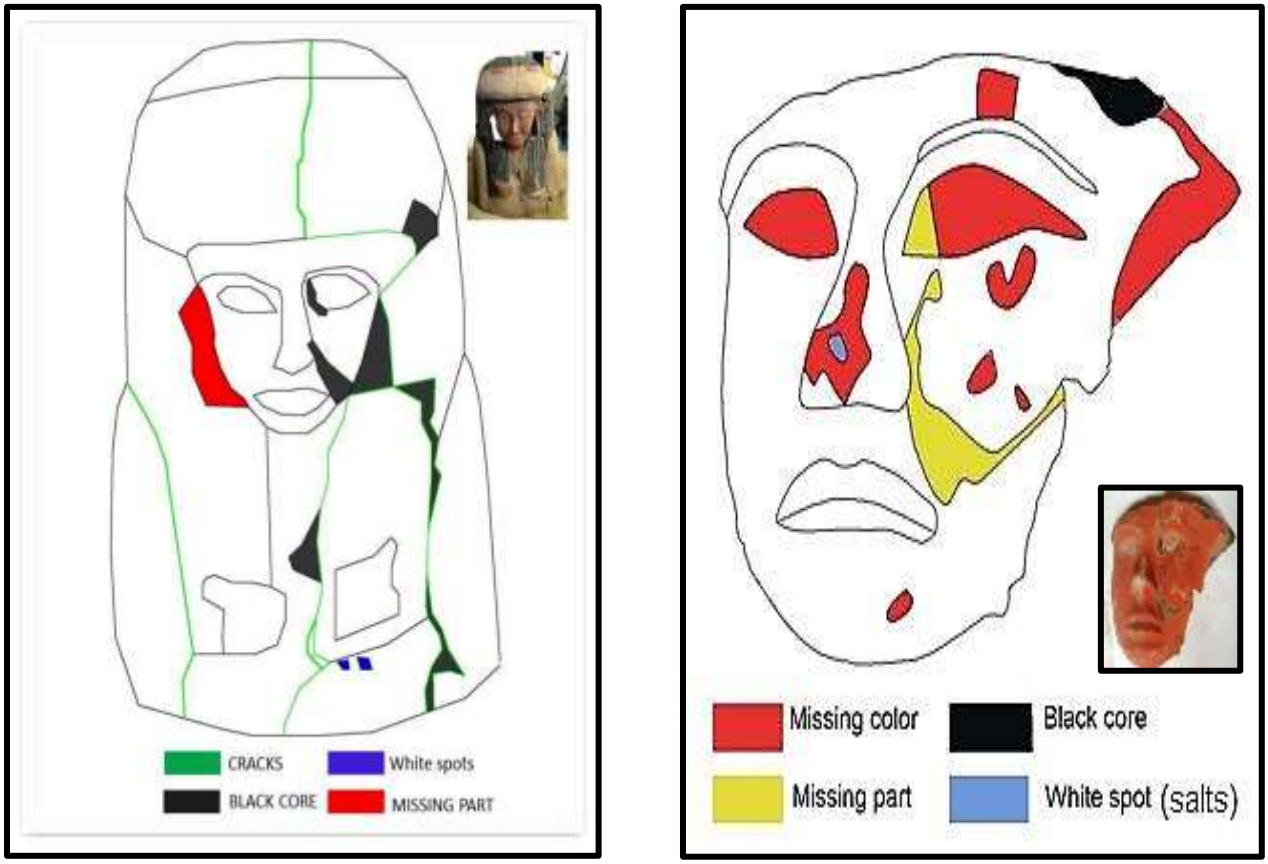

Figure No. (1,2) Using AutoCAD programs to document the appearance of damage on the face of the coffin lid

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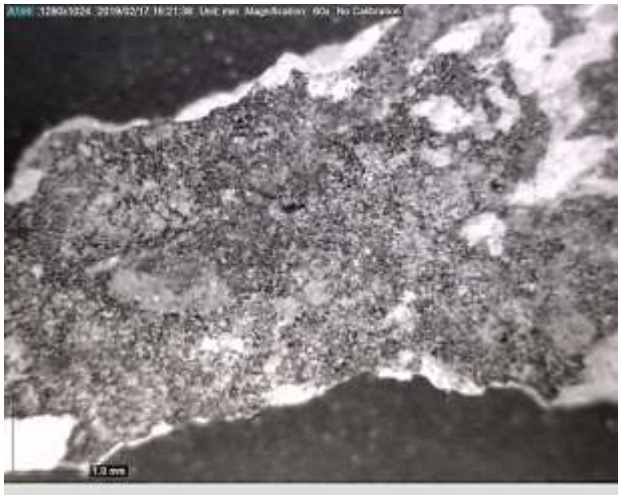
Picture No. (6) shows the upper part of the coffin and shows cracks and some loss of parts of the face

d. Infrared (IR) scan and imaging:

Infrared rays are able to fluoresce distinct colors, especially colors, and each material gives a specific reflection through which the material used can be identified. This method was used to photograph some samples from the coffin as in Picture No. (7,8) infrared imaging.



Picture No. (7) The sample shows layers of black color with the appearance of the lining layer in white, and it shows the separation of the coloring layer and some fine tunnels through the coffin

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Picture No. (8) shows a sample of pottery on the right side, where one of the earthworms appears dead in the pottery mud, as well as the salts caused by these worms, as well as quartz grains, which indicates the state of general weakness in the colored pottery coffin.

c. Scanning Electron Microscope:

It is one of the modern and important techniques that have been widely used in the restoration of antiquities and that are indispensable in the future. It has been used to study the morphology of the sample, the mineral composition, Morphological and Micro textural. A Scanning Electron microscope model: quanta-200 was used, and the following is an explanation The most important samples were analyzed using a scanning electron microscope.

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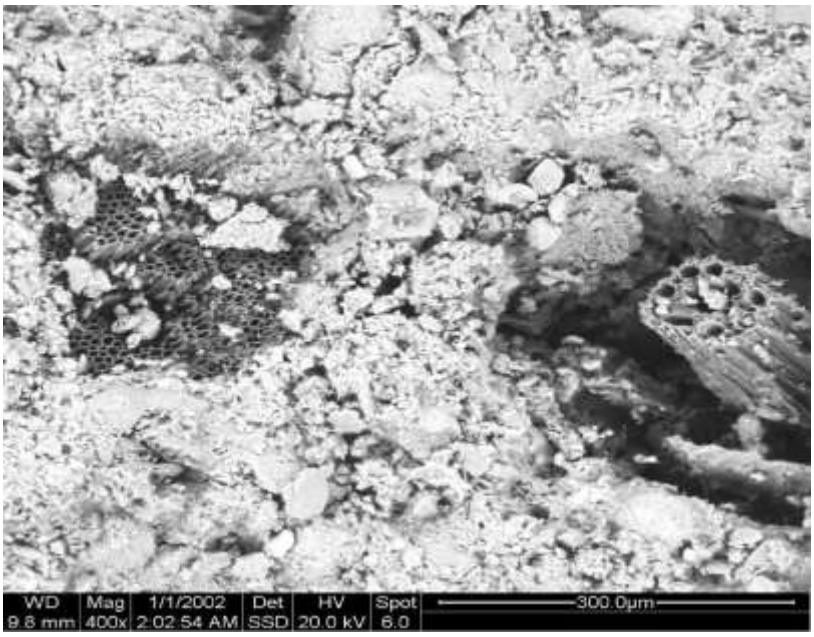
Sample No. 1 represents a sample of pottery under a scanning electron microscope with a magnification of 400X showing the hexagonal tunnels of the hose worm and their destructive effect on the cohesion and strength of the pottery coffin. General weakness of the coffin lid Picture No. (9)



Picture No. (9) Sample No. 1 shows the organic materials used in the pottery industry. The ancient Egyptian used plant stems and Nile rose as an organic additive to pottery.

sample number 2

An image below the scanning electron microscope with a magnification of 130 X showing the shape of one of the tunnels and the breadth of its diameter in the coffin, and this confirms that the overall shape of the coffin is very weak and that these tunnels represent an imminent danger of disintegration and fragmentation of the coffin. Picture No. (10)

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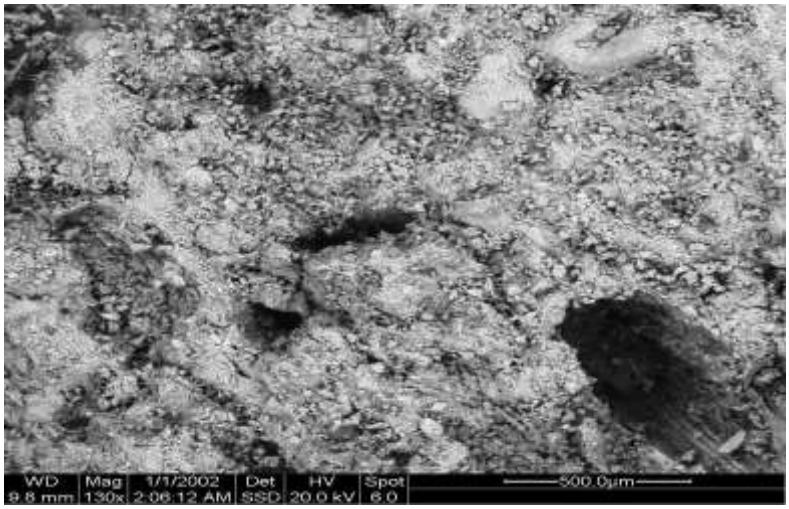

Picture No. (10) Sample No. 2 A sample representing the different tunnels created by the worm of different sizes and sizes and showing the widening of the spaces, which shows the weakness of this coffin

e. Analysis using X-ray diffraction:

It is one of the important and indispensable ways to identify compounds and is characterized by extreme scientific accuracy in identifying archaeological materials in the form of compounds(6), and it is considered one of the qualitative and qualitative methods of materials(7), in which X-rays deal with the distinct crystal structure of each substance and deviate X-rays The X-ray diffraction method helps in studying the mineral changes that occurred when the child was burned, according to the distinctive crystal structure(8), and these distinctive reflections are recorded in what is known as the X-ray

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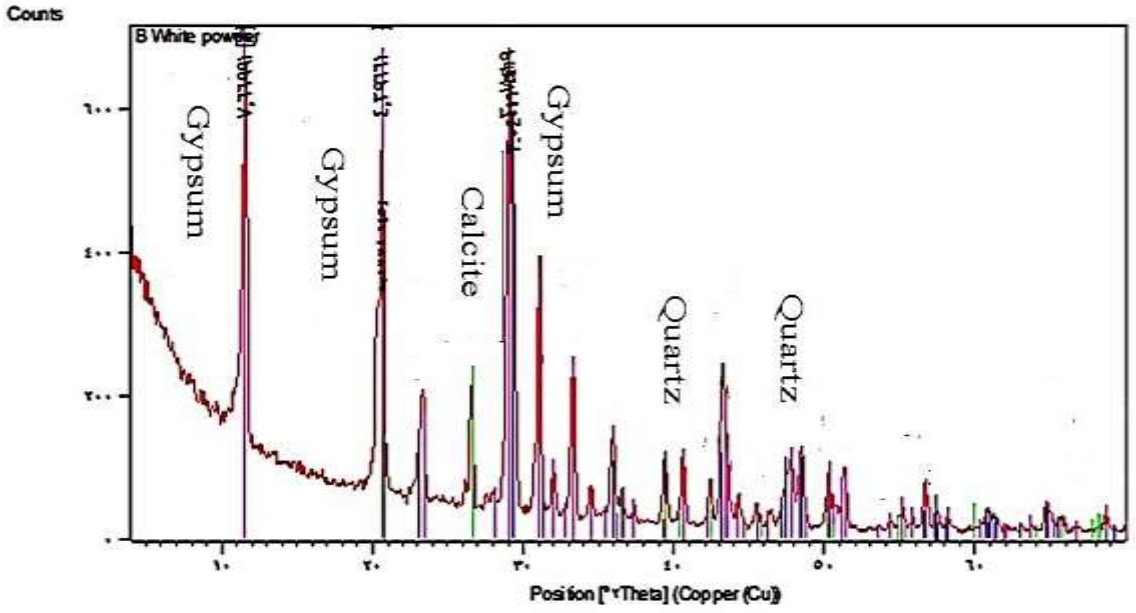
diffraction pattern. Identifying the burning temperature on the basis that the different crystalline phases of the minerals in the burnt clay change according to the burning temperature[9].



proportion of the compound in the sample	compound
%53	Gypsum
%37	Calcite
%9	quartz

Picture No. (11) shows the X-ray diffraction pattern of the Shed layer in the coffin

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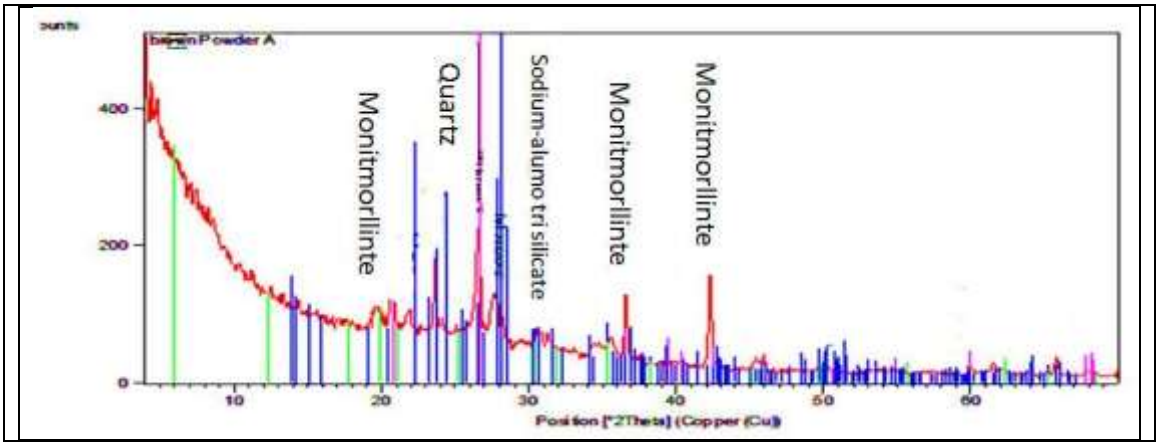
The clay used in the manufacture of the coffin is indigo clay, not lime clay, as shown in Picture No. (12)



proportion of the compound in the sample	compound
%60	Sodium and aluminum silicate
%10	mentholylents
%30	quartz

Picture No. (12) shows an X-ray diffraction pattern of brown falling crumbs in the coffin lid

F–THERMO GRAVIMETRIC ANALYSIS

A sample was taken from the middle of the coffin (from the inner core of the coffin) Picture No. (13)

From the thermal analysis, it was possible to identify the temperature used in the burning, as the temperature reached about 500 degrees Celsius in sample No. 1, which means that the burning temperature was very weak, and this means that the inner core of the coffin is weak in burning and the

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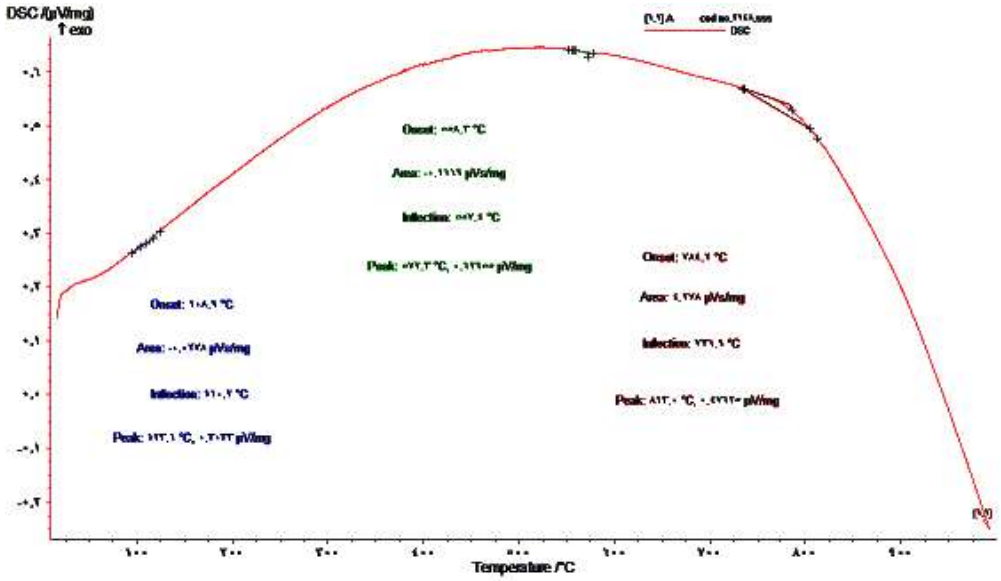
consequent general weakness of the coffin as a whole and this It is clear from the picture No. (13) on the organic materials (10)



Picture No. (13) shows the thermal curve of sample No. 1 taken from the core of the coffin

D. Experimental study

The experimental study included the identification of biological infection with the following stages

First: - The formation of a mixture of clay similar to the composition of the clay of the pottery sarcophagus under study, based on the X-ray diffraction analysis that was conducted for the pottery coffin. Organic as shown in the FTIR analysis. Water was added in a large percentage until the sample was formed to represent the impact environment. It was placed in a plastic box with a height of 70 cm. Slots were made in the lid to ensure that oxygen reached the worm.

Second: - 30 worms were placed at exactly 10 am, and then it was found that the worms escaped to the surface, and after continuous observation, it was found at exactly 4:30 pm that the worms were

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unable to enter the soil again (Photo No. (14) and at exactly 7:00 pm) A part of the soil of the worms was taken, and then the dough was re-kneaded from the silt and the clay again, while maintaining the humidity of the sample. The worms were placed in the dark again. Picture No. (15) and at 8:30, the worms made similar tunnels to the same existing tunnels. With the impact on the surface, these tunnels extend from the inside to the outside, and the tunnels were counted and reached 30 tunnels with the continuous increase in the work of tunnels

After approximately 24 hours, an unpleasant smell began to emitted and the worms rose to the surface at exactly 9 o'clock of the next day. Measurements and statistics were made by measuring nearly 50 sizes of tunnels using the foot of its kind. VERNIER CALIPER 150 MM X 0.02MM/6 "1 / 1000" and pictures No. (16) illustrate the use of the foot in measuring a different number of worms, where the head of the worm and the end of the worm are measured.

Picture No. (14) shows the death of some worms and their exit to the surface

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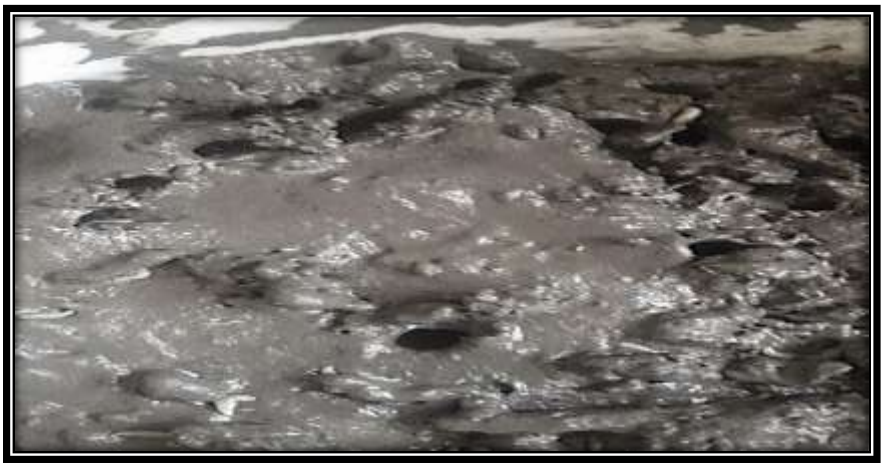

Picture No. (15) shows the shape of the tunnels after feeding the worm on the mud

Picture No. (16) shows the use of kidma in measuring the head and end of the worm

- A comparison was made for these measurements with the tunnels on the surface of the sample, where the sample was burned in the oven at Cairo University, after 6 months of drying the sample until the burning was done in the correct way.

- The sample was burned in the oven at 500 degrees gradually and burned at 100 degrees for an hour and then the burning was gradually increased to reach the indicated degree and the sample was taken out after 24 hours of burning and measuring the tunnels and the picture

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No. 17, 18 shows the sample that was burned and the measurement of the tunnels.

A statistical table was made, and the results showed the congruence between the tunnels in the colored archaeological lid and the tunnels in the experimental part. The cover and caused the deformation and weakness of this coffin, and this is what the following tables show.

Table No. 1 shows a comparative analysis of the measurements of the holes and the diameter of the body of the earthworm

	Fresh earth worm diameter (A) earthworm diameter	The Diameter of the pore in Simulated cover (B) The diameter of the tunnels in the experimental sample	The diameter of the pore in the True cover of the Coffin (C) The diameter of the tunnels in the coffin under study
n	**60**	**14**	**51**
***Mean ± S.D**	**2.8641±0.85**	**2.2643±0.88**	**2.8284±0.97**
Bonferroni and Holm Post Hoc test			
A vs B	***P*= 0.11**		**insignificant**
A vs C	***P*= 0.89**		**insignificant**
B vs C	***P*= 0.16**		**insignificant**
C vs D	***P*= 0.16**		**insignificant**

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It shows the shape of the tunnels after feeding the worm on the mud in the experimental sample

Picture No. (17, 18) shows the sample after burning it and the shape of the tunnels dug by the worm

d. Applied study:

The treatment and maintenance phase of the colored earthenware sarcophagus

This stage included many methods, which are as follows:

1-Mechanical cleaning:

Mechanical cleaning is one of the best cleaning methods because it is less damaging to the effects and safer on them. The cleaning operations were carried out using soft brushes to remove dust and calcifications on the artifacts. The softening method was used in some parts to separate the dust from the surfaces, where these plankton should remain relatively soft as It can be removed and detected easily by different tools.

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Picture number 20

Picture number 19

Picture No. 19 and 20 illustrate the use of brushes and furry in mechanical cleaning operations

e. Chemical cleaning:

Chemical cleaning was used to clean some of the calcifications of salts and lime calcifications, which are soluble halite salts and their main composition is sodium chloride found on some artifacts of the colored coffin. Ethyl alcohol and acetone were initially used, but they did not give satisfactory results. Picture No. (21) due to the speed of volatilization of these compounds. The use of a paste of carbopol (carbo-gel) and carbopol is the trade name for a group of synthetic polymers made of acrylic that has the ability to dissolve in water and alcohols. The practical basis for using carbopol is that it retains the

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cleaning substance within its molecule for long periods thanks to its high viscosity, the carbopol reference.

Picture No. 21 Use of chemical cleaning

1- Assembly stage (reconstruction of pottery coffin) Re attachment

Picture No. (22) represents the hole of the artifact in preparation for placing the fiberglass sticks

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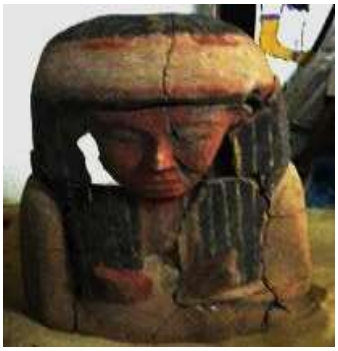
Picture No. (23) of fiberglass sticks in the holes and joining the pieces on each other in preparation for their assembly

Picture No. (25) shows the assembly of the coffin



Picture No. (24) shows while assembling a face

-The coffin parts and the separate colors were hardened with Paralloid 72 concentration 2%.

- It was also collected by using fiberglass bars and making fillers from microballoon with Paralloid 72.

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