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Mud Wasps and Its Role in the Destruction of Ancient Buildings in Application to the Temple of Isis in the Temple of Dandara, Qena, Egypt and Methods of Prevention

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Abstract

Mud wasps are one of the most important problems that many archaeological sites suffer from in Egypt, especially in southern Egypt. Wasp's growth increases, especially on the surface of stones or on mud-brick buildings, which represents a major challenge to these archaeological sites. It works to hide the stone surfaces and archaeological inscriptions found on them in addition to that it works to damage the stone surfaces themselves through the nests that they build on these surfaces. It works on weakening the structure of sandstone and the study that included a study on mud wasps and Analysis of nests and studied through the use of various devices and methods, the damage and its nature have also been studied as a result of the presence of wasp nests and the reasons for their existence. Various treatment methods and the best appropriate methods for treating sandstone and stopping wasp activity have also been studied.

Keywords

Mud Wasps, Sandstone, Temple of Isis, Destruction, Treatment

1. Introduction

1.1. Archaeological Study of the Temple of Isis

The Temple of Isis, a small temple, is located in the western corner of the Temple of Dendera in Qena, Egypt, which was built by the Roman Caesar Nero. The two temples are linked by a paved road with a length of 130 meters. There is also a “mamizi” (birth house) in the north of the Temple of Isis, about 70 meters away, which was built for the goddess Hathor (**Figure 1**).

1.2. Degradation Causes

It was observed that many inscriptions, especially those found in the outer walls, were obscured by wasp nests, which are clay nests as a result of the presence of wasps, where they live on the surfaces of stones for decades, the amount of coverage caused by the nests of the wasps has increased, especially in recent periods, as a result of the increase in the number of wasps on the site until they started to cause some harm to visitors, it was necessary to devise some appropriate solutions to eliminate the wasps, which is the main source in addition to removing the nests of the wasps in ways that are scientifically recognized and as permitted by the impact case, and through the observation of the temple, it was monitored how difficult it is to remove these nests, as the area was completely covered by these deposits on a flat surface of approximately. In addition, these deposits on the walls are very thick and this is observed in areas exposed to shade for large periods of the day and are effective on the degree of thickness of other walls, which range from the thickness of the products of wasps to nests and other adhesives from 20 - 50 cm, it is noted that when the wasps do not find the appropriate place to make their own nests, they exploit the deep places near the inscriptions or in stone breaks (**Figures 2(a)-(d)**), and we may find this in the cracks in the stones as a result of the stresses on the sandstone. There are also large quantities of sediment formed on the old mud bricks surrounding the temple, which were built to protect the temple, also, many of these deposits are found on the walls of the buildings of the people and the surrounding or near the temple. The deposits and calcifications are present in the window openings or at the entrances to the doors, especially in the buildings that have been discontinued for a while.

And many studies dealt with sandstone damage and discussed several processes that lead to damage [1]. Sandstone damage leads to the beginning of exposure to

Figure 1. The Temple of Dendara, Google 2021.

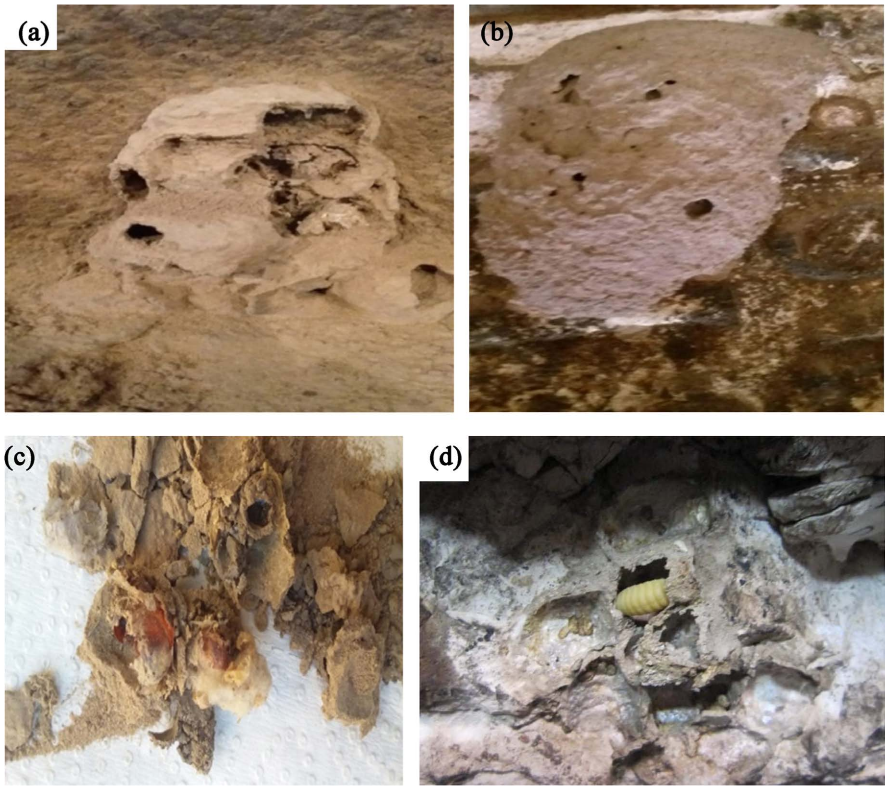


Figure 2. Shows some areas where wasp nests are deposited and under which many of the inscriptions on the stone surface are hidden.

other types of damage [2]. And sandstone contains some clay materials such as cement [3], Which causes severe damage to the sandstone [4] as a result of the occurrence of swelling and contraction of the clay material [5] due to the absorption or dryness of water [6] [7]. As a result of the presence of clay materials in the sandstone, it leads to weak mechanical properties [8], which results in the weakness of the sandstone in its ability to resist the pressures on it [9], which leads to the emergence of many cracks [10]. Also, sandstone damage depends on the environmental conditions to which it is exposed [11]. Also, sandstone damage is a result of internal factors in terms of the nature of its formation or as a result of external influences such as the average temperature, relative humidity, and biological and human damage factors [12]. Also, the extreme change in climate factors has a major impact on the damage of sandstone [13], especially that contains clay materials [14], as cement or presence with the cement from other materials [15]. Sandstone is greatly affected by the presence of salts [16] on or below the stone surface [17]. There is also a direct relationship between the chemical composition of sandstone and the rates of damage [18] [19].

Mud wasps are ecologically beneficial, but they can be dangerous to ancient buildings due to their build nests in these buildings. The present study was aimed at the screening of wasp repellents to point out the most promising ones, and to this effect, we designed a Y-olfactometer bioassay. The olfactory responses of wasp adults to the odors of different essential oils including *Artemisia* *absinthium* (Asteraceae), *Cinnamomum zeylanicum* (Lauraceae), *Mentha piperita* (*Lamiaceae*), *Zingiber officinalis* (Zingiberaceae) and *Cinnamomum camphora* (Lauraceae) were studied.

1.3. Sandstone Building Study

Sandstone is largely found on the surface of the earth [20]. Sandstone is a sedimentary rock that has been widely used in many ancient buildings around the world. Sandstone damage has been studied in several studies in recent periods [21] [22]. The effect of heat on sandstone components was also studied [23]. Sandstone is made up of particles with a diameter of no more than 2 mm. Quartz is considered the main component in sandstones, while some small parts are found in feldspar, mica, clay minerals, ferrous minerals, and carbonates [24]. sandstone properties are changed by the presence of various minerals in cement materials such as silicon dioxide, iron oxides, iron hydroxide, clay, and calcium carbonate [25] in addition to the size of the granules, the degree of screening, the degree of rotation of the particles, the mineral composition, the sedimentation rate of the cement materials, the types of cement, and the texture of sandstone [26].

2. Materials and Methods

2.1. Methods of Examination

To define the sandstone, the authors collected non-destructive sandstone samples from the Isis temple compartment. These samples were petrographically studied using a polarizing microscope and chemically analyzed by XRF techniques. Moreover, representative sandstone samples were powdered and x-rayed to identify, quantify, and characterize their mineral species. The mineralogical analyses were carried out by the (XRD) technique. XRD patterns of powdered bulk samples were recorded using a Philips X-ray diffraction equipment model PW/1710 with a monochromator, Cu k -α radiation (λ = 1.54 Å) at 40 kV, 35 mA, in the Department of Physics, Assiut University, Egypt. After that, diffraction data were analyzed. Finally, Scanning Electron Microscope (SEM), (SEM JEOL JSM5500LV) was used to study the micro-texture, degradation, and deterioration characteristics of the studied sandstone.

The study was conducted in terms of the reasons for the wasps attacking the temple buildings in addition to the scientific methods to stop this problem and remove these deposits, study of the types of wasps present and their feeding methods, the way in which they build their nests, the types of secretions that they secrete in construction operations and the extent of their chemical and physical effects on the stone surface of the sandstone with a study of wasp activities and periods that are more dangerous in the year.

2.2. Chemical Analyzes

It was noted through the study of non-destructive samples which collected consists mainly of clay and sand and a small percentage of sugars in addition to the presence of salts, fats, and waxes, and this indicates the possibility of removing these deposits using water. According to what was done in 1951, the work that was done to clean a small area of the Mamaisei walls using water, where the results showed that the water removed with the difficulty of all sediments, but it was noted that brown dirt was left behind from the previous cleaning and the places containing modern nests were the most affected by this dirt. Most of this dirt was removed with 10 percent ammonium hydroxide solution. Two nests were taken. One of these nests was old, while the other was modern. It was collected from under the walls of the temple. These samples were analyzed quantitatively by chemical methods.

2.3. Insect Bioassay

Collection of Wasp Samples

Wasps were collected from several farms nearest to the temple of Dandara using a net at the daytime, generally in the morning. Then, the adults were transported to the laboratory in plastic vials (diameter 3.5 cm, height 7 cm) and they were provided with a droplet of sugar syrup.

2.4. Essential Oils

Plant Materials

Parts of the plants collected Leaves of *Artemisia absinthium* (Asteraceae), *Mentha piperita* (*Lamiaceae*), *Ocimum basilicum* (Lamiaceae), and Inner bark of *Cinnamomum camphora* (Lauraceae), and rhizomes of *Zingiber officinal is* (Zingiberaceae) were collected from organic farmers in Egypt (Table 1).

The herbs were then dried in a dark room under ambient conditions (30˚C - 40˚C) for four days on a large screened tray, packed in bags of polyethylene. Then, put in a cardboard box and placed in a dark and cool room for make tests. The moisture content of the plants was measured using a laboratory oven by drying until constant weight and was about 12.4% ± 0.2%.

2.5. Extract Oils-Steam Distillation Apparatus and Procedure

A schematic diagram of the steam distillation apparatus used for essential oil extraction. The apparatus has a cylindrical Pyrex body (6 cm inside diameter and 60 cm height). A batch of 100 - 200 g of dried and ground part of each plant was

Table 1. Essential oils evaluated for repellent activity against *Sceliphron caementarium.*

Botanicals	Common name	Family	Parts used
Artemisia absinthium	wormwood	Asteraceae	Leaf
Cinnamomum camphora	Camphor	Lauraceae	Leaf
Cinnamomum zeylanicum	Cinnamon	*Lauraceae*	Inner bark
Mentha piperita	Peppermint	*Lamiaceae*	Leaf
Zingiber officinale	Ginger	*Zingiberaceae*	Rhizome

packed in the column with 2000 ml water in the steam source. Then, the lid was closed and steam was injected into the bottom of the column to begin the process of distillation. Each plant bed was exposed to a flow rate of steam for up to 3 h. The extraction process of essential oils from tested plants was continued at no more essential oils were shown in the column. During the first 1 h, the collected essential oils were decanted from the condensate at 2.5-min intervals followed by decanting of the essential oils every 30-min. Water in the essential oils was removed by drying the extractions over anhydrous sodium sulfate and stored in amber vials at 4˚C.

2.6. Olfactometer Bioassay

Adult *Sceliphron caementarium* was tested in a two-way airflow olfactometer. The bioassay provides a measure of wasp behavior to different repellent compounds. The olfactometer consisted of a Y-shaped glass tube (2.5cm diameter, 23 cm arm length, and 23 cm common arm length) connected to two tubular glass chambers (8 cm × 2.5 cm) [27]. The Pyrethroid insecticide or each essential oil with bait was placed in one arm and the bait alone was placed in other arms. Charcoal-filtered and moistened air was drawn into each of the two glass chambers and Y-tube arms with a flow rate of 300 ml/min. The temperature in the chamber was maintained at 26˚C ± 1˚C at all times by an air conditioner. Each adult spent the olfactometer for a maximum of 5 min. Each experiment was replicated with 50 individual wasps.

2.7. Statistical Analysis

All Y-olfactometer data, the preference for a bait or bait + essential oil/insecticide, were analyzed using a Chi-square goodness of fit test based on the hypothesis that there would be a 50:50 chance of insect responding to both treatments was used to test for significance at P = 0.05. Analyses were performed using the SPSS version 16.0 (SPSS Inc., Chicago, IL, USA) [28].

3. Result

The types of wasps that live on the stone surface of the temple walls were classified by laboratories of the Department of Plant Protection at the Faculty of Agriculture, Sohag University as *Sceliphron caementarium* (Hymenoptera: Sphecidae).

It was also found that the activity of this insect in Upper Egypt will be between late March and mid-October. The adult females begin to capture insects that are placed into each mud nest cell. Eggs are deposited on the prey within each cell, and the cell is sealed with mud. The wasp larvae that hatch from the eggs feed on the prey put in the nest by the adult wasp. After a few days, the larvae change into the pupal stage that overwinters. Then, the pupae turn into adults the following spring, at this time of year the new generation of mud wasps begins. Adults feed on plant nectar, honeydew, and the body fluids of the spiders and insects they capture. The shape clarifying clay blocks from nests located on the walls of a temple.

The analysis of the nests gave results as follows, as the old primary sample, which contained old fragmented deposits and a yellowish-gray color to somehow and had few holes, noting that there were no remnants of wasp insects, and the sample was dried at a temperature of 100 degrees Celsius, it gave the following results [Coarse sand (47.59%), Soluble salts (2.23%), Clay and silt (31.30%) & Fine silica (18.88%)].

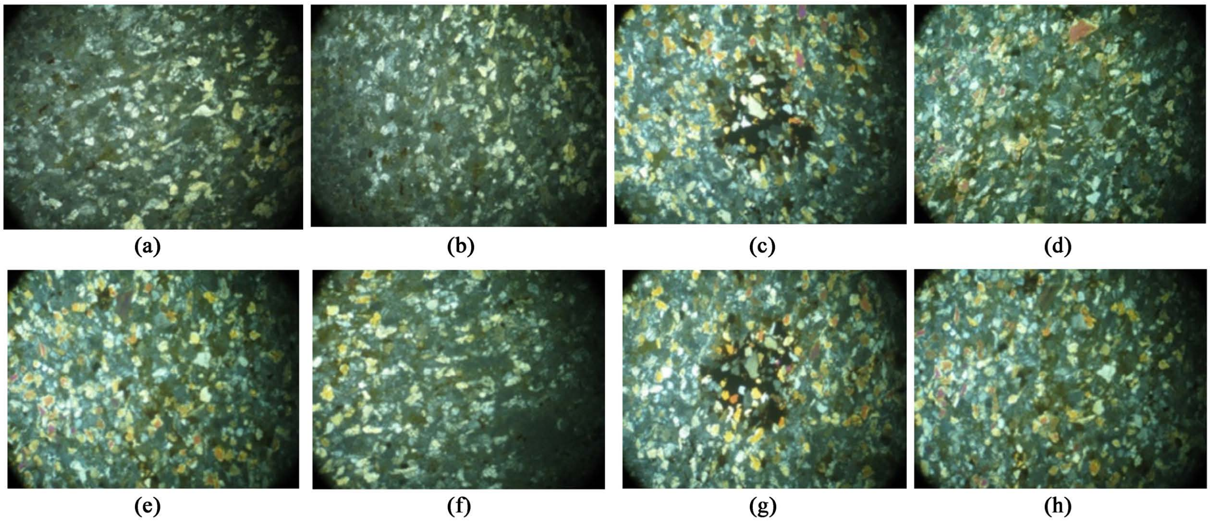
The soluble salts were identified and their compounds were as follows [Sodium sulphate (0.34%), Sodium carbonate (0.48%), Soluble calcium hydroxide (0.18%) & Sodium chloride (0.20%)].

The second sample obtained from recent nests showed that it is composed of a mixture of clay and sand. The microscopic examination showed the presence of many pollen grains, quartz and clay grains.

The chemical quantitative analysis of this sample was given compounds as follows [Fatty and waxy matters (0.18%), Moisture (5.60%), Silica (60.73%), Resinous matter (0.30%), Ferric & Aluminium oxides (3.06%), Sulphates N_2SO_4 (0.22%), Chloride NaCl (0.13%), Magnesium carbonate(1.47%), Calcium carbonate (2.14%), Sugars (25.15%) & Insects remains and grains of pollen (1.02%)].

3.1. Petrography

By studying a thin section of sandstone that is subject to damage as a result of the presence of mud wasp nests on it through non-destructive fallen stone pieces, it becomes clear that the sandstone is exposed to destructive weather factors besides the effects of mud wasps. Medium to fine sorting shows the extent of damage to sandstone exposed to damage due to wasp nests. The petrographic study also showed the presence of minerals such as limestone, quartzite, quartz, biotite, clay minerals, and chlorite. Sandstone can be classified according to the grain sizes from fine to medium. It indicates an increase in the rate of porosity, and these cracks are areas of accumulation of clay minerals and iron oxides (Figure 3).



(a) (b) (c) (d)
(e) (f) (g) (h)

Figure 3. Composed mainly of crystal fragment of quartz and albite together with biotite, Cracks in the microstructure and accumulation of clay were observed on the crack surfaces, mimicrytic accumulation, clay minerals and Calcite found on its surfaces, iron oxide minerals and Chlorite in degraded fine-grains of sandstone.

3.2. XRD

Fine and medium-grained sandstones had similar XRD, and had the same principal components as quartz, calcite, and feldspar being anorthite and albite (**Figure 4** & **Figure 5**).

3.3. Geochemistry

The chemical analysis under XRF showed that it contained the following: SiO_2 (81.3380% - 81.3490% - 81.2372%), AI_2O_3 (7.8669% - 7.3427% - 7.5326%), CaO (1.1584% - 1.1492% - 1.1325%), Fe_2O_3 tot. (3.4659% - 3.2143% - 3.5738%), SO_3 (0.1842% - 0.2120% - 0.1537%), Na_2O (0.1523% - 0.1351% - 0.1261%), P_2O_5 (0.0215% - 0.02263% - 0.02381%), and CI (0.2315% - 0.2861% - 0.2136%) (**Table 2**). Cao and SO_3 indicated the presence of gypsum and Na_2O, and Cl indicated halite salt and P_2O_5 is also in the mineralogical composition of sandstone or as a result of found nests of mud wasps and its activity. It was found as a result of sewage and agricultural drainage.

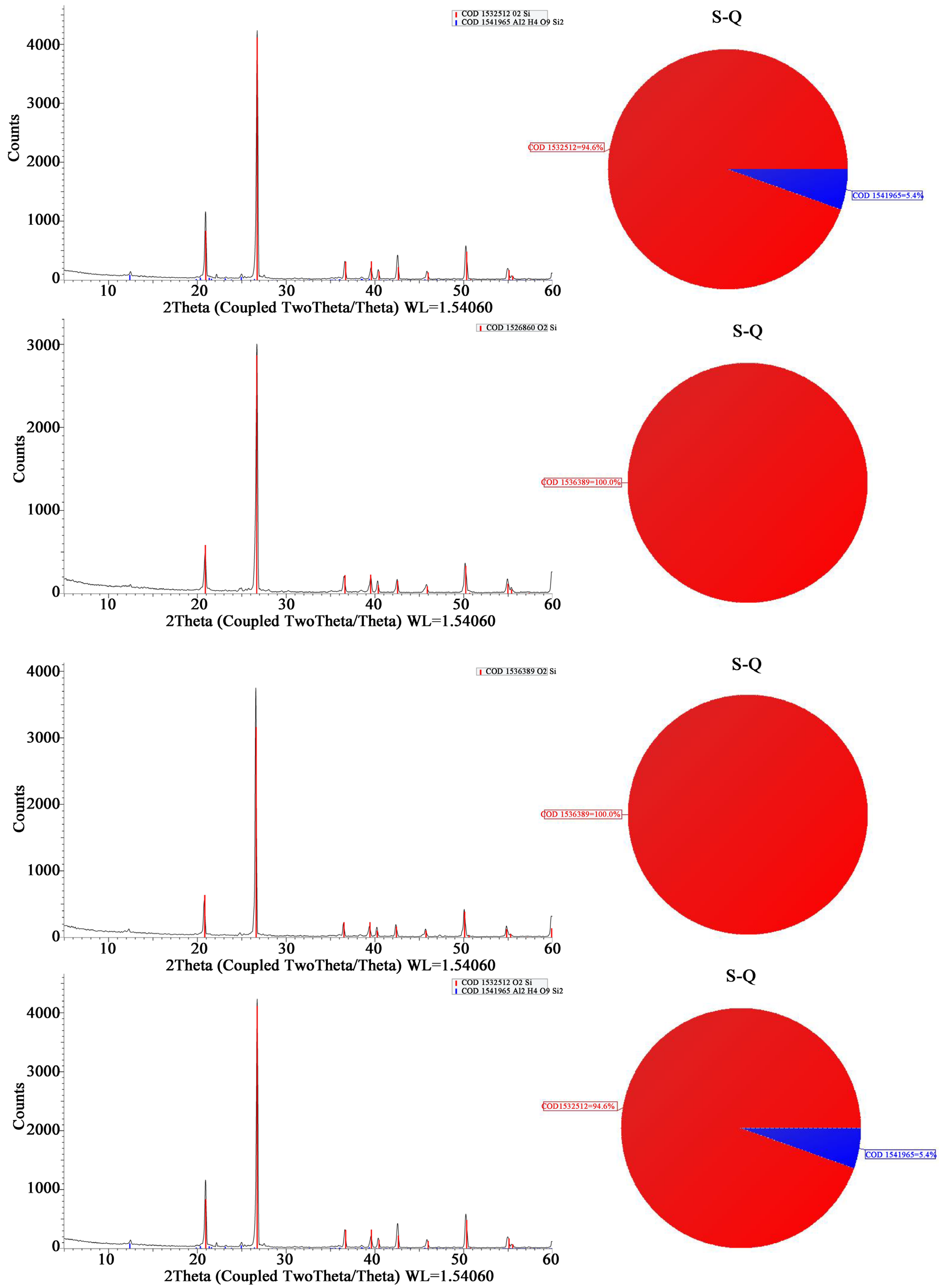
3.4. SEM

The study with (SEM) showed in the presence of (EDX) analysis of degraded sandstone samples for the presence of iron oxides and clay minerals, where the proportions of Si, Al, K, Mg, and Na confirmed what was reached from the study with SEM also of the presence of clay minerals and iron oxides in Sandstone formations under study (**Figure 6**).

4. Discussion

It was observed the presence of chlorite form and the presence of dark minerals in the thin sections form. These were grains of minerals in a fine-grained carbon matrix. They were classified as fine and medium-grained sandstones. The average grain size of the sandstone was medium-grained. Both fine and medium-grained sandstones were poorly sorted sandstones. The study samples were defined as sandstones, and the main components of sandstone were proved through XRD analyzes as quartz, and clay minerals. There were no clear composition differences in the main components of sandstones with medium and fine grains.

The results of the chemical quantitative analysis of the old nests' sample indicate that they are very old deposits that can be removed using water without leaving any dirt on the walls and are free from organic content. The recent samples in which the wasps live also indicated that most of them can be removed using water, but the method of removal is relatively slow and difficult at the same time and may be due to the strength of the bonding of their grains and as a result of increasing their content of organic materials that may work as a strong contact between the grains, which increases the difficulty of removal as The removal process leaves brown dirt that may have resulted from the presence of waxy content, resins, and oily residues present in those nests. This dirt increase in


COD 1532512 02 Si
COD 1541965 Al2 H4 O9 Si2
S-Q
COD 1532512=94.6%
COD 1541965=5.4%
Counts
2Theta (Coupled TwoTheta/Theta) WL=1.54060
COD 1526860 O2 Si
S-Q
COD 1536389=100.0%
Counts
2Theta (Coupled TwoTheta/Theta) WL=1.54060
COD 1536389 O2 Si
S-Q
COD 1536389=100.0%
Counts
2Theta (Coupled TwoTheta/Theta) WL=1.54060
COD 1532512 O2 Si
COD 1541965 Al2 H4 O9 Si2
S-Q
COD1532512=94.6%
COD 1541965=5.4%
Counts
2Theta (Coupled TwoTheta/Theta) WL=1.54060

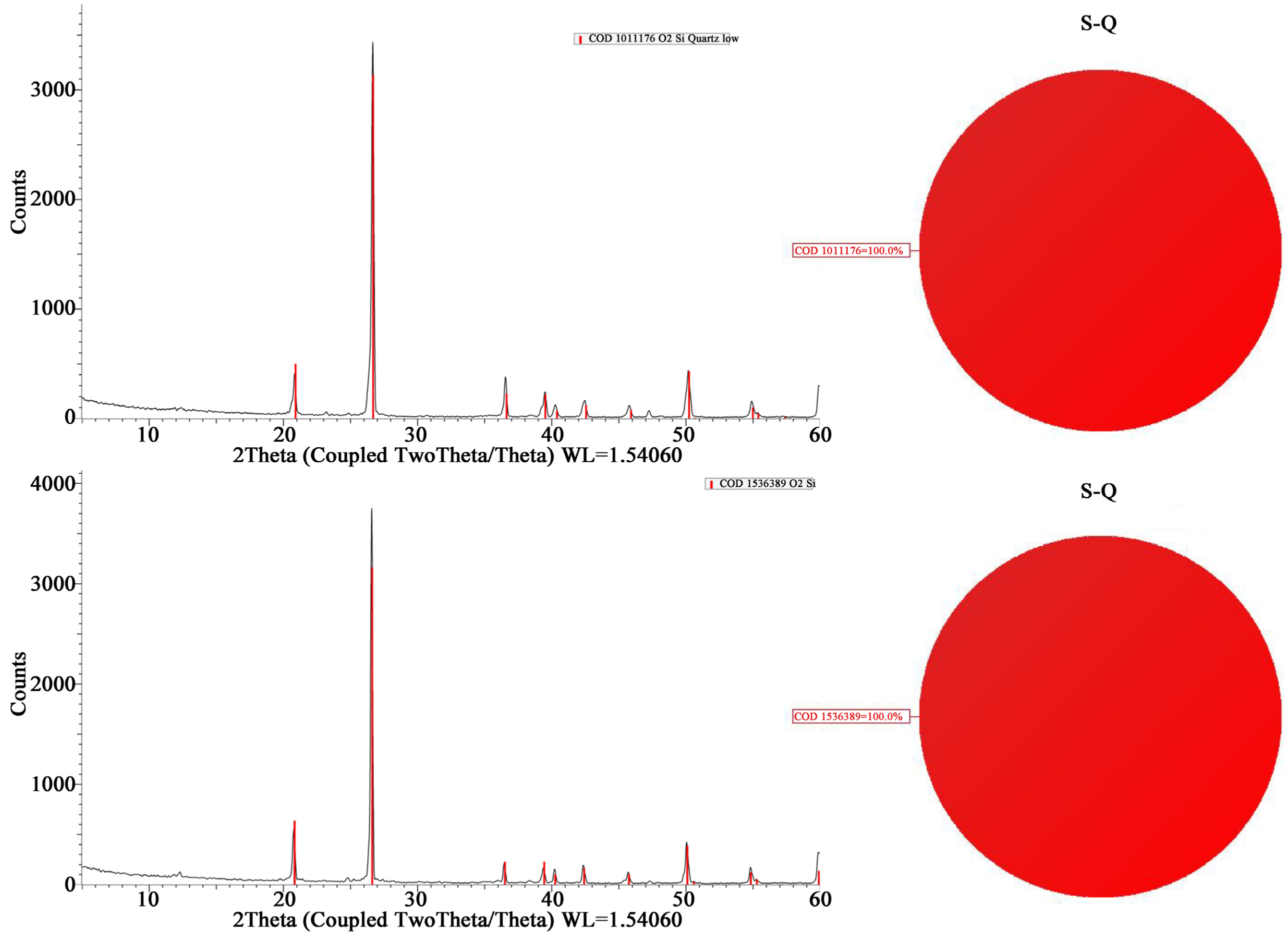


Figure 4. XRD trace of fine grained powdered sandstone from Isis temple.

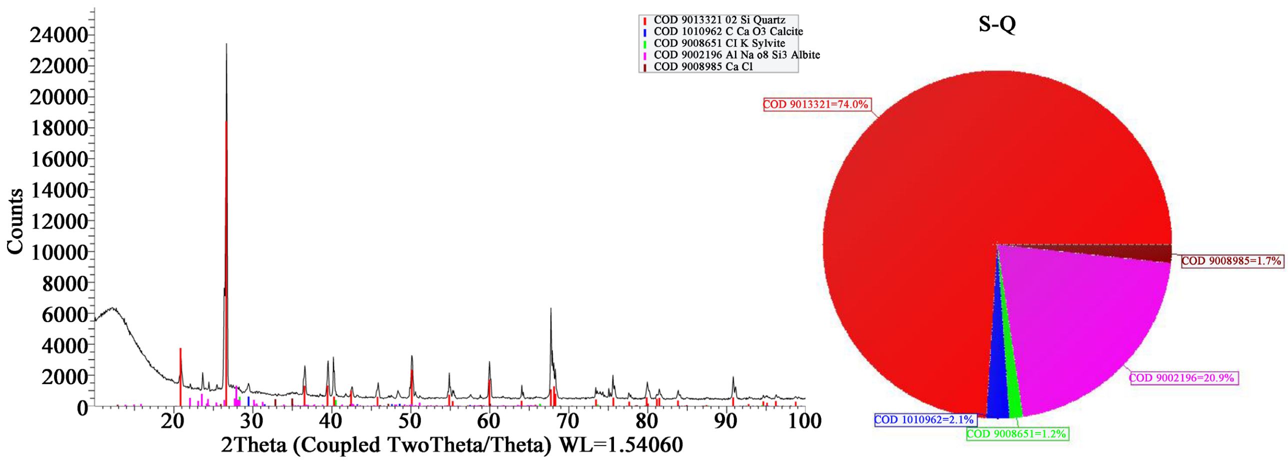


Figure 5. XRD trace of fine grained powdered nests from the surface of Isis temple.

the case of these recent nests directly on the stone surface and decreases when those nests are located on nests older than them.

Repellent Bioassay

The five tested essential oils exhibited a high degree of repellent activity in wasp adults, with an overall repellency rate of 86% (Figure 7). The best repellent

Table 2. Chemical analysis by XRF for 3 samples.

Main Constituents Wt%	(a)	(b)	(c)
SiO_2	81.3380	81.3490	81.2372
TiO_2	3.7238	3.6334	3.5226
AI_2O_3	7.8669	7.3427	7.5326
Fe_2O_3 tot.	3.4659	3.2143	3.5738
MgO	0.4732	0.4126	0.4251
CaO	1.1584	1.1492	1.1325
K_2O	1.7356	1.7244	1.7672
MnO	0.0055	0.0045	0.0052
V_2O_5	0.0124	0.0136	0.0129
ZnO	0.2202	0.2437	0.2358
SO_3	0.1842	0.2120	0.1537
Na_2O	0.1523	0.1351	0.1261
P_2O_5	0.0215	0.02263	0.02381
CI	0.2315	0.2861	0.2136

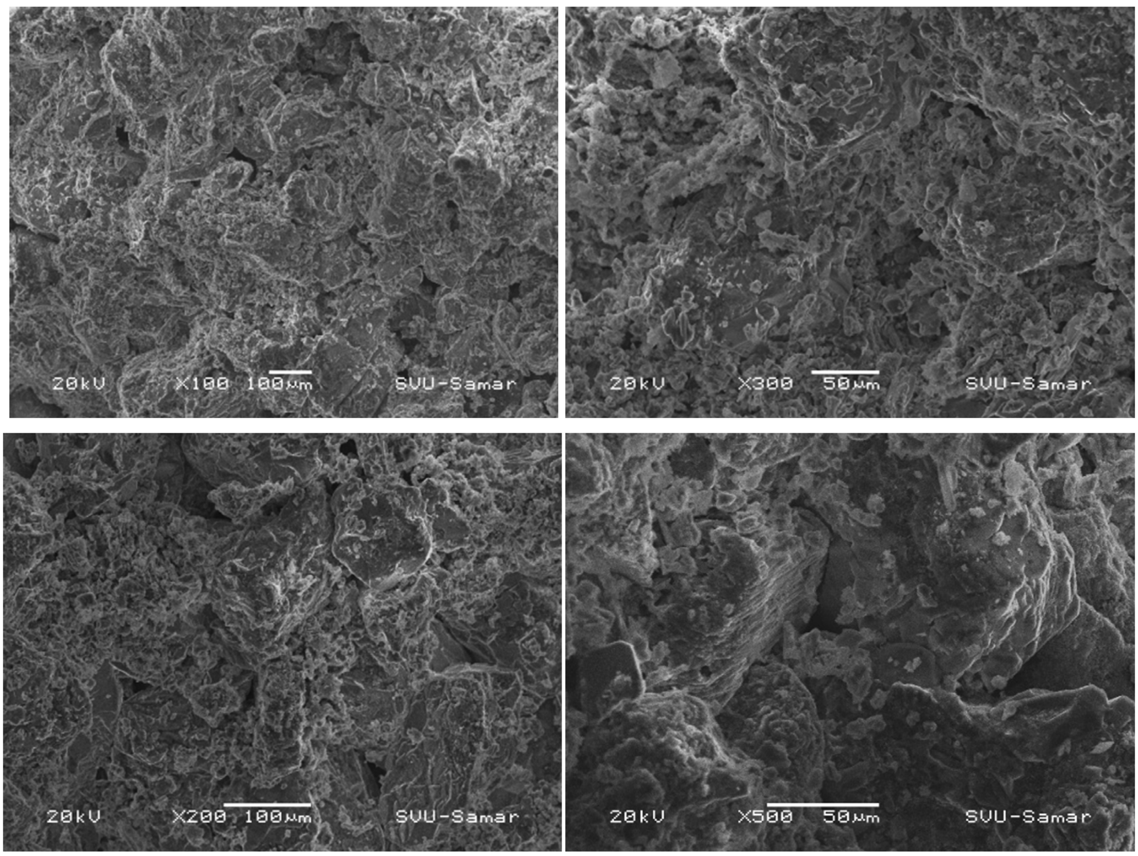


Figure 6. Macro view of deteriorated sandstone sample, SEM image of interior face of deteriorated sandstone sample.

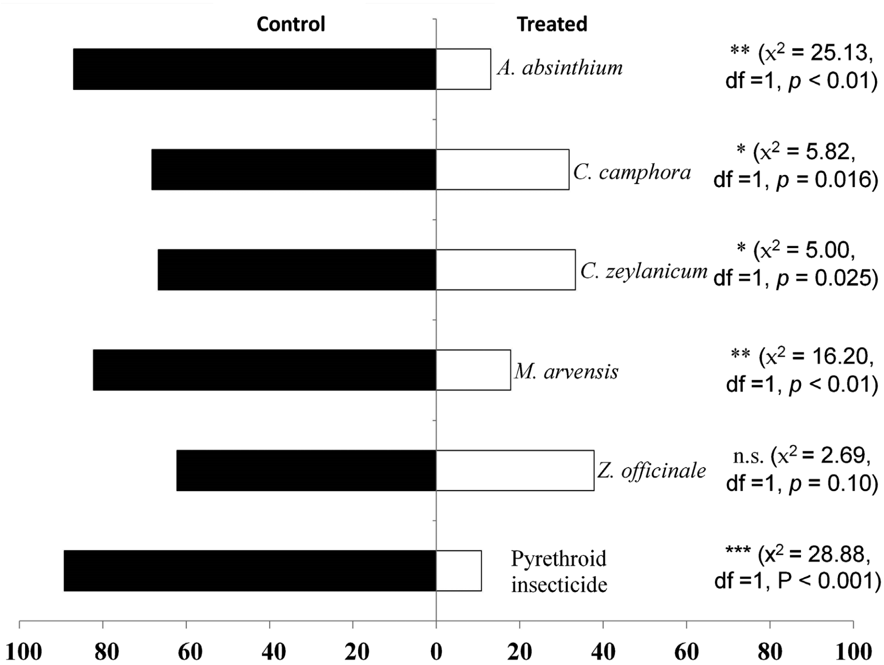


Figure 7. Response (%) of mud wasp adults in Y-tube olfactometer single choice tests to odours from Pyrethroid insecticide, essential oils [*Artemisia absinthium* (Asteraceae)] [*Cinnamomum zeylanicum* (Lauraceae)] [*Mentha piperita* (*Lamiaceae*)] [*Zingiber officinalis* (Zingiberaceae) and *Cinnamomum camphora* (Lauraceae)]vs. control (sugar syruponly). n = 50. Asterisks indicate significant differences within the choice test. *P < 0.05, **P < 0.01, ***P < 0.001, n.s. = Non-significant by using Chi-Square (Goodness of Fit) test. The wasps which no given any response were not included in the analysis.

was the Pyrethroid insecticide. The best repellent essential oils among oils tested were *A. absinthium*and *M. arvensis* oils with 86.96% and 82.22% repellent rates, respectively) followed by *C. camphora*, *C. zeylanicum*, and *Z. officinale*.

5. Treatment

From the above from this study, the most appropriate cleaning times can be in the inactive periods of an insect through the following stages, the deposits are removed by mechanical methods, hammers, and wooden hammers, noting that these tools do not come into contact with the stone surface and remove the remaining nests' layers from the surface by using small bump water, preferably the machines used within the power of 3 hp so as not to affect the stone surface as a result of the bursting force of the water and until it is controlled during the cleaning process, the soft clay layers are removed first, and then washed with water with the use of some appropriate brushes, which does not affect the stone surface. This process is done until you make sure that all the clay layers attached to the stone surface are removed, as parts of the clay remain difficult to remove later. Also, the cleaning process takes time according to the bonding of the clay layers with the stone surface and according to the porosity of the stone surface and the degree of penetration of the clay layers inside the pores of the stone surface, when washing is completed with water and the appearance of brown dirt as a result of the presence of resinous, waxy and oily substances on the stone surface where it is removed using a dilute solution of ammonium hydroxide and appropriate brushes are used to remove this dirt, then water is used again to remove the remaining dirt and to remove excess chemicals, in some areas, especially near or beside the cleaning places, it is noted that some salts are therefore washed with water continuously with water until these salts disappear after the dry surface of the stone, in the case of nests that contain larvae, they are permanently removed and placed in water to kill the larvae that are still alive. It is preferable to use hot water to avoid the Transformation of these larvae into adult insects.

According to our result, can protect the stone surfaces of a temple from attack wasps by using pyrethroid insecticides or essential oils such as; *A. absinthium* oil as repellents. Pyrethroids and *A. absinthium* showed a repellent action in laboratory and field studies on Hymenoptera insects such as bees and wasps [29] [30] [31] [32]. These compounds can be used as repellents by putting them in different locals of the temple or spraying them on the stone surface periodically every year and spray operations during periods of insect activity. A complete treatment plan for wasps control is placed on the stone surface [33].

There are some problems that face the process of removing the insect nests and controlling the presence of insects and preventing them from being as the area of the stone surfaces in the temple, which is covered by sediments, is close to 4500 square meters. Also, large parts of these deposits are thick, especially in the upper parts and in the western walls, and range between 20 to 50 cm. It has also observed that the thickness of the sediments resulting from the presence of nests decreases in the lower areas of the walls, but the nests in them contain a large proportion of honey that causes viscosity to these nests in addition to the difficulty of removing them.

It was noted that wasps prefer to build nests in areas where there are deep inscriptions or in areas that have cracks in the building blocks of sandstone. Several nests were found in the mud-walled fence.

Mechanical restoration is always preferable to use this method at the beginning of the restoration of stone monuments. Chemical cleaning is not preferable until all mechanical cleaning methods are exhausted. Mechanical cleaning relies on manual methods to remove dust, and plankton and break the bonds between granules. dirt and the surface of the impact without using any of the cleaning solutions such as solvents that may carry dirt inside the pores of the stone surfaces of sandstone, which is known for its high porosity, also water may sometimes increase the damage of stone and some Chemicals are dangerous and toxic to the restorer, and the mechanical methods used depend on causing a collision or collision between the dirt and the material used in the collision process, and the main objective of this process is to break the bonds between the dirt and the impact surface in addition to moving the dirt away from the impact surface safely, treatment must be handled with great care during cleaning, and the restorer who deals with these surfaces subject to damage must be highly trained and skilled so that the surface layers of sandstone that are subject to damage are not exposed to falling or separation during cleaning operations. Mechanical cleaning operations depend on the safe tools used by the restorer in the cleaning operations in removing the fine dust accumulated between the folds and folds of the sandstone surfaces. Remove cobwebs on the surface of wasp nests and on the sandstone surface, calcified bird droppings, black crusts [34], nests of bees, wasps, and termites [35], the crystallized salts on the surface, and the layers of lime that were used in old treatments on the surface of the sandstone. It is used in mechanical cleaning operations by manual means, starting first with soft brushes. It includes toothbrushes and the use of metal brushes, scalpels, and wooden brushes to remove surface dirt and soot. Some chisels, metal brushes, and blunt scalpels are also used. Mechanical cleaning aims to break the connection between layers of dirt and dust or calcified salts on sandstone surfaces in removing clay calcifications, salts, and lime layers, provided that The use of water is minimal, and the lack of running water on archaeological surfaces. Disengagement processes begin with weak areas adhering to the sandstone surface by generating external.

6. Conclusions

Some of the temples are exposed to the influence of bees and wasps, such as the Edfu temple, the Mamaizi temple, the Dandara temple, the Ramsium temple, the Karnak temple, and the Ramses II temple Abydos. It has known that bees and wasps prefer to stabilize their nests over deep inscriptions. Many beautiful reliefs on the surface of the outer walls, especially those located on the eastern side and the western walls of the Temple of Hathor. The western gate and the temple of Isis largely disappeared under thick sediments of clay nests, which were the bees and wasps that lived for hundreds of years. Many beautiful inscriptions have disappeared beneath them, and the bees and wasps cause great inconvenience to visitors to the temple. It is important and necessary to control the bees and wasps that live on the stone surfaces of the temple, and the nest deposits that obscure the inscriptions on the stone surfaces must be removed.

Whereas, it was found to be compatible with the results obtained from the chemical quantitative analyzes, as the method of water removal for these nests is preferable to be applied to all stone surfaces subject to damage through the presence of nests on them and it is preferred to use them in the summer so that condensation of water does not occur on the stone surface or to reduce the water penetration of the surface. The stone with a great depth will have negative results in addition to the speed of evaporation of water from the stone surface and the water is used through pressure machines so that the water coming out on the nests surface is pressed and the ejectors of pressurized water are perpendicular to the surface to be cleaned to increase the effectiveness. Even the control does not occur with dirt in new places on the surface of the stone.

And the dirt left from the cleaning process with water resulting from fatty, waxy, and resinous ingredients can be cleaned in recent nests by using sodium hydroxide solution and potash alcohol dissolved in ammonium hydroxide solution. The use of ammonium hydroxide solution is appropriate because it contains two strong alkaline groups and it is completely volatile, which prevents efflorescence of salts on the stone surface during the period of its use, and its performance continues for a long period on the stone surface, especially in removing those remaining brown dirt from the process of removing it.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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