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A STATISTICAL APPROACH OF THE MARBLE PHOENICIAN ANTHROPOMORPHIC SARCOPHAGI: AMRĪT SITE

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ABSTRACT

In this paper we statistically analyze, and interpret anthropoid Phoenician sarcophagi found on the Syrian coast (archaeological site of Amrīt), from an archaeological perspective. All sarcophagi (11 complete and 8 damaged) under the study are dated between the fifth and fourth centuries BCE. We must highlight how previous scholars established periods of use as well as the influence of these funeral artifacts, viewing them purely as works of art. The main goal of this research is to study the sarcophagi from an archaeological perspective with reference to the quantitative data taken from each piece. The data set which we analyze is composed of the dimensional components of twenty-two sarcophagi. The challenge to be overcome in the analysis of this data set is the state of the sarcophagi themselves; half of them are damaged to an extent that direct measurements are impossible. Thus, a statistical analysis is necessarily based on estimates of original measurements of undamaged parts of those sarcophagi. Accordingly, we carried out an analysis of the dependence between the dimensional components of the complete, relatively undamaged sarcophagi. Given the anthropomorphic morphology of sarcophagi, the length and width present a significant linear relationship, whereas there is no relationship between length and height.

KEYWORDS: Levant; protohistory; anthropomorphic sarcophagi; predictability; statistical correlation; Greek-Roman.

1. A REVIEW OF MARBLE PHOENICIAN ANTHROPOMORPHIC SARCOPHAGI FROM AMRĪT

Sarcophagus is a word *Plinius* used for a special kind of stone, meaning "flesh-eating" from the Greek *σαρκοφαγός* (Plinius, 2013). The term was first used in reference to the cemeteries of ancient Egypt (Harden, 1963; Lembke, 1998; Wenger, 2003; Hosh, 2009), where religious customs required the corpse to be placed in a box made of stone so that the body of the deceased could survive in the afterlife (Faegersten, 2003; Dixon, 2013). Scholars have established different phases for the chronologic classification of sarcophagi. The first is of Archaic (Greco-Egyptian) influence (Elayi and Haykal, 1996; Haykal, 1996a), dating from *ca*. 535 BCE to 500 BCE (Versluys, 2010). The best example from this period is located in Sidon (present day *Saydā,* Lebanon) (Wenger, 2003). The second phase is Persian (Richter Augusta, 1970), well represented in Amrīt's archaeological records (Elayi, 2002), dating *ca*. 460-450 BCE (Almagro-Gorbea et al. 2010). The latest is the Hellenistic period, which is heavily influenced by Classical elements (Lembke, 1998). Many examples were documented in the territory under discussion (Elayi and Haykal, 1996), estimated to have originated *ca*. 400-370 BCE (Buhl, 1991; Frede, 2000). The phases and chronological data indicated have always followed artistic (Torrey, 1919; Haykal, 1996b; Lembke, 1998; Frede, 2009), rather than archaeological conventions. As such, these enigmatic pieces are still ambiguous with regards to the aspects discussed.

The Phoenician artistic cultural environment was formed under the influence of the Greek, neo-Babylonian, Egyptian, and Persian cultures (Kukahn, 1951, 1955). It seems that aspects of Phoenician culture were developed by adapting and integrating foreign artistic styles and external cultural influences—in this case, sarcophagi from Egypt (Gubel, 1993; Wenger, 2003). Egyptian culture provided the Phoenician elites living on the Levant coast with these luxury objects. Phoenician anthropoid sarcophagi have a long history in the region of the Levant coast and their styles have followed artistic trends throughout history (Stucky, 1988; Lembke, 2001; Frede, 2002; Almagro-Gorbea *et al*., 2010). Indeed, they clearly show marked influences of the artistic customs of their contemporary cultures. The sarcophagi that have been discovered in the territory of *Amrīt* and its Island neighbour *Arados* are particularly remarkable in this area of the Levant coast. Specifically, we note that the number of Phoenician anthropomorphic sarcophagi discovered in and around this area, Arados/Amrīt, is second only to Sidon in Lebanon. Unfortunately, most of the findings of coffins in Amrīt were made by antique dealers (Bey and Reinach, 1892), whose main purpose was only to satisfy the interests of museums and private collectors throughout the world (Renan, 1864). This means that for archaeologists, they stand only as a mute testament to the significance of these funeral monuments in Phoenician culture. Few have been discovered or recovered through exacting excavation techniques that have ensured contextualization and documentation appropriate for modern archaeology, with processes that note and maintain data on their intrinsic aspects. For example, we find that facts as rudimentary as physical measurements are not even recorded. Therefore, the process of reconstruction of these astonishing pieces remains a difficult task today. While the findings in recent centuries were useful to initiate a scientific approach to analyze these memorial pieces, contemporary archaeological methods require a much more exacting approach.

Recently, thirty Phoenician anthropoid sarcophagi have been documented in this region of the mediterranean coast surrounding Arados and Amrīt (Mustafa and Abbas, 2015). Various raw materials were used to build these coffins, such as marble, basalt, and terra-cotta (Frede, 2000, 2002). However, for our purposes we focus solely on the sarcophagi crafted from marble. To date, twenty-two (22) marble sarcophagi have been unearthed in Amrīt, eleven of them incomplete. In this work, we are interested in estimating as closely as possible the original measurements of these damaged sarcophagi by comparing relevant measurements with those of the undamaged. We base the suitability of this estimation on reasonable relationships with the anthropomorphic shape of the Phoenician sarcophagi. In the next section, the data set studied is introduced jointly with a descriptive analysis of the dimensional components. For our purposes, then, a statistical assessment of possible dependencies between the dimensional components of the sarcophagi is performed. Then, we obtain the best statistical model to estimate the measurements corresponding to the damaged areas of the incomplete sarcophagi quantifying the prediction error. In the concluding section, we summarize and discuss the main aspects and related interpretations derived from the study.

2. DATA SET

In this section, we focus on the morphological study of the Phoenician sarcophagi found in the area under study. As mentioned in the introduction, Amrīt territory is the most important area for discoveries of Phoenician sarcophagi after the

Lebanese city of Sidon. Unfortunately, most of the sarcophagi that have been found have problems related to their preservation and documentation due to the fact that they were uncovered and relocated to other countries by antiquarians. Recently, a significant number of Phoenician sarcophagi have been discovered (Mustafa, 2013; Mustafa and Abbas, 2015). Unfortunately, some of them were damaged due to poor excavation techniques, which resulted in the loss of pieces of the coffins. Such treatment of those sarcophagi, therefore, requires the development of a methodology to determine their original measurements.

We analyze these sarcophagi, focusing on the coffins made of marble. The data set is composed of 19 sarcophagi, eleven of which are damaged (Figs 1,2). Thus, the main purpose of this work is to try to estimate the original physical morphology of the damaged sarcophagi. For this, we concentrate on their dimensional components (length, width, and height) hereinafter denoted as L, W, and H. Based on the assumption that the sarcophagi have anthropoid morphology, we can estimate the dimensions of the damaged coffins by means of analyzing those that are complete.

Before applying a predictive statistical analysis to the data, we perform a first exploration by means of descriptive plots. Firstly, the scatterplots of L vs. W and L vs. H for the complete and the damaged sarcophagi are displayed in Fig. 1. Here we can see a strong level of clustering for the complete and damaged sarcophagi by length. We do not observe significant differences regarding the values between the values of width between complete and damaged sarcophagi. On the other hand, the height values among the damaged sarcophagi are lower than those of the undamaged.

We now focus on the undamaged sarcophagi. The above data allows us to estimate the original lengths of the damaged coffins. Fig. 2 shows the scatterplots L-W and L-H for the complete sarcophagi. In the left plot, we can note a positive lineal relation between L and W, whereas between L and H there is no trend. From the descriptive analysis of the completed sarcophagi, we can interpret that width could be a valuable factor to predict length. On the other hand, height does not seem to be a reliable factor to estimate length, due to two factors: the differences between the height values for complete and damaged sarcophagi, and the fact that there is no visible relation between length and height for the complete coffins.

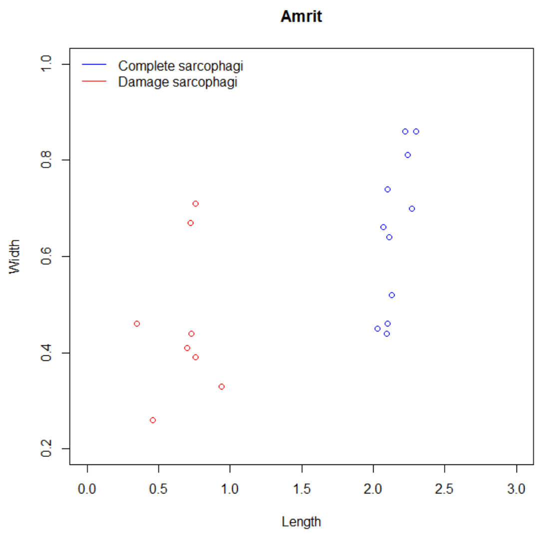

Figure 1. Scatterplots of the lengths with the widths and heights for the complete sarcophagi, represented by blue circles, along with the corresponding dots for the damage sarcophagi, represented by red circles.

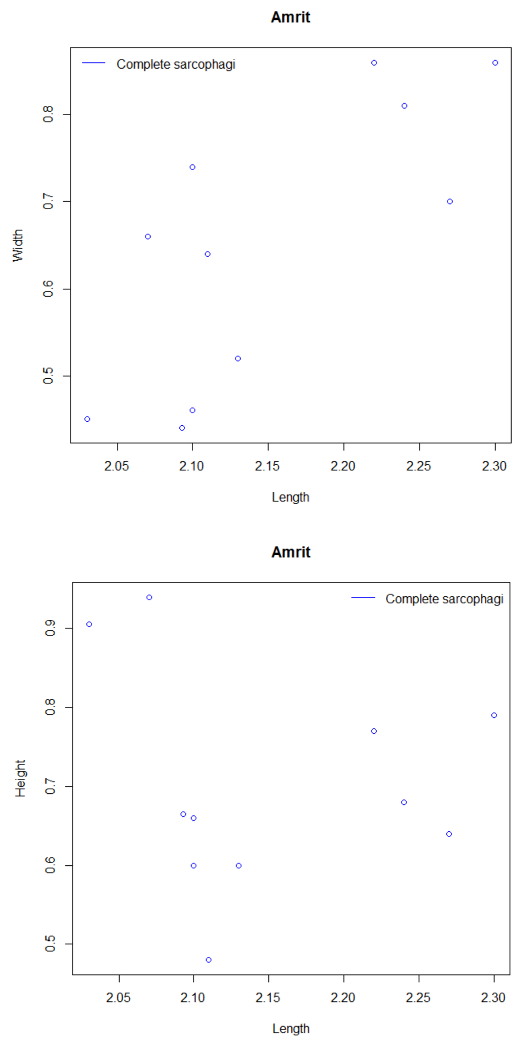

Figure 2. Scatterplots of the lengths with the widths and heights for the complete sarcophagi (from left to right).

3. STATISTICAL ANALYSIS

In this section, we carry out a quantitative analysis of the three dimensional components using the usual statistical tools in the study of archeological materials (Orton, 1982; Sokal and Rohlf, 1982; Mark and Goldberg, 2001; Venables and Ripley, 2002; Fernández, 2015). Firstly, we start performing a variability analysis of the three components by means of the coefficient of variation, obtained as:

$$C.V. = \frac{\sigma}{\bar{x}} x100$$

This coefficient quantifies the degree of variability of the variable under study and it is dimensionless. Thus, we can study possible differences between the distribution patterns of the three components. The results obtained for the three components are depicted in Table 1. Regarding the complete sarcophagi, we can observe that the length component presents a very high level of concentration indicating that these sarcophagi have been made by very skilled craftsmen. The other two components are markedly lower showing low levels of standardization, which suggests that not all the sarcophagi may have the same origin. As for the damaged sarcophagi, the value of the variation coefficient significantly increases for the three components; but in the case of the length component, the increase is six times greater in comparison with the other ones. This matches with the fact that it is this component that presents important damages.

Table I. Values of the variation coefficient for the three components corresponding with the complete and damaged sarcophagi

Complete sarcophagi	Damaged sarcophagi
C.V.(length) = 4.1820%	C.V.(length) = 45.6684%
C.V.(width) = 24.9223 %	C.V.(width) = 42.4173 %
C.V.(height) =19.4999%	C.V.(height) = 60.4923%

Now, we study the statistical association between the dimensional components using the Pearson correlation coefficient (Pearson, 1895), which is a measure of the strength and direction of the linear dependence between two variables. Using the software R, we get the correlation matrix depicted in Fig. 3. Here, we can observe that there is a significant linear dependence between L and W, whereas the relation between L and W is negative and much lower, confirming the results from section 2. However, this measure by simple correlation quantifies the strength of the linear relationship between the two variables without taking into consideration the fact that both of these variables may be influenced by a third. Therefore, we perform the partial correlation analysis (Kendall, 1943), which maps the linear relationship between the two variables after excluding the effect of one or more independent factors. From this, we obtain the following partial correlation matrix:

Table III. Partial correlation matrix for the three components

	Length	Width	Height
Length	1.0000000	0.7798841	-0.3220757
Width	0.7798841	1.0000000	0.3227633
Height	-0.3220757	0.3227633	1.0000000

These results show an improvement on the dependence, but the conjectures continue to be the same. From these results, the predictive statistical model has only one independent variable, length. Next, we verify these results by means of the stepwise method, using both the backward and forward regressions.

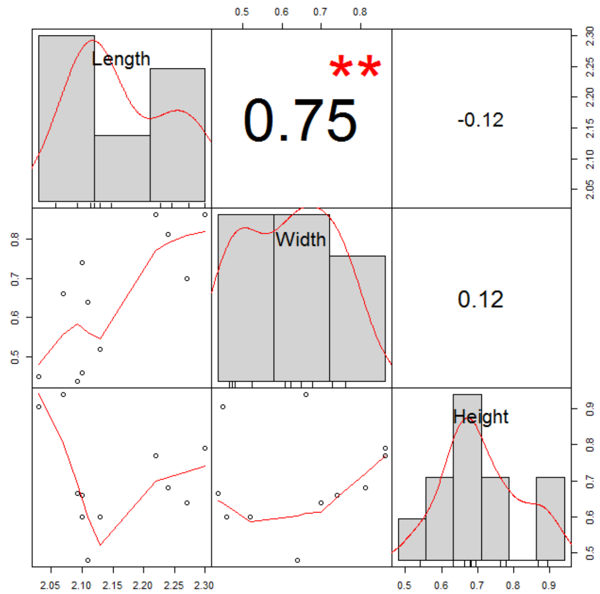

Figure 3. Correlation matrix composed of the distribution of each variable on the diagonal, the bivariate scatter plots with a fitted line on the bottom of the diagonal, and the value of the correlation plus the significance level as stars on the top of diagonal.

As we observed in the descriptive analysis, according to the dependence analysis, we conclude that there is a linear dependence between length and width, whereas between length and height there is not. Thus, we obtain the following regression function considering just the width as an independent variable:

$$Length = 1.8788 + 0.4195 \times Width$$

Fig. 4 displays the regression line fitted with the representation of the L vs. W values of the sarcophagi. To evaluate the good-fit of the model to the data, we assess whether the model explains the relation between X and Y, performing the hypothesis tests of the parameters. First, we contrast whether the slope is equal to 0. Secondly, we test whether the constant term is equal to 0. In both cases, the null hypothesis is rejected, concluding that the line regression is significant. Furthermore, we verify that the error term is normally distributed by means of the qqnorm function (see Fig. 5).

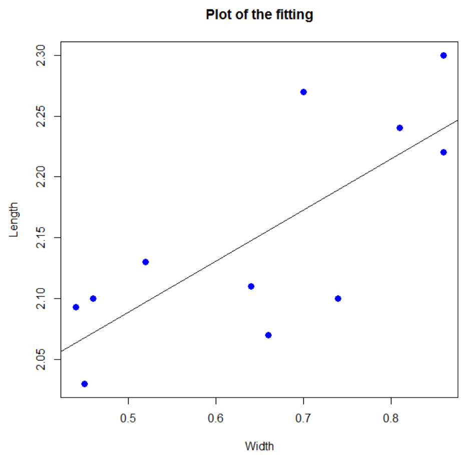

Figure 4. Representations of the fitted line for the complete sarcophagi.

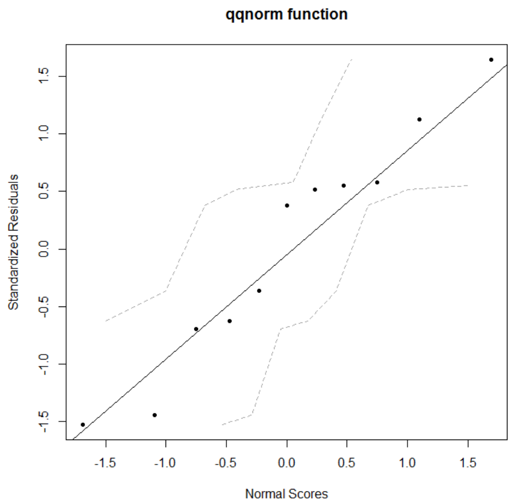

Figure 5. Representations of qqnorm function of the standardized residuals of the fitting.

Accordingly, with these results, to solve the problem of predicting the length component of the damaged sarcophagi we can only use the width component for estimations. That confirms our assumption of the anthropomorphic morphology of the coffins. However, we have to take into consideration that we only have a few observations available and have attempted to perform the same number of estimations.

4. CONCLUSION

There has been an increasing interest among the scientific community on Phoenician anthropomorphic sarcophagi, although, as stated above, we believe these past studies offer little in the way of empirical and rigorous analysis from an archeological point of view. While, in the past, the study of Phoenician sarcophagi has been affected for the greatest part by the culture of art history, current archaeology requires more accurate methods by means of which we may gain more answers than questions about the material culture under study. From an archaeological perspective, the attribution to their correct cultural context of the observable differences in these sarcophagi, and the establishment of periods of production and use without rigorous study remains a difficult task. This is specifically hampered by the lack of archeological context of most of the examples in our possession.

Statistical analyses indicate that measurements of the sarcophagi of Amrīt obtain a low level of standardization with regard to the dimensional components, indicating that the source of the blocks of stone was diverse. Based on these results, we may hypothesize that a certain amount, perhaps only half, could have had a common origin. The assumption of predicting the unknown measurements is based on the anthropoid morphology of these sarcophagi. We analyzed the cases, using multiple correlation measures to study the degree of association between components, and stepwise regression to perform the best fitting to the data. The results obtained confirm the anthropoid morphology of the coffins. Regarding the length and the width, there is indeed a linear dependence, whereas in the case of the height there is no discernable relationship.

From an archaeological perspective, the attribution of the observable differences in these sarcophagi is a serious problem attributed to their correct cultural context, as well as to the establishment of periods of production and use. This is hampered by the lack of archeological data of most of the examples in our possession. Hopefully, new approaches will give us more insight into these enigmatic funeral pieces from the Syrian coast, and the need for conjecture concerning this fascinating culture will be greatly diminished.

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