1996

Using Statistics to Analyze the Ancient Egyptian Scarab

Sarah C. Guthmann

Using Statistics to Analyze the Ancient Egyptian Scarab

Sarah C. Guthmann

The University of Nebraska State Museum (UNSM) houses a significant collection of nearly 100 ancient Egyptian scarabs. The collection is a wonderfully diverse group, providing examples of different usage and stylistic conventions, as well as spanning several periods of ancient Egyptian history (from the First Intermediate Period to the late New Kingdom). The scarabs vary in size, type of inscription they bear, and materials from which they were produced. This study statistically demonstrates that assignments of specific dimensions of scarab size and particular inscription types were not random occurrences, nor was the employment of certain materials and particular inscription types a random pairing.

Ancient Egyptian scarabs are a unique class of artifact produced by the civilization of Ancient Egypt. The Ancient Egyptian scarab was usually portrayed in the shape of the actual scarab beetle, with such features as are found on the several varieties of beetle present in Egypt, the most common being the species *Sacrabaeus* (Ward 1978: 88-93). The scarab beetle was sacred to the Ancient Egyptians as a representation of their God, Khepera (Budge 1925:278). During the process of mummification, a special scarab inscribed with religious text was often put in the body in place of the heart (Budge 1925:289). In addition to the amuletic and religious value of these artifacts, scarabs also served as seals for private individuals, offices of the state, and the Pharaoh (Newberry 1905). They were also sometimes used to commemorate important Pharonic accomplishments and historical occasions (Budge 1925:282). Scarabs were continually produced in Ancient Egypt for over two thousand years (from Dynasty VI through the Ptolemaic and Roman periods) (Budge 1925:288). Because of this, vast numbers of them have been found and collected. The great quantities of this artifact class which exist today afford Egyptology a rare research opportunity.

Scarabs have long been published in catalogues; however, it was not until 1889 that an attempt was made by Flinders Petrie to bring some order to their history. Petrie's *Historical Scarabs* focused mainly on the chronology of scarabs based on their ventral designs (Newberry 1905:1). Others followed, such as Newberry, Hall, Pieper, Rowe, and Martin. Ward and Tufnell's more recent *Studies On Scarab Seals, Vol. 1 and 2* concentrated heavily on the classification and investigation of dorsal and ventral stylistic components. In general, scholars have concentrated on the use and purpose of scarabs, general classification techniques, and scarabs from a specific time frame and/or site (Newberry 1905:1); thus, the majority of scarab research has concentrated on ordinal, or categorical, data. Most scarab studies' conclusions have been based foremost on relationships and patterns which were able to be detected in raw observations. The use of statistics in the field of Egyptology is relatively new, but it is proving to be a valuable tool to explore intricate relationships within ancient Egypt's material culture; relationships which would likely be lost to the Egyptologist working with raw observations alone.

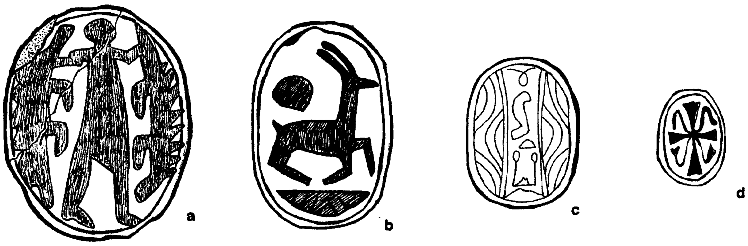
The use of statistics in scarab research is vital to move beyond observations and general conclusions in order to pinpoint and better understand subtle relationships which exist between scarab manufacture and usage. To this end, the research summarized in this paper used statistics to detect any relationships existing between the size of a scarab and 1) the type of inscription which is found on the scarab's ventral side, and 2) the type of material from which the scarab is made.

MATERIALS AND METHODS

The scarabs of UNSM were largely unprovenienced and unresearched; therefore it was necessary to create a data file for each scarab. The scarabs were first gathered together onto a tray where they were tagged with assigned identification numbers and a brief description. The scarabs were then were placed in individual acid-free, archival quality, plastic zip-lock bags to protect them during handling. Data collection then proceeded, with detailed data sheets completed for each scarab. These data sheets included such information as general measurements of the scarab (length, width, and point of greatest thickness), material of the scarab, notes on the dorsal side's stylistic features and on the ventral side's inscription (where applicable), as well as approximate estimates of period of origin. On the reverse of each data sheet was a scientific illustration of the scarab showing the dorsal and ventral sides in both actual and enlarged views.

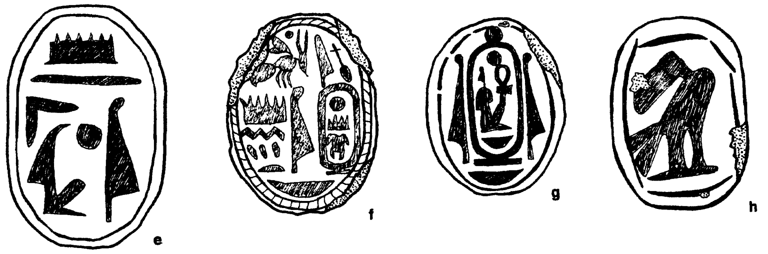
The scarab data which is included in this paper consists mainly of measurements of length, width and thickness;

Examples of Common Scarabs



a) Man holding two crocodiles. b) Gazelle in stride. c) Private name seal. d) Floral design.

Examples of Divine Scarabs



e) Name of the god Amen-Re. f) Text and cartouche of Thutmosis III. g) Cartouche of Amenhotep III. h) Horus the falcon, holding a flail.

type of material; and the type of inscription that was featured on the scarab's ventral side. The length, width, and thickness measurements, taken in centimeters, were made using calipers and a short metal ruler. The material identification was made on the visual appearance of the piece. Three general material types represent the scarab collection: stone, ceramic, and faience.

The original intent in dealing with the inscriptions was to classify each according to 14 exclusive categories, but exploratory data analysis and initial findings proved such a system to be too cumbersome, and one which would provide little if any statistically significant findings. A revised approach consisting of three categorical "contrasting pairs" was used in order to carry out an analysis of the inscriptions. These paired categories were arrived at by first determining the type of inscription on each scarab, and then grouping these specific categories into more general categories which could be used on the collection as a whole and which could possibly point to clues as to the use or significance of scarabs bearing such inscription types. These general categories included: "Text" vs. "Non-Text" inscriptions, inscriptions "With Cartouche" vs. those "Without Cartouche," and finally, inscriptions bearing "Common Images or Text" vs. those bearing "Divine Images or Text."

The "Text/Non-Text" category was fairly simple to determine. If the scarab's inscription included hieroglyphic text in the form of words, names, titles, or "good wishes," the scarab was considered to bear "text." Those exhibiting only pictures or designs were considered "non-textual." The "With Cartouche/Without Cartouche" category was determined by the presence or absence of a royal name, which in nearly all cases of a royal name was signaled by the specific "cartouche ring" in which the component signs making up the name are written (Gardiner 1927:522). The "Common Images or Text" designation was assigned to inscriptions bearing forms or text which were not specific to divinities or royalty. The "Divine Images or Text" designation was given to inscriptions exhibiting specific images, names, or titles known to represent a divinity or Pharaoh.

Since this study focused heavily on the type of inscription on a scarab, it was necessary to exclude those scarabs which did not bear an inscription. Furthermore, those scarabs bearing inscriptions which were unable to be identified at this time were also excluded. Scarabs which were made of a material other than the principal three type being examined in this study were excluded from consideration at this time. Out of the collection's 96 scarabs, 69 were able to be used.

The scarabs amassed at the UNSM have come from many different sources and places and can be assumed to be a random sampling of scarabs. Exploratory data analysis showed the scarabs to be normally distributed as to their dimensional categories.

ANALYSIS

Chi-Square Tests

The first type of test used on the scarabs was a Chi-square test which examined the relationship between the type of inscription and the choice of material used in producing the scarab. The material types examined consisted of stone, ceramic and faience. The inscription types examined in this test were a) "Text/Non-Text" Inscriptions, b) "With Cartouche/ Without Cartouche" Inscriptions, and c) "Common Images or Text/Divine Images or Text." The following null hypothesis was tested:

Ho = There is no relationship between the type of inscription found on a scarab and the material from which the scarab is made. (The two are believed to be randomly selected.)

The accepted value of $\alpha = .05$ was used as the significance level used for these Chi-square tests. The results of the Chi-square tests for the three inscription types are described below.

a) *Material and "Text/Non-Text" Inscriptions*: p = .125 is not a statistically significant probability value, and therefore the null hypothesis cannot be rejected. (See Figure 1 in the Appendix.)

b) *Material and "With Cartouche/Without Cartouche" Inscriptions*: Two out of six cells had an expected frequency of <5 (33.3%); therefore the results of the test cannot be considered. More revised testing is needed.

c) *Material and "Common Images or Text" / "Divine Images or Inscriptions*: This test also showed two of six cells to be below the expected frequency of 5 (33.3%), so that the test results cannot be considered. More revised testing could perhaps remedy this.

T-Tests

The second type of statistical test used in this study was the "Independent Samples T-test." This test was used to examine the relationship between the size (dimensions) of a scarab and the type of inscription found on the ventral side. The size dimensions which were examined included: length, width, thickness, surface area, two shape indexes, and volume. The inscription categories examined again included: a) "Text/ Non-text" Inscriptions, b) "With Cartouche / Without Cartouche" Inscriptions, and c) "Common Images or Text / Divine Images or Text" Inscriptions. The following null hypothesis was tested:

Ho = There is no relationship between the type of inscription found on a scarab and the size of a scarab. (The two are believed to be randomly selected and thus should show random variances.)

The results of the T-Tests follow:

a) *Scarab size and "Text / Non-Text" Inscriptions:* In all the size cases tested (length, width, thickness, surface area, two shape indexes, and volume) with regard to "Text/Non-Text" inscriptions, the null hypothesis could not be rejected.

b) Scarab size and "With Cartouche / Without Cartouche" Inscriptions: Again, in all the size cases tested (length, width, thickness, surface area, two shape indices, and volume) with regard to "Text/Non-Text" inscriptions, the null hypothesis could not be rejected.

c) Scarab Size and "Common Images or Text / Divine Images or Text" Inscriptions: The null hypothesis (that the variances are equal) was able to be rejected in two dimensions of scarab size (length and thickness, but not in the other dimensions of scarab size (width, surface area, two shape indices, or volume). See Tables 1.1 and 1.2 below.

Table 1.1 *Scarab Length (cm):*

Variable	Number of cases	Mean	SD	S E of Mean
common images or text	27	2.1630	1.125	.217
divine images or text	42	1.7024	.705	.109

Mean Difference = .4606 *Levene's Test for Equality of Variances: F= 3.407, P= .069*

Table 1.1 *(cont.)*

T-test for Equality of Means

Variances	t-value	df	2-tail Sig	SE of Diff	CI for Diff (95%)
Equal	2.09	67	.040	.220	(.022, .900)
Unequal	1.90	39.18	.065	.242	(-.029, .951)

Table 1.2 *Scarab Thickness (cm)*

Variable	Number of cases	Mean	SD	S E of Mean
common images or text	27	.9641	.435	.084
divine images or text	42	.7879	.265	.041

Mean Difference = .1762 *Levene's Test for Equality of Variances: F=2.961, P= .090*

T-test for Equality of Means

Variances	t-value	df	2-tail Sig	SE of Diff	CI for Diff (95%)
Equal	2.09	67	.040	.084	(.008,.344)
Unequal	1.89	38.51	.066	.093	(-.012, .365)

One-Way ANOVA

The One-Way ANOVA test was the final type of statistical test used in this study. It was used to examine the relationship between scarab size (measured in length, width, thickness, surface area, two shape indices, and volume) and the choice of materials (stone, ceramic or faience) from which the scarab was produced. This relationship was not one which was originally planned, but as work with the data progressed, it became clear that this was a related aspect of scarabs that would complement the aims of this study. The following null hypothesis was tested:

Ho = There is no relationship between the type of inscription found on a scarab and the material of which a scarab is made. (The two are believed to be randomly selected. and thus should show random variances.)

Results: The null hypothesis was able to be rejected in the following size cases: length, width, thickness, and surface area. (see Tables 2.1, 2.2, 2.3, and 2.4 below). The null hypothesis could not be rejected in the size cases of two shape indices and volume.

Table 2.1 *ANOVA - Scarab Length (cm) x Material 2:revised coding*

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Probability
Between Groups	2	11.9560	5.970	8.8049	.0004
Within Groups	66	44.8101	.6789		
Total	68	56.7661			

Table 2.2 *ANOVA - Scarab Width (cm) x Material 2:revised coding*

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Probability
Between Groups	2	6.6170	3.3085	9.1078	.0003
Within Groups	66	23.9753	.3633		
Total	68	30.5923			

Table 2.3 *ANOVA - Scarab Thickness (cm) x Material 2:revised coding*

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Probability
Between Groups	2	1.6868	.8434	8.4090	.0006
Within Groups	66	6.6195	.1003		
Total	68	8.3063			

Table 2.3 *ANOVA - Scarab Surface Area (cm^2) x Material 2: revised coding*

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Probability
Between Groups	2	142.0397	71.0199	5.1409	.0084
Within Groups	66	911.7617	13.8146		
Total	68	1053.8015			

DISCUSSION

Both the Independent Samples T-test and the One-way ANOVA test resulted in instances where the null hypotheses could be rejected due to statistical probability values.

Results of the Independent Samples T-test

In the case of the Independent Samples T-test, the rejection of the null hypothesis means that there does appear to be some sort of relationship between the size of a scarab, in terms of length and thickness, and whether a "common" or a "divine" type of inscription was chosen to appear on the ventral side. In other words, the chance that the relationship between choice of scarab size (in reference to length and thickness) and either a "common" or "divine" inscription was purely random is extremely unlikely.

After generating a scatterplot graph of this phenomenon, it was clear that while both "common" and "divine" inscription groups of scarabs tended to be clustered in the smaller size ranges, those scarabs with "common images or text: inscriptions had a greater size range than those scarabs with a "divine images or text" inscription. The scatterplot also showed that the dimensions of length and thickness in scarabs tend to be directly proportional to each other.

Two immediate questions arise from these findings: 1) why would scarabs bearing "common" inscriptions tend to be longer and thicker than that of "divine" inscription scarabs, and 2) why is there more diversity in dimensions (such as length and thickness) in scarabs bearing "common" inscriptions than in those bearing "divine" inscriptions? These questions offer an interesting "springboard" from which Egyptology may come to better understand the purpose and significance of scarabs in ancient Egyptian culture. Perhaps the makers of such scarabs which were to be inscribed with "divine images or text" had to more rigidly conform to the Egyptians' well-established canon in art and writing, while the makers of such scarabs which were going to be inscribed

with "common images or text" were more free to experiment with different size ranges, as it might be argued that "common" inscriptions in and of themselves had a greater range of freedom to express diverse concepts.

Results of the One-way ANOVA test

In the case of the One-way ANOVA test, the rejection of the null hypothesis means that there does appear to be some sort of relationship between the size of a scarab, in terms of length, width, thickness, and surface area, and the choice of material from which the scarab was produced. In other words, the chance that the relationship between choice of scarab size (in reference to length, width, thickness, and surface area) and the type of material from which the scarab was made was purely random is extremely unlikely.

Once again various scatterplots proved useful in examining the relationship between the type of material being used and the size of the scarab. These graphs indicated that while scarabs made of each of the three types of materials (faience, ceramic, and stone) tended to be clustered around the small end of the size range, there were noticeable differences in scarab size between the material groups. Faience scarabs proved to have the smallest size range of the three material types examined. Ceramic scarabs exhibited a greater size range than faience scarabs. Stone scarabs showed the largest size range, and indeed the largest scarabs of the collection were of stone.

The question then appears to be, why is stone the material in which the largest scarabs were produced and in which the greatest amount of size range occurs? What sets it apart from faience and ceramic scarabs? In terms of the materials themselves, stone is relatively more easy to come by than ceramic or faience. Non-precious or non-semi-precious stone was readily available to most Egyptians. By contrast, ceramic may have been harder to come by, and faience perhaps even more difficult. The latter two materials would have required specific knowledge, such as how to mix the paste or clay from which the scarab was to be produced, molding the scarab out of clay or dough, placing the ceramic or faience in an oven and firing it with appropriate levels of heat for a specific time, and also perhaps glazing the piece. It could be the case that, for the most part, only specific people in ancient Egyptian society were producing scarab amulets, and therefore may have established general rules or guidelines in scarab manufacture that would affect the size range of a scarab and the choice of materials from which it was produced. Some have suggested that scarabs were at times "mass-produced" in antiquity. If so, this may also contribute to the lack of size diversity in materials such as ceramic or faience.

CONCLUSION

This study is an example of how statistics can be used successfully to reveal some of the subtle relationships present in material culture, which may in turn afford clues about how a particular society functioned. Some of the problems encountered in this study were due to the relatively small scarab pool which was used. Future research may prove facilitated and more conclusive by using a larger pool of scarabs. It would perhaps be worthwhile to conduct the study again, using a true random sampling of scarabs, to check for flaws in this study's data pool.

The results obtained in this study provide new ideas and direction for exploration into aspects of this class of ancient artifact. Further studies on more specific classes of inscriptions to test against the "Common/Divine" inscription results of the Independent T-Tests would be valuable. Certainly, the use of statistics as a tool in examining the material culture of ancient Egypt should prove valuable to the discipline of Egyptology as a whole.

REFERENCES CITED

Budge, E.A.W.
1925 *The Mummy*. Dover Publications, New York.

David, R.
1980 *The Macclesfield Collection of Egyptian Antiquities*. Aris and Phillips, Warminster, Wilts, England.

Gardiner, A.
1927 *Egyptian Grammar*. University Press, Cambridge, UK.

Newberry, P.E.
1905 *Ancient Egyptian Scarabs*. Ares Publishing, Chicago.

Ruffle, J.
1977 *The Egyptians*. Cornell University Press, Ithaca, NY.

Thomas, D. H.
1986 *Refiguring Anthropology*. Waveland Press, Prospect Heights, IL.

Tufnell, O.
1984 *Studies On Scarab Seals: Vol. II*. Aris and Phillips, Warminster, Wilts, England.

Vercoutter, J.
1945 *Les Objects Egyptien et Egyptisan.* Librarie Orientaliste Paul Geuthner, Paris.

Ward, W. A.
1978 *Studies On Scarab Seals: Vol. I.* Aris and Phillips, Warminster, Wilts, England.

1994 Beetles In Stone. *Biblical Archaeology* 57(4):186 -202.

***Sarah C. Guthmann** is an undergraduate anthropology major from Hastings, NE., specializing in Egyptology. Other concentrations include Old World archaeology and scientific illustration. Guthmann served for three years as the senior research assistant and scientific illustrator for the Egyptian Collection Research Project at the University of Nebraska State Museum and is currently involved with the project's ongoing research.*

APPENDIX

Figure 1. *Chi-Square Test results of "Material and 'Text/Non-Text" Inscriptions."*

		text 1	non-text 2	
stone	1	27 26.6 75.0% 52.9% 39.1%	9 9.4 25.0% 50.0% 13.0%	36 52.2%
ceramic	2	3 5.2 42.9% 5.9% 4.3%	4 1.8 57.1% 22.2% 5.8%	7 10.1%
faience	3	21 19.2 80.8% 41.2% 30.4%	9 9.4 25.0% 50.0% 13.0%	26 37.7%
Column Total		51 73.9%	18 26.1%	69 100.0%

Chi-Square	Value	DF	Significance
Pearson	4.15732	2	.12510
Likelihood Ratio	3.70156	2	.15711
Mantel-Haenszel test for linear association	.16340	1	.69605

Minimum Expected Frequency - 1.826 Cells with Expected Frequency < 5 : 1 of 6 (16.7%)

Statistic	Value	Approximate Significance
Phi	.24546	.12510*1
Cramer's V	.24546	.12410*1