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PALEOENVIRONMENT. THE STONE AGE

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ANALYZING FERTILITY AND ATTRACTION IN THE PALEOLITHIC: THE VENUS FIGURINES

Countless hypotheses have focused on the enigmatic "Venuses," but most are not testable. The current authors investigate a hypothesis suggested by R.D. Guthrie involving the waist-to-hip ratio. This measurement determines fertility, beauty, and health in modern females; a 0.7 indicates cross-cultural beauty and fertility. Guthrie argued that the statuettes share an average waist-to-hip ratio of 0.655, indicating that Paleolithic males preferred curvier women. We sought to test this and analyze regional data. Our mean was significantly different than Guthrie's and we found evidence for regional differences. While some statuettes may have served as Paleo-erotica, it seems unlikely that they all did.

Keywords: *Paleolithic, art, waist-to-hip ratio, Gravettian, Venus.*

Introduction

Over the past century, there has been a ubiquitous fascination with a specific form of Upper Paleolithic art. These artifacts are diverse in type including bas reliefs, masks, pendants, figurines, and solitary heads. The majority is interpreted as females, and was created in the Gravettian. Based on the shared sex of many of these objects, and their supposed external similarities, they are commonly referred to as the "Venus" figurines. A substantial body of research has developed, each aimed at answering different questions in regards to either the appearance, or the usage of these artifacts as a whole. Countless hypotheses have been erected to shed light on different spheres of Gravettian life including, the social (Duhard, 1993; Markale, 1999; Gamble, 1982), religious/belief systems (Bégouen, 1925; Hawkes, Wolley, 1963; Mussi, Cinq-Mars, Bolduc, 2000), and sexuality (Taylor, 1996; Guthrie, 2005). Yet, after more than 100 years of research and interpretation, these anthropomorphic objects remain enigmatic. This is probably because although many of the previously mentioned hypotheses are plausible, few are testable.

Instead of suggesting another assumption, the current authors aim to analyze a testable hypothesis first suggested by R. Dale Guthrie. Guthrie (2005) argued that the figurines represent "Paleo-erotica" based on the shared presence of a low average waist-to-hip ratio (WHR) of 0.655. In human females, this ratio is correlated with fertility, beauty, health, and body shape (Buss, 2004; Singh, 2006; Singh, Singh, 2006). The range of fertility for females is 0.67– 0.80 (Buss, 2004). In particular, women with lower waist-to-hip ratios have less trouble getting pregnant, are healthier, and in general are considered more attractive than women with higher waist-to-hip ratios (Buss, 2004; Henss, 1995; Singh, 1993; Singh, Singh, 2006; Wing et al., 1991). While Guthrie's results were lower than the modern cross-cultural preference of

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a 0.7, and just outside the range of fertility, he argued that Paleolithic males were attracted to curvier women (Guthrie, 2005).

While it is impossible to know exactly what was considered attractive in the Paleolithic, or whether these were in fact supposed to represent fertility emblems, men from cultures all over the world prefer women with WHRs that are significantly lower than their own (Singh, 2006). Since this measurement is independently correlated with fertility, one could assume that attraction to this body shape would have existed in the Paleolithic as well. Additionally, Singh and Singh (2006) present evidence for a long lasting appeal of the low WHR across time an in space.

Since many of the statuettes appeared pregnant, thus indicating a high WHR, the current authors decided to do a comprehensive analysis of the Gravettian statuettes from across Eurasia. A p-value greater than 0.05 would support Guthrie's hypothesis, while a p-value lower than 0.05 would support the alternate hypothesis and suggests that these figurines do not represent Paleo-erotica. We also analyzed whether the mean was homogenous across four geographic regions: Central Europe, the Russian Plain, Western Europe, and Siberia.

The Gravettian

The Gravettian is a technocomplex found throughout Europe following the Aurignacian. Tools that are characteristic of this culture include Noailles burins, Gravette points, backed blades, and micrograveттes, but regional variants are also evident (Bordes, 2003). While the term Gravettian is commonly used in literature, it is unclear when this period begins and ends radiometrically. What is apparent is that the technology lasts longer in some regions than in others. K. Laurent (2007) for example noted that it lasts from 28,000–20,000 BP in France, while in Eastern Europe it dates from 30,000–20,000 BP (Svoboda, 2001). In Italy, M Mussi stated that it lasted until 20,000 BP and was then followed by the Epi-Gravettian lasting until 16,000 BP (Mussi, Cing-Mars, Bolduc, 2000). Therefore the assemblages will be classified as Gravettian if they fall into their region's time span through either radiometric dating or relative dating (stylistic attribution).

Background to the WHR

Body fat composition is different between the sexes, but also between different age groups in females. Before puberty, both males and females will share similar WHRs. After puberty, males begin to deposit more fat to their upper bodies including the abdominal area, but will lose fat from their lower body. This process is known as android fat distribution (Singh, Luis, 1995). Generally, females will have more than 20 % body fat after puberty, in comparison with males which will have below 10 % (Guthrie, 2005). Females with less than 20 % body fat are unable to menstruate, and have little chance of becoming pregnant (Guthrie, 2005; Zaadstra et al., 1993). After menarche, estrogen activates fat deposits to the breasts, buttocks, and thighs of females. This is known as gynoid fat distribution (Singh, Luis, 1995). Higher amounts of circulating testosterone are indicative of a higher WHR, and higher amounts of circulating estrogen denote a lower waist to hip ratio (Singh, 2006; Sugiyama, 2004). Therefore, there is not only a difference in the amount of body fat between males and females, but also the location of storage within the body (Buss, 2004). While the average WHR varies slightly between different ethnic groups, regardless of environmental circumstances, a population in which females have higher or equal WHRs to males has never been found (Singh, Luis, 1995). According to Singh and Luis (Ibid.: 53), "a moderate degree of obesity, relative scarcity of food, or climatic conditions (Arctic versus temperate zones) does not significantly affect gynoid or android fat distributions."

WHR and fertility. WHR is independent from overall body fat percentage, and is correlated with fertility and long-term health in females (Wing et al., 1991; Zaadstra et al., 1993; Singh, Luis, 1995; Buss, 2004). Not all women are equally fertile. The healthy WHR for females is between 0.67 and 0.80 (Buss, 2004). This is indicative of having either a pear or an hourglass body type, depending on the size of the chest (Zaadstra et al., 1993).Women with higher WHRs, meaning women with waists that are nearly equivalent to their hips, have more difficulty getting pregnant (Zaadstra et al., 1993; Buss, 2004; Guthrie, 2005). In fact, Zaadstra et al (1993) found that independent of overall body fat percentage, age, length and irregularity of menstrual cycle, smoking habits, parity, and the degree of infertility of the partner, having a high WHR was negatively associated with, and had the most dramatic effect on fecundity. The first author has not been able to find a single article that demonstrates that women with higher WHRs are more fertile than women with lower WHRs. Women with higher WHRs are also more susceptible to various diseases including: diabetes, hypertension, heart attack, stroke, and gallbladder disorders (Buss, 2004, Wing et al., 1991).Women with higher WHRs are also more likely to experience depression, anxiety, and anger (Wing et al., 1991).

WHR and attraction. Since ovulation is hidden in human females, men who are able to pick healthy and fertile females will be more likely to pass on their genes. One would therefore expect that universally, males would be attracted to females with a lower waist-to-hip ratio (i.e. a more constricted waist). In order to investigate this, men

from various ethnic groups, professions, and education levels, have evaluated line drawings and photographs that vary in weight (underweight, average, and overweight) and WHRs generally from a 0.7 to a 1.0 (Singh, 1993, 2006; Henss, 1995; Furnham, Moutati, Baguma, 2002; Singh, Singh, 2006).

Devendra Singh and several other scholars have shown that there is a widespread appeal for females with low WHPs, in many cases, a 0.7 (Singh, 1993, 2006; Henss, 1995; Buss, 2004; Singh, Singh, 2006). This is significant because the average WHR among women today is above a 0.7, making it somewhat uncommon (Guthrie, 2005). A recent article by Singh noted the prevalent link between attraction and a low WHP among 20 ethnic and cultural groups including the "United States (white, black, and Latino), England, Germany, Holland, Poland, Greece, Australia, Kenya (Africa), Guinea-Bissau (Africa), Uganda (Africa), Azores islands, Shiwiar tribe of East Ecuador, Indonesia, Hong Kong (China), India (Sugali and Yanadi tribes), Chile (South America), and Jamaica" (Singh, 2006: 364). What is significant about these studies is that while the majority of groups prefer a 0.7, men from Uganda are more attracted to a 0.5 (Furhnam, Moutafi, Baguma, 2002). Nevertheless, in all of the above-mentioned cases, males are attracted to females that have a significantly lower WHR than themselves.

Guthrie's method and findings

Guthrie decided to test this information about the WHR on Paleolithic female imagery. His database consisted of 53 Paleolithic images and he calculated the WHP by measuring the hips and waist from the front and the back of each image (Guthrie personal communication, 2008). If the female art was within the range of fertility, and collectively had a low WHP, it would suggest that the figurines did in fact represent the Paleolithic male ideal of beauty. His results indicated a 0.655 WHR, with a standard error of the mean of 0.0188, and a standard deviation of 0.133 (Guthrie, 2005). This could suggest that while near the range of fertility, Paleolithic males preferred more voluptuous women than do modern males (Ibid.).

Materials and methods

The total database included 69 statuettes. However, out of that 68, the first author was only able to take the WHR of 29 of the statuettes. This was due to several factors. Twenty-three of the statuettes were indirectly analyzed from photographs, and therefore were not included. This is because discrepancies were found after trying to measure the WHR from pictures, and then comparing the data with the actual measurements from the statuettes. The other 17 figurines were either too incomplete or had body parts that were obstructing the measurement. Our sample is biased toward figurines from the Russian Plain sites and somewhat toward those from the Malta collection. This is not only because more statuettes were created in these regions, but also because they were generally found complete, or nearly so. This contrasts with the Brassempouy collection, many of which were broken by excavators, their remaining pieces never to be found (White, 2006). Similarly, several Central European pieces created from fired loess were also too fragmentary to measure.

The image below indicates the correct way to take the WHP (Fig. 1). The value of the circumference of the narrowest part of the waist is divided by the widest section of the hips. A string was used to take the circumference and then was held next to measuring tape for both the hip and waist measurements. All measurements were checked three times before being recorded. Calipers were not used because they were found to be ineffective when measuring circumferences. In many cases, it was not possible to simply use the measuring tape alone because it proved too bulky to accurately measure some of the small figurines. Original statuettes were preferred over casts, but often only casts were available. In cases where both the cast and the original were accessible, measurements were taken on both objects. The casts were found to be representative. While the process seems straightforward, this was much more difficult to carry out on figurines. Not all of the figurines have belly buttons for example. In this case, the statuette was measured from the narrowest part of the middle of torso, and was always measured below the breasts. When either the waist or the hips could not confidently be determined, the ratio was not taken.

Results

The data are given in Table 1 and plotted in Fig. 2. The values for WHR ranged from a minimum of 0.58 (Eliseevichi from the Russian Plain) to a maximum of 1.51 (Gagarino stat. 2 from the Russian Plain), with most values between 0.89 and 1.29. The mean WHR for all 29 figurines was 1.049 (standard error 0.035) with a 95 % confidence interval from 0.976 to 1.122.

After we examined the data as a whole, we looked at the four sites individually. Means, standard errors, and 95 % confidence intervals are given in Table 2 by site. The mean WHR for Siberia, for Central Europe, and for Western Europe were all approximately 0.97, although variability varied greatly by group. Siberia data were quite consistent, while Central Europe data were less consistent. WHR variability is difficult to gauge for Western Europe because there were just two statuettes.

In contrast to the other three regions, the mean WHR for the Russian Plain was higher at 1.15; the data were

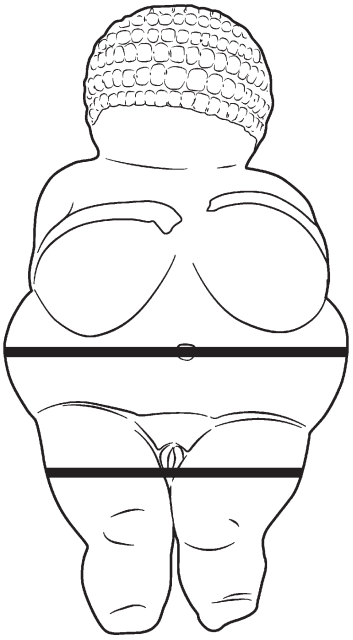


Fig. 1. Waist-to-hip ratio on the Venus of Willendorf.

more variable and had one extreme value, 0.58 for Eliseevichi. Upon reanalysis of the literature this statuette was found to fall outside of the Gravettian range and is dated to 17,000 years BP (Soffer, 1985), therefore we decided to exclude it from further analysis. Galgenberg was also excluded because it was created during the Aurignacian (Clottes, 2000).

Part 1 of our analysis was to test whether the statuettes represented fertile "Paleo-erotic" images as suggested by Guthrie. We compared our WHR values with Guthrie's value of 0.655 by conducting a one sample *t* test with data from n = 27 statuettes. Our mean WHR was significantly different than Guthrie's ($t = 13.21$, $p < 0.0001$), indicating disagreement with Guthrie's findings. Even when we included the Eliseevichi statuette and the Venus of Galgenberg statuette in the analysis, we found highly significant differences ($t = 11.26$, $p < 0.0001$).

Part 2 of our analysis was to see if WHRs were homogeneous across Eurasia. We conducted an analysis of variance on the data from n = 27 statuettes. Results were significant ($p = 0.0025$) and we proceeded with Scheffe's multiple comparisons to locate the difference(s). We found that on average, WHR from

Table 1. **Individual waist-to-hip ratios of female figurines from across Eurasia**

Figurine	Region	WHR
La fillette of Brassempouy	Western Europe	0.940
Laugerier-Basse	Same	1.000
Venus of Dolní Věstonice VI	Central Europe	0.933
Venus of Galgenberg	Same	0.790
Venus of Moravany	»	1.000
Venus of Pavlov	»	0.800
Venus of Petrokovice	»	1.030
Venus of Willendorf	»	1.290
Kostenki X	Russian Plain	1.130
Kostenki torso	Same	1.220
Eliseevichi	»	0.580
Gagarino, stat. 2	»	1.510
Gagarino, stat. 3	»	1.240
Gagarino, stat. 4	»	1.260
Kostenki I, stat. 1	»	1.190
Kostenki I, stat. 2	»	1.070
Kostenki I, stat. 3	»	1.400
Kostenki I, stat. 4	»	1.020
Kostenki I, stat. 5	»	1.000
Kostenki I, stat. 87	»	1.220
Kostenki I, stat. 83-2	»	1.110
Malta 74	Siberia	0.890
Malta 370/746	Same	1.000
Malta 370/747	»	0.920
Malta 370/753	»	1.000
Malta 370/750	»	0.960
Malta 370/755	»	1.000
Malta 370/ 756	»	0.980
Malta 370/761	»	0.940

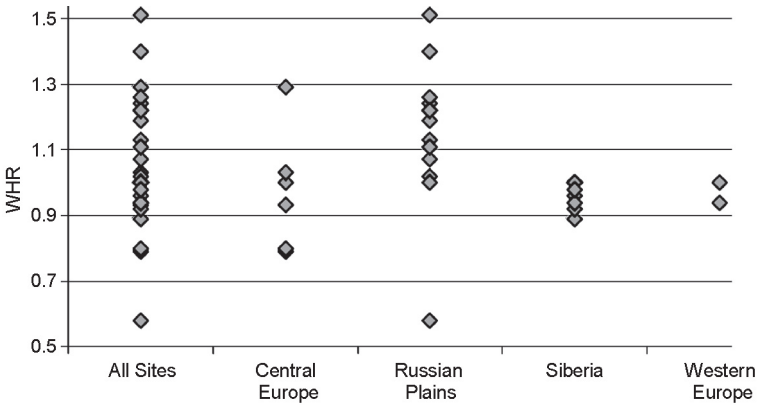


Fig. 2. Waist-to-hip ratio of all statuettes in sample.

Table 2. **Means of regional waist-to-hip ratios**

Region	Mean	Standard error	95 % confidence limits	
Central Europe	1.011	0.058	0.891	1.131
Russian Plain (without Eliseevichi statuette)	1.198	0.039	1.128	1.277
Siberia	0.961	0.047	0.864	1.059
Western Europe	0.970	0.094	0.775	1.165

Siberia, Western Europe, and Central Europe were not significantly different from each other. However, on average, WHR from the Russian Plain were significantly different than WHR from Siberia. This is clearly evident in the plot of mean WHR and confidence intervals in Fig. 3. These intervals indicate that our WHRs were not homogeneous across Eurasia, with those from the Russian Plain being distinctively different than those from Siberia.

Additionally, Fig. 3 illustrates the difference between our WHRs and those of Guthrie. We plotted Guthrie's confidence interval as his reported mean (0.655) with a margin of error of 0.0376, which we approximated as 2 times his reported standard error of 0.0188. All of our confidence intervals are well outside of his. If we consider the raw data, only one of our values is within his range: that value is for Eliseevichi, which we have already determined as being an extreme value and not representative of Gravettian Russian Plain statuettes.

Based on our analysis of the WHR for these four sites, we find that our statuettes do not represent images consistent with Guthrie's findings. Also we find that there are differences in mean WHR among the four sites we sampled, with Central Europe, Siberia, and Western Europe being similar to each other and the Russian Plain being different.

Discussion

One problem with Guthrie's method was that he did not list information about which samples he specifically used. It was however mentioned that both figurines and bas reliefs were used in the analysis (Guthrie, 2005). This presents problems as the reader does not know which regions were examined, let alone which time periods, or individual pieces of art that were used. If both figurines and engravings from the Magdalenian were included, this would bias the data towards a lower WHR. In general, Magdalenian figurines display much more abstract depictions of the female body (Fig. 4). Some of these statuettes are so abstract that it is possible to argue that they are not anthropomorphic at all. As is evident from the figures, Magdalenian examples are much curvier than normal women indicating a very low WHR. In fact, the first author was also able to measure the WHRs of two Solutrean/Magdalenian statuettes at Schloss Monrepos, in Germany. One was a 0.5 and the other was a 0.61; both of which are much curvier than the Gravettian samples. Therefore, if these statuettes were used, they could have skewed the data towards a lower WHR.

Another problem could be differences in methodology. Guthrie did not provide a photograph indicating where he took the waist and the hip measurements. As mentioned

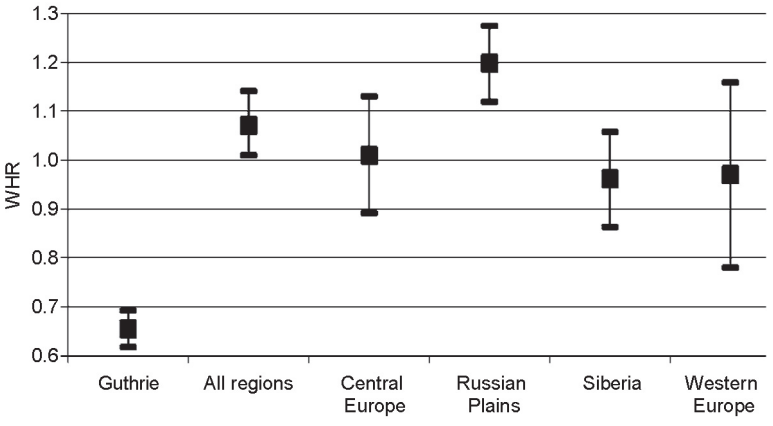


Fig. 3. Mean waist-to-hip ratio and 95 % confidence intervals.

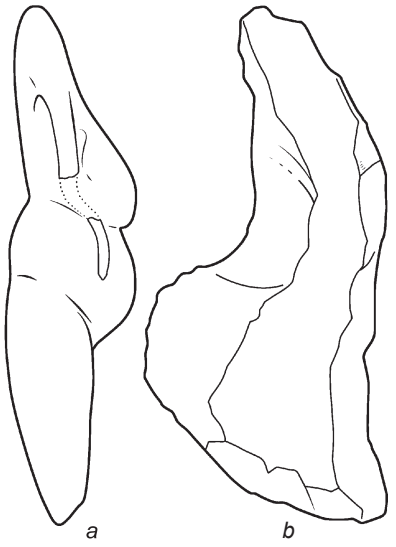


Fig. 4. Profile line drawings of Gravettian (*a*) and Magdalenian (*b*) Venuses.

earlier, the figurines are not real women, and various aspects of their body proportions may not be realistic. It is very important to make sure that measurements are standardized. As is demonstrated in the Fig. 1, the hip measurement is not taken through the hipbone, but much further below it. Also Guthrie's method involved measuring the front and the back of the waist and the hips from published pictures (Guthrie personal communication, 2008). While this may give a rough estimate, it is not possible to accurately deduce the WHR from photographs. When this method was utilized on Kostenki I statuette 1, at the Museum of Anthropology and Ethnography (Kunstkamera) in St. Petersburg, the WHR was a 0.86. When the first author measured the actual circumference of both the waist and the hips, the accurate WHR was actually 1.19. This is because it is impossible to measure the exact protrusions of the belly or the buttocks. Also, while many statuettes appear curvy from behind, when viewed from the front, they are actually apple shaped; such as the Venus of Dolní Věstonice. Both of these factors could therefore lead to an underestimation of the actual measurements.

Our results indicated a high average WHR overall (1.049), and for each collection (Siberia 0.961, Central Europe 1.011, Western Europe 0.970, and the Russian Plain 1.15).This is not indicative of Paleo-erotica. We found that the Russian figurines were statistically different from the Malta collection. Our analysis is limited in that none of the Italian Venuses were utilized as these statuettes were inaccessible to the first author. Incorporation of these figurines would enhance the study. Future research could also analyze the WHRs of the Magdalenian statuettes as well.

Conclusion

Our results do not support the Paleo-erotica hypothesis and contrast with Guthrie's findings. This is probably due to differences in methodology and/or samples used. While it could be argued that Paleolithic males were attracted to heavier set and less curvy females, there is no evidence to support this. Also, variation between regions makes this hypothesis very unlikely. This would suggest that males were simply indiscriminate with mating choices. As mentioned earlier, females with high WHRs are more prone to serious diseases, depression, and have a more difficult time getting pregnant. Males that would have chosen these females, would have had a lower chance of leaving offspring, or would leave no offspring at all. While some of the statuettes may have served as "Paleo-erotica," it seems unlikely that they all did. While the maker of a particular Kostenki figurine might be trying to depict pregnancy, *Le Torse* from Brassempouy may have served as Paleo-erotica for example. Imagery therefore could have been contextual, with some statuettes being sexual images, others depicting pregnancy, or others depicting ancestors for example. If the figurines are read "literally", the appearance of variation in nearly all of the samples aligns with Rice's (1981) hypothesis that the "Venuses" represent women of all ages since WHR is not constant throughout a woman's life.

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