# PALEOLITHIC FAT, PROBIOTICS, AND THE CORNER STORE

A unifying aspect of these three research projects is how they demonstrate the contemporary role inquiry plays in the development of the human species. At the junction of human heath and market systems, Alina Enoiu investigates measures to effectively advance beyond a period where food insecurity plagues areas, like in West Oakland, where only 1 supermarket exists compared to 32 emergency food distribution sites. A hope within this dismal food distribution system is the "healthy corner store movement." Alina examines the role government has played in advancing this movement by comparing the effects of the Food Stamps "WIC" program with a more case-specific assistance measure related to partially subsidizing the cost of a corner store's healthy renovations. This data is then applied to support an insightful public health suggestion for swaying the economy of food deserts toward healthier purchasing patterns.

While Alina's insights fundamentally challenge the assumptions of neoliberal market policies, Allison Yates explores how probiotics, a profoundly valuable and abundant contribution to human health, can adopt new meaning tailored to benefit the private sphere. She discovers how different narratives used to form the commodity's market position perpetuate issues like colonialism and racism. Her goal is to apply inquiry in order to appreciate the "social production" of probiotics and the narratives embedded within before common knowledge of probiotics is determined. She hopes this more comprehensive picture will help mitigate the perpetuation of such problems before they are embedded within the meaning of probiotics.

The final work of inquiry reflects on the shared historical success of our species. Suzan Ubick investigates a peculiar story of global triumph, which is attributed to a boom in fat

that followed 1,000 years of cooling and occurred between 75kya to 60kya. In supporting her argument she takes a three-stranded bicultural approach to understand the relationship between body fat and reproductive success of women. Studying archeological records, images of women in the last 40,000 years, and genes that determine a body's shape, Suzan begins to piece together the casual factors body fat had on our species' dramatic expansion during the stated period. The implications of Suzan's work may match the evolutionary importance of fat with that of the human brain.

In these three pieces of research, a challenge is investigated under the lens of how to improve food distribution systems, prevent the perpetuation of hereditary social dysfunction, and to appreciate our communal success over adversary. The ways in which these challenges are approached demonstrate a bright future through inquiry.

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# HEY FATTY BOOM BOOM!

## Fat and Fit in the Upper Palaeolithic

## SURF Conference Panel Session 4A

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Mentor: Dr. Lisa Maher, Anthropology

### I. Introduction

Sometime around 75,000 years ago, a supervolcano in Sumatra, known as Mount Toba, erupted at magnitude 9 on a scale with a maximum of 10. Over two weeks, Mt. Toba pumped a total of 670 cubic miles of ash and lava to a height of around 40 miles. 40 miles is the horizontal distance between San Francisco and San Jose. The ash dimmed the sun in a six-year volcanic winter, gradually settling in drifts totaling more than one-third of a mile in thickness. The volcanic winter was followed by 1,000 years of intensified cold and glaciation worldwide.[1] There may have been another consequence of Mt. Toba's supereruption: an explosion of body fat in our species, Homo sapiens, particularly in women. I argue that the severe climate and dietary changes following the supereruption may have a catalyzed a genetic shift event leading to increased ability to store body fat. In turn, high amounts of body fat relative to other primates may well be a major contributor to Homo sapiens's astounding success in colonizing Earth. My research questions asks whether the study of images of women across the last 40,000 years can yield clues as to whether such an event occurred between 75,000 and 60,000 years ago.

### II. Context

It is important at this point to define the words modern, fat, and fit, as they have very different meanings in common usage to those used in this article.

> *Modern humans are all Homo sapiens who have lived since 195,000 years ago.*[2]
>
> *Fat refers to women with a minimum of 18% fat, the level required for menstruation.*[3]

1 Oregon State University. Toba, Sumatra, Indonesia. N.d. http://volcano.oregonstate.edu/vwdocs/volc_images/southeast_asia/indonesia/toba.html

2 Robert Juhrmain et al., *Physical Anthropology* (Belmont: Wadsworth Cengage Learning, 2010), 400.

3 Rose Frisch, "Body Fat, Menarche, Fitness and Fertility," *Human Reproduction* 2, No. 6 (1987): 521.

> *The women I describe as biologically fat would be considered thin by Western cultural norms. Normal body fat for lean young women, regardless of ethnicity, is 17—25% of their body mass.[4] To put this into context, a female chimpanzee has 5% body fat,[5] and a blue whale 12%.[6]*
>
> *A fit individual produces offspring that survive to reproductive age.[7] An out-of-condition woman with three children and five grandchildren is fitter than an Olympic gold-medallist with one child and no grandchildren.*

In investigating the role of body fat in maximising reproductive fitness, I use the standard conceptual tool for archaeological problems: the three-pronged biocultural approach. This tool comprises:

> *Analysis of the archaeological record—bones, tools, and artwork.*
>
> *Ethnographic analogy, which studies and compares the genetic and cultural traits of different human populations.*
>
> *Comparative biology, which compares human genetic traits with those of non-human primates, especially chimpanzees.*

I argue that, if humans suddenly gained the ability to store large amounts of body fat, it happened within the time frame of 75,000—60,000 years ago. 75,000 years ago, following the Mt. Toba eruption, the onset of cold conditions in the Levant corridor linking Africa and Europe drove out H. sapiens, leaving Neanderthals in sole possession of previously shared territory (see Figure 1).[8]

At the other end, 60,000 years ago modern humans began pulsing out of Africa again,[9] pushing far north into Europe despite the severe, previously exclusionary cold. By 32,000 years ago, H. sapiens had driven Neanderthals to extinction,[10] even though the stocky, short-limbed Neanderthal body shape is more cold-hardy than Homo sapiens' elongated form.[11] The extreme cold of northern Europe reconfigured the bodies of Homo sapiens to resemble those of Neanderthals only sometime between 10,000 and 5,000 years ago.[12] I argue that body fat, which both generates heat as the fat tissues continuously break down and build up, and serves to insulate by keeping heat inside our core,[13] would have protected our gracile species with its long limbs against cold.

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4 Caroline Pond, *The Fats of Life* (Cambridge, U.K.: Cambridge University Press, 1998), 61.

5 William D. Lassek and Steven J.C. Gaulin, *Why Women Need Fat* (London: Penguin Books, 2012), 47.

6 Lori A. Smolin and Mary B. Grosvenor, *Nutrition and Weight Management*, 2nd Edition (London, Chelsea House Publishers, 2010), 34.

7 Robert Juhrmain et al., *Physical Anthropology*, 37.

8 John J. Shea, "Neandertals and Early *Homo sapiens* in the Levant" in *South-Eastern Mediterranean Peoples Between 130,000 and 10,000 Years Ago*, ed. Elena A.A. Garcea (Oxbow Books, 2010), 136.

9 University of Huddersfield. "Modern Humans Did Not Settle in Asia Before Eruption of Sumatra Volcano 74,000 Years Ago, Study Finds." *ScienceDaily*, 11 Jun. 2013. http://www.sciencedaily.com/releases/2013/06/130611084105.htm. (accessed July 20, 2013)

10 Joao Zilhao, Simon J. M. Davis, Cidalia Duarte, et al., "Pego do Diabo (Loures, Portugal): Dating the Emergence of Anatomical Modernity in Westernmost Eurasia", PLoS ONE 5(1): e8880. doi:10.1371/journal.pone.0008880:18. Published January 27, 2010. Accessed 26 July, 2013.

11 John Shea, "Neandertals and *H. sapiens* in the Levant," 126.

12 Timothy D. Weaver and Karin Steudel-Numbers, "Does Climate or Mobility Explain the Eifferences in Body Proportions Between Neanderthals and their Upper Paleolithic Successors?" *Evolutionary Anthropology* 14 (2005): 218.

13 Pond, *The Fats of Life*, 239.

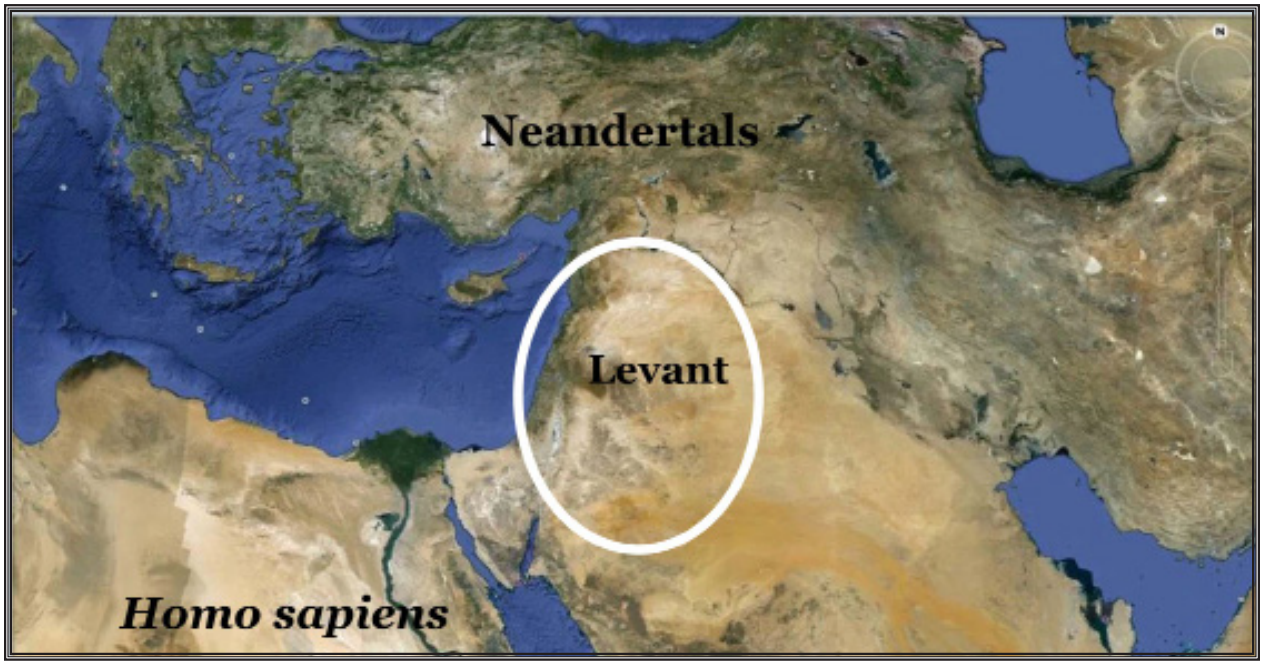


**Figure 1.** *Regions Inhabited by Neandertals and Homo sapiens 75,000 years ago.* Credit: Suzanne Ubick 2013-10-23.

Mt. Toba's eruption fits neatly between 75,000 and 60,000 years ago, a period which also sees Homo sapiens' first population boom.[14] I hypothesize that the volcanic winter and ensuing icy millennium led to heavy reliance on starchy tubers as a dietary staple, which, by increasing body fat (an excellent energy store), increased the reproductive rate of human females. I base this hypothesis on the costs of reproduction. It takes some 100,000 calories for a woman to maintain a pregnancy to term. At 3,500 calories per pound, this equates to 30lb of fat. Lactation costs another 500–1000 calories per day.[15] In bad times, a fatter woman will rear more offspring than her thinner sisters.

## III. Methods and Materials

In order to assess fatness as a trait of anatomically modern human females, I studied photographs of 80 representations of women from the period 40,000–10,000 years ago (known as Venus figurines), 67 women of hunter-gatherer or horticultural societies, and 105 U. S. American women. The Venus figurines and hunter-gatherers portray women who had never experienced a modern lifestyle of abundant processed foods and low physical activity, and can be argued to be closer to the so-called primitive state. For comparison, I used images of Western women, as it is clear that the Standard Western Diet is strongly implicated in obesity and ill-health.[16] For the U.S. American women, unretouched photos of women, who meet the Upper Palaeolithic

14 Ambrose, Stanley. "Late Pleistocene Human Population Bottlenecks, Volcanic Winter, and Differentiation of Modern Humans."*Journal of Human Evolution* 34 (1998): 638–640.

15 Sarah Blaffer Hrdy. *Mother Nature: A history of mothers, infants, and natural selection* (New York: Pantheon Books, Random House, Inc., 1999): 196.

16 Weston Price. *Nutrition and physical degeneration* (La Mesa, CA: Price Pottenger Foundation, 2006).

norms of 5'3" tall and between 95 and 230 lb in weight,[17] were downloaded from the website Mybodygallery.com.

I assigned each image a shape: apple, pear, column, or hourglass, depending on the relative proportions of shoulders, waist, and hips. Medical science considers the ideal shape for both health and fertility to be the pear or hourglass, with fat concentrated on the hips and thighs (see Figure 2).[18]


**Figure 2.** *Shaping Up.* Credit: http://blog.frational.com/wp-content/uploads/2013/07/different-body-types-278x173.png

I measured the diameters of the waist and hips of each woman and calculated waist-to-hip ratio. The medical ideal, again for both health and fertility, is a waist whose circumference is less than 70% that of the hips (0.7), with an upper limit of 80% (0.8) (see Figure 3).[19]

Where information on height and weight is available, I calculated Body Mass Index, an assessment of fatness.[20] I hoped to put these measurements together to create picture templates that would allow me to match up images of Venuses and hunter-gatherer women with templates for specific categories of fatness in terms of body fat percentages.

I hypothesize that if high waist-to-hip ratio, high overall fatness, and the apple shape with fat stored around and above the navel result from modern life—overeating and underexercising—then prehistoric and hunter-gatherer women should be mostly pears and hourglasses with low waist-to-hip ratio. Falsification of this hypothesis would suggest that fatness is rooted in our recent evolutionary history and therefore advantageous to the survival of our species. As previously noted, the first population boom detectable anywhere in the archaeological record occurred in eastern Africa during the period of intense cold following the Mt. Toba eruption.

17 László G. Józsa, "Obesity in the Paleolithic era," *Hormones* 10, No. 3 (2011): 244.

18 Mayo Clinic, "Metabolic Syndrome," http://www.mayoclinic.com/health/medical/IM04175 (accessed 25 July 2013).

19 Devendra Singh, "Female Mate Value at a Glance: Relationship of Waist-to-Hip Ratio to Health, Fecundity and Attractiveness," *Neuroendocrinology Letters* 23, Suppl.4 (2002): 82.

20 National Institutes of Health, "Aim For a Healthy Weight," http://www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/index.htm (accessed 20 June 2013).

One possibility for this surge is an increased ability to store body fat, as women's reproductive success is tightly correlated with body fat percentages far higher than that of any other primate.

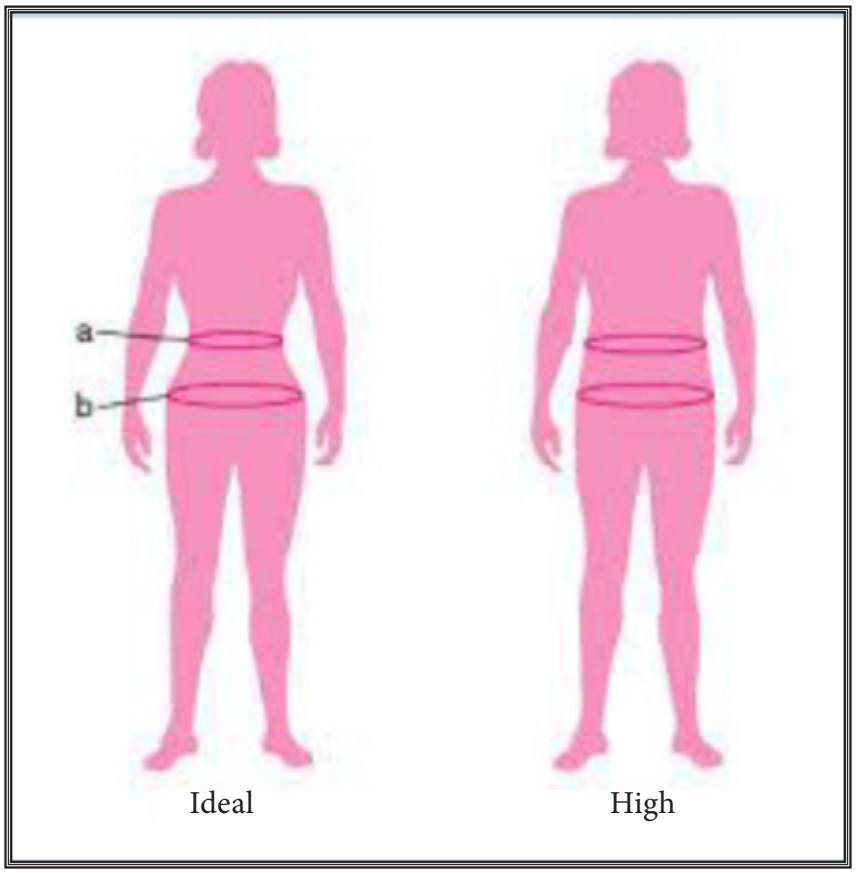


**Figure 3.** *Measuring Up*. Credit: http://gfreeconnect.com/wp-content/uploads/2012/02/waist-to-hip.jpg

## IV. Results and Discussion

Direct comparison of all images shows that women have been very similar over the last 40,000 years (see Figure 4), falsifying the hypothesis that women eating diets closer to those of those likely in the Upper Palaeolithic would be predominantly pear and hourglass shapes, and that they would have lower waist-to-hip ratios than those of today's Western women.

Regardless of time period or geographical location, women are fat and thin, and their body shapes include pear, hourglass, apple, and columns. This holds true even for women living at the same place and at the same time. My interpretation is that obesity and slenderness fall on a continuum of normal weight for humans, given that even very lean H. sapiens individuals have extreme body fat compared to other primates.

Analysis of the measurements garnered from these images shows that WHR variation is greatest in the Venuses; only Venuses have WHR below 0.7 and above 1.2 (see Figure 5). Speciation theory postulates that ancestral populations have greater genetic diversity, and that daughter populations lose variability over time unless continuously trickle-charged by new

inputs.[21] Northern Europeans have lower genetic diversity than southern Europeans, who in turn are less diverse than Africans, themselves with much less diversity than chimpanzees.[22] In this light, I argue that the higher diversity of the Venus figurines suggests recent evolution, as these women are very differently shaped to the waistless chimpanzees and Neanderthals.

Also contrary to my hypothesis that Venuses and hunter-gatherers would have waist-to-hip ratios lower than those of U.S. American women, all three groups cluster between 0.7 and 0.9 (see Figure 6). Hunter-gatherers have the most women with WHR above 0.8 despite having the fewest visibly overweight individuals. I interpret this unexpected result as concentration of body fat in the abdomen (visceral fat) rather than as subcutaneous fat on the hips and thighs.

Coupling the thick-waisted hunter-gatherers with depictions of obese and slender Venuses at both the French Mediterranean coast and at the foot of the Siberian glaciers, (see Figure 7) I argue that visceral fat provides survival advantages for humans, and that this advantage was acquired between 75,000 and 65,000 years ago, as described above. I argue that high waist-to-hip ratio may have high population survival value. Despite the baby's sex being determined by his or her father, women with low WHRs give birth to more sons than expected, while those with higher WHRs give birth to more daughters.[23] I argue that in harsh conditions a population is more likely to survive if there are more girls than boys, as only women can produce babies and one man can impregnate many women. Hence, the women with higher WHR, and more fat, would produce more girls, enhancing the chances for Homo sapiens to survive.

Regardless of WHR, although three groups exhibit all four body shapes, there is some evidence that particular body shapes predominate in particular groups. For example, the images show that Jarawa women of the Andaman Islands run to pears and hourglasses, while Huoarani women of Ecuadorian Amazonia are usually columns and apples (see Figure 8). Both groups live in tropical forests, suggesting that the driver behind their differences is cultural preference in the form of sexual selection. Venuses are more likely to be pears in Western Europe, apples in Eastern Europe, and intermediate shapes in Central Europe.[24] Hence, I argue that fatness may be more important than body shape in species survival, and that body shape may be a more recently evolved feature than fat storage capability.

Whether natural or sexual, selection must have material to work on. At least 14 genes determine pear or apple shape,[25] while 32 genes control body fat, and the effects of these genes are much stronger in women than in men.[26] I argue that the sheer number of these genes implies both high importance for fatness and its newness in our history, given that genetic variability decreases in daughter populations,[27] yet these genes are present in all groups sampled.

No correlation was found between waist-to-hip ratio and body mass index. Hence there is no direct relationship between WHR and body fat percentage (see figure 9). No picture-matching

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21 Robert Juhrmain et al., "Heredity and Evolution," in *Introduction to Physical Anthropology* (Belmont: Wadsworth Cengage Learning, 2010): 100–103.

22 Marcia Malory, "Southern Europeans Have North African Genes," *Phys.org*, Jun. 5, 2013. http://phys.org/news/2013-06-southern-europeans-north-african-genes.html (accessed Aug. 13, 2013).

23 David Concar, "Sexual Power of the Waistline," *New Scientist,* No. 1974 (1995): 28

24 Olga Soffer, James M. Adovasio, and David C. Hyland. "The 'Venus' Figurines: Textiles, Basketry, Gender, and Status in the Upper Paleolithic," *Current Anthropology* 41, No. 4 (2000): 515.

25 Iris M. Heid, Anne U. Jackson, Joshua C. Randall et al. (279 authors) "Meta-analysis Identifies 13 New Loci Associated with Waist-hip Ratio and Reveals Sexual Dimorphism in the Genetic Basis of Fat Distribution," *Nature Genetics* 42, No.11 (2010): 949–961.

26 Elizabeth K. Speliotes, Cristen J. Willer, Sonja I. Berndt et al., "Association Analyses of 249,796 Individuals Reveal 18 New Loci Associated with Body Mass Index," *Nature Genetics* 42, No. 11 (2010): 937.

27 Robert Juhrmain et al. "Heredity and Evolution," 100–103.

templates could be made, hence there is no way to derive body fat percentage from a photograph or artwork, and the archaeological record can be used only as a proxy measure.

**Figure 4.** *Then and Now*. Credits: Yeliseevichi Venus: Don Hitchcock, http://www.donsmaps.com/willendorf.html; Catherine Ndereba: Kirby Lee/WireImage: http://grist.files.wordpress.com/2008/08/catherine-ndereba_wire_v400.jpg?w=400&h=600; Undescribed Figurine: Themis, http://www.donsmaps.com/willendorf.html; Marilyn Monroe: http://topvintage.nl/images/products/3866-23981-marilyn-monroe-red-dress-full.jpg; Venus of Willendorf: Don Hitchcock, http://www.donsmaps.com/willendorf.html; Woman in Blue Bikini: http://www.mybodygallery.com/photos-21134-body-shape.htm?StartAt=16#.Ufmw3W2ZYYI

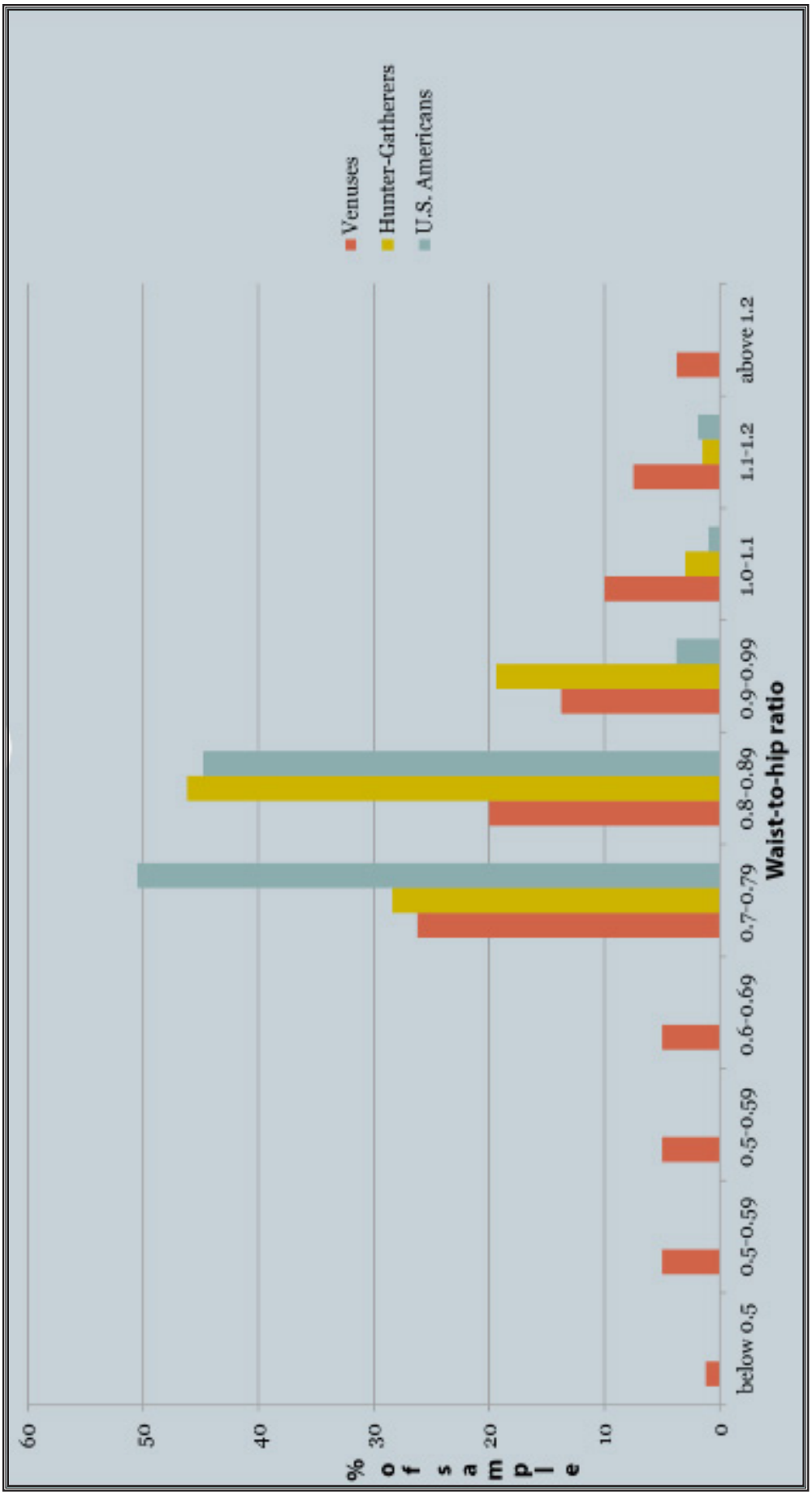


**Figure 5.** *Mirror, Mirror, on the Wall, Who's Most Fertile of Us All?* Credit: Suzanne Ubick 2013.

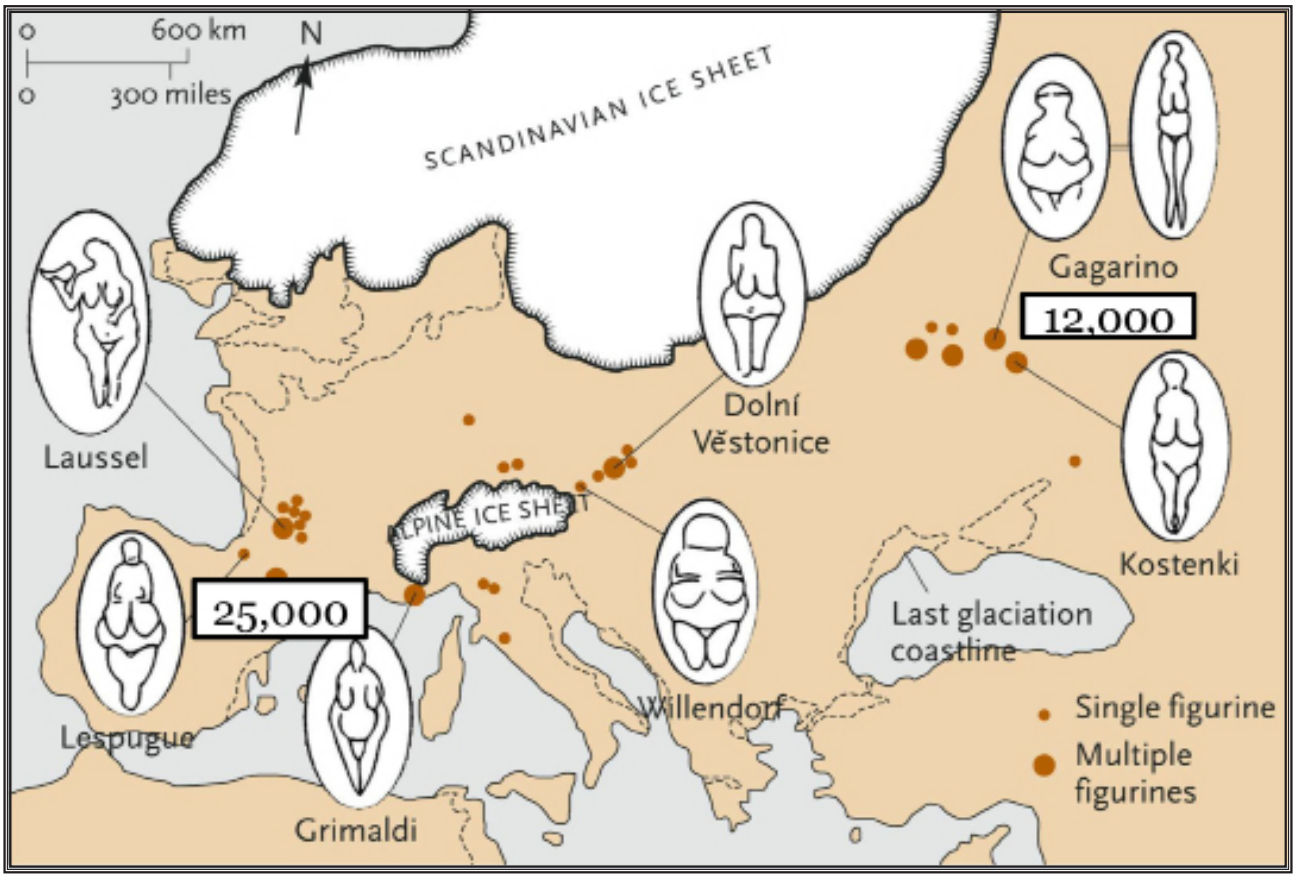


**Figure 6.** *Fat and Thin Over Time and Space.* Credit: Adapted from Pettit, P. The Rise of Modern Humans in The Human Past, ed. C. Scarre. London: Thames Hudson, 2005. The Meaning of Venus Figurines, page 164.

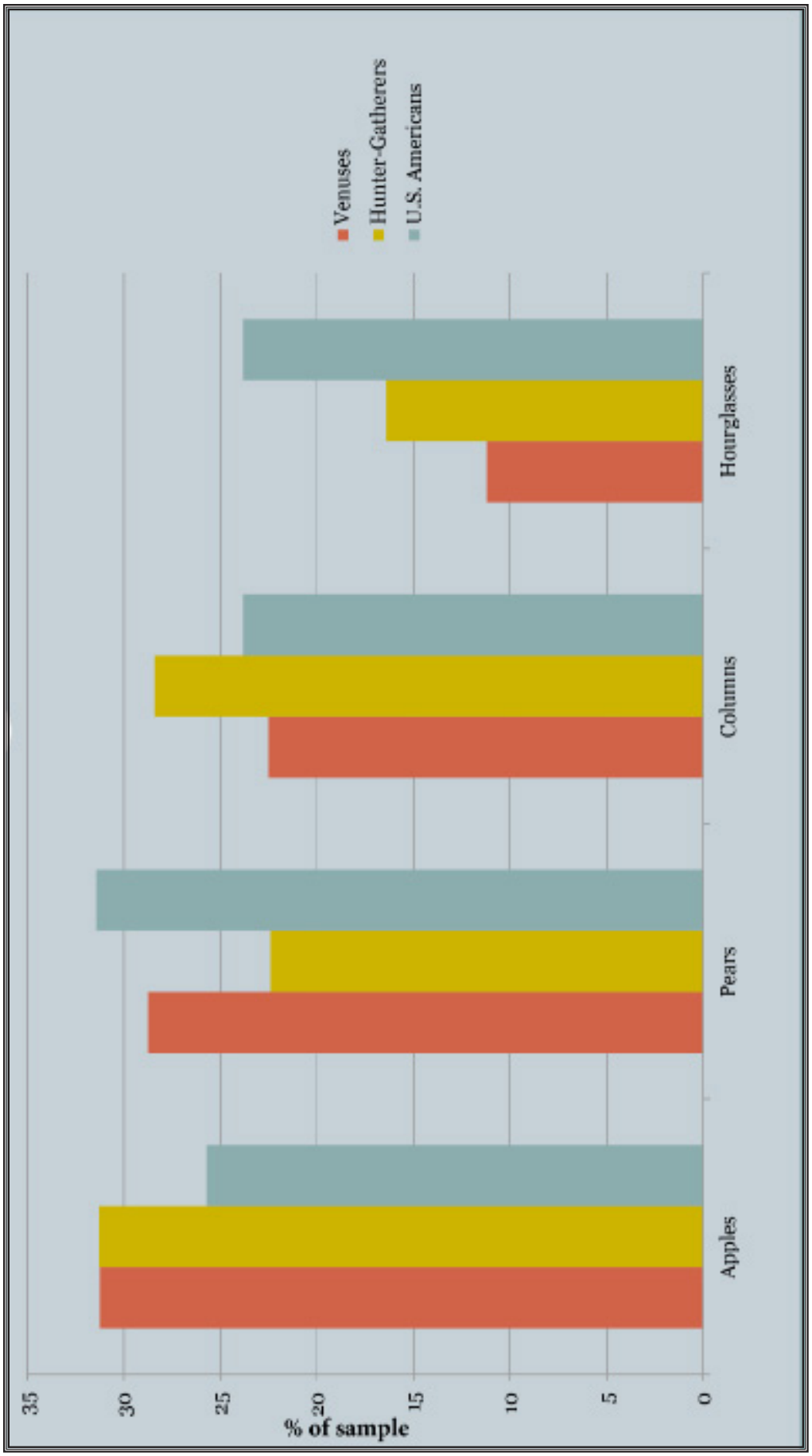


**Figure 7.** *Mirror, Mirror, on the Wall, Who's the Shapeliest of Us All?* Credit: Suzanne Ubick 2013.

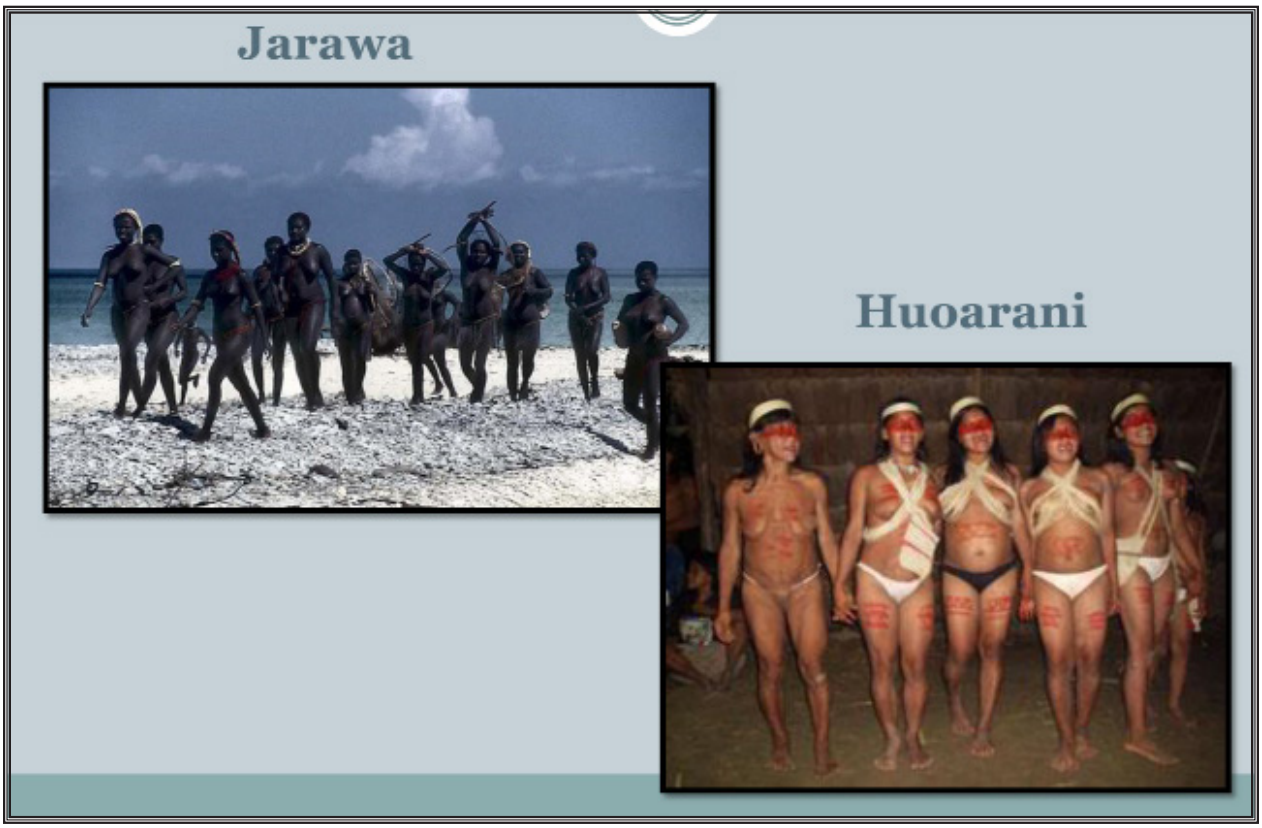


**Figure 8.** *Shaping the Shape*. Huaorani Women: http://kempery.com/images/amazonia/lodge-bataburo/lb-huaorani-2.jpg; Jarawa Women. http://3.bp.blogspot.com/-TnrGaKF9zYA/UHNCbqAOhKI/AAAAAAAAEuI/kswvv9W_Ey4/s640/Jarawa_02_large.jpg

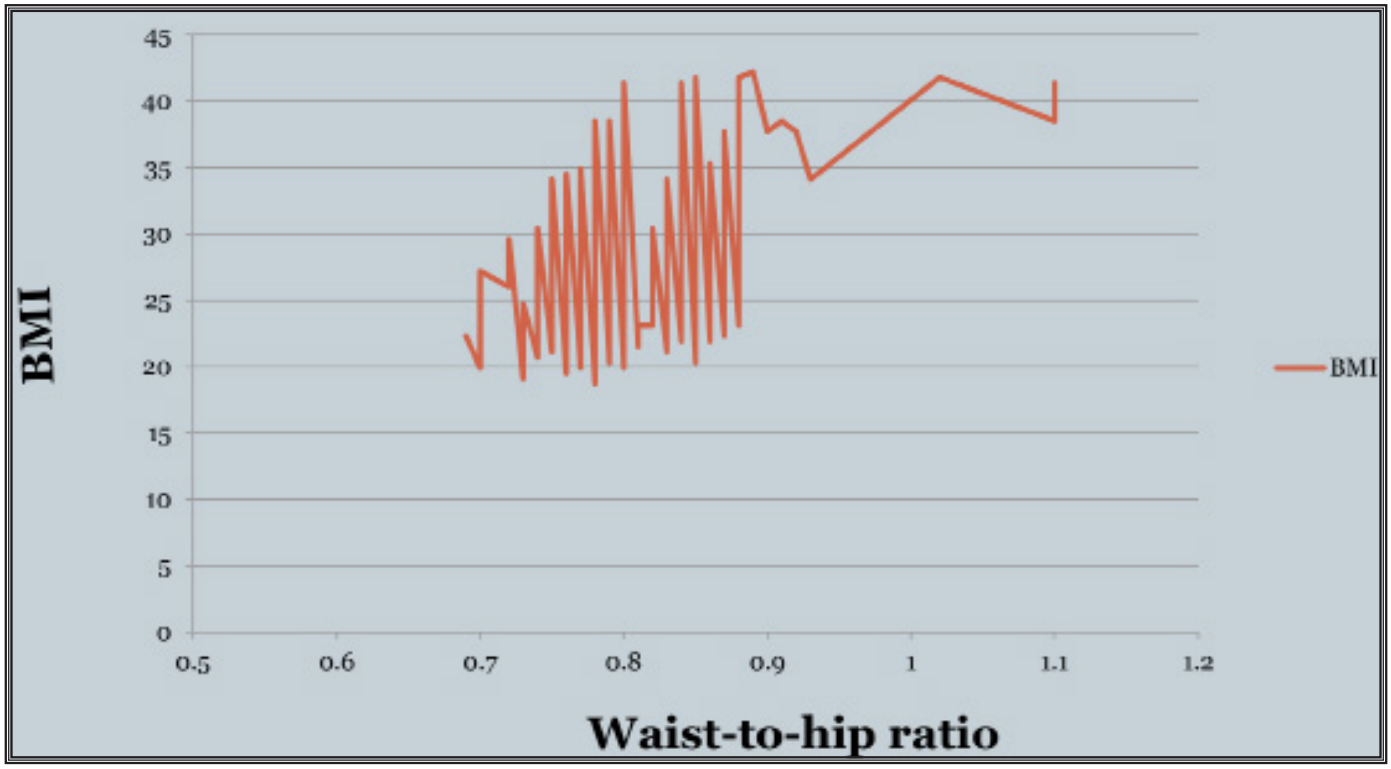


**Figure 9.** *More Noise Than Signal.* Credit: Suzanne Ubick 2013.

## V. Conclusion

My findings suggest that there is good reason to test my argument that human fatness was acquired between 75,000 years ago (when H. sapiens could not endure cold) and 60,000 years ago (when the species expanded into extremely cold regions). Strong continuity in women's shapes and proportions across time and space shows that humans have been fat since emigrating from Africa around 60,000 years ago. The above modern medical ideal clustering of WHR of all women across the last 40,000 years strongly suggests that fatter women do more for the species, through producing more children under harsh conditions, than thinner women even though modern medical science prescribes a low WHR for individual health. A higher degree of variation in WHR of the Venuses suggests that the groups coming out of Africa had highest diversity, and highest diversity would occur just after a microevolutionary event leading to genetic change.

It is a sobering thought that humankind may owe its staggering success as much to its fat cells as to its brain cells—and that the fat explosion may have been randomly touched off by a supervolcano blowing itself inside-out 75,000 years ago.

## Works Cited

Ambrose, Stanley. "Late Pleistocene Human Population Bottlenecks, Volcanic Winter, and Differentiation of Modern Humans." *Journal of Human Evolution* 34 (1998): 623–651.

Concar, David. "Sexual Power of the Waistline." *New Scientist*, No. 1974 (1995): 28–29.

Frisch, Rose E. "Body fat, Menarche, Fitness and Fertility." *Human Reproduction* 2, No. 6 (1987): 521–533.

Heid, Iris M., Anne U. Jackson, Joshua C. Randall, et al. (279 authors) "Meta-analysis Identifies 13 New Loci Associated with Waist-hip Ratio and Reveals Sexual Dimorphism in the Genetic Basis of Fat Distribution." *Nature Genetics* 42, No.11 (2010): 949–961.

Hrdy, Sarah Blaffer. *Mother Nature: A History of Mothers, Infants, and Natural Selection.* New York: Pantheon Books, Random House, Inc., 1999.

Hrdy, Sarah Blaffer. *The Woman That Never Evolved.* Cambridge, MA: Harvard University Press, 1983.

Józsa**,** László G. "Obesity in the Paleolithic Era.**"** *Hormones* 10, No. 3 (2011): 241–244.

Juhrmain, Robert, Lynn Kilgore, Wenda Trevathan, and Russell L. Ciochon. *Introduction to Physical Anthropology.* Belmont: Wadsworth Cengage Learning, 2010.

Lassek, William D. and Steven J.C. Gaulin. *Why Women Need Fat.* London: Penguin Books, 2012.

Malory, Marcia. "Southern Europeans Have North African Genes," Phys.org, Jun. 5, 2013 http://phys.org/news/2013-06-southern-europeans-north-african-genes.html (accessed Aug. 13, 2013).

Mayo Clinic. "Metabolic Syndrome," http://www.mayoclinic.com/health/medical/IM04175 (accessed 25 July 2013).

National Insitutes of Health. "Aim for a Healthy Weight," http://www.nhlbi.nih.gov/health/public/heart/obesity/lose_wt/index.htm (accessed 20 June 2013).

Oregon State University. "Toba, Sumatra, Indonesia," http://volcano.oregonstate.edu/vwdocs/volc_images/southeast_asia/indonesia/toba.html (accessed June 12, 2013).

Pond, Caroline. *The Fats of Life.* Cambridge, U.K: Cambridge University Press, 1998.

Price, Weston. *Nutrition and Physical Degeneration.* La Mesa, CA: Price-Pottenger Foundation, 2006.

Shea, John J. "Neandertals and Early Homo sapiens in the Levant" in *South-Eastern Mediterranean Peoples Between 130,000 and 10,000 Years Ago,* ed. Elena A.A. Garcea. Oxbow Books, 2010.

Shea, John J. **"**Transitions or turnovers? Climatically-forced extinctions of Homo sapiens and Neanderthals in the east Mediterranean Levant." *Quaternary Science Reviews* 27 (2008): 2253–2270.

Singh, Devendra. "Female Mate Value at a Glance: Relationship of Waist-to-Hip Ratio to Health, Fecundity and Attractiveness." *Neuroendocrinology Letters* 23, Supplement 4 (2002): 81–91.

Smolin, Lori A. and Mary B. Grosvenor. *Nutrition and Weight Management*. 2nd Edition. London, Chelsea House Publishers, 2010.

Soffer, Olga, James M. Adovasio, and David C. Hyland. "The 'Venus' Figurines: Textiles, Basketry, Gender, and Status in the Upper Paleolithic." *Current Anthropology* 41, No. 4 (2000): 511–537.

Speliotes, Elizabeth K., et al. (279 authors) "Association Analyses of 249,796 Individuals Reveal 18 New Loci Associated with Body Mass Index." *Nature Genetics* 42, No. 11 (2010): 937–948.

University of Huddersfield. "Modern Humans Did Not Settle in Asia Before Eruption of Sumatra Volcano 74,000 Years Ago, Study Finds." *ScienceDaily*, 11 Jun. 2013 http://www.sciencedaily.com/releases/2013/06/130611084105.htm. (accessed July 20, 2013)

Weaver, Timothy D. and Karen Steudel-Numbers. "Does Climate or Mobility Explain the Differences in Body Proportions Between Neanderthals and Their Upper Paleolithic Successors?" *Evolutionary Anthropology* 14 (2005): 218–223.

Zilhao, Joao, Simon J. M. Davis, Cidalia Duarte, et al. "Pego do Diabo (Loures, Portugal): Dating the Emergence of Anatomical Modernity in Westernmost Eurasia," PLoS ONE 5(1): e8880. doi:10.1371/journal.pone.0008880:18. Published January 27, 2010 (accessed 26 July, 2013).