

FOSSIL FAT - A FORENSIC KEY TO UNDERSTANDING LIFE IN THE LATE PALEOLITHIC OF NORTHERN EURASIA

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RESUME

La graisse, produit organique, se présente de façon différente et en quantité variable selon l'espèce animale considérée. Par exemple, une importante prise de poids se révèle impossible pour certaines espèces. En effet, certains animaux vivent dans des biotopes aux ressources alimentaires, certes riches en énergie, mais cependant disponibles en quantité limitée. En revanche, les situations de pénurie en ressources énergétiques (pénuries saisonnières ou épisodes climatiques défavorables) déclenchent, chez l'animal, une capacité à produire un surplus compensatoire de gras. Le stockage des graisses dans le corps varie également selon les espèces et dépend d'exigences et d'adaptations liées à la thermorégulation, à la locomotion et à l'éthologie. L'aptitude et la façon d'accumuler les graisses constituent, par conséquent, une grande source d'information sur les communautés vivantes. En outre, au sein d'une même espèce, les individus, selon leur âge et leur sexe, accumulent et répartissent les graisses différemment. Le constat est également valable dans le cas de l'Homme. En effet, sa capacité à engraisser révèle l'absence de systèmes économiques et techniques permettant le stockage des aliments et la conservation des denrées périssables. Ceci traduit un mode d'approvisionnement fondé sur des ressources aléatoires ou sur une abondance ponctuelle et prévisible de nourriture (migration annuelle des troupeaux). L'art paléolithique, à travers de nombreux exemples, révèle une corrélation entre le mode de dépôt et de localisation des différents paramètres que sont le sexe, l'éthologie, l'appartenance à un groupe humain particulier, les activités socio-économiques et le régime alimentaire. Il est évident qu'à l'Holocène, l'Homme subit des changements physiologiques : morphologie dentaire, mode de dépôt des graisses. Une économie agro-pastorale permet la constitution de réserves alimentaires qui rendent inutiles la production compensatoire de gras par l'organisme en cas de pénurie.

ABSTRACT

The very capacity to fatten as well as the pattern of fat deposition are informative about animal life histories, including those of humans. The capacity for prodigious fatness is limited to situations in which energy sources are occasionally severely restricted. Some species are incapable of putting on significant amounts of fat. These animals live in environments which are often nutrient, but not energy, limited. The location of fat depots also varies among

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species, as a product of thermoregulatory, locomotor, and ethological demands and compromises. Within a given species, individuals of different ages and sex do not put on quantities of fat equally nor in the same places. Using other animals as our comparative base, we can see how human adipose variations are similarly adaptive. The physiological capacity to fatten towards obesity implies an evolutionary history of a lack of predictable resources or predictable annual bottlenecks of high energy foods. It also implies a lack of efficient external storage systems or storable energy resources. Evidence from Paleolithic art of the occurrence and distribution pattern of human fat is informative about Pleistocene: demographics, sexual dimorphism, division of labor, ethology, intra and intergroup adipose variations, activity budgets, diets, and variability of those diets. While these data from the art are biased, I propose the biases are both transparent and informative about human life histories of the late Pleistocene.

ADIPOSE TISSUE

In our 20th century view, adipose tissue is considered simply as an extraneous, unwanted, and inadvertent extra part of the body, more of a cosmetic and health problem. Additionally, anatomists and evolutionary biologists have not paid much attention to fat (Pond, 1978). The biology of fat has received considerable attention from physiologists who deal with ecological considerations, as fat is critical in assessing how animals cope with periodic energy deficiencies (e.g., Myrberget and Skar, 1976). Wildlife managers also use fat to assess body condition of both individuals and populations (e.g., Franzmann *et al.*, 1976). And understanding of the biology of fat is becoming increasingly significant in the study of animal behavior, as fat seems to be used by animals themselves as indicators of individual quality, and hence is important in assessing fighting potential and mate choice (Pond, 1978). Curiously, little attention has been given to human body fat along these lines. There is a striking variability in the way that people put on fat and there are observable sexual and racial patterns of fattening. Both the amount of adipose tissue and where it is deposited are revealing (Guthrie 1976, 1996). If fat were preserved in the fossil record it would be an important forensic tool (e.g., Guthrie, 1990).

WHAT HUMAN FOSSIL FAT COULD TELL US

If we had a direct fossil record of human soft tissue, like adipose depots, instead of just bones and teeth, we could gain more insight into life in the late Paleolithic, these early times in human prehistory in which we were evolutionary modeled physically, physiologically, and mentally. And such information would be important, because the Paleolithic evolutionary modeling of our physical and mental beings still exert influences on our actions today. Evolution does not have foresight; present adaptations are for the past, and we are Pleistocene products.

Fossil fat could tell us a great deal about the security and predictability of Paleolithic life. *Did Paleolithic people enjoy idyllic times as some have*

proposed ? If life was predictably good and resources were abundant then we should not find fossil obesity. For fat is always a signal of dearth. Why is that true? If we look at populations of wild animals that always have enough food, these animals are lean and do not become obese. Obesity is expensive in energetic terms. Fat is tiresome and cumbersome to carry around. It limits locomotion and travel. And obesity places undo physiological loading on cardiovascular function. A human population adapted to the idyllic life would be antelope lean and unencumbered by preparations for the great likelihood of future hunger. Were Paleolithic peoples fat or is fat a response to modern circumstances?

Fossil fat could tell us something *about the limiting forces in Paleolithic human population demographics*. Fat is about stores for future energetic bottlenecks, and bottleneck constraints are what ultimately shape the upper limits to population growth. Adequate food is a matter of both energy (simple calories) and critical nutrients (a complex array of proteins, vitamins, and minerals). Were Paleolithic peoples mainly constrained by energy or by nutrients? Today most subsistence cultures are limited by nutrients. What was the case 30,000 years ago?

If we could assess the amount of body fat of late Paleolithic peoples we could also get some idea as to *the nature of food stores*. If daily food resources failed, were there back-up food reserves in the form of stored surplus? Or did late Paleolithic people live primarily by sharing not storing, producing only body fat stores? Also, if we could look at fossil fat of these early peoples we could assess the degree of sexual specialization, *division of labor*. Many cultures historically have allocated the high-risk distant chores to males who remain lean, and nearer-camp chores to females who have the responsibility of nursing and care of children. In such cases women can occasionally become obese, to their considerable advantage, without much locomotor penalty, especially if some of the above constraints pertain.

Fat changes the body shape and seeing the shapes of Paleolithic peoples, focusing on the location of their fat depots, would provide wonderful insights. Fat can be positioned on the body in quite different places. This relates to locomotor efficiency, but it also relates to behavior. Fat is a social organ. Like wearing a tall hat or jacket with wide shoulders, wearing fat changes one's appearance. *Fat depots are used in many species, including humans, to artificially enlarge some regions of the body enhancing display impact, both for agonistic and erotic purposes*. What was the story with Pleistocene peoples?

FAT PRESERVATION IN THE FOSSIL RECORD

Is there fossil Pleistocene human fat? Unfortunately fat is broken down in the soil quickly, very quickly, and is rare as a fossil. Non-mineral parts of animals do not preserve well, because billions of small organisms in the soil specialize in breaking down organic tissues, like proteins, fats and carbohydrates. It is mainly the minerals in bone, teeth, and antlers which produce fossils. The protein (collagen) locked within bone tissue is unusually slow to decompose, and as a

consequence can be used in radiocarbon dating. Bone marrow is usually decomposed quickly. Microbial activity is held to low levels in frozen ground of the far north and some Pleistocene fat has been recovered in large mammal mummies uncovered in Siberia and Alaska (Guthrie, 1990). But most evidence of late Paleolithic humans does not occur in today's regions of permanently frozen ground. I know of no Paleolithic human remains that contain significant fat. If we are to make use of Pleistocene fat we must reconstruct it from indirect sources.

HUMAN 'TRACE FOSSIL' FAT FROM THE PALEOLITHIC

Geologists use the term 'trace fossil' to refer to a special kind of fossil, not of the organism itself, but indirect evidence about it. These are such things as tracks, burrows, homes, gizzard stones, gnaw marks, feces, beaver dams, wallows, regurgitated bolus, and plant fragments wedged into teeth. These trace fossils often contain as much or more information about the living creature than the normal skeleton fossil. For example, a preserved imprint made by an individual Paleolithic woman lying in deep mud would give us information unavailable by mere skeletal reconstruction. Though we do not have such imprints (there is one rough imprint from a Paleolithic burial found in Spain) we do have Paleolithic people's images baked in clay, carved into ivory, engraved on bone, ivory, antler, and stone—the wealth of Paleolithic art.

Though these images in the art are not random, nor are they photographic, they can inform us about many of the above questions. We can, I think, identify many of the underlying biases of the Paleolithic artists which will help us assess their images for our forensic uses as trace fossils.

USING PALEOLITHIC ART IMAGES AS TRACE FOSSILS

We must remember that Eurasian late Paleolithic art includes items found across many hundreds of thousands of square kilometers that were made over the span of some 20,000 years. The makers of this art were not from a single culture or even speakers of the same language. However, certain basic elements of their lives were similar. Paleolithic people apparently lived in small kinship bands for most of the year. The evidence also suggests that they used large mammals as a principle food resource, hunting them with weapons which were only modestly effective in range and killing power. Yet, these people seem to have been flexible in their ecological strategies, were quite mobile, and constructed no permanent villages. The habitat in which most of them lived was the skirt of a cold grassland, penetrated in a limited way by riparian woodland fingers. And it was cold and harsh for a significant part of the winter.

Within this general pattern, conditions varied considerably from time-to-time and place-to-place. But the remarkable unity of the art is, I believe, reflected in an actual unity in late Paleolithic life. And it is that unity which we will use forensically to reconstruct the prevailing aspects of late Paleolithic life. And it

must be remembered that in addition to the similarities we've just discussed, these Paleolithic people were genetically related with a common evolutionary history, sharing the same basic cognitive propensities and social biology.

Among the mammoths, horses, and bison and other mammals represented in Paleolithic art there are dozens of human images. In some sites, like La Marche, human images even predominate (Pales *et al.*, 1976). Paleolithic images of humans occur engraved on stone plaquettes, osseous tools and fragments, painted on cave walls, and on loose stones. They are carved in mud, osseous materials, and stone, and baked in clay. Human images span the entire spatial and chronological range of Paleolithic art. These are the trace fossils we will use to study patterns of fat and obesity in the late Paleolithic.

JACK SPRAT COULD EAT NO FAT AND HIS WIFE COULD EAT NO LEAN, BUT TOGETHER THEY LICKED THE PLATTER CLEAN

Pales (1976) calculated that there were 57 males and 171 females pictured in Paleolithic art. Since that time more have been found and continue to show the same distortion of more women than men. With a few exceptions, the women portrayed in Paleolithic art are fat to obese, while males are universally lean (fig. 1) or at least not obese. This pattern is striking, and holds true for the whole span of Paleolithic art, both geographically and temporaneously. What are we to make of this disparity? Were all Paleolithic males lean and women fat? There are possible biases as to why women would be drawn fat when most women were, in fact, probably not fat, and reasons why those biases would not pertain to men. But, I am going to ask you to hold onto these questions while we take a brief look at the biological role of fat. This biological basis will enable us to return to these questions with new insights.

ANIMAL FAT AS STORED SURPLUS AGAINST COMING FAMINE

As I said earlier, people do not normally think of fat as being adaptive, the result of natural selection. But be reminded that the ability to fatten is a complex interactive process, including genetic predispositions, seasonal propensities, physiological process, energy expenditures, temperature, social context (such as stress intensity), and of course, dietary potentials. The ability to fatten to obesity is not universal among animals, in fact it is uncommon. The capacity for prodigious fatness is limited to adaptive contexts in which energy sources are severely restricted during certain seasons or episodes. The adaptive rise of intense hunger, high satiety-point, and metabolic allocation of energy to fat, which produce obesity are not only about bounty but about the prospects of coming starvation.

Animal fat varies greatly in quality and character in its different depots. Leg fat, for example, is composed mostly of unhydrogenated fatty acids with low melting point (neatsfoot oil), and kidney fat has a high melting point (Irving *et al.*, 1957). Some fat depots are easily tapped, like brown fat, while other fats are

slow to be marshaled for energy release; bone marrow fat is one of the last to go, at least in most herbivores (Neiland, 1970). Although fat is not as important as people once thought as a direct insulator against cold, it is important in thermoregulation as an energy source, and hence a heat source, when food is scarce. Birds and mammals use about 85% of their dietary calories simply to maintain constant body temperature.

Fat is a true organ system which occurs in various degrees and in different patterns in many animal groups. In both birds and mammals the quantity, anatomical location, and timing of fat deposition are under tight physiological control. Migratory or hibernating species wait until the last possible moment to store fat (Baker, Marshall and Baker, 1968), as do species restricted by other tight energy-limited bottlenecks (cold and deep snow). Species incapable of putting on significant amounts usually enjoy predictable environments, or at least environments in which food calories are not limited. Certain adaptive situations require rapid flight or running which makes fat too expensive an encumbrance. In still other situations thermoregulation makes subcutaneous fat too costly an insulating obstacle in dumping body heat. For some species the use of stored food surpluses replaces adipose depots. A brief look at mammalian species which illustrate each of these points will clarify things.

Snowshoe hares, *Lepus americanus*, like most hares, never become obese, even though it is the smallest mammalian herbivore to live above the insulating snow cover in the far north. Yet, these lean animals live with ambient temperatures ranging down to -40°C almost every winter and as low as -60°C on occasion. Hares eat enough to stay warm in such cold. Energy-packed bud tips, sapling bark, and bark from twigs are available all winter. Thus snowshoe hares carry only fat reserves to last less than one day at those cold temperatures. Also, speed is important for hares. The loss of speed and endurance due to carrying unessential fat could be deleterious. Camels are at the opposite extreme; their populations seem to be quite energy limited during dry seasons. Camels (*Camelus*) put on prodigious fat during the season of plenty. This greatly reduces their running speed, and camels become abundant only where there are few large carnivores, for example, in outback Australia (Pond, 1978).

Large carnivores are part of the African scene and fleetness is probably one of the reasons most African antelope are so lean. Fat accounts for less than 5% of total body weight for most terrestrial African Artiodactyls (Smith, 1970). Even Australian kangaroos (*Macropus rufus*, *M. major*) have almost no fat on the trunk or limbs, but concentrate fat on the tail. Without snow to dig through, these southern species seem not to be so limited by off-season calories, unlike northern ungulates. So lack of fat is not much of an energetic handicap.

If an animal is carrying unnecessary fat it can result in overheating. So, in addition to fleetness, this rarity of fat among tropical-subtropical species is probably a thermoregulatory adaptation and one of water conservation, as precious water would have to be used to cool an overheated animal. One can see that African aardvarks (*Orycteropus*) which live underground and hippopotamuses (*Hippopotamus*) which live in water during the day, are

unusual among African mammals because aardvarks and hippos normally fatten prodigiously. This suggests that locomotion and temperature constraints probably play an important role in selecting for leanness in other African mammals.

Northern hemisphere tree squirrels, such as red squirrels, *Tamiasciurus hudsonicus*, remain active all winter and put on little fat. Instead they busily store conifer cones, dried mushrooms, etc. which they feed on all winter. Whereas, Arctic ground squirrels, *Spermophilus undulatus*, fatten prodigiously in autumn, because being hibernators they must have sufficient body reserves in the form of fat to last the whole winter. In these two kinds of squirrels we see the opposite extremes of winter survival strategy, both hoard energy, ground squirrels use body fat and tree squirrels use food stores.

Stores of fat are especially important for large herbivores in the north, and not just for winter survival. Prime aged, socially-dominant bull moose (*Alces alces*), reindeer bulls (*Rangifer tarandus*), mule deer bucks (*Odocoileus hemionus*), dall sheep rams (*Ovis dalli*), and males of most other northern ungulates become enormously obese just prior to autumn rut. But they do not save this fat for the hard winter ahead. Instead, during the month or so of rut the competing males seldom eat, but use body fat reserves while they are occupied with the more pressing affairs of mating. This added weight provided by prodigious fat undoubtedly also adds to their fighting strength because a component of success in clashes and wrestling with other males depends on the relative weight of the opponents. Unlike females, the adult males of these species go into winter with few fat reserves. This loss of fat from early winter rutting seems to be a significant component to male winter mortality in these species. Why not change the season of rut? Apparently breeding season is tricky to reschedule by natural selection. An early winter rut is optimal because it means females will bear the young at peak green-up in spring. And changing gestation timing itself—as opposed to simply rescheduling the season of rut and subsequent birth—is a vastly complex and therefore highly conservative process. Thus, with regard to fat, the season of rut remains optimum for females and unfortunate for males.

Of course, we have selected for ease of obesity in domestic livestock: pigs, cattle, chickens, sheep, rabbits, ducks and geese, in contrast to their wild counterparts. Fat was prized in an era when much of labor and transportation used human energy.

THE SOCIAL RITES OF FAT

I would now like to shift from quantitative considerations about fat to qualitative ones. While mechanical and thermoregulatory forces affect the location of fat depots, the best explanation for depot location relates to changing contours for social purposes (Pond, 1978). A few examples will help clarify that conclusion. Male gorillas, *Gorilla gorilla*, have a height display with erectile head crests of hair, but also adult males also have a fat mass on the top of the head —

an artificial height-enhancer. Orangutans, *Pongo pygmaeus*, have fatty masses on the cheeks, exaggerating the size of the face (Schultz, 1969), in this case jaw power, as temporal-masseter muscle size. Males of some species that fight with their heads (teeth or antlers) undergo exaggerated muscle growth of the neck before rut (neck size is a crucial predictor of opponent's strength). Many of these animals, that use necks as an organ to support their weaponry grow huge neck manes to artificially exaggerate the size of the neck. And some use neck fat for the same purpose. Among these are squirrel monkeys, *Saimiri sciureus* (Dumond and Hutchinson, 1967), sea lions, *Zalophus californicus*, and stallions, *Equus* sp. (Pond, 1978). Many other examples are reviewed by Pond (1978). But our concern here is with humans. Are there ethologically related fat depots which differ with age and sex among humans and could this have presented a bias as to the skew of representation we see in Paleolithic art?

THE SARTORIAL ROLES FAT PLAYS IN OUR LIVES

Young babies are generally fat. One can appreciate how the higher relative metabolic rate (surface : volume ratio) and lower absolute fat reserves, combined with illness or starvation would have dire consequences without a higher proportion of fat reserves. On a subsistence diet (away from modern dietary abundance) older, more active, children exhibit very little obesity. This prepuberty period is a time of intense energetic demands from great activity and rapid growth. At puberty, young males typically undergo even more fat reduction, shifting to a new set-point around 5-10% body weight, whereas women undergo a major increase in fat, averaging well over 20% — increasing fat percentages by more than a factor of two in the two years after puberty (Frisch, 1976). Differences between males and females are smallest in youth and in old age, and maximal during early reproductive life (see Pond, 1978 for review). This tendency of women to fatten in the early reproductive years of life has been explained by the great energetic demands placed on pregnant, nursing, and nurturing mothers, requiring caloric increases of over 50%.

Thus, fat or obesity is associated with the two times in a woman's life when she can become pregnant : during courtship, prior to conception and after she has weaned children (fig. 2). These are times of maximal fecundity. This is true because the energetic demands during nursing-nurturing peaks shift women toward lean-body weight. This reduces or ceases ovulation and hence fecundity plummets. So, in the Pleistocene, a female's fatness was a direct indicator of her fecundity status. Theoretically, men who were attracted to copulate with fat women would father more offspring than men erotically attracted to lean-weight women. This may explain why, still today, rounded curves are generally thought to be more erotic than a more masculine-lean muscularity-defined female physique. However, it is not just absolute amounts of fat which effect attraction, but its location. This is because fat depot location changes with age, and reproductive potential is highly correlated with age. Males choosing to bond or copulate with women exhibiting fat depots located in youthful reproductive peak locations would be favored to leave more young than men not doing so. Where are those locations?

FAT DEPOTS CHANGE WITH AGE

For primates, a particular pelage or skin color provides the special signal of protection and care-solicitation of the very young. In *Colobus* monkeys it is a white color, among baboons it is jet black pelage, combined with light skin (see Guthrie 1976 for a review). For humans babies it is Michelin-man rounded dimpled curves, that is, thick subcutaneous fat. In fact these rounded curves and dimples of healthy fat babies form the central releaser of our innate attraction to, and protection of, healthy children (Morris, 1967, Guthrie, 1976). As children age the amount of subcutaneous fat decreases, this is especially true of males after puberty, though women in their peak reproductive years maintain considerable subcutaneous fat. Perhaps it is because the evolution of the mate bond in humans derives from the parent-offspring bond (Guthrie, 1976).

At puberty, the main fat depots of women shift to two main centers. One is around the pelvic girdle and the other underlies her mammary tissue. These two centers produce artificially large breasts and large hips-thighs-butt region (fig. 3). There are other much smaller sexually dimorphic fat depots (Vague and Fenasse, 1965) which are not directly relevant here. These sexual differences in adipose distribution produces a strikingly different body form between males and females. Additionally individual women vary greatly in the exact proportion of fat in these 'gynoid' centers, but they follow a roughly similar pattern. There are also subtle interracial variations in fat distribution among women (Guthrie, 1996).

Among all human groups the distribution of male fat is rather similar. It is concentrated on the torso, neck, and shoulders. There is much individual variation, but these variables are primarily within the neck and trunk. Some men center their fat in the greater omentum, resulting in a protruding abdomen on an otherwise lean body. Other male patterns seem to be in the depots between skin and torso muscles, others still, become broad across back and shoulders. As men age there is a greater "roll" over the iliac crest (Garn, 1954). With age, women tend to become more masculine in their redepositon of fat onto the trunk and neck (Pond, 1978).

Pond (1978) suggests that for an upright human body the most mechanically efficient place to carry large quantities of fat is on the trunk, especially internally near the center of gravity. She suggested that for dominant males, some torso mass may have social value, as it increases apparent muscular mass, and modest amounts of weight may result in more 'sumo wrestler' advantages. Neck muscles are highly testosterone sensitive (as an adaptation to a more violent life, to protect the vulnerable head), and are an important fat depot among males, providing a more formidable image.

For an active person obesity indirectly builds muscles. It exercises muscles carrying around considerable fat necessarily and thus increases muscle mass and strength. This indirectly increases aspects of fighting ability. However, those selective advantages may be countered by the decreases in potential speed, flexibility, and locomotor range.

Pond (1978) suggests that the woman's shift of fat depots from the highly estrogen-sensitive pelvic-breast regions with age to include the torso-neck may give the added advantage of a more masculine image. As an aging woman moves away from the peak reproductive years, her fitness may be maximized by defending descendants, and their resources, against rival members of both sexes. The selective pressure for a less 'sexy image' for senior women toward a more 'formidable image' is consistent with the changed role of protection and provisioning rather than sexual attraction of mates.

ADIPOSE DEPOTS AND FEMALE SEXUAL ATTRACTION

All cells, tissues, and organs are not equally sensitive to growth steroids (fig. 4). Testosterone, in addition to activating primary sexual organs, also targets growth in certain muscle-bone groups, especially those associated with shoulders, arms and neck. Bone-muscle tissues around the pelvis are sensitive to estrogen. Why? Presumably shoulder-arm strength is crucial for high-risk killing of dangerous bulls and for fighting bullies, and in all cultures those tasks are on males shoulders. The pelvis is critical in women's labor. The pelvic aperture needs to be larger for passage of large babies. The pelvis is important in carrying the fetus and affords a broad base to carry the nursing child— usually in a hip-carry. Breasts are estrogen sensitive because those mammary organs provide the bulk of food to the child — roughly for the first three years. Breasts are portrayed as large fat-filled structures in Paleolithic art (fig. 5), and some are exaggerated beyond normal size (fig. 6). Likewise, the fat on butts, hips, and thighs are exaggerated (fig. 7). There are some common individual variations among women within this breast-pelvic pattern sometimes called apples and pears (fig. 8).

Shoulder breadth, neck thickness, and arm muscles are important predictors of male strength, and hence formidability. And are part of the women's physical attraction to males, part of our inherited Pleistocene predictors of more successful family protection and resource provisioning — though mainly illogical today. Likewise, among males, pelvic girdle size (relative to waist diameter) and breast size are predictors of maturity and relative fecundity. This probably explains why pelvic and breast size are artificially enhanced by the fat depots which are located in those organs — a form of evolutionary cheating. One can see that many of the female images in Paleolithic art de-emphasize non-erotic areas and exaggerate erotic regions of breast and hip-butt-thigh (fig. 9). This exaggeration pattern produces the familiar spindle shaped Venus. One can only presume that in our past women who had fat depots in those areas, hip-butt-thigh and breast, attracted more male interest than those who had their fat located on mid-torso, shoulders and arms. Again, this artificially enlarged pelvic girdle and breast enlargement by fat is not necessarily an appropriate indicator of reproductive success today, but one can readily understand how it once was. Male's erotic attraction to females is so focused on the torso that as a 'releaser' of attraction it loses very little impact even missing head, arms, and feet. This probably explains the faceless and headless, armless and atrophied arms, and footless images in Paleolithic art (fig. 10). Remember, all behavior is not organized around broad

gestalt recognition and attraction. In some species, like turkeys (*Melegrus gallopavo*), males will even try to copulate with an isolated stuffed head of a female turkey. For turkeys the female's head and neck are the key indicators of female reproductive condition, that is, the main erotic releasers. For human males it is female torso configuration.

The great number of direct and explicitly erotic images in Paleolithic art: erect penises, vulva, below-the-belt-art, bent lordosis postures, copulation scenes, etc., strongly argue for the underlying theme of fat women being coarse male erotica. Along with violence prone behavior, erotic coarseness is one of the cross-cultural sexual differences between males and females, and can be used as a solid forensic indicator in Paleolithic art.

THE FASHION FOR FAT IN PALEOLITHIC ART

There seems to be a large taphonomic bias to preserved Paleolithic art in general (Guthrie, 1984). Traditional materials in which women work, cross-culturally, at least prior to pottery, are mostly in media which are unlikely to fossilize: skins, woven fibers, furs, wood, culinary products, songs, and stories, theater, games with children, etc. Many women's tools in hunting-gathering societies are not likely to preserve: bags, needle-thread, skin boilers, horn and wood ware, blankets, tents, mats, digging sticks, etc. Additionally the place of highest preservation, deep caves, where the majority of Paleolithic art occurs, is not frequented equally by all sexes and ages. Evidence from historical and modern habits of cave entry show a heavy bias toward young males in the high-risk-taking era of life (this adolescent male risk-taking is a behavior humans share with most mammal species).

Despite the fact that in most cultures women do most of the adult art, the above biases seem to have created an artificial warp in the Pleistocene fossil record favoring representational images made by males (Guthrie, 1984). The link of erotic attraction to female curvaceousness combined with the evidence that much of female imagery preserved in Paleolithic art was made by males, accounts for another important bias. Males making female images would be likely to represent them in their most sexually attractive form, which is to say, fat. So despite the fact that most females in Paleolithic art are made to look obese (there are a small number of exceptions, but these are less than 10% of all the women portrayed), we can assume that not nearly that many were actually fat — that this representation in the art is a gross distortion.

There is other evidence of this bias. For example, there are virtually no (there are a couple of possible exceptions) prepuberty female images. It should be so if these are images made by males with underlying erotic motives. Evolutionarily, infertile prepuberty girls should appear less erotic to fertile males than postpuberty females. Virtually all images in Paleolithic art seem to be of women within the peak reproductive years of 18-40 in age. Even though some Paleolithic images of women show considerable trunk fat, the rest of the body contours are not that of aged post-reproductive women. Another key observation

is that none are shown nursing or with a nursing age child (again there is one possible exception). As with prepuberty girls, lean nursing women have reduced erotic value for men, and again evolutionarily predictions would favor that emotion (unnecessary risk for a philanderer to mate with an infertile mother, risk for the woman to have another child while still nursing a baby, and a nursing woman is less than an ideal choice for a new male mate because the man would be acquiring long-term costly responsibilities for another's child). Paralleling this evolutionary force of reduced eroticism are wide-spread social taboos about copulation during prepuberty and nursing (Reynolds and Tanner, 1995).

We can make a rough approximation of some demographic aspects of Pleistocene females. Let's assume a reproductive rate sufficient to maintain a reasonable population replacement (2.5 children surviving to adulthood) and, say, an average mortality of 15-20 years life expectancy, and the major fraction dying before age of 40 (these estimates are consistent with Eskimo and late Paleolithic skeleton age structure). Let us also assume that over half of the females in a hunting-gathering band would be under the age of puberty (14 or so) and say at least half of the mature females should be nursing children under 3 years of age. Members of those classes would likely be lean. So at any one time less than 25% of the women could be significantly fat. We then can conclude that the large fraction of obese women in Paleolithic art are a distortion of the actual frequency of obesity. The fact that some late Paleolithic women had large breasts is corroborated by the portrayal of brassieres—straps to restrict breast movement—the ancient version of a sport bra (fig. 11).

LOOKING BEYOND THE BIASES

My proposal here is that indications of a biased record of obesity in the Paleolithic may not really figure importantly into our use of fat to understand life in the late Paleolithic. Because what the art does show us, no matter what the exact numbers, is that while obesity was not ubiquitous, it was common. We can see that the women drawn in Paleolithic art were drawn by people accustomed to fat women. The fat depot locations, details of fat folds, etc. are too anatomically correct for these to be some never-seen, only imagined images. We can still conclude that a significant fraction of mature women were consistently obese. The original question was not whether all people during these times were obese, but were mature people occasionally obese? And, did males and females differ in obesity? Paleolithic art still gives solid clues to answering those questions.

MALE FAT

Despite the dichotomy in Paleolithic art of lean males and fat females, we know from looking at extant variations, that men and women differ in tendency toward obesity in degree more than in kind, and that probably was true in the Paleolithic as well. It is possible that this dichotomy was principally related to the different divisions of labor in the Paleolithic. Greater male mobility fostered

higher caloric consumption and rarity of obesity. However, we do know from castrated livestock and pets that the relative decrease in testosterone and increased amount of estrogen does increase tendency for fat deposition. Today, obesity is experienced as a greater problem among women than men, especially among people under 30. This suggests that while there are variable 'lean-fat' bell-curve tails for both males and women, the statistical means of 'proneness to fatten' between men and women are significantly different. Perhaps we could most correctly say that the late Pleistocene adaptive processes to fatten would have applied to males as well as females, but to rather different degrees. It is quite possible and even probable that there were some fat Paleolithic males, and a number of males that were fat during occasional episodes of their lifetime.

MEANING OF THIS PLEISTOCENE OBESITY AND FAT FEMALE — LEAN MALE PATTERN

We can return to those "what if" questions with which we began this paper. The fat images in the art are indeed almost as good as if the burials contained fresh-frozen nude people or we had full-body "snow-angel" prone imprint from the mud of nude bodies in the Paleolithic. The observations from the art lead to the same robust implications and insights. On the basis of the fatness seen in the art we can say that Paleolithic communities represented a consistent pattern seen in later small-band hunter-gatherer groups : prepuberty children, nursing mothers, and active wide-ranging males are seldom obese, but early-puberty girls, pregnant women, and women in between nursing do put on body fat and tend toward obesity.

There are individual exceptions to this general pattern, but it is a consistent overall human profile prior to Holocene technologies (bows, dogs, fish hooks and nets, toggle harpoons, domestic cereals, domestic livestock, etc.) which allowed the amassing of large stored surpluses (Testart, 1968). Stored surplus decreased mortality and increased recruitment, density and village size. At that point classes of people began to exhibit different competitive hierarchies 'macroparasitic' (McNeil, 1980) for food within the same village, some nursing women were not energy restricted, and some adult males became sedentary and obese.

But in the late Paleolithic, a society, organized in small family-based bands, with little class hierarchy, using thrown weapons which killed by slow hemorrhaging, economically dependent primarily on large terrestrial mammals, life was qualitatively different than the later tribal village socio-economic structure. We can surmise from the fat that the following forces prevailed in the late Paleolithic.

1. *Population numbers were held in check by energy constraints and not by nutrient availability.* In fact, in a Pleistocene hunting-dependent society, energy was so limiting that protein nutrients were probably inefficiently used as energy. This is not to say that people personally felt the constant pang of hunger. Rather, during some times of the year or perhaps even less frequently there were

occasional episodes with severe energy limits. Nuts, tubers, cereals, and animal fat are rich in calories, but the availability of these must have been irregular—plenty punctuated with rarity. Even though there were episodes of real abundance, things were evidently not so predictably abundant to make significant stores for energetic bottlenecks, otherwise (A) populations would have increased to levels not reached until much later (B) there would have not been need for the genetic-behavioral satiety levels which produced obesity.

2. *Quality of life was uneven, good but far from idyllic.* People had to know what hunger was all about. Without something to restrict reproduction the population would have continued to increase. Demographically, we can trace this to energy limitations. But on the ground this would have been experienced as some premature still-births, episodes of no one ovulating or producing babies, kids starving once in a while, infanticide practice and option familiar to all, occasionally older people being abandoned because they were too weak and there was no food. And, everyone was likely familiar with the experience of going to bed hungry. It did not have to be often, but frequently enough to have to hold the average woman to only a little over two children reared to maturity (population maintenance level). Starvation had to be frequent enough to make being fat pay off—to give the relaxed fat lady the edge over the thin energetic one—we have the art to portray that for us. And we also have the evolutionary documentation of our own bodies, relicts of our Ice Age legacy.

3. *Late Paleolithic peoples lived without substantial food stores.* Had they devised some system of extensive meat 'overkill', or a wealth of collected carbohydrates stores, populations would have eventually increased to village size, identifiable in the archaeological record. And, it is likely that they would not have become so dependent on such large body fat stores. A kinship based band, with relative bands nearby is probably better off storing social favors, by sharing episodic windfalls of food surplus within the band and with neighbors rather than trying to process it for long-term storage. In an economy of small-groups in which serendipity plays such a large role, sharing is a powerful insurance system.

4. *Men and women did not have symmetrical lives, there seems to have been sexually distinct divisions of labor.* Males probably ranged far from camp in search of game, while females ranged in closer camp proximity. These roles may have been without overlap or the overlap may have been age related—older non-reproductive women doing male-like work, and perhaps older males participating in woman's traditional camp work. But a large mammal hunting economy almost demands specializations of labor.

The presence of this or a similar fattening pattern among most human groups suggests that the above circumstances were universal even prior to the late Paleolithic when people began to separate into today's main racial stocks.

LATE PALEOLITHIC TERRESTRIAL LARGE-MAMMAL HUNTING

In a large-mammal hunting dependent society, living in winter where there are few plant resources to gather, what do women do while men hunt? If you ask that question then you misunderstand the hunting process. We get to be mentally trapped into word images like *hunting*. While in all cultures men do most of the violent killing of large mammals that is only a small part of hunting, in fact it is a relatively small part. Hunting consists of organizational planning, preparation (clothing, foot gear, packs, food, spike tents, weapons, tools, etc.), travel, set up, search, spotting, planning, stalks, killing, butchering, transport, food preparation, cooking, and much more. Plus all the social and religious rituals and ceremonies of good luck, distribution of kills, sharing, thanksgiving, etc. Most of these elements of a hunting-based economy include all members of the group, but some parts may involve mainly women or mainly men. We do not know exactly how these proportions ranged in the different cultures of the late Paleolithic but we can construct a model of what it might have been like, based on cultural analogs and things like fat-pattern clues from Paleolithic evidence (fig. 12). Cross-culturally, skills requiring fine coordination, like needle-work are usually confined to women, and those which require risks relating strength to violence are relegated to the vigorous prime-aged males. This is a consistent cross-cultural pattern for good reason. People can't always do everything well, some specialization of tasks makes life more efficient and interdependent. Men and women bring consistently different anatomical-physiological-behavioral strengths to these demands, and were probably selected to be slightly different primarily for those reasons.

Even with the cooperation of the whole band, all willing to undergo hardships of long forays, camp mobility, and occasional hunger, the hunting of large mammal with only moderately effective spear-dart weapons is a difficult proposition. Paleolithic art is informative about that, it shows mainly single animals with protruding spears, mortally wounded spewing lung blood, or dangerously wounded and threatening. Even with a spearthrower one has to get close to a large mammal, less than 20-25 meters for some certainty of a hit. And, even then, the target area of thorax (heart, lungs, and liver) is small. Hits in most all other body regions result in a lost or dangerous animal, even though many of these wounds are eventually mortal.

Hunting a variety of species, as seen from the middens and art, in a variety of situations, required considerable experience, quality education, and years of intensive practice. From what we know about hunting today, we can see that such hunting was very difficult. I am a bow hunter, using equipment which has a longer range and is considerably more accurate than a Pleistocene atlatl, and hunting is still quite difficult. It is more difficult by an order of magnitude out in open, away from tree-stands in the forest or forest edge. The late Pleistocene European landscape was a much more open grassland than it is today. Many social anthropologists have portrayed Paleolithic life as Rosseauian-Gauganesque idyllic leisure and free from worry, as if one spent most time in social-mystical concerns and went out and took game only whenever the larder became empty. They suppose that hunting was an easy task, one just picked the most appetizing animal. It is far more demanding and complicated than that.

In such a Paleolithic economy food would not have been easy to obtain, but required constant work, planning, and preparation, involving most adults. It involved a clear head, intimately involved to the order of empirical objective reality. Success and failure would have been erratic, directly correlated with empirical information, decisions, actions, and preparation. The presence of the ability to fatten to obesity is informative about the nature of that irregularity. The anatomical-physiological-behavioral ability to easily become obese comes both with a appetite satiety-point way beyond maintenance and an efficient metabolism geared to lay on fat.

HOW TO BECOME FAT IN THE PLEISTOCENE ?

Lean muscle has few calories, about 1000 kilocalories per kilogram. During hard work in cool conditions one can easily utilize 4,000-5,000 kilocalories per day. That amounts to 4-5 kilograms of meat just to maintain weight. By far the most efficient and direct way to fatten is to consume fat (Speiss, 1979). But fat is available for a comparatively short period of time during the year. The prime bulls which put on most fat in late summer burn most of it up during rut battles. Female large mammals are not so fat. So, there is a period of two to three months during late summer and autumn when fat is available. It would pay to hunt intensively during this time and gorge on fat (Speiss, 1979). Fat obtained from wild game is difficult to store because, every other carnivorous mammal and bird is facing the same situation and is willing to take risks to obtain fat. Large stores of fat and meat make a small camp vulnerable to direct or a night sneak attack by powerful predators and constant harassment by corvids and smaller mammalian scavengers. Under those situations it would pay for a woman to 'eat all the fat you can and share all you have to'. Obesity is not only critical insurance in pregnancy and the beginnings of nursing, it is sometimes the key to life itself.

EVOLUTION OF THE PROPENSITY-TO-OBESITY

Primates in general do not easily become obese. Among those that do, it is usually because they are out of their normal context, kept in an enclosure where they cannot maintain normal activity and eat out of boredom. This rarity of a fat wild primate is undoubtedly because the eclectic opportunistic skills of being a primate can usually come up with energy, but they find difficulty acquiring sufficient nutrients. Early humans developed a hunting skill and technology which changed that, moving into a life rich in nutrients, of frequent availability of nutrient rich animal tissue, where it was energy which became limiting. With that change the propensity for obesity became selectively advantageous. This change may have occurred in the middle Paleolithic or even early Paleolithic.

But, remember, the ability to fatten to obesity as a normal circumstance had to be selected for by competitive means. That is to say, that during times of plenty some people could eat more than others and metabolically use that energy more efficiently, by metabolic means (low thyroid setting, long sleep habits, low heart rate, etc.) and conservative behavior (relaxed at doing sedentary chores, etc.).

During times of food shortage these people could continue to function and reproduce, better than people genetically predisposed to be lean, those more active people and those with high resting-state calorie consumption. And during times of long famine these obesity-prone people could stay alive better than others. The ability to become obese and to remove it conservatively has a relatively high heritability. There seems to be at least one gene which has a great influence, but overall predisposition to fattening seems to be more complex than a single gene.

SLIM HOLOCENE PHYSIQUES

How does one account for obese-prone and lean-prone people in the same populations? With the Holocene cultural shift to acquisition of stored surplus outside the body, becoming fat was less valuable. Many animal species use the strategy to store large amounts of food, and none of these fatten to obesity. One would suppose that with corn in the storage house it would not be an advantage to lay up much energy reserves as fat. Hence, there seems to have been a selective pressure to favor lean energetic women, able to range far from camp gathering or working hard in the fields. The Holocene technologies and domesticates which allowed the predictable elimination of energetic bottlenecks are highly effective and have changed the world. But they still carry some uncertainty. The whales may choose an open lead too far beyond range of land, salmon runs for a given year may be unusually small, locusts may kill the wheat crop, domestic livestock may come down with an incurable contagious disease. Even in the best tribal 'storable surplus' food economies, there may still be some selection pressures to favor obesity.

This is how selection often works, there is not an overall single best "mean response" but because of a variable environment several different responses are alternatively favored, in a dynamic evolutionary 'steady-state' — both obese and lean variants being selected for in different changing circumstances. In fact, this balance probably occurred to some extent in the Pleistocene, maintaining a few lean-prone women. It is just that during the Holocene the fitness balance has apparently shifted toward more leanness.

PALEOLITHIC INSIGHTS FROM FAT AND LEAN TODAY

Obesity proneness still predominates today. In the context of these Pleistocene pressures there are two evolutionary points which have to be made relevant to fat and lean propensities. The first is that throughout most developed countries we have now eliminated the bottleneck of food limitation, so that we are faced with an unwanted and unhealthy Ice Age legacy — proneness to fatten (Williams, 1991). It has not been long ago in our history that being obese was not taken as a undesirable thing, because one never knew.... never knew when a debilitating disease would drop your weight by 20 kg, and for a lean person that would usually mean death. But today we can even feed someone intravenously. Slowly, there is a rising emotional discomfort of people for their own fat. Yet, we

have made fat foods cheap (plant oils, fat meat, and cheeses) so it is harder to not get fat. We look upon this old Pleistocene appetite inheritance with dismay and incomprehension. It is telling that we have reached the point in which pharmacological companies treat obesity as a medical problem, which can be treated biochemically with hunger suppressants, gene control, and indigestible fat.

The second point is that, for men, bulging curves on women have been associated with erotic signals in the past. And while trim, hipless, breastless, physiques may be the healthy woman's ideal, they do not seem to be the ideal woman of male's choice. Just as the ability to put on fat is an Ice Age legacy, so is the male's experience of fat as an erotic stimulator. And this seems to go beyond cultural tastes, because in the distant past it was one of the best predictors for evolutionary fitness in mate choice. But this is also not logically appropriate anymore. Males do not have to be assured by an indicator, like fat, that women are optimally fecund — food no longer sets population limits. Yet the logical inappropriateness of erotic fat does not change the attraction, and *while that attraction exists*, it still must have a direct correlation — as to which women marry, have children, how many children, attract husbands, have quality marriages, quality children, etc. This may mean that, in terms of long-term genetic changes, women's potential to fatten may be reduced slowly at best, even though it carries obvious functional restrictions and costly health consequences.

In terms of sexual attraction, our Ice Age legacy of values is that rounded breasts and butts in women and lean hardness in males are ideal. Being a plump woman during the Pleistocene meant 'beautiful', more likely to be fecund, a good mate. Leanness for Paleolithic men meant 'handsome', an indicator that you were an active hunter and provider, a good mate. During the Holocene these have been reversed. Leanness in women shows that they are not only pre-puberty youthful lean, they are so rich in available stores that they do not have to use their body to gamble with the future. So for women, extreme obesity has become a symbol of poverty. Rotund men on the other hand do not have to advertise with hard muscles that they work hard physically to gain resources, but can buy them by dint of their social position, let others do the lower class physical work. Males of high social stature (read attractive to women) are often not lean and hard.

Yet strong elements of these old Pleistocene feelings still exist, plump curves in women are not all together unappreciated, nor is hard leanness in men. Who has the most appeal to women, the hard muscular waiter or the full bodied, wealthy, restaurateur? Are men more attracted to hard slender-hipped flat-chested marathoners or fully curvaceous Marilyn Monroes (the indirect answer to this is that over 150,000 American women a year go through the expensive and not-insignificant operations to enlarge their breasts with artificial implants for cosmetic purposes, and *millions* more purchase artificially padded brassieres). All of this is fake fat. It is the Pleistocene against the present.

So, like the artifacts of fat images portrayed in Paleolithic art, our propensity to fatten easily is an artifact of the different demands the Pleistocene made on our bodies. Our environment has changed, but our adaptations still target those Pleistocene days when energy was limiting, when all the drippy fat tasted delicious, when it was energetically stressful to rear a child, when illness made insufficient fat dangerous, when love and sex were directly tied up with bulging curves.

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Fig. 1. : Males in Paleolithic art are, technically speaking, drawn poorly (there are a few exceptions), but all are portrayed lean, or at least not obese. Here are a sample taken at random. From upper left to lower right these are from: Le Fieux, La Pileta, La Pileta, Cueva de la Peña, Portel, Minateda, Geissen Klösterle, Gourdan, Pergouset, Pin Hole Cave, Mas d'Azil.

EVOLUTIONARY CONNECTION OF THE EROTIC WITH FEMALE FATNESS

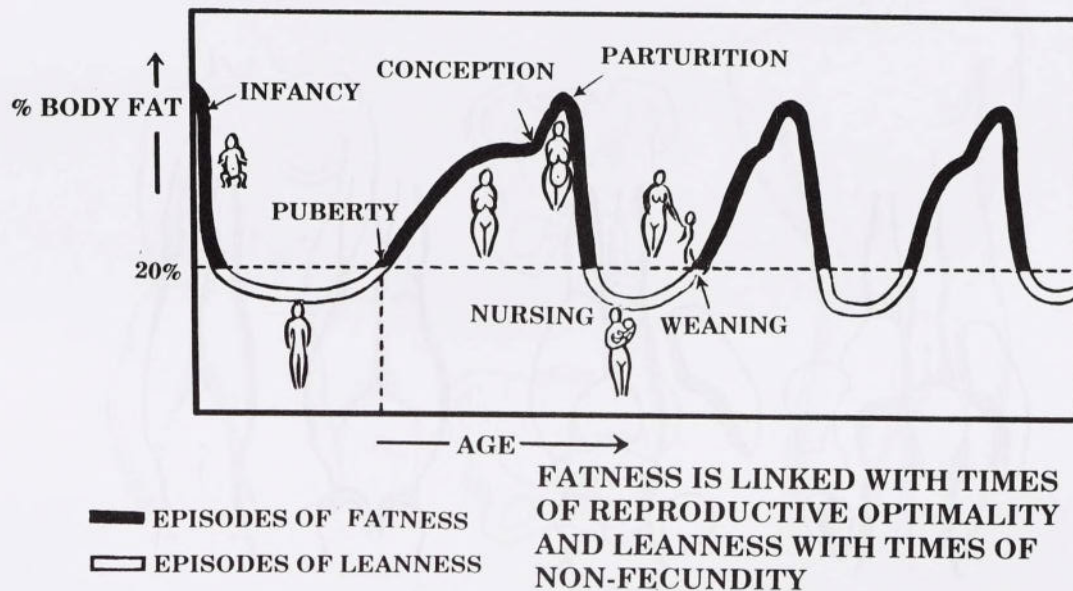


Fig. 2 : The answer to the question of why female fatness seems to have some inherent association with erotic attraction may be answered by the fact that in the Pleistocene it would have been a strong predictor of fecundity, that is, fat women were more likely to be ovulating than lean ones. This cut-off line is at about 20% body fat. All else being equal, men sexually attracted to female's rounded curves would have left significantly more offspring than those attracted to hard-muscle leanness. This 'ideal' graph shows the curve under optimum conditions. As the conditions deviate from optimum, women would spend a greater time below the 20% fat level.

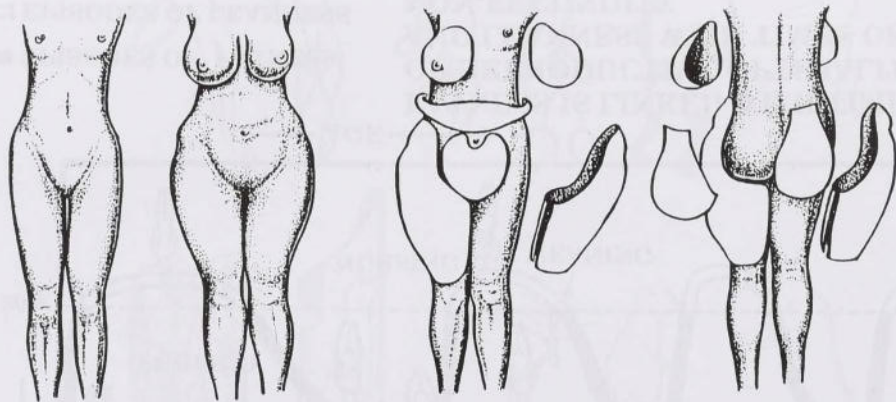


Fig. 3. : While the main fat depots among men are located in the greater omentum, shoulders, neck and subcutaneous trunk tissue (especially above the navel), women's fat depots are more specifically positioned around the pelvis: thighs, buttocks, and hips, a small belt above the hips, and in a heart-shaped abdominal pad below the navel. Also, a major female depot exists within the breasts.

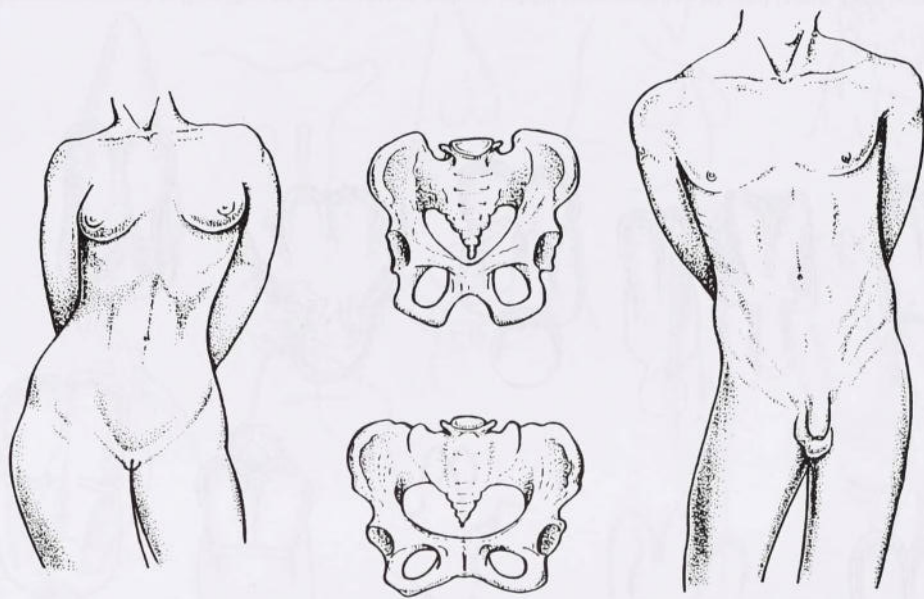


Fig. 4. : The pelvic and pectoral regions are sensitive to developmental steroids — the pelvic region to estrogens, and pectoral to testosterone. This sexual dimorphism is adaptive to the special role the appendicular girdles play in each sex. The pelvic region is important in nurture: carrying a fetus, birthing, and in the hip-carry of toddlers. Likewise, the heavy musculature and bones of the neck, upper trunk, and upper arms of males are adapted to the violent parts of Pleistocene fighting and hunting. This pelvic-pectoral girdle sexual distinction is mirrored in the centers of fat depot locations, artificially exaggerating these portions in the different sexes.

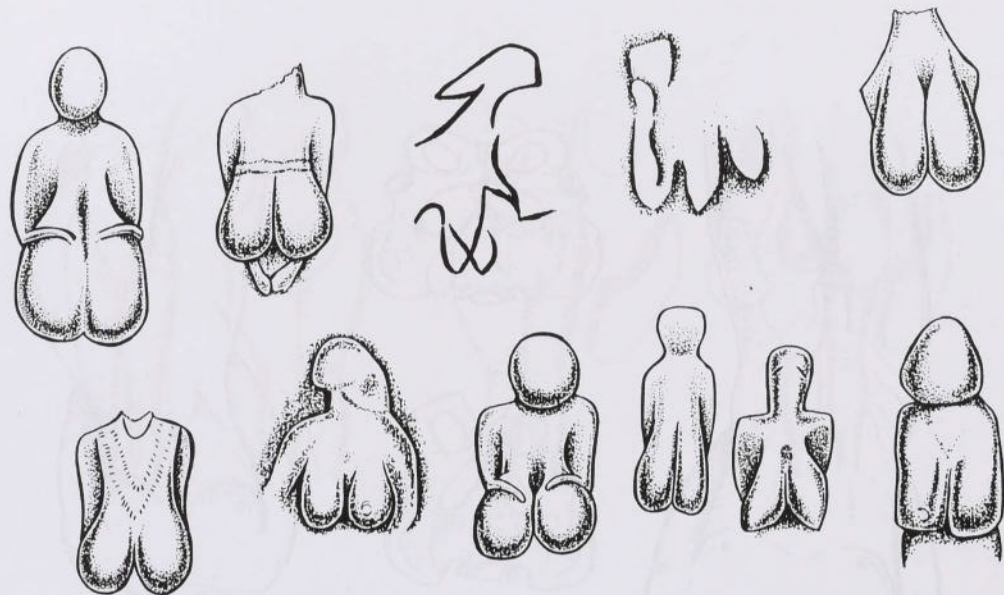


Fig. 5 : The greater majority of women portrayed in Paleolithic art, in a variety of postures, exhibit large pendulous fat-filled breasts. From upper left to lower right these are from : Dolni Vestonice, Caberets, Gönnersdorf, La Vache, La Marche, La Marche, La Marche, La Marche, Rytirska, Moravany.

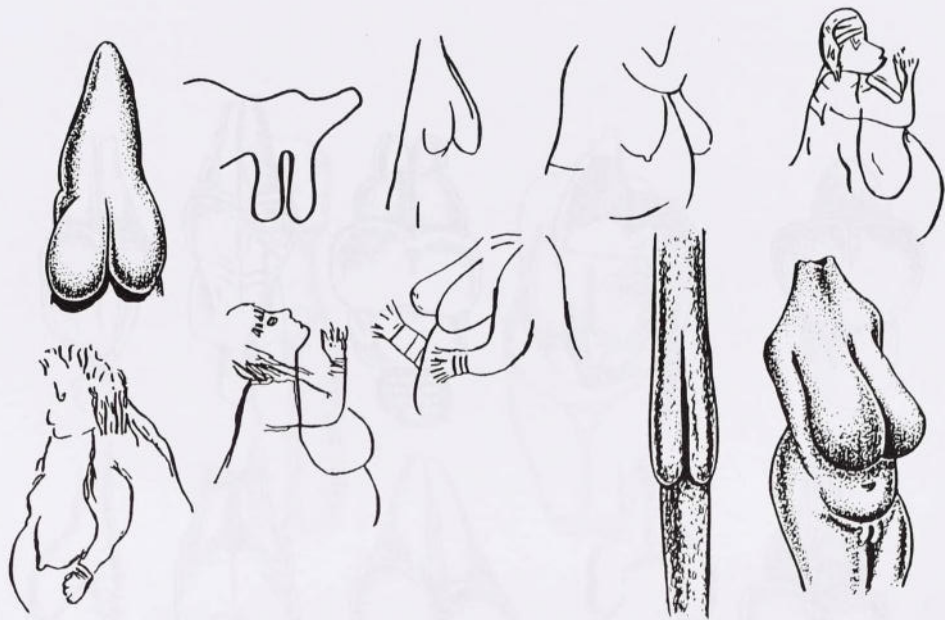


Fig. 6. : The breasts in Paleolithic art are not simply those of fat women but many breasts are exaggerated beyond what would be normal for even very obese women. From upper left to lower right these are from : Lespugue (reconstructed), Kostenki I, Pech Merle, La Madeleine, Moravany, Kostenki I (reconstructed), Laussel, Gargano, Kostenki I, Dolni Vestonice, Chiozza.

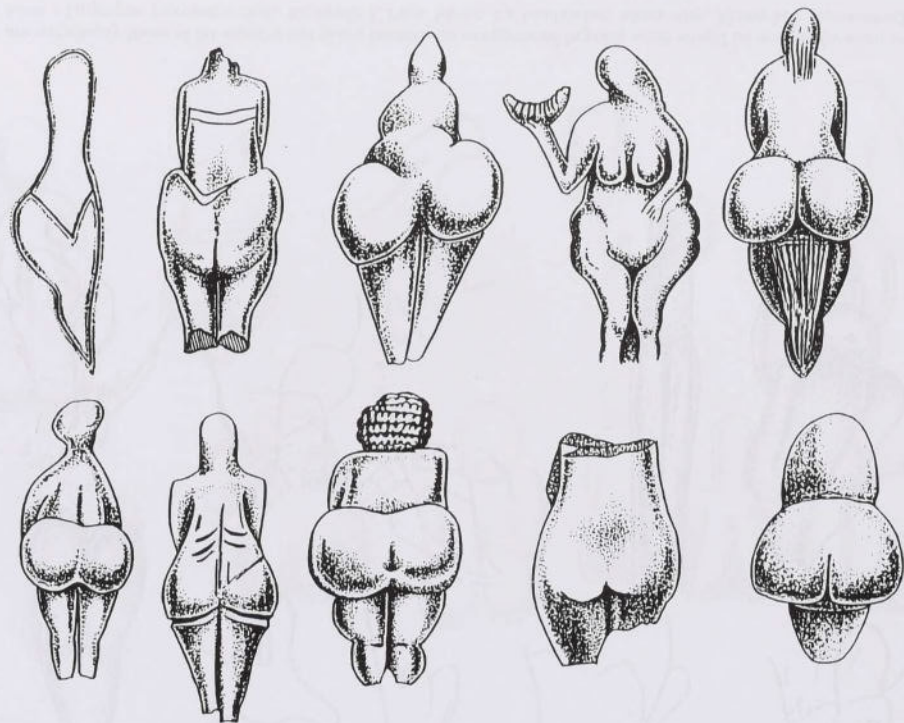


Fig. 7 : Buttocks, hips, and thighs of most women portrayed in Paleolithic art are shown fat to obese. From upper left to lower right these are from: Laugerie Haute, Kostenki I, Grimaldi, Laussel, Lespugue (reconstructed), Gargano, Dolni Vestonice, Willendorf, Brassempouy, Weinberg.

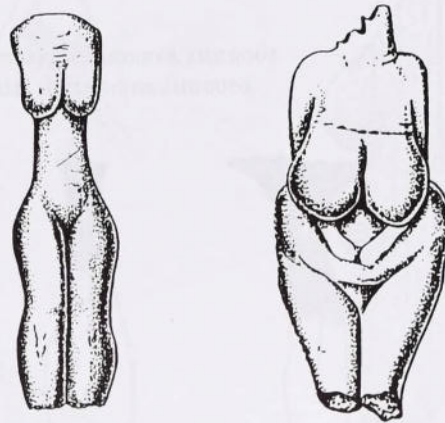


Fig. 8 : There is a difference among women as to how much fat is deposited on the thighs or waist-hips, sometimes referred to as centripetal or centrifugal patterns. Normally those that have fat thighs have relatively small breasts, those that deposit on hips-waist have large breasts. Thus, these images have been referred to as pears and oranges. The pear pattern is rare in Palcolithic art, there are only one or two which show that pattern. This frequency seems much rarer than among today's European populations, in which there are more pears. On the left is a 'pear' from Eliseevici and the right an 'apple' from Kostenki I.

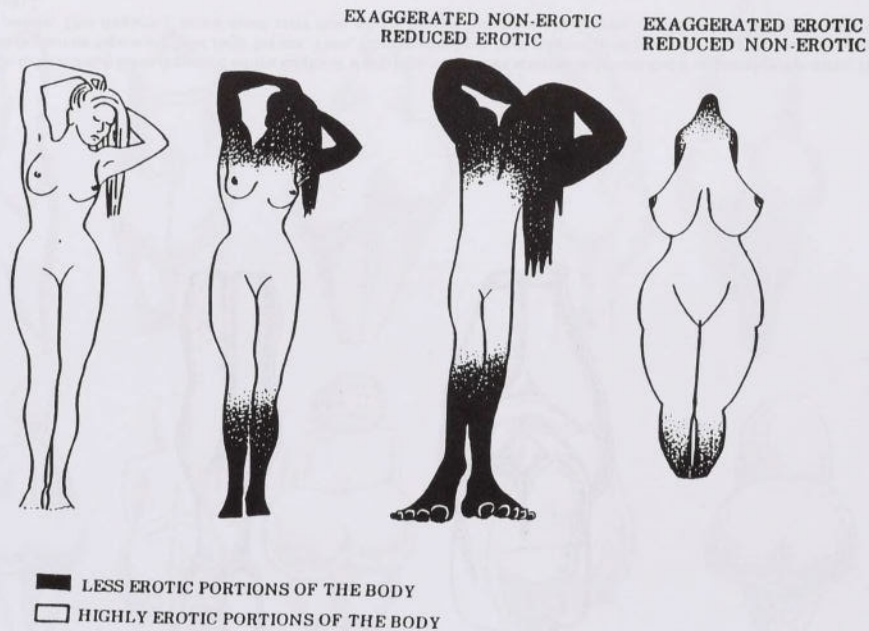


Fig. 9. : One can appreciate visually low-erotic and high-erotic visual centers on the female body with this quick visual exercise. If one demarks the breast-pelvic regions of peak-reproductive female bodies from all other regions, and exaggerates and de-emphasizes these portions respectively it results in either a bizarre body or one which looks similar to a Paleolithic 'Venus' figurine. Note, the unblackened regions of the body are the ones most concealed by clothing around the world, that is, those predicted to have the most visual erotic loading.

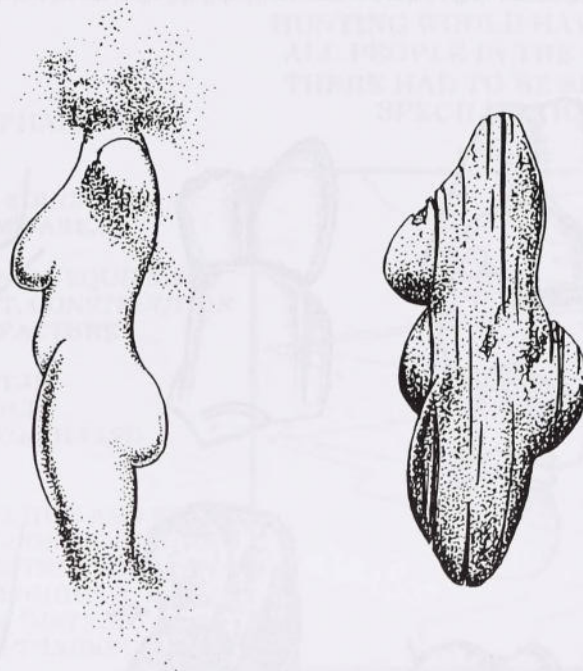


Fig. 10 : The abstraction of female bodies so common in Paleolithic art, distilled down to the breast-hips erotic estimators of potential fecundity, highlight the role of these structures as direct coarse erotic signals to males. Males depend more heavily than females on direct visual signals in assessing mates or copulatory appeal. Optimum choice of a male mate for women is much more complex and depends, in addition to physical attraction, on status, resource control, emotional fidelity, proneness to sharing, etc. The key 'predictors' used in attraction and mate choice are not symmetrical between the sexes, and were likely even more asymmetrical during the Pleistocene.

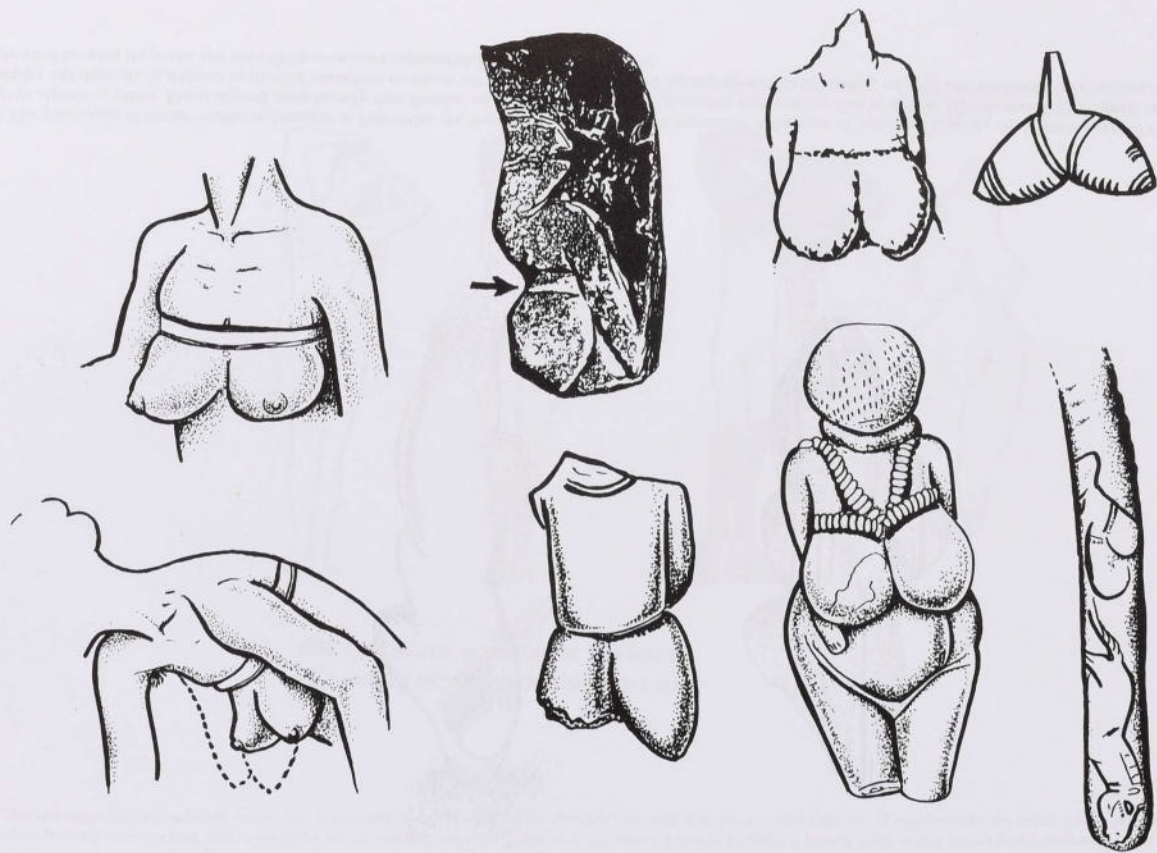


Fig. 11 : Evidence for the existence of fat filled pendulous breasts in the late Paleolithic comes, not only by their portrayals in Paleolithic art, but also from the portrayals of a breast-restraining-strap or brassier to restrict breast movement during activity. The two drawings on the left are my reconstructions. The other six are from Paleolithic art, they are, in order Kostenki I, Kostenki I, Dolni Vestonice, Dolni Vestonice, Kostenki I, La Madeleine.

A FEW DIFFERENT PHASES OF HUNTING:

HUNTING PLAY-EDUCATION
 SEARCH OF GAME AREAS
 PREPARATION
 ORGANIZATION OF EQUIPMENT
 SPECIAL EQUIPT. CONSTRUCTION
 WEAPON MANUFACTURE
 TRAVEL
 SPIKE CAMP SET-UP
 SCOUTING SEARCH
 STALK-TRACKING-KILLING
 BUTCHERING
 TRANSPORT
 FOOD PRESERVATION AND PREP.
 COOKING AND COOKING EQUIPT.
 SKIN AND SINEW TREATMENT ETC.
 SOCIAL AND RELIGIOUS RITUALS
 CEREMONIES OF DISTRIBUTION,
 LUCK, SHARING, THANKSGIVING

PALEOLITHIC LARGE-MAMMAL HUNTING WOULD HAVE INCLUDED ALL PEOPLE IN THE BAND, BUT THERE HAD TO BE SEX-AGE SPECILIZATIONS.

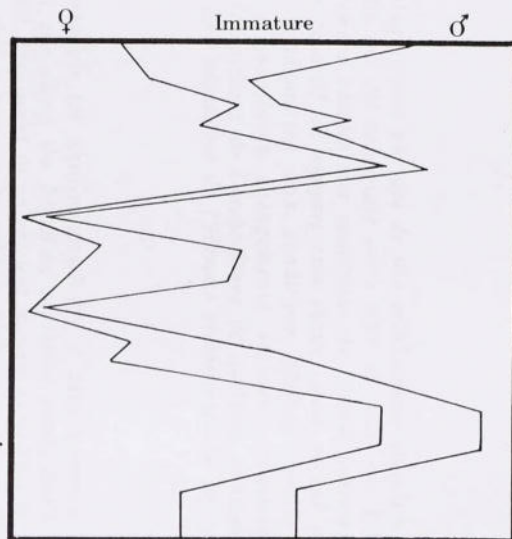


Fig. 12 : Hunting had to be a complex behavior in Paleolithic cultures. A restricted view of hunting, as killing, does not acknowledge all of the other important activities which consume over 99% of the time and energy of hunting. Likewise, in all hunting cultures there is a difference in the division of labor associated with this variety of tasks. Among known small-band hunting societies the pattern of sexually-specialized chores has some consistency which lets us make a theoretical approximation of how this would work in the Pleistocene. Cross-culturally all violent and risky large-mammal killing is relegated to males as well as the manufacture of weapons used in killing. Virtually all refined clothing tailoring, beading, and such exacting work is the task of women. Children, both boys and girls, participate early in these chores but not equally, or with sexual symmetry.