

# THE BEHAVIORAL MEANING OF THE EARLY AFRICAN ARCHAEOLOGICAL SITES: REVISION OF THE DISCUSSION AND NEW CONSIDERATIONS

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**ABSTRACT.**—*The main topics concerning early site formation and the behavioral models proposed to explain it are discussed. It is concluded that hominids have played an important role in site formation and that this process indicates a new type of behavior—different from those of the other primates—which is better understood by elaborating social hypotheses.*

**RESUMEN.**—*En el presente artículo se discuten las principales cuestiones relacionadas con la formación del registro arqueológico plio-pleistocénico y los modelos conductuales propuestos para explicar su aparición. Se pone de relieve la relevancia de la participación de los homínidos en la formación de los yacimientos arqueológicos y se subraya que semejante hecho obedece a un comportamiento nuevo—distinto de los del resto de primates—que resulta más comprensible desde la elaboración de hipótesis sociales.*

**KEY WORDS:** *Hominids. Site formation processes. Taphonomy. Subsistential (behavioral) model. Social model. Africa.*

**PALABRAS CLAVE:** *Homínidos. Procesos de formación de yacimientos. Tafonomía. Modelo subsistencial (conductual). Modelo social. Africa.*

## 1. INTRODUCTION

The emergence of the plio-pleistocene archaeological record, nearly 2.5 million years ago, means a crucial milestone in the process of human evolution. Not only does it prove that some late Pliocene hominids were engaged in a tool-using and carcass-processing behavior, but it is also a clear proof that hominid adaptation had become more complex and even different from the adaptive attitude exhibited by apes. A careful interpretation of early site formation from a socio-ecological consideration might shed new light on this issue. So far special emphasis has been laid on hominid subsistential behavior, as sites contain a fraction of their material evidence: the remains of part of the food they ate and some of the tools they used to process it. However, if we consider the contextual circumstances that propitiated their accumulation at determined spots, we cannot linger only on a simple subsistential interpretation of the early archaeological record. Sites were formed not only because hominids used lithic tools and included meat in their diet. This could even be an adaptive trait of a "minor" importance, as stone tool-use and meat-eating have been widely reported in chimpanzees (McGrew, 1992). Concerning both aspects, the hominid participation in site formation could even be understood as the

material expression of a progressive evolutionary trend of these adaptive traits that already exist in some apes.

What we can infer from sites seems to indicate that their formation was not only due to an evolution of certain subsistential attitudes, but to their development within a new behavioral framework that differed from the basic primate adaptive patterns. In this regard, the study of the forms of social interaction becomes essential to make inferences about the social behavior of hominids and also to account for the models proposed to explain their subsistence.

## 2. TAPHONOMY: THE PROCESS OF SITE FORMATION

After a century of palaeolithic research in which sites have traditionally been considered as the material result of human subsistence in the past—and therefore their integrity and resolution were indirectly assumed to be high—the discovery that diverse natural agents could intervene and even mimic human bone accumulations has led to a revision of this previously untested interpretation.

In the early 80's—after several years of taphonomic research—a controversy was raised about the criteria used to account for the formation of the African Late

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Pliocene and Lower Pleistocene sites. Some non-hominid agents were even attributed the main authorship thereof and, subsequently, new interpretive models were proposed to explain hominid behavior. These models were more gradualistic and ethologically-oriented than previous assumptions and, therefore, seemed to fit better traditionally darwinian evolutionary frameworks. In a first moment, it was postulated the static nature of site formation by using natural factors as exegesis. Thus, archaeological sites were interpreted as derived hydraulic jumbles, carnivore kill sites and hyaenid dens to which hominids only had a secondary access (Binford, 1981, 1985). However, the taphonomic analysis undertaken in the 70's—and published in the next decade—and in the 80's, to discern the different processes that might have intervened in the bone accumulation and sedimentation of plio-pleistocene sites were revealing. As a matter of fact, the early archaeological record could not have been formed by static natural (non-hominid) causes due to the following reasons:

1. The degree of bone clustering at each site is extremely high, compared to the bone concentrations observed on savanna landscapes. Under normal conditions, attritional mortality does not generate the spatial clumping of carcasses observed in the archaeological record. Furthermore, the process seems to be inverse: as animals die their bones become scattered if they are not consumed or otherwise destroyed (Hill, 1975, 1979a, 1979b, 1980; Behrensmeyer & Boaz, 1980; Behrensmeyer, 1983). This could also be applied to other environmental dynamics, such as water flow where, although the degree of bone concentration could be higher and even more stable, it never reaches the bone density and the state of bone alteration documented in most of sites (Hill, 1975, 1979b; Shipman, 1975; Potts, 1982, 1988).

2. Under natural circumstances, the mixing of bones from different animals occurs only occasionally and tends to be low most of the times (Hill, 1975, 1979b; Behrensmeyer, 1983). Behrensmeyer (1983) found an average of one individual—and a maximum of three—in the 1500 m<sup>2</sup> sampling units of the bone collection that she carried out in Amboseli. A personal study that I made in the surrounding zone of an open-area pond, in the north of the lake Ndutu in Tanzania, yielded a maximum number of five individuals in a smaller area (Domínguez-Rodrigo, 1993). In contrast, the minimum number of large mammal individuals, calculated from the Olduvai archaeological levels, ranges from 34 to 36 and appear in areas smaller than those used in the sampling of bone dispersal on modern landscapes (Potts, 1982, 1988).

3. The taxonomic and ecological diversity from the archaeological faunal assemblages is high (Bunn, 1982; Potts, 1982, 1988). This goes against the suggested pattern of multiple kill sites, as the taxonomic range represented around death sites tends to be low (Kruuk, 1972). Furthermore, bones from species that belong to different habitats are known to occur in the same faunal assemblages (Bunn, 1982; Potts, 1982, 1988), for which a natural process cannot be responsible, as most

animals die and are killed within the limits of their ecological niche.

4. Axial bones are more widely represented around death sites than limb bones (Hill, 1975, 1979a). The skeletal remains preserved at early archaeological sites show a small frequency of axial bones relative to limb elements. This further indicates a post-mortem transport of carcasses, instead of an "in situ" processing of their contents (Potts, 1982, 1988).

As a consequence, it seems that site formation was the result of the accumulation of faunal remains generated by a process of transport. After excluding the physical agents, such as wind and water, as major causes (Hay, 1976; Potts, 1988)—though bearing in mind their contextual intervention—the taphonomic analysis concluded that the main—but not only—responsible for the bone transport observed in the archaeological accumulations could only be either the hominids or other savanna animals.

Several authors have insistently claimed the key role that some felids might have played in site formation, as they have been reported to accumulate faunal remains (Brain, 1969, 1981; Bunn, 1982; Tappen, 1990). However, this general assumption is somewhat misleading. Felids do not usually propitiate the formation of bone clusters, because they process carcasses where they obtain them or in a nearby spot, which always depends on the point where they have captured them (Domínguez-Rodrigo, in press(a)). One of the few situations in which this is slightly altered is in the areas where a serial predation is practised. In this case, it depends on the establishment of sleeping-places by lions, which mostly occurs in proximity to open-air water sources, such as ponds or puddles. These situations are highly exceptional and are characterized by a widespread distribution of remains, by determined patterns of bone alteration, by a limited range of spatial patterning and by the ecological context in which they appear (Domínguez-Rodrigo, 1993), clearly opposed to the paleohabitats where archaeological sites were formed.

Leopards are exceptional compared to the rest of felids. Accumulations in caves ascribed to them have been reported, but the information yielded by the analysis of the faunal remains studied in such places is somewhat contaminated, because other taphonomic agents—porcupines in particular—have intervened in the accumulations (Brain, 1981; Bunn, 1982). Nevertheless, leopards are known to transport carcasses repeatedly to caves and rock shelters, but caves are not the sedimentary context in which early sites were formed. Leopards have also been documented to carry their kills into trees but, although this behavior could theoretically generate some bone accumulations, none has been reported in open-air settings, like those at which sites were formed. A study of carnivores in East Africa that I initiated in 1991 has led me to explain this fact in terms of trophic dynamics (Domínguez-Rodrigo, in press(a)). I have observed leopards eating their preys on the spot where they had hunted them, in riparian woodland contexts. This lack of carcass transport could be responsible for the

absence of any relevant bone concentrations in this type of habitat. In contrast, I have also observed leopards repeatedly carrying their kills into trees in open-vegetation areas. This variation in their behavior can be accounted for a different degree of trophic pressure in both habitats. Whereas the riparian woodland settings where I observed the "in situ" processing of carcasses were almost devoid of potential carnivore competitors that could snatch the preys, the open-air settings where I documented leopards continuously transporting kills into trees were habitats in which the trophic pressure was high: felids—particularly lions—were common, and hyaenids were very abundant. This situation can also help to explain the lack of bone clusters around the trees where preys were carried—which could have been facilitated by the leopards' attitude—because not only did these felids take their kills to different trees frequently, but also did hyaenas act as bone collectors, taking away most of the remains that fell down from them. Thus, the existence of different trophic dynamics in both types of natural settings can account for the distinct behavior exhibited by leopards in such contexts and for the absence of any relevant bone accumulation.

Nonetheless, even though some leopards were able to accumulate bones, their remains would belong to small mammals—particularly ungulates—as these animals make up most of their range of predation (Kruuk & Turner, 1967). In contrast, medium-sized animals comprise the majority of individuals preserved at early sites (Bunn, 1982; Potts, 1982, 1988). This clearly shows that the faunal body sizes of the carcasses accumulated at archaeological sites are inconsistent with the prey sizes of leopards.

If we do not consider felids as a major agent in site formation, the only plausible option that is left—within the attribution of it to savanna (non-hominid) animals—are hyaenids. Porcupines can also be eliminated as the main cause, as the incisal gnawing—present on most of the bones that they accumulate—is very rare at plio-pleistocene sites (Potts, 1982, 1988).

Hyaenas are known to accumulate substantial numbers of bones at dens, to inflict on them extensive damage and to break them. Based mainly on the skeletal-part frequency—hyaenas do preferentially accumulate limb bones (Hill, 1975; Brain, 1981; Domínguez-Rodrigo, in press(a))—and the presence/absence of determined bone ends—proximal epiphyses of humerus and tibia and distal epiphyses of femur and radio-ulna are underrepresented in hyaena dens (Hill, 1975; Brain, 1981; Bunn, 1982)—, Binford (1981, 1985) attributed a major role in site formation to these carnivores. However, several taphonomic analysis have revealed that such an approach to bone accumulations may be insufficient. The absence of the epiphyses mentioned and other anatomical elements—especially axial bones—is not necessarily the result of primary access to carcasses by hyaenas, but may be due to post-hominid ravaging by these scavengers (Potts, 1982, 1988; Marean et al., 1992).

The intervention of both hominids and hyaenas in the configuration of sites can be inferred by the

presence of tooth-marks and cut-marks on the surface of several bones (Bunn, 1981, 1982, 1983a; Bunn & Kroll, 1986; Potts & Shipman, 1981). During the last decade, one of the aspects that the academic discussion that stemmed from the taphonomic studies focussed on was the discernment of the priority of both agents in the access to carcasses. Had it been a hyaenid accumulation in which hominids might have participated secondarily (Binford, 1981, 1985) or was it the result of hominids' primary access to faunal remains and the later intervention of hyaenas to process what was profitable from the remains abandoned by hominids? (Bunn, 1982; Isaac, 1983; Bunn & Kroll, 1986; Blumenschine, 1988; Marean et al., 1992).

The presence of cut-marks on meat-bearing bones seemed to indicate the primary access of hominids to carcasses. Otherwise there would have been no meat to get from them. Therefore, it was logical to conclude that hominids were the main agents and hyaenas the secondary ones in the process of site formation. This "standard argument"—as Binford (1985) denominated it—of the interaction of both taphonomic agents has been increasingly receiving support from several middle-range studies. Sites cannot be the result of hominids operating at hyaenid—made bone clusters due to various reasons; some of which are succinctly put forward below:

1. The relevant number of meat-bearing bones with cut-marks can only be satisfactorily explained if hominids had obtained them first. Non-hominid scavengers—particularly hyaenas, which also extract the marrow—do not leave any significant quantity of meat on these bones (Bunn, 1981; Potts & Shipman, 1981; Bunn & Kroll, 1986; Isaac, 1984).

2. The average of tooth-marked bone fragments in the faunal accumulations that make up early sites is much lower—less than 25%—than the one observed in assemblages accumulated and fed upon first by hyaenas—which averages approximately 60-80% (Bunn, 1982; Potts, 1982, 1988; Blumenschine, 1988; Domínguez-Rodrigo, in press(a)). Furthermore, this low incidence of tooth-inflicted—mark bones is consistent with a secondary intervention of hyaenas on a hominid-generated assemblage (Blumenschine, 1988).

3. The paleoecological distribution of sites contrasts with the ecological niche of hyaenas. These carnivores have an adaptive preference for open-air plains, away from forested areas. Archaeological sites, on the contrary, were formed in riparian woodland areas—lacustrine and gallery forest—, where hyaenas are actually very uncommon (Blumenschine, 1986; Domínguez-Rodrigo, in press(b)).

4. Hyaena dens are at least partially excavated. If these carnivores had the primacy in site formation, there should be some sedimentary evidence of burrows or other aspects of den structure. So far none has been archaeologically detected.

5. If hominids had obtained some bones from hyaena dens, some authors presume the aim was to extract the marrow they contained (Binford, 1981). Although the amount of marrow-yielding bones in a hyaena den is very reduced (see point one), if this had

been the main intention, it seems logical to think that hominids would only have used nodular artifacts in the processing of such bones —like hammerstones and anvils—. The reality, instead, is that taken as a whole plio-pleistocene sites are composed of flakes and debitage in an average superior to 90% (Leakey, 1971; Merrick & Merrick, 1976; Isaac, 1976; Toth, 1982, 1985). This means that hominids constantly elaborated cutting-tools because they needed them for cutting functions. This could be further supported by the analysis of the microscopic wear that Keeley & Toth (1981) undertook on several artifacts from Koobi Fora. Only flakes were documented to wear polish and some of them had clear traces of contact with meat. Thus, as no cutting-tool is needed to process bones from hyaena dens and as there is no meat on them, a thorough study of the functional potentiality of plio-pleistocene lithic tools serves to assess that hominids had the primacy in site formation.

6. A simple observation of hyaena dens is enough to claim that there is nothing in them that a hominid would eat, as hyaenas are the most terminal scavengers indeed.

After two decades of taphonomic research, we have reached a stage where we can grant hominids the priority in the faunal accumulation of sites. The wide range of studies undertaken during all these years has helped a lot to make us understand that although sites can be the result of a complex web of agents, hominids probably were the main importers of bone (Blumenschine & Bunn, 1987). Actually there is no reason to argue otherwise. The assessment which some authors still make (Sept, 1992a, 1992b) that proof thereof has “so far eluded researchers” is a simplistic statement that cannot be supported in the light of taphonomic research (Dominguez-Rodrigo, in press(b)).

Assuming such a set of conclusions, one of the most interesting points that are being held in the discussion about the behavioral meaning of the early archaeological record is the confrontation of different subsistential models, to account for its formation. But such models are established on the premise that sites were intentionally produced. That is, hominids would have created referential places, which they would have repeatedly visited and whose function inferred varies according to the behavioral hypothesis proposed (see below the “stone cache” model versus the “central-place foraging” one). But this view has recently been challenged again. From the consideration that hominids were primary agents in site formation, some authors propose that the bone and stone accumulations that make up the early archaeological record could have been the result of accidental and unintentional reoccupations of determined spots, in which material remains would have been successively deposited (Sept, 1992; Quiatt & Huffman, 1993). Thus, archaeological sites would not have been the manifestation of the establishment of referential places, but the result of redundant visits to the same places of hominids exhibiting a debris-discarding behavior. The criteria used to support this kind of inference are the next:

— Chimpanzees and macaques are reported to make sporadic concentrations of stones at determined

spots (Boesch & Boesch, 1984; Quiatt & Huffman, 1993).

— Chimpanzees and baboons are also documented to show spatial redundancy in nesting and sleeping-site behavior (Whiten, Byrne & Henzi, 1987; Sept, 1992).

Although this is presented as a discovery, it is not a new or uncommon adaptive trait, as a matter of fact. A lot of species exhibit spatial redundancy at certain places. Predators established in particular areas where features in terrain —such as ponds— favour a “serial predation” as well as those who keep returning daily to their dens or lairs are but one clear example. However, one of the questions that is clearly misunderstood in this discussion is that repeated occupation of some spots is one thing and debris accumulations made in them is another. Archaeologists are challenged to seek the answer not only to a spatial redundant behavior, but to a bone-plus-artifact accumulating one. Redundant utilization of a point is the result of a series of single occupational events, whose features are the real responsible for the production of clusters of remains. It is not so much a question of time as of distinctive behavior. Thus, could hominids have produced the early archaeological sites if they had kept the same socioeconomic behavioral patterns as the rest of primates? Several reasons could be used to argue against it.

Concerning tool-use and transport, it should be stressed that although both chimpanzees and macaques have been reported to produce small clusters of stones, there exist qualitative and quantitative differences between this behavior and the one attributed to hominids that we can infer from the archaeological record. First, chimpanzees sometimes carry tools to a place where they need them for feeding on particular food items, but they never have been observed to carry stones to a place where there were some already. This can be explained because chimpanzees use tools only when they need them —it is an ad hoc elaboration and not a premeditated act— and, therefore, transport of stones is better understood from this consideration. Stone tools are moved to determined spots, where certain food items need to be processed with their aid, and the “re-use” of such tools only occurs if these products are seasonal and chimpanzees happen to forage the area periodically. Stones thus accumulated are very few and do not usually appear in significant numbers. This can also be observed in macaques, in which stone-handling do not seem to produce large clusters. However, what we can infer from archaeological sites is somewhat different. Hominids were accumulating important amounts of stones—at least at some sites—as if they were stocking them (Potts, 1982, 1988). If this had been so, stone accumulation should be attributed to a behavioral purpose and not to a natural coincidence. Furthermore, the presence of several lithic raw materials seem to indicate that hominids carried stones repeatedly to those places as though they considered them important for their subsistence. The transport of alloctonous lithic items up to 10 km from their source contrasts with the stone-transport behavior exhibited by chimpanzees, which have occasionally been observed to carry some types of tools

up to 500 meters (Boesch & Boesch, 1984). Although some authors claim that this need not have been a single goal-directed journey, but that it could be due to multiple transport over decades, centuries or millenia, it should be stressed that the archaeological stone concentrations were probably carried out in a short time span, as it is thought that sites were deposited and sedimented in less than 10 years. Some researchers even think that sites were formed in less time, not exceeding a 2-3 year lapse (Bunn & Kroll, 1986). Nonetheless, the inference that hominids could carry stones over several kilometers can gain some support from the fact that they treated them differentially. Exotic lithic raw material was more fully exploited, discarding the artifacts made thereof only when they were not profitable any more (Toth, 1982, 1985). Besides, hominids modified the stones they carried to those places to elaborate various artifacts for different purposes, according to their morphology and to the results drawn from the the analysis of microwear polishes on early stone tools (Keeley & Toth, 1981).

With respect to feeding habits non-hominid primates do not transport food to determined places to be processed and eaten, but consume it where they find it. The scarce food remains they create at sleeping-sites are due to the consumption of the products that are found in the trees they occupy or nearby. No food item is imported to these places from other points of the landscape. Although chimpanzees and baboons are predators, preys are consumed near the site of capture. This does not propitiate any bone debris accumulation. They do not transport food to determined spots simply because their socioeconomic behavior does not require it. If hominids had kept the same behavioral pattern as these primates, they would never have produced dense bone patches. Even if carcass transport would have become necessary, to avoid the risk of competition, bone clusters would not have been generated. Carcasses would have been moved from the point of their obtainment to the nearest safe place. And as the latter always depends on the former and the ecological context, it would rarely be coincident in successive carcass transports. My field research on carnivore behavior has allowed me to observe that the peripheral carcass transport that most of carnivores do to avoid the competition with other predators, does not usually propitiate the opportunity to concentrate remains from different carcasses on the same spot, because this always depends on the place where the prey was hunted and the physical features of the surrounding area (Domínguez-Rodrigo, in press(a)).

In contrast, early archaeological sites show that hominids regularly carried carcasses to them, which were processed with the aid of lithic implements. Furthermore, some of the species represented at sites were probably carried over long distances —due to their ecological niche—, which contradicts a transport-only-to-avoid-predator-risk behavior. Therefore, the relevant amount of animal remains that hominids accumulated at determined places cannot be attributed to sites being the nearest safety spots where carcasses

could be moved, but are better understood as the result of the establishment of referential places to which hominids carried food. A series of single occupational events of individualistic foraging hominids would never have created concentrated patches of debris, like those that make up the early archaeological record. So far, none of the proposals made about hominids keeping the same adaptive pattern as other primates has convincingly showed that such behavior could produce any accumulation that could mimic sites.

From all these brief remarks that I have made, what seems to be evident is that if early archaeological sites were formed, it probably was because hominids had a socioeconomic behavior that differed from that of the rest of primates. It was not due to the voluntary or involuntary multiple reoccupation on determined spots, but to the fact that every single occupational event was qualitatively different from the behavioral pattern exhibited by chimpanzees, baboons or macaques.

However, during the last years recent considerations are trying to make us conceive hominid behavior not as human-like as the right models proposed to account for site formation maintain (see below). More remarkable than the hunting-versus-scavenging debate is the issue of what hominids really consumed from carcasses. Accepting that they selected some parts from several carcasses and that they transported them to referential places, Blumenshine (1991) has suggested that hominids mainly scavenged defleshed bones from felid kills —anticipating themselves to hyaenas— with the only aim of extracting the marrow that they contained. This would mean that their behavior at sites would not have been as human as previously thought, because marrow fat constitutes a limited food yield that would not have encouraged its sharing with other members of the same group. Thus, sites are not conceived as spots where food is shared, but as refuges where hominids individually introduced and consumed low food yields. Blumenshine's assertions are mainly based on the analysis of skeletal representation and bone modification at sites (Blumenshine & Selvaggio, 1988; Blumenshine, 1991; Blumenshine & Marean, 1993). Nonetheless, the studies made on bone destruction processes and skeletal representation demonstrate that early sites may have undergone a severe process of destruction and alteration by ravaging carnivores such as hyaenas and, therefore, the elements represented are not indicative of what hominids really carried to these spots (Marean et al., 1992; Blumenshine & Marean, 1993). They might have transported a whole carcass —with high energetic yield— or a few defleshed bones —with low yield—. However, a recent study on long bone marrow yields of african ungulates by Blumenshine & Madrigal (1993) shows that the abundance of long apendicular bones at Olduvai sites is indicative of the selectivity in exploiting the energy from them. As they say:

“Hominids were preferentially breaking those larger mammal bones that provided the greatest gross energy gain. In neglecting many lower-yielding bones, hominids were not maximizing energy gain from marrow exploitation, nor were they operating in an

extremely-limited mode.....Rather the amount of food energy available to the hominids who broke marrow bones at the sites seems to have been adequate". (Blumenschine & Madrigal, 1993: p. 580).

This evidence that hominids selected high-yielding bones, according to the authors, is consistent with passive scavenging from abandoned felid kills, confrontational scavenging and hunting. Blumenschine also argues that the evidence for hammerstone breakage and frequency of percussion-marks specimens at some sites suggest that hominids broke most of—if not all—the marrow bones (Blumenschine & Madrigal, 1993). But this only indicates that hominids extracted marrow from bones. It does not exclude that they could have eaten the meat that these bones might have contained. As a matter of fact, there are several arguments that could be used to prove it:

1. Concerning surface bone alterations, besides percussion-marks, a significant amount of bones at sites exhibit—as I mentioned before—several cut-marks (Bunn, 1981; Potts & Shipman, 1981). Both the quantity and presence of these marks on determined sections of the bones cannot be satisfactorily accounted for as the removal of scraps of flesh that commonly survive carnivore consumption (Blumenschine, 1991). First, they appear regularly on meat-bearing bones (Bunn & Kroll, 1986) and secondly, upper-limb bones from carcasses at felid kills usually are utterly defleshed. Furthermore, to remove the occasional scraps of flesh of these bones stone tools become unnecessary (pers. observ.).

2. Every reconstruction of a behavioral model must be based on a multiple-variable approach. By focussing on bones, Blumenschine does not take into account that sites contain lithic artifacts and stones that suggest their use in meat consumption. Most of the stone tools at early sites are simple or modeled flakes and, therefore, they express a cutting-function. As I said before, microwear analysis on the edges of some of these tools show that they were used for processing meat (Keeley & Toth, 1981). The presence of alloctonous raw materials—whose original sources were fairly distant—suggests that lithic tools were essential for the survival of hominids. If they had only obtained defleshed bones, stones would become less important—bones could be broken by using tree branches as passive percussion platforms—and the type of raw material would not have been taken into consideration.

3. Blumenschine interprets sites as refuges and not central places. In my field study about carnivore involvement in carcass transport I have not reported bone accumulations by reincident transport to safe places. The points of carcass obtainment, the physical conditions of the environment, the social characteristics of the different carnivores and carcass size are some of the features that account for the lack thereof (Dominguez-Rodrigo, in press (a)). If hominids had reacted like other carnivores, they would not have generated any significant bone concentrations, as the nearest safe spot would always have depended upon a wide range of variables. However, they were regularly

carrying animal resources to determined spots. Blumenschine explains this by interpreting these places not only as refuges but also as points where hominids could always find lithic tools from previous carcass-processing acts. This interpretation could be considered as Potts's "stone-cache model" revisited (see below the critic comment to it).

4. If hominids were only obtaining marrow from long bones, they could have processed them either on the spot or in another place where refuge was available. If riparian woodland was this place, they could have chosen a different spot every time they carried bones to this area, as they would have had a wide access to stones—especially in gallery forests—in case they were really needed. This could have eliminated the troubles that might have emerged at sites if such a scarce food had been transported to them. Studies on apes show that when such a thing happens, disputes, confrontations and aggressions are common among the members of the same group (de Waal, 1989). That explains why, when an individual gets some food, he/she tries to eat it alone and get away from the main social focus. The social stress originated by hominids transporting low food yield to the places where other individuals might have stayed, could only have been avoided by carrying that food to other spots apart from the main areas. But this goes against the main conclusions reached through the taphonomic analysis (see above).

If hominids repeatedly carried carcasses to determined spots, it must have been because they could afford—it may even have been intentionally—food dispersal in favour of other individuals. Therefore, this should have required that the bones carried to these sites were not only marrow-limited but also that they included meat. This is shown by the skeletal representation, the bone surface alterations and the bone modification patterns from early sites and by a social and trophic consideration of hominid behavior (Bunn & Ezzo, 1993).

Assuming such conclusions, a new question emerges: What was the real function that early sites accomplished?

### 3. SITES AND BEHAVIORAL MODELS

In basic terms—and in the current state of the debate about the hominid implication in site formation—there are two models that fit the taphonomic premises mentioned above: the "stone cache" hypothesis (Potts, 1982, 1984, 1988) and the "central-place foraging" model (Isaac, 1983).

Potts's model was created on the grounds that sites only demonstrated the elaboration of lithic artifacts and the processing of carcasses on the spots where they appeared. Every other kind of interpretation becomes a secondary inference. Isaac's (1978) model implied that sites had been home bases where food-sharing occurred and which had been formed due to a new social system that was supported by cooperation and sexual labour division. Potts, however, rejects such conception

and claims that sites never were home bases due to the following reasons:

— A home base must be a safe place where the individuals carry out their normal social life and exchange information. The abundance of tooth-marked bones at sites means that carnivores frequented those places. This overlapping between hominids and carnivores in the use of those places would have prevented the former from staying a long time in them and suggests instead that they would have minimized the time spent there.

— The amount of intact bones recovered from sites would also suggest that hominids would have stayed for a short time in those places, as they would not have completely exploited the food resources that these bones contained.

— The temporal lapse of use and bone concentration at sites could have spanned up to ten years, which exceeds the time that modern hunter-gatherers insist in the reoccupation of their camps.

Thus, plio-pleistocene sites should respond to a behavior different from the one proposed by Isaac (1978). The presence of lithic tools and bones in certain areas of the landscape can only be due to: (1) the transport of carcasses to raw material sources, (2) the transport of stones to the points where carcasses were spotted or (3) the transport of both stones and carcasses to referential places. According to Potts, the behavior that requires the least energetic expenditure is the most likely to have occurred. That is, a subsistential strategy whose energetic income is superior to the energetic investment will be adaptively rewarded. Based on this assumption, Potts elaborated several alternative strategies and concluded that only the third option mentioned above is the most beneficial. Curiously, it is also the only option that the taphonomic analysis support. Following these criteria, Potts argues that when the number of carcasses available in a determined area increases, it results more beneficial, in energetic terms, to establish several referential places instead of only one. Likewise, when carcasses are transported, it is more effective to transport them over short distances. For both reasons, he considers that the production of several referential places in different areas of the landscape is more positive than a "single-place" strategy, because it requires a lesser energetic cost.

Thus, hominids could have created several "stone caches" in different places—where they would have stored lithic raw material—and would have carried carcasses there to be processed. This would have meant the use of a strategy similar to other predators, such as leopards, based on the transport of carcasses to particular spots where they were consumed, in order to avoid the competition with other carnivores. So, the "stone caches" would only have been subsistential foci, in which the time spent would have been minimized to avoid the risk of other predators.

According to Potts this model is innovative because :

1. It does not require premeditation in hominids and it is a behavior that can be understood within an ape behavioral framework.

2. It does not require a social organization different from that observed in extant apes, nor a food-sharing attitude.

3. It represents an intermediate model of behavior which, although it is ethologically accounted for, it is not like the behavior exhibited by apes and not so "human" as the home base model reconstruction.

Nevertheless, such assertions are somewhat inexact. Concerning the first point, Potts argues that ethological studies reveal that chimpanzees use stones as tools and that they can transport and re-use them. However, chimpanzees use stones sporadically—without modifying them—and transport them over short distances. They may accidentally re-use them when they come again to the place where they left them in order to have access to the seasonal products of the trees nearby. The "stone cache" model proposes, instead, a repeated supplying of stones to determined spots, which contrasts with chimpanzee tool-carrying, as these apes do not usually transport stones to places where they have already accumulated some. Thus, *reincidence in stone transport* would be the first element that would have differentiated hominids from chimpanzees. A second factor that can be inferred from this model is that hominids would have used lithic tools *more frequently* than chimpanzees and would have transformed them, transporting such items over longer distances. Whereas chimpanzees have been reported to transport stones along some meters, hominids seem to have transported stones over several kilometers (Hay, 1976; Toth, 1982). This fact indicates that the energetic investment required for such behavior could be justified by a greater importance of lithic tools than is observed in apes.

The behavior proposed by Potts's model implies a lot of forethought and strategic anticipation, as hominids would have selected some spots on the landscape where they would have accumulated stones prior to their utilization, in prevision for future needs. By anticipating events that are to come, this behavior is based on planning, in contrast to the attitude exhibited by apes. As Binford (1985) acknowledges himself, such model assumes a set of planning strategies on the part of the hominids that is only known among the most complex modern hunter-gatherers.

Concerning Potts's second statement, a deeper interpretation of his model contradicts his assertions. First, as apes live in groups it is logical to think that several hominids would have intervened in the transport of stones, for the accomplishment of this task individually seems highly unlikely due to the inability of a single individual to cope with the open-savanna predation risks. Also, stone concentrations such as those proposed by Potts would be in-existent if several members of a group had not collectively cooperated, because it would be more positive and effective—in energetic terms—for some individuals to get their lithic raw material from the accumulations made by other hominids. The only way to dissipate competition would be the collective participation in stone concentrations. Besides, this is what some sites seem

to indicate. Sites such as the FLK "Zinj" from Olduvai, where more than 20 kg. of quartzite debitage—whose original source is several kilometers away—were recovered, might show the collective transport of this material. Then if the transport of stones was the result of cooperation among individuals, it is logical to assume that such behavior would have created an expectancy of shared use of the resources obtained. This would have been further increased by the collective transport of carcasses, as it would have accelerated it in the case of medium-sized and large mammals. Therefore, food-sharing seems to be the logical result of such behavior.

Thus, the "stone cache" model would have had the same behavioral consequences as the other models that Potts pretends to criticize. It supposes a strategic planning of future events in which several individuals would have participated and shared the energetic income obtained. The difference between this and other models is that Potts confers to these referential places only the subsistential function of meat-processing spots. Even though we admit this series of consequences, it remains to be seen if Potts's model has the heuristic validity to account for site formation.

It can be tested as it allows some predictions. For instance, it supposes that a long-term stone supplying of sites would mean a variation in the range of lithic raw material, as it really occurs. Likewise, if carcasses were transported to processing places, an important number of non-transformed stones might be expected as it happens at some sites from Olduvai (Potts, 1982, 1988). However, this is something that can be exceptionally observed in this archaeological area. In most of the plio-pleistocene sites all along the African Rift (Omo, Hadar, Koobi Fora, West Turkana) the situation is inverse: manuports are scarce and elaborated artifacts—especially flaked stones—are more common. This contradiction has forced Potts to argue that the other sites should be explained otherwise. Nevertheless, it seems unlikely that the emergence of a bone-plus-artifact clustering behavior could diverge at its very beginning in such a reduced area.

Another reason that advises us to be cautious in considering the validity of the "stone cache" model is that in case sites served the purpose dictated by it, we would expect a taxonomic representation in faunal remains according to the habitat where sites appear. If carcasses were carried to the nearest processing spot, that is what should happen. Instead, the faunal representation of sites is quite homogeneous in comparison and it is made up of species from a variety of habitats that indicate that their transport to these referential places is not due to a behavior like the one proposed by the model commented.

Another argument that contradicts the "stone cache" model is the paleoecological situation of sites. Most of them appear in the proximal ends of alluvial plains, associated to closed-vegetation areas—such as lacustrine and gallery forests—where the risk of predation is the lowest of the whole range of savanna habitats. This does not support Potts's statement that hominids would have minimized the time spent there

to avoid the presence of other carnivores. This would not have happened, as these areas favour a more permanent stay in them. This would have facilitated the performance of other activities in the referential places, besides the processing of carcasses. Such possibility seems to have happened, according to the information drawn from the microwear analysis of some stone tools, which document their use in cutting soft plant material and in scraping and sawing wood (Keeley & Toth, 1981). This contradicts the idea of sites as mere carcass-processing places.

Moreover, the presence of tooth-marked bones does not necessarily reflect the need for hominids to minimize the time spent at those referential places, because of the danger of other predators. It only indicates that some carnivores had access to the remains left there by hominids and this could have happened long after the sites had been abandoned, as it occurs today in modern hunter-gatherers' base camps. Furthermore, the amount of intact bones recovered from sites and their state of fragmentation and alteration can be compared to the remains produced actually by our genus, in non-productive societies (Bunn, 1982, 1983b). Concerning the lapse of time in which bones were accumulated at sites, the analysis of bone weathering as an indication of bone assemblage formation is still far from accurate. Actualistically documented correlations between the years of bone exposure and weathering stages indicate that an assemblage of weathered bones may be formed in various ways. Several factors may condition it. Skeletal element type, taxon and depositional environment are some of them (Lyman & Fox, 1989). Nevertheless, based on the same type of analytical method, Bunn & Kroll (1986) claim that sites were formed in no more than two years, which contradicts Potts's assertions of a longer period. One of the studies that could yield some significant results would be the statistic evaluation of bones concerning their weathering stage. It might be possible—if current methods were valid—that most of bones showed similar stages (short-term accumulation) or that they diverged widely (long-term accumulation).

For all these reasons, Isaac's (1983) "central-place foraging" model seems more acceptable, because it explains the apparition of sites from another behavioral framework. These would have been the result of the establishment of referential places in the landscape that had acted as points of dispersal and congregation of the members of a group, which would temporarily split to get food resources and reunite again to share probably some of the nutrients obtained. Because it is adjustable to all the requirements dictated by the taphonomic analysis and because more than a decade of controversy has granted it support from several studies, it seems to be adequate to account for the plio-pleistocene hominid behavior. The innovative traits of this behavior are:

1. The incorporation to the ecological dynamics of a planning capability of anticipation to events translated into a foreseeable behavior and expressed by means of lithic raw material procurement and its transformation into tools. It would also be responsible for the



production of referential places—which later turned into sites—before the importation of food therein.

2. The postponement of food consumption—at least of animal origin, although the microwear analysis of some tools presumably indicate that vegetable foods were also processed in (and probably transported to) these spots, too (Keeley & Toth, 1981)—and the carriage thereof to a referential place where it might have been shared.

3. A social labour division.

Concerning the first issue, a previsory capacity implies a wider and more complex temporal conception in hominids than in the rest of primates. This means the possession of a “temporal awareness” that had possibilitated the articulation of sequences of processes in diachronic temporal scales, which could have made hominids able to anticipate future events. As Taphonomy indicates that sites were formed because carcasses were carried to referential places, where they were processed with the aid of lithic tools (Domínguez-Rodrigo, in press(b)), the procurement of stones could have been performed in one of the following ways: after the obtainment of a carcass or before it. The first option is negative in ecologic and energetic terms (Potts, 1982, 1988) as the prolonged exposure of food increases the possibility of losing it to other scavengers. Furthermore, if consumption is postponed to fetch some stones, it seems logical to think that the search for the nearest lithic material would have been the rule. But sites show instead that a diversity of different lithic raw materials were brought and some of them from distant sources (Hay, 1976; Potts, 1988; Toth, 1982, 1985).

Thus, it is more reasonable to accept, as Potts suggests, that the places where carcasses were carried were already provided with stones to make their processing easy. This is not only positive—less energetic cost and more energetic income (Potts, 1984, 1988)—, but also in the adaptive and trophic aspects, reducing the time that faunal remains are exposed. In this sense the “stone cache” model as well as the “central—place foraging” hypothesis are coincidental. The importation of stones to selected spots before their utilization is one of the most relevant planning traits. Another element that concedes further support to this variation is the differential treatment of lithic raw materials. The most exotic are more fully exploited than the others (Toth, 1982). Some alloctonous cobbles are carried from one site to another. This valoration and the differential treatment of lithic raw material could also be considered as a planning attitude of hominids.

On the other hand, the selection of determined places on the landscape and their production to accomplish several subsistential functions is an act of prevision in itself. As a result of this behavior that anticipates to future subsistential events, we should conclude that this is a new adaptive response concerning the obtainment of resources, different from the one exhibited by apes. It would have essentially consisted of a collective effort in food procurement, the postponement of its consumption and the transport thereof to previously established referential places, where it was probably shared.

#### 4. SITES AND SOCIAL HYPOTHESIS

The production of referential places—later transformed into sites—responds to behavioral reactions made possible by the social interactions that steered the group configuration of hominids. Both models previously exposed and discussed are subsistential hypothesis that can only account for the ecology of hominids, but which lack the reflexive interpretation about the social dynamics that condition it.

In the revision that I made about this issue (Domínguez-Rodrigo, in press(b)), I defended the necessity to approach this kind of consideration from the elaboration of social theoretical models, which could be positively confronted with the subsistential models that are actually discussed. In this sense, the first step—given the proved act of carcass transport—is the establishment of a double-option division. The first option (A) implicates that the whole group of hominids would have collectively participated in such action, and the second one (B) means that only a part of it would have done so. In both instances, the selective criteria that favour such behaviors should be discerned and the type of internal relationship among the individuals of the same group should be discriminated.

Within the first option (A), two alternatives can be conceived: the “in situ” carcass consumption (A1) or the transport thereof to any other place (A2). Concerning the first hypothesis (A1) (Figure 1), it seems to be the logical result if all the individuals of a group had collectively participated in the obtainment of carcasses. It would be coherent from an energetic consideration and from a trophic one—the time of carcass exposure is reduced—. In this case, it could be expected that hominids had carried lithic material with them and carcass processing would have been made on the spot. Interpretive models such as the “marginal scavenger” (Binford, 1981) could be adapted to this social hypothesis. Nevertheless, as I have mentioned above, this behavioral reconstruction is contradicted by the taphonomic analysis of early sites, which have been formed by a reiteration of carcass transport. A behavior that implies the processing of carcasses where they are found does not generate a relevant bone accumulation. The study of the stone artifacts present at sites does not support this option either, as the variety of lithic raw material demonstrates the reincidence in the utilization of such places, which does not occur on natural kill sites.

As Taphonomy clearly indicates that sites were formed by the effect of successive carcass transport, the most plausible options are those that support this fact. From this consideration—and accepting that all the individuals had participated together (A2)—there exist two possibilities: that carcass mobilization had been performed to the nearest safe place (A2a) (Figure 2) or to a previously selected safety spot (A2b). In the first case the situation would be similar to the first hypothesis (A1), as this behavior does not propitiate any bone clustering, because such places would always depend on the point where carcasses were obtained and on the physical features of the landscape (see

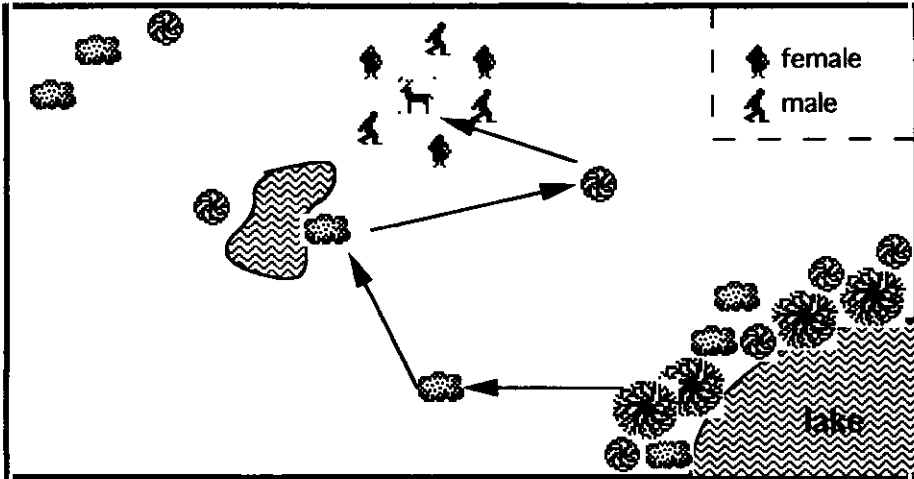


Fig. 1.—Social hypothesis A1. The whole hominid group would have participated in the obtainment of animal resources. Carcass processing would have been made on the spot.

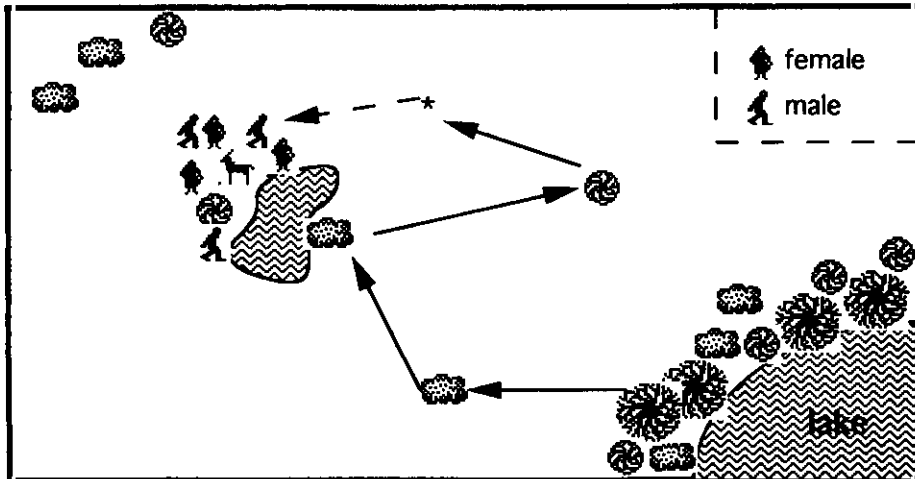


Fig. 2.—Social hypothesis A2a. The whole hominid group would have participated in the obtainment of animal resources. Carcass processing would not have been made on the spot, but on a nearby point.

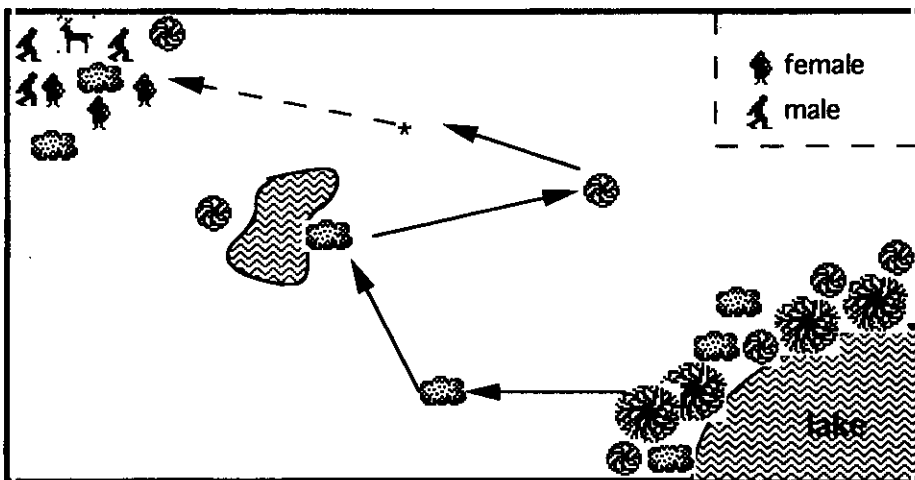


Fig. 3.—Social hypothesis A2b. The whole hominid group would have participated in the obtainment of animal resources. Carcass processing would not have been made on the spot, but on the nearest referential place.

section 2). Redundancy in their occupation would not be very likely. This option would also be contradicted by the analysis of lithic artifacts as it is not positive, in energetic terms, unless hominids had constantly carried stones with them and the raw material had been varied. After moving a carcass to any of these spots, hominids would have searched for stones, delaying therefore its consumption and increasing the risk of competition. This behavior is actually observed in a lot of carnivores, which produce no bone accumulation (Domínguez-Rodrigo, in press(a)).

Thus, as subsistential models indicate, the only valid social hypothesis are those which take into account that sites were formed by systematic transport of carcasses to spots previously selected as referential. If the whole group intervened in this action (A2b)(Figure 3), some contradictions emerge. First, this is the appropriate social option for the "stone cache" model as it would have meant the establishment by hominids of several processing places. However, we have seen that this model is not completely supported by the taphonomic and ecological data (see sections 2 and 3). Furthermore, if scavenging was the strategy used to obtain carcasses, the number of dead animals available in riparian woodland habitats would be very low, making a hunting strategy necessary to account for the relevant amount of bone remains drawn from sites. Nevertheless, if this had been the case, the social hypothesis A2b would be contradicted by the fact that hunting is predominantly a male activity in primates and a participation of a whole group in the obtaining of a prey has never been reported. Females with offspring would not have been able to do so. If they had deambulated with the rest of the group in open-vegetation habitats, the global risk and energetic investment that the group would have had to cope with would have been increased.

For this reason, the hypothesis that maintain that carcass transport was carried out by some members of the group (B) seem more logical. In this case, the hypothesis claiming that carcasses were consumed *in situ* or moved to nearby safe places or to the nearest processing spot —Potts's model— are not valid, for the reasons stated against options A1, A2a and A2b, from which they differ in that only a part of the group had done it. The latter option proposed —only some individuals had moved carcasses to processing places (stone cache model)— could be understood as the females with offspring being unable to deambulate efficiently in open plains or to have been unuseful in any of the stages of the process of carcass obtaining. If the basic primate subsistential patterns had been still maintained, hominids would have thus created a clear ecological differentiation within groups. Individuals that were not in condition to defend themselves in high-risk habitats or to obtain carcasses and lithic raw material sources and to transport both of them to referential places previously created —whose fuction would have strictly been to process carcasses— could not have had access to such food products. Thus, only a fraction of the group would have been collectively engaged in this behavior, whereas the rest of the group —with a negative bias against females— had kept

different subsistential behavior. This means that two different ecological attitudes would have been developed within the same group: one solidarious and the other coordinated. This is not observed in any other living species and does not seem to be logical. Some individuals would eat more meat and others more plants. Such behavior would have produced an internal split with a consequence, from a structural perspective, that results inoperative: the existence of two different ecological niches within the same group. For this reason —the divergence of both sectors of individuals is too wide to keep them living together— and for the implication that this could have on the reproductive behavior —females with offspring (great energetic investors) would have to conform themselves to poorer resources—, this social hypothesis, that fits Potts's model perfectly, further contradicts it.

According to the "central-place foraging" model, site formation was due to the production of referential places where individuals cyclically dispersed and returned with food. As we have pointed out the global participation of a group in a single procurement of a carcass was neither beneficial nor necessary, so it seems logical to think that this task would have been carried out only by some individuals (B). They would have taken it to a referential place where it would have been processed: the simple production of a referential spot means a sectorial participation in food procurement, as a global collective deambulation does not propitiate the formation of such a place. The production of these spots supposes for individuals a compromise to return to them. Thus, there are three possibilities that emerge: the carcass-obtaining group would have been composed of males and females (B1), only of males (B2) or exclusively of females (B3) (Figure 4). This last option can be easily rejected because of the reason mentioned before. Females with offspring are not able to manage without male protection in open plains and young females are always a small part in primate groups. Furthermore, females are not as physically strong as males to cope with predation risks. This is further supported by the fact that hunting is mostly a male activity in apes.

Then, the social hypothesis that could account for site production are two. The option that a mixed group made up of males and females (B1)(Figure 5) had collectively participated in carcass obtainment sets forth an interesting series of questions. One of them would be the number of females involved in such a task. Taking into account that we should eliminate from this group the females with offspring and the immature individuals, only adult females would have been prepared to intervene. An argument that could be used against this option is that among primates —including human hunter-gatherer societies—, females become pregnant as soon as they reach sexual maturity. If the same happened to hominids, then the number of females prepared to take part in that mixed parties would be quite low. Blumenshine (1986) argues that females would have been numerous in this group because the success of the strategy would have depended on the number of individuals that could have

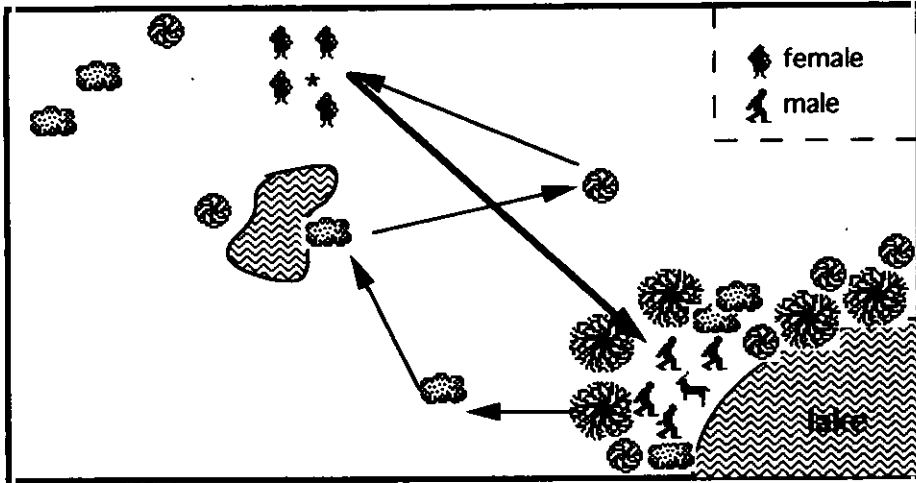


Fig. 4.—Social hypothesis B3. Only a part of the hominid group—composed of females— would have participated in the obtainment of animal resources. Carcass processing would not have been made on the spot, but at the referential place.

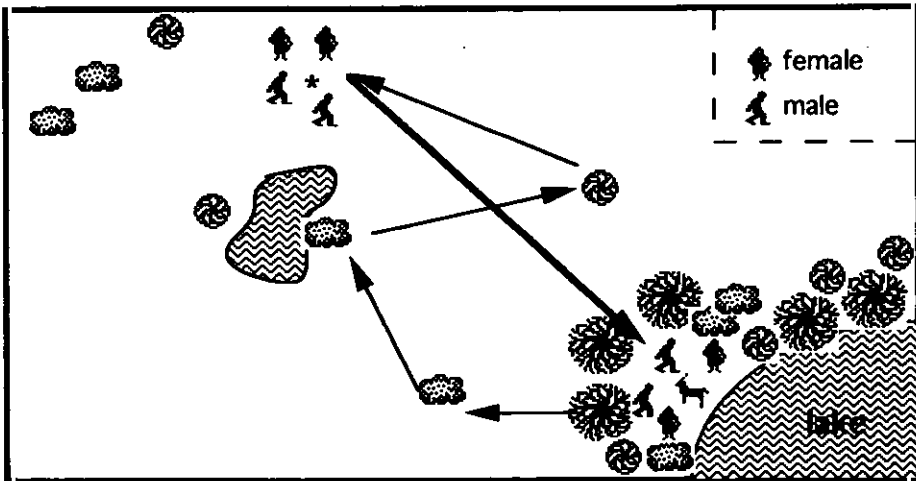


Fig. 5.—Social hypothesis B1. Only a part of the hominid group—composed of males and females— would have participated in the obtainment of animal resources. Carcass processing would not have been made on the spot, but at the referential place.

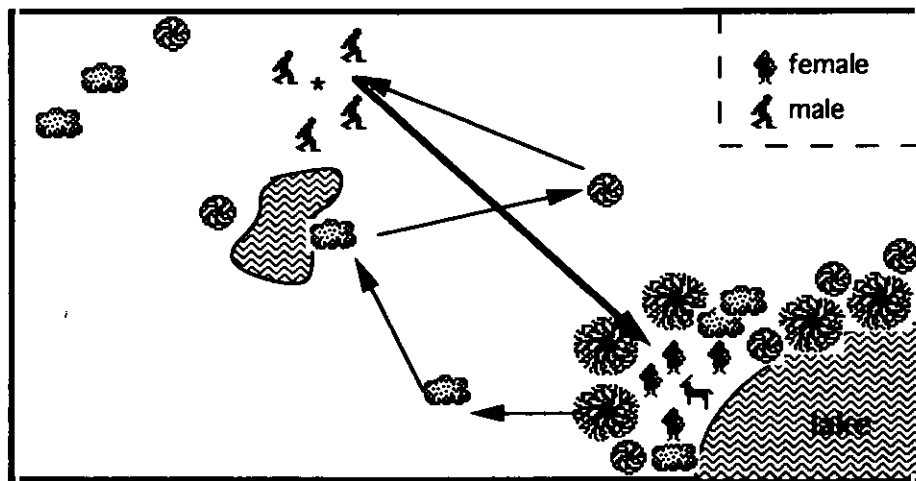


Fig. 6.—Social hypothesis B2. Only a part of the hominid group—composed of males— would have participated in the obtainment of animal resources. Carcass processing would not have been made on the spot, but at the referential place.

participated to defend themselves from predators in case of any aggression. But this statement lacks ethological argument, as after a certain limit has been reached, a quantitative consideration is unimportant because defense effectiveness depends on the intervention of only a determined number of individuals. This is what happens to baboons and apes.

Another argument that could be used against this option is that we are probably overemphasizing a subsistential aspect —meat intake— that probably made up a minor part of the hominid diet. A compared ethnological-ethnological analysis stress that primate diets —human included— are essentially vegetarian. How would this social hypothesis fit into a gathering/foraging strategy? If adult males and females (without offspring) had participated together in carcass obtainment, then most of the group would have dedicated themselves to the least frequent subsistential activity, whereas a more reduced sector of the same group —the least favoured energetically (females with offspring and subadult individuals)— would have taken the responsibility of foraging for the rest of the community. Therefore, it seems logical to think that either only males would have participated in the process of carcass obtainment (B2) (Figure 6), as happens with apes, or the mixed sector had both searched for carcasses and then helped the rest of the group in the other activities. This would mitigate the sexual labour division that stems from the former proposal.

In this sense, I think it is important not to overstress the relevance of meat intake and the preponderant role presumably exercised by males in human evolution.

Although it was important, I think the key role does not lie in a clear sexual labour division (B2) nor in a mixed cooperative one (B1), but in the fact of the establishment of a reciprocal network that is responsible for the increase of cooperation, solidarity and the reinforcement of social ties. Thus, I believe that models focussed on hunting (male-biased) —*Man the Hunter* (Lee & De Vore, 1968)— or on gathering (female-biased) —*Woman the Gatherer* (Dalhberg, 1981)— are misleading, because they do not take completely into consideration the social interaction where both strategies are performed.

Food postponement and its transport to referential places should not be seen as the result of the changes underwent by trophic pressure and adaptive criteria of the environment (see above section 2 and 3 for further discussion), but it seems to be a premeditated act. The production or referential spots and the lithic supplying carried out in them with the import of carcasses are the result of a cooperation that exceeds that observed among the rest of primates. This cooperation would easily have led to labour division. Both subsistential models and social hypothesis suggest that collective participation would have been necessary in the formation of sites and that it should have required communal participation. This does not necessarily mean that early Humans were as we are today, but that the typical human behavior and social organization that underlies it would have first emerged —from a structural consideration— in that time and only a two-million-year evolution would have defined it as it is now.

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