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Dismantling Dung: Delayed Use of Food Resources among Early Holocene Foragers of the Libyan Sahara

Savino di Lernia

Dipartimento di Scienze Storiche, Archeologiche e Antropologiche dell'Antichità, University of Rome "La Sapienza," Via Palestro 63-00185, Rome, Italy

E-mail: dilernia@uniromal.it

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At Uan Afuda, and other Early Holocene sites of the Acacus mountains, in the Libyan Sahara, dung layers and plant accumulation are a major, but repeatedly neglected, feature of hunter-gatherer communities. To understand the formation and meaning of such features, a multidimensional analysis has been undertaken, combining micromorphological, palynological, botanical, archaeozoological, and archaeological data. The hypothesis here formulated is twofold: plant accumulations are evidence of anthropic activity aimed at the storage of fodder; and dung layers are related to a forced penning of a ruminant, very likely Barbary sheep (*Ammotragus lervia*). The exploration of these two features has hinted at the existence of a deep reciprocal relationship, which has been interpreted as the cultural control of wild Barbary sheep, leading to a delayed use of food resources. This behavior may be considered an opportunistic strategy adopted to minimize the effects of lean periods and implicates increasing cultural complexity within Late Acacus Saharan forager societies of the 9th millennium B.P. © 2001 Academic Press

The kitchen of my new guest is excellent and our stomachs were in great need. During the meal, there was a small domesticated gazelle circling the table whining for titbits that was awarded with many delicacies, what it greatly prefers however were the bits of tobacco.

—*H.M. de Mathuisieux*

HUNTER-GATHERER STUDIES AND RESOURCE ACQUISITION

The past two decades of hunter-gatherers studies have been characterized by the debate on the "position" of south African foragers and their relationships with the so-called outside world. The hot debate between *traditionalists* and *revisionists* (e.g., Schrire 1980; Headland and Reid 1989; Wilmsen and Denbow 1990; Lee 1992; Yellen and Brooks 1990), even if tentatively smoothed by some conciliatory contributions (e.g., Kent 1992), appears to focus on the meaning of this label and eventually on the ultimate possibility of anthropology to correctly assess the deep significance of the discipline. Important segments of anthropological and archaeological studies have been powerfully absorbed by this debate, and little room has been left to new data gathered from field research, even when the final goal was to face specific aspects of foraging societies. Prehistoric studies seem to have been particularly affected by this situation and—except for a few, isolated cases—studies of foragers seem to have gone out of fashion in recent archaeological studies. This is particularly true for crucial regions of the planet, such as the African continent, where research on foragers has concentrated since the 1960s, particularly in the Nile Valley and in the Central Sahara (e.g., Wendorf 1968; Mori 1965). In these study areas, the dominant theoretical frameworks had different nuances, according to local specific traditions, but also as a consequence of the different results obtained in the field. Focus was on the intensive, selective, and increasing exploitation of some animal resources

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among Early Holocene hunter-gatherers and namely *Bos primigenius* and *Ammotragus lervia*. The latter was the predominantly hunted large mammal in the central Sahara (Gautier and Van Neer 1977–1982; Gautier 1987a; Corridi 1998) and on the Mediterranean coast as well (e.g., Saxon 1976; Veermersch 1992). Explanations of this kind of resource exploitation significantly varied from attempts at domestication (on the base of inordinate number of bones from the coastal sites: Saxon et al. 1974; Saxon 1976) to the identification of the necessary prerequisite for tentative domestication (Barich 1987a; Close 1992). A similar path was followed by Mori with the case of early remains of domestic cattle found at Uan Muhuggiag, believed to be evidence for a local, autonomous process of domestication (Mori 1965). In the Nile Valley, the hypothesis of a local domestication of *B. primigenius* (e.g., Wendorf et al. 1984, 1989; Close and Wendorf 1992) appears at present quite largely accepted by the scientific community, with some notable exceptions (e.g., Smith 1992; Muzzolini 1993; Clutton-Brock 1993; Gifford Gonzales 1998). In this case, the theoretical scenario is imbued of and sustained by several lines of circumstantial, mostly ecological, evidence.

It is interesting to note as, in both the research areas and within the different explanations, the *real* unexplained theoretical base is Braidwood's (1960) concept of the nuclear zone. For refusing the hypothesis of Barbary sheep domestication and for accepting that of *B. primigenius*, the presence of a local ancestor has been considered discriminating (see, among others, Vermeersch 1992; Smith 1992). The effects of this theoretical premise have been various and not completely understood with regard to the comprehension of food economies among foraging societies of North Africa. In any case, the path toward food production has been judged irrevocable and inevitable: conversely, and as indicated by Lourandos (1988:148), "*the problem of change within hunter-gatherer societies has traditionally received far less attention than the shift from hunting-gathering to agriculture*." In this direction, analysis of attempts at particular forms of resource exploitation of *other*, not domesticable, species (in a strictly "nuclear zone" perspective) received little, if any, attention by scholars of ancient societies. In my view, this situation produced a deep bias in our perception of the mechanisms adopted by hunter-gatherer groups for food acquisition. This phenomenon is fully reflected in the recent literature on some major topics related to hunter-gatherers, such as internal organization, property and rights, and food sharing (e.g., Ingold et al. 1988; Ingold 1992; Kent 1992; Price and Feinman 1995; Bird and Bliege Bird 1997). In hunter-gatherer literature there are clearly problems of definition (e.g., Ingold 1986; Lee 1992), and a much better refined view of the mechanisms of food acquisition is a necessary requisite for a correct allocation of the topic.

This article is based on the firm belief that only accurately facing such mechanisms, without prejudices related to forced paths of explanatory interpretations, may we be able to gather information useful for the reconstruction of food acquisition and related resource use within ancient societies. With this in mind, how should we face the "complex" forms of food acquisition used by foraging groups, if we are not dealing with "domesticable" species? How can we analyze the shifts in food procurement within hunting-gathering societies and yet not encapsulated in a path toward food production? The study of human behavior connected to an advanced, complex management of food resources, being free from the *academic obligation* to identify even

[1] A major element of stress in archaeological and anthropological studies is what may be defined as the "Holy Grail" syndrome, that is, the search for the *First One* (domesticate, fossil, etc.). This dynamic, probably used most to get funding and receive an international audience, led, especially in Africa—a typically nonnuclear zone—to astonishing mistakes or surprising discoveries.

more ancient first domesticates,[1] has great potential, since it permits to better comprehend the innermost mechanisms of these societies. Moreover, this study perspective gives justice, say, to all those *a posteriori* “nonnuclear” regions, where no local process of domestication has been documented, but where it is plausible to hypothesize complex forms of resource management, with relevant implications on the social features of the studied groups. In some ways, it is the emic perspective that must be profoundly reconsidered (but see Ingold 1980, 1986). It is obvious that the attempts toward ever more productive forms of animal and vegetal resource management have been carried out on a wide spectrum of species, with many failures and / or continuous approximation / amelioration(s). I believe that the study of these aspects also, and not only of the contexts related to the regions where such processes had “success” (in a domestication-oriented perspective), provides useful insights in the comprehension of the profound dynamics of foraging societies.

The data here presented deal with evidence of corralled specimens of Barbary sheep among Early Holocene hunter-gatherers of the Libyan Sahara. This kind of food acquisition is strictly related to a planned, delayed use of resources, which holds important ramifications in several segments of social organization, such as the ethic of food sharing and accumulation of a social capital. The article provides analytical evidence for this hypothesis and tries to explore the implications of such a practice, particularly with reference to food storage and increasing cultural complexity (*sensu* Price and Brown 1985) among the Late Acacus groups of the 9th uncalibrated millennium B.P. Thus, the aim of the article is twofold: first, to show theoretical and methodological tools; and second, to explore the anthropological implications of this (original) form of food acquisition.

THE TADRART ACACUS AND SURROUNDINGS: LANDSCAPE, CLIMATE, AND CULTURES

Landscape

The Acacus mountains, in southwestern Libya (central Sahara), are well known thanks to the extensive research of Fabrizio Mori beginning in the 1950s, which essentially focused on its extraordinary rock art, inserting paintings and engravings into a multidisciplinary analysis of prehistoric cultures (Mori 1965). Today the Tadrart Acacus is almost rainless and orographically part of the vast complex of the Tassili-n-Ajjer, and more generally of the impressive morphological discontinuity made up of the so-called central massifs of the Sahara, at around 20°N (Fig. 1). As a whole, this elongated mountain range consists of a monoclinal gently tilted toward Eastnortheast, forming a *cuesta*. The lithology of the Acacus essentially consists of sandstone and clayey schist, of Silurian–Devonian age (e.g., Goudarzi 1970). The massif is delimited to the west by the Wadi Tanezzuft—today punctuated by a few irrigation areas—and to east by the sea sand of the Erg Uan Kasa (Fig. 2). The geomorphological features of the region are extremely diversified from west to east. The massif, in fact, presents an ancient marked hydrographic network, which strongly affected the geological formations, giving place to diversified landscapes. The western slope presents an abrupt interruption of the formations, probably related to an inactive fault, strongly backward and remodeled (Cremaschi 1998). In the western part of the massif there are deep and not particularly large valleys, whereas in the eastern portion of the mountain these incisions tend to expand until they assume the form of real valleys. Moving eastward, the massif progressively merges below Carboniferous and other younger formations which are at the base of the Uan Kasa dune fields. A complex

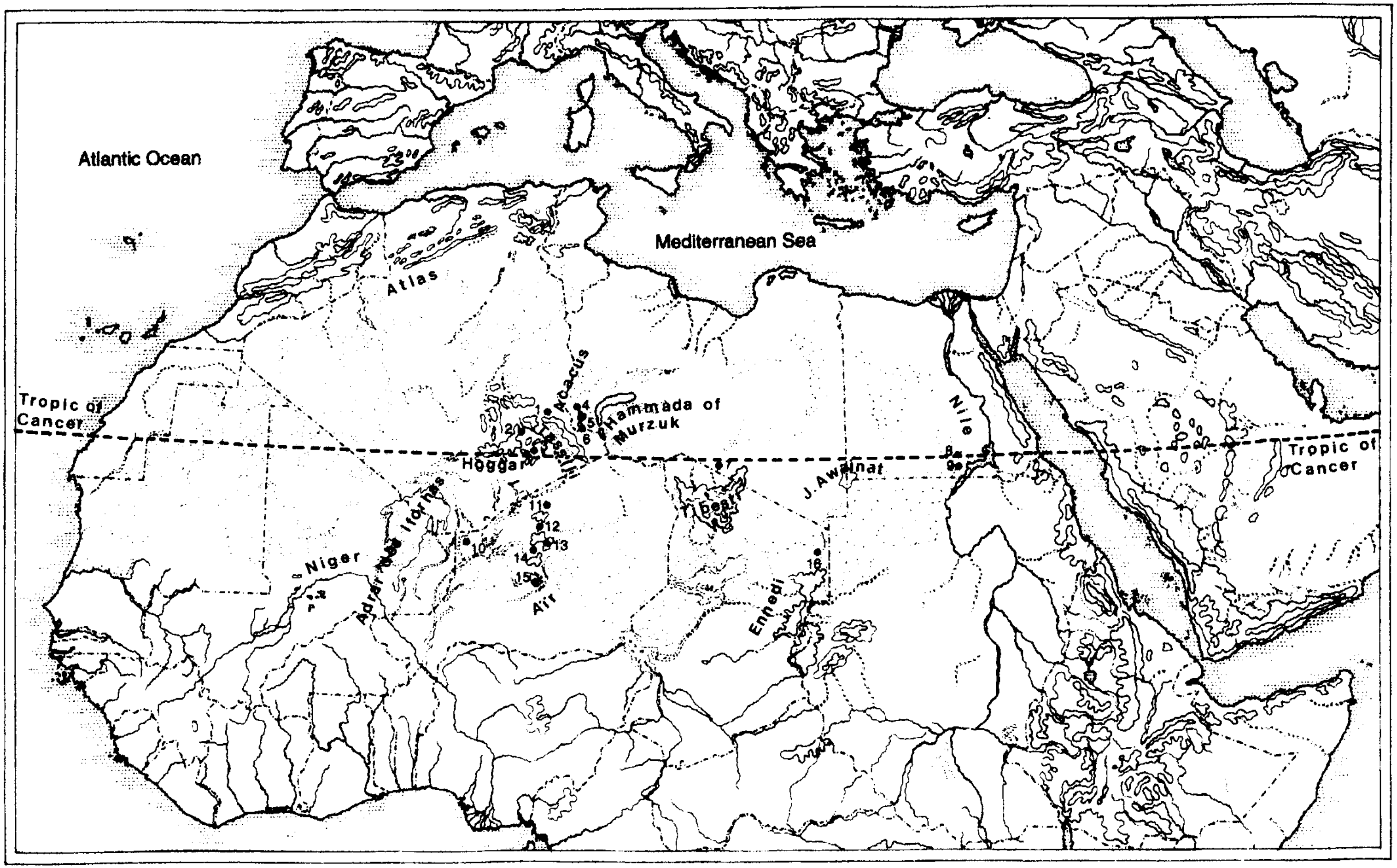

FIG. 1. The Sahara and the central massifs, with location of the main Early Holocene sites. Key: 1, Ti-n-Hanakaten; 2, Launey; 3, Amekni; 4, Ti-n-Torha; 5, Uan Afuda; 6, Uan Tabu; 7, Enneri Yebbigue; 8, Bir Kiseiba; 9, Nabta Playa; 10, Tamaya Mellet; 11, Adrar Bous III; 12, Adrar Bous 10; 13, Tin Ouffadene; 14, Temet; 15, Tagalagal; 16, Great Wanyanga.

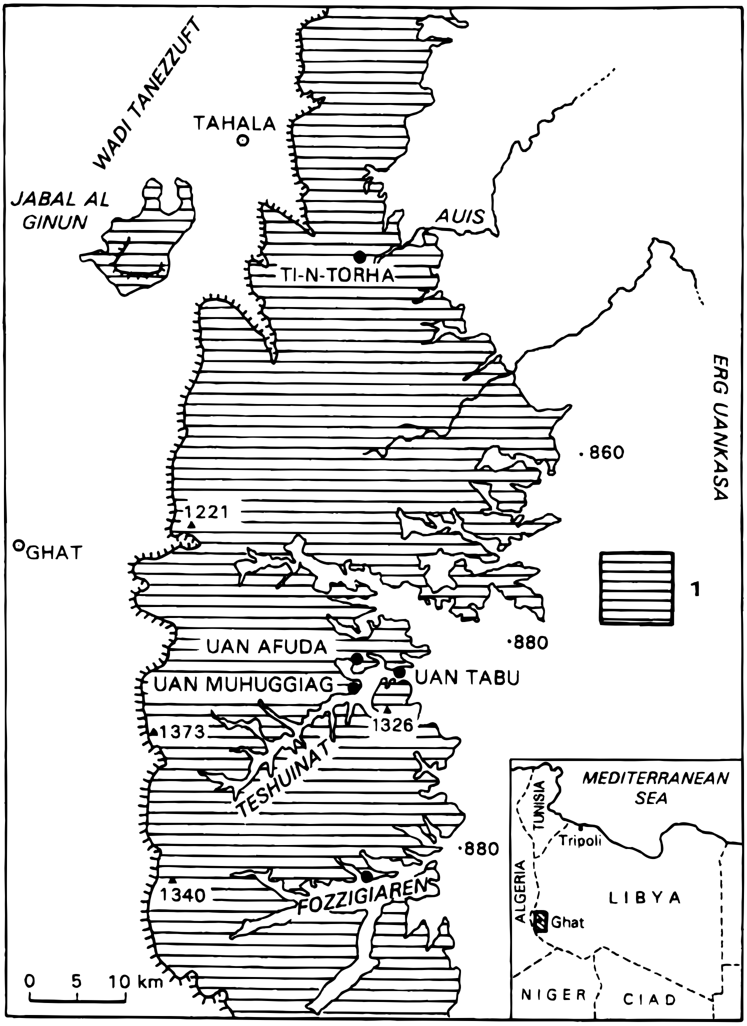

FIG. 2. The massif of the Acacus, with location of the main sites discussed in the text.

sequence of flatirons and alluvial fans connects the mountain fringe to the alluvial plain of Wadi Tanezzuft. Its elevations follow this trend and sensibly decrease eastward, creating microclimatic niches that also affected biological aspects of the region. Generally, marked environmental differences in medium-sized territories provide for an interesting biodiversity, which could have favored different adaptation strategies. This nature could have had immediate effects on settlement dynamics, on resource procurement, and on specific technological repertoires. I believe that this situation as a whole influenced local adaptations, creating specific local cultural traditions. It does not seem by chance that this area has been almost continuously frequented during the Holocene, even during the more unfavorable climatic phases. The concept of "refuge area," referred to often in the past (e.g., Clark 1980), may therefore have its validity. However, it was generally related to discontinuous dynamics—real population pulsation related to climatic fluctuations.

The surrounding lowlands consist of dune sand seas, such as the Erg Uan Kasa to the east, and of fluvial valleys, the Wadi Tanezzuft, to the west. They show different features in terms of ecological settings, geomorphological potentiality, and site visibility (Cremaschi and di Lernia 1998). Lacustrine deposits—the remains of shallow lakes and ponds punctuating the ancient landscape—are located at the western margin of the erg and inside the dune corridors of the Uan Kasa and Edeyen of Murzuq. Today, the vegetation is very scarce, and only rarely scattered trees of Acacia and shrubs of *Tamarix* are present, sometimes with isolated plants of *Aristida pungens*.

Holocene Climatic Fluctuations

During the Early and Mid-Holocene, the African climate changed on both 10- and 100-year scale intervals (Grove 1993). On a global scale, the greatest quantity of rainfall between the tropics is recorded between the end of the Pleistocene and the beginning of the Holocene, to never have been equaled again. Presently, the causes of these variations are not completely clear: orbital movements and other processes, such as the temperature of the sea surface, patterns of oceanic circulation, but also volcanic phenomena, may have produced world-scale changes (e.g., Grove 1993; but see also Hassan 1997). Variations in the earth's axis affected solar radiation, which was much stronger in the Northern Hemisphere during the summer and much weaker during the winter. As a consequence, monsoons were more accentuated and brought much more rain during the summer, especially to the north of Africa (Grove 1993; Hassan 1997).

Palaeoclimatic studies indicate a long arid phase between (at least) 30 and 12 ky B.P. in the Sahara (e.g., Maley 1981; Petit-Maire 1993; Hassan 1997). The end of the post-Aterian arid phase was probably a gradual but discontinuous process rather than a dramatic event. Today instead scholars tend to stress the significance of abrupt events in the shaping of cultural trajectories, especially in marginal environments, but the local record is still sufficient (e.g., Hassan 1997; Gasse and Van Campo 1994). Evidence from Lake Chad indicates that climatic changes occurred from 17 ky B.P. (Roset 1987). Intensification seems to have taken place after 14.5 ky B.P.: In the Tibesti area, Maley (1981) identifies a high lake level at ca. 14 ky B.P.; the level also rises in the Jebel Marra (Williams et al.1980) and in the Niger delta area (Pastouret et al. 1978). After 12–10 ky B.P., a series of wet and arid fluctuations characterized the Holocene, with varying intensity and duration, according to their geographic location (e.g., Petit-Maire 1993; Hassan 1997; Cremaschi 1998).

Recent multidisciplinary research performed in the Acacus mountains (Cremaschi 1998; Cremaschi and di Lernia 1996, 1998) has provided proxy data confirming a slow process of climatic change during the transition from Late Pleistocene to Holocene. The first well-dated indication refers to Late Pleistocene fossil dunes in the stratigraphic sequence of Uan Afuda (di Lernia 1999) and Uan Tabu (Garcea 1998). This formation indicates desert conditions at around 90–60 ka (Cremaschi et al. 1998), and according to the geologist (Cremaschi 1998) may be correlated to the red sand unearthed at the base of Ti-n-Torha sequence (Barich 1987b) and to the sand located at the base of Ti-n-Hanakaten series (Aumassip 1984). These fossil dunes should be interpreted as the effect of desert and/or semiarid conditions in the Saharan Mountains already in the early Late Pleistocene.

A wet period began at the end of the Pleistocene and lasted up to the beginning of the Holocene. This amelioration is indicated by soil weathering at Uan Afuda that already took place at 9765 years B.P., and by fluvial aggradation in the Teshuinat area before 7300 years B.P. (Cremaschi 1998). More evidence is provided by travertine sedimentation in the Acacus: It implies high precipitation that favored the recharge of the hydrographic network within the mountain range (Carrara et al. 1998). According to U/Th determinations, run on several travertine samples collected in the mountain range, this sedimentation is firmly dated between 15.6 ± 1.2 and 9.7 ± 0.2 calendar ky (Cremaschi 1998). The existence of small fresh water lakes, ponds, and swamps located inside the Edeyen of Murzuq and the Erg Uan Kasa are indications for wet conditions in the Early Holocene. Useless to say, their formation appears to be in any case a direct consequence of increased rainfall.

The systematic presence of Early Acacus sites in the lower part of interdunal corridors, where the lakes formed, often buried by peat deposits, is a clue of the rising of the lakes during the Early Holocene. On the base of ^{14}C determinations, this occurred before 8445 years B.P. (Cremaschi and di Lernia 1996; Cremaschi 1998). Unfortunately, there is no reliable chronological evidence at present to understand how long the high stand lasted. The Early Holocene wet phase, however, steadily declined, up to the middle of the 9th millennium B.P. An important interruption of lake sedimentation between 8000 and 7500 years B.P. has been hypothesized on the basis of the stratigraphic evidence, but is still poorly documented by the available radiocarbon dates (Cremaschi 1998; Cremaschi and di Lernia 1998). As a matter of fact, we can identify a stratigraphic gap on the basis of the cave fills located in the Acacus range, roughly radiocarbon dated between 8000 and 7500 years B.P. This gap may tentatively be related to an erosion phase caused by dry environmental conditions, but no direct evidence for this interpretation yet exists (Cremaschi 1998). Nevertheless, regional comparisons indicate sand intrusions clearly due to dry conditions at Ti-n-Hanakaten, roughly occurred in the same period, i.e., between 8100 and 7200 years B.P. (Aumassip 1984).

Wet conditions started again in the second half of the 8th millennium B.P., approximately in concomitance with the emergence of the Pastoral culture, as also indicated by the lacustrine formations in the surroundings of the Acacus (Cremaschi and di Lernia 1996, 1998), by the deposits in shelters of the mountain range (e.g., Barich 1987c; Lupacciolu 1992; Cremaschi 1998; Cremaschi and di Lernia 1998) as well as by palynological, archaeozoological, and geological evidence (Mercuri et al. 1998; Corridi 1998; Cremaschi 1998). As far as the dune fields are concerned, some evidence has been collected in the Erg Uan Kasa, where at ca. 7300 years B.P. lakes probably were low, but rise to their probable maximum level at ca. 6600 years B.P. Pastoral sites located along the lake shores, dated from 5660 years B.P., and the presence of pastoral artifacts material on lacustrine and swamp deposits indicate that the lakes still existed at that time, but probably were declining and later turned into sebkhas.

An abrupt, dry spell is suggested by a gap in ^{14}C chronology, located in the second half of the 7th millennium between 6400 and 6100 years B.P. As suggested elsewhere (Cremaschi and di Lernia 1998; di Lernia in press), this void may be related to a drop in the human occupation. It is tempting to relate this "depopulation"—probably related to inadequate climatic conditions—to the dispersal of cattle keepers out of central Sahara (di Lernia in press), as several elements in the material culture from some sites of the Nile Valley (Caneva 1996) and sub-Saharan regions (Paris 1997) indicate.

Intrusion of aeolian sand, erosion surfaces, and thermoclastic collapses point to the onset of severe dry conditions from 5000 years B.P. This date may be considered the beginning of desert conditions—today still increasing—to which human groups had to adapt.

Early Holocene Occupation: Early Acacus Hunters vs Late Acacus Foragers

Historical and cultural reconstruction of the human occupation during the Holocene underwent significant changes in the past decade. The reprise and enlargement of several excavations, the full use of a multidisciplinary approach, a large data set of radiocarbon determination, but, much more importantly, the extensive survey on a regional scale provided new data for the comprehension of the cultural trajectories in the region (Cremaschi and di Lernia 1998). Moreover, I stress that "continuistic" theoretical paradigms, typical of the 1980s for the region, have been slowly replaced by a punctuated model (di Lernia in press), which aims to better define the instability and multidirectionality of cultural trajectories (but see Gould 1977).

Simplifying, the advances made can be summarized as follows: (1) the backdate of the Aterian technocomplex (up to the 90- to 60-kya interval) and the identification of an impressive hiatus in human occupation until the beginning of the Early Holocene: as a consequence, all artistic production has been subsequently collocated in the Holocene; (2) the fragmentation in two cultural *facies* or phases (Early and Late Acacus hunter-gatherers) of the formerly undifferentiated "prepastoral" or "ceramic Epipalaeolithic" Early Holocene phase; and (3) a much more articulated definition of the Pastoral phase, which leads to the identification of three *facies* (Early, Middle, and Late Pastoral), each of them characterized by a different settlement pattern, economic basis, material culture, and funerary practices: Rock art appears to also follow a similar evolution.

For reasons of space, I here summarize only the most recent data concerning the Early Holocene hunter-gatherers, which are relevant for the issue herein discussed.

The first inhabitants of the Acacus and surroundings at the very beginning of the Holocene were Early Acacus hunter-gatherers: the climate was wetter and cooler than that of the present day (Cremaschi 1998; Mercuri 1999), with an environment able to support an important biomasse. These groups are characterized by a subsistence economy based especially on *A. lervia* hunting, together with a few other mammals and fish (Corridi 1998). The gathering of plants and tubers completes the rather narrow spectrum of exploited resources. The sites are diffuse both in the mountains and in the sand seas: The most significant concentrations are in the central Acacus, the Erg Uan Kasa, and the northern fringes of the Edeyen of Murzuq. A hierarchical site system has been recently hypothesized based on site features (location, size, and phases of occupations), lithic industry properties (weight, functional analysis, technology, and raw material use), and land use (Fig. 3). The framework consists of a few main camps, located mostly in the mountains, which were occupied (almost) on a biseasonal basis, probably after the rainy seasons: Uan Afuda Cave is the most well-known site belonging to this category. Other sites punctuated the lowlands at which different types of activities were performed. They vary from hunting/killing encampments, areas for procurement and processing of raw materials, and small transient camps, to larger sites, probably some types of aggregation areas during the rainy seasons. Lithic industry consists of small blades and bladelets, struck from good-quality raw material, such as silcrete, flint, and quartzite. Diagnostic types are the straight-backed pointed bladelets, as well as hypermicrolithic geometrics. Grinding equipment is rarely present, with significant differences between the principal, mountain sites (well represented are handstones and grinding stones) and the locations in the lowlands (a few attested cases, mainly mortars). No firm trace of ceramic technology has been found so far. The radiocarbon dates available for this cultural phase represent an interval

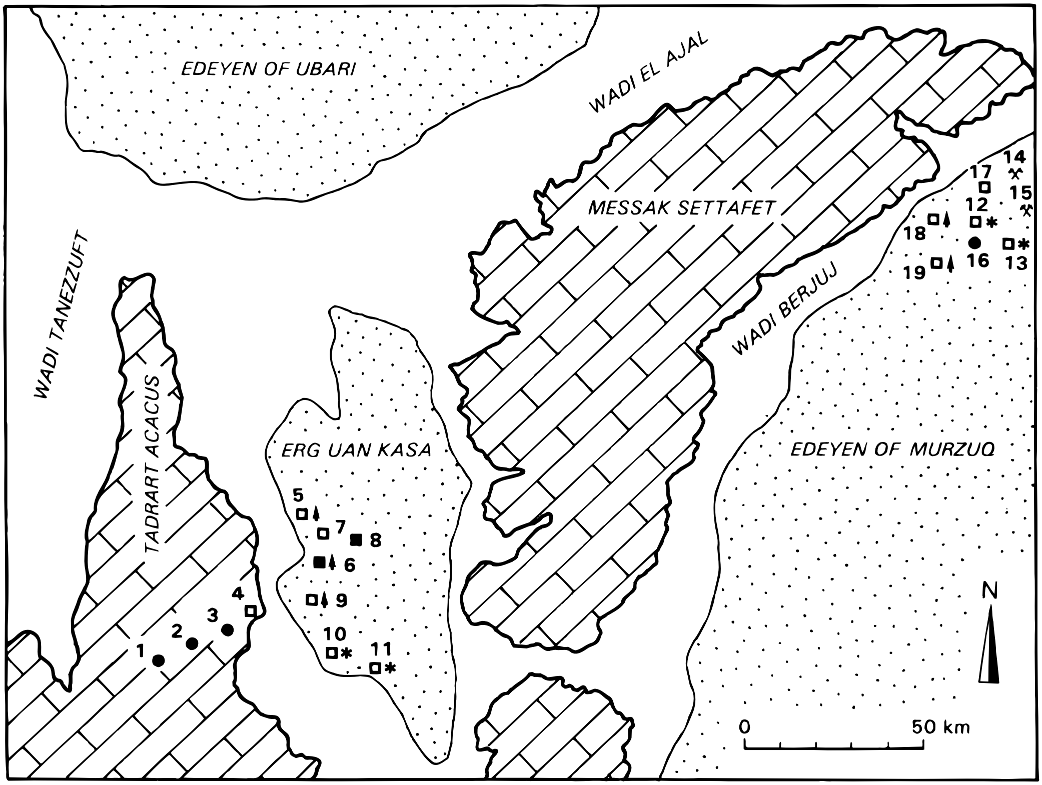

FIG. 3. Schematical representation of the *Early Acacus* settlement pattern. Key: (●) base camp; (□) transient camp; (■) processing site; (*) workshop; (⚒) quarry; (▲)hunting site; 1, Uan Afuda; 2, Uan Tabu; 3, Lancusi; 4, MS; 5, 94/38; 6, 94/102; 7, 94/66; 8, 94/65; 9, 94/96; 10, 94/83; 11, 94/84; 12, 94/4; 13, 94/8; 14, 94/10; 15, 94/12; 16, MT126; 17, MT135; 18, MT145a; 19, MT145b.

covering all the 10th millennium B.P. (from ca. 9800 up to 8900 years ago). It must be stated that the "contemporaneous" presence of sites in the region is supported not only by radiocarbon dates and similarity in the material culture, but, more importantly, also by the stratigraphic setting. In fact, the mountains sites belonging to the Early Acacus phase are systematically connected to the top horizons of the Pleistocene bioturbated red sand and in stratigraphic nonconformity with the organic sand typical of the Late Acacus horizon (di Lernia 1996; Cremaschi 1998; Cremaschi and di Lernia 1995, 1998). This is a major advance in understanding the evolution of the so-called prepastoral phase, which was in the past believed to be a stratigraphic, and then cultural, continuum (Barich 1984). Similarly, in the lowlands, dozens of clusters of artifacts have been found laying on basal bleached sand, systematically buried by organic deposits, whose radiocarbon determination vary from ca. 8900 to 8500 years before present (Cremaschi and di Lernia 1998). Thus, this interval must be considered a *terminus ante quem* for the Early Acacus occupation, which has to be placed, at least, in the 10th millennium B.P., in accordance to what has been recorded also in the mountain regions. Rock engravings of the so-called "Large Wild Fauna" have been intermittently and with different explanatory basis related to these hunter-gatherers. Actually, Fabrizio Mori proposed even a Late Pleistocene attribution for these works (Mori 1965), but recent research, as discussed above, excluded such a possibility, suggesting an attribution to the very Early Holocene and more precisely to the hunters of the Early Acacus (di Lernia 1997; Cremaschi and di Lernia 1998). Barbara Barich already proposed a rather similar attribution for the "Large Wild Fauna" engravings, both on archaeological inference and ideological meaning of the represented subjects (Barich 1987c:115).

The subsequent, recently identified, cultural phase—called Late Acacus—shows an important modification in the settlement system, economic basis, and material culture (di Lernia 1996). The increasing aridity of the 9th millennium B.P. probably forced people to exploit more intensively the mountain ranges and, with some exceptions, to progressively abandon the lowlands. The formation processes of archaeological deposits surely constitute a major feature of Late Acacus sites. These show decimetric-thick layers of plant remains, often with scattered coprolites in the deposits, alternating with thin ash layers (Cremaschi and di Lernia 1995; di Lernia 1996; Cremaschi et al. 1996). It is really surprising that such little attention has been paid to this feature, which instead provides important information with regard to the social and economic organization of ancient groups that settled there. The research presented here is based solely upon the massive accumulation of plants and dung. It is possible that our attention was captured by a sort of emotional *astonishment*, as often happens in scientific research (Gould 1977), when our efforts were turned toward the explanation of this specific trait of Late Acacus groups. The material culture of the Late Acacus is also characterized by the emergence of pottery. According to stratigraphic contexts excavated so far, in fact, ceramic containers enter the archaeological record systematically after ca. 8900 years B.P. (di Lernia 1996, for a comment). It is mostly decorated by comb impressions, with typical decorative motifs, such as zigzags and dotted wavy lines. The most significant sites of this phase are Uan Afuda, Uan Tabu, Ti-n-Torha, Fozzigiaren, and Uan Muhuggiag-Wadi, but Late Acacus sites are widespread in the Wadi Teshuinat, Wadi Sennadar, and Wadi Afozzigiar, all within the mountain range (Cremaschi and di Lernia 1998). The economic strategies are mainly based on hunting of Barbary sheep, together with other small and medium-sized mammals, fish, and birds (Gautier and Van Neer 1977–1982; Gautier 1987a; Corridi 1998). A dramatic shift occurs in plant exploitation, testified by an intensive and specialised use of wild cereals, mostly *Urochlea* and *Brachiaria* (Wasylikowa 1992; Castelletti et al. 1999; Mercuri 1999). The processing of cereal seeds led to a sensational increase of grinding equipment and to the development of a dedicated macrolithic industry, struck form silicified sandstone. Sites of this phase are rare in the lowlands of the surrounding sand seas, suggesting the progressive, but never total, abandonment of those regions (Cremaschi and di Lernia 1996, 1998). The sites in the mountain range appear more numerous and larger, defining also an increasing density in the innermost region of the massif (di Lernia 1997; Cremaschi and di Lernia 1998). In this case as well, tentative relationships between rock art and archaeological contexts have been claimed. Differently from the previous phase, there is a greater consensus among scholars for the attribution of the paintings of the "Round Heads" phase to Late Acacus groups, even if with different terminological nuances (prepastoral groups: Mori 1965, 1998; Mesolithic or Late Acacus phase: Sansoni 1998; di Lernia 1996).

The Uan Afuda cave (Fig. 4), excavated in 1993 and 1994, provides articulated data to assess the question of internal change among hunter-gatherers of the Early Holocene. This was the first site in the Libyan Sahara where the two-phase differentiation of the prepastoral period was recognized (Cremaschi and

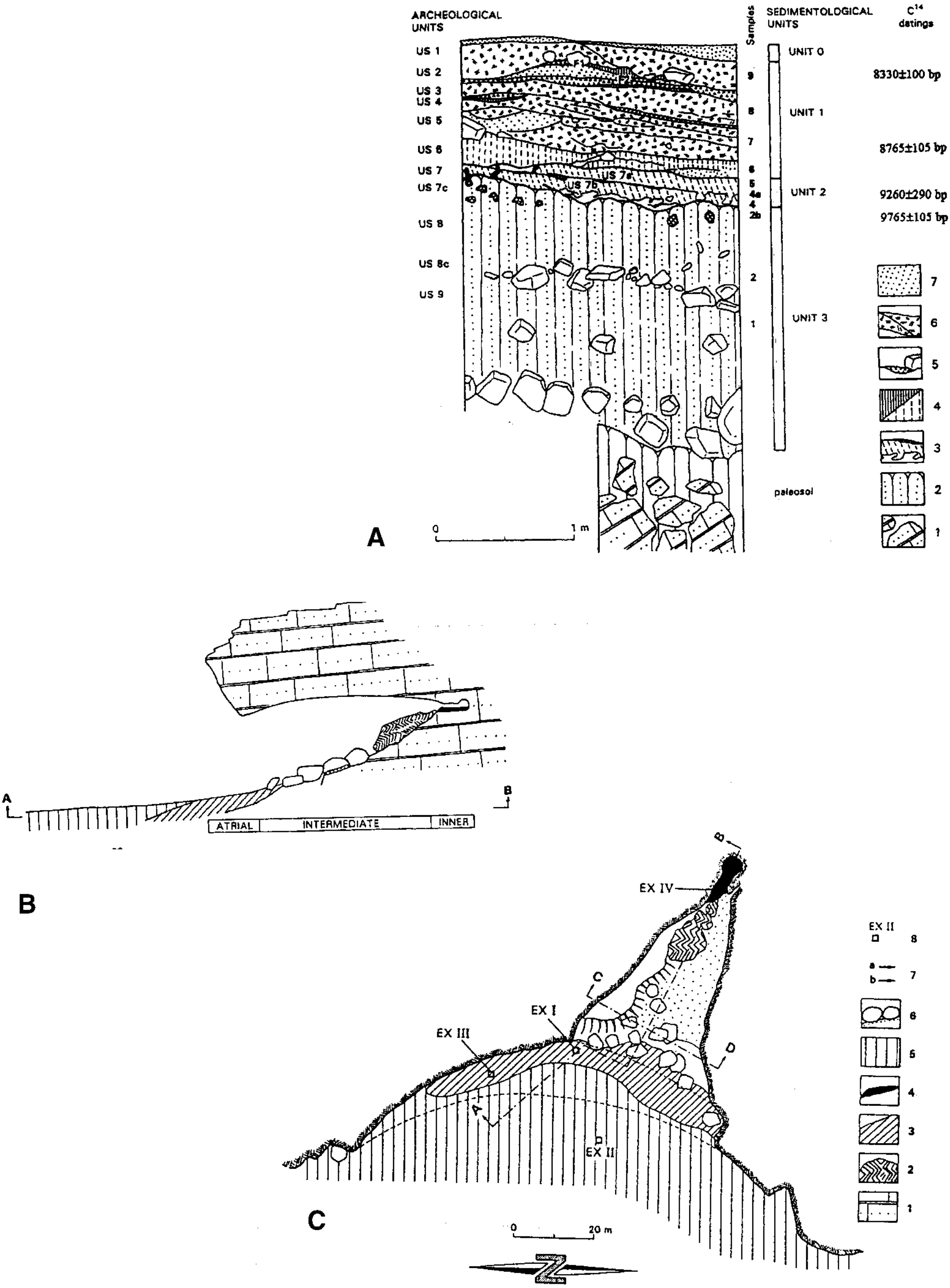

FIG. 4. Planimetry, profile, and stratigraphic sequence of the Uan Afuda Cave (central Acacus). Key: [a (planimetry)]—1, Sandstone; 2, blocks of iron oxides; 3, archaeological deposits; 4, archaeological deposits rich in dung; 5, wadi sediments; 6, collapsed blocks and loose aeolian sand; 7, location of the paintings (a) and of the grooves (b); 8, location of the excavations; 9, location of the profiles; [b (general profile); and c (stratigraphic section)]—1, collapsed blocks with gypsum concretions; 2, Unit 3 aeolian sand weathered at the top, including bioturbation pedotubules; 3, Unit 2 colluvial sand including gypsum concretions; 4, Unit 1 loose sand rich in charcoal and organic matter; 5, Unit 1, ash lenses and stone of hearth; 6, Unit 1 lenses of undecomposed plant remains; 7, Unit 0, top aeolian loose sand.

di Lernia 1995). Furthermore, thanks to the geomorphological nature of the site, the deposit is well preserved, except for its top, removed by wind erosion, and a large amount of information was collected, forming the necessary data set for a correct allocation of the matter. The Late Acacus phase here at Uan Afuda is represented in the upper part of the stratigraphy (with radiocarbon dates spanning from 8935 ± 100 (GX-20754) to 8330 ± 100 (GX-20346) years B.P.) and in the inner area of the cave, where an 8000 ± 100 years old pack of dung was discovered (GX 18104). The presence of dung, together with the accumulation of plants, led to the questioning of the different kinds of activity that could be hypothesized in a food-extractive group, long before the emergence of a pastoral, food-producing economy.

EARLY HOLOCENE DUNG AT UAN AFUDA CAVE: PUZZLING EVIDENCE

Fodder, dung, and other features related to animal management by human groups in the past are a central but neglected topic in the literature (e.g., Chang and Koster 1986; Brochier et al. 1992; Charles 1998; Charles et al. 1998; di Lernia 1998a). Usually, such forms of evidence have been interpreted as additional elements for the identification of herding practices among fully food-producing groups. In this sense, the discovery of stratified dung in the inner parts of the Uan Afuda cave, as well as scattered lumps of dung and coprolites in some Early Holocene sites of the Acacus mountains, such as Uan Afuda, Uan Tabu, and Fozzigiaren, raises original and exciting questions for archaeologists. What animal is the dung maker? Are these remains product of animals managed by food-extractive groups? And what are the implications of such activity? Are there any relationships between wild animal management and the emergence of food production?

The dung discovered at Uan Afuda is located in the inner part of the cave (Fig. 5a), and radiocarbon dated to 8000 ± 100 years B.P. (GX 18104). The extension of this feature interests some 10 m in length and from 2 to 4 m in depth of the much internal area of the cave. The stratum is ca. 40 cm thick and appears as an undifferentiated pile of strongly bioturbated dung (Fig. 5b), including uncharred plants, charcoals, and few other materials: charcoals, lithics, and faunal remains. The absence of true layers inside this pack may be interpreted as evidence for continuous accumulation rather than strong, contrasted, seasonal-based frequentation (Brochier et al. 1992), as evident in other, younger Pastoral dung accumulations of the Acacus (Cremaschi et al. 1996). The strong bioturbation prevents also a morphological analysis of faecal droppings, which were completely obliterated by insect activity: this led to the attempt to perform micromorphological analysis of thin sections, in order to catch information otherwise lost. Moreover, the contextual presence of different indicators (dung, uncharred plants, charcoals, lithics, etc.) hinted at some anthropic activity to be explored in detail. This feature is quite unusual in the region: although we surveyed hundreds of shelters in the Acacus, and populations of wild, free-ranging animals (gazelle and Barbary sheep) are still present in the area, never have we encountered such a situation, only uneven shelters with few droppings and a coated film of fecal remains: it was clear as this spectacular evidence had to be considered a relic of past behavior.

Actually, lumps of dung and coprolites were also found in Layers 1 and 2 of the excavation located at the entrance of the cave, where the dwelling structures of the ancient village were located (Fig. 6). Carbon-14 datings of these layers, and thus the indirect dating of the dung found, span from ca. 8300 to 8500 years BP [(dates: 8330 ± 100 (GX 20346); 8555 ± 110 (GX 20753)]. Important modifications in site organization, formation process, material culture, and

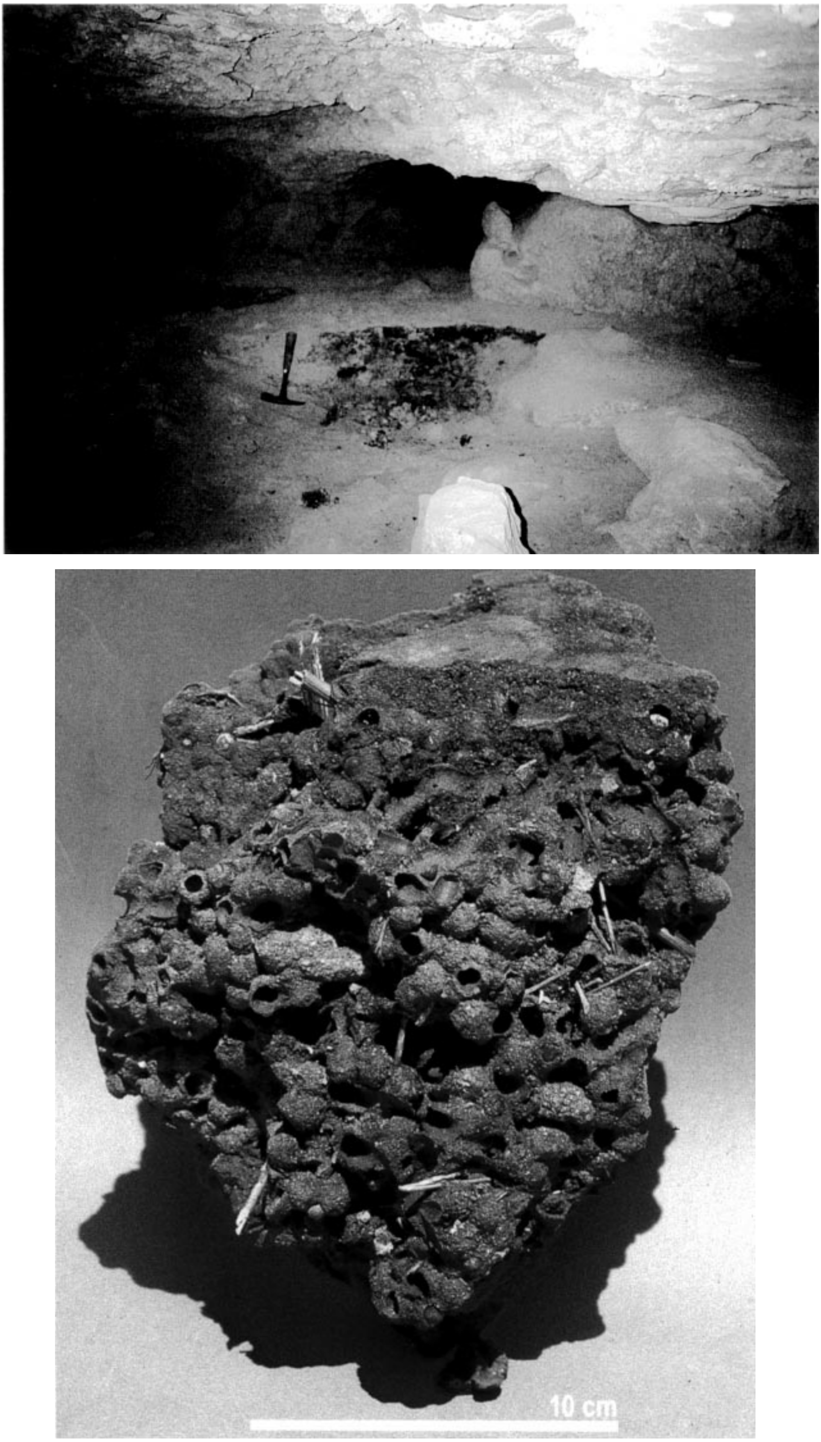

FIG. 5. The dung of Uan Afuda: (a) the accumulation in the internal part of the cave (Excavation IV); (b) sample of dung excavated in the front part of the dung accumulation which was subjected to laboratory analysis.

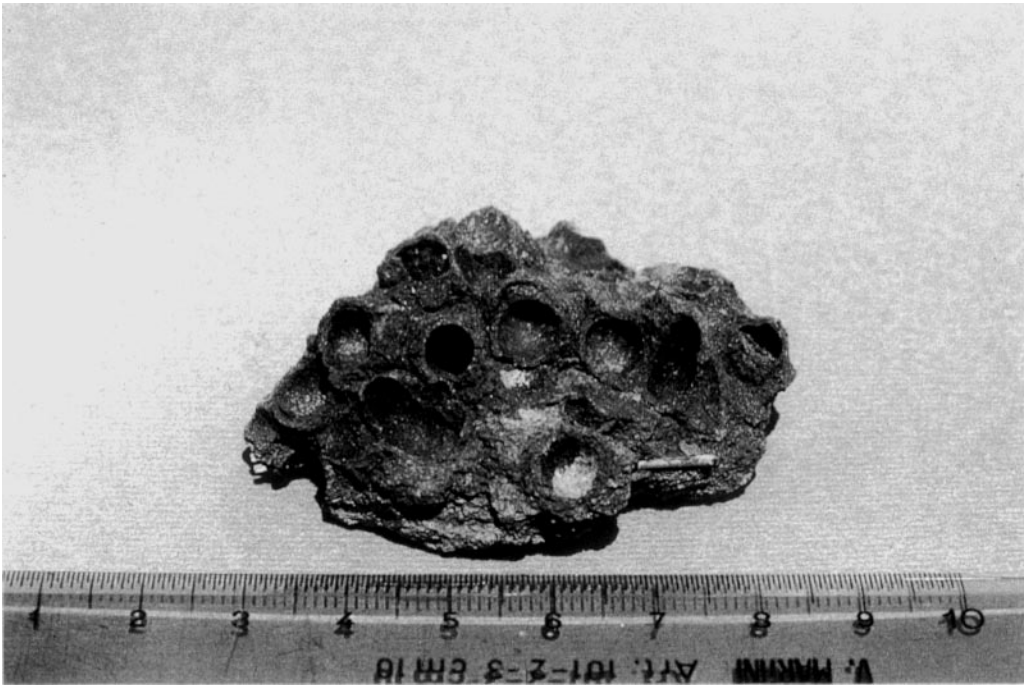

FIG. 6. Lump of dung collected in the Layer 1, Excavation I.

environmental context are evident in the upper part of the stratigraphic sequence. Samples of dung were the object of multidimensional analyses (Cremaschi and Trombino 1999; Castelletti et al. 1999; Mercuri 1999; as last of a series, di Lernia 1999). These analyses first faced the problem of coprolite identification in order to identify the dung maker. Having done this, and compared the results with the archaeozoological data (Corridi 1998), it was necessary to study the features and nature of the dung and plant accumulation in order to understand if and how these remains had to be considered as intentional product of human activities or rather as a disconnected documentation related to free-ranging animals.

Basis of the Data

(Micro-)morphology of coprolites and other dung-related features. Coprolites and spherulites were found in both the atrial sequence as well as in the dung layers in the inner part of cave. Oxalate druses and oxalate prismatic crystals are other crystalline bodies identified in the soil samples (Cremaschi and Trombino 1999). These crystals can be considered mineral constituents of biological origin and can be found in plant leaves (Canti 1998). The morphology of the coprolites indicates an ovicaprine ruminant. For comparisons, droppings of living specimens of Barbary sheep were collected in the high ranges of the Acacus and from the Estación Experimental de Zonas Aridas (Almeria, Spain), where a captive population of this animal has been imported since the 1970s (Cassinello 1998). Macroscopically, the recent samples (Fig. 7) look quite similar to the fragmentary coprolites observed in the thin-section samples at Uan Afuda, especially in the specimens excavated at Fozzigiaren from the dwelling area (Fig. 8). Interestingly, they also show a similar variability in morphology and size as that found in the

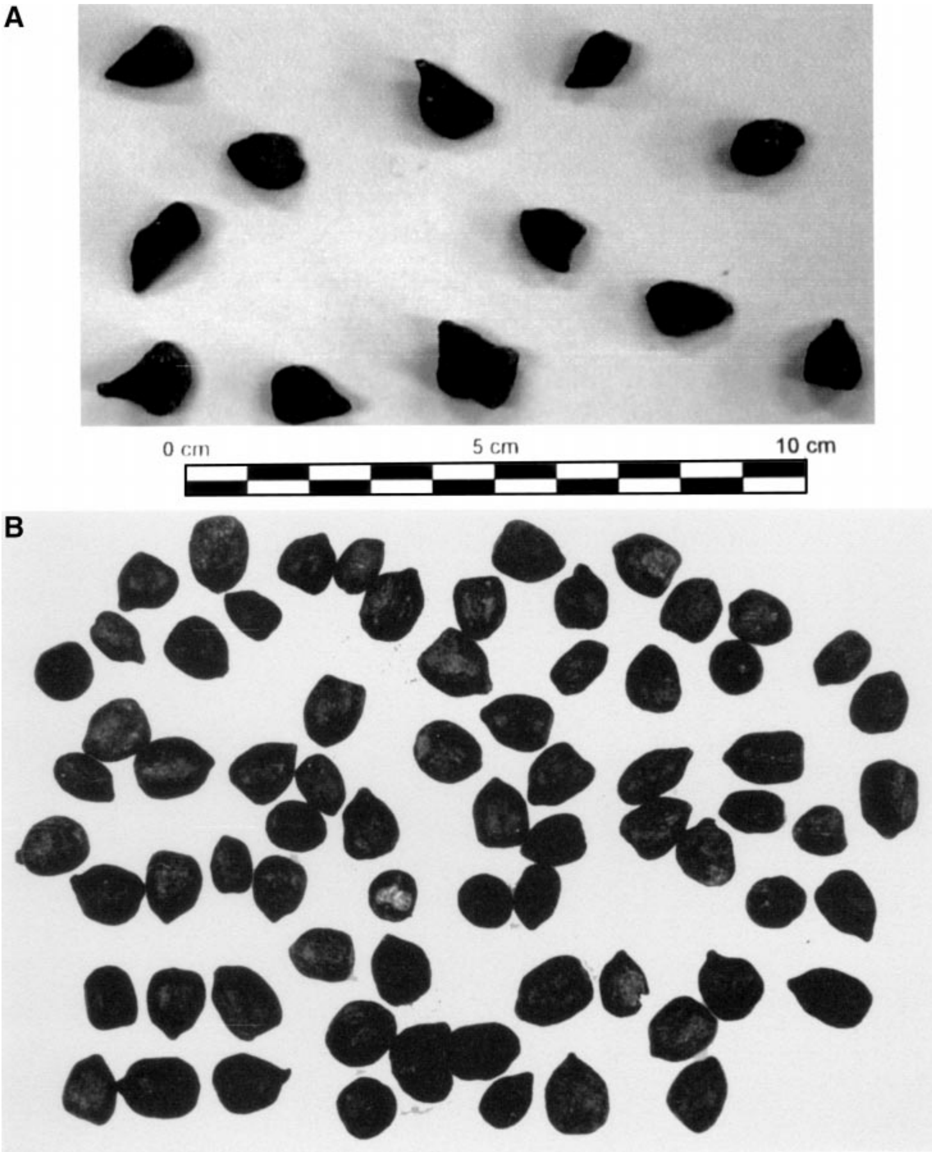

FIG. 7. Recent droppings of Barbary sheep: (a) specimens of animals in captivity from Almeria, Spain (courtesy of Jorge Cassinello, CSIA); (b) scattered droppings from the high ranges of the Acacus mountains.

ancient samples. It is true that also domestic sheep and goats share a quite similar morphology. Consequently, in the ancient samples the coprolite content, and not only its morphology, has been analyzed. On these bases, two types of coprolite fragments have been determined. The fragments of coprolites dispersed in the dung mass of Excavation IV appear rich in vegetal fibers and contain spherulites with oxalate crystals. The fragments of coprolites found in the atrial part of the cave, from both Unit 1 (Late Acacus) and Unit 2 (Early Acacus) are characterized by a dense amorphous fine organic ma-

FIG. 8. Droppings attributed to Barbary sheep coming from the site of Fozzigiaren, radiocarbon dated between 8300 and 8550 years B.P.

terial. Furthermore, vegetal fragments and fecal spherulites are particularly rare, and oxalate crystals are always present. Taking into account such differences between the atrial (Excavation I) and inner (Excavation IV) parts of the cave, a further difference is evident within the sequence of the former. In Unit 2, associated with the Early Acacus occupation, coprolite fragments are rare but frequent, and the content in fecal spherulites and plant fragments is very low. Unfortunately, only a few coprolites of the Late Acacus occupation were intercepted in thin-section samples. This was due to the difficulty of sampling loose sediment, such as Layers 1 and 2, where scattered coprolites were frequently found during the excavation. As a matter of fact, the coprolites found in the dung located in the internal part of the cave (Excavation IV), even if affected by bioturbation, show a quantity of fecal spherulites and vegetal fibers.

In the recent literature, spherulites are considered clear evidence for the prolonged presence of ruminant species (e.g., Brochier et al. 1992; Canti 1998; Cremaschi et al. 1996). According to Brochier et al. (1992), spherulites are produced by specific ruminants (but not cattle), wild or domestic. Abundance of these mineral components in the archaeological record could be considered as a major criterion for recognizing animal domestication or intense herding practices. In the Holocene Uan Afuda sequence, spherulites were identified inside the coprolites as well as dispersed. Their density consistently appears rather limited, but is much higher in the inner area of the cave. Experimental research demonstrated that spherulites are loose, dispersed, and poorly concentrated when produced by free-ranging animals (Brochier et al. 1992).

Botany of dung and plant accumulations. Palaeobotanical analyses of charred and noncharred plant remains coming from both the atrial and inner areas of the cave revealed standardized plant accumulation

(Castelletti et al. 1999). The analysis of dung indicate the abundant presence of Panicoideae, fragments of vegetal parts, and seeds from several species (*Ficus* sp., and other unidentified species), pointing to a mixed composition of plant accumulation. Interestingly, small glume remains are present in both human (from the atrial area, Excavation I) and animal coprolites (samples taken from dung accumulation in the internal zone and from Layers 1 and 2 in the entrance of the cave). The small glumes in the human coprolites suggest that the wild cereals were roughly handground. On these basis, the botanists suggest that the animals' diet was purposely selected by humans or at least that the same resources gathered by humans were used by animals. This evidence supports the hypothesis of some forms of management of the animals kept (animal rearing) as opposed to the possibility of autonomous feeding of the animals.

Routine analyses and counting by means of image processing of the three uppermost layers of the Uan Afuda Cave versus the dung of the internal area of the cave (di Lernia et al. 1998) allows us to distinguish differences in the intrasite organization. These differences were interpreted as specific features of plant accumulations. Moreover, the presence of charcoal and unburned and undigested plant remains (Fig. 5) in the dung accumulation in the internal part of the cave is further proof of human accumulation of fodder there. To summarize, botanical evidence supports the hypothesis of artificial accumulation of plants for animal fodder, but is still unable to identify a specific animal for the dung production.

Palynology of dung and plant accumulations. Pollen data provide important evidence for the comprehension of the dynamics of plant accumulations and dung formation. The pollen spectra at Uan Afuda differ according to specific locations (Mercuri 1999): large and articulated in the atrial zone, narrow and clear-cut in the inner part of the cave. These data, along with the evidence of plant properties, are intrinsic elements to suggest conscious and rather complex human activity in accumulating plants in both the areas of the cave. Mercuri (1999:176) suggests that "*the dung must have been a strictly 'local' product originated by animals that browsed on a limited typology of plants, specifically harvested and carried into the inner part of the cave by humans.*" Pollen data also provide glimpses as to the season of plant accumulation, i.e., late winter / early spring. The almost complete absence of Gramineae in the dung pollen spectrum is quite striking, since these plants mainly bloom in the same season. This absence could indicate, again, conscious and selective plant accumulation by humans. Worthy of note, palynological analysis of present-day Barbary sheep droppings sampled in the Acacus mountains demonstrated how this animal, in the wild, has a quite varied diet, which in fact includes grasses in certain amounts.

The data provided by the stratified dung sampled in the inner part of the cave and by the lump of dung brought to light in the excavation located at the entrance of the cave are very important. In fact, these two samples, quite similar in pollen content, seem to offer rather complex information. The results can be roughly summarized in the following way: (1) high percentages of *Echium* in the dung (more than 80%) reflects "a selection in the selection": that is, not only humans selected plants to stock fodder for animals, but they actually collected plants with special characteristics. The most intriguing aspect resides in the toxic properties of this plant; (2) the difference between the atrial and the entrance samples of dung is caused by the addition of particular plants, specifically scented types, believed to be used as some type of scented lamp in the ancient dwellings.

Archaeozoology of the atrial sequence. Differently from botanical remains, the state of preservation of bones is very poor. This also is a typical feature of other Early Holocene sites of the Acacus (e.g., Gautier 1987a; Gautier and Van Neer 1977–1982; Corridi 1998) and strongly limits the possibility of analysis of hunting strategies and related topics (Gautier 1987b). During the Early Holocene, only wild animals are present at Uan Afuda in both of the cultural horizons—Early and Late Acacus—and Barbary sheep is the most abundant species. Specifically, in the lower layers belonging to the Early Acacus phase, Barbary sheep is represented by two animals, an adult and a subadult, and it is practically the only species present. In the upper layers, several wild species were found: golden jackal, hartebeest, hedgehog, porcupine, and an Equidae. These species are all represented by one animal. These remains not only indicate a subsistence based on *Ammotragus* hunting for both layers, as at Uan Tabu and the contemporary sites mentioned above, but also an enlargement of the killed species in the Late Acacus horizon (Corridi 1998; di Lernia 1996, 1998b).

Is Barbary Sheep the Dung Maker?

The data gathered from different methods of analysis contribute to isolate a few species, and the presence of (corralled) *A. lervia* appears the most parsimonious explanation. I try to precisely specify the inferential, circumstantial path leading to the identification of Barbary sheep as the dung maker of the Uan Afuda cave, purposely captured and kept in the cave and consciously fed very few types of plants by humans, almost exclusively represented by Echium.

We have seen that the micromorphologists have identified two types of coprolites on the basis of their content. Different agents may explain the presence of two types of droppings: the existence of different coprolite makers, i.e., at least two species of ruminants living in the area, different types of nutrition among animals of the same species, and different ages of animals of the same species. Nonetheless, the difference may also be interpreted in view of the formation processes in the two areas of the cave. Actually, the impossibility of analyzing the coprolite content from Unit 1 and Unit 2 of Excavation I, prevents us from understanding possible changes in herd composition or animal presence through time. It is likely that the difference between the coprolite content of the dung inside the cave and the few remains analyzed so far from the atrium is likely to be interpreted as a different microzonal history in the formation processes. Given the contemporaneous presence of animals and humans in the cave, another possible explanation of this difference may be the presence of animals of different ages. A possibility could consist of young (?) individuals at the entrance of the cave, whereas adult individuals (?) could have been corralled in the internal section of the cave, where the dung was accumulated. Unfortunately, the strong bioturbation, which affected the inner sample, prevents us from analysing the size of the different samples.

Taken together, the data provided by botanists also support the identification of a ruminant, likely *A. lervia*, as the dung maker. The typology of plant accumulation (burned / unburned ratio) excludes the possibility of spontaneous gathering by animals. Further, the composition spectrum of plants found at Uan Afuda, even taking into account the artificial accumulation of fodder, fits well with the typical diet of the so-called "Intermediate Feeders" (*sensu* Wilson 1989). This accounts for ca. 65% of leaves and flowers, tubers, seeds, and other storage organs for a proportion rarely exceeding 35% (Table 1). Some animals have this diet, such as sheep, impala, Grant's gazelle, eland, and springbok. Cattle, buffalo, and wildebeest are excluded as animals possibly entering the cave, since these herbivores are bulk and roughage feeders and their diet is composed of grass only.

TABLE 1
Classification of Ruminants of Arid Zones According to Diet and Quantity of Food (after Wilson 1989)

Herbivore class	Preferred food	Examples
Omnivores	Animal material (55%); fruits, tubers, occasional birds and shoots (45%)	Fermenters only
Concentrate selectors	Fruits, tubers, seeds, flowers (65%); leaves (10%); occasional animal material (25%)	Some nonruminants among forestomach fermenters
Intermediate selectors	Leaves of leguminosae and other plants (35%); seeds, blossoms, young shoots (65%)	Goat, camel, dik-dik. Steinbock, gerenuk, kudu, giraffe
Intermediate feeders	Leaves, shoots, fruits and blossoms (65%); tubers, seeds and other reserve organ (35%)	Sheep, impala, Grant's gazelle, eland, springbock
Concentrate feeders	Mainly leaves, shoots and plant stems (60%); a good proportion of grass (40%)	Johnson's gazelle, hartebeest, oryx
Bulk and roughage feeders	Grass (100%)	Cattle, buffalo, wildebeest

Decisive data for interpreting the plant accumulation as fodder storage and the dung samples as product of animals consciously corralled by humans are provided by the pollen spectrum (Mercuri 1999). Again, it is difficult to say that the animal kept there was Barbary sheep. As far as the dung is concerned, is the high content of *Echium* (more than 80%) is very telling. This fact implies two things: First, no ruminant would have accumulated such a particular amount of a specific, single plant; second, this plant has toxic properties, known to modern pastoralists in Africa. Does a relation exist between these two facts? Indeed, pastoralists of Saharan and Sahelian zones used *Echium*, and we do not know the possible effects of a prolonged use of this fodder on Barbary sheep. In a review of the available data on the argument, Jorge Cassinello highlights how Barbary sheep may adopt different types of diet (Cassinello and Alados 1996). The average annual diet of a free-ranging population of Barbary sheep in Texas consists of 50% browse, 24% grasses, and 26% forbs, with significant variations according to seasonal fluctuations (Krysl et al. 1978). Furthermore, opportunistic strategies are typical of several ruminants, particularly goats. Thus, more data are necessary in order to exclude the possibility of a quantity of *Echium* in the diet just for its abundance in the environment. It has to be stressed, however, that in non-dung-related palynological data from the excavation at the entrance of the cave (which theoretically should reflect the *entire* environmental pollen flora) there are much lower percentages of *Echium*. Ethnographic data indicate how at the beginning of this century climatic conditions favored an impressive growth of *Echium* in the environment of the Tuareg Kel Hoggar. In oral tradition, that year was so exceptional as to name it *taynest* ("the year of *Echium*": Gast 1968:34). I think that the high incidence of this plant in the ancient fodder of Uan Afuda has to be related to both the abundance in the foraging area and its low nutritional value for humans. This would explain it being given to animals, since it is optimal in terms of availability and intrinsic (scarce) value. Actually, the possibility of *Echium*'s abundance in the fodder because of its toxic properties cannot be discarded. But why would the Uan Afuda inhabitants have tried to poison their "precious" animals? Mercuri suggests the possibility of a slow process favoring some particular behavior of this animal, perhaps used in specific ceremonies. Indeed, *A. lervia* is among the most represented species in the extraordinary artistic series of the "Round Heads" style. Rock art studies from the Sahara indicated some customary relationships between humans and animals in general (Sansoni 1998; Mori 1998) and with *A. lervia* in particular (Sansoni 1998; di Lernia 1999). Unfortunately, they failed, so far, to demonstrate particular ceremonies between humans and Barbary sheep, as conversely recorded in other regions of sub-Saharan Africa, with specific reference to the eland in the San art (Vinnicombe 1976; Lewis-Williams 1981). An alternative idea might be, as suggested by Andrew Smith (personal communication and 1999), that toxic plants, in this case *Echium*, may be used as a soporific to keep excitable animals under control, more or less as modern Turkish farmers appear to do when they feed their sheep willow leaves.

Turning back to the botanical data—both palynological and anthracological—the presence of plant remains and charcoal is evident, as well as the occurrence of archaeological material in both inner and atrial parts of the site, indicating contemporaneous presence of animals and humans in the Uan Afuda cave. Furthermore, evidence of droppings of ruminants in the wild (whether in captivity or free) indicates loose, scattered faecal remains, sometimes mixed with sewage. The outcome is a particular, coated-state thin layer, which is completely different from the evidence of Uan Afuda dung. Here, we observe a compact, hardened, and stratified layer of fodder and droppings. Therefore, both plant accumulation and dung layers are evidence of forced presence of animals kept in the cave. This led us to sharply exclude the possibility of spontaneous flocking in the cave by ruminant groups.

To summarize, the overall evidence from this multidimensional study allows us to reduce the spectrum of the possible dung maker to only a few ruminants. The morphology of the coprolites and the features of the spherulites indicate an ovicaprine of small to medium size. Botanical and palynological data point to a ruminant, more likely an ovicaprine rather than a bovine. Also, the morphological and dimensional aspects of the inner part of the cave do not allow the introduction of large-sized animals, such as cattle or large antelopes, since the area is very uneven and too low, but is adequate for rather small and medium-sized animals.

The only animal satisfying all the requirements here discussed and present in the archaeozoological record of Uan Afuda is Barbary sheep. This hypothesis, following Occam's razor, is the easiest and more economical, and we should now analyze the implications of the presence of specimens of *A. lervia* in a 8000-year-old cave of central Sahara, 1000 years before the emergence of food production in the area (di Lernia 1998a).

MANAGEMENT OF WILD BARBARY SHEEP: DATA AND COMPARISONS

The Ethology of Barbary Sheep

Ethological information on ruminants in general reveals that they live in small family groups consisting of an adult male and female, with their offspring of various ages (Cassinello and Alados 1996). In particular, herd structures of Barbary sheep consist of adult females (50%), juvenile and subadults (30%), and adult males (20%) showing a high variability which could be connected to rapid adjustments to changing environmental conditions (Gray and Simpson 1982; Cassinello and Alados 1996). These ruminants may visit caves, but do not transport food and their droppings are always loose and scattered

(Cassinello and Alados 1996): therefore, the thickness of dung accumulation at Uan Afuda and the existence of an accumulation *per se* underlines the probable forced penning of the animals if compared to present evidence of free-ranging populations living both in the Acacus and in other regions. General features of this animal seem to have the requisites to permit a successful approach by humans, starting with their mild character. The length of the head and body of this animal is 130 to 190 cm, the length of the tail is about 25 cm, the height of the shoulder may vary from 91.5 to 100 cm. This animal has a life span of about 15 years, and its weight is 50 to 115 kg and may represent an important food stock. *A. lervia* is a sexually dimorphic species in size and length; adult males are 72% heavier and 13% longer than adult females (Gray and Simpson 1982; Cassinello and Alados 1996). The most distinctive feature of this species is surely the long, soft hair on the throat, chest, and upper part of the fore legs, whose representations are widely attested in the rock art of the Acacus range. The horns sweep outward, backward, and then inward; they are rather heavy, grooved, and measure up to 840 mm in length, and the females also have large horns (Cassinello 1998). The Barbary sheep is nowadays a perfect desert-adapted species, but it can also inhabit grassy mountains and dune areas. Observations on a population of Barbary sheep introduced to America show a different habitat preference according to seasonal changes: mainly woodlands during the summer, grassland during the autumn and winter, and protective rocky slopes during spring (Gray and Simpson 1982; Cassinello 1998). The diet is not selective at all and may include, as indicated above, shrubs, succulent forbs, creepers, dwarf shrubs, and grasses depending on specific availability. Night activity is lacking or rare; in the early morning the most active individuals are the adult males. During the day Barbary sheep spend most of their time resting; main activities take place late in the afternoon. Females in captivity are monestrous. The gestation period is 154 to 161 days, and the number of young is one or two. Reproduction in captivity is not strictly seasonal, but approximately 50% births take place in March, April and May. Among ruminants, weight of adult individuals habitually decreases with high inbreeding coefficients: this relationship has not been found in Barbary sheep (Cassinello 1998; Cassinello and Alados 1996): I believe that this fact may have had some significance in the success of corralling of these animals in prehistory.

Immediately before *Food Production? Particular Forms of Animal Management among Foragers*

Ethnoarchaeological analyses of modern human groups inform us that the presence of stratified dung is almost exclusively associated to herding activity (e.g., Chang and Koster 1986; Brochier et al. 1992). This evidence contrasts strikingly with the known subsistence strategies of the Early Holocene groups in the Sahara, which were mainly based on the exploitation of wild resources. Only wild animals are present in the archaeological record of the Late Acacus occupation; moreover, the first documentation of domestic cattle and ovicaprines in the region is recorded at Uan Muhuggiag (Gautier 1987a). This evidence is *at least* 1000 years more recent than the dung layers found at Uan Afuda: Thus, a particular activity should be considered to explain such evidence. The domestication-oriented perspective usually adopted is, in my view, misleading: Of interest is the analysis of particular forms of food acquisition—or animal/humans relationships—among foragers, essential for the comprehension of internal dynamics and mechanisms of change within complex hunter-gatherers.

In the past, as well as in recent times, several wild animal and vegetal species have been intensively exploited, also with delayed use, but never domesticated by humans (for a review, see Clutton-Brock 1987). Among the reasons of intensive exploitation, I recall here trade of special parts, workforce, and evidently food exploitation: as a matter of fact, the “taxonomic status” of these animals did not change. The vicuna (*Vicugna vicugna*), for example, is a wild species of camelid living in the Andes between 4000 and 5000 above sea level. This animal was particularly appreciated for its thin wool: it was systematically driven in fences, sheared, and then let free (Clutton-Brock 1987:123). In northern Europe, the elk, as late as the beginning of the past century, was sporadically “domesticated” and used as a means of transport and often also milked (Zeuner 1963). In recent years, wild animals such as the buffalo (*Syncerus caffer*), the oryx (*Oryx beisa*), and the eland (*Taurotragus oryx*) are managed in southern Africa with other fully domestic animals. Other examples are bison, deer, and antelope in North America (Chang and Koster 1986); the reindeer in Northern Europe (Ingold 1980; Clutton-Brock 1987, 1993); the elephant, both African and Indian; and several other cases in which wild animals are used by human groups (Clutton-Brock 1987). As far as the fences used for wild animals in prehistory are concerned, a debated example comes from the Balearic Islands. According to Kopper and Waldren (1967), activity of capturing and fencing was applied during the Neolithic to *Myotragus balearicus*.

Among past societies, corralling aimed at the containment, capturing, or driving of wild animals has been intermittently interpreted as an indicator of incipient forms of, or theoretically close to, food production (e.g., Kehoe 1990:43). Certainly, the social organization necessary for the realization of specific structures, sometimes complex and of great size, presupposes a particular articulation. Furthermore, such structures may have primed mechanisms of knowledge of the captured animals, indicating possible, alternative paths of management. Cases from North America reveal the existence of fenced areas of modest height. Wild animals, and particularly *Ovis canadiensis*, a species rather similar in behavior and constitution to *A. lervia*, were forced to enter these areas (Frison et al. 1990). Despite the actual possibility of running away, just given the attributes of the fences, the animals remained. Therefore, we should hypothesize rather calm animal behavior, even when corralled. In fact, according to Frison et al. (1990:217) “*mountain sheep become docile much sooner. In fact, their behaviour is strikingly similar to that of domestic sheep under the same circumstances*.”

Even in this rather brief review of these topics, it appears clear how intensive exploitation of wild-animal resources is a wide-spread practice among human societies. It is a task for archaeologists to understand differences and meanings of such practices, taking in account how orientations toward possible food resources in ancient societies may have dramatically changed. The attempt to capture, isolate, and eventually tame wild species is a documented activity in the world, past and present. Economic organization and social implications for hunter-gatherers should be analyzed in view of this possible explanation, taking into consideration specific situations and local variations [e.g., Kent (Ed.) 1996].

Prerequisite for Domestication or Cultural Control of Food Resources?

The idea that increased hunting of *A. lervia* was a prerequisite for domestication, as claimed years ago (e.g., Saxon 1974; Barich 1987a; Close 1992), is ambiguous and contradicted by the same archaeozoological data. The corralling of these animals better fits the data and implies increasing cultural complexity (*sensu* Price and Brown

1985) within these Early Holocene hunter-gatherers.

The "phyletic" possibility that the taming of *Ammotragus* was the base of sheep and goat domestication has to be excluded, since on a genetic basis wild progenitors of sheep and goat are not represented by Barbary sheep (e.g., Gautier 1987; Smith 1992). It must be recalled, however, that a successful crossing of *Ammotragus* with domestic goats was achieved in 1957 in Germany; and offspring of such crossing was also in its turn recrossed with ibex (Walker et al. 1964:1443 and 1474–1476). However, a more intriguing and stimulating point is understanding if and how humans tried to control wild animals, even if "without success" in a domestication-oriented perspective. Presently, all scholars agree that *A. lervia* was the preferred game resource in the Early Holocene of the Acacus region. As already observed, specialization of Barbary sheep hunting in the Acacus was cautiously thought to be related to incipient forms of domestication (Saxon 1976; Barich 1987a; Close 1992).

Actually, if considered as a whole, the archaeozoological data set of the Early Holocene sites of the Acacus would indicate a preferential choice of Barbary sheep. Instead, a closer look at the faunal remains witnesses an articulated exploitation of this animal rather than a continuously increased hunting (Table 2). As a matter of fact, during the oldest phases of the Holocene remains of Barbary sheep are very frequent (from 85–90 to 100% in the Early Acacus), whereas in the most recent radiocarbon-dated phases of the "prepastoral" period they dramatically drop to 45–60% (Late Acacus). Therefore, it is clear how the idea of increased hunting and the subsequent attempt at (or prerequisite to) domestication is, paradoxically, contradicted by the same data. Conversely, the hypothesis of corralling and force penning Barbary sheep fits the archaeozoological data better. Higher frequencies of *Ammotragus* during the Early Acacus are likely to be associated with specialized hunting (with no relation to hypothetical "proto-pre-incipient domestication"). Lower frequencies of *Ammotragus* during the Late Acacus could reflect a different type of exploitation, based, in my view, on delayed use and by scheduled slaughtering. Actually, this evidence may have an (several) alternative(s), such as a higher frequency of capture in the

TABLE 2
Percentages of Faunal Remains from Early Holocene (9800–7800 BP) Sites of the Tadrart Acacus

	Fish	Birds	Hare	Other rodents	Carnivores	Dassie	Wild Ass	Warthog	Dorcas gazelle	Dama gazelle	Hartebeest	Barbary sheep	Facies[a]
Uan Afuda Unit 2	—	—	—	—	20	—	—	—	—	—	—	80	EA
Uan Tabu Unit III	—	—	—	—	—	—	—	—	—	—	—	100	EA
Thora east Rinf	—	1.9	1.9	1.9	1.9	3.9	1.9	—	1.9	7.8	—	76.4	EA
Thora east Rsup	—	3.2	0.8	4.8	3.2	2.4	1.6	—	3.2	7.2	—	73.3	EA
Thora east CII	7	6.6	17.8	2.5	8.3	1	1	0.4	1.9	7	—	46.3	LA
Thora east CI	0.7	6.6	6.6	8	8.8	2.2	1.5	—	2.2	4.4	—	59.5	LA
Uan Afuda Unit 1	1	2.4	2.4	4.7	16.6	—	2.3	—	—	—	2.3	68.3	LA
Uan Muhuggiag Wadi	—	—	6.6	6.6	—	—	—	—	20	—	—	66.6	LA

Note. After Gautier and Van Neer (1977–1982), Gautier (1987a), and Corridi (1998).
[a] EA, Early Acacus, formerly called "Epipalaeolithic" (approximately from 9800 to 8900 years BP); LA, Late Acacus, formerly called "Mesolithic" (approximately from 8900 to 7800 years BP).

Early Acacus, reflected in a major amount of success in hunting. This may have been followed by a decreasing density and dispersal of animals during the Late Acacus, matched by an increasing rate of failure in hunting and subsequent decrease of the presence of Barbary sheep in the animal spectrum. Actually, the overall of data, i.e., site features, settlement system, and environmental constraints, seem to favor the interpretation of a semi-residential site pattern practiced by Late Acacus foragers, with a reduced foraging radius and following estrangement of animals from the much more frequented area. Actually, change in types of animals hunted and the marked reorganization evident in the (scanty) archaeozoological assemblages may hint to a new strategy, rather than a simple adjustment related to a single prey, that is, Barbary sheep. Of major interest, I suspect, is the totally inadequate previous interpretation, which proposed an increasing dependence on Barbary sheep, thought to be indication of attempts at domestication (Barich 1987; Close 1992). Alternative scenarios must certainly be considered, but, again, the idea proposed here appears at present to be the more parsimonious.

Ideology and Related Aspects

The management of wild animals should be interpreted as a form of rational or cultural control of food resources, whose traces may be found in the ideological and ritual world of these groups. In late prehistoric times, the controlling and feeding wild animals was a frequent activity. In funerary Egypt, for example, wall paintings of the Early Dynastic and Middle Kingdom periods represent gazelle, ibex, deer, oryx, addax, and many other animals (e.g., Smith 1969; Clark 1971; Phillipson 1993). Specifically for *A. lervia,* figurations were also depicted on Naqada pottery, again in Egypt (Brentjes 1980). Interestingly, also here we see a radical change in the thematic representations. In the oldest, Naqada phases, Barbary sheep is mostly represented in hunting scenes, whereas in the Dynastic pictographs it is depicted in captivity. According to Brentjes (1980), the progressive scarcity of Barbary sheep in this region led to a progressive use of this animal in rituals and sacrifices, but without using artificial selection: in this case, its preciousness would have motivated maintenance in enclosures. As a consequence, these animals may have received an increasing symbolic relevance. These kinds of relationships are often highly formalized and may provide hints to understanding differences in ideology and the consideration of animals within human groups. This consideration could have determined a radical change in the cultural attitudes toward food, affecting also ideology and ritual symbolization.

In this direction, the animal metaphor among hunter-gatherers is a topic of major interest for the comprehension of such relationships, and it should be adequately addressed in future studies, also taking into consideration ethnographic and ethnoarchaeological examples. According to Molyneaux (1989:193), for example:

> lives of animals and humans converge (. . .), indeed, in virtually all forms of metaphorical communication. If humans and animals are often metaphorical equals, however, their working relationships are much more problematic—animals are also a primary source of food. Among many groups the violation of this conceptual fellowship by killing requires some form of compensation: the hunting process may have specific rules of conduct and the processing, distribution, consumption, or disposal of the animal remains may be attended by ritual in an attempt to maintain the necessary equanimity among the species.

These topics may be explored investigating the extraordinary archaeological and cultural record represented by rock art. As an example, the study done by Lewis-Williams (1981) on the San of the Drakensberg region in southern Africa highlighted special relationships between eland and humans. Interestingly, but not surprisingly, these relations are mostly expressed by themes of driving and guiding animals rather than hunting scenes. As indicated also by Vinnicombe (1976), the eland, among the foragers of the Kalahari, is the animal on which real forms of ideological possession were exerted. Unfortunately, this matter is yet to be fully explored for the Saharan regions. Nonetheless, the study done in this region highlighted the interactions between human beings and certain animal species, and more generally, the relationship between humans and the environment. These are decisive elements in discriminating the artistic production of the "Round Heads" from that of the preceding "Large Wild Fauna" and that of the following "Pastoral" series (e.g., Mori 1965, 1998; Sansoni 1998). As amply discussed in other studies (di Lernia 1998a, but see also Sadr 1998), this phenomenon seems to be particularly expressed in groups of "complex" hunter-gathers that experiment with new and innovative forms of environmental manipulation. The great importance of caprines in the ideological universe is a major feature of the "Round Heads" phase (Sansoni 1998): In fact, antelopes, gazelles, mouflons, and caprines are the great majority of animals represented. In addition, a high formalized relationship between humans and mouflons appears of interest (Mori 1998; Sansoni 1998).

The existence of a dedicated terminology attests a high degree of social complexity. Recent linguistic studies have indicated roots that may be cautiously associated with the existence of some cultural forms of animal control. According to Ehret (1993), the oldest African linguistic group showing terminological roots that can be related to attempts at food production is the Proto-Northern-Sudanic (ca. 8000 BC). Six roots were isolated: "to milk," "to drive" ("domestic" animals), "cow," "grain," "ear of grain," and "grindstone." Actually, only the first two may be considered as clues of domestication. In the Proto-Saharo-Sahelian group (ca. 7000 BC) there are the first terms probably related to cultivation. The geographic location for these linguistic groups extends from the White and Blue Nile confluence, including also the regions of the Ennedi and Tibesti, up to the central Saharan mountain ranges (Ehret 1993: Fig. 6.2), with possible subsequent movements. Certainly, this kind of inference may be risky, since the meaning of the roots may change through time (e.g., Renfrew 1987). However, this evidence, handled with care, may provide elements to define the cultural universe of the social groups using particular strategies of delayed use of resources.

Of interest here is the evidence that the first forms of a planned or delayed use of resources in North Africa were initially directed toward animal rather than plant resources. As a matter of fact, with the Proto-Northern-Sudanic, the roots dedicated to the vegetal world are grains and grindstones, not necessarily implicating either a delayed use of resources, or a possible incipient domestication. Conversely, with regard to the animal universe, the root "to drive" may be referred to a kind of hunting or also other activities. Since examples of hunting performed by means of fences are not known in North Africa, the idea that the root may be related to the driving of animals in specific areas (corrals?) appears to be appropriate. Finally, the root "to milk" is also linked to a typical secondary exploitation, as may be seen in the case of *Bos* exploitation at Bir Kiseiba in the eastern Sahara. The possible existence of appropriate terms to define activities is an essential trait of human behavior, as it translates a consciousness of ancient experimental activities, of which there is evidence in their ideological world.

Focus on Food: Sharing and Delayed Use

The mechanisms and ethics of food sharing surely are major issues in the studies of hunter-gatherer societies that have been extensively explored in the past 2 decades (e.g., Lee 1979; Ingold 1986, 1992; Hawkes 1993; Peterson 1993; Kent 1993; Cashdan 1997; Bird and Bliege Bird 1997; Sadr 1998). Explorations in the delayed use of resources were undertaken since the end of the 1970s by the study of James Woodburn, who formalized the economic division within hunter-gatherer groups between immediate and delayed return systems (e.g., Woodburn 1982, 1988). More recently, this stimulating approach has been integrated in several other studies, which also examine the social and ideological worlds (e.g., Jerardino 1996). Sharing appears to possess different motivations and can be seen as an instrument used differently according to specific societies and particular conditions (Kent ed. 1996). Sharing may be used to counterbalance unpredictable environments (e.g., Chang 1991; Layton et al. 1991; Kent 1993), as a strategy to level variations in hunting skills (e.g., Kent 1993), or also as a form of insurance (e.g., Bird-David 1992). With regard to the analysis of sharing moved toward the perception within groups, it has been noted that this practice is not always spontaneous, but rather is used on request. This is the case with so-called demand sharing, or mutual taking (Peterson 1993). Such activity is typical of small-scale societies, but not exclusively confined to them, as evident in some Bantu-speaking pastoralists and Melanesian horticulturists (Schiefflin 1990, cited in Peterson 1993:871).

A common landmark of these studies is the kind of aptitude toward food-producing strategies. As repeatedly stressed, hunter-gatherers do not easily adopt herding or cultivating strategies, since their social relations are dramatically different compared with those of food-producing cultures (e.g., Ingold 1980; Layton et al. 1991; as a last, Sadr 1998). With regard to the ethic of sharing, it makes any form of private ownership difficult, and this appears to be particularly true for food resources. This aspect is strictly interrelated with the second point, a delayed use of resources, with implications on food storage, since attitudes toward food may dramatically changed under specific conditions. It has to be stressed that most hunter-gatherer societies exploit a large number of resources, and, more importantly, the same group can easily move from one pattern of work to another, according to the specific situation. In some ways, such "organizational flexibility" may be considered the *essence* of foraging adaptation (Layton et al. 1991:279). Tim Ingold (1980) considers this lack of territorial rights and the inclination toward sharing the key traits in the mode of production in hunter-gatherer societies and consequently inimical to the introduction/adoption of intensive husbandry or other food-producing activities. Ethnographic examples appear to support Ingold's position concerning the obligation of sharing. It is not by chance that sharing appears to be prevalent in conditions where cooperative hunting is indispensable. In conditions of abundant resources, strategies of "boundary defence" type are practiced. In general, studies on sharing highlighted the economical meaning of this practice, since it reduces the risks of variations in hunting return and/or difficult environmental conditions between individuals or groups. Susan Kent (1993:480) suggests an important relationship between sharing and conditions of egalitarianism within groups. Sharing is particularly useful since it strengthens social bonds, facilitating the consolidation in larger social wholes, such as clans, up to more complex societies. Actually, we do not fully know how the mechanism of sharing may be adapted to a delayed use of resources, and one has to recall that this process requires accumulation by means of storage and/or control of the resources. Accumulation of resources among hunter-gatherers is not an unknown practice (see, among others, Lee 1969 on the mongongo nuts), but future orientations toward food are quite different among groups, as indicated by ethnographic examples. Meat is probably the most shared resource. Actually, also plants are shared, but this practice appears to be much more symbolic in terms of social relationships (Kent 1993; Lee 1979:200–201). It is certain that important differences exist between acquisition and consumption of resources: On the basis of ethnographic data (e.g., Lee 1979), it is well know that the hunter-gatherers of southern Africa habitually hunt small and large prey and collect plants, but that small animals and plant foods are shared only within the family group possibly including a few others, whereas meat (with capital "M") is redistributed within much larger social units (Hawkes 1993:343).

Such a brief review, far from being exhaustive, illuminates the variety and complexity of this practice among hunter-gatherer societies. To this, we should add the internal change aimed at a delayed use of resource, in some case to be subsequently shared. This matter is of great interest to test different models of exploitation of resources based on their different times of use.

IMPLICATIONS OF THE DELAYED USE OF RESOURCES: SOME UNCONCLUSIVE REMARKS

The main implication of Barbary sheep management is the possibility of planning the slaughter of (corralled) animals during periods of shortage. Actually, since the herds of Barbary sheep sharply decrease during droughts, intensive and indiscriminate hunting in the past may have led to an overexploitation of the species. Conversely, capture and isolation of some specimens may have provided an important food reserve to be used in later times. In this way, the decrease of Barbary sheep from the Early to the Late Acacus phase recorded in the archaeozoological assemblages of the region may be explained by a reorganization of hunting activity based on capturing and isolation of some animals. With this in mind, it is clear how storage and food reserve may be interpreted as cultural tools either to satisfy the immediate necessity of the group or to create a surplus. In this perspective, brilliantly summarized by Gould (1985:432), we should try to understand causes and circumstances of change in food habits within hunter-gatherer societies. The shift appears to be from food and resource sharing—public goods, a kind of "*social capital*"—toward an accumulation of food and resources—the creation of private capital, "*money in the bank,*" according to Richard Gould.

The management of Barbary sheep at Uan Afuda is indicative of a cultural response in managing the subsistence base, likely related to dramatic uncertainties in resource availability during the phase of increasing aridity of the end of the 9th millennium B.P. These processes, I suspect, are related to the need to accumulate resources for social use, but still far from a food-producing economy, which would be the rule in the following millennia. This social capital, archaeologically expressed by the great emphasis on storable plant resources and in the attempt to control some animals, was probably shared by the entire group, I would suggest, and not by single individuals. We are still far from a full comprehension of this topic, but I believe that in the case of the Late Acacus extractive communities it is reasonable to interpret these first forms of resource exploitation as a "satisfaction of needs." A deep ideological and economical distance separates the Late Acacus foragers from the subsequent food-producing communities of the Pastoral phase: from this period onward, the strategy of "money in the bank" was the general rule. For example, figurations of cattle will become a dominant and central theme in the artistic production of the Pastoral phase, emphasizing a deep and marked innovation in the ideological world of food-producing populations, which lasted up to the threshold of historical periods (e.g., Wendorf et al. 1997, but see also Hassan, 1994). Subsistence strategies during the Late Acacus phase were directed toward specific resources, available even in the most unproductive and lean seasons. The broadening of the resource spectrum and intensive use of wild cereals represent well-known adaptive strategies among Early Holocene foragers of North Africa, but the archaeological detection of corralled Barbary sheep constitutes an original practice of delayed use of food resource. Intensive exploitation of wild cereals implies a high degree of territoriality (e.g., Tubiana and Tubiana 1977; Cane 1989). In addition, opportunistic strategies of hunting directed to small- and middle-size prey, associated to the corralling of specimens of Barbary sheep (the most known prey by hunters of the region through time), allowed the use of a more restricted environment. I believe that these strategies adopted by Late Acacus foragers are at the base of a marked reorganization of the settlements, larger and more durable, in turn causative of increasing site density. Consequently, reduced mobility and site density will be among the causes of an increasing intragroup competition (di Lernia 1996). Actually, the path toward the accumulation of resources appears already *in fieri* when the unbalance between population and available resources became pressing. Such pressure has been probably accentuated by the increasing aridity roughly placed at 8000–7500 years B.P.; that is, the final phases of the Late Acacus culture (Cremaschi and di Lernia 1998). Thus, a full food-production activity is attested in the Acacus approximately at the end of this arid phase. It is possible to consider the emergence of food production a phenomenon of progressive, but rather fast, replacement, given the cultural complexity of Late Acacus foragers, which easily adopted the new economic basis, as indicated by the ancient dates of food-producing activity in the region. This process will lead to a drastic interruption of Barbary sheep management in the following periods, replaced by the more productive cattle herding.

Finally, I wonder if this process led to some forms of locational encapsulation of hunter-gatherers at the margins of the region or to a progressive expulsion from the Acacus toward other regions of North Africa, such as the Nile Valley (Caneva 1996). Mechanisms of integration with, or replacement by, complete forms of food production are the true future frontier, I think, of archaeological and anthropological studies of these communities (e.g., Smith 1998; but see also Kent ed. 1996; Sadr 1998).

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