Chapter 16

ROCK ART AND CULTURAL RESPONSES TO CLIMATIC CHANGES IN THE CENTRAL SAHARA DURING THE HOLOCENE

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CLIMATE CHANGE MECHANISMS

Mechanical, thermodynamical, biological and human factors combined through times to bring about the climatic changes whose main result is the present Saharan aridity. The most important of these factors are those stated by Milutin Milankovitch in his 'astronomical theory' (Milankovitch 1920, 1941). This Serbian mathematician stated that, at a planetary scale, temporal and geographical climate variations are linked to insolation, which fluctuates according to the position of the Earth to the Sun. The succession of the seasons is caused by the angle of the polar axis and by the annual ecliptic revolution, but the general succession of the glacial and interglacial periods (corresponding to arid and humid periods in the Sahara, cf. Markgraf 2001) positioned at much more considerable intervals, is caused by what could be called 'astronomical seasons' linked to three main factors: variation in the eccentricity of the Earth orbit, variation of the obliquity, and precession of the equinox.

The Earth revolves around the Sun in a plane called 'ecliptic plane', and the polar axis forms an angle of 23°27' to this plane. This obliquity and the fact that the Earth describes an elliptic (and not circular) orbit have an influence on the interception of Sun's radiation by the Earth, a fact which explains that seasons do exist. Now, these two factors are not constant, and due to Moon's and Sun's attraction, the polar axis slowly describes a cone, following a movement called 'astronomical precession'. These three major variations (eccentricity, obliquity, precession) cause the main variations in Earth's insolation. Each one has its own particular periodicity: eccentricity varies according to 100,000 and 413,000 year cycles, obliquity varies according to a 41,000 year cycle, and the precession cone is described every 25,700 years (the precession of the Equinox cycle being of 23,000 years). The solar activity varies according to 11,000 and 90,000 year cycles, and the resultant of all these variables is a curve evolving like the global variations of the Earth's climate (Berger 1984, 1988; Imbrie 1979; Perry and Hsü 2000; Ruddiman 2001).

The validity of this climatic curve integrating several periodicities has been checked for several hundreds of thousands years, by means of comparisons with many other curves showing, at the same scale, the periodicity of other variables, as atmospheric CO_2 and methane concentrations, levels of oxygen isotopes in water, lacustrine and oceanic sedimentations etc. (Kutzbach and Street-Perrott 1985; Khalil and Rasmussen 1987; Pokras and Mix 1987; Martinson et al. 1987; Mann 2002; Ruddiman 2001, 2003).

For the period concerning rock art, this curve (Fig. 1) shows that the last two European glaciations (Dryas II and III) match the hyper-arid times beginning in the Sahara after the Aterian and going on till the beginning of the Holocene (conventionally established at 10,000 BP). During this hyperarid period, the limits of the Sahara moved several hundred kilometres south, and the whole zone has been completely deserted for several millennia, because the Sahara was then totally abiotic.

After this very sad episode, an appreciable global warming occurred. On Figure 1, the curve jumps around 8500BP, and this 'Holocene warming' favours human settlements in the Sahara: then begins the so-called 'Climatic Optimum'. The sea level rises significantly and the return of permanent rains increases the number of lakes in the whole Sahara (Fig. 2). The most favourable life conditions occur around 8000 BP, but a short arid episode arises around 6900 BP, then a rain season became established. A tendency for increasing aridity can be seen around

5000BP, which provoked the collapse of some shelters here, some landslides there, and became tragic around 4000BP (end of regular rains, drying of lakes, fast disappearing of permanent waterholes).

HUMAN RESPONSES TO CLIMATIC CHANGES

The post-Aterian recolonisation and the introduction of pottery

From the beginning of the Climatic Optimum, some groups of Neolithic hunter-gatherers arrived in the old abandoned zones of the central Sahara and took advantage of the restored environment (Fig. 2). This is shown, for example, by the number of 14C dates obtained for anthropic levels in the shelters of the Akâkûs range in Libya (Cremaschi and Zerboni 2003). Two millennia and a half before the advent of ceramics in the Fertile Crescent around 8000 BP (Cauvin 1997:22-23), some of these Saharan people were already carrying potteries, which are among the oldest in the world , the oldest being the Jomon potteries appearing in Japan at the end of the Pleistocene (Leroi-Gourhan 1997:561). In fact, the oldest Saharan potteries have been found in Niger and are certainly over 10,000 years old:

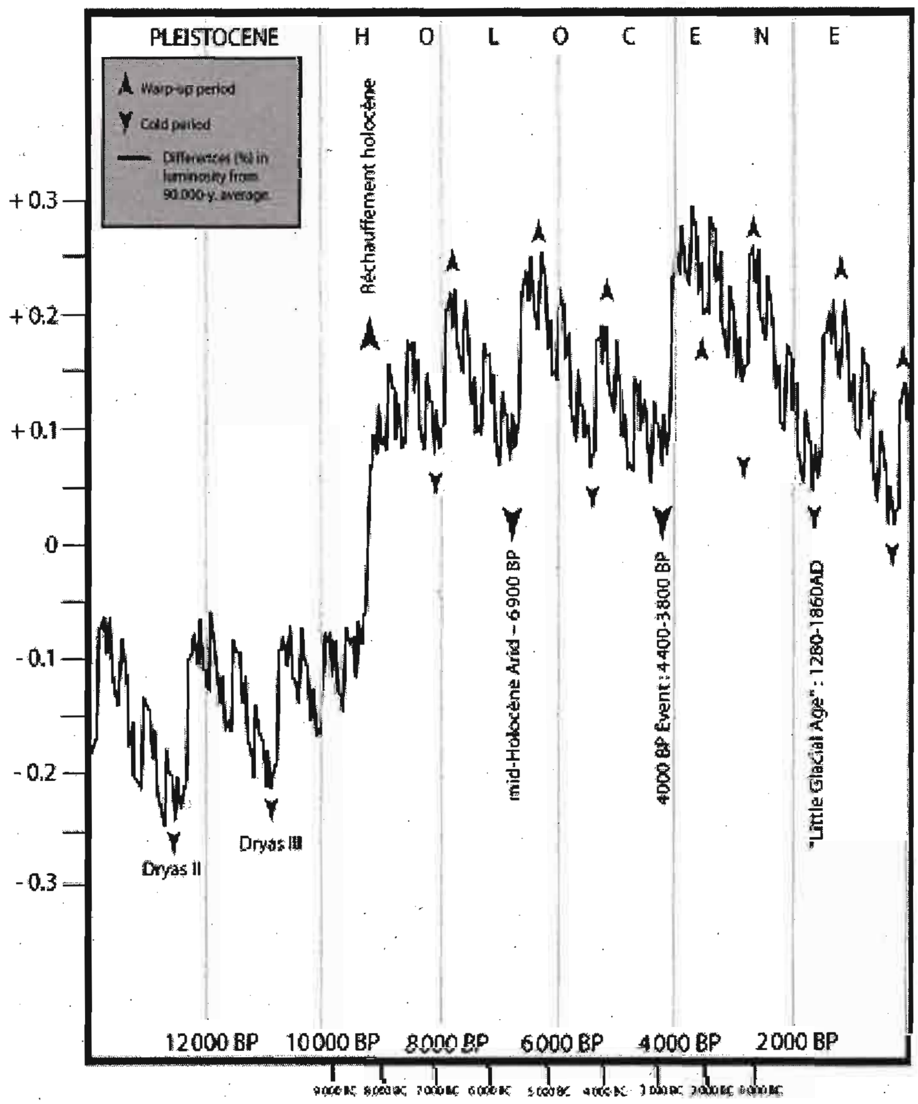

Fig. 1 : Differences (%) in modelled solar-output (luminosity) from 90,000 year average (from Perry and Hsü 2000, fig. 2, modified). Warm-up periods in the Northern Hemisphere correspond to Humid phases in the Sahara, and European Glacial Ages correspond to Saharan Arids.

from 10,500 ± 780 BP to 9820 ± 780 BP at Tagalagal, and from 10,500 ± 750 BP to 9530 ± 730 BP at Adrar Bous. Younger dates show the diffusion of this technique, first in Algeria in the Tassili (at Ti-n-Hanakaten: 9420 ± 200 BP) and the Tefedest n-Ahaggar (Abri Launay: 9210 ± 11 BP), then in the Akâkûs in Libya (Wa-n-Tabu: 8950 ± 55 BP, Wa-n-Afuda: 8790 ± 93 BP, Ti-n-Torha East: 8640 ± 70 BP) (Roset 1983, 1996a, 1996b; Mori 1998:56).

ROCK ART AND DOMESTIC ANIMALS

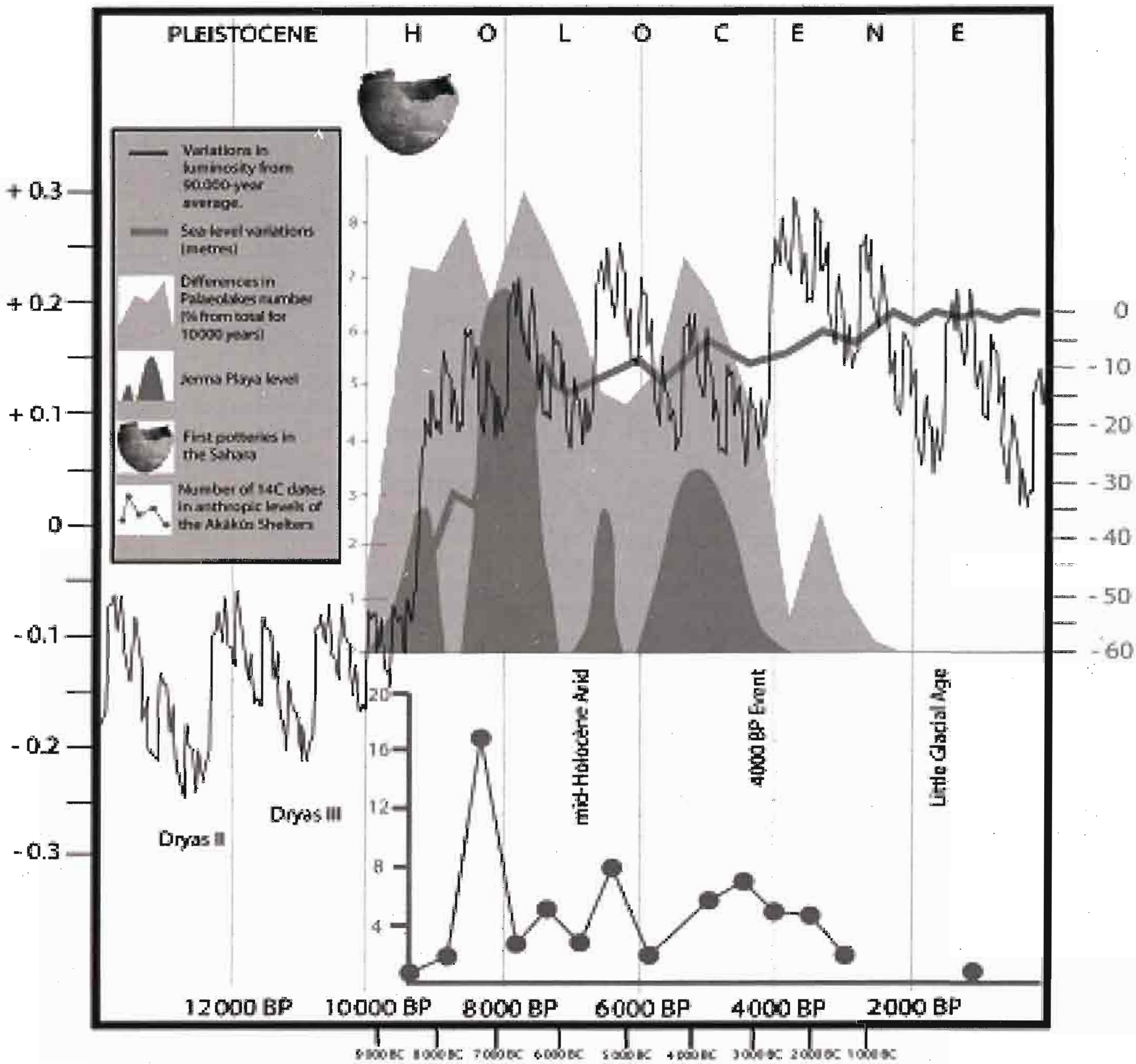

Fig. 2 : Northern Hemisphere Solar-output Model from 14.000 BP to 2000 AD (from Perry and Hsü 2000, fig. 2, modified) compared with Holocene palaelolakes number (from Petit-Maire 2002: 74), sea-level variations (from Ters 1987), Jerma Playa level (from Mattingly 2003), and the number of 14C dates in anthropic levels of the Akâkûs shelters (from Cremaschi and Zerboni 2003). The Holocene Climatic Optimum coincides with the maximum occupancy rate of the Akâkûs shelters and with the introduction of the first potteries in the Sahara.

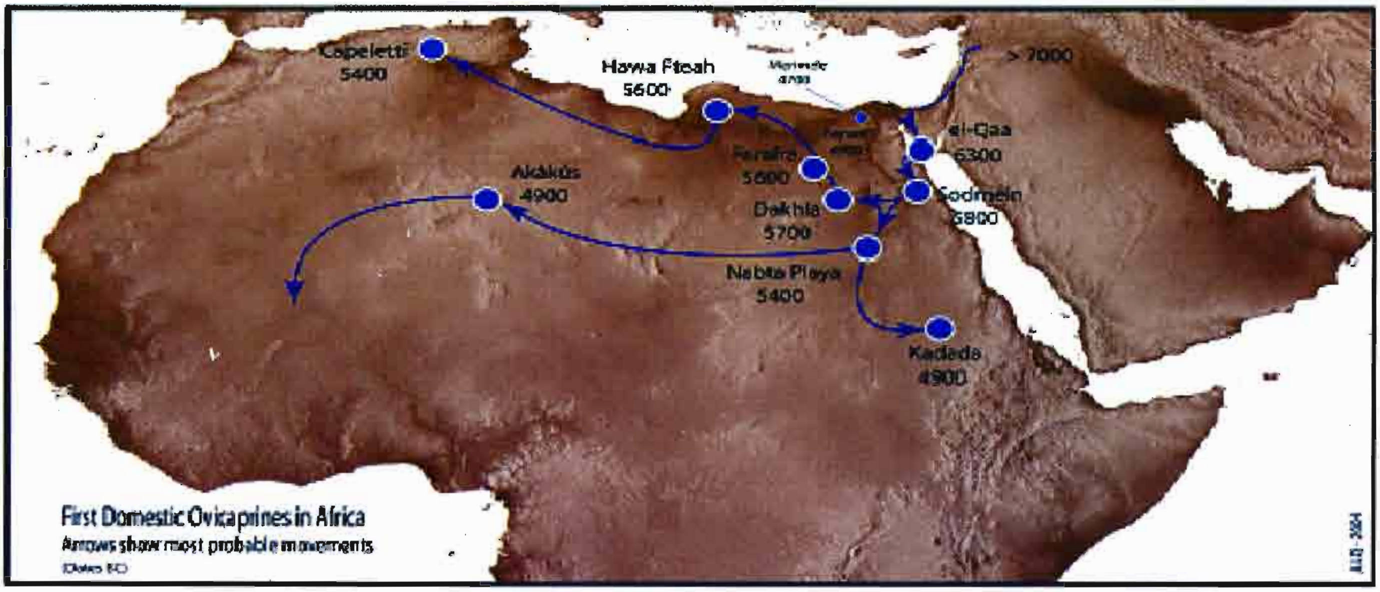

Fig. 3: Movement of domestic ovicaprines in North Africa and the Sahara (from Close 2002, fig. 9, modified)

Saharan rock art is very difficult to date because no reliable technique can be used there for the dating of the petroglyphs despite some interesting attempts in Egypt (Huyge et al. 2001), and because the paintings can be dated only if some organic binder has been conserved. Up to now, only one painting, in the Akâkûs, has yielded a date of 6175 ± 70 BP (Sinibaldi et al. 1996). As a result, most of the chronologies rely on stylistic arguments and on some typical representations. The first surveys were often made by geologists who quite logically followed a geological paradigm. Thus Théodore Monod (1932) coined a classification in four stages:

1. 'Prehistoric bubaline group'
2. 'Old group' or 'prehistoric bovine'
3. 'Middle group' or 'Libyco-Berber'
4. 'Recent group' or 'Arabo-Berber'.

Later, this classification has been often improved, and finally came to a series of four periods called 'Bubaline' (or 'Naturalistic Bubaline'), 'Bovidian', 'Caballine' and 'Cameline'. This quadripartite chronology has hardly ever been questioned until the last ten years, and several scholars are still defending it. Without going into details, the reader must know that the name 'Bubaline' is based on the engraved figures of an extinct species, the Great Bubalus (Syncerus caffer antiquus = Pelorovis antiquus), an animal supposed to characterise an archaic stage of the art, going back up to the Pleistocene (before 10,000 BP) according to an outdated theory. But as comprehensible this characterisation may have been, it is not acceptable anymore since we know that Syncerus caffer antiquus lived very late, at least till the full Bovidian period, for example around 5000 BP at Meniet in the Ahaggar (Hugot 1963) and even after 4000 BP at Chami in Mauritania (Bouchud 1981). Therefore, this species having died out during he late Bovidian, one cannot give its presence among the rock pictures as a reason to define an 'archaic' stage, and one must give up the idea of the so-called 'Bubaline period' (Fig. 4). It is not even possible to salvage this notion by modifying it in some kind of 'big African fauna period', as sometimes the big African species also survived during much more recent periods than previously thought. For example, hippo bones are very frequent in the Tenerean cooking remains, around 3500-2000 BP (Hugot 1974:195), a date which probably indicates here the last possible survival period for this species.

Being characterised by the presence or depiction of domestic bovids and ovicaprids, the Bovidian period cannot begin before the appearance of these animals, never attested in Africa before the seventh millennium BP. Some authors, drawing on mtDNA sequence variations, put the case for an independent domestication centre somewhere

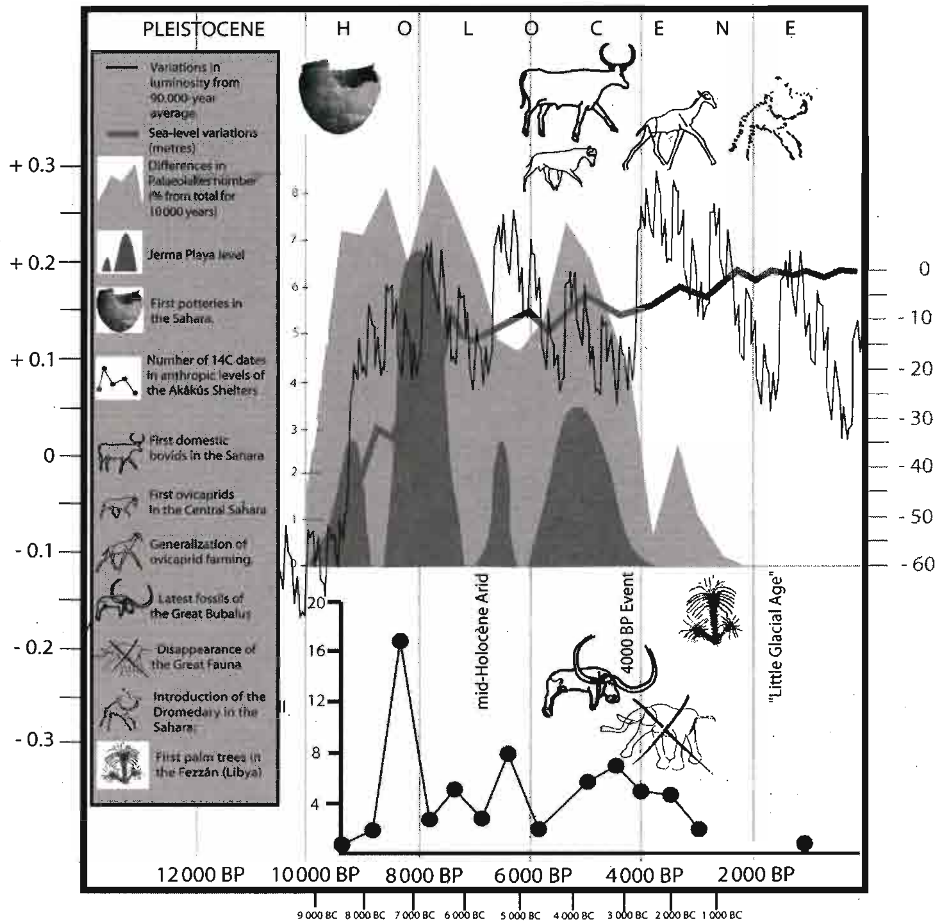

Fig. 4 : Cultural responses to climatic changes: herders appeared only after the Mid-Holocene Arid period, around 6000 BP, and created petroglyphs and paintings glorifying, above all, their domestic bovids. When the Saharan climate seriously deteriorated during the Post-Neolithic Arid Period, cattle farming declined in favour of ovicaprid farming, and the later replaced the former around 4000 BP. The great African fauna disappeared once for all, palm trees appeared ca. 3000 BP, and the dromedary was introduced around the beginning of the Christian era. Since then, the Saharan landscape did not change significantly.

in Africa, perhaps in the Sahara (Grigson 1991; Loftus et al. 1994; Bradley et al. 1996; Hanotte et al. 2000, 2002) but this appealing idea cannot be supported by irrefutable archaeological data (Muzzolini 2000; Stoksad 2002).

During excavations made in Fezzân (Libya) in the 1960s, bones of domestic bovines (Bos primigenius f. taurus) have been dated on charcoal at 7430 ± 220 BP, and a Bos said to be at stage of 'incipient domestication' has been found at Ti-n-Torha East in the Akâkûs (Gautier and van Neer 1977-82:109, Table 1), two elements which led Barbara Barich to first suppose that domestication could have been the result of a local development (Barich 1987d:331-40). But Achilles Gautier (1987a:297) has corrected his identification, and no other research could ever confirm the presence of such ancient domestic bovids (Cresmaschi and Di Lernia 1996b:225). This means that this date of 7430 BP, given by a laboratory in Pise (Italia) at a time where the results were not reliable yet, must be erroneous, and that the idea of an independent process for bovine domestication in central Sahara must be abandoned (Barich 1998).

A frequently quoted theory is Fred Wendorf's idea that some domestic bovids were living at Nabta Playa in the Egyptian Oriental Desert during the 7th millennium BC (Wendorf 1987, 1994), but it has been severely questioned (Muzzolini 1989:9-10; Smith 1992:44). Not only does the latest synthesis published by Wendorf on this topic not answer criticism, but it does not expound any new argument (Wendorf, Schild et al. 2002), and gives the impression that the facts have been somewhat adjusted to a still unproved hypothesis, becoming less and less acceptable (Wengrow 2003).

Fig. 5. Herders and their sheep at Iheren (Tassili-n-Ajjer, Algeria); painted in the Iheren-Tahilahi style.

Fig. 6. *Herd of sheep at Sefar (Tassili-n-Ajjer, Algeria) ; painted in the Abaniora style.*

Fig. 7. *Herder and his sheep at I-n-Fardan in the Akâkûs (Libya); painted in the Iheren-Tahilahi style.*

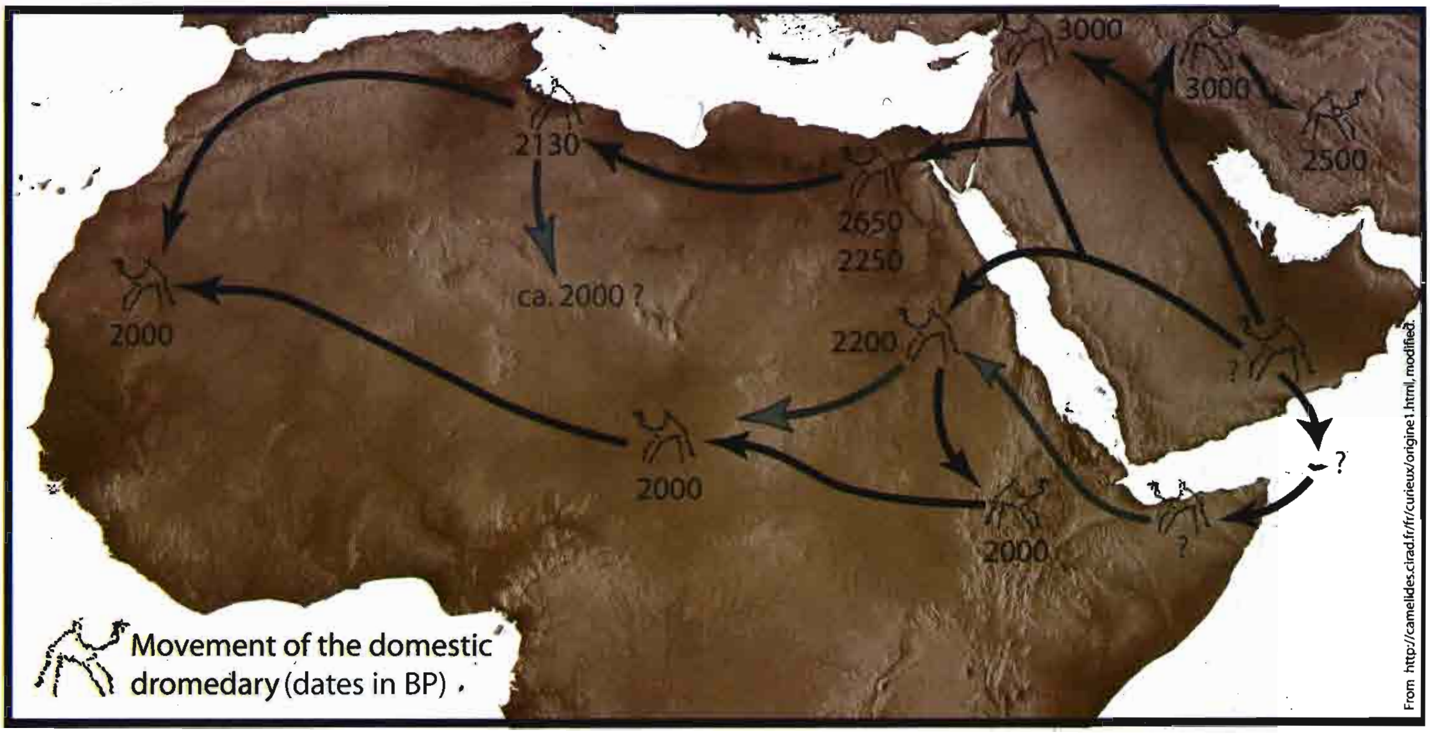

Fig. 8: *Origin and movement of the domestic dromedary in North Africa and the Sahara*

It is now certain that the most ancient bovids bones ever found in a cultural context in Africa have been discovered at Capéletti Cave in northern Algeria, with a date of c. 6530 ± 250 BP, but their domestic status is not conclusive. The first certain domestic bovids known in Egypt go back to 6400 BP in the Fayum, and to c. 6000 BP at Merimde. In the central Sahara, the most ancient domestic bovids have been discovered in the Akâkûs and date back to the 6th millennium BP: 5970 ± 50 BP in the upper levels at Ti-Torha North (Barich et al. 1984), and 6035 ± 100 BP in the middle levels at Wa-n-Muhuggiag (Belluomini and Manfra 1987), while at Capéletti Cave, they do not appear before 5100 BP.

If the oldest domestic bovids appear at the beginning of the 6th millennium BP in the archaeological remains of the central Sahara, then this date must also be valid for their representations in the surrounding rock art sites. This is a very important argument for the dating of the art, and it is confirmed by the most recent data on ovicaprids. Alfred Muzzolini's hypothesis of a possible African stock which could have been domesticated independently (Muzzolini 1990, 1993, 2000:96-98) has not been confirmed (Gautier 2003:634), and most authors agree that ovicaprids were domesticated more than 8000 years ago, then introduced into Africa from the Levant (Clutton-Brock 1993; Brewer et al. 1994:90; Camps 1998:15-16, Bradley et al. 1998:85; Hassan 2000:15; Luikart et al. 2001; MacHugh and Bradley 2001; Close 2002:69; Gautier 2002:201). The Barbary sheep (Ammotragus lervia) is not relevant here, because it is not an ovid, and it even belongs to a particular genus. It has often been said that domestic sheep and goats would have been introduced through the north of the Sinai, as this is the only terrestrial way towards the Nile delta. Then they would have moved towards the west along the Mediterranean coast, as they are located at the end of the Libyco-Capsian at Haua Fteah in the Jebel el-Akhdar (Cyrenaica, Libya) around 6800 BP (Mauny 1967:593; McBurney 1967; Higgs 1967a and b; Klein and Scott 1986:524), then at Capéletti Cave in the Aurès Mountains in Algeria at c. 6530 ± 250 BP (Roubet 1978). Thus, until very recently (Barich 1998: Fig. 5.2), it was generally supposed that sheep came to the central Sahara by a northern way, after their expansion along the Libyan coast, because at Wa-n-Muhuggiag in the Tadrart Akâkûs many ovicaprid bones were said to have been found in a level with a basal date of 7438 ± 220 BP (Mori 1965), i.e., long before the appearance of their counterparts at Merimde and in the Fayum around 6000 BP (Hassan 2000:15).

As a date of c. 7000 BP has been given recently for the first ovicaprids of site E-75-8 at Nabta Playa in the Egyptian Western Desert (Close 2001; Gautier 2003), the global view supposed to synthetise all these elements is not very coherent: how could the sheep, which came from the Levant and crossed the Fayoum in 6000 BP, have already been in Cyrenaica 800 years before, and in the Akâkûs even 1400 years before? And how could these same sheep have already been in the Western Desert one thousand years before they crossed the Delta? If sheep really came from the Levant, the date of Wa-n-Muhuggiag is not only surprising: it is not credible at all. In fact, it has been obtained on a unique sample analysed in the 1950s, i.e., at a time where the first testings of Willard Frank Libby's method just began in the Fayum. Therefore this date is open to doubt. Without questioning the determination of the faunal remains by Achilles Gautier (1987a), this doubt, which concerns only the dating, is increased by the fact that the site of Wa-n-Muhuggiag, excavated once again in the 1990s, has then yielded new dates ranging form 6410 ± 160 BP to 7823 ± 95 BP. These new dates have been obtained just outside the cave, but without any domestic ovicaprid (Di Lernia and Manzi 1998: Table 1). The archaeozoologist Claudio Corridi (1998:90), who identified the bones discovered during these new excavations, could do nothing but deduce that the samples previously seen by Achilles Gautier had to be more recent than his.

Still in the Akâkûs, bones of domestic ovicaprids have been mentioned at Wa-n-Telokat (Wâdi Imha) at 6745 ± 175 BP, a fact which seems to contradict once again the hypothesis of a slow diffusion after a passage through the northern Sinai, where they do not appear before 6500 BP (Smith 1989:71; Corridi 1999; Midant-Reynes 2003:84-85; Close 2002:60). Thus this dating of Wa-n-Telokat is as doubtful as the one at Wa-n-Muhuggiag, and for the same reasons. These two datings, regularly quoted for decades in order to argue about an emergence of domestic sheep in the central Sahara some time in the 8th or 7th millennia BP (Barich 1978-79:314; Garcea 1992:58; Corridi 1998:93) - or even during the 9th millennium (Mori 1998:63) (!) - distort the argument and just clutter the literature. They have been regularly questioned for more than fifteen years now (Muzzolini 1986:312, 1990 100, 1995:190), and they have not been confirmed yet by the more recent data of Wa-n-Muhuggiag (Corridi 1998:90 and Table 1), where the oldest dating obtained by Barbara Barich is 6035 ± 100 BP (Barich 1987:337; Di Lernia and Manzi 1998: Table 1). At Wa-n-Telokat, a test excavation by Elena Garcea has only yielded a date of 5900 ± 80 BP for Level III, where ovicaprids do appear (Garcea 1992:59; Garcea and Sebastiani 1995).

These new data indicate that ovicaprid farming spread in the Akâkûs during the 5th millennium BP, give a more acceptable pattern for the introduction of these domestic animals in the central Sahara, and confirm the firm rejection by Angela Close (2002:460) of any older dating. At present, Close's synthesis (Fig. 3) is the only one taking into account the results of archaeological research from the Levant to the central Sahara, going through Egypt and including Ehret's linguistic reflexions (Ehret 1993, 1999): sheep and goats, present in the southern Sinai around 7000 BP (in the el-Qaa Plain), must have been introduced on the western shore of the Red Sea - where they have been found at Sodmein Cave in levels between 7100-7000 BP and 6300 BP (Vermeersch et al. 1994:39) - then at Dakhla and Nabta Playa around 7000-6900 BP (McDonald 1991:47). From the first area they must have spread up to Hawa Fteah (Cyrenaica), then westward along the Mediterranean shore (Capeletti Cave: 6500 BP); from the second one, they must have spread along the Nile up to el-Kadada where they appear around 6000-5000 BP. According to this pattern, ovicaprids must have accompanied some herders of the Oriental Desert during their crossing of the Sahara from east to west, at a time when this was still possible, and they made their first appearance in the central Sahara at the beginning of the 6th millenniumBP (Close 2002: Fig. 9).

All this implies that sheep images, frequent in rock art of the central Sahara (Fig. 5-7), cannot predate the 6th millennium BP, as is also the case for countless pictures of domestic bovids (Fig. 4). A large majority of Saharan rock pictures having been made by herders, this means that the major flourishing period of this art must be placed in the 6th millennium or slightly later. It can definitively not be earlier, even if one cannot rule out the eventuality of an older dating for some particular figures, but this has still to be proved. It is noteworthy that the inhabitants of the Sahara begin to erect their first funerary monuments precisely during the same millennium, and that they consecrate them to their cattle (Di Lernia and Manzi 2002:5).

THE LAST ARID PHASE AND THE FORMATION OF THE PRESENT ENVIRONMENT

The central Saharan herders must have been worried by the first indications of the Post-Neolithic Arid Phase, as soon as 5000 BP, and it cannot be by chance that it is precisely at this time that they gave up consecrating their funerary structures to cattle tombs, and that they began to bury some (probably important) people in these monuments: the most ancient funerary tumulus with human remains known in Fezzân was excavated at I-n-Habeter in the Messak, and it dates back to 5071 ± 91 BP (Di Lernia and Manzi 2002:5).

This significant functional change between older lithic monuments consecrated to cattle and newer consecrated to some humans is also known elsewhere in the Sahara: in Egypt, the cattle tombs of Nabta Playa date back to c. 6480 ± 270 BP (Wendorf, Schild et al. 2002:469), and in the Aïr area (Niger) the oldest monuments were consecrated to domestic animals, while the most ancient human megalithic tomb dates from 5360 ± 200 BP only (Paris 1997a, 1997b:59, 2000).

If, in the Akâkûs, ovicaprids became more and more frequent at Ti-n-Torha from the 6th millennium, and at Wa-n-Muhuggiag from the 5th to 6th millennia (Corridi 1998:90, and Table 3), evolution of pastoral sites in this area, going hand in hand with an increase of the geographical mobility of the herders, reveals that local economy was mainly based on ovicaprid farming only from the 5th millennium. This shift from cattle farming to ovicaprid farming occurred during the Late Pastoral, and probably corresponds to an adaptation to the growing aridity (Gautier 1987a:299, 304; 1987b:173; Barich 1990:6, 2002:213; Di Lernia 2002:240). This fact is well illustrated with the stereotype of 'The herder and his sheep', frequent among the paintings of the Iheren-Tahilahi/Wa-n-Amil style (Fig. 7), usually placed after the Post-Neolithic Arid Phase, that is to say after 4000 BP, when the Saharan climate was already comparable to the present one (Muzzolini 1995: 199). This situation is easily understandable as ovicaprids are known for their capacity to cope with very arid environments. It explains their prominent role in many human migrations, hence the low phylogeographic variation of their mtDNA compared to that of bovids (Luikart et al. 2001:5931; MacHugh and Bradley 2001:5384).

During the 4th millennium BP, megalithism spreads throughout South Fezzân, and this movement coincides with a greater drying out. Large necropolises appear around 3000 BP, and mark the beginning of the Garamant Period (Di Lernia and Manzi 2002). Life was still possible in the central Sahara, provided people stayed in areas with available surface water (or with water near the surface). Offerings of stone dates in some tombs of the Wâdi Tanezzuft (south-western Fezzân) during the second half of the 4th millennium BP constitute an significant milestone in the history of the palm tree (Phœnix dactylofera L.) in the Sahara (Di Lernia and Manzi 2002:174). The irrigation technique by way of the so-called foggârât (subterranean channels) was introduced from Egypt to the central Sahara during the second half of the 1st millennium BC, allowing a better adaptation to an environment henceforth extremely arid (Mattingly 2003:265).

CONCLUSIONS

Without trying to link systematically all significant events in the history of mankind to climatic events, and without going as far as to say that 'climate makes history' (Hsü 2000), some important human adaptations (Fig. 4) must have been regionally induced by shifts as important as the rapid warm-up which began at the Pleistocene/Holocene time boundary around 10,000 BP, as the Mid-Holocene Arid Period which dominated the Saharan climate around 6900 BP, or as the '4000 BP Event' which lasted from 4400 BP to 3800 BP and which correspond to the Post-Neolithic Arid Period in the Sahara (Figs 1, 2). These important events, perceptible on a worldwide scale, are shown by the solar-output variations (Perry and Hsü 2000: Fig. 2), by the sea-level fluctuations (Ters 1987), and by the number of lakes in the Sahara (Petit-Maire 2002:74). All these events are likely to have prompted, or at least encouraged, significant movements of population.

Prolonged droughts, as indicated by natural archives, involve cultural responses indicated by human archives or excavated by archaeologists. It has already been suggested that the decline or the fall of several civilisations were due to diverse 'mega-droughts'. This is the case in Mesopotamia, where the Akkadian empire collapsed around 4170 ± 150 BP as a result of an abrupt desertification, which lasted three centuries. In North America, the Anasazi people (ancestors of the Pueblos) abandoned their villages during the 26 years of the 'Great Drought', which began in 1280. Similarly, the fall of the Classical Maya Empire coincides with the beginning of very arid conditions in the Yucatán Peninsula between 1300 and 1100 BP (deMenocal 2001).

In the central Sahara, the onset of the Holocene Climatic Optimum coincides with the arrival of people who repopulated the territories abandoned since the Post-Aterian Hyperarid Period, and who made the first known pottery in the continent. After the Mid-Holocene Arid Period, the inhabitants of the Sahara shifted to cattle farming as long as the climate allowed it. They were nomads moving away from their main quarters to look for pasture during the humid season, going back to the massifs with their herds during the dry season. When climatic conditions deteriorated significantly, they shifted from cattle to ovicaprid farming, as sheep and goats are much more adapted to the harsh environment where they had to live thereafter. As the climate deteriorated further, they had to progressively settle near the places where water was still available or easily accessible. Then developed the Garamantic civilisation, mostly in these places of the Wâdi el-Ajâl where the foggârât made it possible to irrigate, hence to cultivate in a hyper-arid environment. Settlement, cultivation and reduction of the living space correspond to the latest adaptive phase to the regional desiccation. Citadels, monumental tombs and necropolises grew in number, and the whole situation began to prefigure the present oasis and their way of life based on the trans-Saharan traffic. The current image of the Saharan life was coined at that time, particularly with the introduction of the palm-tree (Fig. 4), an element essential for life in the oasis. Around the beginning of the Common Era, the newly introduced dromedary (Fig. 8) allowed Saharan people to fully recover the Sahara and to retain control of this huge territory, till modernity lately changed the rules of the game.

Pretending to free oneself from the climatic laws, modern man uses the most recent techniques - financed by the oil manna - to shape a large part of the Sahara just as he wishes. Systematic exploitation of fossil water allows a seeming improvement of the landscapes, which artificially grow green again, particularly in Fezzân. Now it could be appropriate to meditate the Garamants' posthumous lesson: thanks to the foggârât technique, they overexploited the Fezzanese Sahara, and built a powerful State (Mattingly 2003: 369) ... but their needs soon exceeded the renewing capacities of their natural resources, and they were bound to disappear.

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