The Acheulian Site of Gesher Benot Ya‘aqov

Volume II

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Volume II

Ancient Flames and Controlled Use of Fire

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For us nothing is more common than fire; but man could have wandered in the desert for millions of years without once having seen fire on earthly soil. Let us grant him an erupting volcano, a forest set on fire by lightning; hardened in his nakedness against the rigors of the seasons, would he have run forward at once to warm himself? Would he not rather have taken flight?

(Bachelard 1938:23)

Foreword

A View from Western Europe

Most archaeologists would agree that the emergence of stone tool manufacture and the management of fire are the two most significant events in the cultural evolution of early humans. The oldest known stone artifacts are securely dated to 2.6–2.5 Ma at several localities in Ethiopia; their association with ungulate remains and observations of cut marks prove that one of their main functions was for butchery (Domínguez-Rodrigo et al. 2005). The record of early stone tools from a number of sites in the time span 2.5–2.0 Ma is unequivocal; tool use and manufacture were a regular activity with evidence of planning, foresight and considerable technical skills (Delagnes and Roche 2005). In contrast, the timing of the human control of fire is not fully resolved and the antiquity of its habitual use has been debated until now.

This book provides very strong evidence of the habitual use of fire by early humans at the Acheulian site of Gesher Benot Ya'aqov (Israel). The sedimentary sequence at the site is 34 m thick, and it represents different depositional environments, mainly beaches along the margins of a paleo-lake. The Matuyama-Brunhes chron boundary, dated to 0.78 Ma, occurs in the lower part of the sequence. The 15 archaeological levels discussed in the book occur above this boundary and clearly indicate repeated occupations over a long span of time; the lowermost occupation level occurs 4 m above the Matuyama-Brunhes boundary, and the highest is 13 m above the boundary. The duration of the entire depositional sequence at GBY is estimated as ca. 100 kyr.

The evidence is strong because it is based on different kinds of data, in particular the fact that burned microartifacts (≤2 cm) occur in localized concentrations in many superimposed archaeological levels. Similar approaches to the spatial distribution of lithic artifacts and burned ecofacts as a way to locate "invisible" hearths have been used by archaeologists working on Mesolithic open-air sites in NW Europe (Sergant et al. 2006). At many of these open-air sites, hearths are "invisible" because they are not stone-built, charcoal and ash remains have disappeared as a result of postdepositional processes, such as wind and rain, and reddening of the soil did not occur due to a lack or low amount of iron in the sandy soils. The presence of hearths is revealed by the spatial clustering of burned items, that is lithics and burned hazelnut shells. When research on the use of fire and "phantom hearths" started at the GBY site, those approaches were unknown to the Israeli scholars; the convergence on the use of spatial analyses to locate invisible structures at sites of very different ages is a comment on the adequacy of the methodology used in this book.

More importantly, of the 15 assemblages analyzed in this book, five contain clusters with frequencies of burned microartifacts in the order of 3.7–5.8%. As noted by Alperson-Afil and Goren-Inbar in Chapter 4, these values are comparable to frequencies of burned microartifacts 1–3 cm in size at Magdalenian sites in Western Europe, in particular at two sites, Hauterives-Champréveyres and Monruz, both located on the shores of the Neuchâtel Lake in Switzerland and dated at around 13,000 BP. At these sites, the hearths (40 at Monruz, 11 at Hauterives-Champréveyres) are exceptionally well preserved; they are very visible structures with heated

slabs, charcoal and burned bones (Leesch 1997; Bullinger et al. 2006). The spatial analysis of microartifacts at these two sites was done explicitly with the purpose of demonstrating the significance of burned microartifacts for indicating the actual location of an "invisible" hearth, better than the distribution of macroartifacts, which are often rejected away from the combustion area.

The review of the earliest sites with putative evidence of fire (Chapter 1) shows that the evidence (charcoal, heat-altered sediments, burned stones, burned bones and ash) is often fragmentary and judged insufficient. The strongest claims are from Member 3 of Swartkrans (dated to 1.9–1.65 Ma) and Koobi Fora (site FxJj 20, dated to 1.5 Ma). At those sites the heating of bones was supported by ESR analyses of bone and TL analyses of reddened sediments, respectively. Since the lithic assemblages of GBY demonstrate the introduction of African biface-making techniques into Eurasia, the authors argue that fire-making too may reflect an African tradition and a wave of human migration out of Africa (Section 4.5).

Did control of fire play a role in the colonization of Europe?

The colonization of Europe, especially of the regions where temperatures at times dropped below the freezing point, is generally tied to the use of fire. Yet evidence for fire in the Early and early Middle Pleistocene is extremely weak or more exactly negative until about 400 ka. The review of early European sites provided in Chapter 1 shows that good evidence of fire (burned artifacts dated by the TL method, and burned bones and patches of reddened earth, interpreted as remnants of fireplaces) comes only from two sites dated to MIS 11, i.e. about 400 ka, Beeches Pit in England and Schöningen in Germany. At Terra Amata (France), in addition to artifacts dated by TL, there was one clear charcoal concentration; the charcoal was identified as *Pinus sylvestris.* The age estimates of the site vary between 230 ± 40 ka and 380 ± 80 ka (Villa 1983; Falguères et al. 1988). By MIS 7 and 6, several other sites provide evidence of the use of fire, although visible fireplaces were often not preserved: e.g. Vaufrey, La Cotte de St. Brelade, and Orgnac. At some sites overlapping palimpsests of fireplaces formed large combustion areas (Bau de l'Aubesier, Grotte XVI).

Of direct relevance to European prehistory are sites that do *not* have traces of fire, yet might be expected to have such evidence. In Table i I present the current state of our knowledge in Western Europe and include early sites that do not have evidence of fire. In addition, I include evidence of fire originating from sites younger than those discussed in Chapter 1, thus complementing the review of early European sites.

I have excluded many open-air occurrences in fluviatile or clearly disturbed contexts and some sites with ambiguous or underreported evidence. Burned flint artifacts have provided TL dates at two sites: Biache St. Vaast (175 ± 13 ka, mean age of layer IIA; Tuffreau and Sommé 1988) and Maastricht-Belvedere (ca. 250 ka for Unit IV C; Roebroeks 1988) but I have no further information. Two Spanish sites that seem to be of Late Matuyama age, Cueva Negra (a rock shelter in the Estrecho del Rio Quípar, Murcia province; www.um.es/antropofisica/english/cuevanegra.html) and La Boella near Tarragona (open-air site; www.diaridetarragona.com/) are not included because current investigations are too preliminary. By MIS 4 and 3, Mousterian sites that have evidence of fire (concentrations of charcoal, burned bones, stone-lining) are numerous (I count at least 20 in France), so they are not listed in the table except for cases of stone-lined fireplaces, which are uncommon occurrences prior to the Upper Paleolithic.

Table i shows that evidence for the use of fire in the earliest European record, prior to 400 ka, is lacking. It can be argued that sites such as those in the Orce region, Isernia and Venosa Notarchirico have been affected by water transport and that Boxgrove may represent brief occupations and butchery episodes. Eight charcoal particles have been found at Boxgrove, and one charcoal fragment was found in a layer above the main occupation level. Clearly we

Table i Fire and fireplaces in Pleistocene Western Europe. Abbreviations. – = unreported; ? = unlikely or unclear or insufficiently described; yes = reported in some detail, sometime confirmed by TL dates on burned flint; no = reported as absent; A = charcoal analyzed by a botanist. Site type: O, open air; C, cave; E, enclosed (doline, rock shelter). Hearths = structured, spatially defined features presenting a concentration of burned items (ash, charcoal, heated slabs, reddened sediment, burned bones, burned artifacts); one attribute alone may be insufficient, it is the combination or the spatial concentration of at least some attributes that is significant

Site	Site type and reference no.	Age	Charcoal	Burned stones or artifacts	Burned bones	Burned sediments	Hearths	Evidence of fire
Fuentenueva 3, Barranco Léon (Orce)	O (1)	Late Matuyama, probably 1.3/1.2 Ma	–	–	–	–	–	–
Sima del Elefante (Atapuerca)	C (1)	> 800 ka?	–	–	–	–	–	–
Gran Dolina, TD 6 (Atapuerca) (24)	C (1–3)	800 ka	–	–	No	–	No	No
Isernia (central Italy)	O (4)	606 ± 2 ka $^{40}Ar/^{39}Ar$	–	–	??	??	No	No
Venosa Notarchirico (southern Italy)	O (4)	640 ± 70 ka on tephra by TL on quartz grains	–	–	No	–	No	No
Boxgrove (England) (21)	O (5)	MIS 13 Ca. 500 ka	A Dispersed	–	No	–	No	No
Arago; Layers D-Q (southern France)	C (6, 7)	> 350 ka MIS 12–14	No	No	No	–	No	No
Schöningen 13 I (Germany)	O cf. Chapter 1 and (8)	MIS 11 Ca. 400 ka	–	Artifacts (TL dates)	–	Yes	No	Yes
Beeches Pit (England)	O cf. Chapter 1	MIS 11	–	Artifacts (TL dates)	Yes	Yes	No	Yes
Vértesszőllős (Hungary)	O cf. Chapter 1	MIS 9/11	–	–	In concentrations	Patches	No	To be verified
Bilzingsleben (Germany)	O cf. Chapter 1	MIS 9/11	Yes	Yes	Yes	–	–	Likely
Barnham (England)	O (9)	MIS 11	A Dispersed	5 natural pcs (TL)	–	–	No	Not in situ
Terra Amata (SE France)	O cf. Chapter 1 (10, 11)	380 ± 80 ka (ESR) 230 ± 40 ka (TL)	A Localized	Artifacts (TL dates)	Yes	?	Flat lens	Yes
Orgnac 3; Layers 2, 6 (southern France)	E (12,13)	MIS 9–8	Ashes observed during excavation	–	In concentrations	–	?	Yes
Lunel Viel (southern France)	C (14)	MIS 9?	Dispersed	Burned stones	No	?	?	Not in situ
Cagny l'Epinette (Somme, northern France)	O (12)	MIS 9	–	–	Some	–	No	?
Vaufrey Layer VIII (Dordogne, France)	C (15)	MIS 7	Yes Localized	No	Some	No	No	Yes
La Cotte de St. Brelade (Jersey Island)	E cf. Chapter 1	MIS 7 and 6	Yes	Yes	Yes	Yes	Not preserved	Yes

Table i (continued)

Site	Site type and reference no.	Age	Charcoal	Burned stones or artifacts	Burned bones	Burned sediments	Hearths	Evidence of fire
Menez Dregan (Brittany), layer 5	C (16)	MIS 7, ca. 200 ka, TL on quartz grains and artifacts	A	Yes	?	Yes	?	Yes
Bau de l'Aubesier (SE France) Layer H-1	E (17)	191 ± 15; 169 ± 17 ka TL on artifacts	Charcoal and ashes	Yes	Yes	Yes	5 m^2 combustion area, 40 cm thick	Yes
Bolomor, Layer XIII and younger Layers XI, IV, II (Spain)	C (18,19,20)	MIS 7, 6 and 5e, various TL dates	Ashes in layer II	Artifacts	Yes, in layer IV	Yes	3 in layer IV, 2 with stones in layer XIII	Yes
Lazaret Cave (SE France)	C (7)	MIS 6	A localized	–	Yes	–	Flat conc.	Yes
Bau de l'Aubesier Layer IV (SE France)	E (17)	MIS 5	Yes	Yes	Yes	Yes	55 m^2 combustion area, 20 cm thick	Yes
Vaufrey Layer IV (Dordogne, France)	C (21)	MIS 5; 120 ± 10 ka, TL on artifacts	A. Burned plant material	Artifacts	Yes	Yes	Not preserved	Yes
Les Canalettes (southern France)	E (22)	Ca 70 ka	A Charcoal and coal	Stones, TL on flint artifacts	?	Yes	One stone-lined	Yes
Grotte XVI, layer C (Dordogne, France)	C (23,24)	ca 60 ka, TL dates on flint	Altered ash derived from wood and grass	Yes	Yes	Yes	Overlapping palimpsests of hearths forming a combustion zone >12 m^2	Yes
Vilas Ruivas (Portugal)	O (25)	50–60 ka	–	Burned stones	–	–	Two, stone-lined	Yes
La Combette, layer D (SE France)	E (26)	MIS 3	Charcoal	Burned stones	–	Yes	Four, flat and stone-lined	Yes
Abric Romaní (Spain)	E (27,28)	MIS 3	Yes	Yes, TL	Yes	?	Many, some stone-lined	Yes

(1) Santonja and Villa 2006; (2) Díez et al. 1999; (3) Fernández-Jalvo et al. 1999; (4) Villa and Lenoir in press; (5) Roberts and Parfitt 1999; (6) Falguères et al. 2004; (7) de Lumley 2006; (8) Thieme 2000; (9) Ashton et al. 1998; (10) Falguères et al. 1988; (11) Villa 1991; (12) Moigne and Barsky 1999; (13) Moncel et al. 2005; (14) Le Grand 1994; (15) Rigaud and Geneste 1988; (16) Mercier et al. 2004; (17) Lebel and Trinkaus 2002; (18) Blasco López 2006; (19) Fernández-Peris 2007; (20) Sanchis Serra and Fernández-Peris 2008; (21) Courty 1988; (22) Meignen 1993; (23) Karkanas et al. 2002; (24) Rigaud et al. 1995; (25) Vega Toscano et al. 1999; (26) Texier et al. 1998; (27) Pastó et al. 2000; (28) Vaquero and Pastó 2001

cannot exclude natural fires. At High Lodge, also dated to MIS 13 like Boxgrove (Ashton et al. 1992), five charcoal particles were found but they were dispersed in the deposits. No burned bones and no burned artifacts have been reported from either Boxgrove or High Lodge. Flecks of charcoal were also found at Swanscombe and Hoxne, dated to MIS 11 (Wymer 1999), but again they were dispersed in the sediments and could have been the result of natural fires; there is no evidence of burned artifacts either.

But what about occupation sites in caves which in later times have often provided striking evidence of fire, such as Bau de l'Aubesier, Grotte XVI, Lazaret and Middle Paleolithic/ Middle Stone age caves in Israel and in South Africa?

Traces of fire have been found in the upper part of the sequence at Arago, in layers younger than 350 ka, but no charcoal, no burned bones nor any other evidence of fire have been reported from the lower levels of Arago (dated to MIS 12–14). This is surprising because taphonomic analyses have been carried out (e.g., Moigne and Barsky 1999), and there are paleontological papers and doctoral theses on specific taxa (e.g., Monchot 1996); faunal and lithic remains are very abundant.

No burned bones or burned artifacts have been reported from Gran Dolina, layer TD6. Rare charcoal particles have been found in micromorphological slides, but the origin of the sediments is from the exterior of the cave, and there is evidence of low energy transport (Valleverdú et al. 2001); thus the charcoal may not be in situ. However, the high density of human, faunal and lithic remains, and their state of preservation and refitting (Díez et al. 1999; Fernández-Jalvo et al. 1999) clearly indicate an occupation in situ with little postdepositional disturbance. In sum, both at Gran Dolina TD6 and at Arago, layers D to Q, this absence of evidence of fire is in need of an explanation.

I have suggested in the past (Villa and Bon 2002) that absence or non-systematic use of fire may be one of the reasons why the settlement of Europe took a rather long time. Prior to 400,000 years ago the total number of sites is quite small, and this suggests rather sporadic and discontinuous settlement patterns. Only from MIS 11 onward does the utilization of fire become a significant feature of the record.

I think now that the evidence from GBY should encourage European archaeologists to take a closer look at their data, in particular microartifacts, and to investigate taphonomic and diagenetic processes that may explain the disappearance of fire traces. In the absence of such detailed studies, explanations for the absence of fire at the Early and early Middle Pleistocene European sites would be flawed and may be short-lived.

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Preface

The discovery of evidence for fire at Gesher Benot Ya'aqov was not part of our expectations from the outset; nor was the study of fire, its control and its cultural implications initially among the many and diverse goals of the project. The discovery illustrates the fascination and unpredictability of the archaeological discipline. The presence of fire at the site, and its occurrence in all of the prehistoric occupations revealed during seven field seasons, turned it into a major research objective. The results of this research are presented in this volume.

The origin of the research lies in the proximity of the Gesher Benot Ya'aqov Acheulian site to the Jordan River. This resource was exploited for the wet-sieving of all the sediments removed during excavation. The apparatus was constructed in such a way that the excavators could sit on small stools in the river and operate hanging sieves of 2 mm mesh, which were submerged in water. All sieved material larger than 2 mm was washed, dried, and later sorted. It was during this sorting process that the flint microartifacts that form the bulk of the database of this study were collected and later analyzed.

The small lithic component could not be identified during excavation, due to the waterlogged nature of the sediments, the dark color of the deposit, and the necessity to shade the excavated surface from the sun and moisten it continuously to preserve the organic materials (wood, bark, fruits and seeds) embedded in it. Thus, the recovery of burned flint microartifacts during sieving in the field was accidental, and was later verified in the lab at Kibbutz Gadot, where the expedition was lodged throughout the field seasons. This fortuitous discovery led to a prolonged study of the evidence for fire in all of the archaeological horizons of the Gesher Benot Ya'aqov excavations.

The identification and sorting of microartifacts of all raw materials was carried out at the Institute of Archaeology of the Hebrew University of Jerusalem, a procedure that necessitated the involvement of many individuals. The sorting, which lasted from 1989 to 2007, was carried out by students; most of them had no previous experience in archaeology and came from different departments of the Faculty of Humanities, School of Law, School of Education and Faculty of Social Sciences.

The broken hearts and many other non-archaeological issues that were discussed while tweezers and brushes were operated could have been the subject of an extensive sociological study in themselves. We achieved the sorting of over half a million microartifacts, and the children of the first sorters will probably appear as students of the Hebrew University very shortly.

The order and magnitude of the task we planned made some of the funding agencies very skeptical about the feasibility of the proposed research. One perceived disadvantage was the lack of similar attempts, though they are widespread nowadays. Clearly, the task of sorting needed perseverance more than anything else. Important changes took place throughout the years of sorting and analysis. For example, the GIS and other program packages developed tremendously. The first attempts to explore the applicability of GIS programs to the distribution of microartifacts were rejected by experts, due to lack of experience in intra-site projects and the overwhelming size of the database.

We have carried out this task with a deep sense of duty and with constant curiosity and anticipation. Indeed, every archaeological excavation brings with it the obligations of recovering,

recording and preserving, which are all components of the attempt to reconstruct ancient cultures and past ways of life. At prehistoric archaeological sites, where we rarely encounter constructed features (not to mention monumental structures or historical records), we must endeavor to make the most of the data retrieved. Throughout the course of this study we were guided by the concept of *structures latentes*, first established by Leroi-Gourhan. This concept recognizes the fact that the archaeological record conceals information that is not visible at first sight, since it does not exhibit directly observable features. Accordingly, ancient fireplaces were embedded within the archaeological levels at GBY, though they lacked apparent color, constructed contour or clear accumulations of ashes and burned material. Their presence could be discerned only through careful examination of spatial patterns, particularly those of the small lithic items.

The use of the *structures latentes* concept at GBY enabled the remarkable discovery of Acheulian hearths. Moreover, the fact that such hearths are recorded throughout the long archaeological sequence suggests that fire was not only used but *controlled* by the Acheulian hominins of GBY as early as 0.79 million years ago. Conclusions like these, and their implications for the archaeological, anthropological and evolutionary sciences, illustrate the great potential of such studies. For us, despite the immense amount of time and resources required to accomplish the task, this long journey was truly worthwhile, as it enabled us to recognize an exceptionally significant aspect of the lives and behavior of the GBY hominins.

Jerusalem, February 2009

Nira Alperson-Afil
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Acknowledgments

The realization of this volume, an almost impossible task that could not have been accomplished by a single person, is the result of the work of many individuals and an enormous number of working hours. Despite the attractions of the research subject, the amount of work necessary to accomplish the study put off more than a student or two. While the task initially seemed easy due to the small number of burned flint items, with progress it became evident that each of the archaeological horizons encompassed these artifacts and that the job waiting to be done was enormous.

The fieldwork at Gesher Benot Ya'aqov was supported over the years by the Leakey Foundation, the National Geographic and the Hebrew University of Jerusalem. The laboratory work was supported over the years by the Leakey Foundation, the Irene Levi-Sala CARE Archaeological Foundation, the Israel Science Foundation (several grants) and the Hebrew University of Jerusalem. Part of the work was carried out by the Center of Excellence, supported by the Israel Science Foundation (grant No. 300/06). The study of burned flint microartifacts was supported by grants from the German–Israeli Foundation (GIF I-896–208.4/2005) and the Israel Science Foundation (grant No. 886/02). We also wish to thank the Faculty of Humanities, Hebrew University of Jerusalem, and the Ruth Amiran Fund of the Institute of Archaeology, Hebrew University of Jerusalem, for their support of the publication of this volume.

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