New Evidence for the Northern Dead Sea Rift Acheulian

GONEN SHARON
Institute of Archaeology, The Hebrew University of Jerusalem, Jerusalem 91905, ISRAEL; gonen.sharon@mail.huji.ac.il

CRAIG FEIBEL
Department of Geological Sciences, Rutgers University-New Brunswick, Piscatewy, NJ 08854, USA; feibel@rci.rutgers.edu

NIRA ALPERSON-AFIL
Institute of Archaeology, The Hebrew University of Jerusalem, Jerusalem 91905, ISRAEL; alperson@mscc.huji.ac.il

YEHUDIT HARLAVAN
Israel Geological Survey, ISRAEL; y.harlavan@mail.gsi.gov.il

GILBERT FERAUD
Géosciences Azur, CNRS, Université de Nice-Sophia Antipolis, 06108 Nice Cedex-02, FRANCE; present address: LRSAE,Université de Nice-Sophia Antipolis, 06108 Nice Cedex-02, FRANCE; Gilbert.Feraud@unice.fr

SHOSHANA ASHKENAZI†
National Natural History Collections, The Hebrew University of Jerusalem, Jerusalem 91905, ISRAEL; †deceased

RIVKA RABINOVICH
National Natural History Collections, The Hebrew University of Jerusalem, Jerusalem 91905, ISRAEL; RIVKA@vms.huji.ac.il

DEDICATION
In memory of our dear friend Shosh Ashkenazi, a lover of nature in all of its forms.

ABSTRACT
A new Acheulian locality, NBA (North of Bridge Acheulian), was discovered north of the well-known Early-Middle Pleistocene site of Gesher Benot Ya´aqov (GBY) as a result of a massive drainage operation of the Jordan River in 1999. A preliminary test excavation enabled reconstruction of the stratigraphy of the site's layers. The Ar/Ar date of 658±15 ka was determined for a basalt flow located immediately below the NBA *in situ* archaeological horizon, and is one of the few known dates for any Acheulian site in the Levant. The site's rich surface collection includes a lithic assemblage resembling that of the nearby GBY Acheulian site and is dominated by basalt handaxes and cleavers. However, the assemblage has some marked differences from that of GBY, enlarging our understanding of Levantine Acheulian variability. The NBA fauna resembles that of GBY in the species represented and in its molluscs. The main contribution of the NBA assemblage comes from the confirmation of certain aspects of the GBY lithic industry and from the few but marked differences that do appear between the assemblages. These differences deepen our knowledge of the behavior and ways of life of Acheulian hominins on the shores of the Paleo-Hula Lake during the Early Middle Pleistocene.

INTRODUCTION

In its outlet from the Hula Valley in the Northern Dead Sea Rift, the Jordan River cuts through layers of sediments ranging in age from the Pliocene to the Holocene. Numerous drainage operations took place in this area from the 1860s onward, with the purpose of lowering the water level of Lake Hula in order to create addigional agricultural land. Archaeological remains retrieved during these operations led to the identification of important archaeological sites, primarily in the area of the Benot Ya´aqov Bridge (e.g., Goren-Inbar et al. 2002; Sharon et al. 2002; Stekelis 1960; Figure 1). After many years of excavation and surveying, this area has become one of the most important for understanding the Acheulian phase in human evolution. In

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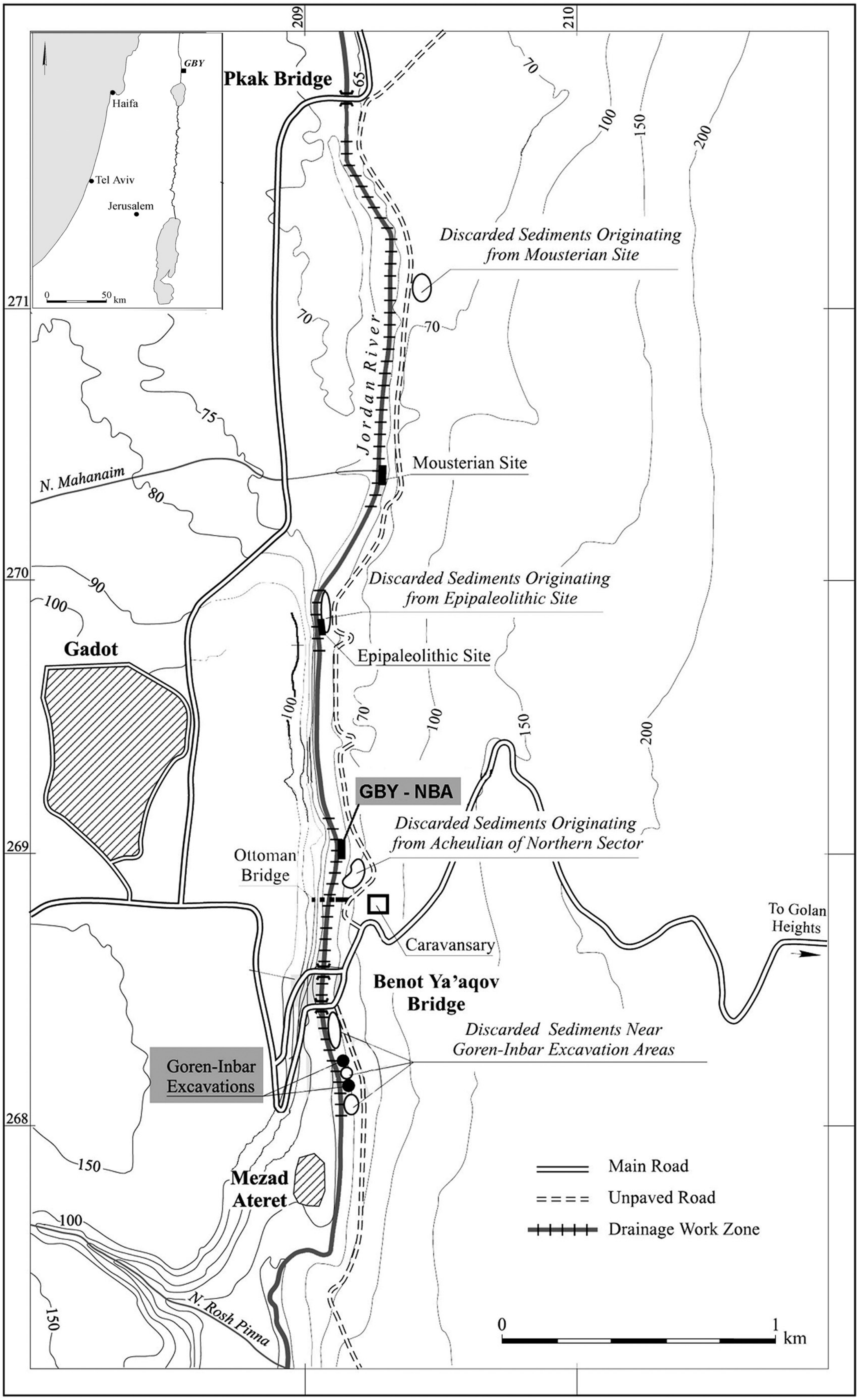

Figure 1. Location map of NBA along with other archaeological sites in the vicinity of the Benot Ya´aqov Bridge.

particular, the 1989–1997 Gesher Benot Ya´aqov (GBY) excavation project (Goren-Inbar et al. 2000) significantly contributed to our understanding due to the excellent preservation of its finds, including botanical remains (Belitzky et al. 1991; Goren-Inbar et al. 2002a; Goren-Inbar et al. 2002b; Melamed 1997), a unique lithic assemblage (Goren-Inbar and Saragusti 1996; Sharon 2007) and a well-established date for the site (Goren-Inbar et al. 2000).

This paper focuses on the results of a geo-archaeological survey of a new Acheulian locality that was exposed north of the Benot Ya´aqov Bridge during a drainage operation in 1999 (see Figure 1). The finds of the survey and test excavation have expanded our knowledge of the GBY Acheulian behavior and of the site's environment. In addition, the new site presented a unique opportunity to obtain a radiometric date for its archaeological layers that has expanded the duration of the Acheulian presence on the banks of Paleo-Hula Lake well into the Middle Pleistocene.

The pioneer researchers of Pleistocene layers in this region worked mainly north of the present-day Benot Ya´aqov Bridge (see Figure 1; Goren-Inbar and Belitzky 1989; Goren-Inbar et al. 2002; Stekelis 1960). Stekelis excavated and surveyed along the Jordan River banks north of the bridge in 1936–37 and again in 1951. Indeed, many archeological find spots were identified by Stekelis (1960) who also suggested a very general stratigraphy for the GBY prehistoric sequence. This stratigraphy includes layers of gravels and clays in which were found the mollusc *Viviparus* sp. The presence of *Viviparus* sp. was used to define these strata as part of the Benot Ya´akov Formation (Stekelis 1960). Numerous faunal remains were recovered, dominated by elephant bones, including a complete tusk. Some of the bones were interpreted as bone tools (Stekelis 1960). The lithic assemblage of these layers included basalt handaxes and cleavers, as well as some flint handaxes. A similar industry was excavated during the 1980–90s GBY Acheulian excavations (Goren-Inbar and Saragusti 1996). Unfortunately, none of the layers described by Stekelis and later by Gilead (1970) can be observed today, probably due to their removal during the course of past drainage operations.

Between 1936 and 1951, drainage operations lowered the channel of the river by more than six meters and even further during the early 1970s and again, most recently, in 1999. These operations caused significant damage to the potential sites. As early as the 1930s, Stekelis noted that:

> "A difficult problem arose because of the specific conditions of the site when deciding where to dig. For many kilometers the banks were mostly covered by heaps of gravel and mud left there after completion of the drainage work, and it was out of the question to remove this debris. There was thus little space available for archaeological work" (Stekelis 1960, 63).

Since then, over two million tons of sediment were excavated and removed from the banks of the Jordan River during the Hula Lake drainage operations, creating the artificial channel in which the present day Jordan River flows (Sharon et al. 2002). Therefore, correlating the context of previous excavations (both horizontally and vertically) with the layers exposed today by the current channel of the Jordan River is extremely challenging.

THE NEW ACHEULIAN SITE NORTH OF THE BENOT YA´AQOV BRIDGE

During the fall of 1999, the Kinneret Drainage Authority once again undertook a large-scale operation to deepen the Jordan River at its outlet from the Hula Valley. This operation caused massive damage to the already badly disturbed archaeological and geological layers in the area (Goren-Inbar 2004; Sharon et al. 2002, for a detailed discussion). During many visits to the area over the course of the drainage operation, large quantities of Acheulian tools and fossil bones were identified and collected along the river and from the piles of the Benot Yaˈakov Formation (BYF), in the site now known as North of Bridge Acheulian (NBA). In addition, find spots were located on both banks of the Jordan River, about 500m north of Benot Ya´aqov bridge at about 60m above sea level (coordinates 33°00'53''N and 35° 37'46''E, see Figure 1). During 2002, a joint geo-archaeological survey, initiated by the Hebrew University and the Israel Antiquity Authority, was conducted in an attempt to record new data revealed by the massive disturbance of the sediment.

STRATIGRAPHY

Although the geology and stratigraphy of both BYF and the site GBY have been described in detail recently (Belitzky 2002; Goren-Inbar et al. 2000; Goren-Inbar et al. 2002) the correlation between these localities south of the bridge and the BYF layers north of the Benot Ya´aqov Bridge is still unclear due to massive tectonic disturbance and 150 years of drainage operations (see Figure 1). The BYF consists of a series of lacustrine and fluvial strata representing changing water levels and the different environmental conditions under which they accumulated (Belitzky 2002; Feibel 2004; Goren-Inbar et al. 2000). In the area north of the Benot Ya´aqov Bridge, the sand and silts of the BYF seem to interfinger with basalt flows of varying thickness. These basalt flows created the Jordan River bottleneck at its Hula Valley outlet and dictate the shallow nature of the water there (see Sharon et al. 2002 for references). Most significantly, the inter-fingering of basalt flows within the BYF suggested great potential for dating the NBA archaeological layers (see Ar/Ar Dating below).

The geological and stratigraphic data of this study were obtained from a series of sections that were cut into the east bank of the Jordan River and from geological cores that were drilled to a depth of 10 meters along the river as part of the 2002 geo-archaeological survey. In addition, the excavation of a small area ($2m^2$) exposed at section 02-5 is the basis for many of the observations presented below. The excavation yielded an *in situ* assemblage of many un-rolled Acheulian tools interpreted as part of an *in situ* archaeological horizon. Though small, this excavation provides a

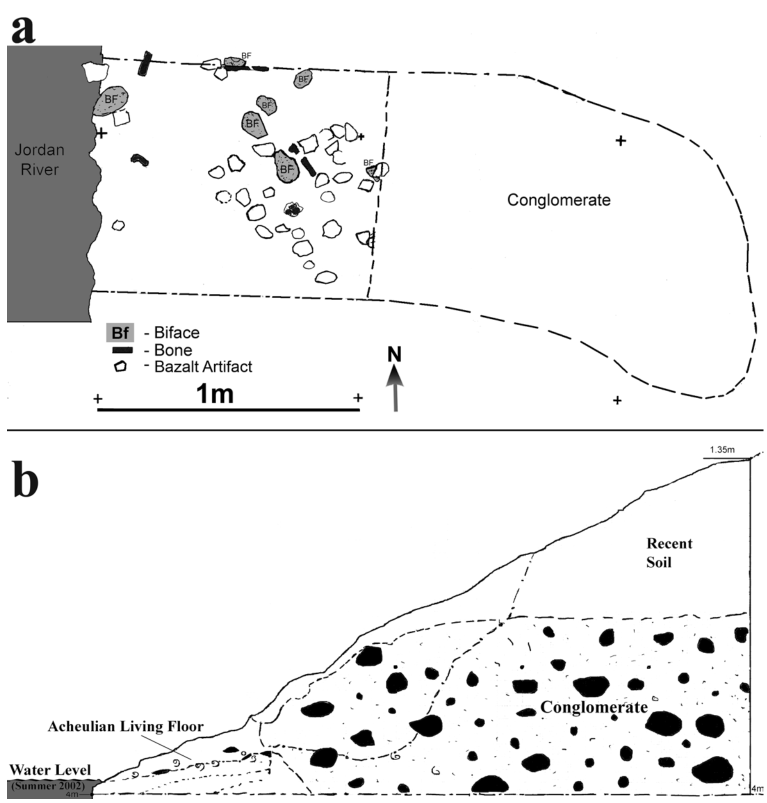

Figure 2. a: Acheulian archaeological horizon at Section 02-5 NBA; b: North Face of Section 02-5 NBA (drawing by B. Madsen); figure after Sharon (2007).

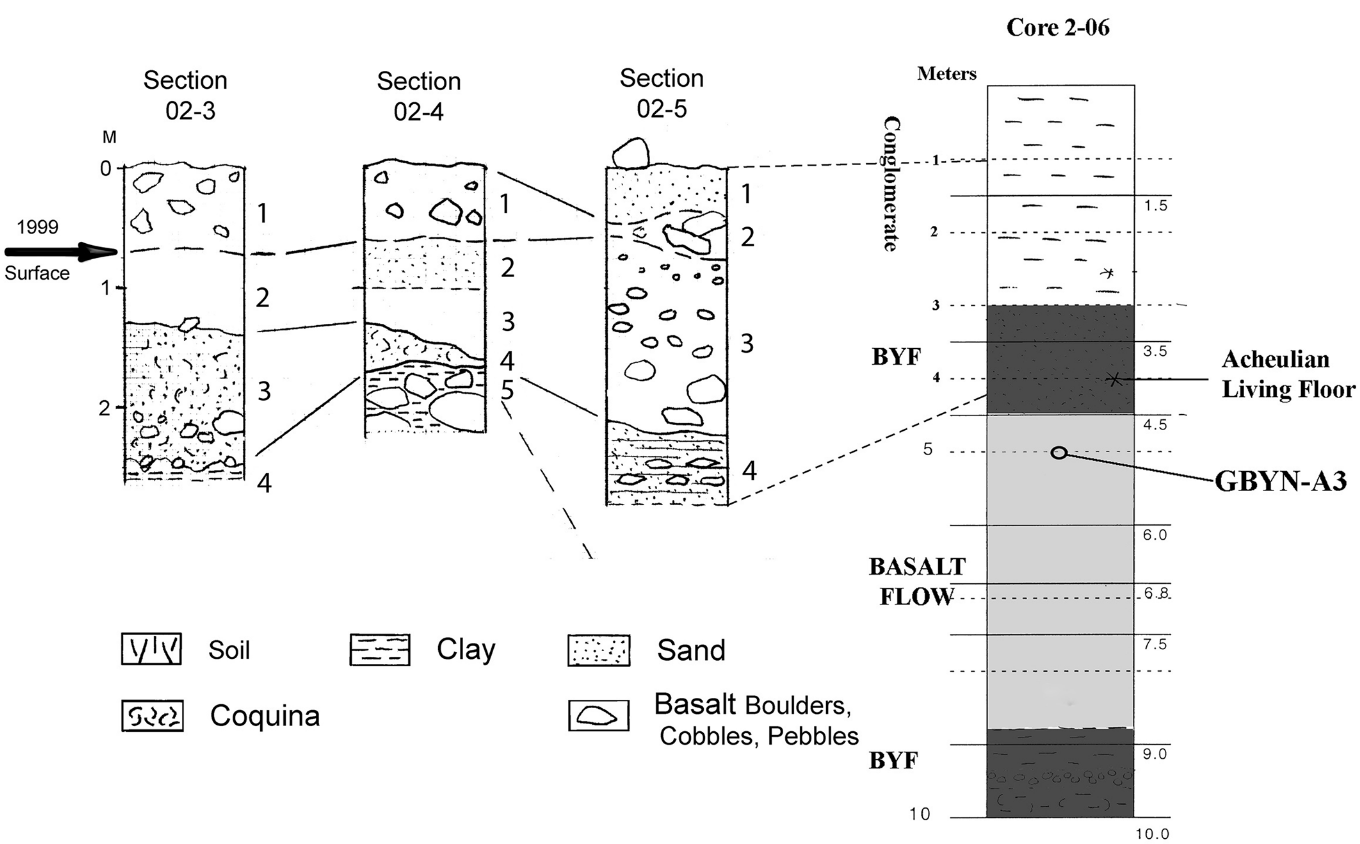

Figure 3. a: Jordan River, East Bank Sections 02-3, 02-4 and 02-5 after Sharon (2007); b: Log for core 6-02 showing relation between basalt flow and Benot Ya´aqov Formation, as well as the approximated location of the Acheulian archaeological horizon.

Figure 4. Artifact collection (during a twenty minute visit in the summer of 2000) of Acheulian bifaces, bones (upper right), and spheroids (upper left). Figure after Sharon (2007). Scale 10cm.

source of observations that are not based solely upon surface collected artifacts (Figure 2).

At the base of this section is a layer of gray, basaltic sand that is probably part of the BYF. This layer is overlaid by un-weathered basalt flow, approximately 4m thick. On top of the basalt are BYF tool-bearing layers containing tools and bones in mint condition (Figure 3: Layer 4 in section 02-5). The upper part of this section (see Figures 2 and 3: Layer 3 in section 02-5) is comprised of a conglomerate of pebble-to-boulder sized basalt and small flint clasts, in which heavily rolled Acheulian artifacts are abundant. In many instances tools excavated from this layer show evidence of breakage of handaxe tips and notched tool edges, indicating transportation in a high-energy stream environment (see below).

Hundreds of bifaces and other stone artifacts, as well as animal bones, were collected from sediment piles dumped some 100m east of the Jordan River (Figure 4; see also Sharon et al. 2002). Obviously, it is not known how many archaeological layers they represent; however, based on the collections' diversity and preservation state, it is clear that the origins of the NBA assemblage lie in several different depositional environments. In addition, because some of these tools were found in mint condition, it can be argued that they originated from a primary context, similar to the finds from the archaeological horizon of Section 02-5 found during the 2002 survey (see Figure 2).

^{40}AR/^{39}AR DATING

The NBA site provides a unique opportunity to set a time frame for the Acheulian occupation in the region. Two basalt samples were dated. GBYN-A1 was sampled from the basalt flow exposed at the eastern bank of the Jordan River ca. 5m south of Section 02-5. GBYN-A3 was taken from Core 2-06 at a depth of 5m (see Figure 3). Samples were dated using the Ar/Ar method at CNRS Geosciences Azur Laboratory, Nice, France (Figure 5). Samples were irradiated for one hour under cadmium shielding at the Hamilton McMaster University nuclear reactor, Canada, in position 5C along with the Alder Creek sanidine neutron fluence flux monitor (age of 1.19 Ma). The mass correction factors are (^{39}Ar/^{37}Ar) Ca=7.30x10^{-4} (± 3%), (^{36}Ar/^{37}Ar) Ca=2.82x10^{-4} (± 1%) and (^{40}Ar/^{39}Ar)K=0.001 (±3%). The plateau age is calculated using a minimum of three successive steps which consist of at least 70% of the ^{39}Ar released where all apparent age-increments agree with within 2σ level.

The sample GBYNA3 displays a plateau age at 664±20 ka. The first low temperature steps show higher apparent ages that are probably the result of recoil of ^{39}Ar during the irradiation. The high temperature ages probably correspond to the partial degassing of Ca-rich minerals, as pyroxene and plagioclase, as shown by the higher $^{37}Ar_{Ca}/^{39}Ar_{K}$ ratios. Nevertheless, the recoil effect is apparently very low in this sample and this plateau age may be considered as valid.

The sample GBYNA1 displays a more complicated age spectrum affected by ^{39}Ar recoil. In that case, lower ages at high temperature correspond to ^{39}Ar gain in low-K, high-Ca minerals. The true age is more probably given by 4 intermediate temperature steps giving a weighted mean age of 651±23 ka, concordant to the GBYNA3 plateau age.

A calculated weighted mean age of 658±15 ka is consid-

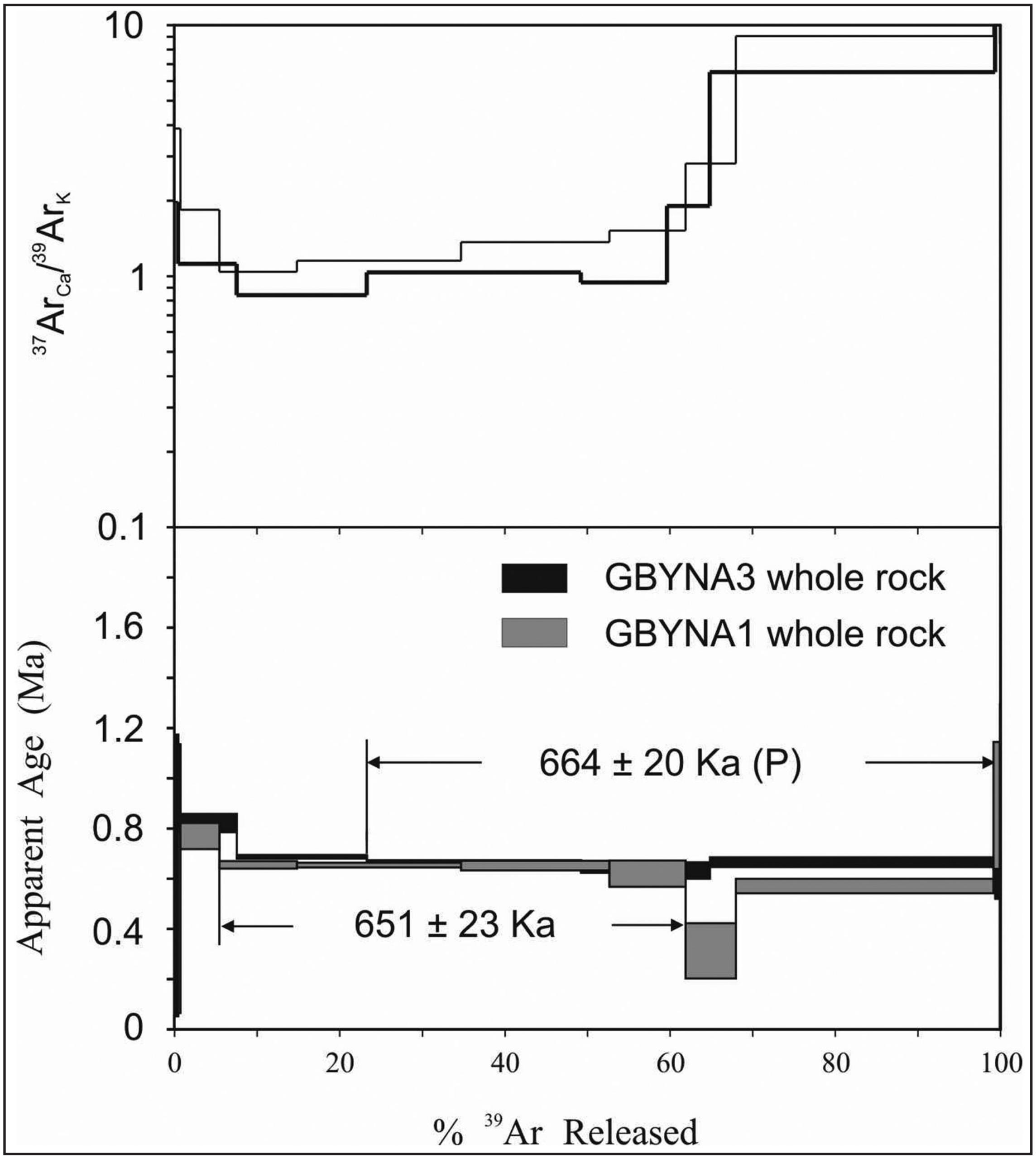

Figure 5. Ar-Ar spectra of two basalt samples.

ered as the valid age of the basalt, which also sets the older constraint on the archaeological horizon age. Nevertheless, in order to establish a more precise estimation for the actual age of the archaeological horizon it is essential to estimate the time elapse between the formation of the basalt flow and the occupation of the Acheulian layer in section 5-02. Since the basalt appears to be unaffected by either weathering or erosion, we argue that this basalt flow was covered by sediments shortly after its formation. In addition, the sandy sediments of BYF in this location seem to indicate a high depositional rate (Feibel, C., personal observation). Finally, the tools and bones excavated from this layer are also very fresh and were most probably buried promptly by the overlaying sandy sediments.

This accepted age is further supported by the comparison to the age obtained for the nearby GBY site. The magneto-stratigraphic age of the equivalent type section (Layer II-6) at the GBY excavation is slightly younger than 790 ka, since the Matuyama-Brunhes chron-boundary in Layer II-14 is situated 4m below the base of Layer II-6 (Goren-Inbar et al. 2000). The similarity in date is further validated by the observed similarity between the lithic assemblages from both sites. The current result contributes to our understanding of the span of time over which the GBY type of Acheulian existed on the banks of the Paleo-Hula Lake. In conclusion, although at this stage we cannot eliminate other possibilities, we suggest an age of ca 660 ka for the Acheulian archaeological horizon at the NBA locality.

Table 1. VERTEBRATE FAUNA DISTRIBUTION FROM NBA.

Species	**NISP**
Gazella gazella	1
Dama mesopotamica	5
Equus cf. *africanus*	1
Palaeoloxodon antiquus	15
Testudo sp.	1
Bones identified to body size groups	
BSGB (*Bos* size)	1
BSGD (*Dama* size)	5
BSGE (*Gazella* size)	1
Unidentified mammal bones*	16
Total	**46**

NISP = number of identified specimens.

*7 of the 16 unidentified bones are of elephant size.

FAUNA

Although resulting primarily from uncertain stratigraphic context, the rich faunal assemblage of the NBA Acheulian site can contribute to our understanding of the Middle Pleistocene environment of the region, particularly when compared with the well studied faunal assemblage of GBY (Rabinovich et al. in press; Goren-Inbar et al. 1994). Primary contribution comes from the presentation of the invertebrate assemblage. The molluscs of the Early and Middle Pleistocene in the Upper Jordan Valley have always been of great importance to the study of the geological formations in this region (Tchernov 1973). The data presented here is one of the only detailed reports available from a Middle Pleistocene site with an established date.

Vertebrate

The vertebrate faunal assemblage of the NBA site, though small, consists of important components that prevailed in the region during the time of the Acheulian occupation of GBY (Rabinovich et al. in press). Bones were collected from sediment piles and the surface, as well as from the Section 5-02 test excavation. The species represented (n=46) include gazelle (*Gazella gazella*), fallow deer (*Dama mesopotamica*), small equid (*Equus* cf. *africanus*), and straight-tusked elephant (*Palaeoloxodon antiquus*), as well as *Testudo* sp., excavated from Section 4-02. The rest of the bones were identified according to body size (Table 1), of which seven elements (that were too broken to be identified) are probably pieces of elephant bones due to their size and specific shape.

The straight-tusked elephant remains are fragmented but represent skull, teeth, tusk, vertebra, and limbs. The occipital condylus is represented by three bone fragments that probably constitute a single bone (NBA 293-295). Three tooth fragments can also be conjoined to one tooth (NBA 825-827). All skull parts are from surface context.

The small excavation at Section 5-02, Layer 4, unearthed several bones, representing the remains of fallow deer, equid, and elephant. Surface modifications were observed on several of these bones including carnivore scratches on an elephant spine vertebra and striations on splinters that may have resulted from post-depositional processes (Rabinovich et al. in press). One bone shows fractures that may have resulted from human modification.

The assemblage of mammalian faunal remains from NBA is small yet of great interest and significance. The presence of conjoinable pieces within this assemblage supports the suggestion that the excavated assemblage is of primary archaeological context. In general, the NBA fauna resembles that of GBY in species representation. The bones show evidence for hominin and carnivore activity as well as for post-depositional processes, indicating a complicated taphonomic history of the assemblage. Currently, not much more can be said due to the small size of the area excavated and the small sample.

Invertebrates

A preliminary study of the fossil invertebrates from NBA indicates the presence of several species that occur in GBY as part of the BYF (see below). These include freshwater molluscs and land snails as well as at least two species of ostracods, some still articulated. In addition, two very small (8–10mm) pincers of the freshwater crab, *Potamon potamios*, though poorly preserved, were found within the sampled coquina.

Though the sediments were handled in a similar manner to the very botanically rich layers of GBY, no wood, seeds or fruits were identified from the Acheulian archaeological horizon of Section 5-02.

A sample of ca. 1kg of sediment was used for further examination of the molluscs from the NBA site. The sample obtained was comprised mainly of a coquina mixed with small (5–10mm) pebbles and flint microartifacts (2–20mm). The molluscs were identified to the lowest possible taxo-

TABLE 2. NUMBER OF SPECIMENS, SURVIVAL STATUS, AND HABITAT OF MOLLUSC SPECIES FOUND IN THE NBA EXCAVATED SAMPLE.

Species	Number of specimens	Status	Habitat
GASTROPODA			
Xeropicta vestalis joppensis	3	Extant	Land snail
Xerocrassa langloisiana improbata	1	Extant	Land snail
Gyraulus crista	2	Extinct	Swamp
Melanopsis costata	950	Extant	Hard substrate, pebbles
Melanopsis costata (very wide)	2	Extinct	Hard substrate, pebbles
Melanopsis costata (developed shoulders)	17	Extinct	Hard substrate, pebbles
Melanopsis costata (weak ribs)	125	Extant	Hard substrate, pebbles
Melanopsis sp. (wavy ribs, small)	40	Extinct	Hard substrate, pebbles
Melanopsis buccinoidea	210	Extant	Hard substrate, pebbles
Theodoxus michonii	650	Extinct	Hard substrate, pebbles
Valvata saulcyi	65	Extant	Aquatic plants
Heleobia longiscata	150	Extant	Muddy sediment
Heleobia contempta	10	Extant	Muddy sediment
Heleobia sp. (wide base)	61	Extinct	Muddy sediment
Bithynia phialensis	100	Extant	Standing water, slow flow
Bithynia sp. (dwarf)	45	Extinct	Standing water, slow flow
Viviparus sp.	11	Extinct	Aquatic plants and mud
Bellamya sp.	2	Extinct	Aquatic plants and mud
BIVALVIA			
Pisidium moitessierianum	3	Extant	Lacustrine
Unioidae (fragments)	5		Muddy habitat

nomic level and their relative abundance and habitats is presented in Table 2. A small amount of sand that was released from shells of larger specimens also was examined for small (<1mm) elements. The mollusc sample comprised ca. 2,500 shells representing 20 taxa. Of these, 11 genera were identified to species or subspecies level (see Table 2). The rest were identified to family or genus level and described by their main features (in parenthesis). Examined shell sizes range between 3–12mm, while the whole fraction of small species and young specimens, as well as very large specimens, is missing. Some sediment extracted from inside the larger shells contained Ostracoda, two 0.5mm specimens of *Gyraulus crista*, and a few embryonic stages of *Theodoxus michonii* and *Valvata saulcyi*, together with small (1–2mm) Cyprinidae fish and micromammalia teeth. Very few *Bellamya* sp. and *Viviparus* sp. specimens were found in the NBA sample. The presence of the viviparids, *Viviparus* sp.and *Bellamya* sp., may contribute to the assessment of a date for the NBA assemblage; in the assemblage from GBY, these taxa occur only in the layers overlaying the MB chrono-boundary, that are younger than 790 ka. All shells in the NBA assemblage exhibit a poor state of preservation.

The differences between NBA and GBY mollusc assemblages can be summarized as follows:

1. The mollusc assemblage of NBA has a lower number of taxa (n=20) in comparison with the very rich assemblage from GBY that contains ca. 70 taxa. All NBA molluscs are present in GBY. It should be noted that a 1 square meter excavated in a section of the Jordan River bank at an Epipaleolithic site, north of NBA (see Figure 1) yielded as many as ca. 50 taxa (Sharon et al. 2002; Ashkenazi, pers. data).
2. The main difference between the molluscs from GBY and those of NBA is the notable absence of the swamp species in NBA, while in GBY they constitute a very rich and diverse group in some layers. However, the swamp species are generally very small (1–3mm) and may have been lost due to sample treatment methods. Similarly, GBY yielded rich populations of young specimens and embryonic stages that indicate seasonality, while in NBA this fraction is missing.
3. The assemblages differ also in the dominance of *Melanopsis* and *Theodoxus*, which require hard substrates for algae grazing and are most abundant in NBA, while in GBY *Valvata*, which requires a habitat of aquatic plants, is one of the

most abundant species in most layers. In addition, rich populations of *Heleobia* (muddy habitat) were not abundant in GBY while they occur in relatively large numbers in NBA.

The mollusc assemblage of NBA does not allow for any clear-cut conclusion about the similarity to the assemblages from GBY. We attribute the differences in species richness to differences in sample size that yielded more species in GBY and to the sample treatment method in NBA (flooding and washing) that removed the fine sediment along with all small fraction mollusc species and species in very young stages. This is evident by the small amount of sand found within some of the large shells that yielded the very delicate and well preserved ostracods, small species and embryonic stages of a few species. In addition, the NBA mollusc assemblage indicates that the excavated small area palaeohabitat is dryer than most GBY layers and contains two species of land snails.

LITHIC ASSEMBLAGE

The NBA lithic assemblage is similar in many aspects to the one excavated from the site of GBY (Goren-Inbar and Saragusti 1996; Sharon 2007). As in the case of the faunal assemblage, currently the main contribution of the lithic assemblage is its potential to expand our knowledge of the GBY Acheulian by highlighting similarities and differences between the two assemblages, as discussed below.

The Bifacial Tools

The assemblage of bifacial tools from NBA comprises 193 handaxes and 98 cleavers that were collected from the Jordan River banks and from the piles of sediments dug in this locality (Figures 6 to 11). In addition, eight handaxes and five cleavers were excavated from Section 02-5. The tools were studied using the methodology applied to the bifacial tools from GBY (see details in Goren-Inbar and Saragusti 1996; Sharon 2007). Descriptive size statistics for the NBA bifacial tools are given in Table 3.

The types of raw material used for the production of bifacial tools at NBA and their frequencies are presented in Table 4, which compares them to the tools excavated at GBY. The dominance of basalt as a raw material used for biface production at NBA generally resembles the frequencies recorded for the excavated assemblage from the GBY Acheulian site (Goren-Inbar et al. 2000; Goren-Inbar and Saragusti 1996; Sharon 2007). Nevertheless, while in the excavated assemblages from GBY the percentage of flint tools never exceeds a few percent, the NBA assemblage includes over 30% flint handaxes. This fact can be explained by collection bias (flint handaxes are more noticeable) and perhaps also by the greater durability of flint in the accumulation conditions of the NBA sediments. Indeed, many of the flint handaxes are heavily battered and probably originate from the conglomerate at the top of the section as discussed further below.

High Frequency of Flint Handaxes

The cleavers at both sites are made almost exclusively on basalt. The handaxes, on the other hand, tell a different story. While at GBY only 3.7% of the handaxes were produced on flint, the NBA assemblage has as many as 27.4% flint handaxes. This is a much higher percentage than in any of the GBY excavated assemblages. It should be remembered that the NBA assemblage results mostly from surface collection and that within the excavated section 5-02 assemblage only one flint handaxe was found.

Both Stekelis (1960) and Gilead (1970) suggested the presence of a layer containing mainly flint handaxes in the area of NBA which they named “Upper Acheulian.” As noted above, due to massive drainage work, the layers to which both scholars refer cannot be identified at present and it is likely that they were completely removed and lost in this vicinity. It is possible that many of the flint handaxes of NBA originated in these layers and were collected from piles of earlier drainage operations. Nevertheless, an alternative explanation can be offered here—in the small assemblage of bifacial tools collected from the “GBY Bar” conglomerate that represents the uppermost layer in the GBY stratigraphic sequence (Feibel 2004; Goren-Inbar et al. 1992; Goren-Inbar et al. 2000), 61 handaxes were collected, out of which 14 (23%) were made of flint. These handaxes collected from the conglomerate show clear evidence of battering and breakage. At NBA, a conglomerate exposed in the river bank as a result of the drainage operation was observed at the top of the sequence (Sharon et al. 2002, and see above). Many of the NBA handaxes, and in particular the flint ones, show similar battering and breakage damage marks to those observed on the “GBY Bar” handaxes. It can be suggested, therefore, that the high frequency of flint handaxes is related to the water transportation of the tools within a conglomerate that, perhaps through a better survival rate of the flint, biases the frequencies of raw material in favor of the flint handaxes (see further details and discussion in Grosman et al. in press).

Bifacial Tool Preservation

The preservation state of the assemblage is presented in Table 5. It is interesting to note that the basalt tools from NBA are less exfoliated (i.e., weathered in the typical onion shaped layer form) than many of the GBY basalt tools, typified by extensive weathering. It can be suggested that different chemical or post-depositional conditions in the NBA sediments resulted in better preservation of the basalt artifacts. Apparently, the waterlogged conditions of the sediments in some of the GBY sites initiated a post-depositional process that caused the deterioration of the basalt tools into clay.

The breakage patterns observed on the NBA bifacial tools is presented in Table 6. A large percentage of the handaxes exhibit a distal break (breakage of the tool tips, Figures 10 and 11). This is expected as the tip is the most vulnerable part of the tool and the most sensitive to damage either during the use of the tool or in post-depositional processes. It is feasible that many of the handaxes in the assemblage originated in the conglomerate at the top of the exposed section, a fact that explains the high frequencies

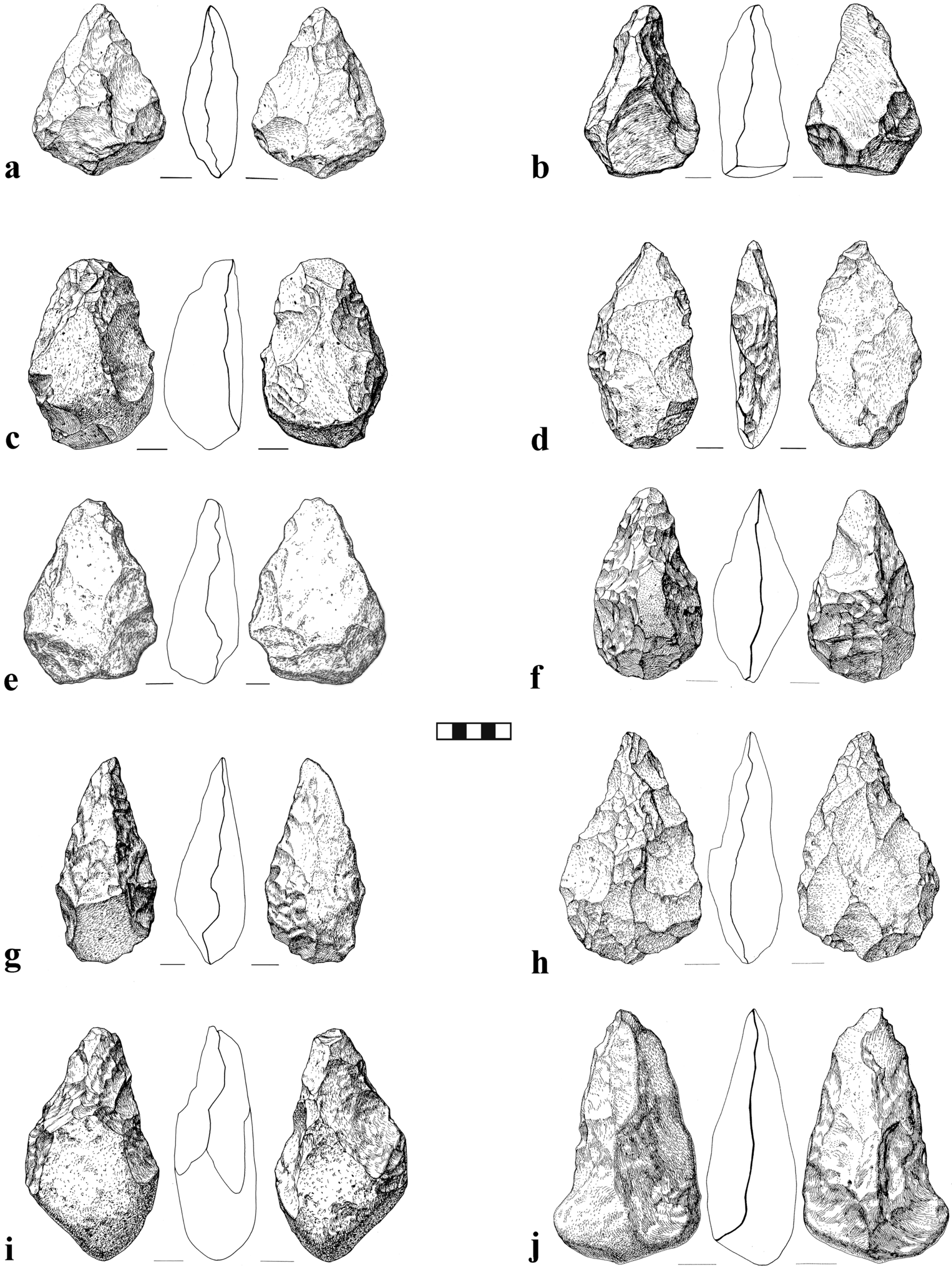

Figure 6. Basalt handaxes from NBA.

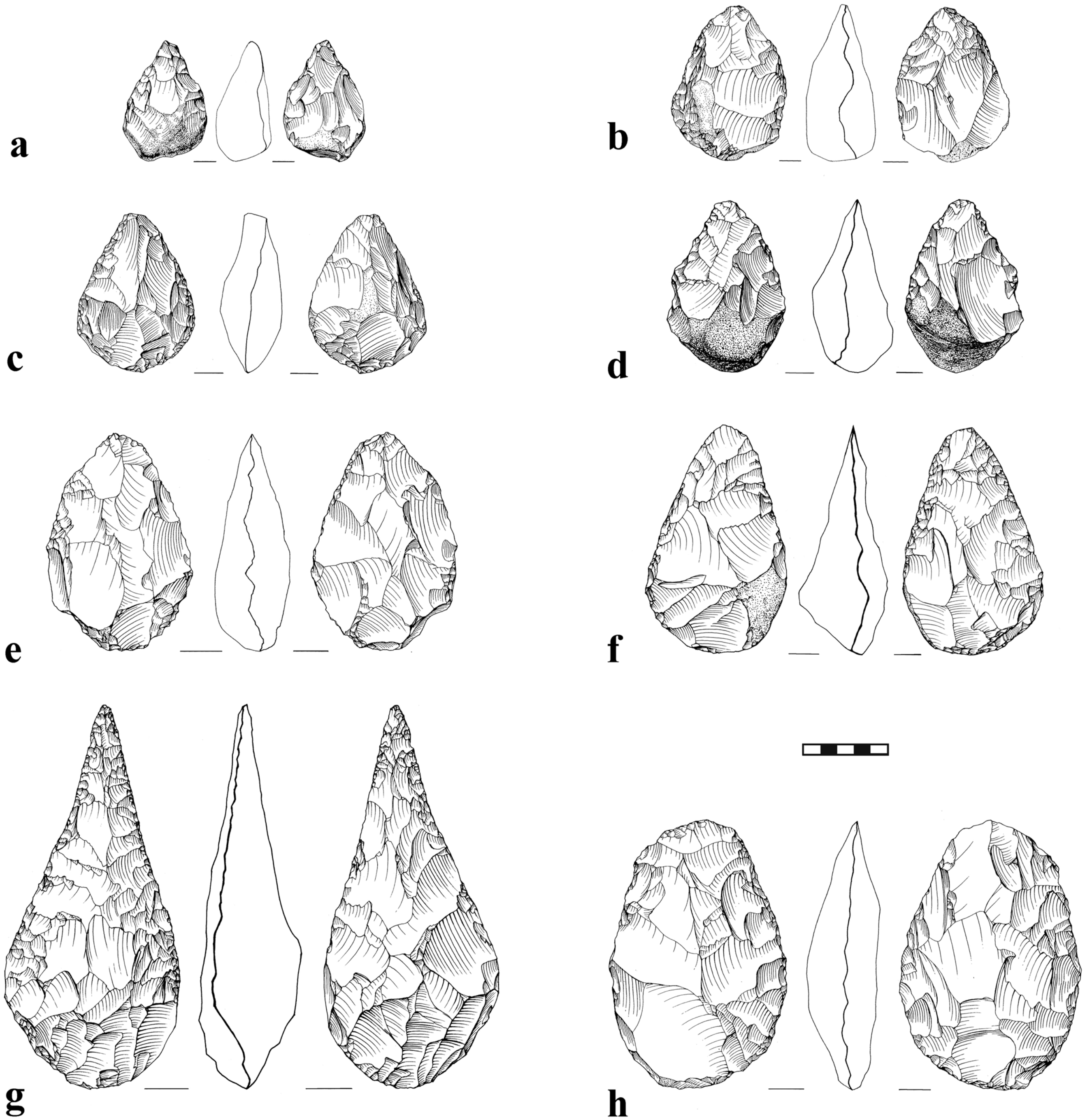

Figure 7. Flint handaxes from NBA.

of broken tools (see further discussion in Grosman et al. in press).

The Size of the NBA Bifacial Tools

The descriptive statistics of the bifacial tools from NBA are presented in Table 3. The site's bifacial tools fall well within the range of Acheulian bifaces made on large flakes worldwide. This is in agreement with Sharon (2007) who observed that over 90% of the complete bifacial tools sampled from many sites worldwide fall in the range of 10 to 20cm in their maximal length. Indeed, the NBA tools follow this observation and are similar to the GBY bifacial tools as shown in Figure 12. It is evident from the data that the NBA tools fall well within the range of size of the GBY tools in all three dimensions.

NBA Biface Technology, Production, and Blanks

As with all other aspects of the biface assemblage, the technology used for the production of bifacial tools at NBA is similar to that of GBY. The primary lithic activity represented in the assemblage is the production of bifacial tools from large basalt flakes. In general terms, giant basalt cores were

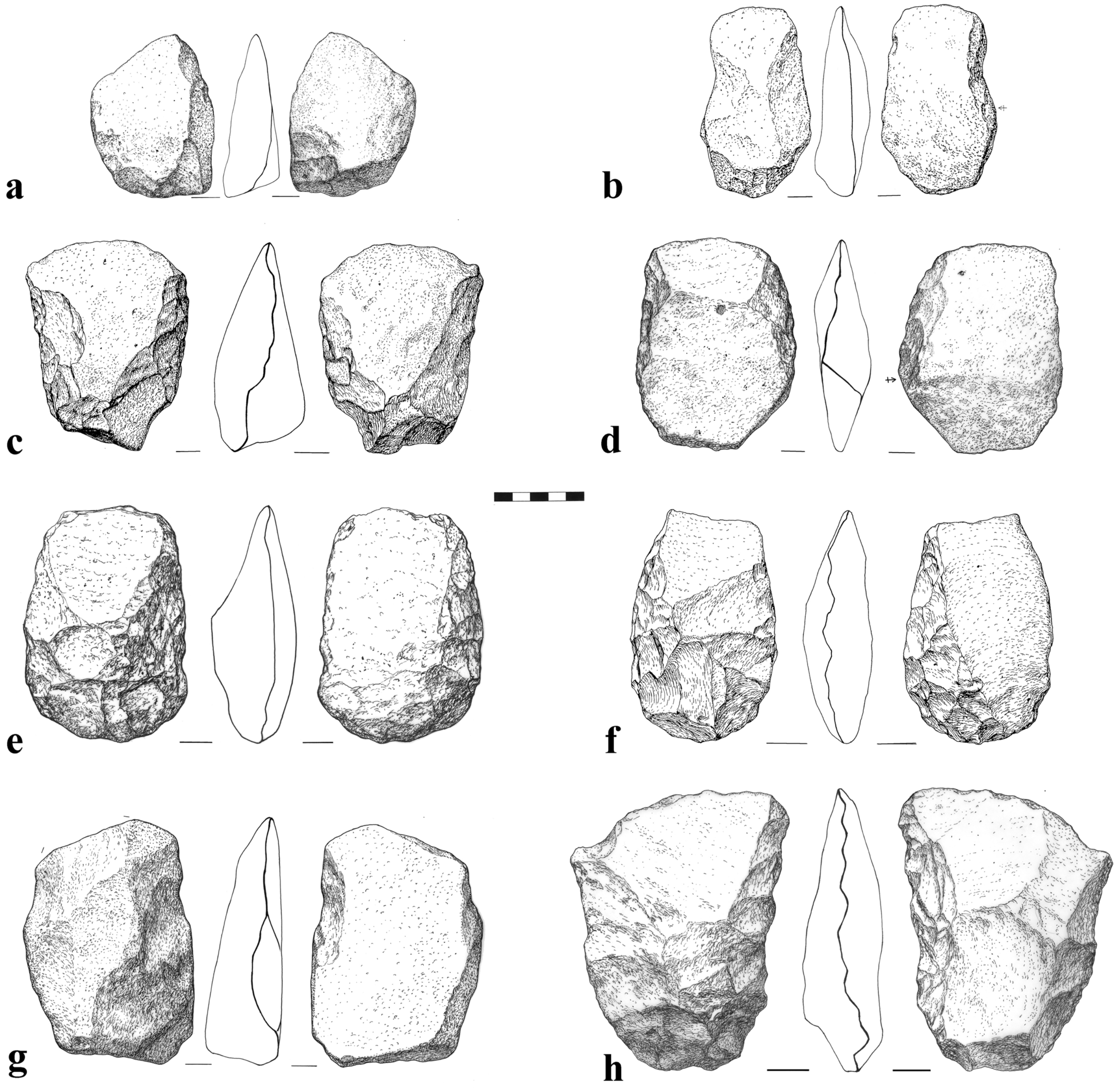

Figure 8. Basalt cleavers from NBA.

most likely knapped and large flakes were detached and later used as blanks for the production of both handaxes and cleavers by means of bifacial retouch. When suitable flakes were produced, the bifaces were shaped by a minimal retouch that, in most cases, involved only the thinning of the bulb of percussion (Goren-Inbar and Saragusti 1996; Madsen and Goren-Inbar 2004; Sharon 2007). On a finer scale, some differences between the GBY and NBA sites have been observed that can extend our knowledge of the technology used by the GBY knappers for their bifacial tool production. These aspects are discussed below.

First, a strong similarity between the GBY and the NBA assemblages is observed in regard to the frequencies of different types of blank usage. It is evident that almost all cleavers were produced on flakes, while, for most of the handaxes, the type of blank used could not be determined due to the intensity of retouch. Nevertheless, for the bifaces whose blanks are identifiable, large flakes were clearly the primary blank type used. This observation is similar to many other Acheulian sites at which the production of large flakes was the main technological characteristic (see detailed discussion in Sharon 2007).

On the other hand, the relatively high percentage of handaxes produced on cobbles should be noted. This high

TABLE 3. DESCRIPTIVE STATISTICS FOR NBA BIFACIAL TOOLS (complete tools only).

		Length (mm)	Width (mm)	Thickness (mm)	Circumference	Weight (gr.)
Handaxe	Mean	123.8	84.13	43.11	368.6	471.4
	N	110	110	110	8	109
	S.D	28.4	13.8	8.4	52.3	229.5
	Minimum	57	47	15	261	85
	Maximum	232	116	65	427	1147
Cleaver	Mean	133.9	94.2	39.0	371.8	569.7
	N	83	83	83	13	83
	S.D	20.5	12.0	6.6	48.6	183.1
	Minimum	87	64	26	261	233
	Maximum	221	154	59	463	1235

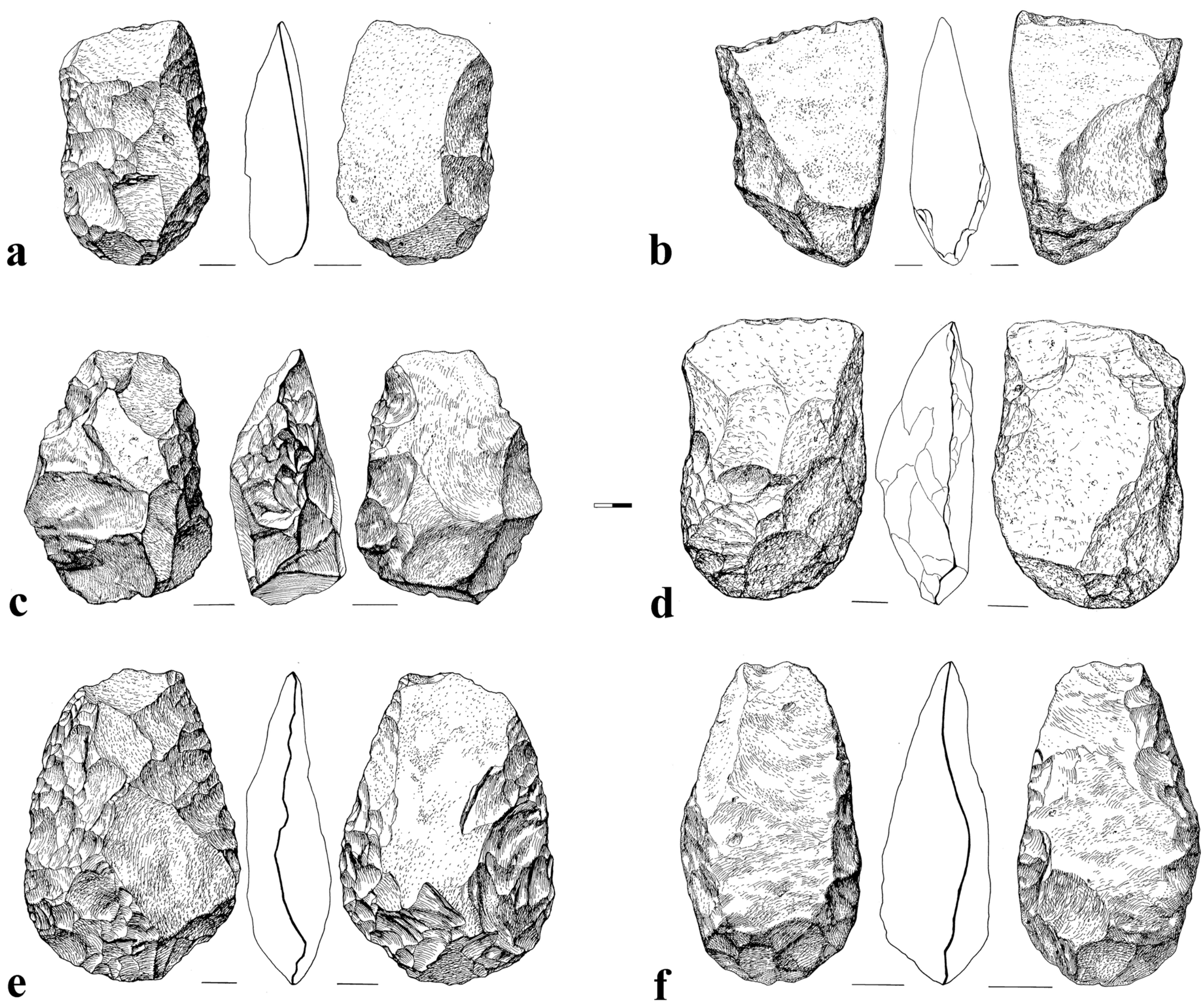

Figure 9. Basalt cleavers from NBA.

TABLE 4. RAW MATERIAL USAGE FOR GBY AND NBA BIFACIAL TOOLS.

	NBA				GBY Layer II-6*			
	Handaxe		Cleaver		Handaxe		Cleaver	
	N	%	N	%	N	%	N	%
Flint	49	27.4	2	2.0	12	3.7		
Limestone					7	2.2	1	.7
Basalt	130	72.6	96	98.0	305	94.1	135	99.3

*Data for GBY layer II-6 from Sharon (2007).

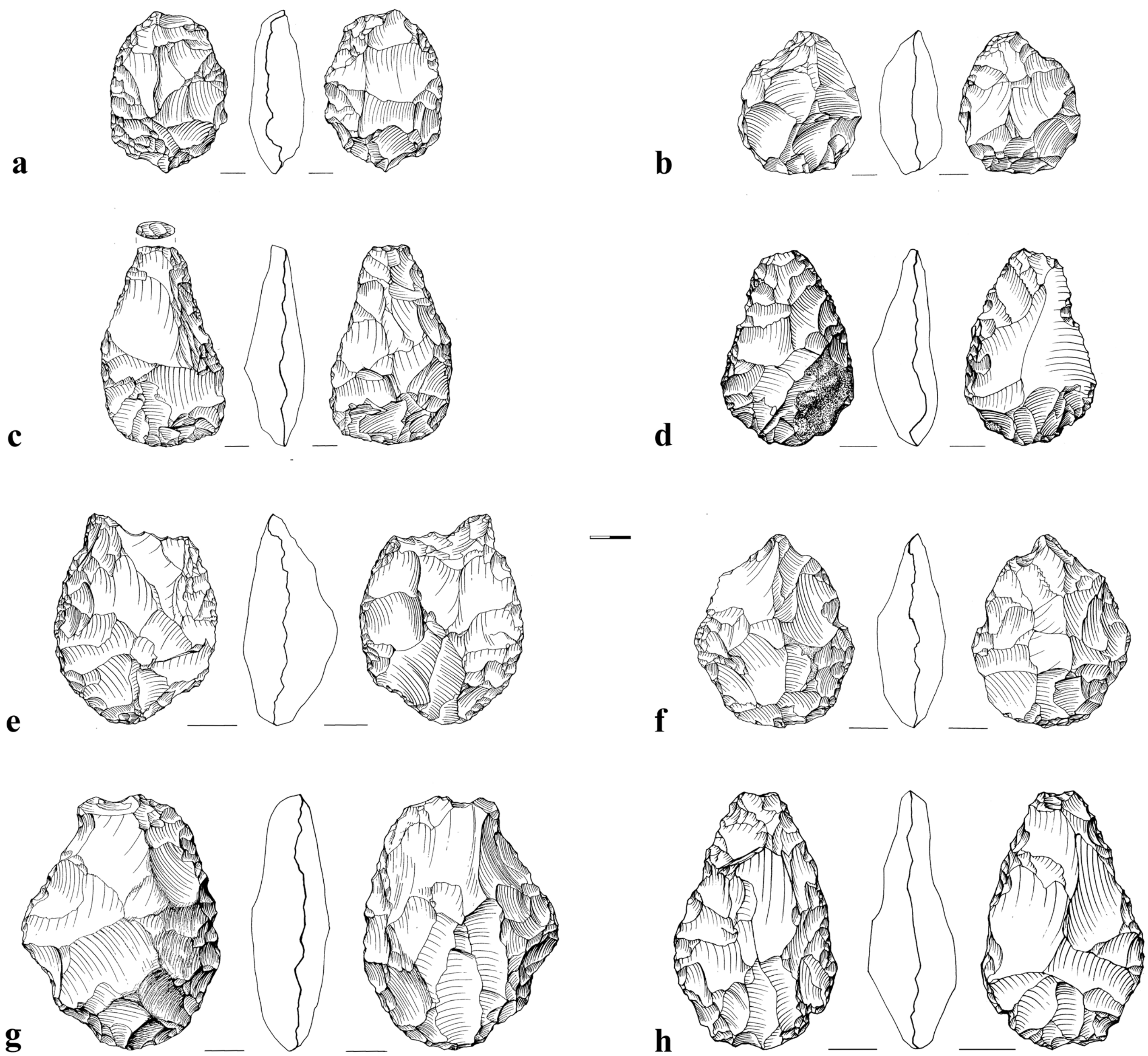

Figure 10. Broken and heavily rolled flint handaxes from NBA.

TABLE 5. PRESERVATION STATE OF NBA BIFACIAL TOOLS BY MORPHO-TYPE.

	Handaxe				Cleaver			
	Flint		Basalt		Flint		Basalt	
	N	%	N	%	N	%	N	%
Fresh	10	20.4	20	13.9	1	50.0	17	17.3
Slightly abraded	28	57.1	43	29.9			54	55.1
Abraded	10	20.4	53	36.8	1	50.0	24	24.5
Rolled	1	2.0	28	19.4	2		3	3.1
Total	**49**	**99.9**	**144**	**99.9**	**2**	**100**	**98**	**100**

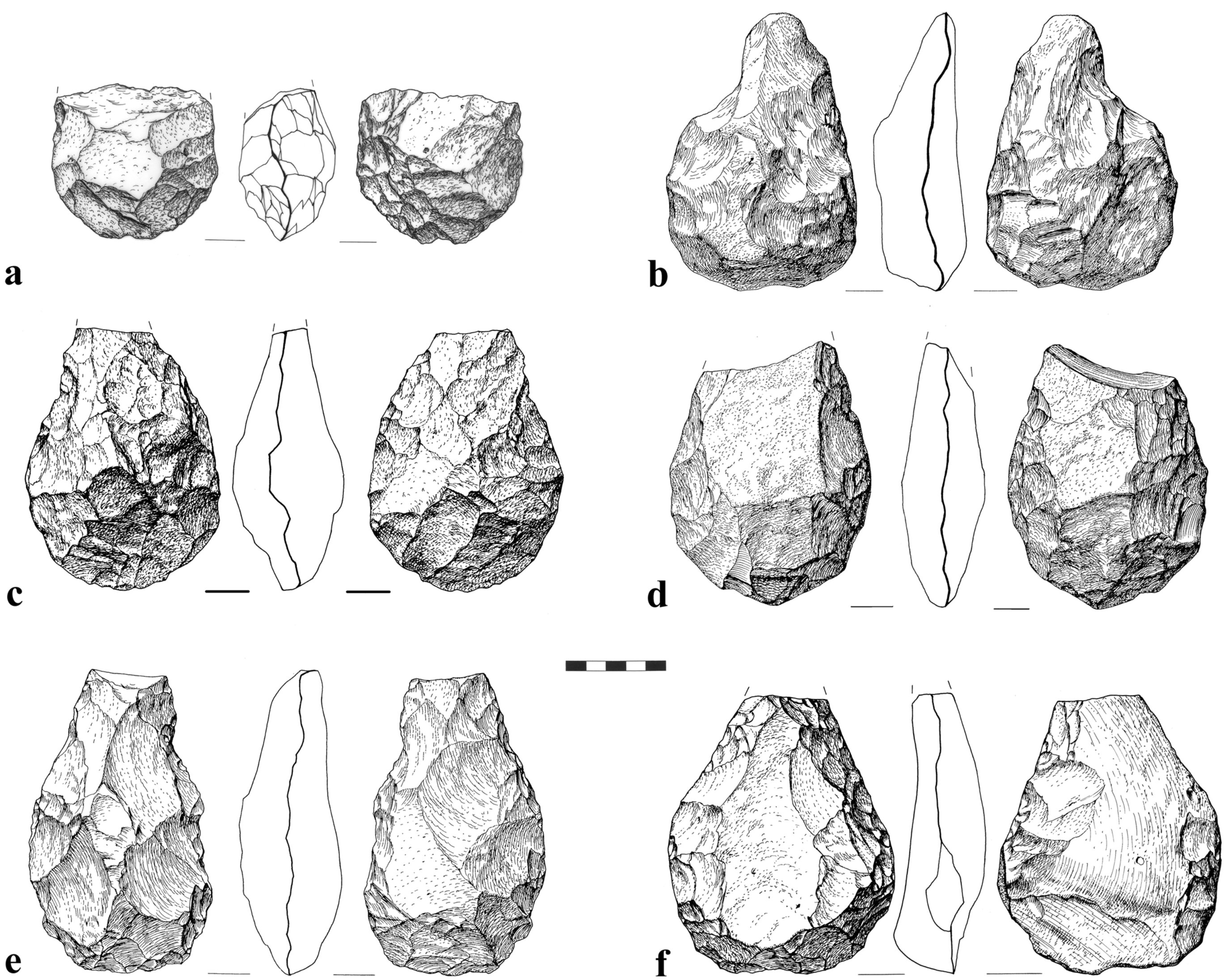

Figure 11. Broken and heavily rolled basalt handaxes from NBA.

TABLE 6. BREAKAGE PATTERNS FOR NBA BIFACIAL TOOLS BY MORPHO-TYPE.

	Handaxe		Cleaver	
	N	%	N	%
Complete	110	57.6	83	83.0
Distal break	63	33.0	14	14.0
Lateral break	1	.5		
Proximal break	5	2.6	3	3.0
Proximal & Distal break	1	.5		
Fragment	2	1.0		
Indeterminate	5	2.6		
Distal end use damage	4	2.1		
Total	**191**	**99.9**	**100**	**100.0**

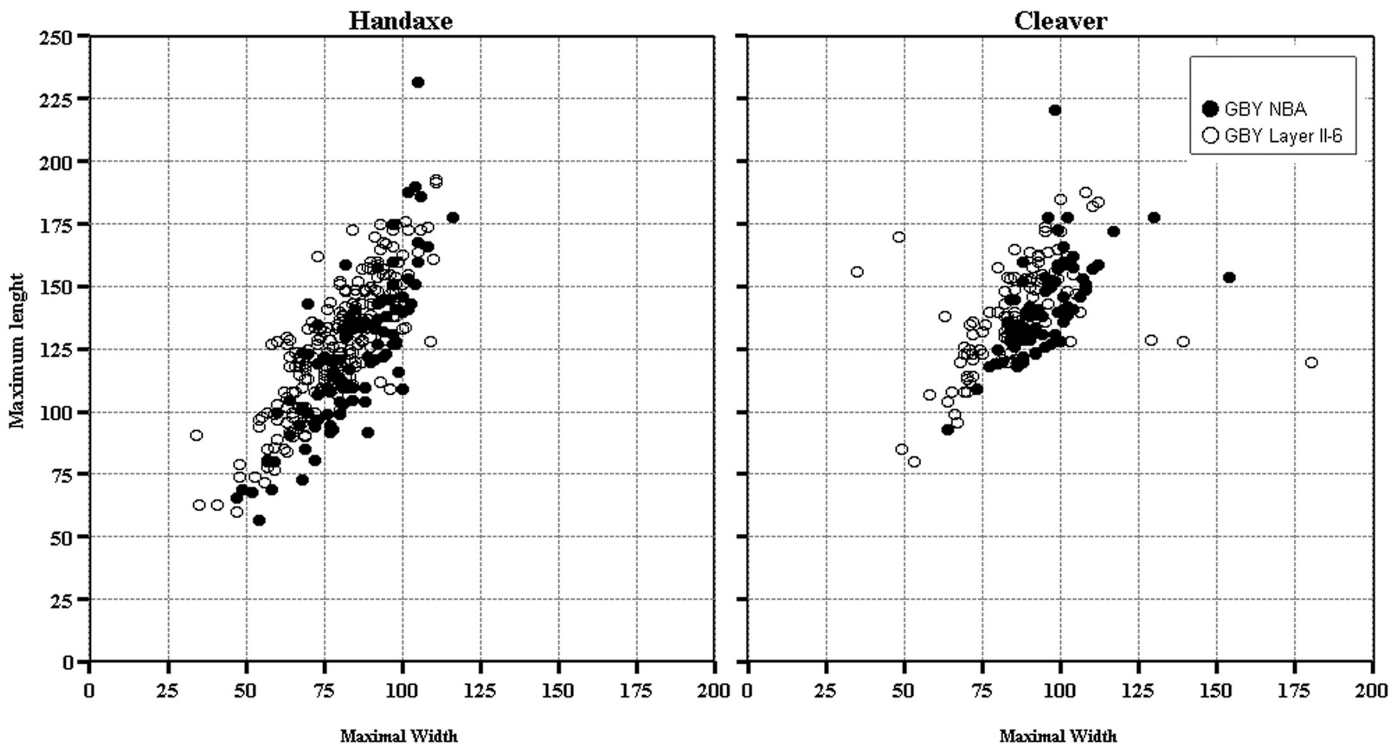

Figure 12. Length to width scatter diagrams for bifaces from GBY and NBA.

frequency simply may be the outcome of the higher frequency of flint handaxes in the NBA assemblage. At GBY Layer II-6, only 4 of 323 handaxes were produced on a non-flake blank. In contrast, at NBA, 9% of the handaxes were modified on a non-flake blank. Because, unlike basalt tools, many flint handaxes in the NBA assemblage are produced on cobbles, they contribute to the high frequency of cobble blanks in this assemblage.

Unmodified Large Basalt Flakes

The lithic assemblage of NBA is characterized by the presence of high frequencies of large basalt flakes. The small assemblage excavated from Section 5-02 is very rich considering the size of excavation. In Figure 13 the length of the unshaped flakes is plotted versus their breadth. The data clearly show that most of the flakes from Section 5-02 are larger than 8cm. Small sized flakes seem to be nearly absent from the assemblage. The size and shape of the flakes indicate that they were produced from giant cores. Such a high frequency of large, unshaped flakes was not observed in any of the GBY site layers, where large flakes are scarce. Though the NBA excavated area is small, which hinders any definite conclusion, the high frequency of large flakes might suggest a scenario in which the NBA assemblage is

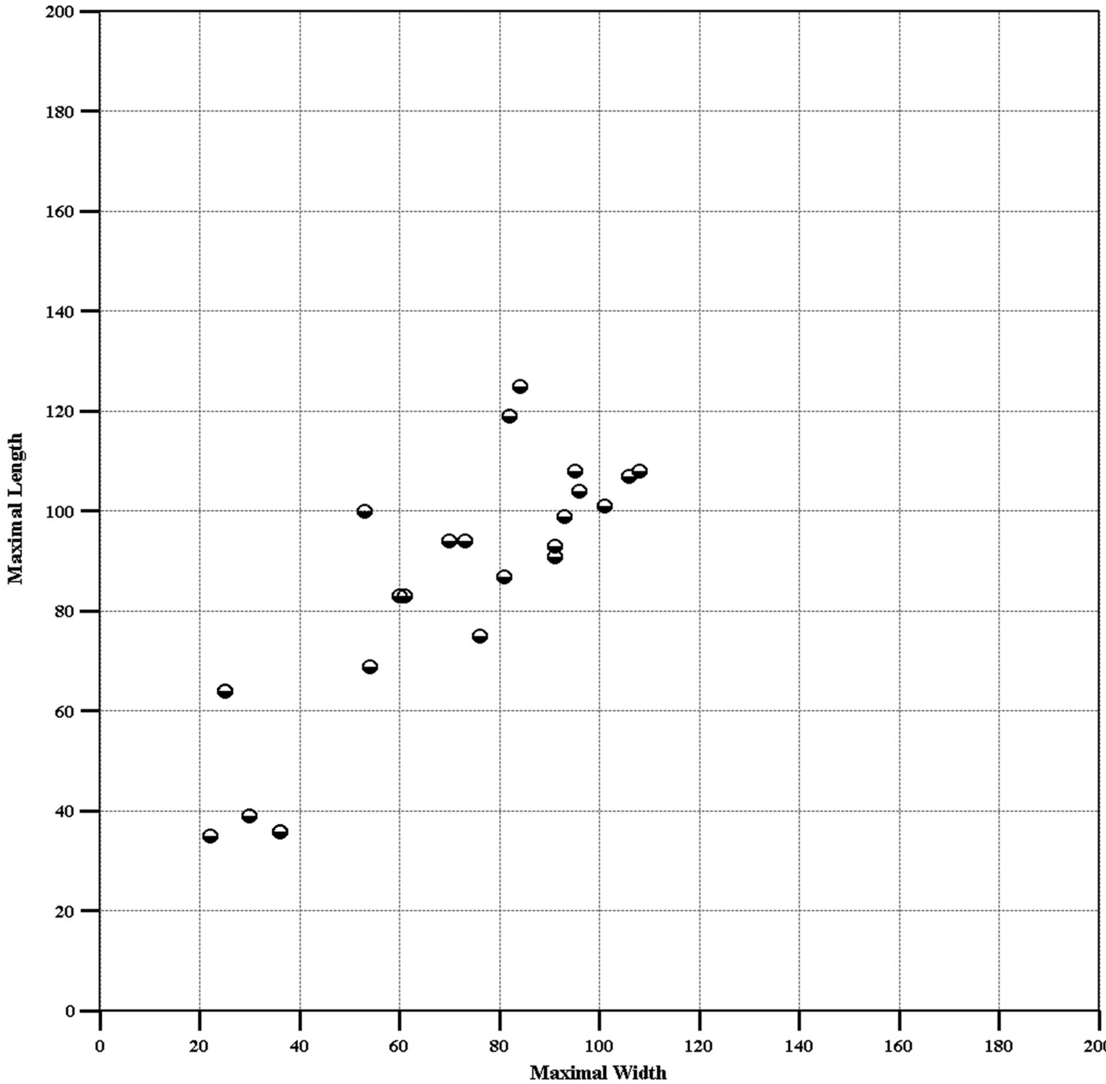

Figure 13. Size of all (complete and broken) NBA Section 5 flakes.

closer to the source of raw material or at least to where large flakes were knapped. This is in contrast to the GBY site that represents, in most of its layers, a behavior that includes the introduction of mainly finished tools into the site, at least some distance from the place where the large flake blanks were produced (Goren-Inbar and Sharon 2006).

Spheroids

A unique find within the Acheulian assemblage of NBA is the nine spheroids and three sub-spheroids collected from the site's vicinity (Sharon et al. 2002). None of these tools were excavated *in situ*; however, their presence is the first evidence of their appearance in the GBY region Acheulian tool kit. Six of the spheroids are modified limestone and the other three are basalt. Their descriptive size statistics are given in Table 7. The spheroids (Figures 14 and 15) are of medium size and in most cases well-made and rounded, with many facets but almost no evidence for battering. The small sample size and the fact that none of them were excavated *in situ* do not permit drawing definite conclusions. Nonetheless, their presence at the site, especially when compared to the absolute absence of spheroids from the GBY excavated assemblage, widens our knowledge of the GBY Acheulian tool kit and might suggest that these tools were associated with special activities that were not taking place at GBY but which did occur at NBA.

SUMMARY AND CONCLUSIONS

The results of the surveys and small excavations presented in this study establish the presence of a new Acheulian site in the vicinity of the Benot Ya´aqov Bridge. The primary contribution of the data presented here is to expand our knowledge of the Large Flake Acheulian by comparison to the well known site of GBY. The study yielded the following conclusions:

1. The Ar/Ar date of 658±15 ka determined for a basalt flow located immediately below the NBA Acheulian archaeological horizon of Section 5-02 allows us to place an additional chronological marker for the Large Flake Acheulian of GBY. The date for the NBA site is one of the few well established radiometric dates achieved for any

TABLE 7. DESCRIPTIVE STATISTIC FOR NBA SPHEROIDS.

	Mean	Std. Deviation	Minimum	Maximum
Weight (gr)	404.1	127.6	241	577
Length (mm)	71.8	8.6	61	83
Width (mm)	67.6	6.5	57	77
Thickness (mm)	62.3	7.5	49	71
Circumference (mm)	225.1	26.1	192	268

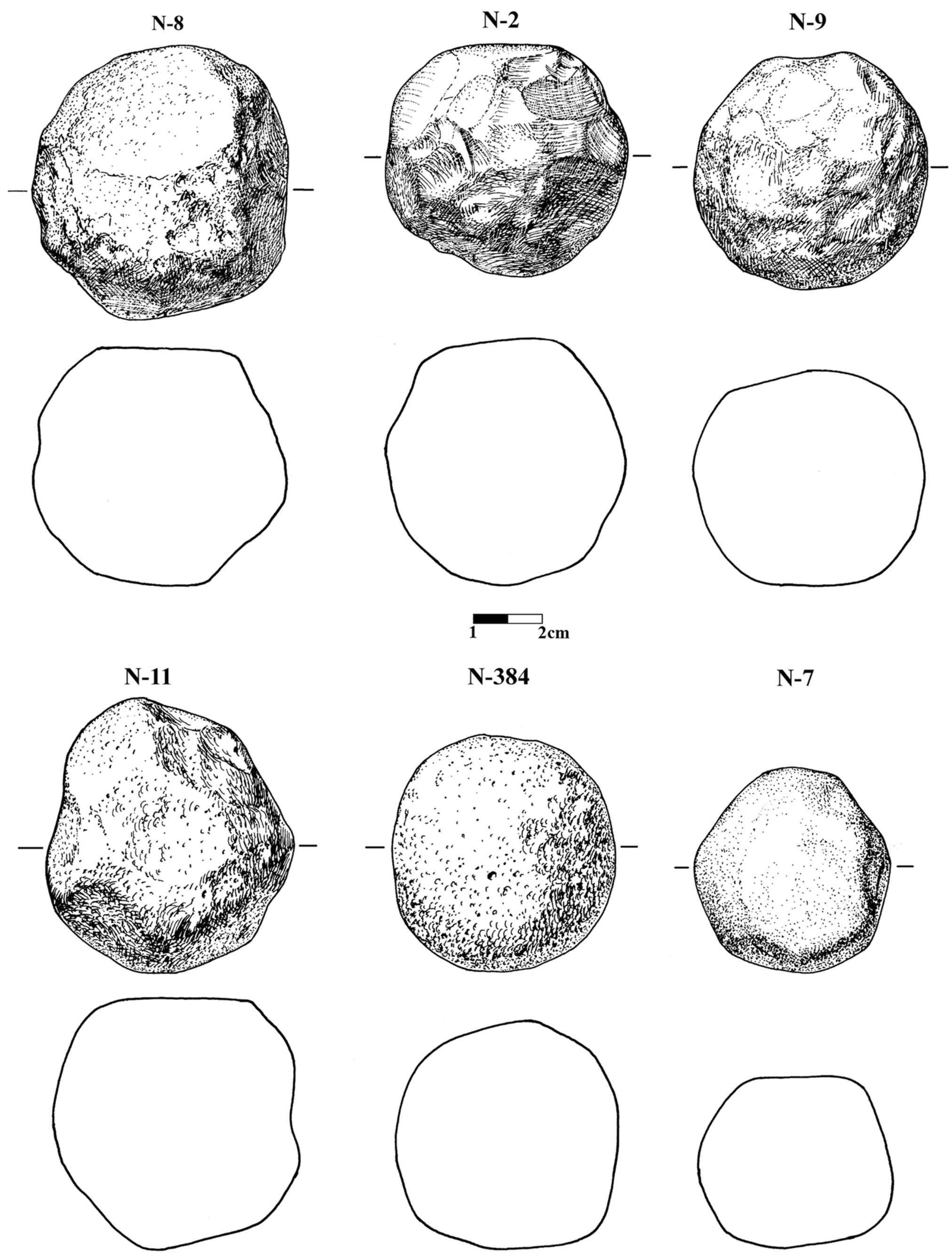

Figure 14. Drawing of six NBA spheroids. N-11 and N-384 are made of basalt. The other tools are made of limestone.

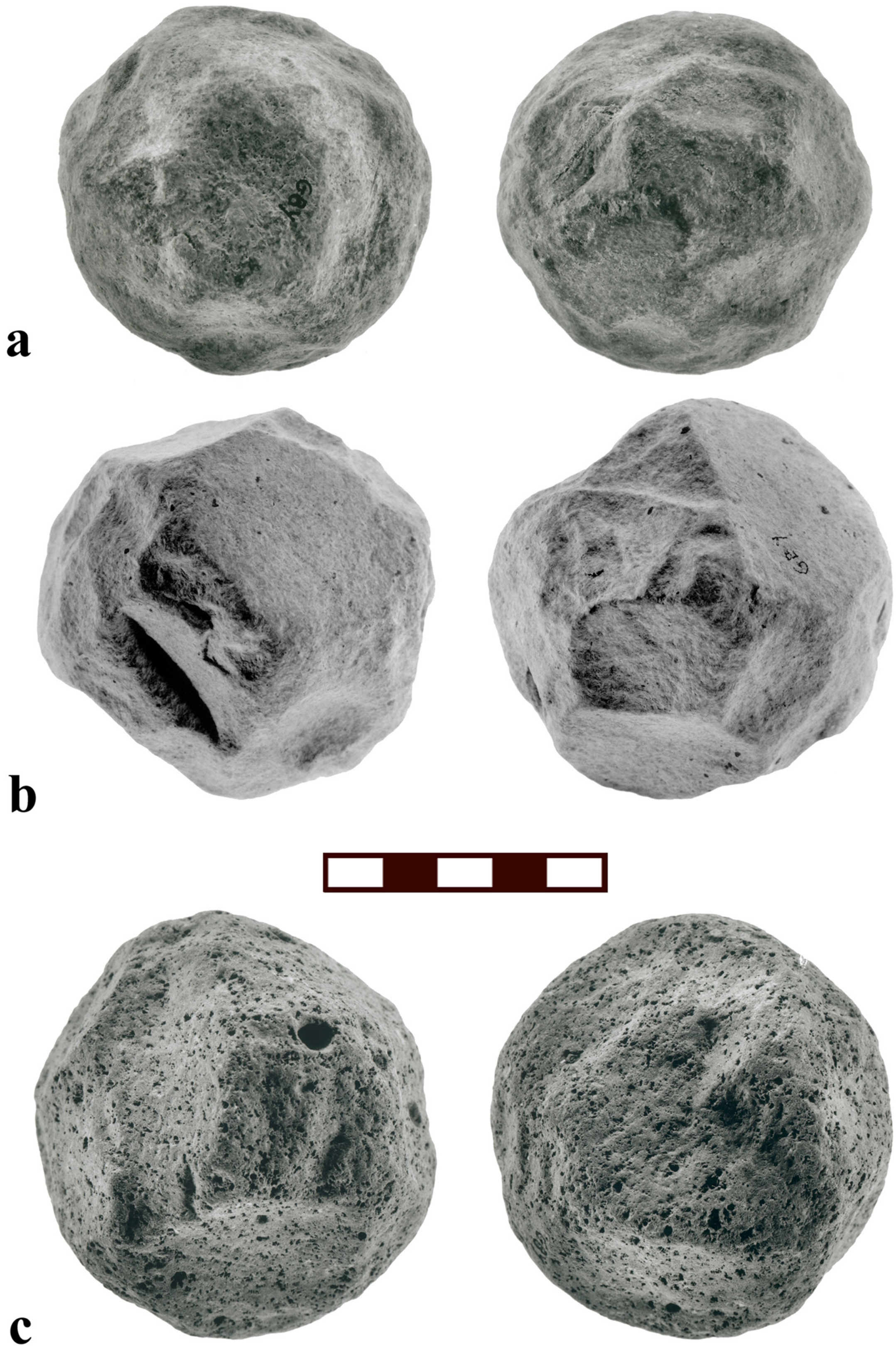

Figure 15. Three spheroids from NBA; a and b: limestone; c: basalt.

Acheulian site in the Levant (and see Goren 1985). It seems that the Acheulian period in the greater GBY area spanned well over the 100,000 years estimated for the section known as the GBY type locality (Goren-Inbar et al. 2000). During this time span, the lithic tradition observed in the different localities remained unchanged.

2. While noting the small sample size, it seems that the NBA fauna resembles that of GBY in the species represented. Though GBY contains all of the NBA mollusc species, the NBA assemblage does not allow for any clear-cut conclusions about the similarity between the assemblages.
3. The NBA Acheulian lithic assemblage is comprised mainly of handaxes and cleavers, but also contains flakes, cores, and spheroids. The NBA assemblage resembles that of GBY in all its main features. The assemblages are similar in tool size and raw material usage frequency (particularly in the use of basalt as the primary raw material for biface production), in the presence of cleavers, and in the morphology of the handaxes. It is safe to argue, therefore, that the two assemblages belong to the same Acheulian entity, known as Large Flake Acheulian, as described from GBY (Goren-Inbar and Saragusti 1996; Sharon 2007).
4. The presence of many large, unretouched flakes suggests proximity of the NBA site to the bifacial tool workshop. This is in contrast to the GBY assemblage that contains mainly finished tools.
5. NBA tools show almost no signs of the characteristic GBY weathering manifested in the exfoliation of the basalt and many are more battered and broken. This difference may lie in the fact that many of the tools originated from a conglomerate depositional environment and/or the low survival rate for chemically exfoliated basalt tools. However, the alternative explanation of bias in the collecting of surface finds cannot be ruled out.
6. The small sample size and small excavated area allow only limited conclusions at the current stage of research.
7. The presence of spheroids at NBA, which are totally absent at GBY, adds a new tool type to the GBY area Acheulian "tool kit." It is suggested that their occurrence is attached to specific activity areas, absent from other GBY localities.

The main contribution of the NBA lithic assemblage comes from the confirmation of some aspects of the GBY lithic industry and from the few, but marked, differences that have arisen between the assemblages. These differences deepen our insight into the behavior and ways of life of Acheulian hominins on the shores of Paleo-Hula Lake during the Early Middle Pleistocene. Up until now, the site of GBY had been the only example for Large Flake Acheulian in the Levant, that is, between the Egyptian Western Sahara Desert (Haynes et al. 1997; Haynes et al. 2001) and Turkey (Bar-Yosef 1998; Goren-Inbar 1995; Sharon 2007; Slimak et al. 2008). Due to the Ar/Ar date obtained for the NBA site, it is now possible to say that the Large Flake Acheulian existed in the Northern Dead Sea Rift at least from 780 to 650 ka. It is very unlikely that are no other sites belonging to the same lithic tradition in the Levant during this lengthy time period. The fortunate geological and geo-morphological circumstances that exposed the GBY layers have enabled a glimpse into this cultural phase of the Acheulian, which is probably deeply buried in other parts of the Levant. The finds from the NBA site clearly place its inhabitants within the GBY Acheulian entity. They expand our knowledge of their technology, tool kit, and behavior, as well as the time period their culture existed. The primary challenge for our understanding of the place of the GBY Acheulian tradition in its regional context, as well as for Out of Africa tempo and geography lies in the discovery, excavation, and dating of new sites belonging to the Large Flake Acheulian tradition.

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