Title:

Sir Arthur Keith's Legacy: Re-discovering a lost collection of human fossils

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Abstract:

In 2001, a collection of skeletal material was donated to the Natural History Museum, London, by the Royal College of Surgeons, London. It consisted of boxes discovered among the personal belongings of Sir Arthur Keith. This paper describes the work undertaken to identify and document the human skeletal material in the Keith Collection.

The study identified the human fossils as having come from a number of excavations directed by Dorothy Garrod in the 1920s and 30s in Israel. The collection contains the long considered lost human skeletal collection from the type-site of the Natufian industry: Shukbah Cave. The majority of this material is of Natufian origin but contains a few Neanderthal specimens. A small amount of heavily fragmented bones associated with Skhul VII and IX were also found.

The most remarkable of the re-discovered collection is the material from el-Wad and Kebara Caves. It was identified to be the missing material from the Middle and Upper Paleolithic levels briefly described in 1939 in *The Stone Age of Mount Carmel vol 2.* by Theodore McCown and Sir Arthur Keith. These important fossils hold great potential to answer questions about the Middle to Upper Paleolithic transition in the Near East, and the emergence of anatomically modern humans.

Keywords:

Sir Arthur Keith, Dorothy Garrod, Skhul, Shukbah Cave, Kebara Cave, el-Wad Cave, Middle Palaeolithic, Upper Paleolithic, Natufian

1. Introduction

In 2001, the Royal College of Surgeons, London (RCS), made a request to the Anthropology curator of the Natural History Museum London, (NHM), Robert Kruszynski, to provide a repository for a series of boxes containing human skeletal material. Although the RCS holds human remains in its own collections, a part of their collection was already transferred to the NHM in the 1950's. The boxes from the Keith Collection came from Buckston Browne Farm, Kent, a research facility built in 1931 by the RCS to provide training to young surgeons. It provided ample space for dissections and operations, and included living quarters for the resident researchers. Shortly after the official opening in 1933, Sir Arthur Keith took up the position of Master and remained there until his death in 1955. Upon the closure of the facility in the early 1990's the boxes of human material had been discovered among Keith's (Figure 1) personal effects. They were labeled with the site names for which he had provided anatomical descriptions during the 1930's: Shukbah, el-Wad, Kebara and Skhul.

The newly re-discovered fossil material was moved from the RCS to the NHM in February 2001. The bones were originally packed in a range of different sized carton boxes lined with cotton wool and newspaper, some infested with insects. Labels were included in some of them, and most of the bones were marked with black ink. In 2006 a first conservation effort was carried out with the goal of stabilizing the material. The cotton wool, newspaper and insects were removed, and the skeletal material was transferred into conservation standard boxes. These were provisionally curated in the Anthropology stores at the NHM until late 2011, when resources were made available by the then Palaeontology Department (now part of Earth Sciences)at the NHM to carry out further work on the collection.

This article is the description of the project aimed to bring together, evaluate, identify and document Keith's human skeletal collection. Extensive archival research was carried out to ascertain the origin of the material and indicated that the majority of the material came from Shukbah Cave and a smaller sample from el-Wad, Kebara and Skhul

(Figure 2). Detailed descriptions and anatomical analyses of all the specimens are beyond the scope of this paper but a full inventory of the material together with matches to published descriptions, and new accession numbers for the Natural History Museum, London, are included in the appendix. ~~Preliminary observations showed that the majority of the material originated from Shukbah Cave and a smaller sample from el-Wad, Kebara and Skhul (Figure 2).~~

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Commented [00002]: Page 3, you mention that "preliminary observations…." Why do you say that only preliminary observations were done. You have done all what was possible to identify the origin of the elements. Do you simply mean that it does not include anthropological descriptions, that will be done later? If it is simply this, rephrase the end of your introduction to valorise your important work.

2. The sites.

2.1 Shukbah Cave

Shukbah cave (site also referred to as Shuqba, Shukba, Mount Ephraim and Wadi el Natuf) is located 28 km northwest of Jerusalem (31° 58' N, 35° 03' E) (Figure 2). The site was discovered in 1924 by Père Mallon (Garrod, 1928) and an excavation between the beginning of April and the middle of June 1928 (Garrod, 1942) was carried out by Dorothy Garrod, who had joined the American School of Archaeology in Jerusalem. Garrod was assisted by George and Edna Woodbury and a team of Palestinian workmen (Figure 3). A series of trenches were excavated in each of the chambers of the cave.

The stratigraphic sequence of the site consisted of three identifiable layers, named from the top: Layers A, B and D. Garrod suggested that Layer A may have been disturbed. Layer B – later subdivided into B1 and B2 – contained an industry reminiscent of the Capsian industries discovered in Northwest Africa and a series of human burials (Garrod, 1942). After her five years of excavations at el-Wad cave and her discoveries there, Garrod concluded that, rather than an Eastern extension of the Capsian, Layer B of Shukbah cave contained a new local Near Eastern Industry, which she named "Natufian" after the location of Shukbah Cave, in Wadi el Natuf, where she had first recognized the industry (Garrod, 1932). Layer C was described to be a sterile clayey layer (Garrod, 1930). Layer D was a hard layer consisting of breccia that appeared to have been eroded and later covered by Layer B and was therefore only present in some areas. It yielded Mousterian implements (Garrod, 1942). The description of Layer D as Levalloiso-

Mousterian was confirmed by Callander and Bar-Yosef (2004), suggesting a correlation of layer D with Tabun Layer B and the Neanderthals.

Dorothy Garrod hoped to return to Shukbah Cave to continue the excavations but in 1929, after exploring a number of caves on Mount Carmel, she was asked by the Department of Antiquities and the British School of Archaeology in Jerusalem to start excavations at el-Wad and later that year at Tabun and Skhul on Mount Carmel, and these took up all of her attention for the next few field seasons. She never returned to Shukbah Cave and it was not until 1942 (Garrod, 1942) that she finally published her findings from the site.

The human remains from Shukbah Cave

In addition to the stone tool industry discovered in Shukbah Cave, a collection of human remains was excavated during the field season of 1928 (Garrod, 1930; Garrod, 1932; Garrod, 1942). Garrod summarizes the human remains from layer B as follows: "Eleven human burials were found in this layer, and of these seven at least had every appearance of being contemporary with the microlithic hearths. In addition, a large number of human bones was scattered throughout the deposit. In one case an adult male skeleton was found in a sitting position under a large fallen rock with the remains of two children on his knees, the bodies being packed into positions with fragments of limestone. Of the remaining burials, two were of young children, and of these one lay in a closely contracted position on a very black hearth. The remaining skeletons were so fragmentary that the position could not be ascertained" (Garrod, 1932) p.258. In 1942, Garrod describes the deposits in more detail (Garrod, 1932; Garrod, 1942) suggesting the human remains came primarily from the Natufian layer, B. In line with the name of the industry, Dorothy Garrod named this population "the Natufians". In addition to the human material from layer B, she reported on Mousterian material from layer D (a molar tooth, a hemi-maxilla, a zygomatic, temporal fragment, a femur fragment and a talus) but that it was mixed with Natufian material as a result of Natufian sediments accumulating in crevices in the Layer D breccia (Garrod, 1942).

An initial search of the Catalogue of Fossil Hominids (CFH) (Oakley et al., 1975) shows a summary for the Shukbah Cave human remains of 45 individuals, of which six are numbered and said to be located at the Peabody Museum, but no repository is given for the other specimens. The material labeled as Shukbah in the Keith collection presented us with the following questions:

- Are these the remaining 39 individuals from the original excavations at Shukbah Cave or were there excavations at Shukbah by a different team that could have unearthed this material?
- Are any of these the 11 burials reported by Garrod in 1932?
- How did the six numbered humans end up separated from the rest of the collection, and how are they associated with the 11 burials?
- If these are the human remains from both layer B and D from Shukbah Cave, can they be identified and documented in detail?

2.2 El-Wad

The el-Wad cave (also known as Athlit cave) is located in the Wadi el-Mughara (the Valley of the Caves) in Mount Carmel, about 20km South of Haifa (Figure 2). This was the first of a series of caves on Mount Carmel to be explored by the Department of Antiquities of Palestine in 1928. During initial excavation of exploratory trenches in both the terrace and inside the cave, an archaeological unit containing Upper Paleolithic tools was discovered inside the cave (Keith, 1931). The bone and stone tools were reminiscent of the later Upper Paleolithic sequences in Europe, which had been absent at Shukbah Cave. Dorothy Garrod was appointed by the Department of Antiquities and the British School of Archaeology in Jerusalem to excavate the site between 1929 and 1933 and she led a systematic excavation of the terrace and three chambers of the cave. The site revealed a long sequence ranging from the Middle Paleolithic to the Natufian. Garrod interpreted two layers, G and F, as belonging to a single cultural unit with a transitional industry between the Middle and Upper Paleolithic (Garrod, 1931). Only a few fragments of bone and one human tooth were recovered from Layer G. There is some confusion

about the original location of the tooth. In 1931, Garrod reported the tooth to have originated from the "grey phosphatic layer", 4.50m below the surface (Garrod, 1931). In 1937, she reports the human molar to have come from the red earth at 3.50m depth (Garrod and Bate, 1937).

Three layers of Upper Paleolithic industry (E, D1-D2 and C) were overlying layers G and F. The finds from Layer E were attributed to Upper Paleolithic III, and layers D1 and D2 to be Upper Paleolithic IV, a Levantine aurignacian industry (Shea, 2013). Layer C was attributed to the Upper Paleolithic although it has been suggested to have associations with the Early Natufian (Weinstein-Evron, 1998). Layer B is attributed to the Natufian, now dated by radiocarbon to between 15.000 and 13.000 calBP (Eckmeier et al., 2012) and contained a series of human burials, both in the cave and on the terrace.

The Human remains from el-Wad Cave

The boxes in the Keith collection marked "El Wad" contained human bones annotated with "WAD" and a letter "D" or "E". This is a small collection and none of the specimens are marked WAD B, suggesting the Keith Collection does not contain material from the Natufian layer. The whereabouts of the Natufian material was confirmed in two ways. Firstly, the RCS archives have notes stating Theodore McCown was transporting the material to Berkeley to finalize his study, which he was due to write up as a PhD thesis in 1939. McCown's unpublished thesis is mainly a study of the material from el-Wad but includes a very brief section on the Shukbah adult cranial material. Secondly, in a letter dated 1960, Hugh Hencken asked Dorothy Garrod for her help to move the human material from Berkeley to the Peabody museum after a series of requests by Hencken's predecessor, Dr. Mac Curdy, had been left unanswered (Figure 4). The Peabody Museum, Harvard University, also confirms to be in possession of all the Layer B Natufian material (M. Morgan, personal communication). This material was most recently described by Bucquentin (2003) as consisting of 47 individuals. With the exception of H25, which is displayed in the Rockefeller Museum in Jerusalem, all the remaining material is in the Peabody collections.

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is not very clear, neither in terms of inventory, nor for the implications of this information for your own work. You can certainly give here more details.

The study Sir Arthur Keith carried out with Theodore McCown at Buckston Browne Farm during the 1930s focused primarily on the Mousterian and Upper Paleolithic materials at Skhul and Tabun, but also includes a series of human remains from the Upper Paleolithic strata of el-Wad (McCown and Keith, 1939). The inventory in this volume, lists that Layer E contained eight isolated teeth and two mandibular fragments; Layer D2 contained two teeth and Layer D1 contained a single lower premolar and one mandibular fragment. Some additional post-cranial material was described in McCown and Keith (1939) and was summarized in the CFH. Between the CFH and the McCown and Keith volume (1939), there is one inconsistency: in addition to the mandibles E1 and E2 the CFH lists a third individual (el-Wad E3), which is not listed in the inventory by McCown and Keith. According to CFH, the whereabouts of the layer E and D material from el-Wad is unknown.

The main question we aimed to answer about the material recovered from the Keith Collection is:

- Does the material found in the boxes labeled "EL WAD D" and "EL WAD E" correspond to the material listed in the appendix of *The Stone Age of Mount Carmel vol.2* (McCown and Keith 1939 p. 375-378)?

2.3 Kebara Cave

Kebara cave (also known as Mugharet el-Kebara or Kebarah) is located at the western foot of Mount Carmel, 15 km south of the Wadi el-Mughara (Turville-Petre, 1932) (Figure 2). In 1930, Garrod organized an exploratory excavation at Kebara Cave (Garrod, 1954) which was carried out by F. Turville-Petre and C. A. Baynes of the British School of Archaeology in Jerusalem and the American School of Prehistoric Research at the same time as the el-Wad cave excavation (Garrod, 1954). The work at Kebara yielded several archaeological layers: Layer A is a historical layer containing Early Bronze Age to recent Arab objects (Turville-Petre, 1932). Layer B contained a Natufian industry and a series of human burials. Layer C contained an industry

previously unknown to Garrod and her colleagues, which she named Kebaran. Layer D and E contained Aurignacian industries, characterized by flakes and endscrapers or burins (Gilead, 1991). Layer D was described as an Upper Paleolithic IV industry and was reminiscent of that found in el-Wad D (Garrod, 1954). The lowest layer, F, yielded a Levalloiso-Mousterian industry similar to that of Layers F and G in el-Wad. The first published dates for the deposits from Kebara Level D place the deposits between 41,000 BP and 30,000 BP (uncalibrated) (Broecker and Kulp, 1957; Vogel and Waterbolk, 1963). Although a further series of dates was published after the 1996 excavations (Bar-Yosef et al., 1996) a more recent publication retested dating of the archaeological levels from the terrace using ultra-filtration and places the Upper Paleolithic IV (Layer D) between 47/46.000 cal BP (Rebollo et al., 2011)**.**

The human remains from Kebara Cave

The totality of the human material from Kebara in the Keith collection is marked "Kebara D". According to CFH, and confirmed in Bocquentin (2003), the human material from layers A, B, C and D is housed at the Peabody Museum, Harvard and the Institute of Archaeology, Jerusalem.

The original description of the Upper Paleolithic material from Kebara D was published in the appendix of *The Stone Age of Mount Carmel vol. 2* (McCown and Keith, 1939). The material is described as "the distal ends of a right and left humerus. There is the proximal end of a right ulna and the proximal end and more than half the shaft of another right ulna. There are five mandibular fragments, three of them belonging to adults, two of them to children" (McCown and Keith, 1939). From its similarities, it is clear this inventory served as the basis of the CFH entry for Kebara D.
The questions related to this human sample are:

- Are the human remains marked Kebara D in the Keith collection (and from the excavations by Turville-Petre) additional material to the collection reportedly housed in the Peabody Museum?, or,
- Are the remains in the Keith Collection the material reported in McCown and Keith (1939), and is CFH therefore erroneous in its location of these specimens?

2.4 Skhul Cave

Skhul Cave (also known as Mugharet es-Skhul) is located in the Wadi el-Mughara, approximately 19km from Haifa (Figure 2). After an initial excavation in 1929 by M. K. Clark, the site was systematically excavated under the direction of Theodore McCown during 1931-2 (Garrod and Bate, 1937). He recognized three archaeological layers (Garrod and Bate, 1937; McCown and Keith, 1939). Layer A, a mixed assemblage containing Natufian, Mousterian and Aurignacian material. Layer B was described as a breccia and subdivided into B1 and B2, although the whole tool assemblage was considered to be Mousterian (Garrod and Bate, 1937). Layer B contained 10 individuals and other unnumbered human remains (McCown and Keith, 1939). Although it is now accepted that the Skhul population represents early modern humans (Stringer, 2012; Vandermeersch, 1982), McCown and Keith (1939) suggested the human remains might be evidence for hybridization between Neanderthals and modern humans.

The human remains from Skhul Cave

This sample of the Keith Collection is the most mineralized and fragmentary. It consists of two boxes with a paper label in each. The label in box 1 reads "associated with Skhul VII" and contains mostly bone shards. Box 2 contained similar material but with bone fragments "associated with Skhul IX". No securely identifiable bone fragments are included in this box.

Skhul VII is currently located at the Peabody museum, Hardvard and Skhul IX at the Natural History Museum, London. McCown's description of the excavation and discovery of the human material (Garrod and Bate, 1937) does not mention boxes of bone fragments as part of Skhul VII and IX, nor are they listed in the CFH or McCown and Keith (1939) . This leaves only one question relating the Skhul material.

- Are these fragments of human bones belonging to Skhul VII and IX?

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3. Resolving the Origin of the Human Remains from the Keith Collection

A preliminary search of the archives of both the Royal College of Surgeons (RCS) and the Natural History Museum (NHM) established the date the materials from Shukbah Cave and Mount Carmel first came to the RCS. Below is the summary of the research carried out to establish the identity of the human material in the Keith Collection for each site. ~~Detailed descriptions and anatomical analyses of all the specimens are beyond the scope of this paper but a full inventory of the material together with matches to published descriptions, and new accession numbers for the Natural History Museum, London, are included in the appendix.~~

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3.1 Shukbah

The osteology curator, Michele Morgan, confirmed the Peabody Museum is storing six crania (accessioned in 1961) and one partial femur (accessioned in 1935). These six crania were part of an extensive study on the Natufians (Bocquentin, 2003). The presence of the cranial material at the Peabody Museum corresponds with the entry in the CFH, but the whereabouts of the unnumbered layer B and the layer D material is unclear. Because only a limited number of papers discuss the Shukbah material first hand (Garrod, 1928; Garrod, 1930; Garrod, 1942; Keith, 1931; McCown and Keith, 1939), the archival research on this site was the most time-consuming. Although much of the original documentation and letters were lost during World War II (RCS Annual report 1941), the quarterly report of the RCS from June, July and August 1928 stated: "Ms. Garrod returns from Mount Ephraim, Palestine, with her fossil remains. Some are Neanderthal, some are human." This confirms Dorothy Garrod returned to London with the remains immediately after closing the site in June. The report from 1930 also reports on the "human remains from a cave at Shukbah, Mount Ephraim. These were excavated by Miss Garrod, working for the British School of Archaeology, Jerusalem, during the winter 1927-1928… A full examination of Ms. Garrod's collection will throw light on the evolution and distribution of prehistoric races of the east".

In 1931, Keith published a preliminary description of the human material (Keith, 1931). He summarized the Epipaleolithic material (referred to as Capsian) to include "no less than 45 individuals ranging in age from birth to old age: 16 men, 9 women, 17

children and 3 very fragmentary adults. Nevertheless, only eight of the 45 individuals found at the site represented all parts of the skeleton" (Keith, 1931) p. 209. Here he also referred, for the first time, to the people of Shukbah as "the Natufians" (Keith, 1931) p.210. Little more is written about the Natufian material. Keith did include a more detailed description of the material from the lower Mousterian levels, concluding that some is of Neanderthal ancestry, whereas some are most likely to be Natufian intrusions (Garrod, 1942; Keith, 1931) (Figure 5). Keith offered no further description of the burials or completeness of the skeletons in the RCS archives that can in any way be useful for identifying the material held at the NHM, but Callander and Bar-Yosef later did (Callander and Bar-Yosef, 2004).

The lack of a more detailed analysis by Keith may be attributed to a series of possible factors. Around 1933, Keith's health was declining and he resigned from the conservatorship role at the RCS to take up the role of Master at Buckston Browne Farm (RCS archives). He also received a large amount of human fossil material from the sites in Mount Carmel (referred to by Keith as the Carmelites in the RCS archives) which required intensive preparation and analyses. This took almost ten years and culminated in the publication "*The Stone Age of Mount Carmel, volume 2*", co-authored with Theodore McCown (1939). This volume describes in detail the fossils from the sites of Skhul and Tabun and summarizes the inventory of the Upper Paleolithic human material from el-Wad and Kebara, all sites on Mount Carmel, Israel, but none of the Natufian material from either Shukbah or el-Wad. Dorothy Garrod spent several field seasons on Mount Carmel co-sponsored by the American School for Archaeology in Jerusalem, the Peabody Museum, and the RCS under the assumption that all fossil and archaeological material would be divided between the three institutions. The animal remains were sent to the NHM for study by her colleague Dorothea Bate and all the human fossil material was sent to the RCS for study by Keith and McCown. After the analyses, the human material was divided between the three institutions (McCown and Keith, 1939).

With the exception of a Neanderthal molar tooth from Shukbah, featured first in McCown and Keith (1939, Keith 1931), there is no further mention of the Shukbah

material in publications by either Keith or Garrod until the 1937-38 annual report of the RCS: "The people, named Natufians by Miss Garrod, are now being investigated and reported on by Mr. McCown. In order that Mr. McCown might do this in addition to his teaching duties in the University of California, Berkeley, permission was obtained from the Government of Palestine to send the Natufian Skeletons to California on temporary loan to Mr. McCown".

An entry in the RCS Memorandums (MS0018/2/1/1 mm1 (9), RCS archives) states "The Natufian material was shipped to Berkeley with permission from the Department of Antiquities, Palestine … The Natufian from Shukba is at Buxton Browne Farm, but the skulls are in London at the museum. It was impossible to arrange the photographing of the skulls and two of the juvenile ones, Nr 16 and 17 have not yet been drawn. It is suggested that this might be done and the photographs and tracings, a lateral face and occipital view, be sent to Mr. McCown in California. The remainder has been drawn, photographed and measured but cannot be packed until a decision is made by the Department of Antiquities in respect to distribution. This should happen with Ms. Garrod". The archivist at the Berkeley Library located the McCown archive and searched it for any Shukbah related paperwork that would allow us to identify the skeletal material. Unfortunately, the archive only contained notes and drawings of the Mount Carmel excavations, not those from Shukbah.

No shipping documents detailing the remains exist in the RCS archives (pers. comm. curator RCS archives) and no skeletal material from former Palestine is currently in the Berkeley University Museums (J. Knudson, personal communication). McCown's unpublished PhD thesis was found in the Berkeley library and although it primarily describes the el-Wad Natufian cranial material, it also contains a brief description of two skulls from Shukbah Cave but without much detail. The thesis implies that the el-Wad Natufians and perhaps some of the Shukbah material were sent to McCown. As the el-Wad material was moved to Harvard in 1961, it is likely that McCown only had the Shukbah material currently at Harvard in his possession, and that the other material remained at Buxton Browne farm. Our search for a detailed anatomical description that

could be used to securely identify the human remains in the Keith Collection at the NHM as being the material excavated by Dorothy Garrod had come to an end.

In order to confirm the material in the Keith collection was indeed the material from the 1928 excavation by Garrod, it was necessary to turn to the recently discovered Dorothy Garrod archives (Smith et al., 1997) held as part of the Suzanne Cassou de Saint-Mathurin archive at the Musée des Antiquites National (MAN) in Saint-Germain-en-Laye, France. The archives hold a series of photographs in an envelope marked "SHUKBAH" taken during the 1928 field season. Some of these photos appeared duplicates of photos held in the Cambridge Library with reference to the "Wadi-el-Natuf". The Cambridge collection has additional information taken from notes on the back of the photos, which are absent from the MAN photo collection. The photos are primarily of the site area, sectors in the cave, and the occasional photo of a human skeleton *in situ*, so do not provide enough information to identify all the skeletal material donated to the NHM. Fortunately, also included in the archive, is the excavation journal Dorothy Garrod wrote during her time at the site. There appear to be more individuals in the Keith collection and reported in the CFH than the 11 individuals mentioned in the excavation journal, which may be explained in two ways. First, in 1931, Keith reported eight skeletons and a large amount of disassociated material from Shukbah cave. The additional skeletal material in the Keith collection could be this disassociated material. The second possibility is that Garrod may have left the field early, and that George Woodbury and his wife Edna excavated the additional skeletal material. In 1942, Garrod confirmed the field season ended mid-June, but the last entry in her excavation diary was dated June 3rd 1928. In the journal, on May 3rd, Garrod left George Woodbury in charge during her absence from the site, so it is plausible that she did the same when she left the site on June 3rd. Woodbury may have finished the exhumation of the rest of the human remains. A search for the archives of George Woodbury was conducted in the hope of finding a field journal. The Bedford Historical Society confirmed that shortly after his return to the USA, Woodbury's wife died and he abandoned the field of archaeology. When he died in 1976, he did not leave any archaeological archives.

Although only 11 human skeletons are mentioned in the journal (Weinstein-Evron, 2003), and the numbered material from the Peabody Museum in the CFH does not correspond to the numbering system used in the excavation notes, the journal does mention some ages and particulars about the skeletons that proved useful for their identification. In combination with the publications by Keith (1931) and Garrod (1942), and the catalogue at the Peabody Museum it was possible to make some identifications of the skeletal material in the Keith collection and to confirm that it probably contains material from the original excavation. For example, two skeletons, Shukbah XVI and XVII, match the age and taphonomic description of Homo 6 and Homo 7 in the excavation journal, and one had an accompanying label reading "H7". The postcranial skeleton of these two individuals is currently in the Keith Collection at the NHM, whereas both crania are at the Peabody Museum.

Because of Keith's description of cut-marks on the human material (1931), the totality of the human sample was re-examined to identify possible bone surface modifications using a variable magnification binocular microscope. Observations were aided by illumination from a fiber-optic light source, and drawings were used to record the location of possible damage. Re-analysis of the modifications interpreted as cut-marks by Keith (1931) suggests they cannot be associated with human cutting activity (e.g. cannibalism or defleshing) (Figure 6). The typical micro-morphological characteristics of cut-marks (internal microstriations, shoulder effect and Hertzian cones) (Andrews and Cook, 1985; Behrensmeyer et al., 1986; Bello and Soligo, 2008; Boulestin, 1998; Greenfield, 1999; Shipman, 1981; Shipman and Rose, 1988; White and White, 1992) are absent on these modifications, which appear more rounded and wavy. They might be associated with natural bone features, but more likely are related to excavation or post-excavation damage such as removal of the wax used to consolidate the material on site (Garrod notebook, 1928). This conclusion seems to be confirmed by heavy damage observed on several bones, probably due to intense mechanical cleaning of bone surfaces using a metal instrument (Figure 7).

In Appendix Table 1 details are provided of how specimens when specimens were matched to a numbered individual, either from the numbering system used by Garrod, or

by the numbers assigned to the Peabody Museum individuals. ~~Further details of how the material was matched with the numbered individuals are listed in Appendix Table 1~~.

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3.2 El-Wad

Identification of the material labeled el-Wad in the Keith Collection (Appendix Table 2) was greatly helped by the description of this material and by a series of measurements in McCown and Keith (1939). There were two boxes and a bag of material. The first box was from el-Wad D and contained a right mandibular fragment, and atlas and some teeth ~~some specimens~~ clearly marked WAD D (Figure 8 R-T). These matched the descriptions in McCown and Keith (1939) and it was therefore concluded that this was the missing material from el-Wad D listed in the CFH.

The second box contained bones marked WAD E (Figure 8 A-Q). The specimens matched the descriptions in McCown and Keith (1939) and consisted of two partial mandibles, a collection of teeth, a partial lumbar vertebra, talus, metatarsal fragment, and a pedal phalanx~~.~~ In addition, an unlabeled cranial fragment and an intermediate phalanx were found in this box, as well as a third molar labeled 3. None of these were described in the volume. In the CFH a specimen is listed as el-Wad E3. This specimen was not present, nor was it described in McCown and Keith (1939). We therefore assume there are no specimens missing from layer E at el-Wad, and that there is a possible error in the CFH.

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In the same box as the Mousterian tooth from Shukbah D, a lower right second molar labeled "WAD G (*vis* F)" was found, as well as a second premolar marked "WAD DEF" and these were all found in a box inside an unmarked partially reconstructed cranium. The molar was found to correspond to the molar described in McCown and Keith (1939) (Figure 9). Also, a molar was found in a bag labeled "WAD D/E but probably C". In addition to the el-Wad material from the Keith Collection (Appendix Table 2), we report here the discovery of a partial human foot recovered by the

Anthropology curator from the fossil mammal collection from el-Wad B. No other material from el-Wad B was found.

3.3 Kebara Cave

Identification of the material from Kebara Cave in the Keith Collection (Appendix Table 3) was greatly helped by the description of the material and a list of measurements in the appendix of McCown and Keith (1939). All the specimens are marked "KEB D" and there is close correspondence between the material described by McCown and Keith (1939) and in the CFH. Each of the described postcranial elements has been found, as well as the five mandibular fragments, three of them belonging to adults, two of them to children (Figure 10). It can therefore be concluded that this is the material from Kebara D, and that its location at the Peabody Museum reported in CFH was erroneous. A full inventory can be found in Appendix Table 3.

3.4 Skhul Cave

There is no description of the two boxes with numerous bone fragments in the burial descriptions of Skhul VII and Skhul IX by McCown, in Garrod and Bate (1937) (Figure 11). The material in the Keith collection (Appendix Table 4) may be debris associated with these fossils that resulted from the removal of the skeletons from the very hard breccia in which they were found (McCown in (Garrod and Bate, 1937)). Due to the lack of identifiable fragments, or mention of these fragments in Garrod and et al. (1937), any associations between the two boxes from the Keith collection and the human skeletal material from Skhul cave are tentative at best. No clear connection exists between the fragments in the boxes and the skull IX, for example.

Commented [00008]: Page 17, do you mean that you could not recognize anatomically the fragments? Have you tried directly on the original specimens?

4. Conclusion

The discovery of the Natufian material with its human post-crania from Shukbah Cave in the Keith Collection from Buxton Browne Farm ~~with its human post-crania~~ has

come as a surprise to many who have been looking for this collection for some time (P. Smith, personal communication). The recovery of these human remains from the type site of the Natufian, which had been thought to consist of only six crania, will enable scientists to further study the biology of the people from this important time period. Although it is a small and rather fragmentary collection, the material will add to the existing Natufian skeletal collections (many listed in Bocquentin, 2003) and will help understand the last hunter-gatherers (Belfer-Cohen, 1991; Belfer-Cohen and Bar-Yosef, 2002; Munro, 2004; Portillo et al., 2010) who forayed into agriculture (Bar-Yosef, 1998; Davis and Valla, 1978), as well as population dynamics during the Early Neolithic in the Near East (Haak et al., 2005; Pinhasi and von Cramon-Taubadel, 2009).

The smaller assemblages from el-Wad and Kebara cave are from a time period from which very few fossils survive and are thus invaluable for understanding the Middle to Upper Paleolithic transition in the Near East, the corridor to the rest of the world. The earliest evidence for anatomically modern humans in the area dates back to around 115.000BP (Grün et al., 2005) at Skhul and Qafzeh, where they were associated with a Middle Paleolithic Levalloiso-Mousterian technology (Schwarcz et al., 1988). Recent research on 42-39Ka old material from ~~the~~ Lebanon (Douka et al., 2013) and 45Ka old teeth from Italy (Benazzi et al., 2011) suggests that humans transitioning to more advanced Upper Palaeolithic tools must have passed through the Levant and expanded into Eurasia somewhere between 60 000 and 45 000 BP (Douka et al., 2013; Mellars, 2011; Stringer, 2012). Despite a good archaeological record (Stringer, 2012), there is a scarcity of modern human skeletal material from the end of the Middle Palaeolithic period (Douka et al., 2013).

So-called 'transitional assemblages' combining elements of both the Middle and Upper Paleolithic are known from both Europe and western Asia and have been ascribed to the expansion of anatomically modern humans and the replacement of the local Neanderthals (Hublin, 2012). Recent developments in sequencing of nuclear DNA have shown that Neanderthals and living humans share a small proportion of genetic material that indicates past hybridization between the two species, which perhaps occurred in

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western Asia. Although no sites in the region that demonstrate contemporaneity between the two species have yet been discovered, Neanderthals and anatomically modern humans alternately occupied the Levant, and potentially coexisted there longer than anywhere else (Kaufman, 2001; Shea, 2003, 2008). In order to fully understand the process by which Neanderthals contributed their DNA to that of modern humans, it will ultimately be necessary to go beyond the study of recent populations and directly compare the ancient DNA of the two species, particularly in regions where it is known that they overlapped. For that reason, any fossil material from the late Middle and early Upper Paleolithic of western Asia is potentially of great importance.

The whole of the Sir Arthur Keith Collection is stored in the Anthropology Collection at the Natural History Museum, London (Figure 12). By announcing its re-discovery and publishing details of the skeletal material, it is hoped that the Keith Collection will become part of many future analyses.

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References Cited

Andrews, P., Cook, J., 1985. Natural modifications to bones in a temperate setting. Man, 675-691.

Bar-Yosef, O., Arnold, M., Mercier, N., Belfer-Cohen, A., Goldberg, P., Housley, R., Laville, H., Meignen, L., Vogel, J., Vandermeersch, B., 1996. The dating of the upper Paleolithic layers in Kebara cave, Mt Carmel. Journal of Archaeological Science 23, 297-306.

Bar-Yosef, O., 1998. The Natufian culture in the Levant, threshold to the origins of agriculture. Evolutionary Anthropology: Issues, News, and Reviews 6, 159-177.

Behrensmeyer, A.K., Gordon, K.D., Yanagi, G.T., 1986. Trampling as a cause of bone surface damage and pseudo-cutmarks. Nature 319, 768-771.

Belfer-Cohen, A., 1991. The Natufian in the Levant. Annual Review of Anthropology 20, 167-186.

Belfer-Cohen, A., Bar-Yosef, O., 2002. Early sedentism in the near east, Life in Neolithic Farming Communities. Springer, pp. 19-38.

Bello, S.M., Soligo, C., 2008. A new method for the quantitative analysis of cutmark micromorphology. Journal of Archaeological Science 35, 1542-1552.

Benazzi, S., Douka, K., Fornai, C., Bauer, C.C., Kullmer, O., Svoboda, J., Pap, I., Mallegni, F., Bayle, P., Coquerelle, M., 2011. Early dispersal of modern humans in Europe and implications for Neanderthal behaviour. Nature 479, 525-528.

Bocquentin, F., 2003. Pratiques funéraires, paramètres biologiques et identités culturelles au Natoufien: une analyse archéo-anthropologique. , Sciences du Vivant, Géosciences et Sciences de l'Environnement L'Universite Bordeaux I, Bordeaux, p. 631.

Boulestin, B., 1998. Approche taphonomique des restes humains. Le cas des Mésolithiques de la grotte des Perrats (Agris, Charente).

Broecker, W., Kulp, J., 1957. Lamont natural radiocarbon measurements. IV. Science See Saiensu 126.

Callander, J., Bar-Yosef, O., 2004. Dorothy Garrod's excavations in the Late Mousterian of Shukbah Cave in Palestine reconsidered. Proceedings of the Prehistoric Society 70, 207-231.

Davis, S.J., Valla, F.R., 1978. Evidence for domestication of the dog 12,000 years ago in the Natufian of Israel. Nature 276, 608-610.

Douka, K., Bergman, C.A., Hedges, R.E., Wesselingh, F.P., Higham, T.F., 2013. Chronology of Ksar Akil (Lebanon) and Implications for the Colonization of Europe by Anatomically Modern Humans. PloS one 8, e72931.

Eckmeier, E., Yeshurun, R., Weinstein-Evron, M., Mintz, E., Boaretto, E., 2012. Radiocarbon dating of the Early Natufian at el-Wad Terrace, Mount Carmel, Israel, EGU General Assembly Conference Abstracts, p. 7185.

Garrod, D.A.E., 1928. Excavation of a Palaeolithic cave in Western Judaea. Palestine Exploration Quarterly 60, 182-185.

Garrod, D.A.E., 1930. Fouilles paléolithiques en Palestine, 1928-1929. Bulletin de la Société préhistorique de France, 151-160.

Garrod, D.A.E., 1931. Excavations in the Wady Al-Mughara (Palestine), 1931.

Garrod, D.A.E., 1932. A new Mesolithic industry: the Natufian of Palestine. The Journal of the Royal Anthropological Institute of Great Britain and Ireland 62, 257-269.

Garrod, D.A.E., 1942. Excavations at the cave of Shukbah, Palestine, 1928. John Bellows Limited.

Garrod, D.A.E., 1954. Excavations at the Mugharet Kebara, Mount Carmel, 1931: The Aurignacien Industries. John Bellows Limited.

Garrod, D.A.E., Bate, D.M., 1937. The stone age of Mount Carmel. vol 1. The Clarendon Press.

Gilead, I., 1991. The Upper Paleolithic period in the Levant. J World Prehist 5, 105-154.

Greenfield, H.J., 1999. The origins of metallurgy: distinguishing stone from metal cut-marks on bones from archaeological sites. Journal of Archaeological Science 26, 797-808.

Grün, R., Stringer, C., McDermott, F., Nathan, R., Porat, N., Robertson, S., Taylor, L., Mortimer, G., Eggins, S., McCulloch, M., 2005. U-series and ESR analyses of bones and teeth relating to the human burials from Skhul. Journal of Human Evolution 49, 316-334.

Haak, W., Forster, P., Bramanti, B., Matsumura, S., Brandt, G., Tänzer, M., Villems, R., Renfrew, C., Gronenborn, D., Alt, K.W., 2005. Ancient DNA from the first European farmers in 7500-year-old Neolithic sites. Science 310, 1016-1018.

Hublin, J.-J., 2012. The earliest modern human colonization of Europe. Proceedings of the National Academy of Sciences 109, 13471-13472.

Kaufman, D., 2001. Comparisons and the case for interaction among Neanderthals and early modern humans in the Levant. Oxford Journal of Archaeology 20, 219-240.

Keith, A., 1931. New discoveries relating to the antiquity of man.

McCown, T.D., Keith, A., 1939. The Stone Age of Mt. Carmel, vol. 2: the fossil human remains from the Levalloiso-Mousterian. Clarendon Press, Oxford, UK.

Mellars, P., 2011. Palaeoanthropology: The earliest modern humans in Europe. Nature 479, 483-485.

Munro, N.D., 2004. Zooarchaeological measures of hunting pressure and occupation intensity in the Natufian. Current Anthropology 45, S5-S34.

Oakley, K., Campbell, B., Molleson, T., 1975. Catalog of fossil Hominids. Part III: Americas, Asia, Australasia. British Museum (Natural History), London, p. 226.

Pinhasi, R., von Cramon-Taubadel, N., 2009. Craniometric data supports demic diffusion model for the spread of agriculture into Europe. Plos one 4, e6747.

Portillo, M., Rosen, A., Weinstein-Evron, M., 2010. Natufian plant uses at el-Wad Terrace (Mount Carmel, Israel): the phytolith evidence. Eurasian Prehistory 7, 99-112.

Rebollo, N.R., Weiner, S., Brock, F., Meignen, L., Goldberg, P., Belfer-Cohen, A., Bar-Yosef, O., Boaretto, E., 2011. New radiocarbon dating of the transition from the Middle to the Upper Paleolithic in Kebara Cave, Israel. Journal of Archaeological Science 38, 2424-2433.

Schwarcz, H., Grün, R., Vandermeersch, B., Bar-Yosef, O., Valladas, H., Tchernov, E., 1988. ESR dates for the hominid burial site of Qafzeh in Israel. Journal of Human Evolution 17, 733-737.

Shea, J.J., 2003. The Middle Paleolithic of the east Mediterranean levant. J World Prehist 17, 313-394.

Shea, J.J., 2008. Transitions or turnovers? Climatically-forced extinctions of *Homo sapiens* and Neanderthals in the east Mediterranean Levant. Quaternary Science Reviews 27, 2253-2270.

Shea, J.J., 2013. Stone Tools in the Paleolithic and Neolithic Near East: A Guide. Cambridge University Press.

Shipman, P., 1981. Life History Af a Fossil: An Introduction to Taphonomy and Paleoecology. Harvard University Press.

Shipman, P., Rose, J.J., 1988. Bone tools: an experimental approach, Scanning electron microscopy in archaeology. British Archaeological Reports, pp. 303-335.

Smith, P., Callander, J., Bahn, P., PinÇlon, G., 1997. Dorothy Garrod in words and pictures. Antiquity 71, 265-265.

Stringer, C., 2012. Lone Survivors: How We Came to Be the Only Humans on Earth. Henry Holt and Company.

Turville-Petre, F., 1932. Excavations in the Mugharet el-Kebarah. The Journal of the Royal Anthropological Institute of Great Britain and Ireland 62, 271-276.

Vandermeersch, B., 1982. The first Homo sapiens sapiens in the Near East, in: Ronen, A. (Ed.), The Transition from the Lower to the Middle Palaeolithic and the Origin of Modern Man. British Archaeological Reports. International Series, Oxford, pp. 297-300.

Vogel, J., Waterbolk, H., 1963. Groningen Radiocarbon Dates IV. Radiocarbon 5, 163-202.

Weinstein-Evron, M., 1998. Early Natufian el-Wad Revisited. Université de Liège, Service de Prehistoire.

Weinstein-Evron, M., 2003. In B or not in B: a reappraisal of the Natufian burials at Shukbah Cave, Judaea, Palestine. Antiquity 77, 96-101.

White, T.D., White, T., 1992. Prehistoric cannibalism at Mancos 5MTUMR-2346. Princeton University Press Princeton.