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RESEARCH ARTICLE

The utilization of birds at neolithic WF16, southern Jordan: Cut marks, body parts, and experimental skinning

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Abstract

WF16 is an early Neolithic settlement in southern Jordan with a large bird bone assemblage (Number of Identified Specimens [NISP] = 7808), representing 18 families. We explore how the birds were utilized by considering cut marks and body part representation for each of the families represented, also drawing on the experimental skinning of buzzards, the most common bird in the assemblage. We conclude that the bird bones accumulated from a mix of activities including the exploitation of a seasonally abundant supply of migratory birds for food; the acquisition of skins, feathers and talons for decorative, symbolic and practical purposes; and the trapping of wildfowl and gamebirds as a supplementary food source to large mammals.

KEYWORDS

bird bones, body parts, cut Marks, Faynan, Jordan, Neolithic, WF16

1 | INTRODUCTION

Avian assemblages from Late Pleistocene and Early Holocene settlements of SW Asia provide insights into the economic, social, and symbolic activities of human communities during a period of environmental change and the transition from hunting and gathering to farming. While gamebirds and waterfowl may have contributed to the diet of these communities, the remains of raptors and other large birds indicate the use of wings, feathers, and talons for ornamentation and costume, primarily based on body part representation and, less frequently, cut marks (Gourichon, 2002; Martin et al., 2013; Russell, 2018, 2019; Simmons & Nadel, 1998; Zeder & Spitzer, 2016). We build on this research by considering the utilization of birds at the early Neolithic settlement of WF16 in southern Jordan, dating to between 11.84 and 10.24 Ka BP, with a peak of activity at 11.20 Ka BP (Mithen et al., 2018, Figure 1).

White et al. (2021) describe the composition, chronology, and spatial distribution of the WF16 bird bones. In summary, 17,700 specimens were recovered of which 7808 (44.11%) were identified to at least family level. Sixty-three bird taxa are present from 18 families representing a mix of resident and migrant birds, based on present-day ecology. The Accipitridae family dominate, accounting for 89.19% of identifiable bones (Number of Identified Specimens [NISP] = 6964) with at least 20 species of eagles, vultures, harriers, kite, sparrowhawk, and buzzards represented. The Eurasian/steppe buzzard is by far the most abundant accounting for 63.19% of all Accipitridae (NISP = 4401). Phasianidae is the second largest family accounting for 3.93% (NISP = 307) of the identified material with the resident, ground dwelling chukar partridge (*Alectoris chukar*) most frequent (NISP = 254) and the sand partridge (*Ammoperdix heyi*) and quail (*Coturnix coturnix*) making up the remainder. Somewhat unexpectedly, the third largest family at 0.97% is Threskiornithidae which

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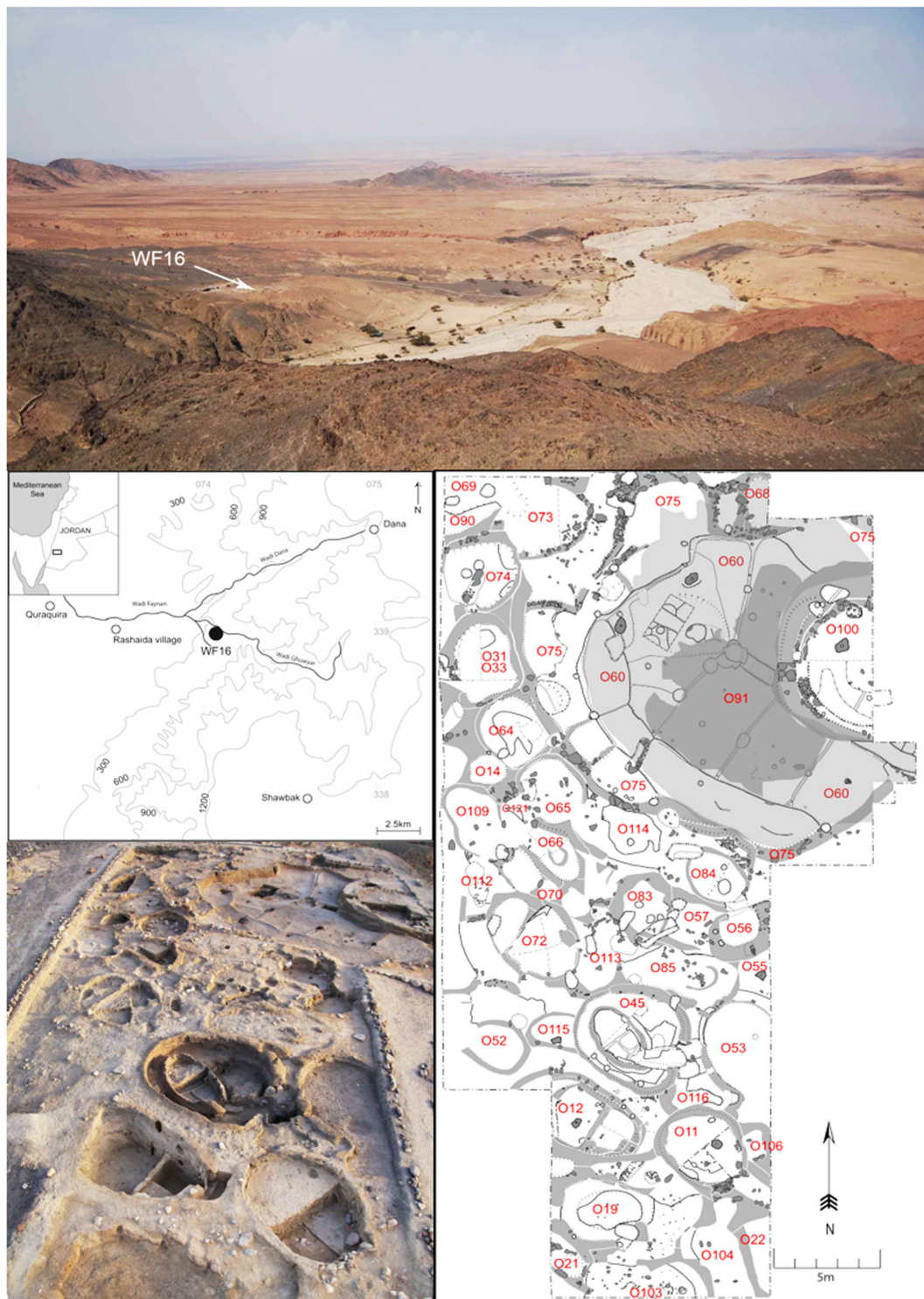


FIGURE 1 The early Neolithic site of WF16 (a) looking east along the Wadi Faynan towards the Wadi Araba; (b) location in southern Jordan; (c) excavation in April 2010; (d) site plan [Colour figure can be viewed at wileyonlinelibrary.com]

includes 70 specimens identified confidently to northern bald ibis (*Geronticus eremita*) and a further 6 as probable, making it the fifth most common bird in terms of NISP. Ducks, storks, herons, bustard, rails, doves, rollers, corvids, and some smaller passerines are also represented, often only by single bones or in the case of the little egret (*Egretta garzetta*), a near complete individual.

In this contribution, we analyze the body part representation, cut marks, and to a lesser extent burning, to infer how these birds may have been utilized. Body part representation is often difficult to interpret because of multiple and complex taphonomic processes that influence preservation and recovery. The absence of body parts at a settlement site might reflect differential decay (Higgins, 1999),

butchery at kill sites, deposition in unexcavated areas, or their removal for social and symbolic use elsewhere, as suggested by Martin et al. (2013) and evident at Hilazon Tachtit (Grosman et al., 2008). Cut marks are often entirely absent in avian assemblages because most birds can be cooked whole and pulled apart. Their presence, therefore, can be especially telling, indicative of special treatment of a carcass. The preparation of birds for food need not result in burnt bones, which instead might arise from ritual burning of carcasses, secondary deposition into fireplaces or the spread of fire within settlements.

2 | METHODS

The WF16 bird bones were recovered by sifting excavated sediment through a 2-mm mesh. The zoning system according

to Cohen and Serjeantson (1996) was used to record bone completeness for most elements, to allow for quantification of minimum number of elements (MNE) and minimum number of individuals (MNI). The skeletal part frequencies for the most abundant taxa were calculated using $MNE/(MNI \times \text{representation of element in skeleton})$ (see Lyman, 1994). Specimens were grouped together (e.g., *Buteo* cf. *buteo*, *Buteo rufinus*, *Buteo* cf. *rufinus*, cf. *Buteo* sp.) to increase sample size and counteract any bias due to fragmentation or overlap in species identification. Butchery marks were recorded by zone (according to Cohen & Serjeantson, 1996) and direction (oblique, transverse, and longitudinal). The type of mark was recorded as "cut," unless clearly a chop mark, striation, or the result of peeling. No attempt was made at distinguishing the type of cut mark, for example, incision, saw. Burning was recorded by color and zone.

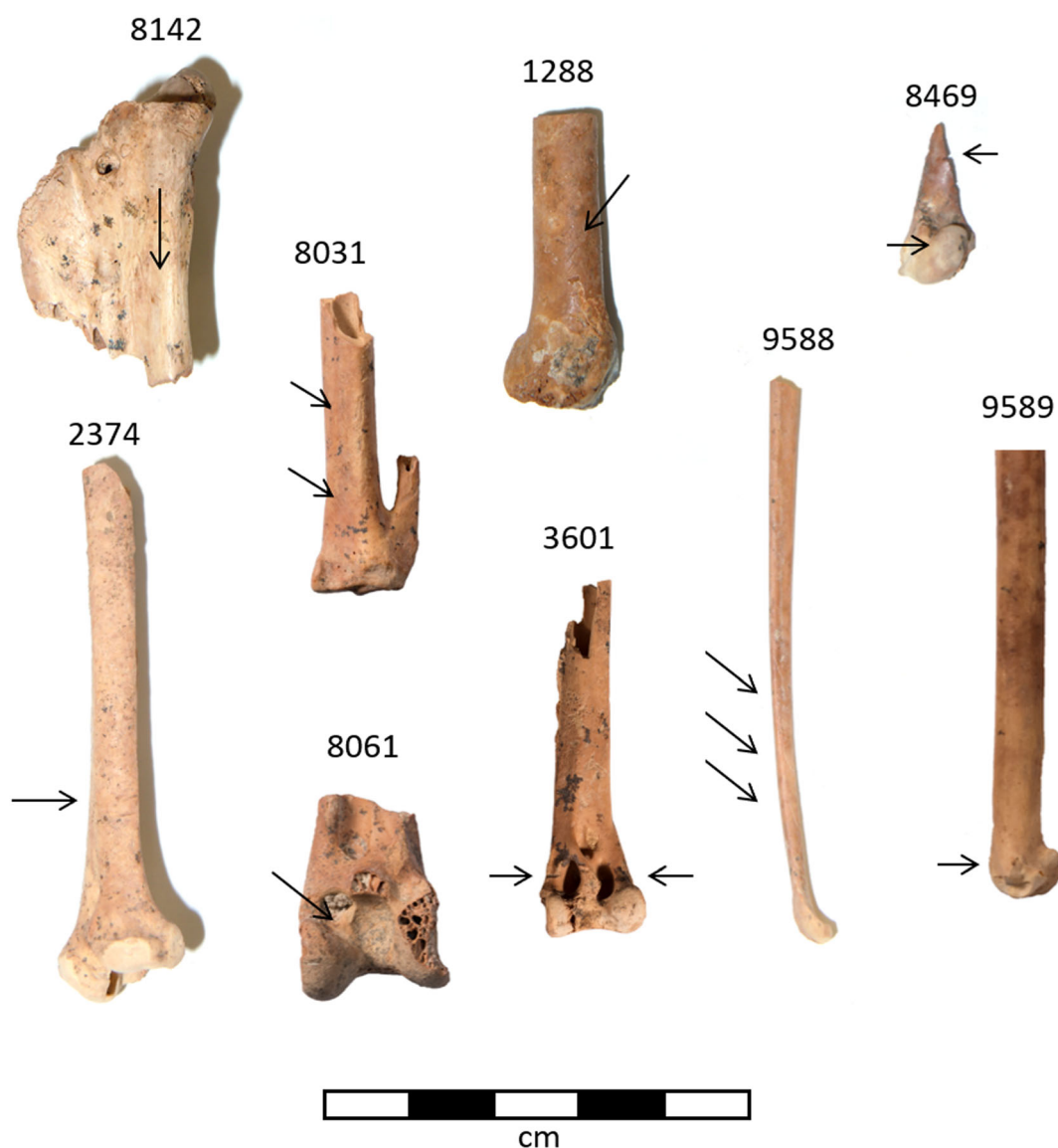


FIGURE 2 Examples of cut marks on non-Accipitridae: 8469 *Anas* cf. *platyrhynchos* (mallard) humerus; 8142 *Grus grus* (common crane) tarsometatarsus; 1288 *Geronticus eremita* (northern bald ibis) ulna; 8031 *Anser anser* (greylag goose) carpometacarpus; 2374 *Bubo ascalaphus* (desert eagle owl) tarsometatarsus; 3601 *Falco biarmicus* (lanner falcon) tibiotarsus; 8061 *Ciconia* cf. *ciconia* (white stork) tibiotarsus; 9,859 *Egretta garzetta* (little egret) ulna; 9588 *Egretta garzetta* (little egret) radius [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

3 | RESULTS

Of the 7808 identifiable specimens, 679 were burnt and 493 exhibited cut marks. Tables S1–S3 provide data on skeletal part representation, cut marks, and burned elements for all taxa.

3.1 | Anatidae (NISP = 58)

At least eight taxa have been identified at WF16, representing 0.74% of the assemblage. Each taxon is represented by less than 10 specimens and in most cases a single bone. Ten specimens are burnt, which at 17.24% of NISP is the highest frequency for any family. Only three bones exhibit cut marks. The shaft of a carpometacarpus of a greylag goose had fine cuts (8301, Figure 2), which are likely to indicate the removal of the primary feathers. A pointed fragment of the distal humerus of a mallard has several cuts and notches on the shaft (8469, Figure 2). The point is smooth and worn which may suggest that the modifications were the result of use rather than processing. A furcula identified to mallard/wigeon has fine striations on the surface, possibly from removing flesh. The diverse range of Anatidae is typical for the Epi-Paleolithic and early Neolithic (Simmons, 2004) and most likely represents occasional trapping of waterfowl as a food resource, and in the case of the goose, for feathers. Their relatively small presence and dispersed distribution at WF16 provide no evidence for the processing of carcasses for grease and fat as inferred at Shubayqa 6 (Yeomans & Richter, 2020).

3.2 | Phasianidae (NISP = 307)

The Phasianidae family is dominated by chukar partridge (*Alectoris chukar*, NISP = 254, MNI = 28), with fewer remains of quail (*Coturnix coturnix*, NISP = 29, MNI = 7) and sand partridge (*Ammoperdix heyi*, NISP = 14, MNI = 5). Most body parts of the chukar are present, although elements from the pectoral girdle predominate (Figure 3). We follow Proctor and Lynch (1993, 134) by including the coracoid, scapula, furcula, and sternum within the pectoral girdle and note that a high frequency of these bones is typically attributed to consumption. Burning was recorded mostly on coracoid, sterna, distal tibiotarsi, and tarsometatarsi. The relatively high frequency of burning ($n = 36$, 11.73%), mostly occurring on areas of bone with less flesh that would be more exposed to the heat suggests that the birds may have been grilled or roasted (Funk et al., 2016). Quail and sand partridge are also represented by bones from the leg, wing, and pectoral girdle, with neither displaying any cut marks. Phasianidae were most likely trapped as small game birds for food.

3.3 | Columbidae (NISP = 66)

At least four species of Columbidae were identified from a range of body parts. With eight burnt bones (12.12%) and an absence of cut marks, the most reasonable interpretation is that they were caught for food.

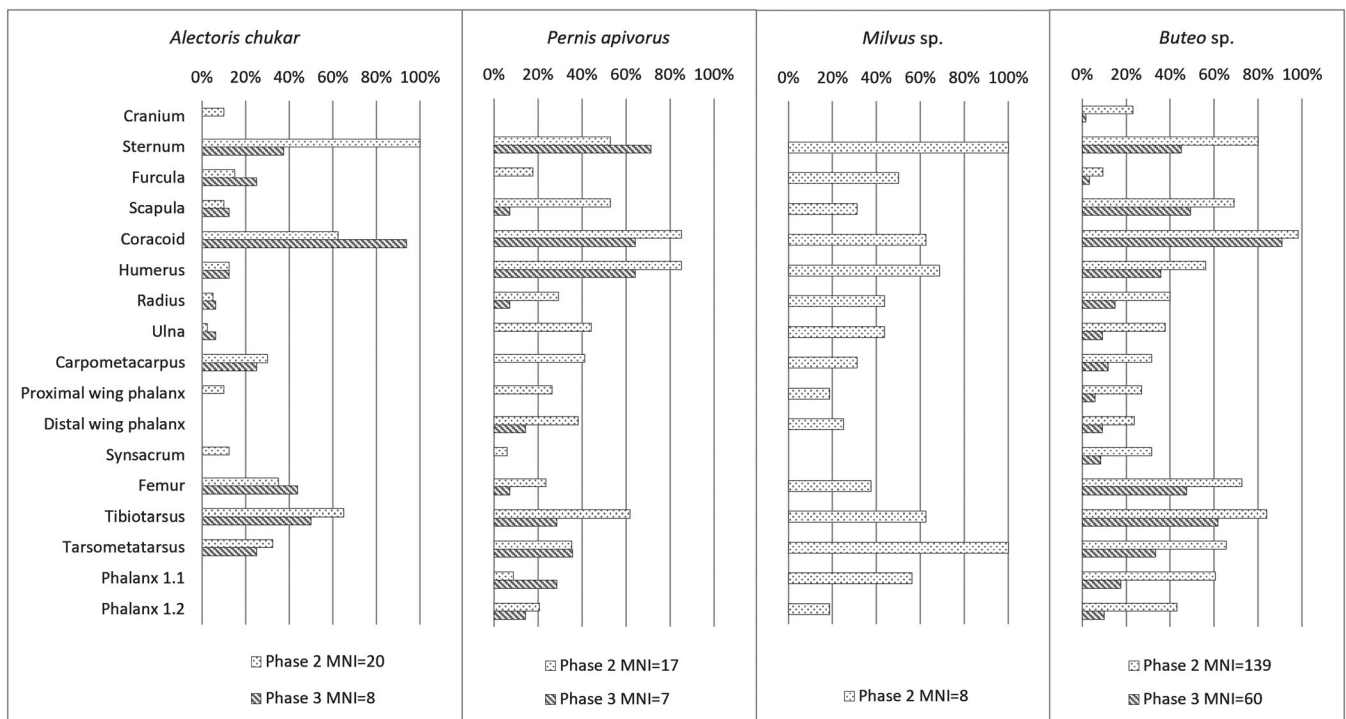


FIGURE 3 Skeletal part frequencies for (a) *Alectoris chukar*; (b) *Pernis apivorus*; (c) *Milvus sp.*; (d) *Buteo sp.*

3.4 | Pteroclididae (NISP = 50)

Eight bones (MNI = 3) could be attributed to the spotted sandgrouse and 42 bones (MNI = 11) to genus. The coracoid and humerus are the most frequent elements, along with other bones from the pectoral girdle, wing, and leg, suggesting that whole carcasses are represented at the site and used for food. No cut marks are present, likely reflecting the small size of the birds, needing minimal processing for consumption.

3.5 | Rallidae (NISP = 30)

The corn crane (*Crex crex*) is represented by 18 specimens, a further five are most likely from this species, with elements mainly from the wing (10), leg, scapula, and coracoid. The moorhen (*Gallinula chloropus*) is represented by a solitary tibiotarsus and the coot (*Fulica atra*) by six specimens (MNI = 2): two tarsometatarsi, two coracoids, a tibiotarsus, and an ulna. None of the bones have cut marks, and four (13.33%) are burnt. As with other gamebirds and waterfowl, rails were likely to have been captured for food.

3.6 | Gruidae (NISP = 2)

A single fragment of a proximal tarsometatarsus (8142) of common crane (*Grus grus*) exhibits fine longitudinal cuts (Figure 2). This element would have been covered in tough scaly skin suggesting the cuts marks arose from cleaning the bone, perhaps for use as a tool, as reported at Çatalhöyük (Russell, 2018). A fragment of humerus is tentatively identified to crane or stork. Given the large size of this bird, it is surprising that no other bones were recovered and may indicate that the bone was opportunistically scavenged from the surrounding area.

3.7 | Otidae (NISP = 8)

Elements from the leg, lower wing, and a furcula represent at least two individuals of MacQueen's bustard (*Chlamydotis* sp.). None of the bones have cut marks or signs of burning. Although only one element is from the pectoral region, there is nothing to indicate this bird was used for anything other than food.

3.8 | Ciconiidae (NISP = 36)

Twenty-one bone fragments were identified to white stork (*Ciconia* cf. *ciconia*), representing at least three individuals and consisting of trunk, wing, leg, and skull fragments. A further 15 fragments have been identified as stork (*Ciconia* sp.) which are mostly wing bones, including two wing phalanges, a toe bone, fragment of tibiotarsus, and vertebrae. Five of these bones have cut marks, four on wing bones (ulna, carpometacarpus, proximal wing phalanx, and distal wing

phalanx) suggesting the deliberate removal of wings and/or feathers and one distal tibiotarsus (8061, Figure 2) perhaps with the intention of removing the foot. The wing phalanges also appear to show polishing from possible wear. These modified bones represent 13.89% of the NISP of Ciconiidae, one of the highest for any taxa at WF16. Although it seems that whole birds were brought to site, the bias towards wing bones and presence of cut marks on these elements may indicate that wings were also selectively brought to the WF16 settlement for their feathers.

3.9 | Ardeidae (NISP = 59)

In this family of long-necked and long-legged wading birds, the little bittern (*Ixobrychus minutus*) is represented by a single toe bone (first phalanx of digit one), while two fragments of proximal radii were identified as purple heron (*Ardea purpurea*), both coming from the right-hand side and hence representing two individuals. The little egret (*Egretta garzetta*) on the other hand is represented by 56 bones, all coming from a partially articulated individual located in a protected niche of a structure and representing the skull, vertebrae, right upper wing and right, and left leg. The left wing is missing, and cut marks located on the right distal radius and ulna indicate that the lower wing had been deliberately removed (9588, 9589, Figure 2). Had that been for display, one might speculate that the attractive head plumes of this bird would have also been used for this purpose. The absent trunk suggests that this bird may have also been a source of food. It is possible that the remains of the carcass had been a deliberate burial or at least a special deposition (White et al., 2021, Figure 6). Alternatively, the butchered and discarded carcass at WF16 might have simply fallen into a niche by a mud-clay wall, where it fortuitously avoided postdepositional disturbance.

3.10 | Threskiornithidae (NISP = 76)

The northern bald ibis is represented by all body parts, with bones from the pectoral girdle and wing most common. Eleven cut marks are present: five located on the pectoral region (four coracoid and one scapula), five on the wings (humerus, carpometacarpus, and three ulnae), and one on the tibiotarsus. This is one of the highest frequency of cut marks and suggests that the birds were carefully butchered, with the distribution of cut marks suggesting both the removal of meat and detachment of wings and feathers which are an attractive iridescent black (e.g., 1288, Figure 2). A fragment of ulna identified to spoonbill/northern bald ibis also exhibits a cut mark. There is a notably high concentration of northern bald ibis bones (NISP = 23, MNI = 3) within a single structure at WF16, O72, with half of these coming from at least three right wings. The relatively high frequency of cut marks is matched by a high frequency of burnt bones at 17.12% ($n = 13$), which is the second highest for any taxa at WF16, just below the Anatidae (17.24%, $n = 10$). All five bones identified to northern bald ibis from O65 were burnt.

3.11 | Falconidae (NISP = 50)

At least three taxa (kestrel, lanner, and peregrine falcon) are represented, primarily by bones from the pectoral girdle, wing, and leg. Only an ulna of a large falcon and the distal tibiotarsus of a lanner falcon exhibit cut marks, these being similar to the cut marks observed on other birds of prey linked to wing/feather removal and disarticulation of the tarsometatarsus from the tibiotarsus (e.g., 3601, Figure 2).

3.12 | Tytonidae and strigidae (NISP = 11)

At least five owl taxa are represented, each by three bones or less, all of which come from the wing or leg, except for a single coracoid. The only cut marks are on two fragments of tarsometatarsi identified as desert eagle owl (*Bubo ascalaphus*), possibly with the purpose of removing the feathers from the foot (2374, Figure 2). Both are from the left-hand side and potentially from the same individual. A distal wing phalanx of short-eared owl (*Asio flammeus*) and a tibiotarsus of barn owl (*Tyto alba*) are the only burnt bones within this group. While we recognize that owls may have taken up residence in abandoned structures, the cut marks and burning indicate that they entered the assemblage by anthropogenic means.

3.13 | Coraciidae (NISP = 3)

A coracoid and carpometacarpus were identified as European roller (*Coracias garrulus*), along with a tentatively identified humerus shaft. The bones from this attractive blue bird lack modifications.

3.14 | Corvidae (NISP = 41)

The Corvidae are represented by at least five species, comprising of elements from the pectoral region, wing, and leg. Two bones display cut marks: the femur of a fan-tailed raven (*Corvus rhipidurus*) and wing phalanx of a fan-tailed/brown-necked raven. Two bones have signs of burning. As with owls, it is also possible that some of the corvids entered the WF16 assemblage by natural processes, coming to scavenge on-site debris; however, the modifications suggest that they may have been used by the inhabitants of WF16 as a source of food or feathers.

3.15 | Other passerines (NISP = 47)

Passerines are poorly represented within the WF16 assemblage most likely reflecting the combined effects of their small size, fragility, and limited exploitation.

3.16 | Accipitridae (NISP = 6964)

3.16.1 | Buzzard

Buzzard bones are most numerous, with 5421 specimens identified as *Buteo* cf. *buteo*, *Buteo rufinus*, *Buteo* cf. *rufinus* and cf. *Buteo* sp. (MNI = 199). The coracoid is the best represented element in both phases (Figures 3 and 4 and Table S1), along with other bones from the pectoral girdle, and to a lesser extent the leg. Fewer wing and foot bones are evident in Phase 3. Field observations suggested that complete carcasses had been discarded at the site, notably within O11, but due to the large samples and fragmentation, it was not possible to

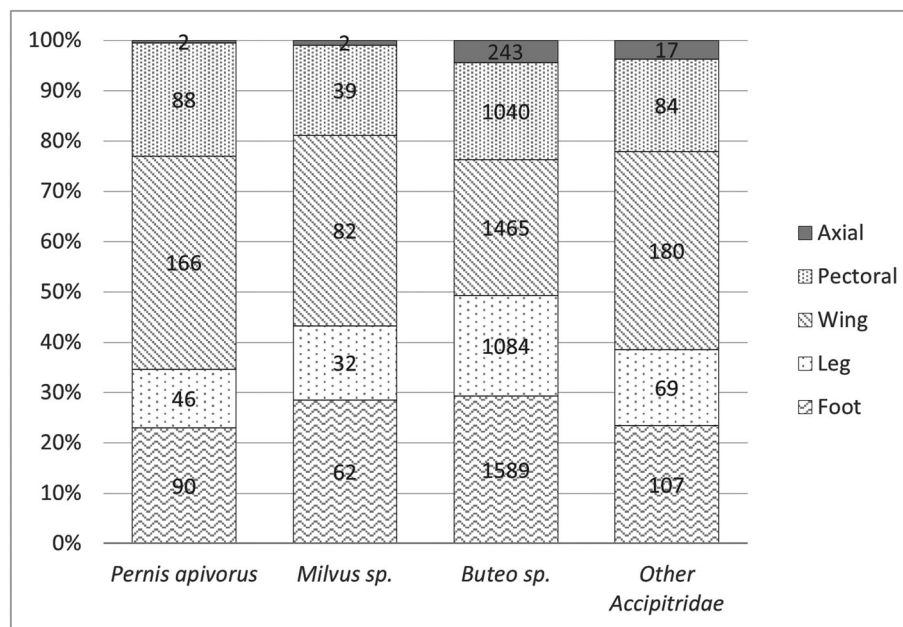


FIGURE 4 Accipitridae: representation of body parts by NISP; see Table S1 for details of elements

recognize complete birds during the analysis. Small sets of elements which appeared to articulate were identified in most objects, including 59 partial sets of toes, 3 sets of articulating axis and atlas, 1 synsacrum and vertebrae, and four sets of lower wing bones. The recovery of most parts of the skeleton indicates that these birds were likely captured and brought back to site as complete carcasses. The prevalence of bones from the pectoral girdle suggests that some were eaten.

Seventy-seven percent 76.67% ($n = 378$) of the total number of cut marks among the bird bones at WF16 are found on buzzard bones, located on the cranium, synsacrum, scapula, coracoid, humerus, ulna, radius, carpometacarpus, alula, proximal wing phalanx, femur, tibiotarsus, fibula, tarsometatarsus, metatarsal one, first phalanx of digit one, and ungual phalanx of digit one (Table S2). Nearly 50% of all cut marks occur on the foot (Figure 5). Figure 6 illustrates a selection of cut marks and their overall distribution.

Longitudinal cuts on the dorsal surface of the skull and synsacrum are indicative of skinning. Cutting around the beak and down the back is part of the skinning process the Inuit of Sanikiluaq employs to salvage feathered skins for clothing and bags (Saladin d'Anglure, Avataq, n.d.). At the site of Offing 2 in Chile, Lefèvre and Laroulandie (2014) proposed that the cut marks recorded on seabird skulls and pelves resulted from skinning.

The prevalence of pectoral elements at WF16 may indicate that buzzards were eaten, and a high occurrence of cuts marks on these elements has been linked to consumption (Finlayson et al., 2012; Peresani et al., 2011), yet very few cut marks were recorded, mostly on the scapula, and could also indicate the removal of the wing.

Cuts on the humerus are mostly found on the distal end, located above the ectepicondylar prominence, on the external and the internal condyles, and the shaft. Similar traces on the articular surfaces were observed on a red-footed falcon (*Falco columbarius*) from the Mousterian assemblage of Fumane Cave in Italy which were presumed to have been made by stretching the joint to separate the humerus from the ulna (Peresani et al., 2011). Cut marks were also reported on distal

humeri from Wadi Jilat 22 in the east of Jordan (Martin et al., 2013). Experimental skinning by Pedergrana and Blasco (2016) found that cut marks are more likely to occur on the distal portion of the humerus which has less muscle coverage protecting the bone. Most of the cuts on the buzzard humeri may therefore be a result of either cutting through tendons to remove the lower wing or from the process of skinning. The occasional traces observed on the proximal end may relate to defleshing or wing removal.

Butchery traces on ulnae consist mostly of oblique and transverse cuts principally situated along the tract of quill knobs on the shaft and at the distal epiphysis, above the external condyle and tendinal pit. Transverse and oblique cuts on a shaft fragment of lammergeier (cf. *Gypaetus barbatus*) from Fumane Cave were linked to the recovery of feathers (Romandini et al., 2016), while cuts above the external condyle and carpal tuberosity of a distal ulna fragment were thought to reflect the disarticulation of the carpometacarpus (Peresani et al., 2011). Two ulnae from WF16 (WF16 4270; Figure 6) exhibit longitudinal striations across the surface of the bone. Similar marks recorded on the ulnae of corvids at Qumrun Cave 24 in the Jordan Rift Valley (Recchi & Gopher, 2002) and raptors at Shahr-i Sokhta in Iran (Gala & Tagliacozzo, 2013) are interpreted as traces from cleaning the bone of organic tissue for tool production. Experimental skinning by Romandini et al. (2016) found that removing feathers from a fresh carcass generated short transverse and oblique cuts, whereas long repeated scrapings derived from intentional cleaning of organic tissue from the bone. Considering these comparisons, the cut marks on the WF16 buzzard ulnae are likely to have resulted from detaching the lower wing and/or removal of feathers, while the striations were from cleaning the bone for tool production.

Cut marks on the radius are less frequent and mostly oblique, some longitudinal, located principally on the dorsal surface of the proximal shaft, the dorsal surface of the distal shaft, and around the tendinal groove of the distal epiphysis. These marks are likely associated with skinning and feather removal. Experimental work by

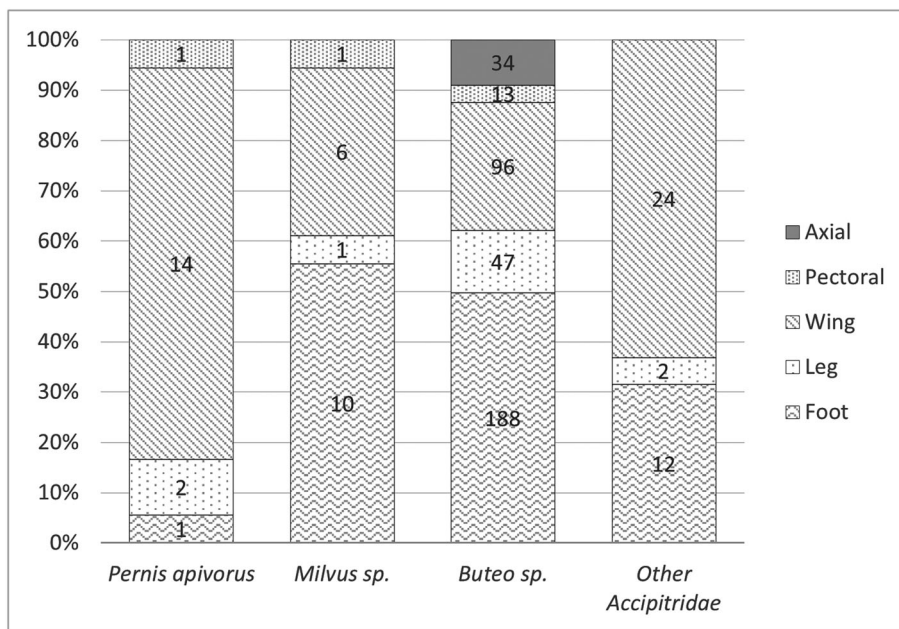


FIGURE 5 Accipitridae: distribution of cut marks; see Table S2 for details of elements

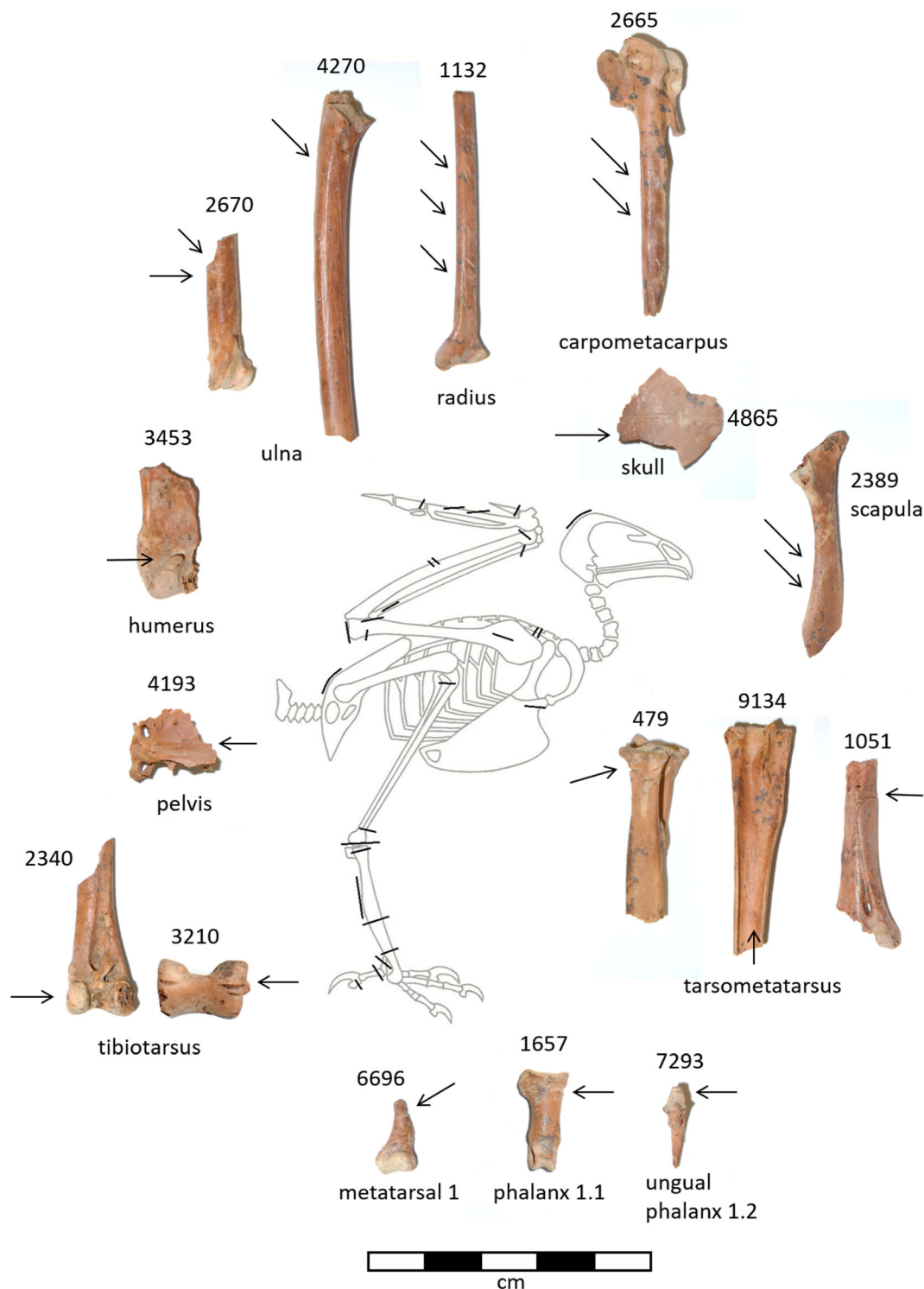


FIGURE 6 Examples of cut marks on buzzard bones and their overall distribution [Colour figure can be viewed at wileyonlinelibrary.com]

Peder gnana and Blasco (2016) found minimal modification of the radius from skinning.

Modifications to the carpometacarpus consisting of oblique or longitudinal cuts located on the shaft are almost certainly associated with the removal of primary feathers. Peder gnana and Blasco's (2016) experimental skinning found that alterations to the carpometacarpus were dependent on the decisions and skill of the butcher. While

Finlayson et al. (2012) interpreted relatively low frequencies of cut marks on carpometacarpi as reflecting the small size of the bone, we suspect that the bone was more often left with the feathers attached and rarely subjected to processing.

Modifications to the distal tibiotarsus at WF16 comprise of short, transverse cuts on the anterior, distal, and posterior surfaces indicating that tendons were sliced through to disarticulate the

tarsometatarsus from the tibiotarsus. Occasional butchery traces on the proximal tibiotarsus and fibula may relate to the removal of flesh from this meaty area.

Cut marks are most frequent on the tarsometatarsus with 35% showing signs of modification. Cuts around the proximal articulation correlate with traces on the distal tibiotarsi associated with disarticulation. Most cuts are transverse around the mid-shaft, the closest comparison being saw marks recorded on Magdalenian snowy owl bones and interpreted as a means to intentionally weaken the bone prior to deliberate breakage (Laroulandie, 2016). The cuts on the mid-shaft of the WF16 buzzard tarsometatarsi appear to encircle the bone to enable snapping; however, breaks at this point are mostly modern from post excavation damage and some specimens can be refitted. Longitudinal cuts on the posterior shaft that are similar to those seen on snowy owl bones at Saint-Germain-la-Riviere thought to indicate removal of tendons or feathers (Laroulandie, 2016). Cuts around the distal trochlea of the WF16 buzzard remains are uncommon but are certainly connected to the removal of the toes, as are those located on the metatarsal one and phalanges of the first digit. Cuts on the toe bones are infrequent relative to the numbers recovered, suggesting that toes and claws attached to the foot may have been utilized more than individual claws.

3.16.2 | *Pernis apivorus*, *Milvus* sp. and Other Accipitridae

The second most common species is the European honey buzzard (*Pernis apivorus*, *Pernis* cf. *apivorus*), accounting for 5.02% of the identified remains (NISP = 392, MNI = 24). All parts of the skeleton are represented, with the sternum, coracoid, and humerus found in high proportions in both phases but notably fewer lower wing bones in Phase 3 (Figure 3). Kite bones (*Milvus* sp., cf. *Milvus* sp.) are also quite numerous (NISP = 217, MNI = 12). The skeletal part frequencies for kite are only presented for Phase 2 as the sample size for Phase 3 is too small to compare. The Phase 2 material has an equally high proportion of sterna and tarsometatarsi. The humerus is also well represented, as is the first toe phalanx. In Phase 3 bones from the wing, leg, feet, and pectoral girdle were identified, yet no sterna were recorded. The body part frequencies for kite and honey buzzard are similar to buzzard with high survival of bones from the pectoral region and leg and fewer bones from the lower wing, particularly in Phase 3.

A further 457 specimens within the Accipitridae represent at least 16 species of eagle, harrier, vulture, and the osprey, each of which is represented by a small number of identified specimens (Table S1). We will collectively refer to these as "Other Accipitridae." An additional 477 specimens of Accipitridae could not be identified beyond small ($n = 40$), medium ($n = 427$), and large ($n = 10$) and will not be considered further.

The body part pattern for the Other Accipitridae based on NISP shares a relatively high frequency of axial elements (3%–4%) with buzzards but a similarly large proportion of wing elements to honey buzzard and kite (Figure 4). This mixed pattern most likely represents

the wide range of species within the sample of Other Accipitridae, some taken to WF16 as complete carcasses and some parts scavenged or butchered off-site depending on their size and attributes. The lappet-faced vulture, eastern imperial, Bonelli's and Verreaux's eagles are represented by wing elements alone, whereas the steppe, spotted, lesser spotted, and short-toed eagles, osprey, harriers, and sparrowhawk are represented by a wider range of elements (Table S1).

Figure 5 compares the distribution of cut marks by body part across the four groups, samples of which are illustrated in Figure 7.

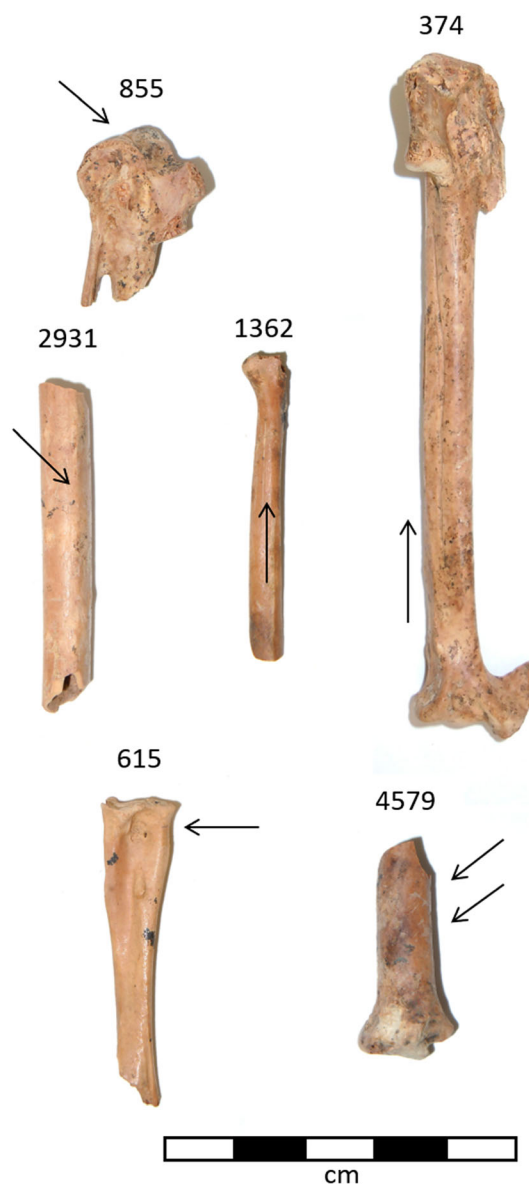


FIGURE 7 Examples of cut marks on Accipitridae: 855, *Neophron percnopterus* (Egyptian vulture) carpometacarpus; 374, *Aquila verreauxii* (Verreaux's eagle) carpometacarpus; 2931, *Circaetus gallicus* (short-toed eagle) ulna; 1362, *Circaetus gallicus* (short-toed eagle) radius; 615, *Milvus* sp.(kite) tarsometatarsus; 4579, *Pernis apivorus* (honey buzzard) ulna [Colour figure can be viewed at wileyonlinelibrary.com]

The sample sizes of cut marks for honey buzzard ($n = 18$) and kite ($n = 18$) are small, but it appears that cut marks are most frequent on the wing bones of honey buzzard and Other Accipitridae, whereas they are more common on the legs and feet of buzzard and kite. The buzzard is notable for having 8.99% of cut marks on axial elements and for having a lower proportion of modified wing elements. The presence of cut marks on the axial elements of buzzards which are indicative of skinning may be a reflection that buzzards were treated differently to other birds. On the other hand, it may be a consequence of the large sample of buzzard bones and that the evidence for other birds has simply not yet been excavated.

Figure 8 compares the distribution of burning by body part across the four groups. The overall frequencies of specimens with burning traces are similar: steppe buzzard 8.12%; honey buzzard 9.69%, kite 8.29%, and Other Accipitridae 9.85%. While the high frequency of burnt foot elements for the kite is notable, we suspect this is a consequence of the small sample size. When comparing the frequency of burning in relation to the representation of those body parts in the assemblage, the steppe buzzard has a lower frequency of burning on wing and pectoral elements (7.51% and 8.94%) than found for the honey buzzard and Other Accipitridae (>11% in both groups).

In summary, the recovery of most parts of the skeleton of honey buzzard, kite, and buzzard indicates that these birds were likely captured and brought back to the Neolithic settlement as complete carcasses, while a prevalence of bones from the pectoral girdle suggests that they may have been eaten. This pattern was also recognized in the remains of black kite in the assemblages of Netiv Hagdud (Tchernov, 1994) and Gilgal (Horwitz et al., 2010), which the authors attributed to consumption. The relative scarcity of lower wing bones in Phase 3 bears similarity with the site of Wadi Jilat 22, where a conspicuous absence of lower wing bones, combined with cut marks on the distal humeri was used as evidence to support the idea that the

wings were removed for their feathers (Martin et al., 2013). The body part representation and cut mark distribution for Other Accipitridae suggest that selected parts, notably wing elements, may have been butchered or scavenged off-site and brought to WF16, in addition to occasional complete carcasses. While butchery traces were broadly similar across Accipitridae, the presence of skinning traces exclusive to buzzards indicates an interest in removing and utilizing complete skins. The high concentration of cut marks on the feet and presence of numerous articulated toe bones suggest that they also served a special purpose.

3.16.3 | Experimental skinning of buzzards

To support our interpretation of the cut marks and explore the process of skinning, three buzzards were skinned, using birds donated to the Natural History Museum as natural casualties from road collisions and wildlife sanctuaries (NHMUK S/2019.10.1, S/2019.11.1, S/2019.12.1; Figure 9). Each buzzard was skinned using an unretouched flint flake with the intention of having one wing completely skinned and the other retaining the carpometacarpus and wing phalanges, one leg disarticulated at the distal tibiotarsus leaving the foot attached to the skin, with the other skinned down to the feather line on the shaft of the tarsometatarsus (supporting experimental procedure, Methods S21).

The distribution of cut marks on the experimentally skinned buzzards closely corresponds with those found at WF16 (Figure 10 and Table S4). Cut marks were observed on the nasal and mandible but were absent in the WF16 assemblage, possibly due to the fragility of these bones. The cuts on the mid-shaft of the tarsometatarsus were not as deep and frequent as those observed on the WF16 material and their interpretation remains unclear.

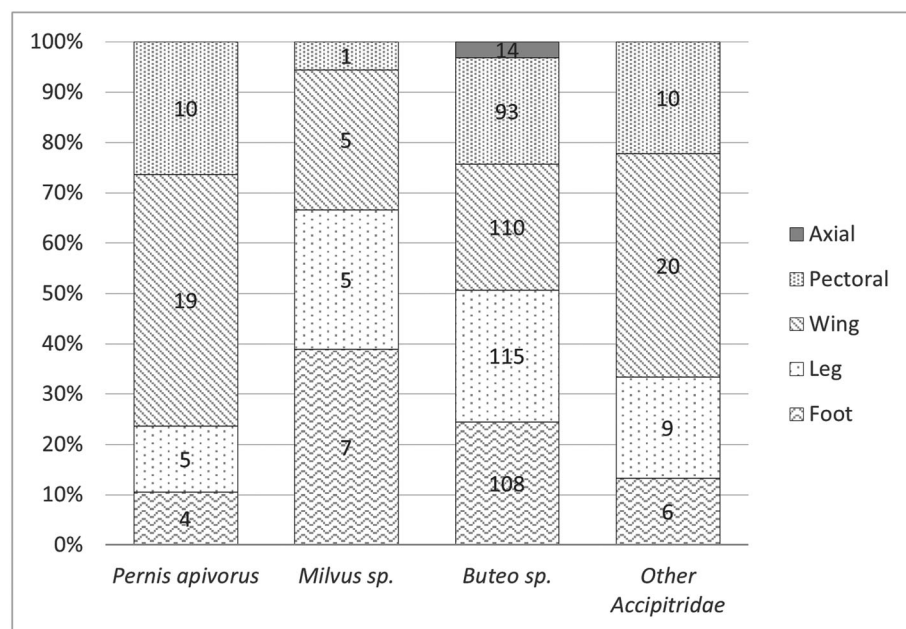


FIGURE 8 Accipitridae: distribution of burning; see Table S3 for details of elements

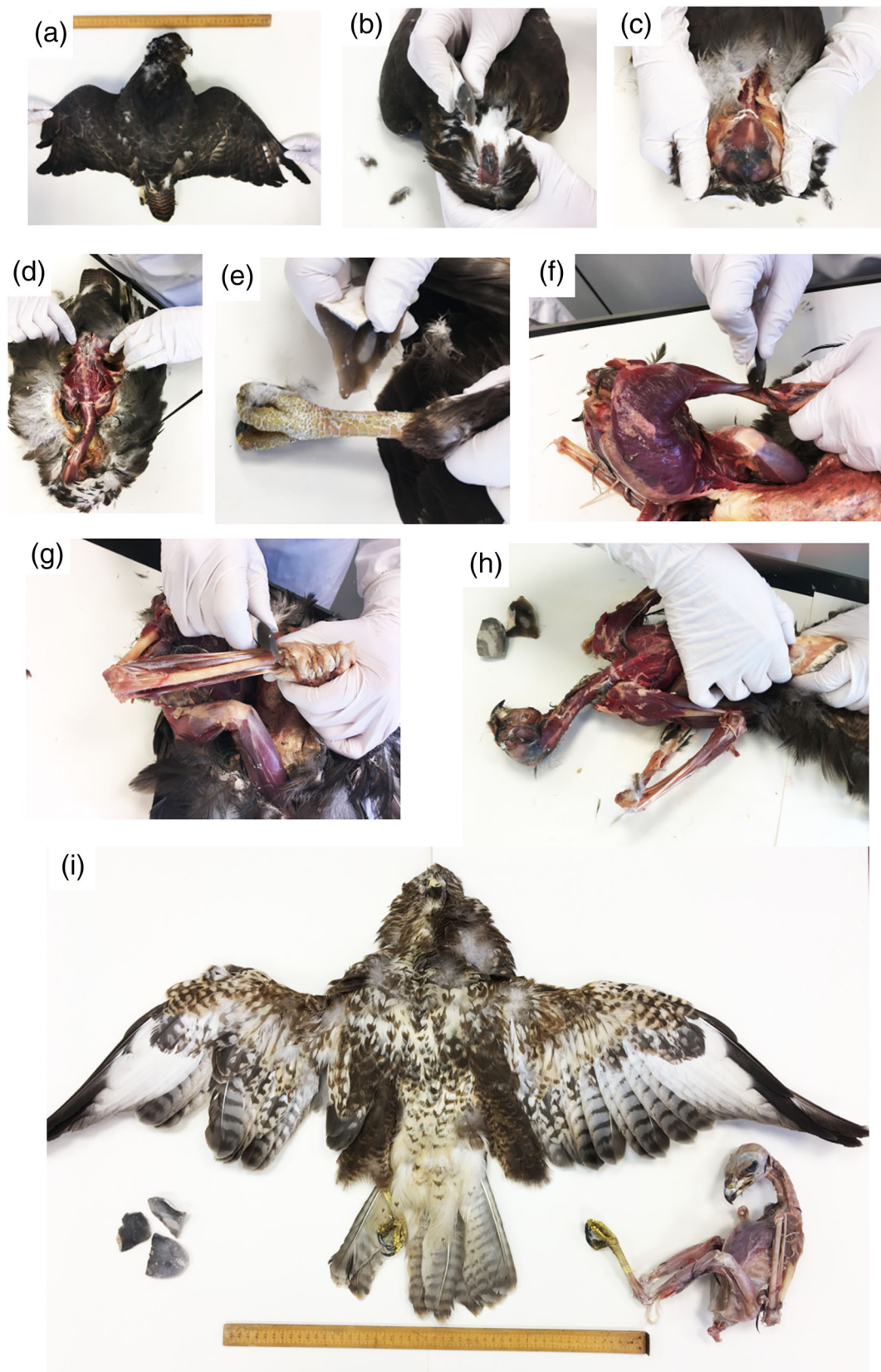


FIGURE 9 Experimental skinning of buzzards (a) complete buzzard carcass (NHMUK S/2019.11.1); (b) first incision along the mid-line of the skull; (c) easing the skin away from the head and neck; (d) after cutting down the back of the body the skin is pulled away from the trunk; (e) preparing to cut along the feather line of the foot to remove the skin; (f) cutting through the muscle above the distal epiphysis of the humerus to extend the wing; (g) the secondary feathers have been detached from the quill knobs of the ulna by cutting and pushing the skin towards the articulation with the carpometacarpus; (h) detaching the tail feathers from the pygostyle to remove the skin; (i) buzzard skin and carcass (NHMUK S/2019.12.1 from the collections of the Natural History Museum, Tring). © NHM, London [Colour figure can be viewed at wileyonlinelibrary.com]

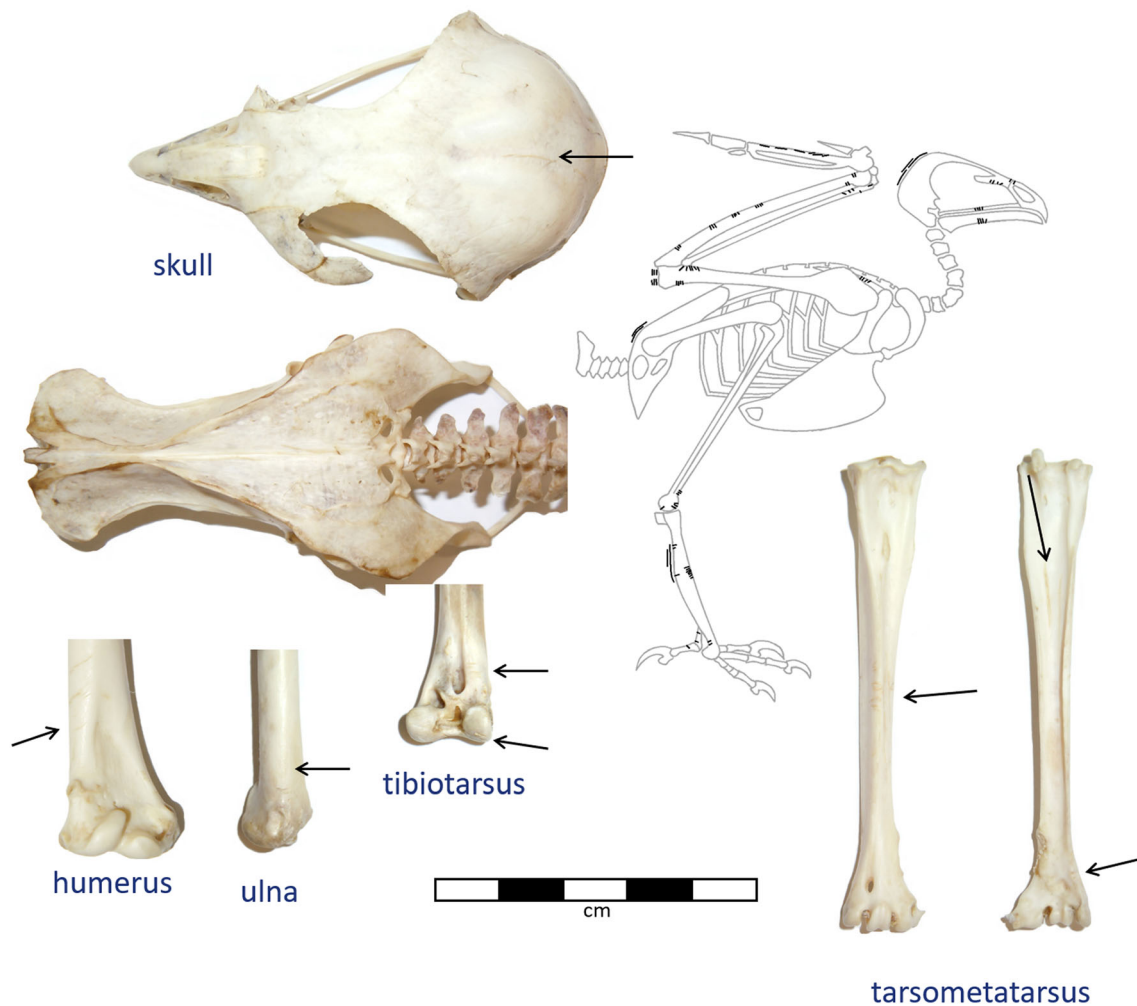


FIGURE 10 Distribution of cut marks on experimentally skinned buzzard bones (NHMUK S/2019.10.1 from the collections of the Natural History Museum, Tring). © NHM, London [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

4 | DISCUSSION

Multiple factors influence the composition of an excavated assemblage of bird bones, always leaving uncertainty regarding interpretations of past utilization. While the WF16 assemblage is relatively large and well preserved for an early Neolithic site, our main constraint is partial excavation, with “missing” body parts potentially located within unexcavated areas. Nevertheless, it appears that a wide range of taxa were used as a source of food, such as the chukar partridge, other gamebirds, and waterfowl. The predominance of elements from the pectoral region of buzzards, honey buzzards, and kites suggests that these birds were also consumed. Although we have yet to undertake a formal quantitative assessment, we estimate that their dietary contribution would have been limited, compared to the mammals.

The range of cut marks at WF16 differs significantly to the Natufian sites of Hayonim Cave and Mallaha (Pichon, 1983) where there is evidence of working the distal portion of the tibiotarsus of chukar into beads. Despite this element being well represented at WF16, there are no cut marks on chukar bones recorded. Similarly,

at Shubayqa 1, the cut marks observed are almost exclusively restricted to the tibiotarsus of waterfowl for bead manufacture (Yeomans & Richter, 2018). Parallels can be seen with the raptor remains from Wadi Jilat 22 as discussed earlier, despite the limited quantity of remains. The recently excavated site of Nadal Roded is unique by having only birds of prey represented in deposits, with many bones reported to bear cut marks (Birkenfeld et al., 2020). Further analysis of the remains from this new site has the potential to provide interesting comparisons and insights into the activities at WF16.

The cut marks observed on the bird bones from WF16 indicate an interest in removing skins, wings, feathers, and feet. Buzzards appear to have been primarily brought to site as whole carcasses and skinned. While buzzards are the only birds to have traces on the skull and synsacra indicative of skinning, other medium and large birds also appear to have been utilized for their wings and feathers, notably Verreaux's eagle, white stork, northern bald ibis, and little egret. We assume that skins, wings, feathers, and feet were used for both practical and social purposes.

Primary feathers are likely to have been preferentially selected for use for fletching arrows. As with other PPNA sites, WF16 has large frequencies of El-Khiam points, some of which have impact fractures and wear traces that indicate their use as projectile points (Smith, 2007). Numerous grooved stones, traditionally interpreted as shaft-straighteners, were also recovered from WF16 (e.g., Mithen et al., 2018, Figure 6.9) suggesting the on-site manufacture of arrows. Primary feathers and whole wings may have also been used to adorn headdresses and costumes for social display. The large amphitheater-like structure at WF16 (075, Figure 1) may have provided a venue for performance involving costumes, while the large quantities of stone and shell beads at WF16 provide further evidence for social display (Mithen et al., 2018).

The bone tools from WF16 include a range of pointed artifacts of various sizes and a bone needle (Mithen et al., 2018). There are numerous pieces of worked and incised bone. Although these have yet to be formally cataloged, initial assessment has not identified any examples of bird bone within this collection to add to those identified in this article.

5 | SUMMARY

The avian fauna at WF16 accumulated from a mix of activities, encompassing those evident from Epipalaeolithic and early Neolithic sites within the region. The most significant was the exploitation of a seasonally abundant supply of migratory birds for food and to acquire skins, feathers, and talons. We suspect that these were used for decorative and symbolic purposes, as has been suggested for Jerf el Ahmar and Hallan Çemi in the northern Levant (Gourichon, 2002; Zeder & Spitzer, 2016) and for practical tasks such as fletching arrows. The exploitation of a seasonal abundance of birds was also identified at Shubayqa 1, where migratory wildfowl were used as a source of food (Yeomans & Richter, 2018). The trapping of resident wildfowl and gamebirds undertaken at WF16 appears to have been on a relatively small scale to provide a supplementary food source to the staple diet coming from mammalian hunting and plant gathering, as occurred at contemporary PPNA sites in the southern Levant, such as Netiv Hagdud and Gilgal (Simmons, 2004). While a full interpretation of the WF16 avian assemblage must await completion of studies of mammalian fauna and material culture, the current evidence indicates the exploitation of birds had been for a diverse range of purposes and played a significant role in the lifeways of this Neolithic community.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available in the supporting information of this article. Requests for additional data can be sent to the corresponding author.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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