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Scoping the Past Human Environment: A Case Study of Pollen Taphonomy at the Haua Fteah, Cyrenaica, Libya

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Introduction

The Haua Fteah in Cyrenaica, Libya contains one of the most archaeologically significant sequences in North Africa. Palynological analysis of the cave sediments forms an integral component of the current reinvestigation of this sequence. Major uncertainties exist however, regarding the degree to which the fossil pollen assemblages recovered from archaeological deposits reflect past environments. This is especially true for caves, where the majority of research into pollen taphonomy (the processes of dispersal, transport, deposition, burial and diagenesis by which pollen is [partially or completely] preserved) has been conducted in temperate latitudes. A programme of taphonomic study was therefore implemented at the Haua Fteah to evaluate the contributory influence of air-fall and vertebrate transport routes on the pollen assemblages in a Mediterranean karstic environment. A site-specific understanding of contemporary taphonomic processes is of utmost importance when conducting palaeoenvironmental research

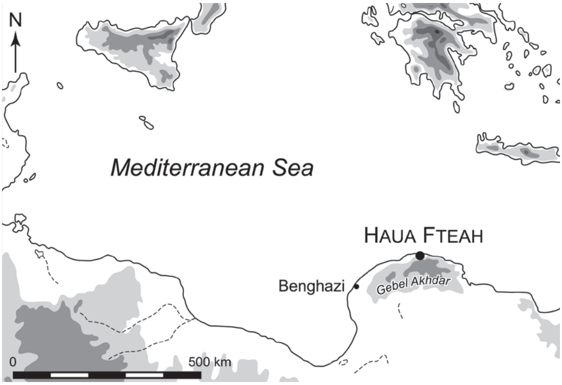

Fig. 1. Location of the Haua Fteah (Drawn by D. Kemp).

within caves and other 'non-standard' depositional sites if the data produced is to be treated as valid by the rest of the scientific community. This knowledge is especially vital when working within the context of an archaeological project where the recognition and separation of anthropogenic and environmental influences on the pollen assemblage is crucial. The identification of such factors not only allows for a robust interpretation of the fossil pollen record but also provides key information regarding the behaviour of the past occupants through the identified taphonomic factors, for example ovicaprid transport and input linked to stabling. The Haua Fteah provides an exceptional opportunity to carry out this research due to the fact that past anthropogenic processes, such as animal herding and the burning of dung, are still actively practiced in the cave today. Such research will help facilitate the interpretation of the fossil record at the Haua Fteah and will aid the recognition of anthropogenic signals within it, as well as being widely applicable in other palaeoenvironmental and archaeological projects in the region. In order to confidently apply the pollen assemblage at the Haua Fteah to other sources of palaeoenvironmental data, however, it is imperative that the taphonomy of fossil pollen assemblages present at the Haua is fully understood. The study presented here is the first in a programme of taphonomic research devised for the Haua and focuses on the pollen influx via aeolian and vertebrate (ovicaprid and Aves) transportation.

Research Context: Cave Pollen Taphonomy

Lake and bog pollen taphonomy is well documented (e.g. Kabailiene 1969; Prentice 1985; Tauber 1965) and in the main applicable when working on cave sites. Caves however, are non-standard depositional sites and the taphonomic factors influencing one cave environment may radically differ from those active in another cave. A universally applicable taphonomic model for pollen deposition in cave environments is therefore not a practical possibility and it is essential to assess each cave as a separate ecosystem and depositional system. Examples of vectors that may contribute to pollen influx within the cave environment include aeolian transportation, vertebrate and invertebrate transportation (Carrion et al. 2005; Carrion et al. 2006; González-Sampériz et al. 2003; Hunt and Rushworth 2005) and the reworking of older deposits by bioturbation, erosion and deposition, inwash and collapse (Coles and Gilbertson 1994: 736). The few studies addressing these matters have been mainly confined to temperate regions (e.g. Coles et al. 1989; Coles and Gilbertson 1994; Diot 1991; Genty et al. 2001). In other regions, very few studies have addressed the topic directly (e.g. Bottema 1975; Carrion et al. 2005; Carrion et al. 2006; Horowitz et al. 1975; Hunt and Rushworth 2005). This paper therefore provides one of the very few assessments of pollen taphonomy in the semi-arid Mediterranean zone and one of the few worldwide where anthropogenic processes are still active in the modern cave environment.

The Haua Fteah

Environmental Setting

The Haua Fteah (figs 1 and 2) is located some 10km to the west of the ancient settlement of Apollonia (Sousa), approximately 20km north of the ancient Greek city of Cyrene (Barker et al. 2007). It lies on the lowest escarpment of a series which form the northern side of a mountainous area of Cyrenaica, north east Libya (Barker et al. 2007), known locally as the Gebel Akhdar (Green Mountain; fig. 1). This elliptically shaped upland massif extends for approximately 200km parallel to the north coast of Libya (Hey 1956) and creates a 70km wide boundary between the Mediterranean Sea and the Sahara. The region reaches heights of over 800m, with the peak of Suluntah recorded at 872m (Collins Bartholomew 2007). In an otherwise flat, arid coast line, the Gebel Akhdar region displays contemporary climatic and environmental conditions

Fig. 2. Grazing animals at the mouth of the cave (Photo C. Hunt).

which are characteristically Mediterranean. Annual precipitation which averages between 200–550mm is relatively high when compared to the encompassing arid lands (*c.* 50–150mm) (Moyer 2003). The fertility of the region, in contrast to the grassy and herbaceous vegetation of the coastal plains, supports a tall (3–4m) sclerophyllous scrubland, known locally as *maccia* or *maquis*, which includes an abundance of *Juniperus phoenicea* (Phoenician juniper), *Pistacia lentiscus* (Mastic tree) and a richly diverse understory comprising of various shrubs and grasses (Mepham et al. 1992). The fertility and uniqueness of the area is further underscored by the existence of some 320,000ha of forest which is considered to be natural to Libya (Al Idrissi et al. 1996), comprising of species such as *Cupressus sempervirens* (Italian cypress), *Pinus halepensis* (Aleppo pine), *Quercus coccifera* (Kermes oak), *Juniperus phoenicea* (Faraj et al. 1993).

Site Description

The immense, limestone karstic cave (fig. 2) is approximately 60m above current sea level with the entrance facing north towards the coast, overlooking one of six successive ancient shore lines (Anketell 1989;

McBurney 1967; Moyer 2003) The structure has a 20m high entrance and an interior roofed area which is nearly 80m across (Barker et al. 2007). The structure has technically been described as a 'tafoni' feature (Hunt and El Rishi in Barker et al. 2007: 104). The formation processes of such features is still debated (Cooke et al. 1993: 25–27) but it is probable that the cave initially formed via the weathering of natural weaknesses in the substrate, such as joints or fractures, and then increased in size by the progressive flaking of the interior surfaces. This latter process, referred to as granular disintegration, is still an active process in the cave today as indicated by the presence of 'whitish, floury rock' at the rear of the structure (Hunt and El Rishi in Barker et al. 2007: 104).

The nature of the deposits within the cave fill would suggest that they have accumulated via a combination of in-wash deposits, internal rock fall and aeolian silt influx (Hunt and el-Rishi in Barker et al. 2007: 105; Inglis in Barker et al. 2008: 182). The stratigraphy of the cave fill and the predominance of these depositional mechanisms are discussed at length in various publications (e.g. Barker et al. 2007, 2008; McBurney 1967; Moyer 2003) and therefore will not be considered here in further detail.

Excavation History and Current Research

Originally excavated in the 1950s, under the leadership of Dr Charles McBurney, the deposits at the Haua Fteah are regarded as one of the most important depositional sequences within the context of North Africa (Barker et al. 2007: 94). The exceptional depth of the sedimentary record, which spans at least the last 80,000 years (McBurney 1967; Moyer 2003), has made the re-excavation of the Haua Fteah deposits the main focus for the newly established Cyrenaica Prehistory Project (Barker et al. 2007, 2008). This major research programme will combine an array of analytical and investigative methods to facilitate a truly interdisciplinary understanding of key archaeological and palaeoenvironmental issues in the region.

An integral component of the project will involve the palynological analysis of the deposits to create a detailed vegetation history for the area. The detailed palaeoenvironmental reconstruction will provide a crucial element in gaining a complete understanding of past human populations and the ways in which they influenced and/or were influenced by their local environments from the Palaeolithic to the recent past. The application of this research may help identify subtle variations in the fossil record which may be overlooked through archaeological investigation of material culture alone. The unique location of the Haua Fteah in an area which would have been sensitive to past environmental change makes it an excellent source of palaeoenvironmental data, through which wider archaeological issues, such as the strategies adopted by the past inhabitants to the fluctuating dynamic environments of the coastal strip and the expansion and contraction of the Sahara, can be addressed.

Taphonomic Sampling and Methods

Sample Collection

Sampling of the air-fall pollen was facilitated by establishing a series of transects across the cave using petroleum coated glass slides (Hyde and William 1944). Transect T1 (fig. 3) ran approximately north-south, from the rear of the cave to the exterior environment beyond the dripline of the cave. The slides forming transect T2 (fig. 3) ran firstly in an east-west orientation and then a north-south one. Individual slides were placed at various other locations within the cave and in the surrounding external environment. Slides were left in place for a period of 24 hours to avoid the risk of potential contamination by microfossils released into the air as a consequence of excavation. Although a longer period of exposure would have been desirable, the potential contamination of the slides constrained the time frame to a period of inactivity on the site. After exposure, the slides were collected and protected with glass covers. Modern dung samples from Aves and ovicaprid sources were also retrieved and subjected to palynological preparation techniques and microscopic analysis.

Laboratory Methods

Five grammes of the various guano samples were processed following conventional palynological preparation techniques, such as those presented by Faegri and Iversen (1975) and Moore et al. (1991), and consisted of treatment with Hydrochloric Acid (HCL) and Potassium Hydroxide (KOH).

Samples were stained with aqueous safranin and mounted in silicone oil. The addition of exotic marker grains, i.e. *Lycopodium clavatum* (common club moss), was deemed unnecessary as the study was not concerned with the concentrations of pollen in the samples. No further preparation was required for the analysis of the petroleum coated slides.

Pollen Identification and Counting

The various samples were analysed at x400 and x1000 magnification on an Olympus BX51 light microscope and identification of pollen was made with reference to Faegri and Iversen (1975), Moore et al. (1991), Reille (1992, 1995, 1998) and Beug (2004). At the time of analysing the slides retrieved from the two transects it was decided not to identify all of the trapped pollen types. With the exception of the two most common types (cf. *Trifolium* [clover] and cf. *Juniperus*) and the easily identifiable Poaceae

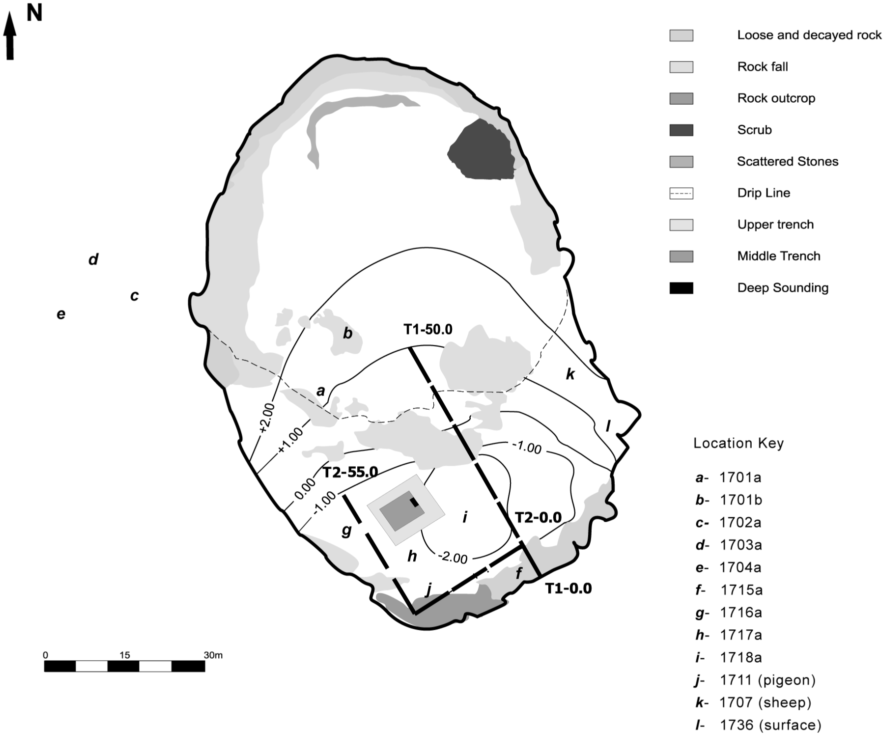

Fig. 3. Floor plan of the Haua Fteah, indicating the position of sampling transects. (Modified from J. Blacking 1952, as published in McBurney 1967).

(Grasses) and Chenopodiaceae the rest of the pollen types were simply grouped as 'Other Pollen'. This decision was taken due to the fact that the study was primarily concerned with variant patterning in the dispersal of aeolian pollen within the cave and specific identification of all pollen types was deemed unnecessary. Analysis of the coprolite samples was conducted to ascertain the introduction of palynomorphs into the cave environment via animal vectors and therefore required specific determination of all pollen types.

Results and Interpretation

Transect 1 (Fig. 4a)

Pollen counts for this transect fluctuate between a highest value of 327 (T1–45.0) and a lowest of 50 (T1–10.0). The beginning of the sample transect (T1–0.0) is marked with a small increase in pollen fallout, whereas the termination (T1–50.0) is marked with a relatively high increase in pollen deposition. Pollen values at, and in the external proximity of, the dripline are consistently higher than the counts recorded within the cave environment. This however, is most probably caused by the high percentages of cf. *Juniperus* pollen at these locations. Counts for this type reach a high of 80% in these samples and suggest the taxa, which are prevalent in the external environment, are creating a bias in the record via over-representation at this location, as opposed to being under-represented within the cave. To substantiate this proposal, the values for undifferentiated pollen can be taken into consideration. The values of such vary marginally, with one exception (T1–40.0) along the course of the sample transect and that suggests a relatively even distribution of other types of windblown pollen within and around the cave environment. When the overall pollen sum is consulted, pollen deposition does appear to be negatively correlated with the distance from the entrance. However, when the lowest pollen sum (50 grains) at T1–10 is compared with T1.0.0 (83 grains) at the rear wall an increase is observed and appears to rule out the simple logic of decreasing pollen fallout as air travels further into the cave. The presence of relatively high values (12–20%) of Poaceae within

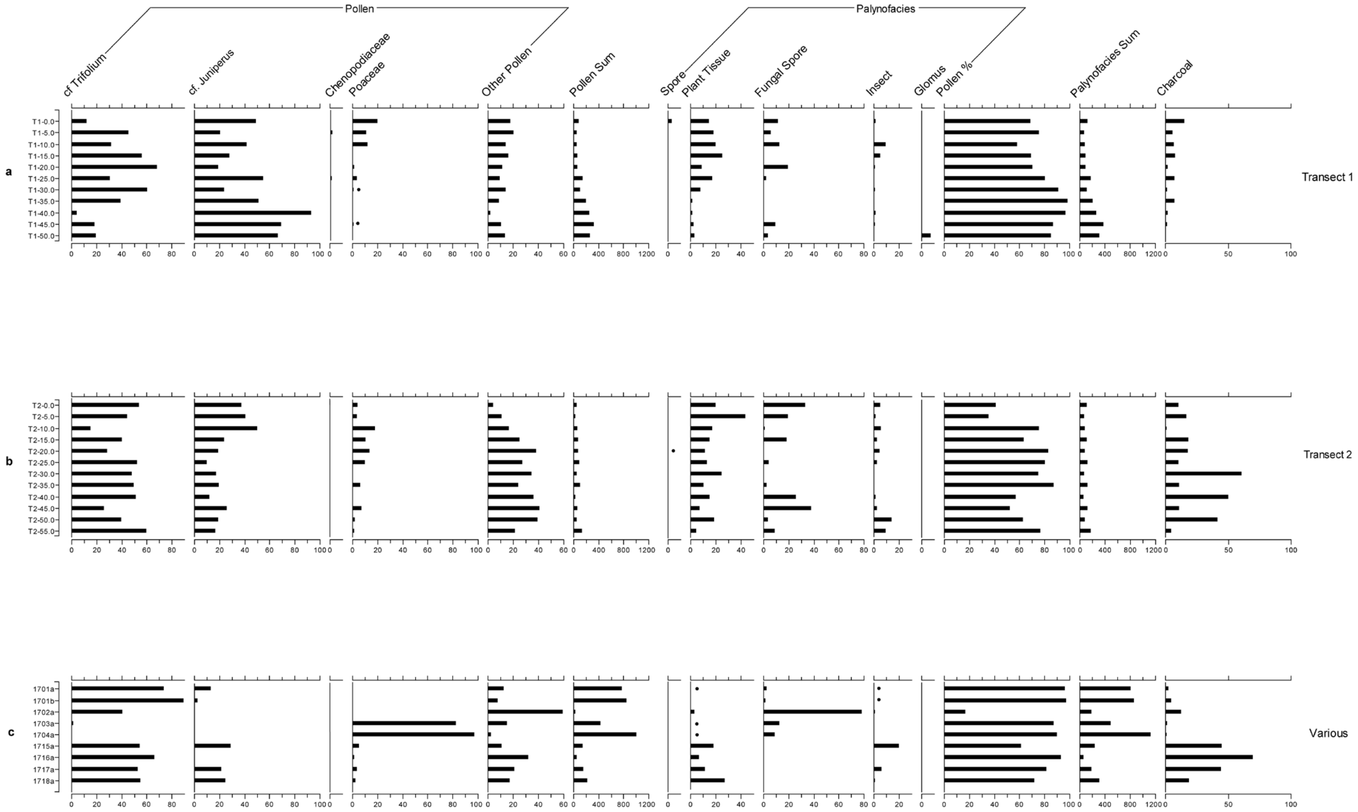

Fig. 4. Percentage pollen diagrams displaying values for the slide transects. (a) Transect 1. (b) Transect 2. (c) Various.

the vicinity of the rear wall, together with substantial counts of both cf. *Trifolium* and cf. *Juniperus* also appear to corroborate this statement.

The rise and fall pattern is also discernable in the palynofacies sum and it is plausible to suggest that air circulation within the cave is responsible. The patterning implies that major air currents are entering the cave and hugging the walls, in doing so creating 'hot spots' for pollen deposition.

Transect 2 (Fig. 4)

Transect 2 displays low values for pollen fallout, with a highest grain count of 134 grains recorded near to the cave entrance (T2–55.0). Although the values for individual types do fluctuate, the overall pollen sums for this sample transect are very consistent, with the majority of samples recording counts of between 50 and 100 grains. This consistency is most probably a further reflection of the air circulation patterns within the cave; this transect was located more towards the internal wall and therefore directly under any circulating air currents. Amounts of cf. *Juniperus* pollen present are on average less, but more consistent than those recorded in the samples of T1. This again could exist as a consequence of the slides being located away from the central area of the cave and therefore not as prone to the possible over-representation of this species seen in some of the samples in T1. Counts of 'Other Pollen' are noticeably higher (up to 40%) throughout this section when compared to the previous counts (up to 21%).

The palynofacies count shows much higher charcoal values, reaching 50% of the total pollen and palynofacies sum along this transect. The close proximity of an exposed hearth to the study area may explain the higher charcoal values and therefore represent a possible bias in the record.

Internal and External Spot Samples (Fig. 4)

The presence of cf. *Juniperus* pollen, seen in the slides from the two transects (figs 4a and 4b), becomes less constant in this suite of samples. The samples 1701a, 1715a, 1717a and 1718a which contained substantial amounts of this type were all retrieved from the cave entrance or within the cave (fig. 3). The slides 1702a, 1703a and 1704a produced no counts for cf. *Juniperus* pollen. The placing of the slides beneath Juniper shrubs is most likely to be the reason for this. The shrubs would have been too close to the slides to deposit their pollen and would have created a shield against air-borne pollen from Juniper growing further afield. Slides 1703a and 1704a were placed among grasses, and with grass representing 80% and 98% of the respective pollen sums, it seems unnecessary to examine this data further. The pollen assemblage from slide 1702a, although placed very close to 1703a and 1704a, is very different, thus indicating that very small variations in sample placement can result in very different results and should be a factor that is considered and addressed in all such research programmes. Of all the sticky slides recovered, 1701a and 1701b were amongst those with the highest pollen sums. Slides 1701a and 1701b were placed exterior to the cave beyond the cave overhang, at approximately 22m and 40m respectively from the termination of Transect 2 (T2–55.0: see fig. 3). Although the two samples in question have higher pollen counts than those within the cave, the core constituents, with the exception of grass pollen are similarly represented in both environments. This has been illustrated below in Figure 5 and tentatively suggests that the internally deposited pollen can be as comparably representative of the external environments as that deposited outside the cave.

Modern Samples (Fig. 6)

Three surface samples were collected from within the cave environment. These comprised one sample of generic surface debris and leaf litter (1736), one representative sample of ovicaprid dung (1707) and a sample of Aves guano (1711). All samples were collected within the quadrant formed around the excavation by the two slide transects and the fence at the fore of the cave. Samples, once located and deemed suitable, were carefully lifted with a trowel and placed in a labelled bag. From the three samples analysed, a total of 37 different pollen types were identified. Of the overall number, the Aves guano contained 19 types, the Ovicaprid dung contained 22 and the surface sample yielded 24. Only seven species, Asteraceae (chicorioideae), Convolvulaceae-*Convolvulus* (Bindweed) spp., Cyperaceae (Sedges), Fabaceae-*Ceratonia* (Carob) type,

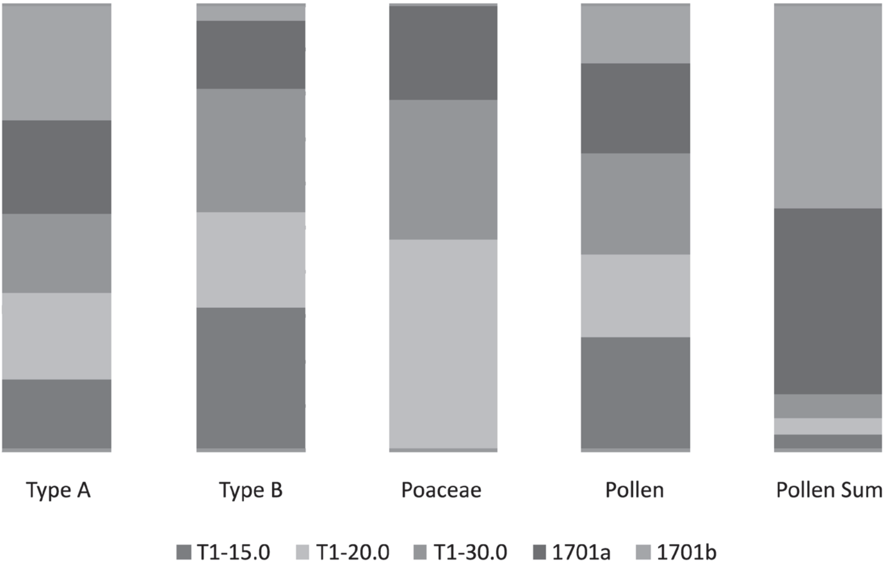

Fig. 5. Chart comparing the main constituents of selected internal and external slide samples.

Poaceae, Saxifragaceae-*Saxifraga granulate* (Meadow saxifrage) type and *Urtica pilulifera* (Roman nettle) were present in all three samples. Of the remaining types, 14 appeared in two of the samples and the other 17 were only present in one of the samples. The pollen assemblages include many species characteristic of the dry *maquis*-like vegetation of the area, including *Pinus, Quercus, Juniperus communis, Ceratonia,* Cistaceae, Rosaceae and *Olea* (Olive) (Hunt et al. 2002). Other species such as those of the Asteraceae, Chenopodiaceae and Gramineae families are representative of the steppeland vegetation in the area. The species present in both of the guano samples may be said to reflect the foraging environments of the respective animals. The sample of Aves guano displays significant percentages (approximately 10%) for woodland species such as *Pinus, Quercus, Ostrya* (Hop hornbeam) and *Juniperus*. High values for Cyperaceae in this sample may also suggest foraging for food and nesting material along the coast. The occurrence of relatively high values for certain Asteraceae types, Gramineae, Ranunculaceae and other shrubs in the ovicaprid dung are on the contrary reflective of a foraging habitat which is scrubbier in nature.

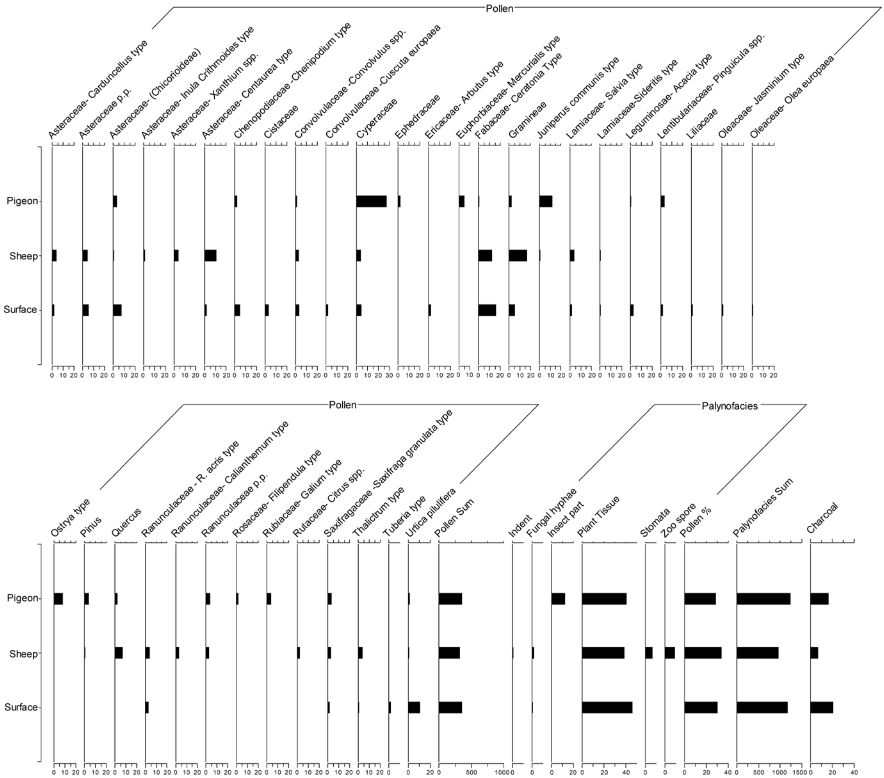

Fig. 6. Percentage pollen diagram displaying values for the modern samples (Guano and Surface).

Discussion

From the study it is immediately apparent that the highlighted taphonomic factors (aeolian and vertebrate transport) can introduce very varied pollen assemblages into the cave environment. The results have shown that it is possible to identify systematic patterning and specific environmental indicators within the assemblages which are influenced by these taphonomic factors. This information can facilitate the creation of a site-specific taphonomic model which can then be applied to the interpretation of the fossil pollen assemblage at the Haua Fteah, which will ensure that the eventual interpretation of the fossil pollen record takes into account the influences of all the taphonomic factors which created it. Not only can the record generate vital data relevant to the current project at the Haua Fteah but it can also act as a potentially important source of data for other archaeological and palaeoecological studies addressing the wider context of past human behaviour in the North African region.

Pollen Taphonomy and Palaeoenvironmental Reconstruction

The brief 'snap shot' of pollen deposition provided by the slide transects has illustrated the role played by air circulation within the cave environment; air currents potentially influence the location and quantity of pollen deposition within a relatively restricted space. Although the detail of patterning is different within different systems, the general principles governing airfall at the Haua are similar to those reported by authors such as Coles and Gilbertson (1994) in other contexts. Pollen from certain species growing further away from the cave mouth appears to be both more evident and more evenly distributed around the internal wall of the cave, whereas that from vegetation growing close to the cave mouth is more centrally located. This is likely to create biases in the records at the differing locations; thus the palynological information from a single trench in one area of the cave may not be generally applicable, as commonly assumed. One positive outcome of this observation is that when pollen assemblages are airfall-dominated, it may become possible to select specific areas of investigation to study a local or regional source for fossil pollen by selecting the point of sampling on the cave floor. Since identification of local or regional sources can be a major issue in pollen analysis (e.g. Carrion et al. 1999; Tauber 1965), this is a potentially critical development.

The influence of vertebrate vectors on the pollen assemblages becomes apparent when it is considered that only 24 of the 37 identified pollen types occur in the sample of surface sediment. This implies that 37% of the pollen in the cave environment has been introduced via animal vectors and, as already stated, are representative of the grazing areas of the respective animals and therefore not a complete reflection of the external vegetation. This finding reinforces the need to understand contemporary taphonomic processes and use these as a filter through which to analyse the fossil record.

Further analysis is needed to clarify these matters, and indeed another similar but longer-term study is in progress at the Haua Fteah. Pollen traps have been placed at various locations within the cave and in the wider landscape. These traps will be left in place for one year, therefore providing a long-term picture which can be correlated with the current results. Ideally this will also involve the further analysis of coprolite samples from vertebrates, including humans (see Hunt et al. 2001). The results can then be correlated with those from modern dung, surface samples, slide transects and pollen traps to highlight any discrepancies or similarities between the particular assemblages.

Full understanding of a site, of course, cannot be achieved successfully through the application of one environmental proxy at the site in isolation. A multi-proxy, multi-site strategy should ideally be adopted, whereby the researcher can draw upon the findings of other environmental analyses, i.e. archaeobotany, micromorphology, microfauna *et cetera,* from the site in question and other similar locations. Only by employing such rigorous research methods can the fossil pollen record or any other fossil record be fully and robustly integrated into models which consider human-environment interactions. If such methods are not employed to identify the factors involved in local pollen taphonomy, studies may be prone to misinterpretation of the palaeoenvironments of particular regions and the behaviour and influence of past human populations within these landscapes. As Coles (1988), notes the results of studies which have not employed such research are prone to be treated with more scepticism than those studies which have. The implementation of a taphonomic study does not mean however that the results will be 'right' when compared to those of a study which has not employed such research. Rather, it illustrates that an objective approach has been adopted and the need to understand the depositional processes at a particular location, which may skew the data, has been identified. The results of a taphonomic study are simply another source with which the palaeoenvironmentalist can validate the interpretation of the fossil record upon which palaeoenvironmental reconstructions are made.

An example of such recognition of a taphonomic factor is illustrated by the initial results of the study of the post-1960s cave floor at the Haua

Fteah: these samples suggest that ovicaprid taphonomy is dominant over air-fall taphonomy, a finding which links well with information from local informants who described the use of the cave as a stock-pen during this time. Secure recognition of the signal generated by the presence of vertebrates will allow the identification of its presence or absence from the archaeological record. Barker et al. (2008) have indicated that the stalling of ovicaprids in the cave was a practice established only from the Graeco-Roman period onwards (approximately 620 BC to AD 400), and analysis of these layers should provide an opportunity to apply the taphonomic results to the fossil record: the stratigraphy before the Graeco-Roman period should be, in contrast, dominated by air-fall pollen assemblages. The ability to identify and isolate the animal influence will also increase the possibility of successfully identifying any stabling imprint on the fossil record at this and other excavations. This imprint of course will vary from site to site. As various research areas are studied, the uniqueness of place, circumstance and ecology are all issues which must be addressed when devising a programme of taphonomic research designed to identify these subtle signals within a particular archaeological or palaeoecological record. The necessity lies however, not only in the scoping of current taphonomy but also in correctly identifying discontinuities in the taphonomy of the past such as the expected change at the Haua Fteah with the transition from hunting to herding.

Behavioural Implications of Taphonomic Factors

The application of a conceptual, site-specific model of pollen taphonomy will be of great benefit to the archaeological issues being addressed at the Haua Fteah, as well as their wider context in North African archaeology. By identifying known taphonomic vectors from the fossil assemblages, it will be possible to create a more complete picture of a site than through archaeology alone. For example, a lack of archaeological evidence in the form of material culture at a particular site may suggest a hiatus in human occupation, whilst examination of the fossil pollen record and the application of site-specific taphonomic knowledge may indicate that instead a change in activity has occurred. The identification of taphonomic indicators which vary from the constant aeolian input, such as those associated with herd animals, may signify that the site has begun to be used as a stable. This change in taphonomic factors would indicate a change in strategy rather than habitation or human influence. In contrast, a suspected hiatus in occupation may be supported by the fossil pollen record if the archaeological evidence is inconclusive. The discontinuation of the taphonomic imprint left by herded animals or the cessation of pollen associated with human foodstuffs (wild grasses, Olive) or bedding and flooring material (Sedges etc.) could be taken as proof that abandonment occurred. These scenarios highlight the potential that taphonomic studies such as these have to go beyond simply constructing palaeoenvironments to reconstructing human behaviour.

These examples are of course general. The model may be applied to all types of archaeological issues. In theory, any aspect of past human behaviour that may have left a signal in the fossil record may be detectable if the modern taphonomy associated with the activity is fully understood.

Conclusion

The extension of this preliminary study will create an understanding of the mechanisms governing pollen deposition at the Haua Fteah and their implications for palaeoenvironmental and behavioural reconstruction. The recognition of definitive patterns of pollen sedimentation within the contemporary cave environment can grant crucial insights regarding fossil assemblages. Whilst the extrapolation of quantified pollen accumulation systems to the past can help generate a full understanding and solid interpretation of the environment represented parallel to the archaeological evidence, the human signal within this environmental record may also be identified, evaluated and explained through the fossil pollen assemblage.

This paper has highlighted that, when applied within the framework of an inter-disciplinary study, taphonomic research provides the archaeologist with the potential to create a more comprehensive story of human occupation at a particular site as well as palaeoenvironmental reconstruction. If archaeologists disregard the taphonomic signal within the fossil pollen record, conclusions regarding human behaviour drawn from the site may not be in sync with the environmental evidence. The application of this holistic approach will be particularly useful at locations such as the Haua Fteah where archaeologists are faced with extremely long and complicated stratigraphical sequences which will have many apparent changes in the nature of human behaviour. Close examination of the fossil record and the identification of subtle taphonomic signals contained within will give the archaeologist another strand of vital evidence which will corroborate or dismiss any proposed interpretations regarding the nature of such changes.

In sum, through the application of the taphonomic research and subsequent findings, the pollen 'story' at the Haua and can be 'read' as an environmental record and context of human activity. The Haua Fteah, however, is only one such case study. As more taphonomic research is undertaken, it may eventually be possible to create a taphonomic knowledge base for 'non-standard' depositional sites. This can be used as a framework upon which site-specific taphonomic research can be based. Perceivably this will lead to more robust interpretations of fossil records, thus providing the wider scientific community with more readily acceptable data which can be applied to the issues regarding the behaviour of past populations within their environmental context.

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