Chapter 2
Methods in Taphonomy

The images in this book were produced using a variety of procedures and methods. This chapter provides a summary and discussion of these procedures and the potential effects they have on the interpretations of fossil assemblages. There are three main data sources: fossil faunas, studies of modern analogue faunas, and examining the impact of the methods used for investigating the modifications (such as DNA sampling). Data on fossil faunas can be collected directly from fossil sites, but in order to retrieve useful information on the taphonomy of fossil bones, basic information on the method of collection is needed. For example, the type of taphonomic information available from an excavated assemblage is different from that derived from surface collections, and the way the information is collected is also different. The interpretation of taphonomic modifications on fossil faunas is always based on inference, however, and the only way to obtain unequivocal data that links types of modification to specific taphonomic processes and agents, is through documentation of modern analogues. Such documentation can be achieved either by actualistic studies in the field or laboratory experiments under controlled conditions. The methods available for analyzing collections of fossils and analogue studies are similar, although some of the techniques differ slightly according to the type of analysis, especially during specimen preparation. In the analyses of fossils, non-destructive and non-invasive methods are preferred, although this is not always possible.

Collecting Methods for Fossils and Artifacts and Their Effects on Taphonomic Results

Surface Collection

Surface collections of fossils or human artifacts are generally organized according to some objective criteria. For example, searches might be conducted following stratigraphic exposures, particularly if it is known that the source of the specimens is one particular horizon. In general, however, some additional control is needed if the fossil deposits are exposed over an unknown area. In this case the recommended method is to set out a linear grid that can be adapted to the nature and extent of the exposure. Each find can be photographed as it is found, and a record made of the type of sediment in which it was found. Criteria for collection of specimens depend on the type of collection being made. A frequently used practice is to collect all identifiable specimens, including all flake debitage and small mammals. Much taphonomic information can be lost by this procedure, and recommended practice is to collect in addition all specimens larger than 2 cm. These should be labeled with date of collection, numbered strip in the linear grid, distance along the grid (as stated above), and type of specimen. When available, location of finds can be made using a GPS or a total station. Where surface collections are able to locate specimens in place in the sediment, the same criteria apply for the recording of the specimens, but some additional criteria should be added (Fig. 2.1).

Excavation

The size and orientation of excavation grids are nearly always determined by the nature of the exposures. Meter grids in caves can often be set out above the surface of the deposits by running an aerial grid of lines from the side walls of the cave. Aerial grids are normally made with tensioned wire or metal cable rather than with string. Horizontal and vertical coordinates of fossils and artifacts, as well as sedimentary features, are recorded by measurements from one or more referential fixed points, or by digital total station using electronic distance measuring (EDM). The coordinates are used to make plans of excavations showing the 3-D spatial distribution of fossils and artifacts, with all finds and

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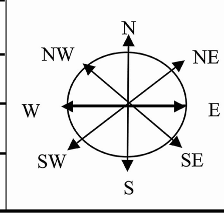
Site Name: Azokh 1										Unit: II (a)		Square: D46	Page #
Diggers:										Date			
No.	Material	Type	Identif.	L	W	T	X	Y	Z inf	orient.	tilt	Sediment	Remark
21	limestone	block	angular	300	210	70	**314**	**4688**	**-274**	NW-SE	SW	crumbly sediment with small dark pieces	rotten limestone
23	bone	II phalanx	equid	80	55	25	**390**	**4687**	**-305**	N-S	N	soft clayish sediment	DNA sample
24	stone tool	chert	BN2G	30	10	5	**311**	**4613**	**-306**	NW-SE	V	hard sediment	
25	obsidian	obsidian	BN2G	40	20	3	**309**	**4611**	**-415**	E-W	flat	silty clayish brown soft	smooth side facing bottom
26	charcoal			-	-	-	**377**	**4654**	**-416**	-	-	silty clayish brown soft	dating
27	coprolite			45	40	25	**370**	**4655**	**-418**	see remarks		silty clayish brown soft	round shape

Material	Type	Identification	IMPORTANT!!!		Sediment:	Remarks (e.g.)
bone/tooth Yellow	anat.elmt / frag.indet	bovid/cervid/ equid/bear	**never forget to mark the ground side**	**Plot in map all coordinated finds.**	silt/gravel/sand	Taken for dating, DNA
stone tool: Blue	obsidian/quartz /flint/chert	flake/debris/ or BN2G/BP	**never forget to mark the ground side**		crumbly/cemented/ soft	broken during extraction
limestone: Red	block/ stone	angular/rounded	**bigger than 10 cms**		heterogeneous/ homogeneous	consolidated in the field
charcoal: Black			**wrap in foil**		colour: red, brown, grey/yellow	uncertain coordinates
coprolites: Brown	isolated/several segments		**wrap in paper**			sample taken for geology

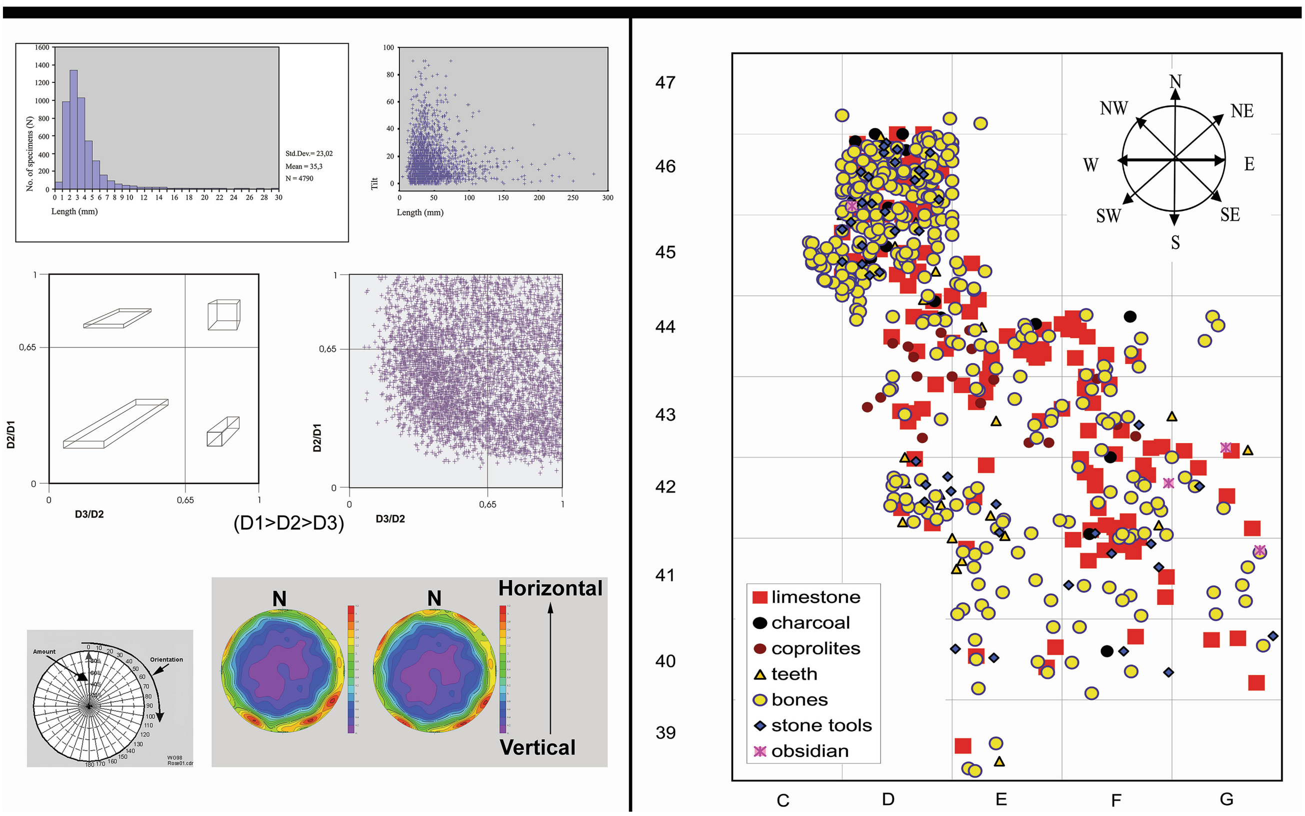


Fig. 2.1 (Top) Excavation sheet: apart from common information such as name of site, unit and square number, as well as the number of find, its dimensions and orientations, it is necessary also to identify the digger, write the date, and describe the color of the find according to a formerly established code. It is important taphonomic information to describe the sediment below and around the fossil, to collect samples of sediment and to distinguish clearly the purpose of the sample. Specimens should be marked with a permanent marker to identify the side in contact with the ground. Bottom right, the measured coordinates for all specimens are used to make plans of the excavation, in this case at Azokh Cave, Nagorno Karabakh. Bottom left, all these data allow the taphonomist to obtain diagrams of size, shape, tilt and orientation to discern the influence of processes that might select fossils and organize according to aerodynamic or hydrodynamic traits of the fossils

sediment described and labeled in detail. Collecting and screening for fragile small mammal specimens may increase fragmentation, but the advantage of this method is recovery of most small mammal fossil bones, both for taxonomy and taphonomy. Recommended protocols for dry screening are three nested screens with mesh sizes of 10, 5 and 1 mm; and for wet screening recommended mesh sizes are 2, 1 and 0.5 mm. Fine residues should be taken back to the laboratory for sorting using a mounted low magnification lens or binocular light microscope.

Collecting Samples for DNA Taphonomy

Sampling for DNA analyses is more specific than most other sampling in taphonomy. Washing and use of consolidants should be avoided, specimens should be kept away from changes in humidity and, in particular, from exposure to the sun. To avoid contamination, the specimen should never be exposed on the surface for longer than a few minutes before extraction under sterile conditions. The collector of DNA samples should wear latex or plastic gloves, face mask, and a disposable cap or clean handkerchief for the head. Tools to extract the fossil should have been previously treated to destroy DNA on the surface, either in the laboratory by exposure to UV-rays, or with bleach before extraction. Sample bags, boxes and foil paper for collection of samples must previously be sterilized or cleaned (nothing can be recycled!). When dealing with human remains, complete coverage in laboratory gowns is advisable, and as far as possible it is recommended that only one person should approach to the fossil and extract the specimens, and they should then provide a sample to characterize her/his DNA. After recovery, specimens are wrapped in foil and kept individually in labeled sterilized plastic bags recording them as DNA samples. Sediment beneath the fossil should be collected separately in foil and in a clean sample bag labeled in detail and noting it as a DNA sediment sample. A control sediment sample should also be collected from another part of the square or excavation level following identical procedures, noting it as a control sediment sample. All samples must be stored as soon as possible under cool conditions, either in a portable freezer, an icebox or buried deep enough into the ground to keep them at relatively low and stable temperatures. The samples should not be frozen before their arrival in the paleogenetic laboratory to prevent repeated freezing/thawing cycles that are harmful for DNA (Pruvost et al. 2007; Fortea et al. 2008). The main point to be considered is that fossil DNA is not modern DNA. The structure is different and procedures to recover it are different, not only to prevent contamination, but because extraction and amplification of DNA from fossils are also different.

Histology and Preservation

Histological analyses to establish microorganism (bacterial or fungal) attack or other modification of the interior of the bone should be carried out on sectioned bones (Bell 2012). The bones are cut transversally and embedded in resin. The surface is polished with 1000 grit silicon carbide powder, finishing with 2500 grit, on a rotating lap using water as lubricant. The final polish is achieved using 3 and 1 micron diamond on a texmet 1000 polishing cloth, using low to medium weight and plenty of distilled water as a lubricant. This also helps to flush away any mineral laboratory contamination and minimize scratching.

In order to study histological traits of bone cross sections, particularly with regard to microorganisms and bone diagenesis modifications (Fig. 2.2) arbitrary divisions of the cortical bone are used: (PCL) periosteal cortical layer, (MCL) medial cortical layer and (ECL) endosteal cortical layer (Fig. 2.2 top left). These layers almost correspond to histological tissues in the bone cross sections: PCL is similar to the outer layer of periosteum and circumferential lamellae, and ECL is similar to the inner circumferential lamellae. Volkmann's canals run within osteons interconnecting canals of Havers (Fig. 2.2 top right). Osteons consist of concentric lacunae and lamellae around canals of Havers which contain the bone's nerve and blood supplies (Fig. 2.2 bottom right). Osteoblasts form the lamellae sequentially, from externally inwards toward the Haversian canal. Some of the osteoblasts develop into osteocytes, each living within its own small space, or lacuna. Osteocytes make contact with the cytoplasmic processes of their counterparts via a network of small canals named canaliculi (Fig. 2.2 bottom left).

The Oxford Histological Index established by Hedges et al. (1995) (see also Millard 2001) can be used to characterize the general preservation of the bone. Descriptions by Jans (2005), Jans et al. (2005), Bell (1990) and Bell et al. (1991, 1996) on the histological traits and destructive foci (MFD) provide further information on this process of modification and implications. Some of the histological modifications recently studied have been shown to provide valuable environmental information (e.g., Bell et al. 2009; Pesquero et al. 2010). Further research, however, is needed to obtain better identification of the origins of these modifications.

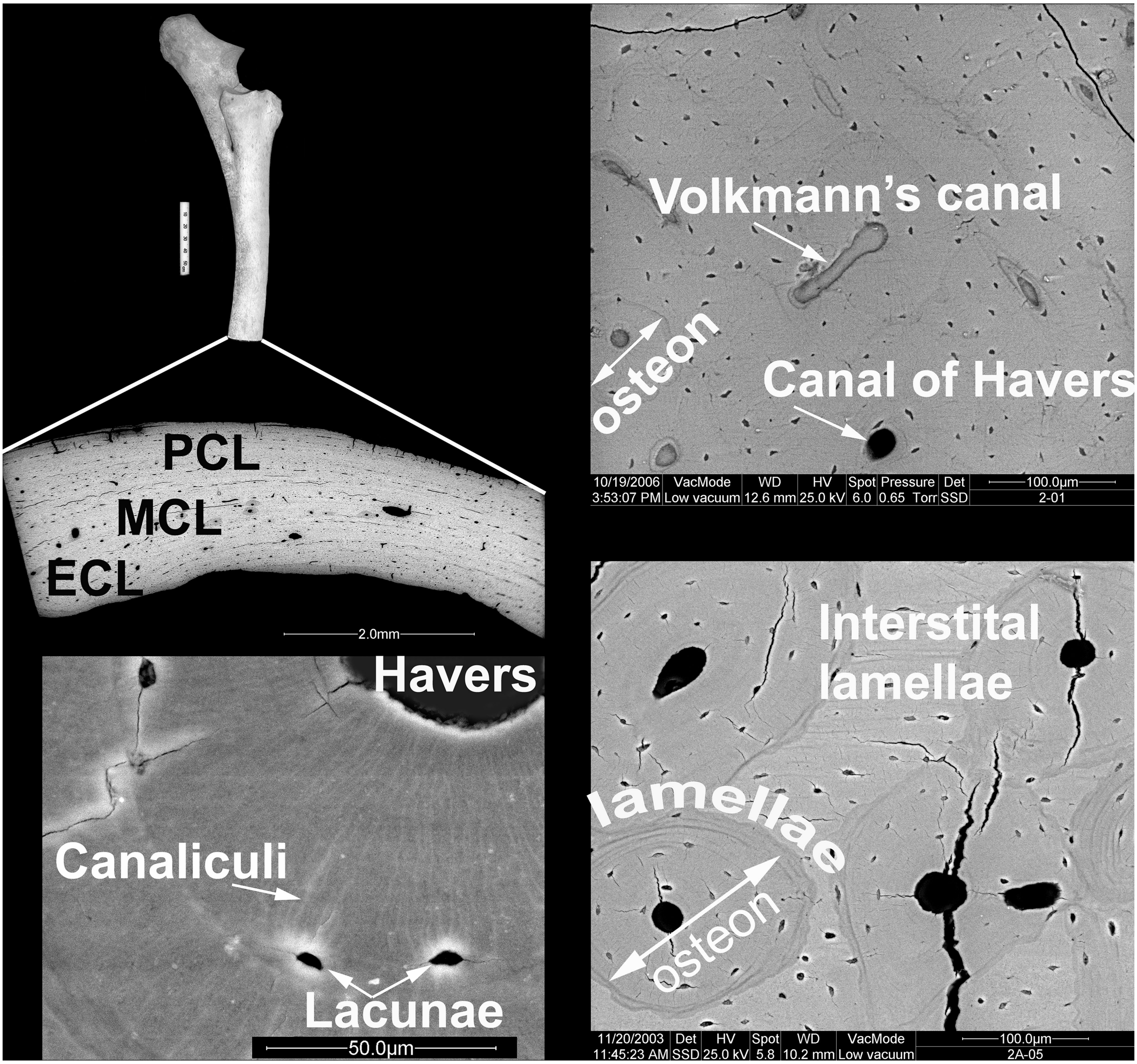


Fig. 2.2 Transverse long bone cross-section: (PCL) periosteal cortical layer, (MCL) medial cortical layer and (ECL) endosteal cortical layer (see text)

Modern Analogues and Experimental Field/Laboratory Projects

Taphonomic history of paleontological and archaeological collections is often complex and all variables need to be investigated in order to reconstruct the history of the assemblages. Interpreting taphonomic modifications depends on identifying the agents producing the modifications and the processes by which they are made, and this depends on actualistic studies providing comparable data from modern observations. These range from studies of the taxonomic composition of whole animal communities and the relative abundance of species within the fossil assemblages, to studies of the elements that make up the fossil assemblage (Behrensmeyer and Hill 1980). Dispersal and accumulation of faunal remains are other considerations, as are the agents responsible for all modifications. All these aspects contribute to the taphonomic history of fossil assemblages, and the modern analogues on which they are based are of several kinds, from single observations of specific types of modification to ranges of modification varying through space or time.

Long Term Monitoring Studies

Particularly valuable are studies monitoring animal remains over periods of time and over different types of landscape and/or climate. Large mammal monitoring has been in progress for many years in East Africa (Behrensmeyer 1984; Western and Behrensmeyer 2009) in UK and Abu Dhabi (Andrews and Armour-Chelu 1998; Andrews and Whybrow 2005) and in Spain (Cáceres et al. 2008). These experiments show how certain taphonomic modifications change through time and space (Behrensmeyer 1978). For example, to address the question of change through time, detailed monitoring by photographing, mapping, and measuring distances of skeletal dispersal are all necessary; while to address effects of the environment, quantifying environmental parameters and evaluating changes should be carried out on a continuing and regular basis, for example at least four times a year in different seasons. Environmental parameters to be measured are soil pH, vegetation type, temperature and humidity fluctuations, both in the air and beneath vegetation, altitude, precipitation, topographic relief, degree of slope, and qualitative assessments of the environment, e.g., damp versus dry, windy versus protected, exposed to the sun versus covered by vegetation, etc. Specimens can be collected periodically, but as much should be left in the field for continuing the long term monitoring. When no traces of specimens are left above ground, the areas should be excavated to determine the extent and depth of burial. Studies such as this, however, are in their infancy and need to be repeated in different environments and on different suites of animal. Figure 2.3 shows how the dispersal and weathering of bones of a camel skeleton in a desert environment changes over a period of 15 years (Andrews and Whybrow 2005): for example, there are episodic dispersal events due to the low and sporadic rainfall, and weathering progresses at less than half the rate observed by Behrensmeyer (1981) in tropical East Africa.

Long term monitoring should also have a spatial element, investigating taphonomic change in different environments. This is another facet of Behrensmeyer's project (Behrensmeyer 1993) in tropical Africa, and it is also incorporated into work in temperate environments both in England and in Spain (Andrews and Armour-Chelu 1998; Cáceres et al. 2007). Many differences have been observed in taphonomic trajectories between different environments even when they are within the same climatic zone, and these are attributed to variations in vegetation cover, type of soil, especially soil pH, topographic aspect of the ground and degree of exposure, degree of slope, existence of barriers, and biological variations due to preference of many animal species to specific parts of the environment.

Monitoring Studies of Small Mammals

Most of the actualistic monitoring studies are being conducted on large animal remains, but taphonomic monitoring of small vertebrate assemblages is also important (Andrews 1990; Montalvo et al. 2007, 2008a, b). Small vertebrate assemblages are usually the result of predator accumulations, and it is difficult to monitor small mammal remains in space and over long periods of time. We have attempted this on several occasions, but invariably the bone assemblages are damaged beyond recognition or disappear completely. Some controlled experiments have been done under field conditions (Korth 1979; Andrews 1990; Fernández-Jalvo and Andrews 2003) showing the long term effects of water movement on different types of bone and the long term effects of inorganic and organic acid soils. Scat collections from a species of mongoose in Kenya were compromised because on the nights following scat deposition many of the scats were eaten, probably by the same individuals that deposited them (Andrews and Evans 1983). The differential effects of the same predator hunting over an area over a period of years, or of different predators hunting over the same area within one time period (Fig. 2.4), have also been investigated (Andrews 1990). Laboratory experiments on insect damage, the effects of plant roots, dispersal of bones by earthworms, weathering and the effects of sediment abrasion need urgent attention.

Preparation Methods

Methods of preparation of animal remains in the laboratory can have marked effects on their preservation. For instance, for specific studies (such as DNA preservation) simply washing the fossils to get rid of the sediment is fully destructive. Similarly, consolidating the surfaces of fossils to preserve them makes it impossible to examine them subsequently with the scanning electron microscope. Some of the methods of bone preparation are not likely to compromise their surfaces or composition, but some of the methods produce modifications that are comparable to those observed in fossils. We have investigated the ones most frequently used by collectors, taxidermists, and museum osteological curators in order to record their effects on animal skeletons, for example boiling bodies to remove soft parts, treatment with enzymes, natural maceration in water, and treatment with insects such as dermestids. Some other methods of preparation have also been investigated, but these have no parallel in the fossil record. Laboratory experiments on the effects of acid during the preparation of fossil bones have

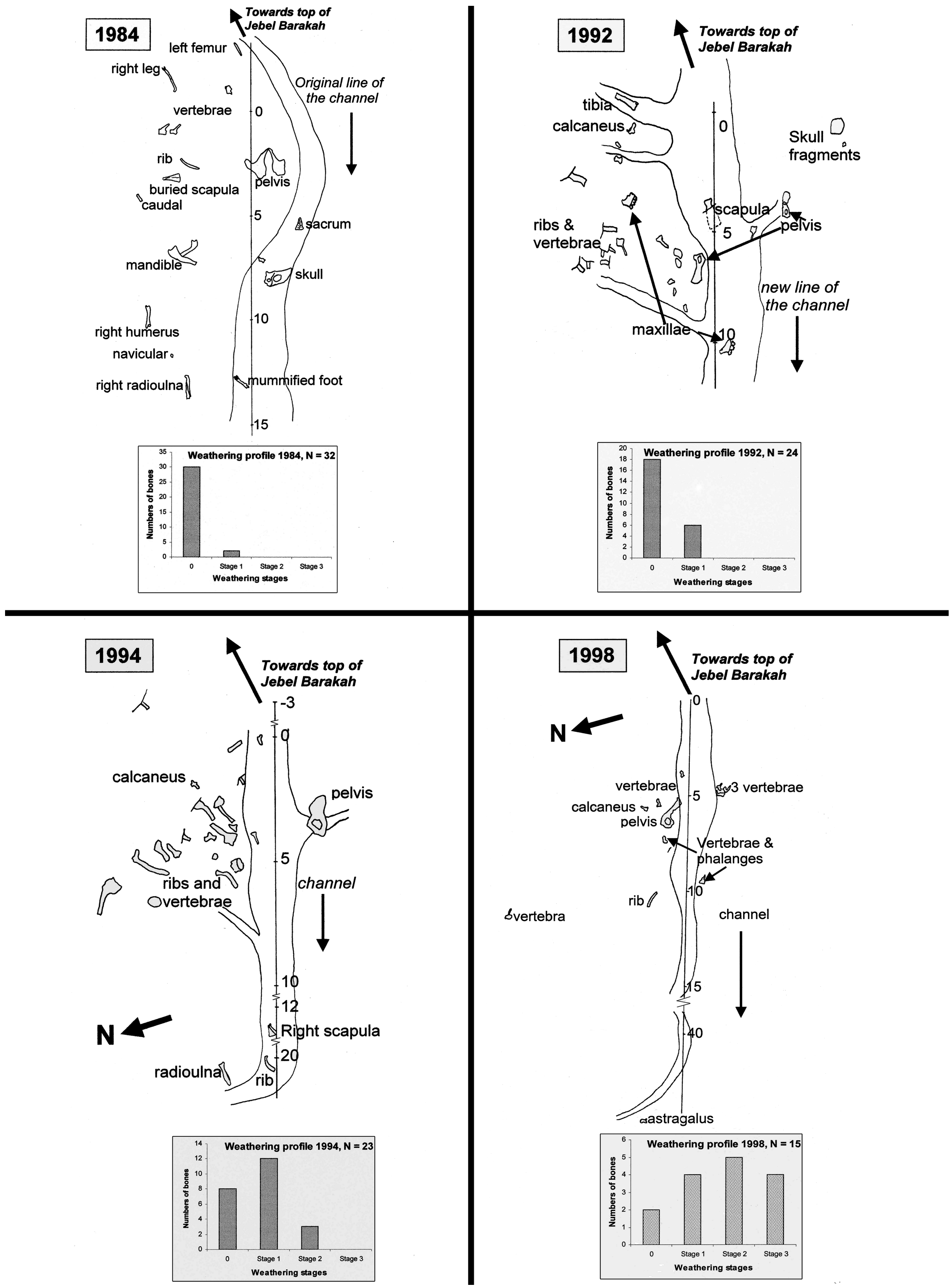


Fig. 2.3 Monitoring the decay and dispersal of a camel skeleton over a 15 year period at Jebel Barakah, UAE. The four plans show the skeleton along the same linear grid and from the same perspective, measured during 1984, 1992, 1994 and 1998. Also shown at the bottom of each figure are the weathering profiles and directionality of all bones visible on the surface at each period

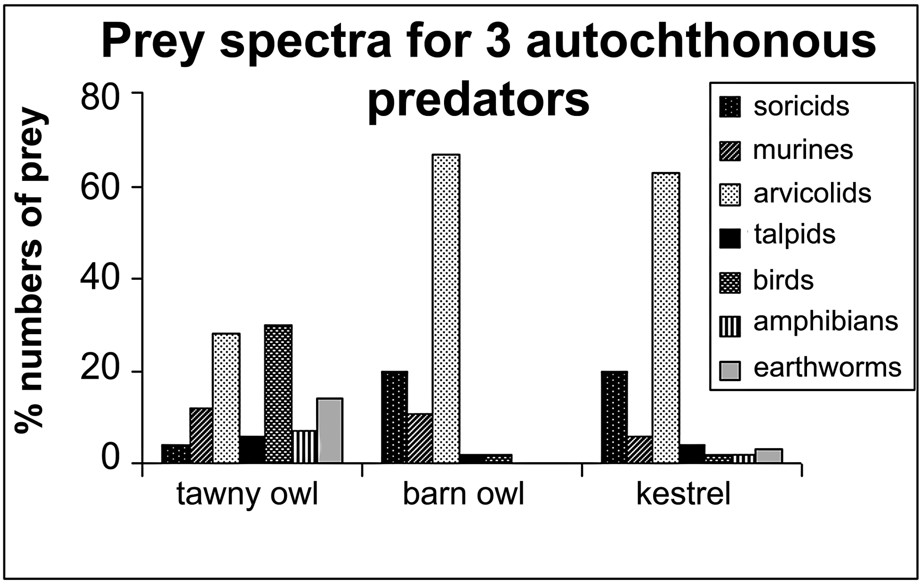


Fig. 2.4 Prey species representation of three predators, tawny owl (*Strix aluco*), barn owl (*Tyto alba*) and kestrel (*Falco tinnunculus*), which occupied different parts of the same barn at the same time over a period of five weeks at Neuadd, Wales

been undertaken, and the effects of weathering and transport, again on fossil bone, have also been investigated (Fernández-Jalvo and Marin-Monfort 2008).

Equipment Used in Taphonomic Research

For surface collections the tools needed for collecting fossils are minimal. Excavation grids are more complex, but at their most basic level no more equipment is needed for setting out a meter grid than is needed for a linear grid. Total station records distances and angles from the instrument to points to be surveyed, so that it records heights as well as horizontal coordinates, but a less expensive way of recording heights is with a laser beam forming a horizontal plane at a referential known height. Equipment needed for field observations on taphonomy comprise a tape measure and hand lens (magnification ×10). Collection of specimens in place in sediment requires in addition a compass for measurement of direction and an inclinometer for measurement of tilt. Magnifying glasses are adequate for a first inspection of the sample, but a binocular microscope is an asset in the field laboratory, although not a requirement. Analyzing fossils in the laboratory is mostly done with a binocular microscope, and magnification up to ×40 is more than adequate. A color chart is used to record color.

Further analyses with more sophisticated equipment may be needed in some cases to distinguish and conclusively identify some taphonomic modifications and the agents that produced them. Scanning electron microscopes (SEM) can be used at higher magnifications and with better resolution than light microscopes, and they also have greater depth of field allowing better three-dimensional images. This method works by directing electron beams at a specimen and collecting electrons emitted from the specimen, either from its surface as secondary electrons (SE) or from beneath the surface as backscattered electrons (BSE) (Fig. 2.5). Conventional SEMs require a metallic surface, and, therefore, fossil or modern organic samples have to be coated by gold or carbon to reflect electrons, which otherwise would be absorbed into the specimen both preventing observation and potentially with disastrous effects. The new generation of SEMs operates in a series of vacuum gradients that absorb some of the electrons and allow the examination of specimens without a metallic covering. These are known as environmental scanning electron microscopes (ESEM) or Low Vacuum (LVSEM) (Bromage 1987) and can operate in both secondary and backscattered mode (Fig. 2.5).

Chemical analysis linked with SEMs can be achieved in two ways. A conventional SEM can be fitted with detectors for X-rays (energy dispersive spectroscopy or EDS) which provides an approximate breakdown of the chemical composition of specimens (Fig. 2.6), but more accurate results

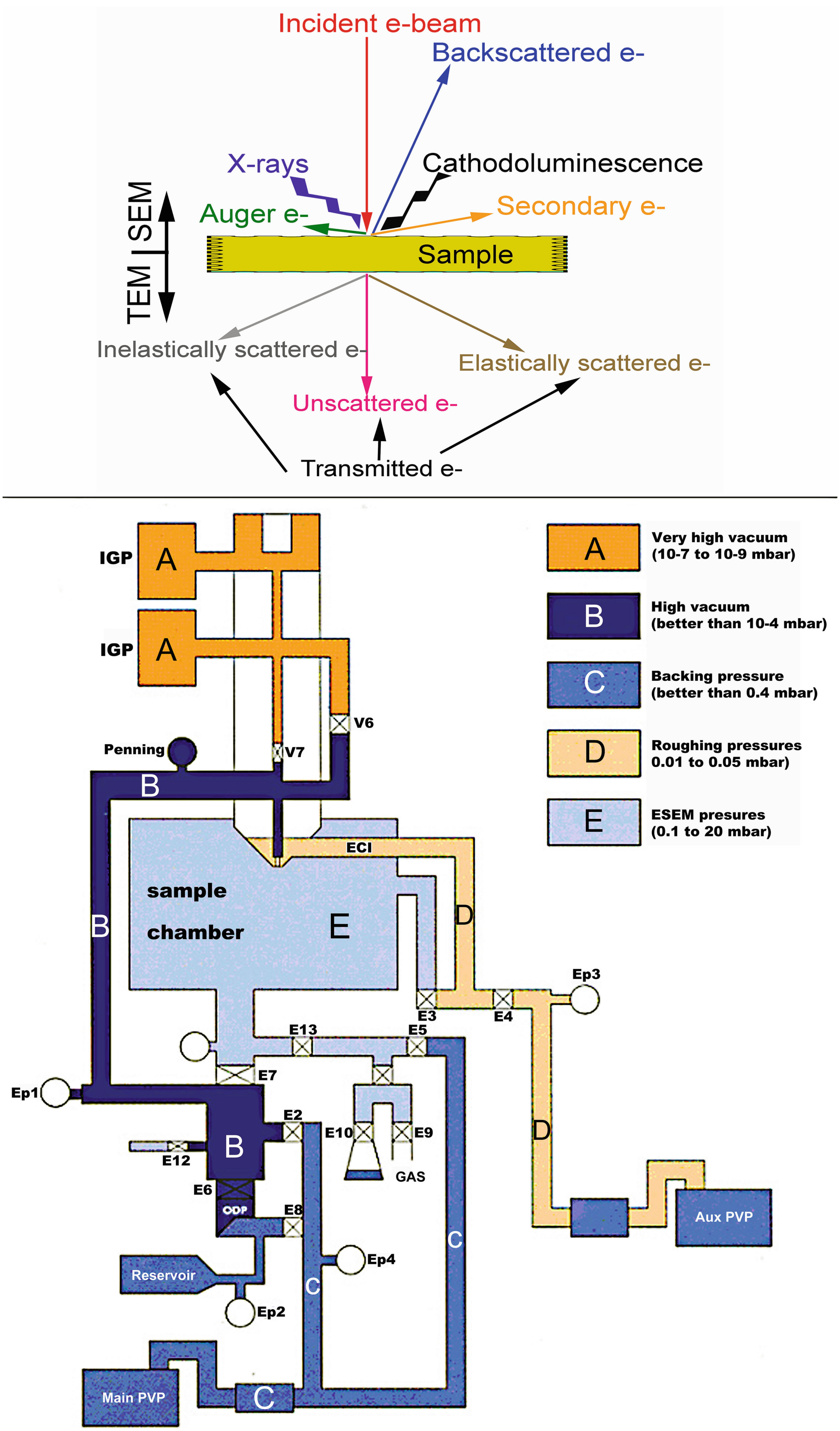
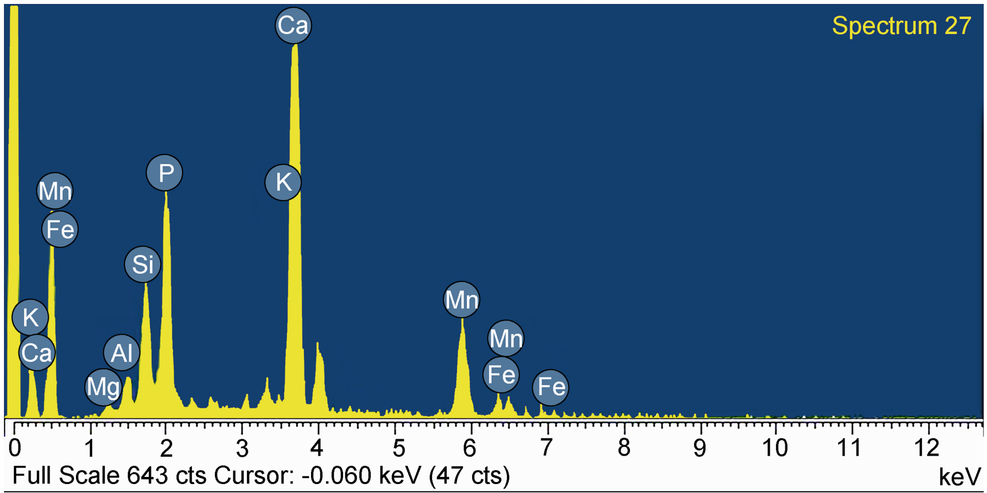


Fig. 2.5 Scanning electron microscope – the incident electron beam reflects off specimens to produce back scattered electrons (BSE), secondary electrons (SE) and X-rays, each of which requires separate detectors fitted to an SEM. Also shown here are the transmitted electrons used in a transmitted electron microscope (TEM); and an environmental scanning electron microscope showing the variations in vacuum in the different chambers



Element	Intensity Corn.	Weight%	Atomic%
Mg K	0.6456	0.52	0.80
Al K	0.8219	2.28	3.15
Si K	0.9893	8.14	10.78
P K	1.2417	25.23	30.31
K K	1.0348	1.36	1.29
Ca K	0.9204	45.41	42.16
Mn K	0.8067	13.83	9.36
Fe K	0.8435	3.23	2.15
Totals		100.00	

Fig. 2.6 Plot and table of chemical element composition of a hydroxylapatite mineral (bone = Ca, P), manganese mineralization (Mn) and sediment (silts [illite] = Mg, K, Al, Si, Fe) using an EDS detector fitted to the SEM. EDS chemical analysis at the SEM is not destructive, takes a few seconds and may analyze micrometric areas such as the infilling of Havers canal or modern unicellular diatom algae, made of silica

are obtained with the microprobe, which has another kind of detector that can also be attached to SEMs and which measures differences in wave length (WDS) to analyze chemical composition.

Confocal microscopes have great advantages as they are based on optical energy (laser) emissions, not electrons (Schmidt et al. 2012). The images obtained may penetrate several microns below the surface of the sample (not limited to the outer layer as in the scanning electron microscopy). Images are based on the fluorescence reflected and emitted, and depending on fluorescence properties of the specimen observed its use may be restricted, but, when appropriate, the advantage of this non-invasive technique is certainly high. A recent generation microscope, also named confocal because it provides focused images of irregular surfaces, is based on natural light. These microscopes provide good depth of field even using high magnifications (3,000×), and they have the advantage of maintaining natural color. Similarly, RAMAN spectroscopy is non-invasive, also based on laser energy and provides a fast chemical analysis (organic and inorganic). Its use is still limited in paleontology, as is catodoluminiscence (applied in electron microscopes), but see Chen et al. (2007) and Damas Mollá et al. (2006). These techniques are especially useful in research on diagenesis and fossilization processes.

Summary of Localities Sampled

The list of localities, samples, monitored and experimental collections for the images illustrated here are summarized below, including both fossil and recent sites. The taphonomic interpretations are based on our work at these sites, where we have either worked directly, been involved through students and associates, or have carried out taphonomic analyses on the collections. Thirty-four sites are represented here, 16 in Europe, 12 in Africa, 4 in the Middle East, and one each in China and South America; 19 sites are open air sites and 15 cave sites; and 21 are fossil sites from the Miocene to recent archaeological sites, and 13 are modern comparative sites, including 7 that are long-term monitoring sites where bones have been observed in naturalistic conditions over periods of time. Taphonomic modifications relate mainly to mammalian bone, both recent and fossil, large mammals and small mammals (less than 1000 g), with some descriptions of modifications to amphibian and bird bones where evidence is available.

Abric Romani, Spain
Abric Romaní is a travertine rock shelter near Barcelona (Spain). Butchery processes, knapping, cooking and eating have been identified at this site in a complex space arrangement of 400 m^2 extent (Carbonell et al. 1996, 2008; Vaquero 1999; Carbonell and Vaquero 1998; Carbonell and Mosquera 2006). The site is characterized by intensive and recurrent Neanderthal occupations through an extended period of time (70.2 ± 2.6 to 39.1 ± 2.8 ka). Abric Romani is especially interesting due to an excellent preservation of all types of remains (including wood), with occupations sealed by repeated collapses of the travertine ceiling, and where a pattern of activities organized around hearths has been distinguished (Cáceres 2002). The taphonomic study of macrofauna from Abric Romaní site was part of the doctoral thesis of Cáceres (2002) supervised by Y. Fernández-Jalvo.

Arrikutz, Spain
Cave site in northern Spain with assemblages of cave bear remains. The bears are all relatively large old adults, and the assemblage is attributed to hibernation deaths (Pinto Llona et al. 2005). Several carnivore species are associated with the bears, including hyena (*Crocuta crocuta*), wolf (*Lupus lupus*) and the large cat *Panthera spelaea*. A high proportion of bones at the site (70%) have been modified by carnivore action, with many spiral breaks.

Arroyo Seco, Argentina
This is a complex of several archaeological sites, located in the eastern and central parts of the Argentinean Pampa region. The sites of Arroyo Seco have yielded human burials from the Late Pleistocene-Holocene associated with contemporaneous mega- and microfauna as well as manufactured tools. The taphonomic study of faunal remains was the subject of doctoral thesis by Gómez (2002) supervised by Y. Fernández-Jalvo.

Atapuerca, Spain
The Atapuerca fossil sites are located in the southern part of the Sierra de Atapuerca, 15 km from the town of Burgos (Spain). This region, located in the Duero Basin in north-central Spain, has an elevation of 1,079 m above sea level or less. The area is extremely rich in fossil sites of different ages, from over 1 Ma (Sima del Elefante site) to the Bronze Age (El Mirador site). We will discuss three sites where we have been directly involved in the taphonomic studies: Gran Dolina with 11 stratigraphic units identified, including TD6-Aurora, a stratum that provided cannibalized human remains of 750 ka (Díez et al. 1999; Fernández-Jalvo et al. 1999), Galería (a butchery site estimated to date to 400–200 ka; Cáceres 2002) and Sima de los Huesos at an age close to 400 ka (Arsuaga et al. 1997; Bischoff et al. 2003). The small mammal taphonomy of Gran Dolina, Galería and the site of Penal was the subject of Y. Fernández-Jalvo's doctoral thesis (1992), and the taphonomy of amphibians and reptiles of Galeria was studied by A. Pinto Llona, both investigations supervised by P. Andrews. The taphonomy of the first 28 human individuals from Sima de los Huesos was studied by P. Andrews and Y. Fernández--Jalvo (1997).

Azokh Cave, Nagorno Karabagh
Azokh cave is part of an extensive phreatic system in limestone rocks of the lesser Caucasus Mountains. The cave is a 200 m dark gallery with several entrances (King et al. 2003). Two of these connections are partially blocked by boulder chokes. The sediments are in part derived from within the cave and in part from avens extending down from the hill slopes above. The sediments consist of silts and breccias, some levels cemented, and they contain fossil animal remains and stone tools in most levels dating from the Middle Pleistocene up to the present (Fernández-Jalvo et al. 2004, 2010). There is extensive evidence of cave bear (*Ursus spelaeus*) and human occupation levels, as well as humanly induced damage, animal activity, bacterial and fungal attack, and diagenesis that produced remineralizations and mineral neoformation in some of these units due to the presence of bats in the cave. Human remains have been

found, including *Homo heidelbergensis*, *Homo neanderthalensis* and *Homo sapiens*. Taphonomic, paleontological, geological and paleoecological studies of this site have been supervised by P. Andrews, T. King, L. Yepiskoposyan and Y. Fernández-Jalvo (Fernández-Jalvo et al. in press), with a taphonomic study by Marin-Monfort et al. (in press). The taphonomy of the macrofauna is the subject of the doctoral thesis by Marin-Monfort (2015) supervised by Y. Fernández-Jalvo. The small mammal taphonomy has been studied by P. Andrews.

Barranco de las Ovejas, Spain
The site at Barranco de las Ovejas is in a steep ravine where local shepherds abandon dead sheep in the Pyrenees (Huesca, Spain). The area is taphonomically interesting because of the presence of the Lammergeier or Bearded Vulture (*Gypaetus barbatus*). This specialized scavenger usually avoids rotting meat, and lives on a diet that is 90% bone marrow. It drops large bones from a height to crack them to get access to the marrow. The site provides information on gravitational dispersal of bones, weathering, and, of course, breakage by high falls (Y. Fernández-Jalvo unpublished data).

Çatalhöyük, Turkey
Çatalhöyük is a Neolithic town dating to approximately 9000 years BP occupying a low mound of approximately 15 ha on the Konya plateau. Both human and animal bones have been found in abundance, but whereas the animal bone is mostly found dumped in midden areas, the human bones come from burials beneath the floors of the houses. The taphonomy of the human bones was investigated to determine the nature of burial practice, in particular looking for evidence of secondary burial, the evidence for which was based on selection of skeletal elements in the burials or by the presence of cut or chop marks (Andrews et al. 2005). Many of the graves were reused, sometimes with many individuals in the same grave, the later inhumations disturbing the earlier ones so that the bones became mixed together. Most of the burials were deep enough so that disturbance from compaction of the surface of the floors above is not an issue, and they were further protected by the multiple layers of clay plaster by which the floors of the houses were sealed. The sediment infill of the burials is generally free of rocks and consists of fine silts. Taphonomic processes observed were both anthropogenic (selected and/or modified by humans), or natural, such as fungal staining of bones exposed during disturbance. The taphonomic study of the human burials at Çatalhöyük was carried out by P. Andrews and B. Boz (Andrews et al. 2005).

Concud, Spain
Concud is a reference site of the Neogene's EuroAsiatic Mammalian faunal stages (Late Miocene zone MN12, 7.5 Ma). The site has yielded an abundant fossil fauna bearing taphonomic modifications (Pesquero 2006; Pesquero et al. 2010, 2013; Pesquero and Fernández-Jalvo 2014). The paleoenvironment was an ancient lakeshore along which fossil accumulations were formed by attritional mortality of large mammal species consisting mainly of artiodactyls (giraffids, suids, bovids and cervids) and perisodactyls (mainly *Hipparion* and some rhinos). Carnivorous species (felids, canids and hyenids) are also present, and evidence of scavenging activity has been deduced from fossils of herbivores. The lake site was highly calcareous and provided the conditions that favored the preservation of delicate structures. The taphonomy of the macrofauna was the subject of the doctoral thesis by Pesquero (2006) supervised by Y. Fernández-Jalvo.

Cueva Ambrosio, Spain
This is a small cave shelter site located in the South-East of Spain in Almeria (Spain), and excavations have been lead by S. Ripoll (1988). Three levels of human occupation have been distinguished from the Solutrean period of the Late Paleolithic. Radiocarbon dates provided an age of 16.6 ± 1.4 ka, with abundant lithics but relatively few remains of vertebrates (mainly rabbit, and some wild goat, deer and horse). The environmental and climatic interpretation of the site suggests a temperate and humid period. The site has been considered to be a stone tool workshop with a high variety of raw material with different qualities and traits collected from the immediate vicinity to the site. The taphonomy of the macrofauna was studied by Y. Fernández-Jalvo.

Draycott, Somerset, UK
Draycott is the site of a single natural death of a cow. The cow fell down a limestone cliff onto a rocky substrate consisting of fallen limestone blocks and surrounded by dense low woodland on the middle slopes of the Mendip Hills (Andrews and Cook 1985). The carcass was left undisturbed except by scavengers. There is a cattle pathway at the bottom of the cliff along which cows pass regularly. The carcass was still partially articulated when first found. Trampling pressed the bones into the rocky substrate and caused multiple scratch marks as the bones were rubbed against the stones, with some bones being buried to shallow depths in the surrounding soil. The carcass was monitored annually from 1978 to 1982, when most of the bones were collected, and a second collection was made in 1984. Taphonomic processes observed were scavenging, trampling, breakage and weathering studied in detail over a period of seven years by P. Andrews and J. Cook.

Gorham's Cave, Gibraltar
Gorham's Cave is located on the Mediterranean side of the Rock of Gibraltar, at Governor's Beach, near the site known

as Vanguard Cave (Stringer et al. 2000). The site, today at sea level, is a wide cave infilling of about 20 m thickness located 50 m inside in the cave, with a stratigraphic sequence of brown-reddish clays and silts. Sediments record successive Neanderthal occupations from 100 ka to the last representatives of this species, followed by *Homo sapiens* occupation levels. The top of the series has yielded fossils and artifacts of Phoenicians and Carthagenians (8th to 3rd centuries BC). Taphonomic analyses of the animal bone showed evidence of carnivore and human modifications (Fernández-Jalvo and Andrews 2000; Finlayson et al. 2006).

Gough's Cave, Somerset, UK
Gough's Cave is part of an extensive cave system in Cheddar Gorge, Mendip Hills, UK. Six human individuals from the Mesolithic Period were found with an assemblage of animal bones during excavations conducted by a team from the Natural History Museum (Stringer 2000). There were 269 fossils consisting of six human, ten equid and six cervid individuals found located between a large rock and the cave wall in sediment of fine gravel and silt. The bones were mixed together and extensively broken, and they included two partial human rib cages, all with a variety of percussion, chop and cut marks (Andrews and Fernández-Jalvo 2003). Human-induced damage was the main taphonomic process, and the similarities in modifications of human and animal bones suggests that they were all the products of human butchery and that cannibalism was being practiced. The evidence for cannibalism was studied by both authors of this book.

Grimstone, Dorset UK
Grimstone Down is an area of chalk downland in south Dorset (Andrews 1990). Predator accumulations include small mammals and remains from natural deaths of deer (*Capreolus capreolus*). Small mammals assemblages are the product of mammalian predators, particular fox (*Vulpes vulpes*), and the deer remains are probably scavenged by foxes also.

Ibex Cave, Gibraltar
Ibex Cave is a small rock shelter on the upper slopes in the Rock of Gibraltar. Taphonomic evidence suggested that humans were involved in the site as stone tools were recorded, but no evidence of butchery on the fauna has yet been found (Fernández-Jalvo and Andrews 2000).

Jebel Barakah, United Arab Emirates
Jebel Barakah is a low hill on the shores of the Arabian Gulf in western Abu Dhabi 24° N latitude. The hill is made up of late Miocene sediments, marine at the bottom trending into terrestrial deposits up the section. A single camel carcass was located soon after death in a remote valley, and the bones of the skeleton were monitored in five survey periods from 1984 to 1998 (Andrews and Whybrow 2005) to record bone dispersal, weathering and burial. After initial scavenging by jackals the skeleton was undisturbed and parts of it were either dispersed down the valley, transported by occasional but usually violent rain storms, or buried by sediment washed down from the upper slopes. Taphonomic processes observed over the period were weathering, transport and burial (Andrews and Whybrow 2005).

Kajiado, Kenya
Sukuta hyena den is 4 km west of Kajiado. The den is situated half way up a steep rocky slope about 16 m high with very large boulders of in situ lava. There are two entrances close together and connecting beneath rocks into a low tunnel at least 10 m long. i.e., this is a true cave in rock (Sutcliffe archive, Natural History Museum). It was found to be accessible for about 3 m; but potentially it could be penetrated further by removing sediment from the floor. Numerous bones were visible inside the cave, mostly pushed against the sides of the tunnel. Human remains, with occasional giraffe and horse, were found, mostly fairly complete but with the ends sometimes gnawed. Many bone splinters were present. Bones were present as far as it was possible to see into the interior of the cave, including a human skull at about 8 m. Taphonomic modifications include hyena breakage and tooth marks studied by P. Andrews.

Langebaanweg, South Africa
Langebaanweg is located on the Cape west coast, where phosphate mining operations uncovered one of the richest fossil sites in the world, dated ca. 5 Ma (Matthews 2004). The site has yielded a wide range of fossils of animals now extinct. The past environment in the area included riverine forests, wooded savanna, the adjacent sea and offshore islands. Over the past 40 years, fossil bones of 200 species of animals, many of them new to science, have been recovered. Large carnivores inhabited the area together with the elephant-like gomphotheres (*Anancus*) and an okapi-like giraffid (*Palaeotragus*), antelopes such as *Miotragus*, three toed equid (*Hipparion*) and Sivatheres, a horned giraffe. The excavators have left fossils exposed as part of an in situ palaleontological museum. Fossils provided evidence of many taphonomic surface modifications and deformations related to wet environments. Taphonomic processes are currently under study by A.K. Behrensmeyer, previous to which, the Taphonomic Analytical Working Group of the RHOI (Revealing Hominid Origins Initiative) project (C. Denys, P. Andrews, Y. Fernández-Jalvo, A. Louchard, T. Matthews and D. Reed) was involved in a preliminary taphonomic study of the site.

Mumbwa Cave, Zambia
Mumbwa Cave has multiple entries in a limestone inselberg situated in a shallow basin. The cave is phreatic and extends about 60 m into the limestone, and sediment infill is

Table 2.1 Neuadd environments

	N	pH	Altitude (m)
Exposed environments			
Rough grazing/grass	11	3.5	380
Bracken moorland	12	3.6	460
Heather moorland	4	4.0	490
Stone scree	5	–	370
Closed environments			
Woodland with leaf litter	8	5.1	270
Scrub with ground vegetation	12	4.2	336
Wet environments			
Woodland-marsh	1	6.0	278
Moorland pool	3	5.1	460
Stream	4	5.0	270–380
Dry ditch	4	4.5	316

N gives the numbers of specimens in each environment

composed of outwash from the surrounding sandstone ridges. The major part of the cave infill is Middle Stone Age, with some Late Stone Age on top, and both animal bone and lithics are present in each level (Barham 2000). Worked bone is present in the Late Stone Age and may be present in the Middle Stone Age (Barham et al. 2000), and in both levels there is anthropogenic evidence of percussion marks on the fossils. Taphonomic features/processes observed were digestion of small mammal bone, percussion marks and rounding/polishing of ends of bones. The taphonomic study was made by E. Jenkins, supervised by P. Andrews.

Neuadd, Wales

A long term project was started in 1976 by P. Andrews at a near the village of Rhulen, Wales, latitude 52° N (Andrews and Armour-Chelu 1998). The purpose of the project was to investigate the rates of dispersal and decay of bones from undisturbed mammal carcasses in a temperate climate, and subsequently to record rates of weathering and burial. Over 100 specimens of domestic animal have been monitored over a period of 30 years. When the monitoring started, a surface collection of bones already present in the study area was made so that bones dispersed from monitored specimens could be more readily identified. The area consists of open moorland along the tops of the hills, with several moorland pools and areas of accumulating peat, and places where springs emerge from underground giving rise to locally wet areas of bog. The lower slopes of the hills are fenced for rough grazing but are rarely ploughed or managed in any way. Along the valley bottoms there are scattered trees, with woodland lower down. The main environments present are listed in Table 2.1, which shows the numbers of individuals monitored in each environmental type. The study area was approximately 900 ha, with 17 km of sampling lines, which were searched to a distance of 20 m on either side of the lines. Histological studies to investigate early diagenesis are currently in process (Fernández-Jalvo et al. 2010). Monitored skeletons are numbered as Neuadd 1, Neuadd 2, etc. and samples collected from the skeletons are numbered ND1, ND2, etc. The long term monitoring over 30 years was carried out by P. Andrews (in preparation).

Olduvai Gorge, Tanzania

Olduvai Gorge has a long sequence of terrestrial sediments from Early to Late Pleistocene with abundant animal remains and human artifacts. The sediments have been described by Hay (1976) and the taphonomy by Fernández-Jalvo et al. (1998), Blumenschine et al. (2007, 2012), and Domínguez-Rodrigo et al. (2007), among others. There is abundant evidence of human and carnivore activities, small mammals accumulated by avian and mammalian predators, and many other taphonomic processes. The small mammal taphonomy of the FLKN and FLKNN excavations by Mary Leakey was studied by Y. Fernández-Jalvo, P. Andrews and C. Denys (Fernández-Jalvo et al. 1998). More recent excavations have yielded new small mammal fossils which are being studied by P. Andrews and Y. Fernández-Jalvo.

Olkarian Gorge, Tanzania

This is a narrow gorge with high cliffs inhabited by a large population of Ruppell's vultures (*Gyps rueppellii*). Evidence of incidental hyena incursions is indicated by regurgitations. These incursions, however, may not be prolonged as vultures defend their territory and nestlings, probably preventing hyenas from entering frequently. The main action observed along this gorge is vultures' and other predators' prey remains and barn owls nesting at the end of the gorge, and we made taphonomic investigations into the bone collecting and taphonomic modifications produced by vultures (P. Andrews and Y. Fernández-Jalvo unpublished data).

Overton Down, UK

Overton Down is an experimental earthwork built in 1960 (Bell 1996). Included within the earthwork when it was built were human artifacts and animal remains, and the intention was to investigate the effects of burial on these objects under experimental conditions. To this end, the earthwork has been sectioned on a progressive scale, i.e., in 1962, 1964, 1968, 1976 and 1992. The next section will not be made until 32 years after the last one, i.e., in 2024. Two animal bones were available from the 1992 excavation (Armour-Chelu and Andrews 1996), and these showed modifications from microorganism and insect attack and cracking and degradation from high humidity. More animal skeletons are still buried and will be available in the following years for taphonomic studies, lead by P. Andrews.

Paşalar, Turkey
The Paşalar deposits are Middle Miocene in age. They accumulated in a shallow basin as a flood deposit transported a short distance from the surrounding hills, where the bones had been accumulating for an unknown but probably brief period of time (Andrews and Ersoy 1990). Much breakage occurred before transport, and the weathering profile suggests that the bone accumulation was in equilibrium with the environment: that is all weathering stages were equally represented showing that the initial period of accumulation was sufficiently long for bones to enter the system and degrade and disappear as a result of weathering (Andrews 1995). Weathered bones were abraded during transport to the site, but fresh bones were not abraded, indicating that the transport duration/distance was not great. More complete bones transported to the site suffered cracking from variable humidity, and in some cases the bone disappeared completely after deposition, for example leaving tooth rows in anatomical position with no trace of bone. Finally, there is evidence of carnivore activity on both large and small mammals. The taphonomic study of the site was carried out by A. Ersoy, supervised by P. Andrews.

Riofrío, Spain
The Bosque de Riofrío is a natural reserve of about 700 ha located in the foothills of the Northern slope of Guadarrama Mountain, 41° N latitude, in Segovia (Spain). This is a natural reserve where hunting practices are forbidden. Since 2000 Y. Fernández-Jalvo in collaboration with I. Cáceres and M. Esteban (Universidad Rovira i Virgili, Tarragone, Spain) have been carrying out an experimental project in the forest (Cáceres et al. 2007, 2008, 2011). The main objectives are to study the natural dispersal of carcasses and to evaluate the activity of vultures and foxes. At present, the study focuses on 45 carcasses (fallow deer and red deer) to which these carnivores had access, making observations on the disarticulation and dispersal of bones of these two species of deer. The aim of the project is to find a consistent pattern that may differentiate between large avian and small terrestrial scavengers. Further observations have been made on other taphonomic processes, such as weathering, soil corrosion, water abrasion and plant or micro-organism attack) This builds upon and expands experimental studies carried out at Neuadd (Andrews and Armour-Chelu 1998) and at Amboseli (Behrensmeyer 1978). The Riofrío natural reserve has different environments of forest, open grassland, seasonal streams, and in general there are low trees with almost complete absence of bushes due to cervid browsing.

Rudabánya, Hungary
Rudabánya is a Late Miocene site in north eastern Hungary with a large and diverse assemblage of fossil animals and plants (Kordos and Begun 2002). The sediments were laid down in two cyclical events with fossil soils forming during falls in lake level of the Pannonian Lake in what is now the Pannonian basin. Initial clays formed under wet conditions were succeeded by lignite formation under swamp conditions, and this was succeeded by transgression of the lake, then lake flats when the lake level fell again and muds and lignites formed above these (Andrews and Cameron 2010). Abundant plant remains occur throughout, many in growth position, but sediment compaction and limited transport have resulted in the breakage and abrasion of many of the fossils. Taphonomic modifications particularly include soft-sediment deformation of the fossil bone, studied by D. Cameron, supervised by P. Andrews.

Rusinga Island, Kenya
Early Miocene sites on Rusinga Island have sediments derived from alkaline carbonatite volcanoes and are preserved as flood plain over bank deposits with soil formation. Fossils are well preserved, occasionally retaining casts of soft parts of the body, and they occur as pockets of fossils dispersed through the sediments (Andrews and Van Couvering 1975). Large and small mammals are abundant, and some levels also contain plant remains (Collinson et al. 2010, Maxbauer et al. 2013). Both forest and woodland environments are indicated at the site, and both are associated with fossil ape remains (Collinson et al. 2010, Michel et al. 2014). The taphonomy of the site was studied by J. Van Couvering (now J. Harris) and P. Andrews.

Senèze (Haute Loire, France)
This site was formed in a Pliocene maar (volcano crater) filled by a lake during the Villafranchian (Nomade et al. 2014). The site represents the international biochronological reference of MNQ 18, with one of the most important Pliocene collections of fossil vertebrates of this period and several holotypes. It was the subject of international collaborative fieldwork from 2000 to 2006, whose taxonomic, geological and taphonomic results are currently in preparation (Delson, Faure & Guérin in prep.). It has yielded thousands of fossil vertebrates, several complete and partial skeletons, some in anatomical position, and taphonomic investigations show a high incidence of damage by falling

blocks and trampling by animals that mimic carnivore chewing (Fernández-Jalvo et al. in prep.).

Songhor, Kenya

Early Miocene deposits with extensive soil development producing alkaline red paleosols. The stratigraphy is much interrupted by minor faulting (Pickford and Andrews 1981). Fossils are abundant and well preserved, with several intact skulls of small mammals, but all fossils are disarticulated. The taphonomy was studied by P. Andrews.

Spitalfields (UK)

The medieval cemetery site in the crypt of Spitalfields church is a large collection of human skeletons, many with known age and sex and some named individuals with documented relationships with others. The crypt was in use from 1729 until 1859. Several types of coffin were used, including wood, where soft parts have decayed except in some cases for the hair, and lead coffins where much organic matter has survived (Molleson and Cox 1993). Insect damage, damage from decaying hair, and decomposition products are common. The taphonomy was studied by T. Molleson, in the NHM collection.

Swildon's Hole and Wookey Hole, Somerset, UK

Swildon's Hole is a long phreatic cave in the Mendip Hills that exits via Wookey Hole several kilometers away. Accumulation of recent bones in the cave has been investigated to see how bones enter, are preserved and are dispersed in cave systems (Andrews 1990). Water flow from Swildon's Hole comes out at Wookey Hole, but the bones collected from the latter site come from the upper chamber, well above the present water table of the system. Some came from an old phreatic chamber that exits through an opening approximately 15 m above the present cave outlet. The cave was excavated and bones collected by E. Andrews and P. Andrews.

Tianyuandong, China

Tianyuandong is a Late Paleolithic site, 6 km from the core area of the Zhoukoudien Complex (site 27). Tianyuandong (or Tianyuan Cave) yielded one fossil skeleton of *Homo sapiens* (43–39 ka, among the oldest in China). Together with the human skeleton, abundant animal remains were found, but no stone tools were recovered. The animal fossil remains are extremely fragmented, in contrast to human skeleton elements that are, for the most part, complete (Fernández-Jalvo and Andrews 2010). A more comprehensive taphonomic study of the human and faunal remains was undertaken by P. Andrews and Y. Fernández-Jalvo and is now published (Fernández-Jalvo et al. 2015).

Troskaeta, Spain

Cave site in northern Spain with an assemblage of cave bears (*Ursus spelaeus*). Adults and many juveniles and infants are preserved, but no other carnivore species (Pinto Llona et al. 2005). It is likely that this cave was a denning site inhabited by adult bears with their young. It is inferred that tooth marks present on the cave bear bones were produced by the cave bears themselves, and 25% of the bones had tooth marks.

Tswalu Kalahari Reserve, South Africa

This Reserve is approximately 100,000 ha in size. It is situated in the Northern Cape Province, South Africa, about 100 km north-west of Kuruman. The grid references are between 27° 04′ S and 27° 33′ S latitude and 22° 10′ E and 22° 36′ E longitude. The terrain consists of plains, parallel dunes with lowlands between them and hills, and includes the Korannaberg mountains and hills in the north and east. There are sandy valleys between these hills. Extensive sandy plains with dunes and dune streets occur to the west and south of the Korannaberg mountains. A few pans and other depressions are found in the extreme west of the reserve. The altitude of the area varies from 1020 m near Rogela pan in the west, to 1586 m at Drogekloof on the Korannaberg in the east. Taphonomic studies on pollen taphonomy and brown hyenadens are in progress. Tswalu's dry environment preserves animal carcasses and scats, providing taphonomic patterns of preservation. We are making seasonal collections of scats from an area around a hyaena den. The study includes experiments in an environmental chamber in Madrid to determine what factors favour pollen preservation in coprolites (Y. Fernández-Jalvo unpublished data).

Vanguard Cave, Gibraltar

Vanguard Cave is one of the archaeological sites located at Governor's Beach on the eastern side of Gibraltar. It provides a rich record of Neandertal everyday life in combination with Gorham's Cave. Vanguard cave is a large shelter that contains a stratigraphic series of over 17 metres, consisting of coarse sand layers interstratified with sterile aeolian sand layers (Goldberg and MacPhail 2000) as well as brown silt and silty-clay lenses. The latter are frequently associated with periods of human occupation. The age of the Vanguard sediments is >41,800 radiocarbon years, based on a series of dates on charcoal from the top of the sequence. The taphonomic study provides evidence that humans fed on marine mammals (Stringer et al. 2008) and indications of human behavior and activity at the site (Stringer 2012; Cáceres and Fernández-Jalvo 2012). The taphonomy of large mammals was part of the Doctoral Thesis of Cáceres (2002) supervised by Y. Fernández-Jalvo.

Westbury Cave, Somerset, UK

Westbury Cave is a two-chambered cave with deposits dating back to the earliest middle Pleistocene (Andrews et al. 1999). The lowermost cave infills consist of water-transported sands and gravels older than 730 ka, common to both chambers, and succeeded by two separate sequences of cave breccias with varying amounts of silts and clasts. Two cave bear (*Ursus deningeri*) denning areas have been identified (Andrews and Turner 1992), at least two levels with water-transported animal remains, several small mammal assemblages accumulated by predators, and a major influx of surface material transported into the cave together with its biologic contents (Andrews et al. 1999). Included with the animal bones is a dispersed flake industry providing evidence of human presence in the cave, and cut marks have been found on the bear and cervid fossils (Andrews and Ghaleb 1999). Taphonomic modifications include breakage, trampling within a den, weathering, digestion by predators, and abrasion.Taphonomic investigations were carried out by B. Ghaleb, supervised by P. Andrews.

Wonderwerk Cave, South Africa
Wonderwerk is a large cave situated in the Kuruman hills (27.50° S; 23.33° E) on the western edge of the Ghaap plateau in the northern Cape Province of South Africa. It has a well-preserved fauna and flora in a continuous sequence from Early Pleistocene (2 Ma) to Holocene deposits (Chazan et al. 2008). Taphonomic studies on small mammals provide information about the predators involved in the site as well as possible evidence of fire (controlled/natural) and site formation (Fernández-Jalvo and Avery 2015).

Special Taphonomic Reference Collections
Behrensmeyer collection Several specimens from experimental work and monitoring studies from Behrensmeyer´s collection have been included to compare and describe some modifications, especially fluvial abrasion and insect damage, from sites including Amboseli Park, Kenya, South Plate, Lost Creek and Calamus rivers (USA). Amboseli occupies a flat basin covering approximately 600 km^2 to the north of Mount Kilimanjaro in Kenya. The climate is semi-arid, but there is an extensive swamp area fed by springs from Kilimanjaro. Over 20 different habitats have been recognized (Western 1973), ranging from woodland to open grassland, but it is a dynamic ecosystem subject to changes in temperature and rainfall patterns and fluctuations in the water table. Much of the woodland is disappearing, being replaced by edaphic grasslands as the water table rises and deeper-rooted trees die off. The naturally occurring vegetation beyond these limits is low *Acacia* woodland. The area has been the subject of a long-term taphonomic monitoring project since 1975 (Boaz and Behrensmeyer 1976, Behrensmeyer 1978, 1981, 1983, 1993, 2007; Western and Behrensmeyer 2009) to investigate aspects of bone dispersal, weathering and burial, and the modifications arising therefrom. Taphonomic modifications observed include a wide range from time of death to burial, and they cover a variety of environments and periods of time sufficiently long to show how processes such as weathering impact the animal bone. The actualistic taphonomic collection from Amboseli was available to Y. Fernández-Jalvo during a predoctoral grant in 1988 supervised by A.K. Behrensmeyer.

E.M. Geigl has provided specimens from sites in Europe, Asia and Near East that were histologically studied and analyzed for fossil DNA in the context of a wider project of research into the domestication of horses and cattle (mainly cows and sheep).

Gómez collection The small mammal actualistic taphonomic studies were performed by G. Gómez (2000). He conducted experiments with different raptors and mammalian carnivores fed with rodents at the Zoo of Olavarría (Argentina) which provides a reference collection of Argentinean predators.

Anthony Sutcliffe collection This is part of the taphonomic collection at the NHM and includes several actualistic collections from Holartic and African environments investigated by P. Andrews (Sutcliffe 1970).

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