7.1. Introduction

Animal bones are among the most common finds from excavations in Ireland, and the majority of these are the remains of cattle, sheep and pig. While bones from other species are also found they rarely receive much attention in excavation reports where most of the discussion is focused on the economically important species. Deer bones are usually only excavated in small numbers but are common themes in medieval artwork, poetry and literature,¹ and so can be said to have a symbolic importance far beyond their economic value.

A red deer skull and six fragments of antler from at least three individual deer were found during recent excavations at a high-status ecclesiastical site at Kilteasheen, Knockvicar, Co. Roscommon, on the shores of Lough Cé, and were analyzed by the author. These bones provided an opportunity to partially redress the lack of attention paid to the minor species by synthesizing what is known about deer and deer hunting in medieval Ireland, so hopefully providing archaeologists and historians with useful background information. The paper briefly reviews the biology of deer and the processes of deer hunting before discussing the material from Kilteasheen and its significance.

7.2. Deer species

Two species of deer were present in Ireland during the medieval period. Red deer (Cervus elaphus) are native or at least pseudo-native in that there is evidence for them since at least the neolithic, while fallow deer (Dama dama) were introduced by the Anglo-Normans in the thirteenth century.²

Male red deer vary between 1.2m and 1.4m to the shoulder, or withers, and weigh up to 200kg when in peak condition, but can lose thirty five per cent of their body weight through the autumn and winter.³ By contrast the females are much smaller, with a withers height of 0.9–1.0m and a weight of up to 130kg. (see plate 7.1). Lowland red deer are generally much larger than upland populations due to the relative climate and access to food. In their natural state red deer are creatures of the woodland margin, grazing on grass as well as browsing on the leaves and bark of shrubs and trees, but due to agricultural expansion this habitat is now rare in Ireland and they have become associated with the open uplands of the west, where they subsist on grasses and shrubs such as heather and furze. Although red deer are herbivores, in winter and spring when food is short they will eat almost anything including carrion and bones.⁴

By contrast, fallow deer are much smaller, with the males generally around 1.0m to the withers and up to 100kg, while females have a withers height of 0.8–

⁴ Ryan, Wild red deer, pp 77, 100; Hayden & Harrington, Exploring Irish mammals, pp 327–35.
0.85m and a weight of 40–45kg. (see plate 7.2). Their natural range is believed to have been the Mediterranean, Asia Minor and possibly North Africa and Ethiopia, but over the millennia they were introduced to many countries in Europe. Their preferred habitat is open woodland with grass clearings, but they will thrive in a variety of habitats feeding on a range of plants. They primarily graze on grass year-round supplementing this by browsing on broad-leaved trees in the summer and shrubs and conifers in the winter. Although they are significantly smaller than red deer, they provide a higher proportion of meat per kilogram of live weight, making them more efficient converters of feed than their larger cousins. This, and their ability to utilise relatively poor-quality food sources were probably key reasons for their semi-domestication in deer parks, where the provision of sufficient fodder was potentially limiting to the herd size.5

In the case of both species only the males have antlers, which are shed annually. The number of points or tines on the antlers is not a direct indicator of age as genetic and environmental factors are significant. However the antlers will tend to become larger as the deer develops from a juvenile to an adult, provided that the animal is in good condition. Then, as an animal becomes aged the antlers begin to ‘go back’ resulting in a decrease in the size of the rack of antlers and giving a characteristic stumpy thickened appearance.6 Antler is harder than bone and was commonly used throughout history and prehistory for manufacturing items such as buckles, combs and knife handles where the extra strength was an advantage.7

7 A. MacGregor, Bone, antler, ivory and horn: the technology of skeletal materials since the Roman period (London, 1985); H. Luik et al. (eds), From hooves to horns, from mollusc to mammoth.
Furthermore, if it is naturally shed it does not contain any blood and so is ready for use immediately after collection. While red deer antler is a valuable craftwork material, there is relatively little evidence for the use of fallow deer antler as a raw material in the past, possibly because it is anecdotally more brittle than that of red deer.

7.3. Hunting landscapes

There is no evidence for any royal or aristocratic hunting reserves in early medieval Ireland; however mountain and bog land was generally held in common by the tuath or clan and so was presumably available for aristocratic hunting. Some woodland may have been privately owned during the early medieval period, but again the majority seems to have been held in common. A number of examples cited by Kelly describe hunting and trapping taking place on undivided land and an early thirteenth century tale *Acallam na Senóirach* quoted by Newman refers to game ‘in the field or on the moor, or on the high ground or in the woods’ so that overall the likelihood is that the early Irish aristocracy would have ranged over the unenclosed open ground and woodland of the tuath in their quest for deer.

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manufacture and use of bone artefacts from prehistoric times to the present, Muinasaja teadus 15 (Tallinn, 2005).


11 Kelly, Early Irish farming, pp 272–81.

Newman\textsuperscript{13} has reinterpreted the pre-crannog levels at Ballinderry Crannog No.2 as a sixth century high-status hunting and feasting camp at which red deer were killed by driving them into the water of the lake.

With the coming of the Anglo-Normans land tenure changed and gave rise to new forms of landscape. The general result of these changes was to reduce access to the landscape for the lower orders of society, which would have reduced their access to wild animals such as deer. Three types of landscape need to be discussed when considering deer hunting in the high and late medieval period: ‘forests’, ‘chases’ and ‘parks’. In modern usage ‘forest’ is almost synonymous with ‘woodland’, particularly plantations of economically important trees. In medieval usage however, ‘forest’ referred to land in which the hunting of game was reserved for the king, so that forest could include woodland, open heaths, farmland and even villages.\textsuperscript{14} These large areas of the landscape were not surrounded by fencing but were legally defined areas subject to forest law, which aimed to ensure that the hunting rights and timber trees of the monarch remained intact. During the late twelfth century approximately one third of England was legally defined as forest, causing much discontent among the English nobility of the time and eventually resulting in the signing of the Magna Carta.\textsuperscript{15} Several medieval forests are known to have existed in Ireland including Glencree, Co. Wicklow,\textsuperscript{16} and Cratloe, Co. Clare.\textsuperscript{17} A chase was similar to a forest but was under the control of a noble rather

\textsuperscript{17} Calendar of documents relating to Ireland, 1252-1284, no.51
than the king and was not subject to forest law.\textsuperscript{18} Irish examples of chases include Ross and Taghmon in Co. Wexford, both controlled by the Marshals,\textsuperscript{19} and in 1227 Henry III instructed Richard de Burgh to ensure that the cantred of Connacht was well maintained as a chase for his use.\textsuperscript{20}

By contrast to forests and chases, parks were relatively small areas of land, designed primarily to confine deer, usually fallow deer, but often also used to graze cattle and sheep, raise horses and supply timber for construction.\textsuperscript{21} Very little fieldwork has been carried out on deer parks in Ireland;\textsuperscript{22} however extensive studies have been carried out on the deer parks of medieval England,\textsuperscript{23} so that these may provide a basis for comparison. In medieval England deer parks usually took the form of an enclosed area surrounded by a high, wide bank usually with an internal, rather than external ditch. They varied in size from 30 acres to 500 acres or more, with parks of 100 acres to 300 acres most typical. They were usually lobe-shaped, roughly circular, or approximately square with rounded corners depending on the local topography and land availability. The top of the bank was often surmounted by pales – vertical slats of wood, or sometimes by a hedge, or, rarely, by a stone

\textsuperscript{18} Watts, ‘Wiltshire deer parks’.
\textsuperscript{21} Rackham, History of the countryside, p. 125.
wall. The enclosure worked on the principle that a deer could jump into the park but due to the ditch, could not jump back out. This meant that over time the number of deer within the park should increase. Deer could be further attracted to enter the park by addition of a ‘deer leap’ – an area of the pale where the fencing was absent or very low, but where a deeper pit was placed opposite the entrance to prevent them escaping in the opposite direction. It is unlikely that any worthwhile hunt could take place within the confines of the smallest deer parks of c.30–50 acres in size, so these were probably used as live larders to maintain deer for slaughter and consumption, or individual deer may have been released in advance of a cross-country hunt.

Throughout the medieval period the Irish and Anglo-Norman aristocracy retained professional huntsmen in their households, while those with deer parks also required the services of one or more ‘parkers’ to manage the parks. The parks often contained a variety of vegetation including copses of trees, open grassland and shrubs and so provided a range of suitable foods for the enclosed deer. Depending on the vegetation and stocking levels, additional feeding of the deer might be required in the winter, and this, in addition to the difficulties of maintaining the pale and keeping out poachers and predators, ensured that deer parks were an expensive luxury.

7.4. Hunting methods

Sources of information on medieval hunting in Ireland include art and literature. Hunting scenes are a common theme on medieval artworks: for example, deer appear on at least twelve high crosses, both as individual stags and within hunting scenes, and there are a number of hunting scenes among the wall paintings at Clare Abbey. The early medieval law tracts have been extensively studied by Kelly and have provided useful information on deer as have early poems and the Lives of various saints. The development of a medieval pan-European elite culture has been widely discussed in a range of contexts. Hunting manuals such as the late-fourteenth-century Hunting Book of Gaston Phoebus were popular in medieval Europe and Britain and while they do not provide direct evidence for Gaelic hunting they give an insight into the activities enjoyed by European aristocracy and hence by the Anglo-Normans in Ireland.

Prior to the arrival of the Anglo-Normans hunting was primarily an aristocratic pastime particularly associated with sport and military training as well as providing opportunities for social, political and cultural interaction. This association of deer hunting with the aristocracy continued into the later medieval period and was strengthened by the introduction of royal forests and deer parks.

26 Soderberg, ‘Wild cattle’, 173-4
27 C. Manning et al. (eds), New survey of Clare Island, iv: The abbey (Dublin, 2005), pp 61-95
28 Kelly, Early Irish farming.
29 Gilbert, Hunting and hunting reserves; Soderberg, ‘Wild cattle’.
32 Kelly, Early Irish farming, pp 273–4.
Several different methods of hunting and trapping deer could be employed depending on the purpose and means of those involved. The methods used during the pre-Anglo-Norman period were broadly similar to those of the later period and for both periods can be summarised into three groupings: chasing, driving and trapping.

Chasing of deer was known in the medieval literature as par force hunting and involved the selection of a single animal that was then tracked and chased using hunting dogs. This method was only suitable over large areas of land such as open countryside and possibly the very largest deer parks, since the aim was to pit the wits of the men and dogs against those of the quarry. In an Irish context it was likely to have been employed mainly for hunting unenclosed red deer, but it could also have been used in the later medieval period to hunt fallow deer that had been deliberately released from deer parks in advance of the hunt, as well as feral fallow deer. Fallow deer have less stamina than red deer and the females tend to flee as a group, while males flee individually so that while fallow deer would not have given as satisfactory a hunt as red deer, both could be hunted in this way. By the high and later medieval period in Europe the par force method was highly ritualised, with a number of key steps that had to be carried out for the hunt to be correctly performed. For example, in England and France during the thirteenth to fifteenth centuries the practise was for the left shoulder to be given to the person doing the ‘unmaking’ or dismembering, the right to the forester, the haunches were

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34 Feldhamer et al., ‘Dama dama’.
36 Cummins, The hound and the hawk, pp 32–46, 72.
reserved for the lord and, depending on which source is consulted, the head was either reserved for the lord or given to the lymer – a type of dog trained to track by scent. A similar situation prevailed in early medieval Ireland where the shoulder was again reserved for the person dividing up the carcass and the owner of the dogs was given the haunches. Since dogs were expensive to maintain it can be assumed that these belonged to the lord or king so that the same general division of the carcass can be seen to be common across early and later medieval Europe.

The second method was the ‘drive’ or ‘bow and stable’ hunting, which could be carried out in the wider countryside, but was also much more suitable than par force hunting for confined spaces such as deer parks and required much less strenuous exercise by the hunters. In this method archers positioned themselves in a suitable area towards which the deer were driven by both humans and dogs or by humans alone. The use of the drive was believed by Gilbert to be the most important of the methods employed in medieval Scotland and he considers that its use in early medieval Ireland is supported by literary evidence such as the mid-twelfth century poem ‘The Magic Pig’ in the Duanaire Finn or Book of the Lays of Finn. The poem describes a mythological hunt that took place close to Cruachan, modern day Rathcroghan in Co. Roscommon, in which deer were driven towards the waiting fian or warrior band. Drives in open country would have been major undertakings in terms of providing sufficient people and dogs to move the deer,

38 Kelly, Early Irish farming, pp 274–6.
40 Gilbert, Hunting and hunting reserves, p. 52.
implying that these were events of particularly high status. However, in later periods, medium- and large-sized deer parks would have been eminently suitable for carrying out ‘bow and stable’ hunting with a relatively small group of beaters to drive the deer towards the waiting hunters.

The final method was to trap the deer. Rather than being driven towards archers, they could be driven into nets or barriers such as fenced enclosures, thereby allowing live deer to be captured and either transported elsewhere or killed at leisure.\textsuperscript{41} An example of a leg trap is shown on the ninth century cross at Banagher, Co. Offaly, and two potential traps have been found preserved in bog at Garvary, Co. Fermanagh and Drummacaladdery, Co. Donegal, with the latter having been dated to the Late Bronze or Early Iron Age\textsuperscript{42}. This was, however, considered to be ignoble and unsuitable for aristocratic hunting. For example the late-fourteenth-century French aristocrat Gaston Phoebus believed that driving deer into nets to kill them was ‘properly the sport for fat men, old men, idle men and churchmen’\textsuperscript{43}. Instead this technique would mainly have been used by professional huntsmen in the lord’s employment to provide live deer for gifts and possibly to supply venison specifically for the table.\textsuperscript{44} In addition to nets and barriers, deer could be trapped using pitfalls, hidden spikes or leg-traps. Kelly notes\textsuperscript{45} that these devices were discussed in some detail in the early law tracts and suggests that legislation for their use was important because of their potential for injuring domestic animals and humans if the traps were set up without warning. Again, these methods of trapping

\textsuperscript{41} Gilbert, Hunting and hunting reserves, p. 54; Kelly, Early Irish farming, p. 277.
\textsuperscript{42} Kelly, Early Irish farming, pp 280
\textsuperscript{43} Cummins, The hound and the hawk, p. 235.
\textsuperscript{44} Gilbert, Hunting and hunting reserves, p. 57; Cummins, The hound and the hawk, p. 235.
\textsuperscript{45} Kelly, Early Irish farming, pp 278–80.
were used as practical ways of capturing venison rather than as noble pursuits and so would not have been appropriate activities for the aristocracy.

7.5. Hunting as an aristocratic activity

The three arts in which any medieval nobleman were expected to be skilled were ‘the practice of arms, love and hunting’. Many authors have stressed the importance of hunting in military training and during times of peace hunting offered the opportunity to practise skills such as horsemanship, the use of arrows and spears, tracking and the development of tactics and co-ordinated manoeuvres. A further advantage was the promotion of an active life since idleness was deemed likely to result in opportunities for sin and lustful behaviour. Shared physical and intellectual activities will result in the development of mutual respect, understanding and friendship and since legal hunting was generally restricted to the aristocracy this barrier to participation stressed social difference and hunting became a vehicle for elite social bonding.

Hunting by the clergy was frowned upon in medieval Europe but nevertheless often took place. Most high-ranking clergy such as bishops and abbots were from noble families, for example Bishop Tomaltach O’Conor was a close relative of the king of Connacht, Aedh O’Conor. Therefore these clergy had been trained in the aristocratic arts from boyhood and many continued to hunt despite official disapproval. Evidence of this can be seen in the number of Irish deer parks owned by high-ranking clerics. Of fourteen medieval parks listed by Murphy

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47 Almond, Medieval hunting, pp 13–17; Thomas, ‘Chasing the ideal?’ p. 125.
and O’Conor,⁴⁹ three were owned by archbishops, while they note that in 1291 the abbot of St Mary’s in Dublin was accused of poaching in the royal forest of Glencree.

Although hunting was an aristocratic activity, there was also a requirement for additional fresh venison for the table and for live deer to be given as gifts to the lord’s peers and subordinates as well as to high-ranking members of the clergy; so aristocrats often employed professional huntsmen to supply this⁵⁰ and it is likely that these hunters would primarily have used traps or nets to capture the deer with minimum effort. Venison was not normally available for sale during the medieval period, so the gifting of venison and live deer conferred prestige and status on the giver and placed obligation on the recipient.⁵¹ Parks provided a valuable store of deer for these social and political obligations, however it is notable that all known medieval deer parks are associated with Anglo-Normans⁵² and that to date no fallow deer remains have been recovered from any medieval Gaelic site⁵³. While other aspects of culture were soon shared between Gaelic and Anglo-Norman aristocrats, this was not the case with deer and deer hunting. It is proposed elsewhere⁵⁴ that this may have been due to differences in the perception of landscapes between the two cultures, with wilderness valued by the Gaelic lords and, by contrast, the Anglo-Normans emphasising the taming of the landscape.

⁴⁹ Murphy & O’Conor, ‘Castles and deer parks’ 66-70.
⁵⁰ Cummins, The hound and the hawk, pp 260–5; Kelly, Early Irish farming, p. 279; Murphy & O’Conor, ‘Castles and deer parks’ 57.
⁵² Murphy & O’Conor, ‘Castles and deer parks’ 66-70.
⁵³ Beglane, ‘Deer and identity in medieval Ireland’
⁵⁴ Beglane, ‘Deer and identity in medieval Ireland’
Excavations are ongoing at Kilteasheen Co. Roscommon, on the western shore of Lough Cé. The site was identified during research by Dr Thomas Finan as the location of Cil-tSeisin or ‘Church of Seishin’ which is mentioned in the Annals of Loch Cé on a number of occasions between 1243 and 1258. According to the Annals a cúirt or court was constructed there in 1253 by Tomaltach O’Conor, Bishop of Elphin and was demolished in 1258 by his kinsman Aedh O’Conor, to prevent the cúirt falling into the hands of Anglo-Norman raiders. So far the excavations have identified a substantial masonry structure, a walled and ditched enclosure, an early and high medieval graveyard and some evidence for prehistoric activity. The current interpretation is that the masonry structure is a hall house and represents the remains of the bishop’s cuirt, while the walled and ditched enclosure surrounds the medieval burials.\textsuperscript{55}

Red deer at Kilteasheen

A partial skull and six antler fragments from red deer (Cervus elaphus) were recovered from the fill of the enclosure ditch excavated in cutting A and shown in figure 7.1. Based on the size and morphology of the fragments these represent at least three adult male red deer. The dating of the ditch is still unclear but is believed to be medieval.

The partial skull consisted of parts of the right frontal, parietal, temporal and zygomatic bones and came from an adult male deer. See plate 7.3. This fragment

\textsuperscript{55} Finan & Read, Kilteasheen Archaeological Project (forthcoming); C. Read, ‘Remembering where the bishop sat: exploring perceptions of the past at the Bishop’s Seat, Kilteasheen, Co. Roscommon’ (this volume).
includes part of the top, sides and rear of the right side of the skull and encloses the braincase, provides a point of attachment for the antler and contains the eye socket. Despite the poor condition of the skull and its disintegration during washing, several features of interest were noted. The antler had been sawn off at the base of the pedicle, which is the bony outgrowth to which the antler is attached. There were also a series of rough chop marks on the medial side of the frontal bone, adjacent to the pedicle base, and a series of cut marks adjacent to the parieto-temporal suture. It is likely that these cut and chop marks were caused by the removal of the hide and antlers.

The remaining deer elements from the enclosure ditch consisted of six pieces of antler from at least three individual animals. In red deer, antlers are found only on the males and re-grow each year. While there is considerable variation in the individual shape of the antlers certain key features are always present. The first of these is the burr which is the base of the antler and is the point at which it was previously attached to the skull. The beam is the main shaft of the antler, the tines are the short conical points extending from the beam and finally the crown is the arrangement of tines at the end of the beam furthest from the skull.\textsuperscript{56} Deer are categorised by the total number of tines on the head so that a deer with five tines on each antler is a ‘stag of ten points’. This stage was the minimum which French and English medieval huntsmen considered to represent suitable quarry for aristocratic hunting.\textsuperscript{57}

\textsuperscript{57} Cummins, The hound and the hawk, p. 32.
The largest piece of antler found at Kilteasheen consisted of a palmate section of crown containing four whole tines as well as the basal stumps of two further tines (see plate 7.4). ‘Palmate’ refers to an antler with a large flat surface from which the tines extend, typified by the antlers of fallow deer, and said to look like the palm of a hand with fingers extending from it. Generally red deer antlers do not become palmated, however this trait is influenced by a number of factors including genetics, the general condition of the animal and the availability of minerals to facilitate antler growth. Selective breeding has been used for many years to produce red deer with impressively large and highly branched antlers for trophy hunting, with breeding stock sourced from Windsor, Woburn and Warnham parks in England, in which palmated antlers are common, being the most highly regarded among modern red deer farmers. An example of a Woburn deer with palmated antlers is shown in plate 7.3. This feature was relatively common in medieval deer, and is seen on some mounted stag heads from the Tudor period.

The Kilteasheen antler was examined in conjunction with Dr. Ruth Carden, a cervid zoologist, who suggests that the animal was a prime physical specimen probably aged between seven and nine years and at the maximum of the potential size range for red deer. This animal was a stag of at least eighteen points and would have been a highly impressive spectacle so that a successful hunt for this deer would have been an event conferring great prestige on the sponsor and participants.

Unfortunately since the burr was not found it was not possible to determine whether the antler had been naturally shed or was deliberately removed from a hunted deer.

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59 R. Carden, personal communication.
60 F. McCormick, personal communication.
In addition to this impressive fragment six other pieces of antler from at least two further individuals were also found. These included a large fragment of the main beam from a mature animal, which retained two partial tines and one complete tine as well as a smaller fragment of beam from a relatively young animal. This latter piece culminated in two tines forming a crown, so that this stag was at the stage of eight or ten points. In addition to these there were two single tines, both of which had been broken but it is not clear whether these were from the same individuals already identified. There was also a small offcut of beam that had been sawn through and which again could have come from any of the three individuals already identified. Unfortunately no burrs were found among the fragments.

The deer skull and antler fragments were found along with a number of cattle, horse and pig bones that have been interpreted as mixed food and butchery waste, with some bias towards butchery waste\(^6\). Their location in a ditch surrounding a graveyard may seem unusual however during the medieval period ditches were the normal place to dispose of rubbish. The archaeological evidence from the site shows signs of occupation in the early and high medieval periods so that residents would have needed to have somewhere to discard waste. The ditch was outside the graveyard as well as away from the immediate area of habitation, and as such would have been considered to be a suitable place for disposing of waste.

There is no evidence for the skull or antlers being the remains of any form of ornament or trophy retained after hunting. Instead their find location combined with the evidence for sawing, chopping and cutting of the antlers and skull suggest

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Note that minor changes were made prior to full publication

that they were craftwork offcuts disposed of once the chosen pieces of antler had been removed.

7.8. Significance of the red deer at Kilteasheen

The discovery of the antlers and skull posed the question of the significance of their presence at Kilteasheen, specifically who had hunted them and how they came to be there. Deer are relatively rare in Irish medieval assemblages, typically representing between one and five per cent of the individual animals on any site with a range from zero to fourteen per cent at sites examined by the author. This suggests that venison provided only a small percentage of the meat consumed. The royal castle of Greencastle, Co. Down is an exception to this rule with venison providing up to six per cent of the meat in the fourteenth century. Early medieval monastic rules forbade the consumption of meat, but some allowed meat from wild species. Evidence from Iona, Illaunloughan, Moyne and Clonmacnoise suggests that these rules were not rigorously observed, with the bones of both domesticates and deer in the assemblages.

The presence of the deer skull at Kilteasheen provides evidence for hunting rather than the mere collection of shed antler. Since the carcass would be ‘unmade’ or dismembered soon after death, if a deer were killed and a portion given to the church as a gift or as a share of the spoils of the hunt then the non-edible portions

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such as the skull and antlers would have reverted to craft-workers associated with the hunt sponsor. In this case it would suggest that the bishop, or his predecessor was the sponsor of the hunt. Alternatively the carcass of a full stag could have been gifted to the church and butchered at Kilteasheen with the antlers then used for craftworking. Either interpretation would fit well with what is known of medieval aristocratic and ecclesiastical activities where hunting and gift exchange were essential to demonstration of power and prestige. The presence of antlers from at least three deer means that on at least two further occasions either shed antler or whole deer were brought to the site. Unfortunately it was not possible to determine whether the antlers were naturally shed or were from hunted deer but they raise the possibility that venison was eaten relatively frequently at Kilteasheen.

These findings shed an interesting light on one aspect of the politics of medieval Connacht by providing a cultural insight into a high status ecclesiastical site associated with one of the most prestigious families of the times. Whether the bishop or his predecessor hunted the deer or whether they were gifts from other noblemen the presence of these deer remains, particularly the very large antler provide a measure of the importance and prestige of the site at Kilteasheen.

7.9. Acknowledgements

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