Earliest direct dated wildcat (*Felis silvestris silvestris*) from Ireland

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The first directly dated wildcat (*Felis silvestris silvestris*) bones in Ireland have been identified from Glencurran Cave, Co. Clare, indicating that this species was present on the island from at least 3,600 BC. The discovery raises the question of when and how wildcat first arrived here, and when the species became extinct in Ireland.

INTRODUCTION

The first directly dated wildcat (*Felis silvestris silvestris*) bones in Ireland have been identified from Glencurran Cave, Co. Clare (Fig. 1). The assemblage comprises 31 bones of an adult female and, though not discovered in an articulated state, their occurrence as a discrete concentration suggests the former presence of a complete skeleton that was subsequently disturbed and dispersed. Radiocarbon dating returned a Middle Neolithic date for the specimen, while aDNA analysis clarified this was a wildcat (*Felis silvestris silvestris*). This is the largest number of confirmed prehistoric felid bones from the country and as yet the earliest definite presence of wildcat in Ireland. Though small numbers of cat bones have been recovered from several Irish Mesolithic and Neolithic sites, none have yet been directly dated and thus may be intrusive.

Fig. 1—The dark zone of Glencurran Cave where the Neolithic wildcat remains were discovered (Ken Williams).

EUROPEAN WILDCAT (*Felis silvestris silvestris*)

Now extinct in Ireland, the wildcat (Fig. 2) was once widely distributed across Europe. Their range and number declined rapidly from the 1700s to the 1900s due to habitat fragmentation, deforestation, low prey availability, human persecution (trapping and poaching for furs) and hybridisation with domestic cats (Velli 2015). The species is now legally protected, but Scottish and Iberian populations continue to decline primarily due to roadkill, poaching and habitat loss (Bastianelli *et al*. 2021). Wildcats are territorial animals though they can occupy a variety of habitats if adequate shelter and prey are present (Klar *et al*. 2008). They exhibit a strong preference for forest habitats and actively avoid areas of human population. Currently, this species lives in low population densities with a home range for adult male wildcats averaging 4.59 km^2 in Scotland (Anile *et al*. 2017, 9). In Europe, home ranges for females can reach up to 53.04km^2, and up to 54.81km^2 for males (Bastianelli *et al*. 2021, 5). Wildcats are crepuscular and nocturnal creatures, spending most of the day in a resting place. They are solitary animals, except during mating season and when the females are rearing kittens (Velli 2015, 2). Wildcats average between 3 and 5 kg in weight and feed primarily on rodents and lagomorphs (Sarmento 1996). Their maximum life expectancy in the wild is 13–14 years (Velli 2015, 2).

Fig. 2—European wildcat (*Felis silvestris silvestris*) (courtesy of Luc Viatour; https://lucnix.be).

GLENCURRAN CAVE WILDCAT

The Glencurran Cave wildcat is part of an assemblage of over 35,000 mammal, amphibian and bird bones recovered during archaeological excavations in Glencurran Cave between 2004 and 2009. Excavations were directed by M. Dowd and the faunal assemblage was fully catalogued and analysed by M. McCarthy. An extensive radiocarbon dating programme revealed the cave to be a multi-period site, with material ranging from the Early Mesolithic through to the post-

medieval period. The cave witnessed particularly intense usage from the Middle Bronze Age to the Early Iron Age, and again during the early medieval period (Dowd 2009; 2015).

In total, 62 cat bones were recovered from Glencurran Cave across all seasons of excavation. Thirty-two felid bones came from six different strata in the outer 20m of the cave, all from heavily disturbed strata that produced material of Bronze Age, early medieval, high medieval and modern date. A left maxilla of an adult cat recovered 10m inside the cave entrance was dated to the early medieval period at 845±41 BP (UBA-43523, cal AD 1040-1280). The largest concentration of cat bones, however, came from the surface of the deepest stratum exposed during the archaeological excavations. This stratum (C.28), recorded during the 2009 season[1], comprised a loose yellowish-grey calcite-rich silty sand with occasional pebbles and moderate large stones; it was at least 0.20m thick. C.28 occurred approximately 50m inside the cave entrance in the dark zone, i.e. the area of permanent darkness beyond the reach of natural light. This stratum produced 258 bones: 31 cat, 29 hare, 4 pig, 19 medium-sized mammal and 175 indeterminate bone fragments. The 31 cat bones were not discovered in an articulated state but, as they were confined to an area measuring 1m x 0.5m, almost certainly represent an intact or partially intact cat that was subsequently disturbed. For instance, a cat tooth and a left cat humerus were recovered from two Late Bronze Age strata and in both cases it is possible that these originated from C.28 but were subsequently disturbed and dispersed by the activities of Bronze Age people.

The felid bones from C.28 were identified as those of a single adult female during zooarchaeological analysis of the assemblage at post-excavation stage. It was assumed to be a wildcat based on the stratigraphic location of the bones, which occurred as a discrete deposit sealed by Middle Bronze Age strata. The identified elements include a right mandible, left mandible, a loose tooth, a scapula, four vertebrae, two metapodials, twelve phalanxes and nine rib fragments. Subsequent aDNA analysis (see below) confirmed this was a wildcat. There is nothing to suggest that this was anything other than a natural occurrence in the sediments, perhaps an animal that died while sheltering in the cave. There are no anthropogenic marks on the wildcat bones related to butchery or skinning, but the absence of primary upper and lower limb bones is unusual. It is possible that the limbs were removed by animal or human activities in the cave after the wildcat had partially decomposed. In 2021, a canine tooth from the wildcat right mandible was extracted and submitted for radiocarbon dating. The tooth returned a Middle Neolithic date of 4778±24 BP (UBA-45133, 3645–3510 cal BC) (Table 1). Other Neolithic material from Glencurran Cave was scarce but included a hare (*Lepus timidus hibernicus*) humerus and a mussel (*Mytilus edulis*) shell, both directly dated to the Late Neolithic or Chalcolithic (Table 1). Four chert lithics and a stone axe may also be of Neolithic origin (Fig. 3).

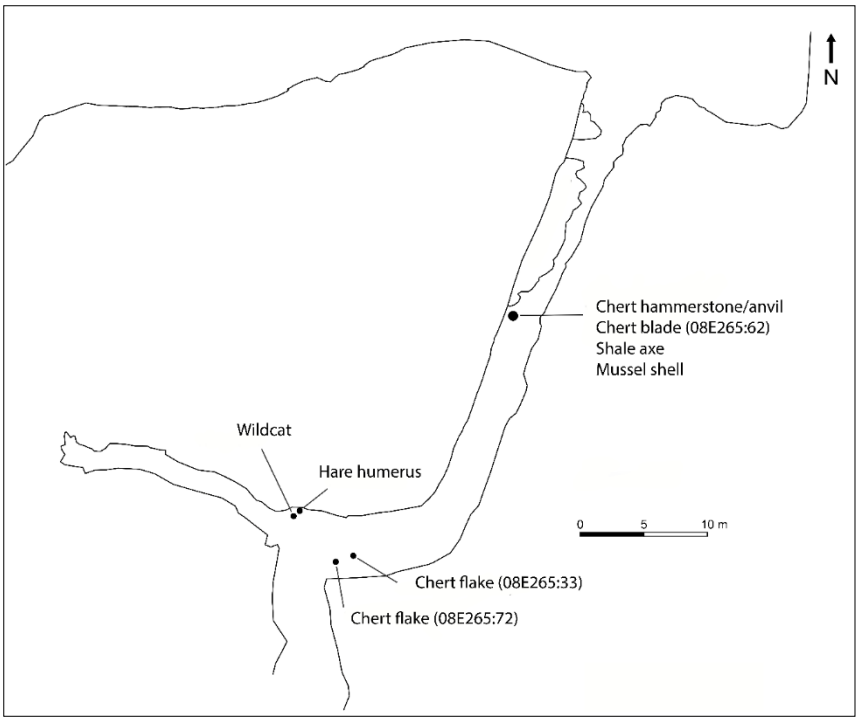

Fig. 3—Distribution of Neolithic and possible Neolithic material in Glencurran Cave.

Material	**Lab code**	**^{13}C**	**^{15}N**	**C:N ratio**	**Collagen yield**	**Radiocarbon age BP**	**Calibrated date cal. BC**
Wildcat (*F. silvestris*) canine	UBA-45133	-19.00	6.70	3.13	6.00	4778±24	3645–3510
Mussel (*Mytilus edulis*) shell	UBA-45139					4270±23	2746–2289
Hare (*Lepus timidus hibernicus*) humerus	UBA-13243	-21.90	2.42	3.27	12.60	4087±21	2865–2490

Table 1 Neolithic radiocarbon dates from Glencurran Cave.

ANCIENT DNA (aDNA) ANALYSIS

Methods.

The Glencurran Cave wildcat was included in a 2024 genomic study of ancient European wild and domestic cats, in which the remains of 225 cats ranging in date from the Mesolithic to the nineteenth century AD were analysed (De Martino et al. 2025). The Glencurran specimen was the only sample from Ireland or Britain included in the study. The body of the right mandible (N7) was sampled for ancient DNA analysis; a tooth from this same mandible had previously been radiocarbon-dated to the Middle Neolithic.

Ancient DNA analysis was carried out at the Centre of Molecular Anthropology for Ancient DNA Studies of the University of Rome Tor Vergata. State-of-the-art clean lab procedures to minimise contamination were adopted (Llamas et al. 2017). The protocols followed for bone powdering, DNA extraction and double-stranded genomic library preparation are described in detail in the supplementary materials of De Martino et al. 2025. Initial shallow shotgun sequencing was conducted on the Illumina NextSeq550 platform (75 bp, single-end) at the Department of Biology, University of Rome Tor Vergata, to assess aDNA preservation (endogenous DNA content) and post-mortem damage (PMD). The library was subsequently resequenced to enable low-coverage whole-genome reconstruction (150 bp paired-end in a NovaSeq6000, Macrogen). Details of bioinformatic pipelines of raw data preprocessing (including alignment to the Felis catus reference genome, PMD-based aDNA authentication, and nuclear and mitochondrial genome coverage assessment), genotyping and downstream analyses are also provided in De Martino et al. 2025. Additionally, molecular sex determination was conducted by adapting a script developed for ancient human low-coverage data by Mittnik et al. (2016). This approach, based on the ratio between reads aligned to the autosomes and the X chromosome, was also used in a recent study on ancient elephant low-coverage data (de Flamingh et al. 2020).

Results.

The initial shallow sequencing yielded a total of 7,122,077 reads, of which 5,321,595 (~74%) were unique reads mapping to the F. catus reference genome, indicating excellent DNA preservation. The PMD analysis revealed a high frequency of C-to-T and G-to-A substitutions at the 5′ and 3′ ends, respectively, along with a mean fragment length of 72 bp, both hallmarks of ancient DNA (Fig. 5). For this reason, the library was resequenced producing 13,547,372 reads. This resulted in a mean nuclear genome coverage of 0.27X, and a mitochondrial DNA (mtDNA) coverage of 94.96X.

A Principal component analysis (PCA) based on approximately 1 million autosomal transversions genetically confirmed the identification of the Glencurran cat as a European wildcat, F. silvestris (Fig. 5A). In particular, it groups tightly with Mesolithic to Bronze Age wildcats from Italy and Spain, forming the core of the European wildcat cluster. In contrast, modern wildcats from Scotland, Italy, and Germany, along with ancient individuals from the Balkans and Anatolia, are distributed along a genetic cline extending from this core. D-statistics (De Martino et al., 2025) revealed the absence of gene flow from either domestic cats (*F. catus*) and Near Eastern wildcats (*F. lybica lybica*) in the Glencurran wildcat (Fig. 6A), consistent with patterns observed in other Mesolithic to Bronze Age wildcats from Italy and Spain. This finding contrasts with Neolithic cats from the Balkans and Anatolia, which exhibit genetic contributions from *F. l. lybica*, and modern European wildcats, which experienced more recent admixture with domestic cats (*F. catus*).

In contrast to morphological analysis, genetic sex determination identified the Glencurran wildcat as male (Fig. 6C). A Maximum Likelihood phylogenetic tree of mtDNA lineages showed that the Glencurran wildcat belongs to Clade-I (Fig. 7), the haplogroup typical of Felis silvestris (Driscoll et al. 2017). Clade I topology revealed two subclades, one including mostly ancient wildcats from Italy, western Europe, the Glencurran individual and present-day

wildcats from Italy. The other subclade consisted of ancient wildcats from the Balkans and present-day specimens from Germany.

In conclusion, genetic evidence suggests that the Glencurran wildcat represents an ancient European wildcat lineage. Its genomic profile aligns closely with that of ancient wildcats from Italy and western Europe, in which no *F. lybica* ancestry, compatible with ancient admixture, could be detected (De Martino et al., 2025). The pattern of introgressed F. l. lybica ancestry in ancient and modern F. silvestris specimens in Europe and Anatolia suggests that ancient admixture may have occurred in the Late Pleistocene in a region spanning geographically the northern Levant and the Caucasus. Climatic oscillations may have driven the mixed European wildcat populations as far west as central Europe via Anatolia and the Balkans. The clustering of ancient Balkan wildcats with those of present-day Germany in the mitochondrial phylogeny supports this scenario. The Alps may have instead served as a geographic barrier, limiting the spread of these mixed populations into Italy. This scenario may explain the clustering of modern Italian wildcats with the Glencurran wildcat and other Mesolithic to Bronze Age wildcats from Italy and Spain in the mtDNA phylogeny.

WILDCAT REMAINS IN IRELAND

Genetic evidence from present-day wildcats and domestic cats has demonstrated that the African wildcat (*Felis silvestris lybica*), distributed across North Africa and the Near East, is the ancestor of the modern domestic cat (*Felis silvestris catus*). Domestic cats were introduced to Europe during the first millennium BC, with at least two waves of genetically distinct cat populations from northwest Africa and Egypt (de Martino *et al*. 2025). It has been suggested that domestic cat arrived in Ireland during the Later Iron Age (van Wijngaarden-Bakker 1974, 350) or early medieval period (McCormick 1999). Recent work has clarified that domestic cats were introduced during the seventh century AD, potentially associated with early Christian monasticism (Doherty et al. 2025). It has generally been accepted that the small numbers of cat bones found on Irish Mesolithic, Neolithic and Bronze Age sites thus derive from wildcat (*Felis silvestris silvestris*). The numbers of cat bones from sites pre-dating the Iron Age are few. A single cat tooth was recovered from the Early Mesolithic site of Lough Boora, Co. Offaly (van Wijngaarden-Bakker 1989, 127). In terms of Neolithic sites, an unspecified number of cat bones were reported from the south recess of Fourknocks passage tomb, Co. Meath (Hartnett 1957, 271) and a fragmented cat humerus was recovered from a Neolithic house (Knockadoon Site C) at Lough Gur, Co. Limerick (Ó Ríordáin 1954, 366; van Wijngaarden-Bakker 1974, 352). Three cat bones were also retrieved from Circle K at Lough Gur (van Wijngaarden-Bakker 1974, 352)—a site that comprised two Neolithic houses and a Bronze Age enclosure (Grogan and Eogan 1987, 366; Cleary 1995). A cat humerus came from the vicinity of Beaker period pits at Newgrange (van Wijngaarden-Bakker 1986, 91). Eight cat bones representing at least two individuals were recovered from different contexts within an enclosed Bronze Age settlement at Chancellorsland, Co. Tipperary (McCarthy 2008, 437).

None of the aforementioned cat bones have been radiocarbon dated or subject to aDNA analyses, but in each instance it has been assumed that the remains represent wildcat based on the prehistoric context of their discovery. Both of these scientific techniques are necessary, however, to securely eliminate the possibility that cat bones from prehistoric contexts represent

later intrusive feral or domesticated cat remains, as whilst metrical analysis can be useful, there is an overlap in size with wildcat in the skeletal elements (e.g. O'Connor 2007). Morphologically, the distinction between wildcat and domestic cat relies primarily on the skull, which needs to be complete (Devillard et al. 2014). There were no cranial fragments in the Glencurran Cave wildcat assemblage. The difficulty distinguishing between wildcat and domestic cat, or between wildcat and domesticated felines gone feral, is apparent from the heated early debates about the authenticity of some identifications (Scharff 1905a; 1905b; Warren 1905; 1911; Stelfox 1965). Further support for adopting a cautious approach is exemplified by a cat maxilla recovered from a Bronze Age pit at Sheephill, Co. Dublin. Initially, this was interpreted as wildcat (Ní Cheallacháin 2020); radiocarbon dating, however, returned an early medieval date indicating that the cat bone was intrusive (Muireann Ní Cheallacháin pers. comm.). Without aDNA analysis, it is not possible to say whether the Sheephill maxilla derives from a feral cat, a domesticated cat or a wildcat. The same holds true for any cat bones recovered from prehistoric sites, and indeed, sites of historic date. In truth, we are not much further along from the early twentieth century debates about wildcat presence in Ireland. As such, Glencurran Cave currently provides the only definite evidence for wildcat in prehistoric Ireland, and emphasises the need for further direct dating and DNA work on the other proposed Mesolithic and Neolithic specimens.

Wildcat extinction from Ireland

Understanding the early distribution of wildcats in Ireland and their overlap with domestic cats is further complicated by the date of their extinction here, which is uncertain. Wildcat extinction across Europe is due to multiple factors: deforestation and the subsequent loss of habitat; hunting for sport or for furs (recorded in Britain from at least medieval times); and pest control (Raye 2023, 38). There is a marked correlation between the expansion of domestic cat populations and the reduction in wildcat numbers, particularly during the period AD 400–800, due to competition for resources and ecological niches (Doherty et al. 2025). Montgomery *et al*. (2014, 149) suggest that the wildcat may have become extinct in Ireland by the Early Iron Age, though do not elaborate as to why this particular period is suggested. Two late medieval writers mention the contemporary presence of wildcat in the Irish landscape, but it is possible that what they perceived as wildcats were feral domesticates. Also relevant is that in recent centuries the pine marten (*Martes martes*) has often been confused with the wildcat, as exemplified by the Irish name for the former: *cat crainn*, literally 'cat of the trees'. Writing in 1626, Don Philip O'Sullivan of Cork described the wildcat as a harmful creature that would 'not only fight with men when provoked, but themselves sometimes challenge a man on his own' (O'Sullivan 2020, 85). Another late seventeenth-century account, penned by the Franciscan Anthony Bruodin (d. 1680), recorded the presence of 'martens, cats, beavers, hares, foxes, rabbits, ferrets, wildcats' in Munster (Raye 2023, 36). Based on current evidence, we are still no closer to knowing when wildcat became extinct in Ireland. It may have been prior to the early medieval period, plausibly linked to habitat loss. It is equally plausible, however, that the wildcat persisted into the early medieval, high medieval and/or post-medieval periods, perhaps confined to remote areas of wilderness at a distance from human settlements. The National Folklore Collection (NFC; https://www.duchas.ie) is replete with references and folklore related to 'wild cat' and 'wildcat' but many or most of these entries seem to relate to

feral cats or pine martens or mythical creatures. That said, we cannot discount the possibility that some folklore reflects the presence of wildcat in the Irish landscape up to recent centuries.

Significance

The assumption that wildcat formed a component of the Early Mesolithic Irish landscape is based on the recovery of a single undated cat tooth from Lough Boora, Co. Offaly (e.g. Montgomery *et al*. 2014; Woodman 2015; Warren 2022; Power et al. 2023). Montgomery *et al*. (2014, 157) have suggested that Mesolithic hunter-gatherers intentionally introduced wildcat to Britain and Ireland for their fur. At present there is no supporting evidence for this proposition, however, and it is equally possible that the wildcat was introduced to Ireland by Neolithic farmers. Essentially, without radiocarbon dating the question of *when* and *how* wildcats first arrived in Ireland remains uncertain. The Glencurran Cave wildcat indicates its presence here by 3634–3526 cal BC. While an earlier presence is likely in Ireland, it has yet to be confirmed.

As has been demonstrated by the cat maxilla from Sheephill, Co. Dublin, a cautious approach is required when assessing and interpreting cat bones recovered from archaeological sites. Felid bones of later historic date—both wildcat and domesticated cat—can become incorporated into prehistoric strata through a variety of natural and cultural formation processes. Furthermore, in the absence of aDNA analysis, a distinction cannot be securely made between wildcat and domesticated cat due to an overlap in size and their close anatomical similarity (Devillard et al. 2014), and a lack of early comparative examples. Further radiocarbon dating and aDNA programmes are essential to build a database of Irish wildcat and domestic cat remains. This would serve to reveal when the wildcat was introduced to Ireland and when it became extinct, as well as clarifying when the domesticated cat first arrived on these shores.

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