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Musical tuning peg from Edinburgh Castle and the stringing of medieval harps

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with a contribution by Dawn McLaren²

ABSTRACT

A stray bone tuning peg from late medieval levels within Edinburgh Castle, the first such find to be published from Scotland, probably belonged to a small, wooden, metal-strung harp. Although it is simply made, its dimensions indicate that the lost instrument had been built to standard units of measurement (inches and fractions of an inch), was probably the product of a craft workshop and was therefore a valuable item of equipment. With the exception of an early antiquarian find from a bog in Co Antrim, of which only a drawing now remains, no such instrument has yet been found in these islands, but numerous images survive, especially in Insular manuscript miniatures. Some feature pegs and strings in the process of being tuned. Under the microscope, the object reveals surface textures that are closely consistent with such use, specifically with its insertion into a wooden socket and with repeated twisting there by means of a socketed metal key. Close to the string hole are oblique stains suggestive of a winding of metal wire. X-ray fluorescence analysis in the vicinity of these stains suggests long-term exposure to contamination from strings of copper alloy or from some nearby copper-alloy fitment. However, an unexpectedly strong iron signal from within the soil residues still packing the string hole leaves open the possibility of iron or steel wire.

INTRODUCTION

Amongst the small finds recovered during the 1988 to 1991 excavations within Edinburgh Castle (Canmore ID 52068; Driscoll & Yeoman 1997; Clark 1997: 148–9, cat no. 5, illus 127) was a tuning peg from a stringed musical instrument: a small, cylindrical bone pin with a squared head and, at the opposite end, an ovoid tip perforated transversely by a fine drill hole (Illus 1 & 2). The artefact was recovered from excavations in the Coal Yard (Illus 3), an area to the north of the Gatehouse and west of the Esplanade of Edinburgh Castle (Area M; Driscoll & Yeoman 1997: 107–14, illus 21). A thick build-up of masonry rubble from a demolished late 16th-century entrance bastion and made ground, incorporating post-medieval artefacts, was found

to overlie a small late 17th-century cemetery which, in turn, was found to overlie backfilled medieval ditches, believed to be 14th century or earlier. The peg came from Context (1176), the fill above post-medieval burial (1175), but was not considered to be directly associated with the grave (ibid: 111, illus 105).

Although now familiar from sites in Ireland, Wales and England, where they seem to range in date from the 12th to the 16th century, the type had not previously been reported in Scotland, or indeed anywhere in mainland Britain north of Whitby in North Yorkshire. However, this has always seemed more likely to reflect survey bias than the true distribution of these useful little objects, and indeed, at the time of writing, news is emerging of further specimens, notably from Achanduin Castle on the island of Lismore

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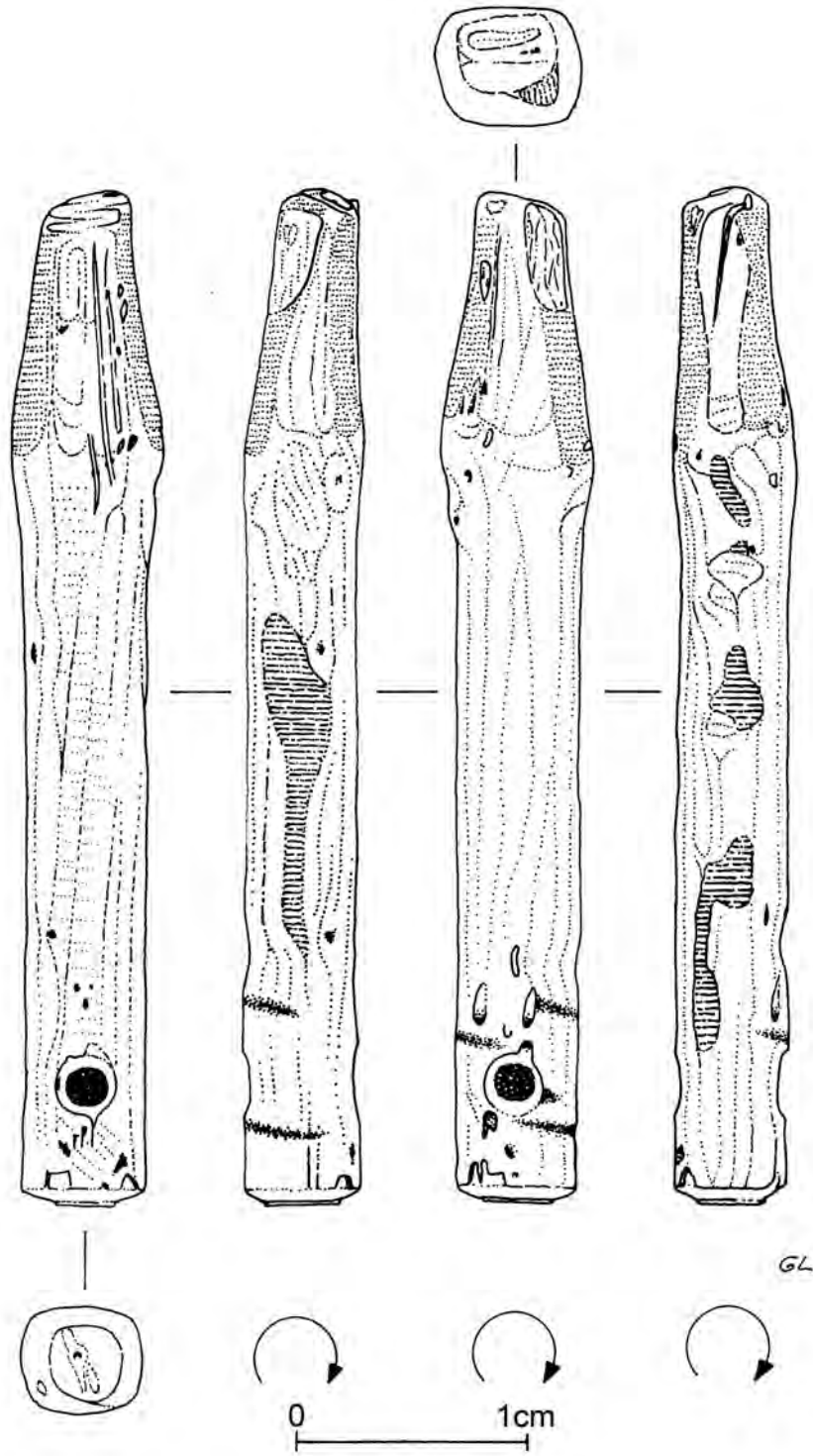
ILLUS 1 The bone tuning peg from Edinburgh Castle. Key: (A) string hole; (B) string stains; (C) paler bone, unexposed when in use; (D) angles burred by key(s). Image AOC

(David Caldwell pers comm; announced in Caldwell, Stell & Turner 2015: 362–4) and, most recently, in the medieval Burgh of Cromarty (Steven Birch pers comm).

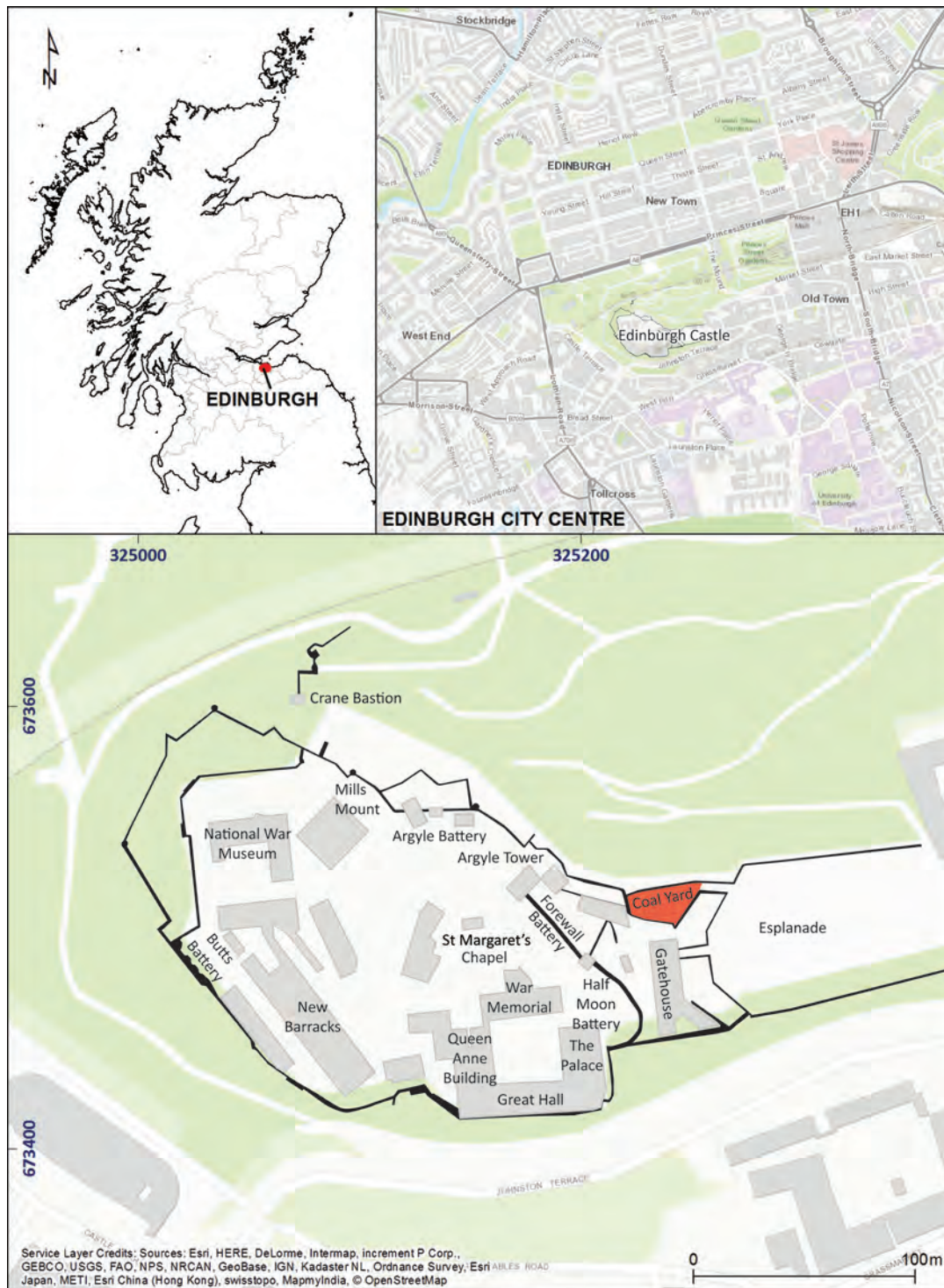
Publication of the Edinburgh Castle excavations in 1997 coincided with renewed interest in Scotland's growing archaeology of music (Purser 1992: 21–8), an archaeology already enriched by some related finds of later, post-medieval date: three copper-alloy harp pins from Finlaggan Castle, Islay (Caldwell in prep), a similar pin and a length of copper-alloy wire, carefully spooled, from Castle Sween, Knapdale (Ewart & Triscott 1996), and a length of fine copper-alloy wire, also carefully spooled, from Fast Castle in Berwickshire (Lawson 2001: 115–16, illus 56). In the absence of the sound boxes, sound boards and superstructures of instruments – wooden elements which survive only in exceptional circumstances – tuning pegs are the components which promise the most information about the forms of the instruments for which they were made, about the processes of construction and repair which serviced them, and about the geographical breadth of musical traditions within which string players and songsmiths plied their crafts (Remnant

1978; Sanger & Kinnaird 1992: 78–100). South of the Border and across the Irish Sea it is no longer unusual to encounter them amongst finds, including other musical finds, from military and fortified sites, as well as in urban and monastic household settings.

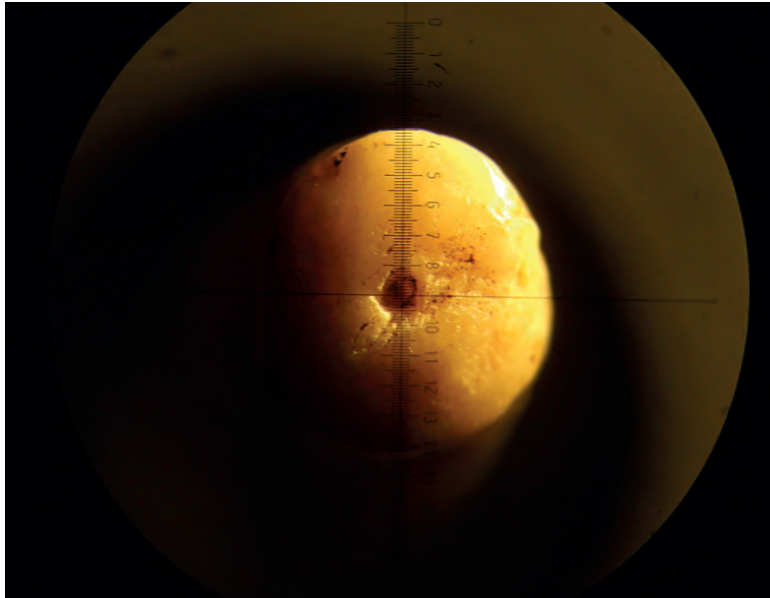
The tuning peg under discussion was published briefly alongside the wider artefact assemblage from the 1988–91 excavations (Driscoll & Yeoman 1997). A catalogue description and brief consideration of the peg's form and date was presented (Clark 1997: 148–9, no. 5, illus 127) but it was beyond the scope of the excavation monograph to present further in-depth discussion of individual artefacts. The rarity of this object type in a Scottish context, alongside ambiguity over its potential date and the form of the stringed instrument it derives from, was recognised during a recent review of the Edinburgh Castle excavation assemblage and it was recommended as an object ripe for specialist re-analysis (McLaren 2013). The recognition of the tuning peg's potential significance and its recovery from such a historically prestigious site instigated this current phase of research, which has been fully funded by Historic Environment Scotland.



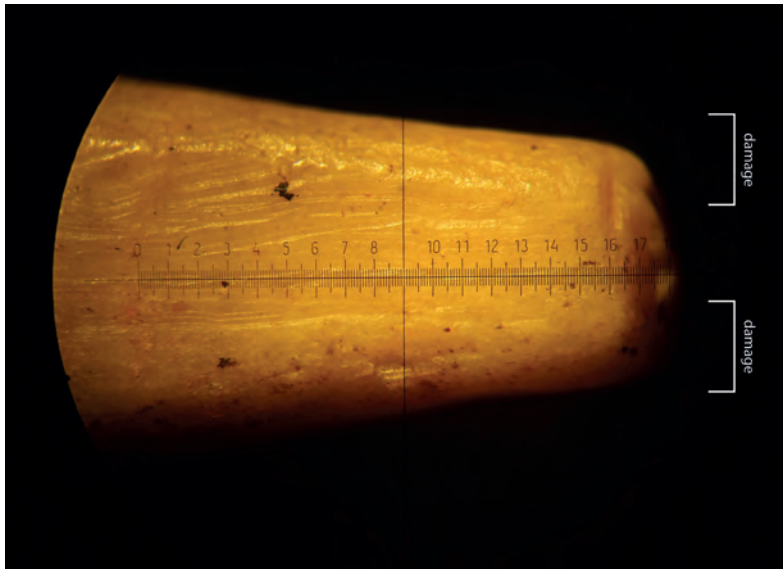
ILLUS 2 The bone tuning peg from Edinburgh Castle. Note the linear string stains flanking the perforation, and the patches of wear (hachured) on the angles of the head and on the faceted surfaces of the shank. Illustration G Lawson



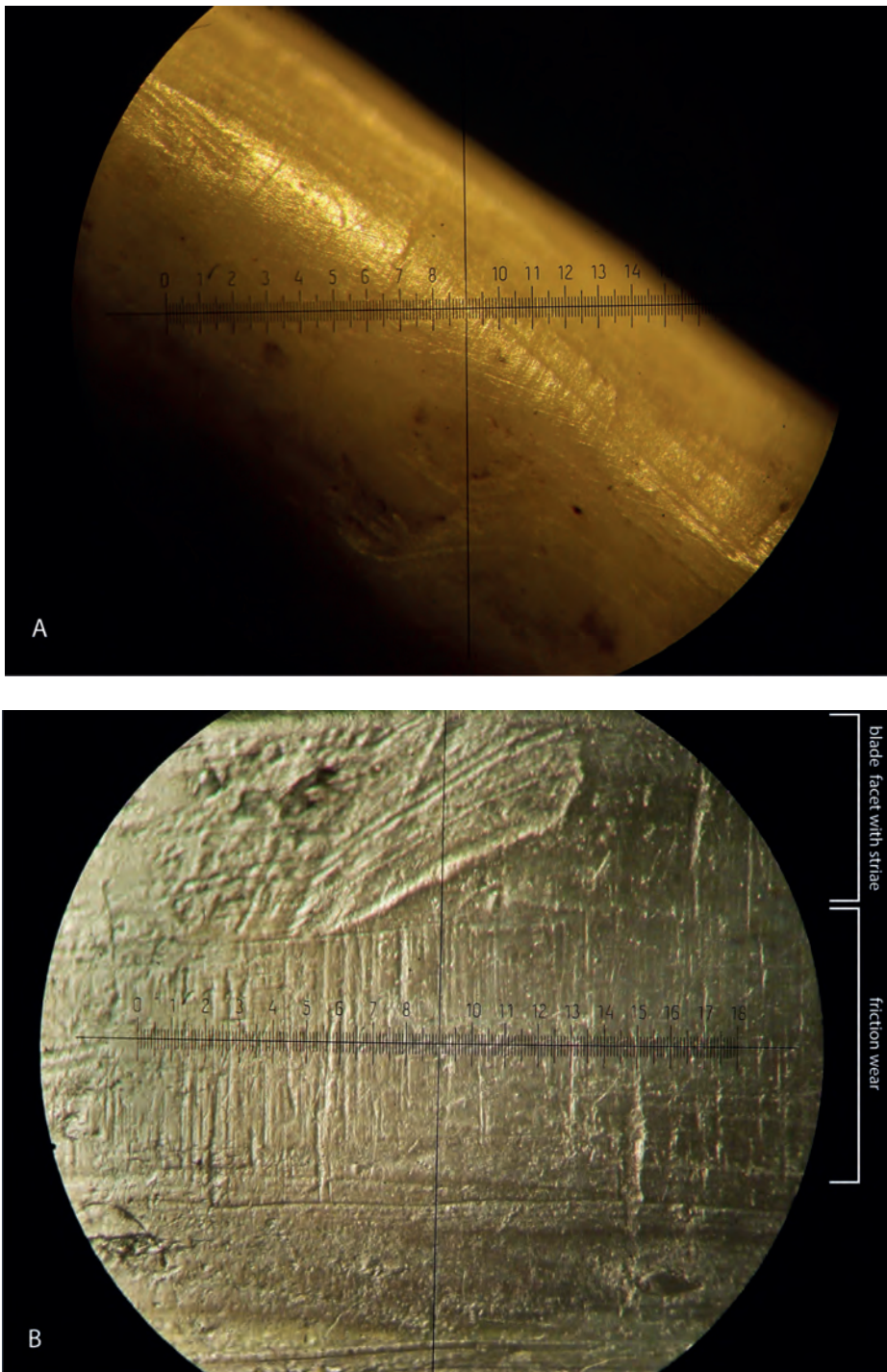
ILLUS 3 Site location map. Map created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under licence. Copyright © Esri. All rights reserved



ILLUS 4 Optical micrograph showing indented tip at $\times 16$ magnifications. 1 numbered unit = 0.5mm. Image G Lawson



ILLUS 5 Optical micrograph showing damage to the head at $\times 16$ magnifications. 1 numbered unit = 0.5mm. Image G Lawson

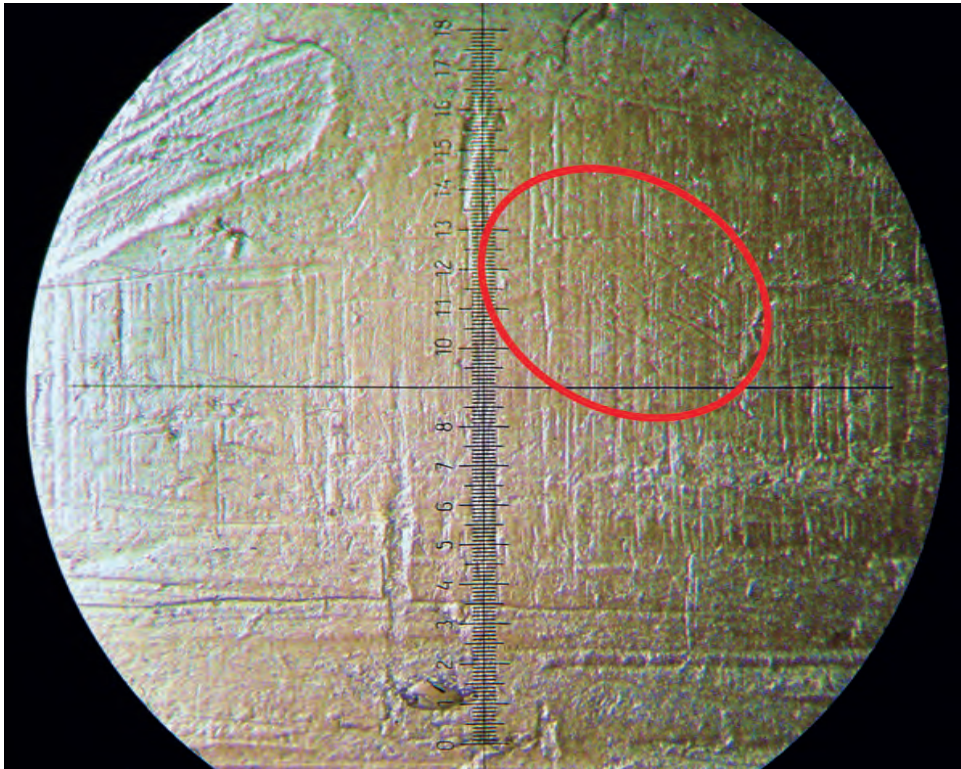


ILLUS 6 (A) (top) and (B) (bottom) Optical micrographs showing friction wear detail on the shank at $\times 32$ magnifications. The peg is orientated with the head to the upper left in (A) and the head to the left in (B). 1 numbered unit = 0.25mm. Image G Lawson

TECHNICAL DESCRIPTION, MANUFACTURE, FUNCTION, USAGE

In stringed instruments of Roman and later date, string tension is achieved by means of rotating tuning pegs set in cylindrical sockets drilled into one end of the instrument: the part variously known as the head, peg-board, peg-box, neck or yoke, according to the type of instrument involved. From its anchor point at the base of the instrument, each string is stretched upwards across the face of the instrument and its free end is passed through a small hole in the peg and secured there by a few turns. The peg is then rotated in its socket, often with a key or wrench, so as to take up any slack in the string and to apply tension to it in the manner of the capstan of a winch. As the tension increases, so the frequency of vibration rises when the string is plucked, strummed or bowed.

The shank of this peg has a slightly flattened polygonal section, the longitudinal facets consistent with manufacture by whittling (paring lengthways using a single-handed blade). It measures 44.2mm in length and the shank has a maximum diameter of 6.35mm tapering to 5.08mm. The narrower tip has a small indentation, as though centred on a spike for finishing (Illus 4). Although still packed with soil residues, the string hole (1.5mm diameter) appears to be cylindrical, not conical, bored using a fine bit rather than a knife point. The head is squared to a rectangular section, tapering slightly towards its tip, its angles abraded through the use of a tuning key of slightly the wrong size (Illus 5); nevertheless, in principle it still appears serviceable. Along the shank, some of the prominent ridges between the facets are modified by use into plateaux of worn, cylindrical surfaces, the result of friction during



ILLUS 7 Micrograph of the shank showing fine oblique striae (ringed at $\times 32$ magnifications). 1 numbered unit = 0.25mm. Image G Lawson

rotation whilst in contact with the walls of a cylindrical socket. Under the microscope this wear is characterised by parallel striae (Illus 6a & b) reflecting its function as a friction-braked journal bearing, which is to say, a bearing in which friction resists rotation up to a certain torque, but releases when a higher torque is applied, as it is during tuning. Amongst the latest marks are some oblique striae, which suggest a twisting movement during final adjustment of the peg and its eventual withdrawal from the instrument (Illus 7). The principal areas of friction-wear contact represented by horizontal hachuring in Illus 2, contrast sharply with the unmodified tool striae of the surrounding cortical bone. Due to the slightly irregular cross-section of the shank, only a small percentage of its surface area (perhaps less than 15%) was ever in friction contact with the walls of the socket, even by the time it was withdrawn from use. Thus, although the peg would have been able to rotate, it is doubtful whether it could have had sufficient grip to resist higher string tensions, and this may go some way towards explaining its abandonment.

Besides mechanical modifications, two elements of discolouration also invite comment: a general darkening around each end of the object and some dark markings close to the hole (Illus 1 & 2). The general darkening corresponds to those parts of the peg which would have remained exposed whilst in service: the intervening shank, hidden inside its socket, is notably paler in colour. Much the same contrast can be seen in bone and wooden pegs withdrawn from experimental instruments after a period of use, as well as in old instruments preserved in ethnographical collections. It is perhaps surprising that it should have survived deposition; but it has, and the paleness confirms that discolouration cannot be attributed to the soil in which the object was deposited. Close to the hole are several fine linear stains in an oblique orientation, which suggest segments of the winding of a string. Brown in colour, it was at first tempting to see these as organic in origin, perhaps some residue from the treatment of a stringing material such as gut. But because they might also be consistent with corrosion

from a metal wire, perhaps iron or steel, and because this might cast some light on the date of the object, it was decided to subject it to further scientific analysis.

The method adopted was X-ray fluorescence analysis (XRF), a non-destructive technique which allows detection of chemical elements present on and within a sample of surface, and enables evaluation of local chemical signatures. The work was undertaken at Historic Environment Scotland's Conservation Centre, by Maureen Young and Sarah Hamilton. The instrument used was a Bruker Tracer III-SD portable XRF (pXRF) with a target diameter of 8mm. Twelve sites were chosen to supply samples of both the stained and unstained areas of the peg (Young & Hamilton 2016). Full details of the method and output data are to be published in a separate technical report (Young & Lawson in prep).

Because this analysis has not previously been attempted for any musical bone peg, the lack of standards for comparison hampered quantitative analysis; however, the output data afford a valuable starting point for further studies of this kind. Whilst peak values for calcium (Ca) and phosphorus (P) represented the bone substrate, as predicted, other significant peaks included iron (Fe), copper (Cu) and zinc (Zn). Significant absences included tin (Sn) and silver (Ag), and only trace amounts could be detected of lead (Pb). Observed variations in the distribution of especially Fe, Cu and Zn promise to open up new avenues of enquiry.

At the 'string end' of the object, a clear contrast emerged between those sample areas that included the aperture of the string hole and those that did not. Two assays from the aperture area exhibited strong Fe peaks of between 12,000 and 21,000 counts per second, values which were not repeated in the assays returned from the shank areas tested (Young & Hamilton 2016: fig 2). Although the XRF, with a target of 8mm diameter, was unable to distinguish between the suspected string marks individually and the background shank in the area of the string marks, peak area values for Cu were between 3,600 and 4,200 net counts, and for Zn, between 7,500 and 14,700 net counts.

The high values for Cu stood in marked contrast to the cluster of values exhibited in the central region of the shank and on the head. Whereas at the string end Cu peak area values ranged between around 3,600 and 4,200 net counts, at the head they spanned between only 1,200 and 1,900, with those in the central region occupying a narrower range between 1,700 and 2,000 (ibid: fig 8). Cu values were thus distinctly higher at the string end, and lower in the centre and at the head (of which the head gave values marginally lower than the centre). The Zn peaks told a slightly different story: here peaks of around 7,500–14,500 net counts at the string end and 5,000–10,000 in the centre and at the head were recognised, within which the head expressed a narrower range of 7,500–10,000 and in which the three lowest Zn values all proved to be from the central region. At the string end, assays that returned high Fe peaks also had higher Zn values (10,200–14,600 net counts) than their adjacent shank assays (7,500–8,400 net counts). The distribution of Zn across the object was curious as it appeared to peak more strongly on one face of the object analysed than any other. The reason for this disparity is not clear.

The ‘string end’ is clearly Cu-contaminated, while the string-hole margins and internal residues are Fe-rich. The central area is on average poorest in Zn. The head and central area are lowest in Cu, of which the head, perhaps surprisingly, exhibits the least. Looking at these results, and at some of the absences, Young and Hamilton (2016) note that whilst the lack of Sn and the presence of Zn might ordinarily encourage us to think of a brass string, the lack of correspondence between Cu and Zn values across the object, and the unequal distribution of Zn generally, suggest that factors other than stringing may be responsible for the presence of Zn. They further speculate that the high Fe values might be due to residues from the tool used to create the string hole. This is possible; but it could also represent a residue of an iron or steel wire, while the high Cu value at the ‘string end’ could represent contamination from either an earlier use of copper-alloy wire or from the polishing of some nearby Cu fitting. An element of environmental contamination also cannot be ruled out.

What is now needed, clearly, is more analyses of similar sort on other stringed instrument components. Such analysis as has been undertaken elsewhere has so far been concerned primarily with rare survivals of strings themselves. Spools of copper-alloy wire recovered at Fast Castle and at Castle Sween have already been mentioned. Both of these are fortified sites, as their names indicate, and in both cases finds have included further evidence of musical activity. However, tuning pegs represent a far richer resource. A copper-alloy connection has already been observed in some medieval bone tuning pegs of a slightly different type and instrumental attribution, notably amongst a significant number recovered from a monastic context at Alvastra Kloster in Sweden, where they were accompanied by copper-alloy wire (unpublished finds, Statens Historiska Museum, Stockholm, inv nos 17237, 455–62; 19149, 518–20; 20748, 654–7; wire: 2168; 22972; examined by G Lawson in 1996). What remains now is to begin to subject some of these specimens to analyses of the same or similar kind.

TYOLOGICAL AND CHRONOLOGICAL CONSIDERATIONS

The form of the peg corresponds to Lawson (1982) Type A/i. Type A is one of three categories of medieval bone tuning peg which are defined according to the location of the perforation in relation to the head, and are thus reflective of the contrasting structures into which they would have fitted. In Type A, the string is attached to the end furthest from the key, implying a neck or peg-board that was open on both faces; examples of instruments adapted to such pegs include harps, lyres and some of the simpler medieval fiddles. (In subtype A/i the string is inserted in a small hole, while in subtype A/ii it fits into a slot.) In Type B, which includes the Alvastra finds, the squared head itself is perforated, or the shank close to the head, implying a thicker board- or box-like structure in which either there is no access to the other end of the peg or access is limited by a table-top posture when in use; examples strung in this way include zithers, such as the

psaltery and dulcimer, and the early keyboard instruments derived from them. In Type C, for which there is so far only one archaeological example, the hole is in the middle of the shank, implying the use of a hollow peg box with twin bearings, similar to that of a modern violin. Each type has its own unique pattern of wear (Lawson 1986: 124, fig 3c–f). Type A/i is so far the most numerous. It must represent several distinct types of instrument since its length has been found to vary considerably – currently between 35mm and 78mm. Amongst the shorter examples, some develop a flatter head, almost a handle.

Pegs in Type A/i are all medieval or very early post-medieval, the securely dated examples ranging between *c* 1150 and 1550. A few examples from later contexts are probably residual. Besides stray finds, some noteworthy assemblages of mixed type include pegs of Type A/i from Battle Abbey, Whitby, Winchester and various locations in Bristol, Lincoln and Oxford. Amongst the earliest to be securely dated are one of Type A/i from a 12th-century phase at Lyveden, Northamptonshire (Steane & Bryant 1971: 141, fig 52, no. 10), another of Type A/i from Waltham Abbey, Essex, of around 1300 (Huggins 1976: 119–20, fig 42, no. 3), and one of Type A/ii from Wallingstones, Herefordshire, which cannot be later than 1250 (Bridgwater 1970; Lawson 1980: 226, cat no. 62). Amongst the latest are one from a 16th-century pit at New Inn Court, Oxford, and four from Danes Terrace, Lincoln, from robber trenches and accumulation ranging between the 15th and 19th centuries, the most recent of them clearly redeposited (Lawson 1980: 224, cat no. 57 ii, iv; Steane et al 2016; Jenny Mann pers comm).

At only 44mm long, the Edinburgh Castle find is therefore amongst the shortest yet found: comparable examples include one of 52mm from the Carmarthen Greyfriars; one of 50mm from King's Lynn; one of 50mm from Bedern, York; one of 49mm from Church Street, Oxford; one of 49mm from St Augustine's, Canterbury; one of 48mm from Dane's Terrace, Lincoln; one of 44mm from Lyveden, Northamptonshire; five from Battle Abbey, Sussex, measuring 48mm, 46mm, 44mm (two) and 39mm; and three from St Aldate's,

Oxford, one measuring 48mm, the others both 35mm (Lawson 1980: 219–28, cat nos 44–66). These shorter pegs contrast markedly with one of 78mm from Chelmsford; two of 69mm and 67mm from Whitby; a second of 65mm from Chelmsford; one broken peg of at least 64mm from Gloucester; one of 62mm from Winchester (Lawson 1990); a third from Whitby of 61mm; and one further example from Bedern, York, of 61mm (Lawson forthcoming).

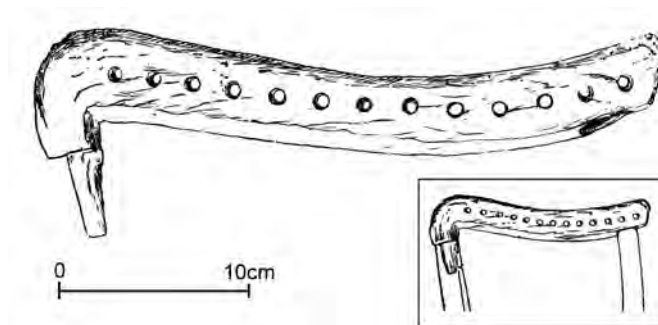
MEASURES, MANUFACTURE AND TECHNICAL MILIEUX

The object is evidently hand-made, formed using no more than three separate tools. But whilst this might ordinarily encourage us to suspect some rustic musical association, a glance at the dimensional data shows deliberate adaptation to standard units of measurement, specifically inches and fractions of an inch. The length is exactly $1\frac{3}{4}$ inches. The shank tapers in diameter from $\frac{1}{4}$ inch at the shoulder to $\frac{1}{8}$ inch at the narrow tip. The portion of the shank that exhibits contact with the parent structure is 1 inch in length. The minimum visible diameter of the string hole suggests use of a $\frac{1}{16}$ inch borer. These measurements together give us some useful facts about the absent instrument, its repair and its original manufacture. Firstly, rough though his or her work might be, the maker of the peg has been working to meet a very particular requirement, which is to say, the requirement imposed by the original instrument maker; and that original maker had in turn been working to a high specification, involving standard gauges of drilling and reaming equipment, most likely in a specialised or partly specialised craft workshop. The drill hole gives us a further clue as to the manner in which the instrument has been strung: pegs of Type A/i are most suited to strings of gut or wire. In this instance, the absence of compaction around the rim of the hole would seem to favour the softer material, whereas the dark markings on the surrounding surface, described above, hint at metal. In either case, it was a string of less than $\frac{1}{16}$ inch gauge.

QUESTIONS OF ATTRIBUTION

The identity of the parent instrument can therefore, to some extent, be glimpsed in the particulars exhibited: the likelihood of metal strings, the likelihood of fine original work executed to a technical specification that included both measurement and precise reaming, the free access to both ends of the pegs, the use of a key (rather than fingers) to turn them in their sockets, and all this in a superstructure only 1 inch thick. The compactness of the exposed parts may also be a consideration: in its final, worn condition only 11mm projected at the head and less than 6mm projected at the tip. What kind(s) of instrument would these features best suit?

16th-century date, found at Ballinderry, Co Westmeath (Wood-Martin 1886: 125–6, pl XXVIII; Rensch 1969; Rimmer 1969: 43, pl 17–18; Crane 1972: cat no. 323.01; Lawson 1980: 210; Sanger & Kinnaird 1992: 57). Many more recorded as stray finds found their way into the national collections of Dublin and London. A wooden neck from a small harp had been uncovered in 1896 at Carncoagh in Co Antrim, lacking tuning pegs but complete with 13 holes for them (Illus 8). Although now lost, a drawing survives of its form on discovery (Knowles 1897: fig 1). From its curved outline, a date of around 1100–1300 may be surmised, based on images of harps in manuscripts; and given its delicacy, a thickness of around 1 inch can readily be imagined. Such a thin structure



ILLUS 8 The wooden neck of a small harp from Carncoagh, Co Antrim (from Knowles 1897). Knowles' inset image demonstrates how the neck would originally have been attached to the sound box (left) and forepillar (right)

The first correct attribution of such pegs to a musical function seems to have been made in Ireland, in the case of two finds from a crannog at Clones in Co Monaghan (D'Arcy 1901: 226 & fig 9) and several more from a crannog at Ardakillen, Co Roscommon (Wood-Martin 1886: 125, fig 171). There an association with harps was naturally suspected. Similar pegs, albeit considerably longer and wrought in copper alloy, were already known, examples having survived not only in late instruments preserved in private ownership, of which the earliest were the Queen Mary, Lamont and Trinity College (so-called 'Brian Boru') harps, but also as part of a group of metal parts of probably

contrasts sharply with later harps, such as the Lamont, which have broad necks, triangular in section, the sockets occupying the thicker, lower part – hence the considerably greater lengths of all later metal harp pins.

Of earlier harps, we may still have only the drawing of Carncoagh, but a glimpse of the technology may be seen in the remains of late lyres, of which one, across the North Sea at Hedeby, Schleswig-Holstein, dates from around 1100 (Lawson 1984). There the yoke (the cross-piece containing the pegs) offers an analogous form, similarly slender, the row of sockets occupying – like Carncoagh – the centre line of the structure. According to Rupert

and Myrtle Bruce-Mitford, the neck of the 7th-century Sutton Hoo lyre, which exhibits much the same frontal profile, was originally 19mm thick (Bruce-Mitford & Bruce-Mitford 1983: 689), while a single copper-alloy tuning peg from an Anglo-Saxon grave at Oakley, Suffolk, also suggests a thickness of around 20mm. So, in theory at least, a lyre could offer another possible attribution, even if lyres seem to have been in general decline by the high Middle Ages and have yet to find unambiguous expression amongst later medieval finds. So too, in theory, should some of the simpler fiddles shown in medieval manuscripts: those with peg-boards (small circular, squared or triangular flat extensions) at the distal end of their necks, with sockets typically for three or more tuning pegs. Wooden remains of three examples of this type were recovered from waterlogged layers of the 12th and 14th centuries at medieval Novgorod (Kolchin 1968: pls 81.6, 81.5 & 81.3; Crane 1972: cat nos 331.02, 331.03 & 331.04; Lawson 1980, cat nos 38, 39 & 40, pls 37a–b, 38a; Povetkin 1992: 211, fig VII.3 and ‘Gudok’ 221–3), while more recently, further specimens have emerged from Poland: a small fiddle from a 14th- or 15th-century layer at Elbląg (Popławska 1997; 2012) and a larger, waisted instrument from 16th-century fill within a well at Płock (Dahlig 1994; Popławska 2012: fig 5). Each of these instruments carries wooden equivalents of Type A tuning pegs (wooden equivalents which have so far failed to survive in these islands). However, in such instruments one would expect a structure rather thinner than 1 inch. At Novgorod, for example, a peg-board from occupation layer VIII, dated to 1369–82, was around 17 to 18mm thick (Kolchin 1968: pl 81.3; Lawson 1980: cat no. 40, pl 38 A), a published image of the Elbląg find (Popławska 2012: fig 4) suggests a thickness of only 9mm to 11mm, while Dahlig gives 15mm to 22mm for the tapering peg board of the Płock instrument (Dahlig 1994: 121, table 1). Equally, their pegs would likely be tuned with the fingers, not with a key. Consequently, despite the small size of the Edinburgh peg, the balance of the comparanda – such as they are – still tends to favour a small harp, and a date earlier rather than later in the range 1150–1550.

CONCLUSION

The re-examination and analysis of this small but significant find more than 20 years after its initial publication demonstrates the merit of re-visiting past discoveries. Not only has the application of scientific techniques, in the form of optical micrography and XRF analysis, added much to our understanding of the technologies of production and use of the object, but comparison of its micromorphology with other known northern European instrument components has shed light on its date and wider significance. These methods now enable the Edinburgh Castle tuning peg to be identified with increasing confidence as having belonged to a small, portable, wire-strung harp of 12th- to 14th-century date.

ACKNOWLEDGEMENTS

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