The Charlesland (Wicklow) Pipes

Peter Holmes/Bernice Molloy

ZUSAMMENFASSUNG

Bei einer Notgrabung südlich von Dublin wurden 2003 zahlreiche sorgfältig hergestellte Röhren aus Eibenholz gefunden, die in einer bestimmten Anordnung auf dem Grund einer holzverkleideten Mulde niedergelegt worden waren. Diese war Teil eines fulacht fiadh, *einer Aufschüttung aus angekohlten Steinen. Der Fund dieser Röhren wird hier beschrieben und in den archäologischen Kontext eingeordnet. Die vorläufigen Ergebnisse einer Untersuchung, die noch vor der Konservierung vorgenommen wurde, werden hier vorgestellt. Verschiedene Interpretationen werden erörtert sowie die Bedeutung, die Eibenholz bei der Herstellung ritueller Gegenstände hatte. Besondere Aufmerksamkeit wird der Deutung gewidmet, die Röhren könnten Teil eines zusammengesetzten Musikinstruments gewesen sein. Auf diese Basis stützt sich die Rekonstruktion des Instruments und der Versuch, Aufschlüsse über seine möglichen Spielweisen zu gewinnen.*

THE ARCHAEOLOGICAL BACKGROUND

By Bernice Molloy

The townland of Charlesland is located south of the village of Greystones, Co. Wicklow, on the eastern coast of Ireland, some 30 km south of Dublin city centre and approximately 2km from the Irish Sea (Figs. 1–2). Extensive archaeological excavation was carried out on a large scale development in this area between December 2002 and August 2004. Topography varied considerably within the development zone, which was approximately 45 hectares in size, and this variation is reflected in the nature of the sites found during topsoil stripping. Seventeen sites were excavated during the project, which ranged in date from the Neolithic to the Medieval Period. A picture of prehistoric society is emerging in this area, with occupation, burial, and dating evidence pointing to extensive Bronze Age settlement. The unique discovery under discussion, a set of wooden pipes, was found on a site known as a *fulacht fiadh*, which was radiocarbon dated to the Early Bronze Age. This paper presents the findings of this excavation, and an archaeological background for *fulachta fiadh* and their functions. It attempts to place the pipes in the context of the Early Bronze Age and the ritual of votive deposition practised in this period.

1. SITE LOCATION AND DESCRIPTION

The site was located on low-lying poorly drained ground at the base of a gradual east-facing slope. A shallow deposit of peat overlay the natural subsoil indicating that the immediate area was once boggy and waterlogged. This is a typical location for a *fulacht fiadh* which are generally located close to a source of water or in a wet area. There was no above-ground indication of the site, which was exposed beneath c. 0.30m of topsoil. The site presented as a low mound of fire-cracked stone (namely sandstone, granite and limestone) roughly oval in plan and measuring 14.50m (E-W) by 11m with a maximum height of c. 0.20m. Four sub-rectangular pits (henceforth referred to as troughs), were identified beneath the burnt mound. One of these troughs was wooden lined and it was at the base of this trough that the pipes were discovered. The cut for the wood-lined trough measured 2.26m by 2.05m and was 0.96m deep. Alder planks and roundwoods formed the base and sides of the trough, forming a box-like structure. Organic, stony sandy clay filled the bottom of the trough to the level of the top of the timbers. This was sealed by a dense layer of wattle fragments, which could be collapsed wattle lining or perhaps a 'covering' or a lid for the wooden part of the trough. A layer of redeposited natural clay sealed this 'covering' and the trough, signalling the cessation of the use of the trough, and possibly the site.

2. *FULACHTA FIADH*: DEFINITION AND FUNCTIONS

As a site type *fulachta fiadh* are defined by a trough or troughs found in association with a mound of burnt stones. Over 5,000 of this general site type have been recorded in Ireland (e.g. Waddell 1998, 174). The term '*fulacht*' means 'recess' or 'cavity', while the term '*fiadh*' has been interpreted as 'of the deer' or 'of the wild'[1].The actual functions of *fulachta fiadh* has long been the subject of debate and while it is generally agreed that the purpose of the trough is to heat water by placing fire-heated stones into it (the mounds are the result of discarded stones shattered in the process), what end this served is not definitely known. Theories have been put forward such as cooking (the widest accepted theory[2]), bathing, sweathouses[3] and activities such as dying or textile production[4]. The term '*fulacht*' occurs in a number of early medieval Irish texts in the context of their function for cooking. For example in the *Agallamh Beg* there is a reference to the use of the *fulacht fiadh* "[…] Coailte and Finnachaidh went down to the stream to wash their hands. 'This is a cooking place', said Finnachaidh, 'and it is a long time since it was made'. 'That is true', said Caoilte, 'and it is not to be worked without water' […]"[5].

Experiments in the 1950's by O'Kelly[6] at Ballyvourney, Co. Cork, demonstrated how easily the trough could be used for cooking meat. There is, however, a lack of specific evidence for this in that animal bone is rarely found in association with mounds or troughs, although this may often be accounted for by acidic soil conditions. However, experiments carried out in Britain by Barfield[7] in PH analysis on a number of burnt mounds where no animal bone was found, indicated neutral rather than acidic soil conditions.

Barfield and Hodder[8] suggested that that the structures occasionally found in association with burnt mounds may be sweat houses, which has led to the suggestion that these sites may have been saunas or baths. Again, there is evidence in the early medieval Irish texts, for example in the 'Romance of Mis and Dubh Ruis' where a feature which appears to be a trough is used for both cooking and bathing[9]. Textile production has also been suggested as a purpose for the trough. Experiments by Anne-Maire Denvir as part of an undergraduate thesis in Queen's University Belfast has shown how the trough can be successfully used for washing, dyeing and fulling (cleaning and thickening fabric after weaving) textiles. Although there is limited evidence for actual textiles dating from this period, evidence such as spindle whorls, dress fasteners etc. suggest the manufacture of cloth.

It could be suggested that rather than having one specific use a trough could be multi-functional and may have served a variety of purposes. There is also a question as to whether *fulachta fiadh* were associated with permanent settlement or temporary habitation. Given their location many *fulachta fiadh* may have been inaccessible in winter and it is probable, therefore, that they were used on a seasonal basis. No direct evidence was found for settlement in association with the *fulacht fiadh* during the course of this excavation but, given the wet location of the majority of these sites, it is likely that any permanent settlement would be found in more suitable locations.

3. THE WOODEN PIPES

Five graded pipes, carved from yew (*Taxus baccata*), lay side by side on the large planks at the base of the trough (Fig. 3). One pipe partially overlay these, and three fragments were found in the primary fill. The pipes at the base were well-preserved and for the most part intact. Slight narrow depressions were visible on some pipes, as were reed fragments, which suggest that the pipes were bound together. Organic matter found inside some of the pipes has been identified by Martyn Linnie as plant material, likely to have accumulated naturally after the deposition of the pipes. Three pipes fragments found in the primary fill were poorly preserved and slightly flattened, but were similar in profile and shape to those found at the base of the trough and it is very probable that they came from the same instrument.

4. DATING EVIDENCE

Two samples of wood were submitted for radiocarbon dating. A sample from T2 of the wooden pipes was dated to 2137 to 1909 BC. A wooden peg from the trough was also dated and confirmed an Early Bronze Age date for the trough. The Early Bronze Age in Ireland is generally defined by the new technology in metal working on copper, bronze and gold and by a rich and diverse bur-

1 O'Sullivan 2004, 36.
2 Ó Drisceoil 1991.
3 Hodder/Barfield 1987.
4 Jeffery 1990.
5 Ó Drisceoil 1991.
6 O'Kelly 1954.
7 Barfield 1991, 60.
8 Hodder/Barfield 1987.
9 Ó Drisceoil 1988, 673.

ial record. This is also the period that saw the introduction of special funerary pottery, such as vases, bowls, and cinerary urns which was placed in the grave, either as an accompanying vessel or inverted over the burial[10]. Cooney and Grogan[11] suggest a link or similarity between the deposition of these vessels and the votive or ceremonial placement of metal objects, mainly in 'wet' places, such as lakes, rivers and bogs. Settlement evidence for this period is rare, but the sparse evidence would suggest that both rectangular and circular houses were being constructed[12].

5. VOTIVE DEPOSIT?

The deposition of the wooden pipes at the base of the trough is more than likely linked to the 'ritual' deposition of artefacts, a tradition which began in the Neolithic and continued into the 1st millennium AD[13]. Cooney and Grogan[14] have defined a ritual deposit as "[…] high quality objects deposited in such a manner or location that casual loss or temporary storage are unlikely explanations of their occurrence". This would appear to apply to the wooden pipes, particularly when it can be suggested from their position in the trough that most of the pipes were bound together on deposition or at least formally arranged to imitate their original structure.

The majority of 'ritual deposits' that can be ascribed to the Early Bronze Age in Ireland are metal artefacts, such as bronze axes, and gold *lunalae*. A musical instrument could be identified as a ceremonial object, and may have been used in communal ritual. Bradley[15] has drawn attention to studies in Denmark by Levy[16] where she defines ritual and non-ritual hoards and links the deposition of ritual hoards to ritual feasting or slaughter. Perhaps this site was the focus of ritual feasting (the amount of burnt mound material indicates that the troughs at this site were used) and the deposition of the musical instrument may have marked its final use. This deposit may be a forerunner of the tradition in the Late Bronze Age of depositing musical instruments in 'wet contexts', such as rivers, bogs and lakes: bronze horns have been found in many wetland contexts, particularly bogs, in Ireland[17].

THE PIPES

By Peter Holmes

The ten timber objects found at Charlesland, Co. Wicklow, Ireland, are carefully-produced round and hollow pipes made from yew (*taxus baccata* – common yew). At the time of their examination for this paper, the timbers were still in their excavated state and were wet, delicate and difficult to handle. Because of this no measuring tools, such as vernier calipers, which might mark the surfaces were used in the investigation. This paper is, therefore, a preliminary report on the pipes, pending their conservation, prior to a more detailed study.

The tubes vary in the degree of preservation from almost complete to very fragmentary but the former tubular shape of all the pipes can be identified.

1. FEATURES OF THE TIMBER

None of the pipes is complete, the rebated end (see below) being particularly degraded. In general, the main bodies of the tubes are well preserved although a few had degraded partially, revealing the bore of the tube (Figs. 4a–b, 5).

The surface of some pipes was covered with longitudinal striations which pass uninterrupted along their entire length (Fig. 6). On these tubes, the surface of the bore is similarly structured, as shown in Fig. 7. Other tubes had smooth surfaces (Figs. 14, 9), suggesting that the tube walls were originally finished in this way and that the striations on the surfaces result from degradation of their timber, post deposition, the striations probably being formed by the timber's prominent medullary rays which have survived better than the surrounding cells. It is not clear why such degradation has occurred on some pipes and not on others but it may result from the use of timber from different sources (Figs. 6, 7).

2. THE GENERAL DESIGN OF THE PIPES

Although each pipe is different, they are all worked objects which have been fashioned in a somewhat similar way, with an overall design concept which contain the elements shown in Fig. 8 – although all the elements are not present on all pieces.

The plain tubular sections of the pipe are very carefully finished, having a smooth surface, while

10 Waddell 1998, 140.
11 Cooney/Grogan 1994, 113.
12 Doody 2000, 143.
13 Bradley 1998, 5.
14 Cooney/Grogan 1994, 115.
15 Bradley 1998, 10–11.
16 Levy 1982.
17 Waddell 1998, 234–236.

the tapered and undercut surfaces still bear tool marks from working and are, thus, roughly finished. This suggests strongly that the two roughly-tooled areas were concealed on the assembled object with the well-finished sections left visible.

The design elements on the pipes are clearly deliberate so, although they could be design elements remaining from an earlier functional object, they should provide some evidence of how the pipes were located relative to each other on the original composite object.

Of the ten timbers, six were found in the same stratigraphic layer – lying on the bottom of the *fulacht fiadh* – and these were designated Timbers, 1, 2, 3, 4, 6 and 8. Timbers 1, 2, 3, 4 and 6 were lying next to each other, with timber 8 lying at an angle across timbers T6, T1 and T3 (Fig. 23). The remaining timbers: T5, T7, T9, T10 and T11, were found elsewhere in the deposit and were the most fragmentary.

2.1 The Tapered End-Section of the Pipes

In their original form, the pipes were probably all terminated at one end by a male taper which varies considerably, both in length and degree of taper. Fig. 9 shows a typical tapered end. Because the surface of this taper was crudely finished, still containing working marks caused by the tool used to generate this taper, it seems likely that this section was mated to a corresponding female section. As the surface of the taper was not circular but was made up of irregular flat or arced surfaces with relatively sharp edges, it is likely that some sealing medium was used to effect a seal between the male and female sections. This end is referred to in this paper as the 'tapered end'.

Before forming the taper, the tube outer diameter was neatly undercut by 1.5 to 2.5 mm (Figs. 9–10). This undercutting was done differently from that on the oblique end of the pipe and has the appearance of having been traversed around the pipe's circumference first with a tool something like a saw.

2.2 The Obliquely-terminated End

The other end of the pipes was terminated by an oblique end face, angled some 20° or so to the axis of the tube (Fig. 11). This end has no apparent provision for mating to another tube, suggesting that this section of the pipe was not connected to any other feature, i.e stood freely in the air. This end of the pipe is referred to in this paper as the oblique end.

Also present on those pipes which still possessed this oblique end, was a section which had been worked to either a rebated section, some 2–4 mm or so below the general pipe surface or to a square section. The generation of the undercutting leaves the oblique end termination standing out like a top knot. The rebated sections were poorly finished with tool marks still being visible on these (Fig. 12).

The tool marks at this point still retain their sharp edges, suggesting that they were chiselled, gouged out or carved with a very sharp tool. Their definition being aided by the fact that no degradation of the timber has taken place at this point on the pipe and no striations are seen on the timber's surface. It is also clear that absolutely no attempt was made to remove the ridges left by the tool as this undercut was formed. Preliminary inspection suggests that the cut surfaces are concave rather than flat, consistent with their having been cut by the convex surface of a gouge. Closer inspection of these surfaces, following conservation may yield more data on the manufacturing techniques used to produce this undercut.

At the point where the undercutting runs into the top knot and the main pipe diameter, the craftsman has formed the edge by cutting down into the undercut, again using a sharp gouge-like tool (Fig. 13). This is in contrast to the working at the other end of the pipe where an undercut was generated in order to demarcate the taper from the tube surface proper.

2.3 The Central Section of the External Pipe Surfaces

The external sections of the pipes are generally round and are mostly cylindrical with a fairly uniform diameter, although one pipe is more lozenge shaped, having a greater diameter in the middle of the tube. The tubes have been made by working down larger blocks of yew and are not simply fashioned from branches of an appropriate size - see Section 3, below. All the external surfaces of the tube have been worked as the grain of the timber has been cut across and shows up as surface markings (Fig. 14).

2.4 The Square-ended Termination of Pipes 3, 5, 6a and 7

Several of the pipes lack a rebated/oblique end termination, these ending in a squared-off portion which had a reasonably well-worked outer surface (Fig. 15).

2.5 The Internal Bore of the Pipes

The internal bores of the pipes are revealed on most of the pipes where the tube wall has perished and these have a regular surface which is round and has the appearance of having been drilled out. Where the wall thickness can be observed, it is quite regular, indicating that the hole through the pipe runs out very little, if at all (Fig. 16).

2.6 Surface Features of the Pipes

Several of the pipes have features on their outer surfaces, some of these being decorative and some possibly resulting from the attachment of other materials to these outer surfaces (Figs. 17–20).

One pipe T2, the longest of all the pipes, has a double band formed around its periphery which lies between the rebated section of pipe and the tube's central section (Fig. 17).

One other pipe T3, the second longest of the pipes, has a pressure indent which runs obliquely around the surface of the tube (Figs. 18–19).

Several tubes have accretions on their outer surfaces which may have been the remnants of the binding materials which had previously held the composite instrument together. At the time of writing, the actual composition of these accretions has not been determined (Fig. 20).

2.7 The Removal of the Tapered Section on Pipes

Several of the pipes totally lack a tapered section but still retain the step which is seen separating the tube and taper on other instruments. On some pipes, the end surface of the tube has markings which are consistent with the taper having been cut through at this point. It appears, therefore, that these tubes previously possessed tapered sections but that these sections have been removed, possibly when disassembling the pipes prior to interment (Fig. 21).

3. THE MANUFACTURING OF THE PIPES

The pipes were made in yew timber which showed no heartwood/sapwood interface and displayed oblique grain boundaries on the tube surfaces. This suggests that the original timber blanks had been cut from a larger piece of timber. Very few knots were to be seen on the surface of the pipes, indicating either that the timber had been carefully chosen or those pieces with knots had failed to make finished pieces.

The 'round' pipes were carefully finished to a circular cross section but, as far as could be discerned with the timber in its current state were not 'round' to the level that would be expected were these to have been generated by turning. There were no circumferential marks on the surface that would indicate that these have been turned and the outer surface of all the pipes is characterised by axial striations along their entire length. No doubt, the effects of 'storage' for 4,000 years will have modified such evidence as did exist following manufacture.

It seems likely that the outer surfaces were scraped to form their shape, a sharp scraper being dragged along their length, axially. Two parts of the tube's outer surface, the taper and the undercut, were then worked by cutting with a sharp object, clearly delineated individual cut marks still being present on the tube's outer surface. This working of these surfaces was carried out in different ways, as discussed above, in one case by cutting a circumferential step around the tube and working up to this (Figs. 6, 9–10), and in the other by chiselling down into the undercut from the tube's surface (Fig. 13). From the apparent concavity of the surviving cut marks on the taper and undercut, it appears that a gouge was used in their manufacture. On both worked surfaces, these cut marks are long continuous ones made by a confident worker. They are not the evidence of material removed by whittling away the timber but of the use of a sharp tool by an equally sharp craftsman. These ancient tool marks will provide an exciting insight into the activities of an ancient craftsman once the pipes are conserved and available for detailed study. Of the tools which it is suggested the maker used, gouges and chisels are known from the bronze age but none from as early as these pipes. Fig. 22 (a, b & c) shows a gouge (b) and a chisel (a) which were found in Co. Waterford, Ireland[18] and a scraper (c) (which is identified as a razor) from the Thames at Richmond, near London, UK[19]. The former two of these items are not dated in the original article but are almost identical to tools found in the UK which are dated in the British Museum work, along with the scraper (or razor?), as late bronze age.

Undoubtedly the greatest achievement in the manufacture of these pipes lay in the creation of their bore. Even when using modern tools, the creation of a hole through a piece of timber some 600 mm. long, to leave a wall thickness of only a few millimetres is a challenge. Yew, the timber chosen by the ancient craftsman is a 'softwood' but it is among the hardest of the softwoods and is, therefore, rather difficult to work. The general consensus view is that woodworking at that time was done using green timber and that may have been the case with these pipes. However, once the

18 Power 1898, 47–52, Figs. 3, 6.
19 British Museum 1953, 34 No. 12 and Fig. 11, No.12.

timber has been worked and the pipes dry out, the very thin sections in the walls might cause problems with distortion. One of the reconstructed pipes bowed a couple of millimetres after it had been turned, despite the fact that the timber had been purchased as 'seasoned' timber. In general, the ancient pipes show little or no bowing, except where part of the tube has eroded away and caused distortion which can be attributed to the loss of section at this point.

The preliminary observations made so far indicate that the all bores except one – T7 – are generally concentric to the outer diameters, probably because the bores would have been started from both ends and these ends are what is now visible. The one pipe which has an eccentric bore is now in two pieces and the maximum runout of the bore is in the middle of the pipe. Even though this runout is measurable, it is still less than 2 mm, yielding tube wall thicknesses of 3 mm and 6 mm. Whether or not discontinuities exist in the middle of the other bores, where the two holes from either side met, may be determined when the pipes are more amenable to handing.

The major challenge for the craftsman, when creating these bores, would have lain in the establishment of a pilot hole through the pipe. This may well have been carried out by burning but would, nevertheless, have been a long, time-consuming process which was not inherently designed to produce a hole which ran true to the tube's outer diameter. Were the timber to have been green when burning out was attempted, the moisture in the timber would likely further prolong the operation. The pilot hole could possibly have been produced by drilling with a bow drill, using a flint cutting edge but this would have presented a great technical challenge when attempting to get the hole to run true.

Once a pilot hole had been produced, the hole could have been opened out, either by drilling, scraping or abrading. This latter process could have been carried out using an abrasive tool made from either wood or rope, to which abrasive material had been attached with pitch or resin. However it was done, these pipes are unlikely to represent a first attempt by a craftsman – they're far too well made for that! Whoever made them was accomplished at the process of drilling out the bore and had, most probably, done it many times before. When attempting to manufacture hollow yew instruments much later in the bronze age in Ireland, the craftsmen resorted to splitting the timber and then rejoining the two halves once the centre had been hollowed out[20].

Following manufacture of the pipes, these were probably assembled by mating their tapered ends with a tapered socket and sealing the joint with an appropriate sealant such as resin. No evidence of such a sealant remains on the pipes but it appears that the seal was strong and resisted disassembly as several of the tapers were cut off at some stage presumably during the breaking down of the composite object.

There is no evidence to suggest whether these pipes were of local origin or were imported into the area, either as individual pipes or within a completed instrument. However, the site is near the coast and it is likely that imported objects made their way into Ireland through this area. The level of specialised skill required to make the pipes does lead one to suppose that whoever made them was experienced in manufacturing items of this type and possessed the requisite knowledge, patterns, designs, etc., to enable them to create an instrument to a pre-defined standard. This would call for sufficient demand for instruments of this type to enable the expertise to be developed, maintained and, perhaps, passed on.

The manufacturer of the pipes left behind a tangible witness to his expertise in a number of ways:

(a) He chose his timber, yew, for the pipes but possibly not for the remainder of the composite instrument, it cannot be said whether this was for technical or cultural reasons.
(b) Appropriate pieces of timber were chosen: the pipes contained no knots which would seriously hinder manufacture and the grain pattern in all the pipes was relatively straight.
(c) All the pipes were formed to a uniform circular external cross section, the original timber from which they were made having been somewhat larger diameter than the finished pipes.
(d) Some concept of mensuration was employed as all the pipes are of roughly the same external diameter. These outer diameters are not similar enough to suggest that anything other than measurement by eye took place but they are, nevertheless, intentionally-formed to the 'same' diameter.
(e) External surfaces of the pipe are 'finished', i.e., deliberately worked to a finer surface finish than the tapered and undercut surfaces. The craftsman understood the concept of different surface finishes and the processes of producing these.
(f) The tapered end of the pipes had an undercut between the tube diameter and the taper itself. The craftsman understood the concept of separating these two elements of the pipe, choosing a tool to enable the undercut to be produced and executing this undercut.

[20] O'Dwyer 2004.

(g) The taper and the undercut were chiselled or gouged out using suitable tools. The craftsman had a selection of tools, knew how to keep these sharp and how to use them effectively.
(h) The craftsman understood how to create a hole through the centre of a pipe, choosing/making appropriate tools and using these to create the bores.
(i) If the pipes were designed to seat into a female taper, as seems likely, the maker understood the concept of using matching tapers to mate together two pipes.

4. ASSEMBLY OF THE PIPES

As found, there are no physical connections between individual pipes and nothing to indicate that they each formed part of a composite object. However, their layout in the trough was by no means random, as they had been positioned with one end aligned and they were laid out in order of length. This layout creates an implicit connection and suggests that they inter-related with each other in a way that had to do with their length (Fig. 23).

The two ends of the pipes are totally different with one end having a tapered section and the other an oblique end face/squared section. While the end faces are well finished, the tapered sections are crudely chiselled and appear designed to fit into a corresponding female taper. Such a taper may have been provided on individually-mating tubes or on a single piece of timber that mated obliquely with their tapered ends. The end of the male taper may have sat proud of the tapered socket slightly as the beginning of the taper may be seen on Pipe T3, its having been cut just below the undercut in order to free the pipe from the assembly.

The obliquely-terminated ends of the pipes were provided with either a circular undercut or a squared-off section, the undercut portion being only roughly finished (Figs. 11–12) This lack of finishing suggests that this portion of the tube was covered by some material on the finished composite object, presumably the material that served to bind the pipe assembly together.

Bands of accreted material are present on the outer surfaces of several tubes and these have the appearance of binding materials which served to hold the pipes in place. In addition to this, several pipes have pressure indents on their outer surface, suggesting that these had been bound by a strong, narrow binding material.

The six pipes which were found in the group at the base of the trough, the basal group – the most-complete pipes – were packed closely together with no physical space between them for other pipes. Were the other pipes – the more-fragmentary ones – found scattered elsewhere in the *fulacht fiadh* to belong to the same instrument then they would have to have belonged at one of the two ends of the instrument and been either longer than the longest or shorter than the shortest of the pipes in the basal group. However, pipe T5, which was in conservation at the time of the study and could only be viewed through a murky PEG solution, would probably have been about 313 mm long, i.e. very similar in length to Pipe T6A. In addition, Pipe T9, which was fragmentary, could have been the same length as Pipe T8. These similarities suggest that the two assemblages – the basal deposit and the scattered fragments – represent the remains of two different instrument.

The finished replica which was made with six pipes, weighed in at just over one kilogram and is reasonable to handle, from a weight point of view, and the addition of six or so more pipes would probably not make it too heavy to handle. This would depend, of course, on whether the additional pipes were longer or shorter than the existing pipes and, significantly, on the pipes' wall thicknesses. On the replica, the walls were a little thicker than on the original pipes, the discrepancy resulting from an age-old technological phenomenon – fear. During manufacture, following the disintegration of one of the pipes, it was felt that discretion was the better part of valour and that the first attempt could allowably be a little heavier than the originals.

The width of the pipes on the replica, excluding the carrying handles, is 229 mm and, while the addition of a further six pipes would make the instrument a little unwieldy, it would still be manageable.

Thus it is both possible that the pipes belonged to two composite objects and that they all belonged to the same object. However, whatever the configuration, it seems likely that their tapered sections fitted into a component which held them together and totally obscured the roughly-worked section at their end. Their arrangement when mounted in this component is likely to be similar to that seen in the *fulacht fiadh* when found. The oblique end of the pipe is likely to be aligned in some way with a line drawn through the ends of the pipes themselves, thus being an aesthetic feature. As it is also roughly worked, the cut-away section towards one end of the pipes is likely to have been covered by some material, possibly a binding material.

The final assembly of the pipes appears to have used only materials which could be removed at the end of the instrument's life without damaging the pipes themselves.

Whether this was done intentionally or not cannot really be ascertained from the available evidence. However, at the time of disassembly, it appears that several of the tapers were tight in their sockets and the pipes needed to be cut out when breaking the instrument down. However, this process was carried out quite expertly with the use of a sharp tool to cut through the male taper (Fig. 21).

5. THE POSSIBLE USE OF THE PIPES

If the assumptions are correct as to how the pipes were assembled, the composite object would:

(a) have a sequence of relatively delicate pipes
(b) have an assembling mechanism which located and retained the individual pipes
(c) have pipes whose relative lengths were in some significant relationship
(d) be a valued and, therefore, important object by virtue of the skill and effort expended in its creation
(e) be important enough to inter ritually at the end of its useful life

A key element in the above list of attributes is the one which considers the significance of the lengths of the pipes. They were clearly manufactured to be different lengths as they have recognizable 'tops' and 'bottoms' and this must give a strong indication as to their intended purpose. In this search for intentionality behind the design of the pipes, everyone will bring their own expertise and experience but, to a musician, the fact that one of the pipes (T6A) is, as far as one may reasonably estimate, half the length of one of the other pipes (T2) is of the greatest significance. In musical terms, this means that the two pipes represent the same 'note' separated by an octave – a very significant musical finding. Further investigation of the tube lengths yields other significant relationships, strengthening the view that the pipes represent the components of a composite musical instrument. It is, of course, possible that the pipes were sound tools designed to perform in a manner which we would not today recognize as 'musical' i.e. the pitches of the notes were randomly-determined and the above ratio was a coincidence.

5.1 The Pipes as Musical Objects

It is possible that these pipes had been used as the resonant cavities of musical instruments, either as pipes that were sounded all at the same time or ones which sounded alternately to create melodic performances. In the first case, the tonality of the pipes would reflect the harmonic structure of the musical practice which employed them while, in the second case, their tonality would reveal something of the modal or scale structure of the society.

These pipes can only have been used as resonant cavities as they contain no sound-generating devices and can only have reacted to a vibration generated by a further, presumably acoustically-coupled device. Such a device may have been attached in such a way as not to increase the effective length of the instrument or may have added further length. If it is assumed that the former is the case, it is possible to work out what frequency input would generate a standing wave in each pipe.

Assuming that the standing wave is a half-cycle, i.e., the pipe is treated as a closed tube, the wavelength of a full cycle of one wave would be 2× the length of the tube (l) or $2l$. The time taken for the wave to travel this distance (in metres), given a speed of sound of 343 m per second is $2l/343$, thus the frequency of oscillation is $343/2l$. In the table below, the estimated frequencies are converted into modern notation (A = 440Hz), using equal temperament, purely to enable a modern musician to interpret the pitches and imagine the range of notes produced by the pipes. Close correspondence between modern standard pitches of notes and those calculated for the pipes are purely coincidental as the frequency level of notes used in modern music was arrived at in a radically different way.

As some pipes were lacking distinct parts, such as their taper, their lengths were estimated by adding on length equal to the average length of the tapers (35 mm). This gives the lengths and frequencies for the pipes shown on Table 1. The numbering of the pipes does not reflect the order of their layout as discovered.

The most significant musical relationship to look for between the pipes would be one of octave relationship as, not only do virtually all societies recognize the octave as being a consonant interval but these pipes, when blown as a fipple flute, (admittedly only one possible configuration) can be made to blow both a tone and its higher/lower octave harmonic. Such an interval is demonstrated between pipes T6A and T2 where the ratio between the two frequencies of these pipes is 554/277, or 1.997.

A second significant ratio to look for would be that of the fifth which is considered consonant in many societies. Based upon a tonic of C#, this interval is present only weakly between pipes T2 and T4, the ratio of their lengths being 619/424 or 1:1.46, the theoretical ratio being 3/2 or 1:1.5. When this is expressed in modern notation, the fifth between the C#4 and C#5 of pipes T6A and T2 would be G#4 but although pipe T4 does estimate at G#4, it is actually 48 cents flat or pretty-well midway between G#4 and G4. Fig. 24 maps all the derived frequencies onto a template based on A = 440Hz and expresses the intervals in terms of an equal-tempered scale - an essentially modern concept. When this is done, the pipes yield the following notes with the divergence from the modern note being expressed in cents below the notes.

5.2 Incorporating the Pipes into a Composite Musical Instrument

As they were found, the pipes contained no sound-generating features, i.e., they could only have functioned as the acoustic cavities downstream of the instrument's sound-generating mechanism. Given the current evidence from the find, it is only possible to speculate as to what the remaining components of such an instrument might have been.

Pipe	*Length (mm.)*	*Corrected Length (mm.)*	*Estimated Frequency (Hz)*	*Pitch & Cents Difference*
1	490	490	171.5×0.490 = 350	F#4 -0.5
2	584 – No taper add 35	619	171.5×0.619 = 277	C#4 -1
3	514 – lacks part of taper add 3	517	171.5×517 = 332	E4 -13
4	424	424	171.5×424 = 404	G#4 -48
5	Tube incomplete	>267 (313?)		
6A	286 – lacks part of taper add 24	310	171.5×310 = 553	C#5 -3
6B	Tube incomplete	N/A		
7	Tube incomplete	>189		
8	324 – No taper add 35	359	171.5×359 = 478	A#4 +45
9	Tube incomplete	>324 (359?)		
10	Tube incomplete	N/A		
11	Tube incomplete	N/A		

Table 1 Pipe Lengths and Estimated Resonant Frequencies of their Air Columns.

However, based upon F# as a tonic, there is a very precise fifth generated between this F#4 and the C#5. The discrepancy of 2.5 cents from a perfect fifth is way below the threshold of detection for virtually all musicians. Perhaps one of the shorter pipes yielded an F#5 to provide the octave. The A#4 which would have provided the third note in the major triad is, in reality, midway between A4 and A#4 and fails to illustrate any similarity between modern musical structures and those upon which the design of the pipes was based. However, a note between A4 and A#4 would conform to many traditional styles of performance in which the interval of the third is flexible, either oscillating between major and minor third, or simply indeterminate.

Unfortunately, the crudeness of the corrections that have been used to estimate the original lengths of most of the pipes, negates any deeper analysis of the tonal structure of the instrument. It could be argued that the analysis carried out above already pushes the data further than is reasonable and, hence draws unsubstantiated conclusions! However, the estimations appear to suggest that the notes sounded by these pipes could be part of a musical scale of some sort and that the musical life of the period was sufficiently developed to utilise some formal musical structures.

If one identifies the pipes as the tone pipes of a musical instrument, the question of what type of instrument remains open, as the pipes themselves contain no sound-generating features. It is not even clear to what family of instruments they might belong. Of the major families, it seems reasonable to rule out stringed instruments as their morphology does not seem amenable to incorporation into such an instrument. This leaves idiophones and aerophones as the most-likely groups.

5.2.1 Idiophones

Were the pipes to belong to an idiophone, they would need to be the tuned components of a composite instrument – such as the tuned chime bars of a set of tubular bells. For use in such a way, individual tubes would need to be resonant when suspended freely and struck with an appropriate beater. Being made in yew, with a relatively thick wall, the pipes would not respond in this way and nor did the replicas. A caveat here, however, is that the replicas at the first attempt are a little thicker than the original pipes. In addition, to be used in such a way, the tubes would need to be suspended in such a way as to allow them to resonate over their entire surface when tapped. However, these pipes have what appears to be a tapered section designed to fit into a tapered socket and to be firmly attached to this, when all that would be necessary as a suspension device would be a hole at one end of the pipe.

An alternative suggestion, from John Purser, is that the pipes could have been fixed into a hollow block, the entire structure resonating when the pipes were struck[21].

5.2.2 Aerophones

In the discussion below, it is assumed that, were the pipes designed to have been assembled so as to line up at their tapered ends, a receptacle or receptacles would have been provided to accept the tapers. This assumption is based upon the grounds that the surface of the taper is crudely worked and, therefore, was designed to be hidden within a wind chest and that a player would need the edges of pipes to lie adjacent to each other to enable them to move smoothly from one pipe end to another. Thus, a receptacle would provide a relatively smooth surface with which the lips would be in contact..

Some types of aerophones are blown by a player directly while others are blown via a bag or wind chest.

5.2.2.1 Player-Blown

In this group, instruments are designed so that the player blows each pipe individually, moving the instrument across the mouth in order to sound different notes.

Brass or Lip-Reed Instruments: as on a Modern Trumpet/Horn

Were the pipes to be blown as a lip-reed instrument, they would need to be provided with some form of mouthpiece or mouth-support. the existing termination at the oblique end of the tubes is unsuitable as the player would be unable to move easily from one tube to another without constantly twisting the whole assembly. At the other end of the pipe, the tapered portion could provide a blowing aperture of sorts but seems more like to have been inserted into another component to hide the poor surface finish at this point. A simple connector block could be provided to accept the tapered section and to provide a series of mouthpieces for each tube. Such a design would enable individual tubes to be sounded by the player. However, experiments with the reproduced tubes suggest that, while such an arrangement is possible, the time taken to settle the lips on the mouthpiece and to establish an embouchure creates a considerable delay between one note and another negating the idea of having a multiple-note trumpet. Someone who has practiced the instrument might be able to overcome this problem but it seems unlikely.

Edge-Tone or Air-Reed Instruments: As on a Modern Orchestral Flute

Were the pipes to belong to an air-reed type of multi-flute instrument, a tube edge would need to be provided over which the player blew. The oblique end of the instrument is an unlikely contender for such an edge as it would require the player to constantly rotate the instrument when moving from one note to another. The tapered end could provide a blowing aperture of sorts as it stands but would present difficulties as the player attempted to establish a new embouchure over the end of each pipe. A receptacle could have been provided which accepted the tapers and provided a more-suitable termination for the player. However, were the tubes designed to have been used as this type of instrument, it is felt that a simple cylindrical tube termination would have been just as suitable and this would have removed the need for the tapered end termination.

The pipes could also have been fixed into a block which contained an individual windway for each pipe and whose function was to direct the flow of air across the top of each pipe and sound it as a panpipe. Fig. 25a illustrates the head block structure suggested by John Purser and Fig. 25b, the possible assembly of such an arrangement.

Fipple Flute

Were the pipes to belong to a composite fipple-flute type instrument, each pipe would need to be connected to its own individual fipple. Such fipples could be provided in a block which accepts the tapers of the pipes' ends and contains a number of fipples and blowing apertures. However, the air flow through and over the beak of the fipple relies on the air flow switching itself alternately above and below the beak. When no pipe is attached to a fipple, this switching occurs at a high frequency and a high piercing note is generated. However, when a pipe is attached to the fipple, the frequency of switching is controlled by the standing wave which is set up in the pipe, the frequency of this being defined by the length of the pipe itself.

Fipples may be cut directly into a tube or provided on an additional circular tube with the fipple being cut into its wall of the tube with the air flow which is directed onto the fipple being created by

21 Purser, personal communication 2005.

means of an air passage formed from the gap between a stopper in the tube end and the tube wall. The reconstruction of the pipes was made in this way. Fig. 26 shows a possible design of such an instrument and Fig. 31 shows the actual reconstructed instrument.

Flue Pipes as on a Modern Organ

Were the pipes to be utilised in a composite flue pipe type instrument, each pipe would need to be connected to its own flue pipe. Such flues could be provided in a block which accepts the tapers of the pipes' ends and contains a number of individual flues and blowing aperture. Flues operate in a similar way to fipples, the major difference lying in the mode of directing air onto the edge over which the air passes and alternates above and below. Air is directed onto this edge, or upper lip as it is referred to by organ builders by two baffles, these being referred to as the lower lip and languid. It would seem unlikely that the maker of these instruments would be able to create such structures in wood within the confines of an 18 mm. bored tube as they are typically made in metal in historic and modern organs.

Single Reed: as on a Modern Clarinet

Were the pipes to belong to a composite, single reed type instrument, each pipe would need to be connected to its own mouthpiece which supports the reed. Such a mouthpiece could be provided in a block which accepts the tapered ends of individual tubes and contains a separate mouthpiece/reed for each pipe. It seems unlikely that the player gripped the individual reeds with their mouth as on a modern clarinet as that would not allow them to move from one note to another with any speed. It seems more likely that the instrument would be provided with a wind cap into which the player blew.

Double Reed: as on a Modern Oboe or Bassoon

Were the pipes to belong to a composite, double reed type instrument, the same limitations would apply as for a single-reed instrument.

5.2.2.2 Bag/Wind Chest-Blown Aerophones

The pipes may have been voiced by air supplied from a bag or wind-chest, much as on a modern bagpipe or organ. Of the various voicing mechanisms discussed above, only the fipple flute and single and double reed arrangements would be feasible when driven from a stored air supply. The lip-reed and air-reed arrangements depend upon the inter-relationship between the player's lips and the instrument's tube and could probably not, therefore, be recreated as a mechanical device during the early bronze age.

An instrument powered indirectly from an air reservoir could operate as a harmonic device in which all the available tonalities are generated at the same time, or as a melodic device where individual pipes are voiced successively to create a melody. In the case of a harmonic device, it is only necessary to supply air to all the pipes more-or-less equally when the instrument is played. However, the melodic device would require the pipes to be voiced individually so as to create the melody. The illustration below shows a spectator's view of an early instrument of this form. It is actually a graphito which was scratched on the wall of a Roman villa in the Via Appia[22] (see Fig. 27). This drawing shows the typical raked top of the pipes, a view not unlike that presented by the pipes laid out in the *fulacht fiadh*.

Air may be supplied to the instrument's reservoir either directly by the player who blows into this, as on the bagpipe or from bellows which may be either held under the player's arm, as on the Uillean pipes or placed on the floor to be operated by the player's foot or by a second person who operates the bellows in some way as on the harmonium or bellows organ. The earliest recorded form of a pumped device on a musical instrument, that of Ktesibios of Alexandrian Greece is separated by some 2000 years from this find. The Greek example is very 'modern' in its engineering and is not suggested as an analogue! Whichever way the air is supplied, valves will be required to stop the air flowing back into the player's mouth or into the bellows (Fig. 28).

However, the blowing of furnaces by means of bellows had become essential for the melting of bronze by the time this instrument was made and such a device could have been used on a composite instrument created using the pipes. It would have been essential to have provided some form of buffer to smooth out the air flow to the pipes and Fig. 29 shows a possible, if elaborate, arrangement which utilises a leather animal skin as a reservoir. In this interpretation, the obliquely terminated ends of the pipes are aligned in a horizontal plane with the tapered ends running at an angle to the horizontal, much in the way of the layout of the pipes in the *fulacht fiadh*.

The second requirement for a bag-blown instrument, when it is to be used melodically, is for some device which enables individual pipes to be sounded in sequence. Again, the earliest reference to such a device is Ktesibios, much, much later than the pipes under discussion here. Fig. 30

22 Perrot 1971, 78, Plate III, No. 2.

shows schematically, the layout of the valves which is reported for Ktesibios' hydraulis. As with the blowing mechanism, it is of quite a modern aspect[23].

Fipple Flutes
The fipple operates as described above, by causing air to flow alternately between the tube and atmosphere – via the fipple opening. This offers the opportunity of causing a pipe to stop speaking by simply obstructing the air exit at the fipple aperture. A device to do this could be created quite simply by hanging a block from the body of the pipe so that it blocked the fipple when hanging freely and thus prevents the air from exiting to atmosphere and, hence, the tube from sounding. Once this is lifted up, the fipple exit is cleared and the pipe is then free to sound. Figure 24 shows how such a mechanism might operate, some of the fipple covers having been left out of the drawing to show the position of the fipples. While this is a feasible arrangement, it suffers from the limitation that air is being driven through all the pipes all the time. Thus, even when a pipe is not speaking musically, air still passes through the bore of the pipe. For this reason, a large supply of air is required and, in spite of building bigger and bigger bellows, the experimental devices built for this study never functioned adequately in the workshop when blown by hand. However, when a powerful electric blower was used as an air supply, the device could be heard a considerable distance away! While this was some recompense for the many hours of experimentation, it served mainly to demonstrate that the large volumes of air required for this device were likely to rule it out as a possible arrangement for the pipes under study.

Flue-Pipe Instrument
A flue-pipe instrument could be made in much the same way as described above for the fipple flute but the same limitation as to the supply of air would hold true.

Single and Double-Reed Instruments
Were single or double reeds to be used to voice a bag-blown instrument, a mechanism would have to be developed to cut off the air supply to those pipes which were not to sound, while allowing air through to those which were being sounded. A wide variety of devices could be proposed from the blocking of a flexible air-supply line to the provision of a valve but such devices would call for a level of complexity which, intuitively, would appear too great for the period.

6. THE CONCEPTUAL GRASP OF THE DESIGN PROCESS

The pipes which were found were clearly components of a more-complex assembly. If they are, as is suggested here, parts of a musical instrument, then they are designed to be the resonant cavities which establish the tonality of the instrument as a whole. This separation of function of the overall instrument, into separate tone-generating and pitch-defining devices demonstrates an understanding of the separate elements which serve to make up a complete musical instrument. Simpler flutes of earlier times were integral devices with all the features needed carved from a single piece of bone or other material. These pipes, however, demonstrate a higher level of understanding of the science of sound-generating devices and the ability to create operational systems from specially-manufactured components.

Someone who was connected with the design/manufacture of each of these pipes understood that their length a) was significant and b) affected the pitch that was produced when this was attached to a sounding device. They further understood that when the pipes are combined together in a particular way, the pitch produced by the combination of pipe and sound generator would produce a complex tonal collection which we would describe as a scale.

It is unlikely that this collection of pipes represents the first such assemblage – because of the technical level of manufacture – and we will never know just where it lies in the developmental sequence of the times. No matter what its role was in the overall scheme of things, the appropriate lengths for the pipes in this collection would, most likely have been arrived at some time earlier, leading to the requirement for the dimensions to be conserved accurately and to be transmitted to later manufacturers. This requires the concept of length and its conservation and reproduction to have been current in the culture of the manufacturer. Were this not to have been so, the maker would have needed to have understood the musical structure of the culture into which the pipes were embedded and to have adjusted the pipe lengths appropriately when finishing them off. As the top-knots on the oblique end of the pipes are relatively short, the maker left no room for later adjustment to his finished product.

As all the tapers on the pipes are different, the maker probably made sockets which matched

[23] Perrot 1971, Fig. 1b.

individual pipes and selectively assembled these. Such mating components as were connected to the pipes would themselves add length to the resonating cavity and it can only be assumed that the manufacturer was aware that it was the combined length that was critical and attempted to conserve this as appropriate. Assuming that the male taper on the pipes was designed to seat in a female taper on another component then the maker understood the concept of mating together male and female tapers in order to effect a seal.

When the range of pitches of pipes is as great as those present in this find, the bore diameter of the pipes becomes an important factor with respect to their ease of sounding. The larger pipes, i.e. those with a lower pitch need to have a larger diameter bore than the shorter ones if they are to sound easily. This may have been understood by the designer/manufacturer of these pipes as, although the outer diameters of the pipes are pretty well the same, the bores of the longest pipe are around 21/22 mm, the bore of the shortest pipe being 16/17 mm. As the difference is achieved by altering the wall thickness, the shorter pipe is noticeably 'heavier' than the longer one, i.e., the doubling in wall thickness can be detected easily from the greater weight of the pipe.

A further interpretation of the separation of function in the components of the composite instrument is that it was done for technological reasons and the pipes could not have been made with the mating piece integrated into them. Were this to be so then the conceptual understanding lay in the realm of manufacturing as it was then necessary to design the various components of the piece in such a way as to allow them to be manufactured utilising the available tools and technology.

If the final assembly was anything like the suggested composite instrument, the maker had created a complex mechanical device made from a number of specially-made components. While it is not suggested that these were made to set standards (apart from the pipes themselves), these components were, nevertheless, created to fit together to form this composite object of, perhaps, 20 to 30 pieces. The variability of the tapers on the ends of the pipes does suggest strongly that the entire object would have been selectively assembled with individual pieces being 'made to fit'.

7. THE DESIGN AND MANUFACTURE OF THE REPLICA PIPES

A set of pipes was made, in yew, in order to investigate the problems involved in their manufacture, as well as possible configurations which could be adopted in a composite instrument. The process was carried out by making the pipes first and then building and assembling a composite instrument around these.

As no local source of yew could be found, a set of 30 mm square blocks of timber of appropriate lengths was purchased off the internet. Because of this mode of sourcing, the actual timber could not be chosen for its smooth grain and some blocks contained a large number of knots. In some cases, the number of knots rendered the timber unusable for making pipes. This timber obtained, thus contrasted sharply with that utilised in the manufacture of the ancient pipes which were almost totally free of knots.

The outer diameter was roughed out and then turned on a large industrial lathe with a bed of some six feet (2m) or so in length. A large lathe was required in order to accommodate the long drills needed to create a pilot hole down the centre of the longer blocks. The blocks were turned to finished size and a pilot hole drilled inwards from both sides in order to minimize run-out of the bore. During this process, two of the knots present caused difficulties, one causing the pipe to shatter and the other flying out the pipe to leave a radial hole in the pipe wall.

Once the pilot hole had been drilled, a long-reach 16 mm drill was used to clean out the bores to size. While making the pipes, one short section was roughed out and then scraped to a circular cross section. In this experiment, a metal scraper was used which was made of steel but was of much the same shape as that shown in Fig. 22c. A further experiment was carried out using a bow-driven drill bit. In spite of the time spent boring away at the timber, this experiment proved little more than that the yew was a hard wood to work. It is very likely that, were a bronze-age craftsman to have been observing our puny efforts, he would have found them hilarious and grimaced at our lack of expertise!

Once the tubes had been made, the tapered end sections were turned, these all being made to the same taper in order to ease assembly of the finished instrument – unlike the tapers on the original pipes which were different on each pipe.

The reconstructed instrument was provided with fipples as the sound generating devices, these being designed to mate up with the tapered end of the pipes. The design of the fipples was totally conjectural, being modelled upon a modern tenor recorder. During the manufacture of these fipples, an inadvertent experiment – to investigate the toxicity of yew – was carried out by blowing a fipple which was filled with fine dust, much of which was either breathed in or ingested! It confirmed that yew had to be treated with care and, for two days, manufacture of the pipes ceased while the yew did its work. However, the maker survived –

uncomfortably – and the fipples were eventually finished.

A pair of simple frames was made to support the fipples and the assembly was lashed together using leather bindings. The pipes' tapered sections were then covered with leather and the pipes lashed to the fipple assembly. Fig. 31 shows the finished composite instrument. Its detailed design is not discussed here as it was not based upon any evidence, but just made!

8. THE IMPORTANCE OF THE PIPES AS OBJECTS

Simply because of their having been made of yew, the pipes can be interpreted as significant cultural objects. In addition, the level of skill demonstrated in their manufacture further emphasizes their importance as it would hardly have been possible for a journeyman craftsman to have created such a thin-walled pipe, their being most probably the product of a specialist worker. Were this to be the case, these pipes were specialist output from someone who had built up their skill by making a number of sets of these and who had, most probably met demand from a large geographic area. The craftsman could have been local or could have been working some distance away, the pipes having been imported into the area.

At some point, a decision was made to put these pipes beyond use, the pipes themselves yielding no clue as to why this was so. It may have been that some other part of the instrument had become irreparably damaged and that the skill to repair it was not available locally. Perhaps the skill had never been available locally. Perhaps the maker/repairer needed some special power which could only be granted by a religious/cult leader and such a person was no longer available necessitating their 'safe' disposal. It may be that the use of the *fulacht fiadh* was an improvisation based on the need to find a site and the opportunistic availability of a trough at the appropriate time.

The life of the instrument could also have been deemed to be over because it had developed a strong association with a person of high rank within society and their death heralded the end of the instrument's life. Had this person been buried, one would have expected the pipes to have been buried with them, mirroring practice elsewhere in ancient times. However, were they to have been cremated, the pipes may not have been allowed to have been similarly committed to the flames and were interred after the ceremony. Their last act could have been to serenade the departed on their last, long, journey to the afterworld and their ancestors.

The pipes were clearly important enough to be disposed of in a ritual way and their careful deposition in the *fulacht fiadh* tells that they were not simply thrown into this. The act either brought the *fulacht fiadh* to the end of its life or may have utilised a coincidental event, the closing of the *fulacht fiadh* providing a resting place. It seems unlikely that these pipes were sacrificed to mark the end of the life of a *fulacht fiadh* as no such marking was done on the many other troughs which are found, these generally being filled with rubble and only occasionally containing objects such as bronze axes. To date, there appears to be no explanation why *fulacht fiadh* are put out of use.

These pipes were preserved carefully in the lined *fulacht fiadh*, the other two of the three *fulachta fiadh* on this site being unlined, and the pipes were laid out in a way which probably reflected their relative orientation during use.

Just why the pipes were removed from their putative composite instrument and buried on their own can only be surmised. However, they had been disassembled prior to deposition in a way that reflects the 'ritual killing' or, at least the disarticulation of instruments that is seen in other finds[24]. Part of this disassembly process – the removal of some of the tapers – involved partial destruction of the pipes. On their own, the pipes were unlikely to be perceived as musical instruments but, as far as we can tell, only the pipes were buried and not the remainder of the instrument. Perhaps they were seen as the voice of the instrument and a voice that had special significance to the community and could not, therefore, be destroyed at the peril of invoking the wrath of some powerful force.

Because of the very high level of skill used in the manufacture of these objects, these were probably objects of great significance to their society and probably ones that took part in the ritual practice of the community or ones that belonged to a high-status individual who could afford such a luxury.

As the pipes were found in isolation, with no contemporary references to their existence, it is impossible to place them in a musical context. It may have been that the composite instruments bridged the gap between ritual and art music. The reconstructed instrument is quiet and well suited to be played in a small group as entertainment or to accompany other social activities. Whether they represent just one example of a continuous tradition of performance or simply a stray instrument which found its way into alien territory can only be guessed at. As the pipes were laid to rest,

[24] Haynes 2000.

did a lament ring out from their successor or did a silent people look on in disinterest as a relic of the past was disposed of with respect but no sense of loss?

8.1 The Role of Yew in the Manufacture of Ritual Objects in ancient times

The decision to make the pipes in yew was probably based upon a mixture of factors which included its availability, working characteristics as a timber and the cultural associations which granted it a special cult status. It seems likely, from the evidence of pollen counts in ancient peat bogs, that yew was much more common in Ireland in ancient times and some estimates suggest that up to 80% of the trees growing in northern Europe in earlier times, as the ice retreated, were yew. Apart from its abundance, it may also have marked itself out by being the only, or at least the most-prominent evergreen around. By the time of the early bronze age, the situation had probably changed, with yew being much less prominent but having been maintained in the folk memory as a tree of mystery with connections to the Otherworld and the ancestors[25].

Although yew is technically a softwood, it is very hard and durable and many ancient yew tools and implements have been found all over Europe, most prominently recently in the hands of 'The Iceman' who carried a bow of yew and an axe with a yew handle. As well as its hardness granting utility, it also yields a timber which is very hard and can be difficult to work. Several trunks may grow from one root, often recombining again into a main trunk. This causes the timber to be burred and very unevenly grained, increasing the difficulty of working it. Yew has long been seen as a mysterious tree and has acquired a special status because of this. All parts of the tree are poisonous to humans and animals except for the fleshy part of the seed and yew toxins were used all over Europe to make arrowheads lethal[26].

The tree itself is very long-lived, some examples being considered to be among the longest-living organisms on the planet at 5,000 and possibly up to 9,000 years of age. Actual age can be almost impossible to establish as the centre of the trunk – the oldest part - decays away and branches of a tree may develop roots and form a grove around the parent tree while new trunks may shoot up from the root stock, similarly forming new 'offspring', sometimes within the hollow of the parent tree. No doubt, the intimations of immortality arise from this regenerating process and led to the yew being the archetypal 'Tree of Life' [27].

This longevity (or apparent immortality) has led to yew trees being used as landmarks to demarcate territories by marking boundaries and meeting places. One Irish myth 'The Yew of the Disputing Sons' tells of the battle of Mag Mucrama which was fought over the ownership of a yew tree[28]. The memory of these ancient trees recorded the history of the ancestors and ensured the continuity of the tribe. They also marked the location of blind wells and twigs of yew are still used in the decoration of wells in the well-dressing ceremonies still practiced in Derbyshire (UK).

As yew trees age, their trunks become hollow and these hollow trees were seen as the gateway to the Otherworld, the route to reunion with the ancestors, the guardians of the underworld, death and the afterlife[29]. Perhaps the hollow yew pipes became vested with the powers of the parent tree and provided an alternative conduit for communication with the ancestors.

According to Kindred "The yew represents direct contact with our past and the old wisdom which we can find deep within ourselves. It also speaks to us of fresh growth rising out of death [...] transformation and rebirth"[30].

Yew feature frequently in Irish literature, one work, the 14th century Irish Book of Lismore, using the age of yew to describe the ages of the world and dates the earth by saying 'Three lifetimes of the yew for the world from its beginning to its end'. Another tale – of Conn Cetchathach - probably dating from the 8th century AD tells of a maiden – 'The Sovereignty of Ireland' – sitting on a crystal chair and wearing a golden crown who writes down the length of the king's reign and that of his successors in Ogam on staves of yew[31].

In yet another tale, King Conchobar, who killed two lovers, attempts to separate their graves by means of yew stakes. The yew stakes, however, grew together, uniting the lovers in death. A similar event is told in the tale of Tristan and Iseult (Isolde) who are buried either side of the chapel in Tintagel Castle so as to separate them in death. However, yew trees sprout on their graves and grow to reach each other over the roof of the chapel. Even when cut down three times, they regrow to reunite the lovers in death. In later versions, such as that below from James Ormerod[32], the yew has been transformed into a briar but the sentiment is the same.

25 Chetan/Brueton 1994.
26 Mitchell 1974; Fraser 2005 (section: The Yew as a Poisonous Plant).
27 Chetan/Brueton 1994.
28 Chetan/Brueton 1994, 224.
29 Kindred 1997a .
30 Kindred 1997b, 47.
31 Chadwick 1976, 177–178.
32 Ormerod 1928.

And saith the ancient chronicle:
A briar-tree sprang from Tristram's grave,
And climbed across the apse, and fell
On Iseult's tomb, and there it clave.
Thrice did the peasants fell the tree,
And thrice it grew and flowered again;
Whereat they marvelled ceaselessly,
And unto Mark did straight complain.

When King Mark heard he scarce could speak
For the strained feeling at his throat.
"O Carles," he said, "depart, nor seek
To kill the briar, lest in the moat"

"I fling you for your villainy."
And whispering to himself he said:
"Iseult of Ireland now hath wed
Sir Tristram in Death's orat'ry."

In another Irish tale[33], a swineherd on the Rock of Cashel, Tiperary, in which he beheld a yew bush on a stone, was interpreted by the Druid of Aed "that will be the residence of the King of Munster for ever and who shall first kindle a fire under that yew, from him shall descend the kingship of Munster!".

So go the many tales which pick out the yew as special and having the powers to grant immortality in the Underworld to those who have left the world of the living and to grant continuity to the line of those who live.

When the ogam (*ogham*) alphabet was created, many years after the period of this find, the sign for yew used the fifth and final vowel in the ogam which is also associated with death, renewal and rebirth and is used to symbolise eternity.

9. CODA

When Bernice Molloy and her team first set eyes on these pipes, they started them off on the next stage of their lives after a 4,000 year sojourn in the ground. They still have a long way to go! So far, we can only ask questions and seek the enlightenment which may be the reward of further study.

CONCLUSIONS

By Bernice Molloy

It is not known exactly how these pipes functioned as a musical instrument. It has been suggested that they are part of a pan pipes or perhaps a composite instrument such as a pipe organ. Initial experiments on the pipes suggested that they generated the notes E flat, A flat and F natural. Without known parallels, it is difficult to establish where the pipes were made. Charcoal analysed on various sites excavated at Charlesland has indicated that yew grew in the surrounding environment[34], and the timber used for the pipes may have been sourced locally. Alternatively, the object may have been imported. Ireland was an important source of copper and gold[35] in the Early Bronze Age and had established a series of trade networks at this time, with Britain, and along the Atlantic coast of Europe. This is evidenced in the distribution of gold *lunalae,* probably an Irish innovation[36], which have been found in Wales and Brittany. Waddell[37] has also identified possible trade contacts during this period by examining the distribution of pottery of the Irish Bowl tradition (elaborate funerary vessels), which are concentrated along the east of Ireland and the western coast of Scotland.

The elaborate nature of the pipes, and their formal deposition at the base of the trough, suggests that this instrument had some type of ceremonial function, and may have been involved in some ceremony or ritual associated with the wooden trough. The possible connection between *fulacht fiadh* and cooking could be drawn on here to suggest a tenuous link with ceremonial feasting. The artefacts' deliberate deposition reflects the tradition of votive deposition practiced in Ireland and Europe during this period. The pipes are carved from yew, a wood which has spiritual connotations and is often found in churchyards and graveyards. It is considered to be a symbol of death, eternity and the afterlife[38] and it is likely that it was especially chosen for the pipes. The nature of this finding is extraordinary when the general paucity of artefacts found during the excavation of *fulachta fiadh* is taken into account. The finds assemblages recorded from these sites generally consist of domestic objects such as flints, pottery and stone objects, although a gold dress fastener was found on a site in Dooros, Co. Mayo. These pipes are a unique find and the care with which they were deliberately deposited, perhaps even hidden, suggests they were both a valued and valuable possession.

ACKNOWLEDGEMENTS

Thanks are due to Peter Holmes and Margaret Gowen for their advice and ideas on the wooden instrument and to my mind, its mysterious work-

33 See Fraser 2005 (section: Irish Tales and Myths).
34 O'Donnell 2004.
35 Waddell 1998, 123.
36 Cunliffe 2001, 239.
37 Waddell 1998.
38 Mac Coitir 2003.

ings. Thanks are also due to Eoin Grogan who edited and advised on the paper. And finally to the developers, Mountbrook Homes and Ballymore Properties, who funded the excavation and post excavation analysis. A special mention must also be made for the excavation crew who worked in occasionally adverse conditions.

Bernice Molloy

Thanks have to go out to Simon O'Dwyer whose extensive network of contacts led to our joint initial visit to view the pipes and with whom I have discussed the pipes, their origin and use for many, many hours. The company that dug the pipes, Margaret Gowen and Associates, the archaeologist who painstakingly recovered them, Bernice Molloy, and the researcher Lorna O'Donnell never failed to give their utmost when assistance was requested. I could not have made the reproduction without the help, advice, encouragement and intervention of Ian Holdsworth and Peter Burn, both of Middlesex University, who showed this old metal worker more than a thing or two about working timber! John Purser stirred me into new thoughts on many aspects of the subject and contributed the panpipes to the panoply of possibilities. Last but not least, my thanks must go to the Irish Government which insists that sites such as this one at Charlesland in Co. Wicklow are competently investigated and recorded before being destroyed by development. Thank you and please continue to insist on this level of investigation before sites are irretrievably lost to the world of archaeology.

Peter Holmes

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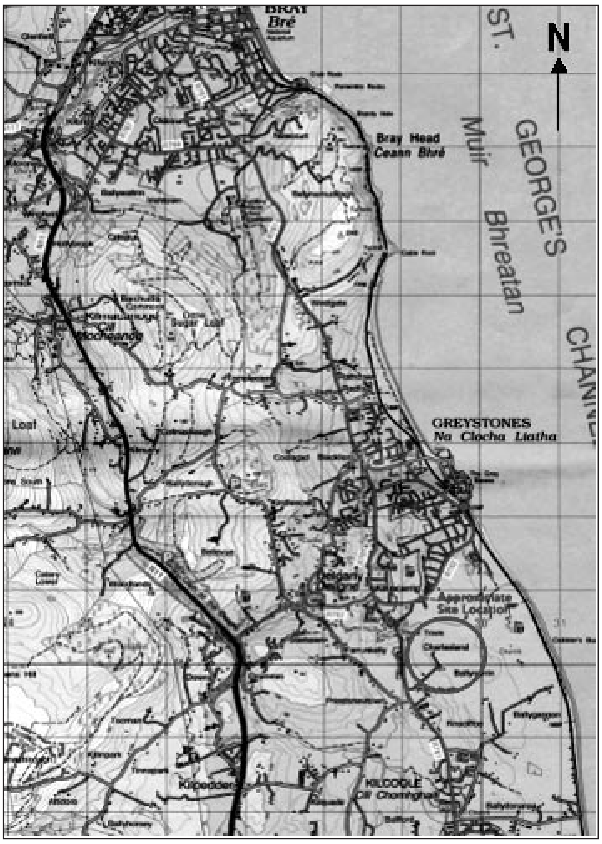

Fig. 1 Location of the site.

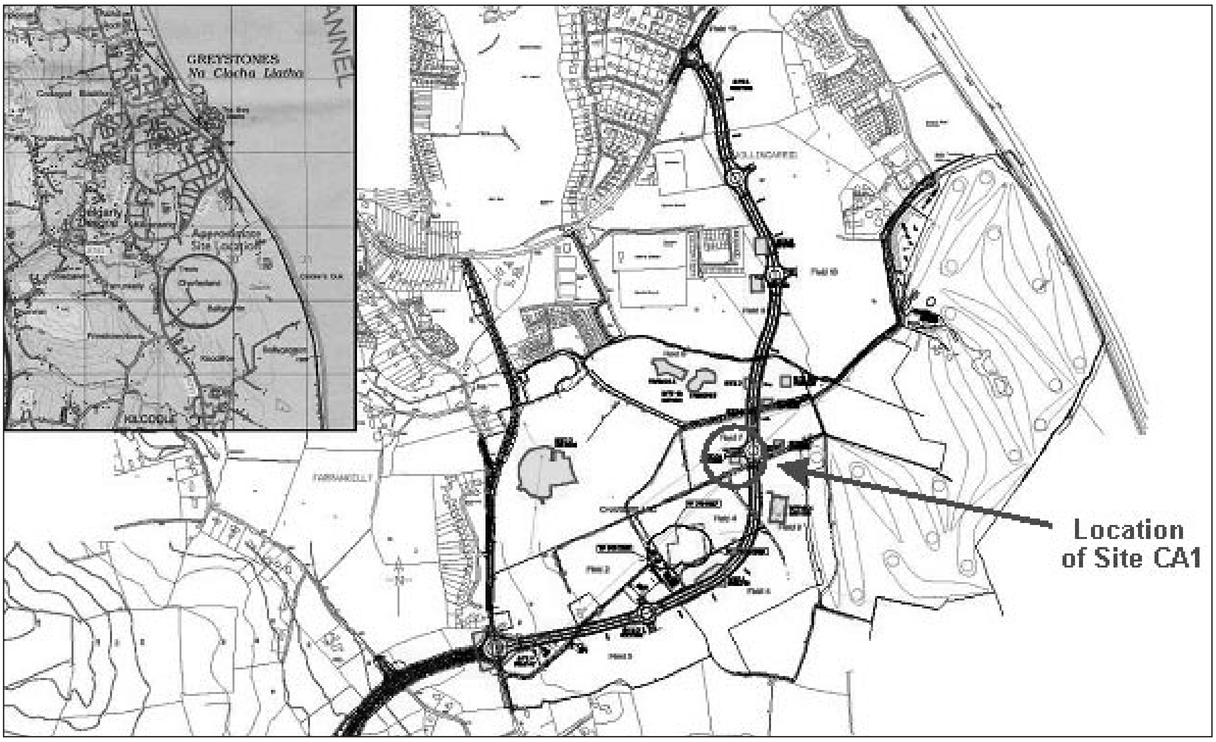

Fig. 2 Detailed location of the site.

Fig. 3 The pipes prior to removal from the trough.

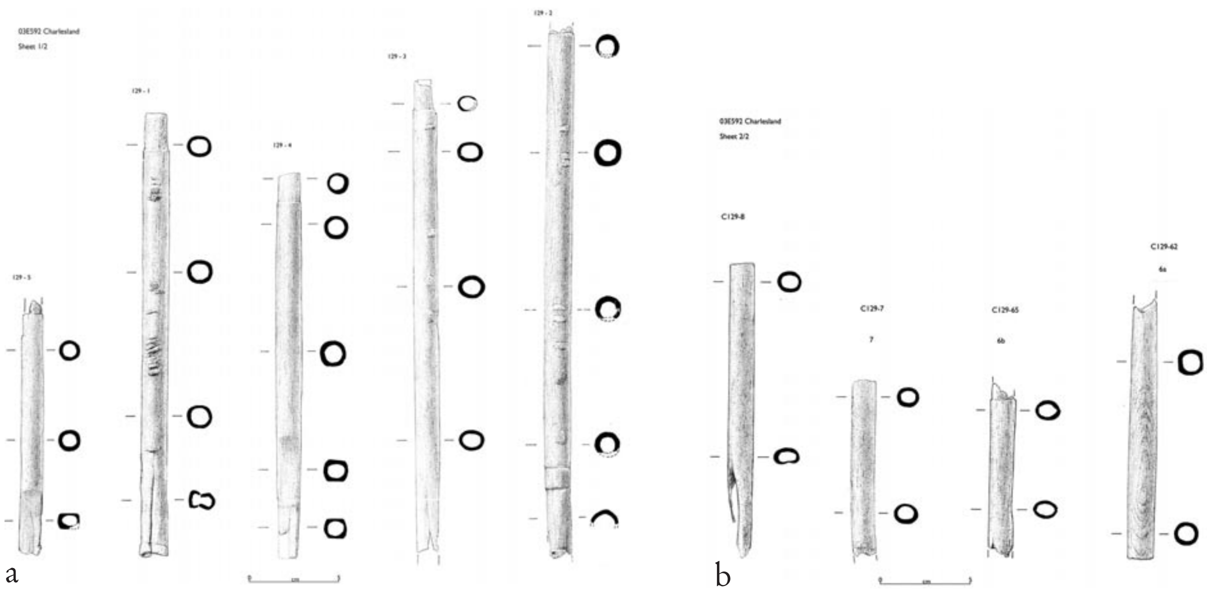

Fig. 4a–b The pipes in detail.

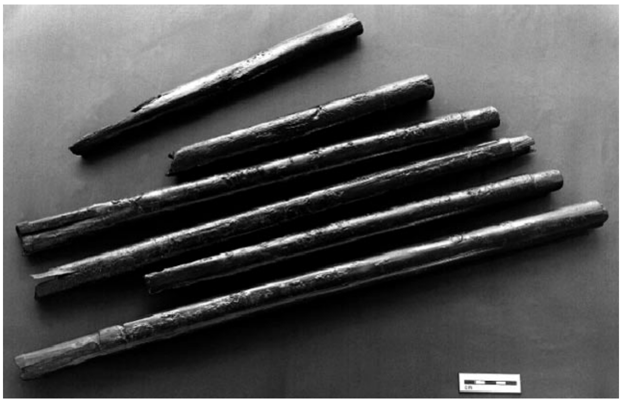

Fig. 5 The six most-complete pipes.

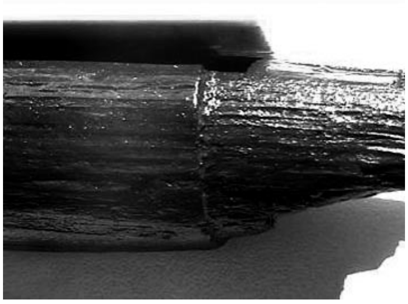

Fig. 6 Striations along the outer surface of a pipe.

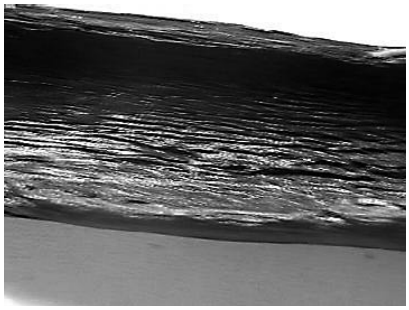

Fig. 7 Striations along the bore of a pipe.

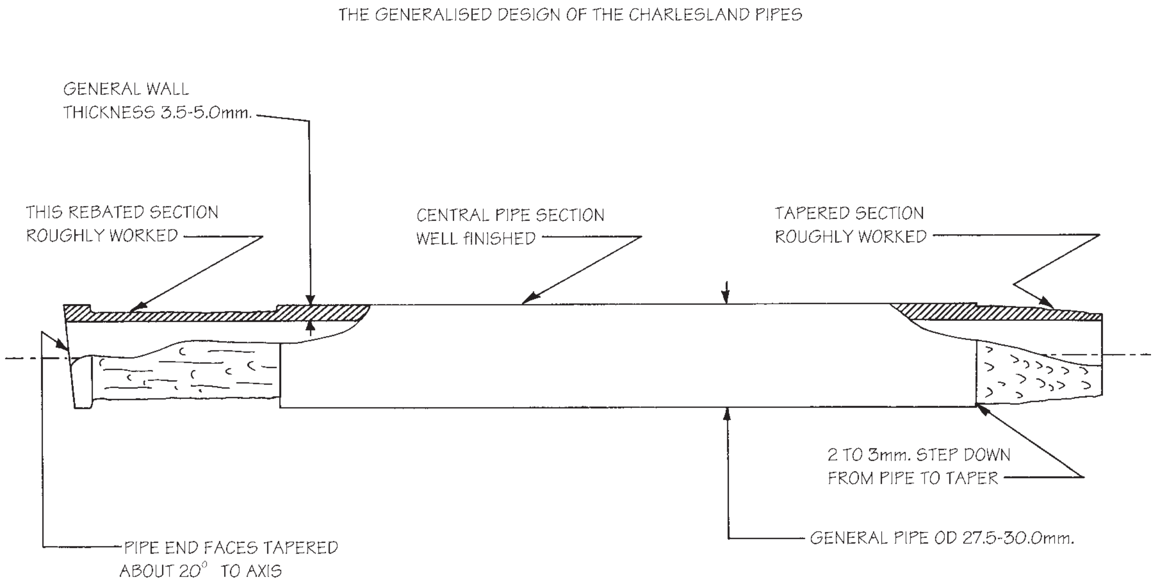

Fig. 8 A generalized pipe design. – NB. no two pipes are the same length. – A tubular body 28-30 mm. in diameter and 3.0 to 3.5 mm. wall thickness. – An externally tapered end section which tapers down from the tube diameter to about 20 mm. and is roughly worked.

Either

A rebated tubular section towards – but not at – the end opposite the tapered section. Here the tube wall is thinned down to yield an undercut section of pipe some 60 mm. long which is roughly worked. A tube end face, at the end adjacent to the rebated section, a termination which is worked at an angle of some 20° to the axis of the pipe.

Or

A squared-off section of tube.

Fig. 9 A tapered end termination.

Fig. 10 The undercut at a pipe's tapered end.

Fig. 11 The obliquely-terminated end of a pipe.

Fig. 12 Tool marks on the rebate at the obliquely-terminated end of a pipe.

Fig. 13 Forming the end of the undercut.

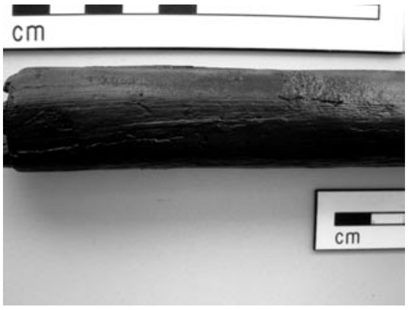

Fig. 14 The tube wall outer surface.

Fig. 15 The squared-off termination of timber.

Fig. 16 A typical bore surface.

Fig. 17 The double band carved on pipe T2.

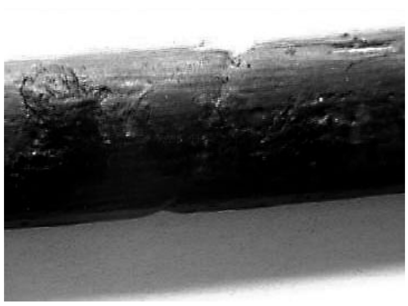

Fig. 18 The pressure indent around the surface of pipe T3.

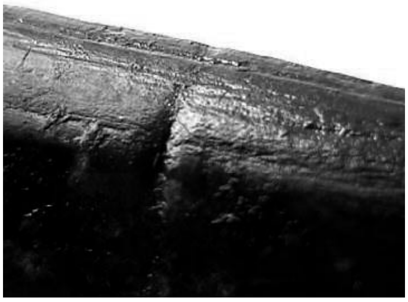

Fig. 19 The pressure indent around the surface of pipe T3 (Detail).

Fig. 20 Accretions on tube T1's outer walls.

Fig. 21 The tube end of pipe T3 showing where the taper was removed.

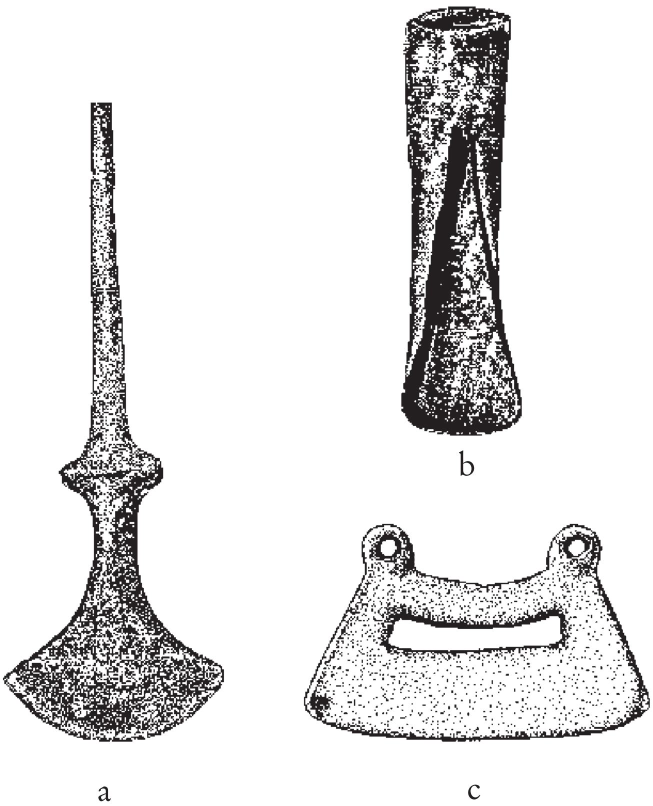

Fig. 22 Bronze-age wood-working tools from Ireland and the UK. – a – Chisel from Co. Waterford. – b – Gouge from Co. Waterford. – c – Scraper from Richmond (otherwise identified as a razor).

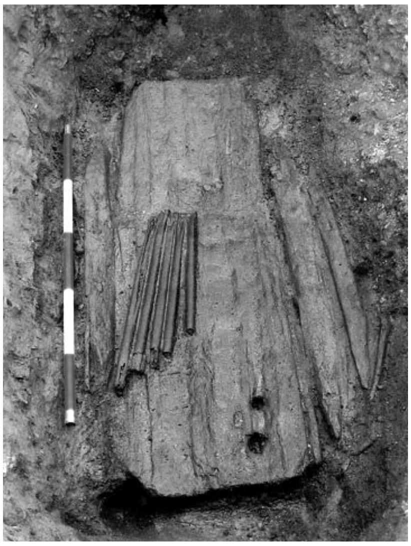

Fig. 23 The pipes laid out on the base of the trough prior to removal.

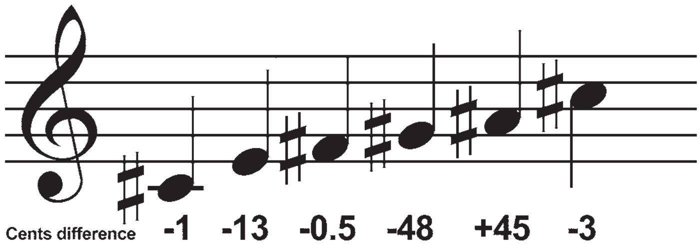

Fig. 24 An estimation of the notes which would be yielded by the pipes when sounded by a tone-generating device.

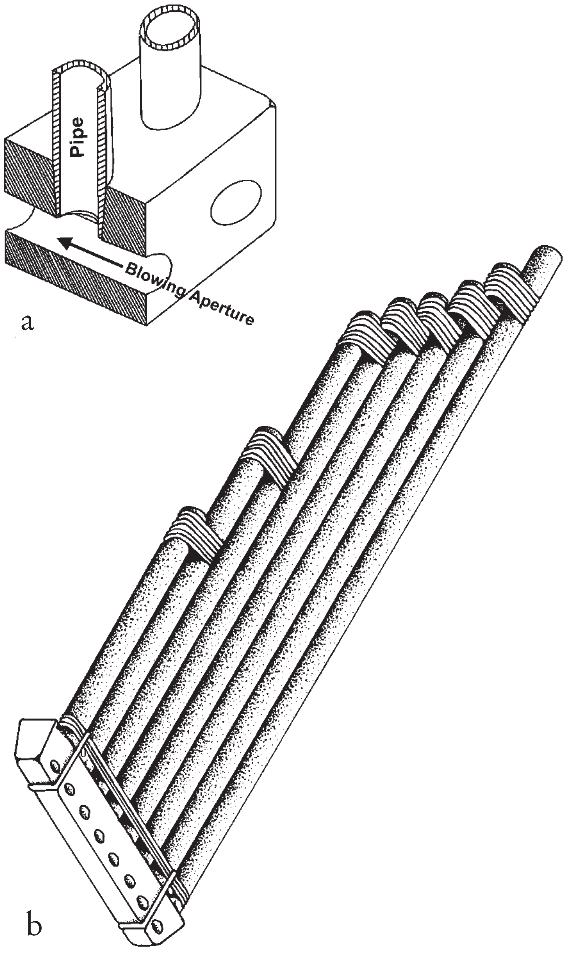

Fig. 25 Construction of a panpipe from the pipes. (a) The arrangement at the head of the pipes – (b) The general assembly of the instrument.

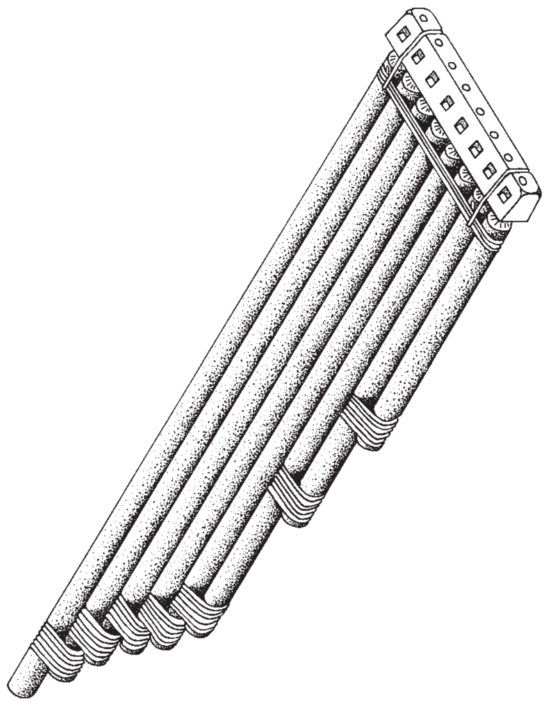

Fig. 26 A possible reconstruction of the pipes as a multi-fipple-flute instrument.

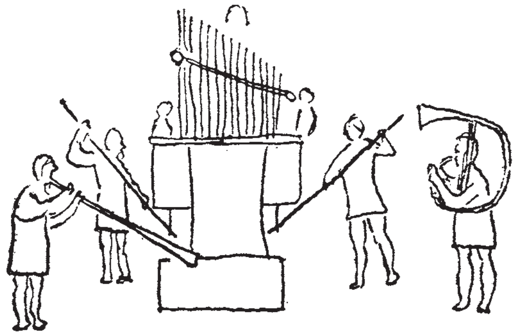

Fig. 27 A graphito of a Roman organ.

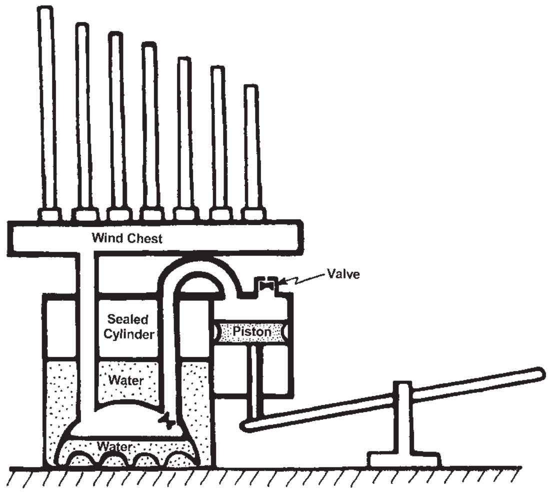

Fig. 28 A schematic drawing of the earliest recorded organ.

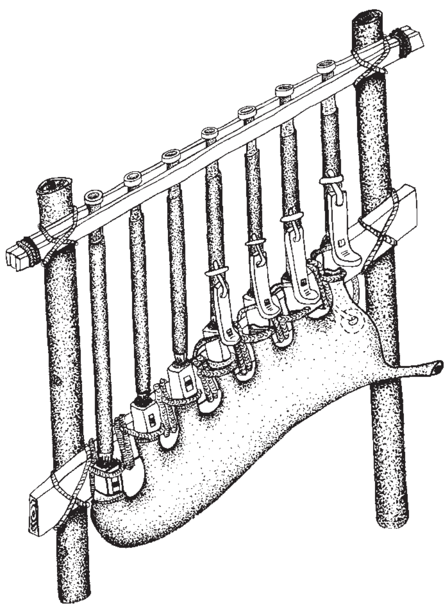

Fig. 29 A possible composite organ-like instrument using the pipes (some fipple covers removed to show detail).

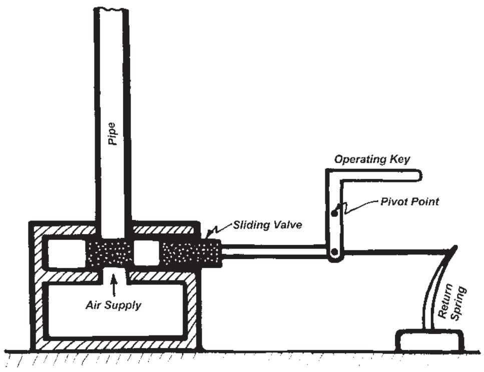

Fig. 30 The reported key mechanism of Ktesibios' Hydraulis.

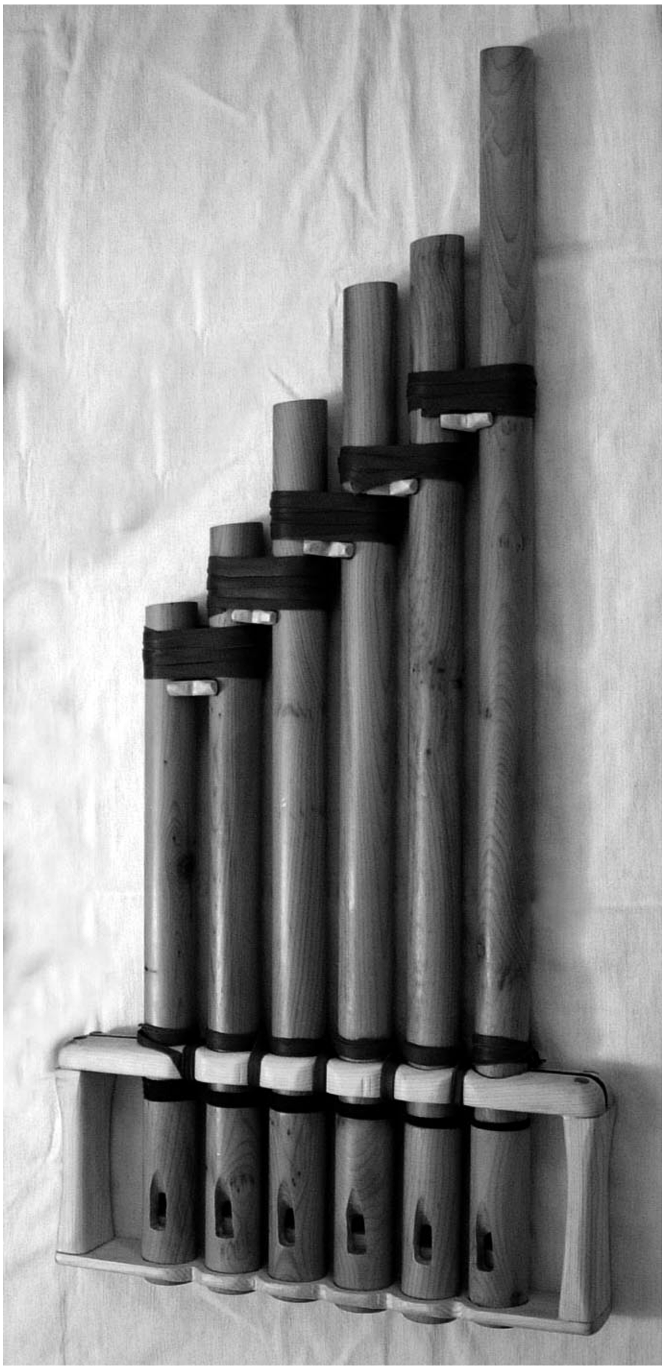

Fig. 31 The replica fipple-flute multiple-flute instrument.