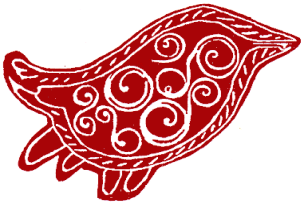

The Excavation of Four Fulachtaí Fia and Iron Age Pits at Ballyadam, Carrigtohill, Co. Cork

Rose M. Cleary and Alan Hawkes

INTRODUCTION

The excavations[1] at Ballyadam were undertaken in 2007 in advance of industrial development.[2] Iron Age pits and four fulachtaí fia were discovered and these were located[3] *c.* 2km east of Carrigtohill and 3km west of Midleton on the north-east side of Cork Harbour (Fig. 1). The geographical location is within the valley north of the Old Red Sandstone Ridge of the Great Island Anticline and south of the Cork and Youghal Anticline. This valley extends eastwards from Cork City to Youghal Bay and the bedrock is Carboniferous limestone covered by glacial till. Cork Harbour to the south is a submerged landscape with the hilltops of the original sandstone ridges surviving as islands in the harbour. This submergence has been caused by gradually rising sea levels.

The landscape within the development area included a limestone ridge with two prominent knolls with exposed limestone bedrock in a quarry-face. The land slopes steeply on the north side from the ridge to the northern boundary and the slope to the west is gentle. The fields on the western side are flat and the fields on the east rise to a crest and thereafter slope steeply to the north. Two ponds were located on the west side and these have seasonal water levels.

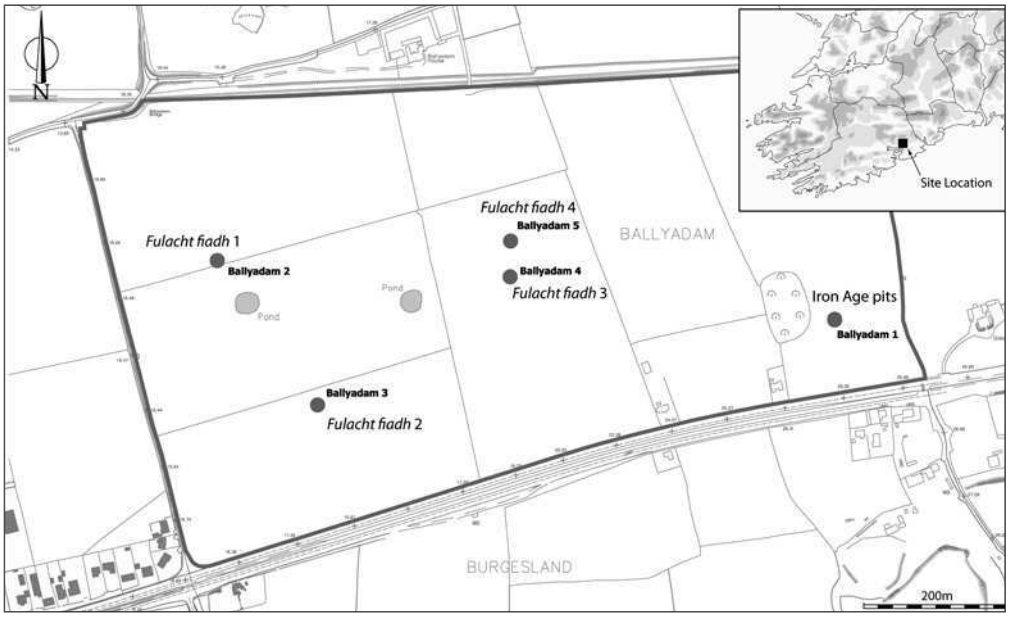

Fig. 1: Site location and location of sites in landbank

The site is located within an area of known Bronze Age settlement and landscape use. Bronze Age settlement and burial sites were uncovered during groundworks for the Fota Island golf course in the early 1990s (Rutter and O'Connell 1994). Prior to the excavations at Ballyadam, there were four known fulachtaí fia in the environs of the site. One to the south (RMP CO 076-105) in Ballyvodock East townland was discovered after the field was tilled. There is also a cluster of three fulachtaí fia south of Barryscourt Castle (RMP CO 075-070/072). Tillage has probably denuded low-visibility archaeological sites.

THE EXCAVATION

The site was monitored during the groundworks phase of a construction project. Five Late Iron Age pits and four fulachtaí fia were uncovered and excavated. The pits were on the crest of the eastern knoll and the fulachtaí fia were located on the west side of the landbank in low-lying ground (Fig. 1).

IRON AGE PITS AND POST-HOLE[4] (Fig. 2)

Five pits (C[5]3A and B, C4, C5 and C20) were recorded in close proximity, on a roughly north-south axis and a post-hole (C12) was recorded 0.12m to the east of one pit (C5). Hazel (*corylus avellana*) charcoal from the basal fill (C9) of pit C3B returned a C[14] determination of 65–316 cal. AD[6]; 1847±45 BP (UBA-8450). Hazel charcoal from a layer of oxidised clay (C11) in pit, C3B returned a C[14] determination of 79–229 cal AD; 1862±29 BP (UBA-8448). These place the pit use in the Late Iron Age.

The fills of pits C3A and B comprised lenses of charcoal-enriched soil and oxidised clay. Oxidised sub-soil at the southern lip of pit C3B suggested some *in situ* burning and the remainder of the pit fills appeared to have been dumped from activity elsewhere. Most of the animal bone assemblage was burnt unidentifiable long bone fragments and where bone was identified the species were cattle and sheep or goat. A rubbing stone fragment was recovered from C3A. The rubbing stone (Fig. 3) is Old Red Sandstone and has a maximum thickness of 21.8mm, extant length of 32.2mm and width of 43.3mm. The stone is smoothened through use. The pit fills also included charred remains of mainly barley and lesser amounts of wheat, hazelnut shells and some edible weed seeds[7]. Charcoal from the pit fills was predominately oak with lesser amounts of hazel, blackthorn/cherry, birch and holly. The overall length of C3A-B was 1.75m and the long axis was north-south. The pits were conjoined and probably dug at the same time. A thin layer of sandy clay (C8) extended across both pits and covered the charcoal-enriched clay (C9) in C3A and abutted the oxidised clay (C6) in C3A.

C3A: Pit (Fig. 2; Section A-A1); irregular in plan; 0.9m N/S X 0.7m E/W; depth 0.22m (north end) X 0.15m (south end). The pit sides sloped to an irregular base that dipped to the north and south and was slightly higher in the centre of the base. The north end was filled with a 0.2m thick (max.) deposit of charcoal-enriched oxidised clay (C6) that extended towards the lip of the pit on the east and north sides. The layer also included several small unidentifiable fragments of burnt bone. The southern end of the oxidised clay (C6) was covered by a 0.05m thick layer of sandy clay (C8) that extended into the northern section of pit, C3B. C6 and C8 were covered by a 0.5-0.12m thick (max.) layer of charcoal-enriched clay (C7) with frequent minute fragments of burnt bone.

C3B: Pit (Fig. 2; Section A-A1); irregular in plan; 0.83m N/S X 0.73m E/W; depth 0.8m. The pit sides sloped to a rounded base. The basal deposit (C9) was a 0.14m thick layer of charcoal-rich soil with some burnt bone. This was overlain by brown sandy clay (C8) that extended into the southern

end of the pit, C3A. The upper layer (C10) was a 0.04-0.1m thick layer of charcoal-enriched clay that included minute burnt bone fragments and patches of oxidised clay. Hazel (*corylus avellana*) charcoal from the basal fill (C9) of C3B returned a C^{14} determination of 65–316 cal. AD; 1847±45 BP (UBA-8450). A 0.02-0.6m thick layer of oxidised clay and charcoal (C11) occurred on the southern lip of C3B and is interpreted as *in situ* burning as the natural subsoil was also fire-reddened. Hazel charcoal from C11 returned a C^{14} determination of 79–229 cal. AD; 1862±29 BP (UBA-8448).

C4: Pit; sub-circular in plan with N/S and E/W axes measuring 0.62m; depth (max.) 0.2m. The pit sides sloped gently to a rounded base. The fill was a homogenous charcoal-enriched soil with minute burnt bone fragments.

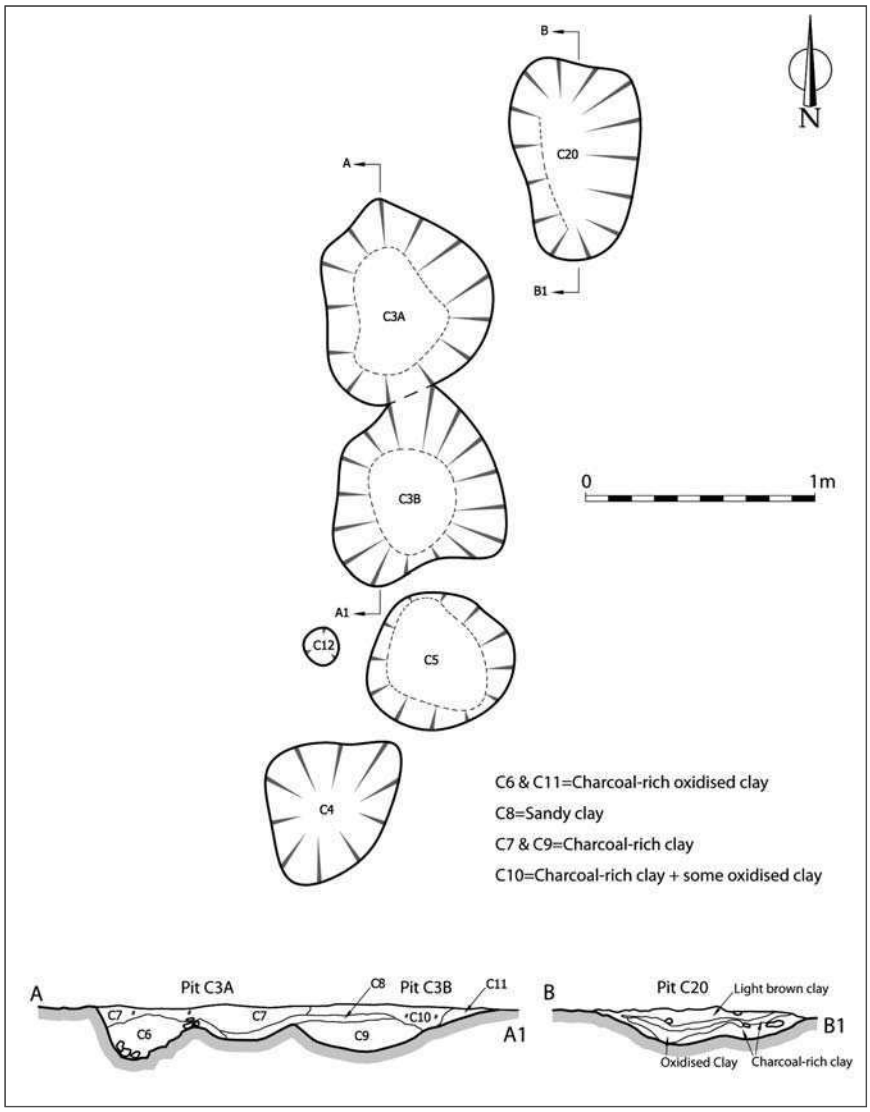

Fig. 2: Plan and sectional profiles of Iron Age pits and post-hole

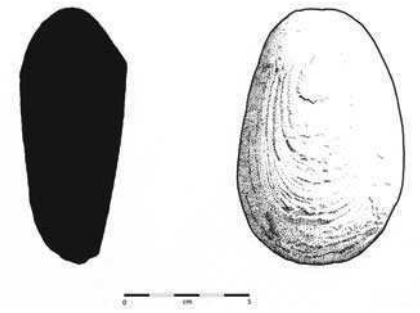

Fig. 3: Rubbing stone from Pit 3A

C5: Pit; circular in plan; diameter 0.6m; depth 0.11m. The pit sides sloped to a rounded base and the fill was charcoal-enriched stony soil. The pit was 0.15m south of C3B and 0.1m north of C4.

C12: Post-hole; circular in plan; diameter 0.12m; depth 0.08m. 'U'-shaped profile; brown soil fill (C13). The post-hole was 0.1m west of the pit C5.

C20: Pit (Fig. 2; Section B-B1); oblong in plan; 0.86m N/S X 0.57m E/W; depth 0.10m. The fill comprised thin layers of stony, charcoal-enriched soil and oxidised clay. The pit was 0.25m east of C3A.

FULACHTAÍ FIA

The fulachtaí fia were in low-lying ground that flooded periodically during the winter months and after heavy rain. The natural topography was undulating and the fulachtaí fia were located in the intermediary hollows. Much of the surface had been intensely cultivated in the recent past and there was no surface indication of any of the sites. Spreads of dark soil and surface stone were recorded in the Geological Survey mapping from the 1860s and these records suggest that the spreads of burnt stone were in the ploughsoil. Emphasis on cereal-growing was a feature of agricultural practice in East Cork in the post-Famine period and the shattered stones may have been spread during ploughing and tilling as far back as the mid-nineteenth century. The stone for the fulachtaí fia and burnt stone spread was predominately sandstone that was sourced at some distance from the site. Possible sources identified by Anthony Beese include a river valley in Anngrove townland, 3km to the west of Ballyadam and the Owennacurra River valley north of Midleton located 4–5km to the north-east of the excavation site.[8]

FULACHT FIA 1 (Fig. 4)

Fulacht fia 1[9] was located initially abutting a modern field wall and continued to the south under the wall. The natural topography in the area was relatively flat ground around the spread of fire-shattered stones and the ground sloped gently to the south beyond the stone spread. The top of the shattered stone spread was under 0.5m of topsoil that may be of recent origin.[10]

The heat-shattered stone spread (C10) was dispersed over an area measuring 20m E/W X 15m N/S (Fig. 4). The maximum extant height towards the north end was 0.4m and the stone tailed off towards the south. The stone spread was a post-use phase when the mound material was dispersed. A modern stone-lined drain cut across part of the stone spread on the southern end. A mixture of alder (*alnus glutinosa*), hazel (*corylus avellana*) and apple type (*pomoideae*) returned a C^{14} determination of 2335–2063 cal. BC; 3788±30 BP (UBA-8449) from the stone spread. Hazel, willow, birch and oak charcoal was also identified from the mound spread and represent fuel used in the process of heating stones. The charred plant remains were recovered mainly from pit fills and were entirely weed seeds, albeit from edible plants including sorrel, cleavers and also from blackberries. Two lithic finds from the mound spread represent waste from lithic production and are identified as a split flint pebble and a small bipolar flint core. The southern area of the stone spread overlay charcoal-rich peaty clay that extended into a low-lying area to the south and the peat is interpreted as the site of a natural pond (C75) and probably

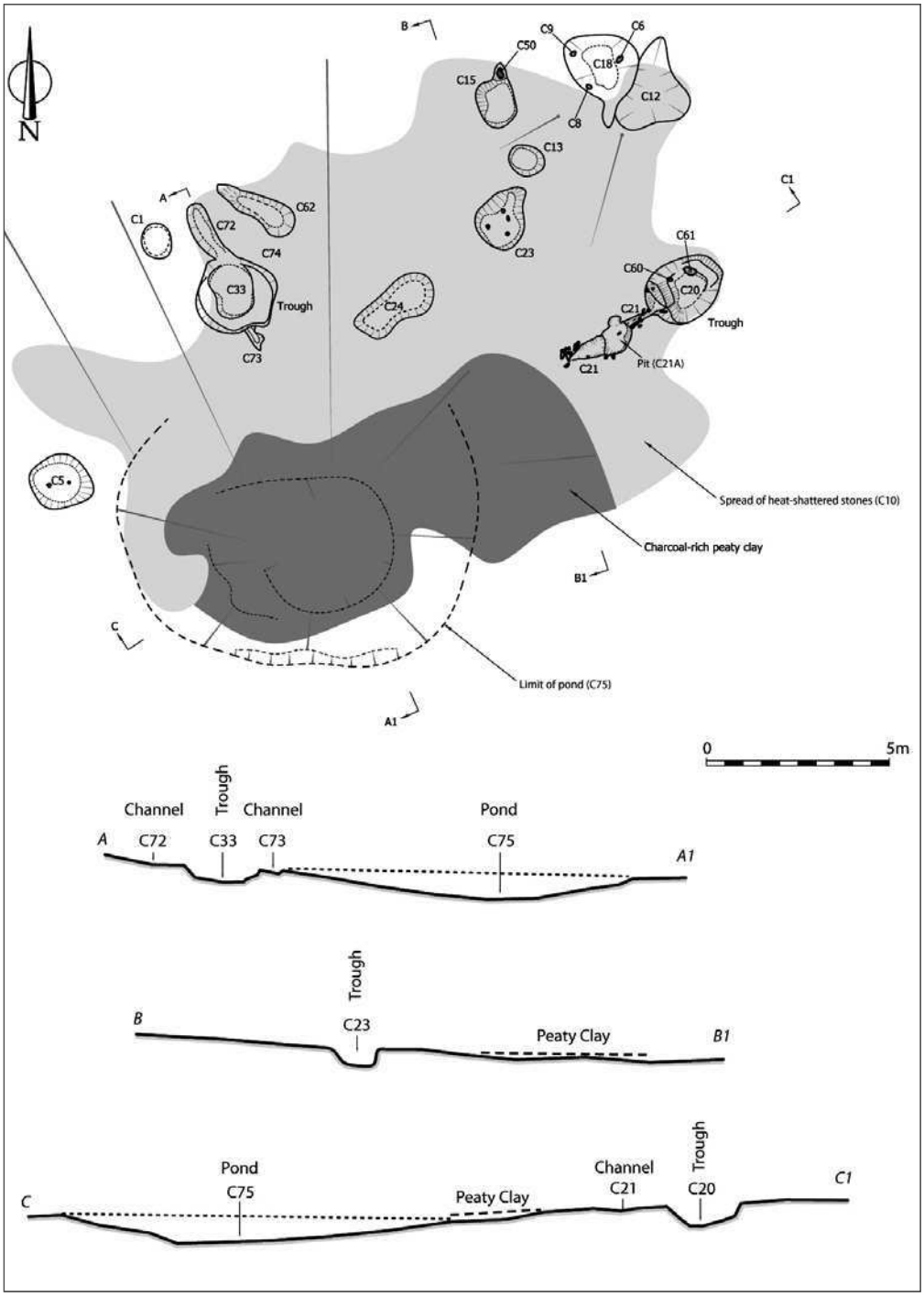

Fig. 4: Plan and sectional profiles of fulacht fia 1

the water source for the activity on site (Fig. 4). All the features were upslope of the pond. The pond was 10m E/W by 9m N/S and was infilled with peat lenses and heat-shattered stone. The maximum depth of the pond was 0.90m and this was due to the natural topography of the landscape rather than an artificially enhanced feature. This peaty clay appeared natural in origin and may reflect peat growth within the pond in a post-fulacht fia phase.

Twelve pits were recorded on the site and three (C1, C5 and C18) were outside the limit of the stone spread (Fig. 4). Two large pits (C20 and C33) are interpreted as the locations of troughs and a third pit (C23) was also the site of a possible trough, being similar in depth (0.5m) to the trough C33. The pits were in two main clusters to the north and north-east of the pond (C75) and pit C20 and associated linear drain (C21) lay to the east; a single pit (C5) was on the west side. It is possible that each concentration of pit activity is related to discrete use of the troughs (C20, C23 and C33).

Trough 1 (C33), associated linear channels (C72 and C73) and pits (C1 and C62)

These features were located to the north of the pond (F75). The trough (C33) was sub-circular in plan (Figs 4 and 5) with a diameter of 2.4m and 0.4-0.5m deep. The sides sloped inward to a stepped ridge that was 0.25m above a flat base. The main fill (C34) comprised dark, charcoal-rich soil with heat-shattered stones. Oak charcoal predominated in the species type but there were also lesser amounts of alder, hazel, apple-type, birch and willow, similar to charcoal identified from the mound spread (C10). The stones were large (up to 0.5m long) and may have been used on only one or two occasions and represent the final phase of trough use. A linear feature (C72) extended from the north-west for a distance of 1.8m to the north edge of the trough (C33). The channel was 0.4m wide and 0.16m deep with a 'U'-shaped profile and steep-sides. The channel was upslope of the trough and could not have functioned as drainage to carry water from the trough, but may have been a conduit from rainwater or surface water into the trough. The basal fill of the channel was an intermittent thin layer (maximum 0.02m) of white ashy material and the main fill was heat-shattered stone and black soil, representing a post-use phase. A short linear channel (C73) on the south side of the trough (C33) was 0.75m long, 0.35m wide and 0.13m deep. The profile was 'U'-shaped with steep sides and the fill comprised heat-shattered stone with some black soil and charcoal. This channel was downslope of the trough and may have carried overspill away from the trough.

A circular pit (C1) was recorded *c.* 0.6m west of the linear trench (C72) and was at maximum 0.1m in diameter and 0.6m deep with a 'U'-shaped profile. The basal fill (C11) was 0.4m thick and comprised grey clay mixed with stones and was probably natural silting. The upper fill (C2) was a 0.2m thick layer of fire-shattered stones and charcoal-enriched clay. Two stake-holes were recorded in the base on the north-west side.

A linear pit (C62) *c.* 0.8m east of the trough (C33) was aligned NW/SE and measured 2.5m long, 0.5-0.8m wide and 0.4m deep. The pit was steep-sided on the south-east side with a 'U'-shaped profile and a shallow trench on north-west side was 0.35m long and 0.25m wide. The basal fill was a thin layer of ashy soil and the main upper fill (C63) was heat-shattered stone with some charcoal and brown soil. Weed seeds of fat hen and one barley grain were recovered from the pit fill.

A single pit (C5) was recorded to the south-west of the trough (C33) and *c.* 0.5m west of the pond (C75). This was sub-circular in plan, shallow (0.11m deep) with a maximum diameter of 1.35m with sides sloping to a flat base. Two stake-holes (C5A and B) were recorded in the base;

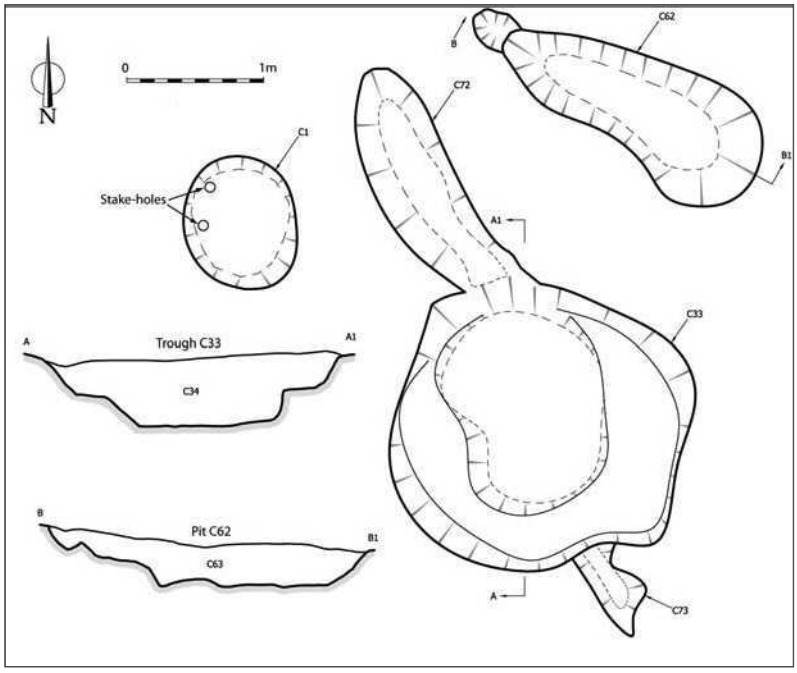

Fig. 5: Plan and sectional profiles of trough (C33) and pit (C62)

both were 'V'-shaped in profile. The stake-holes were circular in plan and C5A was 0.07m in diameter X 0.12m deep and C5B was 0.17m in diameter X 0.12m deep. The basal pit fill was a thin peat layer and heat shattered stone filled the upper 0.08m.

Trough 2 (C23) and pits (C12, C13, C15 and C18) (Fig. 6)

This cluster of features was located to the north-east of the pond (F75) and with the exception of one pit (C18) all were covered by the dispersed mound material although it is likely that the pits were originally outside the perimeter of the mound. A sub-circular pit (C23) that sloped upwards and narrowed towards the north-east is interpreted as a possible trough. This was 1.6m N/S, 1.4m E/W and 0.5m deep with a flat base, steep sided except on north side where the pit sides sloped gently. A 0.06-0.25m thick layer of charcoal-enriched stony silt (C40) was recorded on the pit sides and on the base. This silt probably accumulated over time when the pit was open. This fill extended from the upper edges of the pit to the floor. The main fill (C39) was heat-shattered stones with some silt and charcoal and appeared to be a single infill. Seven small stake-holes (C53-C59) formed a circular arrangement on the pit floor. These were 0.10–0.18m deep and one shallow stake-hole (C55) was driven to a depth of 0.07m. All had fills of charcoal-enriched silt. The stake-holes may have held a timber pit-lining in place or supported some type of superstructure.

Pits

Two adjacent shallow pits (C12 and C18) were located *c.* 3m north-east of the trough (C23). Both were roughly triangular in plan and of similar size measuring 2.1m E/W and 2.6m N/S. The eastern

pit (C12) was 0.15m deep while the western pit (C18) was only 0.12m deep. A thin basal silt layer (C64) with a charcoal concentration (C65) in the south-west side of pit F12 suggests that it may have been open for some time and silted-up prior to being backfilled with heat-shattered stones, charcoal and clay (C52). The adjacent pit (C18) was filled with peaty material. Three stake-holes (C6, C8 and C9) were recorded at the base and all had charcoal-enriched sandy clay fills. C6 on the west side was 0.1m in diameter, 0.15m deep and 'U'-shaped in profile; C8 was 1.20m west of C6, 0.10m in diameter and 0.22m deep with vertical sides and rounded base. C9 on the north-west side was 1.2m west of C6, 0.13m in diameter and 0.22m deep and 'V'-shaped in profile.

A sub-circular pit (C13) was recorded 0.2m north of the trough (C23) and had a diameter of 0.95m and a depth of 0.25m. The pit was bowl-shaped with a flat base. The basal layer was a 0.22m thick layer of heat-shattered stone (C27) covered by a 0.08m thick layer (C26) of grey clay with some burnt stone. Oak charcoal predominated in the species of charred wood but there were minor quantities of birch and holly as well as apple-type wood species. The wood types are similar to those recorded in the main mound spread (C10).

A sub-rectangular pit (C15) 0.6m to the north of C13 was 1.4m long and 1.1m wide with a depth of 0.4m. The main fill was heat-shattered stones (C44) that was overlain on the southern end by a 0.15m thick layer (C43) of charcoal-flecked clay that included white ashy soil and a 0.05m thick layer (C42) of charcoal flecked soil with heat-shattered stones. These layers (C42 and C43) extended over the southern lip of the pit and were post-infill. A post-hole (C50) was driven through the main fill (C43) in the north-east corner and is a post-infill feature. The post-hole was oval in plan, 0.24m (N/S) by 0.18m (E/W) and 0.36m deep with a 'U'-shaped profile, flat base and fill (C51) of grey silt with some small stones.

A sub-rectangular pit (C24) was recorded 1.6m south west of the trough (C23), (Fig. 4) and measured 1.35m (E/W) by 0.75m (N/S) and 0.3m deep. A thin layer (0.01m) of charcoal-flecked redeposited boulder clay (C49) was recorded in the north-west corner while the main fill (C45) comprised heat-shattered stones with some silt and charcoal.

Trough 3 (C20), linear trench (C21) and pit (C21A) (Fig. 7)

A large pit (C20) 6m to the east of the pond (C75) is interpreted as a trough. The trough was oval in plan, 2.2m long, 2m wide and 0.6m deep. The profile was 'U'-shaped with a flat base and the western end was steep sided while the eastern end had a slight lip, 0.20m above the base. A thin layer of iron-rich clay was recorded at the base and this is interpreted as a natural accumulation. The primary fill (C48) was a mixed layer of peat and sand with some stone that appeared to be slumped into the western edge of the pit. The fill was also the basal fill in the linear channel that extended from the west side of the trough. The main pit infill comprised a layer (C47) of large rounded sandstones with some clay. These stones were not heat-shattered and may have been unused stones brought onto the site. The upper fill (C46) was peaty sand with some unburnt sandstone blocks. This layer may be a natural accumulation over the infilled pit. Two post-holes (C60 and C61) were recorded on the north side of the trough (C20). Post-hole C60 on the west side was 0.13m in diameter and 0.21m deep; post-hole C61 was oblong in plan, 0.22m on the long axis and 0.29m deep. Both were driven at a 65° angle to the base of the pit (C20). The fills were silty clay with some pebbles.

A linear feature (C21) aligned north-east/south-west extended from the south-west side of the trough (C20) for an overall length of 2.6m and was cut through by a later pit (C21A). The linear trench was downslope of the trough and is interpreted as a drainage channel to carry excess water

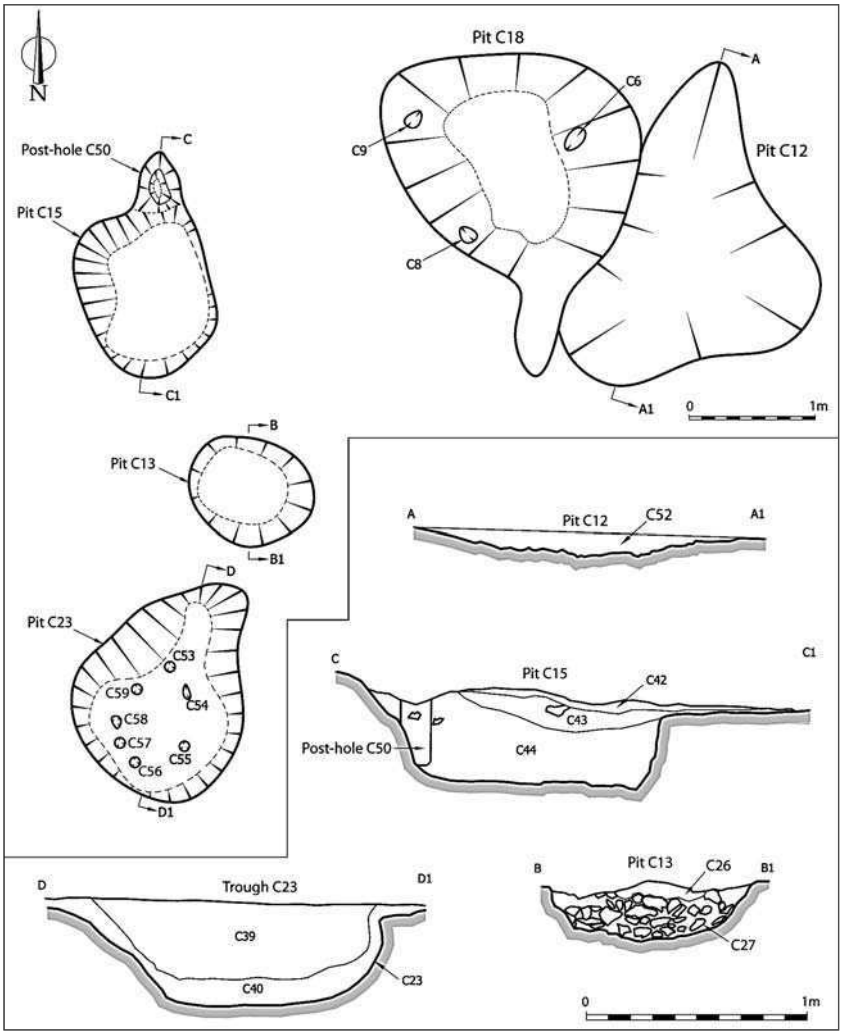

Fig. 6: Plan and sectional profiles of pits C12, C13, C15, C18 and C23 (trough)

from the trough. The western section had a 'U'-shaped profile, was 1m in length, 0.6m wide at the east end and tapered to a point at the west side. The east end had a 'V'-shaped profile, was 0.8m long and tapered from 0.3m at the west end to 0.1m at the east end at the junction with the trough. The depth on the east side was 0.15m and 0.12m on the west side. The fill of peat and silt with some stone suggests that the feature may have functioned as a drainage channel where silt accumulated in the base and a localised wet area caused peat to form when the channel became redundant. A sub-rectangular pit (C21A) cut through the channel (C21) and post-dated its use. The pit had an irregular edge on the north side and was 0.8m long (E/W), 0.7m wide (N/S) and 0.24m deep. The pit was steep-sided with a flat base. The basal fill (C69) comprised a thin lens (0.08m thick) of silt with much charcoal and some small stones and the upper fill (C68) was a 0.16m thick layer of charcoal-rich silt with some heat-shattered stone.

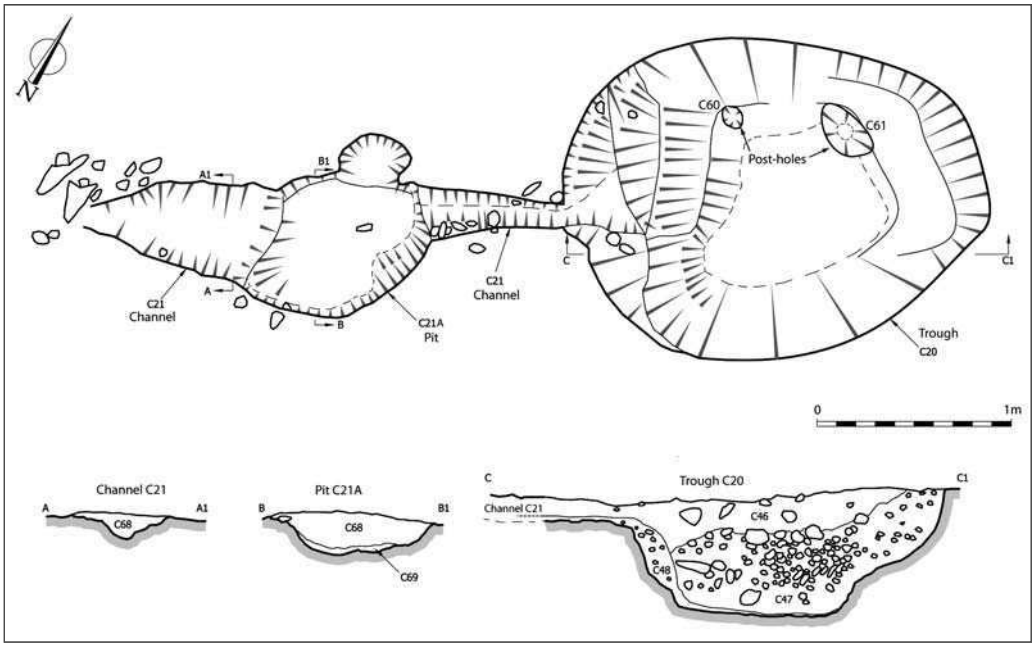

Fig. 7: Plans and sectional profiles of trough (C20), channel (C21) and pit (C21A)

The pond

The pond (C75) was oval in plan, 10m E/W X 9m N/S and sloped to a maximum depth of 0.9m below the ground level (Fig. 4). The pond was probably a naturally-occurring feature rather than having been artificially deepened. The basal layer was grey silt that accumulated due to water-logging. Charcoal-rich peaty clay extended from the basal layer of the pond eastwards and may have originated from localised vegetation growing adjacent to the pond. The pond was probably the water source for the fulacht fia when in use. Burnt stone infill represents a post-use phase when the mound was dispersed across the site.

FULACHT FIA 2 (Fig. 8)

This site[11] was 250m to the south-east of fulacht fia 1 and similarly located in low-lying wet ground, south of the two ponds that were visible on the site before construction work began (Fig. 1). The fulacht fia remains comprised a dispersed spread of heat-shattered stones (C33) over two troughs (C5/20 and C63) that were located to the south of, and upslope from, a smaller naturally-occurring pond (C80). Oak charcoal predominated in the mound spread with lesser quantities of alder, hazel, willow, birch and holly and these represent fuel. The pond had been infilled with gravel in modern times. Four post-holes (C37, C37a-c) were recorded to the north-west of trough C5/20 and ten stake-holes (C18) were to the north of trough C63. Alder and holly charcoal from an infill layer (C23) of Trough 1 (C5/20) returned a C^{14} determination of 1044–894 cal. BC; 2804±31 BP (UBA-8452), placing the period of Trough 1 infill in the Later Bronze Age. Alder charcoal from the fill (C52) of a pit (C2) yielded a C^{14} determination of 2033–1770 cal. BC; 3571±46 BP (UBA-8451) and indicates that at least some features were in use in the Early Bronze Age and that the site had a long history of use.

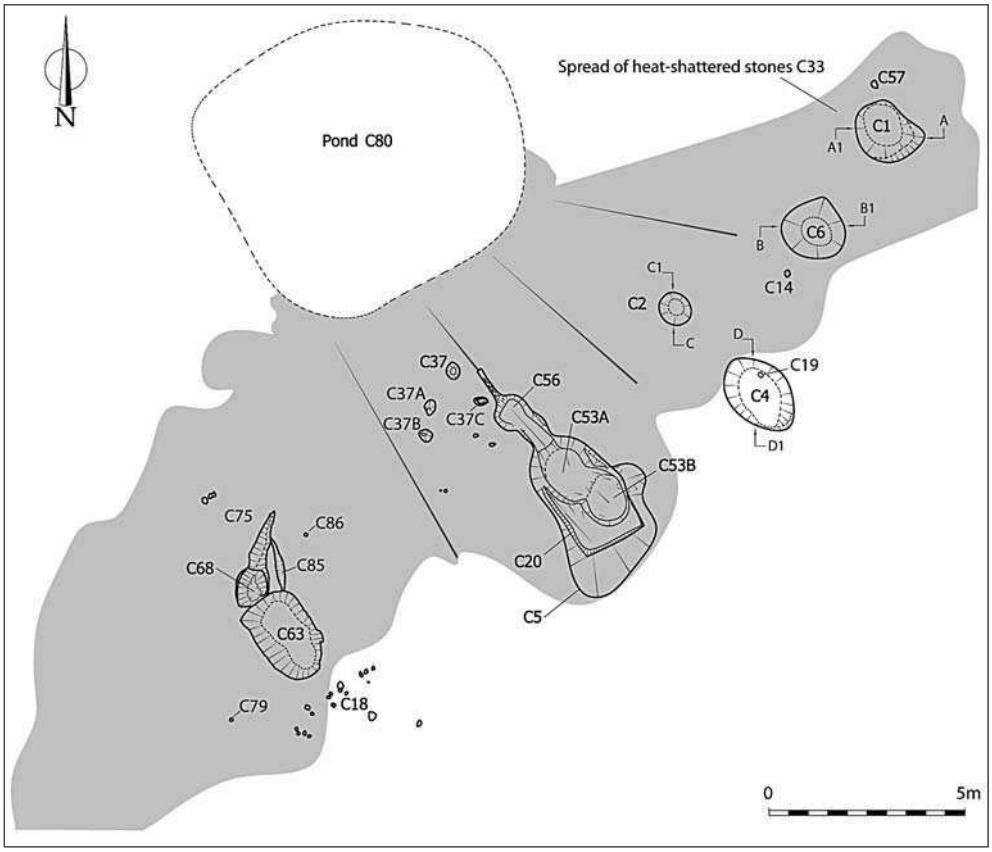

Fig. 8: Plan of fulacht fia 2

Trough 1 (C5/20) (Figs 8 and 9)

This was *c.* 4.8m south of the pond (C80). The pit (C5) was the largest on site, irregular in plan and the edges sloped into a second steep-sided pit (C20) that probably housed the trough lining. The outer pit (C5) was rounded on the southern end with a maximum width (E/W) of 2.6m and length of 4.1m (N/S). The pit sides tapered towards the north where a narrow channel (C56) extended downslope from the pit. The inner pit (C20) was square-ended on the south side, 1.7m wide (E/W), 1.6m long (N/S) and 0.7m deep. Two shallow pits (C53A and B) were cut into the base of the trough (C20) and were sub-circular in plan and 1.2m wide. The north pit (C53A) was 1.6m long and the south pit (C53B) was 1.25m long and both pits were *c.* 0.1-0.15m below the trough base. The function of the pits (C53A and B) is obscure but they may have been no more than an over-cut of the original trough pit when the trough was constructed, or, if the trough was unlined at the base, the ground level may have been reduced when the trough was emptied prior to re-use.

The trough fill comprised a series of layers of heat-shattered stones and charcoal that represented gradual infill. The infill may have occurred over time and be due to the gradual abandonment of the site where stones were not fully removed from the trough during its period

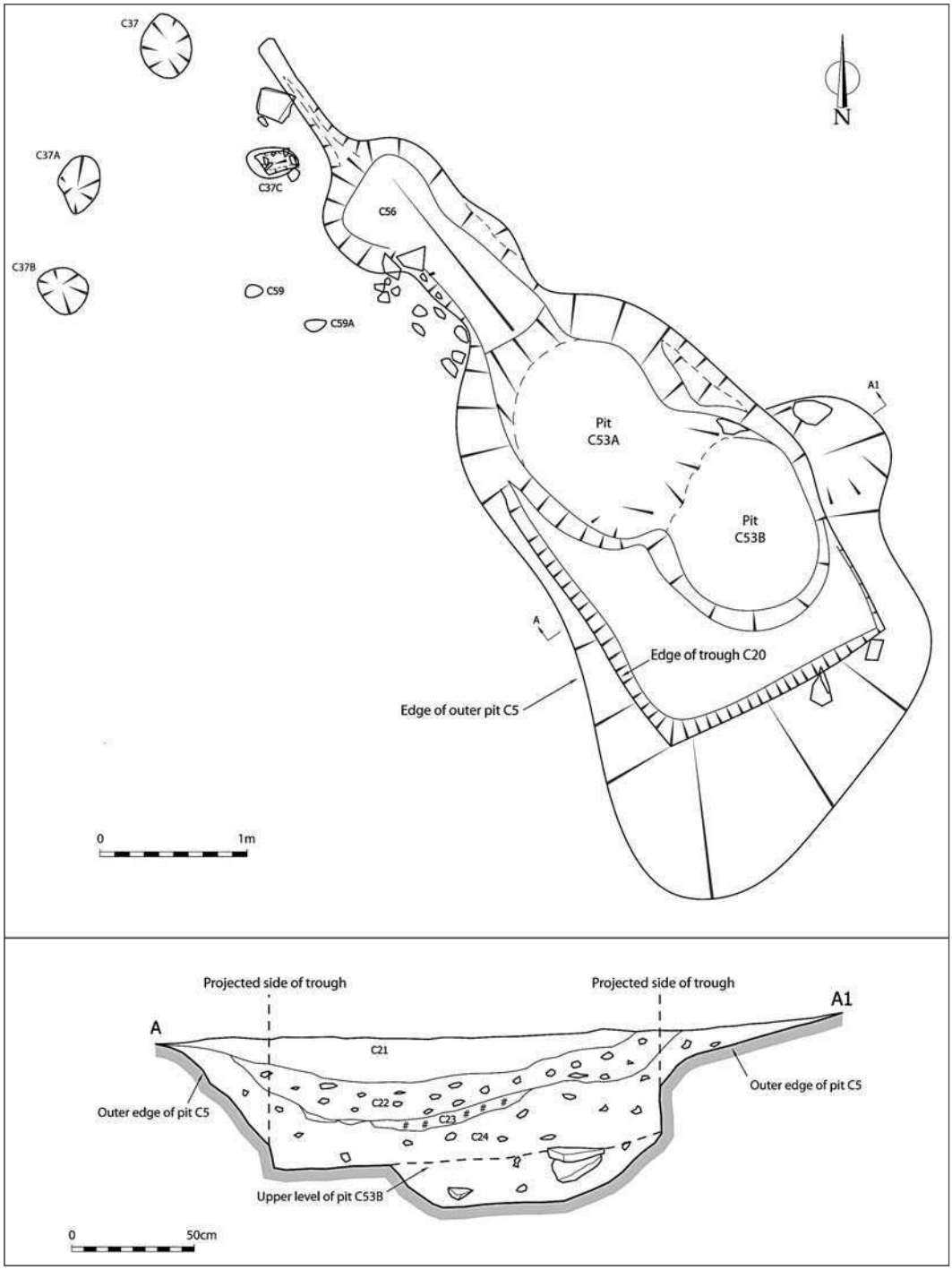

Fig. 9: Plan and sectional profiles of trough C5/20

of use. The basal fill (C24) was a 0.45m thick layer of mainly heat-shattered stones and some leached grey silt. Charcoal from this layer was mainly oak with minor quantities of hazel and holly. This fill was also recorded within the pits (C53A and B) and along the pit sides suggesting that it accumulated after the trough lining was removed. An intermittent 0.05-0.8m thick layer (C23) of mainly charcoal and some heat shattered stones was localised towards the south of the trough and returned a date of 1044–894 cal. BC (UBA-8452). Charcoal from this layer was mainly oak with minor quantities of alder, hazel, birch, apple-type and holly. A 0.2m thick, very stony layer (C22) with a large amount of partially fractured stones and heat-shattered smaller stones overlay the charcoal layer (C23) and the basal layer (C24). This may represent a period after which this trough was abandoned. The upper layer (C21) was a 0.2m thick layer of silt and this was probably a natural accumulation after the trough had finally gone out of use.

The channel (C56) on the north end of the trough may have facilitated overflow from the trough, downslope towards the pond (C80). The channel was 1.75m long, 0.6m wide and had a maximum depth of 0.35m, with a flat base and steep sides. The channel (C56) was also filled with a layer of heat-shattered stones and charcoal, similar to the trough infill layer, C24. A narrow, steep-sided gully (C84) extended from the north side of the channel and was 0.14m wide at the junction with the channel and narrowed to 0.06m at the northern end, was 0.1m deep and sloped downwards to the north. This is also interpreted as a drainage channel and an extension to the gully (C56).

Four post-holes (C37, C37A-C) and two stake-holes (C59 andC59A) were recorded on the north-west side of the trough (Figs 8-9). The post-holes were relatively substantial and may have held large posts. Their positioning adjacent to the trough may indicate a windbreak or drying rack. The post-holes were oval in plan with 'V'-shaped profiles and packing stones *in situ* and all had charcoal-rich grey silt fill. Post-hole C37 was 0.23m (E/W) by 0.33m (N/S) and 0.24m deep; C37a was 0.24m (NE/SW) by 0.33m (E/W) and 0.27m deep; C37b was 0.34m (N/S) by 0.22m (E/W) and 0.53m deep; C37c was 0.35m (E/W) by 0.14m (N/S) and 0.1m deep. Birch and willow charcoal was identified from the base (C48) of post-hole C37b. The stake-holes were 'V'-shaped in profile and had charcoal-flecked grey silt fill. C59 was circular in plan, 0.09m in diameter and 0.13m deep; C59a was oval in plan, 0.09m (N/S) by 0.06m (E/W) and 0.12m deep.

Trough 2 (Figs 8 and 10)

A large pit (C63) to the south-west of the pond (C80) is interpreted as a trough and similar to trough C5/20, had a drainage channel extending northwards and downslope. The trough (C63) was oval in plan, 2.3m (N/S) by 1.4m (E/W) and was 0.5m deep (Figs 8 and 10). The sides sloped to a flat base except on the south-east side where the side was slightly stepped. A 0.1m thick fill (C66) of mixed silt and heat-shattered stones on the south side may be mound slippage. This was overlain by a layer of black soil and peat (C61) that was up to 0.4m thick and petered out towards the north. This layer may represent localised wet conditions and an accumulation of peat in the pit base. Charcoal from this layer was mainly oak with minor quantities of hazel. The final fill (C64) was a layer of heat-shattered stones that was up to 0.3m thick and may have been further mound slippage or a deliberate backfill. A pit (C68) to the north is interpreted as part of a drainage channel and this in turn led to a narrow channel (C75) that extended northwards. The pit (C68) was sub-circular in plan with a maximum diameter of 0.9m and depth of 0.35m. A basal layer (C71) of black soil and peat up to 0.15m thick was similar to that (C61) in the trough (C63). The upper fill was heat-shattered stones and redeposited mound material (C64) that was also part

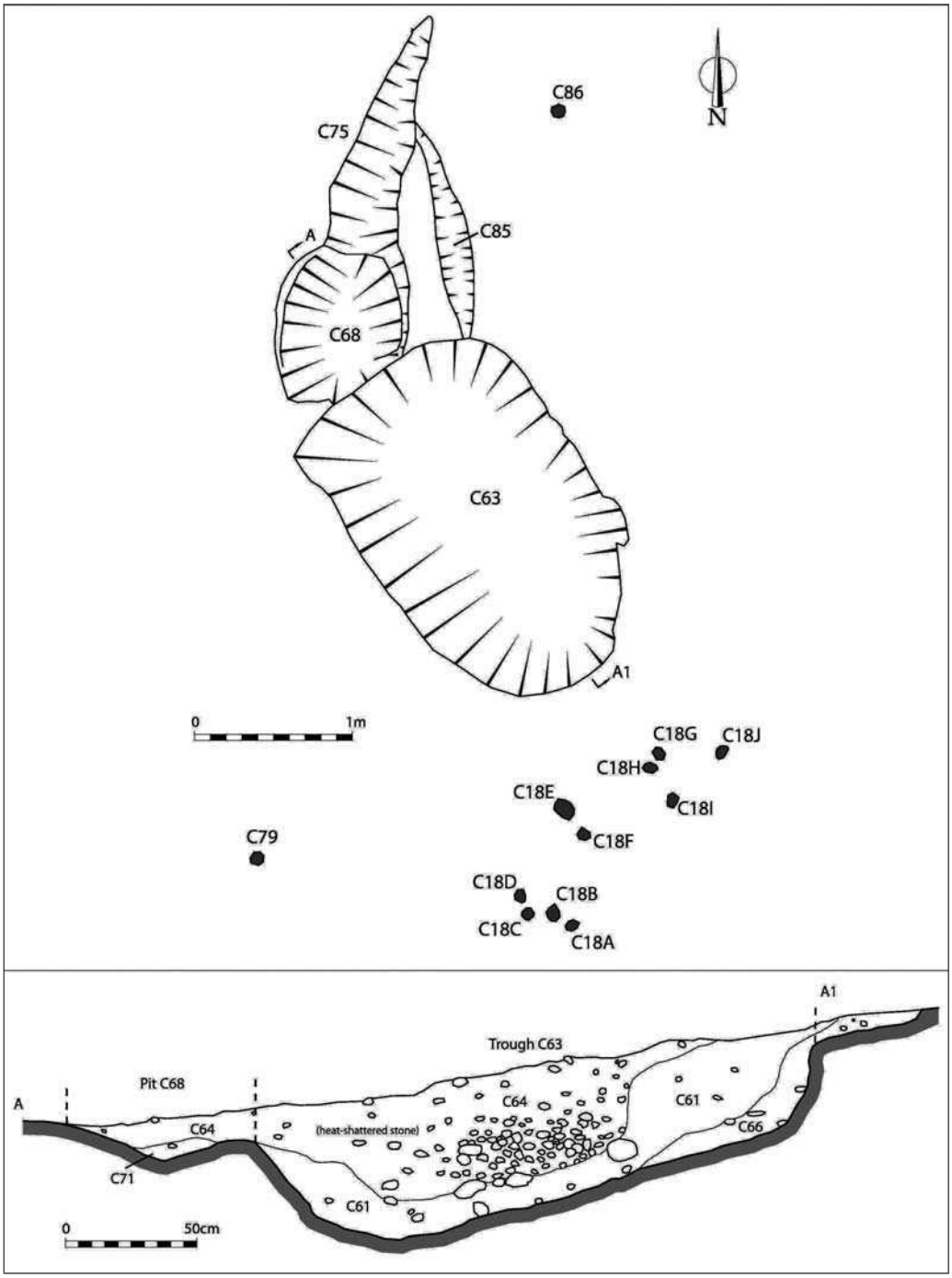

Fig. 10: Plan and sectional profiles of Trough C63

of the trough fill. The channel (C75) was a maximum of 0.25m wide on the south end adjacent to the pit, C68 and narrowed to 0.1m on the north and the depth was 0.35m. The basal fill (C79) was a 0.15–0.2m thick layer of charcoal-rich silt with heat-shattered stone and was in turn covered by a 0.04-0.1m thick layer (C78) of silt and stones. The upper layer (C77) was a thin (0.04m thick) lens of silt. The channel appears to have silted up naturally rather than being deliberately backfilled. A second channel (C85) on the east side of the main channel (C68/75) was narrow (0.1–0.08m) at the north and south ends and broadened to 0.2m in the centre and was shallow (0.09m) and may also have functioned as a run-off drain.

Ten stake-holes (C18A-J) were recorded to the south of the trough (C63). The stake-holes were likely to have held some type of light structural posts such as a frame of uprights for a wind-break or drying rack. The stake-holes varied in diameters from 0.09–0.12 and were 0.09–0.1m deep. All the fills were silty clay, suggesting that they may have been removed and the voids silted-up. A single stake-hole (C79), 1.8m to the west of the trough was 0.09m in diameter and depth. A stake-hole (C86), *c.* 0.9m from the channel (C75) on the north-east was 0.08m in diameter and depth.

Pits

Four pits (C1, C2, C4 and C6) were located to the south-east of the pond (Figs 8 and 11). These were on a south-west/north-east axis and one (C2) was closer to the pond (C80). Three pits (C1, C2 and C6) were under the mound spread (C33). One pit (C4) was sufficiently large to have functioned as a trough. The pit (C1) on the extreme eastern side was located *c.* 9m from the pond and was sub-circular in plan, 'U'-shaped in profile with overall dimensions of 1.9m (E/W) by 1.6m (N/S) by 0.3-0.4m deep (Fig. 11). The basal fill (C36) was a 0.12m thick layer of heat-shattered stone, oak charcoal and grey silt. This was in turn covered by a 0.3m thick layer (C35) of mixed large (0.2m long) and small stones with some charcoal and many fragments of quartz. The upper fill (C34) was a 0.12m thick layer of heat-shattered stones and clay which extended out over the eastern edge of the pit. A stake-hole (C57; Fig. 8) was located 0.5m north of the pit (C1) and measured 0.15m in diameter and 0.18m deep and had a silt fill. A shallow pit (C2) was *c.* 4m south-east of the pond, circular in plan with a 0.75m diameter and 0.08m depth (Fig. 11). The fills (C52 and C55) were heat-shattered stones and dark clay with varying amounts of charcoal. A circular pit, C6 located *c.* 7m south-east of the pond was 1.45m in diameter and 0.44m deep. The sides sloped to a flat base. The basal fill (C27) was a 0.1m thick layer of charcoal-flecked grey clay with some medium and large stones that were unaffected by heat. This basal layer may be a natural accumulation of silt and stones that accumulated when the pit was open. The upper fill (C26) was a 0.25m thick infill layer of primarily heat-shattered stones with some charcoal and silt. A stake-hole (C14), 0.6m south-west of pit C6 was 0.1m in diameter and 0.13m deep with charcoal-enriched silt fill.

A large pit (C4) located *c.*6.5m south of the pond (C80) may have functioned as a trough and was oval in plan measuring 2.2m (N/S) X 1.5m (E/W) and 0.6m deep (Fig.11). The pit was steep-sided except on the north end and the base was flat base. A stake-hole (C19) was driven into the base on the north-east side and was 0.08m in diameter and 0.12m deep with dark gritty clay fill. The main fill comprised a 0.6m thick layer (C17) of heat-shattered stones and large sandstone blocks with some silt in the interstices. A thin lens of silt (C16) with heat-shattered stones overlay part of the lower fill (C17).

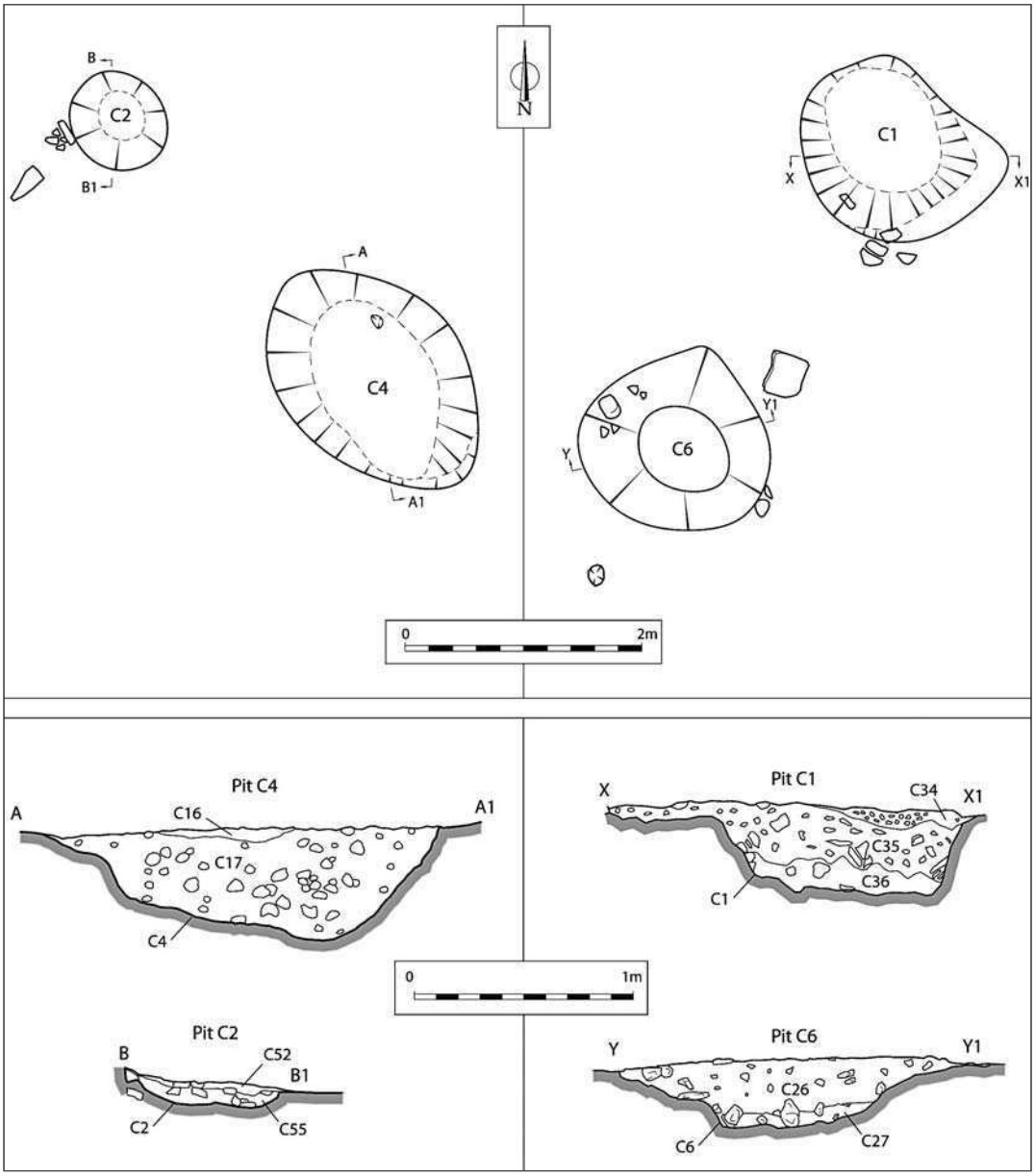

Fig. 11: Plans and sectional profiles of pits (C1, 2, 4 and 6)

The pond

A circular area (C80) 4.8m to the north-west of the trough (C5/20) is interpreted as a pond that probably provided a ready water source for use at the fulacht fia. The overall dimensions were 8m E/W by 7m N/S and *c*. 0.7m deep. The basal layer was grey silt and the pond had been infilled in the recent past with limestone gravel.

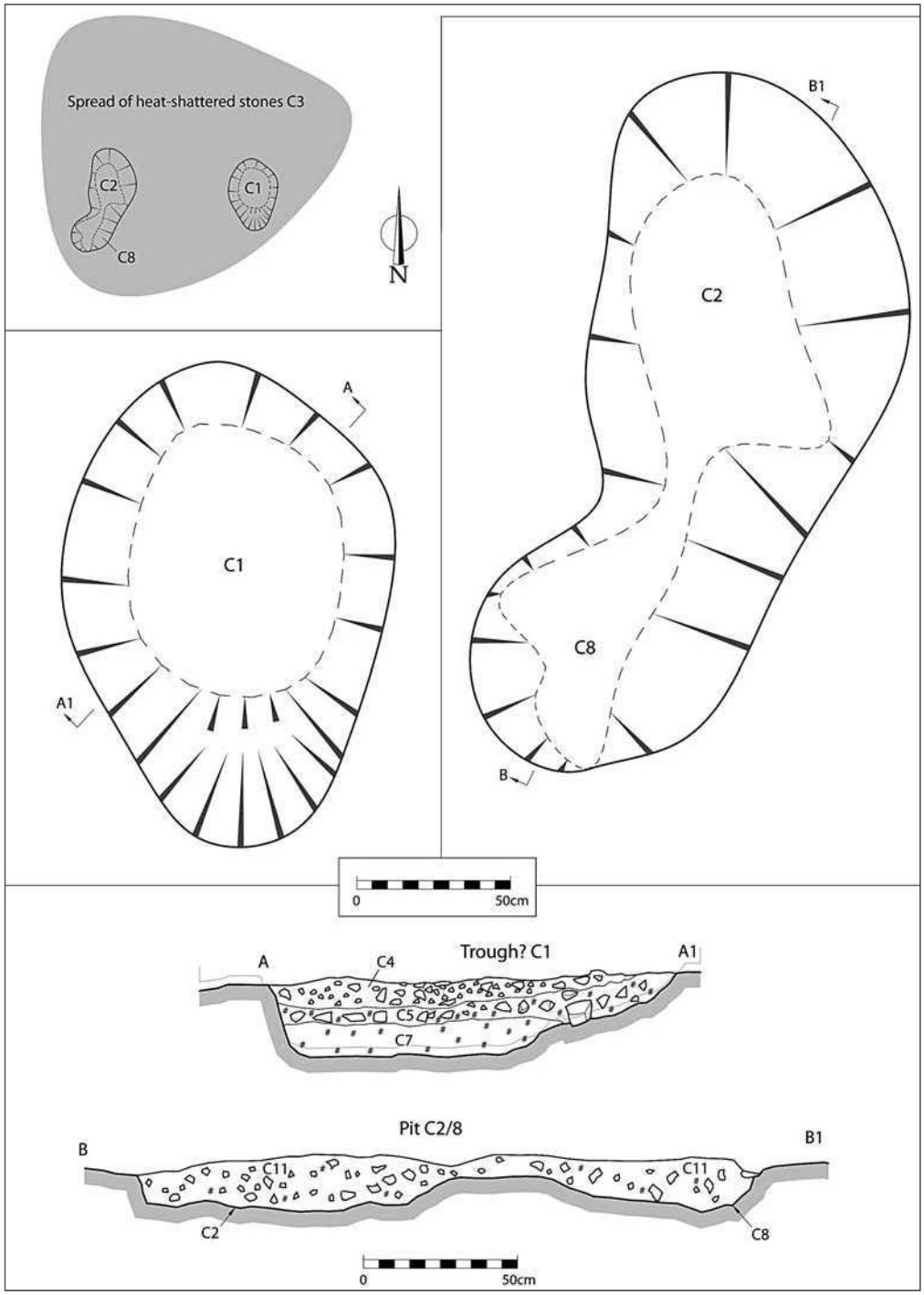

Fig. 12: Fulacht fia 3 – plan and sectional profiles

FULACHT FIA 3 (Fig. 12)

This site[12] was located (Fig. 1) 50m to the south of fulacht fia 4 and comprised a spread of heat-shattered stone (C3) and three pits (C1 and C2/8). The site was relatively small-scale in comparison to the other fulachtaí fia and one pit (C1) was of sufficient size to suggest it may have been a trough. The stone spread (C3) was irregular in plan and measured 6.8m E/W by 6.3m N/S with a maximum central thickness of 0.25m and tailed off around the edges. The basal layer (C9) comprised a charcoal-enriched soil with some heat-shattered stones and this was overlain by layers (C6 and C12) of heat-shattered stones and charcoal and a 0.05m thick layer of charcoal-enriched silt (C10). Hazel charcoal predominated in the mound spread with lesser quantities of oak.

Two pits (C1 and C2/8) were recorded under the stone spread with an intermediary distance of 2m between the pits. The deeper pit (C1) may have functioned as a trough and was oval in plan, 1.1m (E/W) by 1.6m (N/S) and 0.5m deep (Fig. 12). The pit was steep sided on the north side and sloped gradually to the base on the south side. The basal fill (C7) was a 0.12m thick layer of charcoal-enriched silt with some heat-shattered stones. This layer may have accumulated naturally when the pit was open. Hazel, apple-type and willow charcoal from C7 returned a C^{14} date of 2271–2028 cal. BC; 3726±33 BP (UBA-8453). The upper layers (C4 and C5) appeared to be a deliberate infill of heat-shattered stones with variations in the amount of charcoal and stones between C4 and C5. The second pit (C2/8) was a figure-of-eight in plan with a wider northern section (C2). The overall length was 2m and the maximum width was 1.1m. The pit was at maximum 0.15m deep but was shallower in the central section. There was a single fill of heat-shattered stones (C11).

FULACHT FIA 4 (Fig. 13)

Similar to the other fulachtaí fia, this site[13] was located in low-lying ground (Fig. 1) and comprised a spread of heat-shattered stones (C10) over a trough (C3), six pits (C1, C2, C9, C15, C31 and C42) and three post-holes (C11, C21 and C32). The pits were located to the north and south of the trough. A mixture of hazel, apple-type and willow charcoal from a post-hole (C38) beside the trough returned a C^{14} determination of 2203–1983 cal. BC; 3714±34 BP (UBA-8454). Charcoal from the mound was mainly oak with lesser amounts of hazel, willow, holly and apple-type.

Trough

The pit (C3) was the largest on this site and is interpreted as a trough (Figs 13 and 14). The pit was roughly oval in plan with irregular edges on the north side and an overall length of 2.65m (E/W) and width (N/S) varying from 1.6–2.2m. The depth was at maximum 0.45m and the sides were vertical down to a flat base. The trough fill comprised a basal layer (C29) of charcoal-enriched silt and heat-shattered stones and an upper layer (C36) of sandy clay and heat-shattered stones. Charcoal from the layer (C36) at the upper level of the trough fill was mainly oak with lesser amounts of hazel, holly and apple-type. These layers may represent gradual infill from mound slippage. A short channel on the east side of the trough sloped downwards to the east and may have drained away overflow. The channel was 0.5m wide on the west side and defined by four upright stones on the north and south sides at the junction with the trough. Displaced stones to the north and south of the channel may also have been part of a stone setting. The channel broadened out to 2.1m to the east end where it was less-defined.

Six stake-holes (C55a-f) were recorded at the base of the trough. Three occurred on the north and south sides and one stake-hole (C37) was recorded adjacent to the southern edge of the trough pit. The stake-holes were 'V'-shaped in profile with diameters between 0.08–0.11m and driven to

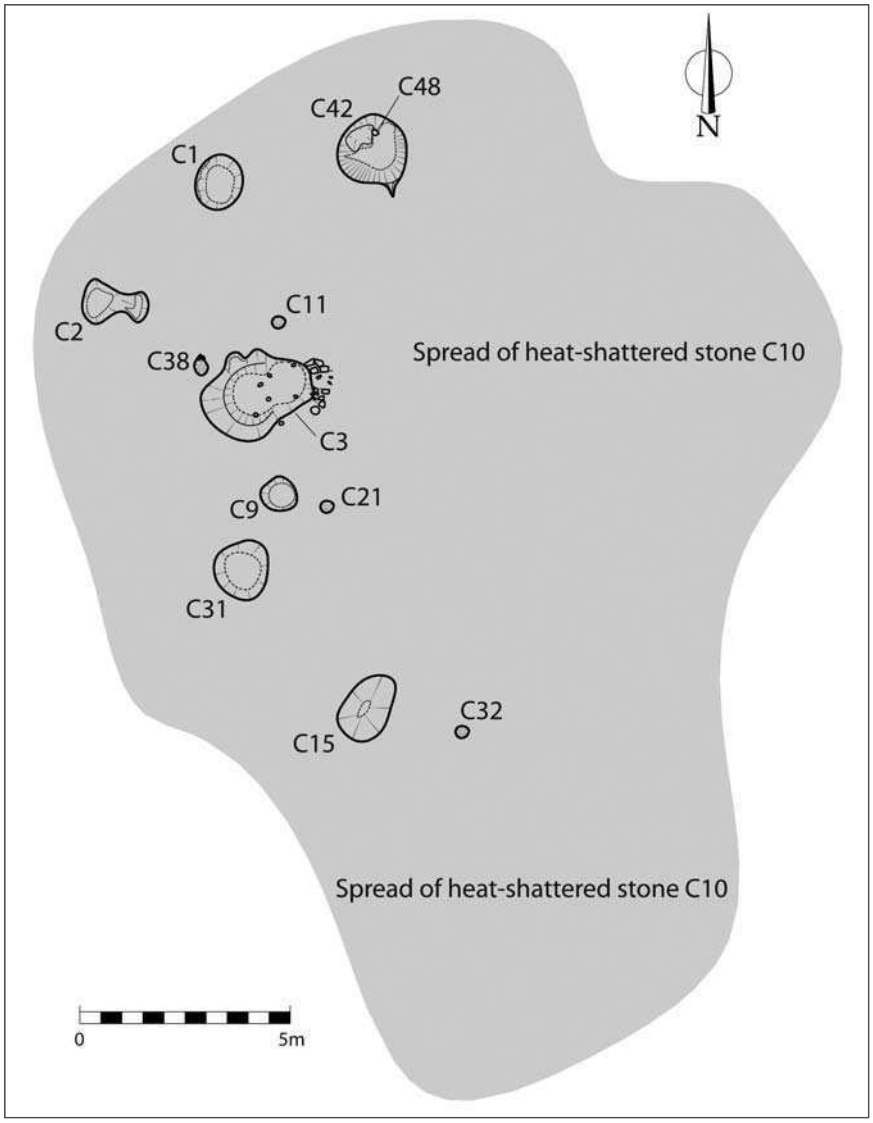

Fig. 13: Plan of fulacht fia 4

depths of 0.08–0.13m. A stake-hole (C37) immediately south of the trough was 0.08 in diameter and 0.09m deep. The stake-hole fills were stony, charcoal-flecked silt and hazelnut shell fragments and barley grains were recovered from the fill of stake-hole C37. The stake-holes within the trough pit may have been part of a trough lining and functioned as pegs to secure the lining in place. A post-hole (C38) was located 0.3m from the north-western edge of the trough pit (C3) and may have held a post related to trough use. The post-hole was oval in plan, 0.3m E/W by 0.5m N/S and 0.31m deep with a 'U'-shaped profile and silt fill. Two packing stones remained *in situ* on the north side and smaller stones along the west side may also have held the post in place. A second post-hole

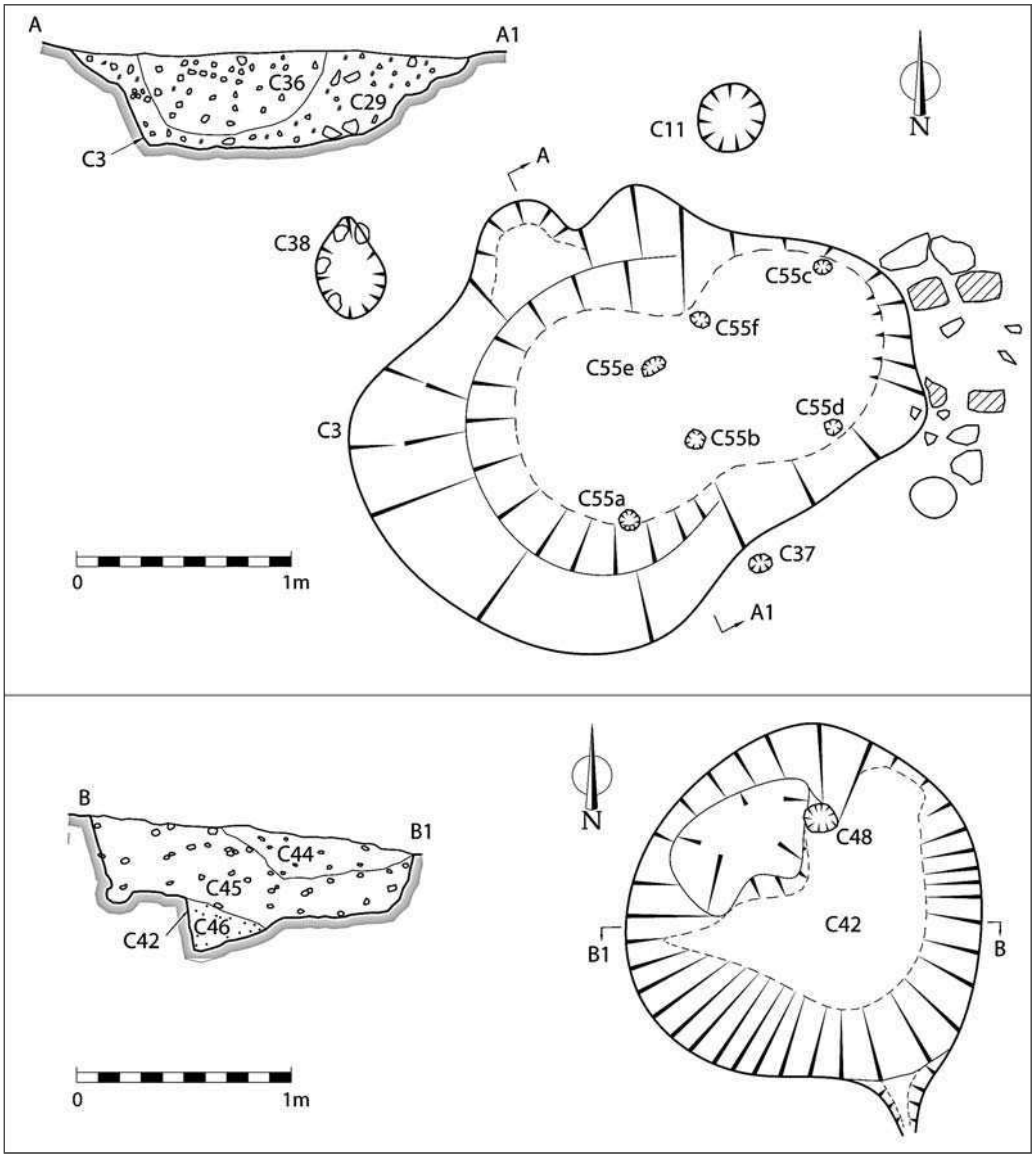

Fig. 14: Plan and sectional profiles of trough (C3) and pit (C42)

(C11) was located 0.75m north of the trough edge. This was oval in plan, 0.26m (E/W), 0.31m (N/S) and 0.21m deep with a 'U'-shaped profile and charcoal-enriched clay fill. Charcoal from the fill was predominately oak with some hazel, apple-type and willow.

Pits on north side of trough

A shallow pit (C1), located 3.6m north-west of the trough was oval in plan (Fig. 13) and measured 1.3m (N/S), 1.1m (E/W) and 0.15m deep. The sides sloped to an irregular base and the fill (C26)

was sandy charcoal-enriched clay with heat-shattered stones. A second shallow pit (C2), located 2.5m northwest of the trough (C3) was figure-of-eight in plan and narrowed to the east. The overall length was 2.1m (E/W), the maximum width was 0.9m and the depth was 0.18m. The fill was a single layer of heat-shattered stones and charcoal-flecked stony clay.

A deep pit (C42) located 4.6m north of the trough (C3) may have functioned as a trough and included a narrow 0.25m long channel on the south side, similar to an overflow feature. The pit was circular in plan with a diameter of 1.6m, 0.65m deep and had vertical sides and an irregular base (Fig. 14). A stake-hole (C48) was recorded on the pit floor. This was 0.14m in diameter and 0.22m deep with a 'V'-shaped profile and silt fill. The pit fill comprised a 0.25-0.35m thick basal layer (C46) of brown silt confined to the east side; a 0.35m thick middle layer (C45) of light brown charcoal-flecked silt with heat-shattered stones and an upper fill (C44) of mainly heat-shattered stones and some charcoal-flecked silt. The middle and upper fills may be due to mound slippage. Charcoal from the pit fill (C44) was oak.

Pits on south side of trough

Three shallow pits and two post-holes were recorded south of the trough (C3). A pit (C9), located 1m south of the trough was circular in plan (Fig. 14), 0.85m in diameter and 0.15m deep. The sides sloped to a flat base and the single fill (C25) was brown charcoal-flecked silt and heat-shattered stones. Charcoal included mainly oak, with lesser amounts of apple-type and some hazel and holly. Pit C31 was 0.8m south of C9, sub-circular in plan (Fig. 14) with a maximum diameter of 1.3m and was 0.15-0.18m deep. A 0.06-0.1m thick layer (C30) of charcoal-rich clay lined the pit sides and this was overlain by a 0.12m thick layer (C7) of mainly charcoal with some small stones and silt. A pit (C15) located 3.5m south-east of C31 was oval in plan and measured 1.5m (N/S) by 1m (E/W) and 0.25m deep. The profile was 'U'-shaped with a rounded base and single fill (C25) of mainly heat-shattered stones with some larger sandstone blocks up to 0.2m long and sandy, charcoal-flecked brown silt.

Two post-holes were located in the pit complex. Post-hole (C21) was oval in plan and measured 0.29m (E/W) by 0.25m (N/S) and 0.35m deep. The post-hole had a 'U'-shaped profile with slightly sloping east side and a packing stone remained *in situ* on the south side. The basal fill (C28) was a 0.15m thick layer of charcoal-flecked grey clay with small stones and one larger angular stone that may have been a packing stone and the upper fill (C27) was a 0.2m thick layer of dark grey charcoal-flecked silt with heat-shattered stones. Charcoal from C27 was predominately oak with a lesser amount of hazel and some holly. A post-hole (C32) was 1.85m east of the pit (C15). It was oval in plan and measured 0.22m (E/W) by 0.15m (N/S) and 0.33m deep with a peaty-clay fill (C33) with some small stones. The profile was 'U'-shaped and the post was driven at a 60º angle into the subsoil.

DISCUSSION

Radiocarbon determinations confirm a Bronze Age date for the Ballyadam fulachtaí fia, similar to other excavated fulachtaí fia in Ireland (Power *et al.* 1994, 24; Brindley and Lanting 1990). The date range for the sites extends from 2335–894 cal. BC, albeit the C^{14} evidence is mainly in the period 2335–1983 cal BC. An infill layer of Trough 1 (C5/20) in fulacht fia 2 returned a C^{14} determination of 1044–894 cal. BC, placing the period of Trough 1 infill in the Later Bronze Age.

Prior to archaeological investigation at Ballyadam, there were four known[14] fulachtaí fia in the environs of the site. One to the south (RMP CO 076-105) in Ballyvodock East townland was

discovered after the field was tilled. There is also a cluster of three fulachtaí fia south of Barrys-court Castle (RMP CO 075-070/072). Two other fulachtaí fia were uncovered in archaeological excavations in Carrigtohill (Cleary forthcoming) and Burgesland (Hurley 2010) and it likely that there are many more in the general environs of the site.

Well-preserved fulachtaí fia are low grass-covered mounds of burnt stone with a crescent or 'U'-shaped plan. Agricultural practices such as ploughing result in the dispersal and spreading of mound material (heat-shattered stone and charcoal) in the plough soil. Proximity to water is also a feature of these sites. The fulachtaí fia at Ballyadam were in low-lying terrain and a small stream was adjacent to Ballyadam 2, while the water table was also high and allowed water to seep into the pits. The clustering of sites at Ballyadam within quite a small area is unusual. The sites at Ballyadam were all levelled and not apparent as field monuments prior to the construction works. Once topsoil was removed all became apparent as burnt stone spreads. The burnt mound material covered some of the associated features, having been spread throughout much of the site. As conditions for the preservation of organic remains at Ballyadam were poor, there were no surviving traces of the timber or wattle lining within the troughs or any lining that may have been used in pits.

Fulacht fia 1

This site produced evidence of two troughs (C20 and C33) and both were located within the burnt mound spread, although originally the associated mound of heat-shattered stones must have been outside the trough area. It is possible that only one trough was in use at any time and one trough site may have replaced the other. The replacement of a trough site may be related to the accumulation of heat-shattered stone in the trough vicinity and slippage into an adjacent trough.

Both trough pits were cut into marl, presumably to allow for some water seepage where the trough was below the water table in the low-lying ground where the fulacht fia was located. Evidence from the charred plant remains from this site indicated that blackberries were eaten and this suggests use in the autumn, when the water-table was probably higher than during the summer.

The troughs consisted of sub-circular pits; C33 had a diameter of 2.40m while C20 was 2.20m X 2m. Both troughs were dug into sub-soil to similar depths of 0.50m (C33) and 0.60m (C20). There was no surviving evidence of lining in either pit. Where ground conditions are conducive to preservation, the archaeological evidence suggests that timber-lined troughs were the norm and in exceptional conditions, moss packing may survive (Gillespie and Kerrigan 2010, 145). Stake-holes of one trough (C20), may have secured a lining, possibly of timber, wicker or leather. Stake-holes along the outside of a trough are often seen as evidence for a directly associated superstructure and have been used to promote the hypothesis that these features were sweat-lodges or bathing places. In the case of fulacht fia 1, it is improbable that the trough was used as a sauna given the scant nature of the evidence, although some pits (see below) may have functioned as saunas.

The fills of the troughs give some indication of their history of use. Large stones in the base of C33 probably reflect the final episode of use where the stones were not removed for further use. The main infill of the trough was heat-shattered stone (C34) and this was either from post-use mound slippage or perhaps a deliberate infill. The peat layer at the base of C20 indicates that the pit was open for some time after abandonment and the main infill comprised both unburnt and heat-shattered stones suggesting again either mound slippage or perhaps a deliberate backfill.

Channels associated with both troughs (C20 and C33) may have been part of the original construction elements. The channel (C21) associated with the eastern trough (C20) drained towards

the pond (C75) and may have been part of a system for lowering the water in the trough or to allow for overspill to be carried away from it. A channel (C72) extended from the north side of the north trough (C33) and as this was upslope the function cannot have been for drainage and may be related to catching water to fill the trough.

Six other pits (C12, 13, 15, 23, 24 and 62) were identified beneath the burnt mound spread and two pits (C5 and C18) were outside the burnt stone spread. These pits (C5 and C18) were both shallow with depths below the surface of only 0.11-0.12m, while they also had stake-holes at the base suggesting supports for some type of overhead covering. A covering over the pit can indicate the creation of a confined space in order to use steam on the site. Modern and ethnographic parallels for saunas show that a pit is not required and water is simply poured onto hot stones. It is possible, however that shallow pits were dug to perhaps bed-in a tent-like structure and to create a confined space. A pit (C12) adjacent to C18 was also shallow, being only 0.2m below the surface and although no structural evidence survived for a cover, the similarity of shape of both these features may indicate that both served the same purpose.

The remaining pits varied in shape and size. The larger examples (C13, 15, 23 and 24) varied in diameters from 0.95-1.6m and in depth from 0.25-0.5m. The function of these is obscure. The rounded bases may indicate that these pits held water containers of wood, bronze or leather. Wood and leather containers survive in the Irish archaeological record from bog finds although a dry-land site like Ballyadam is unlikely to preserve evidence for these types of vessels. The shallow circular pits associated with burnt mound spreads may have acted as receptacles for these containers. It is probable that all of the pits were not in use at the same time and may have developed sporadically over the life of the site. Once a pit was abandoned, a new one was dug close by, indicating that the same people were using the site as they were aware of the existence of the disused pits. Many of the pits were similar in shape and scale and none showed signs of being re-cut: once a pit was abandoned it was not reused.

The ponds adjacent to both fulacht fia 2 and 3 show an opportunistic use of natural landscape features in the choice of location for fulachtaí fia sites. Hot-stone technology, either for cooking or saunas requires a ready source of water. The proximity of the ponds must have facilitated the activity on the sites and contributed to the ease of hot water production.

In contrast to the proximity of water, the sourcing of stones for all the burnt mound/ *fulachtaí fia* sites was unusual in that sandstone was deliberately drawn from distances of 3–5km to the sites (Archival report compiled by Anthony Beese).

Fulacht fia 2

This site was again low-lying ground and was under a modern wall and a considerable amount of topsoil. The mound may have been levelled at any time, but possibly as a result of agricultural activities in antiquity. The spread of heat-shattered stones (C33) and black silty clay with high concentrations of heat-shattered stone was irregular and extended over a distance of *c*. 20m.

The trough (C5/20) at fulacht fia 2 was square-ended on the south side and was set into a broad and wide pit (C5) with overall dimensions of 4.1m N/S by 1.7m E/W and a depth of 0.9m. The trough was the deepest of all the fulachtaí fia sites at Ballyadam. The markedly square end suggests that the trough housed some type of lining and this was probably timber planks. The channel (C56) on the north end of the trough was similar to fulacht fia 1 and probably functioned as a run-off or overflow to the nearby pond (C80) located *c*. 3.5m to the north. The Channel (C68) that extended into one pit (C63) may indicate that this pit also functioned as a trough. On morphological grounds

it is possible that the oval or sub-oval troughs are earlier in sequence than the square/rectangular troughs and it can be suggested that if the pit C63 was a trough that it predated the C5/20 trough.

Three post-holes (C37) and two stake-holes (C59) were positioned on the north-west side of the trough (C5/20). The post-holes appeared to form an arc and may have held uprights for a screen or windbreak used during the lifetime of the trough. A screen of wicker or hide may have protected the pit and its user from wind. The stakes may also have formed a drying-rack used in the preparation of animal hides.

A series of ten stake-holes (C18) were recorded to the south of a large pit (C63) and the patterning suggests two concentric rows. These may have held uprights that supported a screen or windbreak. The double row of stakes suggests that it was a substantial structure.

Six pits were recorded in the environs of the trough and these were either oval or circular in plan and varied in depth and infill. Basal silt in C1, C6 and C63 suggests that they may have been open for some time and that silt was washed in from the surrounding ground. The upper fills were heat-shattered stones and this suggests either mound slippage or perhaps deliberate backfilling. It is also possible that the mound was dispersed in antiquity and that this caused the pit to be infilled. Only one pit (C4) had evidence of some type of cover as indicated by a single stake-hole (C19) in the base. It is also possible that pits with stake-holes were associated with other activities such as saunas while some may have been related to cooking and functioned as roasting-pits. No trace of any lining was evident within any of the pits but during the wet days of the excavation most held water naturally.

Barley from fulacht fia 2 was recovered from below the dispersed mound and was the only indication of crop husbandry from the fulachtaí fia sites. Cereals will only survive the passage of time if they were charred in antiquity and it is possible that barley played an important dietary role although significant evidence of this did not survive.

The ergonomics of fulachtaí fia 1 and 2 were good, with the troughs and water all within easy reach of each other. The troughs were positioned in a north-west/south-east direction. They shared similar fills and may have been in use sequentially. Both the troughs had associated stake- and post-holes suggesting similar functions for upright posts adjacent to the trough pits.

Fulacht fia 3

This was the least substantial of all the burnt stone spreads and comprised a heat-shattered stone spread over two pits and a possible trough (C1). The shallow pit (C2/8) was similar to pits C5 and C18 in *fulacht fia* 1 and a possible explanation for it was a structure bedded into a shallow foundation and perhaps used as a sauna.

Fulacht fia 4

This site had a single trough (C3) and the only trough that had surviving evidence for pegs within the structure. These are interpreted as securing a lining in place. The trough was relatively large and oval in plan similar to the troughs at fulacht fia 1 (C20 and C33) and C63 at fulacht fia 2. The trough had a single fill suggesting that it was backfilled, perhaps when the site was abandoned in antiquity. A post-hole (C38), 0.30m to the north western edge of the trough and a stake-hole (C37a) at the trough pit edge may be related to some structural component of the trough such as a hoist or was perhaps unrelated to trough use.

The pits at fulacht fia 4 were mainly deep cut features. C42 was 0.65m deep and also had evidence for a post-hole (C48) within the pit. A post within the pit suggests it supported some type

of superstructure such as a tent-like covering. The pit C1 was *c.* 0.4m deep and wide suggesting it may have had a specific function.

No formal hearths were identified during the excavation of the Ballyadam sites. The absence of these features may be a consequence of agricultural activity, with intensive ploughing accounting for the removal of many of the more shallow types of features on archaeological sites. Deposits of ash and charcoal however confirm burning on all the Ballyadam sites. Analysis of the charcoal from the Ballyadam sites shows that at least five species were used as firewood: hazel, alder, apple-type, blackthorn/cherry, willow/poplar/aspen and oak. The range of wood species includes larger trees such as oak and smaller species like alder and hazel, as well as scrub such as blackthorn/cherry. These four species demonstrate a varied environment, with oak and cherry indicating deep dry soils while hazel suggests thinner, wetter terrain and alder indicates wetter conditions. Blackthorn can be found along the edges of woodland or amongst hedges. All of this suggests the location of the fulachtaí fia, and the burnt mounds or spreads, at the margins between dryland and wetland, with the fuel being gathered from mixed woodland. The properties of both oak and hazel made them ideal constructional timbers, while alder was often used to line troughs. It is also likely that the species identified were probably available and closest to hand for use as firewood.

The stones within the burnt mound material consisted mainly of sandstone. The underlying bedrock at Ballyadam is limestone and this rock type was not in general chosen by those using hot stone technology. The sourcing of this stone (Beese, Archival Report) suggests that it was favoured over the immediately available limestone. From experimental testing of shatter variation in different rock types, Buckley (1990, 172) concluded that drift-derived stones were most commonly used, with sedimentary rocks being preferred; experimentation also showed that igneous and metamorphosed rocks did not shatter as easily and were therefore very reusable, showing few signs of being fire-affected. After use the stones were removed from the trough and discarded close to the site, often forming a horseshoe-shaped mound, concentrated around three sides of the trough and nearby hearth.

Radiocarbon determinations of charred hazel from a cluster of five pits at Ballyadam indicate site use in the early centuries of the first millennium AD. The Iron Age in Munster was until relatively recently elusive in the archaeological record. A *c.* 550m long section of the Iron Age linear earthwork known as the 'Claidh Dubh' is located near Carrigtohill, Co. Cork (Verling 1988). Excavation of a section of the Claidh Dubh near Ballyhooley, Co. Cork did not produce direct dating evidence for the construction of the earthwork although peat growth over an associated trackway began about 100AD and indicates that at least the trackway had gone out of use at that time (Doody 2008, 568–9). Recent infrastructural projects have documented a number of Iron Age houses in County Cork (Danaher 2012). A house at Muckridge near Youghal is of similar date to the pits at Ballyadam (O'Brien 2012a, 235). There is also good evidence for iron production in the Cork region (ibid., 235–36). Charred barley and wheat grains in the Ballyadam pits confirm cereal cultivation and although the bone assemblage was very small, there is evidence of animal husbandry of cattle and sheep/goat. This evidence contributes to the knowledge of farming practices in the first to fourth centuries AD in the Cork region.

CONCLUSIONS

The remains of four fulachtaí fia sites representing evidence of burnt stone technology and a series of Iron Age pits with burnt animal bone and material subject to fire were discovered on the site at Ballyadam. All the fulachtaí fia were sited within low-lying areas with a ready source of water, which is the typical location for these sites. Three of the burnt mound sites (fulachtaí fia 1,

2 and 4) had the classic components of fulachtaí fia with shattered stone spreads and troughs and the remaining site (fulacht fia 3) comprised burnt mound material with two pits and of these one (C1) was of sufficient depth to include it as a possible trough. As fulacht fia 3 was fully excavated, there cannot be the possibility that the trough was outside the environs of the burnt stone spread. All the fulachtaí fia features, including the troughs and most of the pits, were either sealed or partly covered by the burnt mounds, with the sites occupying relatively small self-contained areas.

None of the fulachtaí fia sites included butchered bone, as might be expected if meat was cooked. The considerable size of troughs at fulachtaí fia 1, 2 and 4 and the quantity of heat-shattered stone does however suggest either prolonged or intense use.

ACKNOWLEDGEMENTS

The writer wishes to record her thanks to the following: Amgen who financed the project; Jean Finn and the staff of Flour PM who facilitated the site works; Laoise Cronin for monitoring and excavation work; Christina Murphy who supervised the excavation; Nick Hogan for the graphics; the specialists for their contributions; the staff who worked on the site; Abigail Brewer for a report on the archaeobotanical remains; Margaret McCarthy for animal bone identification; Farina Sternke for lithic identification; Ellen O'Carroll for charcoal report and Anthony Beese for his work on the stone types used in the pyrotechnology at Ballyadam.

The Excavation of Fulachtaí Fia in Context

Alan Hawkes

The prehistoric water-boiling sites were situated around two natural ponds which served as a water source for the troughs and the radiocarbon evidence suggests significant, episodic use during the Early Bronze Age period with later activity also recorded. The use of pyrolithic technology is an internationally recognised phenomenon with deposits of burnt and fire-cracked stones recognised in many early prehistoric cultures. These stones are often associated with cooking, applying an indirect heat to roast, boil or steam food. In Ireland these deposits are mainly associated with fulachtaí fia where a pyrolithic water-boiling technology was employed using hot stones to heat water held in open-air sunken pits. After numerous firings these stones were eventually shattered by the sudden cooling process, and gradually accumulated near the trough to form a low mound or spread also containing charcoal.

FULACHTAÍ FIA IN CO. CORK

Fulachtaí fia are particularly numerous in Co. Cork with some 2,500 sites recorded (Power *et al.* 1997) out of a total of approximately 7,000 nationally. They are principally concentrated in the northern and central areas of the county with a density of 1 per 3.7 sq km (Ó Drisceoil 1987, 51; Buckley 1991, 3). To date, *c.* 110 fulachtaí fia and burnt stone deposits have been excavated in Co. Cork with 54 examples uncovered as a direct consequence of road development with a further 32 revealed on pipeline schemes. The remainder were excavated as part of other development work or university-led research. There have been over 1000 of these sites excavated nationally over the last fifteen years becoming the most excavated and recorded field monument in the country.

These sites are usually identified as levelled burnt stone spreads with no surface expression, being dispersed as a result of intensive agricultural practices during the nineteenth and twentieth centuries. Extant examples usually survive as low crescent or 'U'-shaped mounds and are therefore highly vulnerable in areas of intensive agricultural activity. This vulnerability was highlighted almost two hundred years ago by Horatio Townsend (1815) in his *Statistical Survey of Co. Cork* where he notes that burnt stone from fulachtaí fia are used in 'convenient spots for repairing the roads'. The mid-nineteenth century antiquarian John Quinlan (1885, 360) observed that 'a great number of these mounds have been broken up and scattered by the plough and harrow'. At Ballyadam, spreads of 'dark soil and surface stone' were recorded in the Geological Survey mapping from the 1860's suggesting that the sites were levelled and visible in the ploughsoil at this early stage. Fulachtaí fia, therefore, have a greater chance of surviving in uplands rather than in low-lying coastal areas where settlement and intensive cultivation is more prevalent.

FULACHTAÍ FIA AT BALLYADAM

Location

The fulachtaí fia were situated in a series of low-lying intermediary hollows that flooded periodically in winter months. They were deliberately located adjacent to a series of natural ponds which acted as a water source for the troughs. This is a typical location for fulachtaí fia which are usually associated with poorly drained marginal land located close to a water source such as a river, stream, spring, pond, lake, or marshy area (Herity and Eogan 1977; Ó Drisceoil 1980; Waddell 1998). Water is an important pre-requisite for pyrolithic activities for it is usually water which is being heated or steam vapour being produced through the quenching of hot stones. Although in some instances where a visible water source is not present, excavation has demonstrated that natural springs and wells were utilized, suggesting people's inherent knowledge of their natural environment prior to hot stone working.

They sometimes occur in groups or clusters of two to six, located in quite a small area. For instance, a group of four fulachtaí fia and four burnt spreads were revealed adjacent to a large pond at Foulkscourt, Co. Kilkenny while a cluster of seven sites were excavated near two ponds at Owen's and Bigg's-Lot townland, Co. Tipperary (Hardy and Green 2009; Hughes 2008, 33). Where this is the case, it might be easy to assume that sites may be closely associated in date. However, this is not always the case, with some sites separated by up to 1000 years (Danaher 2007). Furthermore, some troughs can be returned to after a period of abandonment, re-lined or re-cut for further use, as in examples uncovered at Lissava, Co. Tipperary, Killeen's, Co. Cork and Cahiracon, Co. Clare (Molloy *et al*. 2009, 112; O'Kelly 1954; Dennehy 2003a).

Troughs

A number of troughs were identified during the excavation, many of which were covered and filled by the levelled burnt mound material. All of these boiling pits were sub-circular in shape, except for trough (C20/C5) at fulacht fia 2 which exhibited a rectangular form in plan.

A typological sequence has been proposed with regard to trough development in Ireland, with circular forms dating from the Early Bronze Age and rectangular ones from the Later Bronze Age (Ó Néill 2000, 19). While this may be the case for a number of sites, including Ballyadam, there are too many exceptions to make this a useful dating application. More likely, however, is a development in relation to timber trough linings. Troughs first become timber lined during the Late Neolithic period with wattle-lining becoming popular during the Chalcolithic or Early

Bronze Age period. Hollowed-out tree trunks are also used as water troughs during the Middle Bronze Age while stone-lined troughs are commonly found in Late Bronze Age contexts.

The ground conditions at Ballyadam were not conducive to the preservation of such organic remains. As a result, there were no surviving traces of timber or wattle linings within the troughs; however several internal stake-holes suggest that some boiling pits may have held internal linings. Trough (C23) at fulacht fia 1 had seven small stake-holes cutting the base of the pit in a circular arrangement. This may indicate that the sides of this trough were internally lined with wattle, while the base may have been lined with planks, similar to troughs identified at Kilbegly 2, Co. Roscommon, Dromnevane, Co. Kerry and Ballyclogh North, Co. Wicklow (Jackman 2010; Lynch 2007; Whitty 2009). Six stake-holes recorded at the base of trough (C3) at fulacht fia 4 may also have held a wattle lining. The post-holes identified in the base of trough (C20) at fulacht fia 1 may have supported a lining, possibly of planks, as these were located in the northern corners of the pit. The purpose of the timber lining was not to make the trough watertight but to maintain the integrity of the pit in wet ground conditions. It also facilitated each emptying of the trough as it provided a smooth base from which to remove the heat-shattered stones.

Four troughs at Ballyadam were associated with linear channels at the topographically lower end, where the natural ground level falls off gently into the ponds. Trough (C33) at fulacht fia 1 also had a channel extending upslope in a northerly direction which could not have been related to drainage. Although features associated with water management are not a new phenomenon at excavated fulachtaí fia (Fahy 1960), they have become increasingly apparent in recent years. Often interpreted as simple overflow outlets associated with the natural overfilling of troughs, several excavated sites have highlighted their importance in a more complex arrangement. For instance, some channels can be connected to a series of features that imply not only the emptying of water, but the movement of water between pits in a connected formation (Coughlan 2009; Hackett 2009a). This is suggestive of a production line of events in which each pit served a separate function, however there is no evidence of this taking place at Ballyadam.

The channels connected to troughs (C20, C33, C5/C20 and C63) can all be interpreted as overflow outlets allowing excess water to be directed away from the pits and into the lower ponds. Similar features have been found elsewhere in the country (Walsh 2009; Quinn 2003; Danaher 2004) with one trough at Correagh 1, Co. Westmeath associated with a timber-lined channel (Lynch 2009). The displacement of water and the movement of people in the immediate vicinity of a trough would have made the edges of an unlined trough quite unstable, therefore a mechanism to transport excess water would have been useful. Instability around the trough is often addressed with wooden planks or stone platforms used as 'kneelers' associated with the activities carried out in the trough (O'Brien 2012b; Cross May *et al.* 2005; Dennehy 2003b).

While these features are associated with the displacement of water from a trough, there are certain linear channels that suggest a more deliberate choice of trough location. Here it seems the water channels are transporting water to the trough, either from a natural spring, a nearby river or simply utilising the fall of a slope to collect rainwater. This may have been the function of channel (C72) upslope from trough (C33) at fulacht fia 1. The channel may have allowed rainwater to collect naturally in the trough similar to sites excavated at Mungret, Co. Limerick (Kiely *et al.* 2007) and Carrigatogher Harding and Ryan, Co. Tipperary (Hackett 2009c; 2009d).

It is generally agreed that water heating/boiling was the primary function of *fulachtaí fia* troughs. Excavation of these sites have revealed naturally filling timber-lined pits with primary deposits of broken heat-shattered stone, left *in situ* from the last use. Fine sediments left from the

sudden quenching of hot stones are also found under and between plank linings. The presence of filtering material such as moss, packed between these timbers further supports the interpretation that these pits were designed to hold water for boiling.

Stake-holes

Stake or post-hole arrangements are another common feature of fulachtaí fia and are usually situated close to troughs. These are often interpreted as the remains of possible hut structures, fence lines, windbreaks or drying racks associated with animal hide processing (Waddell 1998). One hypothesis is that these stake-holes may represent the remains of tripod frames for suspended butchery for preparing hide, fat, meat, offal and blood for processing in pits (Delaney and Tierney 2011, 43).

A number of stake-holes were recorded at Ballyadam, most of which were identified in the base of troughs, representing the remains of possible timber or wattle linings. A group of ten stake-holes were recorded to the south of trough (C63) at fulacht fia 2. Stake-hole arrangements such as these are frequently found at long ends of troughs and generally do not form any coherent patterns (Murphy and Clarke 2000; Hackett 2009b). They are usually interpreted as representing some form of ephemeral structure, repeatedly replaced due to the wet ground conditions.

However, the stake-holes at trough (C63) represented two concentric rows forming a small wattle fence. While it is difficult to ascribe a function to this structure, it possibly represents the remains of a windbreak to shelter the hearth from prevailing winds. Alternatively, it may have functioned as a timber revetment for the burnt mound as it is located at the long end of the trough where fired material would normally be deposited. Mound revetments typically occur where sites have suffered limited damage, such as Coarhamore, Co. Kerry (Sheehan 1990), Cahircalla Beg, Co. Clare (Hull 2006) and Dromnea, Co. Cork (Cleary 1987). They usually consist of a series of stones set in front of the burnt mound, retaining the firing debris and preventing it from disturbing the hearth or entering the trough pit. The stake-holes at Ballyadam may represent a stake and wattle equivalent of such a feature. Timber revetments are rarely found at fulachtaí fia, but examples were tentatively identified at Curraheen 4, Co. Cork and Knoxspark, Co. Sligo (Russell 2002; Deevy 2000).

Three post-holes (C37) and two stake-holes (C59) were also positioned on the north-west side of trough (C5/20) adjacent to the drainage channel (C56). The post-holes are difficult to interpret but appeared to form an arc representing some form of screen or windbreak structure.

Pits

Several pits were excavated at Ballyadam and were all located in close proximity to the troughs, implying some connection to the water-boiling processes. These pits varied in size, plan and profile and most contained fills consisting of charcoal-enriched material and heat-shattered stone. Stratigraphically, these features are related to the use of the site; however their function is not readily apparent. None of these pits contained organic linings to suggest they functioned as troughs, however, some were deep enough to suggest they could have functioned as boiling receptacles.

Pits are the most common feature revealed at excavated fulachtaí fia and are often found in great numbers. For instance, 18 pits were revealed in close proximity to two troughs at Moorchurch, Co. Meath (Russell 2001), while 30 pits were excavated at a fulacht fia at Tullahedy, Co. Tipperary (Murphy and Clarke 2000). It is probable that all the pits were not in use at the same time and may have developed sporadically over the life of the site. It has been

suggested that pits such as these may have been used on a temporary basis until such time as a more permanent timber-lined trough was constructed (Ó Drisceoil 1987, 51). In other cases they may have been used to test the suitability of the underlying water-table (ibid., 51). It has also been proposed that these features may have been used as receptacles for organic or ceramic containers for use as pot-boilers (Grogan *et al*. 2007). However, the general lack of prehistoric pottery found in excavated fulachtaí fia would negate the use of such material for heating liquids. It has also been highlighted that Bronze Age pots were not robust enough to survive this type of treatment (Grogan *et al.* 2007; Seager-Thomas 2010).

While some of these pits may have functioned as troughs, the insubstantial nature of others makes it unlikely that they were used as receptacles for heating liquids. While possibly connected to the use of hot-stone technology, albeit on a very small scale, the shallowness of the pits suggests a function possibly associated with roasting, baking or steaming. Roasting ovens were first identified at fulachtaí fia sites such as Ballyvourney and Drombeg, Co. Cork (O'Kelly 1954; Fahy1960), but have also been found elsewhere, such as Clare Island, Co. Mayo (Gosling *et al*. 2007). While these were above ground stone structures, the unlined pits at Ballyadam and other fulachtaí fia sites may have functioned in a similar manner, using dry heat to roast food produce.

This method of cooking has been well documented by others (Steensberg 1980; Smith *et al.* 2001; Thoms 2008; Wandsnider 1997) often using ethnographical accounts, supported by archaeological evidence. The type of cooking involved an unlined pit in which hot stones are evenly distributed and covered by a layer of plant material which served as a base for the food produce. Additional layers of hot stones and plant material may then be added, depending on the amount of food being cooked before being covered by earth. A fire may also be lit on the surface of the covered pit, possibly to expel moisture from the oven depending on what is being cooked. However a moist environment is sometimes preferred to prevent food from burning (Toms 2008, 449). Furthermore, Wandsnider (1997, 14) suggests that a moist environment is needed for several reasons, the primary of which is for preparing a large piece of meat. That is, the fat enables heat to permeate the tissues very rapidly and the protein is thereby quickly denatured. Steaming pits would have functioned in a similar manner to earth ovens, the only difference being a small prepared hole in the earthen lid where water was poured, which was sealed promptly to insure that steam and vapour did not escape (Toms 2008, 450). Meat may not have been the only food produce cooked at these locations. Thoms (2008, 445) has written extensively on the use of hot rocks in western North America, where prolonged cooking is required to hydrolyse inulin-rich roots adequately, as well as to detoxify plant foods, thereby rendering them more readily digestible and nutritious.

Cooking in this manner would leave little in the way of archaeological remains as animal bone has a tendency not to survive in acidic soil conditions. This may explain the difficulty in recognising such an activity at burnt mound sites. Therefore, the unlined pits at Ballyadam may have functioned as roasting or steaming pits with stakes possibly used to secure bedding material or plant matter in place, similar to an Early Bronze Age cooking pit at Coolderry 2, Co. Tipperary (Long 2009).

Hearths

No traces of fires or formal hearth settings were identified at any of the fulachtaí fia at Ballyadam. Hearth locations are difficult to identify during excavation and are particularly uncommon, although the presence of large amounts of charcoal and firing debris at fulachtaí fia suggests that sig-

nificant fires would have been burnt during each episode of use. The majority of informal hearths identified in recent years consist of areas of oxidised subsoil beneath the burnt mound deposits. Formal hearths on the other hand are usually only identified on more well preserved sites, where the mound has survived intact (Fahy 1960; Cleary 1987; Cotter 2005). These hearths usually consist of a semi-circular setting of stones or an area of oxidised soil situated immediately adjacent to the trough on a slightly elevated position where hot stones can simply be rolled into the trough.

Hearths or locations of burning should be visible if the fire exceeds some 300-375° C, since mineral soils will discolour at this temperature (Canti and Linford 2000, 393). However simple fires built on a normal humic topsoil surface rarely heat the underlying soil enough to cause significant reddening (ibid., 392). This may explain the absence of any hearth locations at Ballyadam. Alternatively, hearths may have been positioned on existing burnt mounds, providing a dry platform in an otherwise waterlogged area. These fires are unlikely to leave any archaeological trace; however, some heavier concentrations of charcoal in some burnt mounds may represent such locations (Gosling *et al.* 2007, 264).

PETROLOGY OF BURNT MOUNDS

An assessment of the coarse material from the excavated fulachtaí fia (Anthony Beese, Archival report) identified that each burnt spread was composed of heat-affected sandstone which was not native to the area of underlying limestone bedrock. The sourcing of this stone suggests that it was favoured over the immediately available limestone bedrock and deposits of river gravel. The majority of the stone was not derived from glacial drift deposits as 80% of the sampled gravels consisted of angular rubble of well bedded, closely jointed coarse grained sandstone. Beese (Archival report) identified that the most likely source must be a river-side cliff or bluff and proposed two possible source areas for the sandstone; Anngrove townland, *c.* 3km to the west of Ballyadam and the wide valley of the Owennacurra River north of Midleton, *c.* 5km to the northeast (Archival report). This is supported by the presence of heat-shattered sandstone in an excavated burnt mound at Castleredmond townland, immediately south of Midleton town (Doody 1987, 49).

Based on the density of fulachtaí fia in sandstone rich areas, O'Kelly (1954, 145) concluded that sandstone would have been the preferred stone for pyrolithic water-boiling because when limestone is heated and submersed in water it produces calcium hydroxide. Later experimental testing of shatter variation in different rock types identified that drift-derived stones were most commonly used at fulachtaí fia, with sedimentary rocks being the preferred material in the heating process (Buckley *et al.* 1987; Buckley 1990). Of the *c.* 110 fulachtaí fia excavated in Co. Cork, 72 have been composed of heat-shattered sandstone with only four sites consisting of limestone. Five sites contained both limestone and sandstone material while petrological analysis was not carried out on the remainder of the sites.

The deliberate importation of sandstone for pyrolithic water-boiling was also identified at Poldrain I, Co. Mayo. Sandstone represented 70% of the burnt mound indicating that it was specifically selected and brought to the site (Murphy 2008). The excavation of a fulacht fia as part of the Ballinrobe Sewage Scheme also demonstrated a preference for sandstone (Walsh 1995). In both cases the underlying local natural rock was limestone. Several fulachtaí fia excavated in advance of the M7-M8 motorway in Co. Laois were composed of sandstone with quartzite also present. Mandel (2008) suggests that the closest bedrock source for quartzite occurs in the Clay Gill Sandstone Formation which occurs in the upland areas *c.* 3km east of Durrow. Whilst it is possible that quartzite occur in the glacial tills, the importing of quartzite from other areas, or the preferential

extraction of quartzite from the tills cannot be ruled out (ibid., 55). The excavation of a fulacht fia at Maheraboy, close to the Caltragh Valley, Co. Sligo, revealed that sandstone was the predominant stone used; the closest known source of this material is along the Sligo-Leitrim border, over 10km to the northeast (Danaher 2007, 33).

As carboniferous limestone forms the underlying bedrock in the Ballyadam area, limestone would have been easily sourced. The quarrying of such material would not have been beyond the capabilities of Bronze Age societies if we consider the proficiency of earlier Neolithic groups. However, limestone was deliberately avoided in favour of sandstone. The caustic nature of limestone, when heated and immersed in water, has been used as an argument against the interpretation of such sites as cooking places. When limestone is heated and submersed in water it forms a corrosive substance called calcium hydroxide, or slakelime which would undoubtedly be hazardous to health if mixed with food. This adverse chemical reaction may also be the reason why sandstone is particularly favoured in certain instances. Grogan (2007, 98) has noted, however, that the quantities of calcium carbonate produced in the heating of water would not be harmful if the meat was protected and wrapped in vegetation or straw. It is noteworthy also that limestone forms a major component of burnt mounds in the Irish midlands. Limestone was the principal stone used at many sites excavated along the *Bord Gás Pipeline to the West* (Grogan *et al*. 2007) while visual examination revealed that the stone used at all of the excavated fulachtaí fia along the N18 Oranmore to Gort Road Scheme was limestone (Delaney and Tierney 2011, 39). Similarly, the burnt mound of a fulacht fia identified at Ardnabourkey townland, south of Whitegate village, Co. Cork was also composed chiefly of heat-shattered limestone (Clarke 2008), while large burnt and degraded limestone pieces were found in the base of a timber-lined trough at Curraheen 5, Co. Cork, directly implying that limestone was used to heat water (Russell 2004).

Animal bone has also been recovered from burnt mounds composed chiefly of limestone. For instance, butchered animal bone was recovered from a fulacht fia at Fahee South, Co. Clare (Ó Drisceoil 1988, 675); while an assemblage of cattle bones was recovered from the fill of a trough at Inchagreenoge, Co. Limerick (Taylor 2003). Five of the twelve fulachtaí fia excavated along the N18 Oranmore to Gort Road Scheme produced animal bone, albeit in very small quantities (Delaney and Tierney 2011, 44). In all of these cases, the firing debris consisted mainly of heat-shattered limestone and the presence of animal bone suggests that the sites may have been used for the processing and cooking of animals.

Limestone may have been avoided at Ballyadam due to its heating capabilities. Mandel (2007) has stated that course grained rock types are better in terms of the absorption and discharge of heat whereas fine grained rock types such as limestone does not absorb heat in the same manner. Furthermore, Feehan (1991, 203) has suggested that hard sandstones are among the most resilient for water-boiling, whereas most limestone shatters easily and some will explode dangerously when heated by fire.

The temperature of the fire would also fluctuate depending on fuel used, therefore, the reaction of the limestone to the heat and water could vary depending on external factors. Limestone also has varying chemical and geological components depending on the source, so some limestone would react differently to others. This may be the reason why in certain fulachtaí fia experiments, limestone proved to be insufficient (Lawless 1990, 8), while in others it was quite successful (Allen 1994; Ó Drisceoil pers. comm.). Therefore, the deliberate selection of sandstone at Ballyadam may have been for very practical reasons due to the inconsistency of the local limestone as a heating agent.

DATING AND FUNCTION

The fulachtaí fia at Ballyadam were all dated by radiocarbon analysis to the Early Bronze Age period. The date range for the sites extends from 2335–1770 cal. BC, albeit the C^{14} evidence is mainly in the period 2335–1983 cal BC. The dates are consistent with other published excavations and represent a practice of pyrolithic technology during the period when it becomes particularly widespread in Ireland.

Available radiocarbon evidence suggests that the majority of these sites are Bronze Age in date (Brindley *et al*, 1989; Ó Néill 2009). An analysis of approximately ninety-three dates from Ireland demonstrated the use of pyrolithic technology from *c.*3500 BC with a clear concentration in the Middle Bronze Age and a further significant grouping in the Late Bronze Age (Ó Néill 2003/4, 83; Ó Néill 2009, 40). This tradition of open-air boiling has its origins in the Early Neolithic period in Ireland (Hawkes forthcoming) but seems to have died out sometime in the mid-first millennium BC. There is also no archaeological evidence to support a contemporary use of fulachtaí fia during the early medieval period (Hawkes 2012).

The Ballyadam sites are amongst the earliest dated fulachtaí fia in Co. Cork with only six sites returning earlier radiocarbon determinations. While distinct use events could not be established in the mound material at Ballyadam, the number of troughs and the changes in the location of these troughs suggests a continued use of the same site. This is supported by a Late Bronze Age date of 1044–894 cal BC which was returned from an infill layer of trough 1 (C5/20) in fulacht fia 2 suggesting that this site remained an important focal point for the local communities.

Plant remains are rarely uncovered at excavated fulachtaí fia, however, evidence from the charred plant remains from fulacht fia 1 at Ballyadam indicated that blackberries were consumed. This suggests that the site was in use during the autumn period when water levels may have been higher. Certainly, troughs cut at different elevations could be indicative of use at alternate times depending on the level of the water table. Excavation in recent years has attested to this being the case where alluvial deposits were present within the burnt mound matrix clearly indicating flooding events. This suggests that some sites may only have been used seasonally.

While it is generally agreed that water heating/boiling was the primary concern for fulachtaí fia, the purpose of this heated water is still a matter of some debate as few artefacts are ever recovered. Since the nineteenth century fulachtaí fia have been associated with a culinary process whereby meat was boiled in a pit (Cooke 1849–51; Hackett 1854–5; Quinlan1885–6; Forsayeth 1913). While this has been successfully demonstrated by many (O'Kelly 1954; Fahy 1960; Lawless 1990) the general absence of animal bone from fulachtaí fia has provided a stimulus to examine alternative functions. Alternative interpretations include bathing places or where structural evidence is identified a more complex ritual or symbolic cleansing is favoured where hot stones are used to produce steam in an enclosed space (Barfield and Hodder 1987; Hanley 2009; Eogan and Shee Twohig 2011). Other functional interpretations include textile/hide processing areas, dyeing or felt making sites or even small breweries (Jeffery 1991; Quinn and Moore 2009).

Others have argued that the absence of animal bone at fulachtaí fia may have been the result of acidic soil conditions, the ritual disposal of bones after consumption, scavenging animals or that the users may have consumed the meat at another location (Grogan 2005, 41; Waddell 1998, 177). Recently however, animal bone has become increasingly evident at excavated sites (Tourunen 2008) which has led to a number of other suggestions relating to butchery and cooking practices at these sites (Roycroft 2006; Monk 2007). No animal bone was recovered from the

fulachtaí fia at Ballyadam even though the alkaline soil was conducive to bone preservation. However, as the stone used for the pyrolithic process was sandstone, which is acidic, bone may not have survived.

The boiling of meat produce may have been seen as the preferred cooking method for recently killed animals. Freshly killed meat was seen as tough and barley edible amongst the Greeks and Sythians (McCormick 2009, 408). Wandsnider (1997, 15) explains that lean meats are boiled to restore moisture, which will assist the action of digestive enzymes. She further suggests that fatty meat tissues may be boiled to further lipid hydrolysis and to melt and express tissue lipids that may then be recovered and used for other purposes (ibid.., 15); a point which was recently highlighted by Monk (2007). Boiling was an essentially important heat treatment technique used to extract bone grease among Upper Palaeolithic hunter-gatherers in Europe (Nakazawa *et al*, 2009), while crushed calcined bone identified at sites such as Clowanstown 1, Co. Meath is thought to be consistent with marrow extraction where short-term boiling episodes would make the marrow easier to extract (Mossop 2008).

Domesticated cattle are the most numerous animal bone remains found in excavated fulachtaí fia. As the plant remains from some of the sites at Ballyadam suggested seasonal use, it could be argued that the use of some sites may be a reflection of a cattle surplus each autumn where several animals may not be worth feeding, or that could not be fed through the winter (Roycroft 2006, 38). Such occasions may have warranted communal gatherings for the slaughter, butchery and cooking of animals using pyrolithic technologies and the importance of such events is supported by the deliberate deposits noted at some burnt mound sites in Ireland (Gillespie 2010; Mossop 2008).

CONCLUSION

The fulachtaí fia at Ballyadam can all be interpreted as Bronze Age water-boiling sites possibly used on a seasonal basis for open-air communal events. Although the archaeological evidence does not provide a clear indication of a specific function, the location was deemed an important area for pyrolithic water-boiling as the site was returned to after a considerable period of abandonment.

Features such as drainage channels and possible mound revetments imply a conscientious approach to the management of these sites by the user community. The deliberate importation of over 250 metric tonnes (Beese, Archival report) of a particular rock type over a distance of at least several kilometres also highlights the attention given to different petrology's in terms of their suitability for water-boiling.

While the fulachtaí fia at Ballyadam cannot be described as residential sites, they are certainly an important extension of a local Bronze Age settlement where people engaged on a daily basis, creating distinctive social identities through their work, actions and routine practices.

REFERENCES

Abbreviations

JAA = Journal of Anthropological Archaeology
JAS = Journal of Archaeological Science
JCHAS = Journal of the Cork Historical and Archaeological Society
JIA = Journal of Irish Archaeology
JRSAI = Journal of the Royal Society of Antiquaries of Ireland
PPS = Proceedings of the Prehistoric Society

Allen, D. 1994 'Hot water and plenty of it', *Archaeology Ireland* 21, 8–9.
Barfield, L. and Hodder, M. 1987 'Burnt mounds as saunas, and the prehistory of bathing', *Antiquity* 61, 370–9.
Brindley, A.L., Lanting, J.N. and Mook, W.G. 1989–90 'Radiocarbon dates from Irish *fulachta fiadh* and other burnt mounds', *JIA* 5, 25–33.
Brindley, A and Lanting, J.N. 1990 'The dating of *fulachta fiadh*', in Buckley 1990 (ed.), 55–56.
Buckley, V.M., Gowen, M. and Vaughan, A. 1987 'Analysis of the Petro-Morphology of a destroyed *Fulacht Fiadh* at Castlebellingham, Co Louth', *Journal of the Louth Historical and Archaeological Society* 21 (3), 294–6
Buckley, V. (ed.) 1990 *Burnt Offerings: International Contributions to Burnt Mound Archaeology*. Bray.
Buckley, V. 1990 'Experiments using a reconstructed *fulacht* with a variety of rock types: implications for the petro-morphology of *fulachta fiadh*', in Buckley 1990 (ed.), 170–2.
Buckley, V. 1991 'Irish fulachta fiadh: an overview', in M.A. Hodder and C.H. Barfield (eds) *Burnt Mounds and Hot Stone Technology*. Sandwell, 3-10.
Canti, M.G. and Linford, N. 2000 'The effects of fire on archaeological soils and sediments: temperature and colour changes', *PPS* 66, 385–396.
Clarke, L. 2008 'Archaeological excavations at Ardnabourkey, Co. Cork', Unpublished excavation report prepared by Archaeological Consultancy Services Ltd.
Cleary, R.M. 1986 'Excavation of a *fulacht fiadh* at Dromnea, near Kilcrohane, Co. Cork', *JCHAS* 91, 49–54.
Cleary, R.M. forthcoming 'Excavation of a fulacht fia and ring-ditch in Carrigtohill townland, Co. Cork'.
Cooke, T.L. 1849–51 'Discovery in the ruins of Killyon', *JRSAI* 1, 215–16.
Cotter, E. 2005 'The excavation of a *fulacht fiadh* at Killalough, Co. Cork', Unpublished excavation report prepared by Sheila Lane and Associates Ltd.
Coughlan, T. 2009 'Site A016/054, Burrow and Glenanummer 3', Unpublished report prepared by Irish Archaeological Consultancy Ltd.
Cross May, S., Murray, C., Ó Néill, J. and Stevens, P. 2005 *The Lisheen Mine Archaeological Project.* Dublin.
Danaher E. 2004 'Excavations at Ballinaspig More 7, Co. Cork', Unpublished excavation report prepared by Archaeological Consultancy Services Ltd.
Danaher, E. 2007 *Monumental beginnings: the archaeology of the Sligo Inner Relief Road.* NRA Scheme Monograph 1. Dublin.
Danaher, E. 2012 'A possible Iron Age homestead at Ballinaspig More, Co. Cork', in C. Corlett and M. Potterton (eds) *Life and Death in Iron Age Ireland in the light of recent archaeological excavations.* Dublin, 79–92.
Delaney F., and Tierney, J. 2011 *In the Lowlands of South Galway: Archaeological Excavations on the N18 Oranmore to Gort National Road Scheme.* Bray.
Dennehy, E. 2003a 'Archaeological excavations at Cahiracon, Co. Clare (02E1137)', Unpublished excavation report prepared by Margaret Gowen and Co. Ltd.
Dennehy, E. 2003b 'Archaeological excavations at Cahiracon, Co. Clare (02E0952)', Unpublished excavation report prepared by Margaret Gowen and Co. Ltd.
Doody, M. 1987 '*Fulacht fiadh*, Castleredmond, Co. Cork', in R.M. Cleary, M.F. Hurley and E.A. Twohig (eds) *Archaeological Excavations on the Cork to Dublin Gas Pipeline 1981-82*. Cork, 49-50.
Doody, M. 2008 'The Claidh Dubh – Survey and excavation', in M. Doody, *The Ballyhoura Hills Project*. Discovery Programme Monograph No. 7. Bray, 559–569.
Eogan, J. and Shee Twohig, E. (eds) 2011 *Cois tSiúire—nine thousand years of human activity in the Lower Suir Valley*. NRA Scheme Monograph 8, Vol. 2. Dublin.
Fahy, E.M. 1960 'A hut and cooking places at Drombeg Co. Cork', *JCHAS* 65, 1-17.
Feehan, J. 1991 '*Fulachta fiadh* in the South Midlands', *Tipperary Historical Journal* 22, 202–207.
Forsayeth, G.W. 1913 'Prehistoric cooking places', *Journal of the Waterford and South-east of Ireland Archaeology Society* 14, 142–4.
Gillespie, R. 2010 'Claremorris Sewerage Scheme, Excavations at Coolroe, Co. Mayo', Unpublished excavation report prepared by Mayo County Council.

Gillespie, R. and Kerrigan, A. 2010 *Of Troughs and Tuyères: The archaeology of the N5 Charlestown Bypass*. NRA Scheme Monographs 6. Dublin.
Gosling, P, Manning, C and Waddell, J. 2007 *New Survey of Clare Island: Archaeology.* Dublin.
Grogan, E. 2005 *The North Munster Project* (2 vols). Dublin.
Grogan, E., O'Donnell, L. and Johnston, P. 2007 *The Bronze Age landscapes of the Pipeline to the West: an integrated archaeological and environmental assessment*. Bray.
Hackett, W. 1854–5 'Proceedings and Transactions', *JRSAI* 3, 59–61.
Hackett, L. 2009a 'Archaeological excavations at Ballyburn Lower, Co. Kildare', Unpublished excavation report prepared by Headland Archaeology Ltd.
Hackett, L. 2009b 'Archaeological excavations at Ballybar Lower, Co. Carlow', Unpublished excavation report prepared by Headland Archaeology Ltd.
Hackett, L. 2009c 'Archaeological excavations at Carrigatogher Harding Site 3, Co. Tipperary', Unpublished excavation report prepared by Headland Archaeology Ltd.
Hackett, L. 2009d 'Archaeological excavations at Carrigatogher Ryan Site 1', Unpublished excavation report prepared by Headland Archaeology Ltd.
Hardy, C. and Green, B. 2009 'Site AR 49, Foulkscourt, Co. Kilkenny', Unpublished excavation report prepared by Valerie J. Keeley Ltd.
Hawkes, A. 2012 'Medieval fulachtaí fia in Ireland? An archaeological assessment', *JIA* 20, 77–100.
Hawkes, A. forthcoming 'The beginnings of the fulacht fia water-boiling tradition in Prehistoric Ireland'.
Herity, M. and Eogan, G. 1977 *Ireland in Prehistory*. London.
Hughes, J. 2008 'Cashel's earliest wooden artefacts', *Seanda* 3, 33.
Hull, G. 2006 'Archaeological excavations at Cahircalla Beg, Co. Clare', Unpublished excavation report prepared by TVAS Ltd.
Hurley, M. 2010 'Burgesland', in I. Bennett (ed.) *Excavations Bulletin 2007 Summary Accounts of Archaeological excavations in Ireland.* Dublin, 49–50.
Jackman, N. 2010 'The excavation of an early medieval horizontal mill and a prehistoric burnt mound in the townland of Kilbegly, Co. Roscommon', Unpublished excavation report prepared by Valerie J. Keeley Ltd.
Kiely, J, Doolan, A, and Harte, A. 2007 'Archaeological excavations at Mungret, Co. Limerick', Eachtra Archaeological Projects Online Journal: http://eachtra.ie/index.php/journal/04e0414-mungret/ (accessed 5/7/2012).
Lawless, C. 1990 'A fulacht fiadh Bronze Age cooking experiment at Turlough, Castlebar', *Cathair na Mart, Journal of the Westport Historical Society* 10, 1–10.
Long, P. 2009 'Archaeological excavations at Coolderry 2, Co. Kildare', Unpublished excavation report prepared by Headland Archaeology Ltd.
Lynch, L. 2007 'Archaeological Excavations at Railway Road, Dromneavane, Kenmare, Co. Kerry', Unpublished excavation report prepared by Aegis Archaeology Ltd.
Lynch, P. 2009 'Site A016/066 Correagh 1. Final Report', Unpublished report prepared by Irish Archaeological Consultancy Ltd.
Mandel, S. 2007 'Petrographical report on stone samples from Caltragh, Co. Sligo', Unpublished report prepared for Archaeological Consultancy Services Ltd.
Mandel, S. 2008 'Petrographical report on stone samples from Boherard 1, Co. Laois', Unpublished report prepared by Archaeological Consultancy Services Ltd.
McCormick, F. 2009 'Ritual feasting in Iron Age Ireland', in G. Cooney, K. Becke, J. Coles, M. Ryan and S. Sievers (eds) *Relics of Old Decency: Archaeological Studies in Later Prehistory*. Dublin, 405–12.
Molloy, M. MacQuade, M. and Moriarty, C. 2009 *In the shadows of the Galtees. Archaeological excavations along the N8 Cashel to Mitchelstown Road Scheme.* NRA Scheme Monograph 4. Dublin.
Monk, M. 2007 'A Greasy Subject', *Archaeology Ireland* 21(1), 22–4.
Mossop, M. 2008 'Archaeological excavations at Clowanstown 1, Co. Meath', Unpublished excavation report prepared by Archaeological Consultancy Services Ltd.

Murphy, D. 2008 'Excavations at Poldrain 1, Co. Mayo', Unpublished excavation report prepared by Archaeological Consultancy Services Ltd.
Murphy, D. and Clarke, L. 2000 'Site L/M Nenagh Bypass- *Fulachta fiadh*', Unpublished excavation report prepared by Archaeological Consultancy Services.
Nakazawa, Y., *et al.* 2009 'On stone-boiling technology in the Upper Paleolithic: behavioral implications from an Early Magdalenian hearth in El Miro´n Cave, Cantabria, Spain', *JAS* 36, 684–693.
O'Brien, W. 2012a *Iverni: A prehistory of Cork*. Cork.
O'Brien, W. 2012b 'Aspects of *fulacht fiadh* function and chronology in Cork', *JCHAS* 117, 107–133.
Ó Drisceoil, D. 1980 *Fulachta fiadh: a study*. Unpublished MA thesis, University College Cork.
Ó Drisceoil, D. 1987 'Clohoge, Kilcor South IV, Castleredmond- Discussion', in R.M. Cleary, M.F. Hurley and E.A. Twohig (eds) *Archaeological Excavations on the Cork to Dublin Gas Pipeline 1981-82*. Cork, 51-2.
Ó Drisceoil, D. 1988 'Burnt mounds: cooking or bathing?', *Antiquity* 62, 671–8.
O'Kelly, M.J. 1954 'Excavations and experiments in Irish Cooking Places', *JRSAI* 84, 105–56.
Ó Néill, J. 2000 'Just another fulacht fiadh story', *Archaeology Ireland* 14 (2), 19.
Ó Néill, J. 2003–4 '*Lapidibus in igne calefactis coquebatur*: the historical burnt mound tradition', *JIA* 12/13, 79–85.
Ó Néill, J. 2009 *Burnt mounds in northern and western Europe: a study of prehistoric technology and society*. Saarbrücken.
Power, D. *et al.* 1994 *Archaeological Inventory of County Cork, Vol. II, East and South Cork*. Dublin.
Power, D. *et al.* 1997 *Archaeological Inventory of County Cork, Vol. III, Mid Cork*. Dublin.
Quinlan, J. 1885–6 'The cooking places of the Stone Age in Ireland', *JRSAI* 17, 390–2.
Quinn, A. 2003 'Excavations at Ballynahina, Co. Cork', Unpublished excavation report prepared by Archaeological Consultancy Services Ltd.
Quinn, B and Moore, D. 2009 'Fulachta fiadh and the beer experiment', in M. Stanley, E. Danaher and J. Eogan (eds) *Dining and Dwelling*. Archaeology and the National Roads Authority, Monograph Series No. 6. Dublin, 43–53.
Roycroft, N. 2006 'A theory on boiled bull and burnt mounds', *Seanda* 1, 38–39.
Russell, I. 2001 'Excavations at Moorechurch, Co. Meath', Unpublished excavation report prepared by Archaeological Consultancy Services Ltd.
Russell, I. 2004 'Excavations at Curraheen 4, Co. Cork', Unpublished excavation report prepared by Archaeological Consultancy Services Ltd.
Rutter, I. and O'Connell, P. 1994 'Fota, Co. Cork', in S. Cherry (ed.) *Digging up Cork: Archaeological excavations in Cork 1992*. Cork, 11–13.
Seager-Thomas, M. 2010 'Potboilers reheated. *PPS* 76, 357–366.
Sheehan, J. 1990 'The excavation of a *fulacht fiadh* at Coarhamore, Valentia Island, Co. Kerry', in Buckley 1990 (ed.), 27–37.
Smith, C.S., Martin, W., Johansen, K.A., 2001 'Sego Lilies and prehistoric foragers: return rates, pit ovens and carbohydrates', *JAS* 28, 169–183.
Steensberg, A. 1980 *New Guinea gardens. A study of husbandry with parallels in prehistoric Europe*. London.
Taylor, K. 2003 'Archaeological excavations at Inchagreenoge, Co. Limerick', Unpublished excavation report prepared by Margaret Gowen and Co. Ltd.
Thoms, A.V. 2008 'The fire stones carry: ethnographic records and archaeological expectations for hot- rock cookery in western North America', *JAA* 27, 443–60.
Tourunen, A. 2008 'Fuana and fulachta fiadh: animal bones from burnt mounds on the N9/N10 Carlow Bypass', in J. O'Sullivan and M. Stanley (eds) *Roads, Rediscovery and Research*. Archaeology and the National Roads Authority Monograph Series No. 5. Dublin, 37-43.
Townsend, H. 1815 *A Statistical Survey of Co. Cork*. Cork.
Verling, E. 1988 *The Claidh Dubh, a linear earthwork in County Cork*. Unpublished MA thesis, University College Cork.

Waddell, J. 1998 *The Prehistoric Archaeology of Ireland*. Galway.
Walsh, F. 2009 'Site A016/062 Kilbeg 4, Final Report', Unpublished report prepared by Irish Archaeological Consultancy Ltd.
Walsh, G. 1995 'Archaeological Excavations on the Ballinrobe Sewerage and Sewage Disposal Scheme 1994', Report for Mayo County Council.
Wandsnider, L. 1997 'The roasted and the boiled: food composition and heat treatment with special emphasis on pit-hearth cooking', *JAA* 16, 1–48.
Whitty, Y. 2009 'Site A022/046, Ballyclogh North, Co. Wicklow', Unpublished excavation report prepared by Irish Archaeological Consultancy Ltd.

NOTES

1 Licence No. 06E612.

2 Amgen Ltd was scheduled to construct an industrial complex.

3 Exact location: OS 6" scale sheet no. 76 Co. Cork. Td. Ballyadam; By. Barrymore; Par. Carrigtohill. Site No. 1: 20.8cm from E. margin; 12.4cm from N. margin; NGR 184715, 73618. Site No. 2: 12.8cm from E. margin; 11.6cm from N. margin; NGR 183877, 73714. Site No. 3: 14.2cm from E. margin; 13.6cm from N. margin; NGR 184001, 73506. Site No. 4: 16.2cm from E. margin; 12.2cm from N. margin; NGR 184251, 73670. Site No. 5: 16.4cm from E. margin; 11.3cm from N. margin; NGR 184261, 73724.

The sites have also been assigned monument numbers in the Cork Archaeological Survey as follows: Site 1 (RMP CO 076-119); Site 2 (RMP CO 076-120); Site 3 (RMP CO 076-121); Site 4 (RMP CO 076-122); Site 5 (RMP CO 076-123).

4 The site is recorded in the site archive as Ballyadam 1.

5 C = context.

6 All dates are calibrated to 2 sigma.

7 The plant remains were identified by Abigail Brewer.

8 Information from Anthony Beese (archival report commissioned for this project).

9 This site is recorded in the site archive as 'Ballyadam 2'.

10 The farm was the site of the National Ploughing Championship in 1992 and the land was reinstated after the event.

11 This site is recorded as Ballyadam 3 in the site archive.

12 This site is recorded as Ballyadam 4 in the site archive.

13 This site is recorded as Ballyadam 5 in the site archive.

14 Recorded in the Archaeological Inventory of Co. Cork (Power *et al.*, 1994).