

## III.

## OBSERVATIONS ON HUT-CIRCLES NEAR THE EASTERN BORDER OF PERTHSHIRE, NORTH OF BLAIRGOWRIE. BY WALLACE THORNEYCROFT, F.S.A.Scot.

The area under review is shown on the map (fig. 1). Some excavations were made on Balnabroch on the western side of the map by John Stuart in 1865 (*Proc. Soc. Ant. Scot.*, vol. vi. p. 402), where a brief account of some of the Dalrulzion hut-circles is given.

Sixty-one hut-circles were visited by me during the summers of 1930, 1931, and 1932, but I do not suggest that there are not more, especially nearer the land included in the map, which is now under cultivation. Those visited may be divided into three distinct types:—

- Double concentric rings forming one hut.
- Double tangential rings.
- Single rings.

The list on fig. 1 gives the number of each type in each group.

Fig. 2 shows the result of preliminary surveys of each type. Generally speaking, all visible stones bigger than about 2 cubic feet were measured. The meridian (true north) and the scale are common to all.

The notable features observed are as follows:—

1. None are much above or much below the 1000-foot contour line (see fig. 1).
2. Each group is situated near what are believed to be very ancient tracks, or easily accessible from such tracks shown on the map (fig. 1).
3. All are adjacent to a permanent water-supply from springs. At Drumderg there is a "cup-marked" stone near the spring.
4. Most of them are on the southern or eastern slopes of the hills and command an extensive view.

The two at the head of Glen Beanie convey the impression that they may have been observation posts commanding the track up Glenshee, which may have been a route to Aberdeenshire from Perthshire since very early times.

5. There are indications of ancient cultivation near many of the groups. Stones appear to have been cleared off the adjacent areas to make it available for cultivation, and piled up in small cairns. So far I have only excavated one of these small cairns, and found nothing but such stones and very small bits of charcoal or decayed wood.

FIGURE I.

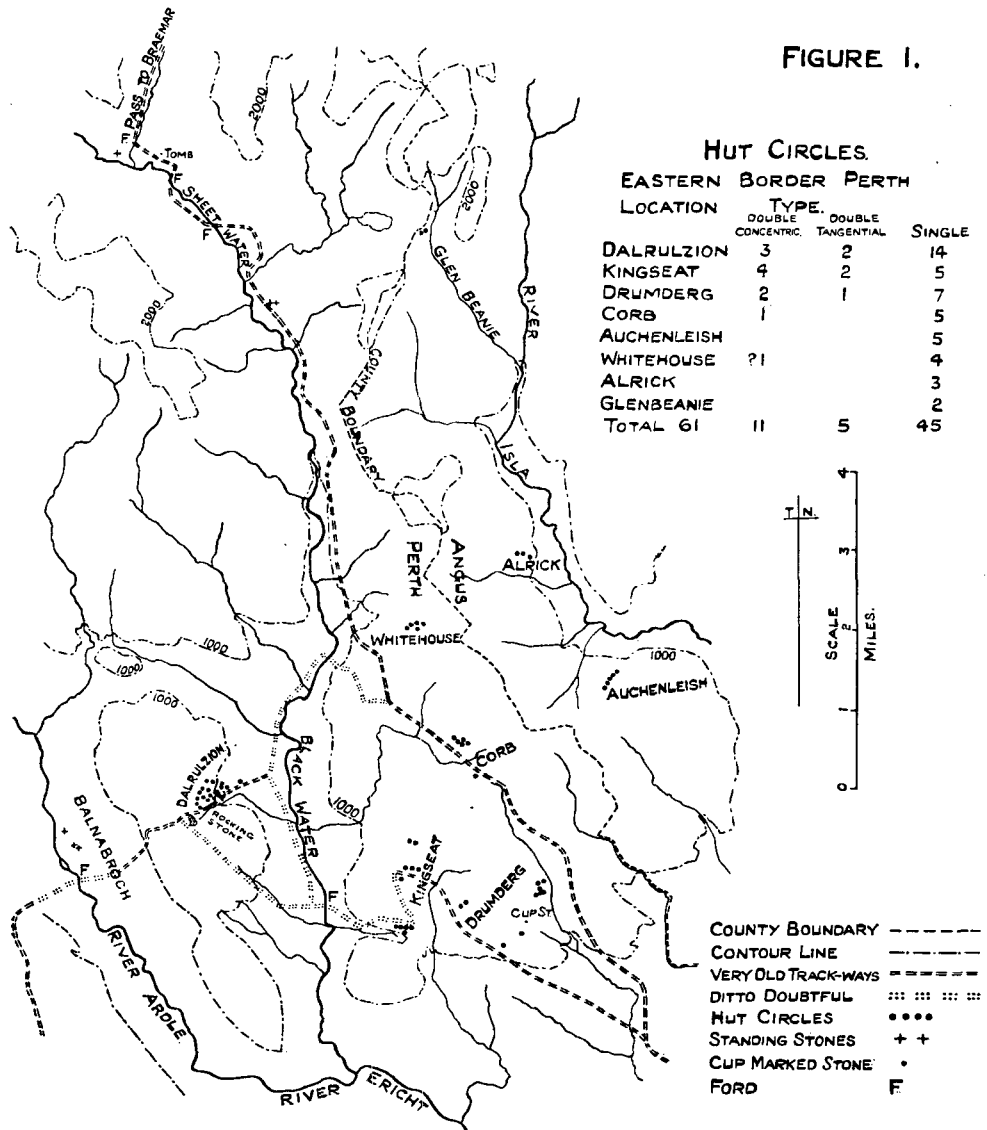


Fig. 1. Map showing distribution of Hut-Circles on the borders of Perthshire and Angus.

Up till quite recent times, stones have been cleared off moorland areas in the district to bring it into cultivation.

The present-day vegetation near some groups is somewhat different from that on the adjacent moors. Often thistles grow, and sometimes foxgloves. Near some of the groups are remains of stone dykes much obliterated and difficult to trace, but I have no evidence to prove whether these were built at the same date as the hut-circles or later. The cultivation may have been of later date; I have no evidence, but I have records of crofts on Dalrulzion, a little lower down the hill, in the sixteenth century, and the land cultivated then is quite distinct and different from the land referred to as adjacent to the hut-circles.

Land is cultivated to-day on the Corb Farm, and oats produced at a higher altitude than any of these hut-circles, except Glen Beanie, where I observed no sign of cultivation, but learned that David Graham had made some excavations here about forty years ago, and is said to have found some charcoal, but has left no record of anything else.

In peat bogs adjacent to the groups, both above and below them, drift-wood, mainly hazel, is found in the peat at depths from 18 inches to 6 feet, which proves that trees grew naturally at higher altitudes than the sites of the hut-circles, but there is very little natural growth of trees above 1000 feet to-day, although there are plantations of conifers above that level.

6. The entrance, when traceable, is always towards the south-east, and, so far as my observations have gone, does not vary more than 10° either way from true south-east.

Dalrulzion T (fig. 2) is abnormal, and no entrance is traceable.

7. The structural details of each hut-circle, as disclosed by superficial observation without excavation, vary. In most of them stones set on edge are visible, forming an inner ring, but never complete. This may be due to some of these stones on edge having fallen and been buried, as in Circle F, Dalrulzion, or due to such stones having been removed in recent times for other purposes.

A feature common to them all is a ring, formed of earth covered with vegetation, rising above the level of the adjacent surface, with stones sticking up out of this ring of earth. In the double concentric type there are two such rings with an annular space between them.

8. The diameter of the inner ring is not easy to define without excavation, but usually is between about 25 feet and 35 feet. Dalrulzion T (plan 2) is about 50 feet, but it is abnormal.

9. It is not unusual to notice a half-moon-shaped area, often south of the entrance, covered with stones, *e.g.* Drumderg and Corb (fig. 2), and

TYPICAL HUT CIRCLES EAST PERTSHIRE.

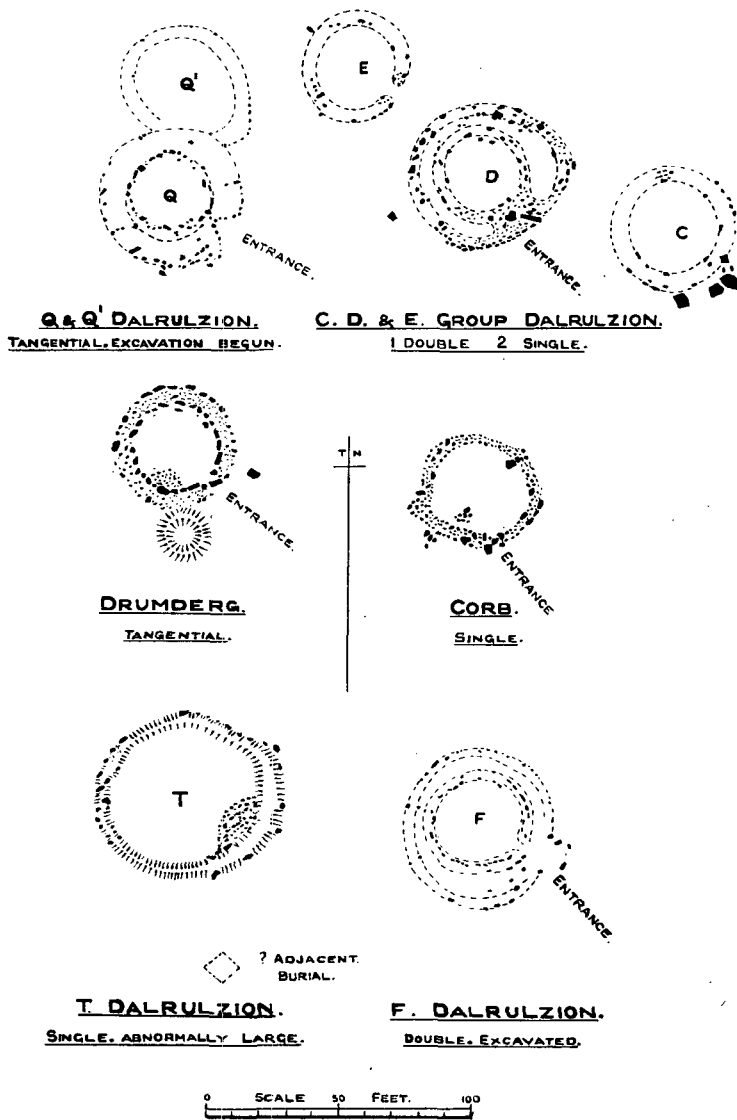


Fig. 2. Typical Hut-Circles in East Perthshire.

in the concentric type the annular space between the rings swells out on one side or other of the entrance, *e.g.* Dalrulzion D and F.<sup>1</sup>

So far I have excavated more or less completely Circle F, Dalrulzion (fig. 3), leaving the inner ring of stone on edge and some part of the occupation layer untouched, and have commenced to excavate Q and Q', finding that the latter differs in many respects from the former, so far as can be seen at present.



Fig. 3. Dalrulzion Hut-Circle F before excavation.

*Circle F, Dalrulzion.*—Fig. 4 is mainly designed to show the sections of the concentric rings where they have been excavated, but it also shows the untouched area. Light stippling on the plan indicates the area over which little more than the layer of turf, etc., has been removed. Dark stippling indicates the area over which the undisturbed ground or below it is exposed. On the plan a series of round dots link up the foundations of both walls between the places which have been excavated. The plan also shows the position of the hearths and other prominent stones, and also the inner ring of large stones that were set on edge; the original positions of these are indicated by heavy dotted lines. It

<sup>1</sup> For descriptions of hut-circles in other parts of the country see *Report, Ancient Monuments Commission (Scotland), Sutherland*, 1911; *Trans. Devon Assoc.*, 1894-99, 1901-3, 1905-6, especially vol. xxviii. of 1906, pp. 175-199; *Reports of Dartmoor Committee*; *Trans. Soc. Ant. Scot.*, vol. vi.; *Journ. Brit. Arch. Assoc.*, December 1928, Chysauster, Cornwall.

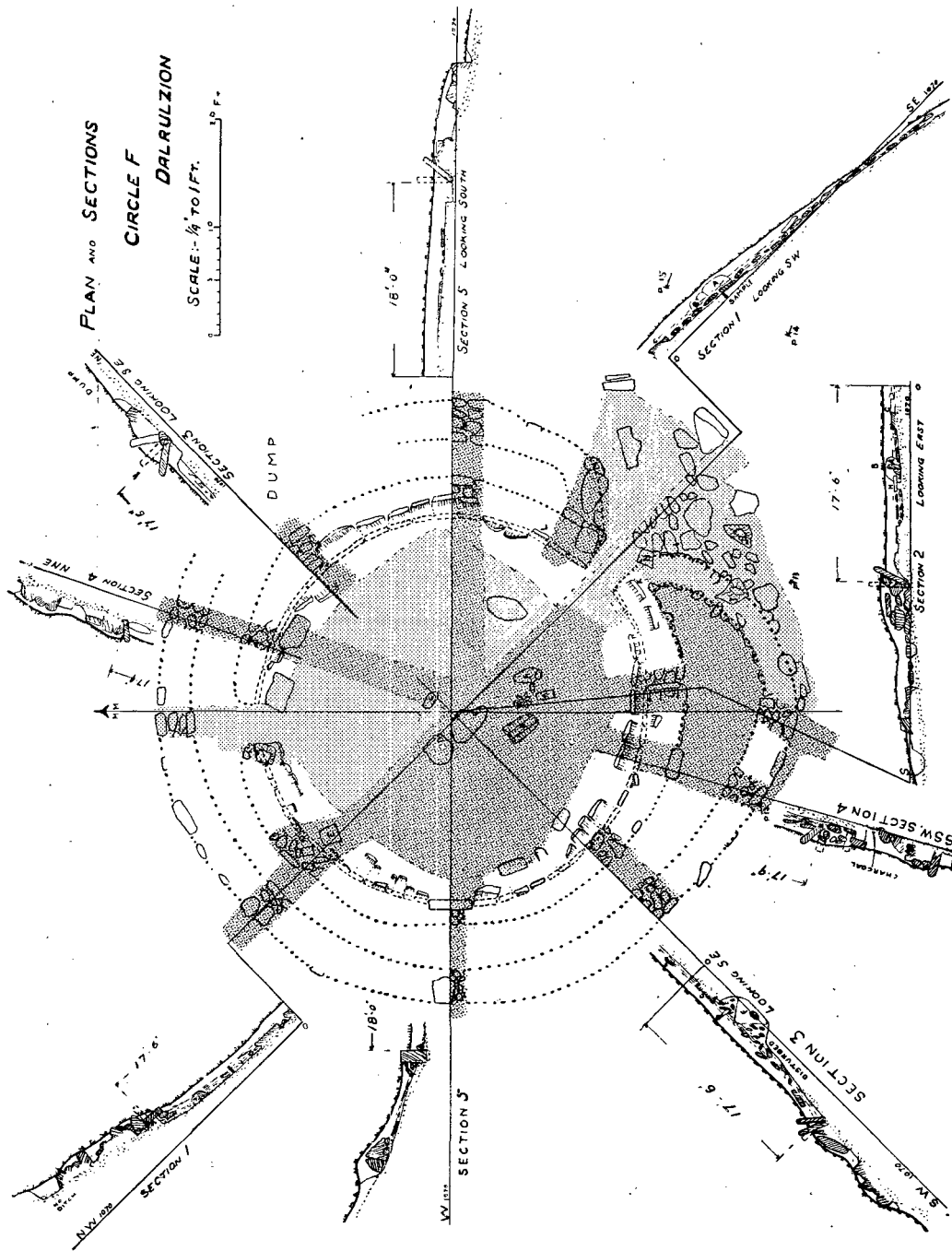


Fig. 4. Plan and Sections of Hut-Circle F at Dalrulzion.

will be noted that all the stones required to complete this inner ring are to be seen on the ground, except for two gaps, one at the main entrance to south-east, and the other north of the centre.

North on this plan is the magnetic north, August 1930, which was  $15^{\circ} 45''$  west of true north. All bearings refer to the magnetic meridian. The undisturbed ground is indicated on the sections by dots, and the "occupation layer" by light shading.

The datum line is at the same level in all sections, 1070 feet above O.D.

Beginning at the first section, No. 4 N.  $18^{\circ}$  E., the foundations of both walls are clear. The inside wall is unusually thin, and the stone seen resting on disturbed ground has fallen off it. The space between the walls is 4 feet 3 inches at foundation level; the outside found is 3 feet 9 inches wide.

The next section, No. 3 N.E., only shows the founds of the inside wall, because turf and soil were dumped too near. It will be observed that the inner ring stones have fallen inwards in one case, and outwards in the other, and one rested on a packing-stone.

Section 5 East is carried up to the centre, as some thin, flat paving stones were found in the trench. These are not shown on the plan, because it would be confusing to do so on the small scale suitable for printing.

The inner ring has a diameter of 36 feet east to west, which is the largest diameter, the average being about 35 feet. The two foundations are quite distinct, and the space between is 3 feet 3 inches.

The next section, No. 1 S.E., is through the entrance. It shows the paving up to the centre, the hearth-stone "C" (fig. 5) and a boulder "A," and a stone on edge "B" in elevation. I suggest that between the boulder "A" and the stone on edge "B" was the cooking place corresponding to the cooking holes observed in some hut-circles elsewhere.

The plan shows the stepped pavement leading to the entrance from the outside, and the foundation of the outside wall curving round to the south side of the entrance at stone "N." "K" is the last inside facing stone on the south side leaning outwards from its original position. "L" is the last corresponding stone on the north side of the entrance standing nearly vertical in its original position, but there were two more inner facing stones south of "L" found displaced, which completed the inner ring to north of the entrance. "J" is a big stone which has been moved from some part of the entrance as it rests on ground but little below the present surface level.

The plan also shows the foundation of the outside wall "M" on the north side of the entrance curving round to the entrance.

In order to prove that the outside wall did not extend farther, the excavation south of "M" was carried down to the undisturbed ground. To do this, one of several flat stones had to be moved, and two flat stones not visible before excavation were found close to the surface, which, when turned over, completed the ring of inside facing stones

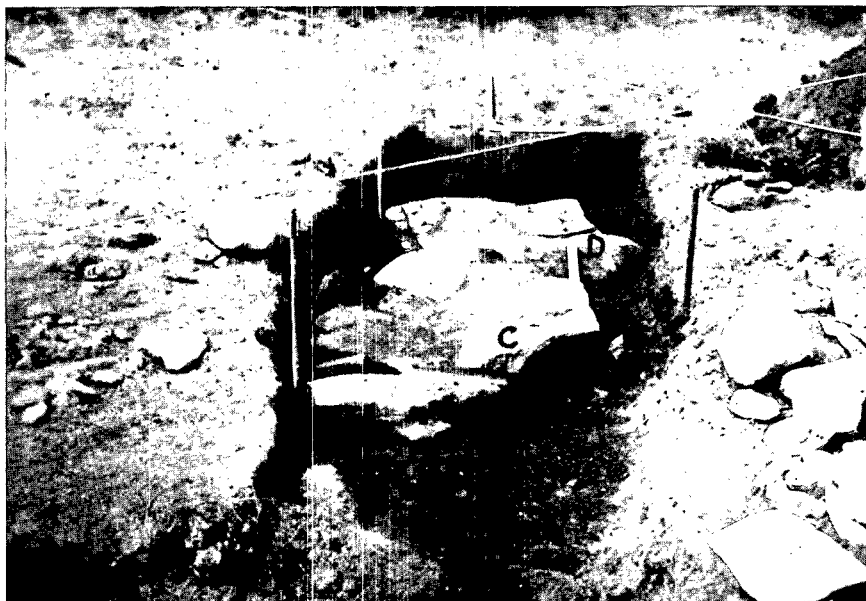


Fig. 5. Dalrulzion Hut-Circle F: Hearth.

beyond "L" to the entrance. The original position of these other flat stones could not be located.

I am unable to suggest at present how the entrance was finished off, but it seems probable that it was destroyed by violence, and possibly more of the structure as well, after which occupation ceased.

Section No. 2 South is across the widest part of the annular space between the rings, and the inner wall is more massive and well built (fig. 6). Note the "header" put in to bind the wall and the irregular paving to the centre.

The stones shown between the walls are not paving stones, for they do not rest on undisturbed ground, and charcoal was found below them. They have fallen off the walls, and there were no similar stones east or west of them.



The space between the walls at the widest is 6 feet 6 inches.

An excavation was made outside the outer wall, but nothing found; there was no ditch. Pottery, including fragments of the bottom pots, type "A," were found in the annular space east of the line of this section.

The next section, S. 18° W., No. 4, also has good walls; the outer face of the inside wall appears to have been faced here—space between

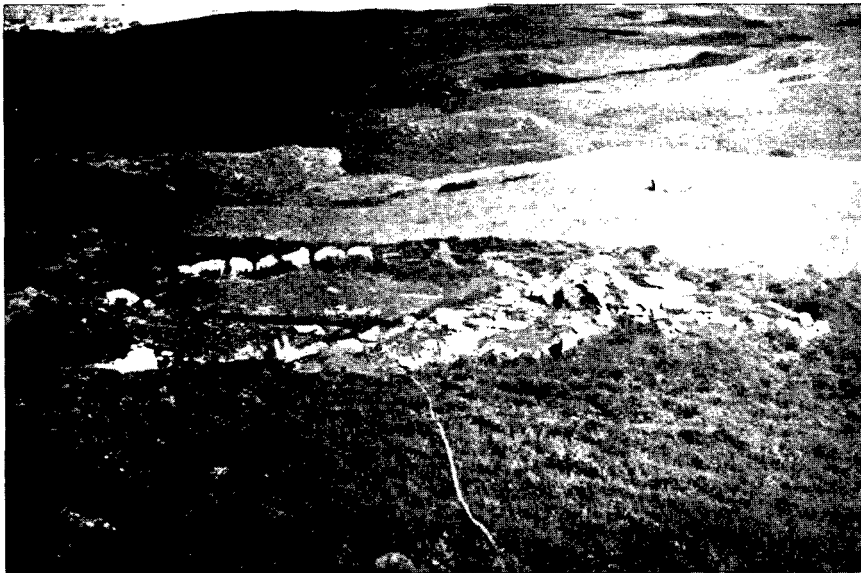


Fig. 6. Dalrulzion Hut-Circle F after excavation.

the walls 5 feet. The outer face of the outside wall was laid bare between this section and No. 2 South.

Section No. 3 S.W. is carried to the centre to show in elevation a big stone we did not try to lift, and the disturbed ground near it, and the position of the saddle quern, which was found at "G," 2 feet north-east from the centre, resting with the smooth side downwards on the top of the occupation layer. It was in the trench made for this section that a bit of iron and a bronze pin were found near the top of the occupation layer, and the quartzite stone, somewhat resembling a very crude axe, in the disturbed ground below the regular occupation layer. North of this the ground begins to rise rapidly as seen in section 5 West.

The facing stone of the inner ring here is massive and in place, but there were very few stones behind it. The outside wall is also massive, and the big stone seen may be a natural boulder.

No. 1 N.W. was the first trench cut, and the inner ring stone was restored to its original place. The foundations here have 4 feet 9 inches between them, and, as an excavation outside proved, no ditch.

Coming now to the north, where there is a gap in the inner ring, but where the founds of the outer wall are normal, it will be noticed that the stones of the inner ring each side are nearly flat, and that a large stone has fallen on the top of the western one. It appears to me that the gap formed the entrance to the annular space from the inside of the hut-circle. It is only in the southern area of this hut-circle that anything like a pavement has been found, and that is very irregular, but the entrance from the south-east seems to have been fairly well paved. The paving stones were mostly flattish pieces of schist and quartzite. There is an outcrop of rock just above this hut from which most of the stones used in the building could have been obtained. I am unable to state the original height of the stone walls, but so far as my observations have gone, and judging by the volume of stones found, I am inclined to suggest that the inside wall was built up to about the level of the top of the inside ring of upright stones on edge, and that the outside wall was not built with stone much above the existing foundation. Both walls probably had a turf bank above the stone-work; the slender evidence of this being the material between them and inside the circle.

No post-holes were observed by me at this place, although I looked for them.

It may be that the annular space was roofed over in some way, but I have no evidence to prove this. I do not think it would be possible for a roof to have covered the 35 feet diameter inner area of the hut.

#### METAL FINDS.

One piece of a bronze pin was found high up in the occupation layer south-west of the hearth-stones, and 7 feet 6 inches from the centre. One shaped piece of iron, with very little of the actual metal left, turned up near the same place and level, and a few similar fragments were got in the southern section.

#### POTTERY.

From the general appearance of the specimens found, the pottery can be divided into two types which will be referred to as type "A" and type "B."

*Type "A"* is generally about 10 mm. thick, except some pieces, probably the bottoms of pots, which are nearly double that thickness.

The colour varies, but is usually buff red on one side and blackish on the other, and nearly all fragments are blackish in the centre. Some few pieces found are red throughout. Sometimes fragments are blackish on the convex surface (*i.e.* the outside of the pot), but more frequently they are blackish on the concave surface (*i.e.* the inside of the pot). On some pieces the black on the inside is scaly.

*Type "B"* is generally 6 to 7 mm. thick. No actual bottom piece turned up. The colour of the outside surfaces of type "B" fragments

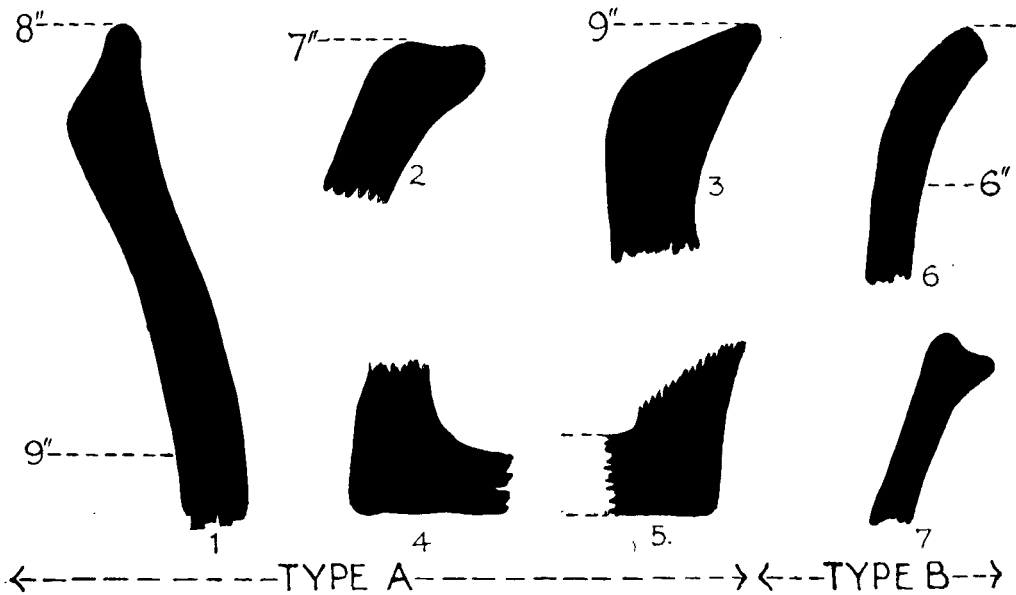


Fig. 7. Sections of Pottery from Hut-Circle F.

is dirty red, but most of the interior body and inside surfaces is black, often with a layer of scaly black material which flakes off readily. The scales are about 0.5 mm. thick. I had a few fragments cut for microscopic sections, one of which shows the scale flaking off, and the change of colour from black on the inside to red on the outside.

Both type "A" and type "B" fragments became fairly bright red when cooled, after heating to dull red in the laboratory, and, in the case of those fragments with adhering black scaly material on the inner surfaces, the scales glowed when heated.

The sections of the rims are shown (fig. 7), with the planes of the rims and approximate diameter as measured by curves of known

diameter of both types "A" and "B." A few bottom pieces of type "A" were found and sections are also shown (fig. 7). One hundred and thirty-seven separate fragments of pottery turned up. Some time was spent trying to fit some of these together, with no success. No ornamentation was observed on any piece. There were no signs of any piece having been made on a wheel.

The specific gravity of a number of pieces was ascertained and the porosity measured by the absorption of water after drying to constant weight. The results are as follows:—

## TYPE "A."

	Specific Gravity.	Porosity or Water Absorbed.
	Per cent.	Per cent.
Highest . . . . .	2.57	32.4
Lowest . . . . .	2.48	29.2
Average . . . . .	2.51	31.2

## TYPE "B."

	Specific Gravity.	Porosity or Water Absorbed.
	Per cent.	Per cent.
Highest . . . . .	2.20	29.0
Lowest . . . . .	2.12	23.4
Average . . . . .	2.17	26.6

The lower specific gravity and porosity of type "B" is probably due to its higher carbon contents.

*Analysis of the Pottery made by H. D. Bennie.*—The chemical analyses tabulated below were carried out upon sample No. D.F.1.P., which consisted of several type "A" fragments finely ground together, and sample No. D.F.2.P., which consisted of several type "B" fragments finely ground together. Both samples were dried below 110° C. prior to commencing the analysis.

The analyses shown in the right-hand columns are calculated from the above determinations, and show what the analysis of type "A" and type "B" would be when reheated to constant weight, and thus freed from carbon, etc.

## OBSERVATIONS ON HUT-CIRCLES NEAR BLAIRGOWRIE. 199

Laboratory Index.	Pottery as found.		Pottery as reheated for comparison.	
	Type "A" D.F.1.P.	Type "B" D.F.2.P.	Type "A."	Type "B."
	Per cent.	Per cent.	Per cent.	Per cent.
Silica (SiO <sub>2</sub> ) . . . . .	53·22	48·22	56·36	56·88
Titanic oxide (TiO <sub>2</sub> ) . . . . .	2·06	1·09	2·18	1·28
Alumina (Al <sub>2</sub> O <sub>3</sub> ) . . . . .	19·01	17·48	20·13	20·62
Ferric oxide (Fe <sub>2</sub> O <sub>3</sub> ) . . . . .	8·37	10·13	8·86	11·97
Lime (CaO) . . . . .	4·29	2·70	4·54	3·19
Magnesia (MgO) . . . . .	3·27	1·01	3·46	1·20
Potash (K <sub>2</sub> O) . . . . .	1·98	1·63	2·10	1·94
Soda (Na <sub>2</sub> O) . . . . .	2·40	2·28	2·54	2·70
Carbon (C) . . . . .	5·57	14·86	...	...
Carbon dioxide (CO <sub>2</sub> ) . . . . .	Nil	0·38	...	...
Water (H <sub>2</sub> O) . . . . .	Nil	Nil	...	...
	100·17	99·78	100·17	99·78

The only marked differences are their respective percentages of iron oxide, lime, magnesia, and carbon.

*The Mineralogical Constitution of the Pottery.*—Thin sections of numerous fragments of the pottery examined under the microscope showed that both types consist of fragments of quartz, granite, and mica schist bonded with clay.

The proportions in which these constituents are present in the pots were estimated by measurement under the microscope, using a travelling stage micrometer of the type devised by Shand, and was found to be very uniform for each type of pot as follows:—

	Type "A."	Type "B."
	Per cent.	Per cent.
Quartz fragments . . . . .	28·4	29·2
Granite and schist fragments . . . . .	19·1	14·8
Other material (by difference) . . . . .	52·5	56·0

*Search for the Clay.*—The nearest clay deposit in the vicinity of the Dalrulzion circles is a clay from the bed of a glacial-period lake, mainly formed by the wash from the granite mass at the head of Glenshee.

A sample of the clay from the side of a drain and below the peat of the Middleton Moss was dug for experimental purposes.

*Analysis of Middleton Moss Clay. By H. D. Bennie.*

An average sample of this clay was ground and dried below 110° C. for analysis, and the result is shown below, together with the calculated analysis after reheating to constant weight:—

Laboratory Index.	Clay as found. D.F.3.P.	Reheated to Constant Weight.
	Per cent.	Per cent.
Silica (SiO <sub>2</sub> ) . . . . .	63·96	66·06
Titanic oxide (TiO <sub>2</sub> ) . . . . .	1·66	1·71
Alumina (Al <sub>2</sub> O <sub>3</sub> ) . . . . .	18·90	19·52
Ferric oxide (Fe <sub>2</sub> O <sub>3</sub> ) . . . . .	4·68	4·83
Lime (CaO) . . . . .	3·32	3·43
Magnesia (MgO) . . . . .	2·44	2·52
Potash (K <sub>2</sub> O) . . . . .	1·04	1·08
Soda (Na <sub>2</sub> O) . . . . .	0·80	0·83
Carbon (C) . . . . .	Nil	Nil
Carbon dioxide (CO <sub>2</sub> ) . . . . .	0·44	Nil
Water (H <sub>2</sub> O) . . . . .	2·74	Nil
	99·98	99·98

Examination of powder slides of this clay under the microscope shows that its mineralogical constitution is closely similar to that of the pottery, the percentage estimation being as follows:—

	Middleton Moss Clay.
	Per cent.
Quartz fragments . . . . .	35·7
Granite and schist fragments . . . . .	17·6
Other material (by difference) . . . . .	46·7

The only important differences in analysis between the clay as sampled, and the pots, both reheated to constant weight, are the higher silica content and lower iron-oxide and alkali contents of the clay; and the similarity between the assemblage of minerals in this clay, and in the pottery fragments from circle F, make it extremely probable that this clay was used by the makers of the pots.

From the proportions of the minerals present it is clear that the increased silica content in the clay is due to a higher proportion of quartz fragments, and it is likely that prehistoric man found a better bed of clay than we did, containing less sand.

The lower iron-oxide content of the clay may be due to one of two causes: (1) The iron in the clay sample, which was taken from a drain just below peat, may have been leached out by peat acids during the centuries that have elapsed since prehistoric man dug his clay, or (2) Prehistoric man may have added ochre to the clay. Fragments of ochre were found in the occupation layer of circle F, and could have been obtained from cracks and backs in some outcrop of whin in the vicinity, where it can be seen to-day.

The reduction in the alkalis, especially soda, is also to be expected, as the alkalis are the most readily leached of any of the constituents; the slower removal of the potash is probably due to the preferential absorption of clay for potash.

I notice in many papers on prehistoric pottery that it is suggested that sand, etc., was added to the clay by prehistoric potters. In this case I see no justification for the suggestion, nor in some other cases that I have had the opportunity to examine. In fact, it is not easy with all modern appliances, to make a uniform mixture of sand, etc., with clay. In most deposits of clay the mixture is natural.

It is noteworthy that no carbon was found in the clay.

*Experiments with the Middleton Moss Clay.*—Some trial pieces were moulded from the clay, mixed and burned in various ways in an attempt to reproduce the results of the prehistoric makers, to ascertain the temperature to which it has been raised, and the source of the carbon found in the pottery.

The results obtained are tabulated below:—

Trial No.	Burning Treatment.	Colour and Strength.	Water Absorption.	Specific Gravity.
D.C. Dry clay puddled in water.	In hot wood fire from 5 p.m. till 11.50 p.m. and in hot ashes till 10 a.m.	Buff red throughout. Probably about as strong as pottery.	Per cent. 22.9	Per cent. 2.44
D.C.M.5. Dry clay puddled in milk.	In hot wood fire from 5 p.m. till 11.50 p.m. and in hot ashes till 10 a.m.	Light buff red. Softer.	...	...
D.C.M.2. Dry clay puddled in milk.	Buried in ashes below wood fire from 2 p.m. till 8 p.m.	Grey tinged buff red to dark grey at bottom. Softer.	35.8	2.22

Trial No.	Burning Treatment.	Colour and Strength.	Water Absorption.	Specific Gravity.
D.C.A.1. 80 per cent. dry clay. 20 per cent. charcoal.	Buried in ashes below wood fire from 2 p.m. till 8 p.m.	Grey tinged buff to dark grey at bottom.	51.0	1.82
D.C.I.O. Dry clay puddled in water.	Hoffmann kiln. Temp. over 790° C. but under 900° C. as per Seger Cones. Atmosphere oxidising.	Bright red. Stronger than the pottery found.	25.0	2.47
D.C.X.O. Finer clay puddled in water. (See Note.)	Hoffmann kiln. Temp. over 790° C. but under 900° C.	Red.	22.5	2.39
D.C.XXX.O. Finer clay puddled in water. (See Note.)	Hoffmann kiln. Temp. over 900° C. but under 1000° C. as per Seger Cones. Atmosphere oxidising.	Darker red than D.C.I.O. Very strong and hard.	22.7	2.41
D.C.RoundO. Finest clay. (See Note.)	Hoffmann kiln. Temp. over 900° C.	Red.	3.3	2.53
D.C.B. Dry clay puddled in water.	Laboratory muffle. Temp. 720° C. by thermocouple. Atmosphere oxidising. Time 6 hours.	Buff red. Similar to pottery found but no blackish areas.  Strength rather less than pots.	24.5	2.48

*Note.*—The finer clay was prepared by mixing the clay in a large volume of water so that it was all in suspension, then allowing it to settle for one minute, and pouring off the water with clay in suspension. This was allowed to settle for a day, the water decanted off, and remaining water evaporated until fit to puddle.

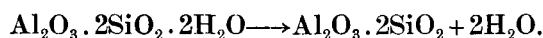
The finest clay was prepared in the same way but allowed to settle for 30 minutes.

Of these trials the only ones at all resembling the pottery found are D.C. and D.C.B.—the first and last mentioned—and it appears certain that none of the fragments of pottery found had been heated up to 800° or over in an oxidising atmosphere, for under these conditions the iron compounds in both clay and pottery produce the bright red colour. Naturally the finest clay makes the least porous pottery.



*The Temperature reached by the Prehistoric Makers in their Burning of the Pottery.* By H. D. Bennie.—An attempt made to establish the maximum temperature to which the pottery had been fired, was based upon the property that clays have of absorbing lime out of solution after having been burned to temperatures over 500° C.

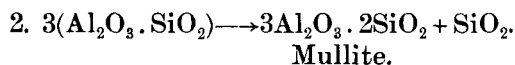
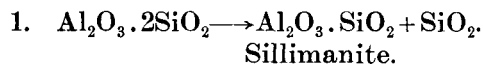
Clay substance loses its plasticity irrecoverably when heated beyond 500° C., at which temperature an endothermic reaction commences in which the combined water is removed from the clay, or hydrated aluminium silicate, thus:



All fragments of pottery found had completely lost their plasticity, it being found impossible to restore the plastic state to any part of the material from the fragments, and therefore it is evident that all have been fired beyond 500° C.

The metakaolin  $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$  has the property of absorbing lime from solution, and the amount of lime absorbed increases with the temperature to which the metakaolin has been fired, until the temperature at which it suffers another change is reached.

At temperatures between 800° C. and 1050° C. an exothermic reaction takes place in two stages, resulting first in the formation of amorphous sillimanite and free silica, and later in the formation of amorphous mullite and more free silica, thus:



Sillimanite, mullite, and the free silica do not absorb lime from solution, and thus, from 800° C. upwards, the amount of lime absorbed by a piece of ceramic material decreases as the temperature to which it has been fired rises.

This provides a means of determining approximately the temperature to which the pots were fired, and the following procedure was adopted.

Samples of the Middleton Burn clay were moulded into small trial pieces and fired in the laboratory muffle, being withdrawn successively at intervals of 50° C. from 500° C. The temperature was measured by a thermo-couple, the hot junction of which was placed in the muffle beside the trial pieces.

Ten grams of each piece was then immersed in a standard solution of lime for 48 hours, and the amount of lime absorbed by each was

determined. Similarly, the amount of lime absorbed by fragments of type "A" and type "B" pottery was determined.

The results are tabulated below:—

Temperature reached during the Burning.	Weight of Lime absorbed by 10 gm. of Sample.	Per cent Lime absorbed by the Clay in the Sample.	Samples Tested.
Degrees C. 500	gm. traces	Per cent. ...	Middleton Burn clay trial.
550	0·0016	0·34	
600	0·0042	0·90	
650	0·0054	1·15	
700	0·0062	1·32	
750	0·0066	1·41	
800	0·0082	1·76	
850	0·0070	1·50	
900	0·0063	1·34	
950	0·0056	1·20	
1000	0·0027	0·57	
?	0·0064	1·22	Type "A" Pots
?	0·0052	0·92	Type "B" Pots

This test indicates that type "A" pottery reached a temperature between 650° C. and 700° C., and that type "B" pottery reached a temperature just over 600° C.

(The higher range of temperature indicated, namely, 950° C. to 1000° C., can be ruled out on account of the colour, strength, and water absorption of the pottery as compared with those of the trial pieces fired to that temperature in a Hoffmann kiln.)

This agrees fairly well with the fact that in the experiments with the Middleton Burn clay the trial piece D.C.B., which was fired in the laboratory muffle to 720° C., most closely resembled the pottery fragments.

*Source of the Carbon.*—Red- or buff-coloured bricks are often made to-day with clay mixed with carbonaceous material, naturally or artificially.

To test whether the carbon found in the pots was added in the form of charcoal in order to assist the burning, some trial pieces were moulded from a mixture of 80 per cent. clay and 20 per cent. charcoal. This mixture suggested itself as a suitable one from the fact that the carbon content of type "B" is over 14 per cent. by weight, and therefore would have been rather more than that before burning took place.

Together with this was considered the likelihood that the prehistoric makers, if they did mix materials at all, would probably do so by volume rather than by weight, and the proportions 80 per cent. clay to 20 per cent. charcoal by weight, approximate 2 vols. of clay to 1 vol. of charcoal.

The trial pieces moulded, however, were weak and friable when fired in the laboratory muffle, and were of a grey colour not seen in any of the pottery fragments.

An attempt to burn the mixture D.C.A.1. in the ashes of a wood fire was equally unsuccessful, and the resulting material would have been useless for pots.

In a reducing atmosphere it might be possible to heat the clay to a temperature above 800° C. without producing the bright red colour, and incomplete combustion of charred wood among the red hot ashes of a large wood fire may create a reducing atmosphere along with that temperature. Experiment D.C.M.2. was designed to attempt this, with very little success, and prehistoric man would have great difficulty in producing the necessary conditions.

At a primitive pottery at Barvas, Isle of Lewis, which only ceased working about thirty years ago, I was informed that milk had been used in the process. I therefore tried puddling the clay with milk, which would add small quantities of carbonaceous material to the clay, but with very little effect, and I subsequently learned that at Barvas the pottery was dipped while hot into milk. This was said to improve its appearance and reduce its porosity. The sample of this Barvas pottery that I have, resembles prehistoric pottery in some respects. It appears to have been moulded by hand, burnt in a peat fire and not in a kiln. It is yellowish grey on the outside and buff red inside.

Specific gravity . . . . .	2.27 per cent.
Water absorbed . . . . .	20.6 „ „

If the carbon was not added during the manufacture, it must have got into the pottery during its use. To test this a crucible and lid was moulded from the clay and fired in the laboratory muffle in the same way as trial piece D.C.B. This test crucible was filled with beef dripping and heated by placing it upon a wire gauze heated by a bunsen flame, with its lid in position. The heating was continued until the crucible appeared to be empty. After cooling, the crucible was examined and was found to be blackened on its bottom surface; its sides were now a dirty buff red and its inside surface was black.

On breaking the crucible to examine the interior, this was found to exhibit a greyish-black centre, becoming blacker towards the bottom,

and also a definite black incrustation on the inside bottom of the crucible. The lid was only slightly discoloured, approximately 5 mm. from the under side upwards being grey-brown.

This experiment shows that carbon will diffuse into the pots from the outside during their use as cooking vessels. Also that carbon will diffuse outwards from the carbonaceous material cooked in the pot, if the material is allowed to reach its carbonising temperature, and repeated occurrences of this kind were probably responsible for the scaly black material adhering to the inner surfaces of some of the pottery fragments found.

#### CONCLUSIONS.

I therefore suggest:

- (1) That pots of which fragments were found in Circle F, both types "A" and "B," were made on the spot from clay dug from some convenient part of what is now the Middleton Moss, without any mixture of sand or anything else, except perhaps a little ochre.
- (2) That they were moulded by hand.
- (3) That they were burned in a fire of peat or wood without anything in the nature of a kiln.
- (4) That the temperature attained must have been over 500° C., and none of the pots would appear to have been subjected to a temperature as high as 800° C. in an oxidising atmosphere.
- (5) That the carbon found in the pottery was not added during the process of manufacture, but penetrated into the pores of the pots when in use: (a) from the inside of the pot, the source being the animal and vegetable matter cooked in the pot; (b) from the outside, the source being the smoke from peat or wood fires.

#### REFERENCES.

Lucas, "Nature of the Colour of Pottery," *Journal Royal Anthropological Inst.*, vol. lix., 1929.

Harrison, *Pots and Pans*, published by Gerald Howe, Ltd.

#### STONES.

A quartzite stone, somewhat resembling a very crude weapon, was found below the regular occupation layer. It may be natural, but there are signs of bits about the centre having been knocked off, and some evidence of its having been worked at the heavy end. I think

there is no doubt that it was brought to the site by the prehistoric occupier.

Three very dubious hammer-stones are produced:

- (1) A water-worn quartzite pebble.
- (2) A whinstone pestle-like stone.
- (3) An irregular quartzite stone.

A large number of quartz chips. None of them appear to have been worked, except perhaps the small knife-like piece. They have been brought to the site, as they were all found in the occupation layer, and I do not think are natural to the soil.

A considerable number of fire-marked "cooking stones" and many bits of schist reddened by fire.

A few fragments of ochre.

A very good specimen of what is called by geologists "Rod structure." It is garnet hornblende schist. Oval cross-section and parallel lineation caused by stretching of the rock in one particular direction. This has undoubtedly been brought to the site.

#### BONES.

A great number of fragments of crushed and probably cooked bones turned up mostly near the hearth-stones. I am advised that the fragments are too small to identify the animals from which they were derived.

#### CHAR AND CHARCOAL.

A few fragments of what I have called "char" were found. It is quite different in appearance from the charcoal referred to below. A fragment of this was sectioned for microscopic examination, and showed cellular structure. Another fragment was washed as clean as possible and dried in a steam oven for analysis. Result was:

	Per cent.	
Volatile Matter	35·10	(The smoke smelt like burning bone.)
Fixed Carbon	55·28	
Ash	9·62	(Containing 0·5 per cent. phosphorus.)

Most of the ash is probably mud, absorbed in the pores of material, which could not be washed out, and some of the ash showed cellular structure under the microscope. It is therefore probable that the proportion of phosphorus in the natural ash freed from mud was much higher.

I came to the conclusion that this material was charred flesh, and it

can be matched by roasting meat in hot oven. Mr Maby, to whom I submitted a sample, does not agree, and thinks it is decayed wood. The quantity found is insufficient to settle the question.

Large quantities of charcoal were found. Dried in air, the total weight was nearly 10 lbs. Near the hearth-stones as much as  $1\frac{1}{2}$  oz. per square foot excavated turned up, but some was found all over the area excavated inside the inner ring of stones on edge, and a little in the annular space between the rings. As a rule, where the undisturbed ground was disclosed odd fragments were found resting on it.

Microscopic sections were made for me by Lomax, Bolton, and submitted along with other pieces to Mr M. Y. Orr, Royal Botanic Garden, Edinburgh, and to Mr J. C. Maby, B.Sc., Oxford, but they found it very difficult to deal with, and were unable to state positively from what wood it was derived. While it seems likely that most of the so-called "charcoal" found in the hut-circle was carbonised by heat, some of it may have been carbonised by decay. It does not seem to be an easy problem to differentiate between these two agencies.