Metallographic examination of iron from Bidford on Avon
(SP 1052. Bidford 1/3 1).

1. Piece of bloom - IR 16.

This is a rounded mass of metal with two flat surfaces at right angles (Fig. 1). It is covered on all surfaces with a thick corrosion layer which varies from 2 to over 5 mm at the corners. Its weight is 2.60 kg.

This would appear to be a quarter of a "split bloom" which has probably cleaved in half with an axe when hot as shown by Percy[1] and Evans (Fig. 2). It was cleaved again to cut it into quarters. If so, the original bloom, which would have been roughly smithed to shape, would have had a weight of 10.4 kg and a size of 17 x 22 x 12.5 cm thick. If we assume this approximates to a sphere of 17 cm diameter we would expect a weight of 20 kg. This suggests a porosity of about 50% which is very normal for an iron bloom.

In order to do the least possible damage a piece was removed from the corner (A in Fig.1) which would have been on the axis of the original bloom. As this proved very sound with no slag in it, a second piece was drilled from the centre of the face shown at B. This area was clearly more porous than A as a slag or corrosion-filled pit was exposed during grinding before drilling.

Metallographic examination.

The piece removed from the corner (A) was very clean coarse-grained ferrite, almost entirely free of slag inclusions. Here and there was some grain-boundary phase, almost entirely confined to the triple points. It looked a little darker than cementite and is probably the sulphide FeS. The hardness varied from 90 to 117 HV1 showing that the metal is of high purity with low phosphorus content. Pearlite was entirely absent.

The two pieces from area B consisted of the same coarse-grained ferrite but here we had two-phase slag inclusions

of the usual bloomery (fayalite-wüstite) type. Some grains showed nitride needles. The hardness of both pieces was 121 HV1. Again pearlite and cementite were absent.

Conclusions.

This is a quarter of a bloom of clean wrought iron that has been cleaved twice, probably with an axe when hot. The metal examined is unusually clean, but density tests suggest that considerable slag or porosity is present. The metal contains less then 0.1% phosphorus and in places the hardness is as low as that of pure iron. Small amounts of slag and nitrides are present but carbon seems to be entirely absent.

The bloom might be compared with a smaller Early Christian bloom from Carrigmuirish, Co. Cork of similar shape which weighed 3.6 kg and had a density of 4.12 g/cc (pure iron = 7.8 g/cc)(Fig. 3). Better parallels still are the three unstratified blooms from Co. Fermanagh which weighed 5.2, 5.2 and 5.4 kg respectively and had been partly split into two parts.[2]

On the whole, as we see from Fig. 4, the weight of this bloom fits the British curve well in a period when the bloom size was increasing from the 5 - 10 kg of the Roman period to the suggested 15 kg of the 14th century before water power was introduced.[3]

A recently examined bloom, probably of Scandinavian origin but dated to about AD 1200 found on East Baffin, weighed 9.09 kg.[4] But this bloom, like that from Carrigmuirish, had a high phosphorus content.

I think that, in spite of the relative absence of slag in the sections examined, this is a quarter of a bloom of typical medieval bloomery iron made from a low phosphorus ore. This could be confirmed by a section cut through from the centre to the outside (cake fashion). But I think that the shape and weight are such that such confirmation is unnecessary.

2. Scythe blade IR 14. D 175/1.

The outline of the blade showing where sections have been removed is given in Fig. 5. The two staggered sections were taken in order to preserve the original length of the blade. But in the section drawing in Fig. 6 they have been placed end-to-end.

The metal was badly rusted but a substantial metallic core remained from which we could learn the following. The blade had been made by folding-over a sheet of wrought iron which at one stage got slightly carburized on one surface. In order to thicken and reinforce the back edge a small piece had been inserted. The folded material had been heated and badly welded along the centre line which has now parted for most of its length due to rusting. Only the back remained well-joined.

The metal was wrought iron of high purity (i.e.with low phosphorus) which is reflected in the low hardness readings which vary from (93 - 111 HV1). Eve. the hardness of the slightly carburized ferrite-and-pearlite structure does not exceed 123 HV1. The pearlitic structure is unresolvable at X 400 and therefore very fine. There appears to be total carburization in the originally ferrite-and-pearlite areas where they have been welded along the centre line. No change in structure is visible at the edge tip, but the actual cutting edge may have been rusted away.

Conclusion.

This is essentially a wrought iron blade with low hardness. Any carburization is probably accidental as no heat treatment has been attempted. But it is possible that the edge was hammer-hardened in the cold - a process very common in the 19th century. Such a treatment would not penetrate very far from the very edge and which would easily be destroyed by rusting.

The scythe could have been made from metal from the bloom.

May 1st 1963
(Mounts 463, 469).

R.F. Tylecote.

References.

1. J. Percy. Metallurgy; Iron and Steel. London, 1864, p.321, Fig27.

2. E.E. Evans. Strange iron objects from Co. Fermanagh. Arch.J. (Belfast) 1948. II, 58, 60.

3. This is based on the circumstantial evidence from Tudeley, Kent.

4. Iron blooms in the north-west passage. J.Hist.Met.Soc. 1983, 17 (1), 50.

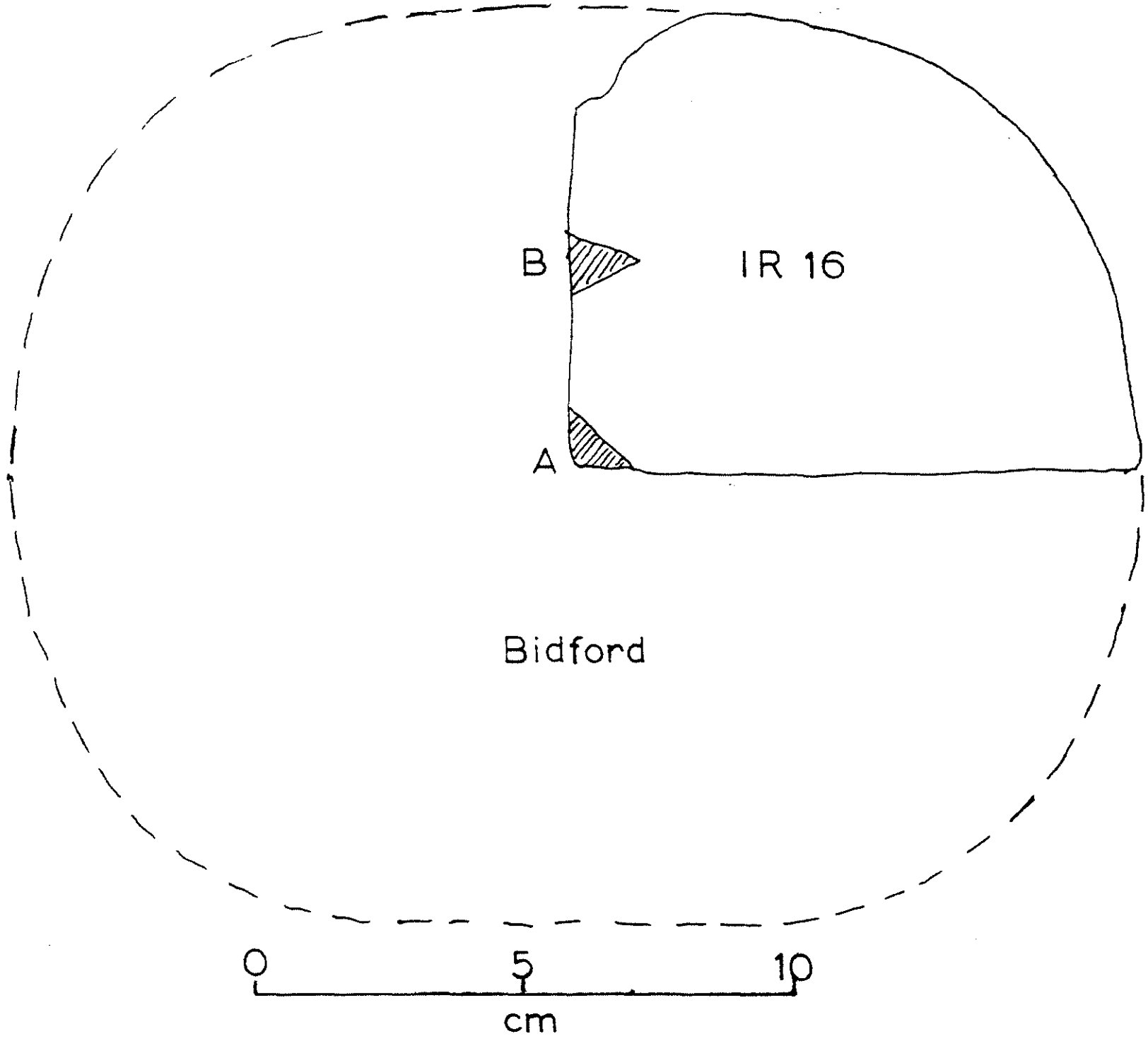
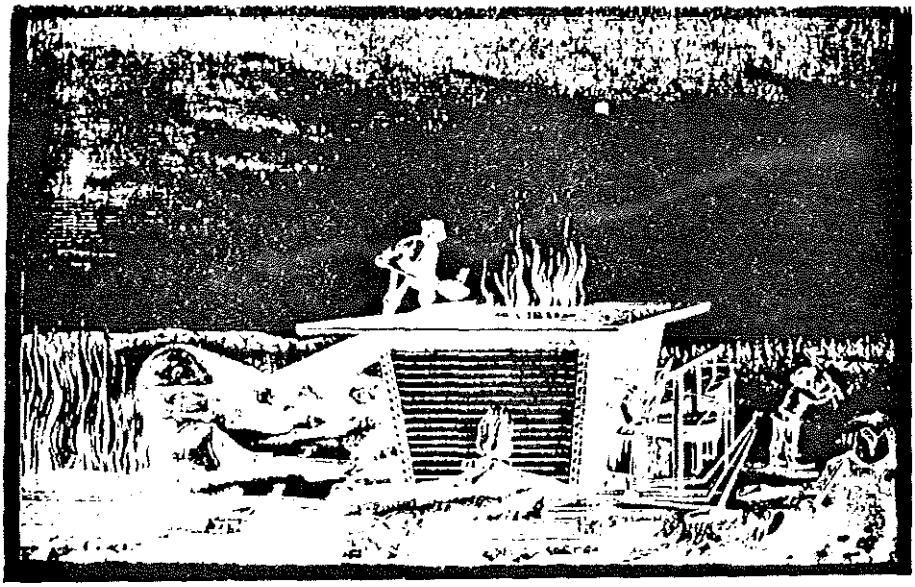
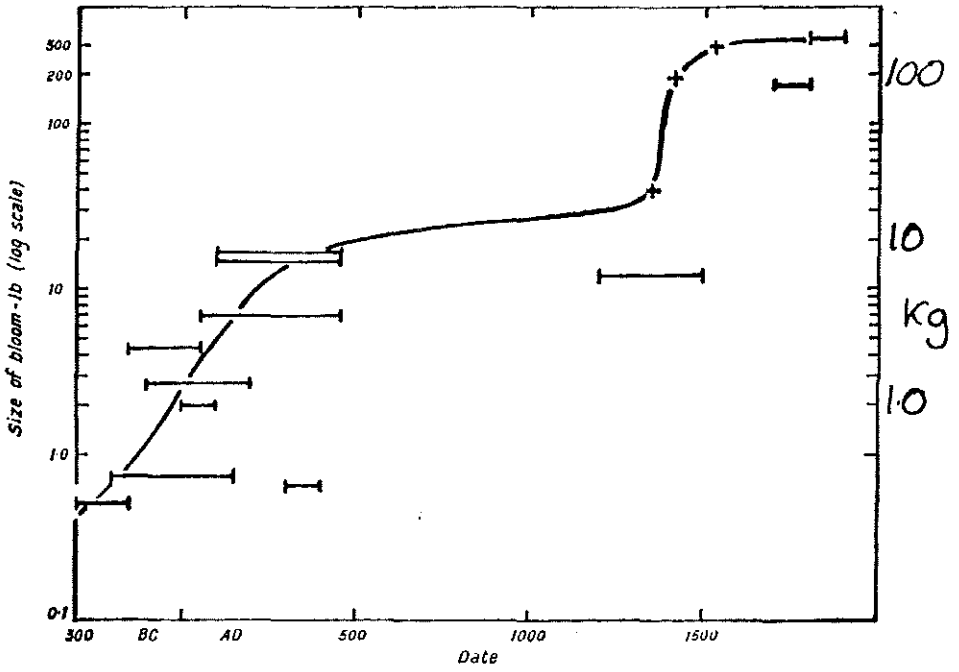


Fig. 1.



2. Scandinavian blowing furnace showing splitting of bloom (Percy).

3. Carrington bloom. Section 8cm wide



4. . Weights of blooms produced by the bloomhearth during its period of use.

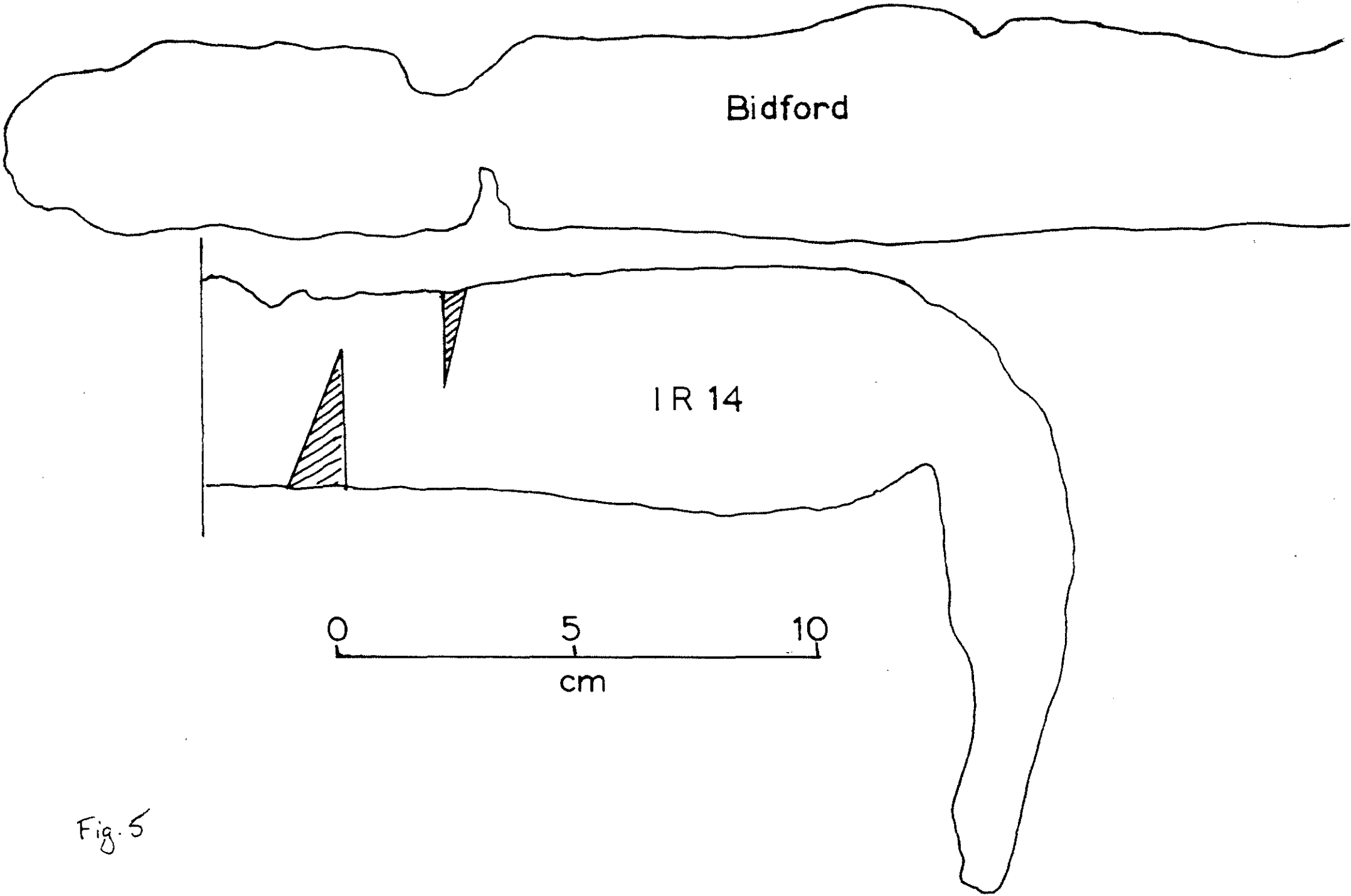
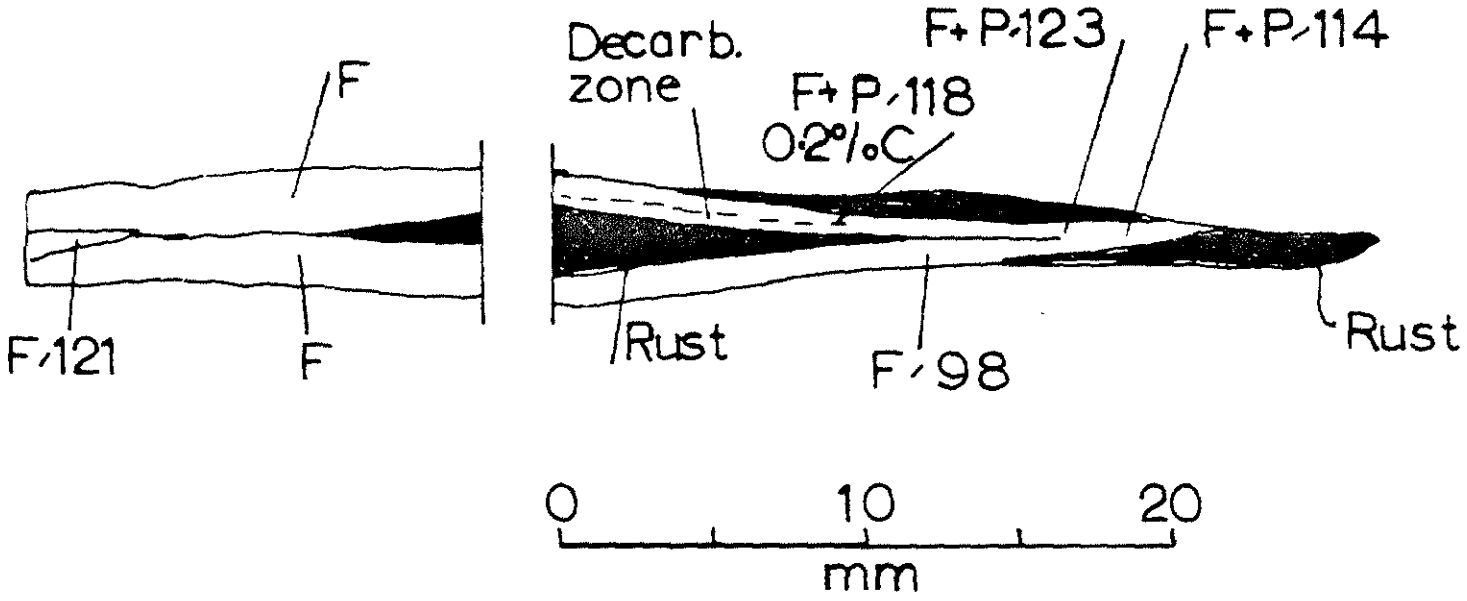


Fig. 5



Bidford scythe blade

Fig. 6