ANCIENT MONUMENTS LABORATORY

REPORT

2412

SERIES/No ENVIRONMENTAL 66/77

AUTHOR Carole Keepax and Maureen Robson
Dec 1977

TITLE Conservation and associated examination of a Roman chest provide evidence for woodworking techniques

CONSERVATION AND ASSOCIATED EXAMINATION OF A ROMAN CHEST PROVIDE EVIDENCE FOR WOODWORKING TECHNIQUES

Abstract

The notable find of a Roman chest was made at Bradwell Villa in 1976. The conservation techniques employed in order to obtain the maximum information from the remains are described below. Detailed recording and examination of the iron fittings and associated replaced wood have provided evidence for the methods of construction employed, including the use of dovetail joints.

CONSERVATION AND ASSOCIATED EXAMINATION OF A ROMAN CHEST PROVIDE EVIDENCE FOR WOODWORKING TECHNIQUES

Carole Keepax and Maureen Robson, Ancient Monuments Laboratory, Department of the Environment, 23 Savile Row, London W1, England.

The chest was discovered in 1976 during archaeological excavations, directed by Mr H.S. Green, of the Roman Villa at Bradwell, Milton Keynes, Buckinghamshire. It was found in the fill of a first/early second century AD ditch which underlay a circular building of third/fourth century date, and was recognised by the presence of the iron fittings found in situ although the original wooden structure had decayed, (Fig. 1).

It was decided that the find merited X-radiographic examination to establish content, conservation, and detailed study to permit reconstruction of the chest.

Conservation

The conservation work was divided into five main stages.

1. Protective packing and lifting in the field, Preparation for transport

Careful excavation of the chest had exposed the iron fittings, leaving them embedded in a soil block. It was decided to lift this in one piece. Special attention was given to loose or fragile areas. Fissures within the soil block at the sites of the iron fittings, and cracks within the iron structure were reinforced with a cellulose nitrate consolidant ('H.M.G' adhesive diluted with acetone). All overhangs and corners were filled with crumpled absorbent tissue and the whole object encased in acid-free tissue paper bound with masking tape. The sides were reinforced with scrim (an open-weave bandage) and gaps padded out with tissues. Aluminium foil was moulded round the block. The chest was isolated on a soil plinth. A plywood box lined with aluminium foil was placed over the object and filled with polyurethane foam, (Bibbithane RM 118, from Bibby Chemicals Ltd).

The two layers of aluminium foil facilitated removal of the foam jacket in the laboratory. Chisels were inserted under the object and rotated in a circular horizontal plane to free the object from its plinth.

2. Removal of the protective packing material

It was then transported to the laboratory where the reverse of the packing procedure was carried out after x-radiography of the block. The undercuts and fissures at the sites of the iron fittings were bridged with dental wax (which had been warmed and worked into a putty-like consistency) to prevent their movement. A 50% solution of methacrylate ester (Bedacryl in toluene) was used to strengthen the attachment of the iron straps onto the back of the soil block.

3. Recording and measurement in situ of the fittings

A drawing to scale and photographic record were made of the iron fittings in situ before excavating the soil block. This was carried out in quadrants, and all the iron fittings were removed. Despite careful examination, no trace of contents (organic or inorganic) were found.

X-radiographs of all the iron fittings were taken prior to cleaning to establish their shape, the amount of metal remaining and the location of nails obscured by iron corrosion products and soil.

4. Cleaning, conservation and stabilisation of the iron fittings

Soil adhering to the iron corrosion was carefully removed by picking with a sharpened needle held in a pin vice. The work was carried out under a microscope at low magnification (x12.5). Iron-replaced wood (Keepax, 1975) was then revealed on the inner surfaces of the fittings, and detailed examination was carried out (see below).

A polybutyl methacrylate resin in toluene was used to consolidate the iron-replaced wood as each area was cleaned. The strength of the solution used was varied from 1-10% according to the state of the remains. Corrosion products obscuring the shape of the iron fittings were gradually removed using an air abrasive unit and dental tools.

Stabilisation, involving the removal of all soluble salts (particularly chlorides) was necessary as small pockets of "active" ferric chloride had been observed on the surfaces of the iron fittings. These were placed in cold distilled water in a thermostatically controlled tank fitted with an electric stirring device. During the day the water was heated to 60°C and was circulated through the tank and a deioniser by means of a pump, thus forming a continuous washing cycle (Cross, 1975). At night the temperature was reduced to 40°C and the pump was switched off. The conductivity of the wash water was recorded daily. After ten days, when three consecutive readings had matched that of the original distilled water, it was felt that a degree of stabilisation had been achieved. The fittings were then air dried and immersed in molten microcrystalline wax to provide some protection against further contamination.

5. Reconstruction of the chest on a perspex mount

A box was constructed from ¼" perspex to the approximate dimensions of the chest. Slots were cut to receive the fittings which were attached in their correct relative positions and held in place by nylon thread.

General description

The chest measured approximately 450mm wide x 370mm deep x 340mm high. There were eight decorative iron corner clamps. The chest had been partially bound with two parallel iron straps which passed under the lid, down the back, across the base and part of the way up the front. These were hinged at the top to allow lifting of the lid. Each hinge consisted of two plates on one strap, either side of a central plate on the top strap and held in place by a pivot, i.e. a strap hinge (Frere, 19[illegible]). The base was attached by eight nails, and eight similar nails were also found at the sites of the corner clamps. In addition, each clamp had been attached by two nails inserted from the outside and hammered over on the inside. All the nails were square in section with a circular head and tapering shaft. Remains of wood replaced by iron corrosion products had survived on the upper surfaces of the lid straps, the inner surfaces of the straps and corner clamps, and on the nails.

Visual inspection of the block suggested that the fittings had undergone slight movement after burial. The ends of the straps at the back were in a lower position than the front, both front and back straps tilted backwards and the vertical distance between each pair of corner clamps was less at the front than at the back of the chest. This suggests that the back ends of the straps had been pushed slightly downwards, and the front of the chest had been crushed downwards and inwards. The iron straps supporting the lid had broken and these were uncovered in their correct relative positions approximately one third of the way down the chest. The vertical distance between each base nail and the lowest edge of the adjacent clamp was 30mm at the front of the chest and 50 mm at the back. The original distance between the bottom of the chest and the base of the lower corner clamp was thought to have been 30 mm (the measurement being larger at the back due to the sinking of the straps). The space between the clamps was about 100 mm (judging from their relative positions at the back of the chest where they did not appear to have moved relative to each other), and the measurement from the underside of the lid down to the top of the upper corner clamp was approximately 110mm. Each clamp was 50 mm high. Therefore, the total height of the chest was 340 mm. This was confirmed by the height of the back strap.

There is no evidence to suggest that the top straps were countersunk into the wood at the back of the chest or the lid although in practical terms this was probably necessary to accommodate the 2 mm thickness of the metal strap.

Examination of the iron-replaced wood revealed further details concerning the construction of the chest. These are described below.

Iron-replaced wood

Wood buried in contact with an iron object becomes impregnated with corrosion products from the metal. In most circumstances the original wood ultimately decays away and its form is often preserved by the iron corrosion products. This process has been described by Keepax (1975). The grain direction of these remains is readily recognisable. When two pieces of wood joined by a nail are buried, replacement will usually occur. The grains of the two pieces are often visible on the nail so that the actual position of the join, and hence the thickness of the top piece of wood, may be determined. All of the wood remains examined were oak (*Quercus* sp.).

Nails attaching corner plates

These were driven through the corner clamps into the boards and hammered over on the inside, indicating a board thickness of approximately 26 mm (about 1").

Reinforcing nails

Eight further nails with replaced wood attached were found, one at the site of each corner clamp. They were driven through the tails of the dovetails on the front and the back into the end grain of the side. Examination of the nail shafts showed a change in wood grain 26 mm from the head, again representing a board thickness of about 1". Most of these nails were partially covered by the corner clamps and in one instance a nail was still attached by replaced wood to its corner clamp.

Lid nails

The two top straps were each attached to the underside of the wooden lid by three nails similar in appearance to the others, but with shorter shafts. The six lid nails may well have been sawn to the required length (i.e. thickness of lid board) prior to attaching the lid straps, or may have been driven in whole and then sawn and hammered flush with the lid surface. Four nails appeared to show evidence of a spreading of metal at the ends of the shafts. The length of the nails was approximately 26 mm which probably represents the original thickness of the lid.

Base nails

There were eight nails attaching the base of the chest, two on each side. Most of these displayed a change of grain direction in the iron-replaced wood at a distance of about 20 mm from the head. This suggested that the base board was about 20 mm thick - a thinner board than that used to construct the sides and lid of the chest - assuming that the nails were not countersunk.

Straps

Replaced wood was found on the inner surface of the straps at the front, back and base of the chest. All observed grain ran in a longitudinal direction. However, on close examination a slight change in grain direction was noticed about 20 mm up from the base, corresponding with the thickness of the base as indicated on the nails. (This suggests that the base nails were not countersunk). The base was therefore nailed directly on to the bottom of the chest, so that it was visible from the outside. The longitudinal grain ran from left to right of the chest. The end grain would have been visible from the sides.

Corner clamps

Iron-replaced wood of variable thickness (1-2mm) was observed on most of the inner surfaces of the corner-clamps. Some areas displayed the end grain of the wood, and some longitudinal grain. These were plotted on graph paper (Figs 2,3,4 and 5).

A chest constructed with simple butt joints would display longitudinal grain only on one side of the corner clamp, while the other side would show both grains (Fig.6). This was clearly not the case, as both halves of the clamps from Bradwell Villa usually displayed grain running in two directions (Fig. 7). In fact, the end grain areas on one half of each clamp clearly represented the pin of a through dovetail joint (Fig.8).

It was possible to make various measurements relating to the dovetails (Fig.9):-

The depth of the dovetails (a) apparently varied between 24 and 28 mm, with an average of 26 mm. This agrees with the estimated thickness of the boards obtained from the nails.

The slope of the dovetails (along side b) apparently varied between 1 in 2 and 1 in 4.5. The variation may, however, have been exaggerated by slight inaccuracies inherent in the material and the methods of measurement. The best fit generally seemed to occur with a slope of 1 in 3.5. This is greater than is often recommended for modern woodwork, which may be as little as 1 in 6 for softwoods and 1 in 8 for hardwoods (Brazier and Harris, 1969); although some modern authors suggest a slope of 1 in 5 (Hayward, 1965).

Projections from available parts of the dovetails indicated that the narrowest part of each pin (c) was about 12 mm and the widest part (d) 26 mm. This conforms to the recommended modern practice (Brazier and Harris, 1969) of making the wider ends of the pins about the same measurement as the thickness of the wood.

Each corner clamp was positioned over a pin. Therefore, there is no direct evidence to indicate the height of the tails (i.e. the distance between two pins). Some inferences, however, may be made from the available data. At the back of the chest, the original positions of the corner clamps seemed to have been preserved fairly well, and the space between the top and bottom clamps was about 100 mm. Various alternatives may therefore be considered for the number of pins occurring between the corner clamps. There is obviously insufficient space for four pins. If three intermediate pins are postulated then the height of the tails would be about 27 mm, but this measurement was at least 32 mm on corner clamp No. 1. It therefore seems most likely that there were only one or two pins between the corner clamps, (or possibly none). Two intermediate pins were arbitrarily selected for the reconstruction.

A number of clamps clearly showed longitudinal grain continuing into the corner on both sides of the joint, both above the top pin and below the bottom pin. This indicates that the dovetails did not continue above and below the clamps, and that the corners at these points were mitred.

The suggested arrangement of the dovetails is superimposed on the drawings in Figs 2, 3, 4 and 5. In most cases, the observed evidence fits into the proposed reconstruction very well. There are a few departures from this which seem to represent errors committed by the original carpenter. For example, on corner clamp No. 4 the space cut to receive the pin is about 5 mm too wide. The gap was filled with a wedge of wood easily distinguishable as the growth rings run in different directions in the pin and wedge (see Fig5).

In each case, the direction of the annual rings on the upper corner clamp differs from that on the clamp below it, suggesting that each board was flat sawn (Morgan, 1975) from one side of a complete trunk (see Fig. 6). A plank split from the trunk would display parallel growth rings.

Discussion

The discovery of this chest is of some importance, as few Roman examples have been found in Britain. Isolated metal fittings are fairly common, but there are few known complete chests. Some are listed by Liversidge (1955), but these are generally more decorative than the Bradwell Villa example, with elaborate bronze plates. One comparable chest for which details are published is from Silchester (Joyce, 1866). This was a large wooden strong box, built into a house floor, and therefore with iron fittings on the lid only. The Bradwell Villa chest differed in primary function, as the decorative fittings indicate that it was intended to be seen. The thickness of the boards used for the Silchester chest was estimated as $1\frac{1}{4}$", but there was no further evidence of the woodworking techniques employed.

Fortunately, examination of the iron fittings and associated replaced wood of the Bradwell Villa chest has allowed many details of its construction to be deduced, producing a fairly accurate reconstruction (see Fig.10). A number of points of special interest arise from this, and are worthy of further discussion.

The presence of large nails at the sites of the corner clamps has stimulated some discussion (Musty and Manning, forthcoming). The use of such nails on a chest of this type may seem puzzling, possibly suggesting that they were secondary. This explanation, however, presents some difficulties as the nails apparently underlie some of the corner clamps. Therefore (unless the clamps were also secondary) placing of the nails would have entailed temporary removal of the clamps. A far simpler explanation is that the nails were used to secure the joints at the time of construction. Cutting of the dovetails was not particularly accurate (suggested by the presence of extra wedges of wood in some joints): therefore, they may have required tightening by addition of the nails. Goodman (1977) states that this is a device sometimes used by modern carpenters, and is known in the woodworking trade as "Chinese dovetails".

The presence of dovetail joints is particularly interesting. These were known to the classical world, when they were referred to as the "little axe-head" (Aldred, 1957), but actual examples are relatively rare. Box joints were used on the "Queen's sarcophagus" of the Early Hellenistic period from Kul-Oba (Sokol'skii, 1969). These were square, however, and therefore not true dovetails. It is interesting to note that these joints were also reinforced, in this case with wooden pins. A coffin from Khersones of 2nd-4th century AD date (Sokol'skii, 1969) displays true dovetail joints and a mitred joint above the upper dovetail comparable to that deduced for the Bradwell Villa chest. There is little evidence for early dovetails joints in Britain. The most common examples are the planks with these joints sometimes used for well linings, for example at Wickford (Wilson, 1970) and Southwark (Schaaf, 1976).

Another interesting feature of the chest is apparent in the reconstruction drawing (Fig. 10). The overall appearance of the chest seems to be unbalanced, with a large 'empty' area above the top bracket. One possible explanation for this is proposed by Goodman (1977):-

"What I find rather strange is the suggested position of the two ranges of corner clamps. When you are making a chest or coffer of this type the first stage is to joint the four sides together and fix the bottom on. When this is done, the lower half of the box is about as rigid as it can be. If you then propose to strengthen the upper (open) half, the obvious thing to do is to put one set of clamps as near the top as possible and the second somewhere near the middle (for example, H.M.S.O. 1974, Pl. IV). This may have been what was intended originally, but after putting the sides together the craftsman fitted the corner clamps in the required position before putting the bottom on. He then may have taken a day or two off (Saturnalia ?), but eventually coming back to his work and not feeling too good, instead of putting the bottom on the bottom he put it on the top by mistake (?)"

This explanation is appealing in its simplicity. Other alternatives include the possibility that the upper part of the chest was decorated in some way.

There is no evidence to indicate the method of securing the chest. The possible use of a perishable fastening cannot be completely discounted, although this would seem unlikely. Perhaps the lock was accidentally lost at some stage, or was deliberately removed. Musty and Manning (forthcoming) suggest that an elaborate lock might have been removed because of its value.

The chest, because of its special interest, was exhibited in the May 1977 ballot of the Society of Antiquaries and is accordingly described and briefly discussed by Musty and Manning (forthcoming). Full details of the lifting of the soil block and basic measurement data are given by Robson and Farrell (1977).

Acknowledgements

We are most grateful to Mr W. L. Goodman for his helpful advice and to Miss E. Pye for her comments on the text. Thanks are also due to Miss J. Jones, Miss H. Farrell and Mr C. Slack for their patient assistance with the lifting and conservation of the chest.

Photographs and the reconstruction drawing were supplied by Miss E. Lawler (Photographic Dept.) and Mr J. Thorne (Drawing Office) and the perspex mount for the fittings by Mr D. Smith (Model Making Unit), all of the Department of the Environment.

Aldred, C. (1957). In (C. Singer, E.J. Holmyard, A.R. Hall, T.I. Williams, Eds) The History of Technology, Vol. II. Oxford: Clarendon Press, p. 233.

Brazier, G.W., & Harris, N.A. (1969) Woodwork London: Chatto & Windus.

Cross, J.E. (1975) A recirculating deionizing/wash system for archaeological artifacts. Ancient Monuments Laboratory Report No. 1502

Frere, S.S. (1972). Verulanium Excavations. Reports of the Research Committee, Society of Antiquaries of London. Vol.1 No. 28

Goodman, W.L. (1977). Personal communication.

Hayward, C.H. (1965). The Complete Book of Woodwork. London: Evans Bros.

H.M.S.O. (1974). Early Chests in Wood and Iron. Public Record Office Museum Pamphlets No.7

Joyce, J.G. (1866). On the Excavations at Silchester. Archaeologia 40, 403-416.

Keepax, C.A. (1975). Scanning Electron Microscopy of Wood Replaced by Iron Corrosion Products. Journal of Archaeological Science 2, 145-150.

Liversidge, J. (1955). Furniture in Roman Britain. London: Alec Tiranti Ltd.

Morgan, R.A. (1975). The Selection and Sampling of Timber from Archaeological Sites for Identification and Tree-ring Analysis. Journal of Archaeological Science 2, 221-230.

Musty, J. & Manning, W. (forthcoming). A Wooden Chest from the Roman Villa at Bradwell, Milton Keynes, Bucks. The Antiquaries Journal.

Robson, M. & Farrell, H. (1977). The "Bradwell Villa" Chest, Excavation, Conservation and Reconstruction. Ancient Monuments Laboratory Report No. 2343.

Schaaf, L. (1976). Excavations at 175-7 Borough High St., Southwark. London Archaeologist 3, No. 1, 3-7.

Sokol'skii, N.I. (1969). _Ancient Wooden Sarcophagi of the Northern Black-Sea Littoral_. Moscow. (Translation and study by Goodman, W.L. (unpublished) _Greek Joinery_).

Wilson, D.R. (1970). Roman Britain in 1969. I. Sites explored. _Brittannia_ _1_, 269-305.

Captions for Figures.

*Fig. 1 The Bradwell Villa chest fittings in the soil block

Figs 2-5 Inner surfaces of corner clamps indicating the distribution of iron-replaced wood

Key:-
‡‡ end grain (.... direction of growth rings, || rays)
∵ end grain (direction of growth rings indistinct)
= longitudinal grain
direction of grain unclear
fractured iron
Unshaded areas-no wood surviving

Fig. 6 Simple butt joint

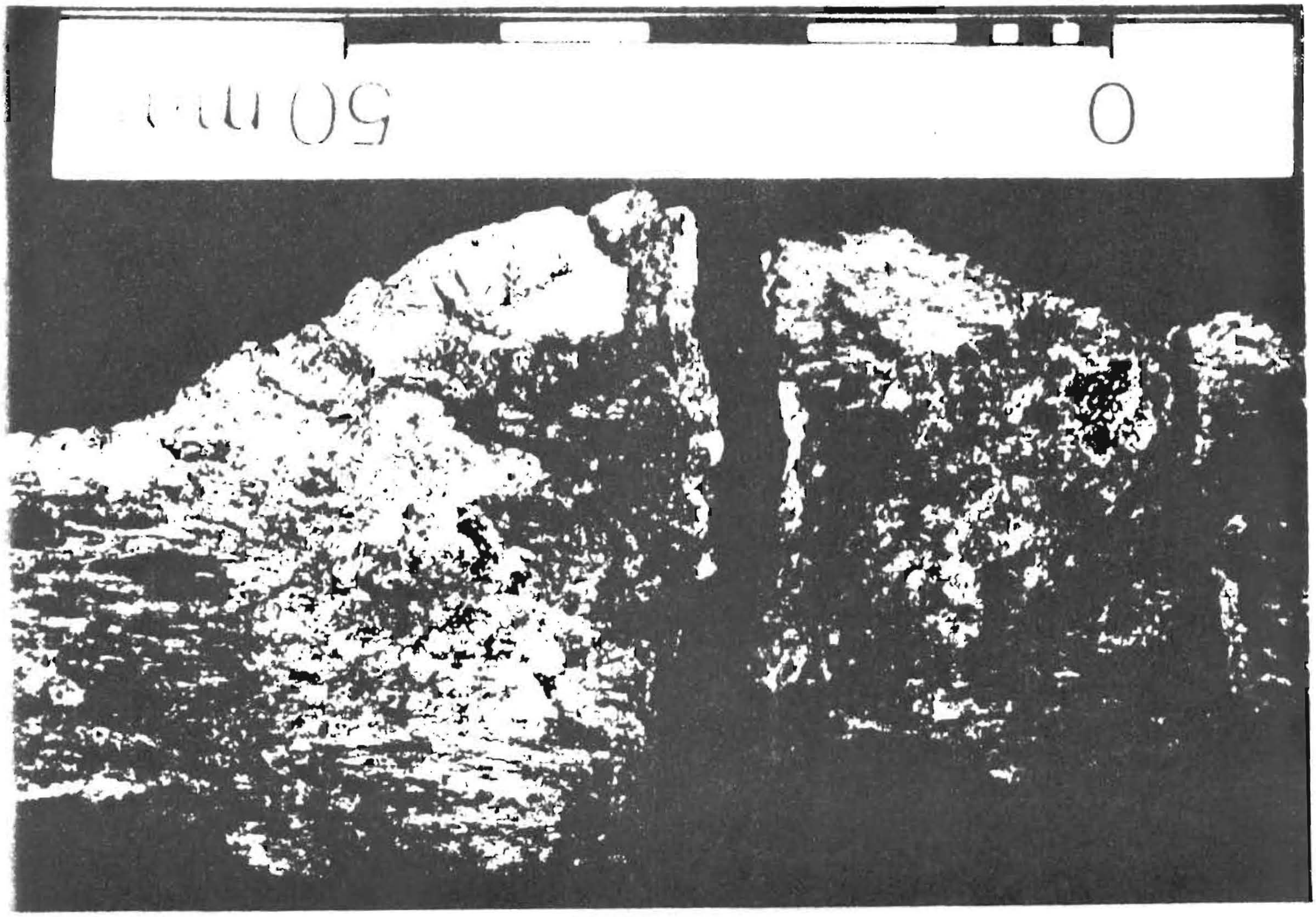
Key:-
direction of growth rings

* Fig. 7 Inner surface of a corner clamp displaying remains of a dovetail pin on one side (left)

Fig. 8 Through dovetail joint (key as in Fig. 6)

Fig. 9 Pin of a dovetail with measurements indicated

Fig. 10 Isometric reconstruction drawing of the chest



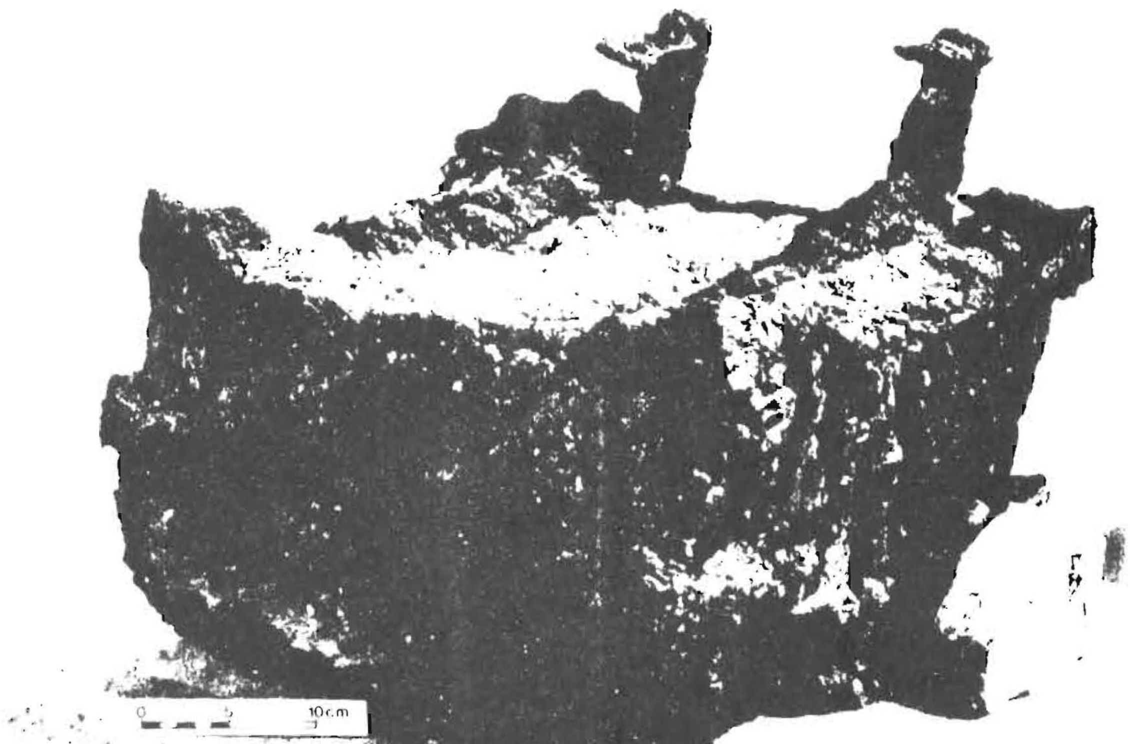


Fig.1

Fig. 2

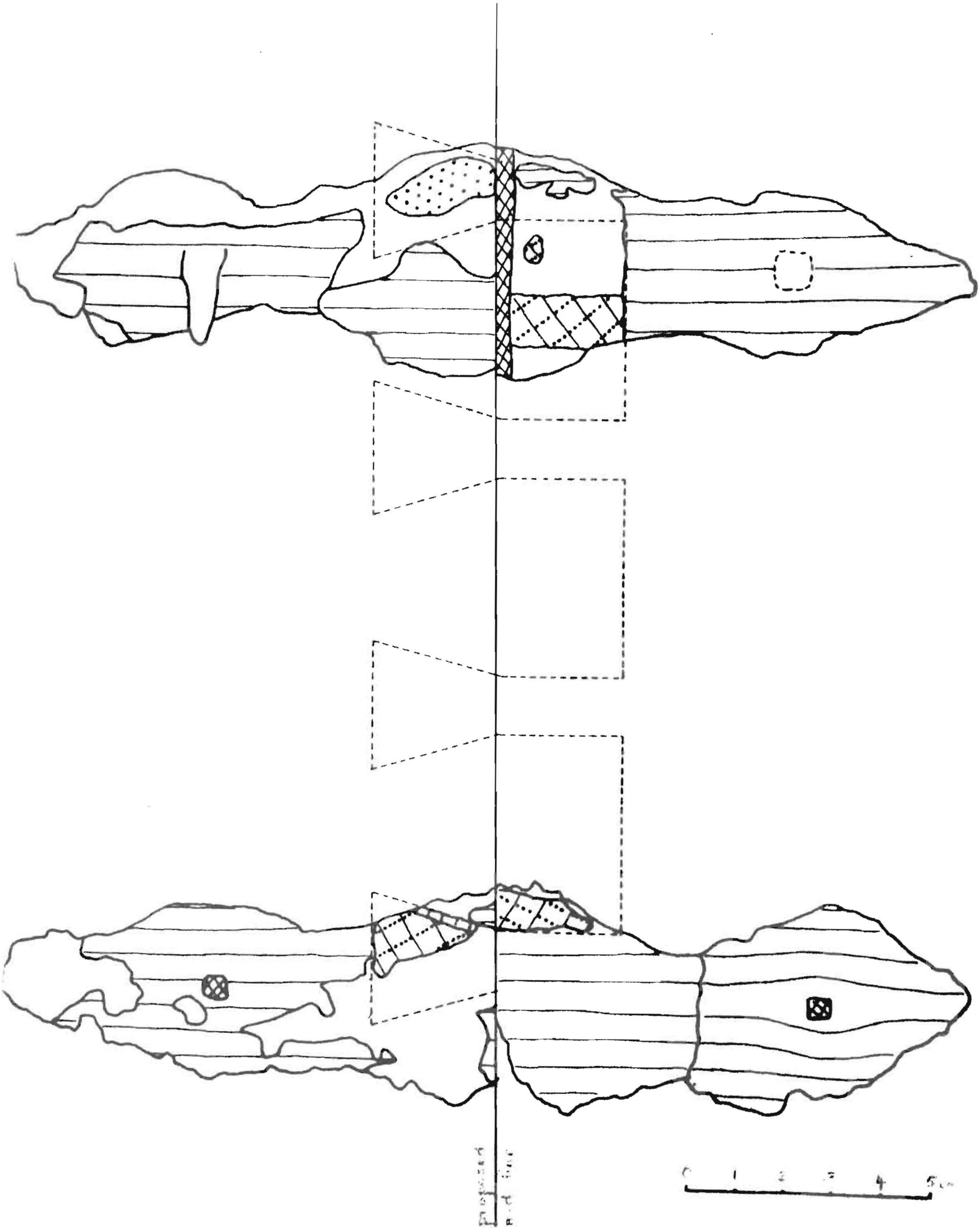


Fig. 3

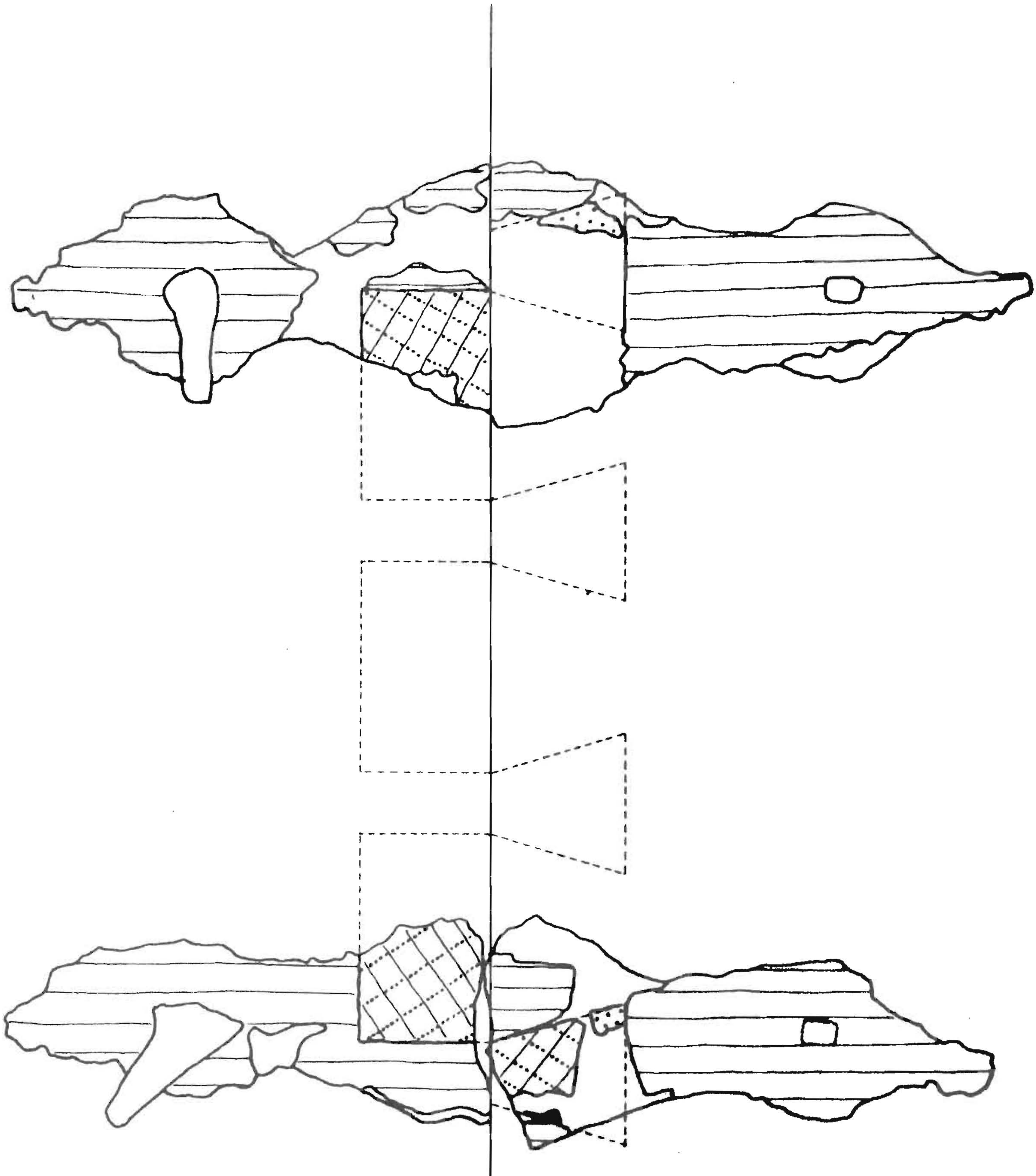


Fig. 4

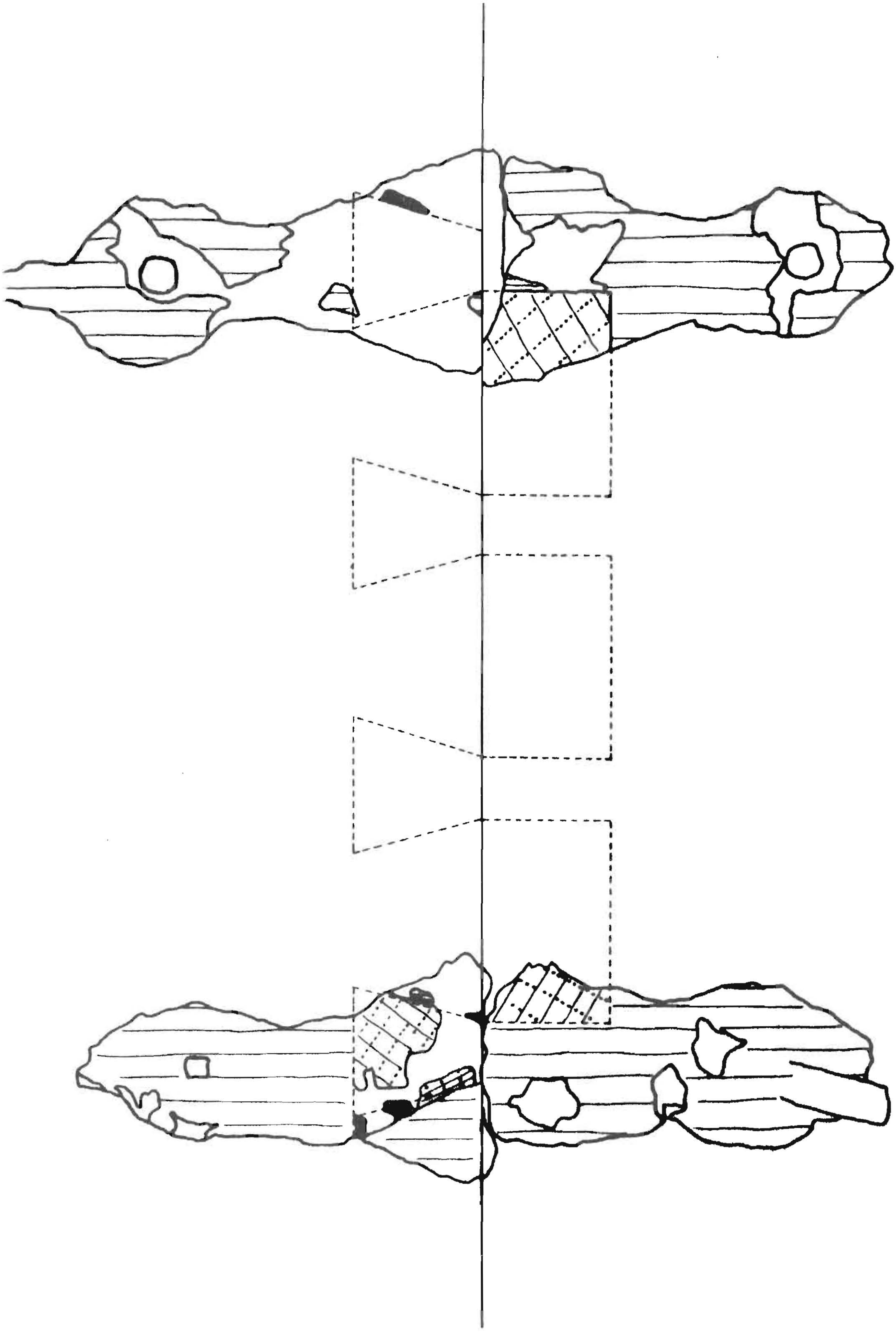
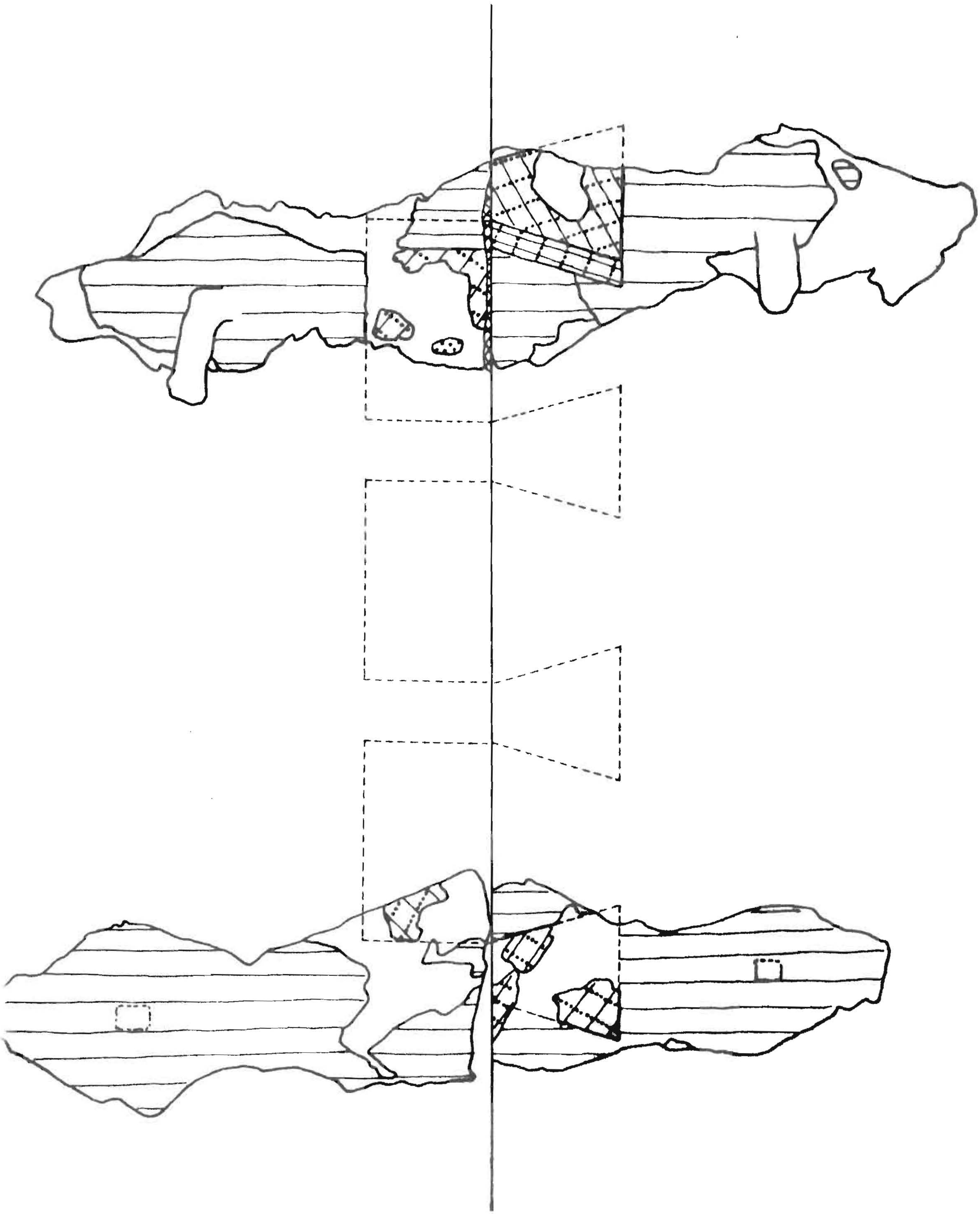
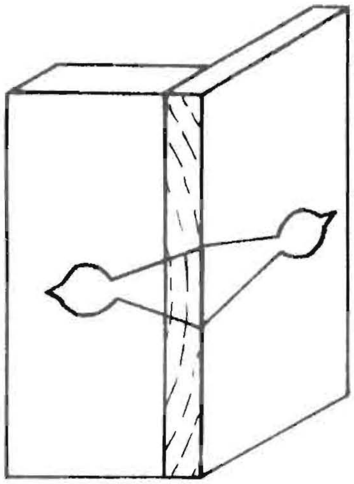
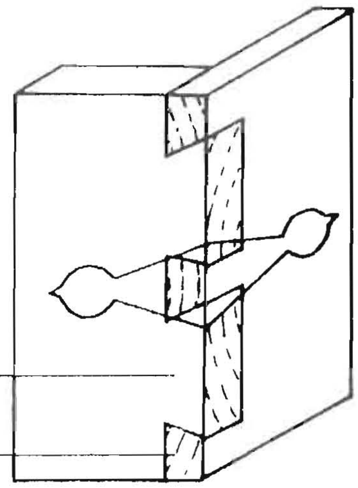


Fig. 5







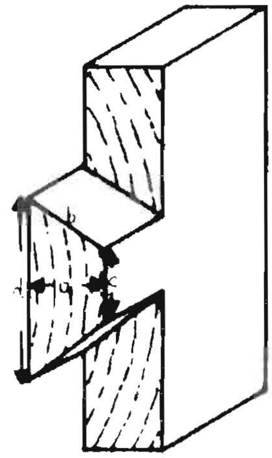


Fig 9