UNDERWATER EXCAVATIONS AT YASSI ADA 1962-1963

George BASS

The University Museum of the University of Pennsylvania devoted its 1962 and 1963 seasons at Yassi Ada to the completion of the excavation of a seventh-century Byzantine shipwreck (*Türk Arkeoloji Dergisi*), and to the further development of underwater excavation techniques. The staff of divers, including archaeologists and archaeology students, photographers, architects, draftsmen, a medical doctor, and a cinemaphotographer, were from America, Turkey, France, Germany, Israel, and New Zealand. One of the major aims of the expedition has been the training of new people in this new branch of archaeology, and to that end a documentary film was made which has been shown to archaeological groups in America, Turkey, and France.

Methods

The same methods of removing sand and mud from the wreck, with a large suction hose, and of raising heavy objects with plastic balloons, were continued from 1961. The air lift, or suction hose, could not be used near the fragile wooden members which were now being uncovered, however, and sand was removed in those places by fanning it by hand away from the wreck. The appearance of substantial wood remains also necessiated a more sophisticated means of mapping, for the plotting of thousands of dimensions and nail holes would have taken an impossible length of time with the planetables and mapping frame used to plot amphora and tile positions in 1961.

In 1962, therefore, a scaffolding of angle-iron and pipe was built over most of the wreck (fig. 1). This took the form of nine horizontal steps, each two meters by six meters, on pipe legs. Riding over the steps, as if on tracks, were two four-meter high photographic towers, with a twometer square wire grid on the base of each tower. With the movable towers, it was possible to take grid photographs of each of the 27 two-meter square areas into which the wreck was divided by the stepped frame. Distortion in these photographs, caused by the index of refraction of water, was minimal and could be practically ignored, but intense scale variations, caused by the slope of the seabed, were necessarily corrected by geometry by the architect before the photographs could be copied onto the overall plan of the shipwreck. As may be seen (fig. 2, a and b), an object might appear to be under the grid, while in reality it was located in the adjoining area.

The scaffolding, or "step-frame," gave the most accurate plans yet made of a wreck site underwater, but its installation alone required the use of 15 divers over a period of two weeks. As always in underwater excavation, the time limitation on divers working at 38 meters was the major disadvantage. In order to speed plotting without losing accuracy, we decided in 1963 to attempt to map the wreck photogrammetrically with stereophotographs; underwater photogrammetry had been attempted by specialists

in other scientific disciplines in the past, but had been considered impossible due to a number of factors.

Figure 3 shows how the first controlled stereo-pairs were taken under-water. A horizontal bar (a), marked every 1.20 meters along its length, was attached to two ropes (b), which were held vertical by floats (c) above two concrete anchors (d). After the bar (a) was leveled with an ordinary carpenter's level, two plumb-lines (e), each six meters long, were dropped from its ends, and an electric cord (f) running between the two anchor ropes, was brought up until it touched the plumbs. This cord (f) served as a base-line running at a fixed distance below the bar.

A Rolleimarin underwater camera was next hung from a simple gimbel (fig. 4) and three legs with adjustable weights were attached to the front of the camera housing. The three weights were moved back and forth on the legs until the camera hung vertically from its gimbel, and were then fixed in place; a bull's eye level on the camera allowed visual verification of the camera's verticality. Thus the photographer could easily slide the camera along the horizontal bar, taking pictures with a cablerelease every 1.20 meters.

The resultant pictures were matched as pairs which could be viewed under a Zeiss Stereoscope (fig. 5), and elevations below the base line (fig. 3,f) could be calculated by measurement of parallex differences read with a micrometer bar. In stereophotography, the small distortion caused by the index of refraction of water became extremely important, for each milimeter of distortion in the photographs caused an error of seven centimeters in elevation. The corrections can be made mathematically, but this time-consuming labor will be relieved in the future by the use of distortion-free lenses.

The Ship

After the cargo of over one thousand amphoras was removed, the preseved wood of the ship was uncovered. Wood in the Mediterranean, if not covered with sand or mud, will be eaten quickly by teredos or shipworms and will disappear. Only the bottom of the Byzantine hull, below its ancient water line, was preserved, and although the stern post was found, the bow had been held above the sand and was completely missing. All traces of the mast or decking were, naturally, also gone, but a piece of rigging did come to light near the bow of the ship (fig. 6).

The wooden members had been held together by nails and spikes, but these iron pieces had long since corroded away. Wood fragments, therefore, had a tendency to float away after being uncovered. A simple solution to this problem was the use of more than 2,000 bicycle spokes, each sharpened at one end and driven through a piece of soft wood, pinning it to the seabed. Identification labels were also attached to the wood by means of the spokes (fig. 7).

After a plan had been made of the hull remains *in situ*, the wood was raised to the surface. Small fragments presented no problem, and could be lifted directly to the barge. Longer pieces, however, such as strakes, wales, stringers, and the keel, were so fragile that they would have broken under their own weight had they been lifted in this manner. Such pieces were placed into a 15-meter-long metal wire basket, which was carried by walking divers directly up the slope to Yassı Ada (fig. 8). Once on land, the fragments were fitted together according to the still attached identification labels, and were studied and drawn in detail (fig. 9). All of the wood now rests in a fresh water basin built in Bodrum, awaiting the preservation treatment in polyethelene glycol which will be administered in 1964.

The final plans and restoration of the hull are now being completed, but a drawing of one section of hull planking, with nail holes, indicates the extreme accuracy with which plans may be made in 40 meters of water. The only previously published plan of an ancient wreck, which lay at the same depth, consited of merely a dotted line which indicated the approximate size of the entire ship.

Although no iron remained on the ship, as been mentioned, it is possible to study nails, anchors and other such objects. Before the iron corroded, coralline concretion had built up over it. Pieces of concretion could be sawed in half, the mushy iron oxide washed away, and perfect plaster casts made of the nails, spikes, etc., in the resultant molds (fig. 10). A diamond-tipped electric saw has now been brought to Bodrum for the large task of cutting the anchor „molds" into sections so that they may be cast with a special rubber compound. Ten large iron anchors were found on the ship.

The terra-cotta tiles are being mended, although some fragments have yet to be recovered before an attempt at restoration of the cabin roof. One tile was of particular interest, for it seems to have had a hole for smoke or a chimney of some sort (fig. 11).

Cargo

Over one hundred amphoras, representative of the two major types, were taken to the Bodrum Museum. The remainder, numbering about one thousand, were placed on either side the wreck and left on the seabed where they are safely preserved in the event that more are ever wanted in the museums.

The cabin area of the ship, under the fallen roof-tiles, had been thoroughly explored in 1961, and no completely new categories of artifacts came to light. Almost all categories were, however, greatly enlarged by new finds.

More coins tend to confirm the date of the wreck as having been during the reign of Heraclius (610-641). Of a total of fifteen gold coins, one was of Phocas and the remainder of Heraclius. Forty-five copper coins were found concreted together in two clusters, which might indicate that they were originally contained in cloth bags which had disintegrated; their study is now in progress, but the majority are clearly of Heraclius or Phocas.

The discovery of new lamps brings the total to twenty; in 1963, the first figured lamps were found with fish depicted on their tops (fig. 12), as well as some with cross-shaped handles (fig. 13). One more weight was found, making the set complete; this was found in the remains of the wooden case which had probably held all of them (fig. 14). Oinochoai (fig. 15) and tableware, including more glazed pieces, continued to come to light, as well as a more complete glass vessel (fig. 16).

These remains have joined those from the 1961 season, as well as those from the Bronze Age ship at Cape Gelidonya (*Türk Arkeoloji Dergisi* XI no. 1 (1962), pp. 7-9 with pls. 1-6), in the modern new museum for underwater antiquities which the Department of Antiquities has built in Bodrum.[1]

1. The excavations were sponsored by the American Philosophical Society, the Catherwood Foundation, the Corning Museum of Glass, the National Geographic Society, Mr. Nixon Griffis, Mr. and Mrs. James P. Magill, and Mr. Julian Whittlesey.

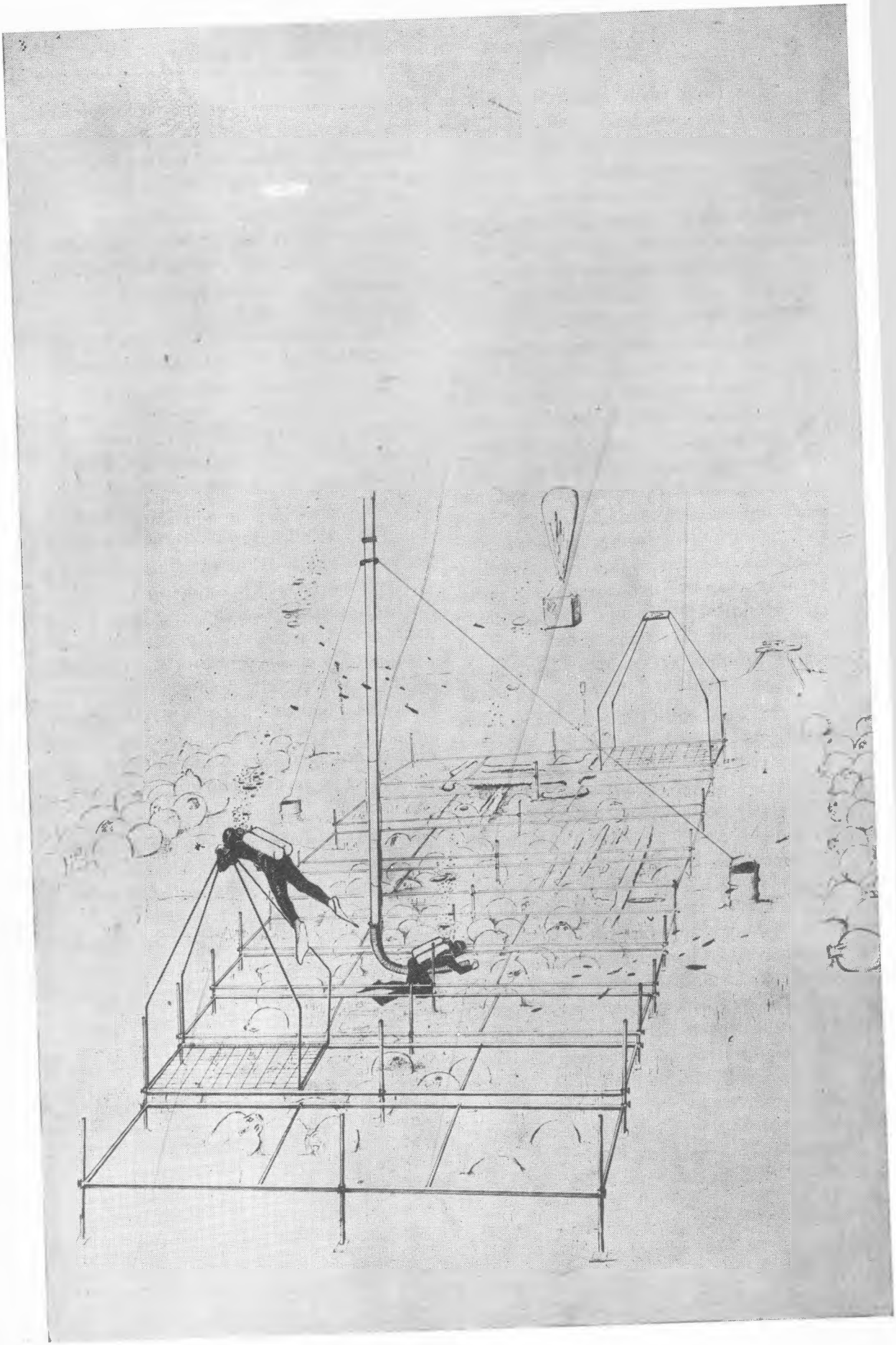

Fig. 1 A.

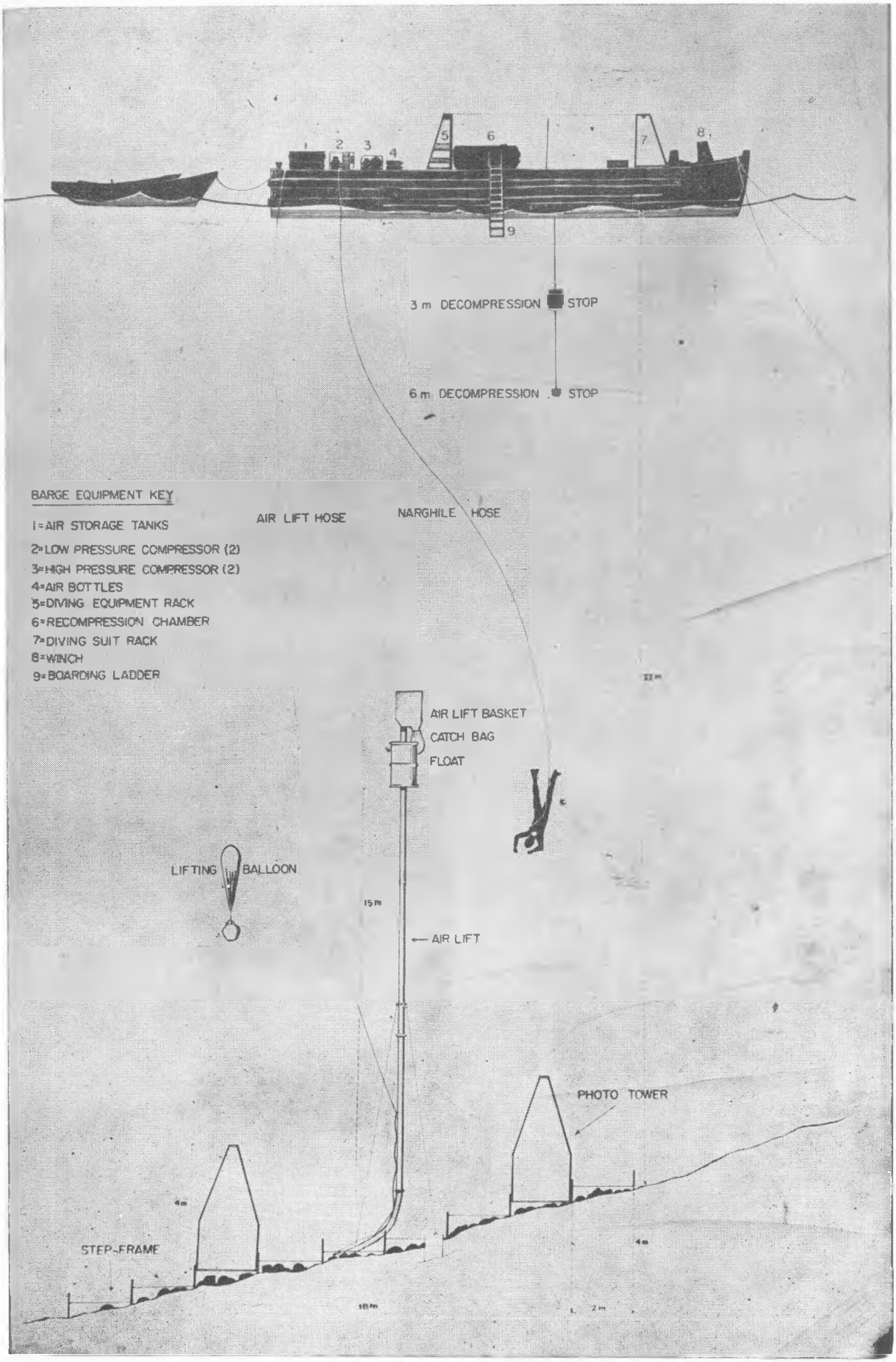
1
2
3
4
5
6
7
8
9
3 m DECOMPRESSION STOP
6 m DECOMPRESSION STOP
BARGE EQUIPMENT KEY
1=AIR STORAGE TANKS
2=LOW PRESSURE COMPRESSOR (2)
3=HIGH PRESSURE COMPRESSOR (2)
4=AIR BOTTLES
5=DIVING EQUIPMENT RACK
6=RECOMPRESSION CHAMBER
7=DIVING SUIT RACK
8=WINCH
9=BOARDING LADDER
AIR LIFT HOSE
NARGHILE HOSE
AIR LIFT BASKET
CATCH BAG
FLOAT
LIFTING BALLOON
15m
AIR LIFT
PHOTO TOWER
4m
STEP-FRAME
4m
18m
2m

Fig. 1 B.

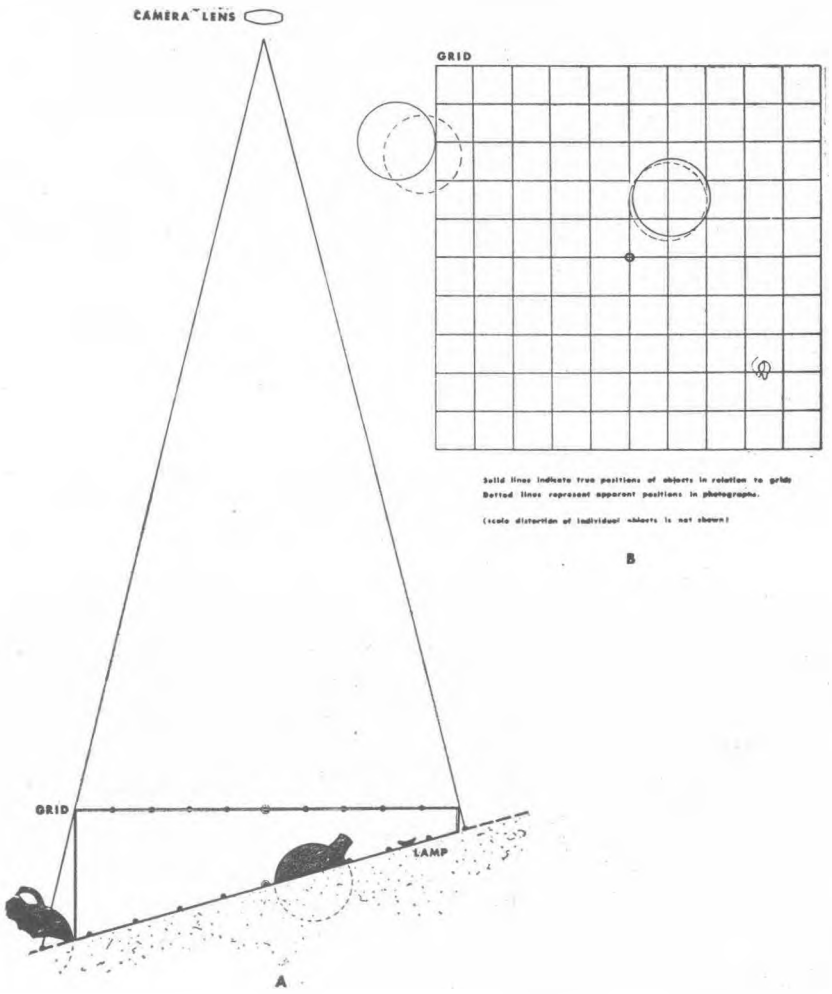
CAMERA LENS
GRID
GRID
LAMP
A
Solid lines indicate true positions of objects in relation to grids
Dotted lines represent apparent positions in photographs.
(scale distortion of individual objects is not shown)
B

Fig 2

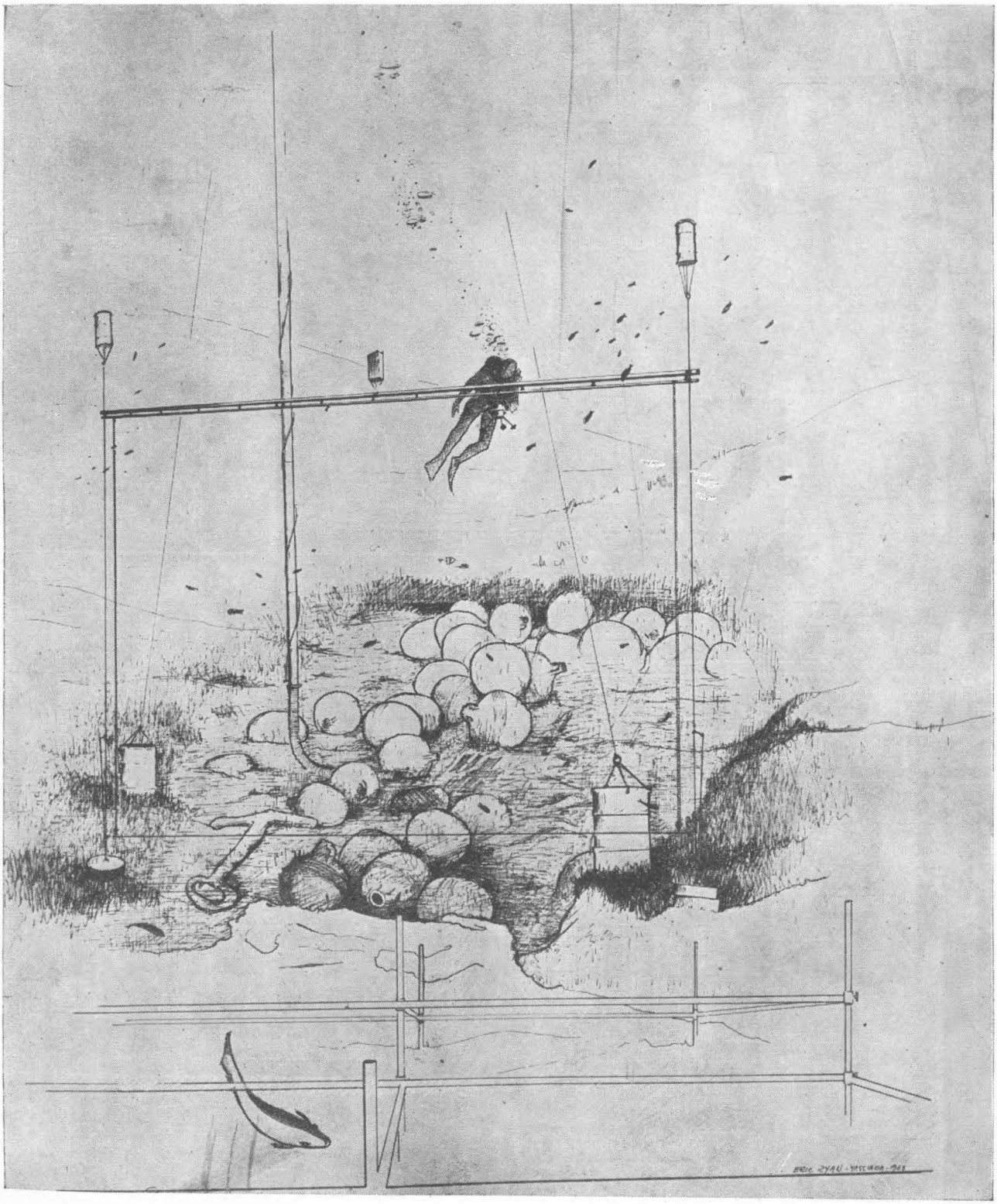

Fig. 3

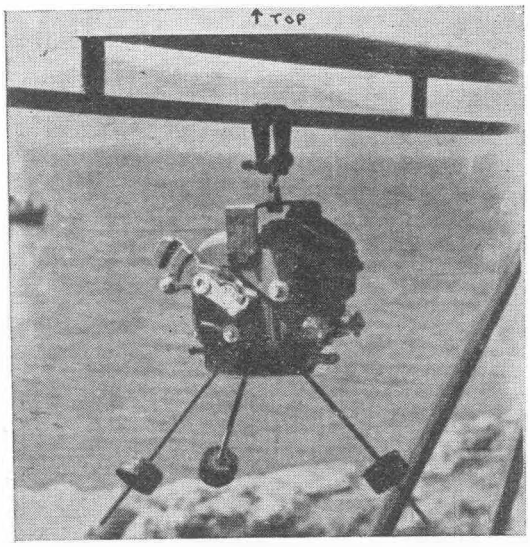

Fig. 4

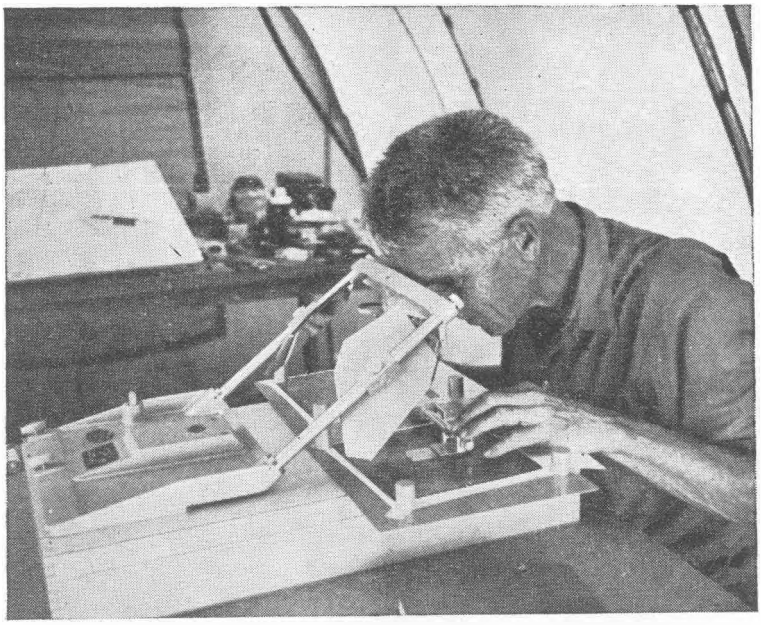

Fig. 5

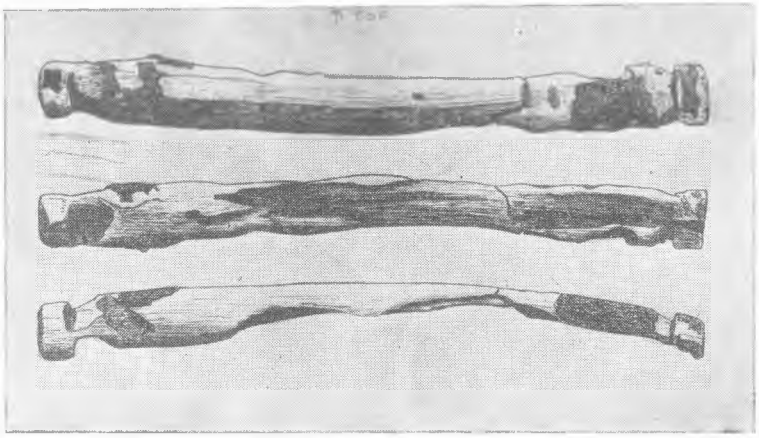

Fig. 6

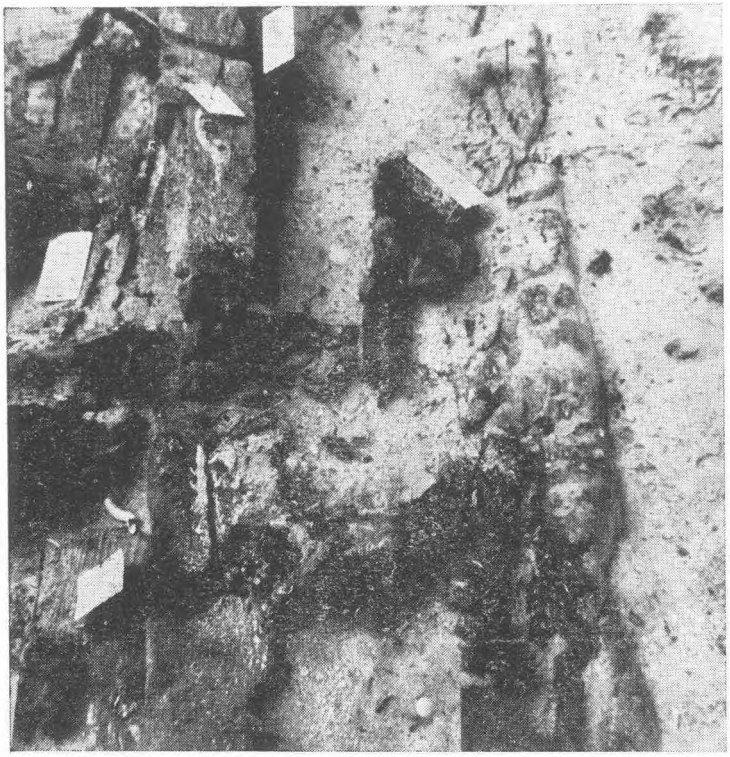

Fig. 7

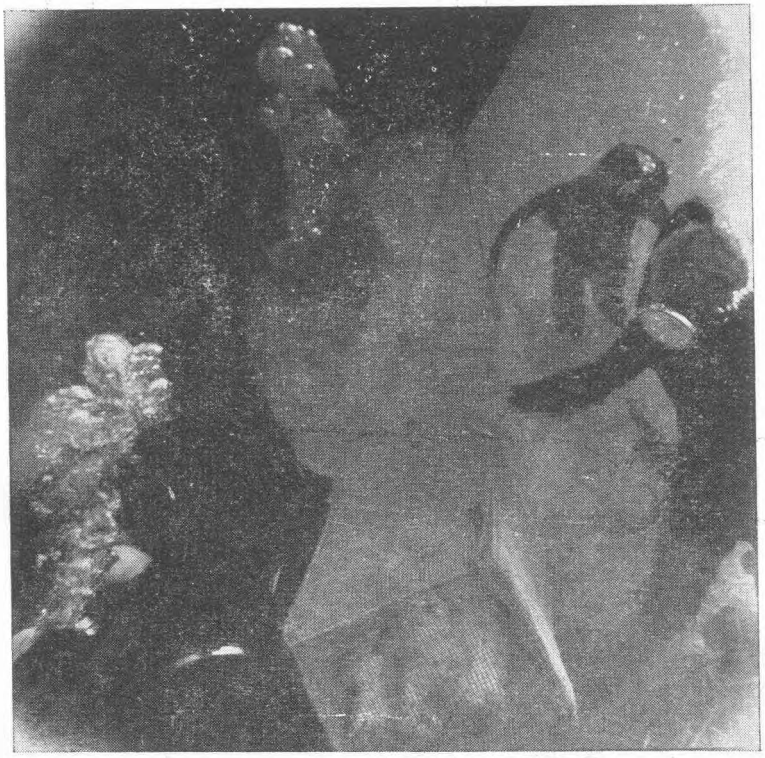

Fig. 8

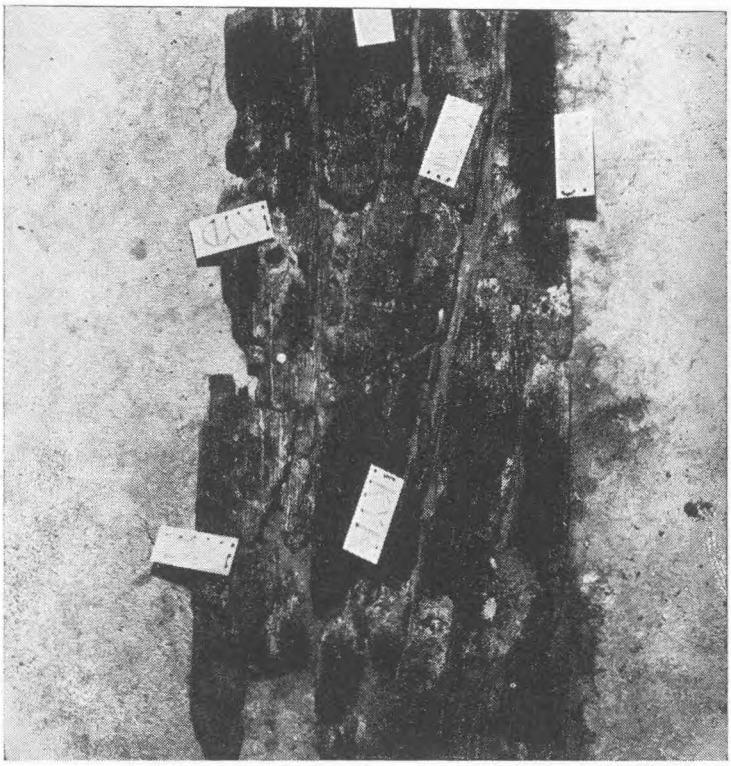

Fig. 9

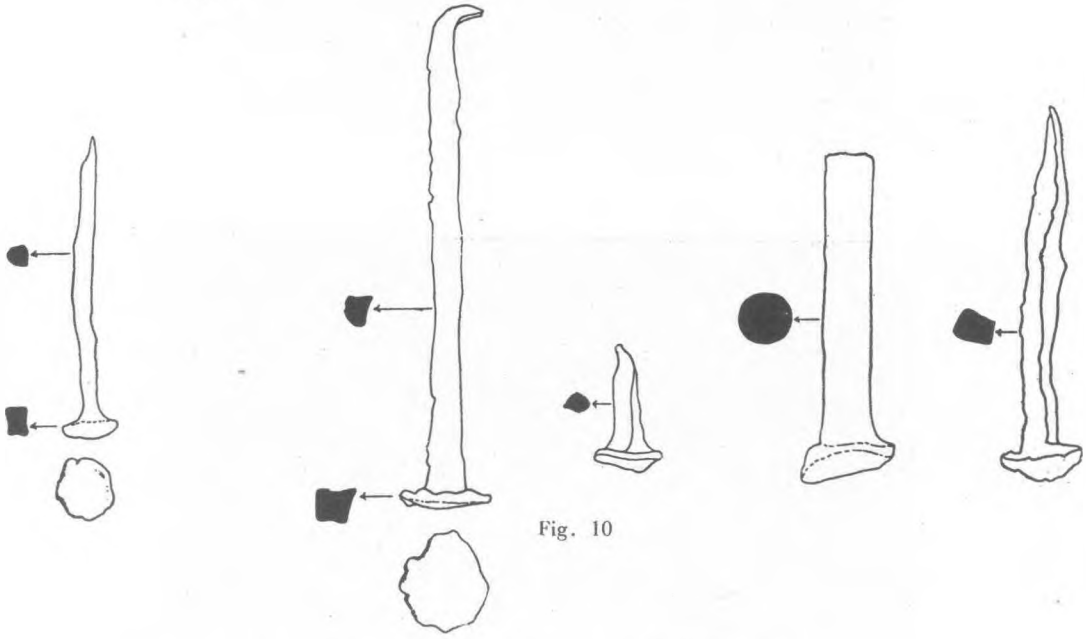

Fig. 10

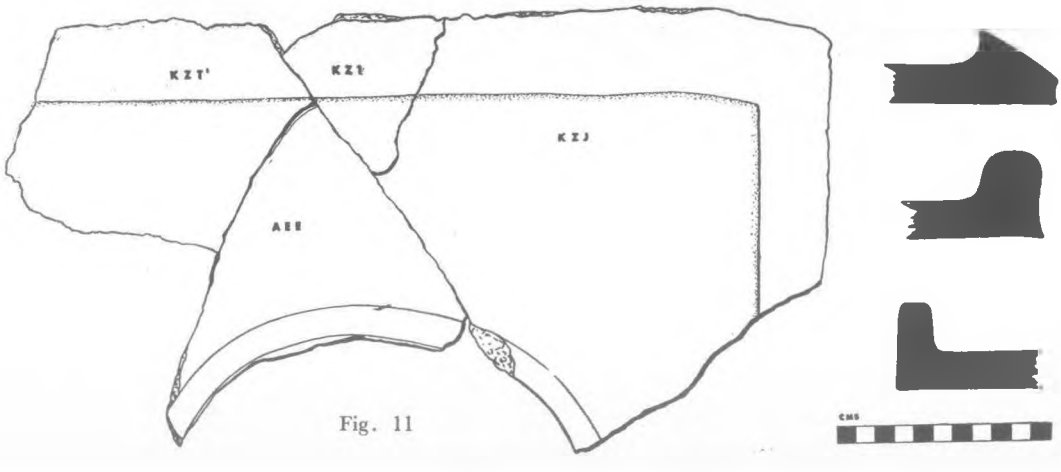

Fig. 11

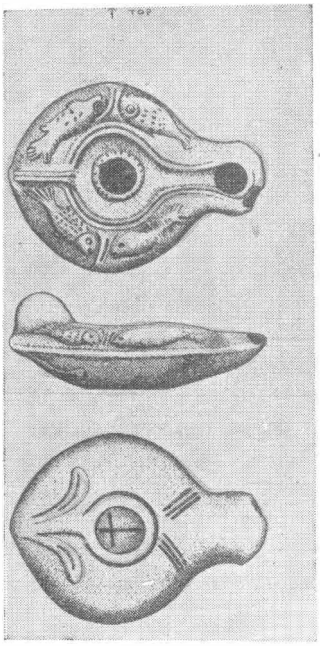

Fig. 12

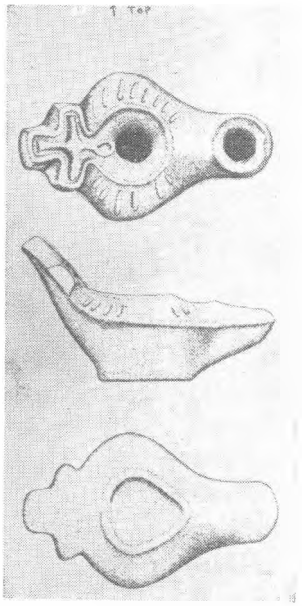

Fig. 13

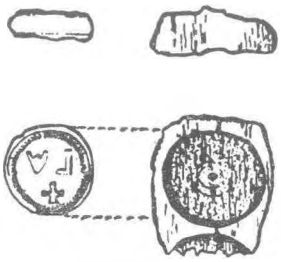

Fig. 14

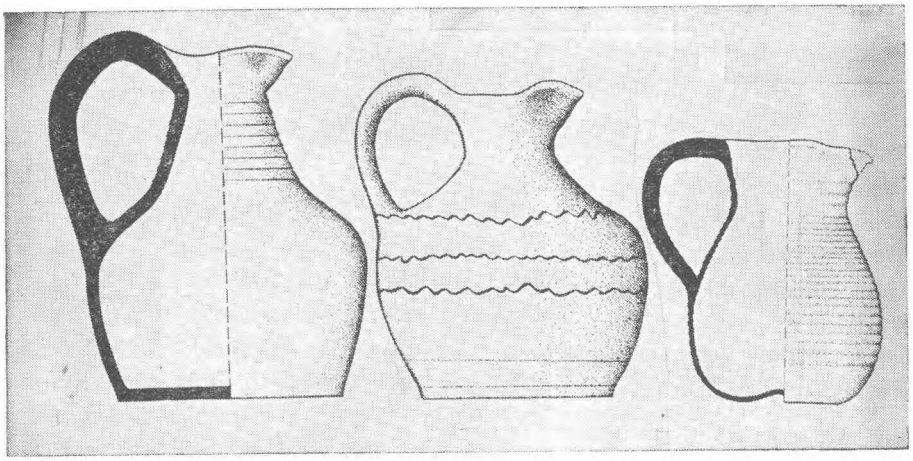

Fig. 15

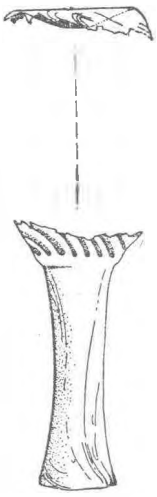

Fig. 16