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Edited by George Grant MacCurdy, Director

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Office of the School

OLD LYME, CONN., U. S. A.

REPORT OF THE DIRECTOR

To the Board of Trustees of the American School of Prehistoric Research:

THE seven seasons of excavation of the group of Mount Carmel caves in the Wady el-Mughara, Palestine, carried on jointly by our School and the British School of Archæology in Jerusalem, produced results of the first importance as revealed by the amount and value of the material unearthed. Equally important is the prompt study and publication of the results. This has been one of our chief concerns during the year 1937. The finds include not only cultural remains covering a period of about 100,000 years, but also human skeletal remains as well as those of the associated fossil fauna. The quarto memoir (240 pages, 55 plates and index) on the cultural and fossil animal remains entitled: "The Stone Age of Mount Carmel," has already appeared. The authors are Miss Dorothy A. E. Garrod and Miss Dorothea M. A. Bate, both of the British School, and Theodore D. McCown (of the American School and the University of Calif.). In order to give some idea of the value of this stupendous work, I quote briefly from a review of it by J. G. D. Clark in the *Proceedings of the Prehistoric Society* (for July-Dec., 1937), of which Mr. Clark is Editor:

"Palestine, forming the central link in the Near Eastern arc that binds together Asia with Africa and Europe, occupies a strategic position in relation to the spread of paleolithic cultures that marks it out as an area of supreme importance to the prehistorian. For this reason the series of excavations (1929-34) sponsored by the American School of Prehistoric Research and by the British School in Jerusalem and led by Miss D. A. E. Garrod, in the Wady el-Mughara (Valley of the Caves), one of the many valleys that dissect the foothills of the western slope of Mount Carmel, has been followed with widespread interest. The interim reports published in the *Bulletin* of the American School and elsewhere have shown that the material obtained has proved to be rich almost beyond hope, and the final results have been awaited with mounting interest.

"The presentation of the archæological results is wholly admirable in design. Two chapters are devoted to each of the three caves excavated—Mugharet el-Wad, Mugharet et-Tabūn and Mugharet es-Skhūl—one describing the features of the cave, the method of excavation and the sequence of deposits, the other the actual finds. . . .

"The Mt. Carmel excavations have established on a firm basis the main lines of cultural development in Palestine for the latter half of the Pleistocene period from the Tayacian to the Natufian, during which time the relations of Palestine with the outer world underwent important changes. . . .

"No one reading this book can fail to be impressed by the dispassionate and scientific atmosphere that pervades it, and, above all, by its essential modesty. The discoveries set out in its pages will be received everywhere with implicit confidence."

The memoir on "The Stone Age Races of Mount Carmel," by Sir Arthur Keith of the Royal College of Surgeons of England and by Theodore D. McCown of our School, will appear in 1938. The Oxford University Press is publishing both these memoirs. A third memoir on the Natufian (Mesolithic) human skeletal remains of Mount Carmel, by McCown, will be published as a special number of the *American Journal of Physical Anthropology* early in 1939.

The cultural remains from Mount Carmel numbering 91,333 catalogued specimens have already been distributed to museums in Jerusalem and England, also to a dozen museums in the United States, including the U. S. National Museum. As soon as casts are made of the priceless Neandertal skeletal remains, the originals will be apportioned among: 1) the Department of Antiquities, Jerusalem, Palestine; 2) the Royal College of Surgeons of England, London; and 3) the American School of Prehistoric Research. The Natufian skeletons will be allotted to the three foregoing institutions as soon as McCown will have completed his study of them.

The director is able to report a most successful summer term of the School, with Professor H. Breuil of Paris in charge, assisted by Mr. Harper Kelley, a former student of the school. Two of the six students—Derwood W. Lockard of the Harvard Graduate School and Dr. George D. Williams, a Faculty Member of Washington University, Saint Louis—were granted fellowships by the School. Students had the privilege of taking part in excavations of various sites: with Bouyssonie* at Chez Pourret (Mousterian); with de Saint-Périer at Isturitz (Aurignacian); Lacorre at La Gravette (Aurignacian); Kidder at Saint Cirq (Magdalenian); and Saint-Just Péquart at Mas d'Azil (Neolithic).

The summer term was confined to France, one of the richest fields to which students can be sent for study. But France does not tell the whole story. With France there should be included England, Belgium and Spain. By lengthening the term this whole western field could be covered. Alternating with a summer term in Western Europe there should be one in central Europe

*Bouyssonie has given to our School a portion of the specimens unearthed by the students at Chez Pourret last summer.

(or perhaps Scandinavia) to include Germany, Czechoslovakia, Austria, Hungary, Yugoslavia and Switzerland. This would give the student opportunity to enroll for two summer terms without duplication.

Our School serves as a link, binding the Old World to the New, in so far as prehistory is concerned. This bond is becoming stronger and more essential from year to year. That America is now awake to the necessity of keeping in touch with Old World progress in prehistory, the International Symposium on Early Man, held in Philadelphia, March 17-20, 1937, to commemorate the one hundred and twenty-fifth anniversary of the founding of the Academy of Natural Sciences, is a striking proof. Eminent prehistorians from South Africa, China, Java, Austria, France, England, Scotland, Denmark, and Norway were present and read papers. The New World was also well represented. Your Director was a member of the Organizing Committee and was editor of the contributions, some forty in number, which are included in a recently published volume entitled "Early Man" (Lippincott). The papers by Miss Garrod and Mr. McCown were based on our joint excavations at Mount Carmel. It is likewise of interest to note that at least fifteen former students of our School were in attendance and took part in the discussions.

Bulletin Number 13 of the School was published in May, 1937.

Respectfully submitted,

George Grant MacCurdy

REPORT OF THE 1937 SUMMER COURSE OF THE AMERICAN SCHOOL OF PREHISTORIC RESEARCH

By Harper Kelley

THE 1937 summer term of the American School of Prehistoric Research opened in Paris on July 1. The Abbé Breuil was Acting Director, and Harper Kelley Associate Director. The term closed in Paris on August 18, but several of the students were able to stay on until September 15, for additional work.

For the first time the entire term was spent in France, and the course consisted of a detailed study of the French quaternary succession.

The ground covered was divided into two parts, (a) the lower palæolithic succession in the north of France, (b) the middle and upper palæolithic sequences, including cave art, in the south of France.

During the past few years, much intensive work has been done in the Somme valley by the Abbé Breuil, and the first ten days of the term were spent in studying his results, both in the laboratory and in the field. The Abbé Breuil lectured on quaternary geology and prehistoric industries, and then conducted a four-day trip in the Oise, Somme and Seine valleys, during which some thirty-two sections were visited. The students studied the specimens and the documentation in the laboratory both before and after the trip.

A most instructive day was spent with Monsieur L Coutier in the forest of Montmorency; he demonstrated the simple and effective methods he has found for making the various types of stone implements. Monsieur Coutier was the first researcher to use wood for the manufacture of hand axes of the Acheulean type.

Before the School left for the south of France, the Abbé Breuil lectured on cave art, and discussed all the caves which the School subsequently visited.

Thirty two days in all were spent in the south of France, the whole trip was done by motor, and the following sites were visited:

Grand Pressigny region
La Quina.
Grotte de Teyjat.
Les Eyzies region, all sites and caves, including all sites near St. Léon-sur-Vézère.
Sauveterre-la-Lémance.

Grotte de Cabrerets.
Mas d'Azil.
Grotte de Niaux.
Grotte de Tuc d'Audoubert.
Grotte de Trois Frères.
Grotte de Gargas.
Grotte d'Isturitz.
All sites around Brive.

The following prehistorians most kindly invited the School to see their private collections:

Count and Countess R. de Saint-Périer.
Monsieur Castanet.
Mr. and Mrs. H. H. Kidder.
Monsieur Latapie.
Monsieur L. Coulanges.
Dr. A. Cheynier.
Count Bégouen.
Abbé Bouyssonie.
Abbé Lejeune.

The principal excavation was undertaken at the Mousterian site "Chez Pourret" near Brive, under the direction of the Abbé Bouyssonie. Two layers of Mousterian are found here, the upper one consisting almost entirely of quartz tools, and the lower one containing many fine flint artifacts. The School has received a portion of the finds from the Abbé Bouyssonie.

Through the kindness of Monsieur and Madame St. Just Péquart the School was invited to excavate at Mas d'Azil. The Count and Countess de Saint-Périer received the School at the well known Grotte d'Isturitz, and permitted the students to dig in the Aurignacian layer. Mr. and Mrs. H. H. Kidder and Monsieur and Madame F. Lacorre also invited the School to excavate in their sites, that of the former being a Magdelenian station, St. Cirq, near les Eyzies, and that of the latter being la Gravette, the well known Aurignacian site.

Talks or lectures were given by the following:

Count Bégouen.
Abbé J. Bouyssonie.
Monsieur L. Coulanges.
Mr. H. H. Kidder.
Monsieur F. Lacorre.
Professor E. Patte.
Monsieur St. Just Péquart.

Monsieur D. Peyrony.
Monsieur E. Peyrony.
Count R. de Saint-Périer.

The following museums were visited:

Musée de St. Germain.
Musée Boucher de Perthes, Abbeville.
Musée du Grand Pressigny.
Musée de la Société des Antiquaires, Poitiers.
Musée de la Faculté des Sciences, Poitiers.
Musée de Périgueux.
Musée Préhistorique, les Eyzies.
Muséum d'Histoire Naturelle, Montauban.
Muséum d'Histoire Naturelle, Toulouse.
Musée de Pujol.
Musée de Brive.

In conclusion those in charge of the Summer Term wish to take this opportunity of thanking all the above mentioned prehistorians, and also Monsieur Louis Bégouen, who most kindly conducted the visit through the most difficult Grotte de Tuc d'Audoubert, for their kindness and collaboration which so greatly contributed to making the 1937 Summer Term a success.

THE BEGINNING OF THE BRONZE AGE AND THE HALBERD

By George Lechler

More than 200 years ago modern science realized for the first time that mankind lived at first in a stone age which was followed by a bronze age. Georg von Eckhart (Eccardus) in his book "De origine Germanorum, Brunswick, 1730" is giving this cultural division. At the end of the last century Montelius finally gave the chronological basis for these periods, a chronological system with sub-divisions which in its main points is still valid. He was the first to classify the development in the different areas in this way, using dominantly the typological methods.[1]

The age of metal did not begin with the appearance of the first find of metal, which scientists discovered among the relics of that time, because these early finds show that metal was used only for decoration, not as tools or weapons. The very beginning of the metal age was the moment when metal became fundamental to the technique of that time, in other words, when tools or weapons were made of it. Only then can we talk of a particular cultural stage with this metal being its material foundation. Thus Montelius *(Ebert's Reallexicon der Vorgeschichte vol II, 1924, p. 179)* comes to the conclusion that, generally speaking, the copper age is not a self-reliant period between the stone and the bronze age, but it is the latest part of the stone age, since the main part of tools and weapons are as before made of stone. In Thuringia, Middle Germany, for instance, the oldest metal finds are made in sites of the Danubian culture. Here pieces of polished iron ore

Main Publications Concerning the Methods of Oscar Montelius

[1] Om tidsbestämning inom bronsåldern, Stockholm, 1885.
[2] Der Orient und Europa, Stockholm, 1890.
[3] Die Bronzezeit im Orient und in Griechenland, *Archiv für Anthropologie*, XXI, Braunschweig, 1892.
[4] L'age du bronze en Egypte in *L'Anthropologie*, Paris, 1896.
[5] Preclassical Chronology in Greece and Italy in *Journal of the Anthropological Institute*, London 1897.
[6] La civilisation primitive en Italie—2 volumes, Stockholm, 1898-1905.
[7] Die Chronologie der aeltesten Bronzezeit in Norddeutschland und Scandinavien, Braunschweig, 1900.
[8] La chronologie prehistorique en France et en d'autres pays celtiques. *Compte rendu Congr. intern. preh.* Paris, 1906.
[9] Die ælteren Kulturperioden, Uppsala, 1912.
[10] Vorsclassische Chronologie—2 vol. 1912, Stockholm.

were unearthed, demonstrating that neolithic man of that area used iron for decoration. (*H. Wagener, Erste Verwendung von Eisenerz in Mannus, vol. 25, 1933, p. 59. Iron ore amulets in 4 settlements.*) The latest possible date for these finds is before 2500 B. C. Nobody will draw from such a statement the conclusion that the iron age began in Middle Germany at that time. The iron age begins there not earlier than 650 B.C., because only from this time on this metal is used for tools.

In the same way Hittite texts talking about iron, as mentioned by Madame Hertz (*Am. Journ. of Arch. 1937, p. 442*), do not prove anything about the very beginning of the iron age, because these texts show that iron was first used for making sacred objects and ceremonial utensils; but not for tools or weapons. That about an iron dagger a correspondence could go on between two mighty kings proves not, as is often said, that then existed consequently the iron age; but on the contrary proof is given by this that iron had still the highest value of rarity therefore this was not the iron age but still the bronze age. In other words, iron is by no means basical or important for the technique of that time. She concedes (p. 443) that the use of iron became common in the Near East not earlier than after 800 B. C., in other words, at nearly the same time as in Southern Germany.

We will see that the dating of the beginning of the bronze age is still more difficult, because of the fact that in addition to what is said above concerning the beginning of a cultural period we have to figure out from which point on the tin copper alloy is intentionally made and is not an accidental natural mixture as a result of smelting a tin containing copper ore. Thus for instance A. Stirm dealing with the properties of alloys in general (*in the "Dictionary of Natural Science", Handwörterbuch der Naturwissenschaften, Jena, 1912, vol. VI. p 124*) makes the statement that "unintended alligation occurs during any smelting operation, when different metals are extracted from the ores." Being a metallurgist he judged quite objectively and only incidentally touched upon historical developments. For this reason his next statement is much more noteworthy as revealing the whole problem discussed. "Many of the so-called bronzes of antiquity represent nothing else than impure copper which is polluted by tin, arsenic, lead, antimony, iron, in about the same proportion as is found in roasted copper of today which is extracted from the smelted ores."

Here may be said at first something about technical premises. Copper is too soft for many purposes. Tin combined with copper makes a harder substance. (In these modern times tin is often replaced by aluminum which makes copper much harder, phosphorus and silicium have the same effect.) But this is not all. Copper is very difficult to cast because gases are constantly formed during the melting and coagulating process as a result of the

oxyde and sulphide present in any copper. A blistered cast is the result. Tin binds the oxygen and liquefies the mixture, lowering its melting point because that of copper is 1084 centigrade and that of tin only 232 centigrade and the alloy being a solid solution follows the rules as established by Van Hoff.

The admixture in order to bind oxygen can be also phosphorus or silicium attracting the oxygen and precipitating it by chemical reaction. The admixture can also enter the final product by alligation besides having the effect of binding oxygen and sulphide. This is the case by use of tin and zinc, the alloy of the first we call bronze and that of zinc, brass. (*About the appearance of zinc in copper-tin alloy in antique days, see fig. 35.*)

Aluminum and manganese are used for both forming the alloy or precipitating oxygen and sulphide, but only the latter is sometimes present in antique bronzes.

Bronzes represent mostly "solid solutions" the consequence of which is that they can be "chilled" or "annealed" and "tempered." But the effect of this process is the reverse as known for iron. Chilling by cold water gives a bronze a better malleability and ductility and the finished piece can be hardened again after the fashioning by tempering which means to make the piece hot and let it cool slowly.

Bronze containing tin up to 7% has a reddish color while bronze containing tin from about 8 to 14% has a golden color. Up to 5 or 6% of tin bronze is workable in cold condition. A mixture from 10 to 35% is forgeable when dark red hot. In fact agreeing with this Chesneau found that cast hatchets (celts) of the early bronze age containing a small percentage of tin were afterwards forged cold, the younger items with higher admixture of tin were forged being hot. This he found by microscopical analysis (*Ebert's Reallexicon der Vorgeschichte, 1924, vol. II, p. 170, Bronzetechnik by A. Götze*). Tin bronze can be chilled within the percentages of 9-35. Bronzes with more than 11% tin and up to 27% have a yellow color. The green patina originates very quickly when H_2O and CO_2 are present—being a texture of malachite and SnO_2 under which follows a film of Cu_2O. The oxydation of bronze items very often gives rise to misleading results if not enough care is taken in the chemical analysis to use only undecomposed metal. How different the results can be from the same alloy is shown by the example mentioned by Montelius (*Ebert's Reallexicon der Vorgeschichte 1924, vol. II, p. 183, Bronzezeit by Oscar Montelius*). An analysis of a bronze sword showed:

thickest part: hilt	thinnest part: point
63,79 Cu	48,56
19,12 Sn	58,39

We give here a practical example of one of the oldest "bronze" items of

Egypt that of the statue of king Pepi (Phiops, VI Dynasty) about 2500 B. C. This statue is very much oxydated, consequently a big amount of copper was decomposed. The analysis showed only 58,5% Cu and 6,58% Sn. That means that the original content of tin was in no case higher than 3%, perhaps only 2% or less (*See p. 22.*) A Cretan dagger of the same time as King Pepi contained only 63,3 Cu and 10,2 Sn thus the alloy had in no case a higher admixture than 5% tin, but probably less.

The prehistoric metallurgist had not all our modern knowledge, of course, but the fact that in the full bronze age the classical alloy of 90% Cu and 10 Sn is the normal mixture proves that he was cognizant of nearly all those properties discussed above, they being discovered during the beginning of the bronze age. V. Gordon Childe (*The Bronze Age, Cambridge, 1930, Chapter I*) is, so far as I see, the only scientist who from the facts offered by the material itself drew the necessary conclusions concerning the improvement of chemical and scientific progress of that time and outlined and emphasized this. In the younger bronze age of Northern Europe, from about 1200 B. C. on, we have occasion to observe this scientific progress still much better, because we have here a type of trumpets, called "lurer" about 5 feet long wound in a screw like S form, which is made by a very complicated process of casting and sweating which shows a surprisingly correct knowledge of the properties of bronze alloys by different admixture of tin, particularly their melting points. It was known that 2% tin lowered the melting point so much that the sectional tubes were composed by a ring armature containing 2% more tin. The consequence of doing so was that during the process of casting, the ends of the sectional tubes which they wanted to put together became so soft that they just began to melt—not completely—but caked together entirely, a process known in modern time as welding.

Before we approach the whole historical problem, one very important thing must be considered further, namely, the fact that before man began to mine ore he had already mined flint stone for at least 6000 years. This he did not only in open pits but also in real mines which he equipped with shafts and galleries, as proved by many rediscovered mines of the Mesolithic and Neolithic periods. The oldest used belong to the early Campignian of France and Belgium (*Similiar mines are found in England, Sweden, Portugal, Sicily, Egypt, etc. Julius Andree, Der Bergbau in der Vorzeit, Leipzig, 1923. H. W. Seton-Karr, Discovery of the lost flint mines of Egypt in Journal of the Anthropological Institute XXVII, 1897, p. 90. H. Quiring, Die Schaechte, Stollen und Abbauraeume der Steinzeit, in Zeitschrift für Berg und Hüttenwesen, vol. 82, 1932.*) The objection that stone mining is absolutely another thing is not justified insofar as we have the fact that man of the Mesolithic period had already learned to distinguish the different quality

of flint in different strata. Thus at Spiennes, Belgium, it was observed that the ancient miner did not exploit every flint-containing stratum. He brought the shaft down passing five flint layers, and used only the sixth and seventh layers which were by no means richer than those nearer the surface, but only here he was satisfied with the quality of the material. Other sites with similar observation are Grimes Graves, Cissbury in England. (*Julius Andree, op. cit. p. 8*). In other words, long before man began to seek for ore containing minerals, he had learned that the material thus acquired showed different qualities. With this training of searching for different qualities, he sought for ore. Thus we are allowed to suppose that from a very early stage on he also examined critically the quality of the copper ore he found. That we must not forget.

The existence of another necessary supposition for smelting ore is also proved by the flint mines of the stone age, namely that man produced and used charcoal. This is observed at Mur de Barrez (4000-2400 B. C.) Grimes Graves (8000-5000 B. C.) (Champignolles about 6000 B. C.) Petite Garenne (5000 B. C.) (*Andree op. cit. p. 13 ff*).

Oscar Montelius was the first scientist who was conscious of the fact that the question of the beginning of the metal age can not be answered without observing the technical processes and chemical properties of the different copper ores. The correct understanding of these metallurgic factors only can bring light to the most important part of the problem as to where the knowledge did originate of the tin-copper alloy, its properties, and where its advantage over mere copper by being much harder, became known. But during the last few years Wilhelm Witter approached the subject exclusively from the technical point of view. He was particularly capable of doing this as he had devoted his life to metallurgy, being foundry director and finally president of the German state's foundry laboratories. From the age of sixteen he had studied mining and after he retired he went back to the University of Halle to study prehistory. Therefore, he had an excellent preparation for this type of research. In fact he gives a new conception of the beginning of the bronze age, even if we take into consideration the fact that he based his research upon such as done by A. Lucas (*Notes on early history of tin and bronze in Journal of Egyptian Archæology 1928, vol. XII.*)

Let us summarize the results of Witter's research (*his book "Die Ausbeutung der mitteldeutschen Bodenschätze in der frühen Metallzeit," Leipzig, 1938 is being printed. Prior to this, he published different papers of which the two most important may be mentioned: Ein Beitrag zur Frage der vorgeschichtlichen Bronzeerzeugung in Mitteldeutschland, in Jahresschrift für die Vorgeschichte, Halle 1936, and Woher kam das Zinn in der frühen Bronzezeit, in Mannus, Zeitschrift für Vorgeschichte, Leipzig, 1936.*) The earliest copper finds of decorations or tools in Europe and the Near East are made of pure copper. Where did this copper come from? It was either gathered on the surface being native copper—a pure copper—or was produced from copper oxyde—CuO—malachite—in the latter case it could happen that the copper ore contained a small percentage of tin. This is observed only in those countries where the copper ore found contained also tin. After this period followed as a second step a period where impure copper was used. This kind of copper is known today as roasted copper. This crude copper may contain all the other metals which were present in the used ore as: tin (Sn), arsenic (AS), antimony (As), silver (Ag), gold (Au), nickel (Ni), bismuth (Bi), iron (Fe), sulphur (S), zinc (Zn). This copper is the result of *mined* ore from exploit layers. In countries where tin-containing copper ores are found, there followed a third stage of use of an impure copper containing more tin, mostly 3%, because this ore became preferred for its quality before others. This impure tin-containing copper cannot be called bronze because it is a natural alloy and is only the result of the roasting process of the copper ore.

The next step is the use of copper with a still higher content of tin, namely, as much as 7%. This is the real beginning of the bronze age, because the effect of tin as improving the quality of copper is fully realized and the addition of tin is artificially made. Very soon followed the classical alloy of 10% tin and 90% copper. This last step has as a supposition the production of pure tin and copper, to make possible the fully intended proportion of mixture. A second necessary supposition is that the miners of that time became familiar with the buddling or washing process of the brown tin stone (tin oxyde). Putting these results of Witter, Montelius, Lucas together, I come to the following chart.

By the use of the abbreviation P for Period I-VI of the bronze age I follow the custom of German Prehistorians which indicate with P the subdivision of the Bronze age.

Chronological System:

	After Oscar Montelius	After Gustaf Kossinna
I Copper Age (a) period of pure copper	Stone age	Stone Age
(b) period of impure copper accidental content of tin, antimony, arsenic	Stone Age	PIa Bronze Age of Bohemia Middle Germany, Silesia = Aunjetitz culture
II Bronze age (a) period of beginning of intentionally made artificial alloy (b) period of typical 10%/90% Cu alloy	P I	PIb Bronze age PIc Bronze age

Let us first outline the finds in Germany; later on we will deal with the Near East and the South of Europe.

More than 700 bronze and copper tools of the earliest types, in German Museums, have been analysed by Witter who applied also spectral analysis. The fact that 600 pieces show a typical composition corresponding to the composition of middle German ore layers proves that the material of these 600 pieces originated from Middle German ore layers. The question what people were living there at that time we shall answer later.

As early as the end of the Neolithic Period this people began to use copper found in the Hartz mountains in the Thuringian basin, in Hessen in the Erzgebirge, meaning "metalliferous mountains," but mostly in Vogtland. Here the valuable mineral was not only exploited by working in the open, Fig 8, but miners also followed the ore veins, driving galleries which were protected by wooden structures. These galleries are called "pingen."

The accompanying result enabled Witter to show the progress step by step toward the harder alloy of copper and tin. The middle German coppers, especially those found in the district of Oelsnitz, Vogtland, contain a naturally rich proportion of tin—up to 3%. The crude metal represented a natural bronze and led automatically to intentionally made bronze. This better ore was accompanied by many brown spots—tin stone—so it was not too difficult to realize that these accompanying brown spots were the reason for the better quality. Thus it is even possible that here originated, independently from other areas such as the Near East, the intentionally made mixture of copper and tin. The independence from outside influence is established for the used material. The independence concerning the forms of the most part of the tools was already emphasized as early as 1898 by Montelius *(Chronologie der ältesten Bronze-zeit)*. He presupposed only an import of the raw material to Middle Europe. We have to ask, how can we put these new facts together with the results concerning the early metal age in the Near East.

How could the prehistoric miners learn that tin gave copper a harder quality? They observed at first that the roasted product of mined copper had different qualities. To look for different qualities they were accustomed from the Neolithic flint mining which was already a specialized profession, and it is probable that these flint miners became copper miners. They observed that, where the green or blue copper ore was accompanied by brown spots in the stone, the roasted copper was much harder and lighter and more yellow in color. Only by such observations could they have been led to try to smelt this brown mineral separately. This knowledge could be acquired only on places where tin oxyde is connected in lodes with copper ore. Tin is not found in pure condition as copper is—only tin oxyde exists. It is either found in washouts, alluvial stream deposits or in lodes, here only interspersed in the veins of copper. A content of 0,5% tin is estimated as a rich ore. In any case an intentional mixture of copper and tin was only possible after the property of tinstone was discovered and it was smelted separately, exploited from mines or alluvial stream deposits. The old theory that tin was discovered in connection with the gold washing process has the following difficulty as emphasized by A. Lucas, 1928, T. Rickard, 1930, H. C. Richardson, 1934, W. Witter, 1936: *(A. Lucas op. cit.; T. A. Rickard: The early use of the metals in: The Journal of the Institute of Metals, London, 1930, Vol. XLIII.; Harry Craig Richardson: Iron, Prehistoric and Ancient in: Am. Journal of Arch. 1934 vol XXXVIII. p. 555 f.)* Even if they smelted the brown looking tinstone found in washouts together with gold and realized that the result was a soft white metal even then it is unexplained why they came to the idea to mix it with copper in order to harden it. The situation of Oelsnitz explains the way of discovery in the best manner. Here the brown tin oxyde is directly connected with the copper ore in such a quantity that it had a striking character. The step of using tin oxide from alluvial deposits was the next one. That the stages as given above really correspond to the run of events is proved by the fact that these periods correspond to the relative chronology of the tools. The tools being the oldest by their typological form *(see Oscar Montelius, die älteren Kulturperioden, Stockholm, 1907, p. 1ff.; his method is outlined in V. Gordon Childe, The Bronze Age, Cambridge, 1930, p. 53ff.)* are from pure copper. The younger typological forms are of 3%, the still younger of 7%, and then of 10% tin content. Not only the layers of ores of Oelsnitz but also that of the "Mansfeld" district, southeast of the Hartz Mountains (today the only copper mine district in Germany) are at the beginning of the Bronze age, inside of the range of a cultural group known as the Aunjetitz culture (Unetice, south of Prague). This culture originates at the end of the neolithic period by mixture of different groups in Bohemia and Silesia, it covered also the Thuringian basin as far as the Hartz and, southward, Moravia and westward, Upper Franken west of the "Baierischer Wald" mountains. Our map fig. 1 gives its range. Since the research of A. Winkler *(Zur Herkunft der Aunjetitzer Keramik, in 25 Yahre Siedlungsarchæologie Festschrift für Kossinna, Leipzig 1922, p. 134)* the origin of this group is satisfactorily cleared. G. Kossinna called this group Aunjetitz-Block because, since Period II of the bronze age with its spreading toward the East and West, this group begins to differentiate, due to the fact of intermixing in both parts with other peoples which it met there. The Aunjetitz-Block becomes in this way the root of two main groups of population in Middle Europe: The primeval Celts and the primeval Illyrians

and partly of a third group, the Italians of which the Sabelleans in Period III became members, who also derived from the Aunjetitz-Block. The spreading out of the Aunjetitz culture in P I of the bronze age explains why we have the same types all over Middle Europe. We show also, the map of the influence of the neolithic corded ware group and the boat-axe culture fig. 2, in order to give an understanding for the situation at the beginning of the metal age and the origin of the Aunjetitz-Block. It is a fact that already in Period I of the Aunjetitz culture, local differences are present, so that we are able to distinguish eastern and western types, indicating a certain differentiation which makes understandable the quick split of the Aunjetitz-Block into primeval Celts and primeval Illyrians. (Chart fig. 3).

N. Aberg in Bronzezeitliche und Eisenzeitliche Chronologie, Stockholm, 1927, vol. III, p. 100 goes so far as to make from the beginning on a distinction between East and West group. But the halberd (Dolchstab) shows (see later) that other local variations are present, because the Thuringian Aunjetitz is obviously full Aunjetitz in the main character. Halberds are not found in Bohemia.

The bronze invention in Middle Europe was made by tribes which were the ancestors of the primeval Celtic and Illyrian tribes but they were also relatively closely related to the population which emigrated in P I b (Kossinna) to Northern Italy into the Po Valley—the settlements of which are known as Terramara *(W. Helbig: Italiker in der Po-Ebene; 1879)*. The relation leads a little farther back, namely, to the main ancestors of Aunjetitz, but besides that the bell beaker folk coming from Western Europe intermixed with people in the Rhine Valley—the result being the zoned beaker (see chart fig. 3). The same bell beaker also spread over into Bohemia. By the way, there is generally acknowledged that the bell beaker folk are a migrating tribe, not a cultural influence. These relations explain the strong contact as given by the distribution of the triangular dagger and other types over Middle Europe and Upper Italy, a fact that enabled Montelius as early as 1898 to build up a chronology concerning the beginning of the bronze age in Italy and Middle Europe, as developed in his standard work: Chronology of the earliest bronze age *(Chronologie der ältesten Bronzezeit in Norddeutschland und Skandinavien, Brunswick edition 1900)*.

Already in the stage of the pure copper in the groups of the final Neolithic period in Middle Germany, we find copper decorations quite regularly. On our chart fig. 4 the columns before 2200 and 2200-2000 represent this stage. We have in the area around Halle not less than 25 sites (my list is not complete as 10-15 new sites exist).

1 Megalithic group (Tangermünde)

5 Bernburg group (Heiligenthal, Latdorf, Tangermünde, Rhinow, Polleben)

2 Globular amphorae (Niedereichstädt, Rödgen.
1 Rössen group (Rössen)
10 Corded ware (Auleben, Dorndorf, Latdorf). Kirchscheidungen, Mittellausen, Nautschütz, Nerkewitz, Hainichen, Niederzimmern, Hardisleben)
4 bell beaker (Achim-Tempelhof, Eisleben, Zaschendorf, Höhnstedt)
2 Uncertain group (Poserna, Petersberg)

This shows that the copper of the Mansfeld district played a role, since further west or southwest finds are absent. (Fig. 8.)

Concerning the provenence of the copper used in the beginning of the bronze age of P I a and b (see chart fig. 4) it is mostly overlooked that Moravia, lower Austria and eastern Hungary are nearly void of finds of the time in question *(Kossinna: Zur älteren Bronzezeit Mitteleuropas in Mannus, Leipzig, 1912, vol. IV, p. 174)*. These countries received their population by infiltration of Aunjetitz people. Transylvania (Siebenbürgen), Roumania, cannot be the source of copper, because this district is completely empty of finds belonging to P. I and P. II. At the end of the Neolithic Period, tribes belonging to the Thracian group migrated southward. Typical to them was the wart ceramic (Buckelkeramik), vessels showing warts decorated with spirals or furrows around them. These vessels are the ancestors of the ceramic which is found later at Troy VI-VII.

Montelius had developed the typological method, thus giving a key for the relative and consequently, for the absolute chronology. Later on Gustaf Kossinna added the "siedlungsarchaeologische Methode," meaning the "archæology of settlements," the mapping of finds and settlements of the same cultural groups thus showing on practical examples that uniform prehistoric groups represent not only cultural units but tribes or peoples of prehistoric Europe. *(Gustaf Kossinna, Ursprung und Verbreitung der Germanen in vor-und-frühgeschichtliche Zeit, Leipzig, 1936, 3d edition.)* One of the results is the recognition of the Aunjetitz-Block. But even Oscar Montelius noticed, as emphasized above, that at the beginning of the metal age there was to a very large extent an exchange of material from Middle Europe and north- and southward. By this fact he came to the conclusion that P I of the bronze age started in Italy, Middle Europe and Western Europe at the same time and that Northern Europe (coast of Germany, Denmark, Sweden) followed toward the end of this period. Even more recent works could not establish any other result. In support of his findings he used 32 different groups of types, as given in his chronology of the earliest bronze age (op. cit.).

The area along the coast line of Germany, Denmark and Sweden is the range of the primeval Germanic tribes as clearly proved for the beginning

of P II of the bronze age. This group originated from two different groups of the final Neolithic stage, 1) "Megalithic Group" and 2) culture of "separate graves". The intermixing of both was completed during P I of the bronze age which here started later than in Middle Europe or Great Britain. This is proved by such deposits as Pile and Skifvarp, Sweden for example, *(Montelius, Chronologie, op. cit. p. 56 p 24)*. The deposits contain typical flat bronze blades of British type among the indigenous items. The British types represent already the real bronze alloy, the Scandinavian types still impure copper with accidental tin content.

Pile

British type: 89,08 Cu 10,875 Sn 0 Ni
Scandinavian type: 98,00 Cu 0,31 Sn 0,27 Ni

The proportion of nickel demonstrates that the rough material was imported from Middle Europe, probably Austria, because the British ores do not have an admixture of nickel but Mitterberg ore contains much nickel. Fig. 9. Here may be said, by the way, that the fact that the copper items of the lake dwellings at Mondsee in the Austrian Alps do not show nickel is no longer a riddle, since we know that the deeper layers of copper ore at Buchberg and Einödsberg near Bischofshofen are free of nickel and that the inhabitants of Mondsee from the final neolithic stage could gather it in the washout of the Salzach river. *(Ferdinand Birkner, Ur und Vorzeit Bayerns, Munich, 1936, p. 94)*.

Skifvarp contemporary with Pile:

Flat type: 89,76 Cu 6,75 Sn 0,15 Ni 2,36 antimony
Scandinavian flanged type: 94,04 Cu 2,13 Sn 1,27 Ni 1,37 antimony

The deposits of Pile and Skifvarp show that Britain was familiar already with the classical alloy 10% SN 90% Cu, when in Sweden copper was still used with an admixture of tin and antimony. As Wilhelm Witter wrote me this copper alloy occurs naturally in a very big ore layer near Saalfeld, Thuringia. The old idea of Montelius and Kossinna that in the beginning of the bronze age a stage of intentional experimenting with antimony or arsenic admixture existed is no longer acceptable. But it would not be correct to estimate the distance in time too high because the depot Fjällinge P I (Ic) contains English, Italic and indigenous Scandinavian types of the same mixture, Fig. 5. *(Montelius, Minnen from var forntid, Stockholm, 1917, fig. 802-5)*; according to Gustaf Kossinna the items with intentional admixture of tin belong to P I b. He is emphasizing that P I a is present only in the Aunjetitz area. *(Mannus, vol. III, 1911, p. 317.)*

The admixture of a higher percentage of tin than normally present in roasted copper shows that this was added intentionally, consequently proving that the metallurgists of that time were already able to produce pure tin. A little later the old metallurgists were able also to produce pure antimony. This we know from the Caucasus items made of pure antimony *(Verhandlungen der Berliner Anthropologischen Gesellschaft 1884, p. 126.)* We cannot expect many finds of such material and really items of pure tin are very rare. Among the decorations from the Nordic district we have only the napring ("Noppenring") of Baarse (Zealand, Denmark) which is the oldest find of pure tin in general, at least north of the Alps *(Fig. 6 after Montelius, Chronologie, op. cit. fig. 205)*, and some ingots of tin from England, representing the condition in which tin was traded as rough material (Fig. 7), as found at Borlase, Cornwall, together with celts. In the lake dwellings of Switzerland also have been found small ingots of tin, but we are not able to give an exact date. They belong to the bronze age, probably about 1400 B.C. In P II and III of the Nordic bronze age tin nails were used for decoration of wooden bowls—the burned ornaments are outlined by these nails in pleasing silverlike contrast with the brown pattern. The tin ring of Baarse (probably 1600 B.C.) is at least as old as the tin ring and pilgrim bottle made of tin from the 18th Dynasty *(J. H. Gladstone, On metallic copper, tin and antimony of Ancient Egypt, London, 1910, p. 104)*, probably older. That not only ingots of tin were imported to Egypt, where tin oxide in the alluvial deposits is absent (only in far Upper Egypt magnetite iron kernels are present) is illustrated by the fact that since the 18th Dynasty glassware is colored with opaque white by the use of tin oxide *(B. Neumann and G. Kotyga, Zeitschrift für angewandte Chemie, 1925, p. 776-780, 857-864, and H. D. Parodi, La Verrerie en Egypte, Paris, 1908, p. 34,35.)*

The source of copper in Egypt was either the mines in Sinai or Cyprus, the Alasya of the Tell el Amarna correspondence, but in both areas no tin is found. At Monte Bradoni, Etruria, tin buttons with V shaped boreholes have been found together with a copper dagger of early Helladic period, 2000-1900 B.C. V. Gordon Childe *(Dawn of European Civilisation, London, 1925, p. 33)* believes that it is a "sure find" (after the term created by Montelius meaning twofold: belonging together and deposited on the same day) but W. Witter *(Mannus, vol. 28, 1936, p 448)* objects and declares uncertain the connection of both finds. In any case, buttons with V shaped boreholes are typical for the beginning of the metal age, being often of stone or copper, in the north of amber *(See Much, Die Kupferzeit in Europa, Jena, 1893, p. 100, Olshausen Zeitschrift für Ethnologie 1884 Verhandlungen, p. 287)*.

That the tin layers of Tuscany were exploited during the bronze age is nearly impossible because of the fact that the tin lodes are here connected with iron ore, which was only exploited by the Etruscans after 1000 B.C. *(A. Lucas, op. cit. p. 99.)*

The tin layers on the island of Elba probably played only a local role for the neighbor island, Sardinia, because its bronzes have in a very high degree a particular local character.

Sir Arthur Evans who supposes that the tin used in Crete came from the Monte Bradoni in Italy or from the Cantabrian Mountains in Spain does not take in consideration the tin from the Middle German area or from England. The tin exploited near Delphi Greece and the Middle German layers would be the most probable sources. He mentions concerning the tin used in Egypt a very important fact *(op. cit. vol II 1, p. 176)*. The pilgrim bottle mentioned above represents an Aegean import as shown by its form and generally spoken Evans states that bronze appears in Egypt together with the curvilinear system, with the spirals of the Minoan art. Therefore is given proof that the source of tin and bronze for Egypt was Crete, but Crete was only the middleman.

A. Lucas, mostly dealing with Egypt *(Notes on the early history of tin and bronze, in The Journal of Egyptian Archæology, London, Vol. XVI, 1928, pp. 97-108)*, gave a very valuable outline concerning the problem. He states: "It is extremely probable that vein tin ore was used at first to make bronze, originally only in a natural and accidental admixture with copper ore," and he comes to the final statement that the first bronze production took place in Persia.

But if we are trying to localize the place of origin we must concede that such combined ores occurred in three districts:

1. Armenia, particularly at Tillek
2. Middle Germany, Oelsnitz district
3. Northwestern Spain.

The reason why Lucas gives the preference to Persia is motivated by him (p. 107) by saying that the place of origin of bronze can be only: "(d) where there was early commercial intercourse with Egypt." But since bronze appears in Egypt not earlier than after 2000 B.C. it would be possible also that bronze came to Egypt by oversea trade directly or indirectly (via Crete) from the West or Northwest. This opens at least theoretically the possibility that bronze from Western or Middle Europe reached Egypt, because at that time in both places bronze was produced intentionally and both areas had relations with Crete.

The statue of King Pepi (Phiops, VI Dyn) mentioned above can no longer be used as a proof that intentionally made bronze existed in Egypt as early as

2500. The content of tin, less than 3%, is accidentally present in the copper ore. Prof. Cecil H. Desch was kind enough to send me the Reports of the Committee on Sumerian Copper of the British Association (published 1928, 1930, 1931, 1933, 1936). Among the published analysis is a new one of the statute of King Pepi (report 1928, p. 3) showing that no tin is present, the old analysis was wrong. The metal contains a high admixture of nickel.

Copper	Tin	Nickel	Iron	Lead	Sulphur	Arsenic
98.20	—	1.06	0.74	—	0.01	—

Here may be emphasized again that the often cited item of Medum containing 9.1% tin is by no means a sure find. This item was found outside of a destroyed tomb. Here also the grave was completely disturbed and destroyed. Another find, cited as attributed to the VI Dynasty, has no record and we do not know where it was found. Montelius *(Chronology op. cit. p. 147)* consequently and quite correctly eliminates these items. The fact that no absolutely sure finds are known is the reason that these items occur again and again in the literature. Harry Craig Richardson *(Am. Journal of Arch. vol. 38, 1934, p. 555)* cites only Medum and the Pepi statue, but it is no longer possible to operate with them so far as our question is concerned. Accordingly, G. Möller *(Die Metallkunst der alten Aegypter, Leipzig, 1925 pp. 11, 18)*, states that tin appears in Egypt not earlier than during the 12 Dynasty, after 2000. At the same time there appears in Egypt also silver. The same observation has been made in Middle Germany where silver is also found together with the bronze items of P I (site Leubingen, Mus. Halle, Germany and fig. 39.) It is a remarkable coincidence that silver is present also in the El Argar culture of Southeastern Spain. Even during the 12 Dynasty bronze items are very rare in Egypt, as has been emphasized by Montelius *(Ebert's Reallexicon op. cit. vol. II, p. 184)* who for this reason believes that Egypt became acquainted with real bronze only through her connection with Crete where, he claims, the classical alloy was invented. There copper was known since 3000 B.C. A. Evans puts the appearance of bronze in Crete into MMI 2100-1900 B.C. The classical alloy is common in MMIII about 1700 B.C. V. Gordon Childe doubts, and quite correctly, that the Cretans discovered the value of the admixture of tin because tin ore does not occur in the area of the eastern Mediterranean. Witter, summarizing these opinions *(Mannus, 1936, p. 448)*, judges that Crete, since tin-stone is not occurring in this island, acquired the tin from Troy II where bronze is proved to be present in the second city which was destroyed after 1900

B.C. This is according to Henri Frankfort *(Studies on early Pottery, London, 1927, p. 152)*, who claims *(op. cit. p. 144ff)* that the invention of the classical mixture 10%-90% was made at Troy II.

But, to be exact, since the tin content of the items of Troy II fluctuates and only a minority shows 10-12% tin no proof is given of intentionally made chemical alloy. T. A. Rickard *(The early use of the metals, in The Journal of the Institute of Metals, vol. 43, London, 1930, p. 129)*, objects to the analyses published by Dörpfeld (Troy and Ilion) as not correct because they were not made from undecomposed metal.

Childe puts the destruction of Troy II first at about 1900 *(Dawn of Civilization, London, 1927, p. 63)*, but later (1930) changes this to about 2002 B.C. *(Bronze Age, op. cit. p. 19)*. In any case there is doubt that MMI is to be put 2100-1900 B.C., and Nils Åberg *(Bronzezeitliche und eisenzeitliche Chronologie, Stockholm, 1933, vol. III p. 275)* wants this stage to be eliminated completely. But he also sets the date for the destruction of Troy II as late as 1700, influenced by A. Götze *(Kleinasien zur Hettiterzeit, Heidelberg, 1924 and Kulturgeschichte des alten Orients, Munich, 1933)*. Åberg has generally the tendency of pressing down all prehistoric dates extremely; as, for instance, for the beginning of the Hallstatt period he accepts 650 B.C., while about 1000 B.C. is given by such careful scientist as A. Birkner *(Ur and Vorzeit Bayerns München, 1936, p. 98, and also Harry Craig Richardson, Am. Journal of Arch. 1937, p. 443.)*

Geographically the nearest source of tin for both Troy II and Crete was in northern Greece near Delphi *(O. Davies, Mining Cities of Northern Greece, in Journal of Hellenic Studies, vol. 49, 1924)*. Here old tin mines have been discovered which were exploited during the late part of the Early Helladic period which ended 1900 B.C. Slag and crucibles prove that the tin was melted and that buddling was known. Copper might have been imported into Troy II from Hungary where copper with a natural admixture of antimony up to 0,84% was present *(Montelius Chronologie op. cit. p. 180)*. This makes the provenence from Hungary more probable than from eastern Asia Minor. Our map fig. 2 showing the influential range of the boat axe culture, as indicated by the spread of battle axe types of this group, demonstrates that the area around Troy belonged to its influence. These connections towards the Danube valley and Bohemia become still more substantial if we study the indications by the pottery of Troy I and II. C. Schuchhardt *(Alteuropa, Berlin, 1919, p. 211)* has dealt with the similarities of vessels in both areas. Here may be added some further new examples, among which the newly excavated house of Succase, Western Prussia, is very striking, belonging to the latest corded ware of the end of Neolithic Period, Fig. 10. Significant are the connections as illustrated by figures of pigs found in Troy as well as in Bohemia *(Mannus, vol. I, 1909, p. 193)*. To these we add the new pieces found at Stoessen near Weissenfels, Germany (Mus. Halle). Fig. 11. The commercial connection of Troy II with Western Hungary for copper ore offers yet one more consequence. Hungary used tin from the Erzgebirge as v. Miske *(Archiv f. Anthropologie, 1917, p. 253)* has stated. Thus we must also take into consideration the fact that Hungarian copper together with tin of the Erzgebirge (Middle Germany, Bohemia), reached Troy II. By this supposition the list of types of the early bronze age, as distributed over Middle Europe as well as Troy given by Montelius *(Chronologie, op. cit.)* becomes clear.

Italy, so far as tin layers are concerned, we have dealt with above. In the narrow bounds of this paper we can give only the essential points about the Iberic or Spanish peninsula and its connections with the other European countries.

From the description of antique writers we know that besides its rich copper layers, tin layers were exploited—the latter not only from wash outs but in real mines with tinoxyde lodes, which in Galicia and Lusitania occurred in the same area as the copper layers, particularly near Oviedo. *(Strabo, quoting Posidonius, 2nd century B.C., Georgraphy III, II,9, V,11, and Pliny, Natural History, 34,37. H. C. Hoover, Tin Mining in Spain Past and Present, London, 1897, Julius Andree, Der Bergbau in der Vorzeit, Leipzig 1922, pp. 43 and 56.)*

Hubert Schmidt, who was particularly interested in the relations of the Iberic peninsula to the other European countries gave an excellent outline in 1909 *(Prähistorische Zeitschrift, Leipzig, vol. 1, 1909 p. 113 ff)*. The material offered by him is still fundamental *(see Ebert's Reallexikon, Bosch-Gimpera, Iberische Halbinsel)*. At the end of the Neolithic period, just at the climax of the flint technique, copper tools, such as hatchet-blades, chisels, saws, knives, arrowheads, etc. appear. In Portugal, La Palmella near Lisbon is of significant importance, in Spain it is Los Millares in Almeria. The richness of precious materials, amethyst, turquoise, ivory and amber, indicates that they possessed, as a means of trade, a valuable material: copper! The connection with France and England was very intensive so that many forms of graves, tools, and pottery are similar. Hubert Schmidt, therefore, did not hesitate to call the whole area the western European cultural circle, with its provincial modifications. The influence of the Spanish peninsula on the whole western Mediterranean district is obvious. In Northern Italy Remedello, in Sardinia Anghelu Ruju

(Ruyu), in Sicily Villafrati and Stentinello are groups closely related to Palmella and Los Millares. The spread of the Spanish influence of the final Neolithic period is characterized in the best way by the bell beakers which are typical also for the groups in Italy named above.

The bell beaker folk—an extremely short headed tribe—is also the bringer of the metal used for weapons to Great Britain, by the detour of the Rhine valley. In the great beehive tombs in England, Scotland and Ireland no metal weapons occur as in the Iberic beehive tombs which contain copper, in spite of the fact that they are the models for the British graves. The appearance of vase painting in Spain is explained by the spread of the bell beaker folk to Italy where it also appeared under the influence of the East. T. E. Peet used this together with the white inlaid ceramic of Stentinello to show the pre-Mycenean relations between East and West. G. Wilke is going so far as to suppose that copper was first used in Spain and from there became known to the East *(Megalithkultur und ihre Beziehungen zum Orient, Leipzig, 1912; Ebert's Reallexikon, op. cit. vol VII Kupfer p. 191, Kupferzeit)*. Here may be mentioned by the way a word equation he is giving; as we have the root pelecu=Greek: Pelekus=indo-iranean: paracu=babylonian—Assyrian; pilacu=german beil=hatchet, meaning one with a metal blade, so we have sumerian: urud=basque: urraida=copper.

C. Schuchhardt puts Troy II=I Siculic period=earliest Terramara of Northern Italy=El Argar, Spain before 2000 B.C. *(Alteuropa op. cit. p. 213)* following by this Hubert Schmidt. It is a matter of observance made already by Montelius *(Chronologie op. cit. p. 92)* that with the beginning of the metal age in Middle Germany the western influence from the Iberic peninsula nearly disappeared, this in spite of the fact that the bell beaker invasion into Thuringia and Bohemia was just finished. Thus Montelius states as a final result: "before the end of the stone age North (of Europe) and Orient had two connection lines; the western way along the coasts and the southern way, Elbe river valley to Brenner-Italy or Elbe river valley to Asia or Greece by the way of the Danube. The reason of the stop of this earlier south-western connection is the migration of the people of the Rhine Valley, at first toward England and later towards Italy Fig. 3 (as we have no finds on the east side of the Rhine river of early bronze age PIb).

Because the halberd plays an important role concerning the chronology of the first period of the bronze age, it shall be dealt with in more detail. In English literature the word *halberd* mostly is used, but unfortunately this term applied for a special type of the early bronze age is also used for different other forms of axes. (So doing Plenderlieth in C. Leonard Wolley Excavations of Ur. London, Vol. II, 1934, p. 288). Therefore it may be proposed to all archæologists to use the term *halberd* exclusively for the type of Bronze Age PI the variations of which are described in this paper.

Since Sean P. O'Riordain (op. cit.) published a very painstaking paper, including the list of all the finds of halberds (about 275) we may here deal with it in connection with the chronology of Middle Europe only.[1]

The halberd is especially important for the question of chronology concerning the beginning of the Middle European bronze age, for five reasons:

1. Because the connection with Spain became stopped directly at the end of the stone age, after the appearance of the bell beaker and before its modification by intermixing with corded ware style of the Rhine valley into the zoned beakers. Therefore the spread of the halberd from Spain goes further back than the types which illustrate the "Southern way" to the North as Montelius called this route (see above).

2. Because the development of the halberd did not run in the direction as Montelius still believed, namely: origin in Spain; thence spreading Eastward and then Northward, following the "Southern way" but directly North and from there south and eastward.

3. Because we have an unbroken typological series of the development of the halberd from the flint blade to the final stage as ceremonial stick, and because by comparison with other types of the later bronze age we have an approximate estimation for the length of this development.

4. Because during its (IV) fourth step of development a connection with Ireland existed and the technical use of ring rivets was imported to Ireland from Middle Germany, which connection enables us to test the time in reverse direction.

5. Because one of the youngest types is found in a Mycenean shaft grave and we are able from this final point to account backward approximately the date of the beginning of the bronze age in the areas in question.

Let me give now an outline about the range of the halberd and its typological development. In the Iberic peninsula we find its earliest

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[1] Oscar Montelius, Chronologie op. cit. p. 27ff.
Jahresschrift für die Vorgeschichte der sächsisch thüringischen Länder vol. III, 1904; vol. IV, 1905.
Hubert Schmidt, Der Bronzefund von Canena in Prähistorische Zeitschrift, vol. I, 1909 p. 113, and vol. IV, 1912 p. 28.
George Coffey, The bronze age in Ireland, London, 1913.
Monteliusfestschrift, Stockholm, 1913 (Hubert Schmidt).
Gustaf Kossinna in Ztschr. f. Ethnologie, Berlin, 1902, p. 194.
Sir Arthur Evans, The palace of Minos, 1928, Vol. II, part I, p. 167 ff.
Rob. Beltz, Die vorgeschichtlichen Altertümer Mecklenburgs. Schwerin, 1910, p. 155.
Ebert, Reallexicon op. cit. Dolchstab.
S. P. O'Riordain, "The Halberd in Bronze Age Europe" in Archaeologia, vol. 86, 1936, p. 195-321.
George Coffey, Irish copper halberds in Proceedings of the Royal Irish Academy, XXVII (1908-9)
Beringer, Stabdolche aus Niederosterreich in Prehistorische Zeitschrift XXV, 1934.
Marton, Dolchstabe aus Ungarn in Prehistorische Zeitschrift XXII, 1931.

form with a flint blade only in the Southwest, approximately covering modern Portugal (Figs. 12, 18), and in the Southeast only at Malaga and a little further Northeast at Los Millares.

The copper and bronze blades of halberds occur exclusively along the East coast between Malaga and the mouth of Ebro river, here belonging to the El Argar period which is a younger stage than the aeneolithic period to which the halberds with flint blades belong. Figs. 13, 14. It is very significant that two copper blades still of aeneolithic age have been found on the Southwest coast between Lagos and Palos, a connecting link to the East group of the El Argar period. That in Almeria two flint blades only have been found, demonstrates the migration as being coincident with the transition from stone to metal.

There in the Southeast (Almeria) the full halberd with a bronze blade developed. Hubert Schmidt unhesitatingly derived the type of halberds represented by rock carvings in the Ligurian Alps (Fig. 15) from those in the Southeast of Spain. He may be right, but there another consideration is possible also, as we shall see later. The Ligurian rock carvings of halberds are so naturalistic that we even can say definitely that they belonged to our group IV. (But it could be possible that they represent a type with bronze shafts, our group V.)

According to Hubert Schmidt (Seminary 1919) the halberd spreads from this area to Thuringia, following probably the Rhone and Rhine

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List of halberds found in the Iberic Peninsula
By courtesy of Prof. Bosch-Gimpera, Barcelona

I. Portuguese sites of flint blades:
Orca dos Palheiros
Casal da Serra das Alhadas
Dolmen de Cabecinha
Alcobaca
Villas do Niza
Garrovillas
A Casa da Moura
Serra das Mutelas (Torres Vedras)
Monte Abrão
Folha das Barradas
Granja do Marquez

II. Spanish sites of flint blades in the Southeast
Malaga
Los Millares

III. Sites of copper blades of the aeneolithic period (southwest between Lagos and Palos)
Alcala
Marcella

IV. Sites of copper or bronze blades of the El Argar period.
El Argar, Fuente Alamo, El Officio, Guadix } Almeria
Alicante, Cabanes } north of Almeria
Roufeiro, Alto da Pereira (Vimioso) } North West along Spanish Portuguese border.

For all other countries the sites are given after S. P. O. Riordain (op. cit) site Göding (Much, Kupferzeit p. 105) Moravia is not mentioned there.

valleys; thence, from Frankfort on Main, following the old trade route to Middle Germany which is represented today by the main railroad line Frankfort-Halle. Many groups followed the same route, as for instance the neolithic Rössen pottery from Middle Germany to the Rhine or, reversed, the bell beaker. Here in Thuringia, as part of the Aunjetitz culture, now a new development took place, leading to new types which spread from there northward as far as Southern Sweden (Skåne) and eastward as far as Kovno (Kaunas). (Compare Fig. 16 for the distribution.)

From Spain the halberd spread still in another direction, going to Ireland by sea. From Ireland the halberd reached Scotland on the one hand and on the other Southern England. A contact between Ireland and Middle Germany is proved by the appearance of typical Middle German ring rivets in Ireland. These ring rivets are totally absent in Spain.

The few pieces found in Moravia, Switzerland, Italy, Hungary, Mycenae and Amorgos are imports from Middle Germany, as indicated by the typological study.

The typological development of the halberd is without any gap, therefore a very dependable relative time scale.

I. Oldest stage fig. 18
  Flint blades attached to a wooden shaft:
    All sites in Portugal
    Only two in Almeria
    Aeneolithic period

The shafting notches below the broad basis are very characteristic and leave no chance for misinterpretation as being real dagger blades. The real dagger blades have no notches.

II. Second stage (Fig. 19)
  Blade of copper attached to a wooden shaft by peg rivets:
    Southwest of Iberic peninsula between Lagos and Palos
    End of aeneolithic period
    Southeast in Almeria
    El Argar period
    Ireland

III. Third stage (Fig. 25)
  Bronze blades attached to a wooden shaft by peg rivets:
    Southeast of Spain, North Portugal, Liguric Alps(?), Ireland, England, Thuringia
    P. Ia b of the bronze age

The dagger blade and the blade of the halberd are mostly easily distinguishable. On the halberd the marking line of the shaft is straight,

sometimes a little slanting, not completely rectangular to the axis of the blade, but on the real dagger blade it is marked as a curved line from the hilt.

IV. Fourth stage (Fig. 21)
  Bronze blade becomes attached by typical ring rivets:
    Fig. 20
    Middle Germany—Ireland
    P. Ib. (Kossinna division)

The Irish pieces with ring rivets cannot be imagined without connection with Middle Germany, because they were developed here. (*Montelius, Chronologie op. cit. Fig. 112-114.*) The existence of such a connection of exchange is proved among other examples, for instance by a typical Irish hatchet blade found at Weimar, Museum Halle (*fig. 203 Montelius, Chronologie op. cit.*)

V. Fifth Stage (Fig. 22, 23, 24)

The bronze blade becomes attached to a shaft which is either partly of bronze, or both ends of the shaft are of bronze with a wooden piece between, or the shaft is completely cast of bronze. The link between the latter two are finds like Schmöckwitz (Fig. 23), where the wooden middle part is decorated with a number of metal rings. Now the ring rivets become mere decoration and are no longer used technically to fasten the blade to the shaft. (Figs. 26, 27)

P I b }
P I c } (Kossinna division)

Furthermore three local variants develop which were first distinguished by Kossima (*Zeitschrift für Ethnologie 1902 p. 194*).

IVa
  Halle-group (area around Halle on the Saale river)
  The neck or back of the shaft above the blade is curved (Figs. 22, 27)
  They belong to the depots of period Ib-c

The rock carvings in the Ligurian Alps are probably of this type, which therefore might be assumed as having been introduced to Liguria from Middle Germany. The appearance of the halberd in Middle Germany could be the result of a connection with Ireland. The acceptance of the ring rivets by Ireland would then represent a throwback, an exchange, as so often observed in prehistory. In any case the interpretation of these four discussed ways: either (1) from Spain through the Rhone-Rhine valley to Middle Germany or (2) from Ireland to Middle Germany or (3) from the Ligurian Alps to Middle Germany, or (4) from Middle Germany to Liguria has the same effect, seen from the chronological point of view. The fact that the halberd of the Ligurian Alps are sometimes pictured with a bronze ring on the end of the shaft Fig. 15 makes this supposition much more probable than that of Hubert Schmidt, because on the ends of the bronze shafts of type IVa, Vb, Vc, we observe at different times perforations in which originally were fixed metal rings.

Vb

North German group

The neck above the blade becomes triangular and pointed (Fig. 23)

Range: between Elbe and Oder, Provinz Brandenburg, Mecklenburg, South of Sweden (Skåne).

Vc

Poznan group (Posen Gruppe)

Neck completely straight (Fig. 24). Blade and shaft are mostly cast in one piece.

Range: east of the Oder, reaching as far as Kovno (Kaunas, in Lithuania)

By the comparison of many thousands of items of the bronze age in the North, Montelius arrived at a division into 6 periods. He has demonstrated *(Tidsbestänning op. cit.)* that the types changed in a run of about 100 years each. Every period includes only 2 or 3 types overlapping in typological sequence of the same series as he has shown on bronze vessels, fibulae, swords, necklaces, bracelets, shaving blades, knives, etc. Consequently we can by no means suppose a faster development in the beginning of that era, Period I. If we suppose 50 years each for the development of the Halle type, North Germany type, Poznan type (which we now know is too short) then we arrive for the Halle type at about 1800 B.C.

Let us now take Mycenae as the final point. Here as Hubert Schmidt *(Prähistorische Zeitschrift, 1912, vol. IV, p. 35)* emphasized, an inherited piece of a halberd, brought to Greece probably with the Mycenean immigrants coming from an area around Hungary, was deposited in shaft grave VI (Fig. 28). From seals of the 18 Dynasty of Egypt, the whole group of graves is dated to about 1550 B.C. Let us suppose that this halberd, used as "baton de commande" as a sceptre like symbol, was used by the Myceneans only for 100 years, then it arrived in Greece at 1650 B. C. Adding the 150 years from the last 3 types we come to a time of at least before 1800 B.C. But the connection with Ireland-England teaches us that we must go further back, because according to V. Gordon Childe's chronology we come for the ring rivets at least to a time about 1900 B.C. since he puts the beginning of the Bronze Age there about 2000 B.C., contemporary with the beginning in Bohemia. *(Bronze Age op. cit. p. 12.)*

- According to Georg Karo *(Die Schachtgräber von Mykenae, München 1930-33 p. 258)* shaft grave VI in which the halberd is found, represents the oldest burial of the graves in the ring which he puts in the time 1550 B.C. He came to this result by studying the pottery which is a very sensitive indicator. On p. 334 he opposes Nils Åberg's *(Bronzezeitliche und früheisenzeitliche Chronologie vol. III, Stockholm, 1932 p. 113ff.)* chronological establishment as being too low.

The type of halberd represents a very late one. The asymmetric blade is characteristic, typical also for blades with cast bronze shaft. The same form occurs in England *(Kemble, Horae ferales pl. X, 4,5)* and Germany. The halberd from the VI shaft grave shows a particular development, with a tang, indicating a late quaint step in the same way as the piece found in Hungary shows another late development, having the socket cut off at the end slanting in prolongation of the edge of the blade, Fig. 29. Very important is the presence of ring rivets which are completely the same as in Middle Germany; that their decorative purpose is more emphasized, since they are made of gold. Consequently Hubert Schmidt concludes that the original halberd type must have been developed about 2000 B.C. *(Prähistoriche Zeitschrift, vol. IV, 1912, p. 36.)*

In order to be complete it may be mentioned that in shaft grave II a triangular dagger has been found *(Karo No. 217 op. cit.)* of a type similar to PIc in Middle Europe; Karo states that its form is strangely archaic and singularly and widely different from all the other dagger types found at Mycenae. During the Mycenean epoch we find at different times iron decorations, small rings; Montelius mentions five pieces *(Chronologie op. cit. p. 169)*. But this means only that iron was theoretically known and gives no reason to talk about technical progress and to super-estimate the occurrence of iron. In the same way even in the Mycenean epoch stone tools were still used. For instance in the grave ring of Mycenae, shaft grave IV contained 35 arrow heads made of flint stone *(Karo op. cit. pl. Ci, No. 536-540)*, showing that here the same happenend as in Northern Germany and Scandinavia, where until the end of Bronze Age P III flint arrow heads were used. (See chart Fig. 4.)

We followed in our estimate the date given by G. Karo in his work "Die Schachtgräber" *(op. cit.)*, but we want to mention that he later on in 1933 *(in Pauly's Realenzyklopädie der Klassischen Altertumskunde; Mykenai p. 1017)* puts the shaft graves of which VI is the oldest in the time 1570-1520, so that our statement is rather too low than too high.

Sir Arthur Evans *(The Palace of Minos, London, 1928, vol. II, p. 171)* distinguishes two types of halberds on the rock carvings, following thereby Colini

(Bull. di Paletnol. Ital. XXV, 1899, p. 301). The older type has the semicircle behind the head of the shaft (Figs. 15, 20), and the more developed type has a straight line shaft, (Fig. 30). The latter may perhaps represent our type Vb with bronze shaft, since the spread of the halberd started from East Germany (Silesia) as shown in our map (Fig. 16). Evans connects the Mycenean halberd with Ireland (p. 173), but contrary to this the ring rivets connect it with Middle Germany. The same direction is indicated by the amber beads of the shaft graves and the flint arrow heads which are of the same type as in Middle and Northern Europe. The double axes of copper found in Middle Europe point in the same direction (Fig. 32). Very often the conclusions are overlooked which are to be drawn from the amber trade. During the Neolithic we have finds of amber in the whole range of the North-Indoeuropean group (Megalithic groups, corded ware, boat axe culture), but not further. Only after the dissolution of the Aunjetitz block, amber trade spreads again southward and reaches Greece. The interruption of amber export by Aunjetitz shows also that Mycenae is post Aunjetitz chronologically.

The beaker of Nienhagen has also a similar form of handle as the Vapheio beakers (Fig. 31). This Nienhagen handle is often used to force down the chronological estimation of Aunjetitz. I had an oral discussion with Moetefindt who published this item *(Jahresschrift op. cit. vol. X, 1911, p. 77)* because in reality this find is an uncertain one and its attribution to Aunjetitz is only done because other graves nearby belong to this group. I interpret the Nienhagen handle absolutely in another way. At Egolzwil, Switzerland, H. Reinerth excavated beakers carved out of wood, now Mus. Luzern, which show that the form of the cup in wood is nearly the same, and that the wood carved handle starts from the bottom of the cup in the same way as Nienhagen only that we have in Egolzwil a simple plug, at Nienhagen two which are connected at the end by a cylindrical piece. This is not, as every time emphasized, a metal form but a form of wood carving. In other words Nienhagen represents a wooden model imitated in clay for a later metal form. The secondary position of the metal handle is given by the fact that it is no longer attached to the bottom but to the upper rim of the body. Åberg uses this piece of Nienhagen to force down the time of the Aunjetitz culture and puts in 1936 *(Vorgeschichtliche Kulturkreise in Europa, Copenhagen, p 21)* Troy II after 1550 B.C. parallel to his estimation of the Mycenean shaft graves, which G. Karo, as we saw above, opposed to as being too low.

These explanations were necessary because the find of Mycenae very often is used wrongly to force down the beginning of Middle European

bronze age. We gave here only the "ante quem" date and it would not be impossible to prefer a higher estimation because type Halle IVa appears not earlier than in the depots of PIb (Kossinna). Thus the following chronology of the halberd gives in the same way a dating of the beginning of the Middle European Aunjetitz bronze age.

2500 B.C. Type I flint blade } Iberic
2300 B.C. Type II copper blade } peninsula
2200 B.C. Type III bronze blade } } Ireland

Middle Germany

1900 B.C. Type IV ring rivets

Middle Germany———Ireland
|
IVa Halle type

Type V bronze shaft————Liguria

1850 B.C.
|

1800 B.C. Vb North German type

1750 B.C. Vc Poznan type

Hubert Schmidt emphasized the sterility concerning new forms and types after the beginning of the bronze age in Southwestern and Southeastern Europe. According to him, the Aunjetitz pin (fig. 33) was created in Bohemia (seminary 1919) whence spread to Troy and Cyprus, in a variation even to Egypt; the pin with loop *(Zeitschrift für Ethnologie, 1904, p. 625)*, occurs earlier in the Aunjetitz area than at Troy, and concerning the "hanging spirals" he states (ibid) that "the Mediterranean range was the receiving part." (Fig. 33.)

Oscar Montelius was particularly impressed by this sterility in technical respect, because he naturally expected a reversed situation. Thus he summarizes this question *(Chronology op. cit. p. 102)*: "The typological study of the bronze hatchets (celts) reveals a big difference between Orient and Europe. The flat hatchet blade was kept in use throughout the whole bronze age in the Old Orient. But in Europe an interesting development started very early (as we have seen: hatchets with flanges, wings, stop ridges, sockets, etc.) In those countries where the Oriental influence was stronger, we find exclusively flat blades. . . . Spain and Britain therefore are persevering on the flat hatchet, only flanges appear, and under the still stronger influence of the Orient Greece kept fully the flat hatchet." (p. 208.)

The development of the main tool, the hatchet being necessary for any kind of carpenter work and loghouse building, is exclusively a technical one. But the invention of bronze, the study of the quality of the different alligations is also a technical question. I had occasion to show that the methods of casting in Middle and Northern Europe were much more developed technically, as variety of applied methods is concerned, than in the South, particularly in the first half of the bronze age. *(Lechler, Vorgeschichtliche Bronzetechnik in Norddeutschland, in Zeitschrift für Metall-Kunde, vol. 26, 1934 p. 256.)* As late as with the beginning of industry of bronze vessels in Middle Italy an equality in technique is reached. All this is said because we must face the true situation if we will come to a fair judgment.

Therefore the general result of our research made above is, that the old statement of Montelius about the coincidence of the beginning of the bronze age in Middle Europe and Italy is a correct one. He only supposed, to use his own words, "a priori" an advantage or start of the south. But technical and cultural level are not necessarily the same. Thus the Indo-Europeans penetrating Asia Minor showed a superiority by the use of horse chariots as special military weapon, as the substitute for our cavalry. Summarizing we must state that in Troy and Crete, Egypt, Italy and Middle Europe (Aunjetitz) the intentionally made bronze appears at the same time. That cannot be accidental. To a very high degree we have to account with a spread from Thuringia-Bohemia (Oelsnitz).

Now the research workers in Mesopotamian archæology will seriously object and claim that the whole situation is different, because intentional bronze appears in Mesopotamia as early as 3300 B.C. Let us now analyze their case. As said before, we had three possible centers for the origin of bronze. With the one of the Iberic peninsula we dealt shortly, because here, in the first part of the bronze age there is a typological sterility which almost excludes this possibility. Therefore we dealt with Middle Europe to show that here was an indigenous transition from copper to bronze, and that the objection generally made that the beginning of the use of bronze in this area is later than elsewhere, is erroneous. So we have to talk about the third center in the Near East.

On the added chart, Fig. 4 all the chronological facts are put together, in order to give a clear conception of the situation in Middle Germany-Bohemia and northward therefrom.

The problems concerning the question of origin of bronze in the Near East are discussed, between Madam Hertz and Harry Craig Richardson in the American Journal of Archæology *(vol. 1937, p. 441)*. Opposing Mr. Richardson's supposition of an origin of the bronze in Europe Madam Hertz says: "Mr. Richardson has carefully omitted the bronze implements

from the great Royal Necropolis of Ur and from the older strata at Kish. As even Prof. Weidner and Christian do not place the Royal Necropolis of Ur later than 2600 B.C., I find it absolutely impossible to admit that the knowledge of bronze passed from Europe to Asia and not in reverse direction (p. 441)—The explanation of Prof. Gordon Childe that the Sumerians ceased to cast copper because they had no bronze is for me incomprehensible (p. 443)." In fact this quotation includes the whole problem. In the graves of Ur "bronze" tools are found, thus many scientists suppose that bronze was known to the Sumerians since 3300 B.C. in which time Woolley puts the graves. Prof. Cecil H. Desch in Teddington, England, was so kind to send me the Reports of the Committee on Sumerian Copper of the British Association in which the complete analyses are published showing that the content of tin is very fluctuating from 0 to 20.2%. More than a third of the analysed items do not show tin. Then later the Sumerians lost this knowledge because the next finds of bronze are not earlier than of Sargonic age, about 2500 B.C. But even the publication of the excavations gives space to the consideration that there is no reason to talk about intentionally made bronze.

H. J. Plenderlieth writes, citing T. A. Richard's authority in metallurgic questions *(H. J. Plenderlieth, Metals and Metal Technique in Woolley, Ur Excavations, London, 1934, vol. II, p. 288)*. "Dr. Richard has expressed the opinion that the ores were not smelted at Ur at all—'a fluviatile region devoid of mineral resources.' He considers that the metal came from somewhere in the upper country of the Caucasian highlands. As regards the early 'bronzes' he considers that the variability in the tin content is so great as to indicate inadvertency, the inference being that tin was an accidental constituent of the ore melted." In fact the analyses show big differences, so that at least the statement is justified that the alloy was not intentionally used at the time of the graves in question.

The last paragraph of the quotation of Madam Hertz directs the attention to the chronological problem. It would be really very strange that for a space of about 700 years the Sumerians should have ceased to have the knowledge of bronze merely because they were cut off by hostile tribes from the areas where tin was available to them. The solution is rather that the chronology of Woolley is not justified on the one hand and that on the other hand the bronze of Ur was no bronze in the sense of intentional making. In fact Profs. Weidner and Christian oppose the chronology of Woolley as being taken far too high and they accept 2600 B.C. as a preferable date. As Oswald Menghin kindly wrote to me, V. Christian is just finishing a comprehensive book about the Mesopotamian excavations, in which book he will deal with these chronological questions in full detail. Henri Frankfort, basing upon new excavations, puts in 1935 the Royal Cemetery between 2700-2560. (Oriental Institute Communications No. 20, Chicago, 1935.) In a friendly manner he referred me to his discussion concerning this question in the Journal of the Royal Asiatic Society for 1937, p. 330-342. The Royal Cemetery is Pre Sargonic, but it begins in the last part of the Early Dynastic period. This Early Dynastic period is preceded by the Jemdet Nasr Period which can not be placed much before 3000-3100 B.C., since it is contemporaneous with the Late Predynastic period in Egypt from Sequence Date 63 onwards. Henri Frankfort accepts the dates fully proposed by Scharff (Grundzüge der Aegyptischen Vorgeschichte) who places Zozer about 2780 and the first Dynasty about 3000 or just before that date. He wrote to me concerning Mesopotamia, that he has the impression that the occurrence of tin, zinc, antimony and other metals together with copper is rather erratic and that it is difficult to say when bronze was consciously produced in preference to copper. He says this might have happened before 2200 B.C. Accounting in this way we come closer to the date found for Bohemia, Thuringia.

If we accept the possible date for Sargon I with 2525, then we come for the Royal Necropolis practically down to a time until about 2550 B.C. This again fits to communications as given to me courteously by Emil Forrer who wrote to me, that the oldest texts known to him concerning the allegation of tin and copper, which texts expressly mention the percentage of the necessary admixture of tin, belong to the time of Urukagina of Lagaš whom he dates about 2450 B.C. About 2000 B.C. the old Assyrian merchants of Asia Minor distinguished different kinds of "mixed copper" which they named from two cities, Haburata mixture and Tismurna mixture. E. Forrer who gave me this information, locates these cities in the East of Asia Minor. He told me also that it is very strange that the "lead" being spoken of, is very high in price in relation to silver being 6 to 1 up to 16 to 1. The natural ratio would be 65 to 1. He believes therefore that the "lead" means also tin. The documents prove that about 2000 the merchants traded intensively in tin, but Forrer does not believe that their trade connections reached further than Asia Minor itself.

Tinstone does not occur very often in the Near East. In Persia we have a number of smaller places *(Stahl, Handbuch der regionalen Geologie, Persia)*. Strabo XV chapt. II, 10 mentions that at his time tin was exploited in Drangiana which is located at the west border of Afganistan. Fischer *(Neues Jahrbuch für Mineralogie, 1882 vol. II, p. 91)* mentions tin mines in Khorasan, Montelius *(Chronologie op. cit. p. 201)* names

Kastamuni as an important place of tin. But Emil Forrer writes me that the best expert concerning this area, R. Leonard *(Paphlagonia, 1915, p. 318)*, denies expressly the occurrence of tin at Kastamuni. As a text published by Emil Forrer *(Keilschrifttexte von Boghazköi IV I BO 2010 obr. 93/40.)* shows, the Hittites obtained copper from Alasya (Cyprus) and tin from the mountain Daggata or Taggata. He tells me that at the foot of Mysian Olympus, a city Daguta is situated, but he doubts that the Hittite text makes reference to this place, since we do not know whether tin is occurring there. Therefore he gives preference to the mount of Dudjik where tin and copper ore occur in the same layers.

Quiring *(über die älteste Verwendung und Darstellung von Eisen-und Stahl in Technikgeschichte vol. 23, 1933, p. 34)* locates for the Near East, the area where bronze could have been invented accidentally by melting tin containing copper ores, in the district of Tillek on the Upper Euphrates (western branch). It is the area where the mount of Dudjik is situated. Here tin lode occurs together with malachite. I. G. Taylor pointed to this site as early as 1868. *(J. R. Geogr. Soc. 38, 1868 p. 339)*. This area would be the place wherefrom the Sumerians could trade the material for their copper alloys. By the way, Quiring states further that in the same way as bronze could originate only in such a district with combined copper-tin ore, thus also iron production could start only in a district where copper was mined and where iron ore was present. This is the situation in the Alps of Middle Europe and in Asia Minor (see map Fig. 34) and really we find both areas being the centers of the earliest iron technique.

The added map, Fig. 34 after Quiring, gives the areas where copper occurs, thus it is not necessary to go into further discussions. A. J. Plenderlieth *(op. cit. p. 287ff)* gives an outline of the copper mines of the Near East. But since the analyses of the Sumerian copper alloys of Ur contain nickel, and hundreds of ore examinations from different sites in Armenia and Persia were negative in this respect, it was possible to locate the region where the copper came from. The Sinai mines could not be the source because here nickel is accompanied by manganese.

As Harold Peake *(Antiquity II 1928, p. 456 ff)* pointed out, in Oman on the Persian Gulf at Jabal al Ma'adan in the Wadi Ahin, inland from Sohar, Arabian peninsula, ores were exploited in old times which contained nickel in corresponding percentage to the copper alloys of Ur. Here in this area of Northern Arabia are different places where copper with nickel occurred. Texts from the time of Sargon I *(Keilschriftexte aus Assur, 1920, No. 92)* mention that he conquered "Dilmun and Maganna countries beyond the Lower Sea" and Naram Sin and Gudea imported from there, from the mountain Magan, diorite for statues. Thus Peake summarizes: "It seems almost certain that from the earliest times down to the days of the first Babylonian Dynasty, the Sumerians obtained their copper either from Jabal al Ma'adan or Jabal Akhdar or from some place not far from either, and so not far from Makanyat and that this district was known to them as Magan."

All these observations fit together very well. Therefore about 2500 B.C. the copper alloy used by the Sumerians came from the Persian Gulf. Real bronze could have occurred in the Tillek district, intentionally made, where tin and copper are found together. The Mosaic from the Royal Necropolis of Ur proves that the Sumerians received mules completely equipped with bridles as tribute paid by people living in the North of Mesopotamia. *(Eckhard Unger, die Bedeutung der Könignecropole from Ur für die Vorgeschichte, in Vorgeschichtliches Jahrbuch vol. IV, 1936, p. 6.)* This shows that enough connections were present to justify the supposition that the knowledge of intentional copper alloy came to them from the Tillek area.

The Indus valley will not bring a clue toward the invention of bronze, since here the facts are not different from the situation in Mesopotamia. Before 2000 B.C. (2500-2000) the copper tools contained tin from 0.1 to 11%, consequently the mixture is very fluctuating and not intentional. *(Witter in Mannus, 1936, p. 446.)*

As Wilhelm Witter wrote to me, he is just finishing a second book about the origin and production of copper and bronze in the Near East and the Antique World, he asks me would I be willing to take care of an edition translated into English. Witter stands to his opinion as a result of his detailed research, that also in Europe the production of copper started before 3000 B.C. and that the copper alloys containing 2 to 6% tin are used in Middle Europe as early as 2500 B.C. This is not in accordance with the present chronological system used for Europe. But naturally we are not in the position to give more than estimations. In any case our research concerning the dagger axe has shown that Bronze Age Period PI b/c can not be later than 1850 B.C. In other words the question is now how long lasted in Middle Europe the period from the use of pure copper to the impure copper and alloy up to 6% tin including Period Ia/b. By pollen analysis we may come to a good subdivision of the bronze age as we did of the mesolithic period.

The other problem is the following: did Middle Europe come independently to the invention of bronze and the Near East also (where the step by step transition until now is not established by archæological observations), or is there a connection and did the knowledge of bronze spread from Middle Europe to the Near East? Our chart Fig. 35 gives an outline over the metallurgic development.

At the end it may be said that Hubert Schmidt *(Praeh. Zeitschrift, Vol. IV, 1912 p. 28)* has shown that in the Near East there existed a weapon similar to the halberd. He based this upon one representation on a seal of Gir-nun-ni of the first Dynasty of Ur (Fig. 36). We add here another seal from the near East (Fig. 37). At Ur are found a number of similar weapons (Fig. 38) which show that this type was more common than usually believed. They all are obviously shafted by a socket at the bases of the blades but never by rivets. This coincidence shows that in early neolithic times a type of flint "dagger" might have existed through the whole of Europe and the Near East, shafted like an axe, wherefrom we have in Spain the development of the halberd, and in the Near East a similar looking daggerlike blade equipped with a socket at the base of the blade to hold the shaft like an axe. The material is not abundant enough that we are able to say something about the possible connection with Europe. But in any case it is noticeable that we have in Liguria (Fig. 40) rock carvings similar to Figs. 36, 37 and that in Hungary a halberd with socket (Fig. 29) is found.

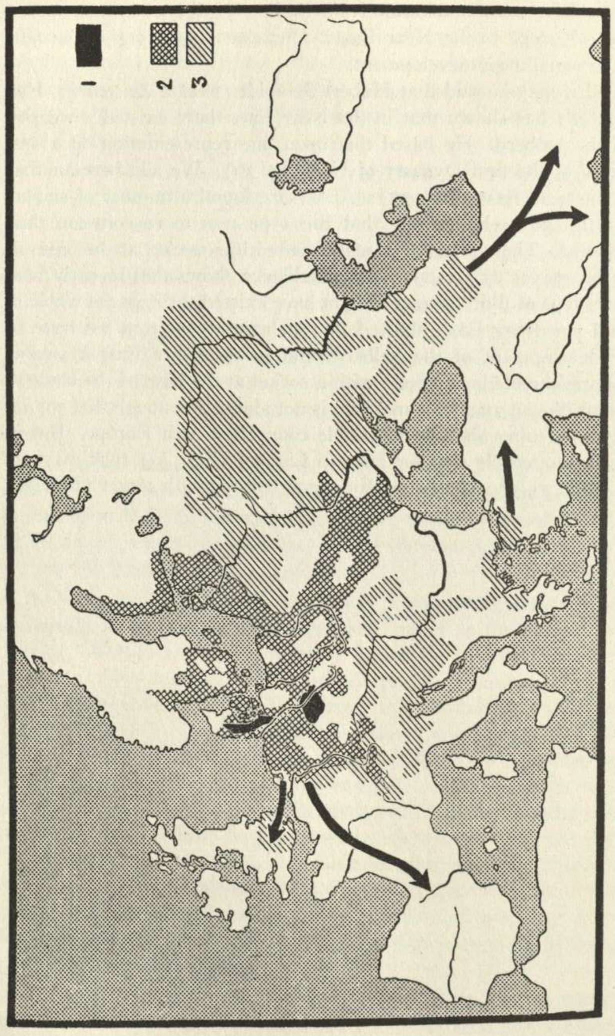

FIG. 2. Range of corded ware and boat-axe culture (after Reinerth).

1. Original centers
2. First expansion
3. Final spread

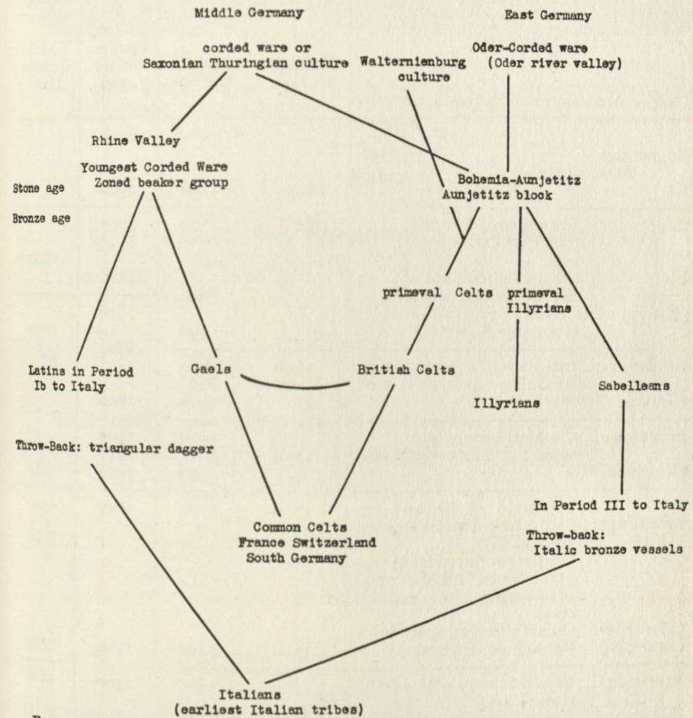

FIG. 3. Relations of prehistoric tribes and cultures second millennium B. C.

FIG. 4. CHART OF METALLURGIC DEVELOPMENT IN MIDDLE AND NORTH EUROPE.

	Chronology: Montelius	Kossinna	Lechler	Åberg
	Northern Europe	Middle Europe	Middle Europe before 2200	Middle Europe Italy
Copper decorations in different neolithic groups — Neolithic period		2300	2200	
Copper age Pure copper I a	Stone	−2100	2000	
Copper age: Impure copper from oxidic or carbonatic ores I b accidental content of tin, antimony, arsenic (Kossinna PIa bronze age in Middle Germany-Bohemia)	age	2100 Bronze age PIa 1900	2000 Stone age 1900 1900 PIa, b	1600 1600 PI
Bronze age: Intentionally made artificial alloy silver, gold, tin (Kossinna PIb)	1800 Bronze age P I	1900 PIb 1800	1800	
Bronze age: Classical bronze typical 10% Sn 90% Cu alloy (Kossinna PIc)	1500	1800 PIc 1750	1800 PIc 1600	1350
Bronze age: P II — Invention of bellows (in Mitterberg district Austria 1600 B. C.) Copper produced from copper pyrites, sulfidic ores. Preroasting of sulfidic ores. (Montelius, (Kossinna) Oldest iron find (ring from Vorwohlde, Hanover)	1500 1300	1750 1400	1600 1300	1350 P II 1200
Bronze age: P III — Bronze mostly with admixture of lead (Montelius, (Kossinna) First appearance of iron in Zealand and Bornholm. Flint arrow heads used until the end of P III.	1300 1100	1400 1150	1300 1100	1200 P III 1000

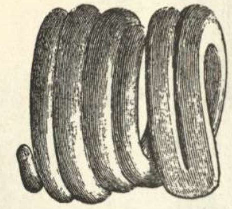

FIG. 6. Napring of pure tin found at Baarse, Zealand, Denmark.

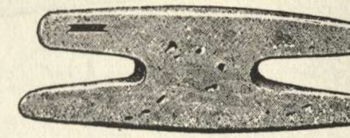

FIG. 7. Ingot of tin, found in the harbor of Falmouth, England (Montelius, Chronologie op. cit. Fig. 510)

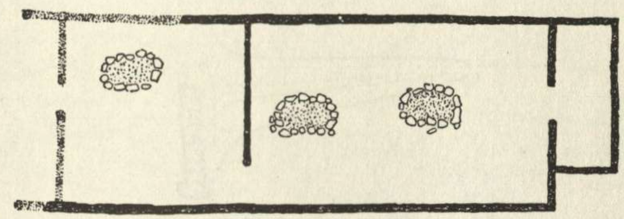

FIG. 10. Ground plan of the house at Succase, East Germany, corded ware. The plan is identical in the arrangements of the doors with the megaron of Troy II. (Germanenerbe vol. I, 1937, p. 8)

FIG. 12. Flint blade of a halberd from Garrovillas, Portugal. (Monteliusfestschrift, p. 73)

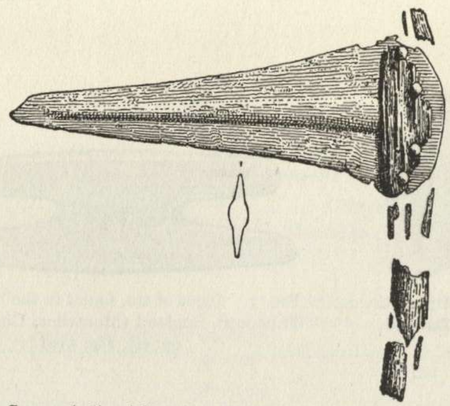

FIG. 13. Copper halberd found at El Argar, near Almeria, Spain, with parts of the wooden shaft. (Siret, Les premiers ages du metal, p. 32.)

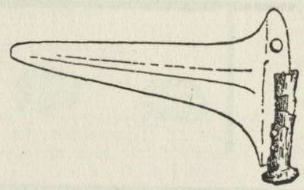

FIG. 14. Copper halberd, El Argar, near Almeria, Spain. (Montelius, Chronologie op. cit. fig. 535)

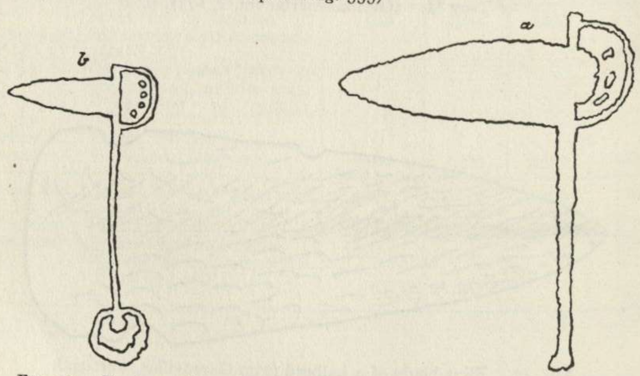

FIG. 15. Rock carvings of halberds. Val Fontanalba, Ligurian Alps. (Montelius Chronologie op. cit. fig. 499b)

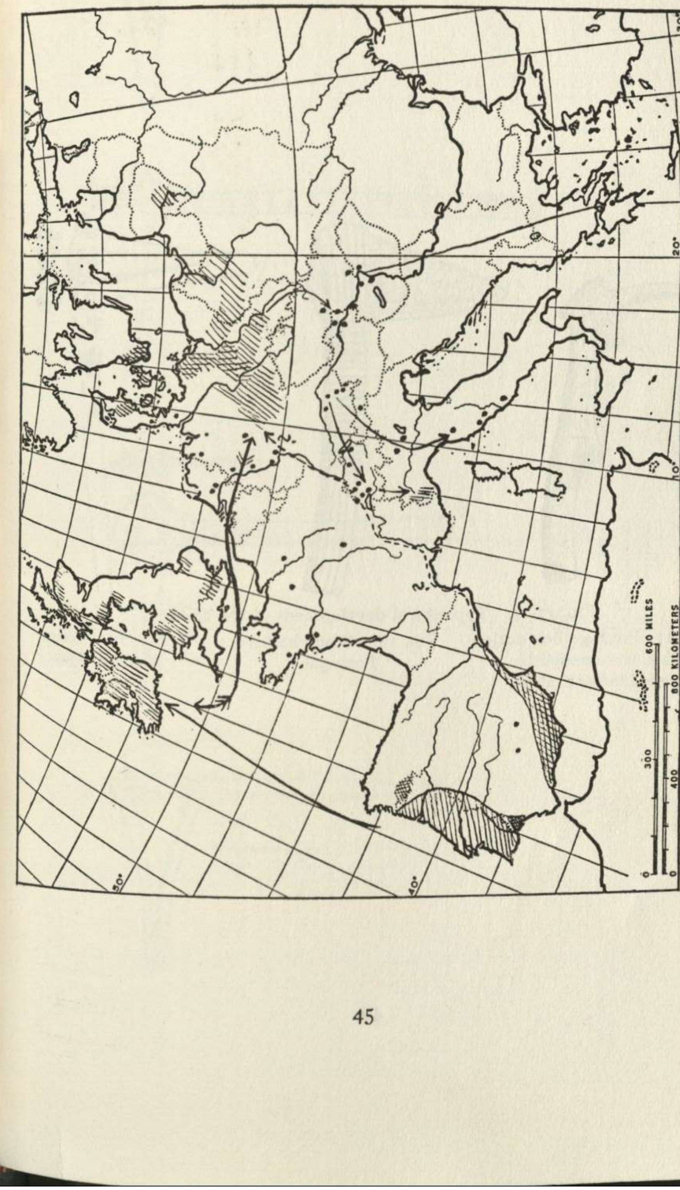

FIG. 16. Map of the range of the halberd. The arrows indicate the connections as supposed by the author.

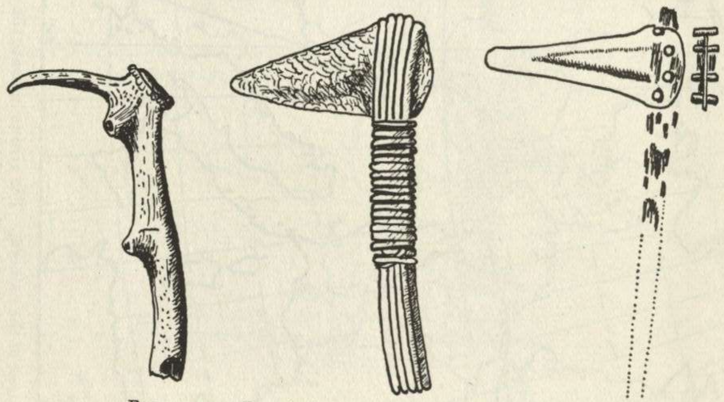

FIG. 17-24. Typological development of the halberd.

FIG. 17. Prestage, deer antler pick, since mesolithic period (after Coffey). FIG. 18. Stone halberd, Portugal. FIG. 19. Copper halberd, Spain.

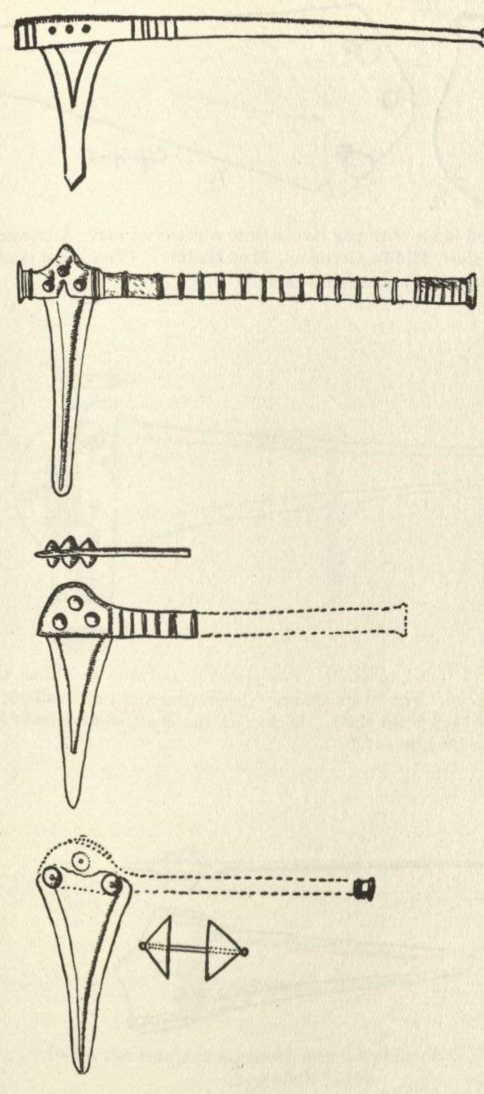

FIG. 20. Bronze halberd, Middle Germany.
FIG. 21. Ring rivet belonging to Fig. 20.
FIG. 22. Halle type, shafthead of bronze (Canena).
FIG. 23. North German type, shaft partly bronze (Schmöckwitz)
FIG. 24. Poznan type with bronze shaft (Kaunas).

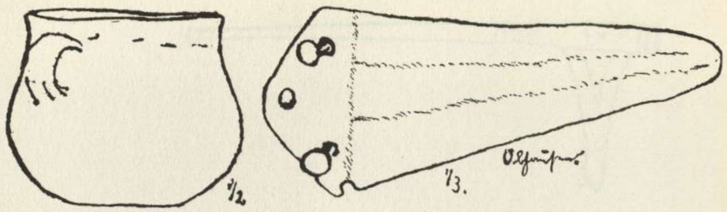

FIG. 25. Halberd blade with peg rivets from a grave of early Aunjetitz type (Obhausen, near Querfurt, Middle Germany, Mus Halle). (The vessel represents still the "pre-Aunjetitz type", after Winkler.)

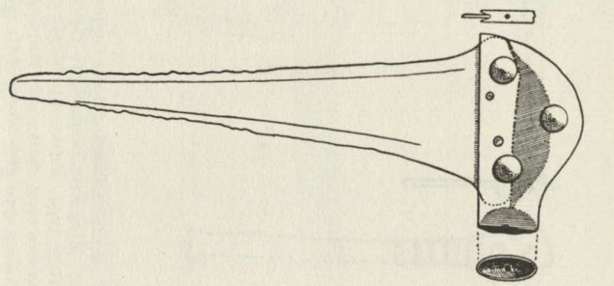

FIG. 27. Halberd found in Halle (Yaegersberg) showing the same kind of fixing the blade as fig. 26. The rivets are only decoration and two small peg rivets keep the blade on the head of the shaft. Socket of the shaft was originally longer. (Praehist. Zeitschrift, 1909, p. 121.)

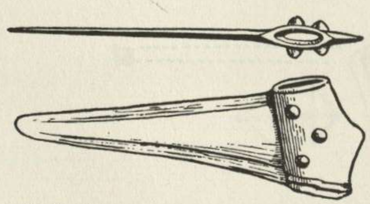

FIG. 29. Halberd found near Hont (now Checkoslovakia) Mus., Budapest.

FIG. 30. Rock carving from the Ligurian Alps (Evans op. cit. vol. II, part, I fig. 85b)

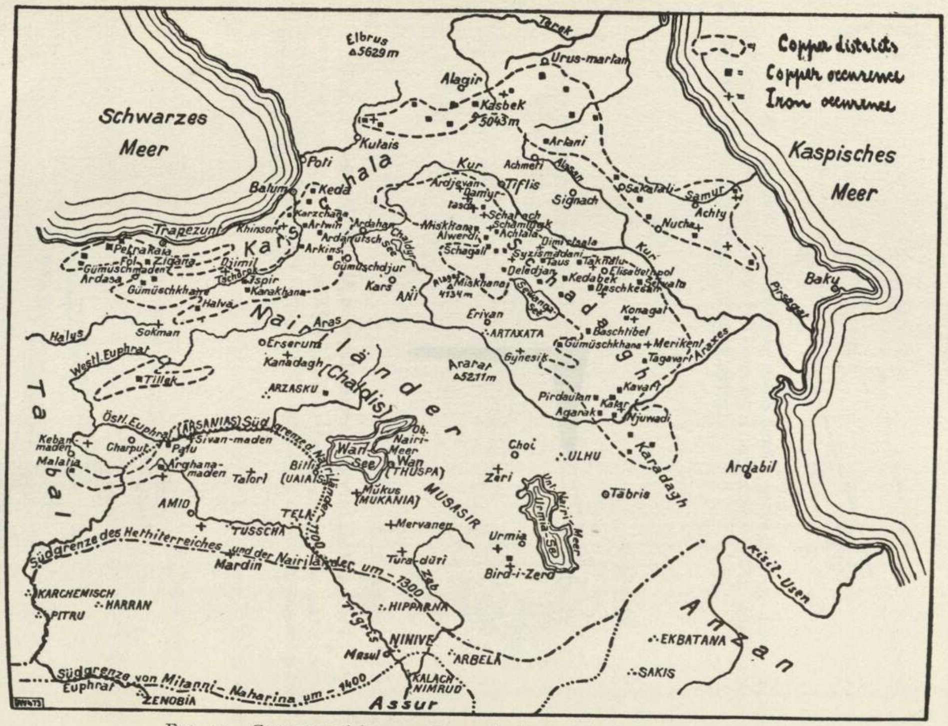

FIG. 34. Copper and iron ore layers in the north of Mesopotamia, showing the Tillek district where copper occurs together with tin. (After H. Quiring).

FIG. 35. CHART OF METALLURGIC DEVELOPMENT IN THE NEAR EAST AND EGYPT.

Neolithic period	copper age pure copper	Ia	main rough material stone cold wrought gold, copper, meteoric iron	−3600 Predynastic −3200
Neolithic period	copper age pure copper	Ia	main rough material stone melting of copper, silver, gold in melting pots using air supply by blow pipes	−3200 Predynastic −II Dyn. −2800
	copper age impure copper	Ib	Production of copper from oxidic and carbonatic ores in closed furnaces	−2800 III Dyn.
About 2500 first production of tin and bronze	many tools still of stone		Production of silver, arsenic, antimony, lead from ores — About 2700 production of weld iron from magnetic iron kernels	−XI Dyn. −2000
			Classical alloy 10% tin 90% copper	−2000
			After 1500 appearance of bellows, copper production from sulphidic ores, preroasting of sulphidic ores.	XII Dyn.
			After 1300 first production of weld iron from surface ore. Hardening by carburizing the suface of weld iron Nairiland, Hayasa (Armenia). In Hallstatt, Austria, 1200 B.C. invention of bloomery hearth — not appearing in Egypt before 1000 — Accidental brass about 1000 B.C. temporarily in Palestine.	−XXII Dyn. Shoshenk III
			Spreading of production of weld iron from iron ores and surface hardening of carburizing	−800
EARLY IRON AGE			Iron becomes predominant material for weapons and tools Start of iron age in Northern Europe — 650 B. C.	−800 XXII Dyn. −XXVII Dyn. (Persians) −500
OLD IRON AGE			About 500 weld steel produced from manganese ores. Invention of shaft furnace without bellows (before 500 in Western Germany) after 100 B. C. production of brass and mercury	−500 ∓ BC 0
Younger iron age since 1 A. D.				AD

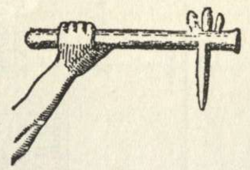

FIG. 36. Weapon from a seal of Gir-nun-ni, 2450 B. C. Telloh. (Praeh. Zeitschrift, 1912, p. 33)

FIG. 37. From a seal after Perrot Chipiez (vol. III, b, p. 657)

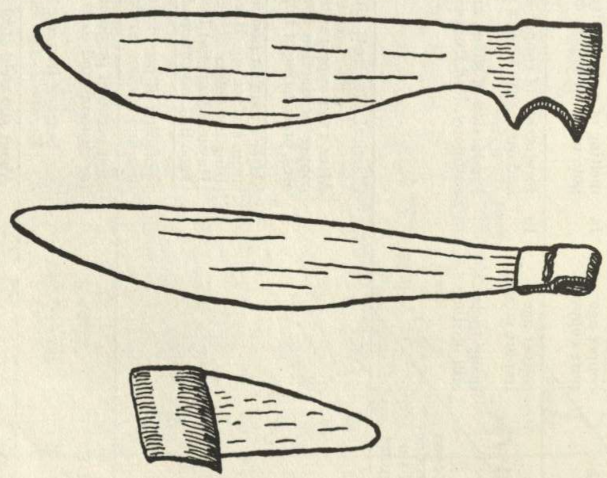

FIG. 38. Pointed blades from the Royal Necropolis Ur. (After Woolley, Ur Excavations op. cit. pl. 225).

FIG. 40. Halberd from rock carvings, Val Fontanalba, Italy, showing the same kind of thorns on the neck as Fig. 36, 37.

FIG. 1. Map showing the range of Aunjetitz culture (after Wilke).

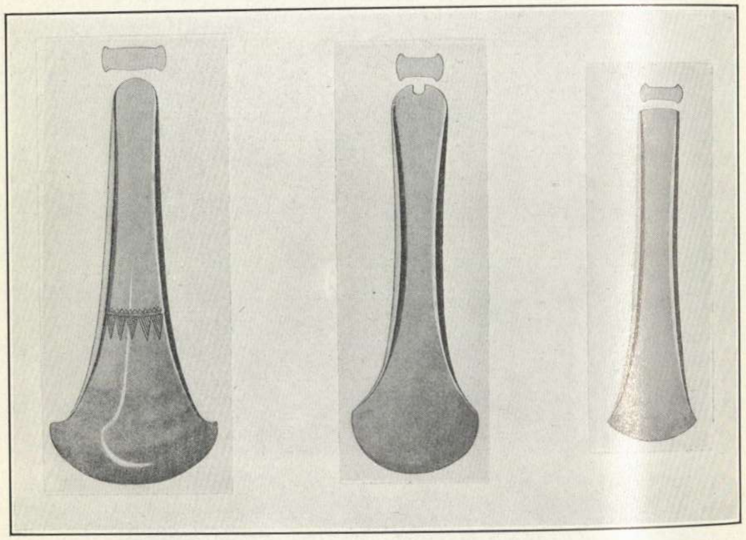

FIG. 5. The three types of the deposit at Fjällinge, Sweden.
a. English, b. Italian, c. Swedish, proving the contemporaneity of PIc in the three areas.

FIG. 8. Copper containing slate layers exploited at the beginning of the bronze age near Mansfield, Middle Germany. (By courtesy of W. Witter)

FIG. 9. Cross section through a copper mine at Mitterberg (Austria). Mining by means of fire in order to brittle the rock. When hot it was chilled with cold water. Shafts and galleries were protected against caving in by stemples.
(After Lechler, 5000 Yahre Deutschland, Leipzig, 1937, Fig. 262)

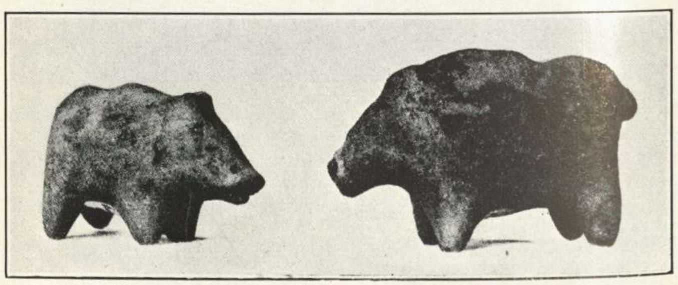

FIG. 11. Pigs of burnt clay, Neolithic, found at Stoessen (Mus. Halle).

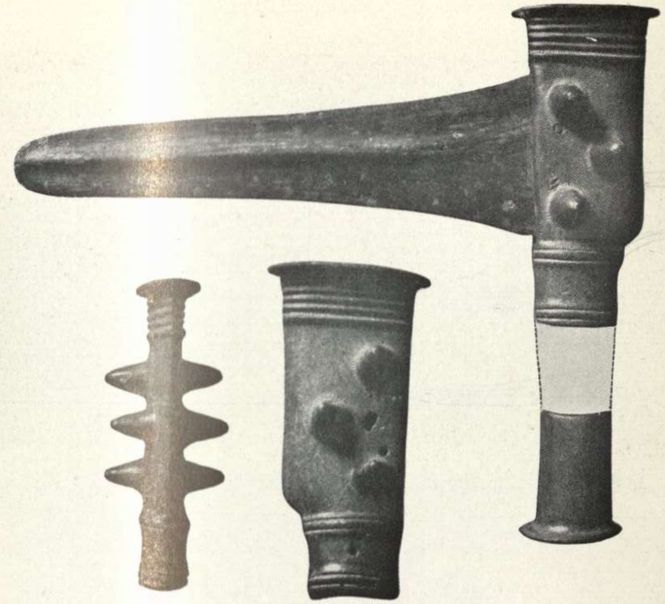

FIG. 26. Transitional type of halberd of the Poznan group found at Schroda, Poland. The ring rivets are merely decoration, between the lower ring rivets two small points indicating the peg rivets which fasten the blade on the shaft. The shaft shows cast defects, and was originally longer. (after Blume, Katalog 884, 1885).

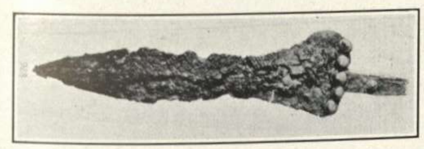

FIG. 28. Halberd from the sixth shaft grave Mycenae with tang indicating a triangular form of neck like the group Vb. 6 ring rivets, the rings of which are golden. (Karo, Die Schachtgraeber op. cit. Fig. 928).

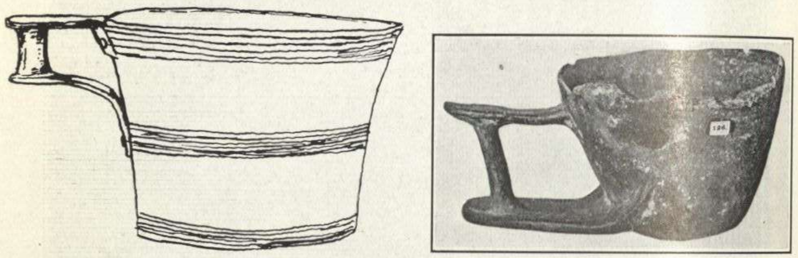

FIG. 31. Vapheio silver cup (left) in comparison with the beaker of Nienhagen (right).

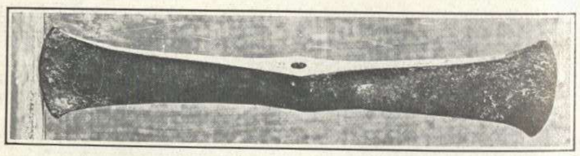

FIG. 32. Double axe (ca. 36 cm) found at Zabitz (Mus. Halle) Double axes occur westward no further than the Rhone valley.

FIG. 33. The gold items from the Aunjetitz chieftain mound near Helmsdorf (Mus. Halle) with two Aunjetitz pins the prestage to the later fibulae. Instead of a metal bow a string was used. Armring, two "hanging spirals" and hair curl spiral.

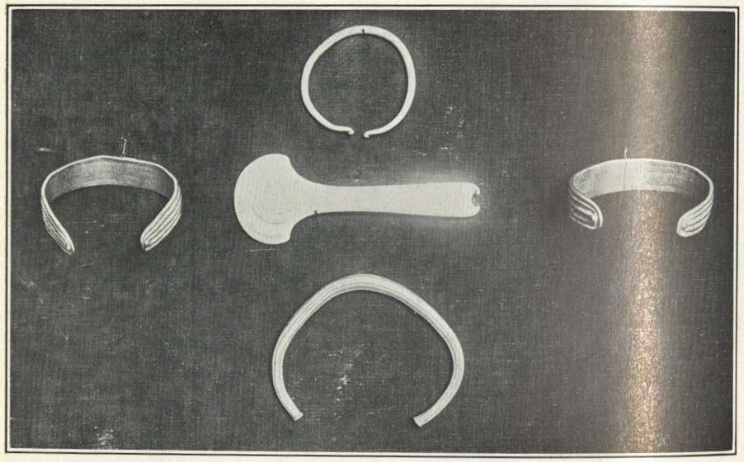

FIG. 39. Aunjetitz depot from Merseburg near Halle (Mus Berlin) Golden hatchet blade of italic type, two golden bracelets, a big corded gold ring and a silver ring (electron).

REMOVAL OF A SIDE IN THE TRANSFORMATION OF KEELED SCRAPERS AT MOUNT CARMEL, PALESTINE

By Virginia Beggs

WHEN nuclei became temporarily unserviceable through their unskilful or prolonged use or by defects in the raw material it was found possible to restore them to use for the detachment of more blades by removing the defective parts and thus exposing a clean surface. Either the striking platform (tablet) or a side was struck off when these became defective.[1] These two methods, practised by the Aurignacian peoples of Mount Carmel, have been observed in other sites dating from the same period.

The same methods were practised in the transformation of keeled scrapers[2] at Mount Carmel. However, the detachment of blades in the latter was in the form of retouch to sharpen the scraping edge and not for the purpose of obtaining blades as in the nuclei. When the keeled scrapers were temporarily unserviceable because this lamellar retouch (or retouch by removal of small flakes) was no longer possible, or sometimes when the under surface needed to be levelled off, the removal of either a tablet or a side became necessary.

Scraper-tablets have been observed at the cave of el-Wad by Miss Garrod[3] and quite often, instead of being rejected, served for the manufacture of various tools, such as an angle burin (Fig. 41, No. 1) and keeled scrapers of a necessarily narrow type (Fig. 41, Nos. 2 and 3).

The other method of transformation, that is, by the removal of a side, has not to my knowledge been described for keeled scrapers. There are several reasons why, in my opinion, they resorted to this procedure instead of the removal of a tablet. In the first place, as in the nuclei, a whole side could have been defective. But in the majority of cases the keeled scrapers themselves, by reason of their form, were not suited to the removal of a tablet. Their fronts were too oblique and their back surfaces either also too oblique, wide, or rough (often composed of cortex), to serve as striking platforms. It should be noticed that the fronts of scraper-tablets are always perpendicular or very slightly oblique in relation to the under surface,

[1] J. Hamal-Nandrin and J. Servais.
[2] Falling into the class of Miss Garrod's "steep scrapers."
[3] D. A. E. Garrod and D. M. A. Bate.

and also that on round keeled scrapers of pyramidal form the blow for detaching a tablet was given on the most vertical front.

Removal of a side, producing a diminution in the width of the keeled scraper, left a new and clean surface behind it. Sometimes, when only slightly reutilized, this latter with its negative bulb of percussion can clearly be seen. The spot destined to receive the detaching blow depended equally on the form of the defective side and on a favorable point determined by this side.

The use of a faceted striking platform, or its equivalent, enabled these prehistoric men of Mount Carmel to obtain a clean and uniform fracture and thin blades.

Fig. 42, No. 1 shows a side which was removed from an elongated and therefore oblique-fronted keeled scraper. It can be seen that not only the scraping edge but the whole side as well have been spoiled by the removal of a series of small flakes which broke off before their entire disengagement, thus rendering the side useless for further resharpening by this process. The removal of a tablet, besides being impossible for this type, would have been of no avail. To remove the defective side the detaching blow had to be given either from the front or back of the keeled scraper. In this instance the back surface was chosen. Upon this they made two facets, delivering the blow directly on the edge thus formed. The side thus removed, which I have called a scraper-side, shows a clean fracture and a diffused bulb of percussion [4] on its under face. The keeled scraper was approximately cut in two by this process. It is to be noticed that the facets, clearly seen on the striking platform of the scraper-side, were made after the manufacture of the keeled scraper and complete use of the side, for they cut into the latter and also, as well as the bulbar face, show a much fresher aspect. The remaining parts of facets are seen on similar keeled scrapers which have been renewed in the same manner. The technique is the same as that employed in the removal of a tablet, but here, as has been shown, the facets were not already present and had to be made.

Another example of a side removed from an elongated keeled scraper is shown in Fig. 42, No. 2. Here, the detaching blow, instead of being given from the back of the keeled scraper was given directly on the front scraping edge which served in the same manner as a narrow faceted striking platform composed of a single projecting edge.[5] The resulting scraper-side is a thin blade. Notice again the clean fracture and diffused bulb on its under face. The upper face shows clearly in this case the remainder of a

[4] Diffused bulbs are often seen on blades with narrow faceted striking platforms.
[5] In giving this blow it was necessary for the back surface of the keeled scraper to remain on the anvil. Had the blow been given with the side resting on the anvil the result would have been a burin spall ("lamelle coup-de-burin").

portion of lamellar retouch, formerly part of the front of the keeled scraper, which was cut obliquely by the detaching blow. This thin blade, which has a maximum thickness of 4.5 mm., was made into an end scraper.

In order to detach uniform slices from keeled scrapers the blow of the hammer had to fall on a spot forming nearly a right angle with the lateral part. In the first scraper-side which has just been described the front scraping edge is rounded and thus useless as a striking platform. Since it was not reserved for this purpose it was utilized to the same extent as the side edge, the detaching blow being given from the back which was fortunately well suited for this purpose. The second scraper-side described was detached from a keeled scraper having a rectilinear front edge, at least on one side where it formed a right angle with the defective side. Otherwise the detachment of this thin and uniform blade would have been impossible. In this last case they undoubtedly conserved the front of the keeled scraper, for if it had been damaged by excessive use and retouch, the ruggedness of the front, as seen on the first mentioned scraper-side, would have prevented the detachment of a clean blade by a blow given on the scraping edge. However, if they had an equally favorable point on the back surface it is possible that they chose between these two for the striking platform. That is, they could either conserve the front or utilize it as a scraping edge.

Fig. 42, No. 3 shows another scraper-side, this time coming from a keeled scraper of a type not quite so elongated and of a height about equal to its length. On the front side of the under surface, which was most suitable as a striking platform, they made two facets. Being close to the corner these formed an angle which produced a narrow striking platform. Then, on these two projecting edges they gave the blow. The resulting scraper-side again shows a clean fracture with diffused bulb. Subsequently they retouched the sharp edge and the end to convert it into a scraper.

They resorted to yet another process for the removal of a side, this time from a slightly elongated keeled scraper, and therefore of a height exceeding its length. The front scraping edge was rounded. To remove this side in its entirety it was necessary, quite naturally, to give the detaching blow on the under surface of the keeled scraper. With the idea of obtaining a fairly uniform side and straight edge they gave the blow at the back corner, which not only left a fairly small negative bulb of percussion but left it in a position which was not obstructive. Notice the fine end scraper which was later made on the scraper-side (Fig. 42, No. 4).

This method of transforming keeled scrapers not only reduced their width but often, to a certain extent, changed the shape of the front, giving it an acute angle at one end. Moreover they afforded a source of blades other than the nuclei proper.

From these examples it follows that the striking platform was chosen according to the type of keeled scraper. But sometimes it happened that, conforming to type, a striking platform was lacking. For example, in the case of an elongated keeled scraper, and therefore of greater length than height (Fig. 43, No. 1), it can be seen that the pointed front edge as well as the back surface were wanting as striking platforms. Only one place remained on which to give the blow, namely the center of the under surface. The formation of a suitable faceted striking platform would not only have been difficult on account of the wide surface, but it would have been of no avail. To remove as much of this spoiled side as possible a blow given on a plain surface was the best procedure, for a flake obtained by this method (Fig. 43, No. 2) is much wider and more extended than a removal obtained on a faceted striking platform. The bulb of percussion is necessarily rather large and prominent, and consequently its counterpart or negative bulb on the keeled scraper is well marked also and gave rise to a single-shouldered keeled scraper (Fig. 43, No. 1). A similar blow given on the opposite side would produce a double shouldered keeled scraper.

Such are the different methods of removing a side in the transformation of keeled scrapers which presented themselves in our collections. All the pieces figured come from the excavations of the Joint Expedition of the American School of Prehistoric Research and the British School of Archaeology in Jerusalem at Mount Carmel, and form part of the prehistoric collections of the University Museum, Philadelphia.

I wish to thank Miss Jean Francksen for the drawings.

For the culture sequence of the Mugharet el-Wad see Plate XV, Bulletin No. 12, American School of Prehistoric Research, 1936. The layers excavated at the Mugharet el-Kebara are given on page 11, Bulletin No. 8 of the School Bulletin, 1932.

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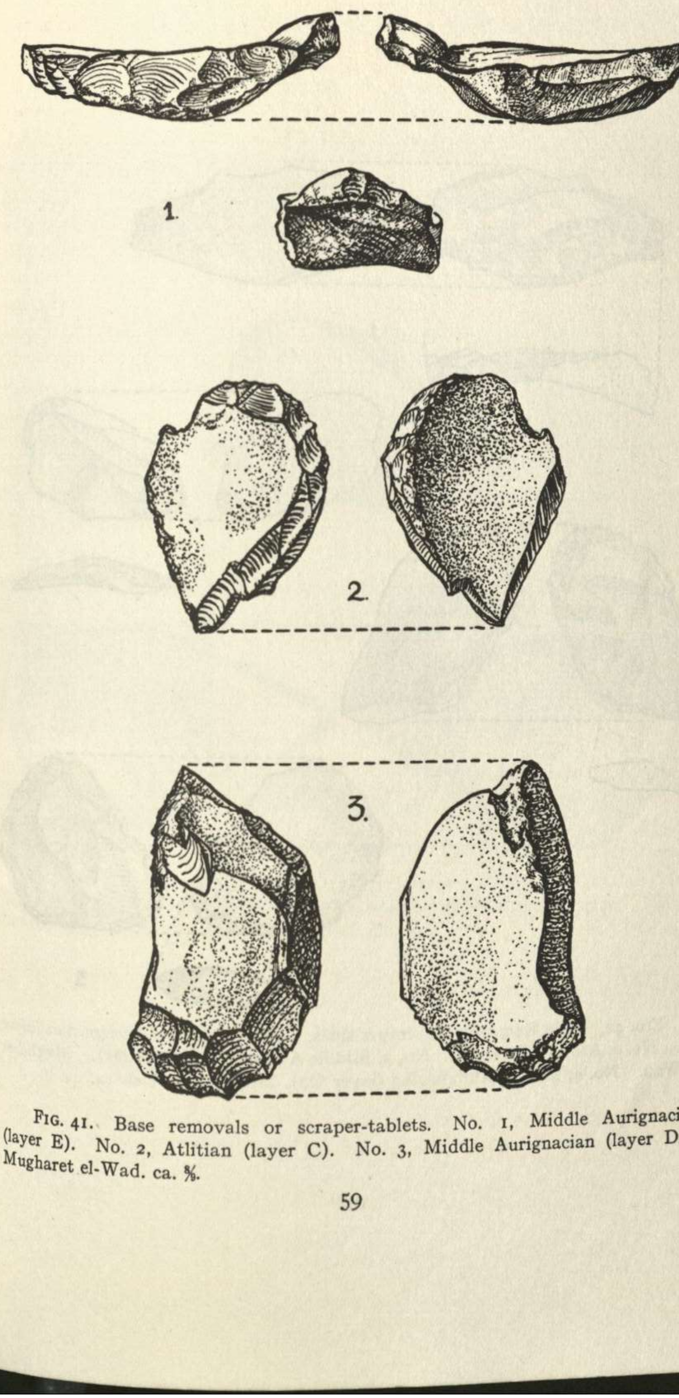

FIG. 41. Base removals or scraper-tablets. No. 1, Middle Aurignacian (layer E). No. 2, Atlitian (layer C). No. 3, Middle Aurignacian (layer D2), Mugharet el-Wad. ca. ⅘.

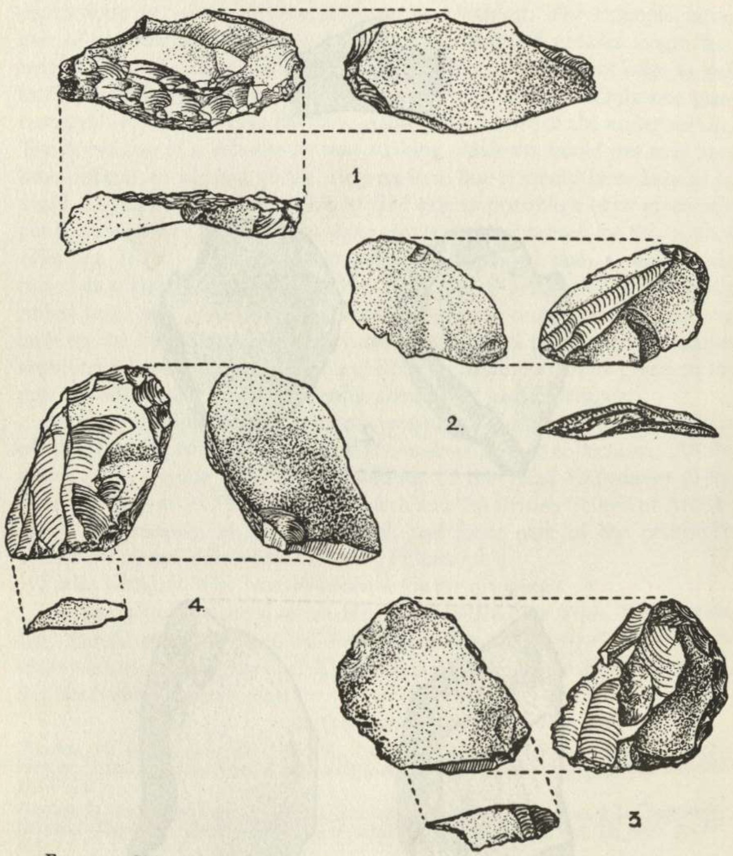

FIG. 42. Side Removals or scraper-sides. No. 1, Middle Aurignacian (layer E). No. 2, Atlitian (layer C). No. 3, Middle Aurignacian (layer D1). Mugharet el-Wad. No. 4, Middle Aurignacian (layer D2), Mugharet el-Kebara. ca. 3/5.

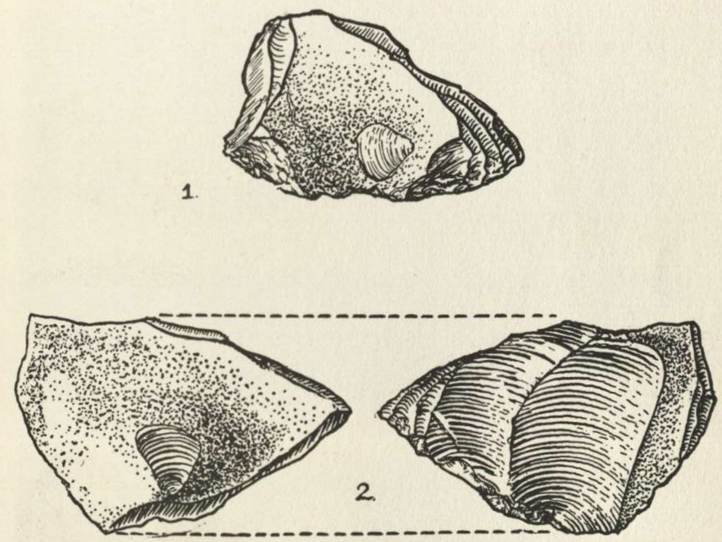

FIG. 43. No. 1, Single-shouldered keeled scraper, Middle Aurignacian (layer D2). No. 2, scraper-side, removed from a keeled scraper of similar type. Middle Aurignacian (layer D1). Mugharet el-Wad. Ca. 4/5.