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THE BEGINNINGS OF THE IRON AGE IN ANCIENT PERSIA

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The position of Iran in the general development of the ancient iron working has not been satisfactorily cleared up till now. Iran represents a big area in the close neighbourhood of the most ancient cultural centres.

There are very important monuments on its own territory though Iran was not of the main interest of scholars dealing with the early history of iron.[1]) Several reasons can explain this fact; one of them may be the chronology of the period about 1000 B. C. or the first half of the 1st millenium, which is not very fix; another cause — perhaps the main one — is the shortage on systematical excavating the monuments of the Early Iron Age. As far as iron is concerned we could solely rely on occasional discoveries until the American-Iranian excavations at Hasanlu in the northwestern part of the country* and the simultaneous reconnaissances made by *C. S. Smith* and *T. A. Wertime* have recently brought a very important material. The beginnings of the Iranian Iron Age are however mentioned cursorily. Even in the meritorious book on traditional Persian crafts[2]) written by *Wulff,* these passages remain within the framework of a general survey.

Nevertheless, the history of the ancient iron working in Persia is of a considerable importance from the general point of view. Some parts of Iran touch areas, which could be considered as the homeland of the iron metallurgy. The territory of Iran, too,

is a joining link to other important countries of ancient culture: India and China. Each of the mentioned countries has its own tradition in metallurgy or in iron working. China was the first country where large quantities of cast iron were produced and India can brag of wootz steel. This sort of steel was well known in the medieval Persia, too. It would be therefore very interesting to know the development of the early Iron Age on the Iranian plateau. In the following I shall try to sum up the sources relating to this problem.[3])

THE METALLURGICAL TRADITION OF THE IRANIAN MOUNTAINS

New investigations of some objects from Tepe Sialk made of native copper, dating to ca 4000 B. C. and being of a similar composition as the native copper deposit of Talmessi near Anarak on the edge of the Kavir desert,[4]) and the important discovery of the copper metallurgy in Tal-i-Iblis (5th millenium B. C.)[5]) throw a new light upon the very beginning of the metal working in the Old World. According to the new data, Iran was one of the two oldest areas of copper metallurgy[6]) belonging to the big mineralization zone reaching from Anatolia to India. Its role in the lead and silver production must have also been very important as lead artifacts were found in many localities in northern Iran (Tepe Hissar, Shah Tepe). The exploiting of cerrusite and galenite must have started on several places of Central Iran very early. Among the various ore deposits of these countries iron ores (Fig. 1)[7]) are not lacking. The scarcity of suitable fuel dates just several centuries ago after the exhausing of the mountain forests. Thus were on hand all prerequisites to the early metallurgy of iron.

THE PROBLEM OF THE DISCOVERY OF EXTRACTING IRON

The problem of the discovery of iron extracting has not yet been solved. It could eventually be connected with the problem of the metallurgy itself, especially what concerns the extracting of copper ore, or, moreover, with the beginning of the ancient

pyrotechnology (including the pottery and using of furnaces and kilns in general.[8]) Some time ago *C. S. Smith* and *T. A. Wertime* directed their attention to the possibility of discovering the process of the metallurgy of iron during the extracting of lead ore.[9]) Once there was known the metallurgy of lead during the extraction of which galenite PbS, scrap iron or iron ore had been used. Lead was precipitated by iron which came over to slag. Also the high melting point of lead slag was possibly reduced.[10]) In all Iranian lead producing districts this process was quite common and, moreover, the single one. In Nakhlak it can be seen even nowadays. Old smelters believe the reduction of lead without one third of iron ore in the charge to be quite impossible. The smelt uses to be carried out in simple shaft furnaces with forced draught (by twin bellows). Temperatures are about 1300 °C. Under such circumstances iron could not only be reduced, but also sintered to the shape of iron sponge or isolated nuggets and grains. Of course, iron remains in the slag.[11]) An experimental smelt proved that isolated grains of iron (and even drops of cast iron) could be obtained in a small shaft furnace when smelting lead and iron ore. Two goat-skin bellows kept the temperature approx. at 1200 °C.[12]) This could be the real way to the discovery of the metallurgy of iron. But evidences are necessary. It must be stated that the Iranian territory brought some of the very early finds concerning the iron metallurgy. Its full Iron Age is, however, to be dated into a relatively late period.

IRON FROM GEOY TEPE

Shortly after the World War II, *T. Burton Brown* published his excavations of a tell called Geoy Tepe, situated not very far from the Lake Urmia in Northwestern Iran. He presented at that opportunity some very surprising discoveries of iron slags from very low levels. This material also contained a piece of white cast iron, amorphous in shape (spec. No. 1234), taken from the level D dating to the last third of the 3rd millenium B. C.[13]) A metallographical investigation proved structures of pearlite, graphite and cementite (hardness 378—876 HV). Carbon content analytically: 3,51% C, phosphorus 0,45%, copper 0,02%, nickel 0,03%, manganese 0,03%, sulphur 0,16%.

The isolated chronological position of this not worked sample of pig iron from Geoy Tepe, so far as the field circumstances are doubtless, presents the possibility of various considerations on an accidental extraction of iron ore. This could be a trace of many occasional reduction processes which could finally lead to the discovery of the metallurgy of iron. From the geographical point of view this area is closely connected with that of Cilicia, Anatolia and Armenia. These countries played without any doubt a very important role in the early history of metallurgy.

FIRST WEAPONS OF IRON

Further development of iron working in Iran is not clear. Much more later, since fifteen hundred years had elapsed, iron objects reoccur. The origin of their metal, however, is not known. Important sites like Tepe Hissar, Tepe Sialk (i. e. the tell, not the cemetery), Murteza Gert, Rey-Tsheshme Ali or Turang Tepe have brought no iron.[14]) Three graves from Tepe Giyan near Nehavend between Hamadan and Tehran (nrs. 3, 5 and 23) equipped with tanged iron daggers (over 20 cm in length)[15]) belong to the period dating before 1000 B. C. These graves were found in the upper level (no. I).

Close to the famous tell of Tepe Sialk near Kashan, two cemeteries had been excavated by *R. Ghirshman.* The older of them is registered as Tepe Sialk A. In its grave no. 4 a badly corroded dagger (fig. 6:1) equipped with a tang (length 32 cm), and an iron punch (circular in section)[16]) were found. Ghirshman suggests the dating of that cemetery to the 12th—11th cent. B. C. We are most probably right, when considering minimally the period shortly before 1000.

The collection of several iron artifacts in the cemeteries rich in bronze implements cannot, of course, prove the existence of any Iron Age. On the contrary, the exceptionality of those objects must be emphasized.

THE METAL WORKING CENTRE IN LURISTAN

Luristan metal working is a relatively wide spread term. It cannot be omitted when reasoning about the early Iron Age in

Persia. Among the bronze artifacts from the region situated northwards of the Persian Gulf (covering nowadays approximately the modern Kermanshah province) are well-formed daggers, halberds or axe-heads, adze-shaped weapons or jewels and ornaments. Unfortunately a greater part of Luristan bronzes belong to the category of not stratified objects. They used to be collected by vendors and from their hands they have come to European and American museums and collections.[17]) No complexes are fixed. From the stylistical point of view the assembly is not uniform and homogeneous, so that the dating must be, and in fact it is, a matter of discussions and polemics.

Until the recent time there were only few controll elements at our disposal. One of them — i. e. flange-hilted bronze dagger with a rim — bears cuneiform inscriptions. For instance Nabukadnesar is named on one of those daggers (1146—1123 B. C.): „'ša Nabukurudurri.usur šar Kiššati šar Babili šar Šumer Akkadi".[18]) Other inscriptions point to further Babylonian rulers or prominents (Ninurta-nadin-šumi 1130—1125 B. C. etc.).[19]) It is the matter of votive gifts from temple treasuries, the provenance of which could be Luristan. Other sorts of Luristan bronzes are chronologically not well fixed; they are considered to be much later. *R. Ghirshman* therefore neglects the evidence of the inscribed daggers; according to his opinion those daggers had been brought only in the 8th cent. B. C. by Cimmerians, who served in Assyria, as a booty from Elamite or Babylonian treasuries.[20]) But it is not easy to explain similarly all finds of flange-hilted bronze daggers of Luristan. The problem remains still open. *C. F. Schaeffer* presented a survey of the dating of Luristan bronzes: Herzfeld 1400—1100 B. C., Przeworski 1250—600, Godard 900—520, Legrain 700—400, Moortgaat 600—300, Contenau ca. 1000, Ghirshman 800—600. Shaeffer himself suggested a very high dating. He included many types of artifacts and distinguished Early Luristan (2300—2100), Middle Luristan (2100—1700), supposed hiatus, Late Luristan (1500—1100); the latter should be transiting into the Iron Age Luristan (1200—1000).[21]) In the recent time the trend points rather to lower dates. The period 1000—700 seems to be the most adequate.[22]) But daggers with flanged hilt (eventually inscribed) must be an exception dating to the period 1200—1000. New discoveries support this

chronology. Danish archaeologists have excavated several graves in Tepe Guran, Luristan, containing flange-hilted bronze daggers together with beak-shaped cans; C 14 date of an oak wood from the grave no. 11 is 1200 ± 120 B. C.[23]) Other similar daggers are from a stone lined grave at Bît Sorgh. Exact analogies of those weapons bear cuneiform inscriptions (for instance Marduk--nādin-Ahhé 1091—1074 or 1098—1081, in various collections). Further analogical finds: Tepe Giyan I (grave 10), Hasanlu V. The fifth level in Hasanlu, containing an iron ring, is dated again by the radiocarbon method to the period 1036±49 and 1016±45 B. C. Hasanlu VI does not contain any daggers of this type.[24]) Radiocarbon dating, however, has its own problems, and it cannot serve as an evidence. The above mentioned dates seem to be right, because the coincidence of the archaeological and physical dating seems not to be accidental. Thus at least one part of the so-called Luristan bronzes could belong to the period before 1000 B. C. At that time first iron artifacts began to appear, but very rarely, on the Iranian territory. Other Luristan bronzes are later (first centuries of the 1st milenium B. C.).

Another problem is that of the ethnicity of Luristan founders. All periods in question are periods of ethnical movements in the Subcaucasian regions. A hypothesis ascribing Luristan bronzes to the Cassites, who also ruled during the 2nd millenium in Babylon and who retired later to the Iranian Mountains,[25]) was quite common some time ago. Other scholars are inclined to connect the appearance of the Luristan bronze artifacts with the invasion of Cimmerians to the northern Iran and into Asia Minor in the 8th cent. B. C. Among Cimmerians should have lived skilled metallurgists.[26]) This theory takes in account Indoeuropean tribes as a new important element in this part of the Middle East. Other Indoeuropeans, Medes, were also held for the Luristan founders. Last stylistical analysis made by *E. Porada* draws attention to the very beginning of the Luristan founding which must have been heavily influenced by the aboriginal Elamite element. This basis was formed later by the penetrating invaders from the north during several centuries in the 1st mill. B. C.[27]) Such a hypothesis could be accepted as a very probable one. But the question of the northern invasion must be checked. At that time only Cimmerians could be taken into consideration. It would be

very difficult to present an iron civilization of that tribe at the beginning of the 8th cent. B. C. Nevertheless, it was *A. Godard* who wrote that these tribes, coming from the north, were equipped with iron weapons warranting them the superiority over other warriors.

Here the archaeology of Transcaucasia, the picture of which is quite different, must be taken into account. The Bronze Age being there at its highest point of development just during the whole first four centuries of the 1st millenium, we can hardly suggest the coming of iron-bearing people from that region at about 800 B. C.[28]) Iron occurs in Transcaucasia at that time approximately in the same frequence as in Tepe Giyan I or in Tepe Sialk A two centuries ago. In the Bronze Age cemeteries of the Trialeti culture several iron objects were found, for instance, an iron spear-head with a bronze plated socket from the rich grave no. 59 in Samthavro (Georgia, fig. 3:1), or an iron dagger from the cemetery Beshtasheni on the Gerjak river. In Armenia, a grave assembly could be mentioned, the inventory of which included a bronze sword, a bronze axe or adze, iron points and knives. Finally, the cemetery of Chanlar (former Helenendorf) belonging to the Gandsha Karabagh Culture is known, with a grave containing an iron bracelet and an iron pin.[29]) These evidences are held explicitly for exceptions in the Bronze Age of the Caucassian area. *B. B. Piotrovskij* suggests the dating to the 9th—8th cent. B. C.[30]) According to his opinion the occurrence of the first iron objects in that area is due to the influence from the south. This hypothesis is just antagonistic to that of Godard.

If the coming of iron to Luristan is presumed from the north and to Transcaucasia from the south, there must have somewhere existed a developed iron civilization, mediating this influence; a civilization apt to produce and spread iron outside its own boundaries. Such a civilization, in fact, existed in the 9th—7th cent. B. C. and its one part included a tip of the present-day Iranian territory. This was the so-called realm of Van or Urartu, well-known, for instance, from Assyrian written sources.

URARTU: THE KEY TO THE EARLY IRON AGE IN IRAN AND CAUCASUS

The realm of Urartu (Biainu, Nairi), represented since the middle of the 9th cent. till the beginning of the 6th cent. a mighty state, matching and fighting with the Neo-Assyrian Empire in its southern and southwestern vicinity. The centre of Urartu was situated in the region of the Lake Van, on the shores of which lay its capital called Tushpa. Since the end of the 9th cent. the region of the Lake Urmia belonged to same (now Iran). But the main expansion had been directed northwards, into the Araxes valley (now Araks and Aras) and to the Lake Sevan in Transcaucasia. Annals describing numerous campaigns of the Urartian rulers, organized for taking spoils, show clearly the north to have been the source of cattle herds and slaves. Some of those regions were occupied later on and protected by strong fortresses. Such points became bases to further raids northwards concentrating, however, simultaneously various penetrating elements of the cultures of the Middle East and Asia Minor over Caucasus up to Ukraine and Eastern Europe.[31])

There was a civilization of iron in Urartu. The scarce evidences for such an estimation differ in value, but they permit such a statement.

Iron occurs solely in one of the Urartian cuneiform texts: as the well-known ancient ideogram AN.BAR. It is mentioned in the annals of the king Sarduri II., son of Agrišti (764—735). The king ordered a seal of iron to be done in connection with one of the campaigns against the country called Kulkha.[32]) Some authors are inclined to overestimate this reference: Urartians must have been very skilled smiths and engravers when manufacturing such goods and their technique was certainly highly developed.[33]). Making a good steel punch really represents a good example of technique. Unfortunately we do not know what was, in fact, the matter. The text reminds us strongly of a formula inscribed on an iron plate, mentioned in the 13th cent. B. C. in the documents of the Hittite king Hatushil III.[34]) It could be only a symbolical formula, the exact meaning of which is not clear. This reference itself cannot serve as an evidence of a developed Urartian iron working.

But there are other sources informing us of the Urartian iron; those of Assyrian annalists. There is a mention in annals of Sargon II. (722—705 B. C.) at Dur Šarruken-Khorsabad on spoils taken from Urartu by Assyrians: also copper and iron artifacts have been brought, mentioned, however, but at the end of the list preceded by tens of talents of gold and over one hundred and a half talents of silver together with gaycoloured and linen textiles.[35]) Badly destroying was the eighth raid of Sargon (714 B.C.) during which the realm of Urartu was near a catastrophe. Westwards from the Lake Urmia was taken the city of Musasir from where enormous treasures are listed in the Sargon's letter to the god Aššur. Among the spoils there were numerous iron horns, but the exact number is not legible; among further goods iron candlesticks and unknown objects called iron *nisibu,* iron *nazru* and iron *aruthi* are to be named.[36]) It would be, however, very important to know their numbers when comparing with copper artifacts: swords, daggers, lances etc., the amount of which is given as 305.412 (?). Anyhow, Urartian cities disposed of such a quantity of iron that it was worth of taking as spoils of war.

A more exact picture, however, offer archaeological sources. They are mainly known from two important centres of the realm of Urartu. But they can be held for evidencing ones. During the excavations in the capital Tushpa or Toprakh-Kale a number of iron weapons were discovered: flange hilted swords, daggers, battleaxes, spear heads. Also implements: among these huge tridents and big plough shares deserve notice.[37]) More details, what concerns the iron assortment, brought Russian excavations of the Urartian fortress of Tejšebaini, now Karmir-Blur on the Zange river near Erivan, supporting the Urartian power in Transcaucasia in the 7th cent. B. C.

In the pre-Urartian layers of the hill no iron is mentioned, but iron from the Urartian period is abundant. The greatest assembly was found in the citadel, where the iron implements and utensils had perhaps been concentrated in the moment of danger. Teišebaini was taken in the beginning of the 6th cent. B.C. by the Scythians invading Media and Persia from the north. The form of the iron artifacts equals to that from Toprakh-Kale: several variants of flange-hilted swords or tang-riveted daggers (fig. 2:10—12). Straight or curved sickle-shaped knives are typical.

Arrow points had tangs and they were of quite a different type than the three-edged Scythian arrows of bronze. Socketed iron hoes, sickles, knives (including the form with a ring on the pommel), adzes, tridents (up to 83 cm in length, fig. 2:1—2) represent the implements. Iron saws were used not only by workes in bone but also by joiners: this proves the 38 cm long saw blade found in the house no. 4 (fig. 2:8). Beside iron bridles, mountings and fittings, phalearae etc., big candlesticks draw our attention. Such an example uncovered in the house no. 14 was 145 cm high, equipped with a tripod and with an iron plate on the top (fig. 2:9). No wonder that such pieces were a welcomed booty to the Assyrians plundering in Musasir. In the house no. 13 there was discovered a hoard of iron objects: bridle, spear, sickle, dagger and several iron objects.[38]) No smithies or bloomeries have been discovered in Karmir Blur up to the present day; but the blacksmith work must be presumed in such an important centre.

The knowledge of the Urartian technology is still lacking, because no investigations have been organized. Nevertheless, some opinions inclined to overemphasize the above mentioned sources. Some authors were inclined to believe that Urartu was supplying the Assyrian empire with iron, or that hundreds of tons of iron stored at Khorsabad were the spoils from Urartian cities.[39])

Such conclusions cannot be verified and we do not intend to follow them. But, in fact, iron ore deposits are more frequent on the territory of Urartu than in other regions of Asia Minor, Syria, Mesopotamia or Elam. Anyhow the same sources could have been exploited by the Assyrians. Their kings, as stated in written documents, used to take iron as tributes also from other cities and countries, not only from Urartu. The Urartian civilization was, of course, advanced in iron making: weapons, all sorts of implements, structure material for making various artifacts, all that in iron. In that way the level of the civilization in Urartu equalled to those in the west and in the south (Greece, Phrygia, Lydia, Neo-Assyrian Empire, Neo-Babylonian Empire) but it predominated considerably over its neighbours in the north, east and southeast. To these coutries was spread its influence. Both knowledge and the artifacts, mainly weapons, have been transported with Urartians.

During the 10th—9th cent. B.C. iron was extremely sporadical in the cultures of Transcaucasia. A certain change can be observed in the 8th cent. The period spanning roughly 750—500 B.C. corresponds there to the beginning of or to the early Iron Age itself. Due to the Urartian occupants the inhabitants had, of course, to pay the appearance of iron very high by their lives, villages and cattle. Later phases of these cultures belong already to the Iron Age. According to the Schaeffer's chronology this was the period of the last two centuries of the second millenium, *Hančar* takes the 10th cent. B.C. into account; nowadays only 8th—6th Cent. come into consideration, whereas elsewhere even a longer surviving is quite possible.

The Urartian raids were directed straightly to the North, towards the present-day Armenia and eastern Georgia. There existed a developed copper metallurgy and bronze founding already during the beginning of the Iron Age. That is the territory of the so-called Lelvar culture according to the mountain range in the Caucasus Minor. Following finds and sites were imported for studying the earliest irons: the Kazbek hoard, Samthavro cemetery (later phase), Mousieri cemetery (later phase fig. 3:2). From the total amount of 30 iron swords of the North Urartian type, 20 weapons were discovered in the graves of Samthavro near Mccheti[40]); further 5 swords came to light in Mousieri.[41]) Another type of swords, for instance, iron swords with bronze hilt were found in the same cemetery, too. Urartian style might be observed also on daggers with long triangular blades and bronze scabbards. Their hilts have numerous rivets (fig. 3:4). Local elements of the style may be seen on some of them. Iron battle axes (fig. 3:7—8) are similar to those from Toprakh Kale, knives with ring on their hilt tops find parallels in Karmir Blur; the same might be said about adzes.[42]) One object seems to be out of the series, namely the iron dagger with a short massive guard; it could be compared with Cimmerian daggers with bronze hilts which were used in the north of Caucasus ca. 700 B.C. and which were brought far to the west.[43])

A further important cemetery is that of Ayrum (Shejtan Dag, fig. 3:13—14). Its late graves contained iron riveted flange-hilted daggers, curved knives and spear heads.[44]) Worth noticing is a bronze dagger from Tak Kilisi equipped with a bronze guard

and a bronze pommel (fig. 3:9) witnessing rather the local than the Urartian style. Close parallels in bronze are well known from the preceding period.[45]) Another type of a dagger is extremely important: pommel formed by fan-shaped lobes. Bronze examples are kown from the localities Ani and Mcchart, several pieces were uncovered in the Tsalka valley (one dagger has an iron blade.[46]) This type of a dagger will be considered later. Urartian weapons from other sites such as Mingetchaur (sword, curved knives, antennae- or flange-hilted daggers),[47]) Aleksandropol, Sadovle, or from the cemetery Steklannyj Zavod,[48]) have also been published.

Different cultural relations may be traced in the eastern Transcaucasia, both in the Soviet and Iranian parts of Azarbaijan. We have to admit that in later tombs of the cemetery at Vornak-Akner there appeared typical Urartian daggers,[49]) but in the regions called Russian and Persian Talyche (near to the Caspian coast) the Urartian influence is slighter, at least what concerns the type of irons. The Talyche culture had developed in the Bronze Age long before the coming of iron. Already at that time it had close connections with Iran. Especially bronzes are of a very similar type. Daggers with flanged and rimmed hilts, mentioned in the paragraph on older Luristan castings are well known from many localities of Persian Azarbaijan. A further step in the development of this type is the dagger with a circular crescent, which is, in fact, a curved rim in the place of the guard. These daggers, too, are more frequent in the south, in Iran; there are also several iconographical evidences of that type; they are depicted on the famous Hasanlu golden bowl (9th cent. B.C.). After all, they served as a model for developing variants made in Talyche in iron. The tips of their tangs are equipped with bronze buttons and their guards have the shape of bronze crescents.[50]) In Georgia, as well as in Talyche, daggers with massive hilts ended with fan-shaped lobes (fig. 3:11) in the pommel[51]) were found. Two examples with iron blades are from cemetery Chagoula Derré, tomb no. 5.[52]) Due to its conception the hilt is to be viewed from the side of the edge of the blade. So the level of the blade seems to be turned to the level of the hilt of 90°. In such a way probably originated a typical weapon (fig. 4) with parallels in Iranian Luristan, where its development presu-

mably continued or had even begun (cf. note 51). From the same cemetery at Chagoula Derré, another dagger must be described, namely that with a tang ended by a basket-shaped button or pommel in bronze,[53]) serving as an example of the local, Transcaucasian tradition. The next important cemetery, with many iron weapons in graves of the later phase, is Agha Evlar (fig. 3:20—22). Among daggers there are parallels to those at Chagoula Derré (grave no. 8). Further objects are: dagger with short bronze guard, iron arrow points (with a transversional edge), knives, and a very curious type of an axe with a cylinder-shaped eye for the shaft.[54]) Many other irons were uncovered in the cemeteries at Chir-Chir (dagger with iron guard fig. 3:16), Tülü (curved knives), Lor Daghi (knife), Aspa-Hiz (fragment of a dagger with the antennae hilt, with analogies in the necropolis of Koban fig. 3:19), Djonü (curved knife with double ring no the hilt-tip, fig. 3:17), Do Kalian (simple tanged dagger fig. 3:18), etc.[55])

Cemeteries of the Talyche culture have been excavated in the late 19th cent. by brothers *de Morgan.* They left very suggestive descriptions of the graves of the Bronze Age having been re-opened by the savage iron-bearing people and occupied by their deads. Field circumstances of that kind used to be explained by a raid of strangers with an iron civilization, destroying cemeteries of the aborigines. Later studies, on the contrary, have stated close affinity between both the Bronze and Iron Age periods of the Talyche culture. *Fr. Hančar* proposed the dating of the Iron Age period into the 10th cent. B.C. Now a later date is suggested, 7th—6th cent. B.C. surviving up to the 5th—4th cent. (for instance Cicamuri, with an akinakes and a bridle of the Scythian type; Kedabek, persisting till the 4th cent. B.C.). No doubt, the Urartian influence did not touch Talyche closely connected with its Iranian neighbourhood: the Southern Caspian, the eastern surroundings of Urmia and Luristan. Iron had been introduced into the area of Talyche on a larger scale, as late as during the Urartian occupation in the west and it was used mainly for the manufacturing of weapons. Implements — with the exception of knives — are still lacking so that the stage in question is to be described as the early Iron Age. Blacksmiths technology is known mostly from the shape of the artifacts. As

far as to the appearance the forming of the metal was mastered quite well. The construtcion and properties of blades seem to be, according to the recent invstigations of *C. S. Smith,* very simple. Combining iron and bronze belonged already to an currenctly employed technique.

BEGINNING OF THE IRON AGE ON TELLS OF NORTHWESTERN IRAN

In the level A of Geoy Tepe there had been found a badly corroded iron sword hilt.[56]) According to the synchronization table based on recent radiocarbon tests,[57]) this level is contemporary with the late period I of Tepe Giyan and with Hasanlu V, and the object belongs therefore to the 11th Cent. B.C. At that time the tell of Geoy Tepe, with its position near to the west coast of the Lake Urmia, must have been under the Urartian reign.

Another tell situated in the south of the Urmia Lake is of a greater importance. It is the Hasanlu, systematically excavated by the American-Iranian expedition. In its level V, dated short before 1000 B.C., flange hilted daggers and an iron ring were found some years ago. Next period was characterized by a fortified citadel with a palace and a complex of buildings, dominating over the whole city. This is the archaeological level no. IV, dated by C 14 tests to the 10th—9th cent. The palace might have been rebuilt about 900 B.C. Full devastation of the place connected with a huge fire destroying the citadel took place — according to the radiocarbon analyses — about 800 B.C.[58]) In this fourth level with typical grey pottery the golden bowl of Hasanlu was found in situ. Chiseled figures and three daggers are worth noticing. One of the daggers has a massive hilt, the second a circular crescent instead of the guard and the third has a hook on the tip of the hilt. The bowl itself is more ancient than the level where it came to light.[59]) Nevertheless, it represents a welcomed point for dating the whole horizon of the circular crescent daggers of Talyche and northwestern Iran. In the same level there were buried even other weapons of bronze, but only their relatively developed forms with flanged hilts.[60]) It is of major importance that the same types were made also in iron. As a good example serves the dagger (fig. 5:3) in the Tehran Archaeological Mu-

seum.[61]) It is 34 cm long and its flanged hilt is bordered by a rim, holding once a wooden inlay by the aid of bronze rivets and a bronze band. A very similar dagger published by Dyson, performs a luxuriously executed piece plated with an ornamented golden sheet on the whole hilt. An analogical but not stratified example can be seen in the Metropolitan Museum in New York (pommel part of the dagger is covered with a golden sheet).[62]) Some isolated finds of those types or their variants kept in various European collections can be found in the paper published by *Maxwell-Hyslop* and *Hodges*.[63]) These daggers or short swords remind us of two traditions: flangehilted bronze daggers as typological predecessors on one side and swords of the Urartian provenance on the other. The latter could have, however, originated on the same typological basis determined by the geographical area. The third type of a dagger is that with the middle blade rim touched by a bronze support of the wooden hilt. All described types were discovered at the skeletons under the ruins of the burnt building no. I: three escaping men, one of them carrying the famous Hasanlu bowl depicting weapons which were in use some centuries ago.

Finally a massive type of the 9th century Hasanlu dagger should be mentioned. Its guard represents an open crescent. *R. H. Dyson* writes that this type should have been quite common in the level IV.[64])

Not only weapons were made of iron in the time of Hasanlu IV. There is a big phalera pressed of an iron sheet in the Tehran Museum (fig. 5:4). The surface is hammered into rays and the border is ornamented by rough globules (diam. 11,5 cm)[65])

Very interesting are many strange objects uncovered in the same level all over the area of the citadel. Iron points, circular in section, the heads of which are of bronze in the shape of crouching lions[66]) or even with more complicated ornaments and again with the motive of a lying animal (fig. 5:1—2). Some of the examples are equipped with fine bronze chains and rings.[67]) Similar fragments were found at Hasanlu by *Sir Aurel Stein* many years ago; one of them is published together with a piece of a triangular iron fitting. The same scholar noticed that in graves outside the citadel area, the skeletons were wearing iron rings on their fingers.[68])

The purpose of the above mentioned iron joints is far from being clear. They use to be considered as pins.[69])

According to the reports published up to date no implements or tools have been found at Hasanlu. But in a founder's house there were moulds for casting bronze axes and ornaments. We can therefore conclude that the use of iron did not exceed certain limits at that time. Bronze maintains its place when manufacturing weapons, but iron sligthly prevails. The frequence of its occurrence signalizes the beginning of the Iron Age. This stage in Hasanlu was a little more advanced in comparison with same of the Talyche culture of the 7th—6th cent.

Hasanlu belonged to the sphere of the state of Manna, referred to since the middle of the 9th cent. B.C. in the annals of Assyria. About 800 B.C. Manna got into the sphere of the realm of Urartu. The Urartian king Nenuas conquered the Mannaean city of Meishta; perhaps during the same campaign the city situated near the recent Hasanlu had been completely destroyed. Otherwise the date 714 must be considered, i. e. the plundering of Assyrians during the Sargon's campaign against Urartu. In such a case a disposition of one hundred years must be taken into account in regard to the radiocarbon dating. *R. H. Dyson* presumes the whole assembly of Hasanlu to be more closely related to the Assyrian milieu than to Urartu. Traces of Urartian pottery were found just in the upper layers above the destroyed city.[70]) Other preliminary report of the same archaelogist nevertheless points to some pregnant Urartian influences, especially in the building technique (fortification, the construction of the gate).[71]) It is evident that Manna, the country of non-Semitic and non-Indoeuropean (but Hurritian) inhabitants in the southern vicinity of the Urmia Lake, linked in the 9th cent. B.C. with Assyria in the south-west, with Urartu in the north and Media in the east and south-east. The civilization of iron was penetrating into the material culture of this country through the intermediary of its more advanced neighbours: the Neo-Assyrian Empire and Urartu.

Just on the edge of the Great Salt Desert (Dasht-e-Kavir), not very far from the copper-bearing mountains, there was flourishing since prehistoric times a site recently known as the tell Tepe Sialk. To the periods of the last settlement there belong two cemeteries outside of the hill proper, A and B. The cemetery A

was dealt with in connection with the first iron objects in Iran. The cemetery B is later. Its graves contain a whole series of artifacts made of iron (fig. 6:2—16) the largest complex of which, counting more than 90 objects, was situated in the tomb no. 15. Among them there were three iron daggers, one sword over 50 cm long, one spear head, one knive, two curved sickles with a bent tang, two forks and one trident. In the other richly equipped grave further irons were buried. In the grave no. 3 two daggers with bronze hilts were placed at the skeleton. Similar examples of daggers (with iron tang) are known from the graves 33 and 67. In the grave no. 74 there was a narrow iron knife; two iron knives came to light in the grave no. 21. Grooveshaped fitting or horse bridle can also be mentioned.[72]) The assortment of iron artifacts corresponds roughly to that of the Talyche culture; when considering Central Europe it could be compared with the later Hallstatt period. The cemetery yields evidence for an early phase of the Iron Age.[73])

Chronological position of Tepe Sialk B has been vively discussed. *R. Ghirshman,* director of the excavation, had suggested the period spanning the 10th to the beginning of the 8th cent. B.C. Schaeffer, of course, defends the 12—11th cent. which seems not to be right. Other authors admit the 9th—8th cent. B.C. The finds of Tepe Sialk were recently analyzed by *R. M. Boehmer,* who had drawn the following conclusion: the cemetery was in function all the 8th cent. B.C. through, but the first burials could be dated to the end of the 9th cent. and the latest of them to the beginning of the 7th cent.[74]) This dating seems to be the most adequate when compared with the cemeteries of the Talyche Culture and of the Hasanlu finds. Solely the Medes come into consideration as the people of Tepe Sialk B at that time. They were mentioned since the 9th cent. in the annals of Assyria (Madai). During the 9th—8th cent. they organized an union of tribes of the Indoeuropean origin. In the 7th—6th cent., Media was a mighty state with a differentiated society (noble, magi, kings). About 600 B.C., Median kings destroyed both Assyria and Urartu and were at war with Neo-Babylonia and Lydia (Kyaxares, Astyages). In the middle of the 6th cent. B.C., they rendered hegemony to their consanguinenous tribe — to the Persians.

We presume that Medes or some other closely related tribes

were also the bearers of the Talyche culture in the 8th century B.C. with a border traceable from the Araxes river across eastern coast of the Lake Urmia to Zagros Chains. This border enclosed at that time the sphere of developed civilizations of the so-called high cultures. The area beyond this border was inhabited by various Indoeuropean tribes, whose cultures were just in evolution.

LURISTAN BRONZES AND IRON

We have now to return to the group of so-called Luristan bronzes, some types of which have been already mentioned in previous chapters (flat bronze daggers with flanged hilt). These types were spread, as recently shown, not only in Luristan, but over the whole area up to Talyche at the Caspian. However, Luristan bronzes include various objects from the category of ornaments or weapons. It is not the purpose of the present study to carry out a stylistical analysis. Luristan bronzes sold by merchants are generally not stratified. It seems that their greater part comes from one or several destroyed necropoles.[75])No attempt has been made to reconstruct such a cemetery. Nobody knows the period during which such a cemetery was in use. Several centuries can be considered. Certain forms which are of importance for the beginning of the Iron Age in Iran deserve anyhow our attention. Among various castings there are types made both of bronze or bronze with iron parts: daggers with iron blades and bronze hilts (fig. 7:3), halberds or axes with iron edges and bronze shafts or adzes of a similar construction. In the second group there are combined bronze-iron artifacts without exact analogies made of bronze: other types of daggers, pins, bracelets. Finally the third group: all-iron artifacts as daggers, axes, arrow heads, ornaments.

With Luristan bronzes, rank e. g. bronze daggers with fan-shaped lobes on the saddle-formed pommel. Both type and construction are identical with parallels in Azarbaijan and Georgia (Tsalka, Ani, Chagoula Derré). Their Luristan variant is characteristic by tips on the fan-shaped lobes. *Schaeffer* publishes three examples, one of which is kept in Boston. It is possible to add other objects, one in the University collection in Lausanne, Switzerland,

and the other in the Staatliche Museen zu Berlin or in the Pennsylvania University Mus. in Philadelphia.[76]) The Archaeological Museum in Tehran owns an important example (fig. 7:1) with a broken iron blade.[77]) The bronze hilt is set on the iron tang of the blade as seen on the top of the pommel. Another piece from the Tehran Museum: a dagger with a circular crescent (fig. 7:2) in its guard and with engraved bronze hilt, set in the same manner on an iron blade, cut through in the crescent. This specimen corresponds with the oldest tradition of Luristan weapon manufacturing. Of an extraordinary importance there is an iron dagger or sword with bronze hilt, the pommel of which represents two bears with their heads facing out (fig. 8). It reminds us stronghly of the iron daggers with human heads discussed below.[78])

A characteristic group are bronze axes or halberds. The whole part of the shaft-eye is ornamented and on the neck there uses to be a figure of a crouching animal.[79]) Several pieces are known whose blades or edges are not of bronze but of iron (fig. 7:4) as demonstrated by two pieces in the Tehran Museum. Another example is published by *Godard* (collection Weill) or by *Pope* (collection Meskin). The Brooklyn Museum possesses a very typical example (no. L 62.27.27).[80])

Both in the Gandsha-Karabagh and in the Mannaean milieu there occur bronze mace-heads.[81]) *E. E. Herzfeld* published one of them with iron handle.[82])

Splendid castings are bronze battle-axes or -adzes. Their shaft--eye being similar to the halberds, however, their neck does not cover a crouching animal but three or four pics.[83]) This group includes objects — most probably symbols or ritual weapons — the edges of which are in horizontal position as at an adze.[84]) Among the last mentioned there are several examples with an iron edge set in. *A. Godard* presents one piece from the Louvre collection, but he writes on many with traces of an iron blade.[85])

Some of the Luristan artifacts have no models in all-bronze, f. i. a dagger with a triangular iron blade and a bronze hilt with a short straight guard.[86]) Massive open bracelets with bronze tips[87]) and iron pins with ornamented bronze heads[88]) are known, too.

Referring to the last all-iron group, iron ornaments, especially

massive open or closed bracelets with rich plastic ornamentation[89]) or iron pins with globular head[90]) are to be mentioned. Among weapons there are iron tanged arrow heads[91]) or iron battle axes (fig. 7:5) and iron maces.[92]) The last group contains marvelous daggers with human heads on the pommel, deserving a special chapter.

IRON DAGGERS OF LURISTAN

We have described a sort of a dagger in Talyche and Luristan possessing a saddle-formed pommel with fan-shaped lobes. Their blade level forms with the level of the hilt a right angle. If we imagine instead of the saddle-formed pommel a round disc, we have got a new type of a dagger, an important transitional form, having been recently analyzed by *Maxwell-Hyslop* and *Hodges.*[93]) The results of this investigation are surprising. First, a detailed radiography combined with a section had shown that the hilt was not formed by hot forging, but composed of 5 panels — the middle is prolonged similarly as the blade — fastened by four rivets. The shape as a whole including the imitated bands, had been obtained by previous forming the plates or panels. Only the disc pommel had been set on a tip of the middle part. The complex was not welded together. The metal was inhomogeneous steel (with some eutectoid zones in the middle of the blade), but both edges were decarburized to the wrought iron. This is a curious but rather a primitive example of forging technique in iron.

If we add two bearded human heads to the disc pommel, so that their position would correspond to the fan-shaped lobes of the first type — we have a typical Luristan iron dagger well-known of many museums or private collections (fig. 10). All the known pieces are told to be from the Luristan territory, but none had been found in situ. One of these weapons is equipped with a bronze hilt or plated by bronze[94]) enabling a more exact description: heads with bulged eyes and aquiline noses have lions' faces in their rears. The handle of the hilt has two bands and the level of this handle is turned in a right angle to the level of the blade. Instead of a guard there are two

crouching lions adhering to both sides of the hilt. But the majority of all weapons are of iron (length not over 50 cm, width of the blade 2—3 cm). The uniformity is striking.

These weapons were frequent on markets with antiquities in early thirties of our century, this circumstance being eventually due to the exploiting and destroying of a larger cemetery or of a group of necropoles. Nowadays about 40 daggers can be registered in the scientific literature. The number in various collections might reach more than a hundred. The inventories indicate Luristan as the place of their provenance. Only the Rabenou collection in the United States mentions the finding place of one sword to be Alishtar in Western Iran (1928); further five swords should have originated in the Poukhtę Kooh range (1959) where most probably another gravefield had been destroyed. The museum in Tehran keeps a dagger described as from the vicinity of Kermanshah.[95]) Only one piece should have come to light outside Luristan: dagger from the former Khanenko collection in Kiev, brought either from southern Russia or from the coast of Asia Minor. To both these places it might have been brought by Cimmerians or Scythians.

There are many problems with this type. First, complicated ornaments of the weapon in question inspired scholars with a hypothesis of a chieftan's symbol or emblem, rather than a normal weapon.[96]) Secondly, the relief of the ornamental elements created an impression about casting in iron — which would have heavy consequences for all the history of technology in the Near East (pig iron production in the early 1st millenium B. C.). Finally, the origin of the type had been discussed, sometimes on the basis of a cursory combination of judgements. For instance, *Herzfeld* held these daggers for a strange element in the whole Luristan complex. He used therefore the Khanenko dagger and concluded that it must have originated somewhere in the Pontic coast. Moreover, just there should have been situated the centre of production. Into those regions use to be placed Chalybes, a famous iron smelting tribe.[97]) Eo ipso Chalybes should have been manufacturers of iron daggers in Luristan. Their dating is not fix so that the daggers are considered sometimes as first models of iron working. *A. Godard* believes them to be the weapons of Kassite warriors.[98]) Other historians admit the Hittite

tradition in the forming of Luristan iron daggers.[99]) There is much of imagination in all these opinions, I suppose.

There is no other possibility than to consider all facts before trying to draw any conclusions. First I shall deal with the technology of manufacturing, because about twenty daggers of that type have been analyzed in various laboratories. Individual reports are not of the same value as there was a limited liberty in taking samples in many cases. The information is therefore not complete. The first aim was to clear the superstition of the casting technique. This was mostly the object of a metallographic investigation. *Herzfeld* let already make an analysis of the hilt of the Khanenko sword. The result: wrought iron.[100]) The same is to be said about the dagger from the Museum of the University of Pennsylvania, Philadelphia (inv. no. 30-38-18). The same material had been used for making a bracelet of this collection (inv. no. 30-38-28), *R. M. Brick* stated. *J. Ternbach* published recently an examination carried out by *L. Pitkin* and *E. Silkis;* the object was a bent dagger of the Herzfeld collection.[101]) A microphotograph shows clearly a ferritic structure with various sizes of grains, and lines and chains of non-metalic inclusions (with light segregations) as well. The analysis of the dagger in Musées Royaux d'Art et d'Histoire, Brussels, brought some detailed data. The author *R. Snyers* writes that the disc of the pommel was of inhomogenous steel with varying pearlite and ferrite proportions (maximal carbon contents ca. 0,4 %). The purpose of this test was also to prove wrought iron.

The report of the investigation of a specimen kept in the British Museum signed by *R. M. Organ,* is more detailed. Unfortunately it deals with the hilt only. The disc was covered with black patina (Fe_3O_4) indicating the presence of the object in heat. This is confirmed also by the structure, consisting of ferrite and pearlite in the form of Widmannstätten structure; it signalizes a final overheating with relatively a rapid cooling, not allowing the diffusion or ferrite grains. Original austenite texture is still visible. *Organ* might guess the carbon content as 0,5%, Perhaps 0,3 % would be a better estimation. The steel is relatively homogeneous. The so-called lions on both sides of the guard are very badly fixed. The technique used seems to have been rather burring than real welding. Luristan dagger is that one

bought by the Metropolitan Museum in New York.[102]) Sixty-four carnelian inlays in the hilt support the impression that the manufacturing of the weapon was rather due to a jeweler than to a blacksmith. The X-ray test proved that both lions on the guard are separate additions and that the blade had been inserted into the hilt (fig. 8:1). Iron wire bands in the hilt were overlapping. A layer of black patina was under the corrosion. Microscopical observation examined the beard of one of the human heads and then the rib of the blade. In the first case only ferrite has been stated, in the second, one ferritic structure with spheroidized cementite, i. e. annealed not very hard steel. Microhardness test: 86 HV. The author of this report, *C. Lefferts*, suggests the possibility of forming heads etc. in dies.

A very detailed analysis of a dagger from the Hamburger Museum für Kunst und Gewerbe had been presented by *F. K. Naumann* of the Max-Planck-Institute.[103]) Especially his radiographic examination made by Ir^{192} isotope is very instructive. The sword consisted of 11 separately manufactured parts with the blade slightly inserted into the hilt (fig. 9:2). Metallographically three spots were investigated: the disc pommel (ferrite, traces of pearlite) and the middle of the blade (strips of ferrite and ferrite-pearlite zones, tertiary cementite in the ferritic areas, indication of W-structure, maximal carbon content about 0,3 %). Unfortunately no specimen of edges could be investigated so that the construction and properties of the cutting part remain uncleared. The material used could be described as an unhomogenous carbon steel.

O. W. Ellis investigated a Luristan dagger kept in the Royal Ontario Museum of Archeology in Toronto. The pommels, disc and bearded heads were made of inhomogeneously carburized steel (ca. 0,45—0,65 %). The parts near the surface were probably secondarily decarburized during the reheating. Zones of Widmannstätten ferritic-perlitic structures changed with those consisting of pearlite grains with ferritic network or needles. Quite another picture was observed near the point of the blade. The structure was of ferrite and homogenously distributed spheroidized cementite (hardness 190 HV), this being the property of annealed steel.

R. Damien published a complex investigation of a dagger of

his own collection — Isotope Co^{60} and X-rays proved that the weapon was composed of 8 separate pieces. The hilt and the blade were made from one rod (fig. 9:3) and the blade was not set in as in the case of the Hamburg or New York samples. Broad chinks between crouching lions and the bloc of the guard show that no perfect welding had been employed. Microstructures in the disc, guard, blade and cutting edge correspond with mild inhomogenous carbon steel (ferrite-pearlite, ca 0,25 % C). Some traces of the Widmannstätten structure are visible in certain places of the polished bloc. The author of the metallographic examination *(Steichen)* suggests the material to have been three times heated (at first over 900 °C) and then cooled below A^r 1 (670 °C) and finally left in the open air. The chemical analysis is very fine, but the respective results known from two publications differ.[104]) In any case a sort of iron very poor in phosphorus, containing some nickel and copper is involved.

Recently has appeared a publication of three Luristan daggers one of which represents an example with two human heads. The metallographical examination dealt only with the hilt, but it was stated that the two bands were inserted into two carefully cut grooves. Large ferrite grains were observed at the surface, whereas the finer texture with traces of pearlite was closer to the inside of the hilt body. Another specimen had bee investigated by *C. S. Smith.*[105])

In order to enrich the knowledge of the blade construction, I seized the opportunity to investigate a dagger belonging to a collection of three pieces of this category kept in the Deutsches Klingenmuseum Solingen (fig. 11:1—3), inv. no. 55.132.[106]) After taking radiographs it was clear that the conception corresponds to that known in the case of the Damien's dagger: hilt and blade made of one piece of material (fig. 9:4). Human heads, lions, bands and disc pommel have been added, not by means of right welding, but perhaps by burring or shrinking. Metallographic results are rather surprising: both in the pommel and blade (from the cutting edge up to the middle rib) only homogenous steel could be observed (fig. 10:1) the structure of which consisted of ferrite and spheroidized cementite (fig. 10:2—3). Boundaries of the ferrite grains are still visible. Hardness of that annealed material: 205—245 HV in disc, 257—299 HV in

the cutting edge, 263—314 HV in the middle of the blade. The metal was very pure: P, Mn, Cu only in traces, Ni 0,049 %. The quantity of the nonmetallic inclusions can be characterized by 3—4 of the Jernkontoret scale.

We can draw some preliminary conclusions concerning the technology and properties of those Luristan daggers. The material in question used to be relatively pure iron, extremely low in phosphorus, or medium carbon steel. Carbon is very often divided unhomogenously, sometimes a certain integration had been reached by forging. From this kind of material individual elements have been forged. With the exception of one example, signalized but not published by *C. S. Smith,*[107]) none of the examples points to the stress of the smith to rise the hardness of the blade. On the contrary, annealing and forging lead to the diminuting of hardness on behalf of toughness. The blade was either made separately and set into the hilt (eventually by the aid of rivets, Hamburg) or the hilt was forged together with the blade and made distinct below the guard by upsetting. The manufacturing process of bearded heads and lions has not yet been fully cleared. Chiseling and forging seem not to come into consideration. Making of same in stone dies was likely among the skilled bronze founders with rich experiences in making stone moulds. This possibility, however, is not proved. Iron disc used to be set on the top of the hilt (burring or shrinking again comes in question). In all events the plastic forging underwent a certain progress when compared with the piece composed of riveted panels described above. [107a])

An extremely laborious mode of manufacturing is striking when taking into account the eventual inlaying with precious stones. Each piece underwent 25—30 fundamental forging operations,[108]) and possesed a relatively high artistic value, however without adequate properties of the blade for fighting. In this respect the opinion classifying the daggers as symbols seems to be correct. This hypothesis contradicts a relatively high number of known examples found in a small territory: there must have lived[109]) a greater number of prominents. The lacking archaeological circumstances make the solution of the social function of Luristan iron daggers impossible.

Except for the example of the Khanenko collection, all other

daggers of that type came to light in Luristan. It seems to be evident that the final shape was developed and used in the same territory. Quite another question is that of the model. Although some ornamental elements could be the result of western artistic influence, the fundamental conception (i. e. the complex disposition of the hilt, the turning levels of the blade and that of the hilt) points clearly to weapons known in the local milieu and in the Transcaucasian cultures. In both territories predecessors in bronze-iron or in bronze are not rare. The Luristan iron dagger with two bearded heads sitting on the disc pommel seems to be the last and typologically the youngest member of the sequence. It surely belongs to the latest phase of the Luristan metal artifacts horizon. In the light of the present facts it could not be earlier than the 8th—7th cent. B. C. No other ethnical milieu than that of Medes and Protopersians comes therefore in question.[110])

Luristan metallurgy survived several centuries (from 11th to 7th), but the greater part of artifacts including weapons with bronze hilts and iron blades belong to the period from the end of the 9th to the beginning of the 7th cent. B. C. This stage of the Luristan metal working corresponds very well even chronologically to that of the Talyche culture in Transcaucasia. Both groups of the material culture are, according to my opinion, stigmatized by the same related bearer-groups or tribes of Medes. The Luristan centre was based anyhow on much earlier metallurgical and artistic traditions originating from some more ancient inhabitants. Medes learned to know and to work iron after their arrival to Western and Northwestern Iran. Iron was the metal used for making ornaments and weapons. This is what archaeological sources enable us to state.

THE IRON REALM OF ACHAEMENIDS

Medes, characterized as soon as since the 8th cent. B. C. by the Indo-Aryan ethnic component, occupied about one century later whole Western Iran down into the Kavir desert in the East and subsequently Asia Minor up to the Halys river. In the southern part of the Median realm excelled the Persians being in ethnical relations with Medes and about 550 B.C. they became

superior over the Medes under the king Astyages (Ištumiga), son of Kyaxares (Uvachštara). Cyrus, later called Cyrus the Great, the fifth king of the dynasty beginning with Achaemenes, overruled the Median capital Hagmatána or Ekbatana (now Hamadan) and became the founder of the mighty Achaemanian empire.[111])

We have no evidence of the development of iron smelting and working during the period of hundred and fifty years of the Median era. Nevertheless, a revolution must have taken place in this industry since the period of manufacturing short Luristan swords, as well as before building Pasargadae, a new capital of Cyrus, northheast of the modern Shiraz.[112])

Ruins of Pasargadae in one of the valleys between Shiraz and Dehbid are signed by Cyrus' inscriptions: "I am Cyrus the King, Achaemenian". But in the stones are buried other signs, too: traces of former presence of a huge quantity of iron. By means of steel tools well worked limestone blocs of the palaces of audience and residence were joint by U-shaped iron clamps, set into special cavities and embedded by lead. The last example of a pair of such clamps is preserved in the eastern wall of the Palace of Audience. The beds or cavities are 29 cm long, the iron clamps themselves measure 20 and 20,6 cm, section 20×20 and 17×17 mm (fig. 14:1). In a distance of one kilometer from this palace there is a citadel on a hill. Its western side is faced by large stone blocs joint one with the other by three iron clamps. Estimating their weight approximately to 2,5 kg, the total weight of iron — considering 20 lines and about 6000 clamps — in the western bastion amounts surely to ca. 5 tons and many tons of lead. The same technique had been employed in the case of other buildings as well: for instance, the fire tower and the famous Cyrus' tomb distant some 3 kilometers from the citadel. The latter represents a large building of 7 steps consisting of huge worked stones, joint with iron clamps. The last preserved piece remains in the joint upon the third step in the eastern side of the mausoleum (fig. 14:2). In all city buildings there were buried several tens of tons of structural iron so that in later ages the ruins served as mines of ready-made iron. All easily accessible clamps had been removed; except for the two already mentioned, one single clamp can be seen in the northern stair-

case of the citadel.[113]) Small pits in the wall are last traces of other clamps.

King Darius (Dárajavauš), son of Hystaspes, enlarged the Persian realm. He wished to possess — beside Susa, Hagmatána and Pasargadae — a new site suitable for celebrating spring festivals. Just at the end of the 6th cent. he started to build Persis or Persepolis at the foot of the present Kooh-e-Rahmat range on the edge of the Marvdasht. The construction continued also during the reign of his son Xerxes and during the 5th cent. B. C. Monumental buildings of that city have been constructed by the same technique as in the case of Pasargadae: iron served as joining material not only in the walls of palaces and columns, but also for repairing nearly all plastics and statues. Huge quantity of iron and lead was necessary for making clamps and dovels and for their embedding in the cavities (fig. 13:3). Buried defects in the limestone which occurred very often, used to be discovered no sooner than when finishing the artifacts. In such a case the stonecutter did not resignate, but tried to repair the spot in question. The failing place was chiselled out and a carefully worked piece of stone was placed into the niche (fig. 13:5). Iron clamps and lead emebedment were used as joining material. The huge double-headed bull on one of the column-tops had been patched in this way on five places (fig. 13:6). The basis of a horse statue is repaired in two places by means of 6 small iron clamps (9 cm long). The basis of a lion or tigre marble plastic, now in the Persepolis museum, had a bad crack repaired by the same technique. One of the huge blocs in the wall of the so-called Hundred-Columns Palace was fitted over its crack by four clamps. Nearly each larger stone bloc, worked as a relief (doors) or without any ornamented detail column fundament or its cannelure — bears traces of iron-and-lead repairing. Somewhere the clamps reached the length of 25 cm, sometimes only nails or iron wire were used to be embedded by lead when patching an eye or a fin rim.[114])

Further evidences of this joining technique — after all unnecessary, because fine worked blocs hold together even after removing the clamps — can be seen in Achaemenian buildings of Istakhr near Persepolis (gate, ruins of a palace.[115]) The big fire tower just in the front of the royal rock tombs at Naksht-e-Rus-

tam had 18 such joints in the stone plates of the roof only.[116])

By the courtessy of the Archaeological Service of Iran I had the possiblity to investigate a cross-section of one iron clamp from Persepolis. Dimensions of the section are 17×16 mm. The polished surface was marked by numerous craks (fig. 11:4). A relatively small amount of slag inclusions are visible in the metal, about 2—3 after the Jernkontoret scale. Light segregations are typical of these inclusions. After etching by nital a considerable inhomogeneity could be observed: pure ferritic structure (hardness 157—161 HV, grain size 4—5) transites to the ferritic--pearlitic zone (162—182 HV) with local occurrence of Widmannstätten. The carbon content is arising so that in other part of the section there is hypereutectoid structure with lamellar pearlite (239—247 HV) grain size 4—5 after ASTM and cementite — fig. 10:5—6. Chemical composition: 0,06 % P, — % Cu, — % Ni and Mn in traces. This is a typical heterogeneous carbon steel.[117])

Using iron and lead in the Achaemenian architecture in Persia during the 6th—5th cent. B. C. is very imposant[118]) and proves clearly the big progress of the iron industry.

The common use of iron in the Achaemenian period, so clearly proved by the already mentioned features, is not so striking in the light of other iron objects rather sporadically found in the ruins. Still the few irons have a certain evidencing value indicating full Iron Age. Ploughing by iron ploughshares (fig. 13:1), digging by iron-fitted spades, fighting with iron swords (a flange-hilted form is from Susae) and daggers or spears are evident. Iron scales of a cuirasse deserve certainly the attention, respectively in the light of written sources mentioned below. Bronze pulleys (fig. 13:3) with an iron axle[119]) seem to have found their use in the course of building.

According to the basreliefs, short swords of the akinakes type (fig. 14:4) — wide spread both in Persia as in Scythia[120]) — belonged to quite common weapons.

Smithies or blacksmith's tools have not yet been discovered and also a detailed knowledge of the smithing technique is still lacking. But we have to suppose that the level of iron working crafts in ancient Persia was relatively high. We can take into account some written sources, of course, not very numerous up to the present date. In Persepolis there were found over 30.000

clay tablets: partly in the so-called royal treasury, partly in an administrative wing close to the nothern wall.[121]) These tablets are in fact account records or invoices from the time of building individual palaces or other objects. They are written in cuneiform scripture and in Elamite language. Four of those tablets draw our attention, i. e. in the translated and published part. The information is surprising: blacksmiths must be specialized in different branches and their labour must be organized and paid. Tablet no. 18 is a cheque — certain Darkaush tells to the treasurer Baradkama he has to pay 88 karša and 55 shekels to a group of 239 blacksmiths, who have worked under Vahesh during 3—4 months making iron doors for the palace of Xerxes. The document was payable in the fourth year of the emperor's reign (482 B. C.). Two other tablets were confirmations of receipt: no. 23 registers that two blacksmiths working 6 months and manufacturing iron doors got 1,5 of shekel in the year 480/479. The tablet no. 74 concerns the payment of 139 karsha of silver and $5^2/_3$ shekel for blacksmiths and carpenters under Uratinda; they worked during five months as a team of 501 in Persepolis. On all these documents iron is indicated by the very ancient ideogram AN.BAR. The tablet no. 52 is a cheque again: a foreman named Artataxma asks the treasurer of Persepolis to pay 14 karsha in silver to 55 armourers (rasahara, manufacturers of scaled armour) under Otanes, sitting in Nāreṣi (evidently now Nairiz, about 100 km distant from Persepolis). The armourers were not compelled to place their workshops close to the iron mines and bloomeries, but were perhaps expected to do so. Mediaeval Arab geographers mention iron mines near Nairiz and Khataq.[122]) Recent reconnaissance discovered iron mines and smelting places, also those of the Islamic period in Hannashq, some 100 km northeast of Persepolis.[123])

The reference on making armour is very interesting. The Persian production was famous on the other side of the battle front, namely at the Greeks. For instance Herodotus, describing Xerxes' march across the Hellespont and enumerating different troops with armour, mentions wordly Persian helmets of bronze and iron.[124]) The same author refers to scale-cuirasses of Persian cavalry and infantry, ressembling "bird's feathers and fishes' scales" made of iron; quite similar armour used to be worn by

Median, Hyrcinian, Bactrian, Sogdian and Khorasmian military troops,[125]) Later references of Xenophon concern armour in several places, but without mentioning the material. He informs instead that in the battle of Cunaxa scaled armour protected also horses.[126]) We are told the same by a much later report written by Flavius Arrianus (2nd cent. A. D.): in the Persian cavalry about the time of Alexander the Great (4th cent. B. C.) both horses and horsemen were protected with scale armour.[127]) Armour of high quality used to be common among the Scythians, Sarmatians and Parthians[128]) who, without any doubt, must have continued the Persian tradition. Persians and Medes, too, developed their knowledge due to the contacts with Assyrians. Both archaelogical and iconographical evidences persuade us that scaled armour had been widespread in the Assyrian army.[129])

Greek written sources are completed by some finds and Persian basreliefs documenting weapons of Persians, Medes and other nations and tribes in the Persian empire. Iron weapons were without any doubt quite common since the 6th B. C. According to the tradition a typical Persian weapon was a curved knife, described by Greeks as drépanon — sickle. Herodotus writes that Cyrus has started the revolt against Medes with the words: „I bid you all, men of Persia, to come each of you with your sickle."[130]) Unfortunately we are not well informed about these sickle-shaped daggers; they could be similar to those found in Urartian cities (fig. 2:16). At all events, oriental folks preferred short side weapons such as knives, daggers to long swords of the Aegean or European type. Daggers called by Herodotus encheiridion, Cambyses' iron sword[131]) or those of Persians or nomad Sagartians in Persian army[132]) were all of that type. But most common was evidently the already mentioned dagger of the akinakes type (fig. 14:4). Herodotus writes on "Persian sword that which they call acinaces".[133]) The Median dagger or short sword described by Xenophon and later by Strabo as "kopis"[134]) was probably curved like kris or drepanon or Greek, eventually Iberian falcata. Another type of weapon is an axe or battle-axe. Cynegirus, brother of Aeschylus, lost his arm when attacking the Persian fleet during the operation Marathon; it had been cut off by an axe (pelekei).[135]) Xenophon, in a later report holds axes called sagaris for a typical Persian weapon.[136]) Bron-

ze mace-heads were mentioned in one of the previous chapters; now we want to add that "wooden clubs studded with iron" were in the Assyrian contingent army in the Persian campaign against Greeks.[137]) Lance and spear heads were doubtlessly of iron, although not reliably referred to. But this is the case of the iron-tipped arrows of the Indians in the Persian army.[138]) An unusual effect must be ascribed to a big iron-headed arrow of the Carduchians described by Xenophon in Anabasis. They were over three feet long and easily pierced shields or cuirasses. The Greek soldiers used to pick them up; "they would use these arrows as javelins, fitting them with thongs", Xenophon adds.[139])

Persian armour and weapons used to be completely of iron in the 5th cent. B. C. This fact is confirmed quite well by the following indirect indications. Herodotus, for instance, draws a special attention to the troops in the Persian army not equipped with iron. Ethiopian warriors had short arrows tipped by sharp stones and their spears were pointed by gazelle's horn. Such neolithic-age-weapons must have been in a deep contrast with the equipment of other troops. Lybians and Mysians had javelins of charred wood; Moschi, Tibareni, Mossynoeci, Macroni and Colchi wore wooden helmets on their heads (koléa xylína).[140]) Also Massagetae beyond the Caspian Sea did not use iron, although they had plenty of gold and weapons of bronze.[141])

The short survey of Persian armour and weapons can be concluded with some references concerning famous Persian sickle-wheeled battle chariots, badly destroying the cavalry of the enemy. They are, of course, mentioned in later sources, although always in connection with earlier historical events. Diodoros Siculus (1st cent. B. C.) registers them already when describing the battle at Cunaxa (401 B. C.). They were used in Artaxerxes' army. Flavius Arrianos writes about these vehicles in his description of the battle near Gaugamelae with Alexander (331 B. C.).[142]) We do not know the real shape of that type of armoured cars, but the sickles set into the wheels may be presumed to have been of iron.

Information of Greek authors cannot be understood literally. Neither Herodotus was able to gain exact details on the armour and weapons of all troops of the Persian army having crossed the Hellespont half a century ago. But there is no doubt that

Greek reports do justice to the common use of iron in the Persian warfare of the 5th cent. B. C. Iron armoured Persian cuirasseers (thorékoforoi) — that was a notion for the Greeks. So we have to conclude that the metallurgy of iron and all iron working had underwent a rapid development during the end of the 7th and in the 6th cent. B. C., reaching in the 5th cent. already a very high level.

IRON IN THE AVESTA

The process of the above mentioned rapid development is not yet documented due to lack of systematically excavated monuments of the 7th and the early 6th cent. B.C. We can, however, find out some information in the ancient Indo-Iranian literature, in the Avesta, representing compiled religious texts which were originating somewhere in Northwestern Iran and then spreading all over the Iranian area including both Media and Persia.

This attempt is subject to numerous difficulties. Avesta is not a homogeneous work and consists of several parts: that of Yasna containing liturgical rites, that of Visprat with its invocations, that of Videvdat — a religious codex, that of Yashts, celebrating gods and heroes and other exorcisms and prayers. These texts are only a fragment of the original Avesta. The preserved parts evidently originated in different periods whose dating is not fixed. Avesta used to be recited through many ages by heart only. It had been written much later, perhaps as late as in the Sassanian period in the first centuries A. D. Nevertheless, some parts are of a very ancient origin and they could bring some light in the material culture and technology of ancient cattle breeding Indo-Iranian tribes of Central and Soutwestern Asia. As most ancient parts of Avesta are considered certain sections of Yasna, the so-called Gathas, which are believed to contain sentences of the legendary Zoroaster or Zarathuštra. The data of his life and activity are not exactly known[145]) — the 8th cent. B.C. is recently hold to be the most probable.[144]) From that point of view Gathas, for instance, should contain some important allusion to metallurgy or metal working. To the older Avesta belongs Yasna (Y) 35—41, the so-called Haptanháiti, somewhat later seems to be Yasna 9—11 and 57 of the 72 chapters.

Some of the Yashts (Yt.) may be very ancient, especially the numbers 5, 8, 10, 17—19 of the complex number of twenty one. The remaining Yashts are younger. Later Avesta includes Visprat (Vr.) with its 24 chapters and Videvdat (V.) 22 chapters.[145]) The latter parts originated as presumed in the course of the 2nd half of the 1st millenium B.C.

It was believed that in the whole compendium of Avesta, both in elder or later sections, the term designating iron must exist. *L. Beck* already referred to the Videvdat texts (formerly called Vendidad), where he tried to find out after the *Spiegel's* translation, weapons and implements of iron.[146]) *M. N. Dhalla,* an Indian historian, registers iron helmets and maces or clubs, basing on Yashts 10 and 13 and also on much later, medieval, Pahlavi texts.[147]) The term "iron" occurs in various translations of the Avesta books. It is worthy to deal, for instance, with the German translation of *Wolff* (1924).[148]) In Yasna 9 and again in the Zam Yasht there is an identical episode: hero Keresaspa — after the victory over the Gandereva monstre — cooks meat in an iron kettle at noon.[149]) In Yasna 11 the intoxicating beverage haoma is celebrated[150]) which made the Turanian king Franrasyan drunken so that he had to stay in his underground iron fortress.[151]) Mithr Yasht with its note on thousand gold-tipped arrows with feathers may also be of importance; according to a later addition these were equipped with iron trunnions.[152]) In the same Mithra's charriot, containing the arrows, there were also other weapons: thousand iron clubs, maces made of yellow metal, thousand steel (haosafna) axes with double edges.[153]) Similar places are also in later yashts, for instance in the Ram Yasht: the mythical king Haošjanha Paradáta makes sacrifice on the top of the Hará Mountain (Elburz), seated on a throne joint together by iron.[154])

The later Avesta contains much more places where the word *ajañh* used to be translated as iron. It occurs three times in Visprat, relating to the blessing of the sacrificial implement: the haoma press, dedicated to Ahura Mazda.[155]) This press seems to have been made of iron. Many notes on metals are in Videvdat. In the chapter 14, there is described a complete equipment of a varrior including spear, cuirass, dagger, club, quiver with thirty arrows, a pair of leg-armour. But no mention as to the material is added, excepting arrow tips of iron.[156]) Heavy chastisements

to the passing body are assigned in chapter 4: cutting with iron knives or tying by iron bonds.[157]) Several times there are enumerated various drinking cups made of different metals. If a dead body touched such a cup it had to be purified once more — the golden vessel once, the silver one twice, the iron one thrice and that on steel even four times.[158]) During various processes of purification connected with the rite of the dead, oxen urine kept in iron or lead vessels[159]) should have been used. A menstruating woman was a problem: "... in what vessel should be her brought the meal, and in what the beer?" — "In that of iron or lead (AirW 1649) both the less precious metals."[160]) Finally, an important place is in the 8th chapter of Videvdat — for the purification process as mentioned above, there is necessary the fire of the potter's klin, of the glass-maker's furnace, of a furnace of unknown purpose, and then of metallurgical furnaces or metallworker's hearts (pisra-):[161])

V. 8 89 "Oh Cretator, if somebody will bring the fire from the hearth where (iron) is gloaming ...
90 Oh Creator, if somebody will bring the fire from the hearth where steel is heated?"

The metallurgical evidence of this fragment is not very important due to the rather unclear terminology — one and the same term could be explained as heating, melting, smelting or welding of all metals including gold, silver, iron and steel. The importance persists in the fact of dealing with pyrometallurgy at all and in ranging of metals. The term ajańh, again, preceded the term haosafna.

One thing draws our attention when reading the translations of Avesta; there are references neither to copper nor bronze. This circumstance is quite striking in the places systematically enumerating metals (cf. V. 7 75 or V. 8 89). But a whole series of objects used to be translated as "made of metal". In the original text there appears in such cases solely the term ajańh or ajanhaena-. We have just drawn our attention to Wolff's "haoma press of metal" (Y 22 2) and — in the same connection — "of iron". Chapter six of Videvdat says that the feet and the hair of the dead are to be fixed with pieces of metal (iron?).[162]) There are

many cases where translations use the term "metal" (cf. Yt. 10, 70 describing various metals parts of the monstre Verethragna). It is very important that this notion occurs also in the most ancient parts of Avesta, in the Gathas. There are places relating to ordeals where gloaming metal plays its role.[163]) The Fravartin Yasht contains the "sky similar to the gloaming metal".[164]) Stream of metal (perhaps ordeal again) is worshipped in two other places.[165]).

All these observations lead us to the following conclusion: the ancient Avestan language[166]) used one term, namely *ajańh,* for describing "metal", most probably copper or its alloys. It is quite possible that the same term was used later on for some objects of iron. After all, Bartholomae's Altiranisches Wörterbuch translates ayańh (ayah) as "Metall — Eisen".[167]) Still later in the Pahlavi language āsēnēn means already iron and so does the recent Persian áhaen. The text of the Avesta makes impossible to distinguish the places where metal (copper, bronze) and where iron is meant. The analysis of Avesta brings no positive information of the use of iron in the ancient Indo-Iraian society.

Avesta is not the only example demonstrating the transposition of the term of "metal" into that of "iron". In the Indo-Iranian area there existed another term of the same stem, namely "ayas" in the Vedic language which has been also discussed. Formerly some scholars believed same to mean iron, but *H. Zimmer*[168]) seems to be right when interpreting it already in the seventies of the 19th cent. as copper or metal.[169]) Only having an attribute *"śyaman-ayah"* or (blue or darkblue copper), which is the case in the later Atharva-Veda,[170]) it may mean iron. Analogically in the Sanskrit: *kalayasa* (darkblue copper) and *kršnáyas* (dark copper).

There is no doubt about a certain link between both Avestan *ajańh* and Vedic *ayas* with the ancient Indo-European stem *aios* meaning metal or copper. The same meaning has the Latin *aes* (aeneus), Gothic *aiz* (ore, copper, coins) and acient Germanic *a(i)z* (cf. ehern — copper). In the western Indo-European languages this stem had been changed into iron as well: ancient German *ēr* or Nordic *eir* (copper, ore) became Anglosaxon *iren,* English *iron,* Scandinavian *jarn, järn, eisarn, isarn* and German *Eisen.* Celtic *isarno,* ancient Irish *iarnn,* Cymrish *haiarn,* ancient

Cornish *hoern.*[171]) The same transformation of the term for "copper" or "metal" could be eventually observed, too, in the case of the second Indo-European stem ghel(e)gh, i. e. copper, bronze and later iron. Some linguists connect χάλκος (Cretan term for purple κάλχος) and χάλκος (red metal, copper) with iron of the Northeastern Indoeuropeans: ancient Slavic *žělezo,* Russian железо, Polish *żelazo,* Czech *železo* etc., Lithuanian *gelžís,* ancient Prussian *gelso,* Lettish *dzels.*[172])

According to my oppinion Indoeuropeans were not acquainted with iron when colonizing the Iranian plateau. Copper and bronze were common metals described as ajańh or ayas. The people learned to know iron while contacting highly developed civilizations somewhere in Northwestern Iran. We do not know the term for iron in the ancient Persian language, because the Persian texts use the very ancient ideogramme AN.BAR. In the language of Eastern Iran iron might be buried under ajańh, however we are not able to distinguish both metals. Some indication could offer the comparison with later Pahlavi translations of Avestan texts. So the completely isolated term haosafna of the Avesta is substituted by pōlawāt i. e. the recent Persian *pūlād,* Arabian *fulad* and Russian *bulat* meaning wootz steel. The authenticity of later versions is not very fix. The evidence of Avesta is rather negative confirming, however, the ignorance of the Indo-Iranian inhabilants of the metallurgy of iron until their arrival to the territory of Iran.

Summary

Iran is very rich in metal ores. In ancient times or in Middle Ages even wood for burning charcoal was abundant. During the 5th—3rd milleniums B.C. high civilizations occupied some parts of the Iranian territory offering natural and cultural conditions for developing an important area of the early metallurgy. This was really the case of smelting copper and possibly lead.

The situation was quite different with the metallurgy of iron. The process of its discovering could have taken place in the

northwestern part of Iran only (white cast iron of Geoy Tepe, 3rd millenium B.C.), but both cultural and technological relations of that country pointed to eastern Anatolia and North Mesopotamia, later on — during the 2nd millenium B.C. — the cultural level of other parts of Iran became much more simple, perhaps in conection with the coming ethnical elements of Indoeuropean origin. The greater part of Iran never belonged to the homeland of iron. On the contrary, the Iron Age had begun there relatively late.

First iron objects — very rare artifacts — occur only in Northwestern Iran before 1000 B.C. (Tepe Giyan I, Tepe Sialk A). Their origin can be tentatively placed in the West (Assyria, Babylonia, Urartu). These states already had an iron civilization in 10th—8th cent. B.C. with iron playing an important role not only in the warfare, but also in the agriculture and in economy in general. Some ethnical groups near the eastern frontier of the mentioned realms used iron as well, however, on a smaller scale (for instance the Mannaeans conquered by Urartu). The new Hasanlu finds show the use of iron in the weapon manufacturing and in making some other objects (phalerae, not identified iron picks with lion heads). In the remaining adjacent areas belonging presumably to the Medes or Persians, iron occurred more or less sporadically until the 8th—7th centuries (at least what concerns the present number of archaeological finds). There are enregistered daggers or dagger blades, spear or lance heads or iron ornaments in the Talyche culture, in the cemetery of Tepe Sialk B and among the so-called Luristan bronzes.

One of the youngest types of the Luristan group is the double-headed iron dagger. These daggers used to be made of steel, either inhomogeneously carburized or quite homogeneous, but annealed. Excepting one case (not yet published) daggers of that type amounting to 30 pieces had not been hardened by quenching. Moreover, not a single part these weapons consisting of 8—10 pieces bears traces of correct welding. Some of them seem to have been forged by using a die, but this is not proved.

Implements of that period are rare. Sickles, forks and knives are still limited to the rich of the graves at Tepe Sialk B. The resource of iron of those artifacts is not known. Imports may not be excluded, local metallurgy is not proved.

On the other hand we have to presume that during the 7th century B.C. at least the metallurgy of iron must have started in Media and Persia undergoing, moreover, a considerable progress. In the second half of the 6th and in the 5th centuries we find the Persian iron working to be highly developed. The use of iron is no more limited to the manufacture of weapons and tools, but transgresses to the category of structural material. According to the Greek authors of the 5th cent. B.C., iron is not lacking among the Persians (in comparison to similar remarks on other tribes — Massagetae, Lybians or Ethiopians; on the contrary, they bring up Persian iron cuirasses of scales; Greek armour used to be of bronze at that time). Archaeological monuments of Persia reveal iron weapons and implements. Iron clamps in lead embedments were used for large-scaled monumental building. According to one investigated example from Persepolis this structural iron was unhomogeneous, primarily carburized steel.

Smiths worked in Persian sites. As the clay tablets prove, there were specialists among them as well, for instance, doormakers or armourers. Their labour was organized. They were represented by foremen and paid in silver or goods. These facts permit the conclusion that the extent of the iron smelting and working in Persia and the specialization in the frame of the black-smith's work in the 5th cent. equalled, for instance, to the stage of this industry in the contemporary Greece, the Greek tradition being, however, older. The iron working craft had begun to develop in Greece already about three centuries ago. The quick development in Media and Persia, which must have taken place during the 7th—6th cent. B. C. is one of the most interesting features. It was due to the fact that Medians and Persians took over already ready experiences. The source of their knowledge must be somewhere in Assyria, Babylonia or Urartu.

The evidence of the ancient Iranian literature is in accordance with this explanation. After the study of Avesta, for instance, it seems to be clear that Indo-Iranians did not know iron (or at least iron smelting) until their arrival to Iran. That is why they could not have any specific term for this metal. The word *ajaṅh* meant metal in general, then copper and its alloys. Much later, possibly in the Pahlavian stage of the Persian language, the word indicating iron developed from the same stem. In comparison to

same, written documents in Persia (western Iranian world) distinguished iron perfectly — using, however, the old ideogram AN.BAR.

Further evolution of the Persian iron industry is not the matter of the present study.[173]) It is mainly connected with the material culture of the Islamic era.

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NOTES

[1]) Following items contain important notes: *L. Beck,* 1884, 256—269; *W. Witter,* 1942; *R. J. Forbes,* 1950 and 1964; *H. H. Coghlan,* 1956, 16, 62—63; *S. Przeworski,* 1939, 1967, 257—259. *A. France-Lanord,* 1969 (see Appendix).

* See Appendix

[2]) *H. E. Wulff, 1966,* 4—10.

[3]) The author of the present study took part in the American Expedition to Iran in 1966. See the acknowledgements.

[4]) *T. A. Wertime,* 1964, 1258—1262.

[5]) *J. R. Caldwell,* 1965.

[6]) The area in question has been recently named "croissant orique" — an analogy to the fertile crescent of the antiquity. Cf. *R. Ghirshman,* 1964, 5.

[7]) *P. Bariand—V. Issakhanian—M. Sadrzadeh,* 1965; *H. E. Wulff,* 1966, 7, notes 51—52; in the north and northwest of Iran there are iron ores in many places (Semnan, linses at Goljuk and Quajar-Ab, Babar Goyor, veins at Qamsab, Farigand); in the southwest veins near Bafq and pyrometasomatic ores near Baft, Khadar-Mah, and Kooh-Banaan or Khotakh; in the Persian Gulf sedinents on the Hormuz island, Larah, Qesh and in other places. Limonite must be presupposed in gossans of all ore resources.

[8]) On the possibility of the iron smelting discovery during working chalcopyrites ($CuFeS_2$) cf. *W. Witter,* 1942, 69—71; on accidental reduction of iron ore in the potter's kiln cf. *H. H. Coghlan,* 1956, 46—47, 102; *R. J. Forbes* (1964, 215—216) considers a simple test by fire made with an unknown material (ore) which is less probable. Some remarks cf. *C. S. Smith,* 1965, 911.

[9]) *T. A. Wertime,* 1964, 1c.

[10]) Cf. *O. Quadrat,* 1948, 75.

[11]) *R. Pleiner,* 1967. Metallic iron is in the lead slags of Nakhlak, Anarak, Yazd etc. Slags from all centres contain much of Fe_2O_3. The same together with ferrite grains and cast iron drops was stated in slags from a trial smelt carried out in Tal-i-Iblis 1967 (not yet published).

[12]) Experimental smelting oragnized by the Illinois State Museum expedition, October 1966 (*J. R. Caldwell, C. S. Smith, R. Pleiner, T. A. Wertime,* cf. *R. Pleiner,* 1967).

[13]) *T. Burton Brown* 1951, 198—202; idem 1950, 8—9, fig. 1 a (analyses by *A. Herbert*).

[14]) According to *E. O. Negahban,* Tehran, the iron knife found in Tall Bakun is not a stratified object, *A. Langsdorff—Donald E. McCown* (Tall-i-Bakun A, Chicago 1942) do not make any reference to same; now Museum Persepolis.

[15]) *G. Contenau—R. Ghirshman,* 1935, 44, pl. 8:3:14, pl. 9:5:1, 12:23:3.

[16]) *R. Ghirshman,* II, 1938, 9, pl. XXXIX:458—459; Archaeol. Mus. Tehran, inv. no. 51731, 51432.

[17]) Numerous literature exists on Luristan bronzes. I am referring to several items: *T. J. Arne,* 1926; *E. E. Herzfeld,* 1941, 124—165; *A. Godard,* 1931; *Fr. Hančar,* 1934; *C. F. A. Schaeffer,* 1947 etc. See Appendix.

[18]) *E. E. Herzfeld,* 1941, 133 sq.

[19]) *E. Porada,* 1964, 11, note 10.

[20]) *R. Ghirshman,* 1963, 231.

[21]) *C. F. A. Schaeffer,* 1948, 480—482.

[22]) *E. Porada,* o. c.

[23]) *J. Meldgaard—P. Mortensen—H. Thrane,* 1964.

[24]) *R. H. Dyson Jr.,* 1964, 32 sq.

[25]) *A. Godard,* 1931, 32 sq.

[26]) *R. Ghirshman,* 1963, 284; ibidem 1964.

[27]) *E. Porada,* o. c.

[28]) *B. B. Piotrovskij,* 1949, 51—97; cf. also *Fr. Hančar,* 1934.

[29]) Samthavro: *B. B. Piotrovskij,* 1949, 63, pl. 5; *P. M. Abramišvili,* 1957, both according to *Vyrubov* and *Bayern* (inaccessible to the author); Beshtasheni: *B. B. Piotrovskij,* 1949, 63; Akner-Vornak: ibidem 64; *I. Lengyel,* 1956; Helenendorf-Khanlar: *E. Rösler* 1901, 148; *S. Przeworski,* 1939, 1967, 258. The last named author presents (l. c.) other localities rather in Transcaucasia (Bayan, Kalakent, Artshasdor, Kizil Vank, Zemovtshala, Delijan) where iron objects have been discovered: daggers, spear or arrow points, bracelets. But no analysis proving his dating into the 12th—11th centuries B. C. is added. All objects could be of a later date. But the revision of the cemeteries according to the original publication is very difficult. The papers are not easily accesible. Recent studies do not work with find complexes. For instance, the paper of *Abramišvili,* 1957 — according to the summary in Russian — does not present any complexes; it only classifies five periods of the Samthavro necropolis. The level containing the

rich grave no. 591 should be of the 11th—10th centuries B. C.; but the most important objects are lacking — i. e. the iron lance head with a bronze socket from the same grave. Instead of same an iron dagger on fig. 152 is seen. There is no possibility to controll the conclusions.

[30]) The above mentioned cemeteries were in use during several centuries and there is no accordance in the dating. I am inclined to believe in the chronology of *Piotrovskij* (1949, 59—69; cf. also *I. Lengyel,* 1956); it seems to be probable when considering a certain retention character of Caucasian cultures. Nevertheless, differing opinions are also often. *R. J. Forbes* (1956, 252) writes after *Przeworski* (1939, 1967, 258) that iron occurs in the region near Gandsha Karabagh or in Georgia and Armenia in the 13th cent. B. C. No author brings any evidence. Przeworski, moreover, takes into account the 13th cent. only for the tumulus no. 28 in Helenendorf-Khanlar; a more common use of iron should have taken place since the 9th cent. The high dating could originate in the following text written by *Fr. Hančar* (1934, 65): "Damit erhalten wir für die Gandša-Karabagh-Kultur ein vor 1000 liegendes Datum ... Wieweit sie aber im ersten Jahrtausend reichte ..., das kann nur schätzungsweise bestimmt werden ... Das Eisen bringt in dieser Beziehung kaum eine Fixierung, da sein Umsichgreifen in Vorderasien vor die Jahrtausendwende (13., 12. Jh.) fällt. Geben wir uns mit der Festlegung der Gandša-Karabagh-Kultur innerhalb der mit dem 14.—8. Jahrhundert sehr weitgezogenen Grenzen zufrieden". So Hančar considers the dating as an open question and, moreover, he is not inclined to date iron according to the find complexes but, on the contrary, the cultures in Asia Minor according to the occurrence of iron. Recently, Georgian scholars try to date first irons and the metallurgy of iron in the Trialeti group (Samthavro, Beshtasheni) into the 14th—13th centuries B. C. (*P. M. Abramišvili, A. Gzelišvili,* 1964, 10, 51 with a polemics with *B. B. Piotrovskij,* but without persuading arguments, cf. *P. M. Abramišvili—T. Mikeladze,* 1966 at the Archaeological Congress in Prague). These authors would be happy to have the homeland of iron in Transcaucasia; they use for this purpose, I think, the chronology of *C. F. A. Schaeffer.*

[31]) *B. B. Piotrovskij,* 1959 (with bibliography); idem 1950; recently *A. A. Martirosjan* 1961; *J. M. D'jakonov,* 1951.

[32]) Sardur II., Annals 155 D 11 cf. *G. A. Melikišvili,* 1960, 273—289, cf. 281—282.

[33]) *I. A. Gzelišvili,* 1964, 9 (after *G. A. Melikišvili,* cf. note 19).

[34]) K Bo IV 10 Rs 22; cf. *V. Korošec,* 1943.

[35]) Sargon II, Annals 129 (cf. *Fr. Thureau-Dangin,* 1912; *I. M. D'jakonov,* 1951, 318—319).

[36]) Sargon II, letter to Aššur, 352 (ibidem 331).

[37]) After *C. F. Lehmann-Haupt,* Armenien II, 2, 547, cf. *B. B. Piotrovskij,* 1959, 160—185.

[38]) *B. B. Piotrovskij,* 1949, 106—114; idem 1950 (Karmir Blur), 54—55, fig. 32; *A. A. Martirosjan,* 1961, 94—98, 130.

[39]) *B. B. Piotrovskij,* 1959, 163 draws attention to such interpretations.

[40]) Kazbek: iron sword, bronze hilt of another iron sword, spear heads, bridles etc., cf. *A. M. Tallgren,* 1930, 148—149, 170. Samthavro: recently *N. M. Pogrebova,* 1967.

[41]) *M. N. Pogrebova,* o. c.

[42]) Mousieri: *J. de Morgan,* 1939, fig. 279: 1—4, fig. 280 (daggers), fig. 281 (dagger with a cross-shaped guard), fig. 283 (swords), fig. 285 (knives), fig. 282 (battle axes). Cf. also *I. Lengyel,* 1956, fig. 8:11, 14.

[43]) *J. Podborský,* 1967.

[44]) Ayrum-Shejtan dag: *J. de Morgan,* 1929, fig. 278: *I. Lengyel,* 1956, fig. 7:1.

[45]) Tak Kilisi: *C. F. A. Schaeffer,* 1948, fig. 274.

[46]) *C. F. A. Schaeffer,* o. c. fig. 271:1; fig. 282:1—7, 6 after *Kuftin*).

[47]) *I. Lengyel,* 1956, fig. 10:3,5, 8—9.

[48]) *M. N. Pogrebova,* 1956: fig. 6:7—8.

[49]) *I. Lengyel,* 1956: fig. 6:7—8.

[50]) *C. F. A. Schaeffer,* 1948, fig. 232, 1, 11.

[51]) A model of these daggers could be seen in a bronze example from a Talychian cemetery at Chila Khane (*C. F. A. Schaeffer,* 1948, fig. 223) or in Samthavro in the Trialeti area (*P. M. Abramišvili,* 1957, pl. I: 145). Typologically older could be a weapon given by *J. de Morgan* (1929, fig. 249:k) — it is necessary only to deploy the side arcs of the pommel to find out a dagger with a saddle shaped pommel. Another explanation offer several daggers kept in the Antisksamling of the National Museum in Copenhagen. There are bronze daggers with flanged and rimmed hilts, comleted with marble

or limestone parts representing together a hilt with fan-shaped lobes (NM Copenhagen, Antisksamling no. 14648, 14385). Another example is in the Metropolitan Museum in New York (Dunscombe, no. 61.265). This may prove a substantially quicker typological development of this hype of dagger. In fact, the origin of this conception could have started in the 12th to 11th cent., because the lobes of some flange-hilted daggers might have been of wood or horn, i. e. materials which disappeared. I am preparing a special paper dealing with this problem.

[52]) *J. de Morgan,* 1929, fig. 251:2, 3—4; *C. F. A. Schaeffer,* 1948, fig. 232:3—4, 12; in the Museum in Tehran there is a quite similar dagger with an iron blade from an unknown locality in Azarbaijan (inv. no. 646). From an unknown site is the dagger of the same type in the Deutsches Klingenmuseum Solingen (length 54 cm). This type all in bronze, cf. Oud-Iraanse Kunst, 1966, 68 (no. 175), locality Ardabil.

[53]) *J. de Morgan,* 1929, fig. 259:6.

[54]) Agha Evlar: *J. de Morgan,* 1929, fig. 255; *C. F. A. Schaeffer,* 1948, fig. 237:23; cf. *E. E. Herzfeld,* 1941, fig. 247.

[55]) Chir-Chir: *J. de Morgan,* 1929, fig. 250:2—3; Tülü: ibidem, fig. 254:2—5; Lor-Daghi: ibidem, fig. 254:4; Aspa Hiz: ibidem, fig. 250:1.

[56]) *T. Burton Brown,* 1950, specimen no. 1238 incl. rust analysis.

[57]) *R. H. Dyson Jr.,* 1959, 18.

[58]) *Idem,* o. c., idem 1960.

[59]) *E. Porada,* 1959. The daggers cf. *R. H. Dyson Jr.,* 1964, pl. X.

[60]) *R. H. Dyson Jr.,* 1964, pl. XI:2.

[61]) Archaeol. Museum in Tehran, inv. no. 6812.

[62]) *R. H. Dyson Jr.,* 1964, fig. 2:3, pl. XI:2.

[63]) *K. R. Maxwell-Hyslop—H. M. W. Hodges,* 1966, sword no. 1.

[64]) Hasanlu: *R. H. Dyson,* 1964, 422, fig. 2:8; Metropolitan Museum, New York: Dunscombe Coll., no. 62.252 (Caspian area in NW Iran).

[65]) Archaeol. Museum in Tehran, inv. no. 12189.

[66]) Ibidem, inv. no. 6776.

[67]) Ibidem no. 16032.

[68]) *Sir Aurel Stein,* 1940, pl. XXV:1, 2, 29.

[69]) It is very difficult to find out exact analogies. The conception of the object reminds us of some Luristan pins (cf. *Fr. Hančar,* 1934, 101, fig. 42; *C. F. A. Schaef-*

fer, 1948, fig. 267:g, h. i.), but these are smaller and thinner. The explanation is based on the fact, that the Hasanlu objects use to be found near the shoulders of bodies (*R. H. Dyson,* 1968, 88).

[70]) *R. H. Dyson Jr.,* 1959, 17. Among the Luristan bronzes there are some plug-shaped objects (*C. F. A. Schaeffer*, 1948, cf. fig. 265:11—13) with goat or horse heads, too. On the other hand, the figure of the crouching lion on the Hasanlu plug is the same as that on the silver bar from Karmir Blur (cf. *Piotrovskij*, 1959, pl. XLVII:a).

[71]) Idem, 1960, 6, 8.

[72]) *R. Ghirshman,* 1939, II, 48, pl. LVII:592, 827a, 832, 845a, b, pl. LXXV: 916 bm, pl. XXVII 723a, b, pl. LXXVI: 1, pl. L: 545b, pl. LXXVII: 969.

[73]) There are other irons from the Iranian territory, but their chronological position is not quite sure. They belong probably to this phase of development of the Iron Age: for instance, an iron spear head from Ganj Tepe near Qasvin (Mus. Tehran, length ca. 15 cm), an iron sickle from a hut found near Alishtar (Nehavend), cf. *Sir Aurel Stein,* 1940, 291, pl. XV: 13 with an exact analogy in Tepe Sialk B (*R. Ghirshman,* 1939, II, pl. LVII: 826, length 23 cm). *St. Przeworski* (1939, 1967, 258) refers — after *Godard* — to iron objects found on the cemetery of Ab-i-Zal (axes, hoes, bracelets, pins); he compares same with the Urartian Toprakh Kale; Pennsylvania Univ. Mus. possesses a dagger with bronze hilt and iron blade from Mazandaran area (No 1—41—09). See also the Appendix.

[74]) *R. M. Boehmer,* 1966, 822.

[75]) In the inventory books of the Tehran Archaeological Museum there are, in fact, some Luristan objects held for finds of a cemetery in the province (?) or in the vicinity of the city (?) of Kermanshah. Individual pieces bear, moreover, numbers of the grave. But I could not get any clear information, whether they have been excavated or saved. The finds were probably made in 1931. On the site of War Kabud see the Appendix and note 111.

[76]) *C. F. A. Schaeffer,* 1948, fig. 265:18—19; the Boston example ibidem fig. 268; Copenhagen: NM Antisksamling No 9162, cf. *M.-L. Buhl*, 1968, 68, No. 160; Lausanne: Musée d'Archéologie; Berlin: Staatliche Museen zu Berlin, Vorderasiatisches Museum; Philadelphia: Pennsylvania University Museum (Luristan Coll.).

[77]) Inv. no. 1664, so-called grave 198, preserved length 13 cm.

[78]) Ibidem, inv. no. 1766, so-called grave 70(preserved length 15 cm). The bear-headed sword: NM Copenhagen, Antisksamling 12182. Depicted in: *M.-L. Buhl,* 1968, 71 (No. 165).

[79]) *C. F. A. Schaeffer,* 1948, fig. 265: 9—10; *Fr. Hančar,* 1934, fig. 16: a, f; *A. Godard,* 1931, pl. XXII: 67, pl. XXIII: 68a.

[80]) Archeol. Museum Tehran: inv. no. 1535, so-called grave 218, edge 16 cm; cf. inv. no. 7038; Collection Weill: *A. Godard,* 1931, pl. XXI:65, *A. U. Pope,* 1938, IV, 50:A.

[81]) Karabulag: *Fr. Hančar,* 1934, fig. 17; Hasanlu: *R. H. Dyson Jr.,* 1959, 13 (figure right above).

[82]) *E. E. Herzfeld,* 1941, 123—124, fig. 241:middle. The mace-heads from War Kabud see in *L. Vanden Berghe,* 1968a, 126—128, pl. 30. Examinations of not stratified iron maces in: *C. S. Smith,* 1968.

[83]) Examples in *C. F. Schaeffer,* 1948, fig. 266:2—4.

[84]) Ibidem, fig. 266:1.

[85]) *A. Godard,* 1931, pl. XX:60, *K. R. Maxwell-Hyslop—H. W. M. Hodges,* 1966, pl. L:6 (Faroughi Collection).

[86]) Archaeol. Museum Tehran, inv. no. 1673, so-called grave 577 (length 38,5 cm). Best analogy in bronze cf. Hasanlu, *R. H. Dyson Jr.,* 1960, 10 (middle).

[87]) Museum Pars, Shiraz, inv. no. 81 (∅ 10 cm).

[88]) *A. Godard,* 1931, pl. XXXV: 149 (Louvre).

[89]) *E. E. Herzfeld,* 1941, 151, fig. 271; Museum Philadelphia: inv. no. 38-28-18, cf. *R. Maryon,* 1961, pl. 71:13. Two other bracelets from the Ternbach collection cf. Made of Iron, 1966, 19, fig. 18—19. N. M. Copenhagen: iron bracelet from Shir-i-Shika (sine No.); Amsterdam: Coll. I. van Lier (B 26), an iron bracelet from Amlash.

[90]) Museum Pars, Shiraz, inv. no. 114.

[91]) Archaeol. Museum Tehran.

[92]) Ibidem, inv. no. 1533, so-called grave 435, length 17,5 cm. For analogy see War Kabud, *L. Van den Berghe,* 1968 a, pl. 27a above. A quite unique object, possibly of Luristan, is an iron goat (lenght 16,5 cm) from the Menil collection (cf. Made of Iron 1966, 56—57, fig. 21). Unfortunately the dating is not fixed. Not stratified maces and mace heads are in the collection of *C. S. Smith,* who investigated several pieces. Drilling of unhomogeneous steel had been stated (C. S. Smith, 1968).

[93]) *K. R. Maxwell-Hyslop—H. W. M. Hodges,* 1966, sword no. 2. Cf. *V. Bird—M. Hodges,* 1968.

[94]) Weill Collection, Paris, inv. no. 4080, cf. *Fr. Hančar,* 1934, fig. 26: *A. U. Pope* gives for the same piece: Boston, Museum of Fine Arts, cf. *Pope,* 1938, 54:c). Bronze plated hilt can be clearly seen on the dagger from Faroughi Coll., now Brussels (*K. R. Maxwell-Hyslop—H. W. M. Hodges,* pl. L:4—5).

[95]) Private communication of *J. Ternbach,* New York (12th June, 1967) which I am deeply indebted for. Archaeol. Museum in Tehran; inv. no. 1677, so-called grave 730, preserved length 30,5 cm. N. M. Copenhagen, Antisksamling: two other daggers (No. 12183 and one piece sine no.). In the same collection a dagger with arch-shaped pommel without heads (sine no. provisional 35).

[96])*H. Maryon,* 1961, 183 sq.

[97]) *E. E. Herzfeld,* 1941, 135—139. Following his own considerations this author puts together the manufacturing of this type of a dagger and Kizzuwatna, the most ancient known iron smelting area. He admits the older localization in the vicinity of Trapezunt. Further combination leads him to Kizzuwatna and Qasvin, former Persian capital in Nothern Iran (1. c., 135—136).

[98]) *A. Godard,* 1931, 99.

[99]) *R. Damien,* 1962, 17.

[100]) *H. Mayron,* 1961, 174, 176, 180. This paper quotes the following investigation reports: British Museum, p. 177—178, pl. 65:2, pl. 66; Toronto, 178—180, pl. 66:6, pl. 67—70; Philadelphia, 180, pl. 71:12; Brussels, 180, pl. 14; summary of the *Naumann's* report on the Hamburg dagger, 180—184. All these reports contain referrences to the formerly believed casting technique.

[101]) *J. Ternbach,* 1964, 48, 51.

[102]) *K. C. Lefferts,* 1964, 59—62. Investigations made by *C. S. Smith* on fourteen daggers are not published; there is only a remark in Made of Iron 1966, 54. In one case thermical hardening should have been stated.

[103]) *F. K. Naumann,* 1957, 575—581.

[104]) *R. Damien,* 1962; simultaneous publication cf. *E. Salin* et alii, 1962, 209—217.

[105]) *K. R. Maxwell-Hyslop—H. W. M. Hodges,* 1966, sword no. 3. *C. S. Smith* (1968, now printed) gives some information on another sword (no. 105); one half of the blade section is richer in carbon. Worth mentioning are the cutting and cold working of grooves for inserting swage-made parts. Six further swords have been examined by *A. France-Lanord,* 1969; see the Appendix.

[106]) The specimen no. 78 of the Archaeological Institute, Prague (report no. 4850/67). I am very indebted to *Dr. H. Uhlemann,* Director in the Deutsches Klingenmuseum in Solingen-Gräfrath. See Arch. Anzeiger 1969, 41—47. The Museum in Solingen possesses still another Luristan dagger and one hilt without blade (inv. no. 56.62).

[107]) Made of Iron, 1966, 54.

[107a]) An important study dealing with the Luristan blacksmith's technology and written by *C. S. Smith* is being published (I am very indebted to him for the possibility to read the manuscript). The author examined several not stratified objects of his own collection, partly of the Luristan type (dagger with human heads, maces), partly of Talyche type (daggers); one weapon seems to be Scythian or Sarmatian. The results of this investigation show that the artisans of that period worked with the highest skill what concerns the cold working and mechanical joining of parts, cold drilling the roles, shaping in swages, but, on the other hand, they completely ignored the intentional welding, carburizing of edges, quenching and other fundamental blacksmith's techniques. This supports our opinion that the artifacts of the 9th—7th cent. B. C. in Iran had not yet reached the niveau of the real Iron Age technology. The products correspond more to the skilled jeweller's working with iron. Another important paper by *A. France-Lanord* (1969) appeared recently, see Appendix.

[108]) About morphological classification of archaeological iron objects cf. *R. Pleiner,* 1967a, and *R. Pleiner,* 1968 In the light of this analysis, Luristan iron daggers with human heads belong to intensively worked artifacts without any signs of progressive techniques.

[109]) *H. Maryon,* 1961, 183 refers to a note of *Godard,* who ought to have seen, as related, hundreds (?) of such weapons in Persia.

[110]) The dating of Luristan bronzes suggested in the present study finds independently its support in the chronological table in Oud-Iraanse Kunst 1966 (appendix). In the Median-Persian period (7th cent. B. C.) somme artifacts of another provenance could be brought to Iran as well. The complex of golden and silver objects found at Ziwiyé in Kurdistan is held for Scythian. Iron daggers (for instance no. 6897 in Arch. Museum Tehran, hilt with inlays) and spear heads (cf. *R. Ghirshman,* 1963, 118—119) belong to the assembly. On the treasure

cf. *A. Godard,* 1950. Some new irons (a dagger, brooch) came from recent Danish excavations (Tepe Guran, Grave 7, about 6th cent.; N. M. Copenhagen. I am much indebted to Dr. E. Thrane for the possibility to examine that material).

The only hint of an increasing use of iron was recently signalized by *L. Vanden Berghe* (1968, 107—108; idem 1968a) at the occasion of a preliminary report on the cemetery War Kabud, dating to the 8th and beginning of the 7th cent. B. C. In a richly equipped grave there was found an iron dagger (o. c., fig. 9). But iron daggers, knives, arrow and spear heads, agricultural implements and axes were taken also from another graves.

[111]) Assyrian sources know a country called Parsua in the south of Media. In Urartian documents it is Baršua. The Luristan centre was situated in the sphere of the Median might, concentrated in the vicinity of the capital Hagmatana-Ekbatan.

[112]) It was, in fact, the centre of the Pasargadae tribe mentioned by Herodotus (I, 125). Cyrus fought near this site (after Poliaenus) the deciding battle with the Medians (*E. Katz,* 1893, 10). This event could have inspired him to found a capital and lastly to be buried on that place.

[113]) This method of joining stone blocs is mentioned already in *G. Rawlinson,* III, 1879, 313. A preserved iron clamp in the northern staircase of the citadel at Pasargadae is published by *D. Stronach,* 1963, 30—31, pl. Vd. Further references cf. *R. Pleiner,* 1967.

[114]) *G. Rawlinson* (III, 1879, 273) suggested that all clamps had been removed. Preserved examples cf. *R. Pleiner,* 1967, l. c., fig. 24:2, pl. 66:1—2; pl. 64:2.

[115]) *R. Pleiner,* 1967, l. c.

[116]) *G. Rawlinson,* III, 1879, 325, fig. 2, 326 (references to *P. Flandin*).

[117]) *R. Pleiner,* Investigation report no. 4839/67, specimen no. 300, in the Archaeol. Institute, Prague. Not yet published.

[118]) It would be important to know the origin of this technique. Persian monuments are of the most ancient date. Nevertheless, it is necessary to consider other data as well: the bridge in Babylon, described by Herodotus in the 5th cent., had been built by the same method (Her. I, 186). The same author refers to the Phocian wall in Lydia, which was constructed by "huge

stones joint together" (Her. I 163). The Pantheon in Athens, 5th cent., was built in the same way (*Livadefs,* 1956; *Campbell—E. E. Thum,* 1931). Iron clamps were there, of course, of a little different type (H-shape). The same structural iron was found in the Artemis temple in Magnesia, Asia Minor (*B. Neumann—H. Klemm,* 1949). Vitruvius does not mention this technique, but it occurs in the later Roman period (Colosseum, Porta Nigra in Trier, theatre in Verona, stone blocks in the fora of Rome); clamps themselves disappeared during the Middle Ages. *Koldewey* stated that in ancient Babylon wall elements used to be joint by wooden clamps embedded in bitumen. This method seems to have been common in Mesopotamia. From there it was perhaps spread to the west, to Greece, and to the east, to Persia.

[119]) Mus. Persepolis: plough share, inv. no. 413. This is a very simple hook-plough tip. Prof. *Hodges* kindly directed my atention to a certain backwardness of the Achaemenian plough in comparison to the agricultural implements of the cultures to the west of Persia; he takes into account the pictures on seals: cf. *A. U. Pope,* 1938, 124:E.; *H. Frankfort,* 1939, pl. 37: This only confirms the complex trend of the cultural development of Persia in the relationship to Mesopotamia and other countries. It must be considered also in the study of the early Iron Age. Metropol. Mus. New York has an iron pick-axe with a silver socket, possibly Iran, 6th Cent. B. C. (Dunscombe Coll., no. 65.4). The recent excavation of Tappeh Yahya, S. Iran (director *C. Lamberg-Karlowsky,* Harvard University) discovered the first important occurrence of iron in the Achaemenian level; the pre-Achaemenian layer offered one object only. However, the full confirmation of this situation must be brought by further seasons of the excavation on the site. Mus. Persepolis: axe, spear head or dagger, no. 417, pulleys no. 322 (from the Apadana palace of Xerxes), no. 32 from the treasury area. Archaeol. Mus. Tehran: sword no. 2124, spade no. 2503. Several other weapons, tools and utensils (rim-hilted swords etc.) and first of all masses of iron armour-scales were found in Treasury which served certainly as an arsenal, cf. E. F. Schmidt 1953 I, 172, 174, 185—186, 207—208, 211; 1957 II, 97—100, pl., fig. 19 (p. 98).

[120]) *R. Pleiner,* 1967, pl. 65:2. Various swords and daggers may be also seen above the entrances of the rock

tombs of Artaxerxes' in the Kooh-i-Rahmat; among different nations the Persians wore akinakes' only.

[121]) *G. G. Cameron,* 1948, tablets no. 18, 23, 52 and 74.

[122]) Ibidem, 66 (texsts of Muqaddasi and Ibn al-Balkhi are cited after Schwartz, Iran im Mittelalter). Some authors believe that the regions of Nairiz in Fars and of Bafq and Baft in Kerman province must play a considerable rôle in the Achaemenian iron production. This pinion might be supported by the 4th cent. B.C. author Onesicritus (F 28, apud Plin. VI, 96—100, cf FGrHist II D 28 (26), Berlin, 1927): Achemenidas usque illo tenuisse; aeris et ferri metalla et arsenici ac mini exerceri. But earliar Strabo (XV 2 14) referring to Onesictritus omitted iron.
So this report cannot be proved as fully reliable. Direct evidences of Achaemenian smelting in Persia were not yet discovered, as I could see during the *Wertime* expedition 1968. This question must be followed in the future.

[123]) *R. Pleiner,* 1967, fig. 16—21, pl. 58—61.

[124]) Herodotus, VII, 84.

[125]) Herodotus, VII, 61: lepidos sidéreés hopsin ichthyoeideos.

[126]) Xenophon Anab, I, 8: 3, 6 (horses), 7, 28.

[127]) Arrianos, Alex. anab., 3, 13.

[128]) On Scythian armour generally *A. I. Meljukova,* 1964, 69—74, pl. 22 (there bibliography); recent papers on new findes in Scythian kourgans: *A. I. Puzikova,* 1964; *V. I. Markovič,* 1965; *A. I. Puzikova,* 1966; *E. V. Černenko,* 1968. There are many evidences concerning Parthian and Sarmatian armour and weapons; on Parthians cf. *Ph. Lozinski,* 1959, 22—35.

[129]) *G. Rawlinson,* I, 1879, 426—446.

[130]) Herodotus I, 125.

[131]) Herodotus, III, 29: encheiridion sidérion.

[132]) Herodotus, VII, 85.

[133]) Herodotus, VII, 54: persikón xifos, ton akinakén.

[134]) Xenophon Cyropaed., VIII, 2, 23; Strabo, XV, 3, 19.

[135]) Herodotus, VI, 114.

[136]) Xenophon, Cyropaed., l. c.; the Persian prisoner from the Tiribazes troop in a Xenophon's episode wears an axe called *sagaris,* cf. Xen. Anab, IV, VI, 16—17: The same sagaris See Herodotus VII 64.

[137]) Herodotus, VII, 63.

[138]) Herodotus, VII, 65.

[139]) Xenophon Anab., IV, II, 28.

[140]) Ethiopians: Herodotus, VII, 69; Lybians: VII, 71; Mysians: VII, 74; wooden helmets: VII, 78—79.

[141]) Herodotus, I, 215.

[142]) Cunaxa: Diodorus Sic., XVI, 22, 7.
Gaugamaleae: Arrianos, Alex. anab., 3, 11.

[143]) Greek authors possessed little information on life and work of Zarathuštra; they supposed it should have been several thousand years ago; modern historians, on the contrary, have dated his life to the 6th cent. B.C. because of the simple synchronism of historical king Hystapes (Vištaspa), Darius' father, and of the king Vištaspa, who had received Zarathuštra at his court. The name Vištaspa-Hystaspes seems to have been a common one and thus any identification must be problematical.

[144]) *O. Klíma,* 1964, 79.

[145]) I am very indebted to Dr. *O. Klíma,* Oriental Institute, Prague, for his kind advices and information on Avesta.

[146]) *L. Beck,* 1884, 256—257.

[147]) *N. N. Dhalla,* 1922, 131.

[148]) *Fr. Wolff,* 1924.

[149]) Y. 9 11; Yt. 19 40.

[150]) This part does not belong to the oldest because Zarathuštra was an antagonist of the haoma sacrifice. In the text Zarathuštra is named, but haoma worshipped.

[151]) Y. 11 7.

[152]) Yt. 10 129: ayanhaēna spareγaγa (AirW 1613); cf. Fr. Wolff, 1924, 218. The transliteration of Avestan expressions does not correspond to the conventional usus, because of technical difficulties.

[153]) Yt. 10 131: gadanąm ayanhaēnam. Cast maces: Yt 10 132; axes of steel: Yt. 10 130: hazaṅrem čukušnąm haosafnaēnam.

[154]) Yt. 15 7: upa tāerem harayā yuctayā ayanhō. Later tradition presented by Ferdowsi (Shah Name, 10th—11th Centuries A.D.) helds the king Haušyanha for the man who had introduced iron.

[155]) Vr. 10 2; Vr. 11 2; Vr. 12 5: ayanhaēnaibya hāvaněaibya, ayanhaēna hāvana. Nearly the same is the passage in Y. 22 2, where Wolff employed "metal" for translation of "ayanhaēn". A haoma press of stone and iron (?) is worshipped also in the part of Avesta called Aiwisu rim Gah.

[156]) V. 14 9: ŷrias ayō.aγrāiš.

[157]) V. 4, 50—51: ayanhaēnaiš kavataiš; ayanhaēnaiš frābiš.

[158]) V. 7 75: haosafnaěniš.

[159]) V. 9 14: ayanhaěnanem vā srum vā.

[160]) V. 16 6.

[161]) V. 8 89: pisraṭ hača ayō saěpāṭ... pisrat hača haosafnaěnō saěpāṭ.

[162]) V. 6 46: ayanhaěnam vā.

[163]) *Chr. Bartholomae,* 1879. According to the transliteration and translation by *Humbach:* Y. 30 7: aěšam tōi ā aṅhat yaϑa ayanhā ādānāiš pauruyō (damit er durch deren Festschmiedung mit dem Ordalerz dem Ersten sei). Y. 32 7: yāš srāvi xvaěna ayanha (um derentwillen er durch das Ordal mit glühendem Erz zur Aussage gebracht wird). Y. 51 ayaṅhā xšustā (durch das Ordal mit dem flüssigen Erz). The term x^{v}aena (glühen) originates in *xvaidna-, radical x^{v}id-, which is to be compared with the German "schweissen", to weld. Any technical identification of that terminology is impossible. I am indebted to Dr. Klíma for the data.

[164]) Yt ayanhō kehrpa x^{v}aěnahe.

[165]) Vr. 20 1: Sīh rōčak 1,4 and 2,4.

[166]) I. e. in the language which used to be contemporary with the ancient Persian in the west of the Iranian plateau.

[167]) AirW 146—157.

[168]) *H. Zimmer,* 1879, 51.

[169]) Ayodamištra (the colour of a sun ray) in Rig Veda (RV. 1 85 5); RV. 9 5 4.

[170]) AV. 11 3 7; AV. 5 62 8 .

[171]) Cf. *A. Walde,* 1930, I, 4. With the conception of Walde, which I am holding for correct, there is in a deep contrast the meaning of *J. Pokorny,* the editor of late Walde's work. Pokorny looks for the radical of the word in the stem ieros, i. e. strong, old Irish. iwirah (angry, strong), then iron as a "strong metal". In the same way it would be comparable eira, ira i. e. anger, ire. That would mean, of course, a secondary transformation, because Walde, in the same dictionnary, takes ira from eis- i. e. to move quickly. The conclusions of Pokorny seem to me, in this respect, extremely doubtful.

[172]) Ibidem 628.

[173]) The beginnings of the manufacturing of Persian wootz blades fall, therefore, out of this study. The problem remains still rather unclear. Two blades indicated by A. France-Lanord (1969) are not datable.

Appendix

During the print of the present paper two important studies have been published. They appear in the bibliography but could not be referred to in the text. The first is the book of Prof. *L. Vanden Berghe* ("Het archeologisch onderzoek naar de bronscultuur van Luristan", Brussel 1968). Beside the rich bibliography and a list of collections containing Luristan bronzes, the book deals with two recently excavated cemeteries: *War Kabud* (ca. 800—650), with graves (no. 10, 106, 116, A'16) equipped with iron daggers (types with tanged and arch-shaped hilts, arrow-heads, spears and hammeraxes); and *Kalwali* (ca. 650—600), poor in metal objects, but entirely made of iron (bracelets, arrows, spear-heads, one dagger). These finds, represeting the beginning Iron Age in Iran, belong to the critical phase of the 8th—7th Centuries.

A. France-Lanord presented in his paper ("Le fer en Iran au premier millénaire avant Jésus-Christ", Revue d'histoire des mines et de la métallurgie 1, 1969, 75—126) a considerable series of twenty investigated Luristan irons including 6 daggers with human heads. These are held by the author for more ancient than other iron daggers and knives belonging partly to the Talyche type. The blades of three human-headed daggers (not stratified, private collections) are of wrought iron, other three consist of inhomogeneous steel without any traces of quenching or tempering. The fixing of individual parts had been studied by means of many sections (rivets, inserting, burrying). The other series of irons (possibly 8th—7th Cent.) represents inhomogeneous or mild and medium steels (0,3—0,4 % C). A special attention must be paid to the two dagger fragments made of hypereutectoid steel; one of then reminds strongly of piled steel carburized by pig iron. The author believes their dating to the 7th—6th Cent. However we are inclined to be very careful, be cause the shape of those not stratified fragments does not allow any fix conclusion about their date. On the other hand we find technological analogies to the second sample in the 18th century. The paper of Mr. France-Lanord brings, beside the work of C. S. Smith (1968), the largest collection of Iranian irons analyzed by metallography.

Finally we have to mention the work in progress by Prof. *R. F. Tylecote,* who prepares an analysis of a 9th cent. iron dagger hilt, spear-head and punch from Marlik, Northern Iran (Archaeological Museum, Tehran). Materials with low carbon contents (0,1—0,2 %) were stated. The punch had a ferritic material of considerable hardness 202—257 MV. I am indebted to Prof. Tylecote for his sending me the preliminary results.

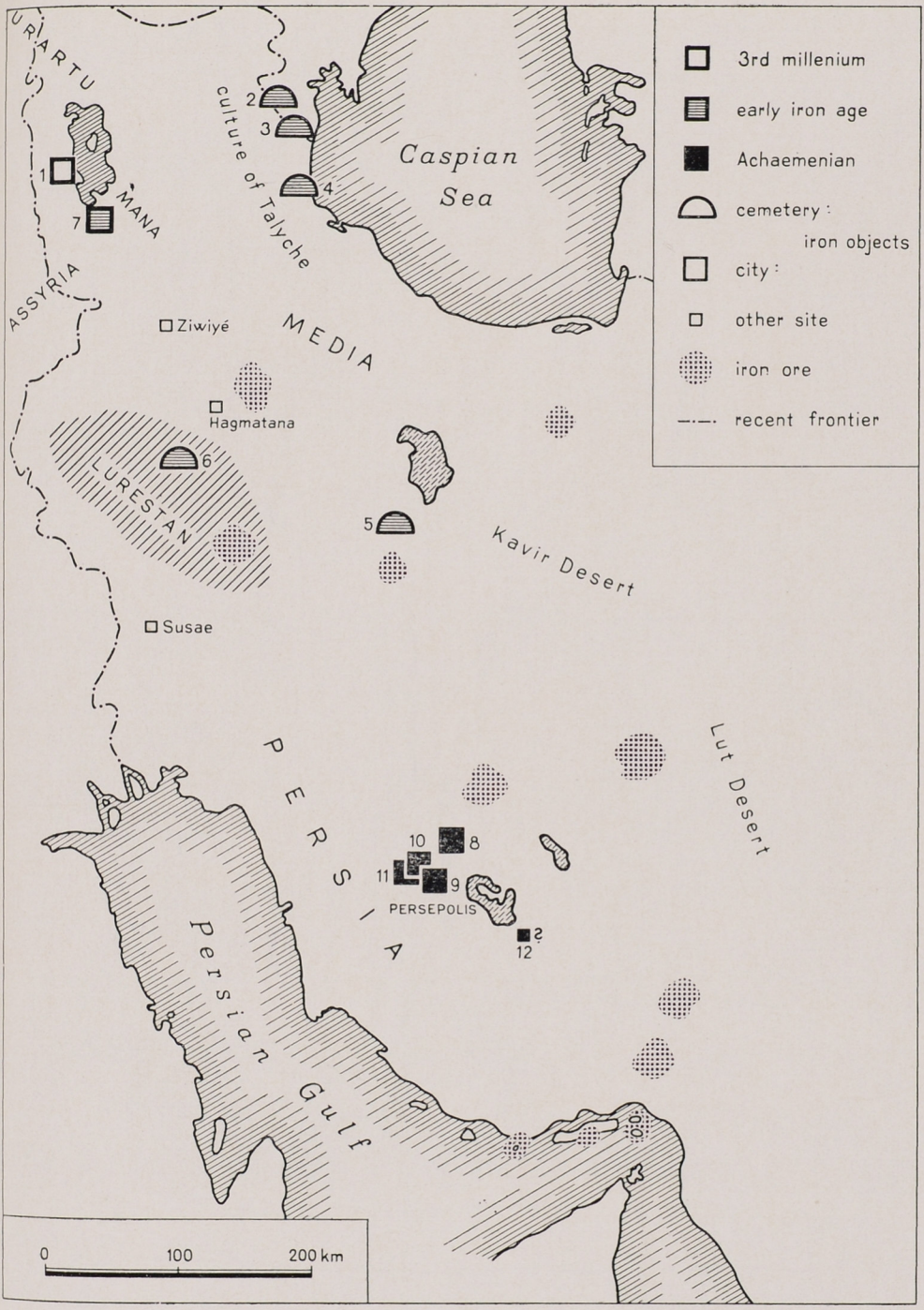


Fig. 1

Map of important early Iron Age sites in Iran. 1 Geoy Tepe, 2—4 cemeteries of the Tolyche culture, 5 Tepe Sialk, 6 Kermanshah, 7 Hasanlu, 8 Pasargadae, 9 Persepolis, 10 Istakhr, 11 Naksht-e-Rustam, 12 Narisi-Neiriz.

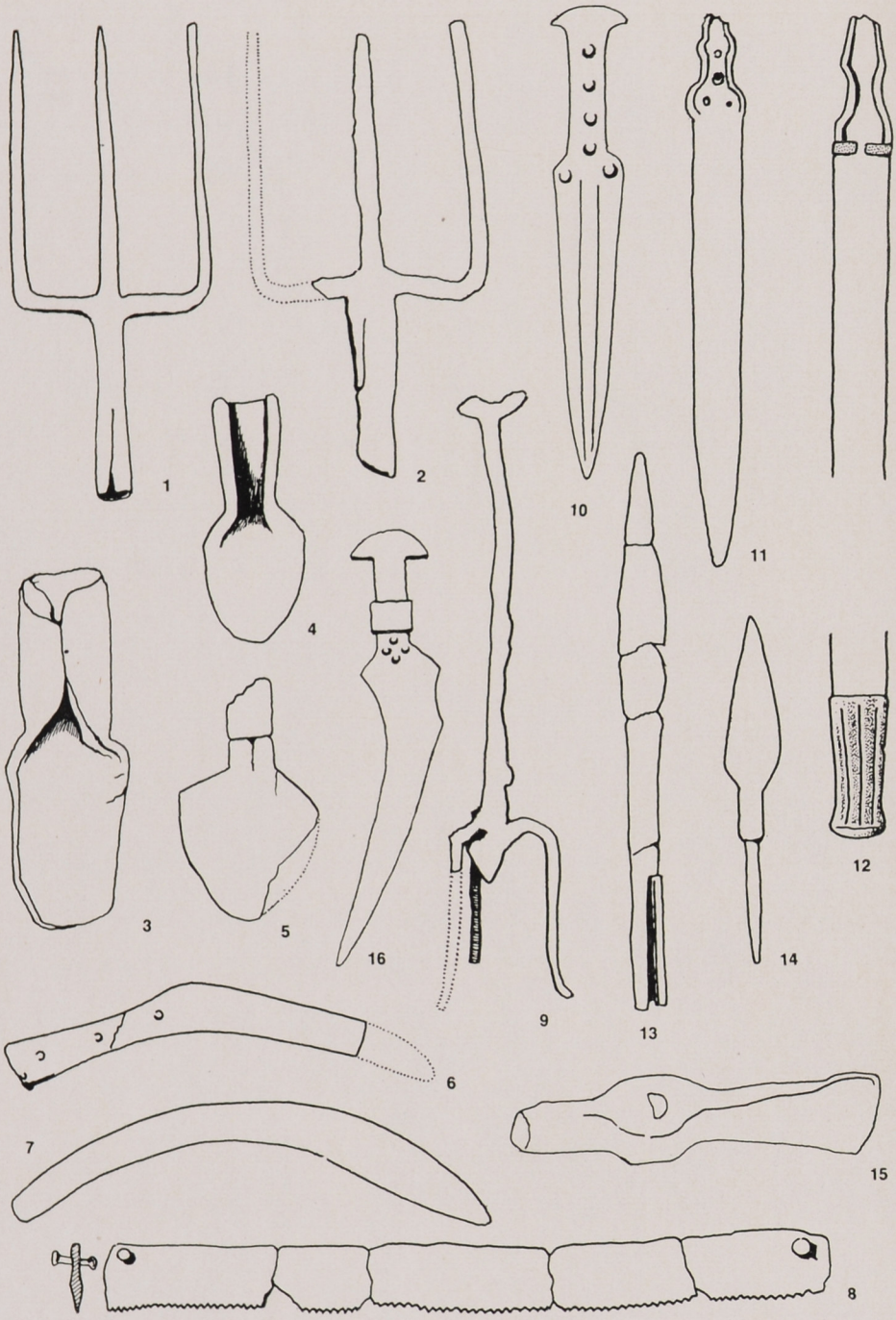


Fig. 2.

Urartian iron artifacts: Karmir Blur (1—2, 5—14, after Piotrovskij), Toprakh Kale (3—4, 15, after Lehman-Haupt). Implements: 1—2 tridents, 3—5 plough shares and hoes, 6—7 knives, 8 saw, 9 candelabrum. Weapons: 10, 16 daggers, 11—12 swords, 13 spear head, 14 arrow tip, 15 battle axe. Different scales.

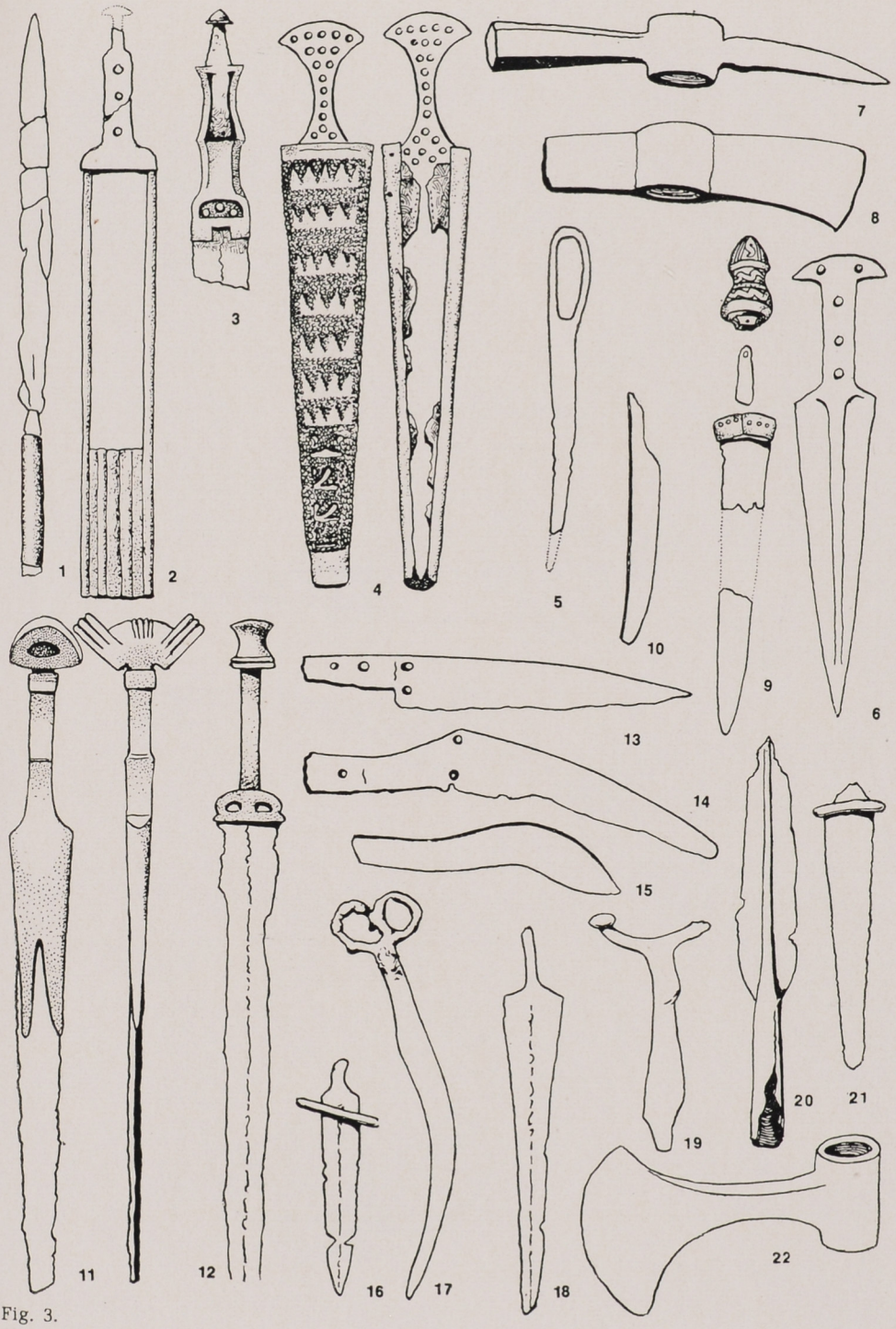


Fig. 3.

Early irons in Tranccaucasia. 1—8 Lelvar culture: 1 Samthavro (Trialeti), 2—8 Mousieri, 9 Tak Kilissi. 10—22 Talyche culture: 10, 15 Tülü, 11—12 Chagoula Derré, 13—14 Sheytan Dag, 16 Chir-Chir, 17 Djonü, 18 Do Kalian, 19 Aspa Hiz, 20—22 Agha Evlar. 1 After Piotrovskij, 2—3 after Pogrebova, 6 after Lengyel, 5, 7—22 after de Morgan. Different scales.

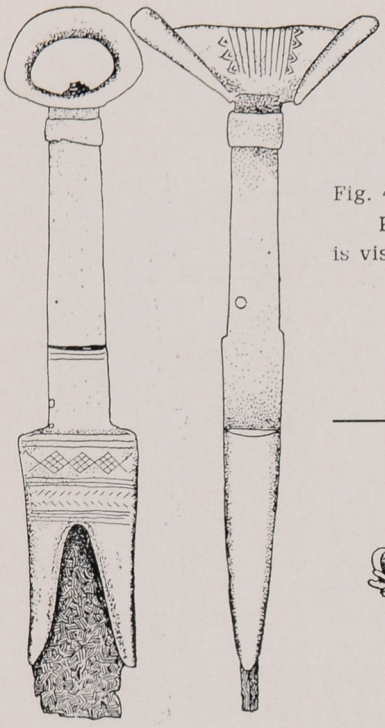


Fig. 4.

Persian Azarbijan. Iron dagger with bronze hilt. The technique of fixing is visible in the hollow saddle shaped pommel. Archaelogical Museum, Tehran

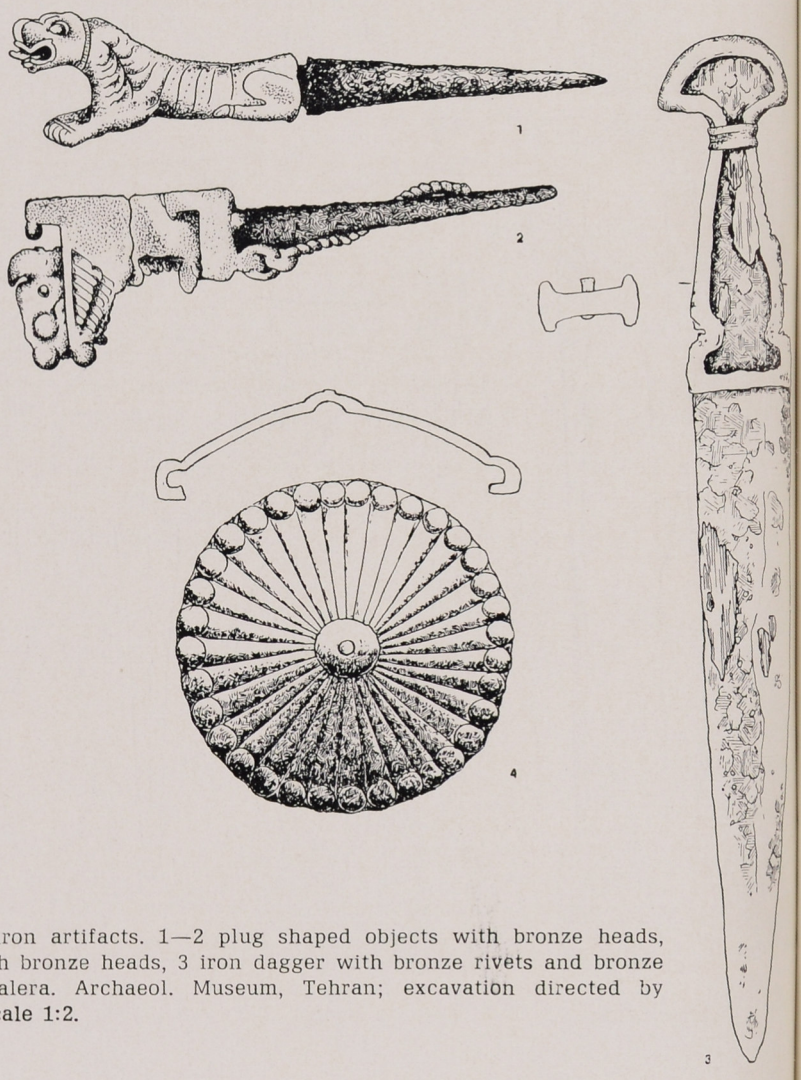


Fig. 5.

Hasanlu IV, iron artifacts. 1—2 plug shaped objects with bronze heads, 3 iron dagger with bronze heads, 3 iron dagger with bronze rivets and bronze band, 4 iron phalera. Archaeol. Museum, Tehran; excavation directed by R. H. Dyson Jr. Scale 1:2.

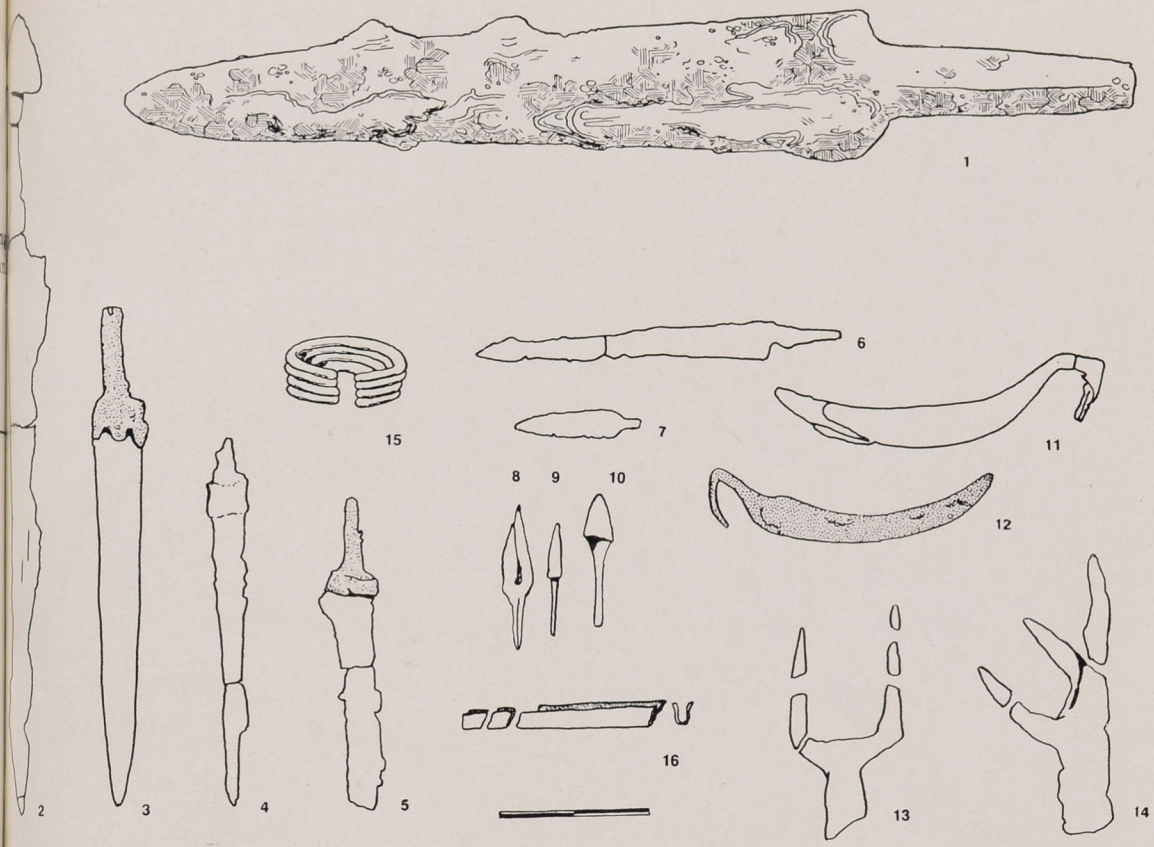


Fig. 6.

Tepe Sialk, iron artifacts. 1 cemetery A, dagger, tomb. 4. 2—16 cemetery B: Tomb 15 (2, 4, 6, 11, 13—14, 16), tomb 3 (3, 8, 10), tomb 67 (5), tomb 21 (7), tomb 66 (15). Excavations of R. Ghirsman (1 Archael. Museum Tehran, 2—16 after Ghirsman).

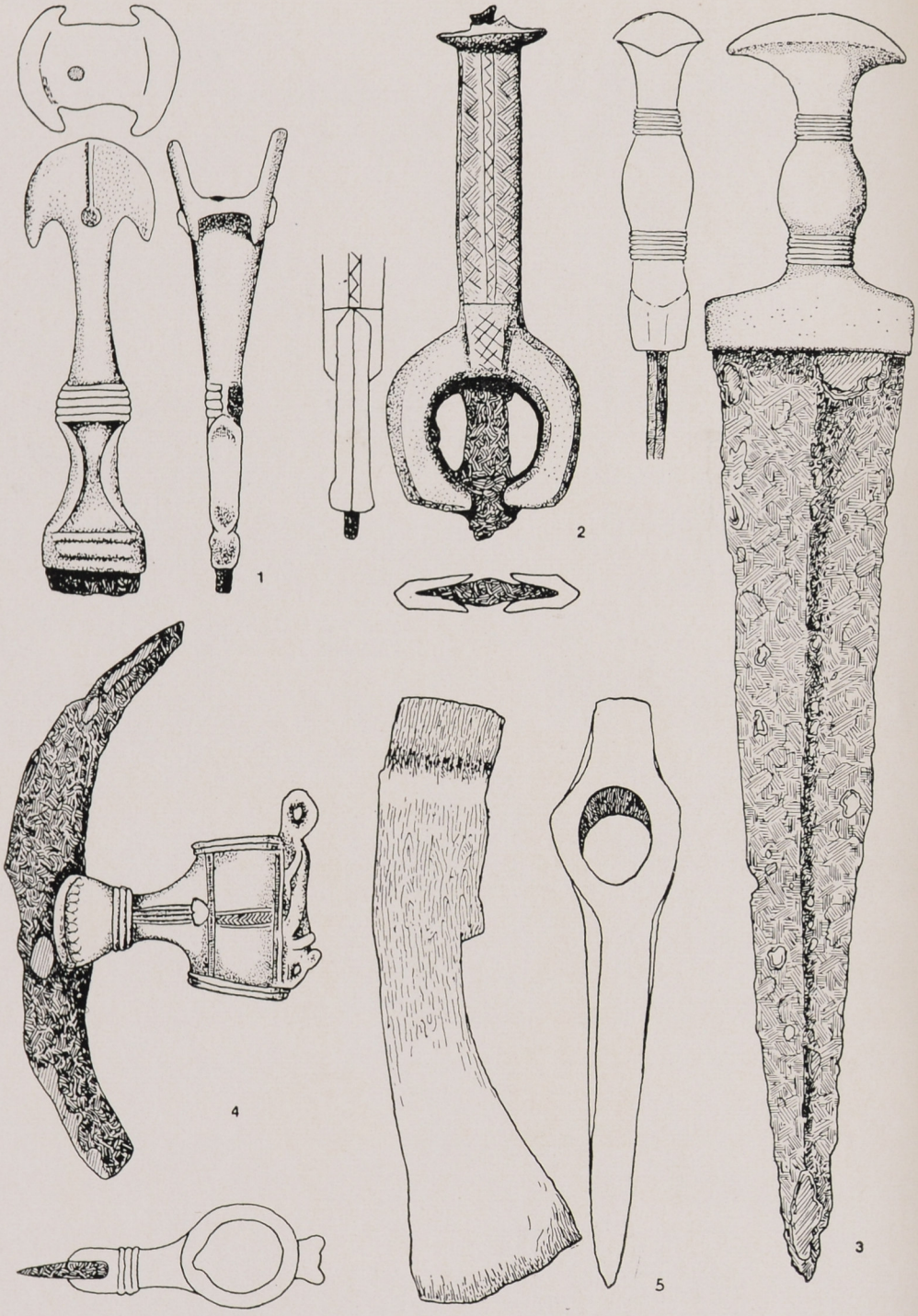


Fig. 7.

Luristan bronzes with iron parts in the Archaeol. Museum in Tehran. 1—3 daggers with iron blades, 4 halberd with iron edge, 5 iron axe. Scale: 1:2.

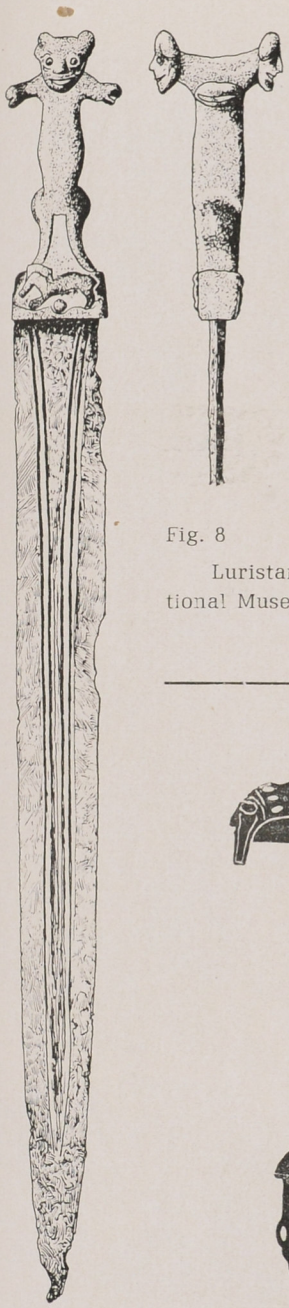


Fig. 8

Luristan. Iron dagger with bronze hilt representing two bear figures. National Museum Copenhagen.

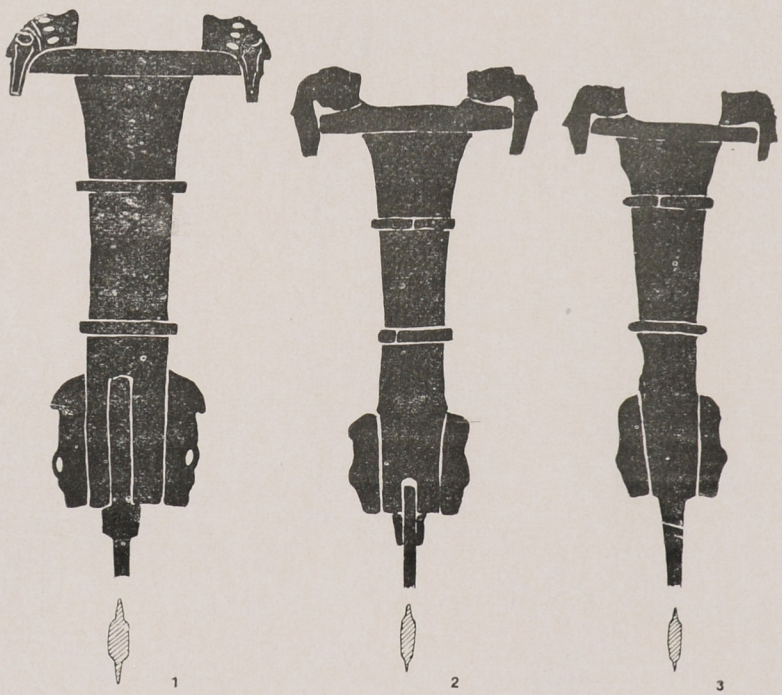


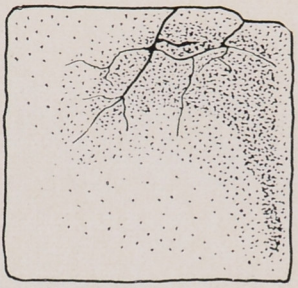
Fig. 9.

Luristan iron daggers with human heads (according to radiographs). 1 New York, 2 Hamburg, 3 Collection Damien, Paris.

Fig. 10.

Luristan iron dagger (Deutsches Klingenmuseum Solingen). 1 general view with specimen for investigation, 2—3 details of the hilt and pommel, 4 radiograph of the hilt (joints of separately fixed parts). Photo Archaeol. Inst., Prague (1, 2—3), radiograph Inst. for Testing Materials, Prague.

1



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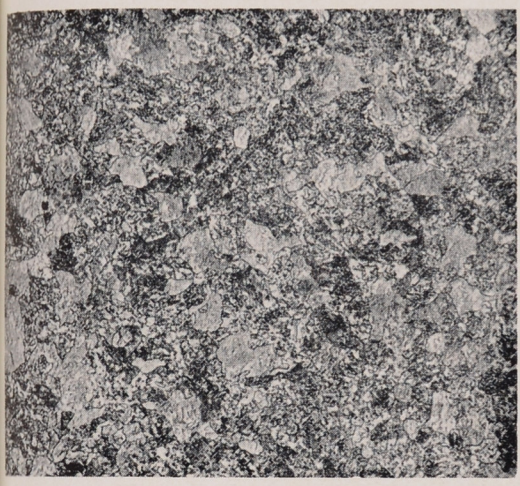

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Fig. 11.

Metallographical investigation of Persian iron. 1—3 Luristan iron dagger (Mus. Solingen): 1 scheme of polished blocs (both hilt and blade homogeneuos steel), 2 hilt, 3 blade (both ferrite and spheroidized cementite). 4—6 iron clamp from Persepolis: 4 polished section with carburized areas (dark), 5 white ferrite (needles and net), dark lamellar pearlite, 6 pearlite and white needle of cementite (steel area). All etched by nital, 2 %, 200×. Protographs Archaeol. Inst., Prague.

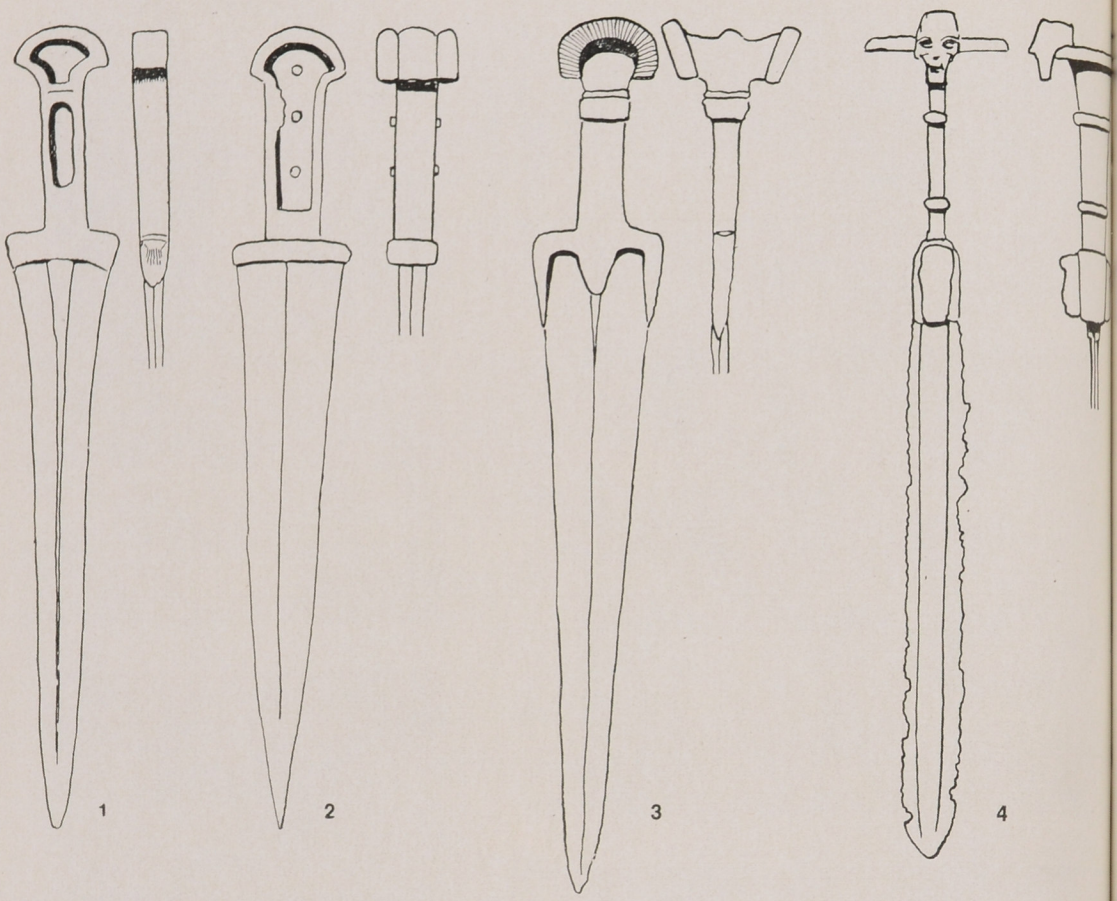

Fig. 12.

Tentative typological evolution of the Luristan iron dagger with human heads. 1. Agha Evlar, bronze (flanged hilt); 2 Chagoula Derré, bronze (flanged hilt, implication of lobes); 3 Tsalka, bronze (caddle shaped pommel with lobes); 4 Luristan, iron (human heads instead of lobes, the position of the blade the same as in the case no. 3).

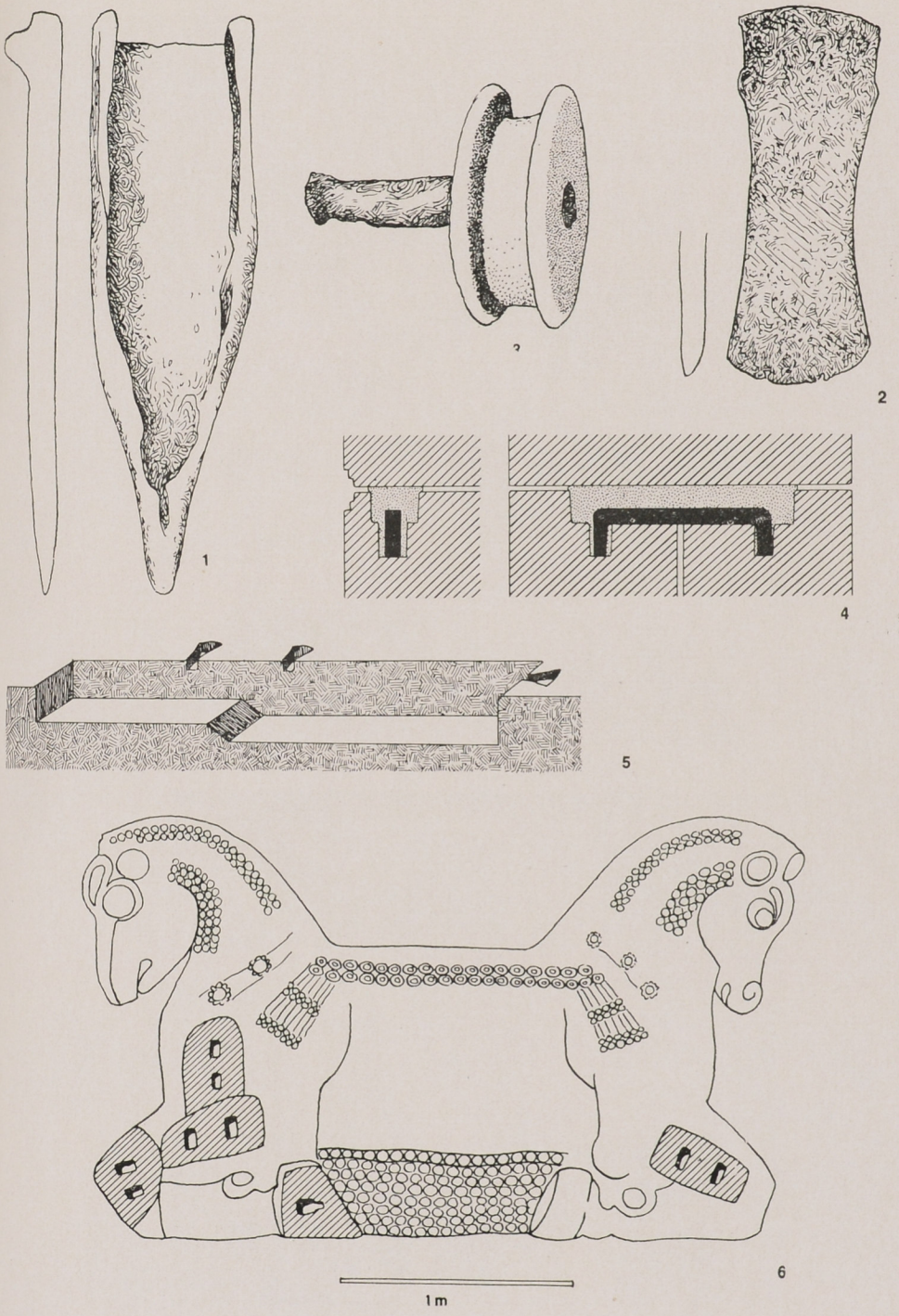

Fig. 13.

Iron in Persepolis. Tools: 1 plough share, 2 adze, 3 bronze pulley with an iron axle. Application of structural iron: 4 joining technique by iron clamps and lead, 5 repaired rim by the same technique, 6 five repaired places of a column head. 1—3, 6 Mus. Persepolis, 4—5 doors of the Hundred-Columns-Palace.

1

2

3

4

Fig. 14.

Pasargadae (1—2), structural iron. 1 Audience Palace, clamps; 2 Tomb of Cyrus the Great, clamp. Persepolis (3—4): 3 two joints with iron clamps and lead, 4 Persian warrior with acinaces sword (relief in the door of the Hundred-Columns-Palace). Photographs R. Pleiner.