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ARROWHEADS (*TEMREN*) FOUND FROM THE EXACAVATIONS AT THE SULTAN GIYASEDDİN KEYHÜSREV-II CARAVANSERAI IN EĞİRDİR, ISPARTA

ISPARTA-EĞİRDİR SULTAN II. GIYASEDDİN KEYHÜSREV KERVANSARAYI KAZILARINDA BULUNAN TEMRENLER

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Abstract

The number of studies on comparisons of technical features of arms in the sophisticated history of Medieval Ages is very limited. One of the reasons for this deficiency is the disregard of this topic in researches, and another reason is that the unclear information about the layers of archaeological finds. Such is the case for Medieval Anatolia as well. Excavation finds like knives, arrowheads and spearheads are not included in the interpretations of war history. Understanding the war technology of Crusaders, Seljuks and Mongols can only be possible by morphologic, archaeo-metallurgical and terminological examinations of the original excavation finds. In this study 64 arrowheads, which were revealed during the 1993, 2006 and 2007 excavations at Gıyaseddin Keyhusrev II Caravanserai, Isparta-Eğirdir, were discussed in morphologic, archaeo-metallurgical, and terminological perspectives. The finds were evaluated by their layer contexts, dimension, weight, morphology, terminology and typology features; they were classified in accordance with their figural features and compared with contemporary examples. Discussions and proposals were made about naming the types with proper technical terms which are mentioned in arrow treatises and warfare books related to the period. 8 of these arrowheads were examined by using archaeometric methods, their micro-structures and the others were determined by the use of Scanning Electron Microscope (SEM) and Energy Dispersive X-ray Spectrometry (EDS). Apart from the other published medieval arrowheads the samples subjected in this study are the first samples to be directly dated in light of the stratigraphic data collected from the layer contexts that were found in the excavation. Thus, the different types of arrowheads determined by this study are significant in means of the data collected from their technological features such as internal structure and hardness, for a comparative study with other contemporary samples, and building a data base on the technique data of Anatolian Seljuk arrowheads.

Keywords: *Arrowhead, Eğirdir, Anatolian Seljuks, Typology, Caravanserai*

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Öz

Ortaçağ'ın karmaşık tarihi içinde orduların silah kabiliyetlerini teknik özellikler açısından karşılaştıran araştırmalar çok azdır. Bu eksikliğin bir sebebi bu konudaki araştırmalarda konuya yeterli önem verilmemesi bir diğeri de kazılardan elde edilen objelere ait tabaka bilgilerinin sağlıklı olmamasıdır. Anadolu-Ortaçağı için de durum böyledir. Kazılardan elde edilen bıçak, okucu, mızrak ucu gibi buluntular savaş tarihini izah edecek açıklamaların içinde yer almazlar. Haçlı, Selçuklu, Moğol savaş teknolojilerini anlayabilmek ancak orijinal kazı buluntularının morfolojik, arkeo-metalürjik, terminolojik boyutuyla incelenmesiyle mümkün olabilecektir. Bu çalışmada Isparta-Eğirdir'deki II. Gıyaseddin Keyhüsrev Kervansarayı'nın 1993, 2006-2007 yıllarında gerçekleştirilen kazılarına ait altmış dört temren, morfolojik, arkeo-metalürjik ve terminolojik açılardan ele alınmıştır. Buluntular tabaka bilgisi, ölçü, ağırlık, morfolojik, terminolojik ve tipolojik hususiyetleriyle birlikte değerlendirilmiş, biçimsel özellikleriyle sınıflanıp çağdaşı örneklerle mukayese edilmiştir. Ayrıca dönemin ok risaleleri ve savaş tarihi kitaplarında geçen isimlerden hangi teknik tabirin hangi tipe uygun olduğu tartışılıp tekliflerde bulunulmuştur. Bu objelerden sekizi arkeometrik yöntemlerle incelenmiş, taramalı elektron mikroskobu (SEM) ve enerji dağılımlı X-Işını Spektrometresi (EDS) ile içyapı ve diğer malzeme özellikleri tespit edilmiştir. Çalışmaya konu olan temrenler, daha önce yayınlanan Ortaçağ örneklerinden farklı olarak, bulundukları tabakaların sunduğu stratigrafik veriler ışığında doğrudan tarihlenebilen ilk örneklerdir. Dolayısıyla bu çalışmayla belirlenmiş olan farklı tipteki temrenlerin içyapı, sertlik gibi teknolojik hususiyetlerine ait veriler, çağdaşı örneklerin mukayesesi ve Anadolu Selçuklu temrenlerinin teknik verilerine ait oluşturulacak veri tabanı açısından büyük önem arz etmektedir.

Anahtar Kelimeler: *Temren, Eğirdir, Anadolu Selçuklu, Tipoloji, Kervansaray.*

Until the invention of firearms the most effective assault weapon was without a doubt arrow and bow. With its shape, weight or internal structure, the tip of the arrow, which is called *temren* in Turkish archery culture, mostly provides the main wound and is one of the main factors that affect the shooting ability. The technical features of the Medieval iron arrowheads are determined by the carbon amount, hardness, hardening technique and usage of clean or recycled forging material. While these peculiarities are effective for the intended use of an arrowhead such as hunting, warfare or training, they also have a direct influence on the form of armours. After all these small iron pieces are important enough to make a direct alteration on the course of a war. It is not common to see a medieval history study with comparison on the weapon capabilities of armies in their technical features. Although objects obtained from the medieval excavations are the most important material data to enlighten this subject, when in case they came from unclear layers the chance to determine their date ceases. Because of this arrowheads belonging to dated layers present very important information with their features in contexture and shapes. In this sense, the arrowheads obtained from the cultural layers with detectable date range of the Sultan II. Gıyaseddin Keyhüsrev Caravanserai at 3 km. south of Eğirdir, Isparta, presents very enlightening information for Medieval archery.

Sultan Gıyaseddin Keyhüsrev II Caravanserai and Excavations

The caravanserai, which is situated at the 3 km. south of town centre on the road between Eğirdir-Konya, is built on a sloping land at the foot of the Akpınar mountain range (**Photo 1**). Being situated on the caravan road stretching from Konya to Antalya on the south, and to Denizli on the west, the building was refered as 'Pınarpazarı Hanı' for a while during the medieval ages because of a market place established here[1]. In present day there is an interurban highway on the east, the town cemetery on the north, and a modern day housing complex on the south of the building.

The building, which is the fourth biggest caravanserai of the Anatolian Seljuk period in respect of its size, composed of a closed rec*iğne*ular space (shelter), and a larger courtyard on east-west axis. There are two piers on all the façades and one on each corner of the walls made with lime mortar and rubble fillings between ashlar. The portal on the axis of eastern façade was opening to an entrance iwan providing access to the courtyard. There is a rec*iğne*ular space on both sides of the iwan. The pillar foundations on the north wing of the courtyard indicate that this space had two rows of galleries (riwak)[2]. Only traces of the foundation remains from the kiosk masjid in the centre of the courtyard, a traditional design feature of a Sultan Han. Entrance to the shelter is provided by another portal on the same axis with the courtyard portal. This cross aisled space is composed of a central aisle stretching between east and west, and seven other aisles perpendicular to the central aisle. The traces of a platform were excavated, which surrounds the central aisle in a U shape. The original state of the space between the third and fourth pillars of

1 Özergin 1965,159.

2 Bozer, 2009, 69.

the central aisle was revealed as domed, by the existence of a stone piece with muqarnas found during the excavations[3].

The earliest publications on the building are from the beginning of 20th century. Süleyman Şükrü's[4] reports provides that the caravanserai was already in ruin during this time. Kurt Erdmann, who has visited the building twice in 1953 and 1959, provides the most extensive data about the caravanserai. Erdmann draws the plan of the building almost correctly, and dates it to the period of Alâeddin Keykubat[5]. The exact date of the building was unknown until recently. A marble piece which was found at the south-western corner of the courtyard during the 1993 season of the excavations has cleared this. The Dündar Bey Madrasas at the Eğirdir Town Centre has two stone inscription plaques. The one situated at the iwan is dated to 1301 and belongs to Dündar Bey. The other one is on the framing border of the portal's arch **(Photo 2)** is dated 1237 and belongs to Gıyaseddin Keyhüsrev II. Because of the existence of the second inscription it becomes possible to suggest that the portal may belong to the caravanserai was possible[6]. But it was not clear to determine this before the excavations. It was proved that this small decorated marble piece[7], which was found during the excavations, completed the composition of the framing border on the left side nisch of the same portal, by placing it on the broken part. This exposed that the portal was taken from the caravanserai and brought to the madrasah while it was being built in 1301. While the main portal of the caravanserai with its inscription expressing the titles of the Seljuk Sultan Gıyaseddin Keyhüsrev II is situated at the façade of the madrasah, the inscription belonging to Dündar Bey was brought in to the main iwan of the madrasah. During the excavations proceeded it became obvious that the caravanserai was robbed on a large scale, the robbing has not stopped only with hauling the portal to the madrasah but also the ashlar stones of the walls were pulled out down to the foundation[8]. It is apparent that stones from one of the largest buildings of Anatolian Seljuk caravanserai s would have been excessive for this small madrasah. Likewise traces can be seen that the rest of the materials left from the madrasah have been used at the citadel walls and other town buildings. Looking at the rigorous placement of the portal to the main façade of the madrasah indicates that this removing process was not done in a looting manner. It is understood that the caravanserai was heavily damaged in 64 years from 1237 (the construction date of the caravanserai) to 1301 (construction date of the madrasa). A layer of fire which extends almost to the whole building was determined during the excavation, beckons this destruction. On this layer there were no coins belonging after the joint sovereignty of İzzeddin Keykavus II, Rükneddin Kılıç Arslan IV, and Alaeddin Keykubat II, which points out that the

3 Bozer, 2009, 71.

4 Süleyman Şükrü, 2005, 59.

5 Erdmann, 1961, 125-126.

6 Proposals and opinions on this subject see, Bozer, 2007, 246.

7 Bozer, 1994, 98.

8 Bozer, 2007, 248.

caravanserai's functioning has stopped around 1249-1254 or right after, but the reason for the fire is not clear. The Mongolian khan Geyhatu, who came to help Mesud II because of the actions of the Turkomans who has revolted with Karamanids against Seljuks in the region, has created destruction and salughter first on the lands of Karamanids then later Eshrefids in 1291-1296, Eğirdir and the surrounding area was also greatly harmed by his actions[9]. The caravanserai may also be ruined during this time. The intense ash layer at the shelter and courtyard seen with the excavations must be the production of such destruction[10]. It is commonly seen of the Anatolian Seljuk caravanserais being functioned as some kind of defence structure like a citadel during wartime. We can say that the fourth largest caravanserai of its period, which was built by a sultan, was used like this, and the ash layer found with excavations might be the traces of a fight during such a usage.

The first excavations at the building were held in 1993 and directed by Asst. Prof. Dr. Rüstem Bozer as a part of the Project of Archaeological-Cultural-Touristic Research and Assessment of the Lake District which was directed by Prof. Dr. Rüçhan Arık. This period of excavation was completed only on the ¼ of the caravanserai came to a halt after the cut of funding[11], later, in the summer of 2006 with the support of the Directorate General of Foundations, the excavations have restarted under the scientific headship of Bozer, and completed in 2007.

*Temren*s of Sultan Gıyaseddin Keyhüsrev II Caravanserai

Evaluation on Contexture, Production Techniques, and Other Morphological Feature

All of the arrowheads found during the Eğirdir Caravanserai excavations are made of iron and produced by forging. The materials used for arrowhead production were blooms coming from smelted ore. Among 64 arrowheads which were found here,[12] a chemical analysis with EDS on eight different form and shaped ones pointed out that the metals were originated from different ores. Among these the arrowhead No.52 was produced with iron, originated from an ore rich in manganese which is commonly seen in Anatolia. Iron material, rich in nickel was encountered in arrowhead No.02. That the Eğirdir arrowheads were made with iron originated from various ores, gave rise to the thought of these materials being shaped in different workshops or the blacksmith has used starting materials which came from different regions. But, since arrowheads are movable objects, and no evidence of any production trace at the caravanserai were found with the excavations, indicates that these objects were made from ores and/or productions of different regions.

9 Kofoğlu 1997, 471.

10 Bozer 2007, 248.

11 Bozer 1994, 95-103.

12 To have a unity with future studies we have used the inventory numbers given to the temrens by the excavation works. Since figures and photographs were typologically sequenced the numbering is not in order.

In medieval times arrowheads were made from iron sticks in various sizes which were prepared from semi-products (bloom) and forged until the desired shape was formed starting from their *iğne*. The arrowheads were forged while the iron was still soft, would harden by carburization or cold work. The semi-product iron material sometimes have a pyramidal form same as the ones from Samsat Tumulus or amorphous like the ones from Kubad-Abad Palace. These are semi-products, which have been processed primarily at the hearth, and brought to the production site for various functions. The preparation pieces cut from these ingots in the shape of long sticks were formed by forging them into the desired objects[13]. These iron sticks are frequently found at the Medieval European excavations[14]. The 'iron nails' mentioned among the necessary materials for arrow production[15] in the book of Fahri Müdebbir, a 12th century war master and author of a book on war techniques, must be these iron sticks.

It was not possible to determine if carburation method (shell hardening), which can be described as keeping the arrowhead in the high heated hearth with carbon sending substances for a determined time, was applied to the Eğirdir arrowheads because of the thick corrosion layer on them. Even though there aren't any carburation marks on the samples where the corrosion layers don't reach to the sides and didn't affect the contexture, the tips of some have reached to really high level of hardness. Because there is a limited number of samples found at Eğirdir Caravanserai excavations, and no data was found related to midproduct or blacksmith forges, proves that there wasn't a production activity here. The differencing contexture and hardness calibres indicate that these arrowheads were produced in different blacksmith hearths.

The number of arrowheads found at Eğirdir Caravanserai excavations may be small but they are various in terms of typology. Alongside with sub-types of kite, lozenge, and short and long deltoid, flat, composite, circular, crescent, quadrangle, and chisel formed types we face the richest arrowhead repertoire of Medieval Anatolia. The first sub-type of flat sectioned samples are kite shaped ones, they weight approximately 5,84 gr., the size of the *ağız* is 1,3x3,31 cm., and the size of the *iğne* is 0,4x2,4 cm.; lozenge sectioned sub-types weight approximately 9,54 gr., the size of the *ağız* is 2,38x3,94 cm., and the size of the *iğne* is 0,36x2,82 cm.; short deltoid sub-types weight 6,88 gr., the size of the *ağız* 1,3x3,62 cm, and the size of the *iğne* is 0,43x2,81 cm.; long deltoid sub-type weight 8,52 gr., the size of the *ağız* is 1,9x4,26 cm., and the size of the *iğne* is 0,62x2,6 cm.; composite types weight 6,07 gr., the size of the *ağız* is 1,41x2,53 cm., and the size of the *iğne* is 0,88x1,27 cm.; quadrangle sectioned arrowheads weight 8,48 gr. The size of the *ağız* is 0,76x3,54 cm., and the size of the *iğne* is 0,4x3,23 cm.; chisel type arrowheads weight 3,72 gr., the size of the *ağız* is 1x3,5 cm., and the size of the *iğne* is 0,35x1,5 cm.; circular sectioned arrowheads weight 4,91 gr., the size of the *ağız* is 0,84x1,76 cm., and

13 For detailed information about Medieval *temren* production methods see Yavaş, 2020.

14 Pleiner, 2006, 49, Fig.20.

15 Uyar, 2007, 222.

the size of the *iğne* is 0,3x3,55 cm.; crescent shaped ones weight 2,7 gr., the size of the *ağız* is 1,6x5,3 cm. The arrowheads were found all around the caravanserai irregularly, they don't present a significant distribution.

Chronology

A decorated marble piece was found during the excavations at Eğirdir Caravanserai has completed the side niche framing border of the madrasah portal at the town centre, and this discovery has revealed that the portal was belonged to the caravanserai[16]. The inscription panel over the portal presents that the caravanserai was built by the Seljuk Sultan Gıyaseddin Keyhüsrev II in H.635/A.D.1237-38[17]. So we can accept the date of 1237-38 as the earliest date for the arrowheads found at the caravanserai. One cannot expect from Dündar Bey, who has developed Eğirdir as the capital for Hamidids, to not use such a building which has significance for trading, useful for defence in case it's needed, and the fourth largest building of Anatolian Seljuks. The reason Dündar Bey wasn't able to salvage this building must be that it was already ruined enough way before the madrasah's building date of 1301-1302, and it became too expensive to repair[18]. Thus all the covering stones were dismantled down to the foundation; it is clear from the decorated stones existing some of them were used at the madrasah, mosque, and citadel in the town. In this sense it could be prudently accepted that Eğirdir Caravanserai has been functioning between 1237 and 1302, when the portal was removed to the madrasah. Thus the arrowheads also belong to the period of 1237-1302. If that's so, when did the events caused such devastation and turning the building unserviceable has unfolded? It's not possible to positively determine the event caused this. The latest date of the coins found from the ash layer seen all around the building under the debris is 1254. The struggles between the Mongol-Seljuk forces and uprising Turkomans which have also affected the region in the second half of 13th century must have caused this devastation at the caravanserai. Six arrowheads found inside the ash layer must be products of this struggle. Still, it is certain that all of the 64 arrowheads found here, in the largest sense, belong to the second half of 13th century, and they present the first group from Medieval excavations which can be dated with this accuracy based upon the stratigraphic data. Thus the formal, typological, and metallurgic data presented by the Eğirdir arrowheads are highly significant for dating samples from other Medieval sites.

Typology

In this study, instead of the term of arrowhead, which tries to define a part of an arrow, "***temren***", a specific term used in our history of archery, will be preferred. Naming the parts will be based upon historical pamphlets (risale) about arrows. The medieval *temren* consists of two main parts. The first one ***ağız*** (blade) (in some studies it's referred

16 Bozer, 2009, 68.

17 Bozer, 2007, 250.

18 Bozer, 2009, 69.

as namlu), the other one is ***iğne*** (tang) (referred as saplama in some studies). "İğne", the part where the *temren* stuck into the shaft of the arrow, is generally circular sectioned and consists of a single piece. The part where the *temren* connects to the shaft and wrapped with tendon dressing is called "***bilezik***" (stem), and the thinning part between "***bilezik***" and "***ağız***", which can be seen in some samples, will be referred as called "***boyun***" (neck) **(Fig. 1)**.

There are two types of classifications narrated in the medieval arrow pamphlets (risale). When doing an arrow typology naming is done in accordance to the functions, such as *meşk oku (exercise arrow)*, *pişrev oku (outridden arrow)*, *hedef oku (target arrow)*, *tirkeş oku (quiver arrow)*, on the other hand in case of classifying the arrowheads it would be done under geometric names such as triangle, pentagon. Sometimes the naming would be plant based such as *zeytunî* (olive), animal based such as *haydarî* (lion), or material based such as *pulâd peykân* (steel arrowhead). Determining the function of a *temren* is done by either the arrow it's attached or from the given name such as *haydarî*. In short, classifying in the pamphlets is generally done by arrows thus the *temren* classifications are done in accordance to the arrows.

Medieval *temren* typology may be established in two points of views as morphological and functional. The main determinant of morphological classification is the *ağız* of a *temren*. Classifications based on the connection to the arrow body as it is done for prehistoric or Roman, Greek period typologies aren't valid for medieval. For arrowheads with sockets have almost disappeared in this period; they were strictly used only with the arrows made for çarh type arbalests. Assorting based on material will also be incorrect, because almost all of the obtained materials are iron. An attempt for a classification based upon the *bilezik*, the part where the *iğne* and *ağız* connects, will prove that there isn't enough data on this, and they are not diverse or important enough to directly affect the classification. Because *ağız* with more than a single wing have disappeared in this period a classification based on the number of the wings on the *ağız*, as it was done for the *temren*s of B.C. years, is not possible.

*Temren*s were grouped into six as "*triangle, square, flat, circular, olive shaped, and chisel shaped*" in the 14th century arrow pamphlet of Mamluk weapon master Taybuga, which has also affected the Ottoman arrow pamphlets. The pamphlet explains the functions of the *temren*s in this morphological classification. Thus statements such as these are seen, the flat type is "*used for hunting and known as canvari*" or the circular type is "*used for target shootings and known as nuşl el ahdaf*"[19]. J. Allan, remarks that these six groups were used in the early Islamic Iran too, sometimes in eight groups[20]. An arrow has four main utilization fields as *war, hunting, competition, and training*. Functions of *temren*s may be classified based on this typology. As the actual penetrating part the *ağız* is the main determinant of the morphological typology. In accordance with this, we come

19 Latham/Paterson 1970, 31.

20 Allan 1976, 441.

across types which are used with *Quadrangle, Triangle, Flat, Circular, V or Crescent shaped, Chisel shaped, Dovetail or Hooked/Barbed shapes, Composite type* classical bows, and others used with *Arbalet/*Çarh type crossbows. Furthermore each type has two subtypes of long and short. Apart from this there are dozens of different types indicating the personal providence of the ironmaster. *Temren*s found at the Eğirdir Caravanserai have *quadrangle, flat (with subtypes of kite, lozenge, short and long deltoid), and circular, composite, crescent, and chisel* types.

Among these there are nine samples of ***quadrangle*** type (No. 6, 8, 26, 30, 50, 54, 63, 64) (Fig. 2, Photo. 3). These kinds of *temren*s are the most commonly found types at medieval excavations. The reason for this is that they could be utilized almost in all kind of fields. This type named as "***murabba***" in the Ottoman pamphlet named Telhîs-i Rumât, "*besides shield and iron, either flesh, tendon, bone whatever it has pierced removing it would shatter the place of entrance*"[21]. In the anonymous Mamluk pamphlet dated to 1500, it's recorded that these were used to "*shoot at armoured enemies and animals like lions*"[22]. In the Ottoman arrow literature it is recorded that this little quadrangle type was used against armours (cebe or cevşen), helmets (tolga, serpenah), and shields[23]. The finding of a quadrangle type *temren* on the spine of a body found at a cemetery dated to 12th century in Urfa-Zeytinlibahçe[24], proves the pamphlet record about the usage of this type for shooting at unarmoured enemies. This square or lozenge (sometimes refered as diamond or lens shaped) sectioned type is generally short and narrow, and has an *ağız* turning into a conical shape at the tip, and a circular or square sectioned *iğne*. The quadrangle *temren*s at Eğirdir have an average of 8,48 gr. weight, 0,76-3,54 cm. *ağız*, 0,4-3,23 cm. *iğne*. The *bilezik*, where the *ağız* and *iğne* is connected, is just a thin line in most of the samples from this group. This may be the reason why the quadrangle type *temren*s are mostly broken from the place where the *ağız* and *iğne* connects. This type has versions with quadrangle prism *ağız* of which the corners are chamfered and the shape revolves into an octagon. While some of these types are square sectioned others are lozenge. It could be said that this is a result of the productions by various masters. There is no difference for their utilizing fields. Some of the lozenge sectioned ones have elaborated chamfer on their corners. The opinions differ on the emergence of this type. They could be found in a large period of time from Roman era to the end of the Medieval era. In Asia, this type is commonly found especially among Göktürk period *temren*s[25]. Other samples can be listed as this: Gritille (Medieval)-Adıyaman[26], Tille (Medieval)-Adıyaman[27],

21 Mustafa Kâni Bey 2010, 131.

22 Faris/Elmer 1945, 108.

23 Yücel 1999, 300.

24 Dell'Era 2012, 398, Fig.5/a.

25 Çerezci 2017, 28.

26 Redford 1998, 169, Fig. 4:2e,b.

27 Moore 1993, 154, Fig.70/106-109.

Minnetpınarı (Medieval)-Kahramanmaraş[28], Taşkun Citadel- Elazığ (Medieval II-III layer)[29], Aşvan Citadel (Byzantine layer)-Elazığ[30], Samosata (12-13th century layer)-Adıyaman[31], Pergamon (Empire period, Late Byzantine, Early Roman layers)-İzmir[32], Olynthus-Macedonia[33], Paneas-Israel[34], Corinth (Byzantine 13th century layer)-Greece[35], Djodovo (Byzantine 11-12th century) Bulgaria[36], Amorium (Byzantine layer)-Afyon[37], Qal-at-Seman (Byzantine layer)-Syria[38], Samaria (Medieval layer)-Israel[39], Konevo/ Kuznetsk Mound (Medieval layer)-Russia[40], Toretsky Mound (end of the 14th century, start of the 15th century)-Kazan[41], Chornivka Citadel (first half of 13th century)-Ukraine[42], Oktyabrsky settlement (11-12th century)-North Caucasia[43], Gorodische (1241 Mongol invasion layer)-Ukraine[44], Hama (Citadel excavation)-Syria[45], Novgorod-Ukraine (13th century)[46], Boğazkale (Middle Byzantine village)-Çorum[47], Zeytinlibahçe (grave dated to the end of 12th century)-Urfa[48], Sardis-İzmir (12-13th century Byzantine layers)[49], Vadum-Iacob Citadel (ruins dated to 1265)-Jordan, (12th century)[50], El Markab Citadel (12th century layer)-Syria[51], Damascus Citadel (stored samples of late Mamluk period 13th

28 Tekinalp 2005, 124, Fig.75:1A.
29 Mc Nicoll 1983, 246, Fig.119/48.
30 Mitchell 1980, 186, Fig.90/26.
31 Yavaş 2017, 38-39.
32 Gaitzsch 2005, 143, Taf.39/P.35-37-41,44,54,58-61.
33 Robinson 1941, Pl.CXXIII, Fig.1988-1989, 1993.
34 Tzaferis/Israeli 2008, 181, Cat. No:66.
35 Davidson 1952, Pl.93, Fig.1532.
36 Borisov 1989, Fig.131.
37 İnce 2010, 11, Res.2.
38 Kazanski 2003, Pl.6, Fig.16,17, 22-24.
39 Crowfoot vd. 1957, 454, Fig.11//20.
40 İlyushin/Sülemaniov 2007, 79, Рис.1/9-12.
41 Valiulina 2009, Рис.1/1-2.
42 Pyvovarov /Kalinichenko 2014, 137, Рис.1/1.
43 Kaminsky 1996, 103, Fig.7/11.
44 Kirpičnikov 1986, 100, Tab.XIII/1.
45 Plaug vd. 1969, 55-56, Fig.21/1.
46 Medvedev 1966, Рис. 25/2-3, Рис. 28/4-5.
47 Böhlendörf 2012, 361, Abb.10/4.
48 Dell'Era 2012, 400, Fig.6/a-d.
49 Waldbaum 1983, 38, Pl.5/74-75,77,82.
50 Raphael 2008, 263, Fig.2.
51 Török 2017, 3-4, Fig.3-4.

century)[52], Yogne'am Citadel (Medieval layer)-Israel[53], Atlit (Medieval)-Jerusalem[54], Red Tower (12-13th century Crusader Citadel)-Palestine[55], Safed Citadel (1266 layer)-Israel[56], Montford Citadel-Israel (Medieval)[57], Arsuf Citadel (layer of Mamluk-Crusader war of 1265)-Palestine[58], Kinet Mound (Medieval layer)-Hatay[59], Karacahisar Citadel (end of the 13th century)-Eskişehir[60], Heraion (Hellenistic and Roman layer)-Tekirdağ[61], Altay-Minusa (9-10th century Göktürk-Kyrgyz period)[62], Gevale Citadel (Medieval)-Konya[63], Başpınar at Nif Mountain (14th century layer)-İzmir[64], Recovery Excavation at Kureyşler Dam (Byzantine)-Kütahya[65], Alliani (from Late Roman period to 14th century)-İzmir[66], Karamettepe-Ballıcaoluk at Nif Mountain (Roman period-14th century)-İzmir[67], Kubad-Abad Palace (13th century) –Konya[68], Horis Citadel (Seljuk layer)-Adıyaman[69].

The ***flat*** sectioned *temren*s constitute the most extensive group among the Eğirdir Caravanserai *temren*s. These have four different subtypes, which are shaped as lozenge (No.1,5,19,28,31,38,45,58) (**Fig. 3, Photo 4**), long deltoid (No. 9, 14, 15, 32, 33, 48,52,53,57) (**Fig. 4, Photo 5**), kite (No. 10, 11, 13, 16, 18, 22, 24, 25, 27, 37, 39, 46, 47, 56, 59, 61) (**Fig. 5, Photo 6**), and short deltoid (No.3,4,17,20,23,35,36,41,43,51,62) (**Fig. 6, Photo 7)**. This *temren* group is the most used and effective type of Medieval era. It could be said that the most characteristic *temren* of the Medieval era is the flat type. Medvedev remarks that even though the emergence of this type in Asian steppes is in 4th century, the actual increase of it and the arising of characteristic subtypes for it has been in 13-14th centuries. As for in Europe he records that this type emerged with Mongol invasion, and points out that the samples from south of Kyiv and Poland are characteristic[70]. The earliest

52 Nicolle 2011, 396.

53 Boas 1999, 173, Pl.617.

54 Johns 1997, Fig.15/2-4.

55 Pringle 1986, 116-119, Fig.56:21/2, Fig.57:23.

56 Damati 1988-89, 159-160.

57 Dean 1926, 53, Fig.53/N.

58 Raphael 2005, 91, Fig.1.

59 Redford 2001, 134, Fig.45/1-5.

60 Altınsapan vd. 2015, 8-9, Tip 3A.

61 Atik 2017, 69-71, Cat.15-20, Res.7.

62 Çerezci 2017, 28, Grup 4, Tip 1.

63 Aygör 2017, 10, Tip 4.

64 Baykan 2017c, 60.

65 Türktüzün vd. 2017, 34, Res.8/11.

66 Baykan 2017b, 12, Res.6.

67 Baykan 2017a, 24, Res.7.

68 Yavaş 2012, 128.

69 Doruk 1980, 167.

70 Medvedev 1966, 75-76.

naming of this type in the sources is '***yasıc***'[71]. This expression, mentioned in Divânü-Lûgati't-Türk, derived from the name '*yası*', and explained in Sir Caluson's etymological dictionary as "*flat and long arrow temren*"[72]. Apart from this Fahri Müdebbir has named it '*peykân-e sepahlu/peykân-e sesu*', and explained as "*it will settle into the flesh, if wanted to remove it the flesh must be ripped*"[73]. Khudyakov records that there were developments among the Kyrgyz military equipment – especially on the *temren* type – during their fight against Uighurs in 9th century; subtypes of asymmetrical lozenge or blunt tip among flat types, which he states that they have emerged in 9-10th centuries, came into focus; that this *temren* type has spread all around Asia with Mongols, and although Kyrgyz were using this type four centuries before the Mongols it's referred as Mongol type[74]. We can list the places where flat type has occurred: Tille-Adıyaman (Medieval)[75], Taşkun Citadel-(Medieval II-III layer) Elazığ[76], Aşvan Citadel (Byzantine layer)-Elazığ[77], Korucutepe (Medieval layer)[78], Olynthus-Macedonia[79], Pergamon-İzmir (Late Byzantine)[80], Sardis-İzmir (12-13th century Byzantine layers)[81], Amorium-Afyon[82], Samaria (Medieval layer)-Israel[83], Tsagaan-Khad Mountain-Mongolia (14th century)[84], Basandaika Kurgan-West Siberia (13-14th century)[85], Konevo/Kuznetsk Mound (Medieval layer)-Russia[86], Barnau-Biysk Region-Russia (Mongol period)[87], Novorsky (grave finds)-South Urals (11-13th century)[88], Chornivka Citadel (first half of the 13th century)-Ukraine[89], Smugowa Góra-Poland (1241-1242/Mongol)[90], Zarechno-Ubinsky Mound-Moldova (Medieval)[91],

71 Teres 2007, 1187.

72 Clauson 1972, 974.

73 Khorasani 2014, 23.

74 Khudyakov 1980, 79-88, 95.

75 Moore 1993, 159, Fig.69/102, Fig.71/120.

76 Mc Nicoll 1983, 186, Fig.90/27.

77 Mitchell 1980, 246, Fig.119/42.

78 Van Loon 1980, Pl.115m.

79 Robinson 1941, Pl.CXXIV, Fig.22167-2168.

80 Gaitzsch 2005, 141-142, Taf.38/P38, 10, 57.

81 Waldbaum 1983, 38, Pl.4/50.

82 İnce 2010, 14, Res.5.

83 Crowfoot vd. 1957, 454, Fig.111/13.

84 Ahrens 2015, 690, Fig.6.

85 Zinchenko 2013, 138, Fig.6/3-4.

86 İlyushin/Sülemaniov 2007, 79, Рис.1/4-6.

87 Tishkin 2002, 146, Рис.II/4.

88 Matyushko 2013, 113, Рис.7/18.

89 Pyvovarov /Kalinichenko 2014, 137, Рис.1/5.

90 Bodnar vd. 2006, 533, Fig.1-4; 537, Fig.6/1-4.

91 Malinovski 2004, Рис.1.

Lesokyafar-North Caucasia (11-13th century)[92], Czerno/Depno/ Plemieta-Poland (13th century)[93], Arkhyz-Gorodische-Ukraine (Medieval), Gorodische-Ukraine (1241 Mongol invasion layer)[94], Molchanovka Mound/ Molchanovka grave/Russia (8-14th century)[95], Moldova (12-13th century)[96], grave finds of Eastern Europe - Mongol (13th century)[97], Kokel Kurgan-Altai Mountains (8-9th century)[98], Djodovo- Bulgaria (Byzantine 11-12th century)[99], Chernovca-Serbia (Middle Byzantine)[100], İstahr ve Şimşir-Nishapur (11th century)[101], Arsuf Citadel-Palestine (layer of Mamluk-Crusader war of 1265)[102], Bilge Kağan Tomb-Mongolia (735)[103], Beş taş Koroo I Cemetery-Kyrgyzstan (Göktürk period-9-10th century)[104], Allanoai-İzmir (from Late Roman period to 14th century)[105], Perre-Adıyaman (Medieval)[106], Antique City of Lagina -Beybağ-Milas (13th century)[107], Kubad-Abad Palace-Konya (13th century)[108].

Circular sectioned *temren*s (No.7,12,42) are in long conical shape (**Fig. 7, Photo 8**). The main distinctive feature of this type is that it could be used for war, hunting, and training. In the anonymous Mamluk arrow pamphlet it is recorded that the short ones of this type were used for shield and the long ones were used for armours[109], in the Taybuga pamphlet it's mentioned that they were used at target shootings (contest)[110]. Apart from this, it could be said that the socket type *temren*s with cylindrical bullet shaped circular ones, of which samples can be found both in England[111]and at the Seljuk layers from

92 Kaminsky 1996, 103, Fig.7/7.
93 Świętosławski 1999, 57, Fig.1/1,3,4,6,8.
94 Kirpičnikov 1986, 100, Tab.XIII/2.
95 Medvedev 1966, табл. 30, 64-65.
96 Mandache 2011, 43, Fig.1/A-3.
97 Nemerow 1987, 219, Рис.2/3-6, Рис.3/6-8.
98 Khudyakov 1986, 147, Рис.64/41.
99 Borisov 1989, 117, Fig.130.
100 Babuin 2009, Fig.1420/d.
101 Allan 1982, 56.
102 Raphael 2005, 91, Fig.2.
103 Tika 2002, 99, Foto 76.
104 Çerezci 2017, 28.
105 Baykan 2017b, 12, Res.6.
106 Erarslan vd. 2008, 184, Resim 2.
107 Tırpan vd. 2009, 513.
108 Yavaş 2012, 128.
109 Faris-Elmer 1945, 108.
110 Latham-Paterson 1970, 25.
111 Jessop 1996, 199-200.

Turkey[112], were for trainings[113]. The different usages directly reflect on the forms of the types. In Jessop's Medieval typology there are special arrowheads with sockets for both shooting animals such as hares or birds, and to use at wars. In the Divan-ı Lûgat-it Türk an arrow for training or students named '***kalva***' is mentioned[114]. But any information on its form is not given. Since they were for training consideration could be made that they were circular. In Taybuga it's recorded that the head of '***naşl el hadaf***', which was used for targets (contest), are circular sectioned. The name '***amacî***' is mentioned for this type, which is the ancestor of the blunt tipped/blind target (contest) arrowheads of the Ottoman[115]. Lastly the 18th century Ottoman arrow pamphlet Telhis-i Rûmat explains that *zeytunî temren*s have circular tips and are specific for target and experiment shootings[116]. as it is said in the pamphlet these circular *temren*s, which are used at war where short ones can pierce shields and long ones can pierce armours, have two subtypes taking into consideration the Perre, Amorium, Kubad-Abad, Samosata, and Karacahisar samples, of which we are able to obtain their dimensions. The first one is the ones we have seen from Samosata, Perre, and Eğirdir. These have circular sectioned conical *ağız*. Their weight are 4,01x5,97 gr., *ağız* are 0,70x0,90 cm. in width and 0,90x1,67 cm. in length, *iğne*s are 0,20x0,32 cm. in width and 2,8x4,38 cm. in length. This very short and narrow sized type is obviously the *temren*s mentioned in the anonymous Mamluk arrow pamphlet as '*specific to shoot at shield*' with circular section. The other circular type specific for war also has a conical shape with a thinning tip, but is bigger and heavier than the former group. The sample, which is in a good condition, found at Kubad-Abad weights 7 gr., and its *ağız* is 1,03x5,60 cm. the *iğne*s of this type are shorter than the others. Neither of them has a *bilezik*. It could be evaluated that these are also long circular *temren*s for shooting at armours. Then only circular arrowhead used for hunting is the socket type samples we come across at Jessop's Medieval English arrowhead typology[117]. Training/ practice *temren*s of circular ones can also be seen among Jessop's typology. the other locations this type is seen can be listed as the following: Taşkun Citadel-(Medieval II-III layer) Elazığ[118], Adzapsh-North Caucasia (11-13th century)[119], Gorodische-Ukraine (1241 Mongol invasion layer)[120], Kuznetsk Kurgan-Russia (8-14th century)[121], Novgorod-Ukraine (10-11th century)[122], Kara-choga Kurgan-Tuva (9-10th century)[123], Free Grammar

112 Aygör 2017, 11, Tip 6.

113 Jessop 1996, 194, Fig.1

114 Yıldırım-Çiftci 2012, 1243.

115 Latham-Paterson 1970, 25.

116 Mustafa Kâni Bey 2010, 131.

117 Jessop 1996, 200, Fig.1, Tip H5.

118 Mc Nicoll 1983, 186, Fig.90:29.

119 Kaminsky 1996, 103, Fig.7/5.

120 Kirpičnikov 1986, 100, Tab.XIII/XI.

121 İlyushin 2009, 124.

122 Medvedev 1966, 58 табл. 30, 9; 30п, 103-104.

123 Khudyakov 1986, 146, Рис.64/33.

School, Basing House-England[124], Beş taş Koroo I Cemetery-Kyrgyzstan (Göktürk period-9-10th century)[125], Karacahisar Citadel-Eskişehir (end of the 13th century)[126], Gevale Citadel-Konya (13th century)[127], Kubad-Abad Palace-Konya (13th century)[128].

Composite type *temren*s (No.2,34,40,55,60) (**Fig. 8, Photo 9**) are the ones with two different forms combined. These can be with a flat *boyun* and quadrangle *ağız*, or flat *ağız* and long circular or flat *boyun*. In this type the *ağız* is as long as it could be. The *boyun* is long, sometimes quadrangle and flat. It is inferred that this type was developed as a solution for some technical difficulties. According to the data from Kubad-Abad Palace, Eğirdir Caravanserai, Amorium, and Perre this type weights between 3,51 and 13,67 gr., *ağız* are between 0,45-1,3x1,55-4,29 cm., *iğne*s are between 0,2-0,45x0,9-5 cm., and *boyun*s are between 0,33-0,9x0,8-2,56 cm. In Ü. Yücel's study which is based on Telhis and Abdullah Efendi's pamphlet, the term of '*composite*' was used for this type. We didn't come across to any other term for this type neither at other contemporary studies or arrow pamphlets. For the emergence of this type Ilyushin-Süleymanov[129], in regards with the data from Western Siberia, Altai Minusink, proposes the date as between the 11th and 13th centuries. Other Medieval locations where these type is seen are: Gorodische-Ukraine (1241 Mongol invasion layer)[130], Gnezdovo-Ukraine (10th century)[131], Qal-at-Seman-Syria (Byzanitne layer)-Syria[132], Pergamon-İzmir (Empire period, Late Antiquity, Late Byzantine)[133], Torestky-Kazan (Medieval)[134], Zeytinlibahçe-Urfa[135], Sherna Mound-Russia (13-14th century)[136], Kuznetsk Mound-Russia (10-13th century.)[137], Konevo/ Kuznetsk Mound (Medieval layer)-Russia[138], Volga-Bulgars (10-12th century)[139], Srostki Kurgan-Yin Cemetery-Gileovo Kurgan/Altai (6-10th century)[140].

124 Jessop 1996, 199-200.

125 Çerezci 2017, 28, Res.3d.

126 Altınsapan vd. 2015, 8-9, Tip 3B.

127 Aygör 2017, 11, Tip 6.

128 Yavaş 2012, 128.

129 İlyushin-Süleymanov, 2007, 80-81, Рис. 1/4-8.

130 Kirpičnikov, 1986, 100, Tab.XIII/IV.

131 Medvedev, 1966, 56, табл. 30/71-84.

132 Kazanski 2003, 80, Pl.6/11-12.

133 Gaitzsch, 2005, 142-143, Taf.39/P51.

134 Valiulina, 2009, 23, Рис.2/14.

135 Dell'Era, 2012, 400, Fig.6/h-i.

136 Chernov-Ershova, 2013, 390, Fig.6/845, 871.

137 İlyushin, 2009, 127, Рис.4.

138 İlyushin-Sülemaniov, 2007, 80-81, Рис.1/7-8.

139 Sitdikov vd., 2015, 169-170.

140 Khudyakov, 1986, 186.

Chisel shaped *temren*s are (No.21,44) (**Fig. 9, Photo 10**) actually similar to the flat *temren*s in terms of form. But according to the arrow pamphlets it's a special type produced for specific purposes. The ones found at Eğirdir Caravanserai excavations have flat sections, and are in a concave form with an *ağız* narrowing from tip to the *boyun*, ending in a straight and sharp line, just like a scalpel. Their average weights are 3,72 gr., *ağız* 1x3,5 cm., and *iğne*s are 0,35x1,53 cm. The *temren* with a wide *bilezik* has a short and narrow circular *iğne*. In Taybuga's pamphlet this type was described as "*there are temrens looking like chisels that are used by the archers in the Turkish lands. ... cylindrical but its tip is like a scalpel ...*", the conical tip was cut in a line, and the diameter of the *ağız* is as much as the tip of the knife. The Mamluk was master and author expresses that he has tried this *temren*, and it's much effective against the laminated armours called '***karkal***'[141]. We lack any precise evidence about which term from the pamphlets was this type referred. None the less, terms of *tīr-i bakaltāk*[142], tīr-i cevşen-guzer and tīr-i ziri[143], explained as 'armour piercer', must be referring to the chisel type recorded by 12th century Ghaznavid-Ghurid war expert Fahri Müdebbir. Medvedev reports the emergence of this type as 10-11th century. The Russian researcher remarks that different variations of this type have developed until the Mongol invasion in the second half of 11th century, and 12-13th century, and was used widespread among Russians and Volga Bulgarians[144]. Sitdikov[145] states that this type has become prevalent among Volga Bulgarians between 10th and 12th centuries. Another significant researcher Khudyakov[146], records that this type was seen in the Altais since 8-9th century, it has spread to the eastern Europe from here, and was seen in Kyiv-Novgrodova from 11th century up to the start of the 14th century. Other locations with this type: Peebles-Russia (Medieval layer)[147], Gorodische-Ukraine (1241 Mongol invasion layer)[148], Princely-Ekimousty Alcedar Mound-Ukraine (10-11th century)[149], Volga-Bulgarians (10-12th century)[150], Ibyrgys-Kiste Kurgan/Altai (8-9th century)[151], Djodovo (Byzantine 11-12th century)-Bulgaria[152].

V, Y or Crescent shaped *temren*s are arrowheads which almost all of the sources are in agreement of their functions. Carpini mentions about a type shot at the birds

141 Latham-Paterson, 1970, 25.

142 Khorasani, 2012, 43.

143 Khorasani, 2014, 26.

144 Medvedev, 1966, 85-86.

145 Sitdikov, 2015, 169.

146 Khudyakov, 1986, 149-150.

147 Shirin, 2002, 131, Рис.I/1,1-2.

148 Kirpičnikov, 1986, 100, Tab.XIII/III.

149 Medvedev, 1966, 74, 85-86, табл. 30B, 50; 30π/95-97.

150 Sitdikov vd., 2015, 169.

151 Khudyakov, 1986, 146, Рис.64/38.

152 Borisov 1989, 118, Fig.134.

while explaining the Mongolian *temrens*[153]. Świętosławski says that this type was shot specifically at water birds, and some V shaped ones are Mongolian types. According to Muhammed Zaman's Safavid period arrow pamphlet, these *temren*s, which are named 'čandratiyān' in Hindi, were used for dropping the fruits from trees, cutting the bowstring of the enemy, cut of the snake's head, and extinguish the candle's flame (some kind of a arrow shooting contest to show off skills)[154]. Taybuga denotes in his pamphlet that these crescent shaped *temren*s were used to shoot at birds and unarmoured enemies[155]. This type has two main forms. The first one has a forked or V shaped *ağız* with flat section, and a long circular *boyun* part. The angle of the V part of these *temren*s varies in regards of the master's forming style. In the second type *ağız* are formed in a crescent shape. Both types have circular sectioned *iğne*s, and wide *bilezik*s. Among all the recorded Medieval-Anatolian samples, this type is only seen at Eğirdir Caravanserai (**Fig. 10, Photo 11**). It weighs 2,96 gr., the (crescent) *ağız* is 0,68 x 1,6 cm., the *boyun* is 0,58 x 0,94 cm., and the *iğne* is 0,26 x 3,21 cm. Traveller Carpini mentiones that this type of *temren* among the Mongol arrows are 3 fingers long (must be meaning the finger knobs). The sample found at Bain-Davane Aman in Tuva has an *ağız* size in 2x3,5 cm., and *iğne* size in 2 cm.[156]. Medvedev, reports that the *temren* in this type which was found at Kuzhnovskogo, and Gnezdova mound has a 1,6x4,5 cm. crescent part, 2,3-8 cm. total length, and weighted 3-12 gr.[157]. In Muhammed Zaman's pamphlet this *temren* is referred as '***hilalî***'[158]. Khudyakov proposes the 9-10th century for the development of this type[159]. Kaminsky[160], expresses that in North Caucasia these hilalî *temren*s were started to be used after the 10th century. On the other hand Sitdikov records that it has emerged among the Volga Bulgarians 10-12th centuries[161]. István[162], mentions that this type has entered to the Hungarian lands in 9-11th centuries. Malinowski[163], takes the history of this type as early as the 6th century. Świętosławski [164], who has followed the trail of this type in the lands of Poland, says that this type, which is foreign to Western Europe but widespread in the Asian

153 Świętosławski, 1999, 62.

154 Khorosanî, 2016, 54.

155 Latham-Paterson, 1970, Pl.5.

156 Khudyakov, 1986, 147.

157 Medvedev, 1966, 72-73.

158 Khorosanî,2016, 54, dpnt.79.

159 Khudyakov, 1986, 147, Res.64/43.

160 Kaminsky, 1996, 102, Fig.7/17.

161 Sitdikov vd., 2015, 169.

162 M. T. István, http://ijasznemzet.hu/hu/olvasnival%C3%B3/tanulm%C3%A1nyok/154-a-ix%E2%80%93xi-sz%C3%A1zadi-magyar-nyilakr%C3%B3l.html. (Access date: 28 June 2017).

163 Malinowski, 2004, Рис:2.

164 Świętosławski, 1997, 88.

steppes, is referred as Mongolian type. On the other hand Medvedev[165] while counting the eight subtypes of this *temren* type, he mentions that it gain widespread usage in the lands of Russia and Eastern Europe starting from 9th century, specially in 12-13th centuries. Other locations this type is seen are as follows: Lentinsky Temple-North Caucasia (11-13th century)[166], Gorodische-Ukraine (1241 Mongol invasion layer)[167], Barnau-Biysk Region-Russia (Mongol period)[168], Kuzhnovskogo-Gnezdovo Mound-Ukraine (9-13th century)[169], Bain-Davane Aman-Tuva (9-10th century)[170], Smugowa Góra-Poland (1241-1242/Mongol)[171], Free Grammar School, Basing House-England[172], Zarechno-Ubinsky Mound-Moldova (Medieval)[173], Tupesy-Czech Republic[174], Djodovo (Byzantine 11-12th century Bulgaria[175], Sardis-İzmir (Late Byzantine)[176], MNational Museum of Hungary-Hungary[177].

Archaeo-Metallurgical Analyses

All analysed *temren*s were forged from bloom produced by direct smelting of iron bearing ores. Slag inclusions and heterogeneous distribution of micro-structures with different carbon amounts are general features of this kind of material and were observed in all of the samples. Carbon is an alloying element turning iron into steel and it hardens the material. More carbon content makes it difficult to forge small steel objects with details. Moreover, in Medieval times homogeneous steel with moderate quality was a lot more valuable than the ordinary bloom and used for economically profiting objects such as knives or swords. In this sense, the use of steel in the Eğirdir *temren*s would not be expected as a general practice. Thus, we evaluate that the carbon bearing (mainly pearlite) sections of the Eğirdir *temren*s was a result of forging the heterogeneous bloom. This kind of heterogeneous material was used to produce No.52 flat type (**Photo 12**). From the No.07 *temren*'s microstructure, it was seen that pure forms of iron were used for the quadrangle sectioned *temren*s. Because of the thick corrosion layer on them, it was not possible to determine whether carburization, which can be explained as keeping the objects in the smithing hearth inside carbon rich atmosphere with high temperatures,

165 Medvedev, 1966, 72-73.

166 Kaminsky, 1996, 103, Fig.7/17.

167 Kirpičnikov, 1986, 100, Tab.XIII/VIII.

168 Tishkin, 2002, 146, Рис.II/1,3.

169 Medvedev, 1966, 72-73, табл. 30, 56-57;14,27; 16, 35,37; 18,35; 21,5-8; 23,31-35; 26,18-23.

170 Khudyakov, 1986, 147, Рис.64/43.

171 Bodnar vd., 2006, 536, Fig.4,7.

172 Jessop, 1996, 199-200.

173 Malinovski, 2004, Рис.2/19.

174 Dostál, 1966, Tab.67/2.

175 Borisov 1989, 118, Fig.135.

176 Waldbaum, 1983, Pl.5/83.

177 Karasulas, 2004, 19.

also known as case hardening, was applied to the samples in this study or not. No signs of carburization were observed in the samples where the corrosion layers could not destroy the surface and did not affect the microstructure. Data demonstrating that the *temren*s have different ore origins was obtained by the chemical analysis done with EDS. In accordance with these results, the iron used to produce *temren* No.52 was obtained from an ore rich in manganese. Iron ore rich in manganese is widely encountered in Anatolia. At the same time, having 3,53% nickel rate points out that the ore used for the production of *temren* No.02 was rich in nickel. Although, not as high as this sample, *temren* No.60 has parts with a high nickel rate as well. Lateritic iron deposits are known with their rich nickel content. The well-known lateritic iron deposit in Turkey is located at Çaldağ district of Turgutlu, Manisa[178]. There are also laterite ore deposits in Gördes and Muratdağı[179].

It was detected that among the flat sectioned *temren*s, ferrite sections and pearlite ones with a bit higher in carbon rate, align along the cross- sections as layers. It was observed from the micro-structure of similarly produced *temren*s at Kubad Abad that materials with heterogeneous carbon structure were specially used with this type of *temren*[180]. The steel structure of the *temren*s with layers on their tips increases the strength of the *temren*. Thus, in productions with this type of *temren*s heterogeneous material was particularly chosen. Moreover, these kind of heterogeneous materials were prepared by forge welding of iron and steel materials with different carbon rates in some cases. There is no trace of quenching on the *temren*s which were examined. Although quenching the steel with 0.1% and higher carbon rates makes it possible to reach extremely high hardness, it also causes the material to be more brittle against impacts. Not encountering the quenching process on any *temren*s shows that this hardening technique was not used with *temren* production. Measuring the hardness of the low carbon regions at the tips of some *temren*s gave high values i.e. 234 HV. Therefore, examinations made to search if there was alloying element (such as phosphor) in the iron structure or if any other mechanical hardening process was done. EDS analysis of the *temren* No.02 did not show any alloying elements besides nickel to harden the low carbon material used for the production of *temren*s. This situation indicates that cold work might have performed especially with flat sectioned *temren*s. In the forming process, forging the *temren* while it is cooling deforms the micro-structure; and these deformations cause hardening[181]. Forging the tips of the *temren*s while cooling down explains the reason for different hardness measurements between *iğne*s and tips. Elongation of grains seen on the SEM image of the sample taken from the tip of *temren* No.52 presents traces of cold working (**Photo 13**). No.49 differs from the others with its crescent tip form. Analysis on this *temren* indicated that it was produced from completely soft and plain iron. It was contemplated that this kind of material was used to not to complicate the detailed forming stage of it.

178 Çağatay-Altun-Arman, 1981.

179 Tufan, 2014.

180 Güder-Yavaş-Yalçın, 2015.

181 Sherby-Wadsworth, 2001, 348.

Conclusion

Among other published Anatolian *temren* collections from the Turkish Period, *temren*s of Eğirdir Caravanserai may be few in numbers but are the richest in type diversity (**Photo 14, Fig. 11**). Among the flat, circular, quadrangle, composite, crescent, and chisel type *temren*s the crescent one is the only uniquely known sample. We have encountered all the types of *temren*s' areas of usage mentioned in the arrow pamphlets as war, hunting, contests, even for training. But we must express that each type was used for more than a single area, and in this sense it is not possible to precisely determine the function of each *temren*. The weight and measures of Eğirdir *temren*s parallels the *temren*s found at Medieval Anatolian locations such as Samosata Mound, Kubad-Abad Palace, Alanya, Amorium, Horis Citadel, and the Mongol *temren*s found in Russia and Europe.

Eğirdir *temren*s, are among the rare Anatolian samples to be dated for the cultural layer data. Some samples, which can be dated 1237-38, when the Caravanserai was built, and the start of 14th century, when the building was in ruins and stones and its portal was removed, was found in the ash layer (**Photo 15**). Because there weren't any coins found in this layer dating after 1254, six *temren*s which were found here could be dated to the third quarter of the 13th century. Although the event causing this fire all around the building is unknown, we know that there was a fight for power between the Seljuk-Mongol forces and Turcoman with Karamanids. A fire rendered the caravanserai unserviceable might have happened during this fight. If so, the *temren*s found especially in the fire layer, may possibly be productions from this fight. All the *temren*s from the aforementioned layer are subtypes of flat type. This type which we come across in every stage of the Medieval Era, on a large scale land from Asia to inner Europe being brought by the Mongols, does not belong to a specific period or geography. Thus these *temren*s may belong both to the Mongols or their rival Turkomans.

Archaeo-metallurgical analysis shows that *temren*s from Eğirdir Caravanserai were produced from metals originated from different ores. Lack of production data such as slags, smithing hearth or semi-products show that there was no smithy here. After all it is not necessary in a building where there is a constant circulation of people, and a constant production, like in a citadel or city, is not needed. In this sense, it is natural that Eğirdir *temren*s do not belong to a local production. Our analyses show that some of the *temren*s found here were hardened by cold work. Besides the skills of the blacksmiths, this must be caused by necessity from the material. The differences between hardening methods are not relevant to the *temren* types. Likewise, it was observed that the same type of *temren* was hardened with different methods in the samples from different historical sites. Thus, our opinion is that, as hardness is one of the main causes of injury, after forming process, blacksmith decided the hardening technique according to the material he has used. It was understood that Eğirdir *temren*s are consist of unique samples exhibiting these different Medieval techniques.

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Photo. 1

Photo. 2

Figure 1

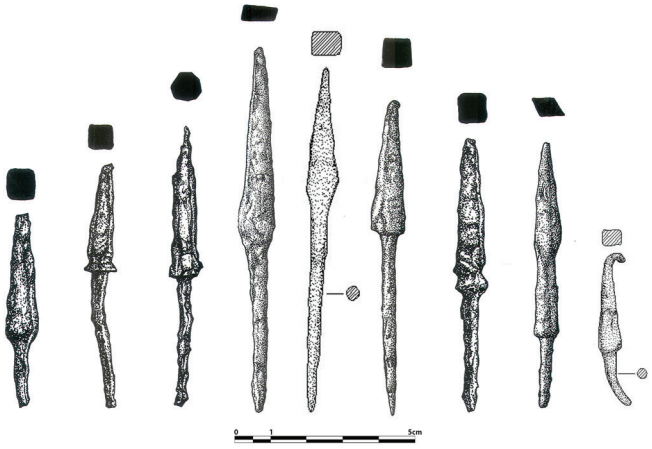


Figure 2

Photo. 3

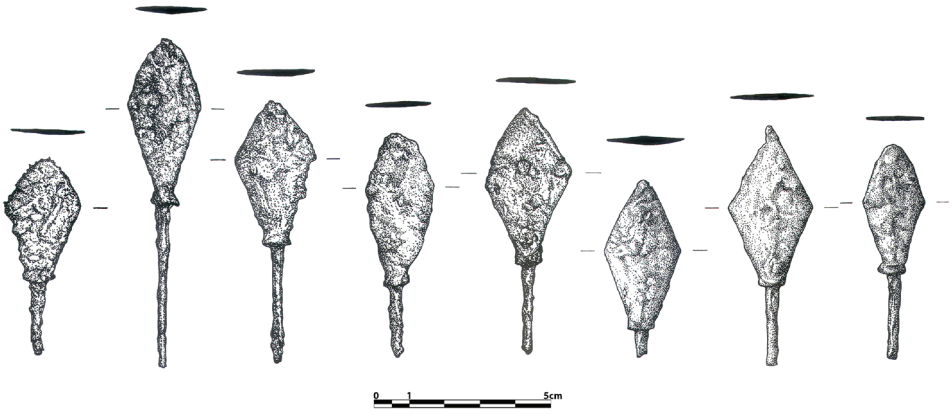


Figure 3

Photo. 4

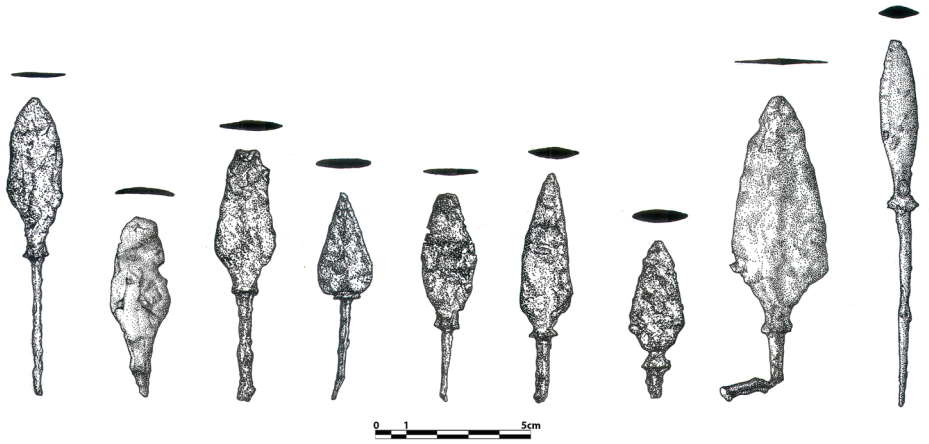


Figure 4

Photo. 5

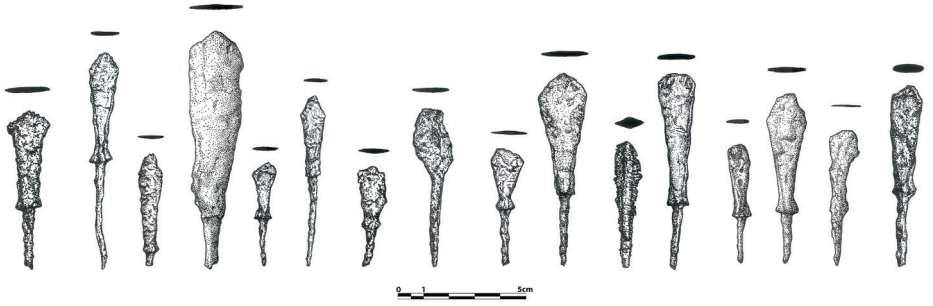


Figure 5

Photo.6

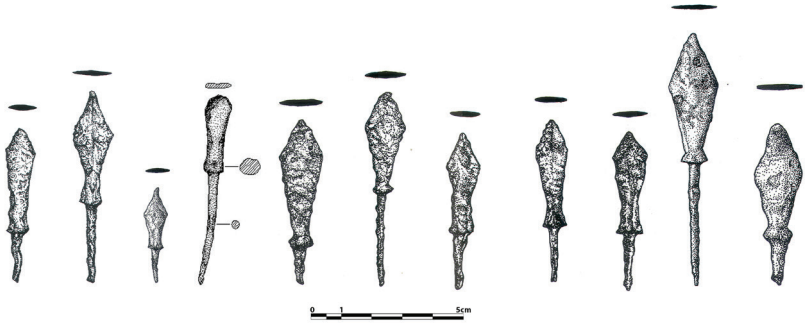


Figure 6

Photo. 7

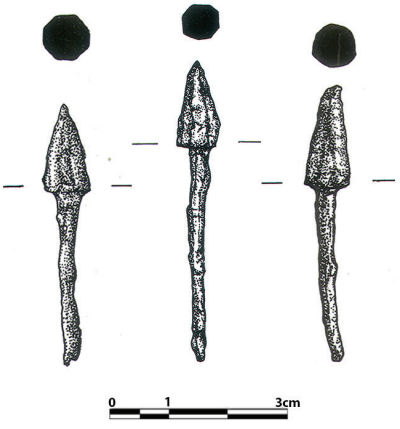


Figure 7

Photo. 8

Figure 8

Photo. 9

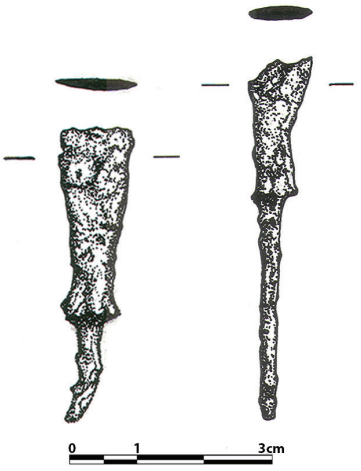


Figure 9

Photo. 10

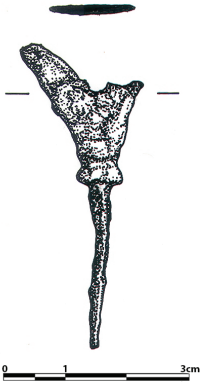
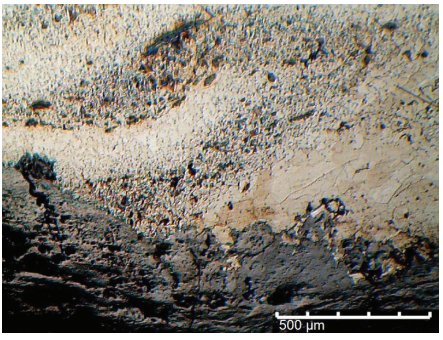


Figure 10

Photo. 11



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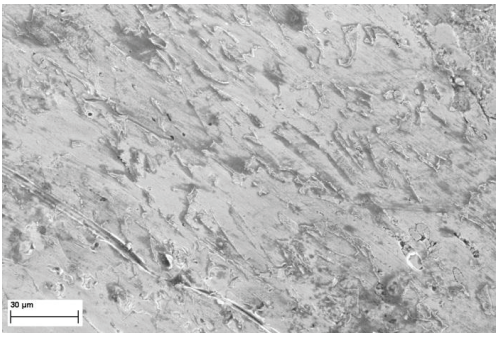

Photo. 13

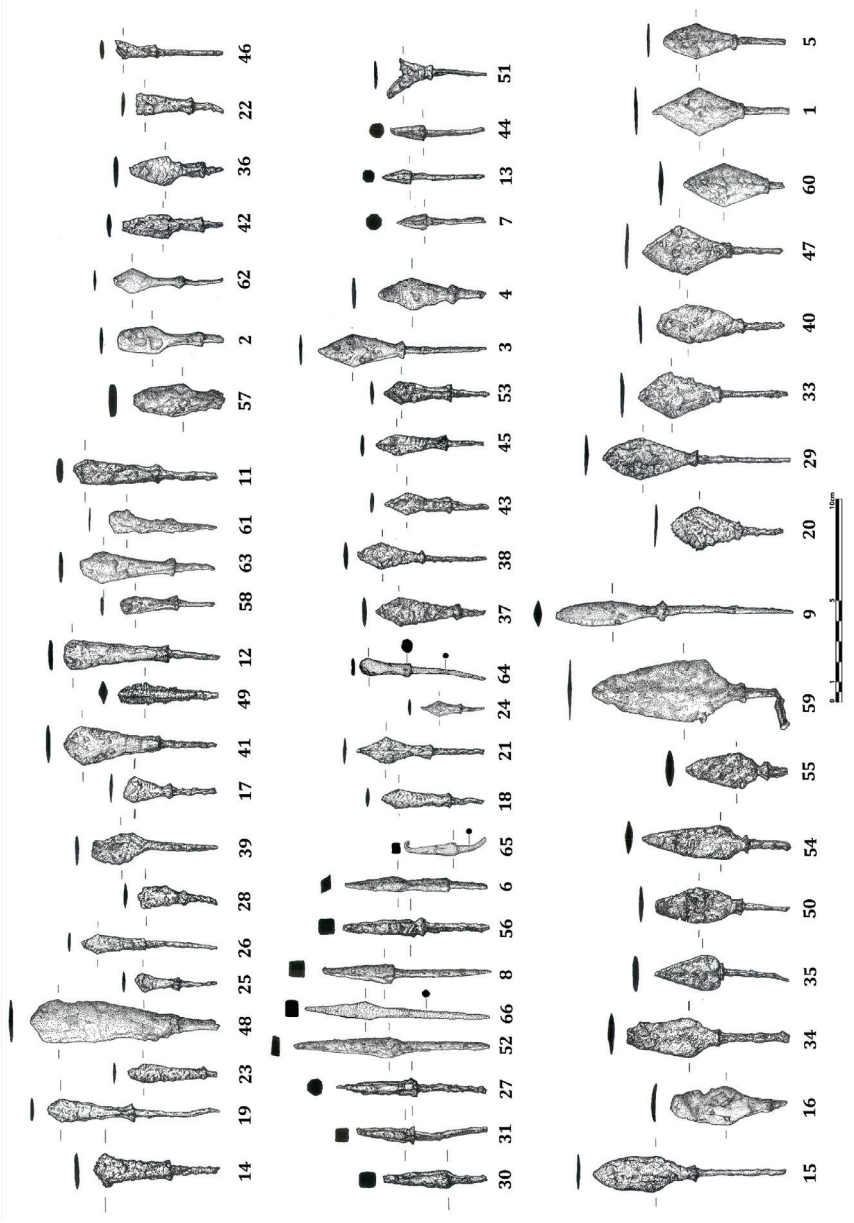
14 19 23 48 25 26 28 39 17 41 49 12 58 63 61 11 57 2 62 42 36 22 46
30 31 27 52 66 8 56 6 65 18 21 24 64 37 38 43 45 53 3 4 7 13 44 51
15 16 34 35 50 54 55 59 9 20 29 33 40 47 60 1 5
10cm

Figure 11

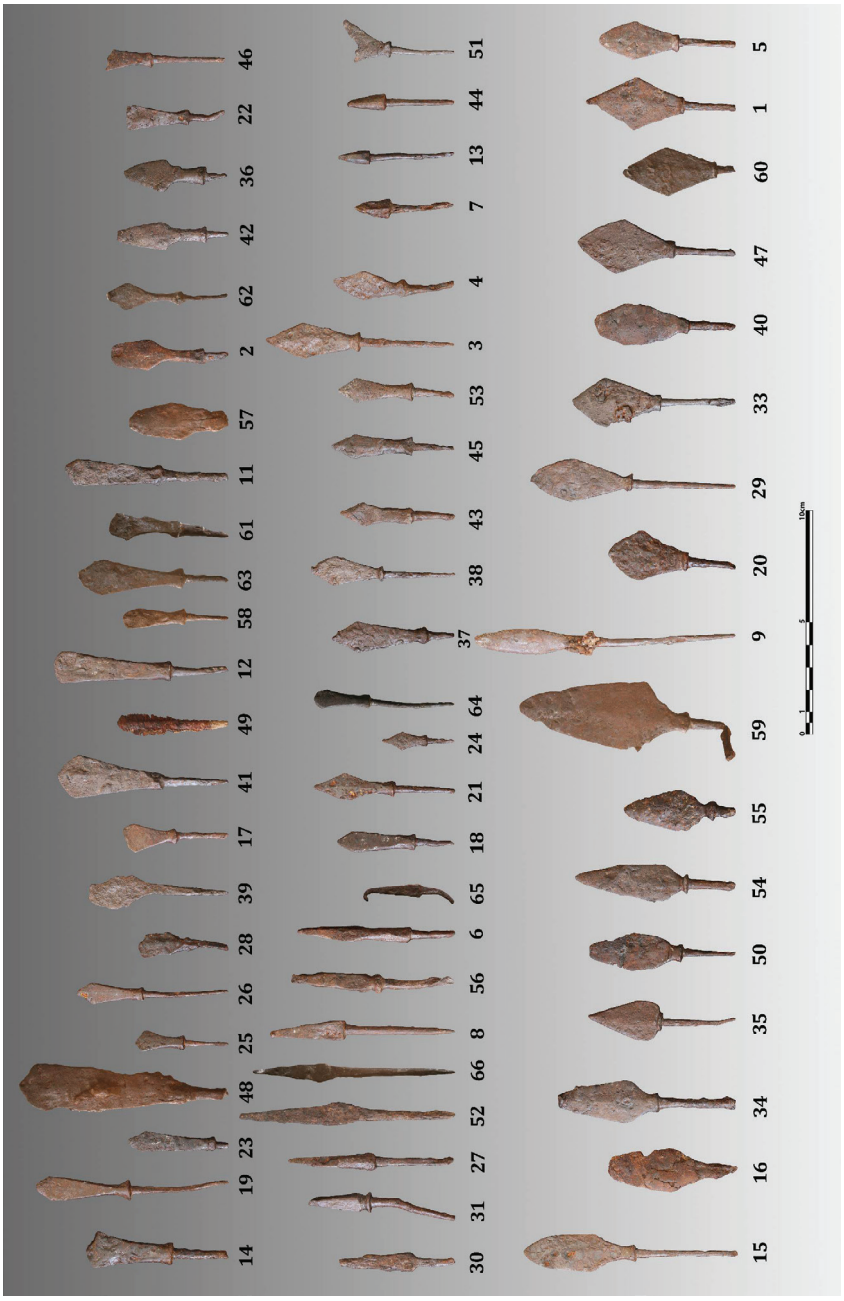
14 19 23 48 25 26 28 39 17 41 49 12 58 63 61 11 57 2 62 42 36 22 46
30 31 27 52 66 8 56 6 65 18 21 24 64 37 9 59 55 54 50 35 34 16 15
38 43 45 53 3 4 7 13 44 51
20 29 33 40 47 60 1 5
0 1 5 10cm

Photo. 14

Photo. 15

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