Archaeological Notes

TECHNICAL NOTES ON ANOTHER LURISTAN IRON SWORD

PLATES 23-24

An iron sword which was found in Luristan has recently been acquired by The Metropolitan Museum of Art. It belongs to a group which began to appear on the market in the early 1930's. They are difficult to date and their method of manufacture has not been completely explained. In the *AJA* for April 1961, Mr. Herbert Maryon[1] has summarized technical reports by the Royal Ontario Museum of Archaeology, the British Museum, The University Museum of the University of Pennsylvania, Musées Royaux d'Art et d'Histoire, Brussels, and the Hamburg Museum for Arts and Craft. He also mentions Dr. Herzfeld's dagger,[2] those in the Khanenko Collection in Kiev, the Louvre, the Oriental Institute of the University of Chicago, the museum in Teheran, as well as examples in museums in Solingen-Grafrath and Dusseldorf, Germany, as falling into the same class. His interpretation and summary bring much new knowledge to the disputed question of provenance, materials and method of construction. We should like to add our technical findings, partly in corroboration of some of the information published by Mr. Maryon, and partly to add further data, which we are able to do because of the excellent state of preservation of this sword.

DESCRIPTION

As can be seen from the photograph (pl. 23, fig. 1), the Metropolitan Museum sword is almost described by the reports already published. The blade is set at right angles to the hilt which terminates in an oval disc-shaped pommel; the hilt is divided into three sections by two metal rings; the guard is decorated with two crouching lions, the pommel with two double-headed ornaments: a lion head flows into a bearded man's head which extends down below the edge of the pommel. However our sword has some added features which have not been previously mentioned.

1) There were originally 64 carnelian inlays on the hilt. One of the four on the pommel is now missing, but 63 are still in place. These occur as follows: nine in each of the two lions on the guard, twenty-one in each of the double-headed, bearded man-lion ornaments on the pommel, and four in the pommel, flanking the bearded heads. The stones are a clear, reddish color with a hardness of 7+. Parts of many have a semi-transparent whitish appearance due to deterioration. They are set into sockets and are held in place by the crimped edges of the surrounding metal.

2) A three-step ornamental flange lies against the underside of the disc where hilt and pommel join (pl. 23, fig. 2).

3) The surface of the lion ornaments on the guards are extensively chased in geometric pattern, as are the beards on the heads (pl. 23, fig. 3).

4) The ricasso, described by Mr. Maryon, in this case is on two levels. The lower level, next to the blade, is chased in chevron pattern (pl. 23, fig. 4).

Conforming with the Brussels[3] and Hamburg reports, and the Louvre[4] photograph, our blade has a center ridge which runs the length of the blade. It is approximately 14 mm. wide for the first 20 cm. but appears to taper to 10 mm. as it nears the tip. One cannot be precise as to the form of the ridge at the end of the blade, as it is corroded. The blade itself flares slightly from the ricasso to a point about half-way down, and then narrows again.

The only feature mentioned in any of the reports which is completely lacking on the Metropolitan Museum sword is the scabbard tip attached to the Brussels sword.[5]

MEASUREMENTS[6]

Blade	315 x 38 mm. (center ridge 14mm. wide) maximum thickness 7 mm.
Hilt	(including ricasso) 188 mm. maximum width 33 mm. maximum thickness 12 mm.
Ricasso	(l.) 16 x (w.) 28-32 mm. maximum thickness 13.5 mm. ornamented band (l.) 4 x (w.) 32 mm., thickness 12 mm.
Guard	broad face 44 x 26-29 mm. ornamented face 44 x 26-21 mm. The undecorated faces are wider than the decorated and the adjoining faces taper in opposite directions, resulting in a square end next to the ricasso (26 x 26 mm.)
Total length	503 mm.
Disc	Diameter 86 x 76 mm. Diameter with ornaments 99 x 76 mm. Thickness 11 mm. where heads join, 6 mm. elsewhere.
Center of Gravity	120 mm. from top of head ornament.

The measurements and proportions of all swords, ours included, vary considerably, which supports the

[1] Maryon, Herbert, "Early Near Eastern Steel Swords," with technical reports by Mr. R. M. Organ, Dr. O. W. Ellis, Dr. R. M. Brick, Dr. R. Sneyers, Dr. E. E. Herzfeld → Dr. F. K. Naumann, *AJA* 65 (1961) 173-84, pls. 65-72.

[2] Herzfeld, Ernst E., *Iran in the Ancient East* (London 1941).

[3] Speleers, Louis, "Une Épée en Fer du Luristan," *BMusArt*, 3ème sér., No. 5 (1933) 111.

[4] Goddard, André, "Les Bronzes du Luristan," *Ars Asiatica* 17 (1931) 40-41, pl. 10.

[5] Speleers, *op.cit.* (supra n. 3).

[6] For comparative figures → *AJA* 65 (1961) 176.

theory that each sword was hand-wrought. Unfortunately, though the measurements of the working parts have been published, there are available no statistics on the size of the ornaments, and it is partly the intricacy and uniformity of the ornaments that lead to the theory that all must have been made from the same mold. The only indication of the size of the ornaments is the measurements of the guards which have been published in only three cases. The length of the British Museum and the Metropolitan Museum guards are identical, though Philadelphia differs.

CONSTRUCTION

Inspired by Dr. Naumann's x-ray report on the Hamburg sword, we attempted an x-ray with our much weaker machine. A beryllium window tube with aluminium filter at 10 ma, 75 kv. and 3 min. 40 sec. exposure did not penetrate the metal, but did reveal the slight open spaces between the hilt and the blade tongue as well as the imperfect join of the lion ornament to the guard (pl. 24, fig. 5) and of the lion-man to the pommel. The plane of the tongue is the same as the blade, at right angles to the hilt. It is about 4 mm. thick, and 20 mm. long, rectangular in shape, and fits snugly into the lower section of the handle which was split to take it. The open spaces between the guard and the lions demonstrate that the ornaments were made separately. The separation between the lion and the guard is a straight line at the level of the top of the forepaws and the bottom of the rear legs. At the tail of the lion a piece of the guard extends out and over part of the animal. It seems probable that this piece and the forepaws were forged over to hold the lion as added security to whatever other locking or genuine welding may have been achieved. The locking technique, described by Mr. Organ in the British Museum report seems the more likely.

Unfortunately with our machine we could not obtain a record of the joining of the hilt to the pommel, or of the space between the two rings and the hilt, nor did we discover any rivets in the ricasso. However the limited evidence of our x-ray, and Mr. Organ's discovery when he happily was able to detach the side ornament, certainly corroborate Dr. Naumann's conclusion that the swords were made up of a number of separate parts. In addition, variation in width and thickness of the rings on the hilt can be observed on the Metropolitan Museum sword, and at a thin point they appear to overlap, so almost certainly they must have been hand-forged separately and wrapped around the hilt. Also the three-stepped flange where the hilt enters the pommel can be more easily explained if the two parts were made separately. Disregarding rivets, it seems probable that our sword was made in nine, ten, or eleven parts, depending on whether the ricasso is separate and if so, whether it was made in one or two parts.

[7] Forbes, R. J., *Metallurgy in Antiquity* (Leiden 1950), chap. 11.

MATERIAL

On arrival, the Metropolitan Museum sword was covered with soil accretions and a rather thick layer of haematite which obscured much of the detail. This has now been removed mechanically by vibration and with instruments. The interrupted underlayer of black, reflective magnetite has not been removed.

Mr. Maryon's compilation has disproved any theory that these swords might be made of cast iron, and certainly all the historical evidence is against the smith of that time having the knowledge or equipment to cast it. We know that the ancient air blast furnaces were hot enough to work iron, but not to melt it, and as cast iron requires smelting, it could not be produced until the technique of raising the temperature of the furnace was perfected. This is the technical difficulty in the way of the earlier theory that these swords were cast. However wrought iron could be produced by heating and hammering in an air blast furnace.

The first material produced by heating the ore was a pasty mass of iron with impurities known as "bloom." Only rich ore could be worked and the yield was about 30% to 50% of the iron present. Though the actual ores worked are not known, limonite or haematite, which are easily reduced in bloomeries, were prevalent in the Ancient Near East. It is quite probable that in the earliest period the source of limonite was pockets of lake and bog ore. The bloom was then again heated and hammered into a compact mass, to drive out further slag.[7]

Steel could be produced by carburization in the process of heating the wrought iron. It would still contain small particles of slag and the carbon content would vary throughout the object. Steel could also have been produced accidentally when working a suitable ore. Forbes suggests a manganese-bearing iron ore, free from phosphorus, arsenic, or sulphur, as one possibility for obtaining steel in the bloomery furnaces, if the bloom is not fully decarburized.[8]

To find out more about the type of iron ore that was used in the working, spectrographic analyses were made, of the blade by Lucius Pitkin, of the side of the beard tip, near the surface, by Mrs. Jane Sheridan of the New York University Conservation Center.

	Blade	Beard
Silicon	O.X (low)	O.X
Magnesium	O.OX	O.X
Aluminum	O.OX	
Copper	O.OOX	O.OX
Manganese	O.OOX	O.OX
Molybdenum	O.OOX (low)	
Chromium	NF	O.OX
Zinc	NF	O.OOX
Lead	NF	O.OOX
Nickel	NF	trace, less than O.OOX
Tin	NF	NF

[8] Forbes, *op.cit.* (supra n. 7) 409.

Mrs. Sheridan tested the beard sample for silver, and was surprised to find none. She also tested for phosphorus, and found none. Though the sample was not large enough for a complete phosphorus determination, it is certain that there could not be more than 1%. The high silicon content in both our samples and also that reported by Dr. Naumann might presuppose a siliceous gangue, or Theophrast's "fire fighting stone" used in Pontus as a flux, which Forbes interprets as the limestone walls of a rectangular furnace, disintegrating in contact with the fire to liberate carbon dioxide and act as a flux with the limonite type of ore which is generally phosphoric. "If the temperature is kept low enough the phosphorus combines with lime and is slagged away."[9] More simply, the silicon content may represent slag usually found in wrought iron or mild steel produced by the ancient air blast furnace. In any case, in our sword there is obviously not a high enough phosphorus content to make wrought iron castable as this would have to have been in the neighborhood of 6%. The manganese content does not appear high enough to have affected the working of the iron.

Samples of the other Luristan swords examined metallographically vary between wrought iron and mild steel. The discs, where tested (Ontario, British Museum, Brussels) are mild steel and are described as producing no evidence of cold work, case hardening or hard-hammering. The Ontario beard samples appear to be mild steel of varying carbon content while Hamburg's headband and hilt are wrought iron, and the Khanenko or Herzfeld handle tested as wrought iron.

The appearance of our sword was so attractive that it seemed inadvisable to remove samples for analysis. It was decided to polish an inconspicuous area in place and for this reason the idea of polishing the disc had to be discarded. The first place selected was the tip of the beard on the less well-preserved head attached to the pommel. The sword was supported vertically in a cradle and the beard tip was lapped by hand with emery papers, followed by 10 micron silicon carbide powder. The final polishing was with Fisher's gamal solution on gamal polishing cloth. The polished section before etching (pl. 24, fig. 6) shows a pattern of iron with slag inclusions. The area was then etched with picral and our second photograph (pl. 24, fig. 7), shows a structure of polygonal crystals of iron with slag inclusions. No graphite flakes were observed, nor any pearlite. Our findings in this area therefore fall definitely into the wrought iron category.

As the sword blades tested (Ontario, Hamburg) as well as the discs, have a mild steel structure, we felt a comparable area should be tested before assuming our entire sword was of wrought iron. The technique of grinding and polishing in place was attempted again on a small section of the ridge about half way down the blade. Etching with 5% nital gave us a spheroidized carbide in ferrite structure (pl. 24, fig. 8). No pearlite was observed. Though our blade can be classed as mild steel it seems less hard than others, possibly with the exception of the sword illustrated by Herzfeld, which appears to have bent back on itself in a U shape without breaking. Our blade has a noticeable double bend, and the extreme tip is folded sharply back on itself.

Dr. George L. Kehl of Columbia University, who was kind enough to advise and check on our metallurgical findings, also measured the hardness of our sword blade. It tested as Rockwell B 28, 33, 43 (B 43 = Vickers 86), which is considerably less hard than the Toronto sword. This gives us a hardness softer than air-quenched steel and again indicates, as does the absence of pearlite, that the blade was not quenched. In grinding, the metal of the beard was found to be harder and less ductile than the blade.

It seems likely then that our sword was hand-forged from wrought iron, and that the parts worked over became carburized during the frequent heating process and took on the pattern of mild steel. Still unresolved remains the remarkable similarity of the various swords, particularly that of the ornaments. It could be that the main parts of the swords were hand-forged and so have varied proportions, but that the sophisticated ornaments, which are of lower carbon content, were formed by swaging. This technique of hammering heated metal into a mold, was understood at an early date.[10] It was used in shaping wrought iron objects before the process of smelting was developed. There may have been more than one set of swage blocks, as the Philadelphia guard is longer and narrower than ours (48 x 24-15 mm.),[11] suggesting different proportions for their lion. The unique carnelian inlays are not evidence in this respect since their recesses could have been drilled out like the four in the pommel. Assuming, however, that the ornaments were made from at most a very limited number of molds, the different angles at which the bearded heads protrude from the discs, and the slightly different positioning of the ornaments, could be explained as the natural result of attaching standard pieces to supports differing in angle and measure. No variation can be observed between our lions, or between the pommel ornaments, except those produced by degree of deterioration, though the angles of the two pommel ornaments differ slightly. Certainly the method used to attach the ornaments has proved most effective, whether it was a true weld or a combination of locking and crimping. The current evidence favors the latter method. In any case the final details were made with chas-

[9] Forbes, *op.cit.* (supra n. 7) 397.

[10] Forbes, *op.cit.* (supra n. 7) 422, and Przeworski, Stefan, "Die Metallindustrie Anatoliens in der Zeit von 1500-700 Vor Chr.," *Internationales Archiv für Ethnographie* 36, Suppl. (Leiden 1939) 160.

[11] Letter from Miss Maude de Schauensee, Research Assistant, University Museum, Philadelphia.

ing tools. Traces of the slight burr along the lines of chasing are still apparent.

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A SERIES OF NOTES IN FOUR PARTS ON CAMPANIAN MEGALOGRAPHY

A. The Composition of the Villa Item Painting
B. Numerical Grouping and the Balance of Opposites
C. The Boscoreale Cycle
D. The Homeric House Cycle and the Herculaneum Megalography

C. THE BOSCOREALE CYCLE

PLATES 25-28

1. THE UNITY OF THE COMPOSITION

Unlike the groups of the Villa Item's megalography which formed the subject of the first two Notes in this series, those of the Boscoreale cycle were evenly distributed, three panels to each wall, over the interior of the room, and within a framework of full-length columns made up a well-unified composition. It is unfortunate that the physical unity of the scheme is now broken up by the loss of two of the central wall's panels and by the division of its remaining groups between the museums of Naples and New York, but in pl. 25, figs. 1, 2, 3, an attempt is made to reconstruct the appearance of the walls at the time of discovery, including the missing central panels which were seen by Sogliano. On the left wall repairs which were in progress at the time of the eruption had obliterated the last group of figures.

Since the unearthing of the villa in 1901 the relationship of the side-wall figures to those of the central wall has been variously explained, but even after sixty years the unifying theme which gave coherence to the whole sequence is still in doubt, a matter for conjecture. The most favored theory has been that the series represents a distinguished family group or groups under the protection of the divinities of the central wall. Since Studniczka first saw in the side-wall figures the home circles of Demetrius Poliorketes and Antigonus Gonatas, two other efforts have been made to identify them with Hellenistic royalty, with Alexander the Great, and with Pyrrhus of Epirus.[1] Pfuhl and Dr. Bieber, on the other hand, saw in them possibly the family of the villa's owner.[2]

Some scholars, however, have laid greater stress on the relationship of the side-wall figures to Venus-Aphrodite. Barnabei, in publishing the villa, identified the citharist as Sappho, poetess of love, together with Hercules and his wife Iole in the pair seated next to her.[3] Mrs. Lehmann in a special study of the villa's painting took this couple for Aphrodite and Adonis and the room itself for a hall dedicated to the mystic cult of these lovers.[4] Perhaps a closer look at the figures of the central wall will supply some unexpected clues to the symbolism which the decorators intended to convey.

2. THE FIGURES OF THE CENTRAL WALL

Within the over-all composition of the cycle the central section had a special significance which Mrs. Lehmann was the first to emphasize.[5] Including the focal group of Venus and Amor, the wall contained in all seventeen figures, large and small, while at the top of the wall was painted a large bearded Silen's mask. Around the goddess fifteen figures were arranged in three categories. These were, first, the large-scale flanking divinities (Dionysus and Ariadne on the left, the Three Graces on the right), secondly, a group of small symbolic figures inside the landscape behind Venus, and finally, another small group distributed over three triptychs on the painted cornice, one above the center of each panel.

In relation to the side-walls the central wall and its contents served a double purpose, namely to separate and contrast the side-wall groups and at the same time to establish a link between them. Thus in contrast to the human figure-types on either side of the room which stood out against a uniform plain red field, the flanking divinities were set in a field of bright cerulean blue suggestive of the heavens, while in further contrast to them the central group of Venus and Amor received additional emphasis from their background. Alone in the series they were given a landscape setting peopled by diminutive figures. At the same time, however, the cornice triptychs served as a connecting link between the three parts of the cycle, since, as we will see below, their contents were such as to suggest a two-way orientation, first towards certain selected figures on each of the side-walls, and secondly, towards the divinities directly beneath them on the central wall.

The focus of the whole series was the central panel containing the statuelike Venus and Amor. If at first sight the landscape behind them seems out of place in such an architectural setting, closer analysis reveals

[1] F. Studniczka, "Imagines Illustrium," *JdI* 38/39 (1923/24) 64-128, M. Robertson, "The Boscoreale Figure Paintings," *JRS* 48 (1955) 58-67, saw in the central group on the right wall Alexander and his bride Stagira, daughter of Darius, in that of the left wall personifications of Macedonia and Persia. A. Rumpf in *Handbuch der Archäologie*, ed. W. Otto and R. Herbig (Munich 1953) IV 152, saw in the same groups Pyrrhos-Neoptolemos and his mother Deidameia and Pyrrhus of Epirus with a personification of Epirus.

[2] E. Pfuhl, *Malerei und Zeichnung der Griechen* (Munich 1923) II 879; M. Bieber, "Notes on the Mural Paintings From Boscoreale," *AJA* 60 (1956) 171-72, 283-84.

[3] F. Barnabei, *La Villa Pompeiana di P. Fannio Sinistore Scoperta Presso Boscoreale* (Rome 1901) 47-62.

[4] P. W. Lehmann, *Roman Wall Paintings From Boscoreale in the Metropolitan Museum of Art* (Cambridge 1953) 23-81.

[5] Lehmann, *op.cit.* 63-69.

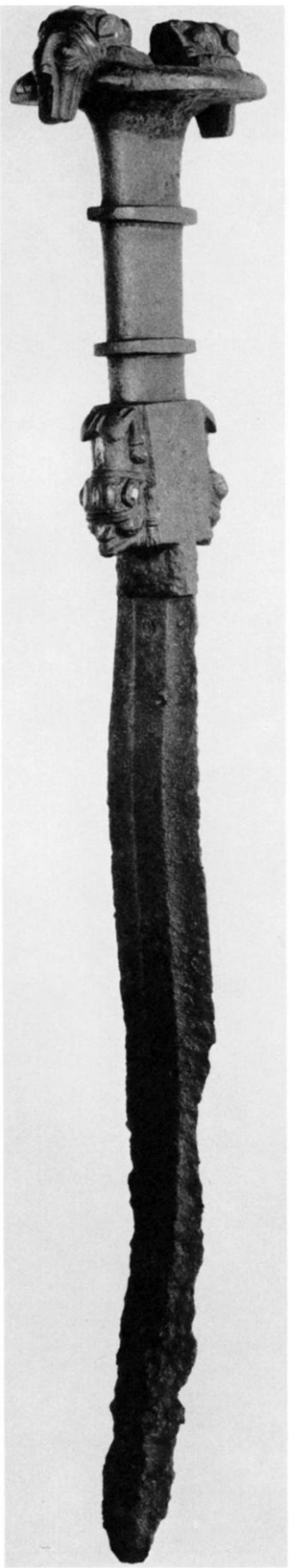

Fig. 1. Luristan sword, The Metropolitan Museum of Art

Fig. 2. Ornamental flange at joining of hilt and pommel

Fig. 4. Detail of ricasso, x 2¼

Fig. 3. Detail of one of lions mounted on guard, x 2¼

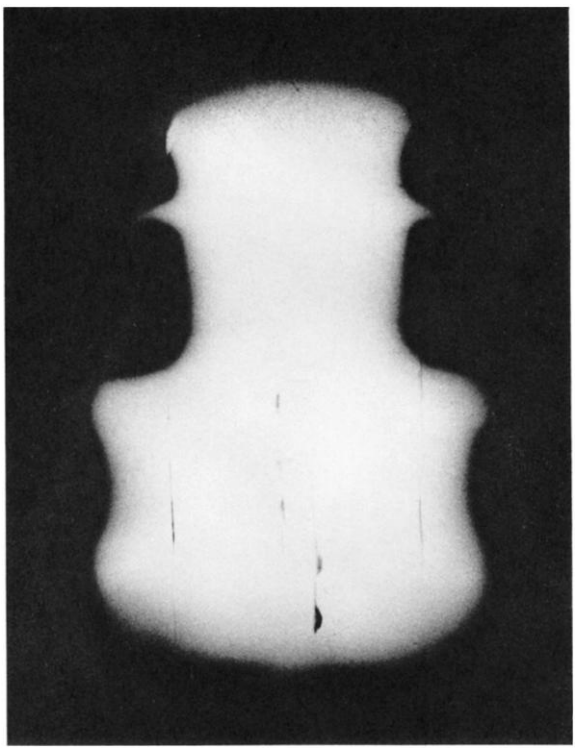

FIG. 5. Radiograph of guard. Thin dark lines show the slight space between lions and guard and outline shape of blade tongue

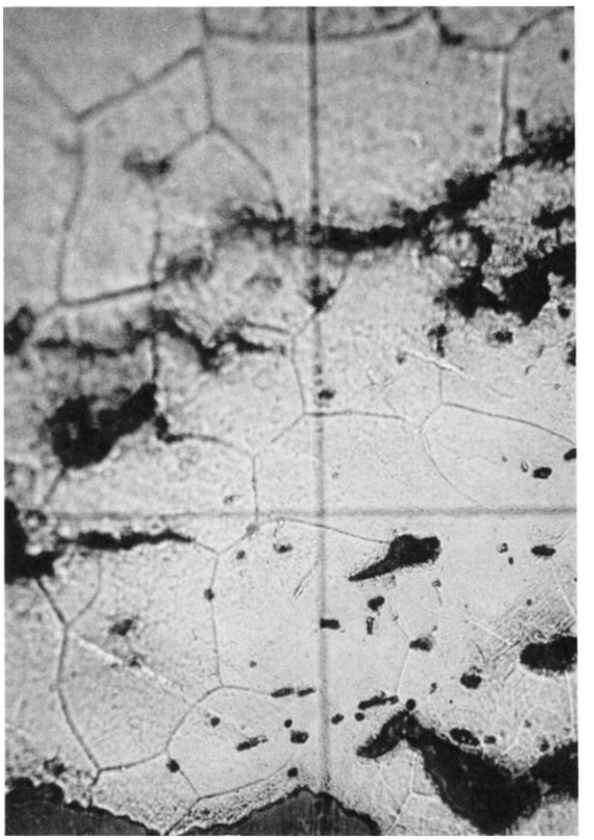

FIG. 7. Polished section of tip of beard, after etching, x 500

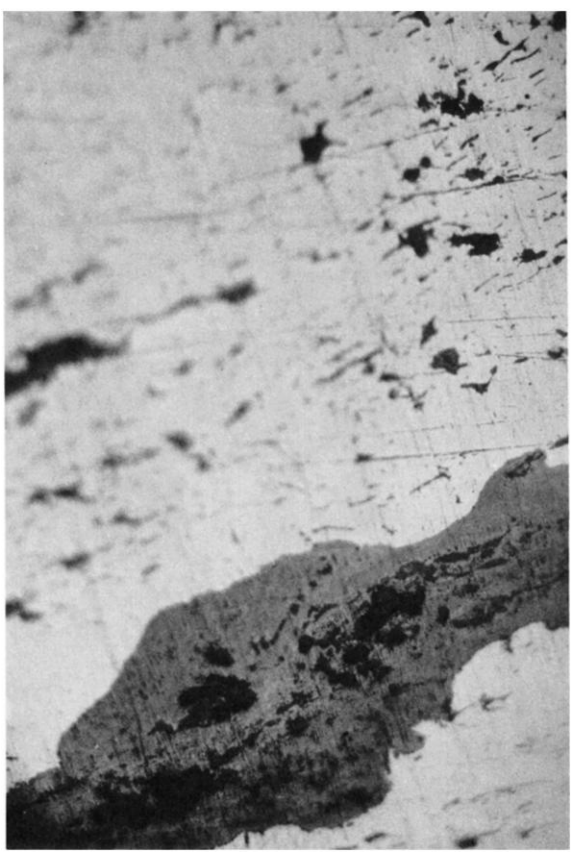

FIG. 6. Polished section of tip of beard, before etching, x 200

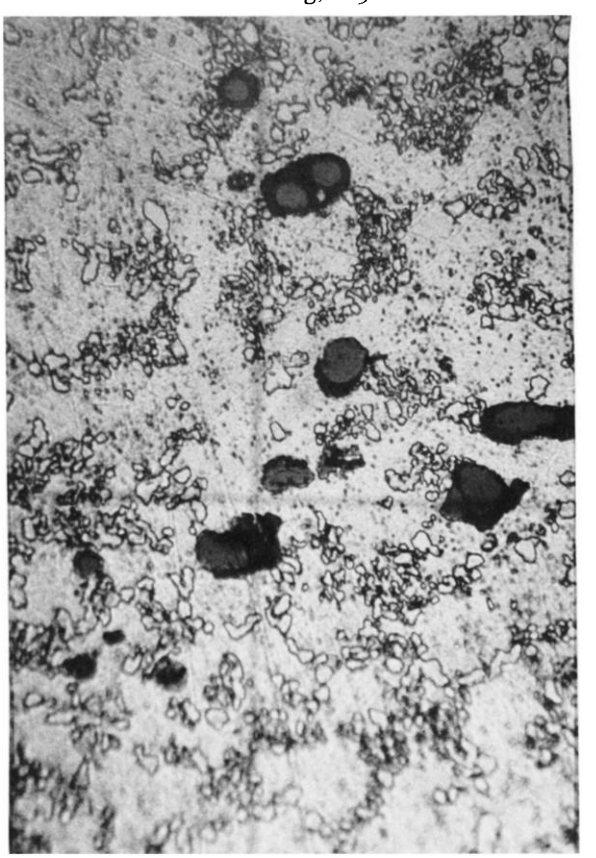

FIG. 8. Polished section of blade, x 500