

Chapter 27. IRON OBJECTS

(INCLUDING STEEL)¹

THE OBJECTS of iron described below represent only a small fraction of those brought to light at Taxila; for the vast majority were in so fragmentary and corroded a state that even their form was unrecognisable; and in many cases nothing remained but a rusty discolouration of the surrounding soil to show that they had ever existed. Of the 221 objects included in the list more than four-fifths came from the Šaka-Parthian strata of Sirkap and the early medieval monasteries at Jauliāñ, Mohrā Morādu, etc., and less than one-fifth from the Bhir Mound and the early settlements in Sirkap. This disparity, however, must not be taken to imply that iron at Taxila was less common in the centuries before than in the centuries after Christ. It is simply because iron, which is peculiarly liable to corrosion and disintegration, has the best chance of survival when subjected to great heat (without of course being melted) and then buried in wood ash, and that these conditions were fulfilled only in the case of the objects found in some of the Šaka-Parthian buildings of Sirkap and the later monasteries of Mohrā Morādu, Jauliāñ, etc., of which the former were burnt out by the invading Kushāns and the latter by the White Huns. In the lower settlements of Sirkap and in the Bhir Mound no such general conflagrations appear to have occurred, though individual houses were burnt down, and the number of iron objects that escaped disintegration was accordingly very small.

As will be seen from the subjoined stratigraphical chart, the objects that have survived fall into five groups, viz.: (A) Household utensils, (B) Arms and armour, (C) Horse-bridles and elephant-goads, (D) Carpenter's and blacksmith's tools, and (E) Agricultural implements. Besides these, there is also a small group (F) of miscellaneous articles such as needles and plummets, and a number of unwrought ingots. Some of these objects are clearly of foreign origin, by which I mean that they are copied from non-Indian prototypes. Thus, in Group A, the ladles with vertical handles (nos. 24, 25), candelabra (nos. 33-5), wheeled braziers (nos. 37, 38) and folding chair (no. 54) were all familiar types in the Graeco-Roman world of the first century A.D., but not previously known in India. In Group B, again, the heavy iron javelins (nos. 64-6), plate armour for men and horses (nos. 90, 91), helmet (no. 92), and shield-bosses (nos. 93-5), and in Group C, the snaffle-bits (nos. 95-8) and cheek-bars (nos. 99, 100) were introduced into the North-West by the conquering Greeks or their successors, the Šakas and Parthians. Even in some of the arrow-heads (nos. 72-89) we detect the influence of the Bactrian Greeks; in

Disparity of iron objects on earlier and later sites explained

Classification

Objects of foreign origin

¹ It should be noted that only in the case of the ten specimens in the Table of Analysis on p. 536 has the precise nature of the metal, whether iron or steel, been determined. Other specimens described in this chapter and classed, generally, as iron, may be either iron or steel.

others the influence of the Śakas, Parthians and White Huns. Carpenter's and blacksmith's tools and agricultural implements (Groups D and E) were least likely, perhaps, to be affected by foreign innovations, but it is noteworthy that even among them scissors (no. 135) and the spade (no. 198) made their first appearance at Taxila in the first century A.D., about the same time that they did in the Mediterranean area.

Abundance
and purity of
Indian iron

High quality
of Indian steel
in ancient and
medieval times

Probably in no country of the world is iron found more abundantly than in India, and in none are the ores from which it is extracted of greater purity or more easily accessible. Once, therefore, that the use of iron had been discovered and its advantages over copper and its alloys proved, Indians could have had little difficulty in obtaining adequate supplies of the metal. Indeed, the sources from which it might have been traded to Taxila are so many, that there would be small purpose in naming them. From a very early period India was famous for the high quality of its iron and steel. Thus Ktesias, who was at the court of Persia in the fifth century B.C., mentions two remarkable swords of Indian steel presented to him by the king of Persia and his mother, and it has been plausibly suggested that the *ferrum candidum* of which the Malloi presented a hundred talents' weight to Alexander the Great, was the same metal. Again, the *Periplus* informs us that in the first century A.D. Indian iron and steel were being exported from Ariaca (Gulf of Cambay and thereabouts) to Abyssinia, and *ferrum Indicum* also figures in the lists of dutiable articles under Marcus Aurelius and Commodus. Salmasius, too, speaks of a Greek treatise (now lost) on the tempering of Indian steel.

Of the fame enjoyed by Indian steel in medieval and later times there is no less evidence. Writing in the twelfth century, Idrisi says: 'The Hindus excel in the manufacture of iron. They have also workshops wherein are forged the most famous sabres in the world. It is impossible to find anything to surpass the edge that you get from Indian steel.' In the following century Marco Polo speaks of iron and *ondanique* in the markets of Kerman, and the latter has been recognised by Yule as a corruption of the Persian *hundwániy* (=Indian steel), which was used for the far-famed sword blades of Kerman. Tavernier, again (1605–80), writes: 'The steel susceptible of being damascened comes from the kingdom of Golconda; it is met with in commerce in lumps about the size of a halfpenny cake; they are cut in two in order to see whether they are of good quality, and each makes half the blade of a sabre.' (Cf. McCrindle, *Ancient India, its invasion by Alexander the Great*, p. 252 and n. 1; Schoff, *The Periplus of the Erythraean Sea*, ch. 6, pp. 24, 70, 172; Neogi, *Iron in Ancient India*, pp. 66–8; Marco Polo (ed. Yule), bk. I, ch. xvii; Tavernier (ed. Ball), I, 157.)

Analysis of
specimens
from Taxila
and Besnagar

The literary evidence as to the excellence of ancient Indian iron and steel has been fully corroborated by the analysis and micro-examination of selected specimens from Taxila and Besnagar. The latter, which appear to have been pieces of a broken sword used as wedges by the engineers when they were setting up the Khambāba pillar of Heliodorus (c. 100 B.C.), and in the opinion of the late Sir

Robert Hadfield must have been deliberately manufactured as steel,¹ yielded the following analysis:

C	Si	S	P	Mn	Fe
0·7	0·04	0·008	0·02	0·02	99·3

The ten specimens from Taxila, which have also been examined for me by the same eminent authority, are described in the Table below. Three of them (nos. 1, 2, 5) show a very high carbon percentage, between 1·2 and 1·7% (which is about double that of the Khambāba specimens), and leave no doubt that high carbon steel was being knowingly made as such at this period in India. On the other hand, it is a matter of surprise that these specimens show no signs of having been tempered. The absence of such tempering in a single or even in two specimens might perhaps be explained on the hypothesis that they were newly made and unused and for that reason had not yet been tempered, but this explanation could hardly be true of all three specimens, and we must therefore conclude that the makers of these objects were either ignorant of the process of tempering or did not think it necessary to temper steel of such high quality. Seeing, however, how close were the relations at this time between Taxila and the Western world, it seems scarcely possible that the art of tempering could have been unknown there.

As to the process by which this ancient steel was produced, it was probably the same as that by which the celebrated wootz steel is still produced—or was, at any rate, being produced until a recent date—in the South of India. In this process, which is known as 'cementation', wrought iron is first obtained by the direct method, viz. by heating the ores of iron with charcoal in small blast furnaces (the blast being produced by means of hand-bellows) without the intermediate formation of cast iron. 'The wrought iron is then cut into small pieces and placed in crucibles along with certain kinds of wood and leaves of plants, and then heated in charcoal blast furnaces with the lids closed. The blast is continued from four to six hours, when the steel is obtained in a molten condition. Water is then sprinkled or poured on the metal, which is thus hardened on being quenched and the steel is obtained in a crystalline condition.' (Neogi, *Iron in Ancient India*, p. 72. Cf. also Dar. et Sag. s.v. 'Ferrum', p. 1093, and for further particulars of the process, Heyne, *Tracts on India, historical and statistical*, p. 359; Buchanan, *Travels from Madras through Mysore, etc.*, vol. I, pp. 118, 306; vol. II, pp. 20, 118, 308; Percy, *Metallurgy*, vol. II, p. 778.)

Process
employed in
production of
steel

Tavernier's remarks quoted above about Indian steel being traded in lumps 'of the size of a halfpenny cake', agree with what H. G. Graves says concerning the blooms used for forging the iron beams at Konārak, which according to his measurements averaged some 6 in. in length by 1·2 in. in cross-section and weighed from three to four pounds,² but it is to be noted that the latter are of iron, not of steel. The 108 ingots found in Sirkap and described below (nos. 217–20) are of much the same size and weight, averaging about 5·4 × 1·4 in. and weighing from 1½ to 4 lb.

¹ Cf. A.S.R. (1913–14), pp. 203–4.

² Neogi, *op. cit.* p. 48.

TABLE OF ANALYSIS. BRINELL HARDNESS AND MICRO-EXAMINATION

	Serial no. in list below	Taxila reference	Description	Length (in.)	Brinell hardness		Probable nature of the material
						Av.	
1	57	Sk. '16-229; stratum II	Double-edged sword	15	233 236	235	High carbon material; about 1·3-1·5% carbon
2	58, a	Ch.T. D. '21-3	Copper guard Fragmentary sword	— 9·9	47 234 240 240	— 238	High carbon material; about 1·5-1·7% carbon
3	62, a	Sk. '12-96; stratum II	Dagger End of blade near haft Micro piece from point-end of dagger	9·4	161 167 161	164	Medium or low carbon material severely de-carburised on the surface
4	59, a	Bm. '24-897; stratum IV	Dagger	9·6	134 128	131	Probably iron
*5	116	Sk. '20-76; stratum II	Adze for carpenters Away from edge	5·75	— 220 240 259	— 240	High carbon steel (1·23%)
†6	109	Sk. '24-98; stratum II	Near cutting-edge Axe	5·75	103 106 167	125	Iron
7	120	Sk. '16-1,124; stratum II	Chisel	5·25	106 106 110	107	Iron
8	126	Sk. '15-294; stratum II	Knife	5	122 118	120	Iron
9	88, a	Sk. '26-2,847; stratum II	Arrow-head, three-flanged	4·1	177 187	182	Medium or low carbon steel
10	63	Bm. '19-505; stratum I	Spear-head, double-edged	7·5	105 121	113	Iron
Analysis				C	Si	S	P
*5, 116				1·23	0·28	0·004	0·024
†6, 109				0·10	0·03	0·004	0·062
						Mn.	
						0·01	
						Nil	

Specimen no.	Micro-examination
1	Micro no. 8134. Structure consists of small slightly elongated grains of ferrite and spheroidal carbide, the result of decomposition of the pearlite. The grains are outlined by cementite. Traces only of decarburisation round the outer surface. Non-metallic inclusions fairly small and comparatively few.
2	Micro no. 8135. Structure similar to specimen 1, but cell walls of cementite thicker and grains larger and more elongated. Slight partial decarburisation of the surfaces. Non-metallic inclusions similar to those in specimen no. 1.
3	Micro no. 8136. Shows a core of small ferrite and pearlite grains, corresponding to material of 0·15-0·25% C. surrounded by a skin 0·1-0·25 mm. in thickness of coarse columnar-shaped grains of ferrite. Non-metallic inclusions moderately large and numerous.

Remarks

Sir Robert Hadfield remarks on the above: 'The very low sulphur content in the two specimens analysed is in accordance with our experience with practically all previous Indian specimens. The phosphorus content is rather low compared with many of these previous specimens, one of which ran as high as 0·303. At the same time there have been specimens (no. 2441—Khambāba) as low as 0·020.'

'The chief feature of the present specimens is the high carbon percentage, 1·23, in no. 5. The Brinell hardness and the micro-structure of nos. 1 and 2 also indicate they are of similar high carbon. We have never come across any ancient specimens as high as this before. The highest was 0·7 carbon in the Kham-baba specimen, 2441, and this was so exceptional that we thought at the time it must be a fluke.'

'Evidently the Indians in this locality (Taxila), and at this period, quite deliberately made high carbon steel. But apparently they did not know how to harden and temper. If they had, the two swords, specimens 1 and 2, and the adze (no. 5) would be just the articles to apply this treatment to. The micro gives no indication of anything more than the ordinary heating for forging, and of course the hardness is only ordinary.'

'The specimens with low carbon, if no. 3 can be taken as representative of these, contain the usual amount of non-metallic inclusions. The high carbon specimens are, however, comparatively clean.'

TABLE SHOWING DISTRIBUTION OF IRON OBJECTS
IN SIRKAP

Block	Strata VI-V Greek	Stratum IV Early Śaka	Strata III-II Śaka-Parthian	Stratum I Surface
EAST SIDE OF MAIN STREET				
I	—	—	45, 62	78
A	—	—	—	—
B	—	—	36, 213	154, 155
C	—	—	107, 109, 121, b, 142, 190, 193, 197, 219	—
D	—	—	—	—
E	—	84	11, 100, a, b, 129	—
F	—	211	—	—
G	—	—	69, 146, 157	200
H	—	—	9, 105, 121, c, 188	—
I	—	—	24, 38, 43, 49, 54, 77, 87, 126, 172, 203, 207	6, 49, 144
J	—	—	10, 68, 98, 108	111
K	—	—	41, 44, 48, 91, 97, 116, 125, 133, 137, 139, 216	—
L	—	—	58, 132, 138, 140, 141, a-c, 148, 214, 215	—
WEST SIDE OF MAIN STREET				
I'	119	—	13, 145	—
A'	—	—	2, 4, 120, 149, 186, 212	—
B'	—	29	3, 110, 192, 194	37
C'	—	—	35, 95, 96, 102, 124, 185, 198, 218	—
D'	—	22	14, 15, 18, 42, a-y, 88, 94, 104, 147, 158, 217	220
E'	—	—	1, 17, 20, 33, 57, 106	—
F'	—	—	5, 60, 61, 90, 162, 201	—
G'	—	—	156	—
H'	—	—	—	—
K'	—	—	53, 93, 180	—
Main Street	—	—	30, 115, 121, a, 187	—
Fifth Street (west)	—	—	65, 66	—

Note. Objects found in trial trenches or spoil earth are not included in the above Table.

STRATIGRAPHICAL CHART OF IRON OBJECTS

Class	Bhiq Mound strata				Sirkap strata				Other sites ¹	Class
	IV 5th to 6th century B.C.	III 4th century B.C.	II Maurya	I Surface	VII ?Pre- Greek	VI-V Greek	IV Early Saka	III-II Late Saka- Parthian		
I. Cooking-pots or cauldrons (nos. 1-4)	—	—	—	—	—	—	—	—	—	I
II. Tripod stands (nos. 5, 6)	—	—	—	—	—	—	—	—	—	II
III. Bowls (nos. 7-12)	—	—	7	—	—	—	—	5-11	—	III
IV. Dishes and saucers (nos. 13-15)	—	—	—	—	—	—	—	13-15	—	IV
V. Frying- and baking-pans (nos. 16-18)	—	—	—	—	—	—	—	17, 18	—	V
VI. Spoons and ladles (nos. 19-25)	—	—	19	—	—	—	—	22	20, 21, 24, 25	VI
VII. Sieve (no. 26)	—	—	26	—	—	—	—	—	—	VII
VIII. Scale-pans (?) (nos. 27-9)	—	—	27	—	—	—	—	29	28	VIII
IX. Lamps (nos. 30-2)	—	—	—	—	—	—	—	30	—	IX
X. Candelabra (nos. 33-5)	—	—	—	—	—	—	—	33-5	—	X
XI. Incense-burner (no. 36)	—	—	—	—	—	—	—	36	—	XI
XII. Wheeled braziers (nos. 37, 38)	—	—	—	—	—	—	—	38	37	XII
XIII. Shovels (nos. 39, 40)	—	—	—	—	—	—	—	39, 40	—	XIII
XIV. Bells (nos. 41-7)	—	—	—	—	—	—	—	41-5	—	XIV
XV. Locks, keys and lock-plates (nos. 48-53)	—	—	—	—	—	—	—	48, 53	49	XV
XVI. Folding chair (no. 54)	—	—	—	—	—	—	—	54	—	XVI
XVII. Axle of spinning-wheel (?) (no. 55)	—	—	—	—	—	—	—	—	55 from Mn.	XVII
GROUP B. ARMS AND ARMOUR										
XVIII. Swords and daggers (nos. 56-62, ^a)	59, ^a	—	59	—	—	—	—	56-8, 60- 2, 62, ^a	—	XVIII
XIX. Spears, javelins and butt (nos. 63-71)	—	—	64	63	—	—	—	65, 66, 68, 69	—	XIX
XX. Arrow-heads (nos. 72-89)	—	—	—	72-6, 80- 3, 85	—	—	—	84	77, 87, 88	XX
XXI. Armour, helmet and shield bosses (nos. 90-5)	—	—	—	—	—	—	—	90-5	—	XXI
GROUP C. HORSE-BRIDLES AND ELEPHANT-GOADS										
XXII. Bits and cheek-bars of horse bridles (nos. 96-100)	—	—	—	—	—	—	—	96-9, 100, ^{a, b} 102	—	XXII
XXIII. Elephant goads (nos. 101, 102)	—	—	101	—	—	—	—	—	—	XXIII

GROUP D. CARPENTER'S AND BLACKSMITH'S TOOLS, ETC.											
—	103	—	—	—	—	—	—	104-10	III	XXIV	
—	112	113	—	—	—	—	—	115, 116	II4	XXV	
—	—	118	—	—	—	—	—	120, 121,		XXVI	
XXV. Axes (nos. 103-11)								a, b,		XXVII	
XXV. Adzes (nos. 112-17)								c			
XXVI. Chisels (nos. 118-21, c)								121, a, b,			
XXVII. Knives and chopper (?) (nos. 122-8)	123	122	—	—	—	—	—	124-7	—	XXVIII	
XXVIII. Saw (no. 129)	—	130	—	—	—	—	—	128 from Mm.	—	XXIX	
XXIX. Tongs, pliers and tweezers (nos. 130-4)	—	—	—	—	—	—	—	134 from Gr.	—	XXX	
XXX. Scissors (no. 135)	—	—	—	—	—	—	—	—	—	XXXI	
XXXI. Hammers, adze-hammer and picks (nos. 136-42)	—	143, 144	—	—	—	—	—	135	—		
XXXII. Anvils or beak-irons (nos. 143-9)	—	150-2	—	—	—	—	—	137-42	—		
XXXIII. Nails, nail-bosses and hooks (nos. 150-66)	—	—	—	—	—	—	—	145-9	—		
XXXIV. Clamps and staples (nos. 167-76)	—	—	—	—	—	—	—	156-8, 162	154, 155	159, 160 and 166	
XXXV. Hinges (nos. 177-9)	—	—	—	—	—	—	—	161 from Jn.	from Jn.	161 from Dh.	
XXXVI. Chains (nos. 180-1)	—	—	—	—	—	—	—	163 and 165	from Mm.	163 and 165	
XXXVII. Spades, spuds and hoes (nos. 182-99)	—	182-4	191	—	—	—	—	164 from Kun.		164 from Kun.	
XXXVIII. Weeding-forks (?) (nos. 200-2)	—	—	—	—	—	—	—	169 from Mm.		169 from Mm.	
XXXIX. Sickle (nos. 203-7)	—	—	—	—	—	—	—	171 and 173	from Jn.	171 and 173	
XL. Nos. 208-21	—	—	—	—	—	—	—	172, 174	—	172, 174	
								175 and 176 from	Dh.	175 and 176 from	
								177 from Mm.		177 from Mm.	
								178 and 179 from	Jn.	178 and 179 from	
								181 from Kun.		181 from Kun.	
								181, a from Jn.		181, a from Jn.	
GROUP E. AGRICULTURAL IMPLEMENTS											
								185-90,	—	XXXVII	
								192-4,	—	XXXVIII	
								197, 198	200	199 from Jn.	
								201		202 from Dh.	
								203, 207	—	204 and 205 from	
										Dh.	
										206 from Gr.	
										208 and 221 from	
										Dh.	
										209 and 210 from	
										Gr.	
GROUP F. MISCELLANEOUS											
								212-19	220	XL	

Note. The following objects picked up from spoil earth or debris, are not included in the above list, viz. no. 79 (arrow-head) from Bhîr Mound; nos. 136 (hammer) and nos. 167, 168 (clamps) from Sirkap.

Ch.T. = Chir Tope; Dh. = Dharmarâjikâ; Gr. = Giri; Hl. = Hathîal; Jn. = Jauliâñ; Kun. = Kunâla; MI. = Mahal; Mm. = Mohrâ Moriâdu; Pl. = Pippala; Ss. = Sirsukh.

Some general remarks on the iron objects from the Bhiṁ Mound will be found in vol. I at pp. 101, 104, 107; and on those from Sirkap at pp. 128, 134-5, 207-8. Other references are given in the individual entries of the catalogue below.

GROUP A. HOUSEHOLD UTENSILS

CLASS I. *Cooking-pots or cauldrons* (nos. 1-4)

With round bottom and wide-open mouth, resembling the modern *handī* and *gharā*. They date from the first century A.D. Cf. 'Pottery', ch. 23, Class IX, type c, and Class IV; 'Copper and Bronze', ch. 28, Class XII, nos. 1-4.

1. Iron cooking-pot of *handī* type with rounded bottom and everted rim. It is made in two sections and riveted round the middle. Two handles were attached on the shoulder. Body and handles damaged. Height 12 in. Sk. '27-1,465; Block E'; sq. 70.119'; stratum III. Cf. p. 185 *supra*. (Pl. 162, a.)
2. Similar, but without ring-handles. Bottom damaged. Height 8 in. Sk. '28-104; Block A'; sq. 27.90'; stratum II. Cf. p. 195 *supra*. (Pl. 162, b.)
3. Similar and of same date, but with vertical neck like the modern *gharā*. Height 9.25 in. Sk. '20-342; Block B'; sq. 33.86'; stratum II. Cf. p. 194 *supra*. (Pl. 162, d.)
4. Similar and of same date but with the two sections welded instead of being riveted. Height 7.75 in. Sk. '20-219; Block A'; sq. 27.78'; stratum II. Cf. p. 195 *supra*. (Pl. 162, c.)

CLASS II. *Tripod stands for cauldrons or cooking-pots* (nos. 5, 6)

5. Tripod stand. Diam. 10.75 in. It consists of a ring supported on three legs. On the inside of the legs are looped projections. First century A.D. Sk. '28-2,335; Block F'; sq. 90.83'; stratum III. Cf. p. 183 *supra*. (Pl. 162, e.)
6. Similar and of same date. Diam. 10.62 in. Sk. '15-215; Block I; sq. 135.54'; stratum I. Cf. p. 170 *supra*; A.S.R. (1915), p. 18, no. 20.

CLASS III. *Bowls* (nos. 7-12)

With rounded bottom and sides and lip sometimes incurved, as in 'Pottery', ch. 23, Class XV, a; 'Stone', ch. 25, Class X; 'Copper and Bronze', ch. 28, Class XVI, a; 'Silverware', ch. 29, Class IV. No. 7 dates from the third century B.C.; nos. 8-11 from the first century A.D.; no. 12 from the fifth century A.D. (?).

7. Shallow bowl of iron, slightly damaged. Diam. 4.12 in. Third century B.C. Bm. '19-636; sq. 13.11'; stratum II. (Pl. 162, f.)
8. Hemispherical iron bowl with incurved rim. Diam. 7.62 in. First century A.D. Ml. '20-91/1; sq. 63.84'; 2 ft. 6 in. below surface. Cf. p. 215 *supra*. (Pl. 162, g.)
9. Shallow iron bowl with curved base and sides tending to the vertical. Diam. 4.62 in. First century A.D. Sk. '15-516; Block H; sq. 125.68'; stratum II. Cf. p. 170 *supra*. (Pl. 162, h.)
10. Similar to no. 1, with slightly flattened base. Diam. 4.37 in. First century A.D. Sk. '26-1,387; Block J; sq. 146.51'; stratum II. Cf. p. 171 *supra*.
11. Similar to preceding, with rounded base. Diam. 4.75 in. Sk. '27-3,222; Block E; sq. 68.46'; stratum II. Cf. p. 162 (15) *supra*. (Pl. 162, i.)
12. Similar. Diam. 4.75 in. Probably fifth century A.D. Dh. '15-756. T2. 3 ft. below surface. Cf. p. 247 *supra*.

CLASS IV. *Dishes and saucers* (nos. 13–15)

All these come from Sirkap and belong to the first century A.D. They are flat dishes with splayed sides, flat or slightly convex base and in one case with horizontal rim. Cf. ‘Copper and Bronze’, ch. 28, Class XVII, c; ‘Pottery’, ch. 23, Class XVI, a; ‘Stone’, ch. 25, Classes VII, VIII; ‘Silverware’, ch. 29, Class V.

13. Iron dish with splayed sides. Diam. 14·75 in. First century A.D. Sk. ’22–388; Block 1'; sq. 10·90'; stratum II. Cf. p. 196 *supra*. (Pl. 162, k.)

14. Similar and of same date, but with slightly convex base. Diam. 8·5 in. Sk. ’19–1,255; Block D'; sq. 55·112'; stratum II. Cf. p. 190 *supra*.

15. Flat saucer with splayed sides and horizontal rim. Same date as above. Diam. 4·62 in. Sk. ’19–958; Block D'; sq. 58·115'; stratum II. Cf. p. 190 *supra*. (Pl. 162, j.)

CLASS V. *Frying- and baking-pans* (nos. 16–18)

Type a. *Frying-pan with single long handle*. Cf. ‘Copper and Bronze’, ch. 28, Class XVIII, and ‘Pottery’, ch. 23, Class XVI, type c.

16. Circular iron frying-pan with splayed sides and handle welded on to side. In good preservation. Length 19·5 in. Fourth to fifth century A.D. Ss. ’15–20. Tofkian; 4 ft. below surface. Cf. p. 220 *supra*; A.S.R. (1915), Pl. xxvi, b. (Pl. 162, m.)

Type b. *Circular baking pans with two loop handles or one lug handle*. Cf. ‘Copper and Bronze’, ch. 28, Class XIX, types a, b; and ‘Pottery’, ch. 23, Class XVI, type d.

17. Shallow baking-pan (*taba*) with two loop handles. Partly broken. Diam. 22·25 in. The pan has a concave depression at the middle surrounded by a broad horizontal rim. The loop handles are riveted to the edge. Sk. ’22–658; Block E'; sq. 73·83'; stratum II. Cf. p. 185 *supra*. (Pl. 162, o.)

18. Two iron baking-pans with flat bottom and splayed sides, stuck together. Each is furnished with a single lug handle riveted to the side. Rim and handle damaged. Diam. 13·5 in. Sk. ’19–924; Block D'; sq. 59·114'; stratum II. Cf. p. 190 *supra*. (Pl. 162, p.)

CLASS VI. *Spoons and ladles* (nos. 19–25)

Cf. ‘Copper and Bronze’, ch. 28, Class XX, type b, and Class XXI; ‘Silverware’, ch. 29, Class VIII.

Spoons:

19. Iron spoon with round shallow bowl and handle on one side broken off above the rim. Diam. 4·75 in. Bm. ’21–464; sq. 38·13'; stratum II. (Pl. 162, s.)

20. Similar, with splayed sides. Diam. 3·12 in. Sk. ’16–161; Block E'; sq. 68·76'; stratum III. Cf. p. 184 *supra*. (Pl. 162, q.)

21. Similar to no. 20, but with flat base. Diam. 2·62 in. Sk. ’14; Trench A629; stratum II. (Pl. 162, r.)

22. Similar to preceding but with pear-shaped bowl. Handle broken. Length 6·75 in. First century B.C. Sk. ’19–1,618; Block D'; sq. 60·117'; stratum IV. (Pl. 162, t.)

23. Iron spoon with a circular shallow bowl and long straight handle. Length 14 in. Affixed to the handle at a distance of about 2 in. from the bowl is a crescent-shaped stop or clip. Fifth century A.D. (?) Gr. ’27–C408. West of stūpa; 3 ft. 4 in. below surface. (Pl. 162, u.)

Ladles:

24. Iron ladle with spherical bowl and vertical handle (=κύαθος, cyathus). Diam. 2·37 in. First century A.D. Sk. '20-1,597; Block I; sq. 138·55'; stratum II. Cf. p. 171 *supra*. (Pl. 162, *l.*)
 25. Similar. Diam. 1·62 in. Sk. '14; Trench A630; stratum II. (Pl. 162, *n.*)

CLASS VII. *Sieve* (no. 26)

26. Fragment of iron sieve. Length 3·25 in. Bm. '13-17; stratum II.

CLASS VIII. *Scale-pans*(?) (nos. 27-9)

The small iron saucers described below have the appearance of scale-pans, but as they are provided with two loop handles only for suspension, instead of three or four, it is questionable whether they can have been used for this purpose.

27. Small iron pan, with rounded bottom and two loop handles on rim for suspension. Diam. 4 in. Slightly damaged. Third to second century B.C. Bm. '21-1,448; sq. 16·61'; stratum III. (Pl. 163, *a.*)
 28. Similar, with flat base. Diam. 4·25 in. First century A.D. Sk. '14; Trench A593; stratum II. (Pl. 163, *b.*)
 29. Similar, with one handle missing. Diam. 3·62 in. First century B.C. Sk. '29-575; Block B'; sq. 31·89'; stratum IV. (Pl. 163, *c.*)

CLASS IX. *Lamps* (nos. 30-2)

Type *a*. *Shallow bowls with pinched mouth for wick*. Cf. 'Pottery', ch. 23, Class XXI, *a*.

30. Iron lamp in the form of a round shallow bowl, with pinched mouth for wick. Diam. 3·75 in. Sk. '15-187; Main Street; sq. 91·72'; stratum II. (Pl. 163, *d.*)
 31. Similar. Diam. 4·62 in. Fifth century A.D. Jn. '16-323; chapel C5; 3 ft. below surface. Cf. p. 384 *supra*. (Pl. 163, *e.*)

Type *b*. *Standard vase-shaped lamp, with spherical body and handle*.

32. Vase-shaped lamp of iron, with spherical bowl, standard base, narrow neck and serpentine handle. The body is made in two pieces joined at the middle. Length 11 in. Fifth century A.D. Jn. '16-284; cell no. 21; 9 ft below surface. Cf. p. 385 *supra*; *Jn. Mem.* Pl. xxviii, *f.* (Pl. 163, *f.*)

CLASS X. *Candelabra* (nos. 33-5)

Though of rough workmanship, the few iron candelabra found at Taxila are clearly of Greek or Graeco-Roman parentage. For examples, cf. Spinazzola, *L' Arti decorative in Pompeii*, Pl. 294; Dar. et Sag. s.v. 'Candelabrum'.

33. Iron candelabrum consisting of plain vertical rod with tripod base and leaf-like terminal at top. Circular stop on shaft. Height 39·75 in. Sk. '14-2,051; Block E'; sq. 74·74'; stratum III. Cf. *A.S.R.* (1914), Pl. xxvi, 50.
 34. Similar, with two stops on shaft. Height 27 in. First century A.D. Sk. '14; Trench A625; stratum II. (Pl. 163, *h.*)
 35. Similar and of same date, with ring-handle on top and five pairs of side-brackets. Height 1 ft. 9 in. Possibly the brackets were intended for the support of lamps such as that

figured under 'Pottery', ch. 23, no. 137. The nearest parallels are of the archaic Classical Period, e.g. Ducati, *Arte Etrusca*, Pl. xxxv, no. 118. Sk. '14-1,551; Block C'; sq. 45·74'; stratum II. Cf. p. 193 *supra*; A.S.R. (1914), Pl. xxvi, 47. (Pl. 163, g.)

CLASS XI. *Incense-burner* (no. 36)

Cf. 'Pottery', Class XX, b; 'Copper and Bronze', ch. 28, Class XXII, nos. 320, 321.

36. Iron incense-burner standing on three legs; handle broken. Diam. 3 in. Sk. '24-124; Block B; sq. 36·49'; stratum II. Cf. p. 148 *supra*. (Pl. 163, m.)

CLASS XII. *Wheeled braziers* (nos. 37, 38)

Movable braziers on legs or on wheels were familiar articles of furniture in the Graeco-Roman world, and there can be little doubt that the specimens described below are copied from classical patterns. Cf. Overbeck, *Pompeii*, p. 440, fig. 235. *Gazette Archéol.* (1876), xvii, p. 52. Canina, *Etruria Maritima*, Pl. LVIII; *Mus. Chiusino*, vol. I, Pl. XXXIX. Dar. et Sag. s.v. 'Focus' = Gr. ξοχάρα.

37. Rectangular wheeled brazier of iron. Size 21 x 19·5 in. Two of the four wheels only have survived and three of the corner handles. Part of the body is broken. Two rings were attached to the body, one in front and one at the back. Sk. '20-110; Block B'; sq. 28·83'; stratum I. Cf. pp. 186, 194 *supra*. (Pls. 163, i; 205, a.)

38. Two pairs of iron wheels of a movable brazier with axle attached to each pair. The wheels are furnished with sixteen spokes each. Diameter of wheel 7·37 in. Length of axle 2 ft. 5 in. Sk. '26-784; Block I; sq. 136·57'; stratum II. Cf. p. 170 *supra*. (Pl. 163, j.)

CLASS XIII. *Shovels* (nos. 39, 40)

39. Iron shovel with flat blade and long straight handle. Length 26 in. Sk. '27-382; Trench D28; stratum II. (Pl. 163, k.)

40. Similar. Length 26·40 in. Sk. '24-1,187; stratum II. (Pl. 163, l.)

CLASS XIV. *Bells* (nos. 41-7)

Most of the specimens (nos. 41-5) are of the first century A.D.; nos. 46 and 47 are probably of the fifth century A.D. Cf. 'Copper and Bronze', ch. 28, Class XXV. Flinders Petrie, *Objects of Daily Use*, p. 57, nos. 292-305 and Pl. L.

41. Cylindrical bell of iron with ring-handle. Height 2·68 in. The lower part of the bell is damaged. Sk. '24-1,448; Block K; sq. 155·66'; stratum II. Cf. p. 176 *supra*. (Pl. 163, n.)

42, a-y. Twenty-five iron bells found adhering to one another. Cylindrical shape with slightly tapering sides. Ring-handle at top. Height of one is 8·5 in; of the rest between 4 and 2·62 in. Sk. '27-1,551; Block D'; sq. 61·118'; stratum III. Cf. p. 190 *supra*. (Pl. 163; o.)

43. Similar, but clapper missing. Handle damaged. Height 2·5 in. Sk. '26-480; Block I; sq. 138·61'; stratum II. Cf. p. 171 *supra*. (Pl. 163, r.)

44. Similar, but sides more splayed. Clapper missing. Height 2·62 in. Sk. '14-379; Block K; sq. 161·46'; stratum II. Cf. A.S.R. (1914), Pl. xxvi, 49. Cf. p. 176 *supra*. (Pl. 163, s.)

45. Bowl-shaped bell of iron. Clapper and ring-handle missing. Diam. 4 in. Sk. '16-1,072; Block 1; sq. 12·59'; stratum II. Cf. p. 142 *supra*. (Pl. 163, p.)

46. Large cylindrical bell of iron, with ring-handle. Height 12·25 in. Slightly damaged; clapper missing. Dh. '30-712; sq. 15·10'; 3 ft. 10 in. below surface.

47. Bowl-shaped bell of iron; clapper missing. Traces of copper rust at the edge. Height 2 in. Jn. '16-F54; monastery. Cf. p. 385 *supra*; *Jn. Mem. Pl. XXVIII, n.* (Pl. 163, q.)

CLASS XV. Locks, keys and lock plates (nos. 48-53)

Cf. 'Copper and Bronze', ch. 28, Class XXVI, and remarks there made, which apply to the iron specimens equally with those of copper and bronze.

48. Iron key, with ring-handle and four teeth. Length 4·5 in. First century A.D. Sk. '14-314; Block K; sq. 154·60'; stratum II. Cf. p. 176 *supra*. (Pls. 164, no. 48; 184, o, no. 6.)

49. Similar and of same date, with square moulded top. Length 4 in. Sk. '26-1,002; Block I; sq. 133·52'; stratum I. Cf. p. 171 *supra*. (Pl. 164, no. 49.)

50. Similar, but the wards are perforated with four irregular holes instead of being provided with teeth. Ringed handle. Length 4·62 in. Fifth century A.D. Pippala '21-160; cell 23; 6 ft. 7 in. below surface. Cf. p. 367 *supra*. (Pls. 164, no. 50; 184, o, no. 5.)

51. Iron latch or key, with bent and notched end. Length 5·37 in. Date uncertain. Hl. '12-88; 1 ft. 6 in. below surface. (Pls. 164, no. 51; 184, o, no. 3.)

52. Latch, with end turned over at right angles and hole for nail at other end. Cf. also no. 164 *infra*. Length 4·5 in. Mm. '15-54; west side of cell 2; 6 ft. 6 in. below surface. Cf. p. 363 (16) *supra*. (Pls. 164, no. 52; 184, o, no. 4.)

53. Rectangular iron lock-plate, with keyhole near middle and holes for nails at the four corners. Size 5·25 x 5·12 in. Sk. '15-668; Block K'; sq. 167·105'; stratum III. Cf. p. 180 *supra*; *A.S.R.* (1915), Pl. XVI, 3. (Pl. 164, no. 53.)

CLASS XVI. Folding chair (no. 54)

54. Iron folding chair, with hoof-feet of classical pattern, somewhat like those of a curule chair. Height 26 in. Presumably the seat was of cloth or carpet. Sk. '15-218; Block I; sq. 134-53'; stratum II. Cf. *Dar. et Sag. s.v. 'Sella'*, and for a similar seat on coins of Kadphises I, cf. *Cat. of Coins in the Indian Museum*, vol. I, pt. I, p. 66, nos. 6-15, and Pl. XI, 3. Cf. p. 170 *supra*; *A.S.R.* (1915), Pl. IX, 5. (Pl. 170, s.)

CLASS XVII. Axle of spinning wheel (?) (no. 55)

55. Iron axle of a spinning wheel(?) with copper band attached. Sharply pointed at both ends. Length 9·2 in. Fifth century A.D. Mm. '15-268. Monastery, outside. 3 ft. below surface. Cf. p. 363 (17) *supra*; (Pl. 164, no. 55.)

GROUP B. ARMS AND ARMOUR

CLASS XVIII. Swords and daggers (nos. 56-62, a)

The iron swords found at Taxila belong exclusively to the first century A.D. They are straight, double-edged and pointed weapons, from 21 to 34·25 in. in length, and with a cross-guard attached to the blade at the base of the hilt. They thus resemble the straight double-edged swords found at Tinnevelly¹ and also the long *spatha* (*σπάθη*) used by the Roman auxiliaries. In the well-known statue of

¹ Cf. *A.S.R.* (1902-3), Pl. XXIII, 11-18.

Kanishka at Mathurā the king is shown grasping a long straight sword which seems to have been of this type (cf. Bachhofer, *Early Indian Sculpture*, Pl. LXXVI). Similar swords are also sometimes depicted in carvings of the Early Indian School (e.g. Cunningham, *Bharhut*, Pl. XXXII, 4), but the sword more usually depicted in these carvings as well as in the Gandhāra reliefs is a short weapon like the Roman *gladius*. Cf. Dar. et Sag. s.v. 'Gladius' and 'Spatha' and figs. 6522 and 6523. Strabo (xv, 67) and Arrian (*Ind.* 16) state that in the fourth century B.C. the Indian soldier carried a broadsword three cubits in length, and Arrian adds that he wielded it with both hands. No weapons of this description have been found.

Of the daggers, one only (no. 59) comes from the Bhir Mound and is referable to the third to second century B.C.; the others (nos. 60-2) are referable to the first century A.D. Except in the matter of length they closely resemble the swords and might well have answered to the term *semispantium*, applied to the Roman *pugio* in later Imperial times. The earlier specimen (no. 59) differs from the later ones in that the blade is straight-edged almost up to the point where it tapers abruptly, and that there is no cross-guard attached to it at the hilt.

56. Double-edged sword. Length including tang 34·25 in. The blade, which is straight-edged on both sides, tapers gradually to a point. In section it is lozenge-shaped and bevelled evenly on either side from the midrib to the edge. Attached to the heel of the blade is a cross-guard shod with bronze. Of the hilt only the tang remains. Sk. '14; Trench A626; stratum II. (Pl. 164, no. 56.)

Swords

57. Similar and of same date, but broken towards the point. Of high carbon steel. Present length 15 in. The blade is flatter than in the preceding specimen and without midribs. Lozenge-shaped guard; tang pierced with two holes for attachment of grip and pommel. Sk. '16-229; Block E'; sq. 71·76'; stratum II. Cf. p. 185, and Analysis Table, p. 536, no. 1 *supra*. (Pl. 164, no. 57.)

58. Similar to preceding and of same date. Length 21 in. Blade convex in section on both sides. Sk. '26-4,430; Block L; sq. 190·69'; stratum II. (Pl. 164, no. 58.)

58, a. Broken blade of steel sword. The blade, which tapers gradually towards the point, is without midribs. Length 9·9 in. Date uncertain, but probably fifth century A.D. For Brinell hardness, analysis and micro-examination, see Analysis Table, p. 536, no. 2. Chir Tope D, '21-3. Cf. p. 319 *supra*.

59. Double-edged straight-bladed dagger. Length 10·62 in. Tang broken at heel of blade. No cross-guard. The blade is lozenge-shaped in section with central ridge on both sides and of uniform width for a length of 8 in., when it tapers abruptly to the point. Bm. '14-296; stratum II. (Pl. 164, no. 59.)

Daggers

59, a. Dagger blade. Length 9·6 in. Double-edged, tapering gradually towards the point. Tang for attachment of grip. For metal, see Analysis Table, p. 536, no. 4. Bm. '24-897; stratum IV.

60. Straight double-edged dagger. Length 7·75 in. The blade, which tapers slightly from heel to point, is lozenge-shaped in section with centre ridge on both faces. Tang broken. Rectangular guard of iron attached to heel of blade. First century A.D. Sk. '15-29; Block F'; sq. 86·74'; stratum II. Cf. p. 183 *supra*; A.S.R. (1915), p. 18, no. 28. (Pl. 164, no. 60.)

61. Similar to preceding. Length 11·5 in. Blade splayed slightly on heel; thinner guard; tang pierced for attachment of grip. Curved pommel riveted to end of tang. Sk. '15-95; Block F'; sq. 86·74'; stratum III. Cf. p. 183 *supra*. (Pl. 164, no. 61.)

62. Similar to no. 61, but tang not pierced. Length 11 in. First century A.D. Sk. '16-541; Block 1; sq. 14·65'; stratum II. Cf. p. 142 *supra*. (Pl. 164, no. 62.)

62, a. Dagger blade, double-edged without midrib. Much corroded. Length 9·4 in. Medium or low carbon material, severely decarburised on the surface. Sk. '12-96. First century A.D. Stratum II. Cf. Table of Analysis, p. 536, no. 3.

CLASS XIX. Spears, javelins and butt (nos. 63-71)

Taxila has yielded several types of these weapons, viz.: (a) four-sided pike-head with tang (no. 63), third to second century B.C.; (b) heavy iron javelin, resembling the οστός of the *cataphracts* (nos. 64-6), third to second century B.C. (?) and first century A.D.; (c) leaf-blade spear-head with central ridge and tang (no. 68), first century A.D.; (d) socketed spear-head of dagger- or knife-blade pattern (nos. 69-70), first and fifth century A.D.; (e) socketed conical spear-butts (no. 71), fifth century A.D. Most interesting of these are the heavy javelins of type (b). The only specimen found in the Bhir Mound has a three-flanged head; two from Sirkap, first century A.D., have four-flanged heads. The former may possibly be a stray, but in any case there seems little doubt that these metal javelins were a foreign weapon introduced either by the Bactrian Greeks or, more probably, by the Sakas or Parthians. Whether, like the Roman *pilum*, they were provided with a wooden butt or handle there is no evidence to show.

Type a:

63. Spike-shaped spear-head of iron, four-sided with tang for fixing into wooden shaft. Length 7·5 in. Roughly made, but of great penetrating power against plate or mail armour. Third to second century B.C. Bm. '19-505; sq. 29·56'; stratum I. Cf. Analysis Table, p. 536, no. 10. (Pl. 164, no. 63.)

Type b:

64. Heavy iron javelin with shaft and head in one piece. Length 38·75 in., but the shaft is broken. The head is three-flanged, like the arrow-heads of type c, below. Third to second century B.C., unless, as seems probable, it is a stray of later date. Bm.; stratum II.

65. Similar to preceding, but with four-flanged head. Shaft broken. Length 25 in. Sk. '22-828; Fifth Street (west); sq. 53·85'; stratum II. First century A.D. (Pl. 164, no. 65.)

66. Similar to no. 65 and from same findspot. Shaft broken. Length 22 in.; stratum II. (Pl. 164, no. 66.)

67. Javelin-head of narrow leaf pattern, with shaft of same metal; broken. Length 6·5 in. This may belong to the same class of heavy javelin as the three preceding specimens, but we cannot be sure on the point as only 3 in. of the shaft are preserved. It is referable to the fifth century A.D. Mm. '15-42; mon., north steps; 5 ft. below surface. Cf. p. 363 (18) *supra*. (Pl. 164, no. 67.)

Type c:

68. Leaf-shaped spear-head, with central ribbing on both sides; tang broken. Length 8·25 in. Sk. '26-1,213; Block J; sq. 145·57'; stratum II. First century A.D. Cf. p. 171 *supra*. (Pl. 164, no. 68.)

Type d:

69. Dagger-shaped spear-head with hollow socket (broken). Length 7·12 in. Sk. '15-487; Block G; sq. 114·49'; stratum II. First century A.D. Cf. p. 169 *supra*. (Pl. 164, no. 69.)

70. Socketed spear-head of knife-blade pattern. Length 11·87 in. Fifth century A.D. Jn. '16-273; cell no. 3; 1 ft. below surface. Cf. p. 385 *supra*. (Pl. 164, no. 70.)

Type e:

71. Socketed conical spear-butts, with horizontal rim. Length 6 in. Mm. '15-E64; fifth century A.D. Cf. p. 363 (19) *supra*. (Pl. 164, no. 71.)

CLASS XX. *Arrow-heads* (nos. 72-89)

Without exception, all the arrow-heads found at Taxila were intended for shafts made of reeds, not of solid wood, and were provided accordingly with long tangs instead of hollow sockets.¹ But a peculiarity of nearly all the earlier specimens is that there is a considerable length of solid shank intervening between the head and the tang. The explanation of this unusual feature seems to be that this type of arrow-head is a compromise between the socketed and tanged varieties. Whoever its authors may have been, they had evidently been accustomed to socketed piles designed for solid wooden shafts, and when, for some reason or other, reeds were substituted for the solid wood, the old form of pile was retained and a thin tang added behind the shank for insertion into the reed, the shank itself being made solid instead of hollow. Since the reed arrow was in general use among Iranian and Central Asian² as well as Indian peoples, it is reasonable to infer that these 'double-tanged' heads, as we may call them, were an adaptation of a Western socketed type rather than an Eastern one, and, this being so, it seems not improbable that they were introduced at Taxila by the Bactrian Greeks. In support of this surmise it is to be noted that the earliest specimens come from the uppermost stratum of the Bhir Mound and are therefore contemporary with the advent of the Bactrian Greeks. No iron arrow-heads of any kind have been found in the earlier settlements on this site,³ although they must, of course, have been in use.

Apart from their double tang, the arrow-heads from the Bhir Mound belong to five different types, viz.: (a) flat, with lozenge cross-section; (b) with triangular cross-section; (c) with square cross-section; (d) with rhombic cross-section; (e) barbed. With the exception of (b) all these types recur in the later settlements in Sirkap, but in the Šaka-Parthian period (first century B.C. to first century A.D.) two new types also make their appearance, viz.: (f) conical, and (g) three-bladed. The older types of arrow-heads also tend to become larger, e.g. nos. 77, 78, 84. In the fifth century A.D. an eighth type (h) with four barbed blades was introduced.⁴

¹ Indian arrows seem to have been usually made of the *sara* reed, but arrows made of bambu (*venu*) and *śalākā* (a hard wood) are also mentioned in Indian literature, e.g. Kauṭilya, *Arthaśāstra*, bk. II, ch. 13; *Agni Purāṇa*, 245, 12.

² Cf. *Excavations at Dura-Europos*, 6th season (1932-3), p. 454, and notes 48 and 49; Stein, *Innermost Asia*, I, pp. 95-6; III, Pls. VI, XXVI, XLVII; *Serindia*, IV, Pls. LI, LIII, etc. The Indian reed-arrow was from two to three cubits in length. Cf. Q. Curtius, VIII, 9; Arrian, *Ind.* c. 16; Strabo, xv, 66.

³ For a double-tanged arrow-head with three blades from Turfan (Kara-khōja), see Stein, *op. cit.* II, p. 608, Kao IV, 19 and vol. III, Pl. LXXI. The author, however, does not attempt to explain the peculiarity of the type.

⁴ Ancient Indian literature refers to arrow-heads of many shapes, e.g. *ardhacandra* ('half-moon'), *kshurapra* (with a razor-edge), *sūcimukha* (needle-shaped), *vatsa-danta* (like a calf's tooth), etc. Cf. *J.A.O.S.* XIII, pp. 275-81.

The three-bladed type (*g*) seems to have been specially favoured by the Śakas,¹ to whom its introduction at Taxila was no doubt due. It is noteworthy, however, that many specimens of this three-bladed, as well as of the four-bladed type, have been found along with specimens of (*a*) and (*d*) types at the Dharmarājikā and other monasteries destroyed by the White Huns in the fifth century A.D. It is a reasonable surmise that the former weapons were used by the attacking Huns; the latter, which were traditional at Taxila, by the defending monks, though the three-bladed type, which had long before been introduced by the Śakas, may also have been used by the defenders.

For arrow-heads made of bone and ivory, see below, 'Bone and Ivory', ch. 32, Class XVIII, nos. 105–14. No arrow-heads made of copper or bronze or horn have been found at Taxila.

Type *a*:

72. Arrow-head, leaf-shaped, with lozenge cross-section and double tang. Length 2·62 in. Point and tang broken. Bm. '21-150; sq. 34·47'; stratum II. (Pl. 165, no. 72.)
73. Similar but triangular in shape. Length 3·25 in. Bm. '21-1,617; sq. 48·124'; stratum II. (Pls. 165, no. 73; 206, no. 47.)
74. Similar to no. 73, but with longer shank and slightly barbed; tang partly broken. Length 2·87 in. Bm. '21-873; sq. 66·89'; stratum II. (Pls. 165, no. 74; 206, no. 40.)
75. Similar, but tang broken. Length 1·87 in. Bm. '21-1,583; sq. 43·123'; stratum II. (Pl. 165, no. 75.)
76. Similar. Length 1·12 in. Bm. '20-15; sq. 35·62'; stratum II. (Pl. 165, no. 76.)
77. Similar, with knife-blade head; tang partly broken. Length 3·87 in. Sk. '26-357; Block I; sq. 133·65'; stratum II. Cf. p. 171 *supra*. (Pls. 165, no. 77; 206, no. 48.)
78. Similar, with triangular blade like no. 75. Length 2·87 in. Sk. '16-788; Block I; sq. 13·58'; stratum I. Cf. p. 142 *supra*. (Pls. 165, no. 78; 206, no. 46.)

Many more arrow-heads of this type, dating probably from the period of the Hun invasions in the fifth century A.D., were found at the Dharmarājikā monastery, particularly in the debris of courts A, H and J.

Type *b*:

79. Arrow-head with triangular cross-section and double tang. Length 4·5 in. Bm. '21-1,491; spoil earth from stratum II. (Pl. 165, no. 79.)

Type *c*:

80. Arrow-head with square cross-section; single tang broken. Length 2·25 in. Bm. '21-873, b; sq. 66·89'; stratum II. Third to second century B.C. (Pl. 165, no. 80.)
81. Similar. Length 3·5 in. Bm. '14-659; sq. 67·76'; stratum II. (Pls. 165, no. 81; 206, no. 49.)

Type *d*:

82. Arrow-head with rhombic cross-section, double-tanged. Length 1·62 in., but tang broken. Bm. '20-569; sq. 12·41'; stratum II. (Pl. 165, no. 82.)
83. Similar; tang broken. Length 2·25 in. Bm. '20-1,380; sq. 20·44'; stratum II. (Pls. 165, no. 83; 206, no. 39.)

¹ Cf. Flinders Petrie, *Tools and Weapons*, p. 34, § 89. The three-bladed arrow-head did not find its way to Egypt until after the Scythian invasion of Syria (624–596 B.C.). Its origin appears to have been Graeco-Scythian.

84. Similar, double tanged. Length 2·87 in., but tang broken. Sk. '13-1,482; Block E; sq. 77·68'; stratum IV. First century B.C. (Pls. 165, no. 84; 206, no. 45.)

Type e:

85. Double-tanged arrow-head with barbed and ribbed blade. Length 3 in. Bm. '21-298; sq. 10·61'; stratum II. (Pls. 165, no. 85; 206, no. 50.)

86. Similar, but with single tang. Length 6·87 in. Sk. '17-Kun. 135; north-east veranda; 5 ft. below surface. Probably fifth century A.D. Cf. p. 352 *supra*. (Pls. 165, no. 86; 206, no. 44.)

Type f:

87. Conical arrow-head with circular cross-section. Tang broken. Length 2·12 in. Sk. '15-303; Block I; sq. 129·43'; stratum II. First century A.D. Cf. p. 171. (Pl. 165, no. 87.)

Type g:

88. Three-bladed arrow-head, with plain tang which is broken. Length 2 in. Sk. '14-1,632; Block D'; sq. 62·75'; stratum III. First century B.C. to first century A.D. A number of arrow-heads of this type have been found at the Dharmarajikā monastery, particularly in the courts A, J, H, where they were probably used in the fifth century A.D. by the White Huns. Cf. pp. 278, 547-8 *supra*. (Pls. 165, no. 88; 206, no. 42.)

88, a. Three-bladed arrow-head with plain tang. Length 4·1 in. First century A.D. Sk. '26-2,847; stratum I. Of medium or low carbon steel. Cf. Analysis Table, p. 536, no. 9.

Type h:

89. Four-bladed barbed arrow-head with short shank and long tang. Length 5 in. Sk. '14-Kun. 2,412; from the Kunāla monastery. A number of arrow-heads of this type have also been found at the Mohrā Morādu monastery (fifth century), where, like the preceding type (g), they were probably used by the attacking Huns. Cf. p. 352 *supra*. (Pls. 165, no. 89; 206, no. 51.)

CLASS XXI. Armour, helmet and shield bosses (nos. 90-5)

90. Eighteen armour plates of iron much corroded and adhering together, along with three links of an iron chain. Size about 10 × 8·5 × 0·08 in. thick. Sk. '28-1,782; Block F'; sq. 85·89'; stratum II. The plates are curved to fit the body and are of different sizes and patterns; some of their edges are straight, others curvilinear, while some are provided with hinges or pierced with small holes for lacing. The plates are so corroded that there is no possibility of separating them, but enough is visible to show that each was made up of several strips of metal, probably hammered together. It is not possible to determine for certain if they were riveted. Rectangular armour plates, either of iron or of lacquered leather, are figured on the skirts of soldiers in certain Gandhāra reliefs (cf. Foucher, *L'Art gréco-bouddhique du Gandhāra*, p. 405, figs. 202, 204), but the size and weight of these plates from Sirkap suggests that they served as armour for horses or even for camels¹ or elephants, rather than for men. Horses and riders clad in mail or plate armour were from early times a feature of the Persian, Seleucid, Parthian and Sarmatian armies. A horseman with an armoured apron protecting his legs is figured on coins of the Śaka satrap, Kharahostes (*B.M. Cat. of Greek and Scythic coins of Bactria and India*, Pl. xxiii, 6). About the second century A.D. the idea was also copied by the Romans, to whom this class of heavy cavalry was known as the *cataphracti* (κατάφρακτοι).¹ Cf. Xenophon, *Anab.* 1, 8, 6-7; *Cyropaedia*, vi, 4, 1; vii, 1, 2; viii, 8, 11; Tit. Liv. xxiv, 48; xxxvii, 40; Polyb. 31, 3, 9; Plut.

¹ The Parthian camelry, which was also heavily armed, may have been copied from the Roman dromedarii. The idea of the *cataphract* also spread eastward to China as early, probably, as the first century B.C. Cf. Laufer, *Chinese Clay Figures* (1914), p. 217.

Lucullus, 28; Dar. et Sag. s.v. 'Cataphractus', figs. 1233–6; *Excavations at Dura-Europos*, 6th season (1932–3), pp. 440–52. For the bardings of elephants, which were also known as κατάφρακτοι, *loricati*, see Dar. et Sag. s.v. 'Elephas', and Armandi, *Histoire militaire des éléphants*. Also, I Maccabees vi. 43. Cf. p. 182 *supra*. (Pl. 170, *t.*)

91, *a*, *b*. Two groups of plate armour intended for the arms. They consist of twenty-four and eighteen pieces respectively, of varying sizes and shapes. The heavy weight of the metal suggests that the armour was designed for a horseman rather than a foot-soldier. Sk. '26–3, 631; Block K; sq. 157·61'; stratum II. First century A.D. Cf. p. 176 *supra*. (Pl. 170, *p*, *q*.)

92. Helmet with cheek-piece (*παραγνωθήσις*) on one side, attached seemingly by pivot, enabling it to be raised or lowered. The other side of the helmet is missing. Length 9·5 in.; width 7 in.; height 6 in. The crown is of one piece, beaten out like an oval bowl and afterwards deepened by means of horizontal bands hammered on to it. It is large enough to admit of a thick padded cap underneath, even on a big head. On the summit is a boss intended for the attachment of a ring, spike or crest (*λόφος*). Cf. Dar. et Sag. s.v. 'Galea', and fig. 3428. Sk. stratum II. (Pl. 170, *r.*)

93. Boss of shield (*umbo*, *δυμφαλός*) with single-looped cross-piece riveted on at the back for attaching the handle. Diam. 1·87 in. Sk. '20–45; Block K'; stratum II. Cf. p. 180 *supra*; 'Silverware', ch. 29, no. 22 and Pl. 187, and 'Copper and Bronze', ch. 28, nos. 388, 389 and Pl. 177. (Pl. 165, no. 93.)

94. Similar, with three looped cross-pieces at back. Diam. 2·87 in. Sk. '14–920; Block D'; sq. 64·77'; stratum II. Cf. p. 190 *supra*. (Pl. 165, no. 94.)

95. Similar to no. 94. Diam. 6·25 in. Sk. '14–409; Block C'; sq. 48·74'; stratum III. Cf. p. 193 *supra*.

GROUP C. HORSE-BRIDLES AND ELEPHANT-GOADS

CLASS XXII. Bits and cheek-bars of horse-bridles (nos. 96–100)

Ancient horse-bits were generally of three kinds, viz.: (*a*) the simple plain or jointed snaffle-bit; (*b*) the protected snaffle, with a ring or cheek-bar at each side to prevent the rein slipping into the mouth; (*c*) the curb-bit, with a curb-chain or strap fastened to the upper ends of the cheek-bars and passing under the horse's lower jaw, while the reins are attached to the lower ends of the cheek-bars. (Cf. Flinders Petrie, *Tools and Weapons*, pp. 55, 56, and Pls. LXX, LXXI; *Ency. Brit.* s.v. 'Saddlery'; Dar. et Sag. s.v. 'Frenum'.) The bits found at Taxila are of (*a*) and (*b*) types only. They date from the first century A.D. Arrian says that in the time of Alexander the Great the Indians did not curb their horses with bits like those in use among the Greeks and Kelts, but they fitted round the horse's mouth a circular piece of ox-hide studded with iron or brass pricks pointing inwards but not very sharp; and within the horse's mouth they put an iron prong like a skewer, to which the reins were attached, so that when the rider pulled the reins, the prong controlled the horse and the pricks inside the muzzle goaded its mouth, compelling it to obey the reins.¹ That the Greeks introduced the snaffle-bit into India is corroborated by the fact that the Sanskrit word for 'bit' = *khalina*, is borrowed from the Greek *χολινός*. The spiked bit is still all too familiar in the North-West,

¹ Cf. Arrian, *Ind.* 16. Strabo (xv, 66) says: 'Instead of bridles they use muzzles, which differ little from halters and the lips are perforated with spikes.'

but no examples of it have been found at Taxila. Cheek-bars of horn and bone have also been found at Taxila (ch. 32, nos. 115-17).

96. Snaffle-bit, jointed in middle, with cheek-rings made in one piece with each section of the bar. The bar is plain. Length 8·62 in. Sk. '14-1,593; Block C'; sq. 46·74'; stratum II. Cf. p. 193 *supra*. (Pls. 165, no. 96; 205, c.)

97. Similar; length 7·5 in. Sk. '14-384; Block K; sq. 154-47'; stratum II. Cf. p. 176 *supra*. (Pl. 165, no. 97.)

98. Similar; length 7·87 in. Sk. '26-21; Block J; sq. 143·69'; stratum II. Cf. p. 171 *supra*. (Pl. 165, no. 98.)

99. An S-shaped cheek-bar of horse-bridle with two holes for rein-strap. The cheek-bar was attached to the bit, in the manner illustrated in Pl. 205, b, which shows a horn cheek-bar and bit from Central Asia. Length 5·5 in. Sk. '14; Trench A627. For S-shaped bars, cf. Flinders Petrie, *op. cit.* p. 56, §158 and Pl. LXX, 19, 20, and Lefebure des Noëttes, *L'Attelage, Le Cheval de Selle*, figs. 247 and 248 (Scythian and Roman), and for earlier and more decorative specimens in bronze from Luristān, *Illus. London News* (6 Sept. 1930), p. 389, figs. 3-10. (Pl. 170, o.)

100, a, b. Two cheek-bars similar to above, but slightly curved instead of being S-shaped. Length 6·75 in. and 7·25 in. respectively. Sk. '14-2,276; Block E; sq. 69·66'; stratum III. Cf. p. 161 (16) *supra*. (Pls. 165, no. 100, a, b; 185, d.)

CLASS XXIII. Elephant-goads (nos. 101, 102)

Somewhat similar implements to those described below are designated 'fire-hooks' by Flinders Petrie and said to have been used in Egypt for raking the charcoal in the braziers (cf. Flinders Petrie, *Tools and Weapons*, Pl. LXXI, 50, 51). There is no reason, however, to suppose that the following implements were other than the familiar *ankusa* figured so often in early Indian sculptures. It is noteworthy that precisely the same type of elephant-goad was used in North Africa. See, for example, the Carthaginian coin in the Cabinet de France, illustrated in Dar. et Sag. s.v. 'Elephas', fig. 2621.

101. Elephant-goad (Skr. *ankusa*) with sharp point at end and curved hook at side. Length 25·5 in. Bm. '24-212; sq. 7·61'; stratum II. (Pl. 170, v.)

102. Similar. Length 5·5 in. Sk. '22-611; Block C'; sq. 51·90'; stratum III. First century B.C. to first century A.D. Cf. p. 193 *supra*. (Pl. 170, u.)

GROUP D. CARPENTER'S AND BLACKSMITH'S TOOLS, ETC.

CLASS XXIV. Axes (nos. 103-11)

All the iron axes from Taxila belong to the socketed class. One only (no. 103) comes from the Bhir Mound and is referable to the third to second century B.C.; the rest come from Sirkap and date from the first century A.D. The commonest is a true iron type (a) with a wide splay and thin blade, such as is frequently met with at Pompeii and on other Roman sites at this period. Cf. Flinders Petrie, *Tools and Weapons*, p. 11 and Pl. IX, 26-36. In the Sirkap specimens the droop of the blade tends to become more marked, giving the axe a broader crescentic edge and enabling it to make a longer cut. In another type (b) the blade is prolonged in both directions,

so as to give a still longer cutting edge, as in Flinders Petrie, *op. cit.* Pl. x, nos. 49–53, 65, 68, 73. In a third type (*c*) the socket is projected up and down the back of the handle in order to meet the strain imposed on it, particularly in such operations as the cleaving of wood. Cf. Flinders Petrie, *op. cit.* Pl. xi, nos. 101, 106, 107, 114, 115.

Type *a*:

- 103. Socketed axe, with slightly drooping blade. Length 4·62 in. Bm. '21–650; sq. 90·79'; stratum II. (Pl. 166, no. 103.)
- 104. Similar, with short irregular blade and unusually large socket for handle. Length 3·68 in. First century A.D. Sk. '20–240; Block D'; sq. 54·90'; stratum II. Cf. p. 190 *supra*. (Pl. 166, no. 104.)
- 105. Similar, with longer and more drooping blade. Length 6·87 in. First century A.D. Sk. '15–732; Block H; sq. 125·67'; stratum II. Cf. *A.S.R.* (1915), p. 18, no. 6; p. 170 *supra*. (Pl. 166, no. 105.)
- 106. Similar. Droop of blade accentuated. Length 5·25 in. First century A.D. Sk. '22–867; Block E'; sq. 73·83'; stratum II. Cf. p. 185 *supra*. (Pl. 166, no. 106.)
- 107. Similar, and of same date as preceding. Length 4·87 in. Sk. '24–98; Block C; sq. 47·49'; stratum II. (Pl. 166, no. 107.)
- 108. Similar and of same date. Length 5·62 in. Sk. '26–1,093; Block J; sq. 146·59'; stratum II. Cf. p. 171 *supra*. (Pl. 166, no. 108.)

Type *b*:

- 109. Socketed axe, with blade projected in both directions. Length 5·75 in. First century A.D. Sk. '24–98; Block C; sq. 47·49'; stratum II. Analysis Table, p. 536, no. 6 *supra*. (Pl. 166, no. 109.)

Type *c*:

- 110. Axe, with drooping blade and back of socket projected up and down handle. Length 6·93 in. First century A.D. Sk. '20–252; Block B'; sq. 33·86'; stratum II. Cf. p. 194 *supra*. (Pl. 166, no. 110.)
- 111. Similar and of same date. Length 5·25 in. Sk. '26–1,259; Block J; sq. 151·58'; stratum I. Cf. p. 171 *supra*. (Pl. 166, no. 111.)

CLASS XXV. *Adzes* (nos. 112–17)

The earliest type (*a*) of carpenter's adze from the Bhiṁ Mound (third to second century B.C.) has a thin rounded top and thick sharply tapering blade. Apparently it was fixed to the handle by means of an iron band and wedges, with the top projecting at the back of the band, as in the example, said to have come from Abydos, which is figured in Flinders Petrie, *op. cit.* Pl. xviii, fig. 132. In the later Sirkap examples of the first century A.D. (type *b*) the blade is relatively broader below and thicker above, with the top squared off for insertion into a metal sheath, which covered it behind as well as above and at the sides, the sheath itself being nailed to the handle. In a still later example of the fifth century A.D. from Jauliāñ (type *c*) the blade is bent, as in the modern Indian adze, to facilitate an even cutting stroke and is furnished with a socket-hole for the handle.

Type *a*:

112. Carpenter's adze of iron with thin rounded top and thick sharply tapering blade. Length 7·25 in. c. late fourth century B.C. Bm. '20-1,412; sq. 28·27'; stratum III. (Pl. 166, no. 112.)

113. Similar. Length 5·87 in. Bm. '21-842; sq. 66·87'; stratum II. (Pl. 166, no. 113.)

Type *b*:

114. Carpenter's adze. Length 5·25 in. The blade is broader below than the preceding examples, but thicker above and squared off at the top for insertion in a metal sheath. The latter encases the blade at the back as well as above and at the sides, and was fixed to the wooden handle by two nails driven through it from side to side. First century A.D. Cf. *A.S.R.* (1915), Pl. VII, 3. Sk. '15-221; Block I; sq. 134·54'; stratum I. Cf. p. 171 *supra*. (Pl. 166, no. 114.)

115. Similar and of about same date. Length 6 in. *A.S.R.* (1914), Pl. XXV, 46. Sk. '14-1,068; Main Street; sq. 83·72'; stratum III. (Pl. 166, no. 115.)

116. Similar, but without sheath for head. Length 5·75 in. Sk. '20-76; east of palace; stratum II. Cf. p. 176; Analysis Table, p. 536, no. 5 *supra*. (Pl. 166, no. 116.)

Type *c*:

117. Socketed adze-head with bent, wryneck blade, as in the modern Indian adze, to facilitate the trimming of the wood surface. Length 5·87 in. Fifth century A.D. Jn. '16-48; mon. court. Cf. p. 385 *supra*; *Jn. Mem.* Pl. XXVIII, g. (Pl. 166, no. 117.)

CLASS XXVI. *Chisels* (nos. 118-21, *c*)

Iron chisels are few in number. The earliest example from the Bhir Mound (third to second century B.C.) is a bare metal, square bar tool, with splayed single-slope cutting edge, intended no doubt for mortising work. Of the chisels from Sirkap (second century B.C. and first century A.D.), some (type *b*) are bare metal, round bar tools for stone-cutting; others (type *e*) are bare metal round bar carpenter's chisels, tapering gradually from the top downwards to a splayed crescentic edge.

Type *a*:

118. Bare metal chisel for mortising, approximately square in section, with single slope and slightly splayed crescentic cutting edge. Length 5 in. Bm. '21-636; sq. 132·94'; stratum II. (Pl. 166, no. 118.)

Type *b*:

119. Bare metal, round bar chisel, with double slope and straight cutting edge, for stone-cutting. Length 5·75 in. Sk. '22-920; Block 1'; sq. 12·92'; stratum V. Second century B.C. (Pl. 166, no. 119.)

120. Similar. Length 5·25 in. First century A.D. Sk. '16-1,124; Block A'; sq. 21·74'; stratum II. Cf. p. 195; Analysis Table, p. 536, no. 7 *supra*. (Pl. 166, no. 120.)

121. Similar; head much hammered. Length 3·87 in. First century A.D. Sk. '14; Trench A635; stratum II. (Pl. 166, no. 121.)

Type *c*:

121, *a*. Bare metal, round bar carpenter's chisel tapering gradually from top, with broad crescentic cutting edge. Length 7 in. First century A.D. Sk. '17-140; Main Street; sq. 96·73'; stratum IV. (Pl. 166, no. 121, *a*.)

121, b. Similar and of same date. Length 5·87 in. Sk. '24-727; Block C; sq. 45·44'; stratum III. (Pl. 166, no. 121, b.)

121, c. Similar and of same date. Length 6·62 in. Sk. '15-732; Block H; sq. 125·67'; stratum II. Cf. p. 170 *supra*. (Pl. 166, no. 121, c.)

CLASS XXVII. Knives and chopper (?) (nos. 122-8)

Iron knives from the Bhiṁ Mound (nos. 122-3) are of the straight-backed, straight-edged type, with a tang for fixing into the handle. Later specimens from Sirkap (nos. 124-6) have the same tang and straight back, but the edge is convex. No. 127 (first century A.D.) is a fragment of what appears to have been a chopper. No. 128 of the fifth century A.D.—a double-edged blade without tang—may have served as either a knife or a dagger.

122. Straight-backed, straight-edged knife, with tang for handle. Length 4·06 in. Bm. '24-218; sq. 7·59'; stratum II. (Pl. 166, no. 122.)

123. Similar, but with slightly convex back. The hollow edge is the result of sharpening. Length 4·37 in. Bm. '20-1,183; sq. 27·27'; stratum III. (Pl. 166, no. 123.)

124. Similar but with convex edge. Length 4·75 in. First century B.C. to first century A.D. Sk. '22-611/2; Block C'; sq. 51·90'; stratum III. Cf. p. 193 *supra*. (Pl. 166, no. 124.)

125. Similar and of same date. Damaged. Length 3·25 in. Sk. '13-103; Block K; sq. 179·47'; stratum III. Cf. p. 170 *supra*. (Pl. 166, no. 125.)

126. Similar. First century A.D. Length 5 in. Sk. '15-294; Block I; sq. 133·54'; stratum II. Cf. p. 171; Analysis Table, p. 536, no. 8 *supra*. (Pl. 166, no. 126.)

127. Fragment of chopper(?) with sheath at corner for handle. Length 2·87 in. Sk. '14; Trench A 632; stratum II. (Pl. 166, no. 127.)

128. Knife or dagger, two-edged, without tang, but with two nails at base of blade for fixing handle. Length 4·62 in. Fifth century A.D. Mm. '15-194; cell 9; 7 ft. below surface. Cf. p. 363 (21) *supra*. (Pl. 166, no. 128.)

CLASS XXVIII. Saw (no. 129)

129. Fragment of straight-edged, straight-backed saw. Length 4·25 in. First century A.D. The metal is too corroded to determine whether there was any rake in the teeth. Sk. '15-461; Block E; sq. 77·50'; stratum II. Cf. p. 161, n. 1 *supra*; A.S.R. (1915), Pl. VII, 9. (Pl. 167, no. 129.)

CLASS XXIX. Tongs, pliers and tweezers (nos. 130-4)

Fire-tongs of all sizes, similar in form to nos. 130 and 131 below, were common in the Mediterranean area from the Roman period onwards (cf. Flinders Petrie, *op. cit.* p. 41). Whether this type of tongs was evolved independently in India is not known. The small pliers (no. 132) are of a pattern which is common enough to-day, but rare, if not unique, among ancient tools of this class. On the other hand, the pattern of the tweezers (nos. 133, 134) could be paralleled by countless examples from the Graeco-Roman world.

130. Pair of tongs. Length 4·87 in. Possibly used by a goldsmith or silversmith; they are too small for use as ordinary fire-tongs. Bm. '15-298; stratum II. (Pl. 167, no. 130.)

131. Similar, but larger. Length 10·25 in. First century A.D. Sk. '14; Trench A 638; stratum II. (Pl. 167, no. 131.)

132. Pair of pliers, of modern-looking pattern, with bow handles. Length 3·75 in. First century A.D. Sk. '26-4,429/11; Block L; sq. 189·70'; stratum II. Cf. p. 178 *supra*. (Pls. 167, no. 132; 205, d.)

133. Half of tweezers incurved and broad at the point; probably used for depilation. Length 3·5 in. First century A.D. Sk. '14-389; Block K; sq. 159·57'; stratum II. Cf. p. 176 *supra*. (Pl. 167, no. 133.)

134. Pair of bow-legged tweezers with fine points, probably used for extraction of thorns or for handling small objects. Length 6·12 in. Probably fifth century A.D. Gr. '27-215 D; room 10; 6 ft. 2 in. below surface. (Pl. 167, no. 134.)

CLASS XXX. Scissors (no. 135)

135. Handle and part of one blade of pair of scissors. Length 3·31 in. First century A.D. Sk. '13-124; stratum I. Scissors of this type, worked by two separate fingers, are not known to occur in the Graeco-Roman world before the first century A.D. (Flinders Petrie, *op. cit.* p. 48, para. 135). There is no evidence of their having been independently evolved in India. (Pl. 167, no. 135.)

CLASS XXXI. Hammers, adze-hammer and picks (nos. 136-42)

For other hammers, cf. 'Copper and Bronze', ch. 28, nos. 373 and 374, *a-f*. All the tools in this class date from the first century A.D. The square, flat-faced hammers (nos. 136-8) were probably used by blacksmiths; the larger round-faced hammer (no. 139) and the single and double picks by stonemasons; and the small adze-hammer (no. 140) for carpentry.

136. Socketed hammer, square in section and flat-headed. Length 3·62 in. First century A.D. Sk. '14-2,049; spoil earth. (Pl. 167, no. 136.)

137. Similar, with socket-hole to one side. Length 4·37 in. First century A.D. Sk. '20-74; east of palace; stratum II. Cf. p. 176 *supra*. (Pl. 167, no. 137.)

138. Similar to no. 136, but shorter and thicker. Length 4·37 in. First century A.D. Sk. '26-4,429/4; Block L; sq. 189·70'; stratum II. Cf. p. 178 *supra*. (Pl. 167, no. 138.)

139. Heavy hammer, approximately square in section with rounded face. Length 6·5 in. First century A.D. Sk. '20-74; east of palace; stratum II. Cf. p. 176 *supra*. (Pl. 167, no. 139.)

140. Small adze-hammer. Length 5 in. First century A.D. Sk. '26-4,429/5; Block L; sq. 189·70'; stratum II. Cf. Flinders Petrie, *op. cit.* Pl. XIV, 73. Cf. p. 178 *supra*. (Pl. 167, no. 140.)

141, *a-c*. Three single-head socketed picks such as might have been used for stone dressing. Length 5-6·12 in. First century A.D. From same findspot as preceding. Cf. p. 178 *supra*. (Pl. 167, no. 141.)

142. Double-headed socketed pick for stone-dressing. Length 5·12 in. First century A.D. Sk. '24-94; Block C; sq. 47·49'; stratum II. Cf. Flinders Petrie, *op. cit.* Pl. XIV, 71, 72 (from Pompeii). (Pl. 167, no. 142.)

CLASS XXXII. Anvils or beak-irons (nos. 143-9)

These implements are of small size and used for light metal-work only. The earliest kind, of the third to second century B.C., are square with four sharply pointed legs for fixing into a wooden block. In later ones of the same type (nos. 145, 146) belonging to the first century A.D. the legs are wider and not so sharp. For Graeco-Roman examples of this type of anvil, cf. Dar. et Sag. *s.v.* 'Caelatura',

fig. 954 and fn. 156; *s.v.* 'Incus', fig. 4036. A second type of later beak-iron, also of the first century A.D., consists of a solid square bar, tapering somewhat downwards but flat at the bottom and without any spike for driving into the wood block.

Stool type *a*:

143. Small anvil or beak-iron, of stool type, for light metal-work. Square in plan with a pointed leg at each corner for fixing into wooden block. $2\cdot87 \times 2\cdot87$ in. Bm. '19-1,773; sq. 7·55'; stratum II. (Pl. 167, no. 143.)

144. Similar, and of same size and age. Bm. '24-499; sq. 32·62'; stratum II.

145. Similar, but legs shorter and broader. Size 3×3 in. First century A.D. Sk. '19-131; Block 1'; sq. 11·110'; stratum II. Cf. p. 196 *supra*. (Pl. 167, no. 145.)

146. Similar to no. 145 and of same age. Size $2\cdot75 \times 2\cdot25$ in. Sk. '26-2,327; Block G; sq. 96·46'; stratum II. Cf. p. 169 *supra*. (Pl. 167, no. 146.)

Solid bar type *b*:

147. Anvil of solid bar type, square in section with splayed top. Height 6·5 in. First century A.D. Sk. '27-1,549; Block D'; sq. 61·118'; stratum III. Cf. p. 190 *supra*. (Pls. 167, no. 147; 205, d.)

148. Similar to preceding and of same age. Height 6·37 in. Sk. '26-4,429/86; Block L; sq. 189·70'; stratum II.

149. Similar but smaller and with more regular taper downwards. Same age. Height 3·25 in. Sk. '28-264; Block A'; sq. 26·93'; stratum II. Cf. p. 195 *supra*. (Pl. 167, no. 149.)

CLASS XXXIII. Nails, nail-bosses and hooks (nos. 150-66)

A curious type of nail (*a*) found only in the Bhîr Mound and dating from the third to second century B.C. has a broad flat head of varying shape with a small round hole perforated from side to side at the upper edge. The purpose of the hole is not apparent; it might be intended to take a wire or string. Of nails with heads turned over at right angles to the shank (*b*) no. 152 is of the third to second century B.C.; no. 153 of the fifth century A.D. Nos. 154-6 with heavy boss heads all come from Sirkap and date from the first century A.D. They were probably used for studding door-fronts but might also have served as beak-irons for light metal-work. Beak-irons with single spikes, like these, for fixing into a wooden block, were in use among Roman artificers (cf. Dar. et Sag. *s.v.* 'Incus', fig. 4037). The ornamental door-bosses of iron, held in place by a centre nail (nos. 157-62), come partly from strata of the first century A.D. in Sirkap, partly from the fifth-century monasteries at Jauliāñ and the Dharmarājikā. Such bosses were more commonly made of copper or bronze than of iron (cf. 'Copper and Bronze', ch. 28, nos. 408-12). Hooks (nos. 163-6) are of two types, viz.: (*a*) a rigid hook driven into the woodwork of the ceiling, for hanging things on; (*b*) movable hooks used in conjunction with staples as door-fasteners.

Type *a*:

Nails 150, *a*, *b*. Two nails, with flat shanks and broad flat heads projecting to one side of the shank. At its upper edge the head is perforated from side to side by a small round hole. Length 4·87 and 4·45 in. respectively. Third to second century B.C. Bm. '21-144; sq. 11·51'; stratum II. (Pl. 167, no. 150, *a*, *b*.)

151, *a-g.* Seven nails, with flattened shanks, splayed at the head and tapering gradually to the point. In the middle of the head is a small hole perforated from side to side. Length 6·25-8·5 in. Bm. '21-82; sq. 10·52'; stratum II. (Pl. 167, no. 151, *a, b.*)

Type *b*:

152. Nail, with flattened tapering shank and head projecting in all directions at right angles to the shank. Length 3·5 in. Third to second century B.C. Bm. '20-586; sq. 25·26'; stratum II. (Pl. 167, no. 152.)

153. Similar, but longer and with square shank and head projecting on two sides only. Length 12·5 in. Fifth century A.D. Mm. '15-F36. Cf. p. 363 (22) *supra.* (Pl. 167, no. 153.)

Type *c*:

154. Iron nail with heavy rounded boss head. Length 4·5 in. This and the two following specimens were probably used for studding door-fronts; but they might also have been used as beak-irons for light metal-work. First century A.D. Sk. '24-170; Block B; sq. 36·60'; stratum I. (Pl. 167, no. 154.)

155. Similar and of same age, but with flattened head, of roughly hexagonal shape. Length 4·62 in. Sk. '24-15; Block B; sq. 35·51'; stratum I. (Pl. 167, no. 155.)

156. Similar to no. 155 and of same age. Length 7·62 in. Sk. '28-1,976; Block G'; sq. 106·79'; stratum II. (Pl. 167, no. 156.)

157. Iron door-boss, saucer-shaped with raised dome in centre. Diam. 2·81 in. Sk. '26-3,081; Block G; sq. 103·50'; stratum III. Centre nail missing. Cf. p. 169 *supra.* (Pl. 168, no. 157.)

Ornamental
door-bosses

158. Similar, and of same age. Diam. 2·75 in. Sk. '19-1,460; Block D'; sq. 59·104'; stratum II. Cf. p. 190 *supra.* (Pl. 168, no. 158.)

159. Helmet-shaped door-boss, with long boss-headed nail through centre. Diam. 1·62. Fifth century A.D. Jn. '16-F42; mon. court. Cf. p. 385 *supra.* (Pl. 168, no. 159.)

160. Two square door-bosses, with nails as in preceding. Size 3 in. square. Fifth century A.D. Jn. '16-F46; mon. court. Cf. p. 385 *supra.* (Pl. 168, no. 160.)

161. Lotus-shaped boss of copper with iron centre. Length 2·12 in. Probably fifth century A.D. Dh. '13-963; east of K; 1 ft. below surface. (Pl. 168, no. 161.)

162. Round door-boss, like inverted saucer, with four petals radiating from centre depression to rim. Diam. 4·5 in. First century A.D. Sk. '17-108; Block F'; sq. 93·75'; stratum II. Cf. p. 183 *supra.* (Pl. 168, no. 162.)

Hooks

163. Hook, with serpentine head at right angles to shank. Length 5·12 in. Evidently intended to be driven into the ceiling and used for hanging things on. Fifth century A.D. Mm. '15-19; mon., south-west corner; 3 ft. below surface. Cf. p. 363 (23) *supra.* (Pl. 168, no. 163.)

164. Movable hook with loop head (broken), used probably as a door-fastener like no. 52. Length 2·87 in. Fifth century A.D. Sk. '17-Kun. 90; south veranda; 3 ft. below surface. Cf. p. 352 *supra.* (Pl. 168, no. 164.)

165, *a-c.* Similar and of same date, but with straight shanks. Length 3·62-4 in. Mm. '15-E31. Cf. p. 363 (24) *supra.*

166. Similar, but of less solid make and irregular shape. Length 8·25 in. Fifth century A.D. Jn. '16-F41; mon. court. Cf. p. 385 *supra.* (Pl. 168, no. 166.)

CLASS XXXIV. *Clamps and staples (nos. 167-76)*

Objects in this class date from the first and fifth centuries A.D. The clamps take the form either of a single straight strip of metal nailed to the object, or of two bands on opposite sides of the object with nails uniting them between, or of a single band of metal bent round the object and secured or not by a nail. The staples

are made of iron wire doubled, with a loop at the middle and with the two ends pointed for driving into the wood.

Type *a*:

Clamps

- 167. Clamp, consisting of straight flat strip of metal, pierced by four long nails. Length 19·75 in. Length of nails about 14 in. First century A.D. Sk. '14-978; north of apsidal temple; debris. (Pl. 168, no. 167.)
- 168. Similar, with two nails; same age and from same spot. Length 4·25 in. (Pl. 168, no. 168.)
- 169. Nine iron clamps with nails intact; similar to no. 168. Length 3·75 in. Fifth century A.D. Mm. '15-E1. Cf. p. 363 (25) *supra*. (Pl. 168, no. 169.)
- 170. Similar. Length 7·5 in. Fifth century A.D. Jn. '16-F49; mon. court. Cf. p. 385 *supra*. (Pl. 168, no. 170.)

Type *b*. Cf. 'Copper and Bronze', ch. 28, no. 380.

- 171. Thirty-three double clamping irons, with nails at each end attached to most of them. Length 3·16 in. Fifth century A.D. Jn. '16-F50; mon. court. Cf. p. 385 *supra*. (Pl. 168, no. 171.)

Type *c*:

Staples

- 172. Double clamping iron with single nail at one end only. Length 3·87 in. First century A.D. Sk. '26-985; Block I; sq. 135·50'; stratum II. Cf. p. 171 *supra*. (Pl. 168, no. 172.)
- 173. Similar to preceding, but made of a single length of stout wire without nail. Length 4·75 in. Fifth century A.D. Jn. '16-F35; mon. court. Cf. p. 385 *supra*. (Pl. 168, no. 173.)
- 174. Iron staple and ring. Length 7·62 in. First century A.D. Sk. '14; Trench A634; stratum II. (Pl. 168, no. 174.)
- 175. Similar. Length 4·37 in. Fifth century A.D. Dh. '15-876; T2; 5 ft. below surface. Cf. p. 247 *supra*. (Pl. 168, no. 175.)
- 176. Similar, but with single shank and two links of chain attached. Same findspot and same age as preceding. Cf. p. 247 *supra*. (Pl. 168, no. 176.)

CLASS XXXV. *Hinges* (nos. 177-9)

Though larger, the iron hinges are of similar pattern to the copper and bronze ones ('Copper and Bronze', ch. 28, nos. 377-9); it is noteworthy, however (though this is no doubt accidental), that no specimens of iron hinges have been found of a date earlier than the fifth century A.D., whereas the bronze and copper ones are of the first century A.D.

- 177. Iron door-hinge of double-leaf pattern. Length 6·37 in. Fifth century A.D. Mm. '15-164; cell 23; 6 ft. below surface. Cf. p. 363 (26) *supra*. (Pl. 168, no. 177.)
- 178. Similar, and of same age, but leaf-pattern on one side only; other side oblong. Length 12·5 in. Jn. '16-F31; mon. court. Cf. p. 385 *supra*; *Jn. Mem.* Pl. xxviii, k. (Pl. 168, no. 178.)
- 179. Three door-hinges of iron, of same age, but both sides consist of narrow tapering strips. Length 8-13 in. Jn. '16-F56; mon. court. Cf. p. 385 *supra*; *Jn. Mem.* Pl. xxviii, o. (Pl. 168, no. 179.)

CLASS XXXVI. *Chains* (nos. 180, 181)

Cf. 'Copper and Bronze', ch. 28, nos. 383-5.

- 180. Three figure-of-eight links of chain. Length 6·5 in. First century A.D. Sk. '27-146; Block K'; sq. 165·110'; stratum II. Cf. p. 180 *supra*. (Pl. 168, no. 180.)

181. Two links of iron chain, figure-of-eight pattern, attached to ring-handle. Length 5·2 in. Fifth century A.D. Sk. '17-Kun. 45; south veranda; 3 ft. below surface. Cf. p. 352 *supra*. (Pl. 168, no. 181.)

181, a. One figure-of-eight link of door-chain attached to staple. Length 6·75 in. Fifth century A.D. Jn. '16-F40; mon. court. Cf. p. 385 *supra*; *Jn. Mem.* Pl. XXVII, n.

GROUP E. AGRICULTURAL IMPLEMENTS

CLASS XXXVII. *Spades, spuds and hoes* (nos. 182-99)

The true spade (no. 198) does not make its appearance at Taxila until the first century A.D.—about the same time that it makes its appearance in the Roman world—and was then only used for shovelling purposes. For breaking and hoeing the ground the ordinary tool was a socketed hoe or mattock, shaped like the modern *krurpi*, with the handle set transversely to the blade. The older specimens of these tools from the Bhir Mound (nos. 182-4) have narrow chisel-like blades, and this type continues on into later times; but some of the later specimens of the first century A.D. from Sirkap have broader blades, like the English garden hoe. Side by side with the hoe, a chisel-headed spud was also used at Taxila as far back as the third to second centuries B.C. (no. 191 *infra*). Later on, this tool, like the hoe also, tends to become broader in the blade. It should be noted that the tools which I here class as spuds, to be used with a vertical handle like a Dutch hoe, or spade, are classed by Flinders Petrie as ordinary hoes to be used with a transverse handle (cf. *Tools and Weapons*, Pls. XIX and XX), but inasmuch as the tools described below (nos. 182-90) are unquestionably hoes with transverse handles, it is highly improbable that nos. 191-5, which are of a totally different pattern, were intended to be used in the same way as hoes.

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| 182. Socketed hoe with narrow blade, thinned out and splaying gradually towards the edge. Socket damaged. Length 7·12 in. Bm. '20-892; sq. 28·27'; stratum II. (Pl. 169, no. 182.)
183. Similar, with narrow-waisted blade and more pronounced bend. Length 8 in. Bm. '21-54; sq. 25·59'; stratum II. (Pl. 169, no. 183.)
184. Similar to no. 183 and of same age, but longer and narrower. Length 9·5 in. Bm. '14-295; stratum II. (Pl. 169, no. 184.)
185. Similar, with larger socket-hole for handle. Length 1 ft. First century A.D. Sk. '14-1,996; Block C'; sq. 44·74'; stratum III. Cf. p. 193 <i>supra</i> . (Pl. 169, no. 185.)
186. Similar. Length 9·25 in. First century A.D. Sk. '20-222; Block A'; sq. 22·79'; stratum II. Cf. p. 195 <i>supra</i> . (Pl. 169, no. 186.)
187. Similar and of same age as preceding; with straight-edged blade. Length 7·75 in. Sk. '14-1,874; Main Street; sq. 82·73'; stratum II. (Pl. 169, no. 187.)
188. Similar, with blade splayed out towards cutting edge. Length 5·75 in. Sk. '15-732; Block H; sq. 125·67'; stratum II. Cf. p. 170 <i>supra</i> . (Pl. 169, no. 188.)
189. Similar to preceding and of same age, but with shorter and broader blade. Length 7·75 in. Sk. '27; Trench D 172; stratum II. (Pl. 169, no. 189.)
190. Similar to preceding and of same age, but with still broader blade. Length 7·75 in. Sk. '16-649; Block C; sq. 51·51'; stratum II. (Pls. 169, no. 190; 205, g.)
191. Socketed chisel-headed spud. Length 6·37 in. The socket, intended to take a straight vertical handle like a spade, is formed by beating out the metal and bending over the two sides | Hoes

Spuds |
|--|-------------------|

to meet in front. Bm. '21-958; sq. 30.125'; stratum I. For type, cf. Flinders Petrie, *Tools and Weapons*, Pl. XIX, 5, 12, 14, 25, etc. (Pl. 169, no. 191.)

192. Socketed spud, with broader blade than preceding and open instead of closed socket. Length 7.37 in. First century A.D. The socket in this specimen consists of two narrow flanges bent only over the edges of the handle. Sk. '20-654; Block B'; sq. 33.86'; stratum II. Cf. Flinders Petrie, *ibid.* nos. 7, 10, 11, 18, etc. Cf. p. 194 *supra*. (Pl. 169, no. 192.)

193. Similar, but with broader blade and closed socket as in no. 191. Length 4.25 in. First century A.D. Sk. '24-91; Block C; sq. 47.41'; stratum II. (Pl. 169, no. 193.)

194. Similar to no. 193, but with open socket as in no. 192. Length 4.25 in. First century A.D. Sk. '16-312; Block B'; sq. 34.75'; stratum II. Cf. Flinders Petrie, *ibid.* nos. 32-3. Cf. p. 194 *supra*. (Pl. 169, no. 194.)

195. Spud(?) with widely splayed blade, probably socketed, but socket destroyed. Length 3.5 in. Fifth century A.D.(?). Dh. '16-545; mon. court A; 3 ft. below surface. Cf. p. 278 *supra*. (Pl. 169, no. 195.)

196. Spud or possibly ploughshare, with more pointed blade and side flanges. Length 9.87 in. Fifth century A.D. From the Kunāla monastery. Sk. '26-Kun. 83; S5; 4 ft. below surface. Cf. p. 352 *supra*. (Pl. 169, no. 196.)

197. Similar to preceding, but with thinner blade. Flanged socket broken. Length 7.25 in. First century A.D. Sk. '15-633; Block C; sq. 43.59'; stratum III. (Pl. 169, no. 197.)

Spades

198. Spade, with double rings for socketing handle, and two rings for attachment of cord. Size 8.12 x 6.37 in. First century A.D. The presence of the two side rings on the face of the spade is of special interest as showing that the spade was intended to be used by two persons for shovelling purposes, just as one sees such implements commonly used in India to-day—one person holding the handle and pushing, the other holding the cord and pulling. Sk. '14-1,604; Block C'; sq. 45.74'; stratum II. (Pls. 169, no. 198; 205, j.)

199. Iron shoe for wooden spade made of two sheets of metal hammered together at the cutting edge and united above by three transverse nails. Size 4.62 x 3.37 in. Fifth century A.D. Jn. '16-F47; mon. court. Wooden spades shod with iron were used also by the Romans and Normans. Cf. Flinders Petrie, *op. cit.* p. 55 and Pl. LXVII, 20, 23. Cf. p. 385 *supra*. (Pl. 169, no. 199.)

CLASS XXXVIII. *Weeding-forks(?)* (nos. 200-2)

The three following implements were almost certainly used as weeding-forks, but similar implements have been taken for forked arrow-heads for shooting birds and small game. Cf. Flinders Petrie, *op. cit.* p. 35, and Pl. XLI, 167-9. The fork is provided with a tang which fitted into a wooden handle (or shaft) and was further secured by a nail. Two of them date from the first century A.D. The date of the third is uncertain.

200. Two-pronged weeding-fork, with pointed tang for fixing into handle. Length 5.62 in. Near the base of the tang is a nail for securing the fork to the handle. First century A.D. Sk. '15-570; Block G; sq. 97.48'; stratum I. Cf. p. 169 *supra*. (Pl. 169, no. 200.)

201. Similar and of same date. Length 5.25 in. Sk. '17-90; Block F'; sq. 92.74'; stratum II. Cf. p. 183 *supra*. (Pl. 169, no. 201.)

202. Similar. Length 5.5 in. Dh. '30-52; sq. 28.16'; 3 ft. below surface. Cf. p. 287 (10) *supra*. (Pl. 169, no. 202.)

CLASS XXXIX. *Sickles* (nos. 203-7)

The earliest sickles found at Taxila date from the first century A.D., though they must have been in use for many centuries before then. When they do appear, they

present us with two distinct types: one with a curved blade of the shape familiar in Europe; the other with a straight blade and sharply curved handle. Both of these types are to be commonly seen in the Panjab to-day.

Type *a*:

203. Sickle with curved blade. Inner edge and tang damaged. Length 6·37 in. First century A.D. Sk. '26-998; Block I; sq. 133·54'; stratum II. Cf. p. 171 *supra*. (Pl. 169, no. 203.)
204. Similar, but bent at sharp angle in middle. Inner edge serrated. End flattened out and pierced with nail-hole for attachment of handle. Length 8·62 in. Date uncertain. Dh. '30-73; sq. 29·25'; 2 ft. 2 in. below surface. Cf. p. 287 (11) *supra*. (Pl. 169, no. 204.)
205. Similar, broken at both ends. Plain inner edge. Length 6 in. Early medieval. Dh. '16-768; mon. court A; 14 ft. below surface. Cf. p. 278 *supra*.
206. Similar to no. 203, but with serrated inner edge. Length 8·37 in. Fifth century A.D. Gr. '27-B67; outer wall of monastery, north-west corner. Cf. p. 344 *supra*. (Pl. 169, no. 206.)

Type *b*:

207. Sickle, with straight blade and curved handle. Inner edge of blade serrated and nail-hole in handle for attachment of wooden grip. Length 5 in, but blade and handle broken. First century A.D. Sk. '15-216; Block I; sq. 134·55'; stratum III. Cf. p. 171 *supra*; *A.S.R.* (1915), Pl. VII, 1. (Pl. 169, no. 207.)

GROUP F. MISCELLANEOUS

CLASS XL. (Nos. 208-21)

208. Iron needle. Length 4·37 in. Date uncertain. Dh. '12-19; B4; 7 ft. below surface. Needles Cf. p. 249 *supra*. (Pl. 170, *a*.)
209. Similar. Length 4·25 in. Fifth century A.D. Gr. '27-244D; site D; 4 ft. below surface. (Pl. 170, *b*.)
210. Similar and of same date. Length 4·37 in. Gr. '27-246E; site E; 6 ft. below surface. (Pl. 170, *c*.)

The three iron plummets described below are all from Sirkap and date from the first century B.C. to the first century A.D. For a bronze plummet of the third to second century B.C. from the Bhir Mound, cf. 'Copper and Bronze', ch. 28, no. 375. Such plummets were commonly used by masons and carpenters.

211. Vase-shaped plummet, broken at top. Height 1·75 in. First century B.C. Sk. '14-1,391; Block F; sq. 84·52'; stratum IV. Cf. p. 166 *supra*. (Pl. 170, *d*.)

212. Similar, with carinated middle. Suspension ring damaged. Height 2·37 in. First century A.D. Sk. '20-221; Block A'; sq. 25·78'; stratum II. Cf. p. 195 *supra*. (Pl. 170, *g*.)

213. Similar to no. 212 and of same date. Height 3·12 in. Sk. '24-297; Block B; sq. 34·50'; stratum II. Cf. p. 148 *supra*. (Pl. 170, *f*.)

214. Jumper(?), square in section with both ends pointed. Length 23·62 in. First century A.D. Sk. '26-4,429/10; Block L; sq. 189·70'; stratum II. Cf. p. 178 *supra*. (Pl. 170, *e*.)

215. Crowbar or lever, square in section, with bent ends. Length 29·5 in. Same age and findspot as no. 214. Stratum II. Cf. p. 178 *supra*. (Pl. 170, *h*.)

216. Weaver's shuttle (?). Length 9 in. First century A.D. Sk. '24-1,584; Block K; sq. 153·64'; stratum II. Cf. p. 176 *supra*. (Pl. 170, *j*.)

Numerous ingots of iron, dating from the first century A.D. have been found in Sirkap. They are long torpedo- or shuttle-shaped pieces, hexagonal in section, and

Plummets

Jumper and crowbar

Shuttle(?)

Ingots

measuring between 4·75 and 7·12 in. in length by 1·3 to 2·5 in. in width at the middle. Their small size might suggest that the metal of which they are composed was of a superior quality, but analysis has shown that this is not so.

217. 105 ingots, six-sided torpedo-shaped, with truncated ends. Length 4·75–6·5 in. Weight from 1·5 to 4·2 lb. First century A.D. Sk. '28-1, 141; Block D'; sq. 62·104'; stratum II. Cf. p. 190 *supra*. (Pl. 170, *i*.)

218. Similar. Length 6·62 in. First century A.D. Sk. '14-1, 593; Block C'; sq. 46·74'; stratum II. Cf. p. 193 *supra*. (Pl. 170, *l*.)

219. Similar and of same age. Length 7·12 in. Sk. '24-514; Block C; sq. 49·51'; stratum III. (Pl. 170, *n*.)

220. Similar and of same age, but pointed at one end. Length 5·12 in. Sk. '20-741; Block D'; sq. 61·86'; stratum I. Cf. p. 190 *supra*. (Pl. 170, *k*.)

221. Similar but broader in middle and pointed at both ends. Length 7 in. Date uncertain. Dh. '14-984; B27; 3 ft. below surface. (Pl. 170, *m*.)

Below is a report (T9073 of 11 July 1938) on the analyses and tests of specimens of these ingots (no. 217) carried out in the Hadfield Research Dept. at Sheffield.

1. Six ingots were received, weighing individually from 1 lb. 11 $\frac{1}{2}$ oz. to 3 lb. 7 $\frac{3}{4}$ oz. The ingots were spindle-shaped, roughly hexagonal in section.

2. Analyses and tests were made on one of the ingots of medium weight, 2 lb. 15 oz., 6 in. long and 1·9 in. at its greatest width.

CHEMICAL ANALYSIS (*per cent*)

3.	C	Si	S	P	Mn	Fe
	0·10	0·03	0·019	0·077	Trace	99·6

GENERAL CHARACTER

4. A complete longitudinal section showed the ingot to be very porous, some of the holes being $\frac{1}{2}$ in. in maximum dimension.

MECHANICAL TESTS

Hardness

5. The standard diamond pyramid hardness figures over the section varied between 76 and 129, with an average of 95.

6. The hardness figures are mostly only approximate because of the irregular shape of the impressions. Several other determinations were discarded for this reason.

Tensile test

7. A small bar, $\frac{1}{2}$ in. in diameter, was forged from the soundest portion of the ingot, and a tensile test made on the bar without further heat treatment, with results as follows:

Yield point Tons per sq. in.	Maximum stress 22·8	Elongation* 15·5	Reduction of area per cent 43·0
16·1			

* Length $\div \sqrt{\text{area}} = 4$.

8. The specimen was roaky.

Shock tests

9. From the $\frac{1}{2}$ in. bar notched specimens were also prepared and tested with results as follows:

Type of specimen	Energy to fracture	Angle of bend	Brinell hardness	Nature of fracture
B.S.S. 10 mm. sq.	67 ft.-lb.	60° unbroken	{ 156 131	Fibrous; several elongated blow-holes
Fremont	18.4 kg.-m.	128° unbroken	126	Roaky

GENERAL REMARKS

10. In their chemical analysis these ingots are fairly representative of the many Indian iron specimens, obtained from various locations, which we have examined.

11. Phosphorus contents as low as 0.015% were found in chippings from the iron beams at Konārak, and as high as 0.28% in the fragment from the iron pillar or beam at Dhar.

12. Sulphur analysed as low as 0.002% in tools found in Dekhan, but as high as 0.024% in the Konārak beams, with a general average of 0.009%.

13. The sulphur, 0.019%, in the present ingots, therefore, is rather above the average.

14. It may be recalled, however, that the iron implements from Taxila examined on a previous occasion contained from 0.024 to 0.064% of phosphorus, and only 0.004–0.005% of sulphur.

15. Apparently, therefore, the ingot now examined is individually, as regards its sulphur content, rather higher than the general average of the iron produced at Taxila.

16. Our examination does not indicate any special qualities in this iron above that produced in other parts of India, recognising, however, that, judged by ordinary standards, Indian iron is in general of excellent purity.